

**West Sacramento GRR EIS/EIR  
Appendix A**

**Final Fish and Wildlife Coordination Act Report**

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# United States Department of the Interior



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FISH AND WILDLIFE SERVICE  
Sacramento Fish and Wildlife Office  
2800 Cottage Way, Suite W-2605  
Sacramento, California 95825-1846

**MAY 19 2015**

Alicia E. Kirchner  
Chief, Planning Division  
Corps of Engineers, Sacramento District  
1325 J Street  
Sacramento, California 95814-2922

Dear Ms. Kirchner:

The U.S. Army Corps of Engineers has requested coordination under the Fish and Wildlife Coordination Act (FWCA) for the West Sacramento Flood Control Project, General Reevaluation Report. The proposed modifications would be along levees surrounding the City of West Sacramento, Yolo County, California. The enclosed report constitutes the U.S. Fish and Wildlife Service's FWCA report for the proposed project.

If you have any questions regarding this report, please contact Harry Kahler at (916) 414-6550.

Sincerely,

Jennifer M. Norris  
Field Supervisor

Enclosure

cc:  
Bay-Delta FWO, Sacramento, CA  
Sarah Ross Arrouzet, COE, Sacramento, CA  
Howard Brown, NMFS, Sacramento, CA  
Region 3 Manager, CDFW, Napa, CA

**FISH AND WILDLIFE COORDINATION ACT REPORT  
WEST SACRAMENTO FLOOD CONTROL PROJECT  
GENERAL REEVALUATION REPORT**

**May 7, 2015**

This is the U.S. Fish and Wildlife Service's (Service) Fish and Wildlife Coordination Act report on the effects of the proposed West Sacramento Flood Control Project (WSFCP), General Reevaluation Report (West Sacramento GRR or GRR project), City of West Sacramento, Yolo County, California. This report has been prepared under the authority of, and in accordance with, the provisions of the Fish and Wildlife Coordination Act (48 stat. 401, as amended: 16 U.S.C. 661 et seq.).

**BACKGROUND**

A series of storms with unusually high levels of precipitation, between December 26, 1996, and January 3, 1997, caused several major flooding events throughout the Sacramento Valley. These events prompted comprehensive studies, which impelled the U.S. Army Corps of Engineers (Corps) to revise levee criteria regarding under-seepage and through-seepage deficiencies. In turn, levees of the WSFCP were evaluated according to the Corps criteria for stability, seepage, erosion, geometry, and levee height. Data collected from the evaluation show that much of the existing system does not provide the City of West Sacramento protection from a 100-year flood event.

In 2006, the Federal Emergency Management Agency initiated the Flood Insurance Rate Map modernization program. Under the program, for properties in a 100-year floodplain, flood insurance would be mandatory with all federally guaranteed loans. Furthermore, California Senate Bill 5, signed into law in October, 2007, by Governor Arnold Schwarzenegger and overseen by the Central Valley Flood Protection Board, requires that urban areas such as the City of West Sacramento achieve 200-year flood level protection by 2025.

The purpose of the West Sacramento GRR is to bring the 50-miles of perimeter levees surrounding the City of West Sacramento into compliance with applicable Federal and State standards for levees protecting urban areas. In four areas with marked levee deficiencies, West Sacramento Area Flood Control Agency (WSAFCA) has sponsored West Sacramento Levee Improvement Program (WSLIP) Early Implementation Projects (EIPs) to make levee improvements in advance of the GRR project. To date, three EIPs have been completed: the I Street Bridge, The Rivers, and California Highway Patrol (CHP) Academy Projects; a fourth EIP, the Southport Project, is currently in final design.

Further, in view of recent community growth, the City of West Sacramento has recreation and open space needs and goals. Surrounding waterways represent not just an element of flood risk, but also provide public open space and opportunities for water-based recreation. Flood protection improvement elements typically underlie or are adjacent to proposed recreation elements that are part of the City of West Sacramento planning documents. Levee crowns, for example, are commonly used as public trails for pedestrians and bicyclists. Therefore, along with flood protection, the Corps has identified open space and recreational goals as part of the GRR project.

Lastly, the levees of WSFCP are part of the Sacramento River Flood Control Project (SRFCP). Concerns exist that the performance of the SRFCP needs to be evaluated comprehensively to ensure

that risk is not being transferred between discrete projects of separate communities. Because West Sacramento is located downstream of many other SRFCP projects, The West Sacramento GRR allows the opportunity to make a comprehensive evaluation of the SRFCP. In combination, the WSLIP EIPs and actions under the GRR project will address levee deficiencies to meet necessary flood protection standards, provide recreational opportunities for the City of West Sacramento, and provide an opportunity to evaluate comprehensively the effectiveness of SRFCP activities.

## **PROJECT DESCRIPTION**

Regardless of alternative, the following measures and policies would be addressed during construction:

- The Corps' standard levee footprint would be established during construction of structural improvements on all levees that are out of compliance. The standard levee footprint consists of a 20-foot-wide crown width, 3:1 waterside and landside slope. If the 3:1 landside slope is not possible based on site specific conditions, then a minimum 2:1 landside slope would be established with supporting engineering analysis.
- A 20-foot-wide landside and waterside maintenance access roads would be established. Where 20 feet cannot be obtained, 10 feet is allowable.
- Compliance with the Corps' Engineering Technical Letter 1110-2-571 vegetation requirements would be enforced. The vegetation requirements include a vegetation-free zone on the levee slopes and crown, 15 feet from both landside and waterside levee toes, and 8 feet vertically. When possible, a variance would be sought to allow vegetation to remain. A variance would allow for vegetation to remain on the lower portion of the waterside slope and within the waterside 15-foot vegetation-free zone.
- Utilities encroachments including structures, certain vegetation, power poles, pump stations, and levee penetrations (e.g., pipes, conduits, cables) would be brought into compliance with applicable Corps policies or removed. This measure would include demolition and relocation or reconstruction as appropriate; or retrofitting to comply with current standards. Utilities replacement would occur via a surface line over the levee prism, or a through-levee line equipped with positive closure devices.
- Private encroachments shall be removed by the non-federal sponsor or property owner prior to construction.

### **Levee Design Remediation**

Where the existing levee cross section does not meet Corps standard levee design requirements, slope flattening and/or crown widening would be required. These improvement measures address problems with slope stability, geometry, and levee toe and crest access for maintenance. Due to the urban nature of the project area, the proximity of development to the levees, and cost, most levee repairs would be fixed in place.

Prior to embankment grading, the area would be cleared, grubbed, and stripped. Where necessary, portions of the existing embankment would be excavated to allow for bench cuts and keyways to tie in additional embankment fill. The existing levee centerline would be shifted landward to meet the Corps' standard levee footprint requirements. Excavated and borrow material would be stockpiled at staging areas. Haul trucks, front end loaders, and scrapers would bring borrow materials from nearby areas to the site, then spread it evenly and compact it according to levee design plans. The levee would be hydroseeded once construction is completed.

### **Seepage and Slope Stability Remediation**

Levees in the project area also require improvements to address seepage, slope stability, overtopping, and erosion. The measures proposed to improve the levees are described below and consist of: seepage cutoff walls, seepage berms, stability berms, slope reshaping, levee raises, flood walls, and bank protection.

#### **Seepage Cutoff Walls**

To address seepage concerns, a cutoff wall would be constructed through the levee crown. The cutoff wall would be installed by one of two methods: conventional open trench cutoff walls; or deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach depends on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of about 85 feet. For cutoff walls of greater depth, the DSM method used.

Prior to construction of any cutoff wall, the construction site and any staging areas would be cleared, grubbed, and stripped. The levee crown would be degraded to about half the levee height to create a 30-foot-wide working platform and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids. Excavated and borrow material would be stockpiled at staging areas. Haul trucks, front end loaders, and scrapers would bring borrow materials to the site, which would then be spread evenly and compacted according to levee design plans. The levee hydroseeded once construction is completed.

#### **Conventional Open Trench Cutoff Wall**

A trench about 3 feet wide would be excavated through the centerline of the levee crown up to 85 feet deep. As the trench is excavated with a long-boom excavator, it would be filled with a low density temporary bentonite water slurry to prevent cave in. The soil from the excavated trench would be mixed nearby with hydrated bentonite, and in some applications, cement. The soil bentonite mixture would be backfilled into the trench, displacing the temporary slurry. Once the slurry has hardened, it is capped and the levee embankment is reconstructed with impervious or semi-impervious soil.

#### **Deep Soil Mixing Cutoff Wall**

The DSM method involves a crane supported set of two to four mixing augers used to drill through the levee crown and subsurface to a maximum depth of about 140 feet. As the augers are inserted and withdrawn, a cement bentonite grout would be injected through the augers and mixed with the native soils. An overlapping series of mixed columns would be drilled to create a continuous seepage cutoff barrier. Once the slurry has hardened it is capped and the levee embankment is reconstructed with impervious or semi-impervious soil.

### **Seepage Berm**

In some areas, geotechnical investigations have determined that a seepage berm is more appropriate to address seepage than a cutoff wall. The seepage berm would extend out from the landside levee toe and would vary in width from 60 to 300 feet, tapering down from a 5-foot thickness at the levee, to a 3-foot thickness at the berm toe. The length of the seepage berm depends on the seepage conditions along the levee reach.

Excavated and borrow material would be stockpiled at staging areas. Haul trucks and front end loaders bring borrow materials from staging areas to the site, which would then be spread evenly and compacted according to design plans. The new seepage berm would be hydroseeded after construction.

### **Stability Berm**

A stability berm would be constructed against the landside slope of the existing levee with the purpose of supplying support as a buttress. The height of the stability berm is generally 2/3 of the height of the levee and extends for a distance determined by the structural needs of the levee along that reach. Embankment fill material necessary to construct the berm is excavated by a bulldozer from a nearby borrow site. Front-end loaders load haul trucks with the borrow material and the haul trucks transport the material to the stability berm site. Motor graders spread the material evenly according to design specifications, and a sheepsfoot roller compacts the material. Water trucks distribute water over the material to ensure proper moisture for compaction. The new seepage berm would be hydroseeded after construction.

### **Setback Levee**

Setback levees are proposed for the Sacramento River south levee to address seepage, stability, and erosion concerns. The typical offset distance of the setback levee from the existing levee is about 400 feet. Most of the existing levee would be degraded to an elevation of 30 feet. In the northern section, the existing levee would be breached in two areas for a length of 800 to 1,000 feet. In the southern section, the existing levee would be breached in three areas for a length of about 800 feet.

### **Sheet Pile Wall**

A trench would be excavated along the sheet pile alignment to allow the pile to be driven to the proposed level below the existing levee grade. A driving template fabricated from structural steel would be placed to control the alignment as the sheet pile is installed. A hydraulic or pneumatically operated pile driving head attached to a crane would drive the sheet pile into the levee crown to the desired depth (up to 135 feet). An additional crane or excavator would be used to facilitate staging of the materials. The conditions of the site, driving pressure, hydrostatic loads, and corrosion considerations determines the thickness, configuration, and finish coating of the sheet piles.

### **Jet Grouting**

Jet grouting involves injecting a grout mixture into the soil at very high pressure. Jet grouting breaks up soil and, with the aid of a binder, forms a homogenous mass that solidifies over time to create a mass with low permeability. Jet-grouted columns range from 1 to 16 feet in diameter and typically are interconnected to form cutoff barriers or structural sections. It is typically used as a spot application to address seepage rather than a treatment to be applied on a large scale.

Equipment required for jet grouting consists of a drill rig fitted with a special drill string; a high pressure, high flow pump; and an attached batching plant to supply the grout and water. The spoil

material contains significant grout content and frequently is used as construction fill material. To provide a wide enough working platform on the levee crown, the upper portion of some segments of the levee may require degradation with a paddle wheel scraper. Material is scraped and stockpiled at a nearby stockpile area. Hauling at the work area involves scraper runs along the levee to the staging area and grout, bentonite, and water deliveries to the batch plant.

### **Relief Wells**

Relief wells are passive systems that are constructed near the landside levee toe to provide a low-resistance pathway for under-seepage. The wells bring seepage water to the ground surface in a controlled and observable manner. Relief wells are an option only in segments where geotechnical analyses have identified continuous sand and gravel layers and the presence of an adequate impermeable layer.

Relief wells are generally spaced at 50- to 150-foot intervals, dependent on the amount of under-seepage, and extend to depths of up to 150 feet. A typical well-drilling rig is used to drill to the required depth and construct the well beneath the ground surface. The drill rig likely would be an all-terrain, track-mounted rig that could access the well locations from the levee toe. A relief well is constructed using soil-boring equipment to drill a vertical hole. Pipe casings and gravel/sand filters are installed to allow water to flow freely while preventing levee materials from entering the stream. The water is collected and discharged into a drainage system via ditches or an underground piping system.

Areas along the levee toe may be used to store equipment and supplies during construction of each well. Construction of each well and the lateral drainage system typically takes 10 to 20 days.

### **Overtopping Remediation**

#### **Levee Raises**

To address identified height deficiencies, additional borrow material would be added after cutoff walls and levee reshaping improvements are completed. The additional material would be brought from nearby borrow sites, stockpiled in staging areas then hauled to the site with trucks and front end loaders. Material would be spread evenly and compacted according to levee design plans. The levee would be hydroseeded once construction was completed.

#### **Floodwalls**

Floodwalls would be used to contain unusually high water surface elevations. Prior to construction, the area would be cleared, grubbed, stripped, and excavated to provide space for constructing the floodwall footing. The floodwall would primarily be constructed from pre-fabricated materials, although it may be cast or constructed in place, and would be constructed almost completely upright. Floodwalls are placed at the waterside hinge point of the levee crown and would be designed to disturb a minimal amount of waterside slope and levee crown. Floodwall heights vary from 1 to 4 feet, as required by water surface elevations. The waterside slope grade would be re-established and a slight downward grade away from the floodwall would be added to the levee crown.

## **Erosion Remediation**

### **Rock Bank Protection**

Bank protection measures consist of waterside armoring of the levees to prevent erosion and subsequent damage to the levee. This measure consists of placing rock revetment on river banks, and in some locations on levee slopes, to prevent erosion. If necessary, the eroded portion of the bank would be filled and compacted prior to rock placement. Pre-construction preparation involves clearing and stripping. In most cases large vegetation would be permitted to remain at these sites. Temporary access ramps would be constructed, if needed, using imported borrow material. The bank protection would be placed at a slope varying from 2:1 to 3:1 depending on site specific conditions.

Revetment would be imported from an offsite location via haul trucks or barges. Revetment transported by haul trucks would be temporarily stored at a staging area adjacent to the construction site. A loader would be used to move revetment from the staging area, and an excavator would place the material onsite. Rock placement from atop the levee would require one excavator and one loader for each potential placement site.

Revetment transported by barges would not be staged, but placed directly on site by an excavator located on the barge. The excavator would construct a large rock berm in the water up to an elevation just above the mean summer water surface. A planting trench would be established on this rock surface for revegetation. Construction would require two barges: one barge would carry the excavator, while the other barge would hold the stockpile of rock to be placed on the channel slopes.

### **Biotechnical Bank Protection**

Biotechnical measures have been proposed to protect several levee reaches. Biotechnical protection would be considered for lower velocity reaches to preserve existing vegetation. Under this measure, the Corps would use plant material and minimal amounts of rock to stabilize the eroded slope and prevent further loss of material.

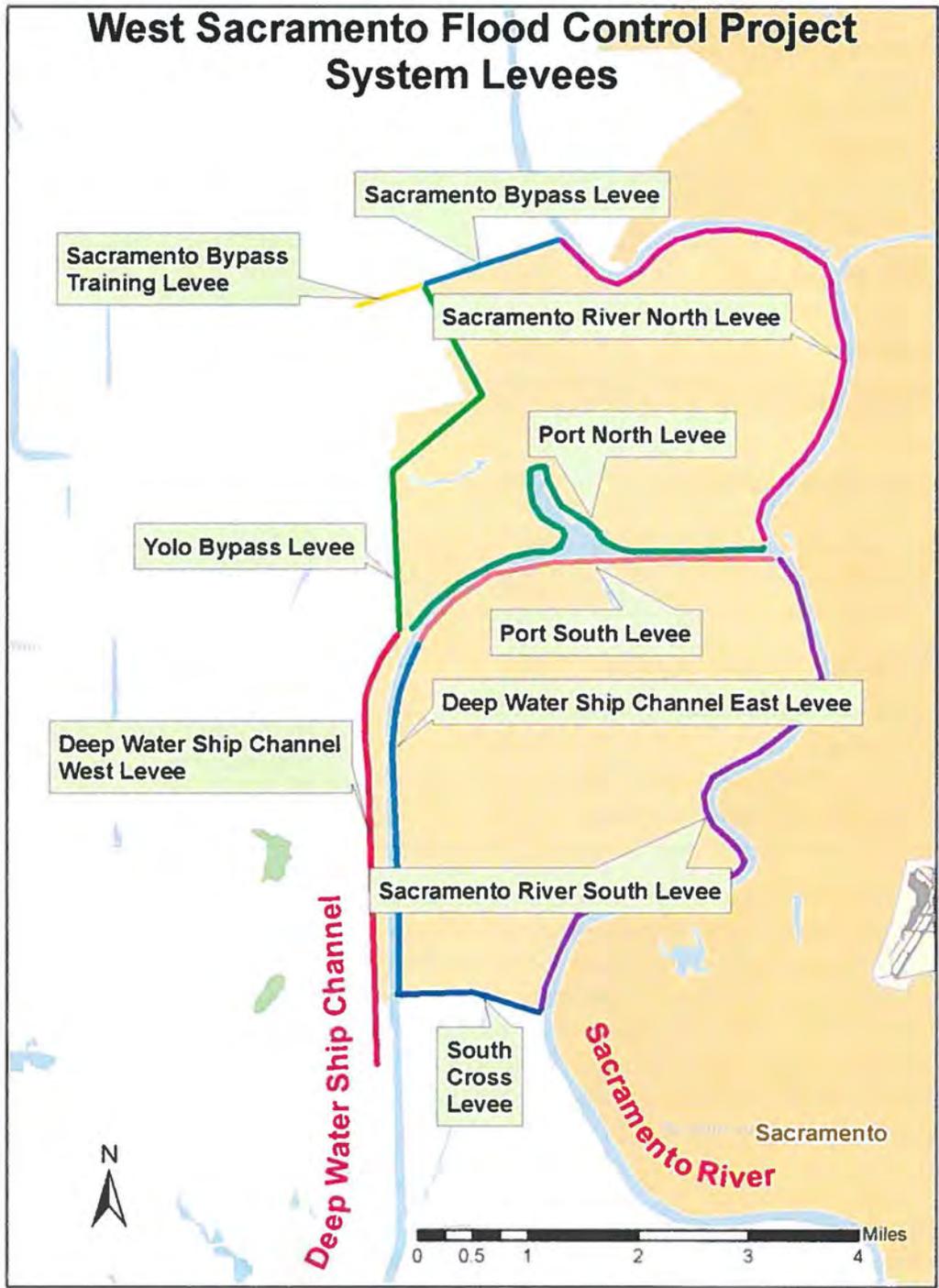
## **Project Alternatives**

The WFSCP involves over 50 miles of levees surrounding the City of West Sacramento (Figure 1). The Port of West Sacramento and the barge canal that flows from the Sacramento River into the Deep Water Ship Channel (DWSC), divides the City of West Sacramento into two sections – the north and south basin. The south basin contains about 6,900 acres, while the north basin contains about 6,100 acres. Levees of the WFSCP encircle each basin (Table 1).

### **No Action Alternative**

A No Action Alternative is required pursuant to NEPA, and a no project alternative is required for CEQA. For this report, it will be referred to as the No Action Alternative. The No Action Alternative serves as a benchmark against which the effects and benefits of the action alternatives are evaluated. The No Action Alternative assumes that current conditions and operation and maintenance practices would continue in the foreseeable future if the project were not implemented, based on current plans and consistent with available infrastructure and community services.

Figure 1. West Sacramento Flood Control Project Features, Yolo County, California, 2015.



**Table 1. West Sacramento Flood Control Report Project levees surrounding the north and south basins of West Sacramento, Yolo County, California.**

Levee Reach Name	Length (miles)	Reach
<b>North Basin Levees</b>		
Sacramento River north levee	5.5	Along the Sacramento River south from the Sacramento Bypass to the William Stone Lock building at the barge canal
Port north levee	4.9	William Stone Lock building west to the Yolo Bypass
Yolo Bypass levee	3.7	Port north levee north to the Sacramento Bypass
Sacramento Bypass levee	1.1	Yolo Bypass levee east to the Sacramento River
Training levee	0.5	West spur beyond the Yolo Bypass levee along the Sacramento Bypass
<b>South Basin Levees</b>		
Sacramento River south levee	5.9	Along the Sacramento River from the William Stone Lock structure at the barge canal south to the South Cross levee
South Cross levee	1.2	Sacramento River west to the Deep Water Ship Channel
Deep Water Ship Channel east levee	2.8	South Cross levee north to the eastward bend southwest of the Port of Sacramento
Port south levee	4.0	East from the eastward bend to the William Stone Lock structure
Deep Water Ship Channel west levee	21.4	Port north levee south to Miner's Slough

Under the No Action Alternative, the Corps would not conduct any additional work to address seepage, slope stability, overtopping, geometry, or erosion concerns in the West Sacramento area. As a result, if a high-water event were to occur, the West Sacramento area would remain at risk of a possible levee failure. The levees protecting the city would continue to require improvements to meet FEMA's minimum acceptable level of flood protection. In addition, the associated risk to human health and safety, property, and the adverse economic impact that serious flooding could cause would continue, and the risk of a catastrophic flood would remain high. Regular operations and maintenance of the levee system would continue as presently executed by the local maintaining entities.

**Alternative 1 – Fix Levees**

Alternative 1 would include the construction of levee remediation measures to address: seepage, slope stability, erosion, geometry, vegetation, and overtopping concerns identified for the Sacramento River, South Cross, DWSC, Port, Yolo Bypass, and Sacramento Bypass Training levees (Appendix A, pg. A1).

Due to environmental, real estate, and hydraulic constraints within the West Sacramento North Basin, Alternative 1 proposes fix-in-place remediation. For the South Basin, fix-in-place remediation and seepage berms are proposed. A berm is proposed for the South Basin where a cutoff wall does not completely remove the through- and underseepage threat. The purpose of this alternative would be to improve the flood damage reduction system to safely convey flows to a level that maximizes net benefits. Table 2 summarizes the levee remediation measure for each reach in each basin.

**Table 2. Alternative 1 – Proposed Remediation Measures by Levee Reach.**

Levee Reach	Seepage Measures	Stability Measures	Overtopping Measures	Erosion Protection Measures
Sacramento River north	Cutoff Wall	Cutoff Wall	Levee Raise	Bank Protection
Port north*	---	---	Flood Wall	---
Yolo Bypass *	Cutoff Wall	Cutoff Wall	---	---
Sacramento Bypass Training levee	---	---	---	Bank Protection
Sacramento River south	Cutoff Wall, Seepage Berm	Cutoff Wall, Stability Berm	---	Bank Protection
South Cross	Cutoff Wall, Seepage Berm	---	Levee Raise	---
Deep Water Ship Channel east *	Cutoff Wall	Cutoff Wall	Levee Raise	---
Deep Water Ship Channel west*	Cutoff Wall, Seepage Berm	Cutoff Wall	Levee Raise	Bank Protection
Port south*	Cutoff Wall	Cutoff Wall	Levee Raise	---

\* Only site-specific sections of the levee reach require remediation.

The following sections describe the specific measures proposed under this alternative for the reaches within the West Sacramento North and South Basins.

West Sacramento North Basin

Sacramento River North Levee-

The Sacramento River north levee does not meet design requirements due to several deficiencies. The measures that would be implemented under Alternative 1 for this levee include: installation of cutoff walls to address seepage and stability concerns; levee raises to address inadequate levee height; and bank protection measures to address erosion concerns. Levee embankment grading, height improvements, and bank protection would be constructed to current Corps standards.

Construction of Alternative 1 would take about 12 years. Construction is expected to take 2 years at each levee reach, yet work may be done concurrently on multiple reaches in any given year. Work along the Sacramento River north and Sacramento River south levee reaches are scheduled first for construction. The construction sequence has been prioritized based on current levee conditions, risk assessments, and construction feasibility considerations.

The Sacramento River north levee has a 20-foot-wide levee crown with 3:1 side slopes. A cutoff wall would be constructed through the levee crown. The conventional open trench method would be used to install a cutoff wall to a depth of about 85 feet and the DSM method would be used to install cutoff walls at depths of more than 85 feet.

Additionally, under Alternative 1 a levee would be constructed at the south end of the Sacramento River north levee reach to close the connection between the Sacramento River and the DWSC. The new levee would connect the existing levees along the Sacramento River between the North Basin and South Basin. Along with the proposed new levee reach, a coffer dam would be constructed on the river side between the north and south basins. The new levee would include a cutoff wall or seepage berm. Construction of the new levee may also include installation of a sheet pile wall.

#### Port North Levee-

The primary issue with the Port north levee is overtopping concerns. Under Alternative 1, a floodwall is proposed to address overtopping. The height of the floodwall varies from 1 to 4 feet.

#### Yolo Bypass Levee-

Seepage and stability deficiencies were identified at various locations along the Yolo Bypass levee. To address these deficiencies open trench cutoff walls would be installed. Following construction of the cutoff wall, the levee would be rebuilt to current Corps standards.

#### Sacramento Bypass Levee-

Work completed by the local sponsors has addressed seepage and stability concerns along the Sacramento Bypass levee adjacent to the CHP Academy. This work is not eligible for Federal credit and is included within the No Action Alternative.

#### Sacramento Bypass Training Levee-

Unlike the Sacramento Bypass levee adjacent to the CHP Academy, the training levee that extends westward into the Yolo Bypass has not been repaired and still has erosion deficiencies. Under Alternative 1, bank protection is proposed to address the erosion concerns.

#### West Sacramento South Basin

In the South Basin, measures that would be implemented include: installation of cutoff walls or seepage berms to address seepage and stability concerns; stability berms to address stability concerns; levee raises to address height concerns; and bank protection to address erosion concerns.

#### Sacramento River Levee-

The Sacramento River south levee measures that would be implemented include: installation of cutoff walls and seepage berms to address seepage and stability concerns; stability berms to address stability concerns; and bank protection to address erosion concerns.

As with the Sacramento River north levee, a cutoff wall would be constructed through the levee crown to address seepage concerns. Seepage berms would be constructed in areas where geotechnical investigations show that a berm would be more appropriate.

#### South Cross Levee-

The measures that would be implemented for the South Cross levee include the installation of cutoff walls or seepage berms to address seepage concerns, and levee raises to address height issues.

#### Deep Water Ship Channel East Levee-

Remediation measures that would be implemented for the DWSC east levee include cutoff walls to address seepage and stability concerns and raise levees to address height concerns. A conventional open trench cutoff wall would address the seepage and stability problems. The irrigation ditch at the levee toe would be relocated outside the levee footprint south of the area of adjacent housing along Southport Parkway. The irrigation ditch would be replaced with two 48 inch diameter pipes along the levee reach adjacent to the housing development.

#### Deep Water Ship Channel West Levee-

The DWSC west levee measures to be implemented under Alternative 1 would include: installation of cutoff walls and seepage berms to address seepage concerns; a levee raise to address height concerns; and bank protection to address erosion concerns. A conventional open trench cutoff wall would be constructed to address the seepage and stability concerns at various locations from the South Cross levee south to Prospect Island. In addition, to address erosion concerns, bank protection would be placed along the Yolo Bypass side of the levee at identified locations.

#### Port South Levee-

Measures that would be implemented for the Port south levee include installing cutoff walls to address seepage and stability concerns, and raising the levee to address inadequate levee height.

### **Alternative 2 – Fix Levees and Widen Sacramento Weir and Bypass**

Alternative 2 levee improvements are essentially the same as those discussed as Alternative 1, except that the Sacramento Weir and Bypass would be widened to divert more flow into the Yolo Bypass. Subsequently, widening the Sacramento Weir and Bypass decreases the need for many levee raises proposed along the Sacramento River (Appendix A, pg. A2). Alternative 2 levee remediation measures are summarized in Table 3. As with Alternative 1, the construction for all levee reaches is expected to take 12 years.

#### West Sacramento North Basin

The primary issues identified in the North Basin are erosion, seepage and stability, and minimal levee height concerns. The measures that are implemented under Alternative 2 for the levees in the North Basin would be slope protection, installation of cutoff walls, levee raises, and widening the Sacramento Weir and Bypass to reduce height concerns and provide resiliency. Except for the alterations to the Sacramento Weir and Bypass in the Sacramento River North levee reach, levee remediation measures under Alternative 2 are the same in the North Basin as those proposed under Alternative 1.

#### Sacramento River North-

The main purpose of the Sacramento Weir is to protect the City of Sacramento from excessive flood stages in the Sacramento River channel downstream of the American River. Because the design flood capacity of the American River is 5,000 cubic feet per second higher than that of the Sacramento River downstream of the confluence, flows during a major flood event often exceed the capacity of the Sacramento River. The Sacramento Weir is designed to accept excessive flows during such flood events.

**Table 3. Alternative 2 – Proposed Remediation Measures by Levee Reach.**

Levee Reach	Seepage Measures	Stability Measures	Overtopping Measures	Erosion Protection Measures
<b>North Basin</b>				
Sacramento River north	Cutoff Wall	Cutoff Wall	Sacramento Weir/Bypass Widening, Levee Raise	Bank Protection
Port north*	---	---	Flood Wall	---
Yolo Bypass*	Cutoff Wall	Cutoff Wall	---	---
Sacramento Bypass Training levee	---	---	---	Bank Protection
<b>South Basin</b>				
Sacramento River south	Cutoff Wall, Seepage Berm	Cutoff Wall, Stability Berm	---	Bank Protection
South Cross	Cutoff Wall, Seepage Berm	---	Levee Raise	---
Deep Water Ship Channel east*	Cutoff Wall	Cutoff Wall	Levee Raise	---
Deep Water Ship Channel west*	Cutoff Wall, Seepage Berm	Cutoff Wall	Levee Raise	Bank Protection
Port south*	Cutoff Wall	Cutoff Wall	Levee Raise	---

\* Only site-specific sections of the levee reach require remediation.

Under Alternative 2, the Sacramento Weir and Bypass would be expanded to roughly twice their current width to accommodate increased bypass flows. The existing north levee of the Sacramento Bypass would be degraded and a new north levee would be constructed about 1,500 feet to the north. The Sacramento Weir would be lengthened across the bypass width accordingly. The new north levee slopes would be flattened to 3:1 and includes a new road on the landside, a 300-foot-wide seepage berm, and a system of relief wells. Agricultural ditches/canals on the landside of the existing levee would be filled and relocated along with the pump station(s) to maintain the existing operation.

Widening the Sacramento Bypass as proposed reduces the need for height improvements along the Sacramento North levee reach. Measures proposed under Alternative 1 that would be implemented under Alternative 2 include the installation of cutoff walls, and bank protection measures.

West Sacramento South Basin

The primary issues in the South Basin are also erosion, seepage and stability, and inadequate levee height. The measures that would be implemented under Alternative 2 are the same as for Alternative 1, except for along the Sacramento River south levee.

Sacramento River South-

As with the Sacramento River north levee, there is a reduced need to address the levee height issues along the South Basin due to the widening of the Sacramento Weir and Bypass. The widening of the Sacramento Bypass reduces the extent of height improvements necessary, but does not eliminate them. Measures that would be implemented under Alternative 2 for the Sacramento River south levee include: installation of cutoff walls, seepage berms, and stability berms; levee raises; and bank protection measures.

**Alternative 3 – Fix Levees and Deep Water Ship Channel Closure Structure**

Alternative 3 would include all of the levee improvements discussed in Alternative 1, except that a DWSC closure structure would preclude repairs on the Port north, Port south, and portions of the DWSC east and west levees (Appendix A, pg. A3). As with Alternative 1, the Sacramento River, Yolo Bypass, and South Cross levees would be improved to address seepage, stability, erosion, and height concerns. The levee remediation measures proposed under Alternative 3 are summarized in Table 4.

**Table 4. Alternative 3 – Proposed Remediation Measures by Levee Reach.**

Levee Reach	Seepage Measures	Stability Measures	Overtopping Measures	Erosion Protection Measures
<b>North Basin</b>				
Sacramento River north	Cutoff Wall	Cutoff Wall	Levee Raise	Bank Protection
Port north*	Closure Structure	Closure Structure	Closure Structure	Closure Structure
Yolo Bypass *	Cutoff Wall	Cutoff Wall	—	—
Sacramento Bypass Training levee	—	—	—	Bank Protection
<b>South Basin</b>				
Sacramento River south	Cutoff Wall	Cutoff Wall, Stability Berm	—	Bank Protection
South Cross	Cutoff Wall, Seepage Berm	—	Levee Raise	—
Deep Water Ship Channel east *	Cutoff Wall	Cutoff Wall	Levee Raise	—
Deep Water Ship Channel west*	Cutoff Wall, Closure Structure	Cutoff Wall, Closure Structure	Levee Raise, Closure Structure	Bank Protection
Port south*	Closure Structure	Closure Structure	Closure Structure	Closure Structure

\* Only site-specific sections of the levee reach require remediation.

Regardless of the measure implemented for the alternative, the levee would be brought into compliance with Corps levee design criteria. To provide for levee construction, inspection, maintenance, monitoring, and flood-fighting access, some properties may need to be acquired.

#### West Sacramento North Basin

Measures that would be implemented for the levees in the North Basin are: installation of cutoff walls to address seepage and stability concerns; levee raises to address height concerns; constructing the DWSC closure structure to address seepage, stability, height, and erosion concerns; and erosion protection to address erosion concerns.

Levees along the Yolo Bypass, Sacramento Bypass, and Sacramento River north reaches would be remediated as described under Alternative 1.

#### Port North Levee-

The primary issue in the Port north area is overtopping concerns, putting in the DWSC closure structure would eliminate the need to construct floodwalls.

#### West Sacramento South Basin

Measures that would be implemented for the levees in the South Basin are: installation of cutoff walls or seepage berms to address seepage and stability concerns; levee raises to address height concerns; erosion protection to address erosion concerns; and construction of the DWSC closure structure to address seepage, stability, height, and erosion concerns.

Levees along the Sacramento River south and South Cross levee reaches would be remediated as described under Alternative 1.

#### Deep Water Ship Channel Closure Structure-

Under Alternative 3, a flood barrier structure would be constructed within the Sacramento DWSC to prevent flood flows from proceeding north in the ship channel. The closure structure would be constructed in three stages using a separate steel sheet pile cofferdam at each stage.

The first stage would require the construction of a cofferdam on the east side of the DWSC that would allow ship traffic to continue to the Port during first stage construction. The first stage cofferdam would be removed upon completion of the first stage structure. The second stage of construction would be similar to the first stage construction, but at the western edge of the DWSC. The second stage cofferdam would be removed upon completion of the second stage structure. The third stage of construction would be to install a cofferdam between the first and second stage structures. Sector gates would be installed during the third stage so that, when closed, the Port and surrounding areas can be protected during flood events. The gates would remain open for normal Port traffic upon completion of the third stage.

#### Deep Water Ship Channel East Levee-

Generally, the Alternative 3 remediation measures for the DWSC east levee are consistent with Alternative 1. However, under Alternative 3 these levee improvements only occur from the closure structure south to the South Cross levee. The closure structure prevents water from flowing north into the Port of West Sacramento, thus eliminating the need to improve the levee north of the structure.

#### Deep Water Ship Channel West Levee-

As with the DWSC east levee, Alternative 3 measures for the DWSC west levee are consistent with Alternative 1, with a few exceptions. Under Alternative 3, there is no need for remedial construction along the west levee north of the closure structure.

#### Port South Levee-

The primary issues in the Port south area are overtopping, seepage, and stability. These issues are addressed with the implementation of the closure structure.

#### **Alternative 4 – Fix in Place, Sacramento Bypass Widening, and DWSC Closure Structure**

Alternative 4 includes the levee improvements discussed in Alternative 1, but with the Sacramento Bypass widening discussed in Alternative 2 and the DWSC closure structure discussed in Alternative 3 (Appendix A, pg. A4). The widening of the Sacramento Weir and Bypass diverts more flow into the Yolo Bypass, decreasing the need to raise levees along the Sacramento River. Levee repairs on the Port north and Port south levees and northern portions of the DWSC east and west levees are precluded by the construction of the closure structure in the DWSC. The levee remediation measures proposed under Alternative 4 are summarized in Table 5.

Once a levee is modified, regardless of the measure implemented for the alternative, the levee would be brought into compliance with Corps levee design criteria. To provide for levee construction, inspection, maintenance, monitoring, and flood-fighting access, some properties may need to be acquired.

#### West Sacramento North Basin

Measures that would be implemented for the levees in the North Basin are: installation of cutoff walls to address seepage and stability concerns; levee raises to address height concerns; widening the Sacramento Weir and Bypass to address height concerns and provide resiliency; constructing the DWSC closure structure to address seepage, stability, height, and erosion concerns; and erosion protection to address erosion concerns.

#### Sacramento River North Levee-

Along the Sacramento River, the measures for the Sacramento Weir and Bypass are consistent with Alternative 2. Under Alternative 2 the Sacramento Weir and Bypass would be widened up to 1,500 feet to accommodate greater flows from the American River during flood events. Other areas of the Sacramento north levee reach are remediated as described in Alternative 1.

#### Port North Levee-

The primary issue in the Port north area is overtopping. Construction of the DWSC closure structure eliminates the need to construct floodwalls in this reach. The closure structure would be constructed as described in Alternative 3.

#### Yolo Bypass Levee-

The measures for the Yolo Bypass levee are consistent with Alternative 1. Measures that would be implemented involve the installation of a cutoff wall to address seepage and stability concerns.

#### Sacramento Bypass Training Levee-

The measures for the Training levee would be consistent with Alternative 1 (bank protection).

**Table 5. Alternative 4 – Proposed Remediation Measures by Levee Reach.**

Levee Reach	Seepage Measures	Stability Measures	Overtopping Measures	Erosion Protection Measures
<b>North Basin</b>				
Sacramento River north	Cutoff Wall	Cutoff Wall	Sacramento Weir/Bypass Widening	Bank Protection
Port north	Closure Structure	Closure Structure	Closure Structure	Closure Structure
Yolo Bypass *	Cutoff Wall	Cutoff Wall	---	---
Sacramento Bypass Training levee	---	---	---	Bank Protection
<b>South Basin</b>				
Sacramento River south	Cutoff Wall	Cutoff Wall, Seepage Berm	---	Bank Protection
South Cross	Cutoff Wall, Seepage Berm	---	Levee Raise	---
Deep Water Ship Channel east *	Cutoff Wall	Cutoff Wall	Levee Raise	---
Deep Water Ship Channel west	Cutoff Wall, Closure Structure	Cutoff Wall, Closure Structure	Levee Raise, Closure Structure	Bank Protection
Port south	Closure Structure	Closure Structure	Closure Structure	Closure Structure

\* Only site-specific sections of the levee reach require remediation.

West Sacramento South Basin

Measures that would be implemented for the levees in the South Basin include: installation of cutoff walls or seepage berms to address seepage and stability concerns; levee raises to address height concerns; widening the Sacramento Weir and Bypass; constructing the DWSC closure structure; and erosion protection to address erosion concerns.

Sacramento River South Levee-

Measures for the Sacramento River south levee are consistent with Alternative 2. Measures that would be implemented for the Sacramento River south levee include: installation of cutoff walls, stability berms or seepage berms to address seepage and stability concerns; levee raises to address height concerns; bank protection measures to address erosion concerns; and Sacramento Weir and Bypass widening to address height concerns and provide system resiliency.

South Cross Levee-

Alternative 4 remediation measures for the South Cross levee are consistent with Alternative 1. Measures that would be implemented for the South Cross levees include the installation of cutoff walls or seepage berms to address seepage and stability concerns, and levee raises to address height concerns.

#### Deep Water Ship Channel East Levee-

The measures for the DWSC east levee are consistent with Alternative 3 and include the DWSC closure structure. Measures that would be implemented for the DWSC east levee are: installation of cutoff walls to address seepage and stability concerns; levee raises to address inadequate levee height, and the DWSC closure structure to address seepage, stability, and height concerns north of the closure structure.

#### Deep Water Ship Channel West Levee-

The measures for the DWSC west levee are consistent with Alternative 3. Measures that would be implemented for the DWSC west levee are: installation of cutoff walls to address seepage and stability concerns; a levee raise to address inadequate levee height; the DWSC closure structure to address seepage, stability, and height concerns; and bank protection to address erosion concerns. A seepage berm is not necessary downstream of the South Cross levee due to the construction of the closure structure.

#### Port South Levee-

The measures for the Port south levee are consistent with Alternative 3. Constructing the DWSC closure structure provides protection and eliminates the need to construct levee remedial measures north of the closure structure.

### **Alternative 5 – Fix in Place, Setback Levee, Sacramento Bypass Widening, and DWSC Closure Structure (Locally Preferred Plan)**

Alternative 5, the locally preferred plan, includes the levee improvements discussed in Alternative 1, but with the Sacramento Bypass widening discussed in Alternative 2, the DWSC closure structure discussed in Alternative 3, and a setback levee configuration along the Sacramento River south levee (Appendix A, pg. A5). Instead of the fix-in-place repair along the entire reach, levee repairs include adjacent levees and the construction of new setback levees in the South Basin along the Sacramento River. To provide for levee construction, inspection, maintenance, monitoring, and flood-fighting access, some properties may need to be acquired. Levee remediation measures proposed under Alternative 5 are summarized in Table 6.

Remediation along the Sacramento River south levee has been planned as an EIP of the West Sacramento GRR project, known as the Southport Project. As an EIP of the preferred plan, the Southport Project has been planned in greater detail than the other components of the West Sacramento GRR. As such, the Corps has coordinated with the Service under the authority of the Fish and Wildlife Coordination Act to consider the construction alternatives for the Southport Project (Service File #08ESMF00-2013-CPA-0007-2). Given the early implementation projects that have already been constructed, it is estimated that construction activities could be completed by 2025 assuming levee reach designs and construction activities are occurring concurrently.

#### West Sacramento North Basin

Measures that would be implemented for the levees in the North Basin include: installation of cutoff walls to address seepage and stability concerns; levee raises to address height concerns; erosion protection to address erosion concerns; widening the Sacramento Weir and Bypass to address height concerns and provide resiliency to the region; and constructing the DWSC closure structure to address seepage, stability, height and erosion concerns.

**Table 6. Alternative 5 - Proposed Remediation Measures by Levee Reach.**

Levee Reach	Seepage Measures	Stability Measures	Overtopping Measures	Erosion Protection Measures
<b>North Basin</b>				
Sacramento River north	Cutoff Wall	Cutoff Wall	Sac Weir/ Bypass Widening	Bank Protection
Port north	Closure Structure	Closure Structure	Closure Structure	Closure Structure
Yolo Bypass *	Cutoff Wall	Cutoff Wall	---	---
Sacramento Bypass Training levee	---	---	---	Bank Protection
<b>South Basin</b>				
Sacramento River south	Setback Levee, Cutoff Wall, Seepage Berm,	Setback Levee, Cutoff Wall, Seepage Berm	---	Setback Levee, Bank Protection
South Cross	Cutoff Wall, Seepage Berm	---	Levee Raise	---
Deep Water Ship Channel east *	Cutoff Wall, Closure Structure	Cutoff Wall, Closure Structure	Levee Raise, Closure Structure	Bank Protection
Deep Water Ship Channel west*	Cutoff Wall, Closure Structure	Cutoff Wall, Closure Structure	Levee Raise, Closure Structure	---
Port south	Closure Structure	Closure Structure	Closure Structure	Closure Structure

\* The entire levee reach does not need remediation, only specific sections.

**Sacramento Weir and Bypass-**

The measures for the Sacramento Weir and Bypass are consistent with Alternative 2. The Sacramento Weir and Bypass would be widened up to 1,500 feet to address height concerns and provide system resiliency.

**Sacramento Bypass Training Levee-**

The measures for the Training levee are consistent with Alternative 1 (bank protection).

**Sacramento River North Levee-**

The measures for the Sacramento River north levee are consistent with Alternative 2. Under Alternative 2, Sacramento River levee remediation measures were proposed to address seepage, stability, and erosion control. The measures that would be implemented for the Sacramento River north levee are: installation of cutoff walls to address seepage and stability concerns; a levee raise to address inadequate levee height; and bank protection measures to address erosion concerns.

#### Port North Levee-

The primary issue in the Port north area is overtopping. As with Alternative 3, construction of the DWSC closure structure eliminates the need to construct floodwalls in this reach.

#### Yolo Bypass Levee-

The measures for the Yolo Bypass levee are consistent with Alternative 1. Along the Yolo Bypass seepage and stability problems exist at various locations. Remediation measures include the installation of a cutoff wall to address seepage and stability concerns using the conventional open trench cutoff wall method.

#### West Sacramento South Basin

The measures that would be implemented for the levees in the South Basin include: installation of cutoff walls, stability berms, seepage berms, or setback levees to address seepage and stability concerns; levee raises to address height concerns; erosion protection to address erosion concerns; widening the Sacramento Weir and Bypass to address height concerns and provide system resiliency; and constructing the DWSC closure structure to address seepage, stability, height, and erosion concerns.

#### Sacramento River South Levee-

Plans for the Sacramento River South Levee include the Southport Project, which is discussed in greater detail in Service file# 08ESMF00-2013-CPA-0007-2. A setback levee would be constructed to address seepage, stability, and erosion. The measures that would be implemented for the Sacramento River south levee include: construction of a setback levee, adjacent levee, seepage berm and fix in place to address seepage, stability, and erosion concerns; installation of cutoff walls, sheet pile walls, jet grouting, and relief wells to address seepage and stability concerns; and bank protection measures to address erosion concerns.

The setback levees would be constructed between River Mile (RM) 57.00 and RM 52.75, separated by Bees Lake. The existing levee at Bees Lake would not be degraded, and flow through Bees Lake would be prohibited by road embankments on each end. The north setback levee is just over a mile long, extending from about RM 56.8 to RM 55.7. The south setback levee is just over 2 miles long, extending from about RM 55.1 to RM 52.8. The typical distance of the setback levee from the existing levee is about 400 feet. Most of the existing levee would be degraded to an elevation of 30 feet. Where necessary, bank protection would be added to the existing levee to protect the bank in place. In the north setback area, there are two locations where the existing levee would be completely degraded to original ground for a length of 800 to 1,000 feet. In the south setback area, there are three locations where the existing levee would be completely degraded to original ground for a length of about 800 feet. Generally, both offset areas are degraded about 10 feet. The complete degradations require bank protection upstream and downstream to prevent erosion during high flows.

#### South Cross Levee-

The measures for the South Cross levee are consistent with Alternative 1. The remediation measures that would be implemented for the South Cross levee include: installation of cutoff walls or seepage berms to address seepage and stability concerns and levee raises to address levee height concerns.

#### Deep Water Ship Channel East Levee-

The measures for the DWSC east levee are consistent with Alternative 3 and include the DWSC closure structure. Remediation measures would address seepage, stability, geometry, and height deficiencies. The measures that would be implemented for the DWSC east levee are: installation of cutoff walls to address seepage and stability concerns; a levee raise to address height concerns; and the DWSC closure structure to address seepage, stability, height, and erosion concerns. A cutoff wall and height improvements would be constructed north of the closure structure. The cutoff wall, seepage berm, and height improvements would be constructed from the closure structure south to the South Cross levee. The DWSC closure structure eliminates the need to improve the levees north of its location.

#### Deep Water Ship Channel West Levee-

The measures for the DWSC west levee are consistent with Alternative 3. The measures that would be implemented for the DWSC west levee are: installation of cutoff walls to address seepage and stability concerns; a levee raise to address height concerns; closure structure to address seepage, stability and height concerns and bank protection to address erosion. A cutoff wall, height improvements, and bank protection would be constructed north of the DWSC closure structure as described under Alternative 1. The cutoff wall, seepage berm, height improvements, and bank protection would not be constructed south of the closure structure.

#### Port South Levee-

The overtopping, seepage, and stability issues are addressed with the DWSC closure structure. Constructing the DWSC closure structure, as described under Alternative 3, eliminates the need to implement the measures discussed in Alternative 1.

### **MITIGATION POLICY AND RESOURCE CATEGORY DETERMINATION**

The recommendations provided herein for the protection of fish and wildlife resources are in accordance with the Service's Mitigation Policy as published in the Federal Register (46:15; January 23, 1981).

The Mitigation Policy provides Service personnel with guidance in making recommendations to protect or conserve fish and wildlife resources. The policy helps ensure consistent and effective Service recommendations, while allowing agencies and developers to anticipate Service recommendations and plan early for mitigation needs. The intent of the policy is to ensure protection and conservation of the most important and valuable fish and wildlife resources, while allowing reasonable and balanced use of the Nation's natural resources.

Under the Mitigation Policy, resources are assigned to one of four distinct Resource Categories, each having a mitigation planning goal which is consistent with the fish and wildlife values involved. The Resource Categories cover a range of habitat values, from those considered to be unique and irreplaceable, to those believed to be much more common and of relatively lesser value to fish and wildlife. However, the Mitigation Policy does not apply to threatened and endangered species, Service recommendations for completed federal projects or projects permitted or licensed prior to enactment of Service authorities, or Service recommendations related to the enhancement of fish and wildlife resources.

In applying the Mitigation Policy during an impact assessment, the Service first identifies each specific habitat or cover-type that may be impacted by the project. Evaluation species which utilize each habitat or cover-type are then selected for Resource Category analysis. Selection of evaluation species can be based on several rationale, as follows: (1) species known to be sensitive to specific land- and water-use actions; (2) species that play a key role in nutrient cycling or energy flow; (3) species that utilize a common environmental resource; or (4) species that are associated with Important Resource Problems, such as anadromous fish and migratory birds, as designated by the Director or Regional Directors of the Service. (Note: Evaluation species used for Resource Category determinations may or may not be the same evaluation species used in a Habitat Evaluation Procedures application, if one is conducted.) Based on the relative importance of each specific habitat to its selected evaluation species, and the habitat's relative abundance, the appropriate Resource Category and associated mitigation planning goal are determined.

Mitigation planning goals range from “no loss of existing habitat” (i.e., resource category 1) to “minimize loss of habitat value” (i.e., Resource Category 4). The planning goal of Resource Category 2 is “no net loss of in-kind habitat value”; to achieve this goal, any unavoidable losses would need to be replaced in-kind. “In-kind replacement” means providing or managing substitute resources that are physically and biologically the same or closely approximate those lost.

In addition to mitigation planning goals based on habitat values, Region 8 of the Service, which includes California, has a mitigation planning goal of no net loss of acreage for wetland habitat. This goal is applied in all impact analyses.

Thirteen cover-types were identified by the Corps for the GRR Project in the project area. The 13 land cover-types identified in the project area have been merged into 9 categories in this report (Table 7). The evaluation species, resource categories, and mitigation planning goals for the nine cover-types that are possibly impacted by the project are summarized in Table 8.

Two evaluation species were selected for the “Riparian scrub/woodland” cover-type. The riparian scrub/woodland cover-type exhibits a variety of characteristics that can support many species in multiple ways. For example, downy woodpeckers will use snags (i.e., dead or dying trees) for breeding and cover (Schroeder 1982a), and yellow warblers will use dense riparian cover for breeding and feeding (Schroeder 1982b). Historically, upland woodland cover has been decreasing in acreage as human populations increase throughout the Central Valley of California (Katibah 1984). The Service designates the “Riparian scrub/woodland” cover-type in the West Sacramento GRR project area as Resource Category 2 with a mitigation planning goal of “no net loss of habitat value or acreage.”

Similarly, the downy woodpecker and wild turkey were chosen as evaluation species for the “Upland woodland” cover-type. As in the “Riparian scrub/woodland” cover-type, downy woodpeckers may use over mature, senescent trees for breeding and feeding. Habitat components important to the wild turkey include the distance between open savannah and tree cover, the amount of herbaceous cover under a tree canopy, and the amount of mast (e.g., acorns) produced by the woodland (Schroeder 1985). These characteristics emphasize the value of upland woodland as habitat for breeding, feeding, and cover from predation. As with riparian woodland cover, upland woodland

**Table 7. Summary of cover-types and acreages directly impacted by all alternatives considered in the West Sacramento Flood Control Project GRR, Yolo County, California.**

Cover-Types	U.S. Army Corps of Engineers Land Cover-Types	Project Acreage
Riparian scrub/woodland	Valley foothill riparian woodland	239
Upland woodland	Woodlands and forest	16
Emergent wetland	Emergent wetland	86
Seasonal wetland	Seasonal wetland	0.3
Shallow water riverine	Open Water (in part)	13
Orchards	Deciduous orchards	6
Agricultural fields	Grain and hay fields	68
	Irrigated grain crops	20
	Irrigated hay fields	5
	Irrigated row and field crops	239
Non-native annual grassland	Grasslands and prairies	1,178
	Pasture	28
Unvegetated/ Developed	Unvegetated, vacant, or developed	724
<b>Total project area</b>		<b>3,022.3</b>

cover has been decreasing over time with increases in human populations throughout the Central Valley (Adams *et al.* 1992, Davis *et al.* 1998). Because upland woodland cover is required habitat by the evaluation species, and due to the recent historical trend of decreasing acreage, the Service designates upland woodland habitat within the project area as Resource Category 2, with its associated mitigation planning goal of “no net loss of in-kind habitat value.”

No species was chosen as an evaluation species for the “Orchards” cover-type. The orchards in the project area are intensively managed for fruit and nut production. However, orchards can provide habitat value to wildlife species similar to naturally occurring walnut “Upland woodlands.” Any orchards that would be permanently removed from crop production should be replaced by “Upland woodland” to ensure no habitat value is lost. Therefore, the Service designates the “Orchards” cover-type in the project area as Resource Category 3, with a mitigation planning goal of “no net loss of habitat value, while minimizing loss of in-kind habitat value.”

The evaluation species selected for the “Emergent wetland” cover-type is the marsh wren. Emergent wetland habitat provides important cover, foraging, nesting, and roosting habitat for such water associated birds as well as some amphibians and aquatic mammals. Insects and spiders are taken from vegetation, the wetland floor, as well as on the wing (Gutzwiller and Anderson 1987). For protection from predators, the marsh wren will usually construct nests in reedy vegetation about 15 inches above water 2 to 3 feet deep (Gutzwiller and Anderson 1987). Because of the medium to high value of this habitat to the evaluation species, and its relative scarcity, the Service designates any emergent wetland habitat within the project area as Resource Category 2, with its associated mitigation planning goal of “no net loss of in-kind habitat value.”

**Table 8. Evaluation species, resource categories, and mitigation planning goals for the cover-types within the study area of the West Sacramento Flood Control Project, City of West Sacramento, Yolo County, California.**

COVER-TYPES	EVALUATION SPECIES	RESOURCE CATEGORY	MITIGATION GOAL
Riparian scrub/woodland	Downy woodpecker Yellow warbler	2	No net loss of in-kind habitat value or acreage.
Upland woodland	Downy woodpecker Wild turkey	2	No net loss of in-kind habitat value or acreage.
Orchards	None	3	No net loss of habitat value, while minimizing loss of in-kind habitat value.
Emergent wetland	Marsh wren	2	No net loss of in-kind habitat value or acreage.
Seasonal wetland	Great blue heron	2	No net loss of in-kind habitat value or acreage.
Shallow water riverine	Salmonids Hérons and egrets	2	No net loss of in-kind habitat value or acreage.
Shaded riverine aquatic		1	No loss of existing habitat value.
Agricultural fields	Black-shouldered kite California vole	4	Minimize loss of habitat value.
Non-native annual grassland	Black-shouldered kite California vole	3	No net loss of habitat value, while minimizing loss of in-kind habitat value.
Unvegetated/ Developed	None	4	Minimize loss of habitat value.

The evaluation species selected for the “Seasonal wetland” cover-type is the great blue heron. Great blue herons occur in a variety of freshwater and brackish habitats where they feed on fish, tadpoles, frogs and toads, and lizards, among other things (Short and Cooper 1985). Herons often feed in marshes and areas of open water, where there is no concealing cover (Short and Cooper 1985). The Seasonal wetland cover-type within the West Sacramento GRR project area is created in lowland areas that may not be natural, yet are of medium to high value for the selected evaluation species. Therefore, the Service designates the Seasonal wetland cover-type as Resource Category 3, with an associated mitigation planning goal of “no net loss of habitat value, while minimizing loss of in-kind habitat value.”

Evaluation species chosen to represent the “Shallow water riverine” cover-type in the project area include salmonids, along with herons and egrets. Not only do wading birds (e.g., herons and egrets) use shallow water cover for feeding, but also a number of gamefish, including sunfish, catfish and striped bass. Shallow water of the riverine system is also part of the critical habitat designated for the federally-listed delta smelt and Sacramento River winter-run Chinook salmon. Such shallow

water is generally removed when typical bank protection is done, especially when the waterside of the levee is reshaped. The result is likely to be higher velocities and deeper water along the new shoreline. Compounding the problem is the large amount of riprap that has already been placed in the vicinity of the proposed action, thus effectively removing many miles of shallow, open water. Salmonids were selected because large declines in their numbers are among the most important resource issues in the region, and because of their very high commercial and sport fishing values. Herons and egrets were selected because of the Service's responsibilities for their management under the Migratory Bird Treaty Act, their relatively high value for non-consumptive human uses, such as bird watching, and their value as indicator species for the many birds which use cover and foraging habitat along riverine edges. Therefore, the Service designates the "Shallow water riverine" cover-type as Resource Category 2, with an associated mitigation planning goal of "no net loss of in-kind habitat value or acreage."

Shaded Riverine Aquatic (SRA) cover is defined as the shallow water area occurring at the interface between a river and adjacent woody riparian habitat. The principal attributes of this valuable cover type include: (a) the adjacent bank being composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water, and (b) the water containing variable amounts of woody debris, such as leaves, logs, branches and roots, as well as variable depths, velocities, and currents. These attributes provide high-value feeding areas, burrowing substrates, escape cover, and reproductive cover for numerous regionally important fish and wildlife species, including the State- and federally-listed species. In 1992, the Service designated SRA cover that is impacted by bank protection activities within the Sacramento Bank Protection Project action area as Resource Category 1 (Service 1992). Under Resource Category 1, habitat to be impacted is high value, unique, and irreplaceable on a national basis or in the eco-region, and the Service's mitigation planning goal is for no loss of existing habitat value.

The evaluation species selected for the "Agricultural fields" cover-type that would be impacted by the proposed project are the black-shouldered kite (white-tailed kite) and the California vole. The black-shouldered kite in California is a common species of open and cultivated bottomland (Faanes and Howard 1987). The black-shouldered kite is an obligate predator on diurnal small mammals; movements and nesting of the kite is largely governed by concentrations of mice and voles (Faanes and Howard 1987). The California vole is a widespread and common herbivore in California (Brylski 1990). Its abundance and widespread distribution, along with daylong activity, make the California vole an important prey species. Because this habitat is not a native and is managed for crop production unless fallowed, the Service designates the "Agricultural fields" habitat in the project area as Resource Category 4, with a mitigation planning goal to "minimize loss of habitat value."

Similarly, the evaluation species selected for the "Non-native annual grassland" cover-type that would be impacted by the proposed project also are the black-shouldered kite and the California vole. Because this cover-type within the City of West Sacramento is of medium to high value for the selected evaluation species, the Service designates the annual grassland cover-type as Resource Category 3, with an associated mitigation planning goal of "no net loss of habitat value, while minimizing loss of in-kind habitat value."

No evaluation species were selected for the "Unvegetated/ Developed" cover-type. This cover-type includes those areas which do not fall within one of the other habitat types, such as roads, access areas, buildings, bare ground, and riprap. Generally, this cover-type would not provide any

significant value for wildlife species. Therefore, the Service designates the “Unvegetated/Developed” cover-type in the project area as Resource Category 4, with an associated mitigation planning goal of “minimize loss of in-kind habitat value.”

## **BIOLOGICAL RESOURCES**

The West Sacramento GRR involves construction zones for levee and roads; demolition areas for levees, roads, and structures; traffic and staging areas for project vehicles, equipment, and materials; and potential borrow areas for materials.

### **Vegetation**

A combination of aerial photograph interpretation and field observation was used to identify land cover-types in the study area. Of the cover-types that occur in the study area, five are considered natural communities: riparian scrub/woodland, upland woodland, emergent wetlands, seasonal wetlands, and open water. The others are associated with human activities: orchards; agricultural fields; non-native annual grasslands; and unvegetated/developed. Each land cover-type is discussed below.

### **Riparian Scrub/Woodland**

As corridors between wetland and upland land cover-types, riparian scrub/woodland cover can provide complexity in vegetation composition and structure, as well as species diversity. Most riparian scrub/woodland cover is associated with the Sacramento River north and Sacramento River south levees, but smaller riparian areas are found on all of the levees in the West Sacramento GRR project area. The total area encompassed by riparian scrub/woodland habitat in the study area is about 239 acres.

Riparian scrub/woodland cover in the project area is dominated by Fremont cottonwoods, Goodding’s black willow, valley oak, and northern California black walnut. A common understory species is blue elderberry, which is the host plant for the valley elderberry longhorn beetle. Northern California black walnut is the dominant riparian tree species in some areas. Plant species associated with riparian scrub/woodland include valley oak, sandbar willow, red willow, poison-oak, and Himalayan blackberry.

Some trees in the riparian scrub/woodland are heritage or landmark trees, as defined in the Tree Preservation Ordinance of the City of West Sacramento. Valley oak riparian woodland (Great Valley valley oak riparian) is identified as a sensitive natural community (CDFG 2003). Riparian woodland (Great Valley cottonwood riparian) is identified as a sensitive natural community (CDFG 2003). The California Department of Fish and Wildlife (CDFW) has adopted a no-net-loss policy for riparian habitat values.

### **Upland Woodland**

Small patches of woodland occur in the study area along the Sacramento River north and Sacramento River south levees, and at the junction of the Sacramento River south and South Cross levees. Woodland and forest encompass approximately 16 acres. These patches of woodland are distinguished from the riparian scrub/woodland habitat by a predominance of valley oaks. Generally, upland woodlands of the Sacramento Valley have a moderate shrub cover interspersed with herbaceous cover. Elderberry, coyote brush, and Himalayan blackberry are common understory shrubs.

As with the Riparian scrub/woodland cover, some of the trees meet the definition of heritage or landmark trees as defined in the City's Tree Preservation Ordinance. Valley oak woodland is identified as a sensitive natural community (CDFG 2003).

### **Emergent Wetland**

There are about 86 acres of emergent wetland within the study area. The largest areas of emergent wetland occur in the vicinity of the turning basin along the Port north and Port south levees. Emergent wetlands also are in the study area near the South Cross, Yolo Bypass, and DWSC west levees. Representative species observed in emergent wetlands in the study area were tules, cattails, and rushes. Much of the emergent wetland in the project area represents jurisdictional waters of the United States that may be subject to regulation by the Corps. Emergent wetland cover is also recognized as a sensitive natural community by the CDFW (CDFG 2003).

### **Seasonal Wetland**

Four small seasonal wetlands occur in the study area at the eastern end of the Port south levee, totaling about 0.3 acre. These wetlands appear to be inundated during wetter times of the year and ongoing and past disturbance contributed to the formation of three of the four seasonal wetlands that appear to have originated from tire tracks within the network of dirt trails in the basin south of South River Road. Representative plant species observed in the seasonal wetlands were hyssop loosestrife, Mediterranean barley, Italian ryegrass, and fiddle dock.

### **Shallow water riverine**

There are about 413 acres of riverine aquatic water cover within the project area. The areas include the Sacramento River, DWSC, and turning basin of the Port of West Sacramento. These navigable waters are considered U.S. jurisdictional waters under Corps jurisdiction. Although much of the riverine aquatic habitat of the project area along the Sacramento River contains shallow water at banksides and SRA cover, areas of rock slope protection do exist. The DWSC and Port of West Sacramento areas do not contain substantial SRA cover. SRA provides high-value feeding area, burrowing substrates, escape cover, and reproductive cover for numerous regionally important fish and wildlife species. Non-shaded riverine aquatic cover lacks most of the benefits that natural vegetation provides.

### **Orchards**

Deciduous orchards in the project area are confined to a small area near the Sacramento River south levee that encompasses about 6 acres. The orchards are managed for nut production, and therefore are likely subject to herbicide and pesticide applications for cultivation and harvesting, along with heavy pruning and cultivation.

### **Agricultural Fields**

Cultivated agricultural fields include large parcels of wheat, ryegrass, and row crops totaling about 332 acres. Agricultural fields may be vegetated or non-vegetated, depending on management concerns. Irrigated row and field crops occur in the project area along the Yolo Bypass, Sacramento River south, and South Cross levees and encompass about 239 acres. Most of the irrigated row and field crops along the Yolo Bypass levee appear to be rice fields. Other grain and hay fields total about 93 acres. However, most agricultural fields in the project area have gone fallow, and appear not to be managed for current production. Fallow agricultural fields resemble nonnative annual grasslands in composition, and may contain small, common shrubs as well.

### **Nonnative-Annual Grassland**

Nonnative annual grassland occurs in the project area mainly on undeveloped parcels, yet also on levee slopes and along roadsides. Non-native annual grassland cover approximately half of the study area and encompass a total of about 1,178 acres. Another 28 acres of pasture occur in small patches within the study area near the Sacramento River south and Port north levees and provide grazing areas for cattle and horses. The largest non-native annual grassland area occurs near the DWSC east, Port south, and DWSC west levees, but grasslands are scattered throughout the study area. The non-native annual grassland is dominated by naturalized annual grasses with intermixed perennial and annual forbs. Grasses commonly observed in the study area are foxtail barley, ripgut brome, Italian ryegrass, and soft chess. Other grasses observed were wild oats, Bermuda grass, and rattail fescue. Forbs commonly observed in annual grasslands in the study area are yellow star-thistle, prickly lettuce, bristly ox-tongue, and sweet fennel. Other forbs observed are perennial peppergrass, Italian thistle, horseweed, black mustard, and fireweed. The nonnative annual grasslands in the project area contain a relatively large proportion of ruderal species, likely because of substantial disturbance from human activities.

### **Unvegetated/Developed**

The Unvegetated/Developed cover-type applies to landscaped residential parcels, roads, and other large paved areas and total about 724 acres. Most of the Unvegetated/Developed areas in the study area occur north of the DWSC along the Sacramento River north, Yolo Bypass, Sacramento Bypass, and Port north levees. Although landscaping can provide value to some terrestrial species, generally the cover is fragmented and frequented by human activity. These qualities lead to low habitat value. Vacant areas within the study area commonly contain ruderal species that have the ability to colonize disturbed areas: bristly ox-tongue, yellow star-thistle, common mallow, milk-thistle, prickly lettuce, chicory, and perennial peppergrass. Vegetation in developed portions of the study area consists of ornamental species used for landscaping: English ivy, crape myrtle, liquid amber, edible fig, and privet.

### **Wildlife**

In addition to providing important nesting and foraging habitat, riparian habitats function as wildlife movement corridors. Overstory trees may be used for nesting and roosting by numerous raptors, including Swainson's hawk, black-shouldered kite, red-tailed hawk, red-shouldered hawk, great horned owl, Cooper's hawk, and American kestrel. Overstory riparian trees also provide suitable roosting sites for herons and egrets, as well as the belted kingfisher. Overstory trees provide foraging opportunities for other birds such as the Bullock's oriole, yellow-rumped warbler, tree swallow, and western scrub jay. Understory riparian habitat is also suitable for numerous mammals, including various species of rodents, raccoon, Virginia opossum, and striped skunk. Areas containing large, dense shrubby vegetation dominated by willow or blackberry may support tricolored blackbird. Riparian forests also provide cover and foraging habitat for reptiles and amphibians, such as terrestrial garter snake, gopher snake, Pacific tree frog, and western toad. Suitable areas in the understory also may be used as nesting habitat for western pond turtles.

Patches of upland woodland are dominated by valley oak and provide similar wildlife habitat uses as riparian scrub/woodland. Along with those species that use riparian habitats, additional birds that use upland woodland cover include the yellow-billed magpie, Nuttall's woodpecker, acorn woodpecker, and northern flicker. Reptiles including gopher snake, California king snake, and the northern pacific rattlesnake also frequent these habitats.

Although emergent wetland does not occur in large continuous patches within the project area, this habitat type is designated as a sensitive natural community by CDFW (CDFG 2003) and provides important wildlife habitat value. This cover-type provides nesting and foraging habitat for several songbirds, including red-winged blackbird, tricolored blackbird, and marsh wren; foraging and nesting habitat for northern harrier and Virginia rail; foraging and cover habitat for numerous reptiles and amphibians; and potential nesting habitat for western pond turtle. Likewise, seasonal wetlands provide breeding habitat for amphibians, as well as foraging habitat for several mammals, birds, reptiles, and amphibians.

Within the project area, open water provides breeding, foraging, and migration habitat for many wildlife species. Mammal species commonly known to use open water habitats include river otter, which uses these areas for foraging and escape cover, and muskrat, which may use open water as migration corridors between suitable foraging areas. Open water areas also provide essential foraging habitat for wading birds including great blue heron, great egret, and snowy egret; numerous waterfowl species including mallard, ruddy duck, and bufflehead; other water birds including eared grebe, double-crested cormorants, and American white pelicans; and land birds including black phoebe and belted kingfisher. These areas also provide breeding habitat, escape cover, and foraging habitat for reptiles and amphibians including western pond turtle, common garter snake, giant garter snake, bullfrog, Pacific tree frog, and western toad. The vegetated areas within open water provide nesting habitat for numerous songbirds, including red-winged blackbird and marsh wren, and wading birds such as Virginia rail.

Orchard crops typically provide less value to wildlife than natural woodland cover-types, yet also may be used for nesting or foraging by species that use woodland habitats. Likewise, agricultural crop lands can provide some habitat value similar to grassland. However, because agricultural fields and orchards are managed for crop production, insects and other vegetation in these cover-types are heavily controlled. Such management objectives can limit the habitat value of these cover-types to birds, small mammals, reptiles, and amphibians. However, agricultural cover-types do provide some habitat value to numerous resident and wintering raptors, songbirds, shorebirds, and wading birds. Agricultural lands also provide foraging habitat for rodents including deer mouse and the California vole; other mammals including coyote, raccoon, Virginia opossum; and reptiles including gopher snake and terrestrial garter snake.

Non-native grassland generally occurs in disturbed areas, such as levee faces and edges of agricultural fields and roads; the species in this land cover type are generally weedy to invasive. The largest area of non-native annual grassland occurs on levees adjacent to the DWSC and Port South Canal, but grasslands are generally scattered throughout the study area. Grasslands provide nesting and foraging habitat for several species of songbirds, including the savanna sparrow, white-crowned sparrow, and western meadowlark. Grasslands also provide foraging habitat for several species of raptors including red-tailed hawk, white-tailed kite, northern harrier, great-horned owl, and Swainson's hawk. California ground squirrels commonly occur in annual grassland habitat. Their burrows provide important nesting habitat for western burrowing owls. Reptiles found in these habitats include California kingsnake, gopher snake, and northern pacific rattlesnake. Additionally, annual grassland areas surrounding levees and those adjacent to aquatic habitat may also provide potential upland habitat for giant garter snake.

Unvegetated/developed lands include areas within levee roads, railways, roads, buildings, and landscaped areas, as well as other barren areas that have been disturbed. Due to frequent human disturbance, these areas typically provide minimal habitat value to wildlife.

**Fish**

Aquatic habitat in the project area consists mainly of the Sacramento River, the DWSC, and Port of West Sacramento areas. Areas of shallow open water also can be found in drainage canals, Bees Lakes, and other isolated ponds. However, due to the shallowness and isolation of these water bodies, their value as fish habitat is limited.

Along the river, riparian vegetation provides SRA cover and aids in temperature control, streambank stability, and habitat complexity. Floodplain and SRA cover along the Sacramento River is used by all life stages of anadromous fish for shelter and feeding. Additionally, vegetated floodplain and SRA cover provides habitat for Sacramento splittail, delta smelt, black bass, and sunfish.

Root structures of riparian vegetation can provide bank stability and shelter for young fish. Woody debris can provide shelter from predation and refugia from stream flow. Riparian vegetation also influences the food chain of a stream, providing organic detritus and terrestrial insects. Terrestrial organisms falling from overhanging branches contribute to the food base of the aquatic community. Vegetation in emergent wetlands can provide similar benefits to fish habitat. Salmonids in particular are primarily insectivores and feed mainly on drifting food organisms. Along with providing water storage, floodplains can add extensively to the habitat components of SRA cover.

The Sacramento River channel provides a migratory pathway to many anadromous fish, and also provides seasonal rearing habitat to many other native fish species (Table 9). Non-native anadromous species such as the American shad and striped bass provide recreational sport fishing opportunities. Non-native resident species include several catfish, bass, bluegill, crappie, and sunfish species. Some non-native species may provide recreational fishing opportunities, such as the largemouth bass, smallmouth bass, and green sunfish, yet these species also prey upon native

**Table 9. Native fish species potentially occurring in the Sacramento River, adjacent to the West Sacramento Flood Control Project, Yolo County, California.**

Resident	Anadromous
California roach	Chinook salmon (winter, spring, fall, and late-fall runs)
Delta smelt	Chum salmon
Hardhead	Green sturgeon
Hitch	Pacific lamprey
Longfin smelt	River lamprey
Prickly sculpin	Steelhead
Sacramento blackfish	White sturgeon
Sacramento pikeminnow	
Sacramento splittail	
Sacramento sucker	
Speckled dace	
Threespine stickleback	
Tule perch	

juvenile species that use floodplain habitats. The native California roach may be extirpated from the Sacramento River adjacent to the project area due to predation from non-native species (Moyle 2002). Similarly, the native Sacramento perch has been extirpated from much of its former range as a result of predation from non-native carp and catfish (Moyle 2002).

### **Threatened and Endangered Species**

Appendix B contains a list of federally listed species which may be found in the project area. Consultation under section 7 of the Endangered Species Act has been completed with the Service (Appendix C), and consultation with the National Marine Fisheries Service (NMFS) is ongoing. Generally, the Service has jurisdiction for land and freshwater species, while the NMFS has jurisdiction for marine and anadromous species. The CDFW should be consulted under the California Endangered Species Act to determine the effects of this project on State listed species.

## **FUTURE CONDITIONS WITHOUT THE PROJECT**

**Vegetation** - The No Action Alternative represents the continuation of the existing levee conditions, including deficiencies, along the waterways surrounding the North and South Basins of the WSFCP. Because no levee improvements would occur, no construction related effects on vegetation or land cover-types would occur. Erosion could lead to levee failures and the loss of existing vegetation. Future compliance with the Corps levee vegetation policy could lead to permanent loss of woody vegetation which would result in a significant effect on riparian habitat.

**Wildlife** - Since only minimal changes are expected in vegetation, wildlife populations in the study area are expected to persist as they are currently, with normal year-to-year fluctuations of individual species.

**Fish** - Under the No Action Alternative, the aquatic resources are expected to remain the same for fish species. As with current Sacramento River conditions, aquatic species populations would fluctuate in relation to water temperature, rainfall, contaminants, and other natural population cycles.

Current levee operation and maintenance activities would continue as is, and there would be no change in the geomorphic or flood control regimes, resident and migratory fishes would continue to use the area as they do today. Alterations to levee management policies concerning current vegetation composition and structure could lead to a permanent loss of woody materials, resulting in major impacts to existing riparian habitat. The loss of riparian habitat would negatively impact fish populations of the Sacramento River.

Because no levee improvements would be made under the No Action Alternative, existing flood risks would continue. In general, future conditions for fish and wildlife species are expected to remain within the current dynamic ecological conditions. As with current conditions, populations would fluctuate, depending on weather, rainfall, contaminants, diseases, and natural population cycles.

## FUTURE CONDITIONS WITH THE PROJECT

**Vegetation** - Regardless of the project action alternative, wildlife habitats will be impacted along 51 linear miles of levees around the City of West Sacramento. Additionally, potential road construction, potential construction borrow areas, changes in traffic alignment, and other project activities also would affect existing habitat cover. For example, habitat may be lost for the western burrowing owl through road construction or the extraction of borrow materials. Although each Alternative is unique, similarities exist among the Alternatives regarding the impacts to habitat.

**Wildlife** - With the project, the alternatives address levee deficiencies through various combinations of slurry cutoff walls, seepage berms, and rock slope protection (riprap). These construction activities could result in potential adverse effects on resident wildlife resources. Not only can animals be physically displaced, but effects include disturbance from construction activity and noise. Amphibian and reptile species typically are not as mobile as other types of wildlife. Consequently they have a greater chance of being killed during construction activities, including the collection of borrow material. Giant garter snakes may use habitat along the DWSC adjacent to the Yolo Bypass as well as the South Cross levee, which borders potential borrow sites to the north and south.

Wildlife such as birds and mammals, typically respond to this type of activity by leaving construction areas. It is likely they would move into adjacent habitat outside of the zone of construction noise and disturbance. However, they may be forced to move to less than optimal habitat conditions as other animals may have established territories in the surrounding habitat. Swainson's hawks, a State listed species, relies on mature riparian cover for nesting and foraging. Similarly, several bat species may use riparian cover for roosting. Pre-construction nesting bird surveys would help avoid disturbing or destroying any nests within the vegetation removal area and assist in complying with the Migratory Bird Treaty Act.

Construction effects to invertebrate species must be considered as well. The valley elderberry longhorn beetle uses elderberry as its sole host plant. Therefore, the effects of construction activities on elderberry bushes, regardless of the alternative chosen, must be analyzed fully.

**Fish** – Regardless of the project action alternative chosen, rock slope protection would be used along the Sacramento north and south levees, as well as the DWSC West levee. Using rock slope protection would permanently remove SRA cover along the Sacramento River. SRA cover provides shelter, resting, rearing, and feeding areas to multiple fish species (NMFS 2008). The loss of SRA cover can negatively impact anadromous fish by removing protective cover from juveniles. Smaller resident fish would also be negatively impacted by the loss of protective cover. Other benefits provided by streamside vegetation, such as temperature and erosion control, would be permanently lost.

A setback levee alignment with a larger floodplain and riparian areas can increase benefits to resident and anadromous fish species. Higher growth rates of Chinook salmon have been observed in fish growing in floodplain areas than in conspecifics growing in main channel flows (Limm and Marchetti 2003). Ecologically, much of the biomass produced in riparian and floodplain areas can eventually flow into open water in the form of detritus and stranded terrestrial insects. However, floodplains carry increased risks of fish stranding, poor oxygen levels, and increased predation if watered areas become cut off from main channel flows (Jeffres *et al.* 2008).

**Alternative 1 – Fix Levees-** The Fix Levees Alternative involves in-place levee remediation measures to address seepage and stability deficiencies. Cutoff walls would be installed in all levee reaches except the Port north and Sacramento Bypass Training areas. To address overtopping levees would be raised in sections along the Sacramento River, the DWSC, and the Port south areas. In areas where woody vegetation is not removed, wildlife species may be temporarily displaced during project construction due to disturbance. Each levee reach is expected to involve 2 years of construction.

Upon remediation levees along the Sacramento River, Sacramento Bypass, and the DWSC would be lined with rock slope protection. The existing slopes contain a combination of riparian woodland, riparian scrubland, and non-native annual grassland. Possible construction effects include increases in turbidity and suspended sediment due to riprap placement, possible contaminant discharge from the construction equipment, and adverse effects caused by construction noise and vibration. On the landside, seepage berms would be constructed in segments along the Sacramento south, South Cross, and DWSC levees. The creation of seepage berms requires the removal of additional vegetation in multiple areas along the existing landside levee toe.

Wooded riparian and grassland habitats are used by numerous mammals, reptiles, amphibians, and birds found throughout the Sacramento Valley. Often in suburban and urban landscapes, these areas provide a network of natural cover in an otherwise fragmented landscape. Woody vegetation can also provide SRA cover for fish, which is important for a variety of reasons, including temperature regulation. Downed woody debris can also provide habitat for invertebrate species and cover for both terrestrial and aquatic wildlife.

**Alternative 2 – Fix Levees and Widen Sacramento Weir and Bypass-** Alternative 2 levee alignments are the same as with Alternative 1, except for widening the Sacramento Bypass and Weir. The widening of the bypass involves the degradation of the existing north levee and subsequent creation of a new north levee along the Sacramento Bypass. Although plans for the widening have not been finalized, there is some riparian woody vegetation along the north levee that likely would be removed. Agricultural lands on the landside of the existing levee would be replaced by the grasslands within the newly created bypass and north levee alignment.

The type of weir that would be created with a widened Sacramento Bypass has not been finalized. Depending on the design and natural water flow, more emergent wetlands could be created within the Sacramento Bypass. Except for high-water events, most of the expanded Sacramento Bypass is expected to contain annual grasslands similar to what currently exists within the bypass.

**Alternative 3 – Fix Levees and Deep Water Ship Channel Closure Structure-** Alternative 3 levee alignments are the same as with Alternative 1, except for the inclusion of a DWSC Closure Structure. Depending on the placement of the Closure Structure, it is likely that the structure would affect annual grassland and unvegetated cover. However, implementing a closure structure would in turn alleviate the need for improvements along the DWSC east and west levees north of the Closure Structure. Also, depending on construction schedules, building the Closure Structure may temporarily affect fish movement in the DWSC.

**Alternative 4 – Fix in Place, Sacramento Bypass Widening, and DWSC Closure Structure-** Alternative 4 contains the fix-in place levee alignments, along with the Sacramento Bypass widening

of Alternative 2 and the DWSC Closure Structure of Alternative 3. Effects to vegetation cover, wildlife, and fish are a combination of the effects under Alternatives 1, 2, and 3.

**Alternative 5 – Fix in Place, Setback Levee, Sacramento Bypass Widening, and DWSC Closure Structure-** As with Alternative 4, effects under Alternative 5 to vegetation, wildlife, and fish are generally a combination of the effects under Alternatives 1, 2, and 3. However, Alternative 5 also involves a setback levee alignment along the Sacramento River south levee.

On the waterside, a setback levee would create floodplain area at least 400 feet wide from the levee toe to the Sacramento River. The existing levee would be breached in five locations. Riprap would be used for erosion protection in other areas of the obsolete existing levee to maintain proper floodplain function. The floodplain would vary in height to allow a more natural riparian – wetland interface. Supplemental plantings would increase the amount of existing wooded riparian and wetland habitats. The creation of the floodplain area results in a net increase of riparian and other wooded cover. Although riprap would be used along existing levee alignments to the north and south of the setback area, the increased riparian acreage increases the functionality as wildlife habitat along the waterside of the project area.

The increased floodplain area allows the Sacramento River to function more naturally between the cities of Sacramento and West Sacramento. The inundation of the new floodplain area would vary accordingly with water levels. Floodplain habitat can provide shade and structure for fish to use for escaping higher velocity flows and predators. Some bird species such as herons and egrets also can use this habitat for foraging. Additionally, the Bees Lakes would retain hydraulic isolation from the Sacramento River.

On the landside, the setback levee includes seepage berms that would not contain woody vegetation. The loss of wooded habitats on the landside would be offset by plantings on the waterside. Agricultural fields, undeveloped lands, and other habitats would be impacted to create new roadways.

## DISCUSSION

The Service's primary concern with the effects to fish and wildlife is the loss of riparian and wetland habitats. The inclusion of the setback levee alignment in Alternative 5 offers the ability to compensate onsite for losses of wooded and wetland habitats due to construction. Onsite compensation allows for the continuance of the landscape context of the land cover, thus providing connectivity and decreasing chances of habitat fragmentation in the West Sacramento GRR area.

To mitigate the loss of this habitat for wildlife species the Service believes that a ratio of at least 2:1 should be used to compensate for the loss of riparian scrub/woodland, upland woodland, emergent wetland, and emergent wetlands habitat values. The ratio accounts for temporal losses while vegetation matures over time. Table 10 summarizes the compensation needs for the project's preferred plan locally. Nonnative annual grasslands and former agricultural lands that will not return to production should be reseeded with a native seed mix. Widening the Sacramento Bypass provides an opportunity to increase riparian and wetland cover within the project area and may be suitable for use as a compensation area.

**Table 10. Compensation need for the habitats affected by the West Sacramento GRR Project, Preferred Alternative, City of West Sacramento, Yolo County, California.**

Habitat Cover-Type	Area Affected (acres)	Compensation Need (acres)
Riparian scrub/woodland	239	478
Upland woodland	16	32
Emergent wetlands	86	192
Ponds	0.0	Not Applicable
Shallow water habitat	13	26
Orchard and Agricultural fields	6	Re-seed
Non-native annual grassland	1,206	Re-seed
Unvegetated/Developed	Unknown	Re-seed*

\* Any areas left unvegetated should be re-seeded with a native seed mix.

Alternative 5, which includes the setback levee option, benefits fish and wildlife species by creating more floodplain habitat. The setback levee decreases the chances of levee erosion in the immediate area by slowing stream flow through widening the channel and placing vegetation in the new floodplain. Throughout the Sacramento River system, the Service’s goal is to work toward the creation of a sustainable, reliable, and resilient flood and riparian system. Setback levee designs are a step in this direction.

Vegetation on river banks, as well as in floodplain habitats, is important in maintaining SRA cover, erosion control, roosting spots, cover from predation and for predators, and feeding opportunities for wildlife species. Means should be provided to allow woody vegetation to persist among rock slope protection so that losses of SRA cover and riparian cover can be minimized.

When specific compensation plans are being designed, they should include development of an operations maintenance manual for the site(s). New floodplain areas resulting from the setback levee designs should be contoured so they do not lose connectivity with the Sacramento River main channel and strand fish or develop pools with potential water quality issues. For compensation areas to be effective, they need to be managed in perpetuity, with established goals and a monitoring plan. Compensation goals should be clearly outlined and adaptive management measures should be established to ensure that compensation is achieved.

The recommendations below are based on preliminary construction designs for the West Sacramento GRR. Once specific project designs are developed, the Service’s recommendations may be refined.

### RECOMMENDATIONS

If the project is constructed, the Service recommends that the Corps implement the following:

- 1) Avoid the loss of SRA cover along the Sacramento River. Unavoidable impacts can be mitigated by planting native woody materials within rock slope protection areas. Work with the Service, NMFS, and CDFW to develop planting and monitoring plans and DWR and WSAFCA to develop a variance to allow vegetation within the Corps’

vegetation free zone to remain in place, especially in areas designed for rock slope protection.

- 2) Avoid impacts to nesting migrating birds by conducting pre-construction surveys for breeding migratory birds. Active nests should not be disturbed until young have fledged.
- 3) Minimize impacts to wildlife species by reseeding all lands disturbed by construction activities, including the staging areas, with native grasses and forbs. Similarly, agricultural lands remaining out of production should be reseeded with native forbs and grasses. Reseeding should be conducted just prior to the rainy season to enhance germination and plant establishment.
- 4) Compensate at 2:1 for losses due to project work by creating and maintain 478 acres of riparian woodland, 32 acres of upland woodland, 192 acres of emergent wetland, and 26 acres of shallow water riverine habitat. If onsite compensation is not possible, the Corps and WSAFCA should work with the Service and other resource agencies on the development of a suitable offsite compensation area.
- 5) Comply with local tree ordinance requirements for any landmark or heritage trees that are impacted by the project.
- 6) For all compensation areas, develop an operations and maintenance plan that is coordinated with the Service and other resource agencies.
- 7) Consult with the CDFW regarding effects of this project on State listed species under the California Endangered Species Act.

## References

- Adams, T.E., P.B. Sands, W.H. Weitkamp, and N.K. McDougald. 1992. Oak seedling establishment on California rangelands. *Journal of Range Management* 45:93–98.
- Brylski, P. 1990. California vole *in* Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White, eds., *California's Wildlife*. Vol. I-III. California Department of Fish and Game, Sacramento, California. Available online at <http://www.dfg.ca.gov/biogeodata/cwhr/cawildlife.aspx>, accessed January 27, 2015.
- CDFG (California Department of Fish and Game). 2003. The Vegetation Classification and Mapping Program; List of California Terrestrial Natural Communities Recognized by the California Natural Diversity Database. September 2003 edition. Wildlife and Habitat Data Analysis Branch, Sacramento, California.
- Davis, F.W., D.M. Stoms, and A.D. Hollander. 1998. The California Gap Analysis Project - Final Report. University of California, Santa Barbara, CA. [http://biogeog.ucsb.edu/projects/gap/gap\\_rep.html](http://biogeog.ucsb.edu/projects/gap/gap_rep.html), accessed January 27, 2015.
- Faanes, C.A., and R.J. Howard. 1987. Habitat suitability index models: black-shouldered kite. U.S. Fish and Wildlife Service Biological Report Rep. 82(10.130). 13 pages.
- Gutzwiller, K.J., and S.H. Anderson. 1987. Habitat suitability index models: marsh wren. U.S. Fish and Wildlife Service Biological Report 82(10.139). 13 pages.
- Jeffres, C.J., J.J. Opperman, and P.B. Moyle. 2008. Ephemeral floodplain habitats provide best growth conditions for juvenile Chinook salmon in California river. *Environmental Biology of Fishes* 83:449-458.
- Katibah, E.F. 1984. A brief history of riparian forests in the Central Valley of California, *in* Warner, R.E. and K.M. Hendrix, editors, *California riparian systems: ecology, conservation, and productive management*. University of California Press, Berkeley, California. 1,035 pages.
- Limm, M.P., and M.P. Marchetti. 2003. Contrasting patterns of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) growth, diet, and prey densities in off-channel and mainstem habitats o the Sacramento River, California State University, Chico. Prepared for The Nature Conservancy, Chico, California.
- Moyle, P.B. 2002. *Inland fishes of California*. University of California Press, Berkeley and Los Angeles, California. 502 pages.
- NMFS (National Marine Fisheries Service). 2008. Programmatic Consultation for Phase II of the Sacramento River Bank Protection Project. July. Southwest Region, Sacramento, California.
- Schroeder, R. L. 1982a. Habitat suitability index models: Downy woodpecker. U.S. Fish and Wildlife Service FWS/OBS-82110.38. 10 pages.

Schroeder, R. L. 1982b. Habitat suitability index models: yellow warbler. U.S. Fish and Wildlife Service FWS/OBS-82/10.27. 7 pages.

Schroeder, R. L. 1985. Habitat suitability index models: Eastern wild turkey. U.S. Fish and Wildlife Service Biological Report 82(10.106). 33 pages.

Service (U.S. Fish and Wildlife Service). 1992. Shaded Riverine Aquatic Cover of the Sacramento River System: Classification as a Resource Category 1 Under the FWS Mitigation Policy. Sacramento Fish and Wildlife Office, Sacramento, California.

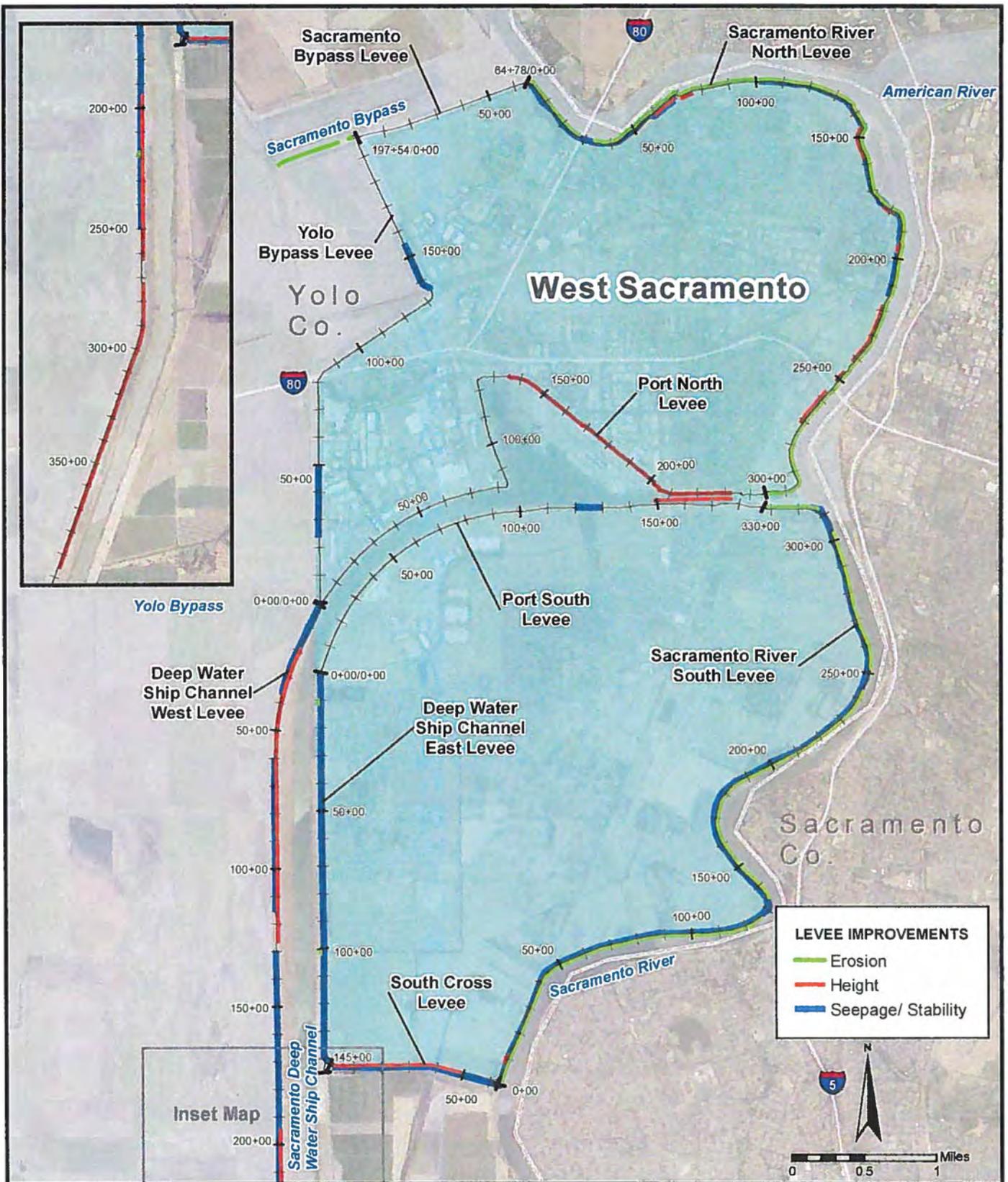
Short, H.L. and R.J. Cooper. 1985. Habitat suitability index models: Great blue heron. U.S. Fish and Wildlife Service Biological Report 82(10.99). 23 pages.



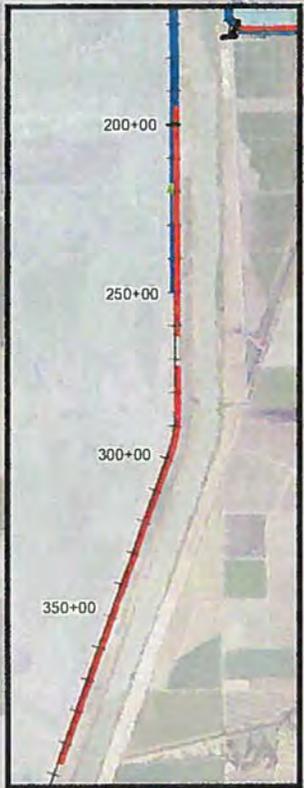
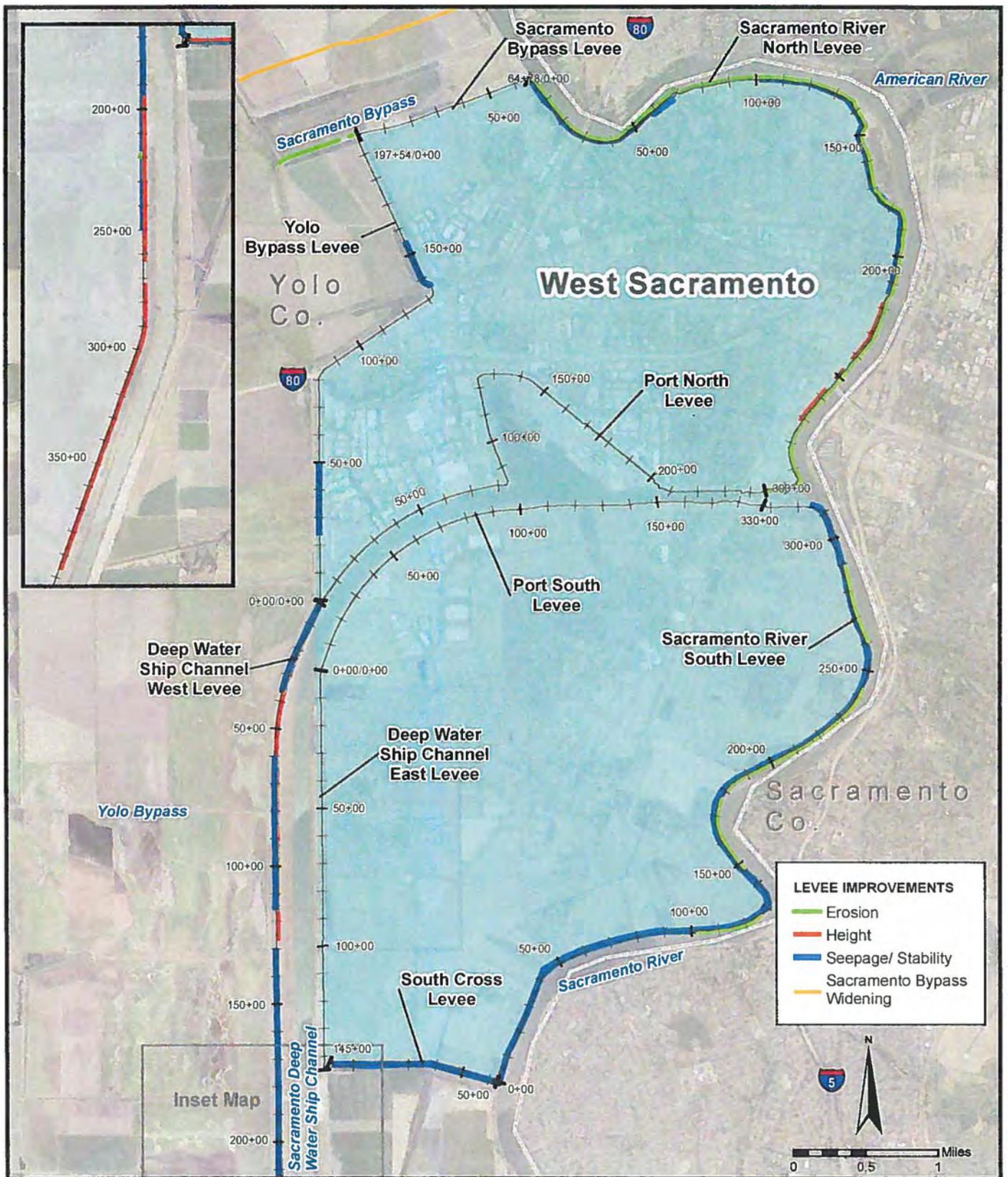
**Appendix A**

**West Sacramento General Reevaluation Report Project  
Post-Construction Design Alternatives**



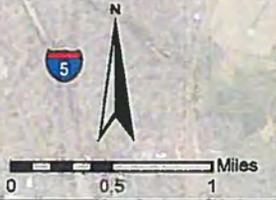






**LEVEE IMPROVEMENTS**

- Erosion
- Height
- Seepage/ Stability
- Sacramento Bypass Widening



**Legend**

- Levee Centerline
- West Sacramento Project Area
- County Lines

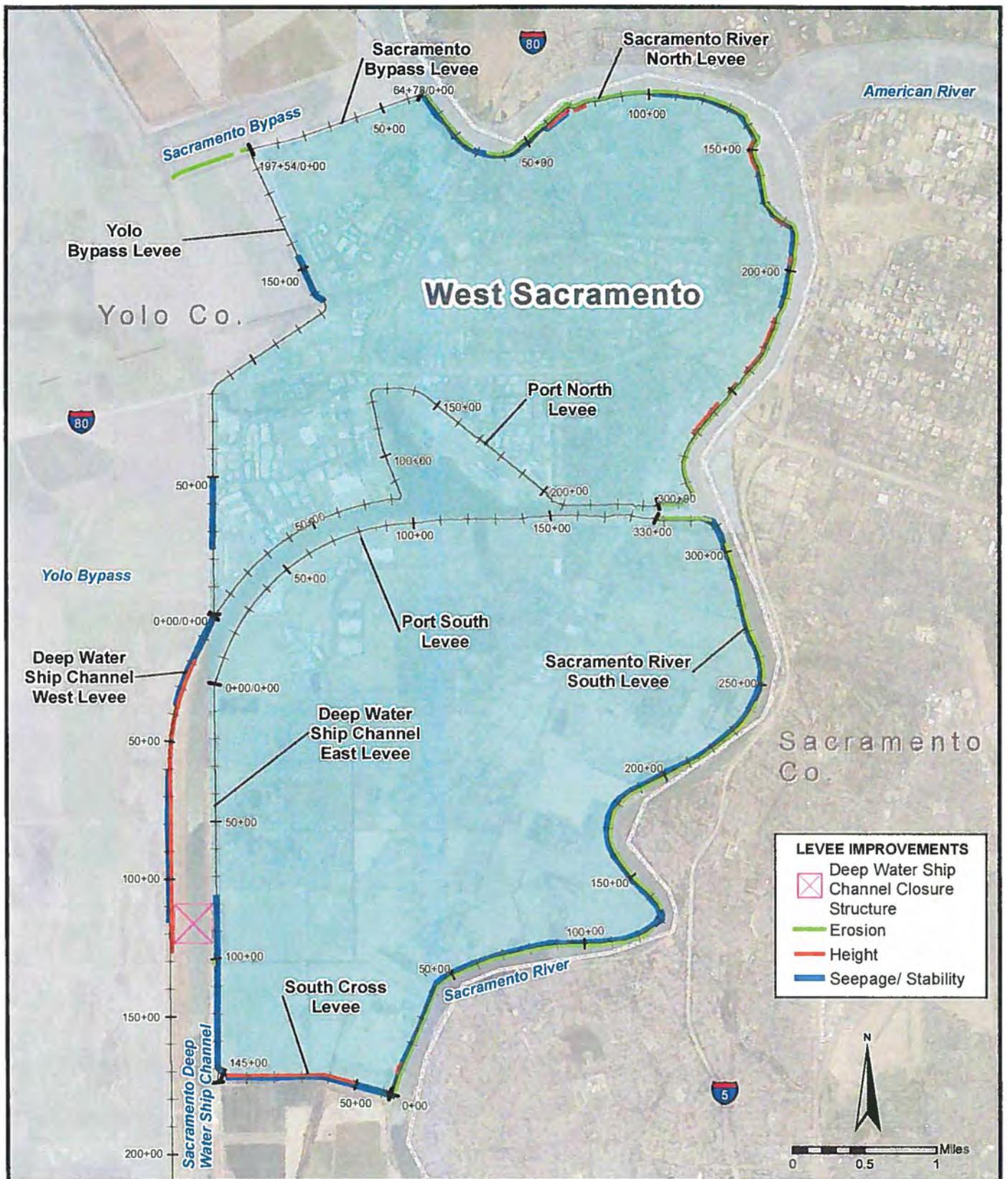


**WEST SACRAMENTO GRR  
WEST SACRAMENTO, CALIFORNIA**

**LEVEE IMPROVEMENTS  
ALTERNATIVE 2**

**U.S. ARMY CORPS OF ENGINEERS  
SACRAMENTO DISTRICT**





**Legend**

- Levee Centerline
- Floodways
- West Sacramento Project Area
- County Lines

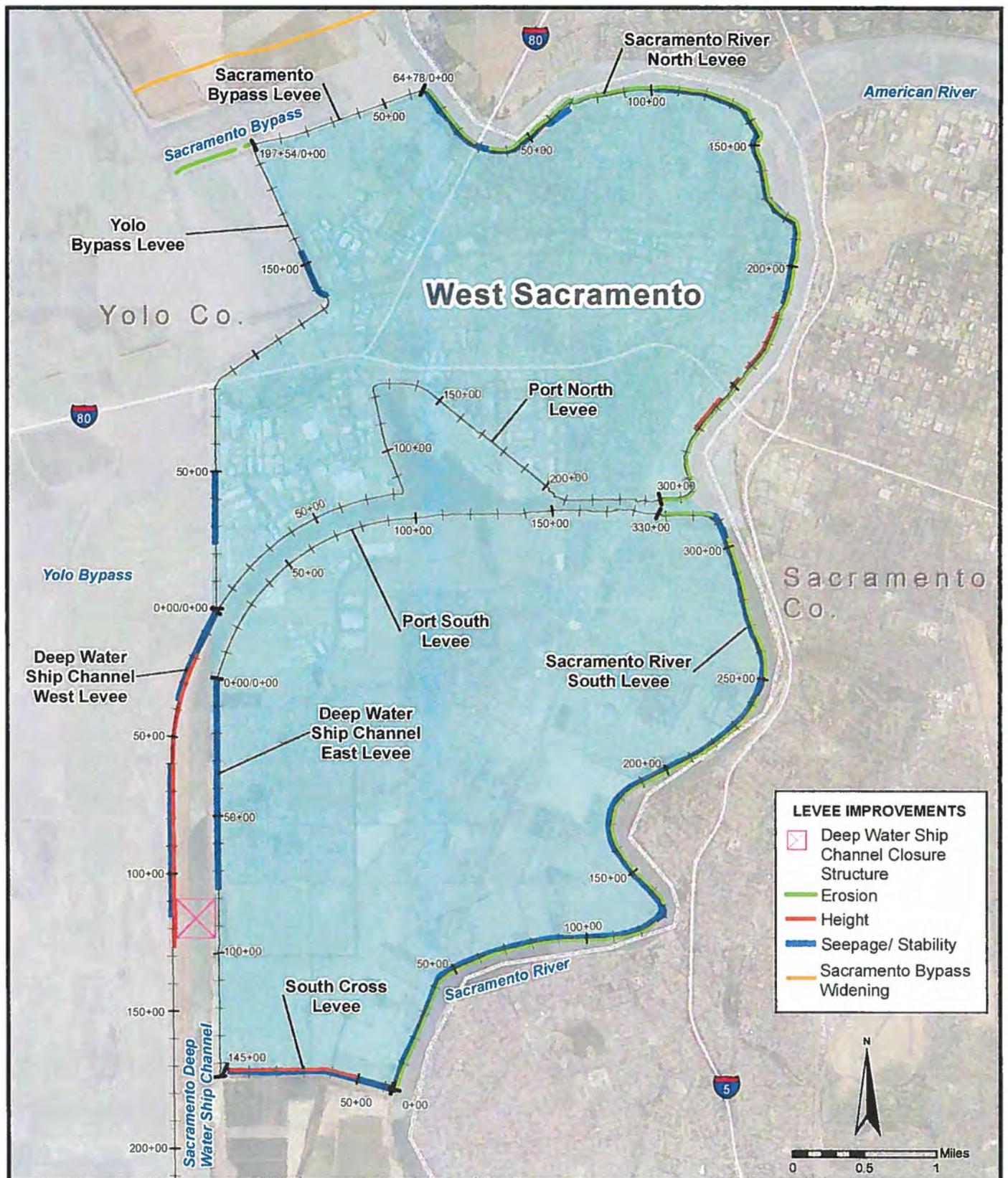


WEST SACRAMENTO GRR  
WEST SACRAMENTO, CALIFORNIA

**LEVEE IMPROVEMENTS  
ALTERNATIVE 3**

U.S. ARMY CORPS OF ENGINEERS  
SACRAMENTO DISTRICT





**Legend**

- Levee Centerline
- West Sacramento Project Area
- Floodways
- County Lines

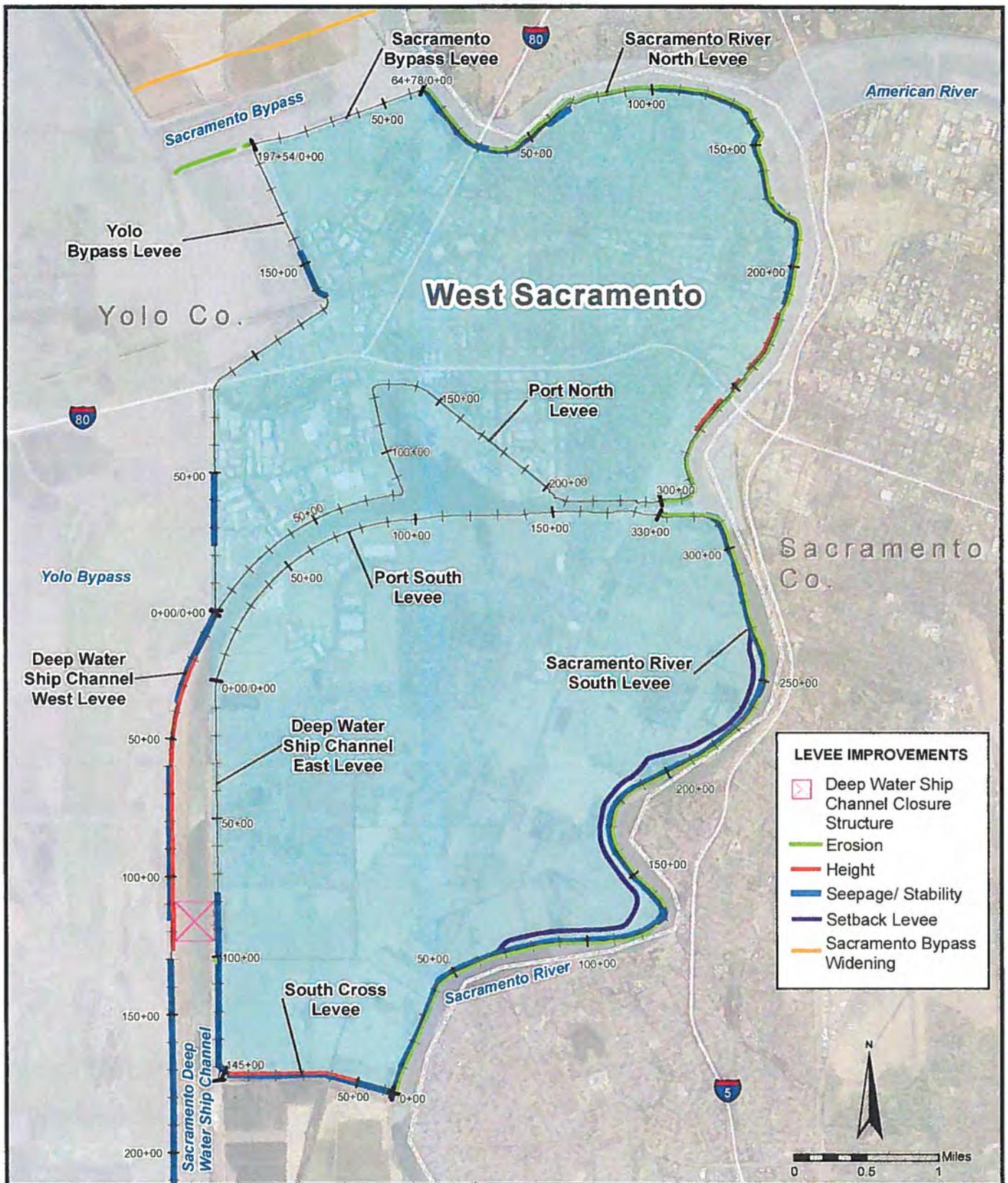


WEST SACRAMENTO GRR  
WEST SACRAMENTO, CALIFORNIA

**LEVEE IMPROVEMENTS  
ALTERNATIVE 4**

U.S. ARMY CORPS OF ENGINEERS  
SACRAMENTO DISTRICT





**Legend**

- Levee Centerline
- Floodways
- West Sacramento Project Area
- County Lines



**WEST SACRAMENTO GRR  
WEST SACRAMENTO, CALIFORNIA**

**LEVEE IMPROVEMENTS  
ALTERNATIVE 5**

**U.S. ARMY CORPS OF ENGINEERS  
SACRAMENTO DISTRICT**



**Appendix B**

**Federal Endangered and Threatened Species that May  
Occur in or May be Affected by the Project**



U.S. Fish & Wildlife Service  
 Sacramento Fish & Wildlife Office  
 Federal Endangered and Threatened Species that Occur in  
 or may be Affected by Projects in the  
*Sacramento West*  
 U.S.G.S. 7 1/2 Minute Quad  
 Document Number: 130703083953

**Listed Species**

**Invertebrates**

- *Branchinecta lynchi*
  - vernal pool fairy shrimp (I)
- *Desmocerus californicus dimorphus*
  - valley elderberry longhorn beetle (I)
- *Lepidurus packardii*
  - vernal pool tadpole shrimp (E)

**Fish**

- *Acipenser medirostris*
  - green sturgeon (T) (NMFS)
- *Hypomesus transpacificus*
  - Critical habitat, delta smelt
  - delta smelt (I)
- *Oncorhynchus mykiss*
  - Central Valley steelhead (T) (NMFS)
  - Critical habitat, Central Valley steelhead (NMFS)
- *Oncorhynchus tshawytscha*
  - Central Valley spring-run chinook salmon (T) (NMFS)
  - Critical Habitat, Central Valley spring-run chinook (NMFS)
  - Critical habitat, winter-run chinook salmon (NMFS)
  - winter-run chinook salmon, Sacramento River (E) (NMFS)

**Amphibians**

- *Ambystoma californiense*
  - California tiger salamander, central population (I)
- *Rana draytonii*
  - California red-legged frog (I)

**Reptiles**

- *Thamnophis gigas*
  - giant garter snake (I)

**Birds**

- *Coccyzus americanus occidentalis*
  - Western yellow-billed cuckoo (I)
- *Vireo bellii pusillus*
  - Least Bell's vireo (E)

**Key:**

- (E) Endangered - Listed as being in danger of extinction.
- (T) Threatened - Listed as likely to become endangered within the foreseeable future.
- (NMFS) Species under the Jurisdiction of the National Oceanic & Atmospheric Administration Fisheries Service. Consult with them directly about these species.
- Critical Habitat - Area essential to the conservation of a species.

**Important Information About Your Species List****How We Make Species Lists**

We store information about endangered and threatened species lists by U.S. Geological Survey 7½ minute quads. The United States is divided into these quads, which are about the size of San Francisco.

The animals on your species list are ones that occur within, or may be affected by projects within, the quads covered by the list.

- Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.
- Amphibians will be on the list for a quad or county if pesticides applied in that area may be carried to their habitat by air currents.
- Birds are shown regardless of whether they are resident or migratory. Relevant birds on the county list should be considered regardless of whether they appear on a quad list.
- 

**Plants**

Any plants on your list are ones that have actually been observed in the area covered by the list. Plants may exist in an area without ever having been detected there. You can find out what's in the surrounding quads through the California Native Plant Society's online Inventory of Rare and Endangered Plants.

**Surveying**

Some of the species on your list may not be affected by your project. A trained biologist and/or botanist, familiar with the habitat requirements of the species on your list, should determine whether they or habitats suitable for them may be affected by your project. We recommend that your surveys include any proposed and candidate species on your list.

See our Protocol and Recovery Permits pages. For plant surveys, we recommend using our Guidelines for Conducting and Reporting Botanical Inventories. The results of your surveys should be published in any environmental documents prepared for your project.

**Your Responsibilities Under the Endangered Species Act**

All animals identified as listed above are fully protected under the Endangered Species Act of 1973, as amended. Section 9 of the Act and its implementing regulations prohibit the take of a federally listed wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any such animal. Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter (50 CFR §17.3).

**Take incidental to an otherwise lawful activity may be authorized by one of two procedures:**

- If a Federal agency is involved with the permitting, funding, or carrying out of a project that may result in take, then that agency must engage in a formal consultation with the Service.
- During formal consultation, the Federal agency, the applicant and the Service work together to avoid or minimize the impact on listed species and their habitat. Such consultation would result in a biological opinion by the Service addressing the anticipated effect of the project on listed and proposed species. The opinion may authorize a limited level of incidental take.
- If no Federal agency is involved with the project, and federally listed species may be taken as part of the project, then you, the applicant, should apply for an incidental take permit. The Service may issue such a permit if you submit a satisfactory conservation plan for the species that would be affected by your project.
- Should your survey determine that federally listed or proposed species occur in the area and are likely to be affected by the project, we recommend that you work with this office and the California Department of Fish and Game to develop a plan that minimizes the project's direct and indirect impacts to listed species and compensates for project-related loss of habitat. You should include the plan in any environmental documents you file.

**Critical Habitat**

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as critical habitat. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal.

Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, there will be a separate line for this on the species list. Boundary descriptions of the critical habitat may be found in the Federal Register. The information is also reprinted in the Code of Federal Regulations (50 CFR §17.95). See our Map Room page.

**Candidate Species**

We recommend that you address impacts to candidate species. We put plants and animals on our candidate list when we have enough scientific information to eventually propose them for listing as threatened or endangered. By considering these species early in your planning process you may be able to avoid the problems that could develop if one of these candidates was listed before the end of your project.

**Species of Concern**

The Sacramento Fish & Wildlife Office no longer maintains a list of species of concern. However, various other agencies and organizations maintain lists of at-risk species. These lists provide essential information for land management planning and conservation efforts.

**Wetlands**

If your project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act, you will need to obtain a permit from the U.S. Army Corps of Engineers. Impacts to wetland habitats require site specific

mitigation and monitoring. For questions regarding wetlands, please contact Mark Littlefield of this office at (916) 414-6520.

**Updates**

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be May 4, 2015.

**Appendix C**  
**Biological Opinion of the West Sacramento General Reevaluation Report Project**  
**West Sacramento, California**





## United States Department of the Interior



In Reply Refer to:  
FF08ESMF00-  
2014-F-0434-2

FISH AND WILDLIFE SERVICE  
Sacramento Fish and Wildlife Office  
2800 Cottage Way, Suite W-2605  
Sacramento, California 95825-1846

JAN 06 2015

Ms. Alicia E. Kirchner  
Chief, Planning Division  
U.S. Army Corps of Engineers  
1325 J Street  
Sacramento, California 95814

Subject: Formal Consultation on the West Sacramento Project General Reevaluation Report,  
Yolo County, California

Dear Ms. Kirchner:

This letter is in response to the U.S. Army Corps of Engineers (Corps) November 21, 2014, request for initiation of formal consultation with the U.S. Fish and Wildlife Service (Service) on the proposed West Sacramento Project General Reevaluation Report (West Sacramento GRR Project or project) in Yolo County, California. Your request, which included the November 2014 Biological Assessment, West Sacramento, California General Reevaluation Study and Section 408 Permission (biological assessment), was received by mail from the Corps by the Service on November 24, 2014. The biological assessment presents an evaluation of the West Sacramento GRR Project effects on species federally-listed under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). This response is provided under the authority of the Act, and in accordance with the implementing regulations pertaining to interagency cooperation (50 CFR 402).

The purpose of the West Sacramento GRR Project is to evaluate flood risk and provide improvements to flood management for the City of West Sacramento. It includes the Southport Project, which is to be completed as an early implementation project by the West Sacramento Area Flood Control Agency (WSAFCA) upon permission from the Corps, pursuant to Section 14 of the River and Harbors Act of 1899 (33 U.S.C. 408). Pursuant to 50 CFR 402.12(j), you submitted the biological assessment for our review and requested concurrence with the findings presented therein. These findings conclude that the proposed project may affect, and is likely to adversely affect the federally-threatened giant garter snake (*Thamnophis gigas*) (snake), federally-threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (beetle), and federally-threatened delta smelt (*Hypomesus transpacificus*) (smelt), as well as delta smelt critical habitat.

In considering your request, we based our evaluation of the biological assessment's findings on the following: (1) your consultation request and biological assessment received November 24, 2014; (2) site visits with Service, Corps, WSAFCA, ICF International (ICF) representatives, and others; (3) numerous meetings with the Service, Corps, National Marine Fisheries Service (NMFS), WSAFCA, ICF, and others; (4) e-mail correspondence and other communication between the Service and the Corps; and (5) other information available to the Service. A complete administrative record is on file at the Sacramento Fish and Wildlife Office.

### **Consultation History**

- May 26, 2011* The Service attended a stakeholders meeting outlining preliminary plans for the Southport Early Implementation Project (Southport Project). The Southport Project was planned to proceed in advance of the other portions of the West Sacramento GRR Project.
- August 15, 2011* WSAFCA held a stakeholder meeting and field visit for the Southport Early Implementation Project of the West Sacramento GRR Project, which the Service and the Corps attended.
- February 12, 2013* The Corps provided the Service a draft biological assessment prepared by ICF for the Southport Project.
- February 21, 2013* The Service provided comments on the draft biological assessment for the Southport Project. The comments centered on the need to include the delta smelt in the biological assessment.
- June 3, 2013* The Service attended a meeting and site visit along with representatives from WSAFCA, ICF, NMFS, the California Department of Fish and Wildlife (CDFW), and others to review the proposed plans for the Southport Project.
- June 5, 2013* The Service received a formal consultation request for the Southport Project from the Corps, dated June 4, 2013, along with a biological assessment.
- August 27, 2013* The Corps hosted a meeting with the Service, NMFS, WSAFCA, and ICF. Mike Hendrick (NMFS) noted that NMFS would be preparing an insufficiency letter based on the project design noted in the Southport Project biological assessment.
- September 4, 2013* Harry Kahler (Service) e-mailed Tanis Toland (Corps) noting that in lieu of impending changes to the Southport Project description, work on the consultation would be suspended until the project description was updated.
- December 18, 2013* The Service attended a meeting at ICF discussing design modifications to the Southport Project that addressed concerns raised in NMFS insufficiency letter and previous meetings.

- January 23, 2014* The Service received from the Corps a draft biological assessment for the West Sacramento GRR Project. The biological assessment did not contain information regarding the Southport Project.
- March 20, 2014* The Corps hosted a meeting attended by the Service and NMFS to discuss the inter-relatedness of concurrent projects – the Southport Project, the West Sacramento West Sacramento GRR Project, the Sacramento River Bank Protection Project, and the American River Watershed Investigation, Common Features, General Reevaluation Report Project.
- April 21, 2014* The Corps hosted a meeting attended by the Service and NMFS. The Service recommended that the Southport Project and the West Sacramento GRR Project be included in one biological opinion.
- June 9, 2014* The Service received a request from the Corps to initiate formal consultation on the West Sacramento GRR Project. The initiation letter and biological assessment included the Southport Project.
- June 19, 2014* The Service conveyed to the Corps via telephone and e-mail that effects to smelt and smelt critical habitat are quantified in terms of acreage, rather than in linear feet of river, as is the case for salmonids. The Service requested the Corps provide the acreage of smelt shallow water habitat that is to be affected by the West Sacramento GRR Project.
- July 23, 2014* The Service sent a letter to the Corps detailing the need for more information regarding the amount of smelt habitat that will be impacted by the project and the amount of smelt habitat that will be created.
- September 24, 2014* The Service received a response from the Corps, dated September 23, 2014, describing the amount of smelt shallow water habitat that will be impacted by the West Sacramento GRR Project and the amount that will be created by the Southport Project.
- October 16, 2014* The Corps held a meeting with the Service and NMFS, stating that they would be seeking incidental take coverage from Section 9 of the Act for the West Sacramento GRR Project as a whole, rather than taking a programmatic approach.
- October 20, 2014* The Service downloaded an updated biological assessment from the Corps' FTP site.
- October 27, 2014* The Corps sent via electronic mail a copy of a letter to the Service that officially withdrew the June 4, 2013, request for consultation for the Southport Project based on updated information regarding the West Sacramento GRR Project Plans.

- November 21, 2014* The Corps sent via electronic mail a new request to initiate formal consultation for the West Sacramento GRR Project. An electronic link was included that provided access to the November 2014 final biological assessment.
- November 24, 2014* The Service received by mail the signed request to initiate formal consultation for the West Sacramento GRR Project along with the biological assessment that addressed concerns raised by the Service and NMFS following the initiation request received June 9, 2014.
- November 25, 2014* The Service requested and received, via electronic mail and telephone conversations, clarification regarding the identification and selection of potential sites for construction borrow material. The Corps explained that although potential borrow sites are identified for the West Sacramento GRR Project, the sites are subject to field verification for suitability.

## BIOLOGICAL OPINION

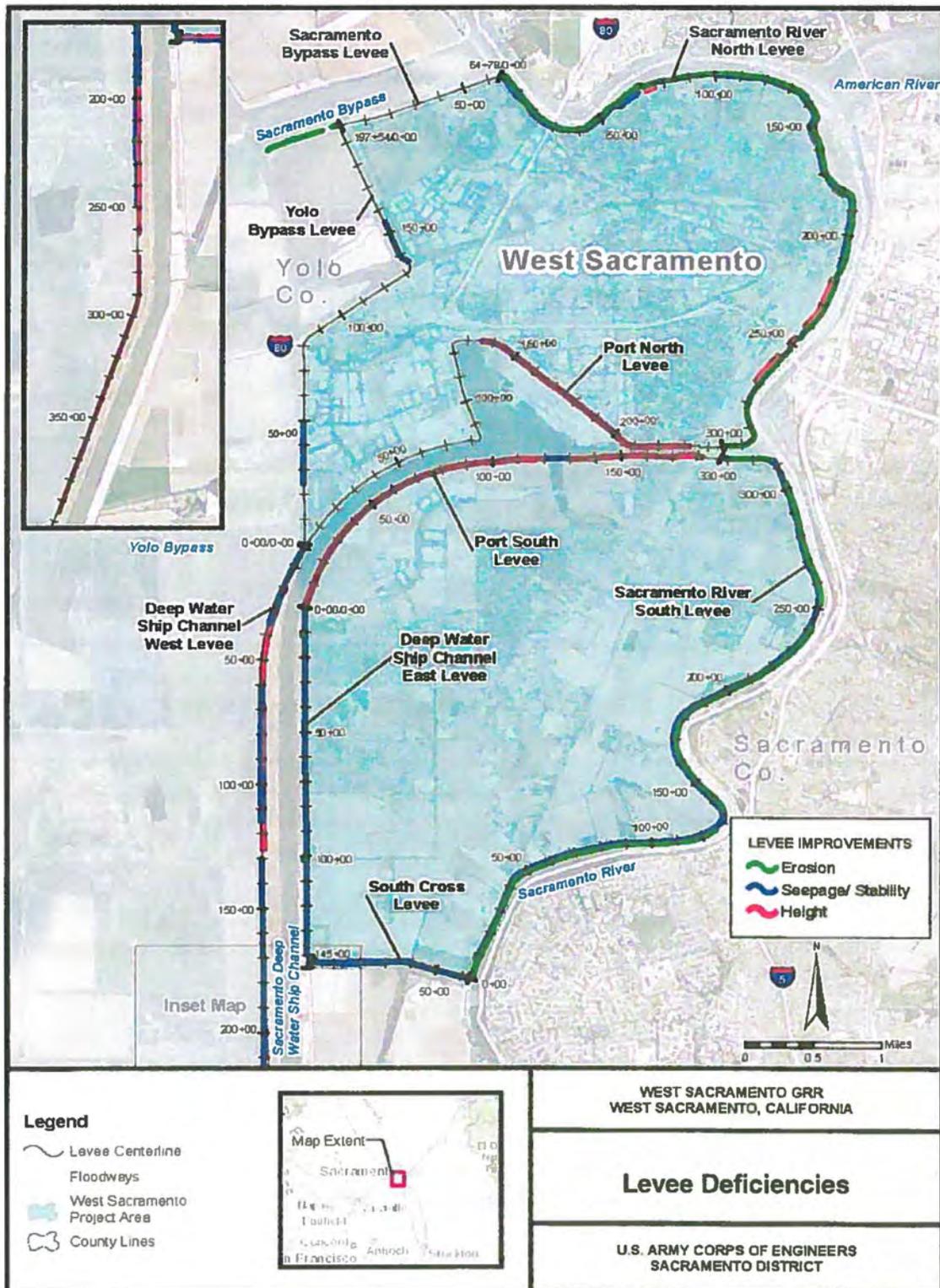
### **Description of the Action**

In 2006, a comprehensive evaluation of West Sacramento levees was completed by WSAFCA, in conjunction with the California Department of Water Resources, to determine the current level of flood protection provided by the levee system, to identify the magnitude and severity of levee deficiencies, and to propose flood risk reduction measures (HDR 2008). Results of the comprehensive evaluation revealed multiple levee deficiencies that would require substantial improvements to meet flood protection standards as implemented federally by the Corps. Furthermore, Senate Bill 5 signed in 2007 by Governor Arnold Schwarzenegger requires that urban areas such as West Sacramento achieve 200-year level flood protection by 2025.

The West Sacramento GRR Project is a Corps feasibility study of the improvements needed to provide West Sacramento with 200-year level flood protection. Its primary purpose is to assess and address the levee deficiencies on the nearly 50 miles of levees surrounding West Sacramento. Improvements to levees will be made incrementally, rather than altogether as one large project. In fact, three levee reaches with severe deficiencies have already been constructed by WSAFCA as Early Implementation Projects at the I Street Bridge, the CHP Academy, and The Rivers sites, all progressing in advance of the West Sacramento GRR Project. A fourth Early Implementation Project, known as the Southport Project, is included herein as part of the West Sacramento GRR Project.

West Sacramento is divided into two basins by levees, a north basin of about 6,100 acres and a south basin of about 6,900 acres. Deficiencies identified among different levee reaches of each basin generally include seepage, slope stability, erosion, and height insufficiencies (Figure 1). Construction will occur sequentially through each levee reach over a 19-year period, beginning with the Sacramento River South Levee. As a proposed Early Implementation Project, the Southport Project design along the Sacramento River South levee reach is more refined and detailed than the rest of the West Sacramento GRR Project. The proposed levee remediation measures vary among the nine levee reaches of the two basins and are summarized in Table 1.

**Figure 1.** West Sacramento General Reevaluation Report Project levee deficiencies, City of West Sacramento, Yolo County, California (Corps 2014b).



**Table 1.** Proposed remediation by levee reach, West Sacramento General Reevaluation Report, City of West Sacramento, Yolo County, California (Corps 2014b).

Levee Reach	Construction Sequence and Duration*	Seepage Remediation	Stability Remediation	Overtopping Remediation	Erosion Protection
NORTH BASIN					
Sacramento River North	3 (2 years)	Cutoff Wall	Cutoff Wall	Levee Raise	Bank Protection
Port North	9 (2 years)	---	---	Floodwall	---
Yolo Bypass	4 (1 year)	Cutoff Wall	Cutoff Wall	---	---
Sacramento Bypass Training Levee	2 (1 year)	---	---	---	Bank Protection
SOUTH BASIN					
South Cross	8 (2 years)	Stability Berm, Relief Wells	---	Levee Raise	---
Deep Water Ship Channel East	7 (3 years)	Cutoff Wall	Cutoff Wall	Levee Raise	Bank Protection
Deep Water Ship Channel West	5 (3 years)	Cutoff Wall	Cutoff Wall	Levee Raise	---
Port South	6 (1 year)	Cutoff Wall	Cutoff Wall	Levee Raise	---
Sacramento River South	1 (3 years)**	Setback Levee, Cutoff Wall, Seepage Berm	Setback Levee, Cutoff Wall, Seepage Berm	---	Setback Levee, Bank Protection

\* Construction throughout all levee reaches is scheduled to occur sequentially over a 19-year period.

\*\* Construction of flood-risk reduction measures will require 3 years; contouring and restoration of the associated offset floodplain area will require an additional 3 years.

### Operation and Maintenance

As construction along levee reaches throughout the West Sacramento GRR Project area is completed, re-sloping and compacting will occur as needed. After construction, piezometers will be installed at various locations along the levees to monitor groundwater levels. Monthly visual inspections by driving along access roads on the crown will monitor levee conditions. Access roads will be maintained yearly with new aggregate base or substrate if necessary. Upon completion of construction, levees will be maintained per the approved operations and maintenance (O&M) manual applicable to each levee reach throughout the West Sacramento GRR Project area. Levees

are expected to be mowed up to four times a year to control vegetation. Herbicide applications will be used as needed. Burrowing mammal activity will be controlled monthly by baiting with pesticides.

Details of each specific construction measures are described below, followed by descriptions of the deficiencies and corrective construction measures for each levee reach of the West Sacramento GRR Project.

### **Construction Methods**

Several construction methods will be used to alleviate seepage, slope stabilization concerns, overtopping, and erosion. In addition, some general construction measures will be implemented throughout the West Sacramento GRR Project, regardless of the specific corrective measures that will be applied. Flood risk reduction measure construction activities will primarily occur during the typical construction season for flood control projects, April 15 to October 31.

#### General Construction Measures

##### *Standard Levee Footprint*

On all levees that are out of compliance with Corps policies, a standard levee footprint will be established during construction. The standard levee footprint consists of a 20-foot crown with 3 horizontal:1 vertical (3H:1V) levee slopes. If a 3H:1V landside slope is not possible given the site-specific conditions, then a minimum slope of 2H:1V will be established. Also, a 20-foot-wide maintenance access buffer will be established on both the landside and waterside levee toes. If 20 feet is not possible, given site-specific conditions, then a minimum of 10 feet will be designed as a buffer. All encroachments into the levee footprint will be brought into compliance with Corps policy or removed. Encroachments include buildings, certain vegetation, utility poles, and pump stations, as well as underground pipes, conduits, and cables. Bringing into compliance generally means relocation, reconstruction, or retrofitting. Any utility lines found within the levee footprint will either be relocated above the new levee prism, or equipped with positive closure devices for through-lines. Private encroachments will be removed by the non-Federal sponsor (WSAFCA) or property owner prior to construction.

##### *Vegetation Policy Compliance*

The Corps has established and plans to follow guidelines for landscape planting and vegetation management at levees, floodwalls, embankment dams, and appurtenant structures, as described in Engineering Technical Letter (ETL) 1110-2-583 (Corps 2014a). The primary purpose of the vegetation-free zone is to provide a reliable corridor of access to, and along, flood control structures. A three-dimensional vegetation-free zone will surround all levees, floodwalls, embankment dams, and critical appurtenant structures in all flood damage reduction systems. The vegetation-free zone applies to all vegetation except perennial grass species, which are permitted for the purpose of erosion control. The vegetation free zone extends 15 feet from both landside and waterside levee toes, and 8 feet vertically.

A variance from the vegetation policy is being sought for work along the Sacramento River North and Sacramento River South levee reaches. Along much of the Sacramento River within the project area, the distance between the levee toe and the river waterline is sufficient to allow vegetation to remain along the riverbank without a variance. However, in some places, trees will be thinned along

the Sacramento River North Reach to allow placement of rock slope protection, and therefore would require a variance.

#### *Borrow Materials*

A maximum estimate of 9 million cubic yards of borrow material will be needed to construct the West Sacramento GRR Project. Because most of the project is in the preliminary stages of design, detailed studies of each levee reach borrow needs have not been completed. A worst case scenario was evaluated for the volume of borrow material needed. Actual volumes exported from any single borrow site may be adjusted to match demands for fill.

To identify potential locations for borrow material, soil maps and land use maps were obtained for a 20-mile radius surrounding the West Sacramento GRR Project area (Figure 2). The criteria used to determine potential locations were based on current land use patterns, soil types from U.S. Soil Conservation Service (SCS), and the Corps' criteria for material specifications. The data from the land use maps and the SCS will be field verified. To reduce impacts, the closest identified potential borrow sites will be evaluated for suitability first, with additional sites being evaluated as needed. Any identified potential borrow sites outside of the City of West Sacramento that may affect federally-listed species, or may adversely modify designated federally-listed species critical habitat, will not be used for borrow material. Borrow sites will only be obtained from willing sellers.

The excavation limits on the borrow sites will provide a minimum buffer of 50 feet from the edge of the site boundary. From this setback, the slope from the existing grade down to the bottom of the excavation will be no steeper than 3H:1V. Excavation depths from the borrow sites will be determined based on available suitable material and local groundwater conditions. The borrow sites will be stripped of top material and excavated to appropriate depths. Once material is extracted, borrow sites will be returned to their existing use whenever possible, or these lands could be used to mitigate for project effects, if appropriate.

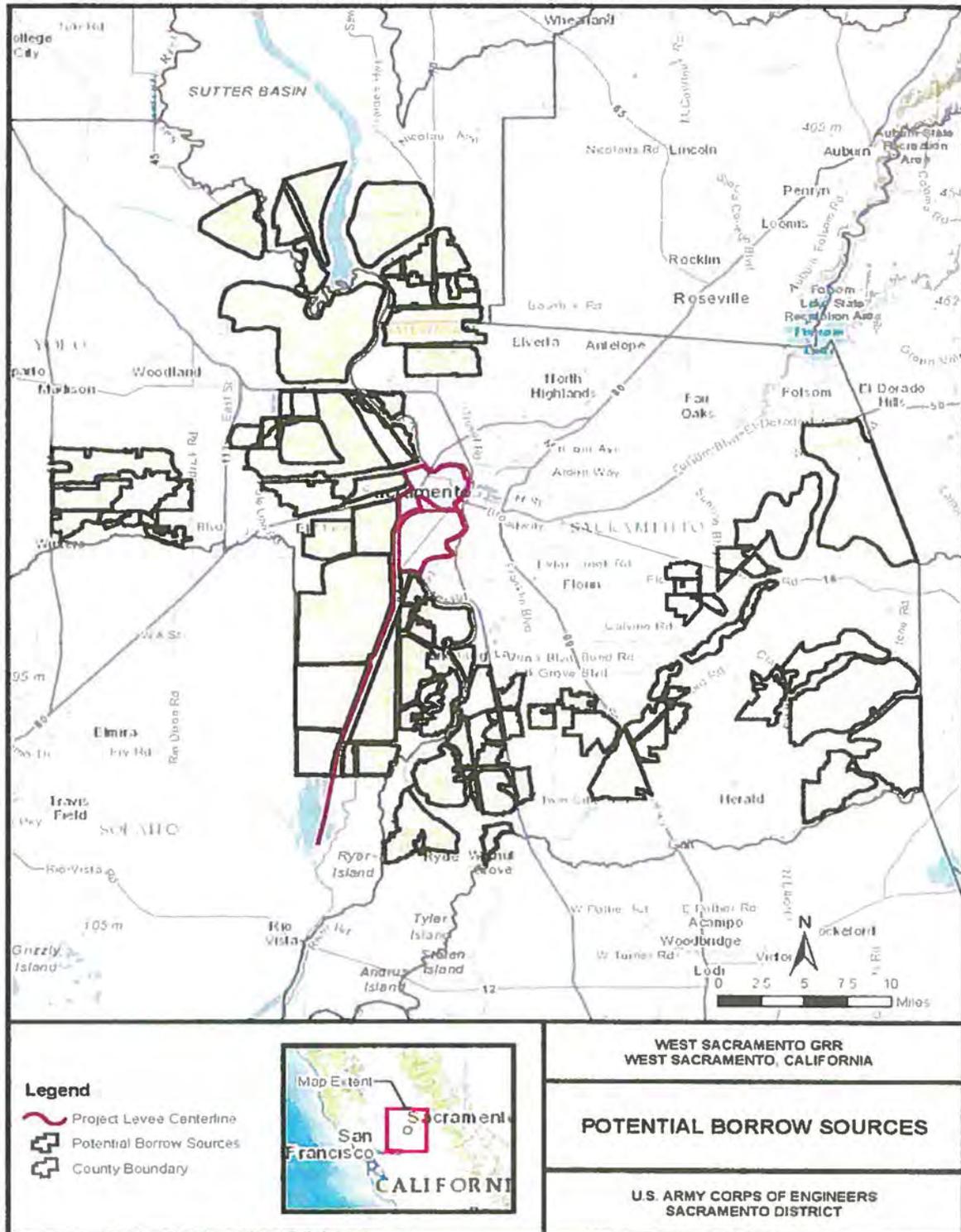
#### Seepage Remediation and Slope Stabilization

##### *Slurry Cutoff Walls*

Conventional Open Trench Cutoff Wall: A 3-foot-wide trench is dug from the top of the levee centerline up to 85 feet deep into the substrate materials. As the trench is excavated, it is filled with a temporary bentonite slurry to prevent cave-ins. To form the wall, the soil from the excavation is mixed with hydrated bentonite or cement and backfilled into the trench, displacing the temporary slurry. Once the permanent soil-slurry mix is hardened, the levee embankment is reconstructed and capped with an impervious or semi-impervious soil. Heavy equipment to be used for cutoff walls includes bulldozers, haulers, excavators, scrapers, rollers, and water trucks.

Clamshell Method Cutoff Wall: The clamshell method is similar to the conventional open trench method, yet also employs a dragline crane with a clamshell bucket. The initial trench is excavated and backfilled as described for the conventional open trench method, yet the dragline crane and clamshell bucket is used when the trench becomes too deep to complete conventionally. The bentonite grout is mixed with the native soil and poured in the trench as the clamshell is removed. Cement is added to the mix at times to add strength and decrease curing time.

**Figure 2.** Potential Locations for Borrow Material within a 20-mile Radius of the West Sacramento General Reevaluation Report Project action area, California, 2014.



Deep Soil Mixing Cutoff Wall: At the wall site a crane with two to four augers will drill through the levee crown to a depth of up to 140 feet. High-pressure hoses will carry the grout from the batching plant to the wall site, where the grout is injected through the augers and mixed with native soils. As the drilling apparatus progresses along the levee crown, a series of overlapping columns of grout mixture are left to form the wall.

Because large quantities of a cement-bentonite grout are used, a contractor-provided onsite batch plant is necessary. The batch plant will consist of an aggregate storage system, an aggregate rescreen system if needed, a rewashing facility if needed, the batching system, cement storage, ice manufacturing, and the grout mixing and loading system. All aggregate used within the batch plant operations will be obtained from local commercial sources and delivered to the site. When the wall has hardened it is capped and the levee embankment is reconstructed with impervious or semi-impervious materials.

Jet Grouting: Jet grouting typically is used in constructing a slurry cutoff wall to access areas other methods cannot. Jet grouting will be used around existing utilities not proposed for removal, and at bridges along the project levees. It involves injecting fluids or binders into the soil at very high pressure to a maximum depth of about 130 feet. The injected fluid can be grout; grout and air; or grout, air, and water. Jet grouting breaks up soil and, with the aid of a binder, forms a homogenous mass that solidifies over time to create a mass of low permeability.

Equipment required for jet grouting consists of a drill rig complete with a high flow pump and portable batch plant. Jet-grouted columns range from 1 to 16 feet in diameter and typically are interconnected to form cutoff barriers or structural sections. A construction crew usually consists of a site supervisor, pump operator, batch plant operator, chuck tender, and driller, and can construct two 6-foot diameter 50-foot columns per day consisting of about 100 cubic yards of grout injected per 8-hour shift.

To provide a wide enough working platform on the levee crown, the upper portion of some segments of the levee may require degradation with a paddle wheel scrapper. Material will be scraped and stockpiled at a nearby stockpile area. Hauling at the work area will involve scraper runs along the levee to the staging area, and grout, bentonite, and water deliveries to the batch plant.

#### *Landside Berms*

Seepage Berm: Seepage berms are constructed in areas where geotechnical investigations indicate that safely releasing seepage water on the landside is more appropriate than a cutoff wall. Generally a seepage berm extends outward from the landside toe of the levee to a width of 70 to 100 feet. The berm is about 5 feet high at the levee toe and tapers to about 3 feet high at the berm toe. The length of the berm is dependent upon the levee seepage concerns.

To construct a seepage berm, the ground is first cleared, grubbed and stripped. If the soil is found to be adequate for berm construction during levee degradation, it will be stockpiled for use later. Otherwise, soils from nearby borrow pits will be used, or if necessary, trucked onsite from other locations. A bulldozer and front-end loader will be used at borrow sites to load haul trucks. Motor graders will be used onsite to grade materials dumped by haul trucks. The fill material is placed in 1- to 2-foot lifts for compaction by sheepsfoot rollers. The width of the berm is dependent on the permeability of the fill material. Water trucks are used to aid compaction and decrease dust emissions. Upon completion, berms are hydroseeded with a native seed mix of grass and forbs.

Additionally, some seepage berms are constructed with a drainage relief trench at the toe of the berm. Generally, a drainage trench is made with loose gravel or sand beneath the toe of the berm materials to allow the drainage of permeated water. Also, a 15-foot vegetation free zone running parallel to the seepage berm is designed to allow O&M access.

**Stability Berm:** Stability berms are constructed along the landside toe of levees with the purpose of providing support to the levee as a buttress. The height of a stability berm is usually  $2/3$  the height of the levee, and the length is dependent on the structural needs of the levee reach. The construction of stability berms is similar to the construction of seepage berms. Plans for the South Cross levee reach include a stability berm.

#### *Adjacent Levees*

Adjacent levee designs essentially widen the existing levee, thereby allowing the adjacent levee geometry to be restructured on the landside to a 3H:1V slope, and also adding stability. Because adjacent levees are constructed on the landside, the waterside levee slopes are generally left with existing vegetation in place.

The first construction phase includes clearing, grubbing, and stripping the work site and any construction staging areas, if necessary. A trapezoidal trench is cut at the toe of the slope and the levee embankment then is cut in a stair-step fashion to allow the new material to be keyed into the existing material. As with berm construction, bulldozers excavate and stockpile material from a nearby borrow site. Front-end loaders load haul trucks with the borrow material, and the haul trucks subsequently transport it to the adjacent levee site. After the haul trucks dump the material, dozers level it as needed. Sheepsfoot rollers compact the material, and water trucks distribute water over the material to ensure proper moisture for compaction. The landside levee will be graded at a 3H:1V slope, and the levee crown will be at least 20 feet wide. The slope may be track-walked with a dozer. The levee crown will be finished with an aggregate base or paved road, depending on the type and level of access desired. Either condition will require importation of material with dump trucks, placement with a loader and motor grader, and compaction. A paver will be required for asphalt placement.

#### *Sheet Pile Wall*

A sheet pile wall is proposed at the Stone Locks to tie together the levees on both sides of the Barge Canal at the end of the Sacramento River Deep Water Ship Channel. A trench will be excavated along the sheet pile alignment to allow the pile to be driven to the proposed depth. A driving template fabricated from structural steel will control the alignment as the sheet pile is installed. A hydraulic or pneumatically operated pile driving head attached to a crane drives the sheet pile into the levee crown to the desired depth (up to 135 feet). An additional crane or excavator may be used to facilitate staging of the materials. The conditions of the site, driving pressure, hydrostatic loads, and corrosion considerations will determine the thickness and configuration of the sheet piles.

#### *Relief Wells*

Relief wells are used to address underseepage and will be applied only on site-specific conditions rather than as a segment-wide application. They will be located along adjacent and setback levee toes in the South Basin and only in segments where geotechnical analyses have identified continuous sand and gravel layers and the presence of an adequate impermeable layer. Relief wells are passive systems that are constructed near the levee landside toe to provide a low-resistance pathway for under-seepage to exit to the ground surface in a controlled and observable manner. Relief wells

generally are spaced at 50- to 150-foot intervals, dependent on the amount of underseepage, and extend to depths of up to 150 feet. Areas for relief well construction are cleared, grubbed, and stripped. During relief well construction, a typical well-drilling rig will be used to drill to the required depth and construct the well beneath the ground surface. The drill rig likely will be an all-terrain, track-mounted rig that could access the well locations from the levee toe.

Areas along the levee toe may be used to store equipment and supplies during construction of each well. Construction of each well and the lateral drainage system typically takes 10 to 20 days. Additional time may be required for site restoration.

### Overtopping Remediation

#### *Levee Height Raise*

Height deficiencies are constructed as needed following the completion of cutoff wall installation and levee geometry corrections. The required additional materials will come from identified borrow pits, stockpiled in staging areas, and hauled to the site with trucks and front end loaders. The levee will be hydroseeded once construction is complete.

#### *Floodwalls*

Floodwalls are proposed along the Port North levee around the Port of West Sacramento. To begin the floodwall construction, the area will be cleared, grubbed, stripped, and excavation will occur to provide space to construct the footing for the floodwall. The floodwall largely will be constructed from pre-fabricated materials, although it may be cast or constructed in place, and will be constructed almost completely upright. The height of the floodwalls varies from 1 to 4 feet, as required by water surface elevations. The waterside slope will be re-established to its existing slope and the levee crown will grade away from the wall and be surfaced with an aggregate base.

### Erosion Protection

#### *Levee Slope Revetment*

The primary erosion protection measure consists of waterside armoring of the levees to prevent erosion and subsequent damage to the levee. This measure consists of placing rock revetment on the river bank, and in some locations on the levee slope, to prevent erosion. The extent of the revetment will be based on site-specific analysis. Along the Sacramento Bypass Training levee, revetment will be placed on both sides of the levee to protect the levee in place when the Sacramento and Yolo Bypasses contain water. When necessary, eroded portions of the bank will be filled and compacted prior to the rock placement. The sites will be prepared by clearing and stripping the site prior to construction. Rock revetment will be placed around existing trees on the lower portion of the slope. Trees on the upper portion of the slope will be removed during degrading of levees for slurry cutoff walls and bank protection will be placed following reconstruction of the levee. Temporary access ramps will be constructed, if needed, using imported borrow material that will be trucked on site.

Revetment will be imported from an offsite location via haul trucks or barges. Revetment transported by haul trucks will be temporarily stored at a staging area located in the immediate vicinity of the construction site. A loader will be used to move revetment from the staging area to an excavator that will place the material on site. Rock required on the upper portions of the slopes

will be placed by an excavator located on top of the levee. Rock placement from atop the levee will require one excavator and one loader for each placement site.

Revetment transported by barges will not be staged, but placed directly on site by an excavator. Rock required within the channel, both below and slightly above the water line at the time of placement, will be placed by an excavator located on a barge. The excavator will construct a large rock berm in the water up to an elevation slightly above the mean summer water surface. Construction will require two barges: one barge will carry the excavator, while the other barge will hold the stockpile of rock to be placed on the channel slopes.

The bank protection will be placed on the existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After rock placement is complete, a small planting berm will be constructed in the rock, when feasible, to allow for some revegetation of the site outside of the vegetation free zone required by ETL 1110-2-583.

#### *Levee Biotechnical Measures*

Biotechnical measures will be implemented along lower velocity reaches to preserve existing vegetation. Biotechnical measures include the use of plant material and minimal amounts of rock to stabilize the eroded slope and prevent further loss of levee materials.

#### *Setback Levee*

A setback levee is an entirely new section of levee built at some distance inland from the existing levee section to be replaced. The new levee section is constructed to meet current design standards for height and geometry. Similar to the levee slope stabilization methods, a setback levee construction site is first cleared, grubbed, stripped, and all encroachments into the alignment are removed. Materials are stockpiled at staging areas after being removed and hauled from borrow sites. Heavy equipment is used to manipulate materials on site. Once the designed height is reached, a slurry cutoff wall is put in the levee crown via the conventional slot trench method or clamshell method, depending on the necessary depth. Topsoil is added and the new levee section is hydroseeded. An all-weather, aggregate base is constructed on the levee crown.

### **North Basin Levee Reaches**

Table 2 shows the extent to which each construction measure will occur within each levee reach in the North Basin. Refer to Figure 1 for the approximate location of each proposed improvement.

#### Sacramento River North

The Sacramento North levee reach extends 5.5 miles from the Sacramento Bypass southward to the William Stone lock structure at the north end of the Sacramento River Deep Water Ship Channel. It is scheduled as the third reach for construction of the project. Slurry cutoff walls will be installed to different depths along the reach to address seepage and slope stability concerns. The conventional open trench method will be used to install walls up to 85 feet deep. A deep slurry method will be used for walls that are installed to a depth greater than 85 feet. Also, to alleviate height deficiencies in some areas, the levee geometry will be restructured with fill materials. Erosion concerns along nearly the entire length of the Sacramento North levee reach will be addressed by bank protection measures. In general, bank protection will involve the placement of rock on the existing bank at a slope between 2V:1H to 3V:1H, depending on specific site conditions.

**Table 2.** The construction length, improvement, and construction measure of each levee reach within the North Basin of the West Sacramento General Reevaluation Report, City of West Sacramento, Yolo County, California (Corps 2014b).

North Basin Levee Reach	Length of Levee Reach (feet)	Length of Measure (feet)	Improvement	Measure
Sacramento River North Levee and Stone Lock Closure	31,270	30,000	Erosion	Bank Protection
		11,000	Seepage	Slurry Cutoff Wall to 30 feet
		1,500		Slurry Cutoff Wall to 80 feet
		500		Slurry Cutoff Wall to 45 feet
		5,500		Slurry Cutoff Wall to 110 feet
		4,600	Height	Embankment Fill
		550	Stone Lock Closure	Embankment Fill, Sheet Pile Wall
Port North Levee	23,225	8,500	Height	Floodwall, 4-10 feet
		14,000	Height	Embankment Fill
Yolo Bypass Levee	19,749	2,500	Seepage	Slurry Cutoff Wall to 40 feet
		2,000	Seepage	Slurry Cutoff Wall to 100 feet
Sacramento Bypass Training Levee	3,000	3,000	Erosion	Bank Protection

Additionally, the William Stone lock structure will be closed and the Sacramento River Deep Water Ship Channel barge canal will be blocked from the Sacramento River via a new levee embankment and sheet pile wall. A coffer dam will be constructed on the east side of the lock structure, and the new levee and sheet pile wall will be built within the dry area. The new levee will permanently connect the North and South Basins. It will require the relocation of three utility poles, two storm drains, and the removal of concrete infrastructure.

#### Port North

The Port North levee work is scheduled as the final reach of the West Sacramento GRR Project, extending 4.9 miles west from the William Stone lock structure at the Sacramento River. Work through the levee reach generally involves the construction of flood walls through the Port of West Sacramento to alleviate overtopping concerns (see Figure 1).

#### Yolo Bypass

To address seepage and slope stability problems, slurry cutoff walls will be constructed at two points along the Yolo Bypass levee. A conventional open trench cutoff construction method will be used

to install cutoff walls in two places to depths of 40 feet and 100 feet. The Yolo Bypass levee is scheduled as the fourth levee reach to be addressed in the West Sacramento GRR Project.

#### Sacramento Bypass Training Levee

Most of the south levee of the Sacramento Bypass was reconstructed as the CHP Academy Early Implementation Project in 2011. However, a 3,000-foot portion of the south levee that lies to the west of the CHP Academy Project is scheduled as the second levee reach to be addressed by the current West Sacramento GRR Project. Bank protection is proposed to address erosion issues.

### **South Basin Levee Reaches**

Table 3 shows the extent to which each construction measure will occur within each levee reach in the South Basin. Refer to Figure 1 for the approximate location of each proposed improvement.

#### South Cross

The South Cross levee reaches west from the Sacramento River at the Riverview area of West Sacramento, to the Sacramento River Deep Water Ship Channel. Plans include a landside berm to address stability issues and a levee raise to address height concerns. It is scheduled as the eighth of the nine levee reaches to be addressed by construction under the project.

#### Sacramento River Deep Water Ship Channel East

The east levee along the Sacramento River Deep Water Ship Channel protects the South Basin from inundation. Noted deficiencies in the east levee are seepage, slope stability, and insufficient height. Slurry cutoff walls will be installed to address the seepage and slope stability issues. In reconstructing the levee prism to address height concerns, the irrigation ditch at the landside toe of the levee will be moved landward, and will be replaced by two 48-inch diameter pipes in the area adjacent to existing housing development. The Sacramento River Deep Water Ship Channel east levee is scheduled as the seventh levee reach for construction of the project.

#### Port South

The Port South levee has overtopping and seepage issues, as well as slope stability problems in a few areas. To alleviate the stability and seepage concerns, a seepage berm will be constructed. Also, relief wells will be added in certain areas to control additional seepage. The levee will be raised as well to address overtopping concerns. The Port South levee will be the sixth levee reach scheduled for construction in the project.

#### Sacramento River Deep Water Ship Channel West

The west levee along the Sacramento River Deep Water Ship Channel provides a barrier between the ship channel and the Yolo Bypass. As a worst-case scenario, levee deficiencies at various locations along nearly 19 miles of the levee will be addressed. Slurry cutoff walls and seepage berms will be constructed to control seepage issues, and the levee will be raised to address overtopping concerns. On the west side of the levee, facing the Yolo Bypass, rock slope protection will be used to address erosion concerns. The Sacramento River Deep Water Ship Channel west levee is scheduled as the fifth reach for construction in the project.

**Table 3.** The construction length, improvement, and construction measure of each levee reach within the South Basin of the West Sacramento General Reevaluation Report, City of West Sacramento, Yolo County, California (Corps 2014b).

South Basin Levee Reach	Length of Levee Reach (feet)	Length of Measure (feet)	Improvement	Measure
South Cross Levee	6,273	1,100	Stability/Height	Stability Berm Embankment Fill
		5,000	Seepage/Height	Relief Wells Embankment Fill
Deep Water Ship Channel East Levee	17,171	1,500	Seepage	Slurry Cutoff Wall to 120 feet
		7,100	Seepage	Slurry Cutoff Wall to 130 feet
		2,600	Height	Embankment Fill
Port South Levee	16,262	15,600	Height	Embankment Fill
		1,000	Seepage	Slurry Cutoff Wall to 70 feet
Deep Water Ship Channel West Levee	100,260	9,000	Height/Seepage	Slurry Cutoff Wall to 85 feet
		7,000	Height/Seepage	Slurry Cutoff Wall to 50 feet
		9,000	Height/Seepage	Slurry Cutoff Wall to 75 feet
		75,300	Height	Embankment Fill
		100,000	Erosion	Bank Protection
Sacramento River South Levee	31,000	31,000	Seepage/Erosion	Setback Levee Bank Protection Slurry Cutoff Wall to 80 feet 70-foot Wide Seepage Berm

Sacramento River South – The Southport Project

The Southport Project, an Early Implementation Project along the Sacramento River South levee, will be the first levee reach to be addressed in the project. Construction is scheduled to begin in 2015 by the city of West Sacramento, in advance of the overall West Sacramento GRR Project. The Southport Project is proposed to construct flood risk reduction measures along the Sacramento River South levee in order to provide 200-year level of performance consistent with the State mandate for urbanized areas, as well as to provide opportunities for ecosystem restoration and public recreation.

The Southport Project is divided into eight segments, A-G, from south to north (Appendix A). Table 4 outlines the construction measures to be built in each section.

**Table 4.** Levee remediation measures of the Southport Project portion of the West Sacramento GRR Project, West Sacramento, Yolo County, California.

Southport Segment	Length (linear feet)	Remediation Measures
A	4,830	Slurry cutoff wall
B	115	Slurry cutoff wall
	1,955	Slurry cutoff wall and seepage berm
	3,490	Setback levee, slurry cutoff wall, seepage berm, bank stabilization at levee breach
C	4,490	Setback levee, slurry cutoff wall, seepage berm, toe rock and bank stabilization at levee breaches
	940	Setback levee, slurry cutoff wall, seepage berm, bank stabilization at erosion sites, waterside toe rock upstream and downstream of erosion sites
D	1,985	Setback levee, slurry cutoff wall, waterside toe rock upstream of erosion sites
E	995	Setback levee and slurry cutoff wall
	2,297	Setback levee, slurry cutoff wall, and seepage berm
F	5,583	Setback levee, slurry cutoff wall, seepage berm, bank stabilization and waterside toe rock at decommissioned levee breach, waterside toe rock and bank stabilization at other decommissioned levee breach
G	2,795	Slurry cutoff wall and bank stabilization at erosion site

The Southport project involves the following elements:

- Construction of flood risk reduction measures, including seepage berms, slurry cutoff walls, setback levees, rock and biotechnical slope protection, and encroachment removal;
- Partial degrade of the existing levee, forming a decommissioned “remnant levee;”
- Construction of an offset floodplain area using setback levees, supplying about 160 acres in total for subsequent habitat restoration of riparian and floodplain habitats;
- Construction of breaches in the remnant levee to open up the offset areas to Sacramento River flows;
- Road construction;
- Drainage system modifications; and
- Utility line relocations.

The levee flood risk reduction measure footprint includes the following elements: a waterside O&M easement where available, the levee from toe to toe, a seepage berm, and the landside O&M easement. The waterside and landside O&M easements will be assumed to be 20 feet wide and

unpaved. The landside O&M easement follows the toe of the levee or the landside toe of seepage berms, where present. The utility corridor is included largely within the Village Parkway right-of-way. In Segment G, where existing residences are close to the existing levee, the landside O&M easement will vary from about a few feet to 100 feet between the proposed flood risk reduction measure toe and the existing residential lot lines. In Segment A, the landside O&M easement coincides with South River Road. For segments where a suitable impermeable tie-in layer was not identified from the geotechnical explorations, a seepage berm will be constructed. Where a tie-in layer was located, a cutoff wall at the associated depth will be constructed. For levee reaches where a seepage berm will be constructed to address underseepage, a shallow cutoff wall also will be installed in lieu of an inspection trench.

A setback levee will be constructed in levee Segments B through F. A setback levee is an entirely new section of levee constructed at some distance behind the landside of the existing levee. The obsolete levee sections will remain in place and be breached to create an offset area containing two separate floodplains for the Sacramento River. The new section of levee will be tied into the existing levee to the south and north and become the Federal project levee. Once the foundation of the new setback is built up to a suitable elevation, a slurry cutoff wall will be constructed using either the conventional slot trench method or clamshell method.

The new levee section will be constructed to meet current design standards, including height and slope requirements. Levee slopes will be graded to a 3H:1V slope, and a crown at least 20 feet wide created. Topsoil will then be placed on the levee slopes and hydroseeded. For the purpose of levee inspection and emergency vehicle access, an aggregate base, all-weather levee-top patrol road will be constructed. Seepage berms for the Southport Project will vary from 50 to 100 feet in width. Lateral length will depend on seepage conditions along the area of identified levee deficiency.

#### *Southport Project Bank Erosion Sites*

Three bank erosion sites requiring repairs were identified in the project reaches along the Sacramento River; two sites are in Segment C and the third site is in Segment G (Appendix A). The Segment C sites will not be subject to the Corps vegetation policy, as they will be on the remnant levee; however, the Segment G site will be located on the Federal project levee and will comply with the vegetation policy. The repairs at all three sites are designed to protect against erosional forces that threaten levee stability, such as wind, waves, boat wake, and fluvial forces.

#### *Southport Project Remnant Levee Sites*

The two erosion sites on the remnant levee are C1 and C2. Once the setback levees for the Southport Project are complete, the existing levee in Segment C will no longer be part of the Federal project levee. Site C1 has a top length of 160 linear feet, while Site C2 has a length of 547 linear feet. Remediation at Site C1 will address a scour hole that has formed on the slope between elevations of -33 feet, North American vertical datum of 1988 (NAVD 88), and +11 feet NAVD 88, as well as slumping that has occurred at the base of the slope. Remediation at Site C2 will address general erosion problems that have been created by wave erosion.

**Design and Construction:** Erosion site repairs on the remnant levee are designed both to control erosion and to maintain existing vegetation and instream woody material. This will be accomplished by incorporating rock benches that serve as buffers against erosion while providing space for planting riparian vegetation and creating a platform to support aquatic habitat features (Appendix A). Rock will be placed onto the levee slope from the waterside by means of barges; one barge will

hold the stockpile of rock to be placed, and a second barge will hold the crane that will place the rock on the channel slopes. A backhoe will be used from the bank to adjust the rock. Clean rock fill will be placed over existing riprap between elevations of -33 feet NAVD 88 and +5 feet NAVD 88, and type C graded stone will be placed over the clean rock fill in a 2.5-foot thick layer with a 2H:1V slope from the toe of the slope to an elevation of +7 feet NAVD 88. The clean rock fill and graded stone at the top of the erosion site will be placed to form a planting bench at an elevation of +7 feet NAVD 88 to match the average annual low-water surface elevation, and the bench will have an average width of about 10 feet. At Site C1, stone will be placed at the upstream and downstream ends of the site to address problems created by a scour hole along the site.

After the rock is placed along the slope of the erosion sites, a 1-foot thick layer of 0.75-inch crushed clean rock will be placed at the upslope end of the stone bench to create a filter between the topsoil and the stone bench. Topsoil then will be placed above the newly constructed bench at a 3H:1V slope to meet the existing bank, and coir fabric will be placed over the soil to keep it in place. Topsoil will be placed from a barge, similar to the process for placing the rock. Pole plantings will be hand-placed in the planting bench between elevations of +7 feet NAVD 88 and +11.5 feet NAVD 88. Beaver fencing will be installed at the upslope and downslope extents of the topsoil installation. Instream woody material will be anchored along the remnant levee erosion sites to achieve at least 40% shoreline coverage, and placed between 1 and 3 feet below the elevation of the average annual low water surface. Instream woody material will likely come from trees removed in other portions of the project area, and will be selected based on suitability for the site. Existing vegetation and riprap at the erosion site will be retained.

The two erosion sites on the remnant levee are located on the outer bank of a bend in the river and are therefore subject to greater erosive forces. Rock will be placed along the toe of the bank (toe rock) at both sites, as well as upstream and downstream of the erosion sites to further protect the bank of the remnant levee. The toe rock will begin about 850 feet upstream of Site C1, will extend through both erosion sites, and will terminate about 300 feet downstream of Site C2. Portions of this area are currently riprapped, and the additional toe rock to be placed will be limited to areas where there is currently no rock below an elevation of +7 feet NAVD 88.

#### *Southport Project Active Levee Erosion Site*

Site G3 is located in Segment G and therefore will remain as part of the Federal project levee. Site G3 includes 410 linear feet of repairs to the top of the erosion scarp and the creation of a planting bench and vegetated slope to protect against boat wake and fluvial erosion.

The design, construction equipment, methods, and materials for Site G3 are similar to those described for Sites C1 and C2. However, Site G3 will require additional rock armoring and soil fill (up to elevation +25 feet NAVD 88) to repair the erosion scarp and meet Federal levee protection standards. The proposed design includes riprap toe protection, earth and rock fill to restore the levee prism between elevation -10 feet NAVD 88 and +25 feet NAVD 88, a soil-covered 10-foot-wide planting bench (10H:1V slope) and bank (3H:1V slope) planted with pole cuttings and large container plantings, and instream woody material anchored between 1 and 3 feet below the elevation of the average annual low water surface. The planting bench will be 15 feet outside the minimum levee template.

*Southport Project Encroachment Removal*

Levee standards for vegetation and encroachments require removing encroachments, such as structures, levee penetrations (e.g., pipes, conduits, cables), power poles, pump stations, and similar features, from the levee footprint. Encroachment removal includes demolition, relocation, retrofitting, or reconstruction as appropriate on a case-by-case basis. Existing pilings within the river at Oak Knoll Bend also will be removed.

Encroachment removal techniques will be implemented based on the needs of the specific encroaching feature. Smaller encroachments will be removed, relocated, or retrofitted by manual labor of small crews (about 2 to 10 workers) using hand tools. Larger encroachments require machinery such as an excavator, skid-steer, and bulldozer. The removal of sections of two-lane asphalt road will be required. Piling removal requires a barge with a crane for removal or cutting at the mud line. Dump trucks will be used for hauling and disposal of removed material at an offsite, permitted commercial source within 10 miles of the project area.

*Southport Project Remnant Levee Degrade*

With the construction of the setback levee, most of the decommissioned levee in Segments B through F will be degraded to provide additional borrow material for constructing seepage berms or for reclamation of other borrow areas. The remnant levee in Segment E will remain to maintain access to Sherwood Harbor Marina and Sacramento Yacht Club. Similarly, although the roadway will be removed up to the Sacramento Yacht Club, the levee will not be degraded on Segment F south of breach N2 to help protect the marinas during high flow events.

Prior to excavation, the area to be degraded will be cleared, grubbed, and stripped. The remnant levee will be degraded to an elevation of +30 feet NAVD 88, with a crown width of 20 feet and a landside slope of 3H:1V. Front-end loaders will load haul trucks with the excavated material. Haul trucks will transport the material to stockpile areas in the staging areas for later use for berms, or to borrow areas for use in site restoration. Material used for borrow area restoration will be spread evenly using motor graders and compactors. Disturbed areas will be planted as part of the offset area restoration plantings, and an unpaved O&M corridor will be established along the landside toe of the remnant segments.

*Southport Project Levee Breaches*

Portions of the remaining decommissioned levee will be breached to allow Sacramento River flows into two separate floodplain areas within the offset area during high flow events (Appendix A). The northern floodplain area breaches, from north to south, are North 1 (N1) and North 2 (N2) (both in Segment F), and the southern floodplain area breaches, from north to south, are South 1 (S1) (Segment C), South 2 (S2) (Segment C), and South 3 (S3) (Segment B). Construction of the breaches will occur during the summer–fall period to comply with Central Valley Flood Protection Board regulations. Both floodplain areas will be distinct from the existing Bees Lakes, which also will remain on the waterside of the new setback levee alignment.

Breaches S3 and N1 will be created in the third construction year and the remaining breaches will be completed 2 years later. Staggering the breaches will allow offset area restoration vegetation to establish before being exposed to flows. Until breaches S1, S2 and N2 are constructed, culverts will be installed at their proposed locations to drain the offset floodplain area. The culverts also will balance the hydraulic pressure on both sides of the degraded levee and to minimize fish stranding. Each culvert will be 54 inches in diameter and about 140 feet long. The culverts will be placed at

about +7 NAVD in order to fully drain the offset floodplain area. To construct the breaches, the existing levee will be degraded with excavators to an elevation of +10 feet NAVD 88. Existing revetment in good condition will be retained below +10 NAVD 88. The breach shoulders will be armored with rock from the existing riprap on the waterside, over the degraded remnant levee crown, and down the landside slope. A 25-foot riprap apron then will extend out from the landside toe of the breach shoulder at an elevation of roughly +10 NAVD 88, as well as from the toe of the shoulder in the breach. All rock for the shoulder and apron armoring will be placed in a layer about 2.5 feet thick.

In-water construction activities are scheduled between July 1 and October 31, when water elevations in the Sacramento River along the project area are typically at the average annual low water elevation of +6.7 feet NAVD 88 to +7.1 feet NAVD 88. Installation of temporary cofferdams may be necessary prior to culvert installation to prevent river flows from entering the construction area. At a minimum, sandbags will be used to construct the cofferdam and water will be pumped out of the inundated construction area. Cofferdams will be constructed using sheet pile walls or other methods, and typically will extend up- and downstream of the end of the culverts to provide a temporary work area.

The upstream shoulder of breach N1 and the downstream shoulder of breach S3 have slightly different erosion control measures than the other breach shoulders. Breaches N1 and S3 are located at the sites where the new setback levee alignment deviates from the old, decommissioned levee alignment. Rock armoring will be placed on the slope of the waterside of the setback levee and will transition along the remnant levee segment.

On the waterside of the breaches, new riprap will be placed from the toe of the bank slope up to an elevation of +7 feet NAVD 88 in areas where the existing riprap is lacking. Breaches N1, N2, S1, and S2 also will have rock placed along portions of the base of the bank to further protect it from erosive forces. Coir fabric will be placed between elevations of +7 feet NAVD 88 and +10 feet NAVD 88, and will be planted with species suitable to create a vegetated bench. Coir fabric also will be placed in the zone between the edge of the +10 feet NAVD 88 elevation and the centerline of the breach, with jute netting continuing landward of the termination of the coir fabric for 100 feet. This area also will be planted with cuttings, rootstock, or container plants.

Rock will be placed onto the levee slope from atop the degraded levee, from the breach sill, from the waterside by means of barges, or by a combination of the three methods. Rock required within the channel, both below and slightly above the surface of the water at the time of placement, will be placed by a crane located on a barge and then spread by an excavator located on top of the levee or in the breach sill. Construction requires two barges—one barge to carry the crane and another to hold the stockpile of rock to be placed on the channel slopes—and one excavator located in the breach. Rock required on the upper portions of the slopes will be placed by an excavator located on top of the levee. Rock placement from atop the levee requires one excavator for each potential placement site. Loaders will haul rock from a permitted source within 25 miles of the project area and dump it within 100 feet of the levee breach. An excavator will move the rock from the stockpile to the waterside of the levee.

#### *Southport Project Offset Floodplain Area Restoration*

The offset floodplain area refers to the two expanded floodways located between the proposed setback levee and the decommissioned, remnant levee that will be created when portions of the

existing levee are breached (Appendix A). Project activities in this area will include floodplain and riparian habitat restoration and borrow excavation. The offset floodplain areas will be planted to provide mitigation for vegetation removed as part of construction.

If suitable for reuse, excavated material will be used in construction of the setback levee and seepage berms. Following excavation, the offset area will be graded to allow the creation and restoration of riverine floodplain and riparian habitats. Excavation in the offset areas may require groundwater management, done by pumping water out of excavated areas.

After the first two levee breaches are constructed and before the final three breaches are made, restoration plantings will be established in the offset floodplain areas during the fall, winter, and spring. Swales will be constructed in both offset floodplain areas, and the surrounding areas will be graded to create drainage to the swales as river stages decrease. Temporary and permanent erosion control measures such as jute netting, coconut fiber with net, live brush mattresses, and native turf will be used as appropriate to protect graded areas.

After breaches N2, S1, and S3 are constructed, three permanent cellular berms will be built across the offset area, between the setback levee and the remnant levee. The berms will be downstream of breaches N1, S1, and S2, and will create separate cells that will have independent drainage once water levels drop below the crest of the cellular berms. Material excavated from the breaches will be used to construct the cellular berms and construct terrain features. Berms will have a top elevation of +20 feet, top width of 20 feet, and side slopes no steeper than 10H:1V; they will overtop once water levels reach +20.0 feet NAVD 88. Floodplain upstream and downstream of the berms will be graded to drain away from the berms and to the closest existing levee breach location. Elevations in the offset floodplain area will vary from about +7.0 feet NAVD 88 to +20.0 feet NAVD 88 in order to provide broad habitat variability for a range of environmental and hydrodynamic conditions.

Habitats in the offset floodplain areas will be upland grasslands, riparian forest, shaded riverine aquatic habitat, and seasonal wetlands. Plants selected for establishment of each of the target plant communities were based on how the plants associate in nature, and the elevations at which these plants were observed growing along the Southport levee. A vegetation stratification survey on the Southport levee conducted by ICF in March of 2012 helped further inform and refine the restoration target plant communities. In the survey, different species of plants were observed to favor different elevation ranges based on species preferences and adaptations. The restoration design intends to mimic this vegetative stratification. Vegetation communities will include emergent marsh, riparian willow scrub, riparian cottonwood forest, mixed riparian woodland, elderberry shrubs and associated native plants for valley elderberry longhorn beetle habitat, and grassland. Planting of the offset area will take place in the fall following finish-grading operations and construction of the flood control features. Features of the offset area that are not finished in any given year will be kept free of vegetation to keep future construction areas clear.

Both container plants and pole cuttings may be used and will be spaced at regular intervals throughout the offset floodplain areas. Both overstory and understory species will be installed to mimic the natural structure of riparian forests along the Sacramento River. Supplemental irrigation will be provided for several years during the 3-year plant establishment period and then discontinued; irrigation water could possibly be pumped from the river or from an adjacent water supply by agreement with the owner. To avoid trampling or disturbing the plantings during the

establishment period, signs will be posted at appropriate intervals providing notice that access to the restoration areas is not allowed.

A network of seasonal wetland swales will be excavated within the offset floodplain area cells and will inundate during high-water events on the Sacramento River to provide habitat for special-status native fish species. The swales will be constructed to elevations that provide shallow, low-velocity, off-channel habitat in the spring during high-water periods. Floodplain inundation is expected to occur at the 1-year recurrence interval event at depths between 0.5 and 3 feet, and at the 2-year recurrence interval event at depths ranging from 9 to 12 feet. Swale margins will be gently sloping to maximize edge habitat during flood events. Instream woody material structures will be installed in some of the swales to provide cover from predators. In larger flood events during the winter and spring, the upper riparian terraces will be inundated and provide additional areas of habitat for fish as well as contribute to the productivity of the river ecology.

The created swales will have several connections to the main river channel at the breach locations in order to maximize connectivity and minimize potential stranding as floodwaters recede. The swales will fully dewater by early summer in a given year, on average, to discourage use by nonnative fish. Areas of upland grassland in the offset floodplain area will serve as potential floodplain rearing habitat for native fish during periods of high flows, as well as foraging habitat for raptors during periods of low water.

O&M access to the offset areas will be provided by O&M corridors at the waterside toe of the setback levee and by unpaved O&M roads that cross the cellular berms. At a minimum, turnaround areas will be located at the breach shoulders.

#### *Southport Project Offset Area and Remnant Levee Revegetation*

Revegetation of the offset areas and remnant levee is proposed as a means to mitigate for construction effects. The riparian willow scrub target plant community will be established in zones with proper soil hydrology, between +8 feet and +10 feet NAVD 88. In the offset area, riparian willow scrub will be established just upslope from the constructed swales in a band width varying from about 10 to 150 feet. On the remnant levee, riparian willow scrub will be established in a narrow band varying from about 5 to 20 feet in width outside of the canopy of the existing trees that will remain. The plants selected for the riparian willow scrub planting are intended to establish a self-sustaining mix of riparian scrub dominated by four species of willows. The plant material installed could be container grown plants, cuttings, or a mixture of both. The areas within the offset area will be seeded, and the areas on the remnant levee with established herbaceous cover will not be seeded.

#### *Southport Project Road Construction, Marina Access, and Bees Lakes*

Village Parkway will be extended southward from its current intersection with Lake Washington Boulevard to Gregory Avenue near the project area's southern extent, moving South River Road traffic to the landside of the Sacramento River South Levee and to the future Village Parkway alignment. The existing alignment of South River Road in Segment A will be retained, as will the railroad abutments at the southern end of Segment A. However, a detour or permanent realignment of South River Road will be constructed at the south end of Segment A to maintain access on South River Road south of the project area during and after construction. Access roads will be built in Segment B to connect residences to the new Village Parkway alignment. At the project's northern extent, South River Road will be demolished. Where practicable, culverts will be constructed in

ditches that are crossed by proposed roadways. Drainage ditches will be constructed along both sides of the new Village Parkway alignment, with an average width of 5 feet.

To maintain access between Sherwood Harbor Marina and Sacramento Yacht Club, South River Road will continue in its current alignment on the existing levee at Segment E and a portion of Segment F. However, to maintain access to the marinas, two new roads will be routed over the levee crown, across the offset area, and the across the decommissioned levee. The two access roads will be constructed to the north and south of the Bees Lake area. While the embankments will not be part of the flood risk–reduction features, they will prevent hydraulic surface connectivity between Bees Lakes and the Sacramento River. Linden and Davis Roads will be connected to the new Village Parkway alignment to restore traffic circulation, and a cul-de-sac will be added at the end of Linden Road, past the intersection with Village Parkway.

Dual access ramps will be constructed along the levee alignment to provide O&M and emergency access to the levee-top patrol road. One ramp will be in Segment B where South River Road currently descends from the existing levee to meet Gregory Avenue; one ramp in Segment C; one ramp in Segment D at the terminus of Davis Road; one ramp in Segment F at the terminus of Linden Road; and one ramp in Segment G near the northern end of the project alignment. Access to the levee-top patrol road also will be provided where the Sherwood Harbor Marina and Sacramento Yacht Club access road embankments cross the proposed setback levee crown. Access ramps will be gated and will have “no parking” signs.

#### *Southport Project Construction Schedule*

Construction of the Southport Project will occur in more than one annual construction season, with construction of flood risk–reduction measures beginning in April of 2015, and finishing in 2017. Construction and restoration of the offset floodplain area will continue after 2017, with final remnant levee breaches constructed in 2020. Some of the Village Parkway construction and utility relocations may occur earlier, but most of the work for those portions of the project will be done in 2015. A description of construction activities and tentative construction year is provided below.

#### 2015:

- Village Parkway construction and utility relocation will be completed.
- Construction of the entire length of the new setback levee will begin with the foundation and working platform. Construction of the cutoff wall will follow if weather allows.

#### 2016:

- The setback levee cutoff wall and remaining buildup of the setback levee will be constructed to a finished elevation of +40 feet NAVD 88.
- South River Road will be detoured at south end of Segment A.
- Seepage berms will be constructed following completion of the setback levee segments.
- Segment A and the southern portion of Segment B will be degraded to an elevation of +32 feet NAVD 88, and in Segment G the levee will be degraded to an elevation of +34.5 feet NAVD 88. Cutoff walls will then be constructed in these segments, tying into the setback levee cutoff walls in Segments B and F. The levee crown in Segment A and the southern portion of Segment B will then be built back up to a finished elevation of +39 feet NAVD 88, and the levee in Segment G will be built back up to a finished elevation of +40 feet NAVD 88. The slurry cutoff wall toe will be at an elevation of -5 feet NAVD 88 through

Segments A, B, C, and D; at 0 feet NAVD 88 for Segments E, F, and the southern portion of G; and will be at -67 feet NAVD 88 for the remainder of Segment G.

- The remnant levee in Segments B, C, D, and F will be degraded to an elevation of +30 feet NAVD 88, and will have a 20-foot-wide crown. Remnant levee degrading will be concurrent with setback levee and seepage berm construction.
- Offset floodplain area grading will begin.
- Erosion site repairs at C1, C2, and G3 will be constructed.

2017:

- Offset area grading will be completed. Culverts will be installed through the remnant levee at breaches N2, S1, and S2 to allow Sacramento River water flow into the offset floodplain areas.
- Breaches N1 and S3 will be constructed.
- Offset area planting will begin.

2018:

- Offset area planting will continue.

2019:

- The three remaining breaches and the offset area cellular berms will be constructed, and the southern offset area will be contoured.

2020:

- Offset area planting will be completed.

At the end of each construction season, the levee system will be restored, at a minimum, to the level of flood risk–reduction performance existing at the project outset. During construction Years 1 and 2, “tie-ins” will be built connecting the existing levee to newly constructed segments, as needed. These tie-ins will be achieved by benching the existing levee and installing compacted lifts to completely bond the new and existing levee materials. During the flood season, maintenance of the flood risk–reduction structures will be undertaken by the maintaining agency, RD 900.

*Southport Project Sources of Borrow Material*

To meet borrow material demands for constructing the flood risk–reduction measures, multiple sources may be used, including the following.

- Embankment fill material excavated from the existing levee structure as part of construction.
- Material excavated from the offset areas.
- Material excavated from borrow sites located on open land within the city, or close to the city limits.
- Dredged material previously removed from the Sacramento River Deep Water Ship Channel (presently stockpiled on high-terrace, upland benches adjacent to the west of the channel).
- Material purchased from permitted commercial borrow locations within 20 miles of the project site (as described on pages 7-8).

#### *Southport Project Vegetation Removal*

Vegetation clearing activities entail removing larger woody vegetation, such as trees and shrubs. Grubbing activities consist of removing roots, and stripping activities requires excavating about 6 inches of organic material from the levee surface. Vegetation on the decommissioned levee segments along the Sacramento River levee will be retained where feasible, with the exception of the five breach locations. However, some vegetation will be removed as part of construction of the new setback levee, seepage berms, and the landside utility O&M corridor.

#### *Southport Project Staging Areas and Equipment Access*

Five staging areas are designated for the Southport Project. The staging areas are located on the landside of the levee at Segments C, D, and E, and occupy about 25.2 acres in total (Appendix A). Areas where seepage berms are proposed also may be used for staging until construction begins on the seepage berms. To facilitate project construction, temporary earthen ramps will be constructed to permit equipment access between the levee crown and each staging area. The earthen ramps will not affect any delineated water bodies and will be removed when construction is complete.

#### *Southport Project Operations and Maintenance*

Following construction of the Southport Project, only the rock slope protection, native vegetation, and other biotechnical features will be permanent. Anticipated O&M actions include regular visual inspections of the site, vegetation maintenance and irrigation for up to 3 years, and periodic repairs, as needed, to prevent or repair localized scour along the bank and rock toe of the site. The previously mentioned O&M activities that pertain to the project as a whole will also occur along Sacramento River South levee reach following the Southport Project construction.

### **Conservation Measures**

As part of the West Sacramento GRR Project description, the Corps and WSAFCA have committed to implementing the following conservation measures to avoid and minimize potential effects on the snake, beetle, smelt, and smelt critical habitat. A number of measures will be applied to the entire project or specific actions, and other measures may be appropriate at specific locations within the study area. Avoidance activities to be implemented during final design and construction include, but are not limited to:

- Avoiding vegetation removal to the extent feasible.
- Avoiding, to the extent possible, grubbing and contouring activities.
- Identifying all habitats containing, or with a substantial possibility of containing, listed terrestrial, wetland, and plant species in the potentially affected project areas. To the extent practicable, efforts will be made to minimize effects by modifying engineering design to avoid potential direct and indirect effects.
- Incorporating sensitive habitat information within project bid specifications.
- Incorporating requirements for contractors to avoid identified sensitive habitats within project bid specifications.

#### General Conservation Measures

- The Corps will seek a variance exempting the Sacramento River levee reaches from vegetation removal as per ETL 1110-2-583 in the lower one-third of the waterside of the levee prior to final construction and design phase. Construction will require removal of vegetation on the upper two-thirds of the waterside and landside slope. Full ETL vegetation

compliance will occur on the Sacramento and Yolo Bypasses, Yolo Bypass Toe Drain, South Cross Toe Drain, and the Sacramento River Deep Water Ship Channel, Barge Canal, and Port of West Sacramento levee reaches.

- The Corps will use a rock soil mixture (a 70:30 rock to soil ratio) to facilitate re-vegetation of the Sacramento River project sites that require bank protection work. The soil-rock mixture will be placed on top of the of the rock revetment along the Sacramento River levees to allow native riparian vegetation to be planted and ensure that shaded riverine aquatic habitat is replaced or enhanced.
- In addition to an approved vegetation variance, the Corps will avoid the removal of existing vegetation in the proposed project area. To the extent possible, disturbance or removal of trees or larger woody vegetation will be replaced onsite with native riparian species, except in the vegetation-free zone, as established in ETL 1110-2-583.
- Best management practices will be implemented to prevent slurry seeping out to the river and require a piping system on the landside.
- Construction materials such as portable equipment, vehicles, and supplies, will be stored at designated construction staging areas and barges, exclusive of any riparian and wetlands areas.
- All liquid chemicals and supplies will be stored at a designated impermeable membrane fuel and refueling station.
- Erosion control measures, including a Storm Water Pollution Prevention Program and a Water Pollution Control Program, will be implemented to minimize soil or sediment from entering the river. The measures shall be installed, monitored for effectiveness, and maintained throughout construction operations to minimize any effects to federally-listed fish and their designated critical habitat.
- Construction will be scheduled when listed terrestrial and aquatic species will be least likely to occur in the project area.
- Site access will be limited to the smallest area possible in order to minimize disturbance.
- Litter, debris, and unused materials will be removed from the project area daily. Such materials or waste will be deposited at an appropriate disposal or storage site.
- Any spills of hazardous materials will be cleaned up within 24 hours and reported to the resource agencies. Any such spills, and the success of the efforts to clean them up, shall also be reported in post-construction compliance reports.
- A Corps-appointed biologist will serve as the point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species. The representative shall be identified to the employees and contractors during an all employee education program conducted by the Corps.
- Screen any water pump intakes, as specified by NMFS and Service screening specifications. Water pumps will maintain an approach velocity of 0.2 feet per second or less when working in areas that may support delta smelt.

#### Giant Garter Snake Conservation Measures

The following measures will be implemented to minimize effects on giant garter snake habitat that occurs within 200 feet of any construction activity. These measures are based on Service guidelines for restoration and standard avoidance measures (Service 1997).

- Construction will be initiated only during the snake's active period of May 1–October 1, when they are able to move away from disturbance.
- Construction personnel will participate in a Service-approved worker environmental awareness program.
- A snake survey will be conducted 24 hours prior to construction in potential habitat. Should there be any interruption in work for greater than 2 weeks, a biologist will survey the project area again no later than 24 hours prior to the restart of work.
- Snakes encountered during construction activities will be allowed to move away from construction activities on their own.
- Movement of heavy equipment to and from the construction site will be restricted to established roadways. Stockpiling of construction materials will be restricted to designated staging areas, which will be located more than 200 feet away from snake aquatic habitat.
- Snake habitat within 200 feet of construction activities will be designated as an environmentally sensitive area and delineated with signs or fencing. This area will be avoided by all construction personnel.
- For projects that anticipate that work may be required past the end of the giant garter snake active season (October 1) and into their inactive season, additional measures must be implemented by the applicant. All of the following minimization measures must be implemented in order for work to continue past the October 1 deadline:
  - The Corps shall contact the Service on or before August 15, to determine if any additional measures are needed to minimize effects to the snake.
  - Work activities must commence on or before September 15.
  - A service-approved biologist will be on-site daily to monitor all construction activities associated with the project throughout the entire extension period.
  - Snake exclusion fencing must be completely installed prior to the October 1 deadline. Snake exclusion fencing will be used to enclose the entire work area preventing the snake from entering the work area. The exclusion fencing will remain in place and in good working order until project activities are completed.

If any giant garter snake habitat is affected by construction, the following measures will be implemented to compensate for the habitat loss:

- Aquatic and upland habitat temporarily affected for one season (May 1–October 1) will be restored after construction by applying appropriate erosion control techniques and replanting/seeding with appropriate native plants.
- Habitat temporarily affected for two seasons will be restored and replacement habitat will be created at a 2:1 ratio of created to disturbed acres.
- Habitat temporarily affected for more than two seasons will be replaced at a 2:1 ratio, or restored plus 2:1 replacement.
- Habitat permanently affected will be replaced at a 3:1 ratio. Habitat permanently or temporarily affected outside of the May 1–October 1 work window will be created at a 2:1 ratio.
- All replacement habitats will include both upland and aquatic habitat components at a 2:1 ratio of upland to aquatic acres.
- One year of monitoring will be conducted for all restored areas. Ten years of monitoring will be conducted for created habitats. A monitoring report with photo documentation will

be due to Service each year following implementation of restoration or habitat creation activities.

- The Corps will work to develop appropriate mitigation prior to or concurrent with any disturbance of giant garter snake habitat.
- Habitat will be protected in perpetuity and have an endowment attached for management and maintenance.

#### Valley Elderberry Longhorn Beetle Conservation Measures

The following is a summary of measures based on the Conservation Guidelines for the Valley Elderberry Longhorn Beetle (Conservation Guidelines) (Service 1999a). These measures will be implemented to minimize any potential effects on the beetle, the sole host plant for the beetle, including restoration and maintenance activities, long-term, protection, and compensation if elderberry shrubs cannot be avoided. Based on worst-case scenario estimates of project effects and surveys between 2011 and 2013, a total of 120 elderberry shrubs may be adversely affected by construction of the West Sacramento GRR Project.

- When a 100-foot or wider buffer is established and maintained around elderberry shrubs, complete avoidance will be assumed. Where encroachment on the 100-foot buffer will occur, a setback of 20 feet from the dripline of each elderberry shrub will be maintained whenever possible.
- During construction activities, all areas to be avoided will be fenced and flagged.
- Contractors will be briefed on the need to avoid damaging elderberry shrubs and the possible penalties for not complying with these requirements.
- Signs will be erected every 50 feet along the edge of the avoidance area containing information about the beetle and its habitat.
- Any damage done to the buffer area will be restored.
- During construction activities, no insecticides, herbicides, fertilizers, or other chemicals that might harm the beetle or its host plant will be used in the buffer areas.
- Elderberry shrubs that cannot be avoided and can be accessed safely will be transplanted to an appropriate off-site riparian area at least 100 feet from construction activities.
- Elderberry shrubs will be transplanted during their dormant season, which occurs from November, after they have lost their leaves, through the first two weeks in February. If transplantation occurs during the growing season, increased mitigation ratios will apply.
- Any areas that receive transplanted elderberry shrubs, as well as elderberry and associated native species plantings, will be protected in perpetuity.
- The Corps will work to develop off-site compensation areas prior to or concurrent with any take of valley elderberry longhorn beetle habitat.
- Management of these lands will include all measures specified in the Conservation Guidelines related to weed and litter control, fencing, and the placement of signs.
- Monitoring will occur for 10 consecutive years or for 7 non-consecutive years over a 15-year period. Annual monitoring reports will be submitted to the Service.
- Off-site compensation areas will be protected in perpetuity and have a funding source for maintenance (an endowment).

### Conservation Measures for the Southport Project

Because the Southport Project along the Sacramento River South levee is scheduled as an Early Implementation Project it will be the first construction project under the West Sacramento GRR Project, and therefore conservation measures have been established in greater detail. The Corps and WSAFCA have committed to implementing the following conservation measures as part of the Southport Project.

#### *Southport Project General Conservation Measures*

#### Conduct mandatory biological awareness training for all project personnel and implement general requirements:

Before any ground-disturbing work (including vegetation clearing and grading) occurs in the Southport Project action area, a Service-approved biologist will conduct a mandatory biological resources awareness training for all construction personnel about Federally listed species that could potentially occur onsite. The training will include the natural history, representative photographs, and legal status of each Federally listed species and avoidance and minimization measures to be implemented. Proof of personnel attendance will be provided to the Service within 1 week of the training. If new construction personnel are added to the Southport Project, the contractor will ensure that the new personnel receive the mandatory training before starting work. The subsequent training of personnel can include videotape of the initial training and/or the use of written materials rather than in-person training by a biologist. Elements of the training that will be followed by construction personnel are listed below:

- Where suitable habitat is present for listed species, WSAFCA will clearly delineate the construction limits through the use of survey tape, pin flags, orange barrier fencing, or other means, and prohibit any construction-related traffic outside these boundaries.
- Project-related vehicles will observe the posted speed limit on hard-surfaced roads and a 10-mile-per-hour speed limit on unpaved roads during travel in the project construction area.
- Project-related vehicles and construction equipment will restrict off-road travel to the designated construction areas.
- All food-related trash will be disposed of in closed containers and removed from the project construction area at least once per week during the construction period. Construction personnel will not feed or otherwise attract fish or wildlife to the project area.
- No pets or firearms will be allowed in the project area.
- To prevent possible resource damage from hazardous materials, such as motor oil or gasoline, construction personnel will not service vehicles or construction equipment outside designated staging areas.
- Any worker who inadvertently injures or kills a federally-listed species or finds one dead, injured, or entrapped will immediately report the incident to the biological monitor and construction foreman. The construction foreman will immediately notify WSAFCA, who will provide verbal notification to the Service within 1 working day. WSAFCA will follow up with written notification to the Service within 5 working days. The biological monitor will follow up with WSAFCA to ensure that the wildlife agencies were notified.

#### Prepare and implement a Stormwater Pollution Prevention Plan

Because ground disturbance would be greater than 1 acre, WSAFCA will obtain coverage under the U.S. Environmental Protection Agency's (EPA's) National Pollutant Discharge Elimination System (NPDES) general construction activity stormwater permit. The Central Valley Regional Water Quality Control Board administers the NPDES stormwater permit program in Yolo County.

Obtaining coverage under the NPDES general construction activity permit generally requires that the project applicant prepare a stormwater pollution prevention plan that describes the Best Management Practices that will be implemented to control accelerated erosion, sedimentation, and other pollutants during and after project construction. The SWPPP will be prepared prior to commencing earth-moving construction activities.

The plan likely will include, but not be limited to, one or more of the following standard erosion and sediment control practices:

- The construction contractor will conduct all construction activities during the typical construction season to avoid ground disturbance during the rainy season. To the extent possible, equipment and materials will be staged in areas that have already been disturbed. No equipment or materials would be stored in the floodway during the flood season.
- The construction contractor will minimize ground disturbance and the disturbance/destruction of existing vegetation. This will be accomplished in part through the establishment of designated equipment staging areas, ingress and egress corridors, and equipment exclusion zones prior to the commencement of any grading operations.
- Grading spoils generated during the construction will be temporarily stockpiled in staging areas. Silt fences, fiber rolls, or similar devices will be installed around the base of the temporary stockpiles to intercept runoff and sediment during storm events. If necessary, temporary stockpiles may be covered with an appropriate geotextile to increase protection from wind and water erosion.
- The construction contractor may install silt fences, fiber rolls, or similar devices to prevent sediment-laden runoff from leaving the construction area.
- The construction contractor may install silt fences, drop inlet sediment traps, sandbag barriers, and/or other similar devices.
- The construction contractor will install structural and vegetative methods to permanently stabilize all graded or otherwise disturbed areas once construction is complete. Structural methods may include the installation of biodegradable fiber rolls and erosion control blankets. Vegetative methods may involve the application of organic mulch and tackifier and/or the application of an erosion control native seed mix.

#### Prepare and Implement a Bentonite Slurry Spill Contingency Plan (Frac-Out Plan)

Before excavation begins, WSAFCA will ensure the contractor will prepare and implement a bentonite slurry spill contingency plan (BSSCP) for any excavation activities that use pressurized fluids (other than water). If the contractor prepares the plan, it will be subject to approval by the Corps, NMFS, and WSAFCA before excavation can begin. The BSSCP will include measures intended to minimize the potential for a frac-out (“fracture-out event”) associated with excavation and tunneling activities; provide for the timely detection of frac-outs; and ensure an organized, timely, and minimum-effect response in the event of a frac-out and release of excavation fluid (bentonite). The BSSCP will require, at a minimum, the following measures:

- If a frac-out is identified, all work will stop, including the recycling of the bentonite fluid. In the event of a frac-out into water, the location and extent of the frac-out will be determined, and the frac-out will be monitored for 4 hours to determine whether the fluid congeals (bentonite will usually harden, effectively sealing the frac-out location).
- NMFS, CDFW, and the Central Valley Regional Water Quality Control Board will be notified immediately of any spills and will be consulted regarding clean-up procedures. A

Brady barrel will be on site and used if a frac-out occurs. Containment materials, such as straw bales, also will be on site prior to and during all operations, and a vacuum truck will be on retainer and available to be operational on site within a 2-hour notice. The site supervisor will take any necessary follow-up response actions in coordination with agency representatives. The site supervisor will coordinate the mobilization of equipment stored at staging areas (e.g., vacuum trucks), as needed.

- If the frac-out has reached the surface, any material contaminated with bentonite will be removed by hand to a depth of 1 foot, contained, and properly disposed of, as required by law. The drilling contractor will be responsible for ensuring that the bentonite is either properly disposed of at an approved Class II disposal facility or properly recycled in an approved manner.
- If the bentonite fluid congeals, no other actions, such as disturbance of the streambed, will be taken that potentially would suspend sediments in the water column.
- The site supervisor has overall responsibility for implementing this BSSCP. The site supervisor will be notified immediately when a frac-out is detected. The site supervisor will be responsible for ensuring that the biological monitor is aware of the frac-out; coordinating personnel, response, cleanup, and regulatory agency notification and coordination to ensure proper clean-up; coordinating disposal of recovered material; and timely reporting of the incident. The site supervisor will ensure all waste materials are properly containerized, labeled, and removed from the site to an approved Class II disposal facility by personnel experienced in the removal, transport, and disposal of drilling mud.
- The site supervisor will be familiar with the contents of this BSSCP and the conditions of approval under which the activity is permitted to take place. The site supervisor will have the authority to stop work and commit the resources necessary to implement this plan. The site supervisor will ensure that a copy of this plan is available onsite and accessible to all construction personnel. The site supervisor will ensure that all workers are properly trained and familiar with the necessary procedures for response to a frac-out prior to the commencement of excavation operations.

#### Prepare and Implement a Spill Prevention, Control, and Counter-Measure Plan

A spill prevention, control, and counter-measure plan (SPCCP) is intended to prevent any discharge of oil into navigable water or adjoining shorelines. WSAFCA or its contractor will develop and implement an SPCCP to minimize the potential for and effects from spills of hazardous, toxic, or petroleum substances during construction and operation activities. The SPCCP will be completed before any construction activities begin. Implementation of this measure will comply with state and Federal water quality regulations. The SPCCP will describe spill sources and spill pathways in addition to the actions that will be taken in the event of a spill (e.g., an oil spill from engine refueling will be immediately cleaned up with oil absorbents). The SPCCP will outline descriptions of containments facilities and practices such as double-walled tanks, containment berms, emergency shutoffs, drip pans, fueling procedures, and spill response kits. It will describe how and when employees are trained in proper handling procedure and spill prevention and response procedures. WSAFCA will review and approve the SPCCP before onset of construction activities and routinely inspect the construction area to verify that the measures specified in the SPCCP are properly implemented and maintained. WSAFCA will notify its contractors immediately if there is a noncompliance issue and will require compliance. If a spill is reportable by regulation, the contractor's superintendent will notify WSAFCA, and WSAFCA will take action to contact the appropriate safety and cleanup crews to ensure that the SPCCP is followed. If an appreciable spill

occurs and results determine that project activities have adversely affected surface or groundwater quality, a detailed analysis will be performed by a registered environmental assessor or professional engineer to identify the likely cause of contamination. This analysis will conform to American Society for Testing and Materials standards and will include recommendations for reducing or eliminating the source or mechanisms of contamination. Based on this analysis, WSAFCA and its contractors will select and implement measures to control contamination, with a performance standard that surface water quality and groundwater quality must be returned to baseline conditions.

#### Monitor Turbidity in Adjacent Water Bodies

WSAFCA or its contractor will monitor turbidity in the adjacent water bodies, where applicable criteria apply, to determine whether turbidity is being affected by construction and ensure that construction does not affect turbidity levels, which ultimately increase the sediment loads. The Water Quality Control Plan for the Central Valley Regional Water Quality Control Board (Basin Plan) contains turbidity objectives for the Sacramento River. WSAFCA or its contractor will monitor ambient turbidity conditions upstream during construction and adhere to the Surface Water Quality Ambient Monitoring Program requirements for turbidity monitoring. Monitoring will continue approximately 300 feet downstream of construction activities to determine whether turbidity is being affected by construction. Grab samples will be collected at a downstream location that is representative of the flow near the construction site. If there is a visible sediment plume being created from construction, the sample will represent this plume. Monitoring will occur hourly when construction encroaches into the Sacramento River. If construction does not encroach into the river, the monitoring will occur once a week on a random basis. If turbidity limits exceed Basin Plan standards, construction-related earth-disturbing activities will slow to a point that results in alleviating the problem. WSAFCA will notify the Central Valley Regional Water Quality Control Board of the issue and provide an explanation of the cause.

#### Prepare and implement a Mitigation and Monitoring Plan (MMP)

A draft MMP for the restoration areas is being developed and will be approved by the Corps, NMFS, Service, and CDFW before implementation of the Southport Project. The restoration objectives of the plan are listed below:

- Provide compensatory mitigation credits for effects on protected land cover-types and to special-status species and potential habitat for these species.
- Maximize shaded riverine aquatic cover/nearshore habitat, over and above current erosion stabilization efforts using biotechnical methods.
- Enhance setback ecological values using topographic and vegetation/habitat heterogeneity.
- Restore portions of the historic Sacramento River floodplain (i.e., waters of the United States).
- Restore riparian and oak woodland habitat on the restored floodplain that will create continuous habitat corridors for fish and wildlife movement.
- Design habitat features to minimize future maintenance obligations (e.g., reduce opportunities for sediment and debris accumulation).
- Design floodplain planting and vegetation management schemes to avoid undesirable hydraulic and sediment transport effects to the offset levee and offset area.
- Comply with current Corps levee vegetation policy to balance habitat needs with flood management objectives.

The monitoring objectives of the MMP are listed below:

- Monitor and evaluate the hydrologic and hydraulic performance of the restored floodplain relative to the ecological design criteria for the target species.
- Monitor and evaluate the success of the riparian/floodplain plantings and other habitat features in compensating, restoring, or enhancing fish and wildlife habitat values on the levee slopes and offset areas.
- Monitor and evaluate the effectiveness of the grading and drainage features in preventing fish stranding.
- Monitor the occurrence and extent of potential sedimentation and scour that may compromise the success of the habitat restoration and mitigation components of the project.

*Giant Garter Snake Conservation Measures for the Southport Project*

Conservation measures for giant garter snake were developed using portions of the Programmatic Formal Consultation for U.S. Army Corps of Engineers 404 Permitted Projects with Relatively Small Effects on the Giant Garter Snake within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo Counties, California (Service 1997).

Conduct all construction activities during the active period for the giant garter snake: To the maximum extent possible, all construction activity within giant garter snake aquatic and upland habitat within 200 feet of aquatic habitat will be conducted during the snake's active period (May 1–October 1). During this time frame, potential for injury and mortality are lessened because snakes are actively moving and avoiding danger. Construction of the setback levee in Segment B through Segment F will begin in 2015. The setback levee and the remaining flood risk – reduction measures for all segments would be completed in 2016. Some preparation of construction may occur during the 2014 construction season, but no changes will be made to the existing levee prism. The construction season is typically from April 15 to October 31, subject to weather and other conditions. Because some construction may extend into the giant garter snakes dormant period (October 2 to April 30), additional protective measures will be implemented at these locations.

Install and maintain construction barrier fencing around suitable giant garter snake habitat: To reduce the likelihood of snakes entering the construction area, exclusion fencing and orange barrier fencing will be installed along the portions of the construction area that are within 200 feet of suitable aquatic and upland habitat. The exclusion and barrier fencing will be installed during the active period for giant garter snakes to reduce the potential for injury and mortality during this activity.

The construction specifications will require a provision to retain a qualified biologist to identify the areas that are to be avoided during construction. Areas adjacent to the directly affected area required for construction, including staging and access, will be fenced off to avoid disturbance in these areas. Before construction, the contractor will work with the qualified biologist to identify the locations for the barrier fencing and will place flags or flagging around the areas to be protected to indicate the locations of the barrier fences. The protected area will be clearly identified on the construction specifications. The fencing will be installed the maximum distance practicable from the aquatic habitat areas and will be in place before construction activities are initiated.

The barrier fencing will consist of 4-foot-tall erosion fencing buried at least 6–8 inches below ground level. The barrier fencing will ensure that giant garter snakes are excluded from the

construction area and that suitable upland and aquatic habitat is protected throughout construction. The exclusion fencing will be commercial-quality, tightly-woven polypropylene fabric, orange in color, and 4 feet high (Tensor Polygrid or equivalent). The fencing will be tightly strung on posts with a maximum of 10-foot spacing.

Barrier and exclusion fences will be inspected daily by a qualified biological monitor during ground-disturbing activities. Once all initial ground-disturbing activities are completed, the biological monitor will perform weekly checks of the site for the duration of construction in order to ensure that construction barrier fences and exclusion fences are in good order, trenches are being covered, project personnel are conducting checks beneath parked vehicles prior to their movement, and that all other required biological protection measures are being complied with. The biological monitor will document the results of monitoring on construction monitoring log sheets, which will be provided to the Service within 1 week of each monitoring visit. Monitoring will continue until project construction is complete or until the fences are removed, as approved by the biological monitor and the resident engineer. The biological monitor will be responsible for ensuring that the buffer area fences around giant garter snake habitat are maintained throughout construction. Biological inspection reports will be provided to the project lead and the Service.

Minimize potential effects on giant garter snake habitat: The following measures will be implemented to minimize potential effects on giant garter snake habitat:

- Staging areas will be located at least 200 feet from suitable snake habitat;
- Any dewatered habitat will remain dry for at least 15 consecutive days after April 15 and prior to excavating or filling of the dewatered habitat;
- Vegetation clearing within 200 feet of the banks of suitable snake aquatic habitat will be limited to the minimum area necessary. Avoided snake habitat within or adjacent to the action area will be flagged and designated as an environmentally sensitive area, to be avoided by all construction personnel;
- The movement of heavy equipment within 200 feet of the banks of suitable snake aquatic habitat will be confined to designated haul routes to minimize habitat disturbance; and
- Conduct preconstruction surveys and monitoring for the giant garter snake.

Prior to ground-disturbing activities within 200 feet of suitable habitat, a Service-approved biological monitor will conduct a preconstruction survey of suitable aquatic and upland habitat and inspect exclusion and orange barrier fencing to ensure they are both in good working order each morning. If any snakes are observed within the construction area at any other time during construction the biological monitor will be contacted to survey the site for giant garter snakes. The biological monitor will have the authority to stop construction activities until appropriate corrective measures have been completed or it is determined that the snake will not be harmed. Giant garter snakes encountered during construction activities will be allowed to move away from construction activities on their own. If they are unable to move away on their own, trapped or injured, giant garter snakes will only be removed by Service-permitted personnel and will be placed in the nearest suitable habitat that is outside of the construction area. The biological monitor will immediately report these activities to the Service by phone and will provide a written account of the details of the incident within 24 hours.

Provide escape ramps or cover open trenches at the end of each day: To avoid the entrapment of snakes, all excavated areas more than 1 foot deep will be provided with one or more escape ramps constructed of earth fill or wooden planks at the end of each workday. If escape ramps cannot be provided, then holes or trenches will be covered with plywood or other hard material. The biological monitor or construction personnel designated by the contractor will be responsible for thoroughly inspecting trenches for the presence of giant garter snakes at the beginning of each workday. If any snakes become trapped, the Service-approved biological monitor will be contacted to relocate the snake, and no work will occur in that area until approved by the biological monitor.

Implement additional protective measures during work in suitable habitat during the giant garter snake dormant period: The following additional protective measures will be implemented during time periods when work must occur during the giant garter snake dormant period (October 2–April 30), when snakes are more vulnerable to injury and mortality:

- A full-time Service-approved biological monitor will be onsite for the duration of construction activities;
- All emergent vegetation and vegetation within 200 feet of suitable aquatic habitat will be cleared prior to the giant garter snake hibernation period (i.e., vegetation clearing must be completed by October 1); and
- Exclusion and barrier fencing will be installed around the perimeter of the work area and across drainage areas where activities associated with levee slope flattening and pipe reconstruction activities will occur. The fencing will enclose the work area to the maximum extent possible to prevent snakes from entering the work area. Fencing will be installed during the active period for snakes (May 1–October 1) to reduce the potential for injury and mortality during fence installation. The Service-approved biological monitor will work with the contractor to determine where fencing should be placed and will monitor fence installation. The barrier fencing will consist of 3- to 4-foot-tall erosion fencing buried at least 6 to 8 inches below ground level. The barrier fencing will minimize opportunities for giant garter snake hibernation in the adjacent upland area.

Portions of the construction area that are temporarily disturbed during construction will be re-vegetated with emergent vegetation and adjacent disturbed upland habitat will be re-vegetated with native grasses and forbs after construction is complete.

Restore temporarily disturbed aquatic and upland habitat to pre-project conditions: Upon completion of the Southport Project, 155 acres of suitable upland habitat will be restored in the borrow areas for giant garter snake to pre-project conditions. There will be no temporary loss of aquatic habitat. All of the temporary habitat effects will occur in the borrow areas within West Sacramento. The actual temporary effects from borrow activities will be substantially less pending an analysis on the suitability of potential borrow materials.

Suitable upland habitat for giant garter snakes consists of fallow agricultural fields and nonnative annual grassland. Cultivated and disked agricultural fields were not considered suitable upland habitat for giant garter snake because they are frequently disturbed during farming activities. Temporarily affected upland habitat will be restored to pre-project conditions within a maximum of one season (a season is defined as the calendar year between May 1 and October 1 [Service 1997]).

Restoration of upland habitat will be detailed in a mitigation and monitoring plan that will be reviewed and approved by the Service prior to the start of construction.

Compensate for the direct loss of giant garter snake upland habitat: The permanent loss of 2.24 acres of upland habitat will be compensated for by restoring habitat onsite or by purchasing credits from a Service-approved mitigation bank. There will be no permanent loss of aquatic habitat.

*Valley Elderberry Longhorn Beetle Conservation Measures for the Southport Project*

Conservation measures for beetle for the Southport Project are based on the Service's Conservation Guidelines (Service 1999a).

Fence Elderberry Shrubs to be Protected and Monitor Fencing during Construction: Elderberry shrubs and clusters within 100 feet of the construction area that will not be removed will be protected during construction. A qualified biologist (i.e., with elderberry/beetle experience), under contract with WSAFCA, will mark the elderberry shrubs and clusters that will be protected during construction. Orange construction barrier fencing will be placed at the edge of the respective buffer areas. The buffer area distances will be proposed by the biologist and approved by Service. No construction activities will be permitted within the buffer zone other than those activities necessary to erect the fencing. Signs will be posted every 50 feet along the perimeter of the buffer area fencing. The signs will contain the following information:

*"This area is habitat of the valley elderberry longhorn beetle, a threatened species, and must not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment."*

In some cases, where the elderberry shrub dripline is within 10 feet of the work area, k-rails will be placed at the shrub's dripline to provide additional protection to the shrub from construction equipment and activities. Temporary fences around the elderberry shrubs and k-rails at shrub driplines will be installed as the first order of work. Temporary fences will be furnished, constructed, maintained, and later removed, as shown on the plans, as specified in the special provisions, and as directed by the project engineer. Temporary fencing will be 4 feet high, commercial-quality woven polypropylene, and orange in color.

Buffer area fences around elderberry shrubs will be inspected weekly by a qualified biological monitor during ground-disturbing activities and monthly after ground-disturbing activities until project construction is complete or until the fences are removed, as approved by the biological monitor and the resident engineer. The biological monitor will be responsible for ensuring that the contractor maintains the buffer area fences around elderberry shrubs throughout construction. Biological inspection reports will be provided to the project lead and Service.

Conduct Stem Counts Prior to Elderberry Shrub Transplantation: Surveys of elderberry shrubs to be transplanted will be conducted by a qualified biologist prior to transplantation. The biologist will survey the area surrounding the shrub to be transplanted to ensure that there are not additional elderberry shrubs that need to be removed. Surveys will consist of counting and measuring the diameter of each stem at ground level and examining elderberry shrubs for the presence of beetle exit holes. Survey results and an analysis of the number of elderberry seedlings/cuttings and associated native plants based on the survey results will be submitted to Service. Elderberry seedlings/cuttings and associated native plants will be planted prior to transplantation of elderberry

shrubs. The data collected during the surveys prior to transplantation will be used to determine if compensation requirements or take limits are being exceeded, and if additional plantings are necessary. Because construction of the Southport project will occur over multiple years, elderberry survey data for each year will be used to rectify any discrepancies in compensation and to ensure full compensation of effects on the beetle. Surveys for the beetle are valid for a period of 2 years (Service 1999a).

Water the construction area to control dust: The construction contractor will ensure that the project construction area will be watered as necessary to prevent dirt from becoming airborne and accumulating on elderberry shrubs within the 100-foot buffer.

Compensate for direct effects on valley elderberry longhorn habitat: Before construction begins, compensation will be implemented for direct effects on elderberry shrubs by transplanting shrubs that cannot be avoided to a Service-approved conservation area. Elderberry seedlings or cuttings and associated native species will also be planted in the conservation area. Each elderberry stem measuring 1 inch or greater in diameter at ground level that is adversely affected will be replaced in the conservation area, with elderberry seedlings or cuttings at a ratio ranging from 1:1 to 8:1 (new plantings to affected stems). The numbers of elderberry seedlings/cuttings and associated riparian native trees/shrubs to be planted as replacement habitat are determined by stem size class of affected elderberry shrubs, presence or absence of exit holes, and whether the shrub lies in a riparian or non-riparian area. Stock of either seedlings or cuttings will be obtained from local, Service-approved sources. At the discretion of the Service, shrubs that are unlikely to survive transplantation because of poor condition or location, or a plant that will be extremely difficult to move because of access problems, may be exempted from transplantation. In cases in which transplantation is not possible, minimization ratios will be increased to offset the additional habitat loss.

The relocation of elderberry shrubs will be conducted according to Service-approved procedures outlined in the Conservation Guidelines (Service 1999a). Elderberry shrubs within the project construction area that cannot be avoided will be transplanted during the plant's dormant phase, which is November through the first 2 weeks of February. A qualified biological monitor will remain onsite while the shrubs are being transplanted.

#### *Proposed Conservation Area*

About 120 acres of riparian habitat in the Offset floodplain area will be restored or enhanced as part of the project implementation. Based on the Conservation Guidelines (Service 1999a), a total of 13.51 acres of the floodplain will be riparian habitat required for beetle compensation plantings for the Southport Project.

Evidence of the beetle occurrence in the conservation area, the condition of the elderberry shrubs in the conservation area, and the general condition of the conservation area itself will be monitored over a period of 10 consecutive years or for 7 years over a 15-year period from the date of transplanting. Monitoring reports will be provided to the Service in each of the years in which monitoring is required. As specified in the Conservation Guidelines, the report will include information on timing and rate of irrigation, growth rates, and survival rates and mortality.

To meet the success criteria specified in the Conservation Guidelines, a minimum survival rate of 60% of the original number of elderberry replacement plantings and associated native plants must be maintained throughout the monitoring period.

### **Action Area**

The action areas is defined in 50 CFR § 402.02, as “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.” For the purposes of the effects assessment, the action area encompasses the Sacramento River from the Sacramento Bypass downstream to the South Cross Levee, the Sacramento Deep Water Ship Channel and the Port of West Sacramento, and the Sacramento and Yolo Bypasses (Figure 1).

The City of West Sacramento is bisected into two basins by the Sacramento River Deep Water Ship Channel and the Port of West Sacramento, and is contained within the levees of the West Sacramento GRR Project. The north basin encompasses 6,100 acres, while the south basin is 6,900 acres. Potential borrow areas, transportation routes, and staging areas have been identified within the city, as well as within 20 miles of West Sacramento. The potential borrow areas identified in Figure 2 are also part of the action area.

The action area also includes the perennial waters extending 200 feet perpendicular from shorelines adjacent to construction areas, and 1,000 feet downstream of the in-water construction areas. These distances represent the extent to which turbidity and sedimentation from the West Sacramento GRR Project may affect the waters.

### **Analytical Framework for the Jeopardy and Adverse Modifications Determinations**

#### Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis in this biological opinion relies on four components: (1) the Status of the Species, which evaluates snake, beetle, and smelt range-wide conditions, the factors responsible for these conditions, and the survival and recovery needs of each species; (2) the Environmental Baseline, which evaluates the condition of the snake, beetle, and smelt in the action area, the factors responsible for these conditions, and the relationship of the action area to the survival and recovery of each species; (3) the Effects of the Action, which determines the direct and indirect effects of the proposed Federal action and the effects of any interrelated or interdependent activities on the snake, beetle, and smelt; and (4) the Cumulative Effects, which evaluates the effects of future, non-Federal activities in the action area on the snake, beetle, and smelt.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the current status of the snake, beetle, and smelt, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of recovery of each species in the wild.

The jeopardy analysis in this biological opinion places an emphasis on consideration of the range-wide survival and recovery needs of the snake, beetle, smelt, as well as the role of the action area in the survival and recovery of each species as the context for evaluating the significance of the effects

of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

#### Adverse Modification Determination

This biological opinion does not rely on the regulatory definition of “destruction or adverse modification” of critical habitat at 50 CFR 402.2. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this biological opinion relies on four components: (1) the Status of the Critical Habitat, which evaluates the range-wide condition of critical habitat for the smelt in terms of primary constituent elements (PCE)s, the factors responsible for that condition, and the intended recovery function of the critical habitat at the provincial and range-wide scale; (2) the Environmental Baseline, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the Effects of the Action, which determines the direct and indirect effects of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units and; (4) Cumulative Effects which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on smelt critical habitat are evaluated in the context of the range-wide condition of the critical habitat at the provincial and range-wide scales, taking into account any cumulative effects, to determine if the critical habitat range-wide will remain functional (or will retain capable habitat) to serve its intended recovery role for the smelt.

The analysis in this biological opinion places an emphasis on using the intended range-wide recovery function of smelt critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

#### **Status of the Species**

##### Giant Garter Snake

Please refer to the Giant Garter Snake (*Thamnophis gigas*) 5-year Review: Summary and Evaluation for the current status of the species (Service 2006).

##### *Environmental Baseline*

Suitable habitat for the snake exists along the western border of both the North and South Basins of the West Sacramento GRR Project. In the North Basin, some additional suitable habitat can be found along the Sacramento Bypass. In the South Basin, drainages along the toe of the South Cross Levee may also provide habitat for the snake. However, most of the developed and undeveloped lands within the City of West Sacramento do not provide suitable habitat for the snake.

There are 28 occurrence records of the snake within 5 miles of the City of West Sacramento (CDFW 2014b). The closest occurrences are about 1.5 miles west of the Sacramento Bypass Training Levee, while 11 occurrences are to the north in the Natomas Basin, across the Sacramento

River from West Sacramento. There are 77 CNDDDB occurrences within 10 miles of West Sacramento (CDFW 2014b). Seven of the occurrence records within 10 miles of West Sacramento are across the Sacramento River and southeast of the City of Sacramento, near Elk Grove. Giant garter snakes are apparently absent from larger rivers, and from wetlands with sand, gravel, or rock substrates (R. Hansen 1980; Rossman and Stewart 1987; Brode 1988; G. Hansen 1988; Brode and Hansen 1992). The North and South Basins contain limited suitable snake aquatic habitat in drainages and canals, yet the Sacramento River generally does not offer suitable habitat and is a significant barrier to snake movement.

#### Valley Elderberry Longhorn Beetle

For the most recent comprehensive assessment of the range-wide status of the beetle, please refer to the *Withdrawal of the Proposed Rule to Remove the Valley Elderberry Longhorn Beetle from the Federal List of Endangered and Threatened Wildlife; Proposed Rule, Withdrawal* (Service 2014a).

#### *Environmental Baseline*

The majority of lands within North and South Basins of West Sacramento are urban and suburban lands in private ownership. Suitable habitat for the beetle (i.e., elderberry shrubs) occurs throughout the City of West Sacramento. Although the status of the beetle and its habitat on most of these private lands is unknown, there are documented occurrences of beetles in both the North and South Basins (CDFW 2014b). In the South Basin, occurrence number 208 near river mile 52 of the Sacramento River, and occurrence number 209 along a railroad access north of Davis road, have identified both male and female beetles. At occurrence number 209, one female was observed laying eggs in 2006 (CDFW 2014b). In the North Basin, occurrences 18, 28, 29, and 56 have all documented elderberry shrubs with exit holes in stems, a sign of beetle presence.

#### Delta Smelt

##### *Listing Status*

The Service proposed to list the smelt as threatened with proposed critical habitat on October 3, 1991 (Service 1991). The Service listed the smelt as threatened on March 5, 1993, and designated critical habitat for this species on December 19, 1994 (Service 1994). The smelt was one of eight fish species addressed in the Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes (Service 1995). This recovery plan is currently under revision. A 5-year status review of the smelt was completed on March 31, 2004 (Service 2004). The 2004 review affirmed the need to retain the smelt as a threatened species. A 12-month finding on a petition to reclassify the delta smelt was completed on April 7, 2010 (Service 2010). After reviewing all available scientific and commercial information, the Service determined that re-classifying the smelt from a threatened to an endangered species was warranted but precluded by other higher priority listing actions (Service 2010).

##### *Distribution*

The smelt is endemic to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta) in California, and is restricted to the area from San Pablo Bay upstream through the Delta in Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties (Moyle 2002). Their range extends from San Pablo Bay upstream to Verona on the Sacramento River and Mossdale on the San Joaquin River. The smelt was formerly considered to be one of the most common pelagic fish in the upper Sacramento-San Joaquin Estuary.

### *Description*

Delta smelt are a small, slender bodied fish of the Osmeridae (smelts) (Moyle 2002). They are nearly translucent with a steely-blue sheen to their sides and a pronounced odor reminiscent of cucumber (Moyle 2002). Although delta smelt have been recorded to reach lengths of up to 120 mm (4.7 in) (Moyle 2002), catch data from 1992 - 2004 showed mean fork length to be  $54.1 \pm .01$  mm (Bennett 2005; Sweetnam 1999). Delta smelt are also identifiable by their relatively large eye to head size (Moyle 2002) and their small, translucent adipose fin located between the dorsal and caudal fins. Occasionally one chromatophore may be found between the mandibles, but most often there is none (Moyle 2002).

The delta smelt is one of six species currently recognized in the *Hypomesus* genus (Bennett 2005). Genetic analyses have confirmed that delta smelt presently exists as a single intermixing population (Stanley et al. 1995; Trenham et al. 1998; Fisch et al. 2011). Within the genus, delta smelt are most closely related to surf smelt (*H. pretiosus*), a species common along the western coast of North America. The wakasagi (*H. nipponensis*), an anadromous western Pacific smelt species introduced to Central Valley reservoirs in 1959, is thought to be seasonally sympatric with the delta smelt in the estuary (Trenham et al. 1998). Despite morphological similarities, allozyme studies have demonstrated that wakasagi and delta smelt are genetically distinct and presumably derived from different marine ancestors (Stanley et al. 1995).

### *Life History*

Adult delta smelt spawn during the late winter and spring months, with most spawning occurring during April through mid-May (Moyle 2002). Spawning occurs primarily in sloughs and shallow edge areas in the Delta and has been recorded in Suisun Marsh and the Napa River (Moyle 2002). Most spawning occurs at temperatures between 12-18°C. Spawning may occur at temperatures up to 22°C, but hatching success of the larvae is very low (Bennett 2005). Fecundity of females ranges from about 1,200 to 2,600 eggs, and is correlated with female size (Moyle 2002). In captivity, females survive after spawning and develop a second clutch of eggs (Mager et al. 2004) and field collections of ovaries containing eggs of different size and stage indicate that this also occurs in the wild (Adib-Samii 2008). While most adults do not survive to spawn a second season, a small percentage do (<5 percent) (Moyle 2002; Bennett 2005) and are typically larger (90-110 mm Standard Length [sdl]). These females may contribute disproportionately to the population's egg supply (Moyle 2002 and references therein) since two-year-old females may have 3-6 times as many ova as first year spawners.

The locations in the Delta where newly hatched larvae are present most likely indicates spawning occurrence and most of what is known about delta smelt spawning habitat in the wild is inferred from the location of spent females and young larvae captured in the DFW's Spring Kodiak Trawl (SKT) (CDFW 2014a) and 20-mm Survey, respectively. In the laboratory, delta smelt spawned at night (Baskerville-Bridges et al. 2000; Mager et al. 2004). Other smelts, including marine beach spawning species and estuarine populations are secretive spawners, entering spawning areas during the night and leaving before dawn. If this behavior is exhibited by delta smelt, then delta smelt distribution based on the SKT, which is conducted during daylight hours in offshore habitats, may reflect general regions of spawning activity, but not actual spawning sites.

Delta smelt spawning has only been directly observed in the laboratory. Consequently, what is known about the mechanics of smelt spawning is derived from laboratory observations and observations of related smelt species. Delta smelt eggs are 1 millimeter diameter and are adhesive

and negatively buoyant (Moyle 2002; Mager et al. 2004; Wang 1986; Wang 2007). Laboratory observations indicate that delta smelt are broadcast spawners, discharging eggs and milt close to the bottom over substrates of sand and/or pebble in current (DWR and Reclamation 1994; Brown and Kimmerer 2002; Lindberg et al. 1997; Wang 2007). Spawning over gravel or sand can also aid in the oxygenation of smelt eggs and eggs that are laid in silt or muddy substrates might get buried or smothered, preventing their oxygenation from water flow (Lindberg pers. comm. 2011). The eggs of surf smelts and other beach spawning smelts adhere to sand particles, which keeps them negatively buoyant but not immobile, as the sand may “tumble” them with water currents and turbulence (Hay 2007). It is not known whether delta smelt eggs “tumble incubate” in the wild, but tumbling of eggs may moderately disperse them, which might reduce predation risk within a localized area.

Mager et al. (2004) reported that embryonic development to hatching takes 11-13 days at 14-16° C for delta smelt, and Baskerville-Bridges et al. (2000) reported hatching of delta smelt eggs after 8-10 days at temperatures between 15-17° C. Wang (2007) reported high hatching rates at temperatures between 14-17° C. At hatching and during the succeeding three days, larvae are buoyant, swim actively near the water surface, and do not react to bright direct light (Mager et al. 2004). As development continues, newly hatched delta smelt become semi-buoyant.

Analyses of otoliths indicate larval delta smelt grow to twice their size after 40 days (Bennett 2005), and by 70 days, most wild fish were 30-40 mm long and beyond the larval stage. This suggests there is a strong selective pressure for rapid larval growth in nature, a situation that is typical for fish in general (Houde 1987). Successful feeding seems to depend on a high density of food organisms and turbidity, and increases with stronger light conditions (Baskerville-Bridges et al. 2000; Mager et al. 2004; Baskerville-Bridges et al. 2004). The food available to larval smelt is constrained by mouth gape and status of fin development. Larval smelt cannot capture as many kinds of prey as larger individuals, but all life stages have small gapes that limit their range of potential prey. Prey availability is also constrained by habitat use, which affects what types of prey are encountered. Larval smelt are visual feeders and their ability to see prey in the water is enhanced by turbidity (Baskerville-Bridges et al. 2004). Thus, smelt diets are largely comprised of small crustacea that inhabit the estuary's turbid, low-salinity, open-water habitats (i.e., zooplankton). Larval smelt have particularly restricted diets (Nobriga 2002) and they do not feed on the full array of zooplankton with which they co-occur; they mainly consume three copepods, *Eurytemora affinis*, *Pseudodiaptomus forbesi*, and freshwater species of the family Cyclopidae. Further, the diets of first-feeding smelt larvae are largely restricted to the larval stages of these copepods; older, larger life stages of the copepods are increasingly targeted as the smelt larvae grow, their gape increases, and they become stronger swimmers.

The triggers for, and the duration of, delta smelt larval movement from spawning areas to rearing areas are not known. Most larvae gradually move downstream toward the two parts per thousand isohaline (X<sub>2</sub>), where X<sub>2</sub> is scaled as the distance in kilometers from the Golden Gate Bridge (Jassby et al. 1995). Young-of-the-year smelt rear in the low-salinity zone (LSZ) from late spring through fall and early winter. Once in the rearing area growth is rapid, and juvenile fish are 40-50 mm sdl by early August (Erkkila et al. 1950; Ganssle 1966; Radtke 1966). They reach adult size (55-70 mm sdl) by early fall (Moyle 2002) and smelt growth slows considerably (only 3-9 mm total) during the fall months, presumably because most of the energy ingested is being directed towards gonadal development (Erkkila et al. 1950; Radtke 1966).

Population Dynamics and Abundance Trends- CDFW conducts several long-term monitoring surveys that have been used to index the relative abundance of smelt. The 20-mm Survey (CDFW 2014a) has been conducted every year since 1995 and samples April-June, targeting late-stage smelt larvae. The summer ternet survey (TNS) has been conducted nearly every year between June-August, since 1959, and targets 38-mm striped bass, but collects similar-sized juvenile smelt. The FMWT has been conducted nearly every year since 1967, and like the TNS, the survey targets age-0 striped bass but collects smelt > 40 mm in length. The FMWT samples from September through December. The smelt catch data and relative abundance indices derived from these sampling programs have been used in numerous publications (e.g., Stevens and Miller 1983; Moyle et al. 1992; Jassby et al. 1995; Kimmerer 2002b; Dege and Brown 2004; Bennett 2005; Feyrer et al. 2007; Sommer et al. 2007; Kimmerer 2008; Newman 2008; Nobriga et al. 2008; Kimmerer et al. 2009; Mac Nally et al. 2010; Thomson et al. 2010; Feyrer et al. 2011; Maunder and Deriso 2011) and the abundance index time series documents the long-term decline of the smelt.

At all life stages, delta smelt are found in greatest abundance in the water column and usually not in close association with the shoreline. They inhabit open, surface waters of the Delta and Suisun Bay, where they presumably aggregate in loose schools where conditions are favorable (Moyle 2002). In years of moderate to high Delta outflow, delta smelt larvae are abundant in the Napa River, Suisun Bay and Montezuma Slough, but the degree to which these larvae are produced by locally spawning fish versus the degree to which they originate upstream and are transported by tidal currents to the bay and marsh is uncertain.

Sampling of larval delta smelt in 1989 and 1990 suggested that spawning occurred in the Sacramento River; in Georgiana, Prospect, Beaver, Hog, and Sycamore sloughs; in the San Joaquin River adjacent to Bradford Island and Fisherman's Cut; and possibly other areas (Wang 1991). However, in recent years, the densest concentrations of both spawners and larvae have been recorded in the Cache Slough/Sacramento Deepwater Ship Channel complex in the North Delta. Some delta smelt spawning occurs in the Napa River, Suisun Bay and Suisun Marsh during wetter years (Sweetnam 1999; Wang 1991; Hobbs et al. 2007). Early stage larval delta smelt have also been recorded in Montezuma Slough near Suisun Bay (Wang 1986).

The timing of spawning may affect delta smelt population dynamics. Lindberg (2011) has suggested that smelt larvae that hatch early, around late February, have an advantage over larvae hatched during late spawning in May. Early season larvae have a longer growing season and may be able to grow larger faster during more favorable habitat conditions in the late winter and early spring. An early growing season may result in higher survivorship and a stronger spawning capability for that generation. Larvae hatched later in the season have a shorter growing season which effectively reduces survivorship and spawning success for the following spawning season.

Early statistical assessments of delta smelt population dynamics concluded that at best, the relative abundance of the adult delta smelt population had only a very weak influence on subsequent juvenile abundance (Sweetnam and Stevens 1993). Thus, early attempts to describe abundance variation in delta smelt ignored stock-recruit effects and researchers looked for environmental variables that were directly correlated with interannual abundance variation (e.g., Stevens and Miller 1983; Moyle et al. 1992; Sweetnam and Stevens 1993; Herbold 1994; Jassby et al. 1995). Because delta smelt live in a habitat that varies in size and quality with Delta outflow, the authors cited above searched for a linkage between Delta outflow (or X2) and the TNS and FMWT indices. Generally, these analyses did not find strong support for an outflow-abundance linkage, which led to a prevailing conceptual model that multiple interacting factors had caused the delta smelt decline (Moyle et al. 1992; Bennett

and Moyle 1996; Bennett 2005). It has also recently been noted that delta smelt's FMWT index is partly influenced by concurrent environmental conditions (Feyrer et al. 2007; 2011). This may be a partial explanation for why few analyses could consistently link springtime environmental conditions to delta smelt's fall index.

Delta smelt abundance plays an important role in subsequent abundance (Bennett 2005; Maunder and Deriso 2011). Bennett (2005) assessed data from CDFW's FMWT and TNS, and concluded that two-year-old delta smelt might play an important role in delta smelt population dynamics, that it was not clear whether juvenile production was a density-independent or -dependent function of adult abundance, and that adult production is a density-dependent function of juvenile abundance. He also concluded that the carrying capacity of the estuary to support this life-stage transition had declined over time. These conclusions are also supported by Maunder and Deriso (2011).

Delta smelt population dynamics may have also changed over time. Previous publications have reported a delta smelt step-decline during 1981-1982 (Kimmerer 2002b; Thomson et al. 2010). Prior to this decline, the stock-recruit data are consistent with "Ricker" type density-dependence where increasing adult abundance resulted in decreased juvenile abundance. Since the decline, recruitment has been positively and essentially linearly related to prior adult abundance, suggesting that reproduction has been basically density-independent for about the past 30 years. This means that since the early 1980s, more adults translates into more juveniles and fewer adults translates into fewer juveniles without being "compensated for" by density-dependence.

In contrast to the transition among generations, the weight of scientific evidence strongly supports the hypothesis that, at least over the history of Interagency Ecological Program fish monitoring, delta smelt has experienced density-dependence during the juvenile stage of its life cycle (Bennett 2005; Maunder and Deriso 2011). This has been inferred because, statistically, the FMWT index does not increase linearly with increases in the TNS index. Rather, the best-fitting relationships between the TNS index and the FMWT index show the FMWT indices approach an asymptote as the TNS indices increases, or possibly even declines at the highest TNS indices.

From a species conservation perspective, the most relevant aspect of this juvenile density dependence is that the carrying capacity of the estuary for delta smelt has declined (Bennett 2005). Thus, the delta smelt population decline has occurred for two basic reasons. First, the compensatory density-dependence that historically enabled juvenile abundance to rebound from low adult numbers stopped happening. The reason is still not known, but the consequence of the change is that for the past several decades, adult abundance drives juvenile production in a largely density-independent manner. Thus, if numbers of adults or adult fecundity decline, juvenile production will also decline (Kimmerer 2011). Second, because juvenile carrying capacity has declined, juvenile production hits a "ceiling" at a lower abundance than it once did. This limits adult abundance and possibly per capita fecundity, which cycles around and limits the abundance of the next generation of juveniles. The mechanism causing carrying capacity to decline is likely due to the long-term accumulation of deleterious habitat changes – both physical and biological – during the summer-fall (Bennett et al. 2008; Feyrer et al. 2007; 2011; Maunder and Deriso 2011).

### *Habitat*

The existing physical appearance and hydrodynamics of the Delta have changed substantially from the environment in which native fish species like delta smelt evolved. The Delta once consisted of tidal marshes with networks of diffuse dendritic channels connected to floodplains of wetlands and

upland areas (Moyle 2002). The in-Delta channels were further connected to drainages of larger and smaller rivers and creeks entering the Delta from the upland areas. In the absence of upstream reservoirs, freshwater inflow from smaller rivers and creeks and the Sacramento and San Joaquin Rivers were highly seasonal and more strongly and reliably affected by precipitation patterns than they are today. Consequently, variation in hydrology, salinity, turbidity, and other characteristics of the Delta aquatic ecosystem was greater in the past than it is today (Kimmerer 2002a). The following is a brief description of the changes that have occurred to delta smelt's habitat.

Changes to the LSZ: There have been documented changes to the delta smelt's LSZ habitat that have led to present-day habitat conditions. The close association of delta smelt with the San Francisco estuary LSZ has been known for many years (Stevens and Miller 1983; Moyle et al. 1992). Peterson (2003) developed a conceptual model that hypothesized how, "stationary and dynamic components of estuarine habitats" interacted to influence fisheries production in tidal river estuaries. Peterson's model suggests that when the dynamic and static aspects of estuarine habitat sufficiently overlap, foraging, growth, density, and survival are all high, and that enables fish production to outpace losses to predators. The result is high levels of successful recruitment of new individuals. The model also hypothesizes that when the dynamic and static aspects of an estuarine habitat do not sufficiently overlap, foraging, growth, density, and survival are impaired such that losses to predators increase and recruitment of new individuals decreases. This model was developed specifically for species spawned in marine environments that were subsequently transported into estuaries. However, the concept of X2, which was developed in the San Francisco estuary to describe how freshwater flow affected estuarine habitat (Jassby et al. 1995), played a role in the intellectual development of Peterson's model.

Current information indicates the most suitable delta smelt habitat is when low-salinity water is near 20°C, highly turbid, oxygen saturated, low in contaminants, supports high densities of calanoid copepods and mysid shrimp (Moyle et al. 1992; Lott 1998; Nobriga 2002), and occurs over comparatively static 'landscapes' that support sandy beaches and bathymetric variation that enables the fish and their prey to aggregate (Kimmerer et al. 2002a; Bennett et al. 2002; Hobbs et al. 2006). Almost every component listed above has been degraded over time and the Service has determined that this accumulation of habitat change is the fundamental reason or mechanism that has caused delta smelt to decline.

Alterations to estuarine bathymetry and salinity distribution- The position of the LSZ, where delta smelt rear, has changed over the years. The first major change in the LSZ was the conversion of the landscape over which tides oscillate and river flows vary (Moyle et al. 2010). Most of the historic wetlands within the system were diked and reclaimed for agriculture or other human uses by 1920 (Atwater et al. 1979) and channels were dredged to accommodate shipping traffic from the Pacific Ocean and San Francisco Bay to ports in Sacramento and Stockton. These changes left Suisun Bay and the confluence of the Sacramento-San Joaquin Rivers as the largest and most bathymetrically variable places in the LSZ. This region remained a highly productive nursery for many decades (Stevens and Miller 1983; Moyle et al. 1992; Jassby et al. 1995); however, the deepened channels required more freshwater outflow to maintain the LSZ in the large Suisun Bay and at the confluence than was once required (Gartrell 2010).

The construction of the Central Valley Water Project and the State Water Project not only provided water supply for urban, agricultural and industrial users, but also provided water needed to combat salinity intrusion into the Delta, which was observed by the early 20th century. California's demand

for freshwater continues to increase and the seasonal salinity intrusion perpetually reduces the temporal overlap of the LSZ (indexed by X2) within the Suisun Bay, especially in the fall (Feyrer et al. 2007; 2011). Consequently, a major habitat change in the Delta has been in the frequency with which the LSZ is maintained in Suisun Bay for any given amount of precipitation. There was a step-decline in the LSZ in 1977 from which it has never recovered for more than a few years at a time. Based on model forecasts of climate change and water demand, this trend is expected to continue (Feyrer et al. 2011).

Summer and fall environmental quality has decreased overall in the Delta because outflows are lower and water transparency is higher. The confluence of the Sacramento and San Joaquin Rivers has, as a result, become increasingly important as a rearing location for delta smelt, with physical environmental conditions constricting the species range to a relatively narrow area (Feyrer et al. 2007; Nobriga et al. 2008). This has increased the likelihood that most of the juvenile population is exposed to chronic and cyclic environmental stressors, or catastrophic events. For instance, all seven delta smelt collected during the September 2007 fall mid-water trawl (FMWT) survey were captured at statistically significantly higher salinities than what will be expected based upon historical distribution data generated by Feyrer et al. (2007). During the same year, the annual bloom of toxic cyanobacteria (*Microcystis aeruginosa*) spread far downstream to the west Delta and beyond during the summer (Lehman et al. 2005), and this has been suggested as an explanation for the anomaly in the distribution of delta smelt relative to water salinity levels (USBR 2008).

Turbidity: From 1999 to present, the Delta experienced a change in estuarine turbidity that culminated in an estuary-wide step-decline in 1999 (Schoellhamer 2011). Since delta smelt associate with highly turbid waters, there is a negative correlation between the frequency of delta smelt occurrence in trawls during the summer, fall and early winter, at a given sampling station with increasing clarity, or Secchi depth (Feyrer et al. 2007, Nobriga et al. 2008). This is very consistent with behavioral observations of captive delta smelt (Nobriga and Herbold 2008). Few daylight trawls catch delta smelt at Secchi depths over 0.50 m and capture probabilities for delta smelt are highest at 0.40 m or less. Turbid waters are thought to increase foraging efficiency (Baskerville-Bridges et al. 2004) and reduce the risk of predation for delta smelt.

Temperature: Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the water is well oxygenated and temperatures are usually less than 25° C in summer (Nobriga et al. 2008). Swanson and Cech (1995) and Swanson et al. (2000) indicate delta smelt tolerate a range of temperatures (<8° C to >25° C), however warmer water temperatures >25° C restrict their distribution more than colder water temperatures (Nobriga and Herbold 2008). Currently, delta smelt are subjected to thermally stressful temperatures every summer, and all available regional climate change projections predict central California will be warmer still in the coming decades (Dettinger 2005). Water temperatures are presently above 20°C for most of the summer in core habitat areas, sometimes even exceeding the nominal lethal limit of 25°C for short periods. Coldwater fishes begin to have behavioral impairments (Marine and Cech 2004) and lose competitive abilities (Taniguchi et al. 1998) prior to reaching their thermal tolerance limits. Thus, the estuary can already be considered thermally stressful to delta smelt and can only become more so if temperatures warm in the coming decades.

Foraging Ecology: Delta smelt feed primarily on small planktonic crustaceans, and occasionally on insect larvae (Moyle 2002). Historically, the main prey of delta smelt was the euryhaline copepod *Eurytemora affinis* and the euryhaline mysid *Neomysis mercedis*. The slightly larger *Pseudodiaptomus forbesi*

has replaced *E. affinis* as a major prey source of delta smelt since its introduction into the Bay-Delta (Moyle 2002). Another smaller copepod, *Limnithona tetraspina*, was introduced to the Bay-Delta in the mid-1990s and is now one of the most abundant copepods in the LSZ, but not abundant in delta smelt diets. *Acartiella sinensis*, a calanoid copepod species that invaded the Delta at the same time as *L. tetraspina*, also occurs at high densities in Suisun Bay and in the western Delta over the last decade. Delta smelt eat these newer copepods, but *Pseudodiaptomus* remains their dominant prey (Baxter et al. 2008).

River flows influence estuarine salinity gradients and water residence times and thereby affect both habitat suitability for benthos and the transport of pelagic plankton upon which delta smelt feed. High tributary flow leads to lower residence time of water in the Delta, which generally results in lower plankton biomass (Kimmerer 2004). Higher residence times, which result from low tributary flows, can result in higher plankton biomass, but water diversions, overbite clam grazing (Jassby et al. 2002), and possibly contaminants (Baxter et al. 2008) remove a lot of plankton biomass when residence times are high. Delta smelt cannot occupy much of the Delta anymore during the summer (Nobriga et al. 2008) and there is a potential disconnect between regions of high zooplankton abundance in the Delta and delta smelt distribution.

Aquatic Macrophytes: For many decades, the Delta's waterways were turbid and growth of submerged plants was apparently unremarkable. That began to change in the mid-1980s, when the Delta was invaded by the non-native plant, *Egeria densa*, a fast-growing aquatic macrophyte that has now taken hold in many shallow habitats throughout the Delta (Brown and Michniuk 2007; Hestir 2010). The large canopies formed by *E. densa* and other non-native species of submerged aquatic vegetation (SAV) have physical and biological consequences for the ecosystem (Kimmerer et al. 2008) and delta smelt. First, the dense nature of SAV promotes sedimentation of particulate matter from the water column, which increases water transparency that then limits the amount of habitat available for delta smelt (Feyrer et al. 2007; Nobriga et al. 2008). Second, dense SAV canopies provide habitat for a suite of non-native fishes that occupy the Delta, displacing native fishes (Nobriga et al. 2005; Brown and Michniuk 2007) and increasing predation pressure on delta smelt. Third, the rise in SAV over the last three decades has led to a shift in the dominant trophic pathways that fuel fish production in the Delta. Until the latter 1980s, the food web of most fishes was often dominated by mysid shrimp (Feyrer et al. 2003) that were subsidized by phytoplankton food sources (Rast and Sutton 1989). Most littoral and demersal fishes of the Delta have diets dominated by the epibenthic amphipods that eat SAV detritus or the epiphytic algae attached to SAV (Grimaldo et al. 2009). Lastly, SAV can overwhelm littoral habitats (inter-tidal shoals and beaches) where delta smelt may spawn making them unsuitable for spawning.

Predators: Nothing is known about the historic predators of delta smelt or their possible influence on delta smelt population dynamics. Fish eggs and larvae can be opportunistically preyed upon by many invertebrate and vertebrate animals. The eggs and newly-hatched larvae of delta smelt are thought to be prey for Mississippi silversides (Bennett 2005), and potentially yellowfin goby, centrarchids, and Chinook salmon. Centrarchid fishes and Chinook salmon smolts released in the Delta for research may prey on larval delta smelt (Brandes and McLain 2001; Nobriga and Chotkowski 2000) and studies during the early 1960s found delta smelt were an occasional, but rare, prey fish for striped bass, black crappie and white catfish (Turner and Kelley 1966). Since delta smelt were a comparatively rare fish historically, it is not surprising that they were also a rare prey item.

The introduction of striped bass into the San Francisco Estuary in 1879 added a permanently resident, large piscivorous fish to the LSZ. The LSZ is a habitat not known to have had an equivalent predator prior to the establishment of striped bass (Moyle 2002). The current influence of striped bass and other predators on delta smelt population dynamics is unknown, mainly because predator effects on rare prey are extremely difficult to quantify. Delta smelt were observed in the stomach contents of striped bass and other fishes in the 1960s (Stevens 1963; Turner and Kelley 1966), but have not been in more recent studies (Feyrer et al. 2003; Nobriga and Feyrer 2007).

Potential native predators of juvenile and adult delta smelt will have included numerous bird and fish species, which may be reflected in delta smelt's life-history. Annual fish species, also known as "opportunistic strategists", are adapted to high mortality rates in the adult stage (Winemiller and Rose 1992). This high mortality is usually due to predation or highly unpredictable environmental conditions, both of which could have characterized the ancestral niche of delta smelt.

Predation is a common source of density-dependent mortality in fish populations (Rose et al. 2001), thus, it is possible that predation was a mechanism that historically generated the density-dependence observation in delta smelt population dynamics that has been noted by Bennett (2005) and Maunder and Deriso (2011). As is the case with other fishes, the vulnerability of delta smelt to predators may be influenced primarily by habitat suitability. It is widely documented that pelagic fishes, including many smelt species, experience lower predation risks under turbid water conditions (Thetmeyer and Kils 1995; Utne-Palm and Stiansen 2005; Horpilla et al. 2004). Growth rates, a result of feeding success plus water temperature, are also well known to affect fishes' cumulative vulnerability to predation (Sogard 1997).

Competition: It has been hypothesized that delta smelt are adversely affected by competition from other introduced fish species that use overlapping habitats, including Mississippi silversides, (Bennett and Moyle 1996) striped bass, and wakasagi (Sweetnam 1999). Laboratory studies show that delta smelt growth is inhibited when reared with Mississippi silversides (Bennett 2005) but there is no empirical evidence in the wild to support this conclusion.

The LSZ historically had the highest primary productivity and is where zooplankton populations were historically most dense (Knutson and Orsi 1983; Orsi and Mecum 1996). However, since the introduction of the overbite clam, this has not always been true (Kimmerer and Orsi 1996). There is some speculation that the overbite clam competes with delta smelt for copepod nauplii (Nobriga and Herbold 2008) but it is unknown how intensively overbite clam grazing and delta smelt directly compete for food.

Contaminants: Contaminants can change ecosystem functions and productivity through numerous pathways. However, contaminant loading and its ecosystem effects within the Delta are not well understood. Although a number of contaminant issues were first investigated during the Pelagic Organism Decline (POD) years, concern over contaminants in the Delta is not new. Current science suggests the possible link between contaminants and the POD may be the effects of contaminant exposure on prey items, resulting in an indirect effect on the survival of POD species (Johnson et al. 2010). Pyrethroids are of particular interest because use of these pesticides has increased within the Delta watershed (Amweg et al. 2005, Oros and Werner 2005). Urban source waters with pyrethroid pesticides have shown toxicity to the amphipod *Hyalella azteca*, and high mortality rates and swimming impairment in fishes (Weston and Lydy 2010).

The association of delta smelt spawning with turbid winter runoff and the association of pesticides including pyrethroids with sediment is of potential concern. Persistent confinement of the spawning population of delta smelt to the Sacramento River increases the likelihood that a substantial portion of the spawners will be affected by a catastrophic event or localized chronic threat. For instance, large volumes of highly concentrated ammonia released into the Sacramento River from the Sacramento Regional County Sanitation District may affect embryo survival or inhibit prey production. Further, agricultural fields in the Yolo Bypass and surrounding areas are regularly sprayed by pesticides, and water samples taken from Cache Slough sometimes exhibited toxicity to *H. azteca* (Werner et al. 2008; 2010). The extent to which delta smelt larvae are exposed to contaminants varies with flow entering the Delta, where flow pulses during spawning increase exposure to many pesticides (Kuivila and Moon 2004) but decrease ammonia concentrations from wastewater treatment plants. The thresholds of toxicity for delta smelt for most of the known contaminants have not been determined, but the exposure to a combination of different compounds increases the likelihood of adverse effects.

#### *Delta Smelt Critical Habitat*

The Service designated critical habitat for the delta smelt on December 19, 1994 (Service 1994). The geographic area encompassed by the designation includes all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the legal Delta (as defined in section 12220 of the California Water Code). Critical habitat is defined in section 3 of the Act as: (1) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features (a) essential to the conservation of the species and (b) that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by a species at the time it is listed, upon determination that such areas are essential for the conservation of the species. In determining which areas to designate as critical habitat, the Service considers those physical and biological features that are essential to a species' conservation and that may require special management considerations or protection (50 CFR 424.12(b)). The Service is required to list the known PCEs together with the critical habitat description. Such physical and biological features include, but are not limited to, the following:

1. Space for individual and population growth, and for normal behavior;
2. Food, water, air, light, minerals, or other nutritional or physiological requirements;
3. Cover or shelter;
4. Sites for breeding, reproduction, rearing of offspring, or dispersal; and
5. Generally, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

The PCEs defined for the delta smelt were derived from its biological needs. In designating critical habitat for the delta smelt, the Service identified the following primary constituent elements essential to the conservation of the species: physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration. Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay.

1. Physical habitat is defined as the structural components of habitat. Because delta smelt is a pelagic fish, spawning substrate is the only known important structural component of habitat. It is possible that depth variation is an important structural characteristic of pelagic habitat that helps fish maintain position within the estuary's LSZ (Bennett et al. 2002, Hobbs et al. 2006).
2. Water is defined as water of suitable quality to support various delta smelt life stages with the abiotic elements that allow for survival and reproduction. Delta smelt inhabit open waters of the Delta and Suisun Bay. Certain conditions of temperature, turbidity, and food availability characterize suitable pelagic habitat for delta smelt and are discussed in detail in the Status of the Species section above. Factors such as high entrainment risk and contaminant exposure can degrade this PCE even when the basic water quality is consistent with suitable habitat.
3. River flow is defined as transport flow to facilitate spawning migrations and transport of offspring to LSZ rearing habitats. River flow includes both inflow to and outflow from the Delta, both of which influence the movement of migrating adult, larval, and juvenile delta smelt. Inflow, outflow, and Old and Middle Rivers flow influence the vulnerability of delta smelt larvae, juveniles, and adults to entrainment at Banks and Jones. River flow interacts with the fourth PCE, salinity, by influencing the extent and location of the highly productive LSZ where delta smelt rear.
4. Salinity is defined as the LSZ nursery habitat. The LSZ is where freshwater transitions into brackish water; the LSZ is defined as 0.5-6.0 parts per thousand salinity (psu) (Kimmerer 2004). The 2 psu X2 is a specific point within the LSZ where the average daily salinity at the bottom of the water is 2 psu (Jassby et al. 1995). By local convention the location of the LSZ is described in terms of the distance from the 2 psu X2 to the Golden Gate Bridge; X2 is an indicator of habitat suitability for many San Francisco Estuary organisms and is associated with variance in abundance of diverse components of the ecosystem (Jassby et al. 1995, Kimmerer 2002b). The LSZ expands and moves downstream when river flows into the estuary are high. Similarly, it contracts and moves upstream when river flows are low. During the past 40 years, monthly average X2 has varied from San Pablo Bay (45 kilometers) to as far upstream as Rio Vista on the Sacramento River (95 kilometers). At all times of year, the location of X2 influences both the area and quality of habitat available for delta smelt to successfully complete their life cycle. In general, delta smelt habitat quality and surface area are greater when X2 is located in Suisun Bay. Both habitat quality and quantity diminish as the LSZ moves more frequently and further upstream, toward the confluence.

#### *Environmental Baseline*

Delta smelt critical habitat extends along the Sacramento River to the I Street Bridge, and marks the eastern boundary of both basins of the West Sacramento Project. Delta smelt critical habitat also includes the Sacramento River Deep Water Ship Channel, which extends along the western boundary of the West Sacramento GRR Project South Basin and separates the North and South Basins at the Port of Sacramento.

Monitoring surveys along the Sacramento River adjacent to project construction areas have confirmed the presence of the smelt in trawl surveys (Service 2014b) and shallow water seine net

surveys (Service 2014c). Trawl surveys conducted in March and April from Sherwood Harbor at River Mile 55, adjacent to the Sacramento River South levee, have recorded 51 smelt (Service 2012b). Similarly, one smelt was identified in a seine net survey at Sherwood Harbor in 2014, and over 50 smelt were netted between river miles 43 and 49, just downstream of the project South Basin, between 2012 and 2014 (Service 2014c). The surveys were conducted between November and April of successive years. The seine net surveys also noted 7 records of smelt adjacent to the project North Basin in February and March 2014, between river miles 60 and 62 (Service 2014c).

The Sacramento River Deep Water Ship Channel also provides suitable spawning habitat for the smelt (CDFW 2014c). At survey station 719, about 12 miles downstream of the South Cross Levee in the Sacramento Deep Water Ship Channel, March, 2014, 20mm surveys noted 48.84 smelt per 10,000 cubic meters, which is the highest catch rate of smelt in the Delta at that period. SKT trawl surveys during March and April of the past 3 years also showed the highest catch rates in the Delta (CDFW 2014a), demonstrating the importance of the Sacramento River Deep Water Ship Channel as a smelt spawning ground. In dry years, river flows can be expected to be relatively low, and hence the LSZ nursery habitat would move much further upstream, toward the project construction area.

### Effects of the Proposed Action

#### *Giant Garter Snake*

Construction activities of the West Sacramento GRR Project, such as fill removal, grading, fill placement, wall construction, and vehicle movement will permanently degrade 30 acres of snake habitat, and results in temporary effects to 211 acres (Table 5). Permanent effects include the direct loss of snake habitat, while temporary effects result from seasonal construction activities that will be restored upon completion of the construction activities at each levee reach. Effects to the snake from the Southport Project portion of the West Sacramento GRR Project are noted in Appendix B.

**Table 5.** Effects on giant garter snake (*Thamnophis giga*) habitat in the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.<sup>1</sup>

Habitat	Temporary Effects	Permanent Effects
Aquatic Habitat	11	20
Upland Habitat <sup>2</sup>	200 <sup>1</sup>	10

<sup>1</sup> The estimate of 200 acres is based on a worst-case scenario when considering necessary borrow material.

<sup>2</sup> Southport Project effects are included.

The Corps has proposed to compensate for the temporary loss of snake habitat through the purchase of snake credits from a Service-approved conservation bank at a ratio of 2:1. The Corps has proposed to compensate for the permanent loss of snake habitat through the purchase of snake credits from a Service-approved conservation bank at a ratio of 3:1.

Habitat affected by the snake includes rice fields, which offer many similarities to the historical, natural wetlands of the area around the City of West Sacramento. Open agricultural fields within the action area of the West Sacramento GRR Project are largely fallow or planted in wheat. These fields are not irrigated with standing water in a manner that mimics the natural wetlands used by the giant

garter snake. Although the drainage canals offer little in terms of prey base and vegetative cover, the drains lining the agricultural fields can provide avenues for snake travel.

Potential snake upland habitat is generally considered upland habitats within 200 feet of snake aquatic habitat. The Sacramento Bypass to the north, the Yolo Bypass to the west, and the South Cross Levee drainage canal to the south of the action area do provide suitable habitat for the snake. In the North Basin, work along the Sacramento Bypass Training Levee and Yolo Bypass Levees will border the Yolo Bypass, an area of agricultural and natural wetlands that provides suitable aquatic snake habitat. In the South Basin, work along the South Cross Levee, and along with the Sacramento Bypass west levee can provide suitable upland snake habitat.

#### *Valley Elderberry Loughorn Beetle*

As an Early Implementation Project, the Southport Project area along the South Sacramento River Levee was surveyed for elderberry shrubs 2011-2013. Surveys identified 41 shrubs containing 424 stems within the action area (Appendix B). An estimate of 18 shrubs (including 4 on inaccessible private lands) will be directly affected by construction activities, and will be removed and transplanted to the project offset floodplain area riparian zone if possible.

Transplanting the elderberry shrubs may cause them to die, become stressed, or become unhealthy due to transplanting. This may reduce the shrub's quality as habitat for the beetle, or impair production of habitat-quality stems in the future. Branches containing larvae may be cut, broken, or crushed during the transplantation process. These effects to the shrubs may cause the beetle to be harmed, harassed, injured, or killed.

The remaining 23 elderberry shrubs within 100 feet of construction activities will be protected during construction activities by implementing the listed Conservation Measures for the beetle. These measures will reduce the likelihood that the health and survival of the elderberry shrubs would be adversely affected by project activities to the point that take of the beetle is not reasonably likely to occur.

For the West Sacramento GRR Project as a whole, shrub counts were extrapolated to provide reasonable effects estimates for the complete project (Table 6). An estimated 215 elderberry shrubs will be affected by the West Sacramento GRR Project. To provide a worst-case scenario for analyses, all shrubs are assumed to be in riparian habitat and with evidence of beetle presence (holes in stems). Based on the results of these analyses, 118.42 acres will be required for elderberry and associated native species compensation plantings (Service 1999a). As part of the proposed conservation measures, the Corps is planning to use at least 13.51 acres of the Southport Project offset area riparian zone as an area for elderberry compensation plantings for the Southport Project portion of the West Sacramento GRR Project. The suitability of the offset area riparian zone for additional compensation will be dependent on site-specific conditions; additional compensation for the beetle will be acquired offsite.

#### *Delta Smelt and Delta Smelt Critical Habitat*

Potential spawning habitat includes shallow channel edge waters of the Sacramento River and Sacramento River Deep Water Ship Channel. Potential construction-related effects to smelt physical

**Table 6.** Estimates of elderberry shrubs affected by the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.<sup>1</sup>

Location	Stem Diameter	Holes	Number of Stems	Elderberry Ratios	Elderberry Plantings	Associate Ratios	Associate Plantings
Riparian	≥ 1 inch and ≤ 3 inches	Yes	1,524	4:1	5,588	2:1	10,580
Riparian	> 3 inches and < 5 inches	Yes	391	6:1	2,160	2:1	4,032
Riparian	≥ 5 inches	Yes	303	8:1	2,237	2:1	4,109
Totals <sup>2</sup>			2,218		9,985		18,721

<sup>1</sup> Information based on the Conservation Guidelines for the Valley Elderberry Longhorn Beetle (Service 1999a).

<sup>2</sup> Southport Project effects are included.

habitat would include disruption of spawning activities, disturbance or mortality of eggs and newly hatched larvae, alteration of spawning and incubation habitat, and loss of shallow water habitat for spawning. The Corps has estimated that 13.35 acres of shallow water habitat that may be used for spawning or dispersal will be permanently lost through the completion of the West Sacramento GRR Project. In contrast, 118.81 acres of suitable delta smelt shallow water habitat will be created by the project in the Southport Project offset area, for a net gain of 105.46 acres of shallow water habitat. The floodplain is designed to contain water during months (December – May) when smelt larva are most likely to be present.

The West Sacramento GRR Project could detrimentally affect delta smelt by increasing turbidity, increasing noise, reducing water quality, creating predator habitat, restricting channels, and changing water velocities. Re-suspended sediments may contain toxic substances which may interfere with the development of young delta smelt. The substrate upon which delta smelt may depend for egg attachment and refugia may become silted over or removed by the proposed actions. As shallow water habitat is removed and turbidity increased, the delta smelt's feeding, breeding, and sheltering would likely be reduced as food sources associated with the aquatic plants and found in the water column is destroyed, and habitat used for spawning substrate and refugia is eliminated.

Rock slope protection can limit the lateral mobility of a river channel, increase flow velocities (Sedell et al. 1990), limit sediment transport, and thus eliminate bankside refugia areas (Gregory et al. 1991). In turn, many of the streamside effects of increased velocity are transferred downstream (Larsen and Greco 2002). Although work along the Sacramento River includes additional rock slope protection, the negative effects to shallow water habitat, both at the project construction areas and downstream along the Sacramento River, are expected to be offset by the creation of the riparian and floodplain area of the Southport Project. The offset floodplain area is designed to absorb much of the increased flow energy, instead of having it transferred downstream. The floodplain area is expected to provide more space for population growth, additional cover or shelter, and additional habitat that is, for the most part, protected from large fluctuations in river velocities.

Adult delta smelt migrate upstream between December and January and spawn between January and July, with a peak in spawning activity between April and mid-May (Moyle 2002). The above effects are reduced by the restriction of project in-water work to time periods when delta smelt eggs, larvae, and juveniles are not present and delta smelt adults are rarely present or present in low numbers, between August 1 and November 30. In addition, the above effects are further greatly reduced by the creation of suitable shallow water habitat in the Southport Project offset floodplain area.

However, the creation of the Southport Project offset floodplain area could introduce increased predation and competition from exotic species. Fishes introduced to the Sacramento-San Joaquin Delta, such as the largemouth bass (*Micropterus salmoides*) and smallmouth bass (*M. dolomieu*), thrive as predators in warm, shallow water habitat. Such introduced fish may increase predation pressure upon the delta smelt in newly designed shallow water habitat. Reduced feeding efficiency and ingestion rates due to introduced competition into the designed smelt habitat, such as from the wagasaki (*Hypomesus nipponensis*), could weaken and slow the growth of young delta smelt and make them more vulnerable to starvation and predation.

### **Cumulative Effects**

Cumulative effects are those effects of future State, Tribal, county, local agency, and private actions that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the Act.

The California Department of Finance (2013) has projected the population within Sacramento County to rise 65% from 2010 levels to 2060, while Yolo County similarly is expected to experience nearly 66% growth over the same period. The West Sacramento GRR Project will afford increased flood protection for a growing community, which in turn could increase human-based pressures incrementally on the federally-listed species. For example, drainage areas that may now be used by snakes as travel corridors may cease to be useful for snakes with the onset of increased human activity in close proximity to waterways with no appropriate snake cover. Also, project effects to the snake, beetle, and smelt are expected to extend for several years as project construction progresses sequentially over time. To minimize unavoidable effects to the federally-listed species, the Corps has proposed several compensatory measures that will be implemented and maintained in perpetuity.

Cumulative effects on the delta smelt and its designated critical habitat include the effects of point and non-point source chemical contaminant discharges. These contaminants include numerous pesticides and herbicides associated with discharges related to agricultural and urban activities. Implicated as potential sources of mortality for delta smelt, these contaminants may adversely affect delta smelt reproductive success and survival rates. Spawning habitat may also be affected if submersed aquatic plants used as substrates for adhesive egg attachment are lost due to toxic substances.

Additional cumulative effects may result from diversions of water that may entrain adult or larval fish or that may change outflows incrementally, either excluding delta smelt from Sacramento River flow or shifting the position of the delta smelt from its preferred habitat.

## Conclusion

After reviewing the current status of the snake, beetle, smelt, and smelt critical habitat, the environmental baseline for the action area covered in this biological opinion, the effects of the proposed project, the cumulative effects, and the proposed conservation measures, it is the Service's biological opinion that the West Sacramento GRR Project, as proposed, is not likely to jeopardize the continued existence of these species. Also, the project will not result in net destruction or adverse modification of smelt critical habitat. The Service reached this conclusion because the anticipated level of take of the snake, beetle, and smelt, upon analyses of project effects in relation to the environmental baseline for these species, will not rise to levels precluding the recovery of these species, or reduce the likelihood of survival of these species.

The West Sacramento GRR Project will contribute to the conservation of the snake by preserving suitable snake habitat at a conservation bank. Also, the description of the West Sacramento GRR Project contains the Southport Project, which includes the creation of an offset floodplain area that will provide riparian habitat with space for transplanting elderberry shrubs displaced by the project. Any additional offsite areas necessary for elderberry compensation will be protected in perpetuity. In addition, the offset floodplain area will provide a net gain in the amount of suitable smelt shallow water habitat during the spring months, when the area is most likely to be used by the smelt for feeding and reproduction.

## INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service regulations at 50 CFR 17.3 as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the same regulations as an act which actually kills or injures wildlife. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

### Amount or Extent of Take

The Service anticipates incidental take of giant garter snakes will occur in the form of disturbance, harm, and harassment. Incidental take also may occur in the form of injury or death to snakes occupying levee holes or crevices unseen during construction. Within the West Sacramento GRR Project action area, effects to snakes at individual levee reaches will vary. Giant garter snakes are secretive and sensitive to human activities. Individual snakes are difficult to detect unless they are observed, undisturbed, at a distance. Most close-range observations represent chance encounters that are difficult to predict. In instances in which the total number of individuals anticipated to be taken cannot be determined, the Service may use the amount of habitat impacted as a surrogate; because the take of individuals anticipated will result from the destruction of the snake habitat, the quantification of suitable habitat serves as a direct surrogate for the snakes that will be lost. Over the course of project construction, the Service anticipates that all giant garter snakes found in 241 acres of habitat will be disturbed, harassed, harmed, or killed by project activities resulting in temporary impacts and permanent impacts, especially from dewatering, channel reconfiguration, and use of heavy equipment within or near aquatic habitat. Thirty acres of giant garter snake habitat may be permanently lost over the course of project construction.

Implementation of the West Sacramento GRR Project will result in the incidental take of the beetle resulting from project impacts to 215 elderberry shrubs with 2,218 stems one inch or greater in diameter at ground level. The life stage affected by this action will be the beetle larvae living within the stems of the elderberry shrubs. The life cycle of the beetle takes 1 or 2 years to complete, during which it spends most of its life in the larval stage. It is not possible to know how many beetle larvae are in the stems of any elderberry shrub, therefore the Service cannot quantify the total number of beetles that we anticipate will be taken as a result of the proposed action. Because the take of individuals anticipated will result from the destruction of the elderberry shrubs, the quantification of suitable habitat serves as a direct surrogate for the beetles that will be lost. Therefore, the Service anticipates take incidental to this project as the 215 elderberry shrubs with 2,218 stems one inch or greater in diameter at ground level that could potentially be destroyed.

The Service anticipates that incidental take of delta smelt will occur. However, the Service anticipates that any take of delta smelt will be difficult to detect and quantify for a number of reasons: they have a relatively small body size; they are relatively secretive; their presence in the Delta and associated areas coincides with relatively turbid conditions, which makes their detection difficult. Therefore, it is not possible to provide precise numbers of delta smelt that could be injured, harassed, harmed, or killed from the project. The Service anticipates that all delta smelt inhabiting up to 13.35 acres of shallow water habitat may be harmed, harassed, injured, or killed as a result of the project. Low mortality is anticipated because of the work restriction windows. Because the species is wide-ranging and its distribution varies from one year to the next, take may vary from year to year over the 19-year construction period. Additionally, losses of the species may be masked by seasonal fluctuations in fish presence. Upon implementation of the following reasonable and prudent measure, incidental take associated with the project in the form of harm, harassment, injury, or mortality to delta smelt, the Corps will become exempt from the prohibitions described under section 9 of the Act.

### **Effect of the Take**

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the snake, beetle, or smelt. Also, the West Sacramento GRR Project will not result in the destruction or adverse modification of designated critical habitat for the delta smelt.

### **Reasonable and Prudent Measure**

The Service has determined that the following reasonable and prudent measure is necessary and appropriate to minimize the effects of the proposed project on the snake, beetle, and smelt:

1. All conservation measures proposed in the biological assessment, and as re-stated in the project description section of this biological opinion, must be fully implemented and adhered to. Further, this Reasonable and Prudent Measure shall be supplemented by the Terms and Conditions listed below.

### **Terms and Conditions**

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are nondiscretionary.

1. The Service shall be informed of any changes in project construction scheduling as soon as possible. Should the project schedule be altered from that described herein, the Corps must immediately reinitiate formal consultation as per 50 §CFR 402.16.
2. The Corps shall comply with the latest Conservation Guidelines for the Valley Elderberry Longhorn Beetle (Service 1999a). The Corps shall check with the Service before each construction season to ensure that any and all updates to these guidelines are incorporated into the project. The Service shall be informed of conservation area monitoring plans to ensure that success criteria outlined in these guidelines are accurately assessed.
3. To monitor whether the amount or extent of incidental take anticipated from implementation of the proposed project is approached or exceeded, the Corps shall adhere to the following reporting requirement. Should this anticipated amount or extent of incidental take be exceeded, the Corps must immediately reinitiate formal consultation as per 50 §CFR 402.16.
  - a. For those components of the action that will result in habitat degradation or modification whereby incidental take in the form of harm is anticipated, the Corps will provide monthly updates to the Service with a precise accounting of the total acreage of habitat impacted. Updates shall also include any information about proposed changes in project implementation that result in habitat disturbance not described in the Project Description and not analyzed in this biological opinion.

## CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information or data bases. The Service is providing the following conservation recommendations:

1. The Corps should communicate with the Service to ensure that the most up to date plans for the recovery of each federally-listed species are recognized and followed:
  - a. The Corps should work with the Service to assist us in meeting the goals of the latest Recovery Plan for the valley elderberry longhorn beetle, which currently is the Valley Elderberry Longhorn Beetle Recovery Plan (Service 1984);
  - b. The Corps should work with the Service to assist us in meeting the goals of the latest Recovery Plan for the giant garter snake, which currently is the 1999 Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) (Service 1999b); and
  - c. The Corps should work with the Service to assist us in meeting the goals of the latest Recovery Plan for the delta smelt, which currently is the 1996 Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes (Service 1996).
2. The Corps and WSAFCA should monitor the effectiveness of the offset floodplain area in providing spawning and rearing habitat, as well the effectiveness of the floodplain in providing juvenile and adult transport and migration.

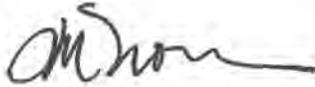
So the Service can be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendation.

## REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the West Sacramento Project General Reevaluation Report Project in Yolo County, California. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (a) if the amount or extent of taking specified in the incidental take statement is exceeded; (b) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) if the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or (d) if a new species is listed or critical habitat designated that may be affected by the identified action.

If you have questions regarding the West Sacramento West Sacramento GRR Project, please contact Harry Kahler, Fish and Wildlife Biologist, or Doug Weinrich, Assistant Field Supervisor, at (916) 414-6600.

Sincerely,

A handwritten signature in black ink, appearing to read "J. Norris", with a long horizontal flourish extending to the right.

Jennifer M. Norris  
Field Supervisor

Enclosure:

cc:

Sarah Ross Arrouzet, Corps of Engineers, Sacramento, California  
Maria Rae, National Marine Fisheries Service, Sacramento, California  
Mike Hendrick, National Marine Fisheries Service, Sacramento, California  
John Powderly, City of West Sacramento, West Sacramento, California

## REFERENCES

- Adib-Samii, J. 2008. Personal communication via e-mail with Victoria Poage, Service, re: water temperature thresholds for collection of delta smelt in routine survey sampling, October 8, 2008.
- Arnweg, E.L., D.P. Weston, & N.M. Ureda. 2005. Use and toxicity of pyrethroid pesticides in the Central Valley, California, USA. *Environmental Toxicology and Chemistry* 24:966–972.
- Atwater, B.F., S.G. Conard, J.N. Dowden, C.W. Hedel, R.L. MacDonald, and W. Savage. 1979. History, landforms, and vegetation of the estuary's tidal marshes. Pages 347-386 *in* San Francisco Bay: The Urbanized Estuary – Investigations into the Natural History of San Francisco Bay and Delta With Reference to the Influence of Man. Pacific Division of the American Association for the Advancement of Science. San Francisco, California.
- Baskerville-Bridges, B., J.C. Lindberg, J.P. Van Eenannaam, and S. Doroshov. 2000. Contributed Paper to the Interagency Ecological Program for the San Francisco Estuary: Progress and development of delta smelt culture: Year-end report 2000. *IEP Newsletter* 14:24-30.
- Baskerville-Bridges, B., J.C. Lindberg, and S.I. Doroshov. 2004. The effect of light intensity, alga concentration, and prey density on the feeding behavior of delta smelt larvae. Pages 219-228 *in* F. Feyrer, L.R. Brown, R.L. Brown and J.J. Orsi, *editors*. Early life history of fishes in the San Francisco Estuary and watershed. American Fisheries Society Symposium 39, Bethesda, Maryland.
- Baxter, R., R. Breuer, L. Brown, M. Chotkowski, F. Feyrer, M. Gingras, B. Herbold, A. Mueller-Solger, M. Nobriga, T. Sommer, and K. Souza. 2008. Pelagic organism decline progress report: 2007 synthesis of results. Available online at <[http://www/science.calwater.ca.gov/pdf/workshops/POD/IEP\\_POD\\_2007\\_synthesis\\_report\\_031408.pdf](http://www/science.calwater.ca.gov/pdf/workshops/POD/IEP_POD_2007_synthesis_report_031408.pdf)>
- Bennett, W.A. 2005. Critical assessment of the delta smelt population in the San Francisco Estuary, California. *San Francisco Estuary and Watershed Science* 3(2). 71 pages.
- Bennett, W.A. and P.B. Moyle. 1996. Where have all the fishes gone? Interactive factors producing fish declines. Pages 519-541 *in* Hollibaugh, JT, *editor*. San Francisco Bay: the ecosystem. Pacific Division of the American Association for the Advancement of Science. San Francisco, California.
- Bennett, W.A., W.J. Kimmerer, and J.R. Burau. 2002. Plasticity in vertical migration by native and exotic fishes in a dynamic low-salinity zone. *Limnology and Oceanography* 47:1496-1507.
- Bennett, W.A., J.A. Hobbs, and S. Teh. 2008. Interplay of environmental forcing and growth-selective mortality in the poor year-class success of delta smelt in 2005. Final Report to the Interagency Ecological Program. Available online at <[http://www.water.ca.gov/iep/docs/pod/Bennett\\_DeltaSmelt\\_Report.pdf](http://www.water.ca.gov/iep/docs/pod/Bennett_DeltaSmelt_Report.pdf)>

- Brandes, Patricia L. and J.S. McLain. 2001. Juvenile Chinook salmon abundance, distribution, and survival in the Sacramento-San Joaquin Estuary. Contributions to the biology of Central Valley salmonids. Fish Bulletin 179(2). 100 pages.
- Brode, J. 1988. Natural history of the giant garter snake (*Thamnophis couchii gigas*). Pages 25-28, In Proceedings of the conference on California herpetology, H. F. DeListe, P. R. Brown, B. Kaufman, and B. M. McGurty (eds). Southwestern Herpetologists Society, Special Publication No. 4.
- Brode, J., and G. Hansen. 1992. Status and future management of the giant garter snake (*Thamnophis gigas*) within the southern American Basin, Sacramento and Sutter counties, California. California Department of Fish and Game, Inland Fisheries. Division.
- Brown, R.L. and W.J. Kimmerer. 2002. Delta smelt and CALFED's Environmental Water Account: A summary of the 2002 delta smelt workshop. Prepared for the CALFED Science Program, October 2002.
- Brown, L.R. and D. Michniuk. 2007. Littoral fish assemblages of the alien-dominated Sacramento-San Joaquin Delta, California, 1980-1983 and 2001-2003. Estuaries and Coasts 30:186-200.
- California Department of Finance. 2013. Report P-1: Summary population projections by race/ethnicity and by major age groups, Sacramento, California. Available online at <<http://www.dof.ca.gov/research/demographic/reports/projections/P-1/>>.
- [CDFW] California Department of Fish and Wildlife. 2014a. Spring Kodiak Trawl Survey. Available online at <<http://www.delta.dfg.ca.gov/data/skt/>>
- \_\_\_\_\_. 2014b. RAREFIND. California Natural Diversity Data Base, Natural Heritage Division, Sacramento, California.
- \_\_\_\_\_. 2014c. California Department of Fish and Wildlife. 2014c. 20mm Survey. Available online at <<http://www.delta.dfg.ca.gov/data/skt/>>
- \_\_\_\_\_. and U.S. Bureau of Reclamation (USBR). 1994. Biological Assessment - Effects of the Central Valley Project and State Water Project on Delta Smelt and Sacramento Splittail. Prepared for U.S. Fish and Wildlife Service, Sacramento, California. 230 pages.
- [Corps] U.S. Army Corps of Engineers. 2014a. Guidelines for landscape planting and vegetation management at levees, floodwalls, embankment dams, and appurtenant structures. April 30, 2014 Engineering Technical Letter 1110-2-583. Sacramento, California.
- \_\_\_\_\_. 2014b. Biological Assessment, West Sacramento, California, general reevaluation study and section 408 permission. Sacramento, California.
- Dege, M. and L.R. Brown. 2004. Effect of outflow on spring and summertime distribution and abundance of larval and juvenile fishes in the upper San Francisco Estuary. American Fisheries Society Symposium 39:49-65.

- Dettinger, M.D. 2005. From climate-change spaghetti to climate-change distributions for 21st Century California. *San Francisco Estuary and Watershed Science* 3(1). 14 pages. Available online at <<http://repositories.cdlib.org/jmie/sfew/vol3/iss1/art4>>
- Erkkila, L.F., J.F. Moffett, O.B. Cope, B.R. Smith, and R.S. Nelson. 1950. Sacramento-San Joaquin Delta fishery resources: effects of Tracy pumping plant and delta cross channel. U.S. Fish and Wildlife Services Special Report, Fisheries 56. 109 pages.
- Feyrer, F., B. Herbold, S.A. Matern, and P.B. Moyle. 2003. Dietary shifts in a stressed fish assemblage: consequences of a bivalve invasion in the San Francisco Estuary. *Environmental Biology of Fishes* 67:277-288.
- Feyrer, F., M.L. Nobriga, and T.R. Sommer. 2007. Multi-decadal trends for three declining fish species: habitat patterns and mechanisms in the San Francisco Estuary, California, USA. *Canadian Journal of Fisheries and Aquatic Sciences* 64:723-734.
- Feyrer, F., K. Newman, M.L. Nobriga and T.R. Sommer. 2011. Modeling the effects of future outflow on the abiotic habitat of an imperiled estuarine fish. *Estuaries and Coasts*: 34:120-128.
- Fisch, K.M., J.M. Henderson, R.S. Burton and B. May. 2011. Population genetics and conservation implications for the endangered delta smelt in the San Francisco Bay-Delta. *Conservation Genetics* 12:1421-1434.
- Ganssle, D. 1966. Fishes and decapods of San Pablo and Suisun bays. Pages 64-94 *in* D.W. Kelley *editor*, *Ecological studies of the Sacramento-San Joaquin Estuary*, Part 1.
- Gartrell, G. 2010. Technical issues related to Delta fall salinity, Delta hydrodynamics, and salvage of delta smelt in the Sacramento-San Joaquin Delta. Technical Memorandum submitted to the Natural Research Council Committee on Sustainable Water and Environmental Management in the California Bay-Delta.
- Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. *Bioscience* 41:540-551.
- Grimaldo, L.F., A.R. Stewart, and W. Kimmerer. 2009. Dietary segregation of pelagic and littoral fish assemblages in a highly modified tidal freshwater estuary. *Marine and Coastal Fisheries* 1:200-217.
- HDR, Inc. (HDR). 2008. West Sacramento Levee Evaluation Project, Problem Identification Report, Draft, April. Prepared for the City of West Sacramento. Folsom, California.
- Hansen, G. E. 1988. Review of the status of the giant garter snake (*Thamnophis couchi gigas*) and its supporting habitat during 1986-1987. Final report for California Department of Fish and Game, Contract C-2060. Unpublished. 31 pp.

- Hanson, R. 1980. Western aquatic garter snakes in central California: an ecological and evolutionary perspective. Master's thesis, Department of Biology, California State University, Fresno. 78 pp.
- Hay, D. 2007. Spawning biology of eulachons, longfins and some other smelt species Sacramento, November 15, 2007, Powerpoint presentation. Available online at <[http://www.science.calwater.ca.gov/pdf/workshops/workshop\\_smelt\\_presentation\\_Hay\\_111508.pdf](http://www.science.calwater.ca.gov/pdf/workshops/workshop_smelt_presentation_Hay_111508.pdf)>.
- Herbold, B. 1994. Habitat requirements of delta smelt. Interagency Ecological Studies Program Newsletter, Winter 1994. California Department of Water Resources, Sacramento, California.
- Hestir, E. 2010. Trends in estuarine water quality and submerged aquatic vegetation invasion. PhD dissertation, University of California at Davis, Davis, California.
- Hobbs, J.A., W.A. Bennett, and J. Burton. 2006. Assessing nursery habitat quality for native smelts (Osmeridae) in the low-salinity zone of the San Francisco Estuary. *Journal of Fish Biology* 69:907-922.
- Hobbs, J.A, W.A. Bennett, J. Burton, and M. Gras. 2007. Classification of larval and adult delta smelt to nursery areas by use of trace elemental fingerprinting. *Transactions of the American Fisheries Society* 136:518-527.
- Horpilla, J., A. Liljendahl-Nurminen, and T. Malinen. 2004. Effects of clay turbidity and light on the predator-prey interaction between smelts and chaoborids. *Canadian Journal of Fisheries and Aquatic Sciences* 61:1862-1870.
- Houde, E.D. 1987. Subtleties and episodes in the early life of fishes. *Journal of Fish Biology* 35 (Supplement A): 29-38.
- Jassby, A.D., J.E. Cloern, and B.E. Cole. 2002. Annual primary production: patterns and mechanisms of change in a nutrient-rich tidal ecosystem. *Limnology and Oceanography* 47:698-712.
- Jassby, A.D., W.J. Kimmerer, S.G. Monismith, C. Armor, J.E. Cloern, T.M. Powell, J.R. Schubel, and T.J. Vendlinski. 1995. Isohaline position as a habitat indicator for estuarine populations. *Ecological Applications* 5:272-289.
- Johnson, M.L., I. Werner, S. Teh, and F. Loge. 2010. Evaluation of chemical, toxicological, and histopathologic data to determine their role in the pelagic organism decline. Interagency Ecological Program. Available online at <[http://www.water.ca.gov/iep/docs/contaminant\\_synthesis\\_report.pdf](http://www.water.ca.gov/iep/docs/contaminant_synthesis_report.pdf)>
- Kimmerer, W.J. 2002a. Physical, biological and management responses to variable freshwater flow into the San Francisco Estuary. *Estuaries* 25:1275-1290.

- \_\_\_\_\_. 2002b. Effects of freshwater flow on abundance of estuarine organisms: physical effects or trophic linkages. *Marine Ecology Progress Series* 243:39-55.
- \_\_\_\_\_. 2004. Open water processes of the San Francisco Estuary: from physical forcing to biological processes. *San Francisco Estuary and Watershed Science* 2(1). 142 pages. Available online at <http://repositories.cdlib.org/jmie/sfew/s/vol2/iss1/art1>
- \_\_\_\_\_. 2008. Losses of Sacramento River Chinook salmon and delta smelt to entrainment in water diversions in the Sacramento-San Joaquin Delta. *San Francisco Estuary and Watershed Science* 6(2). 27 pages.
- \_\_\_\_\_. 2011. Modeling delta smelt losses at the South Delta export facilities. *San Francisco Estuary and Watershed Science* 9(1). 9 pages.
- Kimmerer, W.J., E.S. Gross, and M.L. MacWilliams. 2009. Is the response of estuarine nekton to freshwater flow in the San Francisco Estuary explained by variation in habitat volume? *Estuaries and Coasts* 32:375-389.
- Kimmerer, W.J. and J.J. Orsi. 1996. Causes of long-term declines in zooplankton in the San Francisco Bay estuary since 1987. Pages 403-424 in J. T. Hollibaugh (*editor*) *San Francisco Bay: the ecosystem*. AAAS, San Francisco, CA.
- Kuivila, K.M. and G.E. Moon. 2004. Potential exposure of larval and juvenile delta smelt to dissolved pesticides in the Sacramento-San Joaquin Delta, California. *American Fisheries Society Symposium* 39:229-242.
- Larsen, E.W., and S.E. Greco. 2002. Modeling channel management impacts on river migration: A case study of Woodson Bridge State Recreation Area, Sacramento River, California, USA. *Environmental Management* 30:209-224.
- Lehman, P.W., G. Boyer, C. Hall, S. Waller, and K. Gehrts. 2005. Distribution and toxicity of a new colonial *Microcystis aeruginosa* bloom in the San Francisco Bay Estuary, California. *Hydrobiologia* 541:87-99.
- Lindberg, J. 2011. Personal communication during a meeting conducted by Brian Hansen, Sacramento Fish and Wildlife Office, Sacramento California.
- Lindberg, J., B. Baskerville-Bridges, J.P. Van Eenennaam, and S.I. Doroshov. 1997. Status of delta smelt culture. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary Newsletter, Summer 1997.
- Lott, J. 1998. Feeding habits of juvenile and adult delta smelt from the Sacramento-San Joaquin River Estuary. *Interagency Ecological Program Newsletter* 11(1):14-19.
- Mac Nally, R., Thomson, J.R., Kimmerer, W.J., Feyrer, F., Newman, K.B., Sih, A., Bennett, W.A., Brown, L., Fleishman, E., Culbertson, S.D., and G. Castillo. 2010. Analysis of pelagic species decline in the upper San Francisco Estuary using multivariate autoregressive modeling (MAR). *Ecological Applications* 20:1417-1430.

- Mager, R.C., S.I. Doroshov, J.P. Van Eenennaam, and R.L. Brown. 2004. Early life stages of delta smelt. Pages 169-180 in F. Feyrer, L.R. Brown, R.L. Brown and J.J. Orsi, *editors*, Early life history of fishes in the San Francisco Estuary and watershed. American Fisheries Society Symposium 39, Bethesda, Maryland.
- Marine, K.R. and J.J. Cech, Jr. 2004. Effects of high water temperature on growth, smoltification, and predator avoidance in juvenile Sacramento River Chinook salmon. *North American Journal of Fisheries Management*: 24:198-210.
- Maunder, M.N and R.B. Deriso. 2011. A state-space multistage life cycle model to evaluate population impacts in the presence of density dependence: illustrated with application to delta smelt (*Hypomesus transpacificus*). *Canadian Journal of Fisheries and Aquatic Science* 68:1285-1306.
- Moyle, P.B. 2002. *Inland fishes of California*. University of California Press, Berkeley and Los Angeles, California.
- Moyle, P.B., B. Herbold, D.E. Stevens, and L.W. Miller. 1992. Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California. *Transactions of the American Fisheries Society* 121:67-77.
- Moyle, P.B., Bennett, W.A., Fleenor, W.E., and Lund, J.R. 2010. Habitat variability and complexity in the Upper San Francisco Estuary, Delta Solutions, Center for Watershed Sciences, University of California. Available online at: <<http://deltasolutions.ucdavis.edu>>
- Newman, K.B. 2008. Sample design-based methodology for estimating delta smelt abundance. *San Francisco Estuary and Watershed Science* 6(3). 18 pages.
- Nobriga, M.L. 2002. Larval delta smelt diet composition and feeding incidence: environmental and ontogenetic influences. *California Fish and Game* 88:149-164.
- Nobriga, M.L. and F. Feyrer. 2007. Shallow-water piscivore-prey dynamics in California's Sacramento-San Joaquin Delta. *San Francisco Estuary and Watershed Science* 5: Available online at <<http://repositories.cdlib.org/jmie/sfew/sfew/vol5/iss2/art4>>
- Nobriga, M. and M. Chotkowski. 2000. Recent historical evidence of centrarchid increases and tule perch decrease in the Delta. *Interagency Ecological Program Newsletter* 13:23-27.
- Nobriga, M.L., F. Feyrer, R.D. Baxter, and M. Chotkowski. 2005. Fish community ecology in an altered river delta: spatial patterns in species composition, life history strategies and biomass. *Estuaries* 28:776-785.
- Nobriga, M.L., and B. Herbold. 2008. Conceptual model for delta smelt (*Hypomesus transpacificus*) for the Delta Regional Ecosystem Restoration and Implementation Plan (DRERIP). U.S. Fish and Wildlife Service, Sacramento, California.

- Nobriga, M.L., T.R. Sommer, F. Feyrer, and K. Fleming. 2008. Long-term trends in summertime habitat suitability for delta smelt, *Hypomesus transpacificus*. San Francisco Estuary and Watershed Science 6(1). 15 pages.
- Oros, D.R. and I. Werner. 2005. Pyrethroid Insecticides: an analysis of use patterns, distributions, potential toxicity and fate in the Sacramento-San Joaquin Delta and Central Valley. White Paper for Interagency Ecological Program. SFEI Contribution 415, San Francisco Estuary Institute, Oakland, California.
- Orsi, J.J. and W.L. Mecum. 1996. Food limitation as the probable cause of a long-term decline in the abundance of *Neomysis mercedis* the opossum shrimp in the Sacramento-San Joaquin estuary. Pages 375-401 in Hollibaugh, J.T. (editor), San Francisco Bay: the ecosystem. American Association for the Advancement of Science, San Francisco.
- Peterson, M.S. 2003. A conceptual view of environment-habitat-production linkages in Tidal Riverine Estuaries. Fisheries Science 11:291-313.
- Radtke, L.D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta with observations on food of sturgeon, in Ecological studies of the Sacramento-San Joaquin Delta, Part II, in: S.L. Turner and D.W. Kelley, editors, Ecological Studies of the Sacramento-San Joaquin Estuary, pages 115-129. California Department of Fish and Game Fish Bulletin 136.
- Rast, W. and J. Sutton. 1989. Stable isotope analysis of striped bass food chain in Sacramento-San Joaquin Estuary, California, April-September, 1986. Water Resources Investigations Report 88-4164, U.S. Geological Survey, Sacramento, California. 62 pages.
- Rose, K.A., J.H. Cowan, K.O. Winemiller, R.A. Myers, and R. Hilborn. 2001. Compensatory density-dependence in fish populations: importance, controversy, understanding, and prognosis. Fish and Fisheries 2:293-327.
- Rossman, D., and G. Stewart. 1987. Taxonomic reevaluation of *Thamnophis couchii* (Serpentes: Colubridae). Occasional Papers of the Museum of Zoology, Louisiana State University, Baton Rouge, Louisiana. No. 63. 25 pp.
- Sedell, J.R., G.H. Reeves, F.R. Hauer, J.A. Stanford, and C.R. Hawkins. 1990. Role of refugia in recovery from disturbances: modern fragmented and disconnected river systems. Environmental Management 14:711-724.
- Schoellhamer, D.H. 2011. Sudden clearing of estuarine waters upon crossing the threshold from transport as an erodible sediment pool is depleted: San Francisco Bay, 1999. Estuaries and Coasts 34:885-899.
- [Service] U.S. Fish and Wildlife Service. 1984. Valley Elderberry Longhorn Beetle Recovery Plan, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 70 pages.

- \_\_\_\_\_. 1991. Endangered and threatened wildlife and plants: Proposed threatened status for the delta smelt. Federal Register 56:50075-50084.
- \_\_\_\_\_. 1993. Endangered and threatened wildlife and plants: Determination of threatened status for the delta smelt. Federal Register 58:12854-12864.
- \_\_\_\_\_. 1994. Endangered and threatened wildlife and plants: Critical habitat determination for the delta smelt. Federal Register 59:65256-65279.
- \_\_\_\_\_. 1996. Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 208 pages.
- \_\_\_\_\_. 1997. Programmatic formal consultation for the U.S. Army Corps of Engineers 404 permitted projects with relatively small effects on the giant garter snake within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo, counties, California. File number 1-1-F-97-149, Sacramento, California.
- \_\_\_\_\_. 1999a. Conservation Guidelines for the Valley Elderberry Longhorn Beetle. Sacramento Fish and Wildlife Office, Sacramento, California.
- \_\_\_\_\_. 1999b. Draft recovery plan for the giant garter snake (*Thamnophis gigas*). U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 207 pages.
- \_\_\_\_\_. 2006. Giant Garter Snake (*Thamnophis gigas*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 46 pages.
- \_\_\_\_\_. 2010. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to Reclassify the Delta Smelt From Threatened to Endangered Throughout its Range. Federal Register 75:17667-17680.
- \_\_\_\_\_. 2014a. Withdrawal of the Proposed Rule to Remove the Valley Elderberry Longhorn Beetle from the Federal List of Endangered and Threatened Wildlife. Proposed Rule; Withdrawal. Federal Register 79:55879-55917.
- \_\_\_\_\_. 2014b. Sacramento trawls CHN &POD species 2012-2015. The Delta Juvenile Fish Monitoring Program, Stockton Fish and Wildlife Office, Lodi, California. Available online at: < <http://www.fws.gov/stockton/jfmp/> >
- \_\_\_\_\_. 2014c. Beach seines CHN &POD species 2012-2015. The Delta Juvenile Fish Monitoring Program, Stockton Fish and Wildlife Office, Lodi, California. Available online at: < <http://www.fws.gov/stockton/jfmp/> >
- Sogard, S.M. 1997. Size-selective mortality in the juvenile stage of teleost fishes: a review. Bulletin of Marine Science 60:1129-1157.

- Sommer, T.R., C. Armor, R. Baxter, R. Breuer, L. Brown, M. Chotkowski, S. Culberson, F. Feyrer, M. Gingras, B. Herbold, W. Kimmerer, A. Mueller-Solger, M. Nobriga, and K. Souza. 2007. The collapse of pelagic fishes in the upper San Francisco Estuary. *Fisheries* 32:270-277.
- Stanley, S.E., P.B. Moyle, and H.B. Shaffer. 1995. Allozyme analysis of delta smelt, *Hypomesus transpacificus*, and longfin smelt, *Spirinchus thaleichthys*, in the Sacramento-San Joaquin estuary. *Copeia* 1995:390-396.
- Stevens, D.E. 1963. Food habits of striped bass, *Morone saxatilis* (Walbaum), in the Sacramento-Rio Vista area of the Sacramento River. Master's Thesis. University of California at Davis, Davis, California.
- Stevens, D.E. and L.W. Miller. 1983. Effects of river flow on abundance of young Chinook salmon, American shad, longfin smelt, and delta smelt in the Sacramento-San Joaquin river system. *North American Journal of Fisheries Management* 3:425-437.
- Swanson, C. and J.J. Cech, Jr. 1995. Environmental tolerances and requirements of the delta smelt, *Hypomesus transpacificus*. Final Report. California Department of Water Resources Contracts B-59499 and B-58959. Davis, California.
- Swanson, C., D.V. Baxa, P.S. Young, J.J. Cech, and R.P. Hedrick, R. P. 2002. Reduced swimming performance in delta smelt infected with *Mycobacterium* spp. *Journal of Fish Biology* 61:1012-1020.
- Sweetnam, D.A. 1999. Status of delta smelt in the Sacramento-San Joaquin Estuary. *California Fish and Game* 85:22-27.
- Sweetnam, D.A., and D.E. Stevens. 1993. Report to the Fish and Game Commission: A status review of the delta smelt (*Hypomesus transpacificus*) in California. Candidate Species Status Report 93-DS. Sacramento, California. 98 pages plus appendices.
- Taniguchi, Y., F.J. Rahel, D.C. Novinger, and K.G. Gerow. 1998. Temperature mediation of competitive interactions among three fish species that replace each other along longitudinal stream gradients. *Canadian Journal of Fisheries and Aquatic Sciences* 55:1894-1901.
- Thetmeyer, H. and U. Kils. 1995. To see and not be seen: the visibility of predator and prey with respect to feeding behaviour. *Marine Ecology Progress Series* 126:1-8.
- Thomson, J.R., W.J. Kimmerer, L.R. Brown, K.M. Newman, Mac Nally, R., Bennett, W.A., Feyrer, F. and E. Fleishman. 2010. Bayesian change point analysis of abundance trends for pelagic fishes in the upper San Francisco Estuary. *Ecological Applications* 20:1431-1448.
- Trenham, P.C., H.B. Shaffer, and P.B. Moyle. 1998. Biochemical identification and assessment of population subdivision in morphometrically similar native and invading smelt species (*Hypomesus*) in the Sacramento-San Joaquin Estuary, California. *Transactions of the American Fisheries Society* 127:417-424.

- Turner, J.L., Kelley, DW (*editors*). 1966. Ecological studies of the Sacramento-San Joaquin Delta, part II, fishes of the Delta. California Department of Fish and Game Fish Bulletin 136.
- [USBR] U.S. Bureau of Reclamation. 2008. OCAP Biological Assessment on the Continued Long-term Operations of the Central Valley Project and the State Water Project.
- Utne-Palm, A.C., and J.E. Stiansen. 2005. Effect of larval ontogeny, turbulence and light on prey attack rate and swimming activity in herring larvae. *Journal of Experimental Marine Biology and Ecology* 268:147-170. Available online at <<http://jeb.biologists.org/cgi/content/full/208/5/831>>
- Wang, J.C.S. 1986. Fishes of the Sacramento-San Joaquin Estuary and adjacent waters, California: a guide to the early life stages. Interagency Ecological Studies Program Technical Report 9. 183 pages.
- \_\_\_\_\_. 1991. Early life stages and early life history of the delta smelt, *Hypomesus transpacificus*, in the Sacramento-San Joaquin Estuary, with comparison of early life stages of the longfin smelt, *Spirinchus thaleichthys*. Interagency Ecological Studies Program Technical Report 28. 58 pages.
- \_\_\_\_\_. 1986. Fishes of the Sacramento-San Joaquin Estuary and adjacent waters, California: a guide to the early life stages. Interagency Ecological Studies Program Technical Report 9. Sacramento, California.
- \_\_\_\_\_. 2007. Spawning, early life stages, and early life histories of the Osmerids found in the Sacramento-San Joaquin Delta of California. Tracy Fish Facilities Studies California Volume 38. U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, California.
- Werner, I., L. Deanovic, D. Markiewicz, M. Stillway, N. Offer, R. Connon, and S. Brander. 2008. Pelagic organism decline (POD): Acute and chronic invertebrate and fish toxicity testing in the Sacramento-San Joaquin Delta, 2006-2007. Final report to the Interagency Ecological Program. Available online at <[http://www.science.calwater.ca.gov/pdf/workshops/POD/2008\\_final/Werner\\_POD2006-07Tox\\_Final\\_Report.pdf](http://www.science.calwater.ca.gov/pdf/workshops/POD/2008_final/Werner_POD2006-07Tox_Final_Report.pdf)>
- Werner, I., D. Markiewicz, L. Deanovic, R. Connon, S. Beggel, S. Teh, M. Stillway, C. Reece. 2010. Pelagic organism decline (POD): Acute and chronic invertebrate and fish toxicity testing in the Sacramento-San Joaquin Delta, 2008-2010. Final report to the Interagency Ecological Program. Available online at <[http://www.science.calwater.ca.gov/pdf/workshops/POD/Werner%20et%20al\\_2010\\_POD2008-2010\\_Final%20Report.pdf](http://www.science.calwater.ca.gov/pdf/workshops/POD/Werner%20et%20al_2010_POD2008-2010_Final%20Report.pdf)>
- Weston, B.P. and M.J. Lydy. 2010. Urban and agricultural sources of pyrethroid insecticides to the Sacramento-San Joaquin Delta of California. *Environmental Science and Technology* 44:1833-1840.

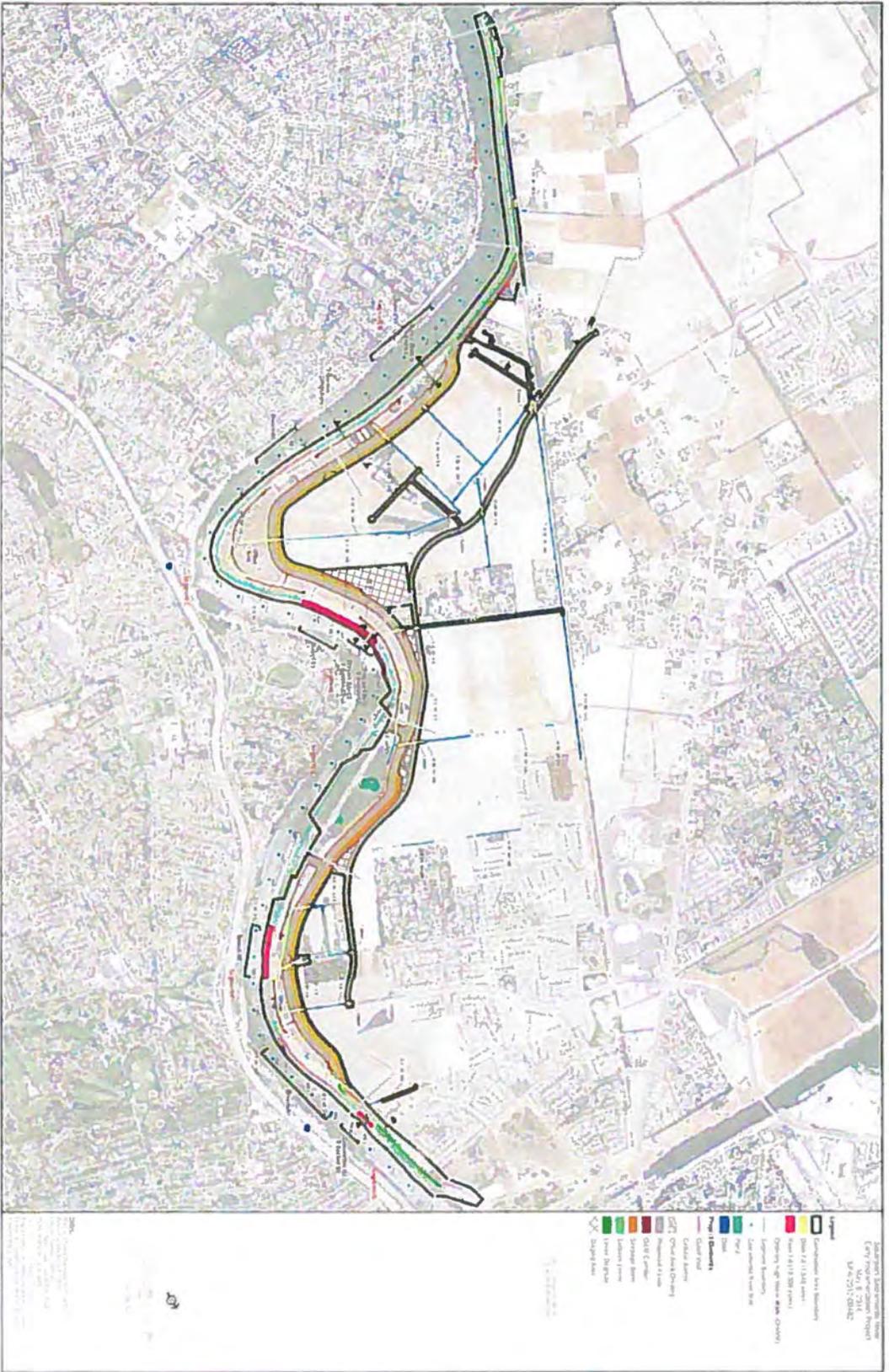
Winemiller, K.O. and Rose, K.A. 1992. Patterns of life-history diversification in North American fishes: implications for population regulation. *Canadian Journal of Fisheries and Aquatic Sciences* 49:2196-2218.



**APPENDIX A**

**SOUTHPORT EARLY IMPLEMENTATION PROJECT**

**Project Plan View**



Appendix A. Sacramento River South Lanes Reach  
 Supplemental Early Implementation Project  
 West Sacramento General Reclamation Report

**APPENDIX B**

**SOUTHPORT EARLY IMPLEMENTATION PROJECT**

**Project Effects on Federally-Listed Species Within  
U.S. Fish and Wildlife Service Jurisdiction**

**Table B-1.** Effects on giant garter snake (*Thamnophis gigas*) in the Southport Early Implementation Project action area of the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.

Habitat	Temporary Effects	Permanent Effects
Aquatic Habitat	0	0
Upland Habitat	155	2.24

**Table B-2.** Estimates of elderberry shrubs affected by the Southport Project Early Implementation Project of the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.<sup>1</sup>

Location	Stem Diameter	Holes	Number of Stems	Elderberry Ratios	Elderberry Plantings	Associate Ratios	Associate Plantings
Non-riparian	≥ 1 inch and ≤ 3 inches	No	6	1:1	6	1:1	6
		Yes	135	2:1	270	2:1	540
Non-riparian	> 3 inches and < 5 inches	No	1	2:1	2	1:1	2
		Yes	22	4:1	88	2:1	176
Non-riparian	≥ 5 inches	No	1	3:1	3	1:1	3
		Yes	37	6:1	222	2:1	444
Riparian	≥ 1 inch and ≤ 3 inches	No	110	2:1	220	1:1	220
		Yes	25	4:1	100	2:1	200
Riparian	> 3 inches and < 5 inches	No	46	8:1	138	1:1	138
		Yes	10	6:1	60	2:1	120
Riparian	≥ 5 inches	No	27	4:1	108	1:1	108
		Yes	4	8:1	32	2:1	64
Totals			424		1,249 <sup>2</sup>		2,021 <sup>2</sup>

<sup>1</sup> Information based on the Conservation Guidelines for the Valley Elderberry Longhorn Beetle (Service 1999a).

<sup>2</sup> Plantings require 588,600 square feet or 13.51 acres.

**Table B-3.** Effects on delta smelt (*Hypomesus transpacificus*) critical habitat in the Southport Early Implementation Project action area of the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.

Shallow Water Habitat Created	Shallow Water Habitat Affected
118.81 acres	8.49 acres (0.04 permanently)

**West Sacramento GRR EIS/EIR  
Appendix B**

**Final Biological Assessment**

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# Biological Assessment

West Sacramento, California  
General Reevaluation Study and  
Section 408 Permission



November 2014

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## Acronyms and Abbreviations

BA	biological assessment
BMPs	best management practices
BSSCP	bentonite slurry spill contingency plan
CDFG	California Department of Fish and Game
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CHP	California Highway Patrol
CNDDDB	California Natural Diversity Database
CNPS	California Native Plant Society
Corps	U.S. Army Corps of Engineers
CVFPB	Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
dbh	diameter at breast height
DPS	distinct population segment
DSM	deep soil mixing
DWR	California Department of Water Resources
DWSC	Sacramento Deep Water Ship Channel
EFH	essential fish habitat
EIP	Early Implementation Project
EIS/EIR	Environmental Impact Statement/Environmental Impact Report
EPA	U.S. Environmental Protection Agency
ESA	Federal Endangered Species Act
ESU	evolutionary significant unit
ETL	Engineer Technical Letter
FRM	flood risk management
GRR	general reevaluation report
IWM	instream woody material
lf	linear feet
LPP	locally preferred plan
MBTA	Migratory Bird Treaty Act
MMP	Mitigation and Monitoring Plan
MSA	Magnuson-Stevens Fishery Conservation and Management Act of 1997
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity unit
O&M	operations and maintenance
OHWM	ordinary high water mark

PL	public law
psi	pounds per square inch
RD	reclamation district
RM	river mile
RWQCB	Regional Water Quality Control Board
SAM	Standard Assessment Methodology
SCS	U.S. Soil Conservation Service
SPCCP	spill prevention, control, and counter-measure plan
SRA	shaded riverine aquatic
SRBPP	Sacramento River Bank Protection Project
SRFCP	Sacramento River Flood Control Project
SWPPP	stormwater pollution protection plan
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
VELB	valley elderberry longhorn beetle
VVR	vegetation variance request
WRDA	Water Resources Development Act
WRI	weighted species response index
WSAFA	West Sacramento Area Flood Control Agency



## 1.0 Introduction

The U.S. Army Corps of Engineers (Corps) is requesting consultation with the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) under Section 7 of the Federal Endangered Species Act (ESA) on potential effects on listed threatened or endangered species and on designated critical habitat from implementation of flood risk management (FRM) improvements proposed under the West Sacramento General Reevaluation Study (West Sacramento Project). The West Sacramento Project's proposed action also includes FRM improvements proposed by the West Sacramento Area Flood Control Agency's (WSAFCA) Southport Sacramento River Early Implementation Project (EIP). WSAFCA is requesting permission from the Corps pursuant to Section 14 of the River and Harbors Act of 1899 (Title 33 of the United States Code [USC], Section 408, [33 USC 408]), for the alteration of the Federal flood management project.

The purpose of this Biological Assessment (BA) is to analyze the potential effects from the proposed project on listed threatened or endangered species and on designated critical habitat, within the project's area of effect (action area). The outcome of this BA and consultation with the USFWS and NMFS will determine the need for formal consultation or whether a determination of "not likely to adversely affect" is appropriate for listed species that may be affected. In addition, this BA intends to fulfill consultation requirements for the Magnuson-Stevens Fishery Conservation and Management Act of 1997 (NMFS 1997). This BA was prepared in accordance with the Corps' Engineering Regulation 1105-2-100 (Corps 2000a).

Section 7 of the ESA requires Federal agencies to conserve listed species and their critical habitat, and to consult with USFWS and NMFS (the Services) to ensure that actions they fund, authorize, or perform do not jeopardize the existence of any listed species or result in the destruction or adverse modification of their designated critical habitat. The actions covered in this BA are associated with future levee modifications proposed under the West Sacramento Project.

The Magnuson-Stevens Fishery Conservation and Management Act of 1997 (MSA) governs the conservation and management of commercially harvested ocean fisheries. The purpose of the Act is to take immediate action to conserve, protect, and manage U.S. coastal fishery resources, anadromous species, and Essential Fish Habitat (EFH). EFH is the aquatic habitat (water and substrate) that is necessary for fish to spawn, breed, feed, or mature, and that allows production levels needed to: (1) support a long-term, sustainable commercial fishery, and (2) contribute to a healthy ecosystem (NMFS 1997). Most, if not all, of the West Sacramento General Reevaluation Report (GRR) study area is designated as EFH habitat for Pacific salmon under Section 305(b)(2) of the MSA. Species to be addressed in this BA include:

- Fish species with designated EFH under the MSA
- Listed species under the Federal Endangered Species Act
- Species with designated critical habitat under the ESA

## **1.1 Action Area**

The action area refers to the area directly or indirectly affected by the proposed action (50 CFR 402.02 and 402.14[b][2]). This includes the project footprint and surrounding areas where covered species could be affected by project-related impacts. The action area for the West Sacramento project is shown in Figure 1 and includes the Sacramento River from the Sacramento Bypass down to the South Cross levee, the Sacramento Deep Water Ship Channel (DWSC) and Port of West Sacramento, and the Sacramento and Yolo Bypasses.

The Action Area includes perennial waters of the Sacramento River extending 200 feet perpendicular from the average summer-fall shoreline and 1,000 feet downstream from proposed in-water construction areas. This represents the potential area of turbidity and sedimentation effects based on the reported limits of visible turbidity plumes in the Sacramento River during similar construction activities (NMFS 2008).

Erosion repairs are proposed as part of the proposed action. These repairs are likely to somewhat reduce the sediment supply for riverine reaches directly downstream because the erosion repair is holding the bank or levee in place. However, from a system sediment perspective, the bank material we are protecting in the project reaches is not a major source of sediment compared to the upstream reaches of the Sacramento, Feather and especially the Yuba River systems. For velocity, the site specific designs will be constrained from allowing any velocity increases outside the erosion repair site.

In addition, the proposed Southport levee setback action would have hydraulic effects which would include slight changes in water surface elevations that extend for several miles upstream and downstream of the project area during flood events. However, hydraulic analyses indicate that potential effects on hydraulic, geomorphic, and sediment transport conditions in the Sacramento River will be insignificant and unlikely to adversely affect listed species and designated critical habitat (ICF International 2013). Therefore the action area for the project would be directly related to the study area and not extend significantly outside where construction activities would occur. The action area is described in greater detail below and includes the following study areas.

### **1.1.1 West Sacramento Project Study Area**

The West Sacramento project study area refers to the area that would be protected by the proposed levee improvements, including the city of West Sacramento itself and the lands within WSAFCA's boundaries, which encompass portions of the Sacramento River, the Yolo Bypass, and the Sacramento DWSC. The flood protection system associated with these waterways consists of over 50 miles of levees in Reclamation District (RD) 900, RD 537, the California Department of Water Resources'

(DWR's) Maintenance Area 4, and the DWSC. These levees completely surround the city, with the exception of intersecting waterways (the barge canal and DWSC). The city of West Sacramento is located in eastern Yolo County at the confluence of the American and Sacramento Rivers. The city lies within the natural floodplain of the Sacramento River, which bounds the city along the north and east. It is made up of a small amount of high ground north of Highway 50 along the Sacramento River, and reclaimed land protected from floods by levees and the Yolo Bypass system. The Yolo Bypass diverts flood flows around the city to the west. In addition to the area within the city limits (in Yolo County), the study area partially extends into Solano County on the extreme southwestern edge along the DWSC.

The DWSC provides a navigable passageway for commercial shipping to reach the Port of West Sacramento (formerly Port of Sacramento) from the Pacific Ocean via the San Francisco Bay, Delta, and connecting waterways. The DWSC water surface elevation is directly influenced by changes in water levels in the Delta at the south end of the Yolo Bypass and is relatively insensitive to stage in the Sacramento River. The study area is within the bounds of the Legal Delta as defined by the State of California under the Delta Protection Act (Section 12220 of the Water Code). The Legal Delta is further subdivided into a primary zone and secondary zone for land use planning and resource protection purposes. Most of West Sacramento is in the secondary zone, while the extreme northern part of the city is outside of any of these Delta planning areas. The study reach along the DWSC west levee is the only portion of the study area within the primary zone.

The DWSC and barge canal bisect the city into two subbasins, separating the developing Southport area from the more established neighborhoods of Broderick and Bryte to the north (City of West Sacramento 2000). The two subbasins are broken up into nine levee reaches based on location and fixes. The North Basin, which encompasses 6,100 acres, contains:

- Sacramento River north levee – 5.5 miles from the Sacramento Bypass south to the stone lock structure on the DWSC.
- Port north levee – 4.9 miles from the stone lock structure west to the Yolo Bypass levee.
- Yolo Bypass levee – 3.7 miles from the Port north levee north to the Sacramento Bypass.
- Sacramento Bypass Training levee – 0.5 miles west into the Yolo Bypass from the Sacramento Bypass levee.

The South Basin, which encompasses 6,900 acres, contains:

- Sacramento River south levee – 5.9 miles south along the Sacramento River from the DWSC stone lock structure to the South Cross levee (just north of the waste water treatment plant).
- South Cross levee – 1.2 miles across the South Basin from the Sacramento River to the DWSC.
- DWSC east levee – 2.8 miles from the South Cross levee north to the point where it bends east.
- Port south levee – 4.0 miles east from the bend in the DWSC east levee to the stone lock structure.
- DWSC west levee – 21.4 miles from the intersection of the Port north levee and the Yolo Bypass levee south to Miners Slough.

The West Sacramento Project study area and the problems identified for improvement are shown on Figure 1.

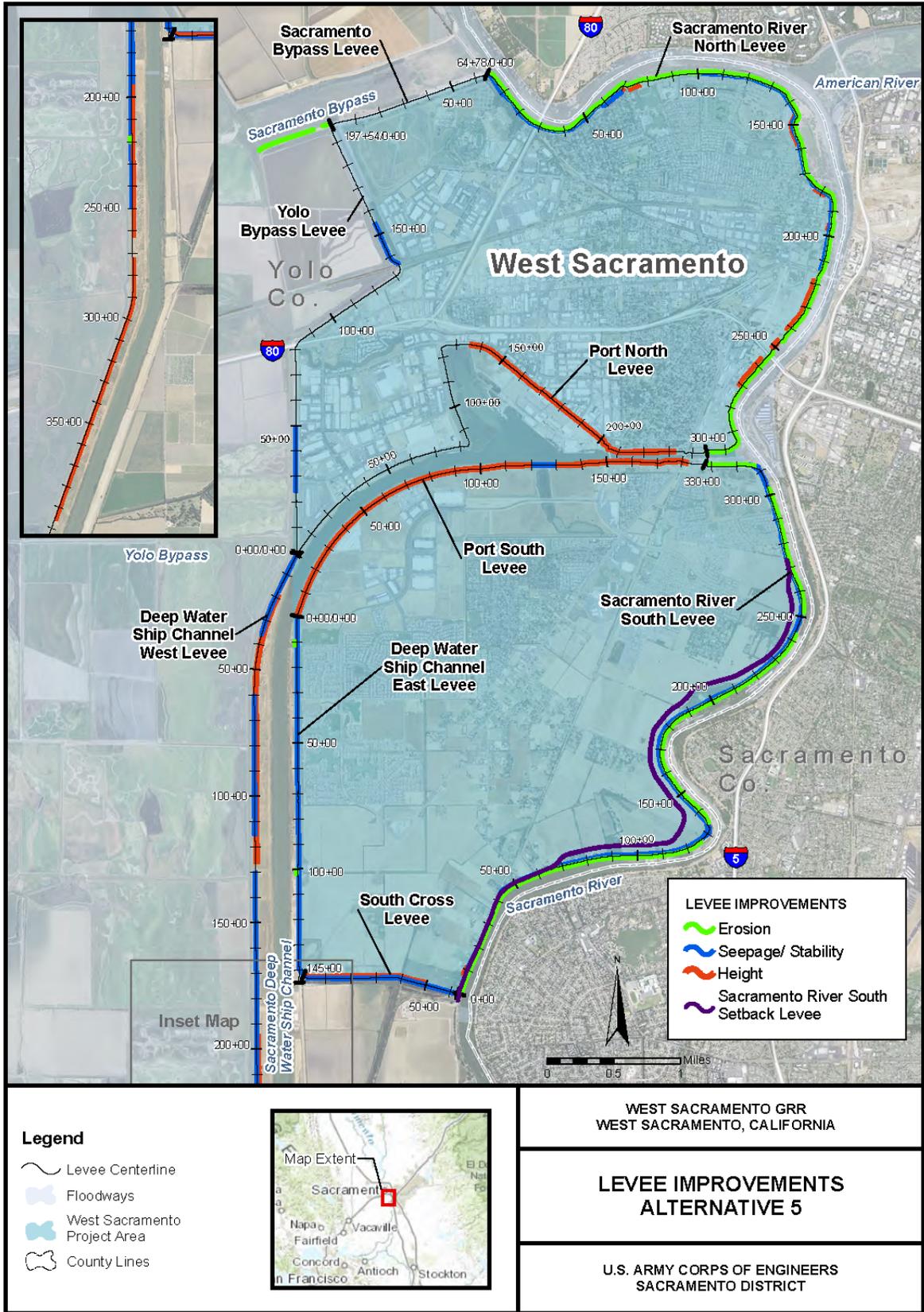


Figure 1. West Sacramento GRR Study Area with Individual Reach Identification.

### **1.1.2 Southport EIP Study Area**

The Southport EIP study area is encompassed within the West Sacramento Project study area. Because the Southport EIP is further along in design, its action area is described in greater detail below. The construction footprint for the Southport EIP component of the West Sacramento Project extends approximately 5.6 miles along the Sacramento River South Levee from the southern end of the Corps Sacramento River Bank Protection Project (SRBPP) at River Mile (RM) 57.2 south to the South Cross levee at RM 51.6. It is comprised of a 3.6-square mile project area, which encompasses 5.8 miles of the existing levee structure along the Sacramento River corridor, the construction footprint in which flood risk–reduction measures would be constructed, the footprint of the Village Parkway extension and associated residential access roads, and potential soil borrow sites located throughout the Southport area of West Sacramento (Figure 2). Potential borrow sites make up large portions of the construction footprint, as soil may be extracted from these areas prior to or during construction of the flood risk–reduction measures. The project area covers all or portions of Sections 10, 15, 21, 22, 28, 29, and 32, Township 8 North, and Range 4 East, Mount Diablo Meridian, Yolo County, California.

South River Road runs along the top of the levee for the majority of this reach of the river. The road diverts off of the levee top and merges with Gregory Avenue and runs along the landside toe for a short distance to the southern end of the construction area. The landside of the levee is bordered mainly by private agricultural lands containing rural residences. Two small bodies of water referred to as Bees Lakes are located adjacent to the levee landside toe near the middle of the construction area, and two marinas and multiple boat docks are located on the waterside of the levee near Bees Lakes.

The Southport project area also includes several adjacent and nearby locations at which suitable borrow material may be available for use in constructing the project. As shown on Figure 2, potential borrow sites are located both close to the levee footprint, to the east and west of southern Jefferson Boulevard, and along the DWSC.

The project construction area was defined as the area in which flood risk–reduction measures—such as setback levees, seepage berms, and slurry cutoff walls—are likely to be constructed, the area in which Village Parkway and ancillary roadways would be constructed, as well as areas in which soil borrow activities may occur. All direct and indirect effects would occur within this area and the 200-foot buffer around this area.

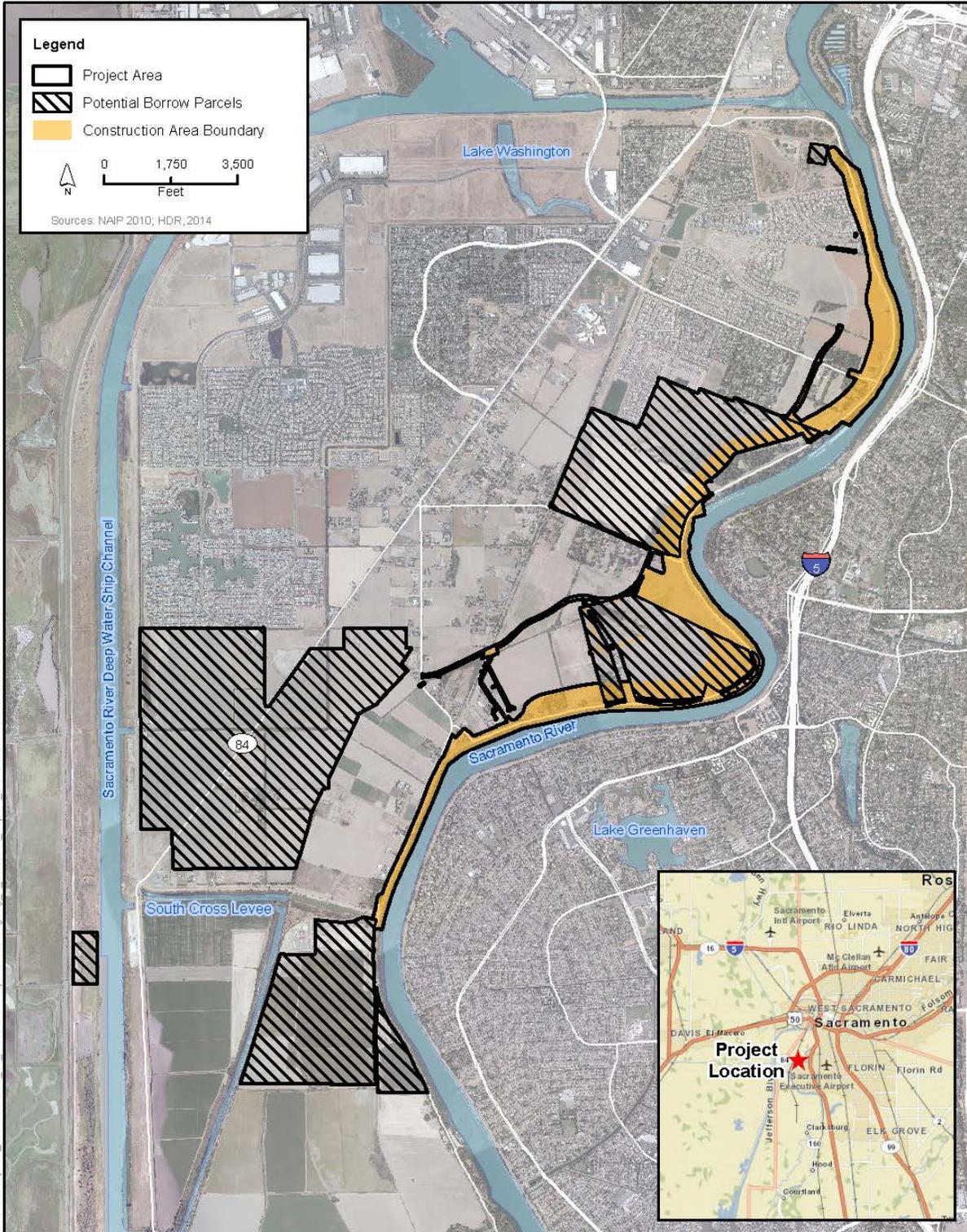


Figure 2. Southport EIP Project Area.

The Southport EIP Action Area includes the 3.6-square mile project area and a 200-foot buffer around this area. The project construction area was defined as the area in which flood risk reduction measures—such as seepage berms, relief wells, slurry cutoff walls, and potential soil borrow sites—are likely to be constructed, the area in which Village Parkway and ancillary roadways would be constructed, as well as areas in which soil borrow activities may occur. All direct and indirect effects would occur within this area and the 200-foot buffer around this area. To address potential construction-related impacts on Delta smelt and critical habitat resulting from in-water construction, the Southport EIP Action Area includes perennial waters of the Sacramento River extending 200 feet perpendicular from the average summer-fall shoreline and 1,000 feet downstream from the proposed in-water construction areas. This represents the potential area of turbidity and sedimentation effects based on the reported limits of visible turbidity plumes in the Sacramento River during similar construction activities (NMFS 2008). Long-term effects of the Southport EIP's Proposed Action include slight changes in water surface elevations that extend for several miles upstream and downstream of the project area during flood events. However, hydraulic analyses indicate that potential effects on hydraulic, geomorphic, and sediment transport conditions in the Sacramento River will be insignificant and unlikely to adversely affect listed species and designated critical habitat (ICF International 2013).

## **1.2 Project Background and Authority**

The current levees do not adequately protect the city of West Sacramento during a 100-year event (an event that has a 1 percent chance of occurring in any given year). Structural modifications to the levee are proposed to address seepage, slope stability, erosion, and height concerns along the existing West Sacramento levees and provide flood risk reduction.

The history of the Sacramento River Flood Control Project (SRFCP) dates back to the mid 1800s with the initial construction of levees along the Sacramento, American, Feather, and Yuba Rivers. The early history of the system was characterized by trial and error, with initial construction followed by a levee failure, followed by improvement (strengthening and/or raising), followed by another levee failure, etc. This continued until the California Legislature authorized a comprehensive plan for controlling the floodwaters of the Sacramento River and its tributaries in the Flood Control Act of 1911. Federal participation in the SRFCP began shortly after authorization in 1917 and continued for approximately 40 years.

Historically, from the mid 1800s onward, most hydraulic engineers at the Federal, State, and local level thought that the most effective way to control flood flows in the river system was to construct levees close to the main channel. The record floods of 1907 and 1909 forced a reevaluation of this historic approach. It was clear from the size of these flood events in relation to existing channel capacities that major bypass systems were needed to control excess flood flows. These bypasses were designed to divert flood flows away from urban centers. Throughout the SRFCP, the frequency that flow starts to divert from the Sacramento River to the bypass system varies between a 3-year to 5-year flood event.

The series of storms that struck California in February of 1986 resulted in the flood of record for many areas in northern and central California. The estimated peak flows associated with the 1986 flood were nearly equal or exceeded the design flows of the Sacramento River, Sacramento Bypass, and the Yolo Bypass in the vicinity of West Sacramento. As a result of the problems experienced during the 1986 flood, the Corps initiated a study of the levees comprising the SRFCP that were impacted by the flood. Due to the large scale of the study, the review was split into five phases. The first phase of this study included West Sacramento and was documented through an Initial Appraisal Report titled, Sacramento Urban Area Levee Reconstruction Project, California dated May 1988. This phase included the review of approximately 110 miles of levee and recommended the repair of 34 miles.

The 1986 flood also exposed structural problems and identified the inability of the existing levees to provide critical flood protection to the Sacramento metropolitan area. As a result, the Corps, in cooperation with the State of California, initiated the study titled, Sacramento Metropolitan Area, California, Feasibility Report. This report was published in February 1992 and indicated the existing flood control system in the study area provided significantly less than a 100-year level of protection. The study went on to recommend a program of improvements. The repairs recommended by the Sacramento Metropolitan Area, California, Feasibility Report were authorized in the Water Resources Development Act (WRDA) of 1992 (Public Law [PL] 102-580).

The Corps was preparing construction plans and specifications for the levee repairs authorized in the WRDA of 1992, when the 1997 New Year's Day Flood occurred. It was one of the largest experienced in northern California since the beginning of the measured record in 1906. In the wake of the 1997 flood, the Corps identified underseepage as an area of greater concern in the design and repair of levees. This resulted in a number of design revisions to the levee repairs recommended in the West Sacramento Project Design Memorandum. These design revisions and the associated increase to the total estimated project cost were captured in a supplemental authorization through the Energy and Water Development Appropriation Act of 1999 (PL 105-245).

The initial study authority for the West Sacramento area was provided through Section 209 of the Flood Control Act of 1962, PL 87-874. The West Sacramento Project was authorized in WRDA 1992, PL 102-580 Sec. 101 (4), as amended by the Energy and Water Development of 1999, PL 105-245. It was reauthorized on October 28, 2009 with a total project cost of \$53,040,000 under WRDA 2010, PL 111-85.

### **1.3 Species Considered and Species Requiring Consultation**

An official list of species with the potential to occur in the vicinity of the West Sacramento project area and Federally listed as threatened, endangered, and proposed threatened or endangered was obtained from the Sacramento USFWS website for Yolo County (USFWS 2014) (Appendix A). The following Federally endangered and threatened species were included on the USFWS species list and were considered for inclusion in this BA.

- Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB)—threatened.
- Conservancy fairy shrimp (*Branchinecta conservatio*)—endangered.
- Vernal pool fairy shrimp (*Branchinecta lynchi*)—threatened.
- Vernal pool tadpole shrimp (*Lepidurus packardi*)—endangered.
- Delta green ground beetle (*Elaphrus viridis*)—threatened.
- California freshwater shrimp (*Syncaris pacifica*)—endangered.
- Delta smelt (*Hypomesus transpacificus*)—threatened.
- California red-legged frog (*Rana draytonii*)—threatened.
- California tiger salamander (*Ambystoma californiense*)—threatened.
- Yosemite toad (*Anaxyrus canorus*)—threatened.
- Giant garter snake (*Thamnophis gigas*)—threatened.
- Western snowy plover (*Charadrius alexandrinus nivosus*)—threatened.
- Western yellow-billed cuckoo (*Coccyzus americanus*)—threatened.
- Northern spotted owl (*Strix occidentalis caurina*)—threatened.
- Least Bell's vireo (*Vireo bellii pusillus*)—endangered.
- Palmate-bracted bird's-beak (*Cordylanthus palmatus*)—endangered.
- Colusa grass (*Neostapfia colusana*)—threatened.
- Keck's checker-mallow (*Sidalcea keckii*)—endangered.
- Solano grass (*Tuctoria mucronata*)—endangered.
- Sacramento River winter-run Chinook salmon evolutionary significant unit (ESU) (*Oncorhynchus tshawytscha*)—endangered.
- Central Valley spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)—threatened.
- California Central Valley steelhead DPS (*Oncorhynchus mykiss*)—threatened.
- Southern DPS of North American green sturgeon (*Acipenser medirostris*)—threatened.

On-going coordination with the Services will occur as the project progresses to the preliminary engineering design phase to ensure compliance with Section 7. The Corps would coordinate potential design refinements with the Services to avoid, minimize, and compensate for affects to listed species and reinstate consultation if necessary. The action area includes the protected species and critical habitat listed in Table 1, as well as fall-/late fall-run Chinook salmon, which has EFH within the study area.

Of the 23 Federally listed species considered for inclusion in this BA, the 7 species (and their critical habitats) listed in Table 1 have the potential to occur in the Action Area and may be affected by the Proposed Action; accordingly, these species are the subject of this BA.

**Table 1. Federally Protected Species and Critical Habitat Addressed in this Biological Assessment.**

Common Name	Scientific Name	Federal Status
<b>Threatened and Endangered Species</b>		
Valley elderberry longhorn beetle	<i>Desmocerus californicus dimorphus</i>	T
Sacramento River winter-run Chinook Salmon ESU	<i>Oncorhynchus tshawytscha</i>	E/MSA
Central Valley spring-run Chinook Salmon ESU	<i>Oncorhynchus tshawytscha</i>	T/MSA
Central Valley steelhead DPS	<i>Oncorhynchus mykiss</i>	T
Delta Smelt	<i>Hypomesus transpacificus</i>	T
Green Sturgeon southern DPS	<i>Acipenser medirostris</i>	T
Giant garter snake	<i>Thamnophis gigas</i>	T
<b>Critical Habitat</b>		
Valley elderberry longhorn beetle	<i>Desmocerus californicus dimorphus</i>	
Sacramento River winter-run Chinook Salmon ESU	<i>Oncorhynchus tshawytscha</i>	
Central Valley spring-run Chinook Salmon ESU	<i>Oncorhynchus tshawytscha</i>	
Central Valley steelhead DPS	<i>Oncorhynchus mykiss</i>	
Delta Smelt	<i>Hypomesus transpacificus</i>	
Green Sturgeon southern DPS	<i>Acipenser medirostris</i>	

Note: ESU = Evolutionarily Significant Unit, DPS = Distinct Population Segment, T = Threatened, E = Endangered, MSA = Magnuson-Stevens Fishery Conservation and Management Act.

### 1.3.1 Other Species Considered but Eliminated from Further Evaluation

The West Sacramento Project’s Action Area does not contain suitable habitat (i.e., vernal or seasonal pools or swales) for conservancy fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, or Delta green ground beetle and is outside the geographic range of the California freshwater shrimp and the Yosemite toad. Therefore, it has been determined that the Proposed Action would have no effect on any of these species, and no further evaluation or consultation on these species is needed (50 Code of Federal Regulations [CFR] 402.12).

Seasonal and perennial wetlands in the West Sacramento Project’s Action Area are connected to the Sacramento River and the Sacramento DWSC (which contains predatory fish) and/or are surrounded by cultivated or developed areas; therefore, they do not provide suitable aquatic or upland habitat for California tiger salamander. California red-legged frog is considered extirpated from the floor of the Central Valley (USFWS 2002) and would not occur in the Action Area. Therefore, it has been determined that the Proposed Action would have no effect on California tiger salamander and California red-legged frog; no further evaluation or consultation on these species is needed (50 CFR 402.12).

There is no suitable nesting habitat for the western snowy plover which requires barren to sparsely vegetated ground at alkaline or saline lakes, reservoirs, ponds, riverine sand bars, and sewage, salt-evaporation, and agricultural wastewater ponds. The least Bell's vireo historically nested in the Sacramento Valley, but no nesting has been documented north of Santa Barbara County since prior to 1970s. Two recent male sightings have been reported from Putah Creek in Yolo County in 2010 and 2011 but no confirmed nesting (CDFW 2013). The western yellow-billed cuckoo, which was recently listed as threatened, historically wintered in this region, but there is no suitable habitat in the West Sacramento Action Area and there have been no recent sightings south of Colusa on the Sacramento River. The West Sacramento Project Action Area is outside the geographic range of the northern spotted owl. Therefore, it has been determined that the Proposed Action would have no effect on any of these species, and no further evaluation or consultation on these species is needed (50 CFR 402.12).

There are four Federally listed plants that could potentially occur in the region, including Palmate-bracted bird's-beak, Colusa grass, Keck's checker-mallow, and Solano grass. Palmate-bracted bird's-beak is not expected to occur because grasslands in the West Sacramento Project Action Area lack typical associates (iodine bush [*Allenrolfea occidentalis*]) and there is no suitable microhabitat (alkaline soils) present. Similarly, Colusa grass is not expected to occur in the Action Area because there are no vernal pools. In addition, habitat conditions are of poor quality for two species; Solano grass, which could occur in mesic annual grassland, and Keck's checker mallow, which could occur in annual grassland or valley oak woodland. Therefore none of these plants are expected to occur in the Action Area. Therefore, it has been determined that the Proposed Action would have no effect on any of these species and no further evaluation or consultation on these species is needed (50 CFR 402.12).

#### **1.4 Consultation to Date**

Coordination with the USFWS and NMFS has occurred independently on the West Sacramento Project and the Southport EIP. On April 21, 2014 an interagency meeting was held to discuss the Biological Assessments for both actions. As a result of that meeting, Biological Assessments were combined because the two projects were determined to be too related to be considered in two separate consultations, and that both actions should be addressed together. A history of the consultation process is provided to document the process that led up to this decision.

##### **1.4.1 Southport EIP Consultation History**

The Corps and WSAFCA, pursuant to the ESA, must consult with USFWS and NMFS with regard to any proposed actions that may affect the continued existence of a Federally listed species. Following is a summary of communications with USFWS and NMFS for the Southport EIP Proposed Action.

- January 2014—an updated species list for Yolo County was obtained from the USFWS website.
- December 18, 2013 – USFWS and NMFS staff participated in an environmental stakeholder group meeting on project design development
- December 11 and 18, 2013—USFWS and NMFS staff participated in public meetings on the Southport EIP Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR)
- September 30, 2013 – NMFS staff correspondence requested additional information from the Corps to support consultation
- August 27, 2013 – NMFS staff met with WSAFCA and Corps staff to discuss project design and BA comments
- June 4, 2013—Corps requested initiation of consultation with USFWS and NMFS
- March 28, 2013—USFWS and NMFS staff participated in National Environmental Policy Act/California Environmental Quality Act (NEPA/CEQA) scoping meeting
- January 3, 2013—a species list for Yolo County was obtained from the USFWS website.
- November 14, 2011—USFWS and NMFS staff participated in an environmental stakeholder group meeting on project alternatives development
- August 15, 2011—USFWS and NMFS staff participated in an informal meeting of the Southport EIP environmental stakeholder group and attended a field visit led by WSAFCA.
- May 26, 2011—USFWS and NMFS staff participated in the kick-off of an environmental stakeholder group for the Southport EIP
- 2008 through 2010—USFWS and NMFS staff participated in numerous site visits and meetings associated with WSAFCA’s overall levee improvements program, leading to completed consultations for the I Street Bridge, The Rivers, and California Highway Patrol (CHP) Academy projects.

## **1.5 West Sacramento Project Future Consultation Approach**

The West Sacramento Project is at a feasibility level of design and therefore an earlier stage of development than the Southport EIP. Due to the uncertainty of when and how the West Sacramento Project will be implemented, this BA analyzes the maximum effects to listed species using the largest foreseeable footprint. The Corps will consult on Alternative 5 which is the locally preferred plan (LPP). As the project moves into further design, design refinements will likely reduce the footprint and reduce the effects to listed species. This approach will allow the USFWS and NMFS to conduct the jeopardy

analysis and to determine the level of take in an Incidental Take Statement. Coordination with the resource agencies will continue into the design phase to obtain input which can help to avoid, minimize, or compensate for affects to listed species. This future coordination would attempt to reduce any mitigation required for the project and also would determine if additional consultation is needed for the project.

## 2.0 Proposed Action and Project Evaluation Approach

### 2.1 Introduction

The Corps has identified a number of problems associated with the flood risk management system protecting the city of West Sacramento and surrounding areas. There is a high probability that flows in the American and Sacramento Rivers will stress the network of levees protecting West Sacramento to the point that levees could fail. The consequences of such a levee failure would be catastrophic, since the area inundated by flood waters is highly urbanized and the flooding could be up to 20 feet deep.

The majority of the Sacramento River north and south levee reaches within the West Sacramento study area require seepage, slope stability, height, and erosion improvements in order to meet Corps criteria. This BA analyzes the effects of repairing the levees in the West Sacramento GRR North and South basins. A summary of the remediation measures proposed under this study are included in Table 2 below.

**Table 2. Proposed Measures for the West Sacramento Project.**

Waterway/Location	Extent of Action	Proposed Measure
North Basin		
Sacramento River North Levee *	5.5 miles from the Sacramento Bypass south to the stone lock structure on the DWSC.	<ul style="list-style-type: none"> <li>• Construct bank protection</li> <li>• Install cutoff walls</li> <li>• Construct levee raise</li> </ul>
West Sacramento Port North Levee **	4.9 miles from the stone lock structure west to the Yolo Bypass levee.	<ul style="list-style-type: none"> <li>• Construct floodwalls</li> </ul>
Yolo Bypass **	3.7 miles from the Port North levee north to the Sacramento Bypass.	<ul style="list-style-type: none"> <li>• Install cutoff walls</li> </ul>
Sacramento Bypass Training Levee **	1.1 miles from the Yolo Bypass levee to the Sacramento River.	<ul style="list-style-type: none"> <li>• Construct bank protection</li> </ul>

<b>Waterway/Location</b>	<b>Extent of Action</b>	<b>Proposed Measure</b>
<b>South Basin</b>		
Sacramento River South Levee *	5.9 miles south along the Sacramento River from the DWSC stone lock structure to the South Cross levee.	<ul style="list-style-type: none"> <li>● Construct bank protection</li> <li>● Install cutoff walls</li> <li>● Construct levee raise</li> <li>● Construct seepage berm</li> <li>● Construct setback levee</li> </ul>
South Cross Levee **	1.2 miles across the South Basin from the Sacramento River to the DWSC.	<ul style="list-style-type: none"> <li>● Install cutoff walls</li> <li>● Construct seepage berms</li> <li>● Levee Raise</li> </ul>
Deep Water Ship Channel East Levee **	2.8 miles from the South Cross levee north to the point where it bends east.	<ul style="list-style-type: none"> <li>● Construct floodwalls</li> <li>● Levee raise</li> <li>● Construct bank protection</li> </ul>
West Sacramento Port South Levee **	4.0 miles east from the bend in the DWSC east levee to the stone lock structure.	<ul style="list-style-type: none"> <li>● Install cutoff walls</li> <li>● Construct levee raise</li> </ul>
Deep Water Ship Channel West Levee **	21.4 miles from the intersection of the Port North levee and the Yolo Bypass levee south to Miners Slough.	<ul style="list-style-type: none"> <li>● Install cutoff walls</li> <li>● Construct seepage berms</li> <li>● Levee raise</li> <li>● Construct bank protection</li> <li>● Construct closure structure</li> </ul>
South Cross Levee **	1.2 miles across the South Basin from the Sacramento River to the DWSC.	<ul style="list-style-type: none"> <li>● Install cutoff walls</li> <li>● Construct seepage berms</li> <li>● Levee Raise</li> </ul>

\* Would establish compliance with Corps vegetation requirements for upper 2/3 slopes of the levee, with a variance allowing the lower 1/3<sup>rd</sup> waterside vegetation to stay.

\*\* Would establish compliance with Corps vegetation requirements. Engineering Technical Letter 1110-2-571.

The West Sacramento project is being completed in accordance with the principles that have been outlined in the Corps' SMART Planning Guide (Corps 2013). SMART Planning requires that all feasibility studies should be completed within a target of 18 months (to no more than three years at the greatest), at a cost of no more than \$3 million, utilizing 3 levels of vertical team coordination, and of a "reasonable" report size. The SMART Planning methodology and framework were developed to facilitate more efficient, effective, and consistent delivery of Planning Decision Documents. All designs associated with this project use the largest footprint to evaluate affects to listed species. The larger footprint will look at the maximum extent the project could affect species in the project area. As design refinements occur, consideration will be given to designs that reduce affects to listed species where practicable.

## **2.2 West Sacramento Project Proposed Action**

### **2.2.1 Measures Proposed for Alternatives**

Levees in the West Sacramento project area require improvements to address seepage, slope stability, overtopping, and erosion concerns. The measures proposed to improve the levees are described below and consist of: (1) seepage cutoff walls, (2) seepage berms, (3) stability berms, (4) levee raises, (5) flood walls, (6) relief wells, (7) sheet pile walls, (8) jet grouting, and (9) bank protection. The above measures would be implemented by fixing levees in place, constructing adjacent levees, or constructing a setback levee. It is possible that sheet pile walls, jet grouting, and relief wells would be used at various locations so they are also described below. Figure 1 identifies the reaches where each measure would be required. Once a levee is modified, regardless of the measure implemented for the alternative, the levee would be brought into compliance with Corps levee design criteria. This would include slope flattening and/or crown widening, where required. The levee crown would be widened to 20 feet, and 3:1 landside and waterside slopes would be established where possible. If necessary, the existing levee centerline would be shifted landward in order to meet the Corps' standard levee footprint requirements.

#### **Seepage and Slope Stability Measures**

##### **Cutoff Walls**

To address seepage concerns, a cutoff wall would be constructed through the levee crown. The cutoff wall would be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach would depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of approximately 85 feet. For cutoff walls of greater depth, the DSM method would be utilized.

Prior to construction of either method of cutoff wall, the construction site and any staging areas would be cleared, grubbed, and stripped. The levee crown would be degraded to approximately half the levee height to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids (Figure 3). Excavated and borrow material (from nearby borrow sites) would be stockpiled at staging areas. Haul trucks, front end loaders, and scrapers would bring borrow materials to the site, which would then be spread evenly and compacted according to levee design plans. The levee would be hydroseeded once construction was completed.

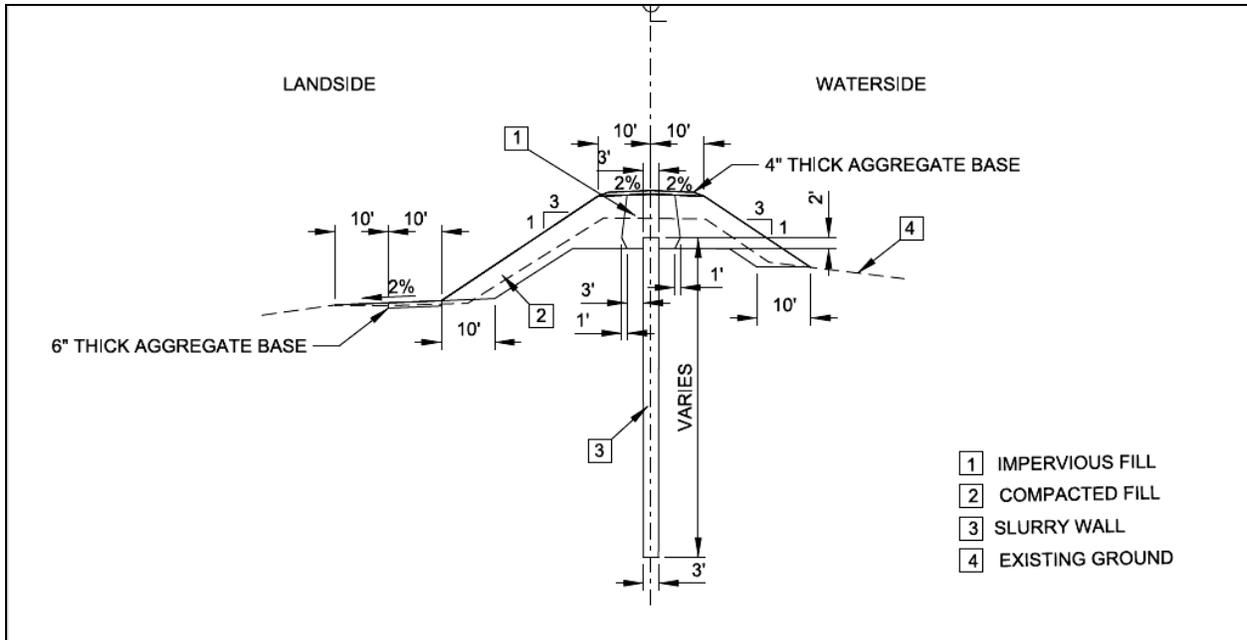
### Conventional Open Trench Cutoff Wall

A trench approximately 3 feet wide would be excavated at the top of levee centerline and into the subsurface materials up to 85 feet deep with a long boom excavator. As the trench is excavated, it would be filled with low density temporary bentonite water slurry to prevent cave in. The soil from the excavated trench would be mixed nearby with hydrated bentonite, and in some applications cement. The soil bentonite mixture would be backfilled into the trench, displacing the temporary slurry. Once the slurry has hardened, it would be capped and the levee embankment would be reconstructed with impervious or semi-impervious soil.

### Deep Soil Mixing Cutoff Wall

The DSM method would require large quantities of cement bentonite grout. This would necessitate the use of a contractor-provided, on-site batch plant and deliveries of concrete aggregate, concrete sand, bentonite, and cement. The batch plant would be powered by generators or electricity from overhead power lines and would be located within the project area or in an adjacent staging area. The batch plant area would consist of an aggregate storage system, aggregate rescreen system (if needed), rewashing facility (if needed), the batching system, cement storage, ice manufacturing, and the grout mixing and loading system. All aggregate used within the batch plant operations would be obtained from existing local commercial off-site sources and delivered to the site.

From the batch plant, the grout mixture would be transported through high-pressure hoses (8,000 pounds per square inch [psi]) to the location of construction. At the construction site, a crane supported set of two to four mixing augers would be used to drill through the levee crown and subsurface to a maximum depth of approximately 140 feet. As the augers are inserted and withdrawn, the cement bentonite grout would be injected through the augers and mixed with the native soils. An overlapping series of mixed columns would be drilled to create a continuous seepage cutoff barrier. Once the slurry has hardened it would be capped and the levee embankment would be reconstructed with impervious or semi-impervious soil.



**Figure 3. Levee Improvement with Slurry Wall.**

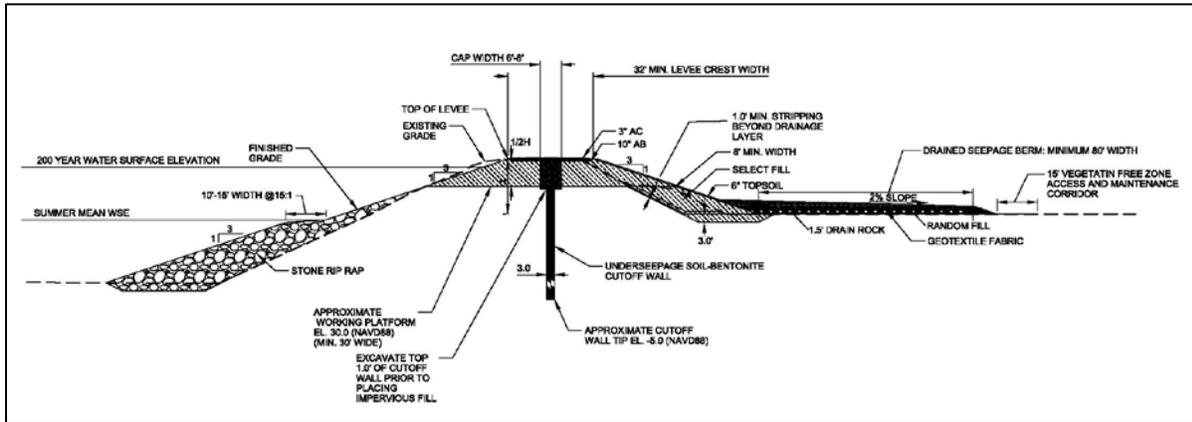
### Seepage Berm

Seepage berms are wide embankment structures made up of low-permeable to semi-pervious materials that resist accumulated water pressure and safely release seeping water. A seepage berm would be constructed in areas where it has been determined by geotechnical investigations that a seepage berm is more appropriate to address seepage than a cutoff wall. The seepage berm would extend out from the landside levee toe and would vary in width from 70 to 100 feet, tapering down from a five foot thickness, at the levee toe, to a three foot thickness, at the berm toe (Figure 4). The length of the seepage berm would depend on the seepage conditions along the levee reach.

Construction would consist of clearing, grubbing, and stripping the ground surface. Depending on the action alternative, soil used to construct a berm would be stockpiled from levee degradation, excavated from nearby borrow pits, or trucked on site from off-site locations (if on-site material is not adequately available). During the degrading, soil would be stockpiled at the proposed berm site. If constructing the alternative does not require levee degradation, all soil material used to construct a berm would come from nearby borrow sites. At the borrow sites, bulldozers would excavate and stockpile borrow material. Front-end loaders would load haul trucks, and the haul trucks would transport the borrow material to the site. The haul trucks would then dump the material, and motor graders would spread it evenly, placing approximately 3 to 5 feet of embankment fill material. Material used for berm construction would have greater permeability than the native blanket material. However, depending on material availability, a lower permeability material may be used. Adjustments to berm width would be made in such cases, as appropriate. During the embankment placement, material would be placed in a maximum of 1- to 2-foot loose lifts, thereby allowing the compactors to achieve

the specified compaction requirements. Sheepsfoot rollers would compact the material, and water trucks would distribute water over the material to ensure proper moisture for compaction and reduction of fugitive dust emissions. The new seepage berm would be hydroseeded following construction.

Seepage berms may have an optional feature of a drainage relief trench under the toe of the berm. Drained seepage berms would include the installation of a drainage layer (gravel or clean sand) beneath the seepage berm backfill and above the native material at the levee landside toe. A drained seepage berm would likely decrease the overall footprint of the berm.

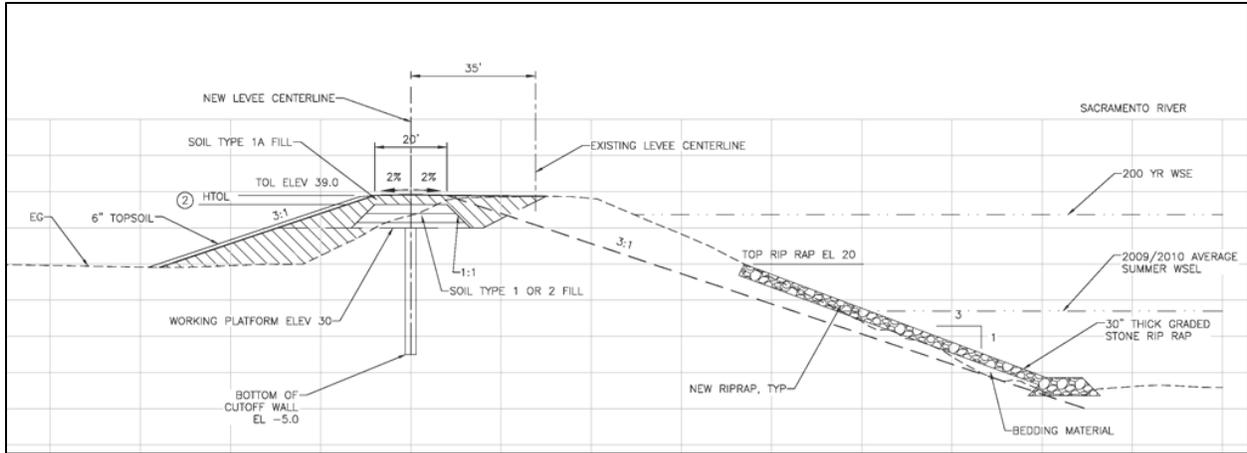


**Figure 4. Fix in Place Levee Improvement with Seepage Berm.**

**Stability Berm**

A stability berm would be constructed against the landside slope of the existing levee with the purpose of supplying support as a buttress. A stability berm is proposed along the South Cross levee as shown in Figure 5. The height of the stability berm would generally be 2/3 of the levee height, and would extend for a distance determined by the structural needs of the levee along that reach. Embankment fill material necessary to construct the berm is excavated by a bulldozer from a nearby borrow site. Front-end loaders would load haul trucks with the borrow material and the haul trucks would transport the material to the stability berm site. Motor graders would spread the material evenly according to design specifications, and a sheepsfoot roller would compact the material. Water trucks would distribute water over the material to ensure proper moisture for compaction. The new seepage berm would be hydroseeded after construction.

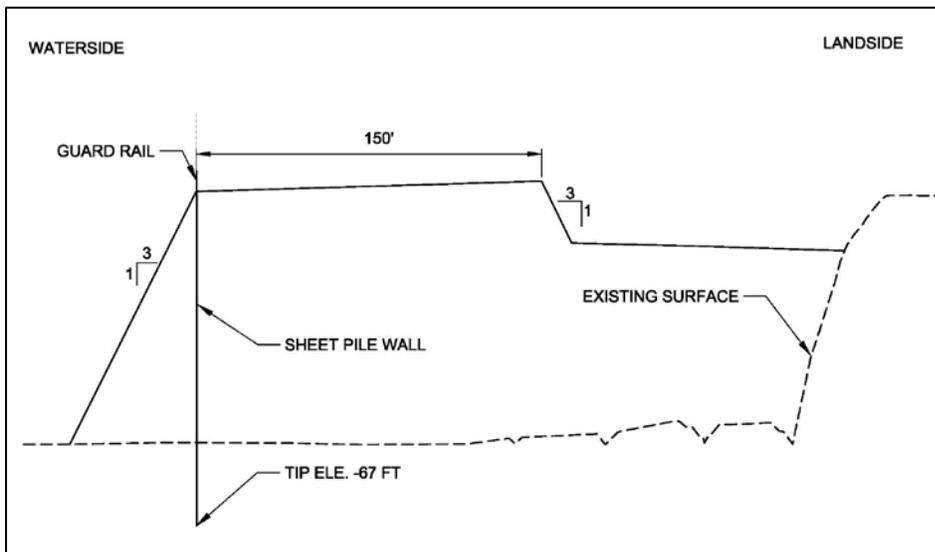




**Figure 6. Adjacent Levee Improvement.**

### Sheet Pile Wall

A sheet pile wall is proposed at the Stone Locks to tie together the levees on either side of the Barge Canal (Figure 7). A trench would be excavated along the sheet pile alignment to allow the pile to be driven to the proposed depth (below the existing levee grade). A driving template fabricated from structural steel would be placed to control the alignment as the sheet pile is installed. A hydraulic or pneumatically operated pile driving head attached to a crane would drive the sheet pile into the levee crown to the desired depth (up to 135 feet). An additional crane or excavator would be used to facilitate staging of the materials. The conditions of the site, driving pressure, hydrostatic loads, and corrosion considerations would determine the thickness and configuration of the sheet piles. If conditions indicate that corrosion is an issue, the sheet piles could be coated, oversized to provide additional thickness as a corrosion allowance, and/or provided with a cathodic protection system.



**Figure 7. Sheet Pile Wall with Embankment Fill.**

## **Jet Grouting**

Jet grouting typically is used in constructing a slurry cutoff wall to access areas other methods cannot. In this regard, it is typically a spot application rather than a treatment to be applied on a large scale. Jet grouting would be used around existing utilities not proposed for removal, and at bridges along the West Sacramento levees. It involves injecting fluids or binders into the soil at very high pressure. The injected fluid can be grout; grout and air; or grout, air, and water. Jet grouting breaks up soil and, with the aid of a binder, forms a homogenous mass that solidifies over time to create a mass of low permeability.

Equipment required for jet grouting consists of a drill rig fitted with a special drill string; a high pressure, high flow pump; and an efficient batch plant with sufficient capacity for the required amount of grout and water, supporting generators and air compressors, holding tanks, and water tanks, with bulk silos of grout typically used to feed large mixers. The high-pressure pump conveys the grout, air, and/or water through pipelines that run the length of the site through the drill string to a set of nozzles located just above the drill bit. Smaller equipment can be used in combination with the single phase–fluid system and can be permanently trailer-mounted to permit efficient mobilization and easy movement at the job site. Jet-grouted columns range from 1 to 16 feet in diameter and typically are interconnected to form cutoff barriers or structural sections. One construction crew, consisting of a site supervisor, pump operator, batch plant operator, chuck tender, and driller under ideal conditions, can construct two 6-foot-diameter, 50-foot columns per day consisting of approximately 100 cubic yards of grout injected per 8-hour shift. Ideal conditions would be characterized by no technical issues, such as loss of fluid pressure, breakdown of equipment, or subsurface obstructions to drilling operations occurring at either the batch plant or the drilling site.

To provide a wide enough working platform on the levee crown, the upper portion of some segments of the levee may require degradation with a paddle wheel scrapper. Material would be scraped and stockpiled at a nearby stockpile area. Hauling at the work area would involve scrapper runs along the levee to the staging area, and grout, bentonite, and water deliveries to the batch plant. To initiate jet grouting, a borehole would be drilled through the levee crown and foundation to the required depth (to a maximum depth of approximately 130 feet) by rotary or rotary-percussive methods using water, compressed air, bentonite, or a binder as the flushing medium. When the required depth is reached, the grout would be injected at a very high pressure as the drill string is rotated and slowly withdrawn. Use of the double, triple, and superjet systems create eroded spoil materials that would be expelled out of the top of the borehole. The spoil material would contain significant grout content and could be used as a construction fill.

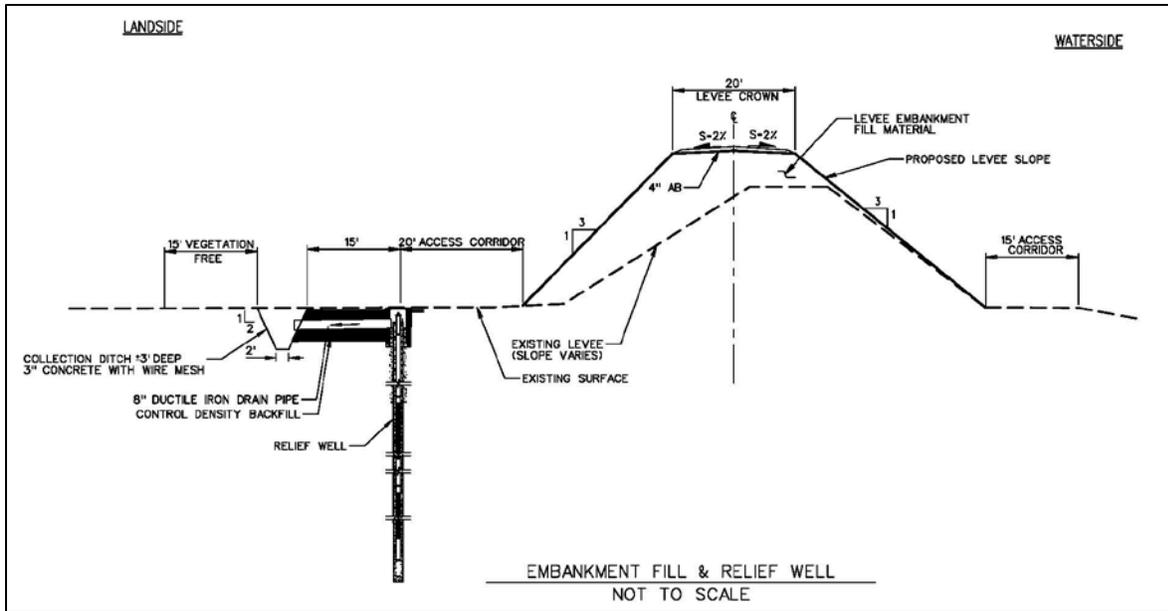
## Relief Wells

Relief wells would be used to address underseepage and would be applied only on a limited basis for site-specific conditions rather than a segment-wide application. They would be located along adjacent and setback levee toes in the South Basin and only in segments where geotechnical analyses have identified continuous sand and gravel layers and the presence of an adequate impermeable layer (Figure 8). Relief wells are passive systems that are constructed near the levee landside toe to provide a low-resistance pathway for underseepage to exit to the ground surface in a controlled and observable manner. A low-resistance pathway releases water pressure under the upper impermeable layer, allowing underseepage to exit without creating sand boils or piping levee foundation materials.

Relief wells are constructed using soil-boring equipment to drill a hole vertically through the upper fine-grained layer (usually clays or silty clays), through the coarse-grained aquifer layer of sand or gravel, and into the lower fine-grained clay layer beneath. Pipe casings and gravel/sand filters are installed to allow water to flow freely while preventing transportation and removal of material from the levee foundation, which can undermine the levee foundation. The water then is collected and discharged into a drainage system using a series of ditches or an underground piping system.

Relief wells generally are spaced at 50- to 150-foot intervals, dependent on the amount of underseepage, and extend to depths of up to 150 feet. Areas for relief well construction are cleared, grubbed, and stripped. During relief well construction, a typical well-drilling rig would be used to drill to the required depth and construct the well (including well casing, gravel pack material, and well seal) beneath the ground surface. The drill rig likely would be an all-terrain, track-mounted rig that could access the well locations from the levee toe.

Areas along the levee toe may be used to store equipment and supplies during construction of each well. Construction of each well and the lateral drainage system typically takes 10 to 20 days. Additional time may be required for site restoration.

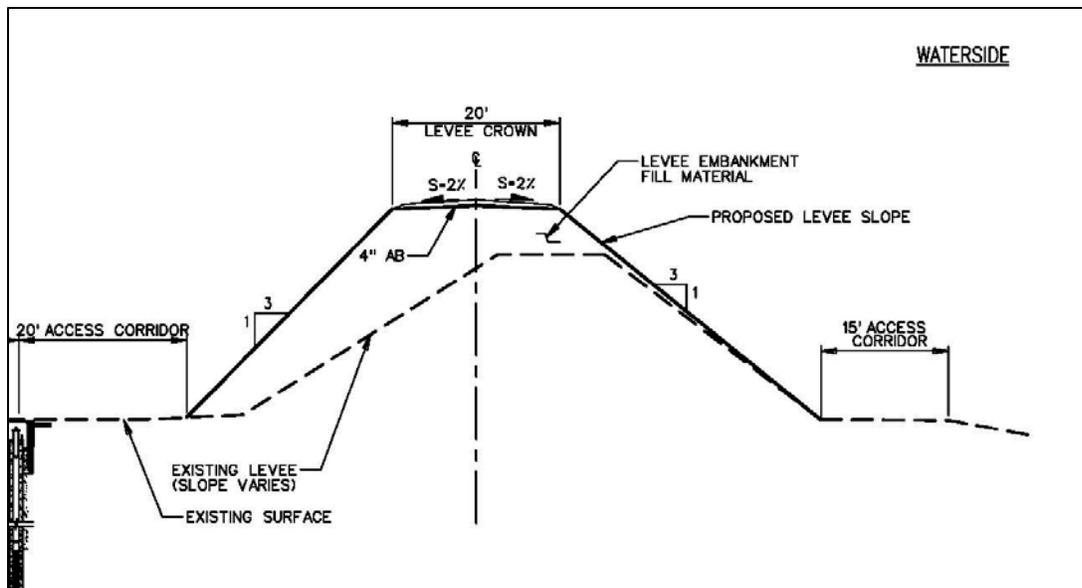


**Figure 8. Fix in Place Levee Improvement with Relief Well.**

## Overtopping Remediation

### **Levee Height Raise**

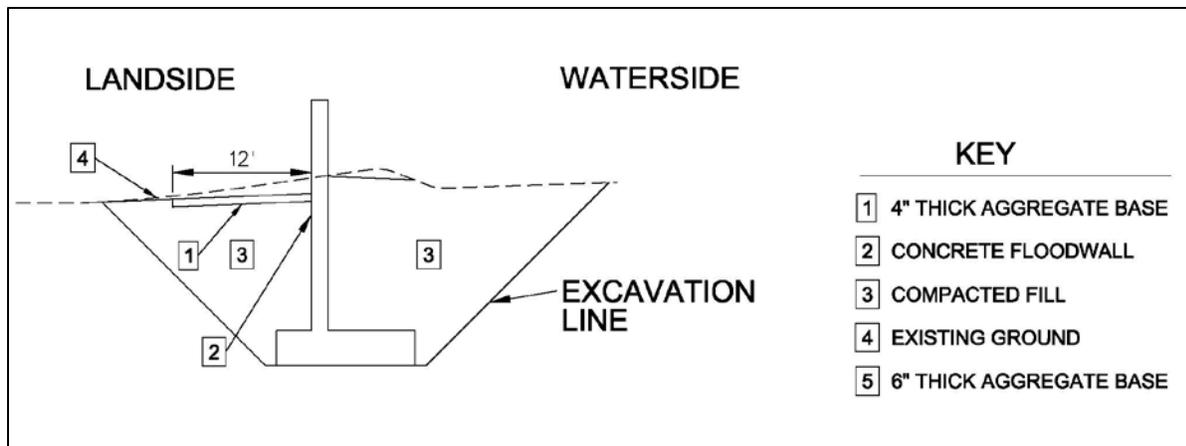
To address the height deficiencies, additional borrow material would be added after cutoff walls and levee reshaping improvements are completed (Figure 9). The additional material would be brought from nearby borrow sites, stockpiled in staging areas then hauled to the site with trucks and front end loaders. Material would be spread evenly and compacted according to levee design plans. The levee would be hydroseeded once construction was completed.



**Figure 9. Levee Height Raise.**

### **Floodwalls**

Floodwalls are proposed along the waterside hinge point of the Port north levee and along the selected levee alignment around the Port of West Sacramento. Floodwalls are an efficient, space-conserving method for containing unusually high water surface elevations. They are often used in highly developed areas, where space is limited. To begin the floodwall construction, the area would be cleared, grubbed, stripped, and excavation would occur to provide space to construct the footing for the floodwall. The floodwall would primarily be constructed from pre-fabricated materials, although it may be cast or constructed in place, and would be constructed almost completely upright. Floodwalls mostly consist of relatively short elements, making their connections very important to their stability. The floodwalls would be designed to disturb a minimal amount of waterside slope and levee crown for construction (Figure 10). The height of the floodwalls varies from 1 to 4 feet, as required by water surface elevations. The waterside slope would be re-established to its existing slope and the levee crown would grade away from the wall and be surfaced with aggregate base



**Figure 10. Floodwall Typical Design.**

### Erosion Protection Measures

#### **Levee Bank Protection**

The primary erosion protection measure consists of waterside armoring of the levees to prevent erosion and subsequent damage to the levee. This measure consists of placing rock revetment on the river's bank, and in some locations on the levee slope, to prevent erosion (Figure 11). The extent of the revetment would be based on site-specific analysis. Along the Sacramento Bypass Training levee, revetment would be placed on both sides of the levee slopes as shown in Figure 12. This would protect the levee in place when the Sacramento and Yolo Bypasses have water in them. When necessary, the eroded portion of the bank would be filled and compacted prior to the rock placement.

The Corps conducts ongoing erosion repairs to sites on the Sacramento River levees under the SRBPP. As part of the SRBPP NMFS Biological Opinions, the Corps is required to conduct post-construction monitoring in order to evaluate the relative success of on-site habitat features that are incorporated into the repairs. Under the SRBPP, bank protection designs have been constantly evolving, as the results of the monitoring help inform engineers to adapt the designs to optimize for site-specific conditions in meeting the objective of the habitat features. The Corps will use the best available information and SRBPP design templates as a basis for designing site-specific bank protection repairs for this project. As a result, the bank protection measure described below is a basic example of a typically designed bank protection site.

The sites would be prepared by clearing and stripping the site prior to construction. Small vegetation and deleterious materials would be removed. Bank protection would be placed around existing trees on the lower portion of the slope. Trees on the upper portion of the slope would be removed during degrading of levees for slurry cutoff walls and bank protection would be placed

following reconstruction of the levee. Temporary access ramps would be constructed, if needed, using imported borrow material that would be trucked on site.

Revetment would be imported from an offsite location via haul trucks or barges. Revetment transported by haul trucks would be temporarily stored at a staging area located in the immediate vicinity of the construction site. A loader would be used to move revetment from the staging area to an excavator that would place the material on site. Rock required on the upper portions of the slopes would be placed by an excavator located on top of the levee. Rock placement from atop the levee would require one excavator and one loader for each potential placement site.

Revetment transported by barges would not be staged, but placed directly on site by an excavator. Rock required within the channel, both below and slightly above the water line at the time of placement, would be placed by an excavator located on a barge. The excavator would construct a large rock berm in the water up to an elevation slightly above the mean summer water surface. A planting trench would be established on this rock surface for revegetation purposes. Construction would require two barges: one barge would carry the excavator, while the other barge would hold the stockpile of rock to be placed on the channel slopes.

The bank protection would be placed via the methods discussed above on the existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After rock placement has been completed, a small planting berm would be constructed in the rock, when feasible, to allow for some revegetation of the site outside of the vegetation free zone as required by Engineer Technical Letter (ETL) 1110-2-571.

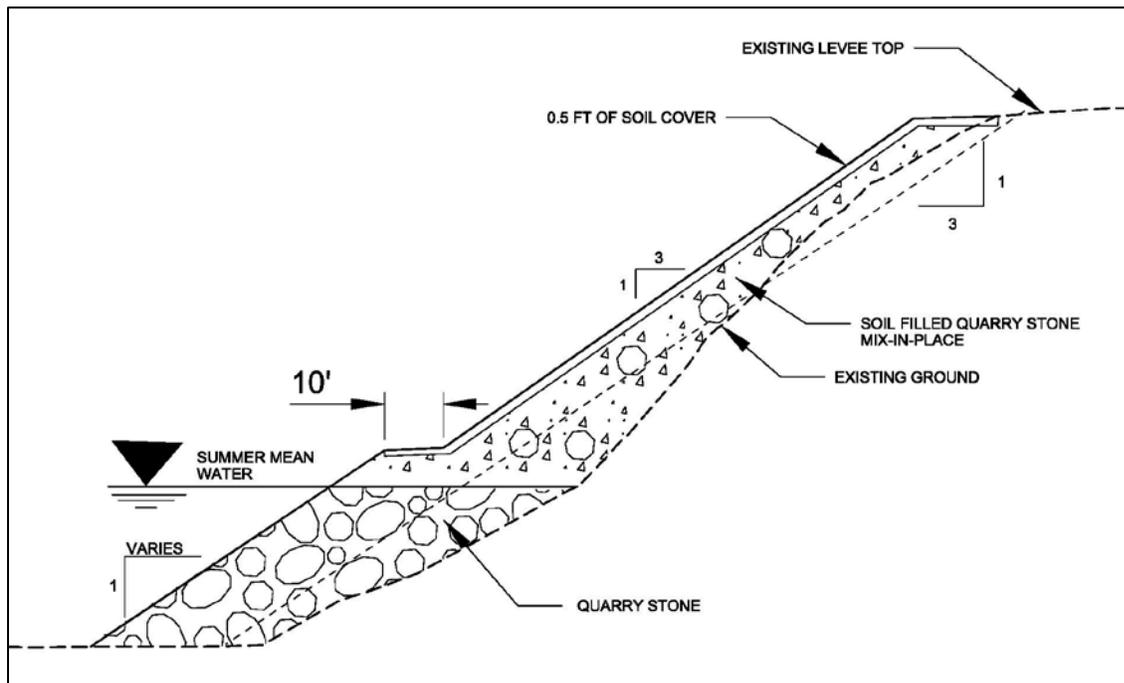
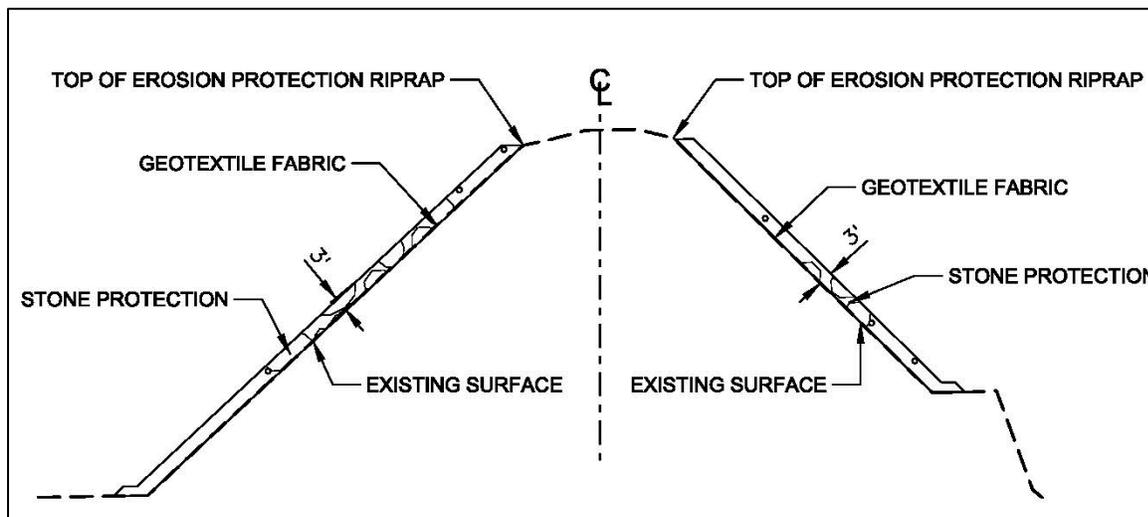


Figure 11. Bank Protection Typical Design.



**Figure 12. Bank Protection along Sacramento Bypass Training Levee.**

### **Levee Biotechnical Measures**

In addition to the bank protection measure, biotechnical measures have been proposed for several reaches. This remediation measure would be implemented for any of the proposed alternatives discussed in this document. This measure is being considered for lower velocity reaches to preserve existing vegetation. Under this measure, the Corps would use plant material and minimal amounts of rock to stabilize the eroded slope and prevent further loss of material.

### **Operation and Maintenance**

Operation and maintenance (O&M) of the levees in the West Sacramento area are the responsibility of the local maintaining agencies, including RD 900, RD 537, DWR's Maintenance Area 4, and the Corps. The applicable O&M Manual the West Sacramento levees is the Standard Operation and Maintenance Manual for the Sacramento River Flood Control Project. Typical levee O&M in the West Sacramento area currently includes the following actions:

- Vegetation maintenance up to four times a year by mowing or applying herbicide.
- Control of burrowing rodent activity monthly by baiting with pesticide.
- Slope repair, site-specific and as needed, by re-sloping and compacting.
- Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.
- Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.

Post-construction, groundwater levels would be monitored using the piezometers.

For sites with a vegetation variance, the O&M manual for these Sacramento River reaches would be adjusted to reflect the variance. Under the adjusted O&M manual, large trees that were protected in place under the variance would be allowed to remain on the waterside slopes, but smaller shrubs would be removed and grasses would be regularly mowed to allow for inspection and access.

### **Additional Construction Measures**

In addition to the proposed levee improvements measures described above, the following measures and policies would apply to all of the alternatives, and would be addressed during construction:

- The Corps' standard levee footprint would be established during construction of structural improvements on all levees that are out of compliance. The standard levee footprint consists of a 20 foot crown width and 3:1 waterside and landside slopes. If the 3:1 landside slope is not possible based on site specific conditions then a minimum 2:1 landside slope would be established with supporting engineering analysis.
- A 20 foot landside and waterside maintenance access would be established. In areas where 20 feet cannot be obtained, 10 feet is allowable.
- Utility encroachments such as structures, certain vegetation, power poles, pump stations, and levee penetrations (e.g., pipes, conduits, cables) would be brought into compliance with applicable Corps policy or removed depending on type and location. This measure would include the demolition of such features and relocation or reconstruction as appropriate on a case-by-case basis (or retrofit to comply with standards). Utilities replacements would occur via one of two methods: (1) a surface line over the levee prism, or (2) a through-levee line equipped with positive closure devices.
- Private encroachments shall be removed by the non-federal sponsor prior or property owner prior to construction.

### **Vegetation Removal/Vegetation Variance Request**

Construction of the levee improvement measures would require compliance with Corps Engineering Technical Letter (ETL) 1110-2-571 Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures. The vegetation requirements include a vegetation-free zone on the levee slopes and crown, 15 feet from both landside and waterside levee toes, and 8 feet vertically. When the Corps is modifying an existing levee, it must comply with Corps levee safety policy in its designs and construction. The levees within the study area

require seepage, slope stability, height, and erosion improvements in order to meet Corps levee safety criteria.

Where feasible, a vegetation variance would be sought during the preconstruction engineering and design phase before construction to allow vegetation to remain on the lower 2/3 of the waterside slope and out 15 feet from the waterside toe. If granted, the variance would allow for vegetation to remain in these areas. No vegetation would be permitted on the landside slope or within 15 feet of the landside toe. To show that the safety, structural integrity, and functionality of the levee would be retained with a variance, an evaluation of underseepage and waterside embankment slope stability was completed by Corps geotechnical engineers.

The preliminary analysis for the vegetation variance was conducted by analyzing two index points. Index Point 1 is located on the Sacramento River north levee. Index Point 6 is located on the Sacramento River south levee. The index points for the project are shown on Figure 13. These two index points were chosen for the vegetation variance analyses because they were considered to be representative of the most critical channel and levee geometry, underseepage, slope stability conditions, and vegetation conditions of the respective basins. The analysis incorporated tree fall and scour on the cross-section geometry of the index points by using a maximum depth of scour for cottonwoods as approximately 11.0 feet; the associated soil removed was projected at a 2:1 slope from the base of the scour toward both the landside, and waterside slopes. The base scour width was equal to the maximum potential diameter at breast height (dbh) of cottonwoods (12.0 feet) projected horizontally at a depth of 11.0 feet below the existing ground profile. The results show that the tree fall and scour did not significantly affect levee performance and that the levee would meet Corps seepage and slope stability criteria when the seepage and slope stability improvement measures are in place (“with project” conditions). Therefore, it is a reasonable conclusion that allowing vegetation to remain on the lower waterside levee slope would not affect the safety, structural integrity, and functionality of the Sacramento River levee.

As a result of the geotechnical analysis, a vegetation variance would be requested to provide compliance for the Sacramento River portion of the project. In many cases along the Sacramento River levees, the levee is far enough back from the water’s edge to allow vegetation providing shaded riverine aquatic cover to remain on the bank with no vegetation variance necessary. However, in the Sacramento River north reach, vegetation along the bank would be thinned in order to place rock on the bank for erosion protection. No woody vegetation would be permitted on the landside slope or within 15 feet of the landside toe for purposes of providing access for levee inspections and flood repair response.

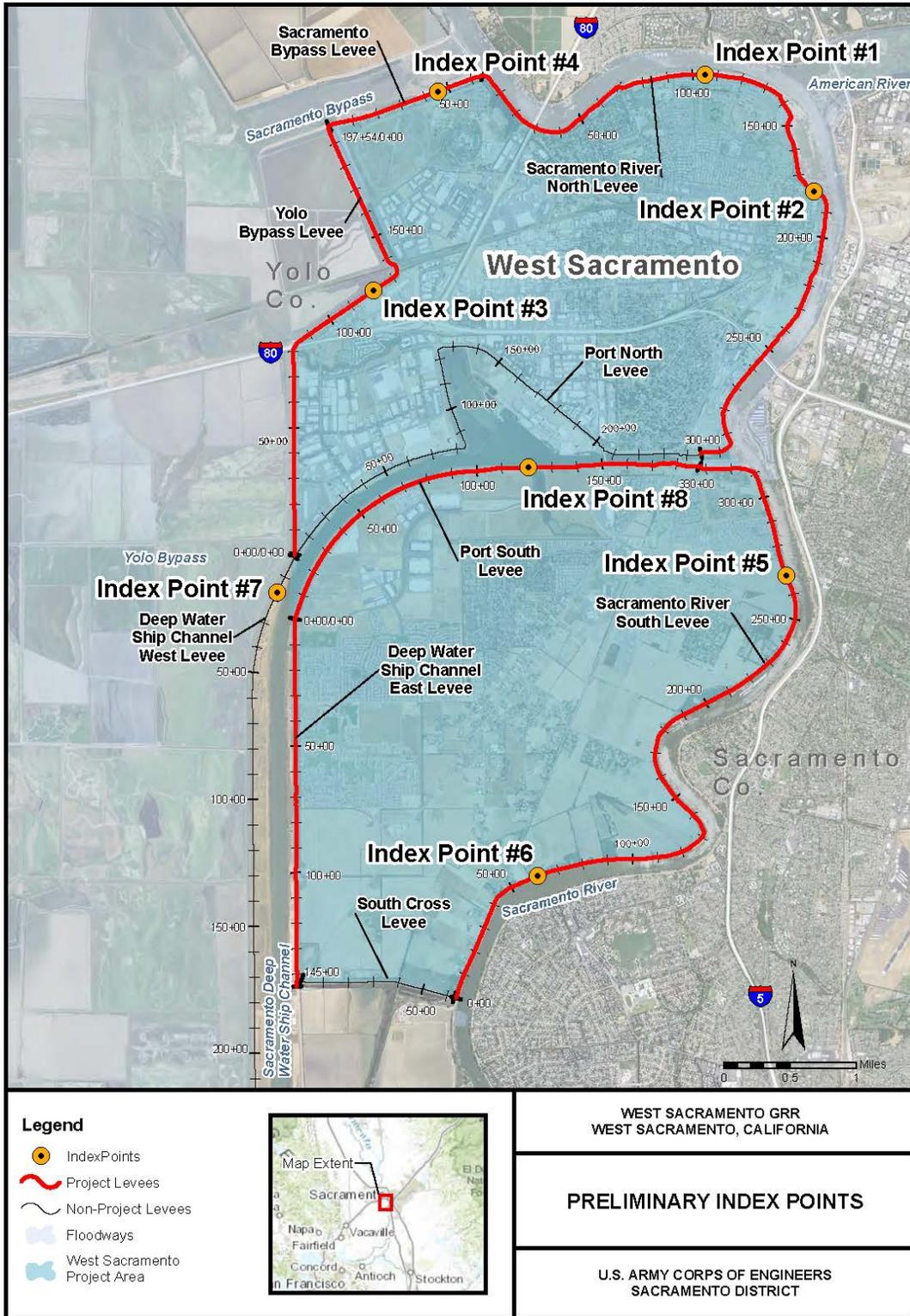


Figure 13. Index Points for the West Sacramento GRR.

Table 3 below summarizes the West Sacramento project reaches and whether or not a variance would be requested. Any reach without a vegetation variance would be subject to vegetation removal as detailed in ETL 1110-2-571.

**Table 3. West Sacramento GRR Project Summary of Variance Requests.**

Levee Reach	Vegetation Variance	Vegetation Removal
West Sacramento North Basin		
Sacramento River North	X	
Port North		X
Yolo Bypass *		X
Sacramento Bypass Training Levee		X
West Sacramento South Basin		
Sacramento River South	X	
South Cross		X
Deep Water Ship Channel East *		X
Deep Water Ship Channel West*		X
Port South		X

\*Vegetation is sparse in these reaches. Individual trees would be considered an adverse affect, however, overall the vegetation removal does not significantly impact the system as a whole.

Out of the seven reaches in which vegetation would be fully removed under ETL 1110-2-571, there would be minimal effects on the Yolo Bypass, South Cross, and DWSC reaches. This is because there are very few trees on these levees, and, in some cases, the levees are inland and any vegetation on the levees is unlikely to contribute to fish habitat. Since the Yolo Bypass toe drain is considered critical habitat for salmonids, there is the potential that any areas with significant vegetation along the toe drain could be considered a significant effect, however, there is potential that in the preconstruction engineering and design phase of the project, site-specific designs could be adjusted to avoid these impacts.

Approximately 65 acres of primarily landside riparian vegetation would be removed, both to provide for the construction footprint, and to comply with ETL 1110-2-571. In addition, approximately 5,000 lf of shoreline habitat would be removed from the Port north and south levees along the Barge Canal due to ETL compliance. Vegetation removed as a part of ETL 1110-2-571 compliance would be mitigated on site, outside of the vegetation-free zone, to the extent feasible. When on-site mitigation is not feasible, mitigation would occur at a local mitigation bank with available credits. If credits are not available locally, then mitigation would occur within the West Sacramento city limits.

Compliance with ETL 1110-2-571 is not expected to have a significant impact on instream woody material (IWM) recruitment in the Sacramento River system. The reach of the river included in this study is constrained by the levee banks and is not currently a significant source of IWM in the system. Most if not all IWM recruitment in the Sacramento River system comes from areas with more natural banks allowing for meandering and overbank erosion, such as upstream sections of the Sacramento River and the Feather River.

Standard O&M activities are discussed above. For sites with a vegetation variance, the O&M manual for these Sacramento River reaches would be adjusted to reflect the variance. Under the adjusted O&M manual, large trees that were protected in place under the variance would be allowed to remain on the waterside slopes, but smaller shrubs would be removed and grasses would be regularly mowed to allow for inspection and access.

### **Staging Areas**

As depicted on Figure 14, ten preliminary staging areas have been identified for use in the West Sacramento project area. These staging areas are located on the landside of the levees or within the project footprint and would occupy approximately 160 acres in total. Preliminary staging area locations were selected by identifying areas with the least environmental impacts on vegetation and endangered species. If it is determined that critical habitat occurs at proposed staging area, they would not be used for staging without further consultation. These areas would be used for staging construction activities and to provide space to house construction equipment and materials before and during construction activities.

### **Borrow Sites**

It is estimated that a maximum of 9 million cubic yards of borrow material could be needed to construct the West Sacramento Project. Because the West Sacramento Project is in the preliminary stages of design, detailed studies of each alternative borrow needs have not been completed. For the purposes of NEPA/CEQA a worst case scenario is being evaluated for the volume of borrow material needed. Actual volumes exported from any single borrow site would be adjusted to match demands for fill.

To identify potential locations for borrow material, soil maps and land use maps were obtained for a 20-mile radius surrounding the project area. The criteria used to determine potential locations were based on current land use patterns, soil types from U.S. Soil Conservation Service (SCS), and Corps' criteria for material specifications. These potential borrow locations are shown on the Borrow Site Map (Figure 15). Evaluation of potential borrow sites would begin with those nearest to the project area, to reduce impacts. Potential borrow sites with endangered species habitat would not be used for borrow material without further consultation. Borrow sites would be lands that are the least environmentally damaging and would be obtained from willing sellers. The data from land use maps and SCS has not been field verified, therefore, to ensure that sufficient borrow material would be available for construction the Corps looked at all locations within the 20 miles radius for 20 times the needed material. This would allow for sites that do not meet specifications or are not available for extraction of material.

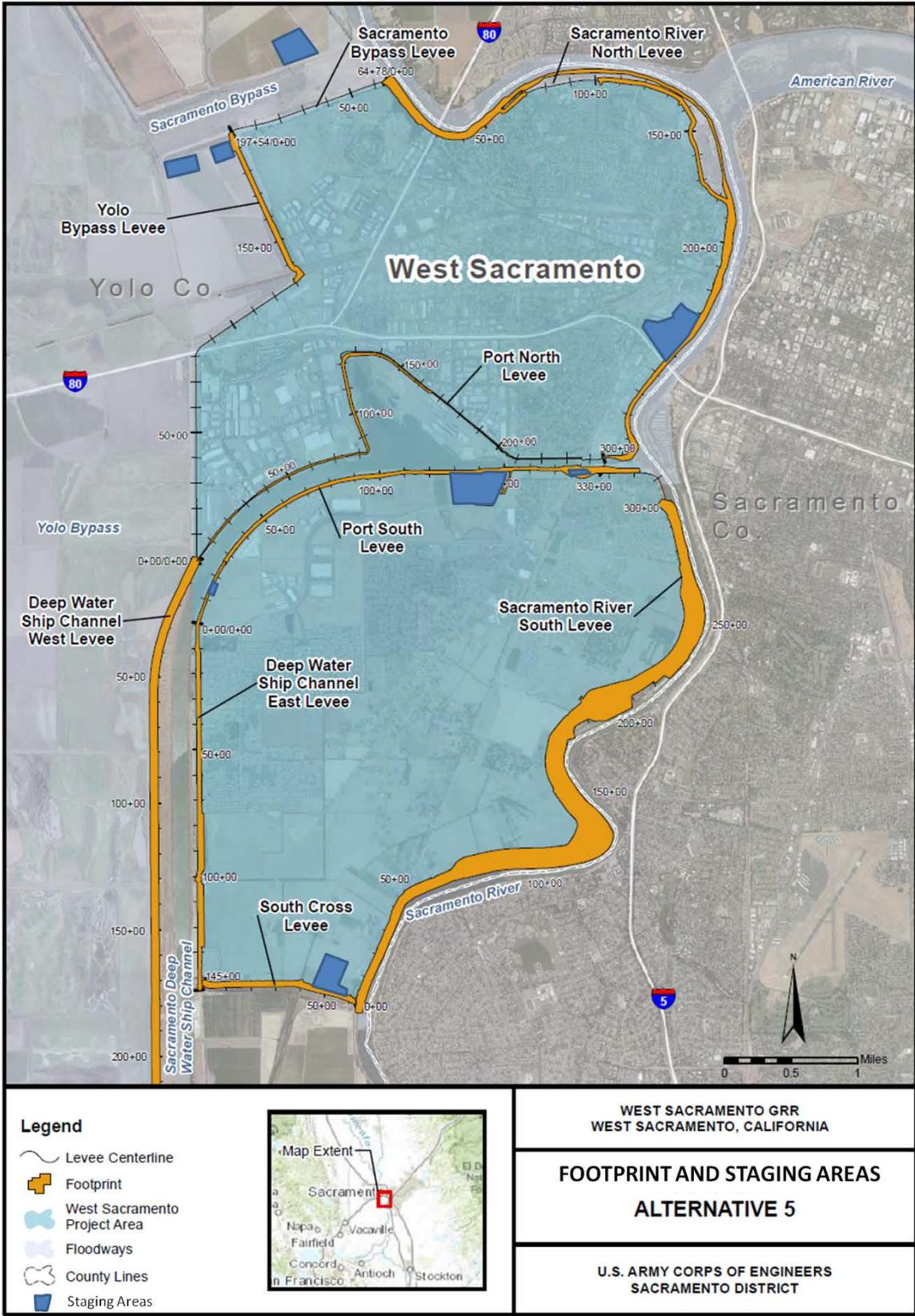


Figure 14. Potential Locations for Staging Areas for the West Sacramento GRR.

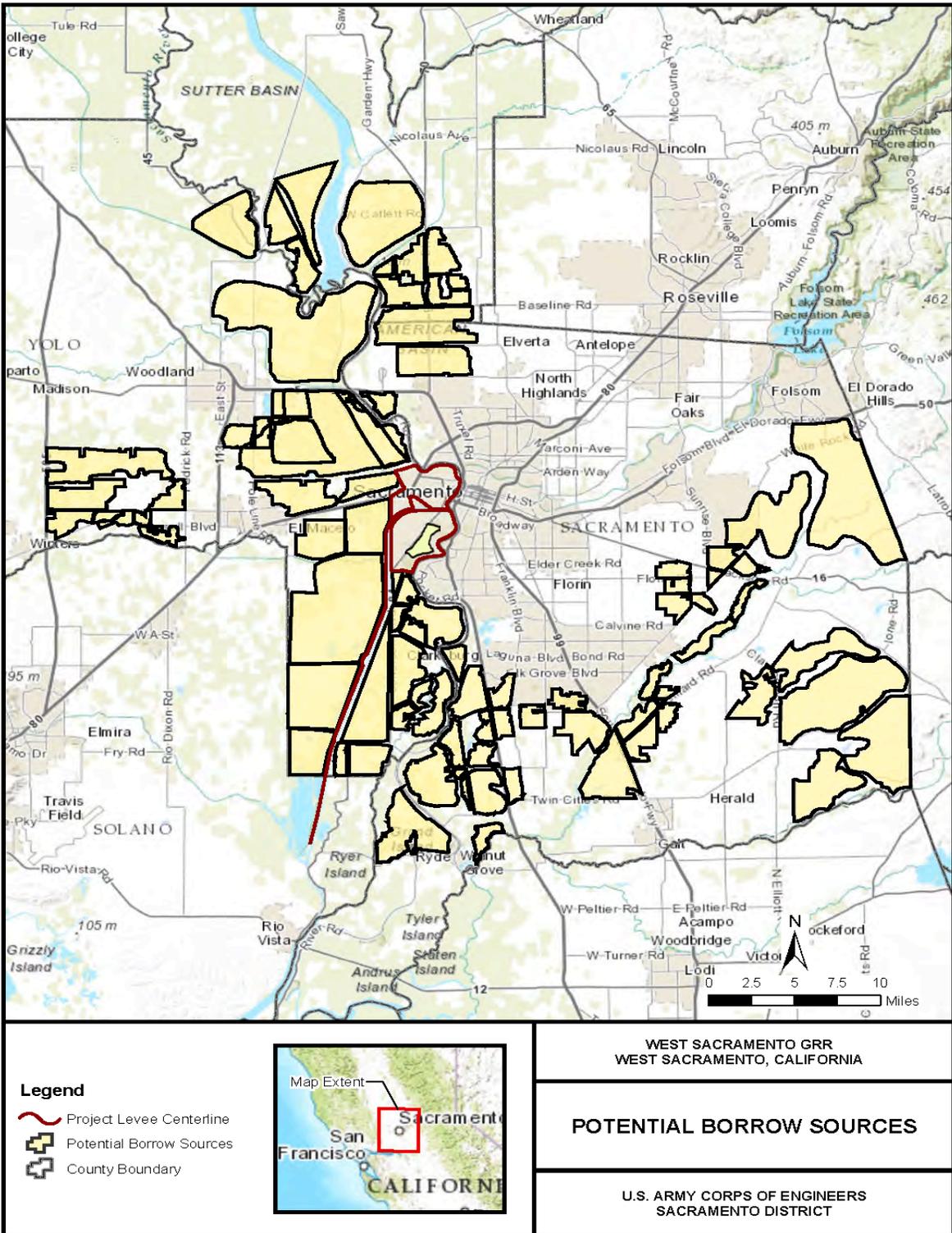


Figure 15. Potential Locations for Borrow Material for a 20-mile Radius Surrounding the West Sacramento Study Area.

The excavation limits on the borrow sites would provide a minimum buffer of 50 feet from the edge of the borrow site boundary. From this setback, the slope from existing grade down to the bottom of the excavation would be no steeper than 3H:1V. Excavation depths from the borrow sites would be determined based on available suitable material and local groundwater conditions. The borrow sites would be stripped of top material and excavated to appropriate depths. Once material is extracted, borrow sites would be returned to their existing use whenever possible, or these lands could be used to mitigate for West Sacramento Project impacts, if appropriate.

### **2.2.2 West Sacramento Project Tentatively Selected Plan – Alternative 5 – Improve Levees with Setback Levee along Sacramento River South**

The tentatively selected plan for the West Sacramento Project is Alternative 5 – Improve Levees with Setback Levee along Sacramento River South. Alternative 5 would include the construction of levee improvements to address: (1) seepage, (2) slope stability, (3) overtopping, and (4) erosion concerns identified for the Sacramento River, South Cross, DWSC, Port, Yolo Bypass, and Sacramento Bypass training levees. Figure 16 below identifies the reaches where each measure would be required under Alternative 5. Levees would be improved through a combination of fix in place and setback levee construction. A description of the measures identified and construction methods can be found above in Section 2.2.1. Once a levee is modified, regardless of the measure implemented for the alternative, the levee would be brought into compliance with Corps levee design criteria. To provide for levee construction, inspection, maintenance, monitoring, and flood-fighting access, some properties may need to be acquired. The levee remediation measures proposed under Alternative 5 are summarized in Table 4 below.

Due to environmental, real estate, and hydraulic constraints within the West Sacramento North Basin, Alternative 5 proposes fix in place remediation. For the South Basin, a combination of fix in place, adjacent levee, and a set back levee are being proposed. In addition, a seepage berm is proposed for the South Basin where there are not as many real estate constraints or the cutoff wall does not completely remove the through- and underseepage concerns. The fix in place is most suitable where real estate is constrained, the existing levee meets or exceeds minimum levee standards, and/or vegetation and erosion are not considerations. Table 4 summarizes the levee remediation measure for each reach in each basin.

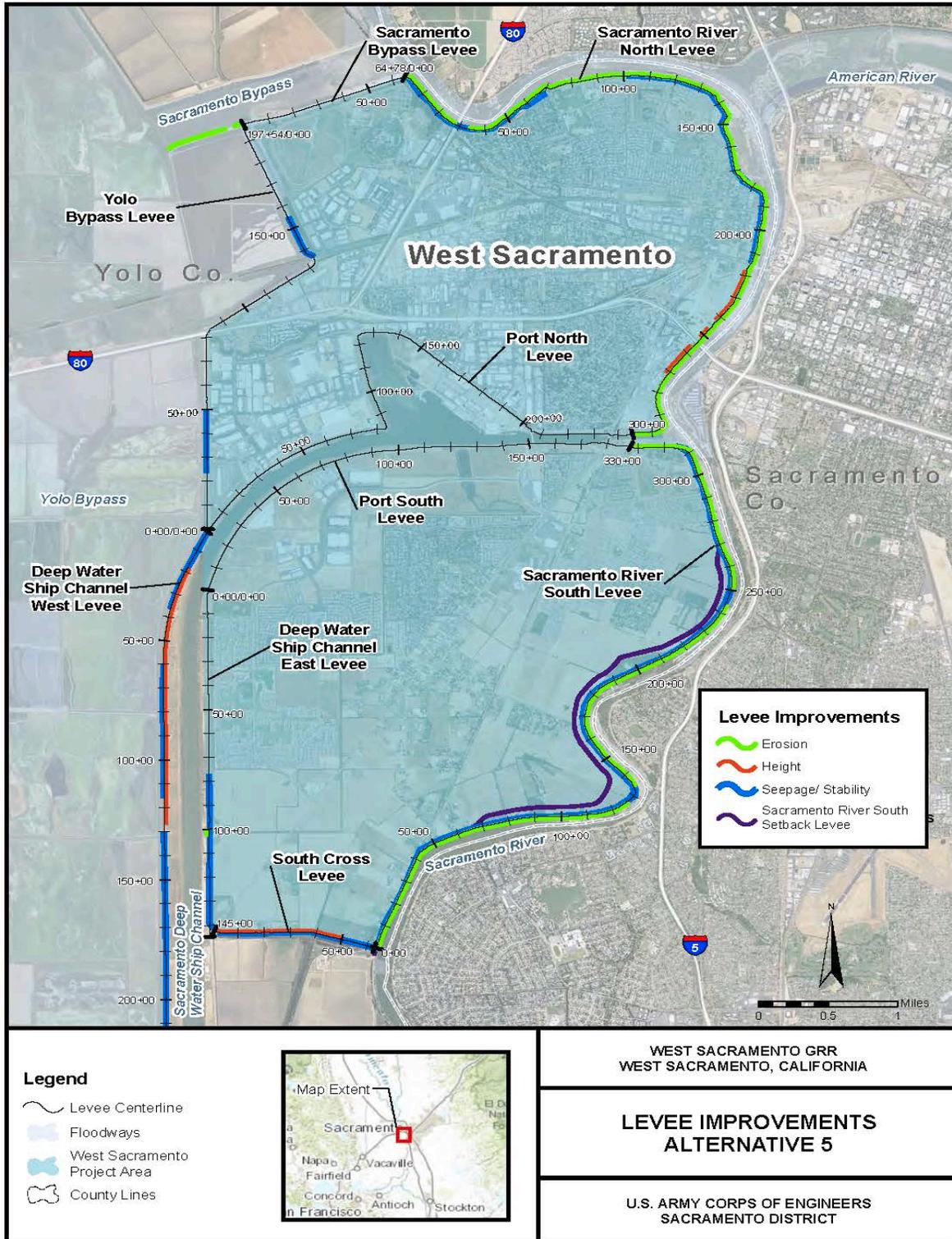


Figure 16. Map of Levee Improvements for West Sacramento Project Alternative 5.

**Table 4. West Sacramento Project Alternative 5 – Proposed Remediation Measures by Levee Reach.**

Levee Reach	Seepage Measures	Stability Measures	Overtopping Measures	Erosion Protection Measures
North Basin				
Sacramento River North	Cutoff Wall	Cutoff Wall	Levee raise	Bank Protection
Port North *	---	---	Floodwall	---
Yolo Bypass *	Cutoff Wall	Cutoff Wall	---	---
Sacramento Bypass Training Levee	---	---	---	Bank Protection
South Basin				
Sacramento River South	Setback Levee, Cutoff Wall, Seepage Berm,	Setback Levee, Cutoff Wall, Seepage Berm	---	Setback Levee, Bank Protection
South Cross	Stability Berm, Relief Wells	---	Levee Raise	---
Deep Water Ship Channel East *	Cutoff Wall	Cutoff Wall	Levee Raise	Bank Protection
Deep Water Ship Channel West*	Cutoff Wall	Cutoff Wall	Levee Raise	---
Port South*	Cutoff Wall	Cutoff Wall	Levee Raise	---

\* The entire levee reach does not need remediation, only specific sections.

It is estimated that 9 million cy of borrow material would be needed to construct Alternative 5. This includes 4 million cy of material for the setback levee. For the purposes of NEPA/CEQA, a worst case scenario is being evaluated for the volume of borrow material needed. Actual volumes exported from any single borrow sites would be adjusted to match demands for fill. Borrow sites for Alternative 5 would be the same as those identified in Section 2.2.1 above.

Construction of Alternative 5 is proposed to take approximately 19 years if each reach is constructed sequentially. The construction reaches have been prioritized based on a variety of factors, including the condition of the levee, the potential damages that would occur due to levee failure, and construction feasibility considerations, such as the availability of equipment at any given time. The tentative schedule of construction is shown in Table 5. The durations are for construction activities only, and do not include the time needed for design, right-of-way, utility relocation, etc.

**Table 5. West Sacramento Project Alternative 5 – Construction Sequence and Duration.**

<b>Construction Sequence</b>	<b>Construction Duration</b>
Sacramento River South Levee	4 years
Sacramento Bypass Training Levee	1 years
Sacramento River North Levee	2 years
Yolo Bypass	1 years
Deep Water Ship Channel West	3 years
Port South	1 years
Deep Water Ship Channel East	3 years
South Cross	2 years
Port North	2 years

Once a levee is modified, regardless of the measure implemented for the alternative, the levee would be brought into compliance with Corps levee design criteria. To provide for levee construction, inspection, maintenance, monitoring, and flood-fighting access, some properties may need to be acquired. The measures proposed for this alternative are described below.

#### **West Sacramento North Basin**

The primary issues in the North Basin, as identified on Figure 15, are seepage, slope stability, and erosion, with minimal levee height concerns. The measures that would be implemented under West Sacramento Project Alternative 5 for the levees in the North Basin would be: (1) installation of cutoff walls to address seepage and slope stability concerns; (2) levee raises to address height concerns; and (3) erosion protection to address erosion concerns. These measures are described above in Section 2.2.1. Table 6 shows the lengths of levee reaches, the measures for those reaches, and the approximate length of improvements for the North Basin.

**Table 6. West Sacramento Project Alternative 5 – Construction Lengths and Measures for the North Basin**

Levee Reach	Length of Reach (feet)	Length of Measure (feet)	Improvement	Measure
Sacramento River North Levee	30,700	30,000	Erosion Protection	Bank Protection
		11,000	Seepage	30 Foot Deep Slurry Wall
		1,500	Seepage	80 Foot Deep Slurry Wall
		500	Seepage	45 Foot Deep Slurry Wall
		5,500	Seepage	110 Foot Deep Slurry Wall
		4,600	Height	Embankment Fill
Stone Locks	570	550		Embankment Fill, Sheet Pile Wall
Port North	23,225	8,500	Height	4 to 10 Foot High Floodwall
		14,000	Height	Embankment Fill
Yolo Bypass	19,749	2,500	Seepage	40 Foot Deep Slurry Wall
		2,000	Seepage	100 Foot Deep Slurry Wall
Sacramento Bypass Training Levee	3,000	3,000	Erosion Protection	Bank Protection

**Sacramento Bypass Training Levee**

The training levee that extends into the Yolo Bypass from the Sacramento Bypass levee was not repaired by the sponsors, and still has erosion concerns as shown on Figure 15. Under Alternative 5 of the West Sacramento Project, bank protection is proposed to address erosion. Bank protection would be implemented as described in Section 2.2.1.

**Sacramento River Levee**

The Sacramento River north levee does not meet design requirements, and has seepage and stability concerns along most of the reach with erosion and height issues identified at various locations which are shown on Figure 15. The measures that would be implemented under West Sacramento Project Alternative 5 for the Sacramento River levee would be: (1) installation of cutoff walls to address seepage and slope stability concerns; (2) levee raises to address inadequate levee height; and (3) bank protection to address erosion concerns.

The Sacramento River north levee consists of 20-foot wide levee crown with 3:1 side slopes. The cutoff wall would be constructed through the levee crown to address seepage concerns. The cutoff wall would be installed by one of two methods discussed in Section 2.2.1, depending on the depth of the cutoff wall needed to address the seepage and stability issues. The conventional open trench method would be used to install a cutoff wall to a depth of approximately 85 feet. The DSM method would be utilized for cutoff walls that are installed to a depth greater than 85 feet.

Levee embankment grading, height improvements, and bank protection would be constructed in the same manner discussed in Section 2.2.1. Following construction, the levee would be reconstructed to current Corps standards as described above in Section 2.2.1.

In addition, a new levee with a sheet pile wall would also be constructed on the Sacramento River side of the Stone Locks to close the connection between the Sacramento River and the barge canal. The new levee would also connect the levee along the Sacramento River between the North Basin and South Basin. To construct the new levee, a coffer dam would be constructed on the river side of the construction footprint and that the new levee would be constructed in the dry area. Initially a sheet pile wall would be placed on the east side of the construction area as described in Section 2.2.1. The levee would be constructed west of the sheet pile wall as described under the setback levee heading in Section 2.2.1. Construction of the levee and sheet pile wall would require the removal of 1.7 acres of riparian habitat along the outlet of the Barge Canal. It would also require the relocation of three power poles and two storm drains, and the removal of concrete infrastructure.

#### **Port North Levee**

The primary issue in the Port north area is overtopping concerns as shown on Figure 15. Under Alternative 5 of the West Sacramento Project, remediation measures were proposed to address the height concerns along the Port north reach. The measure implemented under Alternative 5 would be: (1) installation of flood walls to address height concerns. The flood wall description can be found above in Section 2.2.1.

#### **Yolo Bypass Levee**

Along the Yolo Bypass levee, seepage and slope stability problems were identified at various locations shown on Figure 15. The measures that would be implemented under Alternative 5 of the West Sacramento Project would be: (1) installation of a cutoff wall to address seepage and slope stability concerns. A conventional open trench cutoff wall would be constructed at these locations as described above in Section 2.2.1.

#### **West Sacramento South Basin**

The primary issues in the South Basin, as identified on Figure 15, are seepage, slope stability, and erosion with minimal levee height concerns. The measures that would be implemented under West Sacramento Project Alternative 5 for the levees in the South Basin would be: (1) installation of cutoff walls, stability berms, seepage berms, relief wells, or setback levees to address seepage and slope stability concerns; (2) levee raises to address height concerns; (3) erosion protection to address erosion concerns. These measures are described above in Section 2.2.1. Table 7 shows the lengths of levee reaches, the measures for those reaches, and the approximate length of improvements for the South Basin.

**Table 7. West Sacramento Project Alternative 5 – Construction Lengths and Measures by South Basin Levee Reach.**

Reach	Length of Reach (feet)	Length of Measure (feet)	Improvement	Measure
Sacramento River South Levee	31,000	31,000	Seepage/Erosion	80 Foot Deep Slurry Wall 70 Foot Berm Bank Protection
South Cross Levee	6,273	1,100	Stability/Height	Stability Berm and Embankment Fill
		5,000	Seepage/Height	Relief Wells and Embankment Fill
DWSC East Levee	17,171	1,500	Seepage	120 Foot Deep Slurry Wall
		7,100	Seepage	130 Foot Deep Slurry Wall
		6,000	Seepage	50 Foot Deep Slurry Wall
		2,600	Height	Embankment Fill
Port South	16,262	15,600	Height	Embankment Fill
		1,000	Seepage	70 Foot Deep Slurry Wall
DWSC West Levee	100,260	9,000	Height/Seepage	85 Foot Deep Slurry Wall
		7,000	Height/Seepage	50 Foot Deep Slurry Wall
		9,000	Height/Seepage	75 Foot Deep Slurry Wall
		75,300	Height	Embankment Fill
		100,000	Erosion Protection	Bank Protection

**Sacramento River South Levee**

Under Alternative 5, Sacramento River levee remediation measures were proposed to address seepage, slope stability, and erosion. A setback levee would be constructed under the tentatively selected plan at the location shown on Figure 15. The measures that would be implemented for the Sacramento River south levee would be: (1) construction of a setback levee, adjacent levee, seepage berm, and fix in place to address seepage, slope stability, and erosion concerns; (2) installation of cutoff walls, sheet pile walls, jet grouting, and relief wells to address seepage and slope stability concerns; and (3) bank protection measures to address erosion concerns. The description of these measures can be found in Section 2.2.1 above.

The West Sacramento Project setback levee would be constructed between RM 57.00 and RM 52.75, separated by Bees Lake. The existing levee at Bees Lake would not be degraded, and flow through Bees Lake would be prohibited by road embankments on each end. The natural hydraulic connection through the existing levee would remain intact, maintaining the tidal connection with the Sacramento River. The north offset area setback levee is just over a mile in length, extending from about RM 56.8 to RM 55.7. The south offset area setback levee is a little more than two miles in length, extending from about RM 55.1 to RM 52.8. The typical offset distance of the setback levee from the existing levee is approximately 400 feet. Most of the existing levee would be degraded to an elevation of 30 feet (NAVD 88). Where necessary, bank protection would be added to the existing levee to

protect the bank in place. In the north offset area, there are two locations where the existing levee would be completely degraded to original ground for a length of 800 to 1,000 feet. In the south offset area, there are three locations where the existing levee would be completely degraded to original ground for a length of about 800 feet. Both offset areas are degraded about 10 feet, in general. The complete degradations would require bank protection upstream and downstream to prevent erosion during high flows.

### **South Cross Levee**

The primary issues along the South Cross levee are overtopping and seepage, as shown on Figure 15. The measures that would be implemented under West Sacramento Project Alternative 5 for the South Cross levee would be: (1) a stability berm to address seepage and slope stability concerns; (2) relief wells to address seepage concerns; and (3) a levee raise to address height concerns. These measures would be constructed as described above in Section 2.2.1.

### **Deep Water Ship Channel East Levee**

Along the DWSC east levee there are issues with seepage, slope stability, and height at various locations shown on Figure 15. The measures that would be implemented under Alternative 5 of the West Sacramento Project for the DWSC east levee would be: (1) installation of cutoff walls to address seepage and slope stability concerns and (2) a levee raise to address height concerns. Both cutoff wall methods would be constructed along this reach as described above in Section 2.2.1 to address the seepage and slope stability problems. Since the DWSC levees are set back from the channel with a large berm in between, and because no erosion protection is proposed for this reach, there would be no impacts to the DWSC waterway.

Levee raising would be implemented where required and would be constructed as described above in Section 2.2.1. The irrigation ditch at the toe of the levee would be relocated outside the levee footprint below the housing development and would be covered over with soil and replaced with two 48 inch diameter pipes that would be placed along the levee toe adjacent to the housing development. The construction methods described above in Section 2.2.1 would be used for the cutoff wall and raises and the levee would be brought into compliance with Corps standards.

### **Deep Water Ship Channel West Levee**

The DWSC west levee has seepage, slope stability, height, and erosion problems at various locations shown on Figure 15. The measures that would be implemented under West Sacramento Project Alternative 5 for the DWSC west levee would be: (1) installation of cutoff walls and seepage berms to address seepage concerns; (2) a levee raise to address height concerns; and (3) bank protection to address erosion concerns. The conventional open trench cutoff wall would be constructed at locations shown on Figure 14 to address the seepage and slope stability concerns in that reach. At various locations from the South Cross levee south to Prospect Island in the Delta, a distance of roughly

19 miles, a cutoff wall and bank protection would be constructed. The bank protection would address erosion and would be placed along the Yolo Bypass side of the levee at identified locations, as described above in Section 2.2.1. The cutoff wall would also be constructed as described above in Section 2.2.1. Levee raises would be implemented where required, as identified on Figure 15, and would be constructed as described above in Section 2.2.1.

### **Port South Levee**

The primary issues in the Port south area are overtopping, seepage, and slope stability at a few locations shown on Figure 15. The measures that would be implemented under West Sacramento Project Alternative 5 for the Port South levee would be: (1) installation of cutoff walls to address seepage and slope stability concerns and (2) a levee raise to address inadequate levee height. The cutoff wall would only be constructed along a small section adjacent to Lake Washington. The construction methods described above in Section 2.2.1 for cutoff walls and height improvements would be used to address these issues.

## **2.3 Southport EIP Element of West Sacramento Project Proposed Action**

The Southport EIP element of the Proposed Action is a blend of flood risk reduction measures selected based on their effectiveness in addressing deficiencies, compatibility with land uses, minimization of real estate acquisition, avoidance of adverse effects, and cost. The Proposed Action includes a combination of setback levees, cutoff walls, and seepage berms (along with other measures) (Table 8). WSAFCA is proposing the Southport project to implement flood risk reduction measures along the Sacramento River South Levee in order to provide 200-year level of performance consistent with the state goal for urbanized areas, as well as to provide opportunities for ecosystem restoration and public recreation. The overall project involves the following elements.

- Construction of flood risk reduction measures, including seepage berms, slurry cutoff walls, setback levees, rock and biotechnical slope protection, and encroachment removal.
- Partial degrade of the existing levee, forming a “remnant levee.”
- Construction of offset areas using setback levees.
- Construction of breaches in the remnant levee to open up the offset areas to Sacramento River flows.
- Offset area restoration.
- Road construction.
- Drainage system modifications.
- Utility line relocations.

### **2.3.1 Southport EIP Flood Risk Reduction Measures**

In order to address levee deficiencies, several flood risk reduction measures would be constructed in the Southport EIP project area. These measures consist of setback levees, seepage berms, slurry cutoff walls, rock and biotechnical slope protection, and encroachment removal. The approximate linear length of each flood risk reduction and erosion control measure proposed for each segment is provided in Table 8, below, and is displayed in Figure 17.

The levee flood risk reduction measure footprint includes the following elements: a waterside O&M easement (where available), the levee from toe to toe, a seepage berm (where specified), and the landside O&M easement. The waterside and landside O&M easements are assumed to be 20 feet wide and unpaved. The landside O&M easement follows the toe of the levee or the landside toe of seepage berms, where present. The utility corridor is included largely within the Village Parkway right-of-way. In Southport EIP Segment G, where existing residences are close to the existing levee, the landside O&M easement is assumed to vary from approximately a few feet to 100 feet between the proposed flood risk reduction measure toe and the existing residential lot lines. In Southport EIP Segment A the landside O&M easement is coincident with South River Road. For segments where a suitable impermeable tie-in layer was not identified from the geotechnical explorations, a seepage berm would be constructed. Where a tie-in layer was located, a cutoff wall at the associated depth would be constructed. For levee reaches where a seepage berm would be constructed to address underseepage, a shallow cutoff wall would also be installed in lieu of an inspection trench.

**Table 8. Southport EIP Flood Risk Reduction and Erosion Control Measures.**

<b>Segment</b>	<b>Approximate Length (linear feet)</b>	<b>Measures</b>
A	4,830	Slurry cutoff wall
B	115	Slurry cutoff wall
	1,955	Slurry cutoff wall and landside seepage berm
	3,490	Setback levee, slurry cutoff wall, landside seepage berm, and bank stabilization at breach S3
C	4,490	Setback levee, slurry cutoff wall, landside seepage berm, toe rock and bank stabilization at breaches S1 and S2.
	940	Setback levee, slurry cutoff wall, bank stabilization at Erosion Sites C1 and C2, and toe rock upstream and downstream of Erosion Sites C1 and C2.
D	1,985	Setback levee, slurry cutoff wall, and toe rock upstream of Erosion Sites C1 and C2
E	995	Setback levee and slurry cutoff wall
	2,297	Setback levee, slurry cutoff wall, and landside seepage berm
F	5,583	Setback levee, slurry cutoff wall, landside seepage berm, bank stabilization and toe rock at breach N1, and toe rock and bank stabilization at breach N2
G	2,795	Slurry cutoff wall and bank stabilization at Erosion Site G3

Each of the proposed flood risk–reduction and erosion control measures is described below. Post-construction, the levee slopes, areas used for construction staging, and any other disturbed areas would be hydroseeded with a native seed mix.

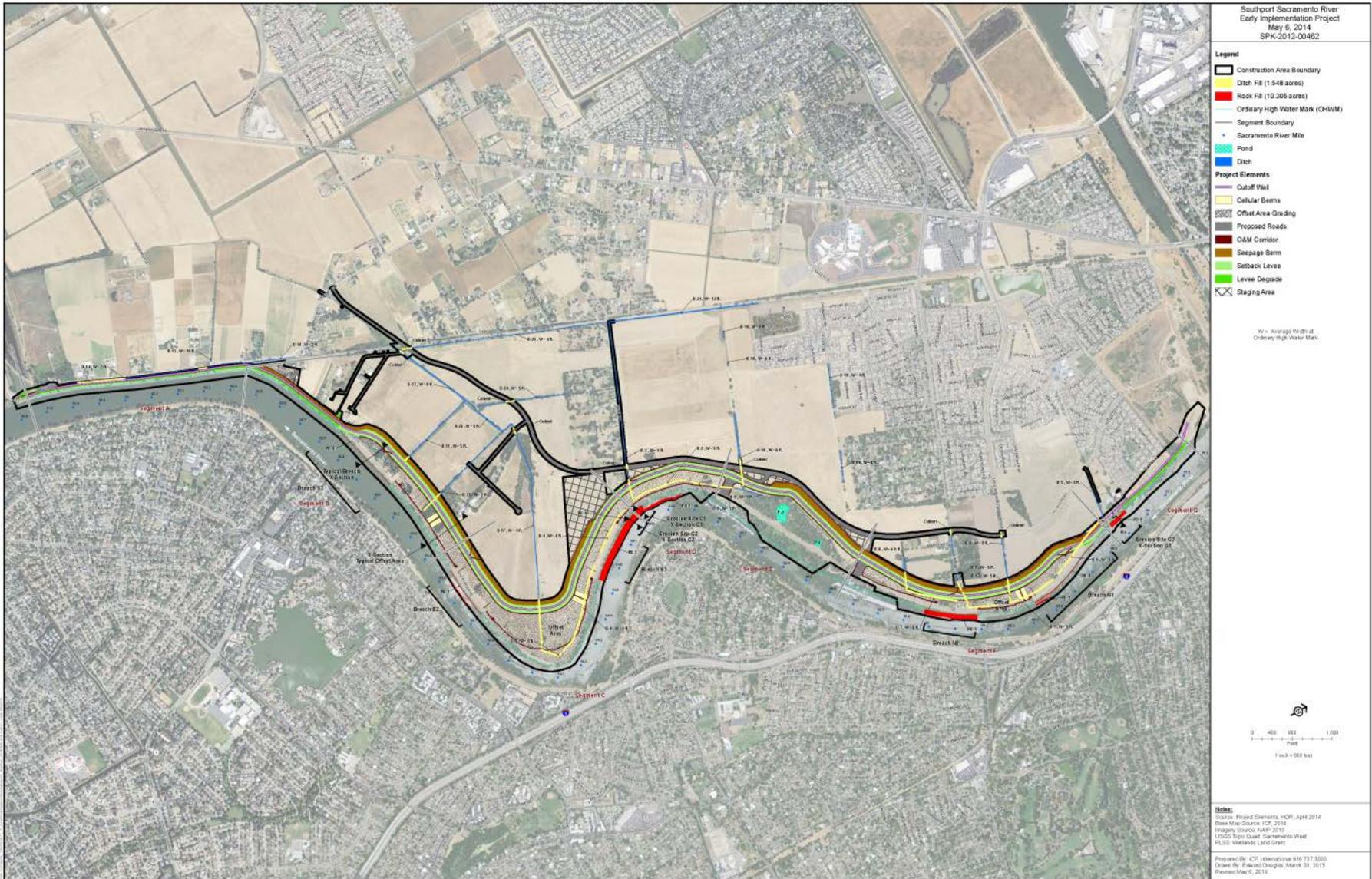


Figure 17. Southport EIP Project Plan.

## **Slurry Cutoff Wall**

A slurry cutoff wall would be constructed throughout the alignment of the proposed Federal project levee. A slurry cutoff wall consists of impermeable material that is placed parallel to the levee, typically through the center of the levee crown. While slurry cutoff walls may be constructed using a variety of methods, this document considers two possible methods of construction: (1) conventional slot trench and (2) clamshell trench.

Shallow cutoff walls are those that extend through the levee embankment and a portion of the levee foundation. They do not finish into a low permeability aquitard but serve to “tie together” surface layers, causing them to function more as a blanket layer, and increasing the seepage path. Shallow cutoff walls also serve to cut off localized seepage pathways, such as high permeability crevasse splay deposits, root pathways, or other subsurface structures. As such, they replace the need for installing an inspection trench beneath or adjacent to new levees. The feasibility and design of these features is evaluated based on local conditions.

Fully penetrating conventional cutoff walls (open trench installation with track-hoe) extend through the levee embankment and levee foundation and finish into a low permeability aquitard. Fully penetrating conventional cutoff walls generally are preferred, if feasible to construct, because they are the least costly compared to cutoff walls installed using the DSM, trench cutting re-mixing, or clamshell technology, while still providing the advantage that all cutoff walls provide of minimizing construction disturbance outside the levee footprint. Where the low permeability aquitard is too deep for conventional cutoff wall, completion of the wall with a clamshell trench is proposed. By this method, the open trench is excavated by trackhoe to the limit of the excavator and is finished by a dragline with a clam shell.

If a fully penetrating wall is not feasible because of the foundation conditions (the lower impervious layer is nonexistent or at a depth impossible to reach with the existing equipment), shallow cutoff walls supplemented with seepage berms are proposed.

### **Conventional Slot Trench Method**

To begin construction, the construction site and any necessary construction staging or slurry mixing areas would be cleared, grubbed, and stripped.

In the conventional slot trench method using a soil-bentonite wall, the levee would be degraded by one-third its height and a trench excavated through the levee center from the top of the levee and into subsurface materials. The size of the trench would be based on the depth of the low permeability aquitard, but is typically 3 feet wide and up to 85 feet deep. As the trench is excavated, it would be filled temporarily with soil, bentonite, and water slurry to prevent collapse of the trench. The soil from the excavated trench would be hauled to a nearby location and mixed with hydrated bentonite. The soil-

bentonite mixture would then be returned to the levee and backfilled into the trench. This mixture hardens and creates the impermeable barrier wall in the levee.

Degradation of the levee crown would be required to prevent hydro-fracturing of the levee, or, in the case of a soil-bentonite wall, to prevent slope failures through the slurry wall caused by extremely low trench strength. Degradation would also provide a temporary work platform, typically a minimum of 40 feet wide, to accommodate seepage berm construction activities and allow equipment to reach lower impervious layers. The temporary work platform also provides access for haul trucks used to haul excavated degrade material to a nearby stockpile area for later use in reconstructing the levee crown, or in constructing seepage berms. The material may need to be hauled offsite and borrow material imported if the in-situ levee material is found to be unsuitable for current levee standards.

Following completion of the slurry cutoff wall, either borrow material or previously degraded levee material would be hauled and placed on the temporary working platform to reconstruct the levee with a 2:1 landside slope and a waterside slope that matches the existing slope. Front-end loaders or excavators would load haul trucks with the borrow material, and the haul trucks would transport it to the degraded levee site. The haul trucks would dump the material, and dozers spread it evenly. Sheepsfoot rollers would compact the material, and water trucks would distribute water over the material to ensure proper moisture for compaction. Topsoil would then be placed on the levee slopes.

One construction crew typically is able to construct 200 to 250 linear feet of slurry wall (approximately 70 to 80 feet deep) in an 8-hour shift. Equipment needed for the crew includes a long-reach track hoe, three or four dump trucks (15 cubic-yard capacity each), bulldozers, excavators, loaders, a rough terrain forklift, compactors, maintainers, and a water truck. Vertical clearance of about 40 feet would be needed for the excavator boom. Horizontal clearance of about 30 feet beyond the levee crest may be required for excavator swing when loading dump trucks.

A mixing area would be located at the construction staging area. The mixing area would be used to prepare the soil-bentonite mixture and supply bentonite-water slurry. The mixing area would be contained to avoid inadvertent dispersal of the mixing materials. Dump trucks would haul material between the excavator and the mixing area along the levee.

The construction equipment and materials necessary to construct a slurry cutoff wall by this method are listed in Table 9. Floodlights and generators would also be used for nighttime slurry wall construction. Post-construction, areas used for construction staging, mixing, the levee crown, slopes, and any other disturbed areas would be hydroseeded with a native seed mix.

**Table 9. Southport EIP Conventional Slot Trench Slurry Wall – Phases, Equipment, and Materials.**

<b>Phases of Construction</b>	<b>Equipment</b>	<b>Materials</b>
Site preparation (clearing, grubbing, and stripping)	Scraper	
Work platform and trench excavation	Excavator or track hoe Haul truck	Bentonite
Mixing/placement of soil-bentonite mix	Long-reach track hoe Haul trucks Bulldozer Rough terrain fork lift	Bentonite Water
Replacement of levee material	Excavator or track hoe Bulldozer Loader Scraper Haul truck Motor grader Sheepsfoot roller Water truck	Embankment fill material Water
Finish grading	Bulldozer Motor grader	
Site restoration and demobilization	Front end loader Haul trucks Motor grader Sheepsfoot roller Water truck	Miscellaneous construction support materials Embankment fill material Topsoil Hydroseed
Piezometer installation	Drill truck	Water Sand Cement Well Casing

## Operations and Maintenance

Post-construction, the only permanent facilities would be the slurry cutoff wall and an aggregate base, levee-top patrol road for the purpose of levee inspection and emergency vehicle access, and the levee O&M corridors. Typical levee O&M in the Southport project area currently includes the following actions.

- Vegetation maintenance up to four times a year by mowing or applying herbicide.
- Control of burrowing rodent activity monthly by baiting with pesticide.
- Slope repair, site-specific and as needed, by re-sloping and compacting.
- Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.
- Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.

Post-construction, groundwater levels would be monitored using the piezometers.

### **Clamshell Method**

The clamshell method is an alternative to the DSM method of constructing a slurry cutoff wall, and uses a dragline crane with a clamshell bucket. The initial trench would be excavated and backfilled as described above for the conventional slot trench method. When the trench exceeds the limit of the excavator's reach, a dragline with clamshell would be used to complete the excavation. As with the conventional slot trench method, soil-bentonite grout would be mixed with the native soil and placed in the trench as the clamshell is withdrawn. Cement may also be added to the mixture to increase strength and reduce curing time when needed. Levee degradation, trench placement, material stockpiling, and levee-top reconstruction would be completed as described for the conventional slot trench method. The equipment and materials necessary to construct a clamshell slurry wall are listed in Table 10. Post-construction, areas used for construction staging, the levee slopes, and any other disturbed areas would be hydroseeded with a native seed mix.

## Operation and Maintenance

Operation and maintenance for a clamshell slurry cutoff wall would be the same as described above for the conventional slot trench method.

**Table 10. Southport EIP Clamshell Method Phases, Equipment, and Materials.**

<b>Phases of Construction</b>	<b>Equipment</b>	<b>Materials</b>
Site preparation (clearing, grubbing, and stripping)	Scraper	
Work platform and trench excavation	Excavator or track hoe Haul truck	
Mixing/placement of soil-bentonite mix	Long-reach track hoe Haul trucks Bulldozer Rough terrain fork lift	Bentonite Cement Water
Replacement of levee material	Excavator or track hoe Bulldozer Loader Scraper Haul truck Motor grader Sheepsfoot roller Water truck	Embankment fill material Water
Finish grading	Bulldozer Motor grader Compactor	
Site restoration and demobilization	Front end loader Haul truck Motor grader Sheepsfoot roller Water truck	Miscellaneous construction support materials Embankment fill material Topsoil Hydroseed
Piezometer installation	Drill truck	Water Sand Cement Well Casing

**Setback Levee**

A setback levee is an entirely new section of levee constructed at some distance behind the landside of the existing levee. The existing levee would remain in place or be removed or breached, depending on conditions. The new section of levee would be tied into the existing levee and then become the Federal project levee.

The Southport EIP’s new levee section would be constructed to meet current design standards, including height and slope requirements. To begin construction activities, the area required to construct the new levee would be cleared, grubbed, and stripped, and encroachments into the new levee footprint would be removed. To construct the new section of levee, bulldozers would excavate and stockpile borrow material from a nearby permitted borrow site. Front-end loaders or excavators would load haul trucks with the borrow material. The haul trucks would transport the material to the new

levee site, where motor graders would spread it evenly. Sheepsfoot rollers would compact the material, and water trucks distribute water over the material to ensure proper moisture for compaction. Once the foundation of the new setback is built up to a suitable elevation, a slurry cutoff wall would be constructed using either the conventional slot trench method or clamshell method, as described in Slurry Cutoff Wall. Following completion of the slurry cutoff wall, the top portion of the levee would be built up to an elevation of approximately +40 feet NAVD 88 for the entire length of the setback levee. Levee slopes would be graded to a 3:1 slope, and a crown at least 20 feet wide created. Topsoil would then be placed on the levee slopes and hydroseeded. For the purpose of levee inspection and emergency vehicle access, an aggregate base, all-weather levee-top patrol road would be constructed.

Equipment and materials necessary to construct a setback levee are listed in Table 11. Post-construction, construction staging areas, levee slopes, and any other disturbed areas would be hydroseeded with a native seed mix.

**Table 11. Southport EIP Setback Levee Phases, Equipment, and Materials.**

<b>Phases of Construction</b>	<b>Equipment</b>	<b>Materials</b>
Site preparation (clearing, grubbing, and stripping)	Scraper Bulldozer	
Embankment fill material placement	Excavator or tack hoe Dozer Loader Scraper Haul Truck Motor grader Sheepsfoot roller Water truck	Embankment fill Water
Finish grading	Bulldozer Motor grader Compactor	Aggregate base rock
Site Restoration and demobilization	Front-end loader Haul truck Motor grader Sheepsfoot roller Water truck	Topsoil Hydroseed

### **Operations and Maintenance**

Post-construction, the only permanent facility would be the improved levee. O&M would be the same as for a typical levee, described under Slurry Cutoff Wall.

### **Seepage Berm**

Seepage berms are wide embankment structures made up of low-permeability to semi-pervious materials that resist accumulated water pressure and safely release seeping water. Seepage berms proposed for the Southport project would extend outward from the landside levee toe and laterally along the levee as needed relative to the seepage conditions. A seepage berm addresses the levee deficiency of underseepage.

Seepage berms for the Southport EIP would vary from 50 to 100 feet in width. Berms typically would be a minimum of 5 feet in height at the levee landside toe, tapering to approximately 3 feet at the landside hinge with a 1.5–2% minimum grade to promote drainage, and then slope down to the berm toe at a 3:1 slope. Lateral length would depend on seepage conditions along the area of identified levee deficiency.

To begin construction, the construction site would be cleared, grubbed, and stripped. Soil used to construct a berm would be stockpiled from levee degradation, excavated from nearby borrow pits, or trucked onsite from offsite locations (if adequate onsite material is not available). During the degrading of the existing levee, soil would be stockpiled at the proposed berm sites or used to construct the berms. At the borrow sites, bulldozers would excavate and stockpile borrow material. Front-end loaders would load haul trucks that would transport the borrow material to the site. The haul trucks would dump the material and motor graders would spread it evenly, placing approximately 3 to 5 feet of embankment fill material. Material used for berm construction would have greater permeability than the native blanket material. However, depending on material availability, a lower permeability material may be used. Adjustments to berm width would be made in such cases, as appropriate. During the embankment placement, material would be placed in a maximum of 1- to 2-foot loose lifts, sheepfoot rollers would compact the material, and water trucks would distribute water over the material to ensure proper moisture for compaction and to reduce fugitive dust emissions. Topsoil would then be placed on the berm and hydroseeded. No new drainage system would be associated with the seepage berms.

Equipment and materials necessary to construct a seepage berm are listed in Table 12. Areas used for construction staging, levee slopes, the berm, and any other disturbed areas would be hydroseeded with a native seed mix.

**Table 12. Southport EIP Seepage Berm Phases, Equipment, and Materials.**

<b>Phases of Construction</b>	<b>Equipment</b>	<b>Materials</b>
Site preparation (clearing, grubbing, and stripping)	Scraper Bulldozer	
Embankment fill material placement	Excavator or tack hoe Bulldozer Loader Scraper Haul Truck Motor grader Sheepsfoot roller Water truck	Embankment fill Water
Finish grading	Bulldozer Motor grader	
Site Restoration and demobilization	Front-end loader Haul truck Motor grader Sheepsfoot roller Water truck	Topsoil Hydroseed

**Operation and Maintenance**

The only post-construction permanent facility would be the berm. Maintenance of the berm would be similar to the typical O&M practices presently in place for maintenance of levee surfaces.

- Vegetation maintenance up to four times a year by mowing or applying herbicide.
- Control of burrowing rodent activity monthly by baiting with pesticide.
- Slope repair, site-specific and as needed, by re-sloping and compacting.
- Visual inspection at least monthly by driving on the patrol road on the levee crown and O&M corridor at the toe of the seepage berm.

**Bank Erosion Sites**

Three bank erosion sites requiring repairs were identified in the Southport EIP project reaches along the Sacramento River; two sites are in Segment C and the third site is in Segment G (Figure 16). The Segment C sites would not be subject to the Corps vegetation policy, as they would be on the remnant levee; however, the Segment G site would be located on the Federal project levee and would comply with the vegetation policy. Therefore, the design of the Segment C sites differs from that of the Segment G site, as described below. The repairs at all three sites are designed to protect against erosional forces that threaten levee stability, such as wind, waves, boat wake, and fluvial forces.

## **Remnant Levee Sites**

The two erosion sites on the remnant levee are Sites C1 and C2, which are adjacent to each other. Once the setback levees for the Southport EIP are complete, the existing levee in Segment C would no longer be part of the Federal project levee. Site C1 has a top length of 160 linear feet and tapers near the bottom of the slope. The proposed repairs at Site C1 would address a scour hole that has formed on the slope between elevations of -33 feet NAVD 88 and +11 feet NAVD 88, as well as slumping that has occurred at the base of the slope. Site C2 would include repairs along 547 linear feet of Segment C. Repairs at Site C2 would address general erosion problems that have been created by wave erosion.

## **Design and Construction**

Erosion site repairs on the remnant levee would be designed both to control erosion and to maintain existing vegetation and instream woody material (IWM). This would be accomplished by incorporating rock benches that serve as buffers against erosion while providing space for planting riparian vegetation and creating a platform to support aquatic habitat features (Appendix B, Figures 3a and 3b). Rock would be placed onto the levee slope from the waterside by means of barges; one barge would hold the stockpile of rock to be placed, and a second barge would hold the crane that would place the rock on the channel slopes. A backhoe would be used from the bank to shape the rock. Clean rock fill would be placed over existing riprap between elevations of -33 feet NAVD 88 and +5 feet NAVD 88, and type C graded stone would be placed over the clean rock fill in a 2.5-foot thick layer with a 2:1 slope from the toe of the slope to an elevation of +7 feet NAVD 88. The clean rock fill and graded stone at the top of the erosion site would be placed to form a planting bench at an elevation of +7 feet NAVD 88 in order to match the average annual low-water surface elevation, and the bench would have an average width of approximately 10 feet. At Site C1, stone would be placed at the upstream and downstream ends of the site in thickened sections in order to address problems created by a scour hole along the site. These sections would extend up and down the bank and would be approximately 5 feet thick and 12.5 feet wide, and would transition laterally to 2.5-foot thickness at a 1:1 slope.

Once the rock has been placed along the slope of the erosion sites, a 1-foot thick layer of 0.75-inch crushed clean rock would be placed at the upslope end of the stone bench to create a filter between the topsoil and the stone bench. Topsoil would then be placed above the newly constructed bench at a 3:1 slope to meet the existing bank, and coir fabric would be placed over the soil to keep it in place. Topsoil would be placed from a barge, similar to the process for placing the rock. Pole plantings would then be hand-placed in the planting bench between elevations of +7 feet NAVD 88 and +11.5 feet NAVD 88. Beaver fencing would be installed at the upslope and downslope extents of the topsoil installation. IWM would be anchored along the remnant levee erosion sites to achieve at least 40% shoreline coverage, and would be placed between 1 and 3 feet below the elevation of the average annual low water surface. IWM would likely come from trees removed in other portions of the project area, and would be selected based on suitability for the site. Existing vegetation and riprap at the erosion site would be retained.

The two erosion sites on the remnant levee are located on the outer bank of a bend in the river and are therefore subject to greater erosive forces. Given the location of these two erosion sites, rock would be placed along the toe of the bank (toe rock) at both sites, as well as upstream and downstream of the erosion sites to further protect the bank of the remnant levee. The toe rock would begin approximately 850 feet upstream of Site C1, would extend through both erosion sites, and would terminate approximately 300 feet downstream of Site C2. Portions of this area are currently riprapped, and the additional toe rock to be placed would be limited to areas where there is currently no rock below an elevation of +7 feet NAVD 88.

Equipment and materials necessary for bank erosion site repairs along the remnant levee are listed in Table 13.

**Table 13. Southport EIP Bank Erosion Phases, Equipment, and Materials.**

<b>Phases of Construction</b>	<b>Equipment</b>	<b>Materials</b>
Rock placement	Crane Barges Backhoe	Rock
Biotechnical element installation	Crane Barge Hand tools	Topsoil Coir fabric Pole cuttings Beaver fencing

### **Active Levee Erosion Site**

Site G3 is located in Segment G and would be part of the Federal project levee. Site G3 would include 410 linear feet of repairs to the top of the erosion scarp and the creation of a planting bench and vegetated slope to protect against boat wake and fluvial erosion.

The design and construction equipment, methods, and materials for Site G3 would be similar to those described for Sites C1 and C2. However, Site G3 would require additional rock armoring and soil fill (up to elevation +25 feet NAVD 88) to repair the erosion scarp and meet Federal levee protection standards. The proposed design includes riprap toe protection, earth and rock fill to restore the levee prism between elevation -10 feet NAVD 88 and +25 feet NAVD 88, a soil-covered 10-foot-wide planting bench (10:1 slope) and bank (3:1 slope) planted with pole cuttings and large container plantings, and IWM anchored between 1 and 3 feet below the elevation of the average annual low water surface. The planting bench would be 15 feet outside the minimum levee template, per the Urban Levee Design Criteria.

## Operations and Maintenance

Post-construction, only the rock slope protection, native vegetation, and other biotechnical features would be permanent. Anticipated O&M actions include regular visual inspections of the site, vegetation maintenance and irrigation for up to 3 years, and periodic repairs, as needed, to prevent or repair localized scour along the bank and rock toe of the site.

### Encroachment Removal

Levee standards for vegetation and encroachments may require removing encroachments, such as structures, levee penetrations (e.g., pipes, conduits, cables), power poles, pump stations, and similar features, from the levee footprint. This measure would include the demolition of such features and relocation or reconstruction as appropriate on a case-by-case basis (or retrofit to comply with standards). Existing piling within the river at Oak Knoll Bend would also be removed.

Encroachment removal techniques would be implemented based on the needs of the specific encroaching feature. Smaller encroachments would be removed, relocated, or retrofitted by manual labor of small crews (approximately two to 10 workers) using hand tools. Larger encroachments would require machinery such as an excavator, skid-steer, and bulldozer. Piling removal would require a barge with a crane for removal or cutting off at or below the mud line. Dump trucks would be used for hauling and disposal of removed material at an offsite permitted commercial source. Encroachments that substantially penetrate the levee (like footings or large woody vegetation) would require levee reconstruction, discussed as a separate measure.

Equipment and materials necessary for encroachment removal are listed in Table 14. Relocations would require similar equipment. Post-construction, areas disturbed by the equipment would be hydroseeded.

**Table 14. Southport EIP Encroachment Removal Phases, Equipment, and Materials.**

<b>Phases of Construction</b>	<b>Equipment</b>	<b>Materials</b>
Encroachment removal and/or relocation	Excavator Skid-steer Bulldozer Loader Dump truck	Debris
Piling removal	Barge Crane Pump Torch	
Site restoration and demobilization	Haul truck Water truck	Hydroseed Water

## **Vegetation Policy Compliance**

Vegetation removal under the Southport project would be limited to only vegetation removed from the project's flood risk–reduction measures footprint to address other deficiencies. New levees (such as setback levees) would be designed to be compliant with Corps levee vegetation policy. Consistent with the Central Valley Flood Protection Plan (CVFPP) guidance, vegetation would be removed to meet specific project objectives. Any vegetation removed as part of direct construction activities would not be replaced at that location, but may require offsite, in-kind mitigation, to be determined in consultation with the appropriate resource agencies.

In accordance with Corps guidance, WSAFCA would submit a detailed removal plan to the local Corps District Levee Safety Officer for review and comment prior to removal of vegetation. Methods for removing vegetation are identified below.

- By excavation, remove the trunk (or stem), stump, rootball, and all roots greater than 0.5 inch in diameter; all such roots in, or within 15 feet of, the flood risk–reduction structure will be completely removed.
- Ensure that the resulting void is free of organic debris.
- Cut poles to salvage propagation materials for replanting, such as willows and cottonwoods.
- Conduct hand clearing using chainsaws and trimmers.
- Conduct mass clearing using bulldozers.

## Operations and Maintenance

O&M would be the same as for a typical levee. Any remaining or replaced encroachments would be maintained as they were pre-project.

## **Additional Construction Elements**

### **Remnant Levee Degrade**

With the construction of the Southport EIP setback levee, the existing levee in Segments B through F would no longer be part of the Federal project levee. Most of the existing levee in these areas would be degraded in order to provide additional borrow material for constructing seepage berms or for reclamation of other borrow areas. The remnant levee in Segment E would remain as-is in order to maintain access to Sherwood Harbor Marina and Sacramento Yacht Club. Also, in the portion of Segment F south of breach N2, the roadway would be removed up to the Sacramento Yacht Club access road but would not be degraded in order to help protect the marinas during high flow events (Figure 15).

Prior to excavation, the area to be degraded would be cleared, grubbed, and stripped. The remnant levee would be degraded to an elevation of +30 feet NAVD 88, with a crown width of 20 feet and a landside slope of 3:1. Front-end loaders would load haul trucks with the excavated material. Haul trucks would then transport the material to stockpile areas in the staging areas for later use for berms or to borrow areas for use in site restoration. Material used for borrow area restoration would be spread evenly using motor graders and compactors. The waterside slope would not be excavated, with the exception of the area above elevation +30 feet NAVD 88. Disturbed areas would then be planted as part of the offset area restoration plantings, and an unpaved O&M corridor would be established at the landside toe of the remnant levee.

Equipment and materials necessary to construct a setback levee are listed in Table 15.

**Table 15. Southport EIP Remnant Levee Excavation Phases, Equipment, and Materials.**

<b>Phases of Construction</b>	<b>Equipment</b>	<b>Materials</b>
Site preparation (clearing, grubbing, and stripping)	Scraper Bulldozer	
Embankment excavation	Bulldozer Loader Haul truck Motor grader Scraper	
Site restoration and demobilization	Haul truck Motor grader Sheepsfoot roller Water truck	Hydroseed Water

#### Operations and Maintenance

Post-construction, there would be no continued maintenance of the remnant levee. However, the remnant levee would be monitored periodically to ensure that future erosion does not jeopardize the flood risk–reduction measures. The landside toe O&M corridor would provide access for inspection and erosion repair, if needed.

#### **Levee Breaches**

Portions of the remnant levee would be breached to allow Sacramento River flows into two separate offset areas during high flow events (Figure 15). The northern offset area breaches, from north to south, are N1 and N2 (both in Segment F), and the southern offset area breaches, from north to south, are S1 (Segment C), S2 (Segment C), and S3 (Segment B). Construction of the breaches would occur during the summer–fall period to take advantage of low flows in the Sacramento River and to comply with Central Valley Flood Protection Board (CVFPB) regulations.

The proposed breaches would be constructed in phases, with breaches S3 and N1 being constructed first, and the remaining breaches likely being constructed 2 years later in order to allow offset area restoration areas to establish before being exposed to flows. To construct the breaches, the existing levee would be degraded down to an elevation of +10 feet NAVD 88 using excavators. Existing revetment found to be in good condition would be retained up to an elevation of +10 NAVD 88. Until breaches S1, S2 and N2 are constructed, culverts would be installed at their proposed locations in order to drain the offset area between the new Federal levee and the degraded remnant levee. These culverts would be used to equilibrate hydraulic pressure on both sides of the degraded levee (i.e., between the offset area and Sacramento River channel), as well as to provide drainage for the associated offset segment in order to minimize fish stranding and extended inundation of restored habitats. Each culvert would be 54 inches in diameter and approximately 140 feet long (Figure 4). The culverts would be placed at approximately +7 NAVD in order to fully drain the offset area behind them. Each culvert would utilize existing riprap located at the mouth of each structure on the Sacramento River.

Excavation to facilitate construction of culverts in the offset area would be to an elevation of +7 feet. In-water construction activities would be scheduled for between July 1 and October 31, when water elevations in the Sacramento River along the project area are typically at the average annual low water elevation of +6.7 feet to +7.1 feet. Installation of temporary cofferdams may be necessary prior to culvert installation in order to prevent river flows from entering the construction area. At a minimum, sandbags would be used to construct the cofferdam and water would be pumped out of the inundated construction area. Depending on water elevations in the river at the time of construction, the cofferdams may be constructed using sheet pile walls or other methods. In order to accommodate the use of construction equipment in constructing the culverts, the cofferdams would typically extend up- and downstream of the end of the culverts in order to provide a temporary work area.

The breach shoulders would be armored with rock from the top extent of the existing riprap at +10 NAVD 88 on the waterside, up and over the degraded remnant levee crown, and down the landside slope (Appendix B, Figure 5a). Along the alignment of the remnant levee, rock would be placed from the base of the inlet shoulder in the breach to the top of the degraded remnant levee, and would extend an additional 100 feet from the top edge of the shoulder on each side of the breach. A 25-foot riprap apron would then extend out from the landside toe of the breach shoulder at an elevation of roughly +10 NAVD 88, as well as from the toe of the shoulder in the breach. All rock for the shoulder and apron armoring would be placed in a layer approximately 2.5 feet thick.

The upstream shoulder of breach N1 and the downstream shoulder of breach S3 would have slightly different erosion control measures than the other breach shoulders, as both of these breaches would have transitions from the newly constructed setback levee to the existing levee (Appendix B, Figures 5b and 5c). Rock armoring would be placed on the slope of the waterside berm of the setback levee. Rock placement on these transition shoulders would be contiguous with the apron zone and riverbank zone protection measures.

On the waterside of the breaches, new riprap would be placed from the toe of the bank slope up to an elevation of +7 feet NAVD 88 in areas where the existing riprap is lacking. Breaches N1, N2, S1, and S2 would also have toe rock placed along portions of the base of the bank to further protect it from erosive forces. Coir fabric would be placed between elevations of +7 feet NAVD 88 and +10 feet NAVD 88, and this “riverbank zone” would be planted with species suitable for coppicing in order to create a vegetated bench. Coppicing is a method of woodland management in which young tree stems are repeatedly cut down to a predetermined height, which takes advantage of the fact that many trees make new growth from the remaining stumps. The vegetation in this area would be coppiced in order to maintain a region of nearly uniform hydraulic resistance and prevent erosion due to concentration of flows between clumps of trees. Coir fabric would also be placed in the “apron zone” between the edge of the +10 feet NAVD 88 elevation and the centerline of the breach, with jute netting continuing landward of the termination of the coir fabric for 100 feet. This area would be planted with cuttings, rootstock, or container plants. The final design of the breaches would be included in the draft Mitigation and Monitoring Plan (MMP), presently under preparation.

Rock would be placed onto the levee slope from atop the degraded levee, from the breach sill, from the waterside by means of barges, or by a combination of the three methods. Rock required within the channel, both below and slightly above the surface of the water at the time of placement, would be placed by a crane located on a barge and then spread by an excavator located on top of the levee or in the breach sill. Construction would require two barges—one barge to carry the crane and another to hold the stockpile of rock to be placed on the channel slopes—and one excavator located in the breach. Rock required on the upper portions of the slopes would be placed by an excavator located on top of the levee. Rock placement from atop the levee would require one excavator for each potential placement site. The loader would bring the rock from a permitted source within 25 miles of the project area and dump it within 100 feet of the levee breach. The excavator would move the rock from the stockpile to the waterside of the levee. Equipment and materials necessary for constructing the breaches are listed below in Table 16.

**Table 16. Southport EIP Levee Breach Construction Phases, Equipment, and Materials.**

<b>Phases of Construction</b>	<b>Equipment</b>	<b>Materials</b>
Breach excavation	Excavator	
Rock placement	Crane Barges Excavator	Rock
Biotechnical element installation	Hand tools	Jute netting Coir fabric Pole cuttings Container stock

## Operations and Maintenance

O&M access to the breaches would be provided by O&M corridor roads that cross the cellular berms described in Offset Floodplain Area Restoration, below, and by the O&M corridor located along the landside toe of the remnant levee in the offset areas. Access to the N1 and S3 breaches would also be from where the setback levee transitions to the existing levee.

### **Offset Floodplain Area Restoration**

The offset floodplain area refers to the two expanded floodways located between the proposed Southport setback levee and the remnant levee that would be created when portions of the existing levee are breached to allow Sacramento River water to flow into the offset area (Figure 16). Project activities in this area would include floodplain and habitat restoration and borrow excavation. The offset areas would be planted to provide mitigation for vegetation removed as part of construction.

If appropriate for reuse, the excavated material would be used in construction of the setback levee and seepage berms. Following excavation, the offset area would be finished and graded to allow creation and restoration of riverine floodplain and riparian habitats. Excavation in the offset areas may require groundwater management, which would potentially be done by pumping water out of excavated areas. The offset areas and existing levee would be degraded, and the existing levee would be breached initially in two locations at such time as permitted to ensure completion of the setback levee before the flood season. The breaches would be constructed to allow for inlet and outlet of floodplain-inundating flows. The remaining three breaches would be constructed at a later time, as described in Levee Breaches, above.

The period between when the first two breaches are constructed and when the remaining three breaches are constructed is referred to as the “interim condition.” The interim condition would allow restoration plantings to establish in the offset areas during the fall, winter, and spring following construction Year 3 without exposure to through-flows from the Sacramento River, increasing the likelihood of long-term planting success. Following breaching of the existing levee in Segments B and F in Year 3, the offset areas would fill as the level of the Sacramento River rises and would drain through the single breach in each offset area, as well as through the culverts installed where breaches N2, S1, and S3 would eventually be constructed, as river stage decreases. Swales would be constructed in both offset areas, and the surrounding areas would be graded to encourage drainage to the swales as river stages decrease. Temporary and permanent erosion control measures such as jute netting, coconut fiber with net, live brush mattresses, and native turf would be selected as appropriate to protect graded areas.

Once breaches N2, S1, and S3 are constructed, permanent “cellular” berms would be built between the setback levee and the remnant levee downstream of breaches N1, S1, and S2 to reduce erosive conditions during flood events in the offset area. The cellular berms would create separate “cells” that would have independent drainage once water levels drop below the crest of the cellular berms. Material excavated from the breaches would be used to construct the cellular berms and

construct terrain features. Berms would have a top elevation of +20 feet, top width of 20 feet, and side slopes no steeper than 10:1; they would overtop once water levels reach +20.0 feet NAVD 88. Offset areas upstream and downstream of the berms would be graded with positive drainage away from the berms and to the closest existing levee breach location.

The target habitats in the offset floodplain area are riparian forest, shaded riverine aquatic habitat, seasonal wetlands, and upland grasslands. Elevations in the offset floodplain area would vary from approximately +7.0 feet NAVD 88 to +20.0 feet NAVD 88 in order to provide broad habitat variability for a range of environmental and hydrodynamic conditions.

The target plant communities in the offset floodplain area would include emergent marsh, riparian willow scrub, riparian cottonwood forest, mixed riparian woodland, elderberry shrubs and associated plants for valley elderberry longhorn beetle habitat, and grassland. Botanical and tree surveys conducted within the project area provided guidance on plant material selection for the mitigation area. A vegetation stratification survey on the Southport levee conducted by ICF in March of 2012 helped further inform and refine the restoration target plant communities. In the survey, different species of plants were observed to favor different elevation ranges based on species preferences and adaptations. The restoration design intends to mimic this stratification of vegetation. Plants selected for establishment of each of the target plant communities were based on how the plants associate in nature, and the elevations at which these plants were observed growing along the Southport levee. Elevations showing the conceptual planting plan and plant palette for the mitigation area will be shown in the draft MMP.

Native riparian plant species could be installed as container plants and pole cuttings spaced at regular intervals throughout the offset floodplain area. Both overstory and understory species would be installed to mimic the natural structure of riparian forests along the Sacramento River. Supplemental irrigation would be provided for several years during the plant establishment period and then discontinued; irrigation water could possibly be pumped from the river or from an adjacent water supply by agreement with the owner. To avoid trampling or disturbing the plantings during the establishment period, signs would be posted at appropriate intervals providing notice that access to the restoration areas is not allowed. The CVFPB would likely not allow exclusionary fencing for these purposes.

Planting of the offset areas would take place in the fall following finish-grading operations and construction of the neighboring flood control features. Areas of the offset that are not finished in any given year would be kept free of vegetation in order to keep future construction areas clear.

A network of seasonal wetland swales would be excavated in the offset floodplain area and inundate during high-water events on the Sacramento River to provide habitat for special-status native fish species, including Chinook salmon, Sacramento splittail and steelhead. Excavation of the swales would also be phased to coincide with the construction of offset areas. To mimic some natural floodplain conditions that species like splittail depend on for spawning and rearing, the swales would be constructed at an elevation that provides shallow, low-velocity, off-channel habitat in the spring during

smaller flood events. Swale margins would be gently sloping to maximize edge habitat during flood events. IWM structures could be installed in some of the swales to provide cover from predators. In larger flood events during the winter and spring, the upper riparian terraces would be inundated and provide additional areas of habitat for fish as well as contribute to the productivity of the ecological foodweb.

The created swales would have several connections to the main river channel at the breach locations in order to maximize connectivity and minimize potential stranding as floodwaters recede. The swales would, on average, fully dewater by the early summer in any given year in order to discourage use by nonnative fish.

Areas of upland grassland in the offset floodplain area would serve as potential floodplain rearing habitat for native fish during periods of high flows, as well as foraging habitat for raptors during periods of low water.

O&M access to the offset areas would be provided by O&M corridors at the waterside toe of the setback levee and by unpaved O&M roads that cross the cellular berms. At a minimum, turnaround areas would be located at the breach shoulders.

#### **Southport EIP Offset Area and Remnant Levee Revegetation**

Revegetation of the offset areas and remnant levee is proposed as a means to mitigate for construction impacts. The riparian willow scrub target plant community would be established where there is proper soil hydrology, between approximately the 8 foot and 10 foot elevation. In the offset area, the riparian willow scrub will be established just upslope from the constructed swales in a band width varying from approximately 10 to 150 feet following both sides of the swales near the middle of the offset floodplain area. On the remnant levee, the riparian willow scrub will be established in a narrow band varying from approximately 5 to 20 feet in width outside of the canopy of the existing trees to remain. The plants selected for the riparian willow scrub planting are intended to establish a self-sustaining mix of riparian scrub dominated by four species of willows. The plant material installed could be container grown plants, cuttings, or a mixture of both. The areas within the offset area will be seeded, and the areas on the remnant levee with established herbaceous cover will not be seeded.

#### **Road Construction, Marina Access, and Bees Lakes**

Village Parkway would be extended southward from its current intersection with Lake Washington Boulevard to Gregory Avenue near the Southport EIP project area's southern extent, moving South River Road traffic to the landside of the Sacramento River South Levee and to the future Village Parkway alignment. The existing alignment of South River Road in Segment A would be retained, as would the railroad abutments at the southern end of Segment A. However, a detour or permanent realignment of South River Road would be constructed at the south end of Segment A to maintain access on South River Road south of the project area during and after construction. Access roads would

be built in Segment B to connect residences to the new Village Parkway alignment. Year 1 would include the construction of this section of the future Village Parkway and the associated residential and marina access roads (Figure 16). “No parking” signs would be installed at the new residential roads in Segment B. At the project’s northern extent, South River Road would be demolished. Where practicable, culverts would be constructed in ditches that are crossed by proposed roadways. Drainage ditches would be constructed along both sides of the new Village Parkway alignment, with an average width of 5 feet.

In order to maintain access between Sherwood Harbor Marina and Sacramento Yacht Club, South River Road would continue in its current alignment on the existing levee at Segment E and a portion of Segment F. However, the existing levee structure would no longer serve a flood risk–reduction function. In order to maintain access to the marinas, two new roads would be constructed that would be routed over the levee crown, with embankment crests of +40 feet NAVD 88 and 3:1 side slopes. The first road would be constructed just north of the Bees Lake area, and the second would be constructed on the southern side of the Bees Lake area. The road embankments would link the setback levee and the existing levee. While these embankments would not be part of the flood risk–reduction features, they would prevent hydraulic surface connectivity between Bees Lakes and the Sacramento River. Linden and Davis Roads would be connected to the new Village Parkway alignment to restore traffic circulation, and a cul-de-sac would be added at the end of Linden Road, past the intersection with Village Parkway.

Dual access ramps would be constructed along the levee alignment to provide O&M and emergency access to the levee-top patrol road. There would be one ramp in Segment B where South River Road currently descends from the existing levee to meet Gregory Avenue; one ramp in Segment C; one ramp in Segment D at the terminus of Davis Road; one ramp in Segment F at the terminus of Linden Road; and one ramp in Segment G near the northern end of the project alignment. Access to the levee-top patrol road would also be provided where the Sherwood Harbor Marina and Sacramento Yacht Club access road embankments cross the proposed setback levee crown. Access ramps would be gated and would have “no parking” signs.

### **Southport EIP Construction Details**

#### **Construction Schedule**

If WSAFCA is granted Section 408 permission to alter the Federal levee and construct the Southport EIP in advance of the West Sacramento GRR, then the following schedule would apply to the Southport action. Construction of the project would occur in more than one annual construction season, with construction of flood risk–reduction measures beginning in April of 2015, and likely finishing in 2017. Construction and restoration of the offset area would likely continue after 2017, with final remnant levee breaches constructed in 2020. A small portion of Village Parkway construction and utility relocations would possibly begin in fall of 2014, but most of the work for those portions of the project would be done in 2015. A description of construction activities by construction year is provided below.

### Year 1

- Village Parkway construction and utility relocation would be completed.
- The entire length of the setback levee would be started in Year 1, beginning with the foundation and working platform. Construction of the cutoff wall would follow if weather allows.

### Year 2

- The setback levee cutoff wall and remaining buildup of the setback levee would be constructed to a finished elevation of +40 feet NAVD 88.
- South River Road detour at south end of Segment A.
- Seepage berms would be constructed following completion of the setback levees.
- Segment A and the southern portion of Segment B would be degraded to an elevation of +32 feet NAVD 88, and in Segment G the levee would be degraded to an elevation of +34.5 feet NAVD 88. Cutoff walls would then be constructed in these segments, tying into the setback levee cutoff walls in Segments B and F. The levee crown in Segment A and the southern portion of Segment B would then be built back up to a finished elevation of +39 feet NAVD 88, and the levee in Segment G would be built back up to a finished elevation of +40 feet NAVD 88. The slurry cutoff wall toe would be at an elevation of -5 feet NAVD 88 through Segments A, B, C, and D; at 0 feet NAVD 88 for Segments E, F, and the southern portion of G; and would be at -67 feet NAVD 88 for the remainder of Segment G.
- The remnant levee in Segments B, C, D, and F would be degraded to an elevation of +30 feet NAVD 88, and would have a 20-foot-wide crown. Remnant levee degrading would be concurrent with setback levee and seepage berm construction.
- Offset area grading would begin.
- Erosion site repairs at C1, C2, and G3 would be constructed.

### Year 3

- Offset area grading would be completed. Culverts would be installed through the remnant levee at breaches N2, S1, and S2 to allow water to flow into, and drain out of, the offset areas during the interim condition.
- Breaches N1 and S3 would be constructed.
- Offset area planting would begin and would continue through Year 6.

#### Year 4

- Offset area planting would continue.

#### Year 5

- The three remaining breaches and the offset area cellular berms would be constructed, and the southern offset area would be contoured.

#### Year 6

- Offset area planting would be completed.

Flood risk reduction measure construction activities would primarily occur during the typical construction season, April 15 to October 31, although extension of the CVFPB encroachment permit may be sought if weather conditions permit. All construction activities, including, but not limited to, structure and vegetation removal, roadway removal and replacement, revegetation, and utility removal and replacement, that may occur outside the primary construction season would be subject to the conditions of environmental and encroachment permits and authorizations to be issued by the California Department of Fish and Wildlife (CDFW), Central Valley Regional Water Quality Control Board (RWQCB), CVFPB, the Corps, USFWS, NMFS, Yolo County, City of West Sacramento, and others.

At the end of each primary construction season, the levee system would be restored, at a minimum, to the level of flood risk–reduction performance existing at the Southport EIP project outset. During construction Years 1 and 2, “tie-ins” would be built connecting the existing levee up- and downstream to the segments constructed that season, as needed. These tie-ins would be achieved by benching the existing levee and installing compacted lifts to completely bond the new and existing levee materials. During the flood season, maintenance of the flood risk–reduction structures would be undertaken by the maintaining agency, RD 900.

#### **Sources of Borrow Material**

To meet borrow material demands for constructing the flood risk–reduction measures, multiple sources are being considered, including the following.

- Embankment fill material excavated from the existing levee structure as part of construction.
- Material excavated from the offset areas.
- Material excavated from borrow sites located on open land within the city, or close to the city limits.
- Dredged material previously removed from the DWSC (presently stockpiled on high-terrace, upland benches adjacent to the west of the channel).
- Material purchased from permitted commercial borrow locations within 20 miles of the project site.

Embankment fill material excavated as part of construction would be evaluated for reuse, and that deemed suitable would be used as part of construction of the new levees and berms. Embankment fill material available for construction of the Southport EIP would include materials salvaged as a result of the proposed partial degrading of the existing levee and grading of the offset areas.

Ongoing borrow analysis has also identified potential borrow sites near the Southport EIP project site from which suitable borrow may be excavated (Figure 2). These potential borrow sites range in location from immediately adjacent to the levee construction to approximately a 7-mile round-trip haul distance from the area of construction. If local borrow sites are used, existing topsoil would be scraped and set aside, and borrow material excavated from the site. Excavation depths would vary, depending on landowner agreement; however, wherever feasible, depths of excavation would not encroach upon the water table. Following material extraction, Southport-area borrow sites would be graded to a depth of no greater than 3 feet. To maximize the use of local borrow sites, high plasticity clay may be used as deeply buried setback levee core fill material. Where feasible, excess embankment fill material deemed unsuitable for reuse could be placed in the borrow site pits and compacted, and the topsoil replaced. The borrow sites then would be reseeded and returned to vegetated conditions.

Also under evaluation for suitability as borrow is material previously dredged from the DWSC as part of routine maintenance, which is presently stockpiled along the western bank of the DWSC and located on the city's western border with unincorporated Yolo County. This possible borrow source, referred to as "dredge material," is located on a high-terrace, upland bench adjacent to the channel, placed during previous dredge events unrelated to this project. If suitable, dredge material would be loaded onto trucks and transported to the project site, an approximately 24-mile round trip. Use of dredge material would not require any postextraction borrow site activity.

Lastly, borrow also could be purchased and hauled onsite from a permitted commercial borrow location within 20 miles of the project site.

### **Management of Woody Vegetation**

For woody vegetation remaining after construction, and until an alternative long-term compliance strategy is agreed upon (which ultimately may include a variance but not as part of this project), the levees would be maintained per the approved O&M manual applicable to this reach (subject to revision).

### **Structure and Road Demolition and Utility Relocation**

Structure and road demolition activities would consist of removing standing structures within the flood risk–reduction measure footprints and removing sections of two-lane asphalt rural road in the project area. Construction activities would consist of removing and demolishing the facilities with the use of a bulldozer and excavator with a percussion hammer attachment for breaking up concrete foundations as needed. The contractor would load the rubble into waste containers using a front-end loader and then haul the waste to a permitted disposal site within 10 miles of the Southport EIP project area.

### **Vegetation Removal**

Vegetation clearing activities would consist of removing larger woody vegetation, such as trees and shrubs. Grubbing activities would consist of removing roots, and stripping activities would consist of excavating approximately 6 inches of organic material from the levee surface. The vegetation on the existing Sacramento River levee would be retained where feasible, with the exception of the five breach locations, because the existing levee would no longer provide flood risk–reduction functions or be subject to the Corps vegetation guidelines. Some vegetation would be removed as part of construction of the new setback levee, seepage berms, and the landside utility O&M corridor.

### **Staging Areas and Equipment Access**

As depicted on Figure 15, five staging areas would be used in the Southport EIP project area. These staging areas are located on the landside of the levee at Segments C, D, and E, and would occupy approximately 25.2 acres in total. These areas would be used for staging construction activities and to provide space to house construction equipment and materials before and during construction activities. Areas where seepage berms are proposed would also be used for staging until construction begins on the seepage berms.

To facilitate project construction, temporary earthen ramps would be constructed to permit equipment access between the levee crown and the staging area(s). The earthen ramps would not affect any delineated water bodies and would be removed when construction is complete.

## **2.4 Proposed Conservation and Mitigation Measures for the West Sacramento Project**

### **2.4.1 Compensation Timing**

Compensation timing refers to the time between the initiation of construction at a particular site and the attainment of the habitat benefits to protected species from designated compensation sites. In general, compensation time is the time required for on-site plantings to provide significant amounts of shade or structural complexity from instream woody material recruitment. Significant long-term benefits have often been considered as appropriate to offset small short-term losses in habitat for listed species in the past, as long as the overall action contributes to recovery of the listed species. The authority to compensate prior to or concurrent with project construction is given under WRDA 1986 (33 USC §§ 2201–2330); however, long-term compensation to offset short-term losses is generally not an option for the loss of critical habitats under the ESA (USFWS 1998).

Depending on the species of interest (e.g., delta smelt), the severity of the short-term habitat losses due to bank erosion repair actions may not be compensated by long-term gains, whereas longer lived species (e.g., steelhead, Chinook) have longer periods for compensation to be provided. The following compensation time periods (based loosely on life expectancy) should be considered as guidelines for compensation:

- Green sturgeon, 15 years;
- Chinook salmon, 5 years;
- Central Valley steelhead, 4 years; and
- Delta smelt, 2 years (Corps, 2012).

### **2.4.2 Valley Elderberry Longhorn Beetle (VELB) Conservation Measures**

The following is a summary of measures based on the *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* (USFWS 1999a). These measures will be implemented to minimize any potential effects on VELB or their habitat, including restoration and maintenance activities, long-term, protection, and compensation if shrubs cannot be avoided. Approximately 120 elderberry shrubs have the potential to be adversely affected due to construction of the West Sacramento project, including the Southport EIP project. The 120 shrubs were estimated based on the number of shrubs surveyed in the Southport EIP action area. An estimated number of stems was calculated based on taking the average number of stems in each stem diameter range for the shrubs that were surveyed in the Southport EIP action area and adding the stem counts from shrubs surveyed in the Southport EIP action area. In addition, to cover a worst case scenario, an assumption was made that all shrubs not surveyed were in riparian areas and that there were exit holes in all the shrubs in the West Sacramento project area not

included in the Southport EIP action area survey. Table 17 shows the estimated stem counts for elderberry shrubs adversely affected in the entire action area. The stem averages used to calculate stems in Table 17 are as follows.

- Number of stems  $\geq 1$  inch and  $\leq 3$  inches = 16.
- Number of stems  $> 3$  inches and  $< 5$  inches = 4.
- Number of stems  $\geq 5$  inches = 3.

**Table 17. Estimated Compensation for Elderberry Shrubs Removed from project area**

Location	Stem Diameter	Holes	Number of Stems	Elderberry Ratios (multiply number of stems by)	Elderberry Planting	Native Ratios	Associated Native Planting
Riparian	$\geq 1$ inch and $\leq 3$ inches	Yes	1,524	4	5,588	2	10,580
Riparian	$> 3$ inches and $< 5$ inches	Yes	391	6	2,160	2	4,032
Riparian	$\geq 5$ inches	Yes	303	8	2,237	2	4,109
Totals			2,218		9,985		18,721

Based on the information in Table 17, the conservation area will need to be at least 120 acres in size to accommodate up to 120 elderberry shrubs, 9,985 elderberry cuttings or seedlings, and 18,721 native plants. However, to ensure accurate compensation, surveys of elderberry shrubs to be transplanted will be conducted by a qualified biologist prior to transplantation. The biologist will survey the area surrounding the shrub to be transplanted to ensure that there aren't additional elderberry shrubs that need to be removed. Surveys will consist of counting and measuring the diameter of each stem and examining elderberry shrubs for the presence of VELB exit holes. Survey results and an analysis of the number of elderberry seedlings/cuttings and associated native plants based on the survey results will be submitted to USFWS. The data collected during the surveys prior to transplantation will be used to determine if compensation requirements are being exceeded or if additional plantings are necessary. The conservation area in which the transplanted elderberry shrubs and seedlings are planted will be protected in perpetuity as habitat for VELB. The following conservation measures will also be implemented.

- When a 100-foot (or wider) buffer is established and maintained around elderberry shrubs, complete avoidance (i.e., no adverse effects) will be assumed.
- Where encroachment on the 100-foot buffer has been approved by the USFWS, a setback of 20 feet from the dripline of each elderberry shrub will be maintained whenever possible.
- During construction activities, all areas to be avoided will be fenced and flagged.
- Contractors will be briefed on the need to avoid damaging elderberry shrubs and the possible penalties for not complying with these requirements.

- Signs will be erected every 50 feet along the edge of the avoidance area, identifying the area as an environmentally sensitive area.
- Any damage done to the buffer area will be restored.
- Buffer areas will continue to be protected after construction.
- No insecticides, herbicides, fertilizers, or other chemicals that might harm the beetle or its host plant will be used in the buffer areas.
- Trimming of elderberry plants may be subject to mitigation measures.
- Elderberry shrubs that cannot be avoided and can be accessed safely would be transplanted to an appropriate riparian area at least 100 feet from construction activities.
- If possible, elderberry shrubs would be transplanted during their dormant season (approximately November, after they have lost their leaves, through the first two weeks in February). If transplantation occurs during the growing season, increased mitigation ratios will apply.
- Any areas that receive transplanted elderberry shrubs and elderberry cuttings will be protected in perpetuity.
- The Corps will work to develop off-site compensation areas prior to or concurrent with any take of valley elderberry longhorn beetle habitat.
- Management of these lands will include all measures specified in USFWS's conservation guidelines (1999a) related to weed and litter control, fencing, and the placement of signs.
- Monitoring will occur for ten consecutive years or for seven non-consecutive years over a 15-year period. Annual monitoring reports will be submitted to USFWS.
- Off-site areas will be protected in perpetuity and have a funding source for maintenance (endowment).

### **2.4.3 Giant Garter Snake Conservation Measures**

The following measures will be implemented to minimize effects on giant garter snake habitat that occurs within 200 feet of any construction activity for the West Sacramento Project. These measures are based on USFWS guidelines for restoration and standard avoidance measures included as appendices in USFWS (1997).

- Unless approved otherwise by USFWS, construction will be initiated only during the giant garter snakes' active period (May 1–October 1, when they are able to move away from disturbance).
- Construction personnel will participate in USFWS-approved worker environmental awareness program.

- A giant garter snake survey would be conducted 24 hours prior to construction in potential habitat. Should there be any interruption in work for greater than two weeks, a biologist would survey the project area again no later than 24 hours prior to the restart of work.
- Giant garter snakes encountered during construction activities will be allowed to move away from construction activities on their own.
- Movement of heavy equipment to and from the construction site will be restricted to established roadways. Stockpiling of construction materials will be restricted to designated staging areas, which will be located more than 200 feet away from giant garter snake aquatic habitat.
- Giant garter snake habitat within 200 feet of construction activities will be designated as an environmentally sensitive area and delineated with signs or fencing. This area will be avoided by all construction personnel.

If any giant garter snake habitat is impacted by construction of the West Sacramento Project, the following measures would be implemented to compensate for the habitat loss:

- Habitat (including aquatic and upland) temporarily impacted for one season (May 1–October 1) will be restored after construction by applying appropriate erosion control techniques and replanting/seeding with appropriate native plants.
- Habitat temporarily impacted for two seasons will be restored and replacement habitat will be created at a 2:1 ratio (disturbed to created acres).
- Habitat temporarily impacted for more than two seasons will be replaced at a 2:1 ratio (or restored plus 2:1 replacement).
- Habitat permanently impacted will be replaced at a 3:1 ratio.
- Habitat permanently or temporarily impacted outside of the May 1-October 1 work window will be created at a 2:1 ratio.
- All replacement habitats will include both upland and aquatic habitat components at a 2:1 ratio (upland to aquatic acres).
- One year of monitoring will be conducted for all restored areas. Ten years of monitoring will be conducted for created habitats. A monitoring report with photo documentation will be due to USFWS each year following implementation of restoration or habitat creation activities.
- The Corps will work to develop appropriate mitigation prior to or concurrent with any disturbance of giant garter snake habitat.
- Habitat will be protected in perpetuity and have an endowment attached for management and maintenance.

#### **2.4.4 Additional Minimization and Conservation Measures**

- Seek an ETL-approved vegetation variance exempting sites from vegetation removal prior to final design and construction phase for the Sacramento River project area.
- Minimize the removal of existing vegetation in the proposed project area. Any disturbance or removal of vegetation will be replaced with native riparian vegetation, outside of the vegetation-free zone, as established in the ETL.
- Implement best management practices (BMPs) to prevent slurry seeping out to river and require piping system on land side only.
- Stockpile construction materials such as portable equipment, vehicles, and supplies, at designated construction staging areas and barges, exclusive of any riparian and wetlands areas.
- Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a 110% containment system.
- Erosion control measures (BMPs) including Storm Water Pollution Prevention Program and Water Pollution Control Program that minimize soil or sediment from entering the river. BMPs shall be installed, monitored for effectiveness, and maintained throughout construction operations to minimize effects to Federally listed fish and their designated critical habitat.
- Construction will be scheduled when listed terrestrial and aquatic species would be least likely to occur in the project area. If construction needs to extend into the timeframe that species are present, then coordination with the resource agencies will need to occur.
- Site access will be limited to the smallest area possible in order to minimize disturbance.
- Litter, debris, unused materials, equipment, and supplies will be removed from the project area daily. Such materials or waste will be deposited at an appropriate disposal or storage site.
- Immediately (within 24 hours) cleanup and report any spills of hazardous materials to the resource agencies. Any such spills, and the success of the efforts to clean them up, shall also be reported in post-construction compliance reports.
- Designating a Corps-appointed representative as the point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species. This representative shall be identified to the employees and contractors during an all employee education program conducted by the Corps.
- Screen any water pump intakes, as specified by NMFS and USFWS screening specifications. Water pumps will maintain an approach velocity of 0.2 feet per second or less when working in areas that may support delta smelt.

Furthermore, the Corps will seek to avoid and minimize construction effects on listed species and their critical habitat to the extent feasible. A number of measures will be applied to the entire West Sacramento project or specific actions, and other measures may be appropriate at specific locations within the West Sacramento study area. Avoidance activities to be implemented during final design and construction may include, but are not limited to, the following:

- Identifying all habitats containing, or with a substantial possibility of containing, listed terrestrial, wetland, and plant species in the potentially affected project areas. To the extent practicable efforts will be made to minimize effects by modifying engineering design to avoid potential direct and indirect effects.
- Incorporating sensitive habitat information into project bid specifications.
- Incorporating requirements for contractors to avoid identified sensitive habitats into project bid specifications.
- Minimizing vegetation removal to the extent feasible.
- Minimizing, to the extent possible, grubbing and contouring activities.

#### **2.4.5 Summary of Environmental Commitments**

Items below present a general summary of environmental commitments that the Corps will adhere to as part of the West Sacramento project.

The Corps will consult with the Services on acceptable compensation for shaded riverine aquatic (SRA) habitat (See Section 4.1.2) either by project constructed compensation sites or in combination with purchase of credits at a Services-approved mitigation bank where appropriate.

- The Corps will seek an ETL-approved vegetation variance exempting the Sacramento River sites from vegetation removal in the lower one-third of the waterside of the levee prior to final construction and design phase. Construction may require removal of vegetation on the upper two-thirds of the waterside and landside slope. Full ETL compliance would occur on the Sacramento and Yolo Bypasses, Yolo Bypass Toe Drain, South Cross levee, and the DWSC, Barge Canal, and Port of West Sacramento levee reaches. This approval process is in alignment with the Corps' Levee Safety Program's goal of maintaining public safety as the primary objective and assuring application of consistent and well-documented approaches. Removal of vegetation is only one part of the overall strategy of assuring that the levees will provide a level of protection consistent with Corps policy.
- The Corps will use a rock soil mixture to facilitate re-vegetation of the project sites that require bank protection work. A (70:30) rock to soil ratio would be implemented. The soil-rock mixture would be placed on top of the of the rock revetment along the Sacramento

River levees to allow native riparian vegetation to be planted to insure that SRA habitat lost is replaced or enhanced.

- In addition to an approved vegetation variance, the Corps will minimize the removal of existing vegetation in the proposed project area. Disturbance or removal of trees or larger woody vegetation will be replaced with native riparian species, outside of the vegetation-free zone, as established in the ETL.
- Construction will be scheduled when listed terrestrial and aquatic species would be least likely to occur in the project area. If construction needs to extend into the timeframe that species are present coordination with the resource agencies will occur.

## **2.5 Proposed Conservation and Mitigation Measures for the Southport EIP Project**

If WSAFCA constructs the Southport EIP as a 408 action prior to construction of the overall West Sacramento Project, WSAFCA would implement the following conservation measures to avoid or minimize effects on Federally listed fish and wildlife species and their habitat. These measures would be included as conditions of any permissions granted by the Corps. Several additional conservation measures are proposed specifically for giant garter snake and VELB. To ensure their implementation, the following measures will be included in the project specifications.

### **2.5.1 General**

#### **Conservation Measure 1: Conduct Mandatory Biological Resources Awareness Training for All Project Personnel and Implement General Requirements**

Before any ground-disturbing work (including vegetation clearing and grading) occurs in the Southport EIP Action Area, a USFWS-approved biologist will conduct a mandatory biological resources awareness training for all construction personnel about Federally listed species that could potentially occur onsite (VELB and giant garter snake). The training will include the natural history, representative photographs, and legal status of each Federally listed species and avoidance and minimization measures to be implemented. Proof of personnel attendance will be provided to USFWS within 1 week of the training. If new construction personnel are added to the Southport EIP project, the contractor will ensure that the new personnel receive the mandatory training before starting work. The subsequent training of personnel can include videotape of the initial training and/or the use of written materials rather than in-person training by a biologist. Requirements that will be followed by construction personnel are listed below.

- Where suitable habitat is present for listed species, WSAFCA will clearly delineate the construction limits through the use of survey tape, pin flags, orange barrier fencing, or other means, and prohibit any construction-related traffic outside these boundaries.
- Project-related vehicles will observe the posted speed limit on hard-surfaced roads and a 10-mile-per-hour speed limit on unpaved roads during travel in the project construction area.
- Project-related vehicles and construction equipment will restrict off-road travel to the designated construction areas.
- All food-related trash will be disposed of in closed containers and removed from the project construction area at least once per week during the construction period. Construction personnel will not feed or otherwise attract fish or wildlife to the project area.
- No pets or firearms will be allowed in the project area.
- To prevent possible resource damage from hazardous materials, such as motor oil or gasoline, construction personnel will not service vehicles or construction equipment outside designated staging areas.
- Any worker who inadvertently injures or kills a Federally listed species or finds one dead, injured, or entrapped will immediately report the incident to the biological monitor and construction foreman. The construction foreman will immediately notify WSAFCA, who will provide verbal notification to the USFWS Sacramento Endangered Species Office and/or the local CDFW warden or biologist within 1 working day. WSAFCA will follow up with written notification to USFWS or CDFW within 5 working days. The biological monitor will follow up with WSAFCA to ensure that the wildlife agencies were notified.
- The biological monitor will record all observations of Federally listed species on CNDDDB field sheets and submit to CDFW.

### **Conservation Measure 2: Prepare and Implement a Stormwater Pollution Prevention Plan**

Because ground disturbance would be greater than 1 acre, WSAFCA will obtain coverage under the U.S. Environmental Protection Agency's (EPA's) National Pollutant Discharge Elimination System (NPDES) general construction activity stormwater permit. The Central Valley RWQCB administers the NPDES stormwater permit program in Yolo County. Obtaining coverage under the NPDES general construction activity permit generally requires that the project applicant prepare a stormwater pollution prevention plan (SWPPP) that describes the BMPs that will be implemented to control accelerated erosion, sedimentation, and other pollutants during and after project construction. The SWPPP will be prepared prior to commencing earth-moving construction activities.

The specific BMPs that will be incorporated into the erosion and sediment control plan and SWPPP will be site-specific and will be prepared by the construction contractor in accordance with the

Central Valley RWQCB's Field Manual. However, the plan likely will include, but not be limited to, one or more of the following standard erosion and sediment control BMPs.

- **Timing of construction.** The construction contractor will conduct all construction activities during the typical construction season to avoid ground disturbance during the rainy season.
- **Staging of construction equipment and materials.** To the extent possible, equipment and materials will be staged in areas that have already been disturbed. No equipment or materials would be stored in the floodway during the flood season.
- **Minimize soil and vegetation disturbance.** The construction contractor will minimize ground disturbance and the disturbance/destruction of existing vegetation. This will be accomplished in part through the establishment of designated equipment staging areas, ingress and egress corridors, and equipment exclusion zones prior to the commencement of any grading operations.
- **Stabilize grading spoils.** Grading spoils generated during the construction will be temporarily stockpiled in staging areas. Silt fences, fiber rolls, or similar devices will be installed around the base of the temporary stockpiles to intercept runoff and sediment during storm events. If necessary, temporary stockpiles may be covered with an appropriate geotextile to increase protection from wind and water erosion.
- **Install sediment barriers.** The construction contractor may install silt fences, fiber rolls, or similar devices to prevent sediment-laden runoff from leaving the construction area.
- **Stormwater drain inlet protection.** The construction contractor may install silt fences, drop inlet sediment traps, sandbag barriers, and/or other similar devices.
- **Permanent site stabilization.** The construction contractor will install structural and vegetative methods to permanently stabilize all graded or otherwise disturbed areas once construction is complete. Structural methods may include the installation of biodegradable fiber rolls and erosion control blankets. Vegetative methods may involve the application of organic mulch and tackifier and/or the application of an erosion control native seed mix. Implementation of a SWPPP will substantially minimize the potential for project-related erosion and associated adverse effects on water quality.

### **Conservation Measure 3: Prepare and Implement a Bentonite Slurry Spill Contingency Plan (Frac-Out Plan)**

Before excavation begins, WSAFCA will ensure the contractor will prepare and implement a bentonite slurry spill contingency plan (BSSCP) for any excavation activities that use pressurized fluids (other than water). If the contractor prepares the plan, it will be subject to approval by the Corps, NMFS, and WSAFCA before excavation can begin. The BSSCP will include measures intended to minimize the potential for a frac-out (short for "fracture-out event") associated with excavation and tunneling activities; provide for the timely detection of frac-outs; and ensure an organized, timely, and minimum-

effect response in the event of a frac-out and release of excavation fluid (bentonite). The BSSCP will require, at a minimum, the following measures.

- If a frac-out is identified, all work will stop, including the recycling of the bentonite fluid. In the event of a frac-out into water, the location and extent of the frac-out will be determined, and the frac-out will be monitored for 4 hours to determine whether the fluid congeals (bentonite will usually harden, effectively sealing the frac-out location).
- NMFS, CDFW, and the Central Valley RWQCB will be notified immediately of any spills and will be consulted regarding clean-up procedures. A Brady barrel will be on site and used if a frac-out occurs. Containment materials, such as straw bales, also will be on site prior to and during all operations, and a vacuum truck will be on retainer and available to be operational on site within 2 hours' notice. The site supervisor will take any necessary follow-up response actions in coordination with agency representatives. The site supervisor will coordinate the mobilization of equipment stored at staging areas (e.g., vacuum trucks), as needed.
- If the frac-out has reached the surface, any material contaminated with bentonite will be removed by hand to a depth of 1 foot, contained, and properly disposed of, as required by law. The drilling contractor will be responsible for ensuring that the bentonite is either properly disposed of at an approved Class II disposal facility or properly recycled in an approved manner.
- If the bentonite fluid congeals, no other actions, such as disturbance of the streambed, will be taken that potentially would suspend sediments in the water column.
- The site supervisor has overall responsibility for implementing this BSSCP. The site supervisor will be notified immediately when a frac-out is detected. The site supervisor will be responsible for ensuring that the biological monitor is aware of the frac-out; coordinating personnel, response, cleanup, and regulatory agency notification and coordination to ensure proper clean-up; coordinating disposal of recovered material; and timely reporting of the incident. The site supervisor will ensure all waste materials are properly containerized, labeled, and removed from the site to an approved Class II disposal facility by personnel experienced in the removal, transport, and disposal of drilling mud.
- The site supervisor will be familiar with the contents of this BSSCP and the conditions of approval under which the activity is permitted to take place. The site supervisor will have the authority to stop work and commit the resources (personnel and equipment) necessary to implement this plan. The site supervisor will ensure that a copy of this plan is available (onsite) and accessible to all construction personnel. The site supervisor will ensure that all workers are properly trained and familiar with the necessary procedures for response to a frac-out prior to commencement of excavation operations.

#### **Conservation Measure 4: Prepare and Implement a Spill Prevention, Control, and Counter-Measure Plan**

A spill prevention, control, and counter-measure plan (SPCCP) is intended to prevent any discharge of oil into navigable water or adjoining shorelines. WSAFCA or its contractor will develop and implement an SPCCP to minimize the potential for and effects from spills of hazardous, toxic, or petroleum substances during construction and operation activities. The SPCCP will be completed before any construction activities begin. Implementation of this measure will comply with state and Federal water quality regulations. The SPCCP will describe spill sources and spill pathways in addition to the actions that will be taken in the event of a spill (e.g., an oil spill from engine refueling will be immediately cleaned up with oil absorbents). The SPCCP will outline descriptions of containments facilities and practices such as double-walled tanks, containment berms, emergency shutoffs, drip pans, fueling procedures, and spill response kits. It will describe how and when employees are trained in proper handling procedure and spill prevention and response procedures.

WSAFCA will review and approve the SPCCP before onset of construction activities and routinely inspect the construction area to verify that the measures specified in the SPCCP are properly implemented and maintained. WSAFCA will notify its contractors immediately if there is a noncompliance issue and will require compliance.

The Federal reportable spill quantity for petroleum products, as defined in 40 CFR 110, is any oil spill that:

- Violates applicable water quality standards.
- Causes a film or sheen on or discoloration of the water surface or adjoining shoreline.
- Causes a sludge or emulsion to be deposited beneath the surface of the water or adjoining shorelines.

If a spill is reportable, the contractor's superintendent will notify WSAFCA, and WSAFCA will take action to contact the appropriate safety and cleanup crews to ensure that the SPCCP is followed. A written description of reportable releases must be submitted to the Central Valley RWQCB. This submittal must contain a description of the release, including the type of material and an estimate of the amount spilled, the date of the release, an explanation of why the spill occurred, and a description of the steps taken to prevent and control future releases. The releases will be documented on a spill report form.

If an appreciable spill occurs and results determine that project activities have adversely affected surface or groundwater quality, a detailed analysis will be performed by a registered environmental assessor or professional engineer to identify the likely cause of contamination. This

analysis will conform to American Society for Testing and Materials standards and will include recommendations for reducing or eliminating the source or mechanisms of contamination. Based on this analysis, WSAFCA and its contractors will select and implement measures to control contamination, with a performance standard that surface water quality and groundwater quality must be returned to baseline conditions.

#### **Conservation Measure 5: Monitor Turbidity in Adjacent Water Bodies**

WSAFCA or its contractor will monitor turbidity in the adjacent water bodies, where applicable criteria apply, to determine whether turbidity is being affected by construction and ensure that construction does not affect turbidity levels, which ultimately increase the sediment loads. The Water Quality Control Plan for the Central Valley RWQCB (Basin Plan) contains turbidity objectives for the Sacramento River. Specifically, the plan states that where natural turbidity is between 5 and 50 nephelometric turbidity units (NTUs), turbidity levels may not be elevated by 20% above ambient conditions. Where ambient conditions are between 50 and 100 NTUs, conditions may not be increased by more than 10 NTUs (Central Valley RWQCB 2009).

WSAFCA or its contractor will monitor ambient turbidity conditions upstream during construction and adhere to the Surface Water Quality Ambient Monitoring Program requirements for turbidity monitoring. Monitoring will continue approximately 300 feet downstream of construction activities to determine whether turbidity is being affected by construction. Grab samples will be collected at a downstream location that is representative of the flow near the construction site. If there is a visible sediment plume being created from construction, the sample will represent this plume. Monitoring will occur hourly when construction encroaches into the Sacramento River. If construction does not encroach into the river, the monitoring will occur once a week on a random basis.

If turbidity limits exceed Basin Plan standards, construction-related earth-disturbing activities will slow to a point that results in alleviating the problem. WSAFCA will notify the Central Valley RWQCB of the issue and provide an explanation of the cause.

#### **Conservation Measure 6: Prepare and Implement a Mitigation and Monitoring Plan**

A draft MMP for the restoration areas is being developed and will be approved by the Corps, NMFS, USFWS, and CDFW before implementation of the Southport EIP project. The restoration objectives of the plan are listed below.

- Provide compensatory mitigation credits for impacts on protected land cover types and to special-status species and potential habitat for these species.
- Maximize SRA cover/nearshore habitat, over and above current erosion stabilization efforts using biotechnical methods.
- Enhance setback ecological values using topographic and vegetation/habitat heterogeneity.

- Restore portions of the historic Sacramento River floodplain (i.e., waters of the United States).
- Restore riparian and oak woodland habitat on the restored floodplain that will create continuous habitat corridors for fish and wildlife movement.
- Design habitat features to minimize future maintenance obligations (e.g., reduce opportunities for sediment and debris accumulation).
- Design floodplain planting and vegetation management schemes to avoid undesirable hydraulic and sediment transport impacts to the offset levee and offset area.
- Comply with current Corps levee vegetation policy to balance habitat needs with flood management objectives.

The monitoring objectives of the plan are listed below.

- Monitor and evaluate the hydrologic and hydraulic performance of the restored floodplain relative to the ecological design criteria for the target species.
- Monitor and evaluate the success of the riparian/wetland plantings and other habitat features (e.g., IWM) in compensating, restoring, or enhancing fish and wildlife habitat values on the levee slopes and offset areas.
- Monitor and evaluate the effectiveness of the grading and drainage features in preventing fish stranding (see Fish Stranding below).
- Monitor the occurrence and extent of potential sedimentation and scour that may compromise the success of the habitat restoration and mitigation components of the project.

The MMP will include representative plans and cross sections of the Southport EIP Proposed Action elements; fish stranding and vegetation monitoring methods; habitat compensation and restoration success criteria; and a protocol for implementing remedial actions should any success criteria not be met. The existing O&M requirements and practices will also be incorporated into the plan. Annual monitoring reports that describe each year's monitoring activities and progress toward the success criteria would be submitted to the resource agencies during the course of the monitoring period. Monitoring would be conducted until the projected benefits of the compensation and restoration actions have been substantially achieved.

### **2.5.2 Valley Elderberry Longhorn Beetle**

Conservation measures for VELB are based on USFWS's 1999 *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* (Conservation Guidelines) (USFWS 1999a).

**Conservation Measure 7: Fence Elderberry Shrubs to be Protected and Monitor Fencing during Construction**

Elderberry shrubs and clusters (*Sambucus* spp.) within 100 feet of the Southport EIP construction area that will not be removed will be protected during construction. A qualified biologist (i.e., with elderberry/VELB experience), under contract with WSAFCA, will mark the elderberry shrubs and clusters that will be protected during construction. Orange construction barrier fencing will be placed at the edge of the respective buffer areas. The buffer area distances will be proposed by the biologist and approved by USFWS. No construction activities will be permitted within the buffer zone other than those activities necessary to erect the fencing. Signs will be posted every 50 feet along the perimeter of the buffer area fencing. The signs will contain the following information:

*This area is habitat of the valley elderberry longhorn beetle, a threatened species, and must not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment.*

In some cases, where the elderberry shrub dripline is within 10 feet of the work area, k-rails will be placed at the shrub's dripline to provide additional protection to the shrub from construction equipment and activities. Temporary fences around the elderberry shrubs and k-rails at shrub driplines will be installed as the first order of work. Temporary fences will be furnished, constructed, maintained, and later removed, as shown on the plans, as specified in the special provisions, and as directed by the project engineer. Temporary fencing will be 4 feet high, commercial-quality woven polypropylene, and orange in color.

Buffer area fences around elderberry shrubs will be inspected weekly by a qualified biological monitor during ground-disturbing activities and monthly after ground-disturbing activities until construction of the Southport EIP is complete or until the fences are removed, as approved by the biological monitor and the resident engineer. The biological monitor will be responsible for ensuring that the contractor maintains the buffer area fences around elderberry shrubs throughout construction. Biological inspection reports will be provided to the project lead and USFWS.

**Conservation Measure 8: Conduct Stem Counts Prior to Elderberry Shrub Transplantation**

Surveys of elderberry shrubs to be transplanted will be conducted by a qualified biologist prior to transplantation. The biologist will survey the area surrounding the shrub to be transplanted to ensure that there aren't additional elderberry shrubs that need to be removed. Surveys will consist of counting and measuring the diameter of each stem and examining elderberry shrubs for the presence of VELB exit holes. Survey results and an analysis of the number of elderberry seedlings/cuttings and associated native plants based on the survey results will be submitted to USFWS. Elderberry seedlings/cuttings and associated native plants will be planted prior to transplantation of elderberry shrubs. The data collected

during the surveys prior to transplantation will be used to determine if compensation requirements are being exceeded or if additional plantings are necessary. Because the Southport EIP would be constructed potentially over a 3-year period, elderberry survey data for each year will be used to rectify any discrepancies in compensation and to ensure full mitigation of impacts on VELB.

#### **Conservation Measure 9: Water Down Construction Area to Control Dust**

The construction contractor will ensure that the project construction area will be watered down as necessary to prevent dirt from becoming airborne and accumulating on elderberry shrubs within the 100-foot buffer.

#### **Conservation Measure 10: Compensate for Direct Effects on Valley Elderberry Longhorn Beetle Habitat**

Before construction begins, compensation will be implemented for direct effects on elderberry shrubs by transplanting shrubs that cannot be avoided to a USFWS-approved conservation area (described below). Elderberry seedlings or cuttings and associated native species will also be planted in the conservation area. Each elderberry stem measuring 1 inch or greater in diameter at ground level that is adversely affected (i.e., transplanted or destroyed) would be replaced in the conservation area, with elderberry seedlings or cuttings at a ratio ranging from 1:1 to 8:1 (new plantings to affected stems). The numbers of elderberry seedlings/cuttings and associated riparian native trees/shrubs to be planted as replacement habitat are determined by stem size class of affected elderberry shrubs, presence or absence of exit holes, and whether the shrub lies in a riparian or nonriparian area. Stock of either seedlings or cuttings would be obtained from local sources (including the Southport EIP Action Area, if acceptable to USFWS). At the discretion of USFWS, shrubs that are unlikely to survive transplantation because of poor condition or location, or a plant that would be extremely difficult to move because of access problems, may be exempted from transplantation. In cases in which transplantation is not possible, minimization ratios would be increased to offset the additional habitat loss.

The relocation of the elderberry shrubs will be conducted according to USFWS-approved procedures outlined in the Conservation Guidelines (USFWS 1999a). Elderberry shrubs within the project construction area that cannot be avoided will be transplanted during the plant's dormant phase (November through the first 2 weeks of February). A qualified biological monitor will remain onsite while the shrubs are being transplanted.

During field surveys, 106 elderberry shrubs were identified in the study area, but only 41 elderberry shrubs were identified in the Action Area (Appendix B, Figure 6 and Appendix C). Eighteen shrubs would be directly affected and the remaining 23 shrubs would be indirectly affected (see Table 22 in Chapter 3). Property inaccessibility and the high density of vegetation surrounding several elderberry shrubs limited the number of elderberry shrubs that could be surveyed for exit holes and

stem counts. For this reason, compensation for the removal of shrubs 33, 39b, 41a, and 41b was estimated based on the average number of stems in each stem diameter range for the shrubs that could be surveyed. In addition, an assumption was made that there were exit holes in the four shrubs that could not be surveyed. Table 18 shows the stem counts for elderberry shrubs directly affected in the Southport EIP Action Area and Table 19 shows the estimated compensation. The stem averages are as follows.

- Number of stems  $\geq 1$  inch and  $\leq 3$  inches = 16.
- Number of stems  $> 3$  inches and  $< 5$  inches = 4.
- Number of stems  $\geq 5$  inches = 3.

**Table 18. Summary of Stem Counts for Elderberry Shrubs Directly Affected by the Southport EIP.**

	Presence of Exit Holes?	Riparian Habitat?	1-3 Inches	3-5 Inches	> 5 Inches
6	N	Y	60	5	9
7	N	Y	33	10	18
8	N	Y	8	5	2
9	N	Y	30	2	8
10	Y	Y	8	4	2
23	Y	Y	3	3	1
32	N	N	3	1	1
33 <sup>1</sup>	Y	N	16	4	3
34	Y	N	12	6	10
39a	N	N	3	0	0
39b <sup>2</sup>	Y	N	16	4	3
41a <sup>2</sup>	Y	N	16	4	3
41b <sup>2</sup>	Y	N	16	4	3
41c	Y	N	5	7	2
52	Y	Y	6	1	1
53	Y	N	29	17	3
98	N	Y	4	0	0
100	Y	Y	8	2	0
<b>Direct Total</b>			<b>276</b>	<b>79</b>	<b>69</b>

<sup>1</sup> Shrubs could not be surveyed because there was no property access. Number of stems was estimated based on average of all counted stems. See text for a description. In addition, exit holes were assumed to be present in shrub 33.

<sup>2</sup> Shrubs that could not be surveyed because they were covered in grapevines or poison oak. Number of stems was estimated based on average of all counted stems. See text for a description. In addition, exit holes were assumed to be present in shrubs 39b, 41a, and 41b.

**Table 19. Estimated Compensation for Elderberry Shrubs Removed for the Southport EIP.**

Location	Stem Diameter	Holes	Number of Stems	Elderberry Ratios (multiply number of stems by)	Elderberry Plantings	Native Ratios	Associated Native Plantings
Non-riparian	1-3 Inches	N	6	1	6	1	6
		Y	135	2	270	2	540
Non-riparian	3-5 Inches	N	1	2	2	1	2
		Y	22	4	88	2	176
Non-riparian	> 5 Inches	N	1	3	3	1	3
		Y	37	6	222	2	444
Riparian	1-3 Inches	N	110	2	220	1	220
		Y	25	4	100	2	200
Riparian	3-5 Inches	N	46	8	138	1	138
		Y	10	6	60	2	120
Riparian	> 5 Inches	N	27	4	108	1	108
		Y	4	8	32	2	64
<b>Totals</b>			<b>424</b>		<b>1,249</b>		<b>2,021</b>

Based on the information in Table 19, the conservation area will be at least 13.5 acres in size to accommodate up to 18 elderberry shrubs, 1,249 elderberry cuttings or seedlings, and 2,021 native plants. The conservation area in which the transplanted elderberry shrubs and seedlings are planted will be protected in perpetuity as habitat for VELB.

Evidence of VELB occurrence in the conservation area, the condition of the elderberry shrubs in the conservation area, and the general condition of the conservation area itself will be monitored over a period of 10 consecutive years or for 7 years over a 15-year period from the date of transplanting. WSAFCA will be responsible for funding and providing monitoring reports to USFWS in each of the years in which a monitoring report is required. As specified in the Conservation Guidelines, the report will include information on timing and rate of irrigation, growth rates, and survival rates and mortality.

To meet the success criteria specified in the Conservation Guidelines, a minimum survival rate of 60% of the original number of elderberry replacement plantings and associated native plants must be maintained throughout the monitoring period.

**Proposed Conservation Area**

Approximately 120 acres of habitat floodplain habitat will be restored or enhanced as part of implementation of the Southport EIP. The required portion of these acres of riparian habitat will be used as VELB mitigation.

### **2.5.3 Giant Garter Snake**

Conservation measures for giant garter snake were developed using portions of the *Programmatic Formal Consultation for U.S. Army Corps of Engineers 404 Permitted Projects with Relatively Small Effects on the Giant Garter Snake within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo Counties, California* (USFWS 1997).

#### **Conservation Measure 11: Conduct Construction Activities during the Active Period for Giant Garter Snake**

To the maximum extent possible, all Southport EIP construction activity within giant garter snake aquatic and upland habitat within 200 feet of aquatic habitat will be conducted during the snake's active period (May 1–October 1). During this time frame, potential for injury and mortality are lessened because snakes are actively moving and avoiding danger. Construction of the setback levee in Segments B through F would begin in Year 1. The setback levee and the remaining flood risk – reduction measures for all segments would be completed in Year 2. Some preparation of construction may occur during the 2014 construction season, but no changes would be made to the existing levee prism. The construction season is typically from April 15 to October 31, subject to conditions. Because construction may extend into the giant garter snakes dormant period (October 2 to April 30), additional protective measures will be implemented at these locations (see Conservation Measure 14 below).

#### **Conservation Measure 12: Install and Maintain Construction Barrier Fencing around Suitable Giant Garter Snake Habitat**

To reduce the likelihood of giant garter snakes entering the Southport EIP construction area, exclusion fencing and orange barrier fencing will be installed along the portions of the construction area that are within 200 feet of suitable aquatic and upland habitat. The exclusion and barrier fencing will be installed during the active period for giant garter snakes (May 1–October 1) to reduce the potential for injury and mortality during this activity.

The construction specifications will require a provision to retain a qualified biologist to identify the areas that are to be avoided during construction. Areas adjacent to the directly affected area required for construction, including staging and access, will be fenced off to avoid disturbance in these areas. Before construction, the contractor will work with the qualified biologist to identify the locations for the barrier fencing and will place flags or flagging around the areas to be protected to indicate the locations of the barrier fences. The protected area will be clearly identified on the construction specifications. The fencing will be installed the maximum distance practicable from the aquatic habitat areas and will be in place before construction activities are initiated.

The barrier fencing will consist of 4-foot-tall erosion fencing buried at least 6 to 8 inches below ground level. The barrier fencing will ensure that giant garter snakes are excluded from the construction area and that suitable upland and aquatic habitat is protected throughout construction. The exclusion

fencing will be commercial-quality, woven polypropylene, orange in color, and 4 feet high (Tensor Polygrid or equivalent). The fencing will be tightly strung on posts with a maximum of 10-foot spacing.

Barrier and exclusion fences will be inspected daily by a qualified biological monitor during ground-disturbing activities and weekly after ground-disturbing activities until project construction is complete or until the fences are removed, as approved by the biological monitor and the resident engineer. The biological monitor will be responsible for ensuring that the contractor maintains the buffer area fences around giant garter snake habitat throughout construction. Biological inspection reports will be provided to the project lead and USFWS.

### **Conservation Measure 13: Minimize Potential Impacts on Giant Garter Snake Habitat**

The following measures will be implemented to minimize potential impacts on giant garter snake habitat.

- Staging areas will be located at least 200 feet from suitable giant garter snake habitat.
- Any dewatered habitat will remain dry for at least 15 consecutive days after April 15 and prior to excavating or filling of the dewatered habitat.
- Vegetation clearing within 200 feet of the banks of suitable giant garter snake aquatic habitat will be limited to the minimum area necessary. Avoided giant garter snake habitat within or adjacent to the Action Area will be flagged and designated as an environmentally sensitive area, to be avoided by all construction personnel.
- The movement of heavy equipment within 200 feet of the banks of suitable giant garter snake aquatic habitat will be confined to designated haul routes to minimize habitat disturbance.

### **Conservation Measure 14: Conduct Preconstruction Surveys and Monitoring for Giant Garter Snake**

Prior to ground-disturbing activities within 200 feet of suitable habitat, a USFWS-approved biological monitor will conduct a preconstruction survey of suitable aquatic and upland habitat and inspect exclusion and orange barrier fencing to ensure they are both in good working order each morning. If any snakes are observed within the construction area at any other time during construction the USFWS-approved biological monitor will be contacted to survey the site for giant garter snakes. The biological monitor will have the authority to stop construction activities until appropriate corrective measures have been completed or it is determined that the snake will not be harmed. Giant garter snakes encountered during construction activities will be allowed to move away from construction activities on their own. If unable to move away on their own, trapped or injured giant garter snakes will only be removed by the USFWS-approved biological monitor and will be placed in the nearest suitable habitat that is outside of the construction area. The biological monitor will immediately report these

activities to USFWS by phone and will provide a written account of the details of the incident within 24 hours.

Once all initial ground-disturbing activities are completed, the biological monitor will perform weekly checks of the site for the duration of construction in order to ensure that construction barrier fences and exclusion fences are in good order, trenches are being covered, project personnel are conducting checks beneath parked vehicles prior to their movement, and that all other required biological protection measures are being complied with. The biological monitor will document the results of monitoring on construction monitoring log sheets, which will be provided to USFWS within 1 week of each monitoring visit.

**Conservation Measure 15: Provide Escape Ramps or Cover Open Trenches at the End of Each Day**

To avoid entrapment of giant garter snake, thereby preventing injury or mortality resulting from falling into trenches, all excavated areas more than 1 foot deep will be provided with one or more escape ramps constructed of earth fill or wooden planks at the end of each workday. If escape ramps cannot be provided, then holes or trenches will be covered with plywood or other hard material. The biological monitor or construction personnel designated by the contractor will be responsible for thoroughly inspecting trenches for the presence of giant garter snakes at the beginning of each workday. If any individuals have become trapped, the USFWS-approved biological monitor will be contacted to relocate the snake, and no work will occur in that area until approved by the biologist.

**Conservation Measure 16: Implement Additional Protective Measures during Work in Suitable Habitat during the Giant Garter Snake Dormant Period**

The following additional protective measures will be implemented for the Southport EIP during time periods when work must occur during the giant garter snake dormant period (October 2–April 30), when snakes are more vulnerable to injury and mortality.

- A full-time USFWS-approved biological monitor will be onsite for the duration of construction activities.
- All emergent vegetation and vegetation within 200 feet of suitable aquatic habitat will be cleared prior to the giant garter snake hibernation period (i.e., vegetation clearing must be completed by October 1).
- Exclusion and barrier fencing will be installed around the perimeter of the work area and across suitable aquatic habitat where activities associated with levee slope flattening and pipe reconstruction activities would occur. The fencing should enclose the work area to the maximum extent possible to prevent giant garter snakes from entering the work area. Fencing will be installed during the active period for giant garter snakes (May 1–October 1) to reduce the potential for injury and mortality during fence installation. The USFWS-

approved biological monitor will work with the contractor to determine where fencing should be placed and will monitor fence installation. The barrier fencing will consist of 3- to 4-foot-tall erosion fencing buried at least 6 to 8 inches below ground level. The barrier fencing will minimize opportunities for giant garter snake hibernation in the adjacent upland area (between canal and existing levee).

Portions of the construction area that are temporarily disturbed during construction will be revegetated with emergent vegetation and adjacent disturbed upland habitat will be revegetated with native grasses and forbs after construction is complete.

**Conservation Measure 17: Restore Temporarily Disturbed Aquatic and Upland Habitat to Pre-project Conditions**

Upon completion of the Southport EIP, 155 acres of suitable upland habitat will be restored in the borrow areas for giant garter snake to pre-project conditions. There would be no temporary loss of aquatic habitat. All of the temporary habitat impacts will occur in the borrow areas. The actual temporary impacts from borrow activities will be substantially less pending an analysis on the suitability of materials.

Suitable upland habitat for giant garter snakes consists of fallow agricultural fields and nonnative annual grassland. Cultivated and disked agricultural fields were not considered suitable upland habitat for giant garter snake because they are frequently disturbed during farming activities. Temporarily affected upland habitat would be restored to pre-project conditions within a maximum of one season (a season is defined as the calendar year between May 1 and October 1 [USFWS 1997]) to avoid requirements for compensation. Restoration of upland habitat will be detailed in a mitigation and monitoring plan that will be reviewed and approved by USACE and USFWS prior to the start of construction.

**Conservation Measure 18: Compensate for Direct Effects on Giant Garter Snake**

The permanent loss of 2.24 acres of upland habitat would be compensated for by restoring habitat onsite or by purchasing credits from a USFWS and CDFW approved mitigation bank. There would be no permanent loss of aquatic habitat.

**3.0 Federally Protected Species and Critical Habitat**

Federally protected species and critical habitat that may be affected by the West Sacramento Project and Southport EIP were determined through consultation with USFWS and NMFS. The Central Valley fall-/late fall–run Chinook salmon, which is an Evolutionarily Significant Unit (ESU) of special

concern but is not Federally listed, is included because the project's effects on EFH must also be assessed.

### **3.1 Valley Elderberry Longhorn Beetle**

#### **Status and Distribution**

The valley elderberry longhorn beetle is listed as a threatened species under the ESA (USFWS 1980). USFWS has undertaken a comprehensive study, known as a 12-month review, to determine whether or not to propose the beetle for delisting (USFWS 2011). According to the USFWS, delisting may be warranted because many new locations of the beetle have been identified since its listing, destruction of habitat has slowed greatly, and efforts have resulted in the protection of significant acreage of habitat (Talley et al. 2006).

The valley elderberry longhorn beetle's range extends from southern Shasta County to Fresno County (Talley et al. 2006). Along the eastern edge of the species' range, adult beetles have been found in the foothills of the Sierra Nevada at elevations up to 2,220 feet, and beetle exit holes have been located on elderberry plants at elevations up to 2,940 feet. Along the western edge of the species' range, adult beetles have been found on the eastern slopes of the Coast Ranges at elevations of up to 500 feet, and beetle exit holes have been detected on elderberry plants at elevations up to 730 feet (Barr 1991).

Several CNDDDB (CDFW 2013a) records of VELB are reported to occur in the West Sacramento study area along the Sacramento River north and south levee reaches. Though not reported to occur in other levee reaches within the study area, VELB has potential to occur wherever elderberry shrubs with branches sized 1 inch or greater at ground level occur.

#### **Life History and Habitat Requirements**

Because historic loss of riparian habitat in the region has already occurred, the rate of riparian habitat loss has slowed significantly over the last 30 years. During this period, incidental take of habitat has been authorized primarily for urbanization, transportation, water management, and flood control, on the order of 10,000 to 20,000 acres. Several habitat conservation plans are being developed to allow for continued urbanization of the Sacramento Valley (Talley et al. 2006).

Approximately 50,000 acres of existing riparian habitat in the Central Valley, primarily in the Sacramento Valley, have been protected by Federal, State, and local agencies as well as private organizations. Additionally, restoration of more than 5,000 acres of habitat has been initiated throughout the beetle's range (Talley et al. 2006). Mitigation needed for the West Sacramento project would be performed in place or there would be purchasing of mitigation credits from nearby banks.

Valley elderberry longhorn beetle is only found in close association with its host plant, elderberry shrubs (*Sambucus* spp.). Elderberry shrubs are found in or near riparian and oak woodland habitats. The valley elderberry longhorn beetle's life history is assumed to follow a sequence of events similar to those of related taxa. Female beetles deposit eggs in crevices in the bark of living elderberry shrubs. Presumably, the eggs hatch shortly after they are laid, and the larvae bore into the pith of the trunk or stem. When larvae are ready to pupate, they move through the pith of the plant, open an emergence hole through the bark, and return to the pith for pupation. Adults exit through the emergence holes and can sometimes be found on elderberry foliage, flowers, or stems or on adjacent vegetation. The entire life cycle of the valley elderberry longhorn beetle is thought to encompass 2 years, from the time eggs are laid and hatch until adults emerge and die (USFWS 1984).

The presence of exit holes in elderberry stems indicates previous valley elderberry longhorn beetle habitat use. Exit holes are cylindrical and approximately 0.25 inch in diameter. Exit holes can be found on stems that are 1 or more inches in diameter. The holes may be located on the stems from a few inches to about 9 to 10 feet above the ground (Barr 1991).

### **Factors Affecting Abundance**

The valley elderberry longhorn beetle distribution decline is most likely related to the extensive loss of riparian forests in the Central Valley, which has reduced the amount of available habitat for the species, and has most likely decreased and fragmented the species' range (USFWS 1984).

Insecticide drift from cultivated fields and orchards adjacent to elderberry plants may affect valley elderberry longhorn beetle populations, if drift occurs at a time when adults are present on the shrubs (Barr 1991). Herbicide drift from agricultural fields and orchards can likewise affect the health of elderberry plants, thereby reducing their quantity and quality as valley elderberry longhorn beetle habitat.

The invasive Argentine ant (*Linepithema humile*) has been spreading in riparian habitats and may affect survival of the valley elderberry longhorn beetle. Argentine ants may predate valley elderberry longhorn beetle eggs although this interaction needs further exploration (Huxel 2000). The spread of invasive exotic plants (e.g., giant reed [*Arundo donax*] may also negatively affect the valley elderberry longhorn beetle by affecting supporting riparian habitats. The presence of giant reed promotes a more frequent fire cycle and homogenous plant community (Talley et al. 2006).

## **3.2 Fish Species**

Six fish species' ESUs or Distinct Population Segments (DPSs) and critical habitats are addressed below. These include Sacramento River winter-run Chinook salmon ESU, Central Valley spring-run Chinook salmon ESU, Central Valley fall-/late fall-run Chinook salmon ESU, Central Valley steelhead DPS, delta smelt, and green sturgeon southern DPS.

### **3.2.1 Sacramento River Winter-Run Chinook Salmon Evolutionarily Significant Unit**

#### **Status and Distribution**

The Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*) was listed as threatened under the Federal ESA on August 4, 1989 (NMFS 1989). NMFS subsequently upgraded the Federal listing to endangered on January 4, 1994 (NMFS 1994). NMFS designated critical habitat for Sacramento River winter-run Chinook salmon on June 16, 1993 (NMFS 1993a). The ESU includes all naturally spawned populations of winter-run Chinook in the Sacramento River and its tributaries, as well as populations from two artificial propagation programs, one at the Livingston Stone National Fish Hatchery and the other at Bodega Marine Laboratory (NMFS 2005a).

Prior to construction of Shasta Dam, winter-run Chinook salmon spawned in the upper reaches of the Sacramento River, the McCloud River, and the lower Pit River. Spawning is now restricted to approximately 44 miles of the mainstem Sacramento River, immediately downstream of Keswick Dam (Yoshiyama et al. 1998). The abundance of winter-run Chinook salmon in the Sacramento River before Shasta Dam was constructed, is unknown. Some biologists believe the run was relatively small, possibly consisting of a few thousand fish (Slater 1963). Others, relying on anecdotal accounts, believe the run could have numbered more than 200,000 fish (NMFS 1993b). During the mid-1960s, more than 20 years after the construction of Shasta Dam, the population exceeded 80,000 fish (USBR 1986). The population declined substantially during the 1970s and 1980s.

In 1989, winter-run Chinook salmon escapement was estimated at 696 adults. Escapement continued to decline, diminishing to an estimated 430 fish in 1990 and 211 fish in 1991 (CDFW 2013b). The rapid decline in escapement during the late 1980s and early 1990s prompted listing of the winter-run Chinook salmon as endangered under the California ESA and the Federal ESA. Escapement in 1992 was estimated to be 1,240 fish, indicating good survival of the 1989 class. NMFS data indicates that the population has increased during the late 1990s through 2001. In 1996, returning spawners numbered 1,337 fish and in 2001, returning adults were estimated to be 8,224 (CDFW 2013b). Despite increased efforts to maintain and enhance the population of winter-run Chinook salmon by various entities, in their final listing determination of June 28, 2005, NMFS again found “that the Sacramento River winter-run Chinook salmon ESU in total is in danger of extinction throughout all or a significant portion of its range” and concludes that the ESU continues to warrant listing as an endangered species under the Federal ESA (NMFS 2005a).

#### **Life History**

Winter-run Chinook salmon spend 1 to 3 years in the ocean. Adult winter-run Chinook salmon leave the ocean and migrate through the Delta into the Sacramento River from December through July with peak migration in March. Adults spawn from mid-April through August (Moyle 2002). Egg incubation continues through October. The primary spawning habitat in the Sacramento River is above Red Bluff Diversion Dam at RM 243, although spawning has been observed downstream as far as RM

218 (NMFS 2001). Spawning success below RBDD may be limited primarily by warm water temperatures (Hallock and Fisher 1985; Yoshiyama et al. 1998).

Downstream movement of juvenile winter-run Chinook salmon begins in August, soon after fry emerge. The peak abundance of juveniles moving downstream at Red Bluff occurs in September and October (Vogel and Marine 1991). Juvenile Chinook salmon move downstream from spawning areas in response to many factors, which may include inherited behavior, habitat availability, flow, competition for space and food, and water temperature. The numbers of juveniles that move and the timing of movement are highly variable. Storm events and their resulting high flows and turbidity appear to trigger downstream movement of substantial numbers of juvenile Chinook salmon.

Winter-run Chinook salmon smolts (i.e., juveniles that are physiologically ready to enter seawater) may migrate through the Delta and San Francisco Bay to the ocean from November through May (Yoshiyama et al. 1998). The Sacramento River channel is the main migration route through the Delta. However, the Yolo Bypass also provides significant outmigration passage during higher flow events. During winter in the Sacramento–San Joaquin system, juveniles rear on seasonally inundated floodplains. Sommer et al. (2001) found higher growth and survival rates of juvenile Chinook salmon reared on the Yolo Bypass floodplain, than those that reared in the mainstem Sacramento River.

### **Factors Affecting Abundance**

One of the main factors in the decline of Chinook salmon is habitat loss and degradation. On the Sacramento River, Shasta Dam blocked access to historical spawning and rearing habitat. Other factors affecting abundance include the effects of reservoir operations on water temperature, harvesting and fishing pressure, entrainment in diversions, contaminants, predation by non-native species, and interaction with hatchery stock (Corps 2000b).

In the Sacramento River, operation of the Central Valley Project and State Water Project influences river flow. Low flows can reduce habitat area and adversely affect water quality. The resulting warm water temperatures and low dissolved oxygen levels can stress incubating eggs and rearing juvenile winter-run Chinook salmon. Low flow may affect migration of juveniles and adults through increased water temperature or reduced velocity that slows downstream movement of juveniles. Low flow, in combination with diversions, may result in higher entrainment losses at the State and Federal pumping plants in the south Delta (Corps 2000b).

In the Delta, flow drawn through the Delta Cross Channel and Georgiana Slough transports some percentage of downstream migrating salmon into the central Delta. The number of juveniles entering the DCC and Georgiana Slough is assumed to be proportional to the flow volume diverted from the Sacramento River (CDFG 1987). Survival of juvenile Chinook salmon that are drawn into the central Delta is lower than survival of juvenile Chinook salmon that remain in the Sacramento River channel.

### **Critical Habitat/Essential Fish Habitat**

Within the West Sacramento GRR study area, the Sacramento River is considered to be critical habitat for winter-run Chinook salmon. Critical habitat includes the water column, river bottom, and adjacent riparian zone which fry and juveniles use for rearing (NMFS 2006b). The conservation value of critical habitat in the study area is high because it supports both recruitment and survival of juveniles and adults (NMFS 2006a).

EFH is defined as those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity. EFH includes currently and historically accessible habitat. All levee reaches within the West Sacramento GRR study area are considered to be essential fish habitat for winter-run Chinook salmon except for the South Cross toe drain.

### **3.2.2 Central Valley Spring-Run Chinook Salmon Evolutionarily Significant Unit**

#### **Status and Distribution**

The Central Valley spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*) was Federally listed as threatened on September 16, 1999 (NMFS 1999). Its threatened status was reaffirmed in NMFS's final listing determination issued on June 28, 2005 (NMFS 2005a). Critical habitat for Central Valley spring-run Chinook salmon was designated by NMFS on September 2, 2005 (NMFS 2005b). The ESU includes all naturally spawned spring-run Chinook salmon in the Sacramento River and its tributaries. Naturally spawned fish of hatchery origin in the Feather and Yuba Rivers as well as hatchery spawned fish in the Feather River are also included as a part of this ESU (NMFS 2005a).

Spring-run Chinook salmon may have once been the most abundant of Central Valley Chinook salmon (Mills and Fisher 1994), historically occupying the upstream reaches of all major river systems in the Central Valley where there were no natural barriers. Central Valley spring-run Chinook salmon are now restricted to the upper Sacramento River downstream of Keswick Dam; the Feather River downstream of Oroville Dam; the Yuba River downstream of Englebright Dam; several perennial tributaries of the Sacramento River (e.g., Deer, Mill, and Butte creeks); and the Delta.

The abundance of Central Valley spring-run Chinook salmon escapement, as measured by the number of adults returning to spawn from 1960 to 2013, averaged 10,236 adults for in-river natural spawners and 2,364 average adults returning to hatcheries (CDFW 2013b). Spring-run Chinook salmon spawn in the early fall and have interbred with fall-run Chinook salmon in the Sacramento and Feather Rivers. Genetically uncontaminated populations may exist in Deer Creek, Mill Creek, Butte Creek, and other eastside tributaries of the Sacramento River.

## **Life History**

Adult spring-run Chinook salmon enter the mainstem Sacramento River from March through September, with the peak upstream migration occurring from May through June (Yoshiyama et al. 1998). Adults generally enter tributaries from the Sacramento River between mid-April and mid-June (Lindley et al. 2006 as cited in NMFS 2006b). Spring-run Chinook salmon are sexually immature during upstream migration, and adults hold in deep, cold pools near spawning habitat until spawning commences in late summer and fall. Spring-run Chinook salmon spawn in the upper reaches of the mainstem Sacramento River and tributary streams (USFWS 1995), with the largest tributary runs occurring in Butte, Deer, and Mill Creek's (Yoshiyama et al. 1998). Spawning typically begins in late August and may continue through October. Juveniles emerge in November and December in most locations but may emerge later when water temperature is cooler. Newly emerged fry remain in shallow, low-velocity edgewater (CDFG 1998).

Juvenile spring-run Chinook salmon typically spend up to one year rearing in fresh water before migrating to sea as yearlings, but some may migrate downstream as young-of-year juveniles. Rearing takes place in their natal streams, the mainstem of the Sacramento River, inundated floodplains (including the Sutter and Yolo bypasses), and the Delta. Based on observations in Butte Creek and the Sacramento River, young-of-year juveniles typically migrate from November through May. Yearling spring-run Chinook salmon migrate from October to March, with peak migration in November (Cramer and Demko 1997; Hill and Webber 1999). Downstream migration of yearlings typically coincides with the onset of the winter storm season, and migration may continue through March (CDFG 1998).

## **Factors Affecting Abundance**

Main factors in the decline of spring-run Chinook salmon populations are habitat loss and degradation. Dams have blocked access to historical spawning and rearing habitat. Other factors affecting abundance of spring-run Chinook salmon include harvest, entrainment in diversions, contaminants, predation by non-native species, and interbreeding with fall-run Chinook salmon and hatchery stocks (Corps 2000b).

In the Sacramento River and its major tributaries, operation of the CVP and SWP controls river flow. Low flows limit habitat area and adversely affect water quality, such as warm water temperature and low dissolved oxygen that stress incubating eggs and rearing juveniles. Low flow may affect migration of juveniles and adults through inadequate water depth to support passage, or through reduced velocity that slows the downstream movement of juveniles. Low flow, in combination with diversions, may result in higher entrainment losses (Corps 2000b).

In the Delta, flow drawn through the Delta Cross Channel and Georgiana Slough transports some portion of downstream migrants into the central Delta. The number of juveniles entering the Delta Cross Channel and Georgiana Slough is assumed to be proportional to the flow volume diverted from

the Sacramento River (CDFG 1987). Survival of juvenile Chinook salmon that are drawn into the central Delta is lower than survival of juvenile Chinook salmon that remains in the Sacramento River channel.

### **Critical Habitat/Essential Fish Habitat**

Critical habitat for spring-run Chinook salmon includes all river channels and sloughs within the West Sacramento GRR study area (NMFS 2006b). The DWSC and South Cross toe drain are excluded from this designation. Critical habitat includes the stream channels and the lateral extent as defined by the ordinary high-water line or bank-full elevation. Primary constituent elements of critical habitat in the study area include: (1) freshwater rearing sites that have adequate water quality and quantity, floodplain connectivity, and natural cover that supports juvenile growth and mobility; and (2) freshwater migration corridors that support adequate water quantity and quality as well as natural cover to provide food and migration pathways for juveniles as well as adults (NMFS 2005e, 2006b). The conservation value of critical habitat in the study area is high because it supports both recruitment and survival of juveniles and adults (NMFS 2006a).

EFH is defined as those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity. EFH includes currently and historically accessible habitat. All levee reaches within the West Sacramento GRR study area are considered to be EFH for spring-run Chinook salmon except for the South Cross toe drain.

### **3.2.3 Central Valley Fall-/Late Fall-Run Chinook Salmon Evolutionarily Significant Unit**

#### **Status and Distribution**

The Central Valley fall-/late fall-run Chinook salmon ESU (*Oncorhynchus tshawytscha*) is not listed under the Federal ESA. On March 9, 1998, NMFS issued a proposed rule to list fall-run Chinook salmon as threatened (NMFS 1998a). However, on September 16, 1999, NMFS determined that the species did not warrant listing (NMFS 1999). On April 15, 2004, NMFS classified Central Valley fall-/late fall-run Chinook salmon as a species of concern (NMFS 2004). However, EFH is designated for this species.

The Central Valley fall-/late fall-run Chinook salmon ESU includes all naturally spawned populations of fall-run Chinook salmon in the Sacramento and San Joaquin river basins and their tributaries. Central Valley fall-/late fall-run Chinook salmon are currently the most abundant and widespread salmon runs in California (Mills et al. 1997), representing about 80% of the total Chinook salmon produced in the Sacramento River drainage (Kjelson et al. 1982). The most abundant spawning populations of fall-/late fall-run Chinook salmon occur in the Sacramento, Feather, Yuba, and American rivers (Mills and Fisher 1994). Fall-run Chinook salmon in the Sacramento, Feather, and American Rivers have a relatively large hatchery component, from 1952 to 2013 the average was 57,508 fish. The

average escapement in-river on the Sacramento and San Joaquin system from 1960 to 2013 was 264,475 (CDFW 2013b).

### **Life History**

Adult fall-run Chinook salmon migrate into the Sacramento River and its tributaries from June through December in mature condition and spawn from late September through December, soon after arriving at their spawning grounds (Yoshiyama et al. 1998). The spawning peak occurs in October and November. Emergence occurs from December through March, and juveniles migrate downstream to the ocean soon after emerging, rearing in fresh water for only a few months. Smolt outmigration typically occurs from March through July (Yoshiyama et al. 1998).

Late fall-run Chinook salmon migrate upstream before they are sexually mature, and hold near spawning grounds for 1 to 3 months before spawning. Upstream migration takes place from October through April and spawning occurs from late January through April, with peak spawning in February and March (Yoshiyama et al. 1998). Fry emerge from April through June. Juvenile late fall-run Chinook salmon rear in their natal streams during the summer, and in some streams they remain throughout the year. Smolt outmigration can occur from November through May (Yoshiyama et al. 1998).

### **Factors Affecting Abundance**

Factors affecting abundance of fall-/late fall-run Chinook salmon are similar to factors affecting abundance of winter- and spring-run Chinook salmon, i.e., habitat loss and degradation. Fall-run Chinook salmon, however, typically use spawning habitat farther downstream than the spawning habitat used by spring- and winter-run Chinook salmon. The effect of dams on spawning habitat area for fall-run Chinook salmon is not as severe as for other runs, although access to substantial spawning habitat area has been blocked by dams.

### **Critical Habitat/Essential Fish Habitat**

Critical habitat is not designated for fall-/late fall-run Chinook salmon, however EFH is designated for this species. EFH is defined as those waters and substrate necessary for spawning, breeding, feeding, or growth to maturity. EFH includes currently and historically accessible habitat. All levee reaches within the West Sacramento GRR study area are considered to be EFH for fall-/late fall-run Chinook salmon except for the South Cross toe drain.

### **3.2.4 Central Valley Steelhead Distinct Population Segment**

#### **Status and Distribution**

The Central Valley steelhead (*Oncorhynchus mykiss*) DPS was Federally listed as threatened on March 19, 1998 (NMFS 1998b). The threatened status of Central Valley steelhead was reaffirmed in NMFS's final listing determination on January 5, 2006 (NMFS 2006a); at the same time NMFS also adopted the term DPS, in place of ESU, to describe Central Valley steelhead and other population segments of this species. NMFS originally designated critical habitat for Central Valley steelhead on February 16, 2000 (NMFS 2000). However, following a lawsuit (*National Association of Home Builders et al. v. Donald L. Evans, Secretary of Commerce, et al.*), NMFS decided to rescind the listing and re-evaluate how to classify critical habitat for several DPSs of steelhead.

Critical habitat for Central Valley steelhead was re-designated by NMFS on September 2, 2005 (NMFS 2005b). The DPS includes all naturally spawned populations of steelhead in the Sacramento and San Joaquin rivers and their tributaries, excluding steelhead from San Francisco and San Pablo Bays and their tributaries. Artificially propagated fish from the Coleman and Feather River hatcheries are included in the DPS (NMFS 2006a).

Steelhead ranged throughout the tributaries of the Sacramento and San Joaquin Rivers prior to dam construction, water development, and watershed perturbation dating from the 19<sup>th</sup> and 20<sup>th</sup> centuries. Wild stocks are now mostly confined to the upper Sacramento River downstream of Keswick Dam; upper Sacramento River tributaries such as Deer, Mill, and Antelope Creeks; and the Yuba River downstream of Englebright Dam. Populations may also exist in Big Chico and Butte Creeks and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996). The abundance of naturally reproducing Central Valley steelhead, as measured by the number of adults returning to spawn, is largely unknown. Natural escapement in 1995 was estimated to be about 1,000 adults each for Mill and Deer Creeks and the Yuba River (S. P. Cramer and Associates 1995). Hatchery returns have averaged around 10,000 adults (Mills and Fisher 1994). The most recent annual estimate of adults spawning upstream of Red Bluff Diversion Dam is less than 2,000 fish (NMFS 2006a).

#### **Life History**

Central Valley steelhead have one of the most complex life histories of any salmonid species, exhibiting both anadromous and freshwater resident life histories. Freshwater residents typically are referred to as rainbow trout, and those exhibiting an anadromous life history are called steelhead (NMFS 1999). Steelhead exhibit highly variable life history patterns throughout their range but are broadly categorized into winter and summer reproductive ecotypes. Winter steelhead are the most widespread reproductive ecotype and the only type currently present in Central Valley streams (McEwan and Jackson 1996). Winter steelhead become sexually mature in the ocean, enter spawning

streams in summer, fall or winter, and spawn a few months later in winter or late spring (Meehan and Bjornn 1991; Behnke 1992).

In the Sacramento River, adult winter steelhead migrate upstream during most months of the year, beginning in July, peaking in September, and continuing through February or March (Hallock 1987). Spawning occurs primarily from January through March, but may begin as early as late December and may extend through April (Hallock 1987). Individual steelhead may spawn more than once, returning to the ocean between each spawning migration.

Juvenile steelhead rear a minimum of one and typically two or more years in fresh water before migrating to the ocean as smolts. Juvenile migration to the ocean generally occurs from December through August. The peak months of juvenile migration are January to May (McEwan 2001). The importance of main channel and floodplain habitats to steelhead in the lower Sacramento River and upper Delta is not well understood. Steelhead smolts have been found in the Yolo Bypass during the period of winter and spring inundation (Sommer 2002), but the importance of this and other floodplain areas in the lower Sacramento River and upper Delta is not yet clear.

### **Factors Affecting Abundance**

The decline in steelhead populations is attributable to changes in habitat quality and quantity. The availability of steelhead habitat in the Central Valley has been reduced by as much as 95% or more due to barriers created by dams (NMFS 1996a). Populations have been most severely affected by dams blocking access to the headwaters of all major tributaries; consequently, most runs are maintained through artificial production. The decline of naturally produced Central Valley steelhead has been more precipitous than that of hatchery stocks. Populations in the range's southern portion have experienced the most severe declines (NMFS 1996b). Other factors contributing to the decline of steelhead in the Central Valley are mining, agriculture, urbanization, logging, harvest, hatchery influences, flow management (including reservoir operations), hydropower generation, and water diversion and extraction (NMFS 1996a).

### **Critical Habitat/Essential Fish Habitat**

Habitat for endangered or threatened anadromous fish is designated as critical habitat under the ESA and as EFH under the MSA. No EFH has been designated for steelhead. Critical habitat for Central Valley steelhead includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-waterline or bank-full elevation. The DWSC and the South Cross toe drain are not designated as critical habitat for steelhead. Primary constituent elements of critical habitat are as described for spring-run Chinook salmon (NMFS 2006b).

### 3.2.5 Delta Smelt

#### Status and Distribution

Delta smelt (*Hypomesus transpacificus*) was Federally listed as threatened on March 5, 1993 (USFWS 1993) and critical habitat was designated on December 19, 1994 (USFWS 1994). Population trends and abundance of Delta smelt are poorly understood due to their short life span (1 year). Based on data from 21 years of monthly sampling in Suisun Marsh, Delta smelt appear to be experiencing long-term declines (Matern et al. 2002). Summer tow-net and fall/mid-water trawl data show fluctuating annual abundance from 1991 through 1996, with an increasing trend in the late 1990s, followed by an overall decline in abundance since 1999 (Bryant and Souza 2004).

#### Life History

Delta smelt are endemic to the Sacramento-San Joaquin estuary and are found seasonally in Suisun Bay and Suisun Marsh. They typically are found in shallow water (less than 10 feet) where salinity ranges from 2 to 7 parts per thousand (ppt), although they have been observed at salinities between 0 and 18.4 ppt. Delta smelt have relatively low fecundity and most live for 1 year. They feed on planktonic copepods, cladocerans, amphipods, and insect larva (Moyle 2002).

Delta smelt are semi-anadromous. During their spawning migration, adults move into the freshwater channels and sloughs of the Delta between December and January. Spawning occurs between January and July, with peak spawning from April through mid-May (Moyle 2002). Spawning locations in the Delta have not been identified and are inferred from larval catches (Bennett 2005). Larval fish have been observed in Montezuma Slough; Suisun Slough in Suisun Marsh; the Napa River estuary; the Sacramento River above Rio Vista; and Cache, Lindsey, Georgiana, Prospect, Beaver, Hog, Sycamore, and Barker sloughs (Wang 1986, Moyle 2002, Stillwater Sciences 2006, and USFWS 1996). Spawning was also observed in the Sacramento River up to Garcia Bend (RM 51) during drought conditions, as a result of increased saltwater intrusion that moved Delta smelt spawning and rearing farther inland (Wang and Brown 1993).

Laboratory experiments have found eggs to be adhesive, demersal, and usually attached to substrate composed of gravel, sand, or other submerged material (Moyle 2002, Wang 1991). Hatching takes approximately 9 to 13 days, and larvae begin feeding 4 to 5 days later. Newly hatched larvae contain a large oil globule that makes them semi-buoyant and allows them to stay near the bottom. As their fins and swim bladder develop, they move higher into the water column and are transported downstream to the open waters of the estuary (Moyle 2002).

### **Factors Affecting Abundance**

Diversions and Delta inflow and outflow may affect survival of Delta smelt. In water exported at the South Delta Central Valley Project and State Water Project export facilities, estimates of Delta smelt entrainment suggest a population decline in the early 1980s, mirroring the decline indicated by mid-water trawl, summer tow-net, Kodiak trawl, and beach seine data (Bennett 2005). Diversions and upstream storage, including operation of the Central Valley Project and State Water Project, control Delta inflow and outflow during most months. Reduced Delta flow may inhibit or slow movement of larvae and juveniles to estuarine rearing habitat and into deeper and narrower channels of the Delta, resulting in lower prey availability and increased mortality from predators (Moyle 2002). Low Delta flow also may increase entrainment in diversions, including entrainment at the Central Valley Project and State Water Project export pumps (Moyle 2002). Additional factors affecting Delta smelt abundance include extremely high river outflow that increases entrainment at export facilities, changes in prey abundance and composition, predation by nonnative species, toxic substances, disease, and loss of genetic integrity through interbreeding with the introduced Wagasaki smelt (Moyle 2002; CDFG 2000; Bennett 2005).

### **Critical Habitat**

Critical habitat for Delta smelt consists of all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the contiguous waters in the Delta (USFWS 1994). Critical habitat for Delta smelt is designated in the following California counties: Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo (USFWS 2003). Critical habitat in the West Sacramento GRR study area includes the Sacramento River up to the I Street Bridge, Yolo Bypass just above Interstate 80 at the railroad tracks, and the DWSC. Primary constituent elements of critical habitat determined to be essential to the conservation of the species include: physical habitat, water, river flow, and salinity concentrations required to maintain Delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration (USFWS 2006a).

## **3.2.6 Green Sturgeon Southern Distinct Population Segment**

### **Status and Distribution**

On January 23, 2003, NMFS determined that green sturgeon (*Acipenser medirostris*) are comprised of two populations, a northern and a southern DPS (NMFS 2003). The northern DPS includes populations extending from the Eel River northward, and the southern DPS includes populations south of the Eel River to the Sacramento River. The Sacramento River supports the southernmost spawning population of green sturgeon (Moyle 2002). On April 6, 2005, NMFS determined that the northern DPS

does not warrant listing under the ESA, but it remains on the Species of Concern List (NMFS 2005c). On April 7, 2006, NMFS determined that the southern DPS of green sturgeon was threatened under the Federal ESA (NMFS 2006c). On October 9, 2009, NMFS (74 CFR 52300) designated critical habitat for the green sturgeon southern DPS throughout most of its occupied range.

Green sturgeon were classified as a Class 1 Species of Special Concern by the California Department of Fish and Game (CDFG) in 1995 (Moyle et al. 1995). Class 1 Species of Special Concern are those that conform to the State definitions of threatened or endangered and could qualify for addition to the official list. On March 20, 2006, emergency green sturgeon regulations were put into effect by CDFG requiring a year-round zero bag limit of green sturgeon in all areas of the state (CDFG 2006).

### **Life History**

The green sturgeon is anadromous, but it is the most marine-oriented of the sturgeon species and has been found in near shore marine waters from Mexico to the Bering Sea (NMFS 2005c). The southern DPS has a spawning population in the Sacramento River (NMFS 2005d) and more recently spawning has been observed in the lower Feather River, a tributary of the Sacramento River (Seesholtz et al. 2012). Adults typically migrate upstream into rivers between late February and late July. Spawning occurs from March to July, with peak spawning from mid-April to mid-June. Green sturgeon are believed to spawn every 3 to 5 years, although recent evidence indicates that spawning may be as frequent as every 2 years (NMFS 2005c). Little is known about the specific spawning habitat preferences of green sturgeon. Adult green sturgeon are believed to broadcast their eggs in deep, fast water over large cobble substrate, where the eggs settle into the interstitial spaces (Moyle 2002). Spawning is generally associated with water temperatures from 46 to 57 degrees Fahrenheit (°F). In the Central Valley, spawning occurs in the Sacramento River upstream of Hamilton City, perhaps as far upstream as Keswick Dam (Adams et al. 2002) and the lower Feather River (Seesholtz et al. 2012).

Green sturgeon eggs hatch in approximately 8 days at 55°F (Moyle 2002). Larvae begin feeding 10 days after hatching. Metamorphosis to the juvenile stage is complete within 45 days of hatching. Juveniles spend 1 to 4 years in fresh and estuarine waters and migrate to salt water at lengths of 300 to 750 millimeters (mm) (NMFS 2005c).

Little is known about movements, habitat use, and feeding habits of green sturgeon. Green sturgeon have been salvaged at the state and Federal fish collection facilities in every month, indicating that they are present in the Delta year-round. Juveniles and adults are reported to feed on benthic invertebrates, including shrimp and amphipods, and small fish (NMFS 2005c).

### **Factors Affecting Abundance**

The historical decline of the southern DPS of green sturgeon has been largely attributed to the reduction of spawning habitat area. Keswick and Shasta Dams on the Sacramento River and Oroville Dam on the Feather River are impassable barriers that prevent green sturgeon from accessing what

were likely historical spawning grounds upstream of these dams. Other potential migration barriers or impediments include the Sacramento Deep Water Ship Channel locks, Fremont Weir, Sutter Bypass, the Delta Cross Channel, and Shanghai Bench and Sunset Pumps on the Feather River. Other factors that have been identified as potential threats to green sturgeon are reductions in freshwater outflow in the Delta during larval dispersal and rearing, high water temperatures during spawning and incubation, entrainment by water diversions, contaminants, predation and other impacts by introduced species, and poaching (NMFS 2005c).

### **Critical Habitat/Essential Fish Habitat**

There is no EFH designated for green sturgeon. Designated critical habitat for the southern DPS of green sturgeon includes the Sacramento River downstream of Keswick Dam, the Feather River downstream of Oroville Dam, and the Yuba River downstream of Daguerre Dam; portions of Sutter and Yolo Bypasses; the legal Delta, excluding Five Mile Slough, Seven Mile Slough, Snodgrass Slough, Tom Paine Slough and Trapper Slough; and San Francisco, San Pablo, and Suisun bays. Freshwater habitat of green sturgeon varies in function, depending on location within the Sacramento River watershed. Spawning areas currently are limited to accessible reaches of the Sacramento River upstream of Hamilton City, downstream of Keswick Dam (CDFG 2002) and portions of the Feather River (Seesholtz et al. 2012). Preferred spawning habitats are thought to contain large cobble in deep and cool pools with turbulent water (CDFG 2002; Moyle 2002; Adams et al. 2002). Sufficient flows are needed to sufficiently oxygenate and limit disease and fungal infection of recently laid eggs (Deng et al. 2002). Within the Sacramento River, spawning appears to be triggered by large increases in water flow during spawning (Brown and Michniuk 2007).

## **3.3 Reptile Species**

One Federally listed reptile species was identified in the USFWS database records as utilizing parts of the West Sacramento project study area: the giant garter snake (*Thamnophis gigas*).

### **3.3.1 Giant Garter Snake**

#### **Status and Distribution**

The giant garter snake (*Thamnophis gigas*) is Federally listed as a threatened species under the ESA. Currently, this species is only known from 13 isolated population clusters within the Central Valley, from Chico to an area just southwest of Fresno (USFWS 1997).

There are no CNDDDB (CDFW 2013a) records for giant garter snakes within the study area, although there are several occurrences within 10 miles of the study area. The closest of these occurrences is located approximately 3 miles from the study area in a drainage canal. This record is

labeled as sensitive, and therefore, provides no specifics on location or type of observation. Other recorded occurrences within 10 miles of the study area include records for one juvenile located in a drainage canal 1.5 miles south of Del Paso Road, one adult found within the Yolo Bypass 0.75 mile south of I-80, and numerous other records that are labeled as sensitive (CDFW 2013a). Within the study area, emergent wetlands and open water areas in sloughs, canals, or vegetated ditches in the Yolo and Sacramento Bypasses, within the Yolo Bypass toe drain, DWSC and areas of the South Cross toe drain have the highest potential to support giant garter snakes. Water areas with little to no aquatic or upland vegetation could provide marginal or seasonal habitat. Throughout the study area, other emergent wetlands and open water areas could provide suitable aquatic habitat and the upland areas adjacent to these aquatic habitats could provide winter hibernacula and dry refugia required by this snake.

### **Life History**

The giant garter snake inhabits agricultural wetlands and associated waterways, including irrigation and drainage canals, rice fields, marshes, sloughs, ponds, low-gradient streams, and adjacent uplands. They have also been observed to use revetment as cover (Wylie et al. 2002). Giant garter snakes are believed to be most numerous in rice-growing regions (USFWS 1999b). Giant garter snakes are typically absent from the larger rivers; wetlands with sand, gravel, or rock substrates; and riparian areas lacking suitable basking sites or suitable prey populations (Hansen and Brode 1980; Brode 1988; USFWS 1999b). The giant garter snake hibernates from October to March in abandoned burrows of small mammals located above prevailing flood elevations (Fisher et al. 1994), and breeds during March and April.

### **Factors Affecting Abundance**

Giant garter snakes have been reduced in distribution and abundance due to habitat loss and degradation throughout the Central Valley. Several factors may degrade habitat for giant garter snakes, including upstream watershed modifications, water storage and diversion projects, and urban and agricultural development. Contamination from agricultural runoff may also have detrimental effects. On-going agricultural practices such as tilling, grading, harvesting and operation of other equipment may also result in mortality and increased rates of predation. Clearing and maintenance of irrigation canals and draining of rice fields may also result in mortality and degradation of habitat (USFWS 1999b).

## **3.4 Birds**

Special status bird species with the potential to occur near or in the West Sacramento project study area are listed below (Table 20), Species protected under the Migratory Bird Treaty Act (MBTA) such as the bald eagle (*Haliaeetus leucocephalus*) may occur transiently during the winter months, although suitable nesting habitat is not present. CNDDDB (CDFW 2013a) data for actual species present in the North and South Basin study area's are located below in Figures 18 and 19.

**Table 20. California Natural Diversity Database Species List for Yolo and Sacramento County.**

Common Name	Scientific Name	Status <sup>a</sup> Federal/State
white-tailed kite	<i>Elanus leucurus</i>	-/FP
Swainson's hawk	<i>Buteo swainsoni</i>	-/T
loggerhead shrike	<i>Lanius ludovicianus</i>	-/SSC
bank swallow	<i>Riparia riparia</i>	-/T
tricolored blackbird	<i>Agelaius tricolor</i>	-/SSC
yellow-headed blackbird	<i>Xanthocephalus xanthocephalus</i>	-/SSC
purple martin	<i>Progne subis</i>	-/SSC
northern harrier	<i>Circus cyaneus</i>	-/SSC
western burrowing owl	<i>Athene cunicularia hypugea</i>	-/SSC

<sup>a</sup> Status explanations:  
 – = no listing  
 E = listed as endangered under the California Endangered Species Act  
 T = listed as threatened under the California Endangered Species Act  
 FP = fully protected under the California Fish and Game Code  
 SSC = species of special concern in California



**Figure 18. Special Status Bird Species in the West Sacramento North Basin, August 26, 2013.**



Figure 19. Special Status Bird Species in the West Sacramento South Basin, August 26, 2013.

### 3.5 Mammals

Special status mammal species with the potential to occur near or in the West Sacramento GRR North and South Basin study area are listed below (Table 21). CNDDDB (CDFW 2013a) data for actual species present in the North study area are located below in Figure 20. CNDDDB (CDFW 2013a) indicates that there were no special status species present in the South Basin of the study area.

Table 21. California Natural Diversity Database Species List for Yolo and Sacramento County.

Common Name	Scientific Name	Status <sup>a</sup> Federal/State
hoary bat	<i>Lasiurus cinereus</i>	-/SSC
pallid bat	<i>Antrozous pallidus</i>	-/SSC
western red bat	<i>Lasiurus blossevillii</i>	-/SSC

<sup>a</sup> Status explanations:  
 – = no listing  
 E = listed as endangered under the California Endangered Species Act  
 T = listed as threatened under the California Endangered Species Act  
 FP = fully protected under the California Fish and Game Code  
 SSC = species of special concern in California



**Figure 20. Special Status Mammal Species in the West Sacramento North Basin, August 28, 2013.**

#### **4.0 Environmental Baseline**

This section describes the physical conditions and special status species habitat and presence within the West Sacramento project and Southport EIP study areas. These conditions are first presented generally throughout the West Sacramento project study area and then site specific SRA is analyzed as well as affected species in the West Sacramento project study area. The environmental baseline provides information necessary to determine if the proposed action would jeopardize the continued existence of species being considered, and if the project can support long-term survival of these species in the study area.

For the Southport EIP, the environmental baseline is described in consideration of “the past and present impacts of all Federal, state, or private actions and other human activities in an Action Area, the anticipated impacts of all proposed Federal projects in an Action Area that have already undergone formal or early Section 7 consultation, and the impact of State or private actions that are contemporaneous with the consultation in process” (50 CFR §402.02). This section describes the general physical conditions and associated vegetation, wildlife, and fisheries resources in the lower Sacramento River and Southport EIP Action Area.

The West Sacramento project study area includes the mainstem Sacramento River 11.4 miles from the Sacramento Bypass south to the South Cross Levee. The study area also includes the Yolo Bypass, DWSC, Barge Canal, Port of West Sacramento, upper Yolo Bypass toe drain, and the South Cross toe drain. The Southport EIP study area is focused on the Sacramento River reach south of the Barge Canal.

Downstream from the American River confluence, the Sacramento River is moderately sinuous (average sinuosity of 1.3), with the channel confined on both sides by man-made levees enhanced by decades of man-made additions. The channel in this reach is of uniform width, is not able to migrate, and is typically narrower and deeper relative to the upstream reach due to scour caused by the concentration of shear forces acting against the channel bed (Brice 1977). However, there is a short reach of setback levee in this reach, on the west bank of the Sacramento River at River Mile 57.2, just downstream of where the Barge Canal connects to the river in West Sacramento. The setback levee at River Mile 57.2 was constructed by the Corps under the Sacramento River Bank Protection Project (SRBPP).

The natural banks and adjacent floodplains of the Sacramento River are composed of silt- to gravel-sized particles with poor to high permeability. Historically, the flow regimes caused the deposition of a gradient of coarser to finer material, and longitudinal fining directed downstream (sand to bay muds). The deposition of these alluvial soils historically accumulated to form extensive natural levees and splays along the river, 5 to 20 feet above the floodplain for as far as 10 miles from the channel (Thompson 1961). The present day channels consist of fine-grained cohesive banks that erode due to natural processes as well as high flow events (Corps 2012).

Seasonal high flows enter the adjacent Yolo Bypass from this reach of the Sacramento River via the Sacramento Bypass (RM 63). Tidal influence emanating from Suisun Bay extends up the Sacramento River for 80 miles to Verona, with greater tidal variations occurring downstream during low river stages in summer and fall.

Descriptions of baseline conditions are based on information published in peer-reviewed scientific literature, resource agency publications, as well as aerial photography viewed in Google Earth Pro within the project area. Baseline conditions are described with a focus on features that affect habitat conditions for threatened and endangered species, including Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, delta smelt, green sturgeon, giant garter snake, and the valley elderberry longhorn beetle.

#### **4.1 West Sacramento GRR Baseline**

The West Sacramento project study area consists of primarily riparian scrub-shrub habitat. Early riparian habitat may be called scrub-shrub. Scrub-shrub generally refers to areas where the woody riparian canopy is composed of trees or shrubs approximately 20 feet high. Species that are typically found in these habitats include young cottonwood, willow, elderberry, buttonbush, Himalaya blackberry, wild grape, and poison oak. In very dense stands there may be no understory; however, in open canopies, understory vegetation may consist of an herbaceous layer of sedges, rushes, grasses, and forbs. Provided disturbance of the area is low, the scrub-shrub may acquire enough overstory cover to become riparian forest within 20 years.

Riparian forest typically has a dominant overstory of cottonwood, California sycamore, or valley oak. Species found in the scrub-shrub would make up the sub canopy and could also include white alder and box elder. Layers of climbing vegetation make up part of the subcanopy, with wild grape being a major component, but wild cucumber and clematis are also found in riparian communities.

The herbaceous ruderal habitat is found on most levees along the Sacramento River. It occurs on the levees and also within gaps in the riparian habitats. Plant species include wild oats, soft chess, ripgut brome, red brome, wild barley, and foxtail fescue. Common forbs include broadleaf filaree, red stem filaree, turkey mullein, clovers, and many others. The majority of these plants are not native to the project area.

#### **Historical Human Resource Use and Current Riparian Vegetation**

Historical precipitation and runoff patterns resulted in the Sacramento River being bordered by up to 500,000 acres of riparian forest, with valley oak woodland covering the higher river terraces (Katibah 1984). However, human activities of the 1800s and 1900s have substantially altered the hydrologic and fluvial geomorphic processes that create and maintain riparian forests within the Sacramento basin, resulting in both marked and subtle effects on riparian communities. Riparian recruitment and establishment models (Mahoney and Rood 1998; Bradley and Smith 1986) and empirical field studies (Scott et al. 1997, 1999) emphasize that hydrologic and fluvial processes play a central role in controlling the elevational and lateral extent of riparian plant species. These processes are especially important for pioneer species that establish in elevations close to the active channel, such as cottonwood and willows (*Salix* spp.). Failure of cottonwood recruitment and establishment is attributed to flow alterations by upstream dams (Roberts et al. 2001) and to isolation of the historic floodplain from the river channel. In addition, many of these formerly wide riparian corridors are now narrow and interrupted by levees and weirs. Finally, draining of wetlands, conversion of floodplains to agricultural fields, and intentional and unplanned introduction of exotic plant species have altered the composition and associated habitat functions of many of the riparian communities that are able to survive under current conditions.

### Site-Specific Analysis of Riparian Vegetation

Analysis of total linear feet (lf) of SRA in the West Sacramento study area was conducted using Google Earth Pro for the levee reaches on the Sacramento River North and South and Port North and South areas (Table 22). The Sacramento Bypass Training levee, Yolo Bypass, and South Cross levee reaches were not evaluated because there is minimal, if any, SRA associated with these reaches. There also could be the potential for habitat removal in the Sacramento Bypass during the widening process but will wait for analysis once future designs are presented.

The Corps would need to remove some SRA habitat in order to place rock along the river bank, but more than half of the existing SRA habitat along the 11 miles of Sacramento River levees would remain in place. A variance would also be sought for these levee reaches, allowing 34 acres of riparian habitat on the lower one-third of the slope to 15 feet waterward of the waterside levee toe to remain in place. As a result, the SRA habitat along the river would continue to grow at a natural rate and would likely increase over time.

**Table 22. Summary of Reach-Specific SRA Analysis<sup>1</sup>.**

REACH	LINEAR FEET (lf) of SRA	REACH	LINEAR FEET (lf) of SRA
Port North Levee	2,468	Sac. River North Levee	27,241
Port South Levee	2,602	Sac. River South Levee	16,047
Total SRA for Study Area: 48,358 lf			

<sup>1</sup> Numbers were obtained using aerial photography and are estimates. Numbers are rounded.

## **4.2 Southport EIP Baseline**

### **4.2.1 Lower Sacramento River in the Southport EIP Action Area**

The Sacramento River watershed receives winter/early spring precipitation in the form of rain and snow (at higher elevations). Prior to the construction and operation of any reservoirs, winter rainfall events caused extensive flooding and spring snowmelt resulted in high flows during spring and early summer. Summer and fall flows were historically low. Currently, much of the total runoff is captured and stored in reservoirs for gradual release during the summer and fall months. High river flows occur during the winter and spring, but these are usually lower than during pre-European settlement times; summer and fall low flows are sustained by releases from upstream reservoirs.

The Southport EIP Action Area is located in Region 1b of the SRBPP regional planning area, which includes the mainstem Sacramento River from Isleton (RM 20) to the Feather River confluence at Verona. Downstream from the Feather River confluence, the Sacramento River channel is moderately sinuous (average sinuosity of 1.3) and confined on both sides by natural and man-made levees that

restrict further channel migration. The channel in this reach is uniform in width and typically narrower and deeper relative to the upstream reach due to scour caused by lateral confinement and the concentration of shear forces on the channel bed (Brice 1977).

The natural banks and adjacent floodplains are composed of silt- to gravel-sized particles with poor to high permeability. Historically, the flow regimes caused the deposition of a gradient of coarser to finer material, and longitudinal fining directed downstream (sand to bay muds). The deposition of these alluvial soils historically accumulated to form extensive natural levees and splays along the rivers, 5 to 20 feet above the floodplain for as far as 10 miles from the channel (NMFS 2008). The present day channels are flanked by fine-grained cohesive banks with erosion due to both mass failures and fluvial erosion (Harvey 2002).

Within this portion of the Sacramento River, bank erosion and lateral migration of the channel is generally limited to a distance of 50 to 100 feet between the levee and river bank. These areas may be occupied by a narrow strip of riparian forest or riparian scrub/shrub. Based on aerial photo-interpretation of 1-foot resolution Digital Globe imagery (2008), many areas between the channel edge and closely set levees support either very little vegetation or a low density cover of weedy herbaceous plants (ruderal species). Bank revetments currently account for two-thirds of the region-wide shorelines based on data obtained from the Corps' revetment database (USFWS 2002; Corps 2006). The bank revetment composition includes medium to large (quarry) rock, rubble, and cobbles. The majority of revetments present at the erosion sites and along the banks without erosion sites is large (>20 inches) rock. The presence of levees and bank revetments and the loss of wide expanses of riparian forest currently limit IWM recruitment, bank erosion, and point bar formation, which in turn limit habitat diversity that would normally result from such natural processes.

Reaches throughout the SRBPP planning area historically provided both shallow and deeper water habitat; however, channel confining levees and upstream reservoirs that maintain year-round outflow have eliminated much of the adjacent shallow water floodplain habitat. Many native fish species are adapted to rear in flooded, shallow water areas that provide abundant cover and prey. As a consequence of habitat alterations, and the introduction of non-native species and pollutants, some native fish species are now extinct while most others are reduced in numbers (Moyle 2002). Levee repair and bank protection projects conducted recently by the Corps and the California Department of Water Resources (DWR) in the SRBPP planning area have included onsite and offsite elements to compensate for the loss of SRA cover, riparian, and floodplain habitat to address the specific conservation and recovery needs of listed fish and wildlife species. These elements include setback levees, riparian and wetland planting benches, and IWM installation.

The quantification of existing SRA cover nearshore and floodplain habitat conditions in the Southport EIP project area, as measured by the Standard Assessment Methodology (SAM), is described in Appendix C.

#### 4.2.2 Land Cover Types

Sixteen land cover types were identified in the project area. Table 23 includes the mapped acreages for each land cover type. Nine of the land cover types are considered natural communities: all four riparian habitats, emergent marsh, valley oak woodland, walnut woodland, nonnative annual grassland, pond, and perennial drainage. The other cover types are associated with human activities: all three agricultural field types, walnut orchard, agricultural ditch, and developed/landscaped. Because land cover types were not mapped to include the Southport EIP Action Area, acreages of land cover for the entire Action Area are not shown in this table. Each of the land cover types is discussed below.

**Table 23. Land Cover Types and Acreage in the Southport EIP Action Area.**

Land Cover Type	Acreage
Cottonwood riparian woodland	29.48
Valley oak riparian woodland	5.66
Walnut riparian woodland	2.19
Riparian scrub	13.23
Valley oak woodland	42.06
Walnut woodland	0.71
Emergent wetland	6.28
Nonnative annual grassland	57.15
Cultivated agricultural field	297.53
Disked/plowed agricultural field	144.50
Fallow agricultural field	1,112.82
Walnut orchard	12.03
Perennial drainage (Sacramento River)	63.65
Ditch	21.02
Developed/landscaped	113.56
<b>Total project area</b>	<b>1,921.87</b>

#### Riparian Communities

Riparian communities in general are some of the richest community types in terms of structural and biotic diversity of any plant community found in California. Riparian vegetation provides three important functions in addition to that of wildlife habitat: (1) acts as a travel lane between the river and adjacent uplands, providing an important migratory corridor for wildlife; (2) filters out pollutants, thus protecting water quality; and (3) helps to reduce the severity of floods by stabilizing riverbanks. Despite widespread disturbances resulting from urbanization, agricultural conversion, and grazing, riparian forests remain important wildlife resources because of their scarcity regionally and statewide and because riparian communities are used by a large variety of wildlife species.

### **Cottonwood Riparian Woodland**

Cottonwood riparian woodland occurs on the sides of the Sacramento River levee, primarily on the water side, and also surrounds the Bees Lakes area. It also occurs along some agricultural ditches. The project area contains a total of 29.48 acres of cottonwood riparian woodland. The dominant overstory species are Fremont cottonwood (*Populus fremontii* ssp. *fremontii*), Goodding's black willow (*Salix gooddingii*), valley oak (*Quercus lobata*), and northern California black walnut (*Juglans hindsii*). The shrub layer is relatively open and contains small valley oaks, box elder (*Acer negundo* var. *californicum*), and tree tobacco (*Nicotiana glauca*). Blue elderberry (*Sambucus nigra*) shrubs also occur in several areas of this woodland. Representative species observed in the herbaceous understory are mugwort (*Artemisia douglasiana*), rough cocklebur (*Xanthium strumarium*), and cudweed (*Gnaphalium luteoalbum*).

Some of the trees in the cottonwood riparian woodland meet the definition of heritage or landmark trees as defined in the City's Tree Preservation Ordinance. Riparian woodland (Great Valley cottonwood riparian) is identified as a sensitive natural community by the CNDDDB (CDFG 2003). CDFW has adopted a no-net-loss policy for riparian habitat values, and the USFWS mitigation policy identifies California's riparian habitats in Resource Category 2, for which no net loss of existing habitat value is recommended (46 FR 7644).

### **Valley Oak Riparian Woodland**

Valley oak riparian woodland occurs on the water side of the Sacramento River levee and along larger irrigation ditches in the project area. Approximately 5.66 acres of valley oak riparian woodland are present in the project area. Plant species associated with valley oak riparian woodland include valley oak, sandbar willow (*Salix exigua*), red willow (*Salix laevigata*), poison-oak and Himalayan blackberry.

As described above for the cottonwood riparian woodland, some of the trees in the valley oak riparian woodland meet the definition of heritage or landmark trees as defined in the City's Tree Preservation Ordinance, and CDFW and USFWS policies support protection of riparian habitats. Valley oak riparian woodland (Great Valley valley oak riparian) is identified as a sensitive natural community by the CNDDDB (CDFG 2003).

### **Walnut Riparian Woodland**

Walnut riparian woodland occurs along an agricultural ditch in the project area. Approximately 2.19 acres of walnut riparian woodland is in the project area. The dominant overstory species are northern California black walnut and valley oak. The understory is dominated by Himalayan blackberry.

As described above for the cottonwood riparian woodland, some of the trees in the valley oak riparian woodland meet the definition of heritage or landmark trees as defined in the City's Tree Preservation Ordinance, and CDFW and USFWS policies support protection of riparian habitats. Naturally occurring California walnut woodland is identified as a sensitive natural community by the CNDDDB (CDFG 2003), although the walnut riparian woodland in the project area was most likely planted along the parcel border where it occurs.

### **Riparian Scrub**

Riparian scrub occurs intermittently on the water side of the Sacramento River levee and along some ditches in the project area. Approximately 13.23 acres of riparian scrub are in the project area. The dominant overstory species are willows and saplings of riparian trees found in the riparian woodland land cover types, and elderberry shrubs also occur along some ditches. Woody vegetation in this community is lower-growing than that found in the woodland communities. Some areas of riparian scrub occur where rock has been placed on the levee for erosion control.

Most of the trees in the riparian scrub community are too small to meet the definition of heritage or landmark trees as defined in the City's Tree Preservation Ordinance. Although riparian scrub is not specifically identified as a sensitive natural community by the CNDDDB (CDFG 2003), it may represent an early successional stage of the mature riparian woodland communities. CDFW has adopted a no-net-loss policy for riparian habitat values, and the USFWS mitigation policy identifies California's riparian habitats in Resource Category 2, for which no net loss of existing habitat value is recommended (46 FR 7644).

### **Nonriparian Woodland Communities**

#### **Valley Oak Woodland**

Valley oak woodland occurs in stands ranging in size from a few trees to several acres and covers approximately 42.06 acres in the project area. This cover type is distinguished from the oak riparian type by not being associated with a drainage. The dominant overstory species is valley oak, although other tree species are present, including interior live oak (*Quercus wislizeni*) and northern California black walnut. Understory shrub species include Himalayan blackberry and elderberry, and herbaceous grassland species are also present.

Some of the trees in the valley oak woodland meet the definition of heritage or landmark trees as defined in the City's Tree Preservation Ordinance. Valley oak woodland is identified as a sensitive natural community by the CNDDDB (CDFG 2003).

## **Walnut Woodland**

One approximately 0.71-acre grove of walnut woodland occurs in the project area north of Linden Road near the intersection with South River Road. The trees are northern California black walnut and are not associated with any drainage. Although native stands of northern California black walnut are considered special-status species (California Native Plant Society [CNPS] List 1B.1) and California walnut woodland is identified as a sensitive natural community by the CNDDDB (CDFG 2003), the grove of trees in the project area most likely is planted and not a native occurrence. The trees, therefore, would not be considered special-status species. However, some of the trees in the walnut woodland meet the definition of heritage or landmark trees as defined in the City's Tree Preservation Ordinance.

## **Wetland Community**

### **Emergent Wetland**

Emergent wetland vegetation occurs in undredged agricultural ditches, in the southernmost borrow area, and in patches along the DWSC in the project area and covers approximately 6.28 acres. The agricultural ditches included in the emergent wetland category support 50% or more cover of wetland vegetation. Ditches that had minimal wetland vegetation at the time of the field survey are discussed below in Open Water Areas. It should be noted that annual maintenance of ditches and the DWSC may cause the location and extent of emergent wetland to vary.

Where present, wetland vegetation along the majority of irrigation ditches in the project area consisted of cattails (*Typha* sp.), bulrush (*Schoenoplectus* sp.), and Himalayan blackberry. These irrigation ditches likely would be considered waters of the United States by the Corps because they are hydrologically connected to the Main Drain, which carries water from the Sacramento River that is pumped back into the DWSC.

Emergent wetlands in the DWSC are vegetated by tule (*Schoenoplectus acutus*), narrow-leaved cattail (*Typha angustifolia*), knotweed (*Persicaria* [*Polygonum*] *hydropiperoides*), and monkeyflower (*Mimulus guttatus*), as well as English plantain (*Plantago lanceolata*) and dallisgrass (*Paspalum dilatatum*). Some emergent wetlands were vegetated almost entirely by tule and narrow-leaved cattail.

## **Herbaceous Community**

### **Nonnative Annual Grassland**

Nonnative annual grassland occurs throughout the project area on levee slopes, along roadsides, and in undeveloped parcels. Two areas of pasture associated with residences are primarily annual grasses that are grazed by horses and were mapped as nonnative annual grassland. Similar vegetation occurs in the fallow agricultural fields, described below, but those areas are larger and are subject to intermittent cultivation. The project area contains 57.15 acres of nonnative annual grassland.

The nonnative annual grassland is dominated by naturalized annual grasses with intermixed perennial and annual forbs. Grasses commonly observed in the project area are foxtail barley (*Hordeum murinum* ssp. *leporinum*), riggut brome (*Bromus diandrus*), Italian ryegrass (*Lolium multiflorum*), and soft chess (*Bromus hordeaceus*). Other grasses observed were wild oats (*Avena* spp.), Bermuda grass (*Cynodon dactylon*), and rattail fescue (*Vulpia myuros* var. *myuros*). Forbs commonly observed in annual grasslands in the project area are yellow star-thistle (*Centaurea solstitialis*), prickly lettuce (*Lactuca serriola*), bristly ox-tongue (*Picris echioides*), sweet fennel (*Foeniculum vulgare*), Italian thistle (*Carduus pycnocephalus*), horseweed (*Conyza canadensis*), black mustard (*Brassica nigra*), fireweed (*Epilobium brachycarpum*), broad-leaf pepper grass (*Lepidium latifolium*), common sunflower (*Helianthus annuus*), pigweed (*Chenopodium* sp.), cheeseweed (*Malva parviflora*), bindweed (*Convolvulus arvensis*), and telegraph weed (*Heterotheca grandiflora*). The annual grasslands in the project area contain a relatively large proportion of ruderal species, likely because of substantial disturbance from human activities. Elderberry shrubs occur in several areas of nonnative annual grassland.

### **Agricultural Communities**

#### **Cultivated Agricultural Field**

Cultivated agricultural field includes large parcels of wheat, ryegrass, and row crops that were in active cultivation at the time of the 2011 and 2012 field surveys. These areas could be transitioned to either fallow or disked/plowed conditions at other times. Cultivated agricultural field covers approximately 297.53 acres in the project area.

#### **Disked/Plowed Agricultural Field**

Disked or plowed agricultural field includes large parcels that were in active cultivation but were not vegetated at the time of the 2011 field surveys. These areas could be transitioned to either fallow or cultivated conditions at other times. Disked/plowed agricultural field covers approximately 144.50 acres in the project area.

#### **Fallow Agricultural Field**

Fallow agricultural fields occur in large parcels throughout the project area where cultivation is inactive but could be reinitiated. Approximately 1,112.82 acres of fallow agricultural field occur in the project area. The dominant species in these fields are essentially the same as those described for nonnative annual grassland, but fallow fields cover larger areas than the noncultivated grasslands in the project area. Elderberry shrubs occur in several areas of fallow agricultural field.

## **Walnut Orchard**

Three areas of walnut orchard occur in the southern half of the project area, comprising approximately 12.03 acres. Two of the orchards are in the River Park area and the third is on the west side of the Yolo Shortline Rail Corridor. Walnut orchards are distinguished from the walnut woodland in several respects—the trees are usually English walnut grafted onto a black walnut rootstock and planted in rows for cultivation and harvesting, and the orchard is generally managed intensively, with understory layers that are often unvegetated and sprayed with herbicides or disked.

## **Open Water Areas**

### **Perennial Drainage**

Perennial drainage occurs in the project area in the Sacramento River. The Sacramento River forms the eastern project area boundary and comprises approximately 63.65 acres in project area. The perennial drainage land cover type is unvegetated, but the river is bordered along much of its length in the project area by riparian woodland or scrub vegetation, as described above. The Sacramento River is a traditional navigable water, considered a water of the United States.

### **Ditch**

Ditches occur throughout the project area and cover approximately 21.02 acres. Ditches in this category include unvegetated agricultural ditches used to irrigate fields and several roadside ditches used to drain runoff. The unvegetated ditches are more highly maintained than the ditches that support emergent wetland vegetation, which are discussed above. Some unvegetated ditches support riparian scrub or riparian woodland habitat along the banks.

The Main Drain in the project area is included as a blue-line feature on the U.S. Geological Survey quadrangle. This ditch averages 90 feet in width. The bank of the ditch is vegetated by an emergent wetland community dominated by cattails (*Typha* sp.), bulrush (*Schoenoplectus* sp.), and Himalayan blackberry, but the majority of the ditch is open water. RD 900 currently controls the flow, which is dependent on water pumped from the Sacramento River and is used for irrigation. At its end, water is pumped from the ditch into the DWSC.

Other irrigation ditches branch off the Main Drain to supply water to individual fields in the project area. These additional ditches are generally narrower (widths of approximately 15 feet and 40 feet) and convey water from the Main Drain to individual fields. Agricultural ditches in the Action Area are considered waters of the United States. Smaller agricultural ditches that are excavated in upland areas and are temporary features generally are not regulated by state or Federal agencies and were not included on the land cover mapping.

## **Developed/Landscaped**

The developed/landscaped cover type was applied to residential parcels that include houses and other structures and where the vegetation is mostly landscaped, horticultural species and to roads and large paved areas, including RD 900's pumping plant on the landside of the DWSC levee. This cover type comprises approximately 113.56 acres and occurs throughout the project area.

### **Waters of the United States, Including Wetlands**

The project area contains waters of the United States consisting of the Sacramento River, emergent wetland, pond, and ditches. A preliminary delineation was conducted and submitted to the Corps to determine their jurisdiction in the project area. A site visit was conducted to verify the Corps jurisdiction. Waters of the United States and any non-jurisdictional wetlands and ditches in the project area also may qualify as waters of the state.

## **4.3 Affected Species in the West Sacramento and Southport EIP Action Areas**

### **4.3.1 Valley Elderberry Longhorn Beetle**

#### **West Sacramento Project**

Documented occurrences of VELB are present along the Sacramento River north and south, Sacramento Bypass, Port south, DWSC east and west, and the South Cross levee reaches. Surveys were conducted in 2011-2013 and a shrub count for the West Sacramento project area was estimated from the detailed surveys conducted in the Southport EIP area. The survey area consisted of the construction footprints for the levee and borrow areas; where access was available. The surveys found the greatest numbers of shrubs on the Sacramento River levee and determined that shrubs are present in both basins. All shrubs are considered to be in a riparian zone. Based on surveys conducted, it is estimated that approximately 120 shrubs have the potential to be adversely impacted by the West Sacramento project. Compensation was estimated based on the average number of stems in each stem diameter range for the shrubs that could be surveyed. In addition, an assumption was made that there were exit holes in all. See Table 17 for a summary of stem counts for elderberry shrubs directly affected and proposed compensation.

#### **Southport EIP**

There are two CNDDDB (2014) records of VELB occurrence in the Southport Action Area. Suitable habitat for VELB is located at numerous places in the Action Area along the levee and borrow construction footprints. A total of 106 shrubs/shrub clusters were identified during the 2011–2013 surveys in the Action Area. Forty-one of these shrubs are in the Action Area (Table 24). Stem counts and examination of shrubs for VELB exit holes could only be conducted for 14 of the 18 shrubs/shrub

clusters directly affected in the Action Area because of property inaccessibility and the high density of California grape and Himalayan blackberry along portions of the Sacramento River riparian corridor.

**Table 24. Summary of Elderberry Shrubs Potentially Affected by the Southport EIP.**

Shrub	Presence of Exit Holes?	Riparian Habitat?	Number of Stems (by Diameter)			Effect on Shrub (Direct or Indirect)
			1-3 Inches	3-5 Inches	>5 Inches	
2	Y	Y	0	1	1	Indirect
3	Y	Y	13	5	5	Indirect
4	N	Y	19	2	2	Indirect
5	N	Y	18	0	1	Indirect
6	N	Y	60	5	9	Direct
7	N	Y	33	10	18	Direct
8	N	Y	8	5	2	Direct
9	N	Y	30	2	8	Direct
10	Y	Y	8	4	2	Direct
23	N	Y	3	3	1	Direct
31 <sup>1</sup>	Y	N	16	4	3	Indirect
32	N	N	3	1	1	Direct
33 <sup>1</sup>	Y	N	16	4	3	Direct
34	Y	N	12	6	10	Direct
37 <sup>2</sup>	N/A	Y	N/A	N/A	N/A	Indirect
38 <sup>2</sup>	N/A	Y	N/A	N/A	N/A	Indirect
39a	N	N	3	0	0	Direct
39b <sup>2</sup>	Y	N	16	4	3	Direct
41a <sup>2</sup>	Y	N	16	4	3	Direct
41b <sup>2</sup>	Y	N	16	4	3	Direct
41c	Y	N	5	7	2	Direct
45	N	Y	1	0	9	Indirect
47	Y	Y	42	8	2	Indirect
49	N	N	0	0	1	Indirect
50	Y	N	16	7	7	Indirect
51	Y	N	14	4	7	Indirect
52	Y	Y	6	1	1	Direct
53	Y	N	29	17	3	Direct
54	N	Y	17	1	0	Indirect
80 <sup>2</sup>	N/A	Y	N/A	N/A	N/A	Indirect
81 <sup>2</sup>	N/A	Y	N/A	N/A	N/A	Indirect
82 <sup>2</sup>	N/A	Y	N/A	N/A	N/A	Indirect
84 <sup>2</sup>	N/A	Y	N/A	N/A	N/A	Indirect
85 <sup>2</sup>	N/A	Y	N/A	N/A	N/A	Indirect
92	N	Y	10	15	8	Indirect
93 <sup>2</sup>	N/A	Y	N/A	N/A	N/A	Indirect
94 <sup>2</sup>	N/A	Y	N/A	N/A	N/A	Indirect
95 <sup>2</sup>	N/A	Y	N/A	N/A	N/A	Indirect
98	N	Y	4	0	0	Direct
100	Y	Y	8	2	0	Direct

N/A = Not Available

<sup>1</sup> Shrubs could not be surveyed because there was no property access

<sup>2</sup> Shrubs could not be surveyed because they were covered in grapevines or poison oak

As described under Conservation Measure 10: Compensate for Direct Effects on Valley Elderberry Longhorn Beetle Habitat, compensation for the removal of shrubs 33, 39b, 41a, and 41b was estimated based on the average number of stems in each stem diameter range for the shrubs that could be surveyed. In addition, an assumption was made that there were exit holes in the four shrubs that could not be surveyed. See Table 18 for a summary of stem counts for elderberry shrubs directly affected in the Action Area and Table 24 for shrubs potentially affected by the proposed action.

#### **4.3.2 Chinook Salmon and Steelhead**

Factors such as levee construction and bank armoring have altered habitat for Chinook salmon and steelhead and their critical habitat. These factors reduce floodplain habitat, change river bank substrate size, and decrease the amount of riparian and SRA habitat, which in turn, reduce habitat availability and quality (NMFS 2006a). These changes have affected primarily adult and juvenile migration as well as juvenile rearing.

Bank armoring projects that have been conducted recently by the Corps and DWR, some of which are on-going, have incorporated design elements to offset the loss of habitat that generally results from placement of river bank protection materials. The creation of setback levees, and the restoration of floodplain, riparian, and SRA habitat have been implemented to improve conditions for listed salmon and steelhead in the action area (Corps 2012).

During the intermittent years when the Yolo Bypass is flooded in the winter and spring all four runs of juvenile Chinook salmon and steelhead can potentially use the floodplain and toe drain for rearing and migration.

#### **4.3.3 Green Sturgeon**

Channelization of the action area has resulted in the removal of riparian and IWM, which simplify ecosystem functions. Simplification results in reduced food input and pollutant and nutrient processing (NMFS 2006a). These factors have degraded habitat quality for larvae and post-larvae and to a lesser extent, rearing and migrating juvenile and/or adult green sturgeon (NMFS 2006b).

As described for Chinook salmon and steelhead, incorporation of riparian plantings and SRA habitat into recent bank protection projects, and development of setback levees, have been implemented to improve conditions for green sturgeon in the action area (Corps 2012)

#### **4.3.4 Delta Smelt**

##### **West Sacramento Project**

As discussed for Chinook salmon and steelhead, levee construction has altered waterside bank habitat resulting in the destruction of spawning and refugia areas for delta smelt. Loss of riparian habitat and overall habitat simplification also reduces food input and pollutant and nutrient processing (NMFS 2006b), which may impair individuals. Revetment also fragments areas of high quality shallow water habitat and accelerates water velocity, which affects use of those areas by delta smelt and other native fishes (USFWS 2006b).

Incorporation of riparian plantings and SRA habitat into recent bank protection projects, as well as development of setback levees, has been implemented to improve conditions for delta smelt and their critical habitat in the action area (Corps 2012).

##### **Southport EIP**

Delta smelt adults, eggs, and larvae may occur in the Action Area from January through July. Critical habitat for Delta smelt includes the Action Area of the Southport EIP.

#### **4.3.5 Giant Garter Snake**

##### **West Sacramento Project**

Much, if not all, of the Sacramento River area is unlikely to provide giant garter snake aquatic habitat because it consists of larger rivers and flood control features, often surrounded by riparian vegetation and steep banks. Areas of the Yolo Bypass are currently being farmed as rice. Rice fields and their adjacent irrigation and drainage canals serve an important role as aquatic habitat for giant garter snake as is the case adjacent to and within the Sacramento Bypass, Yolo Bypass, and the South Cross toe drain.

In the South Basin, the Main Drain, some of the irrigation ditches, and emergent marshes also provide suitable aquatic habitat for giant garter snake. The water creating the habitats is from precipitation or the activities of RD 900. Water is pumped into the Main Canal from the Sacramento River and then flows into several adjoining irrigation ditches that are used to irrigate agricultural fields in the project area. The flow of water through these ditches is variable and depends on the need for irrigation water, but some of the canals in the South Basin are wet year round and were considered suitable for giant garter snake.

Upland basking and overwintering habitat is also present in the project area. Upland habitat consists of nonnative annual grasslands and fallow agricultural lands within 200 feet of suitable aquatic

habitat. The upland areas adjacent to rice fields and canals associated with grasslands provide basking habitat for the snakes also.

### **Southport EIP**

There are no CNDDDB (2014) records for giant garter snakes in the Action Area, although there are 55 occurrences within 10 miles of the Action Area. No giant garter snakes were observed during the field surveys, but this does not eliminate the possibility that they inhabit the site. The Action Area is within the current range of giant garter snake (USFWS 1999b). The closest reported occurrence of giant garter snake is approximately 3 miles west of the Action Area in the Yolo Bypass (CDFW 2013).

In the Action Area, the Main Drain, some of the irrigation ditches, and emergent marshes provide suitable aquatic habitat for giant garter snake. Although Bees Lakes is outside of the Action Area, it creates suitable upland habitat for giant garter snake within the Action Area. The water creating the habitats is from precipitation or the activities of RD 900. Water is pumped into the Main Canal from the Sacramento River and then flows into several adjoining irrigation ditches that are used to irrigate agricultural fields in the Action Area. The flow of water through these ditches is variable and depends on the need for irrigation water. Most of the canals in the Action Area were wet at the time of the spring field surveys due to precipitation. However, most of the active fields in the Action Area are fallowed or planted in wheat, which does not require irrigation; therefore these ditches were not considered suitable for giant garter snake because they are dry during the snake's active season.

Upland basking and overwintering habitat is also present in the Action Area. Upland habitat consists of nonnative annual grasslands and fallow agricultural lands within 200 feet of suitable aquatic habitat. The aquatic habitat provided by Bees Lakes is not within the Action Area; however, suitable upland habitat associated with Bees Lakes is within the Action Area.

#### **4.4 Effects from Changing Environmental Baseline**

The environmental baseline for these two projects is further impacted by the potentially concurrent activities associated with the Corps' American River Common Features project and SRBPP. Concurrent construction of these four projects could contribute to adverse effects on the listed species analyzed in this BA. Due to the cumulative nature of these impacts, they are discussed below in Section 5.7.2, Federal Cumulative Effects Analysis.

#### **4.5 Non-Discretionary and Discretionary Actions**

NMFS' letter dated 9 September 2014 requested that the Corps clearly describe its scope of discretion over the proposed action and establish areas of non-discretion. The Corps agrees with the principle stated in the letter that "... impacts attributable the existence of the levees or to non-

discretionary operations are subsumed within the impacts of the environmental baseline rather than the effects attributable to the proposed action.”

#### **4.5.1 Non-Discretionary Actions**

The Corps has no discretion in regards to the continuing existence and operation of the flood control structures of the SRFCP. The responsibility to maintain Civil Works structures so that they continue to serve their congressionally authorized purposes is inherent in the authority to construct them and is therefore non-discretionary. Only Congressional actions to de-authorize the structures can alter or terminate this responsibility and thereby allow the maintenance of the structures to cease.

The Corps has a non-discretionary duty to maintain the SRFCP and the fact the Corps perpetuates the projects existence is not an action subject to consultation. The Federal government maintains oversight but has no ownership of or direct responsibilities for performing maintenance of the Federal levee system, except for few select features that continue to be owned and operated by the Corps. Considering these exceptions, the great majority of levees, channels, and related flood risk management structures are owned, operated, and maintained by the State of California and local levee and reclamation districts as governed by Corps O&M manuals. The May 1955 Standard O&M manual for the SRFCP is the primary O&M manual for the area. The levees of the West Sacramento and Common Features Projects are part of the SRFCP and therefore covered in the 1955 O&M manual.

#### **4.5.2 Discretionary Actions**

##### **Postconstruction Maintenance**

Following completion of construction of the West Sac and Common Features Projects, the Corps will prepare a supplement to the 1955 O&M manual which will specify maintenance requirements for these projects. Because the Corps does have discretion in how and when levee maintenance activities are performed (as opposed to the results of maintenance), maintenance is a discretionary activity that is part of the proposed action subject to consultation.

Typical maintenance activities would include vegetation control through mowing, herbicide application, and/or slope dragging; rodent control; patrol road maintenance; and erosion control and repair. Vegetation control typically would be performed twice a year. Herbicide and bait station application would be conducted under county permit by experts licensed by the state for pest control. Erosion control and slope repair activities would include re-sloping and compacting; fill and repair of damage from rodent burrows would be treated similarly. These activities are performed for approximately 20 days annually. Patrol road reconditioning activities would typically be performed once a year and would include placing, spreading, grading, and compacting aggregate base or substrate.

To meet Federal Flood Control Regulations (33 CFR 208.10) and state requirements (California Water Code Section 8370), the Federal Flood Risk Management facilities are inspected four times annually, at intervals not exceeding 90 days. DWR would inspect the system twice a year, and the local maintaining authorities would inspect it twice a year and immediately following major high water events. The findings of these inspections would be reported to the CVFPB's Chief Engineer through DWR's Flood Project Integrity and Inspection Branch (FPIIB).

## **5.0 Effects of the Proposed Actions**

### **5.1 Valley Elderberry Longhorn Beetle**

#### **5.1.1 West Sacramento Project**

Effects to VELB may occur if elderberry shrubs are incidentally damaged by construction personnel or equipment. Direct effects include removal or transplantation of VELB habitat for all shrubs within 20 feet of construction activities. Potential impacts due to damage or transplantation include direct mortality of beetles and/or disruption of their lifecycle.

Project actions have the potential to occur within one mile of critical habitat for VELB. Protocol-level surveys were conducted for a number of shrubs in November 2012 and January 2013. Information was recorded for each shrub that could be directly or indirectly affected by the proposed project, including number of stems between 1 and 3 inches, 3 and 5 inches, and greater than 5 inches in diameter; whether each stem 1 inch or more in diameter is located in a riparian or upland area; and presence of VELB exit holes. It was estimated that approximately 120 elderberry shrubs, including those identified in the Southport EIP Action Area, could be adversely affected due to construction activities such as removal of the shrub, heavy equipment vibration, and dust covering the elderberries.

Removal of habitat (elderberry shrubs) and potential injury or mortality of VELB associated with construction of the project would be considered direct effects on VELB. Trimming of elderberry branches that are 1 inch or greater in diameter could also result in injury or mortality of VELB. Because VELB larvae may feed on the roots of elderberries, disturbance of elderberry roots within the shrub dripline could also result in injury or mortality of individuals. Where root damage is expected to be extensive, elderberry shrubs would be removed. Where damage is limited (few roots affected) and roots are expected to grow back, impacts would be considered temporary. Removal of shrubs may also fragment remaining habitats, which may make dispersal more difficult. However, levee repairs may also have beneficial effects by protecting elderberry shrubs from being damaged or washed out due to slope failure.

Long-term effects of the project may include reduced viability of elderberry shrubs due to the placement of project area materials. Temporal loss of habitat may also occur due to transplantation of elderberry shrubs. Although compensation measures include restoration and creation of habitat, mitigation plantings will likely require five or more years to become large enough to provide supporting habitat. Furthermore, associated riparian habitats may take 25 years or longer to reach their full value.

The most likely impacts that may affect but not adversely affect VELB will be on the Sacramento River north and south levee reaches, involving bank erosion protection measures. Additional impacts could occur on the South Cross levee due to compliance with the Corps vegetation requirements. Currently, there are several elderberry shrubs found growing at the South Cross levee that would be adversely affected by fixing this levee in place. Measures to help with these impacts are detailed in Section 2.6.2 above.

### **5.1.2 Southport EIP**

#### **Direct Effects**

Construction activities (e.g., excavation, grading, recreation trails) associated with the Proposed Action could result in the loss of VELB and removal or disturbance of a number of elderberry shrubs, the host plant for VELB. Direct effects include removal or transplantation of VELB habitat for all shrubs within 20 feet of construction activities. Up to 18 elderberry shrubs or groupings of shrubs could be directly affected during construction (Table 23).

Property inaccessibility and the high density of vegetation surrounding elderberry shrubs 33, 39b, 41a, and 41b in the Action Area limited the number of elderberry shrubs that could be surveyed to 14 of the 18 shrubs that would be directly affected. For this reason, compensation for the removal of the 4 shrubs that would be directly affected and were not counted was estimated based on the average number of stems in each stem diameter range for the 14 shrubs that could be surveyed (Appendix C). In addition, an assumption was made that there were exit holes in the 4 shrubs that could not be surveyed. Those averages are as follows.

- Number of stems  $\geq 1$  inch and  $\leq 3$  inches = 16.
- Number of stems  $> 3$  inches and  $< 5$  inches = 4.
- Number of stems  $\geq 5$  inches = 3.

Removal of habitat (elderberry) and potential injury or mortality of VELB associated with construction of the Proposed Action would be considered direct effects on VELB. Trimming of elderberry branches that are 1 inch or greater in diameter could also result in injury or mortality of VELB. Because VELB larvae may feed on the roots of elderberries, disturbance of elderberry roots within the shrub

dripline could also result in injury or mortality of individuals. Where root damage is expected to be extensive, elderberry shrubs would be removed. Where damage is limited (few roots affected) and roots are expected to grow back, impacts would be considered temporary. Because incidental take of VELB would be difficult to detect or quantify, effects on elderberry shrubs will be used as a proxy for measuring take.

Elderberry shrubs within the construction area that cannot be protected will be removed in accordance with to USFWS-approved procedures outlined in the Conservation Guidelines (USFWS 1999a). Shrubs will be transplanted to the proposed Conservation Area, as described in Conservation Measure 10. Transplanted shrubs will be moved prior to construction when the shrubs are dormant, approximately November through the first 2 weeks in February, after they lose their leaves. Transplanting during the dormant period will reduce shock to the shrub and increase transplantation success. However, transplanted elderberry shrubs may experience stress, a decline in health, or death due to changes in soil, hydrology, microclimate, or associated vegetation.

Elderberry shrubs that can be avoided at the dripline of the shrub or greater distance will be protected with fencing and/or k-rail as described in Conservation Measure 7. Figure 6 (Appendix B) shows the approximate locations of elderberry shrubs.

As described in Conservation Measure 8, surveys of elderberry shrubs to be transplanted will be conducted by a qualified biologist prior to transplantation. The data collected during the surveys prior to transplantation will be used to determine if compensation requirements are being exceeded, or if additional plantings are necessary. Because the Proposed Action would be constructed over several years, elderberry survey data for each year will be used to rectify any discrepancies in compensation for the previous year, and ensure that impacts to VELB have been fully mitigated.

### **Indirect Effects**

#### **Loss of Connectivity to Adjacent Habitat**

Loss of connectivity between elderberry shrubs may result when elderberries or associated vegetation is removed. Removal of such vegetation could result in gaps in vegetation that are too wide for VELB to travel across due to their fairly limited movement distances (Talley et al. 2006b), resulting in separation of individuals or reducing the possibility of colonization of adjacent areas. Removal of associated vegetation may result in an altered habitat structure or microclimate that could affect behaviors of VELB in response to these changes in unforeseen ways (USFWS 2003).

Although more research is needed, VELB has been observed to fly a mile or more in contiguous or fairly contiguous habitat, and exit holes have been observed on isolated shrubs that are a minimum of 0.25 mile from the next nearest elderberry (Arnold 2011). Within the American River Basin, evidence suggests that local beetle movements are farther within the riparian corridor ( $141\pm 144$  feet) than in the adjacent non-riparian scrub ( $82\pm 52$  feet) (average $\pm 1$  standard deviation nearest neighbor distances

between recent exit holes) illustrating that VELB population extents may also be habitat-specific (Talley et al. 2006b).

As described above, approximately 18 elderberry shrubs are expected to be removed as part of the Proposed Action, and 23 elderberry shrubs would remain in the Action Area and continue to provide habitat for VELB. Given the distance VELB has been observed to fly, and the amount of elderberry shrubs that will remain in the Action Area, VELB is not expected to be indirectly affected by a loss of connectivity to adjacent habitat.

#### **Soil Disturbance Adjacent to Roots**

Ground disturbance within 20 feet of an elderberry shrub's dripline could result in disturbance of roots. Root damage could result in stress or reduced vigor of elderberry shrubs. Because construction of the Proposed Action may result in disturbance within 20 feet of the dripline of elderberry shrubs, indirect effects on these shrubs may result. Elderberry shrubs will be fenced and/or protected with k-rail, as described in Conservation Measure 7, to minimize soil disturbance adjacent to roots. With this measure in place, and because elderberry shrubs are hearty and frequently resprout after damage, this indirect effect is not expected to substantially affect VELB.

#### **Dust**

Vehicle travel on roads adjacent to elderberry shrubs during construction of the Proposed Action could result in dust becoming airborne and settling on elderberries. Construction of the Proposed Action would increase the amount of dust in the Action Area as a result of ground-disturbing activities and an increase in the frequency of vehicles driving on roads. The amount of dust in the Action Area would be minimized through dust control measures, as described in Conservation Measure 9. Additionally, according to Talley et al. (2006a) in an experiment along the American River Parkway, conditions of elderberry shrubs related to dust from nearby trails and roads (paved and dirt) did not affect the presence of VELB. Additional work by Talley and Holyoak (2009) found no effect on elderberries from dust accumulations. Because dust has not been found to greatly affect elderberry shrubs and because dust control measures would be implemented during construction, this indirect effect is not expected to substantially affect VELB.

#### **Altered Hydrology**

Reduction of water to elderberry shrubs as a result of altered hydrology from changes in topography or compaction of soil could result in reduced shrub vigor/vitality and an associated decrease in shoot, leaf, and flower production and ultimately reduce the suitability of the shrubs to provide habitat for VELB. In most portions of the Action Area, the levee will be degraded and rebuilt within the same footprint, and would not modify the hydrology of the surrounding area where elderberries may be present. There may be a few instances where the slope is modified or there are other changes that may

affect the hydrology in the Action Area. These situations are expected to be rare. Therefore, altered hydrology as a result of the Proposed Action is not expected to substantially affect VELB.

### **Existing Elderberry Shrubs in the Conservation Area**

As described in Conservation Measure 10, elderberry shrubs to be removed will be transplanted to the proposed Conservation Area, which contains existing elderberry shrubs. Although transplantation activities may occur within 100 feet of existing elderberry shrubs, it is unlikely that they would be indirectly affected by transplantation activities, as the transplantations would be conducted by qualified individuals who would be knowledgeable about elderberry shrubs and the existing conditions within the conservation area.

### **Temporal Loss of Habitat**

It generally takes 5 or more years for newly planted elderberry cuttings/seedlings to become large enough to support beetles, and it generally takes 25 years or longer for riparian habitats to reach their full value (USFWS 1999a). Because elderberry shrubs within the Action Area will be transplanted to the proposed Conservation Area, which is immediately adjacent to the Action Area, no temporal loss of habitat for VELB is expected. Additional elderberry plantings in the conservation area will provide additional and/or replacement habitat for VELB in future years.

### **Effects of Operation and Maintenance Activities**

Post-construction the setback levee, adjacent levees, strengthening in place (slope flattening), seepage berms, slurry cutoff walls, riprap bank stabilization, and relief wells would be subject to typical O&M. O&M activities in the project area are conducted per the approved Corps O&M manual applicable to this reach.

Effects on VELB and its habitat include hand and mechanical (mower) removing weeds, spraying of weeds with approved pesticides, minimal tree or shrub trimming all up to four times a year, and reconditioning of levee slope and road with a bull dozer as needed. These effects were determined to have no potential to affect VELB and its habitat as a result of the Proposed Action. Specifically, the following determinations were made.

- There would be no increased use of herbicides and/or pesticides from pre-project conditions as a result of the Proposed Action. Vegetation control would remain the same as existing conditions—typically twice per year. Herbicide use would also be at the same frequency as existing conditions.

The Proposed Action would not result in adverse effects on VELB and its habitat due to an increase in vehicles traveling to the project components to conduct maintenance activities. Inspections

are infrequent (flood control facilities four times per year; relief wells once per year, plus inspections after high water events), and travel would be along the existing levee road and paved roads to the levee. Patrol road recondition activities would typically be performed once per year and would include placing, spreading, grading, and compacting aggregate base or substrate.

## **5.2 Fish Species**

### **5.2.1 West Sacramento Project**

The assessment of effects on fish considers the potential occurrence of protected species and life stages relative to the location, magnitude, timing, frequency, and duration of project actions. Species habitat attributes potentially affected by project implementation include spawning habitat area and quality, rearing habitat area and quality, migration habitat conditions, and water quality.

Short-term construction related effects on fish species include effects on individuals (e.g., displacement, disruption of essential behaviors, mortality) and immediate, short-term effects on habitat. These short-term effects are evaluated qualitatively and generally mitigated through the use of construction BMPs and limitations on construction windows.

Long-term effects typically last months or years, and generally involve physical alteration of the bank and riparian vegetation adjacent to the water's edge, with consequent impacts upon SRA cover, nearshore cover, and shallow water habitat (Fris and DeHaven 1993).

#### **Sacramento River Winter-Run Chinook Salmon**

Potential project effects from the actions are described below for each life stage and its habitat. Effects on designated critical habitat are addressed via description of habitat effects for each applicable species.

#### **Construction-Related Effects**

##### **Adult Migration**

Construction activities may affect but are not likely to adversely affect winter-run adults because construction will avoid the primary migration period (December through July), will be restricted to the channel edge, and will include implementation of the avoidance and minimization measures described in Section 2.6.4 and 2.6.5.

### Spawning

Winter-run Chinook salmon do not spawn in the West Sacramento GRR area. Therefore, the project will have no effect on winter-run Chinook salmon spawning or spawning habitat.

### Juvenile Rearing and Migration

Implementation of the bank erosion protection measures may result in adverse effects to juvenile and smolt winter-run Chinook salmon and their critical habitat. Construction activities that increase noise, turbidity, and suspended sediment may disrupt feeding or temporarily displace fish from preferred habitat. Rearing or outmigrating salmon may not be able to readily move away from nearshore areas that are directly affected by construction activities such as placement of rock revetment; these effects could result in stress, injury, or mortality. Take of juvenile or smolt winter-run Chinook salmon could therefore occur via mortality or injury during construction activity, or by the impairment of essential behaviors such as feeding or escape from predators. Substantial increases in suspended sediment could temporarily bury substrates that support benthic macroinvertebrates, an important food source for juvenile salmonids. However, due to the limited duration and spatial extent of project actions, effects on salmonid feeding are expected to be minimal. In addition, spills or leakage of gasoline, lubricants, or other petroleum products from construction equipment or storage containers could result in physiological impairment or mortality to rearing or outmigrating salmon in the vicinity of the project sites. With implementation of best management practices, the impacts due to spills should be minimal.

Restricting in-water activities to the August 1 through November 30 work window and implementing the avoidance and minimization measures described in Sections 2.4.4 and 2.4.5 will minimize, but may affect and is likely to adversely affect potential construction-related effects on juveniles and smolts.

### **Long-Term Effects**

The West Sacramento GRR area does not support spawning habitat for winter-run Chinook salmon, therefore the projects long-term effects will have no effect to spawning habitat.

Winter-run Chinook salmon are expected to show a long term positive response to project actions in the Sacramento River SAM analysis reach (see Appendix G) over the lifetime of the project. Winter-run Chinook salmon should exhibit a positive response by year 8. Short term habitat deficits are expected within the recommended recovery period for winter-run Chinook salmon. The maximum habitat deficit identified is -1,207 feet for the juvenile migration life stage of Spring-run Chinook salmon in the summer of year 5. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions. For juvenile winter-run Chinook salmon, the bank protection measures will generally provide long-term increases in bank shading at project sites. The plantings of native grasses and willows are designed to benefit juvenile Chinook salmon by

increasing the availability (habitat area) and quality (shallow water and instream cover) of nearshore aquatic habitat and SRA relative to current conditions. Figures 21 through 23 below show the long term scenario once bank protection measures are completed. Long term effects may affect but are not likely to adversely affect critical habitat for winter-run Chinook salmon juvenile rearing and migration.



**Figure 21. Site 4R on the American River after Bank Protection in 2001.**



Figure 22. Site 4R in 2005.



Figure 23. Site 4R in 2010.

Although a SAM analysis for the Yolo Bypass SAM analysis reach was conducted, the results were excluded from the final report. Through discussion with NMFS, it was determined that the unique environmental conditions in the Yolo Bypass SAM analysis reach exceed the applications of the SAM. The Yolo Bypass SAM analysis reach includes portions of the perennial tidal Toe Drain and portions of the Sacramento and Yolo Bypass that are only periodically inundated. During typical summer-fall conditions, SAM focus fish species are generally absent from the Toe Drain (Harrel, 2003). During winter-spring conditions, assuming inundation, the Yolo Bypass provides a large amount of floodplain habitat. Under the “worst case scenario” assumptions, project actions along the Yolo Bypass SAM analysis reach would result in the removal of all trees and vegetation; however, due to the abundance of floodplain habitat during inundation, it is highly unlikely that the loss of these shoreline habitat features would impact the life stages of listed species utilizing the Yolo Bypass during winter-spring conditions, therefore the projects long-term effects will have no effect to fry and juvenile rearing and migration.

### **Central Valley Spring-Run Chinook Salmon**

Potential project effects for spring-run Chinook salmon are described below for each life stage and its habitat, including effects on designated critical habitat.

#### **Construction-Related Effects**

##### Adult Migration

Adult spring-run Chinook salmon migrate up the Sacramento River from March through September although most individuals have entered tributary streams by mid-June and will not be affected by construction activities. Therefore, potential for construction-related effects from the West Sacramento GRR will be similar to that described for winter-run Chinook salmon.

##### Spawning

Spring-run Chinook salmon do not spawn in the West Sacramento GRR area. Therefore, the project will have no effect on spring-run Chinook salmon spawning or spawning habitat.

##### Juvenile Rearing and Migration

Similar to winter-run Chinook salmon, spring-run Chinook salmon typically spend up to 1 year rearing in fresh water before migrating to sea. Therefore, potential for construction-related West Sacramento GRR project effects will be similar to that described for winter-run Chinook salmon above.

Restricting in-water activities to the August 1 through November 30 work window and implementing the avoidance and minimization measures described in Sections 2.4.4 and 2.4.5 will minimize, but may affect and is likely to adversely affect potential construction-related effects on juveniles and smolts.

## **Long-Term Effects**

The West Sacramento GRR area does not support spawning habitat for spring-run Chinook salmon, therefore the projects long-term effects will have no effect to spawning habitat.

Spring-run Chinook salmon are expected to show a long term positive response to project actions in the Sacramento River SAM analysis reach (see Appendix G) over the lifetime of the project. Winter-run Chinook salmon should exhibit a positive response by year 8. Short term habitat deficits are expected within the recommended recovery period for spring-run Chinook salmon. The maximum habitat deficit identified is -1,207 feet for the juvenile migration life stage of spring-run Chinook salmon in the summer of year 5. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions. For juvenile spring-run Chinook salmon, the bank protection measures will generally provide long-term increases in bank shading at project sites. The plantings of native grasses and willows are designed to benefit juvenile Chinook salmon by increasing the availability (habitat area) and quality (shallow water and instream cover) of nearshore aquatic habitat and SRA relative to current conditions. Long term effects may affect but are not likely to adversely affect critical habitat for winter-run Chinook salmon juvenile rearing and migration.

Although a SAM analysis for the Yolo Bypass SAM analysis reach was conducted, the results were excluded from the final report. Through discussion with NMFS, it was determined that the unique environmental conditions in the Yolo Bypass SAM analysis reach exceed the applications of the SAM. The Yolo Bypass SAM analysis reach includes portions of the perennial tidal Toe Drain and portions of the Sacramento and Yolo Bypass that are only periodically inundated. During typical summer-fall conditions, SAM focus fish species are generally absent from the Toe Drain (Harrel, 2003). During winter-spring conditions, assuming inundation, the Yolo Bypass provides a large amount of floodplain habitat. Under the “worst case scenario” assumptions, project actions along the Yolo Bypass SAM analysis reach would result in the removal of all trees and vegetation; however, due to the abundance of floodplain habitat during inundation, it is highly unlikely that the loss of these shoreline habitat features would impact the life stages of listed species utilizing the Yolo Bypass during winter-spring conditions therefore the projects long-term effects will have no effect to fry and juvenile rearing and migration.

## **Central Valley Steelhead**

Potential project effects for steelhead are described below for the relevant life stages and their habitat, including effects on designated critical habitat.

### **Construction-Related Effects**

#### **Adult Migration**

In the Sacramento River, adult steelhead migrate upstream during most months of the year, beginning in July, peaking in September, and continuing through February or March. Adults use the

river channel in the study area as a migration pathway to upstream spawning habitat, and may also use deep pools with instream cover as resting and holding habitat. The potential for construction-related effects on migrating adult steelhead would be similar to that described above for adult winter-run Chinook salmon with the determination being that the construction-related activities may affect but are not likely to adversely affect adult migration.

### Spawning

Within the West Sacramento GRR study area, there is minimal potential spawning habitat. Steelhead spawn in late winter and late spring outside of the August 1 through November 30 construction window; therefore, construction-related effects may affect but are not likely to adversely affect steelhead spawning or their spawning habitat.

### Juvenile Rearing and Migration

Central Valley steelhead rear year-round in the cool upstream reaches of the mainstem Sacramento River and its major tributaries. Juveniles and smolts are most likely to be present in the study area during their downstream migration to the ocean, which may begin as early as December and peaks from January to May. The importance of main channel and floodplain habitats in the lower Sacramento River to rearing steelhead is becoming more understood. Steelhead are expected to show a long term positive response to project actions in the Sacramento River SAM analysis reach over the lifetime of the project (Appendix G). Steelhead should exhibit a positive response by year 8. Short term habitat deficits are expected within the recommended recovery period for Steelhead. The maximum habitat deficit identified is -777 feet for the juvenile migration life stage of Steelhead in the fall of year 7. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions.

Steelhead smolts have been found in the Yolo Bypass during the period of winter and spring inundation (Sommer 2002). Sommer et al. (2001) found that Juvenile Chinook salmon that reared within a large, engineered floodplain of the Sacramento River (the Yolo Bypass) had higher rates of growth and survival than fish that reared in the main-stem river channel during their migration. Due to similarities with Chinook salmon in juvenile feeding strategies and habitats utilized, steelhead would also benefit from inundated floodplains of the Yolo Bypass. For purposes of this analysis, rearing juvenile steelhead are assumed to use nearshore and off-channel habitat in the study area. The potential for construction-related effects on steelhead juveniles and smolts and their habitat will therefore be similar to that described for winter-run Chinook salmon with the determination being that the construction activities may affect but are not likely to adversely affect juvenile rearing and migration.

### **Long-Term Effects**

The potential for long-term effects on adult migration habitat will be similar to that described for winter-run Chinook salmon. However, the potential spawning area is very small and it is expected

that channel areas immediately adjacent to erosion sites do not support spawning riffles. The potential for long-term effects on steelhead juveniles and smolts and their critical habitat will be similar to that described for winter-run Chinook salmon, long-term effects will have no effect to fry and juvenile rearing and migration.

### **Delta Smelt**

Delta smelt in the Sacramento River have been documented upstream as far as the city of Sacramento (RM 60) (Moyle 2002), and may be present throughout their life cycle. Potential project effects are described below for relevant life stages and their habitats, including effects on designated critical habitat. In determining which areas to designate as critical habitat, USFWS considers those physical and biological features that are essential to a species' conservation (50 CFR 424.12[b]). USFWS is required to list the known primary constituent elements together with a description of any critical habitat that is proposed. Such physical and biological features (i.e., primary constituent elements) include, but are not limited to, the following:

- Space for individual and population growth, and for normal behavior;
- Food, water, air, light, minerals, or other nutritional or physiological requirements;
- Cover or shelter;
- Sites for breeding, reproduction, rearing of offspring, germination, or seed dispersal; and
- Generally, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

The primary constituent elements essential to the conservation of the delta smelt are physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration (NMFS 1994a). These elements are described in further detail below.

- Spawning Habitat. Delta smelt adults seek shallow, fresh or slightly brackish backwater sloughs and edgewaters for spawning. To ensure egg hatching and larval viability, spawning areas also must provide suitable water quality (i.e., low concentrations of pollutants) and substrates for egg attachment (e.g., submerged tree roots and branches and emergent vegetation). Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay. The spawning season varies from year to year and may start as early as December and extend until July (NMFS 1994a).
- Larval and Juvenile Transport. To ensure that delta smelt larvae are transported from the area where they are hatched to shallow, productive rearing or nursery habitat, the

Sacramento and San Joaquin Rivers and their tributary channels should be protected, when possible, from physical disturbance and flow disruption. Adequate river flow is necessary to transport larvae from upstream spawning areas to rearing habitat in Suisun Bay. Additionally, river flow must be adequate to prevent interception of larval transport by the State and Federal water projects and smaller agricultural diversions in the Delta. To ensure that suitable rearing habitat is available in Suisun Bay, the 2 ppt isohaline must be located westward of the Sacramento-San Joaquin River confluence during the period when larvae or juveniles are being transported, according to the historical salinity conditions which vary according to water-year type. Reverse flows that maintain larvae upstream in deep-channel regions of low productivity and expose them to entrainment interfere with these transport requirements. Suitable water quality must be provided so that maturation is not impaired by pollutant concentrations. The specific geographic area important for larval transport is confined to waters contained within the legal boundary of the Delta, Suisun Bay, and Montezuma Slough and its tributaries. The specific season when habitat conditions identified above are important for successful larval transport varies from year to year, depending on when peak spawning occurs and on the water-year type. USFWS identified situations in the biological opinion for the delta smelt (1994) where additional flows might be required in the July-August period to protect delta smelt that were present in the south and central Delta from being entrained in the State and Federal project pumps, and to avoid jeopardy to the species. The long-term biological opinion on State and Federal water project operations will identify situations where additional flows may be required after the February through June period identified by EPA for its water quality standards to protect delta smelt in the south and central Delta (NMFS 1994a).

- Rearing Habitat. Maintenance of the 2 ppt isohaline according to the historical salinity conditions described above and suitable water quality (low concentrations of pollutants) within the Delta is necessary to provide delta smelt larvae and juveniles a shallow, protective, food-rich environment in which to mature to adulthood. This placement of the 2 ppt isohaline also serves to protect larval, juvenile, and adult delta smelt from entrainment in the State and Federal water projects. An area extending eastward from Carquinez Strait, including Suisun Bay, Grizzly Bay, Honker Bay, Montezuma Slough and its tributary sloughs, up the Sacramento River to its confluence with Three Mile Slough, and south along the San Joaquin River including Big Break, defines the specific geographic area critical to the maintenance of suitable rearing habitat. Three Mile Slough represents the approximate location of the most upstream extent of tidal excursion when the historical salinity conditions described above are implemented. Protection of rearing habitat conditions may be required from the beginning of February through the summer (NMFS 1994a).
- Adult Migration. Adult delta smelt must be provided unrestricted access to suitable spawning habitat in a period that may extend from December to July. Adequate flow and suitable water quality may need to be maintained to attract migrating adults in the Sacramento and San Joaquin River channels and their associated tributaries, including Cache

and Montezuma sloughs and their tributaries. These areas also should be protected from physical disturbance and flow disruption during migratory periods (NMFS 1994a).

## **Construction-Related Effects**

### Adult Migration

Adult Delta smelt migrate upstream between December and January and spawn between January and July, with a peak in spawning activity between April and mid-May (Moyle 2002). Potential construction-related effects to physical habitat, water, river flow, and salinity concentrations for migrating adult Delta Smelt will be avoided or minimized by restricting in water construction activities on the Sacramento River to the August 1 through November 30 work window, which would allow for unrestricted access to suitable and important spawning habitat. If there is any change in effect due to construction constraints outside the work window, consultation will be initiated. Construction-related effects may affect but are not likely to adversely affect adult migration.

### Spawning

Potential spawning habitat includes shallow channel edge waters in the Delta and Sacramento River. Specific areas that have been identified below the project area as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay. As a result, potential construction-related effects to Delta smelt physical habitat would include disruption of spawning activities, disturbance or mortality of eggs and newly hatched larvae, alteration of spawning and incubation habitat, and loss of shallow water habitat for spawning.

The erosion repair is likely to somewhat reduce the sediment supply for riverine reaches directly downstream because the erosion repair is holding the bank or levee in place. However, from a system sediment prospective, the bank material we are protecting in the project reaches is not a major source of sediment compared to the upstream reaches of the Sacramento, Feather, and especially the Yuba River systems. The majority of the available sediment in the American River watershed is being contained behind Folsom Dam. The site specific designs will be constrained from allowing any velocity increases outside the erosion repair site (Schlunegger 2014).

In response to a USFWS request for more data on July 23, 2014, the Corps conducted an analysis of existing shallow water habitat in the West Sacramento project area, and the effect of the proposed project on that habitat. The results of this analysis are included as Appendix H to this report. The conclusion of the analysis was that approximately 13.35 acres of shallow water habitat would be lost as a result of implementation of the West Sacramento GRR. However, Alternative 5 of the West Sacramento GRR includes the Sacramento River South setback levee, which would create approximately 118 acres of new shallow water habitat during high water events. As a result, the 13.35 acres of impacts

are offset by creation of the setback and there would be no significant effects associated with the loss of shallow water delta smelt habitat.

Construction-related effects on delta smelt spawning and incubation will be minimized by restricting in-water construction activities on the Sacramento River, Yolo Bypass, and the DWSC to the August 1 through November 30 work window, thereby avoiding the seasons when spawning is most likely to occur.. Construction activities may affect but are not likely to adversely affect Delta smelt spawning habitat, due to the creation of the Southport setback levee..

#### Juvenile Rearing and Migration

Juvenile Delta smelt may be subject to disturbance or displacement caused by construction activities that would alter physical habitat, water, and river flow in the form of increased noise, turbidity, and suspended sediment. Delta smelt may not be readily able to move away from channel or nearshore areas that are directly affected by construction activities (i.e., removal or placement of instream woody material, placement of rock revetment). Larvae may be disrupted during summer months as they migrate downstream to rear in the Delta. Incidental take of Delta smelt may occur from direct mortality or injury during a construction activity, or by the impairment of essential behavior patterns (i.e., feeding, escape from predators). Salinity concentrations would not be affected by the construction activities. Construction-related effects on Delta smelt rearing and migration will be minimized by restricting in-water construction activities on the Sacramento River, Yolo Bypass, and the DWSC to the August 1 through November 30 work window, thereby avoiding the seasons when these life stages are most likely to occur therefore construction-related activities may affect and is likely to adversely affect juvenile rearing and migration.

#### **Long-Term Effects**

Non-native species may exploit the warmer water temperature in the shallow bench habitat created as an on-site mitigation feature and prey on Delta smelt eggs and larvae; however, bench habitat would most likely not bring in more predatory fish that don't already exist in the project area. A 2013 draft report on the long-term aquatic monitoring program by FishBio for the SRBPP noted that Black bass (largemouth and smallmouth bass) have the highest probability of habitat occupancy at both sites with bench features and sites with no bench features. Unlike previous years, when highest bass abundance was typically associated with wetland trench designs (not included in the suite of monitored sites in 2013), the highest likelihood of encountering black bass was observed at no bench and bench sites, in particular those near river mile 70, well above the West Sacramento project area (Corps 2013b). Proposed planting of emergent vegetation will enhance habitat complexity by providing cover and incubation habitat, especially during high winter and spring flows.

## **Green Sturgeon**

Potential project effects are described below for each life stage of green sturgeon and its habitat. An accurate assessment of potential project effects on green sturgeon and its habitat is difficult due to the limited information available on distribution, seasonal abundance, habitat preferences, and other life history requirements of this species.

### **Construction-Related Effects**

#### **Adult Migration**

Adult green sturgeon are believed to move upstream through the West Sacramento GRR study area from February through late July (NMFS 2005c). Construction activities occurring outside of these time periods are not likely to affect migrating green sturgeon adults. Construction activities during July, however, may have adverse impacts on any adult green sturgeon that are still migrating upstream. Because construction activities will largely avoid the peak migration period, will be restricted to the channel edge, and will implement the avoidance and minimization measures described in Sections 2.6.4 and 2.6.5, construction-related activities may affect but are not likely to adversely affect adult migration.

#### **Spawning**

Spawning migrations of green sturgeon typically occur during the months of March through June (Thomas et al. 2013). The Sacramento River downstream of Knights Landing (RM 90) is not believed to have suitable spawning habitat for green sturgeon, primarily due to lack of suitable coarse bottom substrate such as large cobbles (Corps 2012). Therefore, the West Sacramento GRR project will have no effect on spawning green sturgeon or their habitat.

#### **Juvenile Rearing and Migration**

Based on general knowledge of green sturgeon life history, larvae may occur in the Sacramento River and Delta shortly after spawning, from February through late July (peak spawning from April through June) (Emmett et al. 1991 as cited in Moyle 2002). Restricting in-water construction activities to the August 1 through November 30 work window and implementing the avoidance and minimization measures described in Sections 2.6.4 and 2.6.5 will minimize potential impacts of in-water construction activities on green sturgeon larvae. However, if larvae or juveniles are present during construction, in-water activities could result in localized displacement and possible injury or mortality to individuals that do not readily move away from the channel or nearshore areas. Project actions associated with bank protection measures may increase sediment, silt, and pollutants, which may affect and is likely to adversely affect rearing habitat or reduce food production, such as aquatic invertebrates, for larval and juvenile green sturgeon.

## Long-Term Effects

Project actions in the Sacramento River SAM analysis reach will mimic SRBPP repair site onsite mitigative features (Appendix G). SRBPP onsite mitigative features were designed to maximize habitat response for salmonid species; Green sturgeon will exhibit a negative response to these onsite mitigative features. Green sturgeon are expected to show long term negative response to project actions in the Sacramento River SAM analysis reach for several life stages at all seasonal habitat conditions over the lifetime of the project.

Impacts to Green sturgeon were analyzed for the Sacramento River SAM analysis reach only. Although the SAM analysis indicates long term habitat deficits, USACE does not expect significant impacts to the Green sturgeon. The SAM indicated a maximum deficit of -5,516 ft for the adult residence life stage in response to the creation of a shallow slope at winter/spring habitat conditions. This value is based on the maximum deficit observed for adult residence life stage of Green sturgeon at the winter of year 50. The SAM also indicated a maximum deficit of -2,139 ft for the spawning & egg incubation life stage in response to installation of fine substrate (natural) at winter/spring habitat conditions and to the installation of course substrate (10 inch rock revetment) at summer/fall habitat conditions. This value is based on the maximum deficit observed for larval & egg incubation life stage of Green sturgeon at summer conditions of year 50. A maximum deficit of -1,004 ft is expected for the larval, fry, & juvenile rearing and juvenile migration life stages in response to installation of fine substrate (natural) at winter/spring habitat conditions and to the installation of course substrate (10 inch rock revetment) at summer/fall habitat conditions as well as a loss of shoreline at the Stone Locks. This value is based on the maximum deficit observed for fry & juvenile rearing life stage of Green sturgeon at winter/spring conditions of year 3.

The habitat requirements of Green sturgeon are not well understood; assumptions built into the SAM on fish response to shoreline features were based on limited information. Habitat use of the West Sacramento project reach by Green sturgeon is likely limited to use as a migration corridor by adults and potential rearing area by juvenile life stages. Although the SAM indicates negative response to habitat by adult life stages, it is unlikely that shoreline repair activities would significantly impact the river for residence or as a migration corridor. SRBPP style repairs are designed to mimic naturally occurring habitat types and are not expected to significantly alter the width of the river. USACE does not expect any significant impacts to the adult residence or adult migration life stages and does not propose any additional mitigation.

Although the SAM indicates negative response to habitat by the spawning & egg incubation life stage, no suitable spawning habitat exists in the West Sacramento project reach. Green sturgeon spawning primarily takes place upriver of Colusa on the Sacramento River and in the lower Feather River. Because no suitable spawning habitat is present in the project reach under existing conditions, USACE does not expect any significant impacts to the spawning & egg incubation life stage of Green sturgeon and does not propose any additional mitigation.

Little is known about the fry & juvenile rearing and juvenile migration life stages of Green sturgeon. The SAM does not evaluate response to specific habitat attributes for the juvenile migration life stage. For the purpose of this analysis it is assumed that these life stages exhibit similar responses to analogous life stages of Chinook and Steelhead. This approach assumes that fry & juvenile rearing and juvenile migration life stages of Green sturgeon will exhibit a positive response to “good riparian habitat” (i.e. increased shoreline coverage of overhanging shade, aquatic vegetation, and IWM). Although the SAM indicates that that fry & juvenile rearing and juvenile migration life stages will exhibit a negative response to with-project conditions, short term deficits are expected to be offset by mitigation for Chinook and Steelhead. Long term deficits are expected to be lower than, and therefore offset by, long term habitat benefits expected for Chinook and Steelhead. USACE does not propose any additional mitigation.

### **5.2.2 Southport EIP**

#### **Salmon, Steelhead, and Sturgeon**

The following assessment addresses potential direct and indirect effects of the Proposed Action on endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, threatened California Central Valley steelhead, threatened Southern DPS of North American green sturgeon, and their designated critical habitat. Potential project effects on listed species and critical habitat include both short-term and long-term effects. Short-term effects include temporary construction-related impacts on fish and aquatic habitat that may last from a few hours to days (e.g., suspended sediment and turbidity). Long-term effects typically last months or years, and are generally due to physical alteration of important habitat attributes of the channel, shoreline, and adjacent bank or floodplain. Short-term effects on listed fish species are evaluated qualitatively based on general knowledge of the impact mechanisms and species responses to construction actions. Long-term effects are measured in terms of the linear feet and area of riparian, SRA cover, and floodplain habitat affected by the Proposed Action and based on the responses of listed species to changes in habitat quantity and quality as measured by the SAM (Corps 2004).

#### **Short-Term Effects**

In-water construction activities, including the placement of rock slope protection, could result in localized, temporary disturbance of habitat that may alter natural behavior patterns of adult and juvenile fish and cause injury and death of individuals. These effects may include displacement, impaired feeding, and temporary disruption of migration and other essential behaviors. The extent of construction-related effects depends on the timing of these activities, the timing of fish presence in the Southport EIP Action Area, and the ability of the fish to successfully avoid the disturbance. Construction work on the waterside slope and shoreline, including in-water construction activities, are scheduled for July 1 through October 31 and, therefore, should avoid the primary migration periods of adult and juvenile winter-run Chinook salmon and spring-run Chinook salmon (November through June).

Steelhead adults occur in the Southport EIP Action Area primarily from September through March, while juveniles occur primarily from January through March. Adult green sturgeon are most likely to be present in the Southport EIP Action Area during the spring but may be present from March through September. Green sturgeon larvae and post-larvae may be present in the Southport EIP Action Area between June and October, and juveniles may be present year-round. Construction-related impacts are expected to occur seasonally over a four-year period, between Year 2 and Year 5 of construction.

#### Potential Effects of Noise, Turbidity, and Suspended Sediment

Construction noise resulting from operation of the barge and placement of rock below the water surface would cause physical disturbance of the bed and water column of the river that could displace juvenile and adult fish into adjacent habitats and possibly cause direct physical injury or death from falling rock. The resulting noise, turbidity, and suspended sediment may disorient and result in temporary displacement of fish from preferred habitats or alter normal feeding, sheltering, and migration behavior.

The effects of increased turbidity and suspended sediment on salmonids have been well studied. Depending on the level of exposure, suspended sediment can cause lethal, sublethal, and behavioral effects in fish (Newcombe and Jensen 1996). For salmonids, elevated suspended sediment has been linked to a number of behavioral and physiological responses indicative of stress (gill flaring, coughing, avoidance, and increase in blood sugar levels) (Bisson and Bilby 1982; Sigler et al. 1984; Berg and Northcote 1985; Servizi and Martens 1992). Migrating adults have been reported to avoid high silt loads or cease migration when avoidance is not possible (Cordone and Kelley 1961, as cited by Bjornn and Reiser 1991). Bell (1986) cited a study in which adult salmon did not move in streams where the sediment concentration exceeded 4,000 mg/L (as a result of a landslide). Juveniles tend to avoid streams that are chronically turbid (Bisson and Bilby 1982; Lloyd et al. 1987) or move laterally or downstream to avoid turbidity plumes (Sigler et al. 1984; Lloyd et al. 1987; Servizi and Martens 1992). Juvenile coho salmon have been reported to avoid turbidities exceeding 70 NTU (Bisson and Bilby 1982) and cease territorial behavior when exposed to a pulse of turbidity of 60 NTU (Berg 1982). Such behavior could result in displacement of juveniles from preferred habitat or protective cover, which may reduce growth and survival by affecting foraging success or increasing their susceptibility to predation.

Laboratory studies have demonstrated that chronic or prolonged exposure to high turbidity and suspended sediment levels can lead to reduced growth rates. For example, Sigler et al. (1984) found that juvenile coho salmon and steelhead trout exhibited reduced growth rates and higher emigration rates in turbid water (25–50 NTU) compared to clear water. Reduced growth rates generally have been attributed to an inability of fish to effectively feed in turbid water (Waters 1995). Green sturgeon may be affected in similar ways although NMFS (2008) stated that short-term increases in suspended sediments or turbidity were unlikely to affect the foraging success of green sturgeon because this species uses olfactory cues as opposed to vision to locate prey. Chronic exposure to high turbidity and suspended sediment also may affect growth and survival by impairing respiratory function, reducing tolerance to disease and contaminants, and causing physiological stress (Waters 1995).

NMFS (2008) reviewed observations of turbidity plumes during similar construction activities in the Sacramento River and concluded that visible plumes are expected to be limited to only a portion of the channel width, extend no more than 1,000 feet downstream, and dissipate within hours of cessation of in-water activities. In addition, in-water construction activities would be limited to daylight hours only. Based on these observations, NMFS expects turbidity levels to exceed 25–75 NTUs and potentially result in disruption of normal feeding and sheltering behavior (NMFS 2008). However, excessive turbidity levels will be avoided with adherence to the RWQCB Basin Plan turbidity objectives. Consequently, the effects of exposure of individual fish to turbid water generated by construction activities would likely be limited to avoidance, brief disruptions of normal activities, and potentially higher risk of predation.

Based on the extent, frequency, and duration of proposed in-water construction activities, potential adverse effects include direct injury from falling rock, temporary disruption of normal behavior, and increased risk of predation. The timing of construction activities is expected to minimize exposure of the most vulnerable life stages of Chinook salmon and steelhead juveniles (i.e., fry). Green sturgeon adults, larvae, and juveniles are more likely to be exposed to short-term disturbances, but their presence along the shoreline is expected to be uncommon based on their benthic nature. With adherence to the proposed in-water construction window, Central Valley RWQCB turbidity objectives, and erosion and sediment control BMPs (SWPPP), potential adverse effects of noise, turbidity, and suspended sediment would be limited to temporary displacement and potential injury or death of small numbers of fish within the affected shoreline areas.

#### Fish Entrapment in Cofferdams

Cofferdams may be required to install temporary culverts needed to maintain connectivity between the river and restored floodplain prior to construction of the final levee breaches. The potential exists for entrapment and mortality of fish following closure and dewatering of the cofferdam. As discussed above, the timing of cofferdam installation and other in-water activities (July 1 through October 31) will avoid the primary period of occurrence of winter-run and spring-run Chinook salmon fry, which are considered the most vulnerable species and life stage that may occur in the Southport EIP Action Area. Other species and life stages that may be present at the time of in-water construction are unlikely to be injured or killed because of their larger size, greater mobility, or preference for deeper, offshore areas. The potential for entrapment of fish will be further reduced by limiting the extent of the cofferdam footprint to the shallow edge of the river. Therefore, potential entrapment of listed fish species is unlikely to occur.

#### Potential Discharge of Contaminants

Contaminants used at construction sites, including gasoline, diesel fuel, lubricants, and hydraulic fluid could enter the Sacramento River as result of spills or leakage from machinery or storage containers and injure or kill listed salmon, steelhead, and sturgeon. These substances can kill aquatic

organisms through exposure to lethal concentrations or exposure to non-lethal levels that cause physiological stress and increased susceptibility to other sources of mortality such as predation. Petroleum products also tend to form oily films on the water surface that can reduce DO levels available to aquatic organisms. There is also a slight risk of the release of bentonite into the Sacramento River during jet grouting or deep soil mixing used to construct slurry cut off walls. Bentonite is a naturally occurring, inert, nontoxic material that meets National Sanitation Foundation/American National Standards Institute Drinking Water Additives Standards 60 and 61. Therefore, any inadvertent release of drilling fluid containing only water and bentonite would not have toxicity effects on ESA-listed fish. However, bentonite released into streams could result in turbidity, and cause many of the same behavioral, physiological, and physical effects described above for turbidity and suspended sediment.

Implementation of a spill prevention, control, and countermeasure plan and bentonite slurry spill contingency plan as part of the environmental commitments of the project is anticipated to minimize the potential for toxic or hazardous spills or discharges into the Sacramento River. Adherence to all preventative, contingency, and reporting measures in the approved plans would reduce the risk of injury or mortality of listed fish species to negligible levels, and would avoid potential contamination of listed fish species prey.

### **Long-Term Effects**

The Southport EIP is expected to result in long-term effects on riparian, SRA cover, and floodplain habitat, including modification of the designated critical habitat of winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and green sturgeon. Long-term effects on listed species and critical habitat may also occur as a result of local changes in hydraulic, geomorphic, and sediment transport conditions in the Sacramento River upstream and downstream of the Southport EIP project area. These modifications may affect behavior, growth, and survival of individuals and the primary constituent elements of critical habitat, including freshwater rearing sites, foraging areas, and migration corridors. The general effects of the Southport EIP on riparian, SRA cover, and floodplain habitat are described below, followed by a summary of long-term changes in habitat values and species responses based on the results of the SAM. This is followed by a general assessment of long-term effects on listed species and critical habitat related to potential fish stranding on the restored floodplain and predicted changes in local hydraulic, geomorphic, and sediment transport conditions in the main channel of the Sacramento River.

#### SRA Cover and Riparian Habitat

The loss of riparian vegetation and woody material and the replacement of natural substrate with rock revetment (riprap) generally reduces the quality of nearshore habitat for juvenile salmonids and other fishes by reducing habitat diversity and altering several important attributes of natural shorelines. These attributes, which characterize SRA cover, include natural substrates, riparian vegetation, woody material, and variable water depths and velocities, including shallow, low-velocity areas used by juveniles as refuge from fast currents and predators. Simple riprapped banks generally

create more uniform physical and hydraulic conditions characterized by deeper, faster water, and lack of cover. These conditions reduce utilization by juvenile fishes and also inhibit the establishment of shoreline vegetation and retention of sediment, organic material, and large woody material, which provide important sources of cover and food for juvenile fishes and other aquatic organisms. In addition to cover and shelter for fish, riparian vegetation provides other important stream ecosystem functions, including channel and streambank stability; inputs of food (e.g., terrestrial insects), organic matter, and nutrients; and temperature-moderating shade (Murphy and Meehan 1991).

The Southport EIP would affect approximately 7,419 linear feet of the existing Sacramento River levee as a result of levee degradation and installation of rock slope and biotechnical bank protection at the proposed erosion repair and levee breach sites. The total area of bank within the construction limits between the submerged toe of the bank (-10 to -45 feet NAVD88) and the ordinary high water mark (OHWM) (+20 feet NAVD88) is approximately 10 acres. Where the remnant levee is breached, all existing SRA cover and riparian vegetation on the levee slope would be lost due to degradation of the levee and the addition of biotechnical and rock slope protection needed to create and protect the breaches. Within the erosion sites, the removal of SRA cover and riparian vegetation would be limited to the lower portion of the bank below elevation +12 feet NAVD 88.

Vegetation mapping of the project site in April–May 2011 indicates that the proposed erosion repairs, rock slope protection, and levee breaches for the Southport EIP would affect 5.44 acres of cottonwood riparian woodland and 1.46 acres of riparian scrub. The impacts to critical habitat include the loss of 2.01 acres of cottonwood riparian woodland and 0.51 acre of riparian scrub below the OHWM on the waterside slope of the existing levee, and the loss of 2,790 linear feet of moderate- to high-quality SRA cover (Figure 24). It is assumed that the portions of the existing levee outside the affected levee sites (totaling approximately 24,198 feet), including all existing SRA cover and riparian habitat, would remain intact and no longer be subject to levee maintenance activities. In addition, portions of the remnant levee that are currently devoid of vegetation or sparsely vegetated would be planted with woody riparian species to enhance SRA cover and riparian habitat values and meet any remaining onsite compensation requirements. Habitat removal below the OHWM on the waterside slope of the existing levee would begin in Year 2 with construction of the erosion repair sites, followed by construction of breaches N1 and S3 in Year 3, and construction of breaches N2, S1, and S2 in Year 5.

Onsite compensation and enhancement of SRA cover and riparian habitat will be achieved through the planting of native riparian species on the floodplain offset areas, levee breaches, remnant levees, and erosion repair sites. A detailed description of the SRA cover and riparian habitat compensation and enhancement objectives is being developed as part of the draft MMP for the Southport EIP (see Conservation Measure 6).

*Erosion Repair Sites.* Erosion repair and bank stabilization would be conducted in the second year of construction at three sites (C1, C2, and G3, comprising approximately 1,013 linear feet of bank) to treat several over-steepened or eroding levee areas in Segment C, D, and G (Appendix B, Figures 2 and 3a–3c). To minimize long-term impacts on SRA cover and riparian habitat, these sites have been

designed to retain existing vegetation and woody material to the extent possible and promote onsite replacement of SRA cover and riparian vegetation. This would be accomplished by retaining existing woody vegetation (Sites C1 and C2) or planting woody vegetation (Site G3) above elevation 12 feet NAVD88, incorporating a 10:1 bench and soil fill within the average annual low and high water inundation zone of the river (between 7 to 12 feet NAVD88) to provide a surface for planting riparian vegetation, anchoring woody material, and creating shallow water habitat (Appendix B, Figures 3a–3c). The low benches will provide shallow water habitat for fish during typical winter and spring flows and woody instream and overhanging cover that will increase in extent over time as the planted vegetation becomes established. To address reductions in SRA cover values associated with the placement of rock and loss of shade along the summer/fall shoreline, onsite and imported IWM will be anchored between elevations 4 and 6 feet to achieve a minimum of 40% cover (approximately 400 linear feet) within the average summer/fall inundation zone. The proposed design is similar to other erosion control designs that have been employed on the lower Sacramento and American Rivers to minimize impacts on existing habitat values and restore some of the key attributes and functions of natural SRA cover and riparian habitat that would otherwise be lost as a result of standard revetment practices or continued erosion. In addition to increasing the amount of structural cover available to fish along the shoreline, the installation of IWM is also expected to promote sediment deposition on the rock bench as observed at locations where similar designs have been used to address the compensation needs of listed fish species (e.g., Sand Cove, RM 62.2).

*Levee Breaches.* Approximately 6,406 linear feet of the existing levee would be degraded to create the five levee breaches and associated shoulder rock (Figure 15), resulting in permanent losses of existing SRA cover and riparian vegetation on the affected banks. Based on the current design, individual breaches range in width (bank length) from approximately 645 to 1,345 feet, while the adjacent rock shoulders range from 90 to 228 feet long. Two of the breaches (N1 and S3) would be constructed in Year 3, and the remaining three breaches (N2, S1, and S2) would be constructed in Year 5. During Year 3 of construction, the existing levee within each of the proposed footprints of the deferred breaches (N2, S1, and S2) would be degraded (approximately 200 linear feet) to install one to two temporary culverts. The culverts will extend through the existing levee (bottom elevation of +7 feet) to maintain connectivity between the river and restored floodplain during the interim period.

A combination of rock slope protection and biotechnical methods would be used to control erosion and maximize the amount of vegetated surfaces within the levee breaches. The riverbank and apron zones will be planted with emergent marsh and woody riparian species (extending along the Sacramento River and laterally into the swales and restored floodplain) to restore SRA and riparian habitat to the extent possible. However, species selection within the riverbank and apron zones may be limited to those suitable for coppicing, which may be necessary to maintain uniform hydraulic conditions and minimize the risk of scour within the levee breaches (Figure 6). Existing rock slope protection within the riverbank zone between elevations +7 and +10 feet would be retained. In areas that lack revetment or where the revetment is found to be in poor condition (coverage), vegetated coir fabric will be installed between elevations +7 and +10 feet. No vegetation or other habitat features will be incorporated into the rock shoulders.

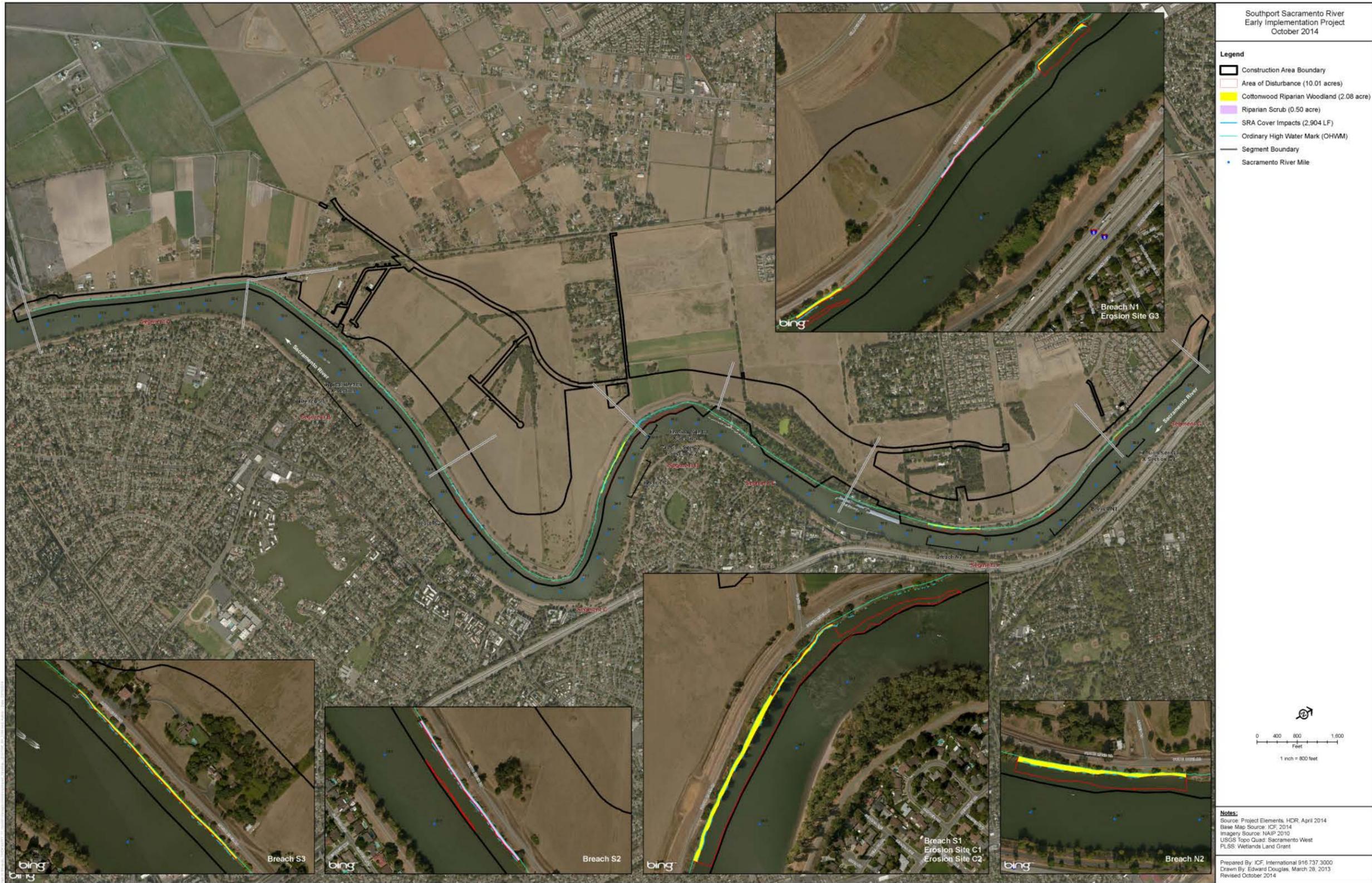


Figure 24. Southport EIP Critical Habitat Impacts.

## Floodplain Habitat

The levee setback component of the project would result in the restoration of approximately 120 acres of historical Sacramento River floodplain with a diverse mosaic of seasonal floodplain, wetland, riparian, and upland habitat. The goals of the offset area restoration design are to increase river-floodplain connectivity, restore ecologically functional floodplain habitat, and meet the flood risk–reduction objectives of the project.

Restoring floodplain habitat and connectivity of large rivers to their floodplains have been identified as important objectives of ecosystem restoration and species recovery efforts for listed and other special-status fish species in the Central Valley (NMFS 2009). Floodplains are recognized as major contributors to aquatic production and species diversity in large river systems where native fish species have evolved specific adaptations to exploit these variable but highly productive habitats (Welcomme 1979; Junk et al. 1989; Gutreuter et al. 1999). Historically, the Sacramento River Valley contained extensive areas of seasonal floodplains and wetlands that flooded nearly every winter and spring. These habitats supported significant production of native fish species and contributed substantially to overall biological productivity of the river and estuary (Ahearn et al. 2006). As demonstrated in the Yolo Bypass, floodplain habitat can greatly expand the quantity and quality of habitat available to juvenile salmon and other native fishes during seasonal inundation periods (Sommer et al. 2001, 2005). After young salmon have dispersed from spawning areas, the distribution and abundance of young salmon is determined largely by their preferences for shallow water and low water velocities, which in large rivers are found mostly along channel margins, floodplains, and other off-channel habitats (Beechie et al. 2005; Lestelle et al. 2005).

Floodplain restoration through the creation of setback levees is considered a key conservation action for addressing historical and ongoing impacts of levee construction and maintenance activities on listed fish species and their habitats, especially in the highly constrained portions of the lower Sacramento River. It is generally assumed that the number or biomass of fish that can be supported by aquatic ecosystems is directly proportional to the area of suitable habitat. In addition to increased living space, floodplains may further enhance the growth and survival of young fish by increasing the production and availability of food, increasing growth capacity (i.e., food conversion efficiency), reducing competition for food, and reducing potential encounters with predators. Floodplains also enhance the productivity of river-floodplain systems by increasing hydraulic residence time, water temperature, and inputs of organic matter, plankton, and macro-invertebrates from the floodplain into river channels (Ahearn et al. 2006).

The levee setback design was developed through a collaborative process among project engineers, biologists, and restoration ecologists to achieve the flood-risk reduction and habitat restoration objectives of the project. A principle step in this process has been the linkage of key hydrologic and hydraulic parameters (inundation timing, frequency, duration, depth, velocity) with habitat suitability criteria of the target species through the application of the the Corps' Ecosystem Functions Model and 2D hydrodynamic modeling (MIKE 21C) (cbec, inc. and ICF International 2013).

Native Sacramento splittail and Chinook salmon (including winter-, spring-, and fall-run Chinook salmon) were selected as the target species for the offset area design. These species were selected because they are considered key indicator species of functional floodplain habitat in the Central Valley. A flood frequency analysis was performed using the long-term flow record from the Freeport gauge to evaluate the recurrence probability of flows and water surface elevations that correlate with the occurrence of suitable habitat for the target species. The ecological criteria for each of the target species and corresponding flows, recurrence intervals, and water surface elevations are summarized in Appendix B. In general, the offset areas have been designed to flood every 1–2 years for at least 2–3 weeks during December through May based on the minimum floodplain inundation requirements for successful spawning, incubation, and larval development of Sacramento splittail, and rearing and enhanced growth of juvenile Chinook salmon.

The levee offset areas were also designed to achieve the desired flooding regime (depth, duration, and extent of flooding), drainage patterns, and soil conditions to support riparian, wetland, and upland vegetation on the restored floodplain. Based on current design, much of the offset areas will be excavated down to an elevation of approximately 10 feet NAVD88 to achieve frequent inundation of the new floodplain and expand the amount of riparian habitat, SRA cover, and floodplain habitat available to fish over a broad range of flows. The floodplain design includes one or more interconnected swales or low-flow channels that would form the primary aquatic and riparian corridors connecting the river and floodplain (Appendix B, Figure 7). These channels are designed to maintain suitable soil moisture conditions for wetland and riparian vegetation, facilitate river-floodplain connectivity and drainage of the floodplain over a broad range of flows, and minimize the extent of suitable habitat (isolated ponds) for bass and other undesirable fish species that spawn and rear during the drier late spring and summer months. In addition, topographic heterogeneity has been incorporated into the project design grading plans to create a mosaic of wetland, riparian, and upland habitats supporting emergent wetland, willow-scrub, cottonwood forest, oak woodland plantings and native grasses. A draft MMP for the offset areas is being developed on behalf of WSAFCA and will be approved by NMFS, USFWS, and CDFW before implementation of the project. The MMP will include a detailed discussion of the design process; an updated review of the hydrologic, hydraulic, geomorphic, and ecological modeling results; representative plans and cross sections of the Southport EIP elements; fish stranding and vegetation monitoring methods; habitat compensation and restoration success criteria; and a protocol for implementing remedial actions should any success criteria not be met. Monitoring will be conducted over a period of 10 years. Annual monitoring reports that describe each year's monitoring activities and progress toward the success criteria will be submitted to the resource agencies during the course of the monitoring period. Monitoring will be conducted until the projected benefits of the compensation and restoration actions have been substantially achieved.

*SAM Assessment.* The SAM was developed by the Corps and Stillwater Sciences, in consultation with NMFS, USFWS, CDFW, and DWR, to address specific habitat assessment and regulatory needs for ongoing and future bank protection actions in the Sacramento River Bank Protection Project (SRBPP) Action Area. The SAM was designed to systematically evaluate the impacts and compensation requirements of bank protection and levee improvement projects on Chinook salmon, steelhead, green

sturgeon, and delta smelt, and their critical habitat. The SAM has been used previously in both programmatic (Corps 2007a) and project-level (e.g., Jones & Stokes 2007) bank protection effect analyses.

The SAM quantifies habitat values in terms of a weighted species response index (WRI) that is calculated by combining habitat quality (i.e., fish response indices) with quantity (i.e., bank length or wetted area) for each season, target year, and relevant species/life stage. The fish response indices are derived from hypothesized relationships between key habitat attributes (described below) and the species and life stage responses. Species response indices vary from 0 to 1, with 0 representing unsuitable conditions and 1 representing optimal conditions for survival, growth, and/or reproduction. For a given site and scenario (i.e., with or without project), the SAM uses these relationships to determine the response of individual species and life stages to the measured or predicted values of each habitat attribute for each season and target year, and then multiplies these values together to generate an overall species response index. This index is then multiplied by the linear feet or area of shoreline to which it applies to generate a weighted species response index expressed in feet or square feet. The species response index provides a common metric that can be used to quantify habitat values over time, compare project conditions to existing conditions, and evaluate the effectiveness of on-site and off-site compensation actions. For example, the difference in WRIs between with- and without-project conditions in a given year provides a measure of the impacts (negative species response) or benefits (positive species response) of the project relative to baseline conditions. More detail on the SAM is provided by the Corps (2004, 2007a).

The SAM employs six habitat attributes to characterize nearshore, SRA cover, and floodplain habitats of listed fish species.

- *Bank slope*—This is the average bank slope along the average annual summer, fall, winter, and spring water surface elevation. This variable is used as an indicator of shallow-water habitat availability, which is important to juveniles for feeding, rearing, and refuge from high flows and predators.
- *Floodplain availability*—This is the ratio of wetted area for the 2-year flood flow to the wetted area for the average annual winter-spring flow. This variable is used as an indicator of the amount seasonally flooded shallow-water habitat, which is important to juveniles for feeding, rearing, and refuge from high flows and predators.
- *Bank substrate size*—This is median particle diameter of the bank (i.e.,  $D_{50}$ ) along each average seasonal water surface elevation. This variable is used as an indicator of juvenile predator refuge and food availability for juveniles and adults.
- *Instream structure*—This is the percent of shoreline coverage of IWM along each average seasonal water surface elevation. This variable is used as an indicator of juvenile predator refuge, food availability, and cover and resting habitat for juveniles and adults.

- *Aquatic and riparian vegetation*—This is the percent of shoreline coverage of aquatic or riparian vegetation along each average seasonal water surface elevation. This variable is used as an indicator of juvenile predator refuge, food availability, and cover.
- *Overhanging shade*—This is the percent of the shoreline coverage of shade along each average seasonal water surface elevation. This variable is used as an indicator of juvenile and adult predator refuge.

The SAM was used to quantify the responses of the target fish species and life stages to with-project conditions over a 50-year project period relative to the species and life stage responses under without-project (existing) conditions. The assessment followed the general steps outlined in the SAM User's Manual (Corps 2004). A detailed description of the data sources, methods, and assumptions used to characterize existing and with-project habitat conditions is presented in Appendix C.

The results of the SAM for each species, life stage, season of occurrence, and target year, as applied to the Southport EIP, are described below and presented graphically in Appendix F. The SAM results focus on the following life stages and primary seasons of occurrence based on the sensitivity of these life stages to project effects.

- Chinook salmon juvenile rearing and smolt migration in fall, winter, and spring (applies to winter-run and spring-run Chinook salmon).
- Steelhead juvenile rearing and smolt migration in fall, winter, and spring.
- Green sturgeon juvenile rearing (all seasons).

Appendix F also includes summary tables of the projected changes in habitat conditions between year 0 (existing conditions) and year 5 in terms of linear feet of specific habitat classes as defined by the SAM.

*Chinook Salmon Juvenile Rearing.* The SAM results indicate that the Southport EIP would result in slight initial habitat deficits (<5% reduction relative to baseline values) for juvenile winter-run and spring-run Chinook salmon rearing during the fall, followed by a gradual recovery in future years (Appendix F, Figure F-1). Nearly complete compensation of impacts resulting from the installation of rock and loss of existing IWM is achieved in Year 2 with the installation of IWM at the erosion repair sites. Subsequent growth of planted vegetation and associated increases in shade at the erosion control sites and on the remnant levee is expected to contribute to full recovery of fall habitat values in future years.

The Southport EIP would result in substantial long-term gains in winter and spring habitat values for juvenile winter-run and spring-run Chinook salmon (Appendix F, Figure F-1). Winter and spring WRIs for juvenile rearing are projected to increase rapidly in years 2–5 and continue to increase over the 50-

year assessment period. Between years 5 and 50, WRI values are predicted to increase 35 to 65% over baseline values. These results reflect the positive responses of juvenile salmon to the large and immediate gains in habitat values resulting from increases in floodplain area, shallow water habitat, and natural substrate associated with the levee setback, increases in shallow water habitat on the constructed benches of the erosion repair sites, and gradual increases in shoreline cover resulting from the growth of planted vegetation on the levee breaches, erosion protection sites, and remnant levee.

*Chinook Salmon Smolt Migration.* The SAM results indicate that the responses of winter-run and spring-run Chinook salmon smolts to changes in SRA cover, riparian, and floodplain habitat associated with the Southport EIP would be similar to those predicted for juvenile rearing (Appendix F, Figure F-2). The slight initial deficit in fall WRIs is expected to recover completely by year 15. Like juvenile rearing, winter-spring WRIs for smolt migration are projected to increase rapidly in years 2–5 and continue to increase over the 50-year period. Between years 5 and 50, WRI values are predicted to increase 6 to 12% over baseline values.

*Steelhead Juvenile Rearing.* Similar to Chinook salmon, the SAM results indicate that the Southport EIP would result in slight initial habitat deficits (<5% reduction relative to baseline values) for steelhead rearing during the fall, followed by a gradual recovery in future years, and substantial habitat gains in winter-spring values (27 to 47% increase between years 5 and 50) beginning in the second year of construction and increasing throughout the 50-year assessment period (Appendix F, Figure F-3).

*Steelhead Smolt Migration.* The SAM results for steelhead smolt migration (Appendix F, Figure F-4) are similar to those for Chinook salmon smolt migration, as described above.

*Green Sturgeon Juvenile Rearing.* The SAM results indicate that the Southport EIP Proposed Action would result in small net gains in habitat values for juvenile green sturgeon in all seasons and project years (Appendix F, Figure F-5). Summer, fall, winter, and spring WRIs are predicted to exceed baseline values by 1 to 2% in years 5 through 50. These results reflect the positive responses of juvenile green sturgeon to increases in shallow water habitat and instream structure associated with the constructed bench and installed IWM at the erosion repair sites. The Southport project would have negligible effects on substrate potentially used by green sturgeon for holding, foraging, and migration in deeper portions of the channel.

### Fish Stranding

Following periods of floodplain inundation, receding floodwaters may collect in existing ponds, ditches, borrow areas, and other depressions on the restored floodplain, resulting in fish stranding and high mortality rates due to lethal water temperatures, low dissolved oxygen, predation, and desiccation. WSAFCA will minimize fish stranding by developing and implementing a drainage and grading plan that minimizes the extent of ponding and facilitates complete drainage of the active floodplain to the main river. The final offset area design will include substantial grading and re-contouring of the restored floodplain as necessary to facilitate complete drainage and unimpeded fish passage to the main river as

floodwaters recede from the levee offset area. Features with substantial stranding risk will be filled and/or graded to minimize this risk. Bees Lakes would remain hydraulically isolated from the main river. As described above, the restoration and monitoring plan will evaluate the effectiveness of the grading and drainage features in preventing fish stranding and will include provisions for remediation should the design fail to meet established performance or success criteria.

#### Long-Term Hydraulic, Geomorphic, and Sediment Transport Conditions

The Southport EIP may adversely affect listed species and designated critical habitat as a result of local changes in hydraulic, geomorphic, and sediment transport conditions that may modify channel morphology, water depths and velocities, and suspended sediment and turbidity levels in the Sacramento River. As described in Appendix C-1 and C-2 of the Southport EIP Draft EIS/EIR (ICF International 2013), hydraulic modeling performed by MBK for Alternatives 2 and 5 (setback levee alternatives) indicate that the Southport EIP would not significantly affect water surface elevations or cause negative hydraulic effects in the Sacramento River under 100-year, 200-year, and 500-year flood events. In general, the risk of channel scour, bank erosion, and levee failure would be reduced relative to existing conditions because of proposed levee strengthening, increased bank stability, and reductions in shear stress associated with the widened floodplain. Although local shear stresses would be reduced, these reductions are not expected to significantly alter erosion, deposition, and sediment transport rates in the main channel of the Sacramento River. Therefore, the Southport EIP is not likely to adversely affect listed species or critical habitat through long-term effects on hydraulic, geomorphic, and sediment transport conditions in the Sacramento River.

#### Operations and Maintenance

O&M activities that require in-water work are expected to occur between July 1 and October 31 for the life of the project to maintain flood control and habitat features in the Southport EIP Action Area. Anticipated O&M activities include vegetation maintenance up to four times a year (mowing or applying herbicide); control of burrowing rodent activity (baiting with pesticide); site-specific slope repair, as needed (resloping and compacting); patrol road reconditioning up to once a year (placing, spreading, grading, and compacting aggregate base or substrate); regular visual inspections of the levee; and relief well monitoring. In addition, periodic rock placement may be needed to prevent or repair localized scouring on the levee slopes and in the offset areas. Potential impacts from slope repairs would be similar to those described for construction activities but would be infrequent, localized, and shorter in duration. Consequently, the potential for adverse effects on listed fish species or critical habitat would be lower and further minimized by application of the BMPs and other minimization and avoidance measures that are proposed during construction.

## **Delta Smelt**

The following assessment addresses potential direct and indirect effects of the Southport EIP on delta smelt and its designated critical habitat. Potential effects include both short-term and long-term effects. Short-term effects include temporary construction-related impacts on fish and aquatic habitat that may last from a few hours to days (e.g., suspended sediment and turbidity). Long-term effects typically last months or years, and are generally due to physical alteration of important habitat attributes of the channel, shoreline, and adjacent bank or floodplain. Short-term project effects on delta smelt are evaluated qualitatively based on general knowledge of the impact mechanisms and species responses to construction actions. Long-term project effects are measured in terms of the linear feet and area of riparian, SRA cover, and floodplain habitat affected by the Southport EIP, and the responses of listed species to changes in habitat quantity and quality as measured by the SAM (Corps 2004).

### **Direct Effects**

#### **Short-Term Effects of Noise, Turbidity, and Suspended Sediment**

In-water construction activities, including operation of the barge and placement of rock below the water surface, would cause physical disturbance of the bed and water column of the Sacramento River. The resulting noise, turbidity, and suspended sediment may result in temporary avoidance or displacement of delta smelt from preferred habitat, disruption of migration and spawning activities, disturbance or mortality of eggs and newly hatched larvae, and alteration of spawning and incubation habitat. Eggs and newly hatched larvae are most vulnerable to these effects because of their inability to move away from areas that are directly affected by in-water construction activities. Potential effects include injury or mortality from falling rock and burial of eggs or larvae by suspended sediment.

The extent of construction-related effects depends on the timing of these activities, the timing of fish presence in the Southport EIP Action Area, and their ability to successfully avoid the disturbance. In-water construction activities are scheduled for July 1 through October 31, and therefore should avoid the primary migration, spawning, and larval dispersal periods of delta smelt. Adult delta smelt migrate upstream between December and January and spawn between late February and June, with peak spawning activity between mid-April and May (Bennett 2005). Because larvae move downstream shortly after hatching, restriction of in-water activities to the July 1–October 31 window should avoid adverse construction-related effects on incubation and early larval stages originating in the Southport EIP Action Area. However, the potential exists for delta smelt larvae or juveniles to be present in the Southport EIP Action Area in the early summer as they disperse downstream from potential spawning areas upstream of the Southport EIP Action Area. Based on the potential upstream extent of spawning in the Sacramento River, small numbers of larvae or juveniles could be adversely affected by in-water construction activities that occur in the Sacramento River after July 1. Potential turbidity and sedimentation effects on these life stages will be minimized by adhering to the proposed in-water construction window, RWQCB turbidity objectives, and erosion and sediment control BMPs (SWPPP).

### Potential Discharge of Contaminants

Contaminants used at construction sites, including gasoline, diesel fuel, lubricants, and hydraulic fluid, could enter the Sacramento River as result of spills or leakage from machinery or storage containers and injure or kill delta smelt and other listed fish species. These substances can kill aquatic organisms through exposure to lethal concentrations or exposure to non-lethal levels that cause physiological stress and increased susceptibility to other sources of mortality such as predation. Petroleum products also tend to form oily films on the water surface that can reduce dissolved oxygen levels available to aquatic organisms. There is also a slight risk of the release of bentonite into the Sacramento River during jet grouting or deep soil mixing used to construct slurry cut off walls. Bentonite is a naturally occurring, inert, nontoxic material that meets National Sanitation Foundation/American National Standards Institute Drinking Water Additives Standards 60 and 61. Therefore, any inadvertent release of drilling fluid containing only water and bentonite would not have toxicity effects on ESA-listed fish. However, bentonite released into streams could result in turbidity and cause many of the same behavioral, physiological, and physical effects described above for turbidity and suspended sediment.

Implementation of a spill prevention, control, and countermeasure plan and bentonite slurry spill contingency plan as part of the environmental commitments of the project is anticipated to minimize the potential for toxic or hazardous spills or discharges into the Sacramento River. Adherence to all preventative, contingency, and reporting measures in the approved plans would reduce the risk of injury or mortality of listed fish species to negligible levels.

### Fish Entrapment in Cofferdams

Cofferdams may be required to install temporary culverts needed to maintain connectivity between the river and restored floodplain prior to construction of the final levee breaches. The potential exists for entrapment and mortality of delta smelt adults, eggs, and larvae following closure and dewatering of the cofferdam. As discussed above, the timing of cofferdam installation and other in-water activities (July 1 through October 31) would avoid the primary delta smelt spawning, incubation, and larval dispersal period in the Southport EIP Action Area. However, because spawning may extend into July, small numbers of adult, eggs, or larvae may be present. The potential for entrapment of delta smelt would be minimized by constructing the cofferdam during summer low water conditions and limiting the extent of the cofferdam footprint to the shallow edge of the river.

### Long-Term Effects on Critical Habitat

The project is expected to result in long-term modification of SRA cover, riparian, and floodplain habitat, including modification of the designated critical habitat of delta smelt. Long-term effects on delta smelt and critical habitat may also occur as a result of local changes in hydraulic, geomorphic, and sediment transport conditions in the Sacramento River upstream and downstream of the Southport EIP project area. These modifications may affect behavior, growth, and survival of individuals and the primary constituent elements of critical habitat. General effects of the project on riparian, SRA cover,

and floodplain habitat are described below, followed by a summary of long-term changes in habitat values and species responses based on the results of the SAM. This is followed by a general assessment of long-term effects on delta smelt and critical habitat related to potential fish stranding on the restored floodplain and predicted changes in local hydraulic, geomorphic, and sediment transport conditions in the main channel of the Sacramento River.

*SRA Cover and Riparian Habitat.* The loss of riparian vegetation and the replacement of natural substrate with riprap generally reduces the quality of nearshore habitat for fish by reducing habitat diversity and altering several important attributes of natural shorelines. These attributes, which characterize SRA cover, include natural substrates, riparian vegetation, woody material, and variable water depths and velocities, including shallow, low-velocity areas used by native fishes for spawning, foraging, and refuge from fast currents, deep water, and predators. Simple riprapped banks generally create more uniform physical and hydraulic conditions characterized by deeper, faster water, and lack of cover. These conditions reduce utilization by native fishes and also inhibit the establishment of shoreline vegetation and retention of sediment, organic material, and large woody material, which provide important sources of cover and food for juvenile fish and other aquatic organisms. In addition to cover and shelter for fish, riparian vegetation provides other important stream ecosystem functions, including channel and streambank stability; inputs of food (e.g., terrestrial insects), organic matter, and nutrients; and temperature-moderating shade (Murphy and Meehan 1991).

The Southport EIP would affect approximately 7,419 linear feet of the existing Sacramento River levee as a result of levee degradation and installation of rock slope and biotechnical bank protection at the proposed erosion repair and levee breach sites (Appendix B, Figures 3a–c, 5a–c, and 6). The total area of bank within the construction limits between the submerged toe of the bank (-10 to -45 feet NAVD88) and the OHWM (+20 feet NAVD88) is approximately 8.49 acres. Where the remnant levee is breached, all existing SRA cover and riparian vegetation on the levee slope would be lost due to degradation of the levee and the addition of biotechnical and rock slope protection needed to create and protect the breaches (Appendix B, Figures 5a–5c and 6). Within the erosion sites, the removal of SRA cover and riparian vegetation would be limited to the lower portion of the bank below elevation +12 feet NAVD 88 (Appendix B, Figures 3a–3c).

Vegetation mapping of the project site in April–May 2011 indicates that the proposed erosion repairs, rock slope protection, and levee breaches for the Southport EIP would affect approximately 5.44 acres of cottonwood riparian woodland and 1.46 acres of riparian scrub. This includes the loss of approximately 2.01 acres of cottonwood riparian woodland and 0.51 acre of riparian scrub below the OHWM on the waterside slope of the existing levee. It is assumed that the portions of the existing levee outside the affected levee sites (totaling approximately 24,198 feet), including all existing SRA cover and riparian habitat, would remain intact and no longer be subject to levee maintenance activities. In addition, portions of the remnant levee that are currently devoid of vegetation or sparsely vegetated would be planted with woody riparian species to enhance SRA cover and riparian habitat values and meet any remaining onsite compensation requirements.

Onsite compensation and enhancement of SRA cover and riparian habitat would be achieved through the planting of native riparian species on the floodplain setback area, levee breaches, remnant levees, and erosion repair sites. A detailed description of the SRA cover and riparian habitat compensation and enhancement objectives is being developed as part of the MMP for the Southport EIP (see Conservation Measure 6 on page 2-30).

**Erosion Repair Sites.** Erosion repair and bank stabilization would be conducted in the second year of construction at three sites (C1, C2, and G3, comprising approximately 1,013 linear feet of bank) to treat several over-steepened or eroding levee areas in Segment C, D, and G (Appendix B, Figures 2 and 3a-3c). To minimize long-term impacts on SRA cover and riparian habitat, these sites have been designed to retain existing vegetation and woody material to the extent possible and promote onsite replacement of SRA cover and riparian vegetation. This would be accomplished by incorporating a 10:1 bench and soil fill within the average annual low and high water inundation zone of the river (between +7 to +12 feet NAVD88) to provide a surface for planting riparian vegetation, anchoring woody material, and creating shallow water habitat (Appendix B, Figures 3a-3c). The low benches would provide shallow water habitat for fish during typical winter and spring flows and woody instream and overhanging cover that would increase in extent over time as the planted vegetation becomes established. To address reductions in SRA cover values associated with the placement of rock and loss of shade along the summer-fall shoreline, onsite and imported IWM would be anchored between elevations 4 and 6 feet to achieve a minimum of 40% cover (approximately 400 linear feet) within the average summer-fall inundation zone. The proposed design is similar to other erosion control designs that have been employed on the lower Sacramento and American Rivers to minimize impacts on existing habitat values and restore some of the key attributes and functions of natural SRA cover and riparian habitat that would otherwise be lost as a result of standard revetment practices or continued erosion. In addition to increasing the amount of structural cover available to fish along the shoreline, the installation of IWM is also expected to promote sediment deposition on the rock bench as observed at locations where similar designs have been used to address the compensation needs of listed fish species (e.g., Sand Cove, RM 62.2).

**Levee Breaches.** Approximately 6,406 linear feet of the existing levee would be degraded to create the five levee breaches (Appendix B, Figure 2), resulting in permanent losses of existing SRA cover and riparian vegetation within the proposed breach locations. Based on the current design, individual breaches range in width (bank length) from approximately 645 to 1,345 feet. Two of the breaches (N1 and S3) would be constructed in Year 3, and the remaining three breaches (N2, S1, and S2) would be constructed in Year 5. During Year 3 of construction, the existing levee within each of the proposed footprints of the deferred breaches (N2, S1, and S2) would be degraded (approximately 200 linear feet) to install one to two temporary culverts. The culverts would extend through the existing levee (bottom elevation of +7 feet) to maintain connectivity between the river and restored floodplain during the interim period.

A combination of rock slope protection and biotechnical methods would be used to control erosion and maximize the amount of vegetated surfaces within the levee breaches. The riverbank and

apron zones would be planted with emergent marsh and woody riparian species (extending along the Sacramento River and laterally into the swales and restored floodplain) to restore SRA and riparian habitat to the extent possible. However, species selection within the riverbank and apron zones may be limited to those suitable for coppicing which may be necessary to maintain uniform hydraulic conditions and minimize the risk of scour within the levee breaches (Appendix B, Figure 8). Existing rock slope protection within the riverbank zone between elevations +7 and +10 feet would be retained. In areas that lack revetment or where the revetment is found to provide insufficient protection, vegetated coir fabric would be installed between elevations +7 and +10 feet. The existing levee bordering the levee breaches (shoulders) would be armored with standard rock revetment to serve as scour protection. Individual segments of shoulder rock would range in length from 90 to 228 feet long and total 1,780 linear feet. No vegetation or other habitat features would be incorporated into the rock shoulders.

Remnant Levee. Portions of the existing levee outside the erosion repair sites and levee breaches (totaling approximately 24,198 feet), including existing SRA cover and riparian habitat, would remain intact and no longer be subject to levee maintenance activities. However, portions of the remnant levee that are currently devoid of vegetation or sparsely vegetated would be planted with woody riparian to enhance SRA cover and riparian habitat values and meet any remaining onsite compensation requirements.

*Floodplain Habitat.* The levee setback component of the project would result in the restoration of approximately 120 acres of historical Sacramento River floodplain supporting seasonal floodplain, wetland, riparian, and upland habitat. The goals of the offset area restoration design are to increase river-floodplain connectivity, restore ecologically functional floodplain habitat, and meet the flood risk reduction objectives of the project.

Restoring floodplain habitat and connectivity of large rivers to their floodplains have been identified as important objectives of ecosystem restoration and species recovery efforts for listed and other special-status fish species in the Central Valley (NMFS 2009). Floodplains are recognized as major contributors to aquatic production and species diversity in large river systems where native fish species have evolved specific adaptations to exploit these variable but highly productive habitats (Welcomme 1979, Junk et al. 1989, Gutreuter et al. 1999). Historically, the Sacramento River Valley contained extensive areas of seasonal floodplains and wetlands that flooded nearly every winter and spring. These habitats supported significant production of native fish species and contributed substantially to overall biological productivity of the river and estuary (Ahearn et al. 2006). As demonstrated in the Yolo Bypass, floodplain habitat can greatly expand the quantity and quality of habitat available to juvenile salmon and other native fishes during seasonal inundation periods (Sommer et al. 2001, 2005). After young salmon have dispersed from spawning areas, the distribution and abundance of young salmon is determined largely by their preferences for shallow water and low water velocities, which in large rivers are found mostly along channel margins, floodplains, and other off-channel habitats (Beechie et al. 2005, Lestelle et al. 2005).

Floodplain restoration through the creation of setback levees is considered a key conservation action for addressing historical and ongoing impacts of levee construction and maintenance activities on listed fish species and their habitat, especially in the highly constrained portions of the lower Sacramento River. It is generally assumed that the number or biomass of fish that can be supported by aquatic ecosystems is directly proportional to the area of suitable habitat. In addition to increased living space, floodplains may further enhance the growth and survival of young fish by increasing the production and availability of food, increasing growth capacity (i.e., food conversion efficiency), reducing competition for food, and reducing potential encounters with predators. Floodplains also enhance the productivity of river-floodplain systems by increasing hydraulic residence time, water temperature, and inputs of organic matter, plankton, and macro-invertebrates from the floodplain into river channels (Ahearn et al. 2006).

The levee setback design was developed through a collaborative process among project engineers, biologists, and restoration ecologists to achieve the flood-risk reduction and habitat restoration objectives of the project. A principle step in this process has been the linkage of key hydrologic and hydraulic parameters (inundation timing, frequency, duration, depth, velocity) with habitat suitability criteria of the target species through the application of the Corps' Ecosystem Functions Model and 2D hydrodynamic modeling (MIKE 21C) (cbec, inc. and ICF International 2013).

Native Sacramento splittail and Chinook salmon (including winter-, spring-, and fall-run Chinook salmon) were selected as the target species for the offset area design. These species were selected because they are considered key indicator species of functional floodplain habitat in the Central Valley. A flood frequency analysis was performed using the long-term flow record from the Freeport gauge to evaluate the recurrence probability of flows and water surface elevations that correlate with the occurrence of suitable habitat for the target species. The ecological criteria for each of the target species and corresponding flows, recurrence intervals, and water surface elevations are summarized in Appendix D. In general, the offset areas have been designed to flood every 1-2 years for at least 2-3 weeks during December through May based on the minimum floodplain inundation requirements for successful spawning, incubation, and larval development of Sacramento splittail, and rearing and enhanced growth of juvenile Chinook salmon.

The offset areas were also designed to achieve the desired flooding regime (depth, duration, and extent of flooding), drainage patterns, and soil conditions to support riparian, wetland, and upland vegetation on the restored floodplain. Based on current design, much of the offset areas would be excavated down to an elevation of approximately 10 feet NAVD88 to achieve frequent inundation of the new floodplain and expand the amount of riparian habitat, SRA cover, and floodplain habitat available to fish over a broad range of flows. The floodplain design includes one or more interconnected swales or low-flow channels that would form the primary aquatic and riparian corridors connecting the river and floodplain (Appendix B, Figure 9). These channels are designed to maintain suitable soil moisture conditions for wetland and riparian vegetation, facilitate river-floodplain connectivity and drainage of the floodplain over a broad range of flows, and minimize fish stranding and the extent of suitable habitat (isolated ponds) for bass and other undesirable fish species during the drier late spring and

summer months. In addition, topographic heterogeneity has been incorporated into the project design grading plans to create a mosaic of wetland, riparian, and upland habitats supporting emergent wetland, willow-scrub, cottonwood forest, oak woodland plantings and native grasses.

An MMP for the offset areas is being developed on behalf of WSAFCA and will be approved by the Corps, NMFS, USFWS, and CDFW before implementation of the Southport EIP. The MMP will include representative plans and cross sections of the Southport EIP elements; fish stranding and vegetation monitoring methods; habitat compensation and restoration success criteria; and a protocol for implementing remedial actions should any success criteria not be met. Annual monitoring reports that describe each year's monitoring activities and progress toward the success criteria would be submitted to the resource agencies during the course of the monitoring period. Monitoring would be conducted until the projected benefits of the compensation and restoration actions have been substantially achieved.

*SAM Assessment.* The SAM was developed by the Corps and Stillwater Sciences, in consultation with NMFS, USFWS, CDFW, and CDWR, to address specific habitat assessment and regulatory needs for ongoing and future bank protection actions in the Sacramento River Bank Protection Project (SRBPP) Action Area. The SAM was designed to systematically evaluate the impacts and compensation requirements of bank protection and levee improvement projects on Chinook salmon, steelhead, green sturgeon, and delta smelt, and their critical habitat. The SAM has been used previously in both programmatic (Corps 2007a) and project-level (e.g., Jones & Stokes 2007) bank protection effect analyses.

The SAM quantifies habitat values in terms of a WRI that is calculated by combining habitat quality (i.e., fish response indices) with quantity (i.e., bank length or wetted area) for each season, target year, and relevant species/life stage. The fish response indices are derived from hypothesized relationships between key habitat attributes (described below) and the species and life stage responses. Species response indices vary from 0 to 1, with 0 representing unsuitable conditions and 1 representing optimal conditions for survival, growth, and/or reproduction. For a given site and scenario (i.e., with or without project), the SAM uses these relationships to determine the response of individual species and life stages to the measured or predicted values of each habitat attribute for each season and target year, and then multiplies these values together to generate an overall species response index. This index is then multiplied by the linear feet or area of shoreline to which it applies to generate a weighted species response index, expressed as feet or square feet. The species response index provides a common metric that can be used to quantify habitat values over time, compare project conditions to existing conditions, and evaluate the effectiveness of on-site and off-site compensation actions. For example, the difference in WRIs between with- and without-project conditions in a given year provides a measure of the impacts (negative species response) or benefits (positive species response) of the project relative to baseline conditions. More detail on the SAM is provided by the Corps (2004 and 2007a).

The SAM employs six habitat attributes to characterize nearshore, SRA cover, and floodplain habitats of listed fish species:

- Bank slope – This is the average bank slope along the average annual summer, fall, winter, and spring water surface elevation. This variable is used as an indicator of shallow-water habitat availability, which is important to juveniles for feeding, rearing, and refuge from high flows and predators.
- Floodplain availability – This is the ratio of wetted area for the 2-year flood flow to the wetted area for the average annual winter-spring flow. This variable is used as an indicator of the amount seasonally flooded shallow-water habitat, which is important to juveniles for feeding, rearing, and refuge from high flows and predators.
- Bank substrate size – This is median particle diameter of the bank (i.e.,  $D_{50}$ ) along each average seasonal water surface elevation. This variable is used as an indicator of juvenile predator refuge and food availability for juveniles and adults.
- Instream structure – This is the percent of shoreline coverage of IWM along each average seasonal water surface elevation. This variable is used as an indicator of juvenile predator refuge, food availability, and cover and resting habitat for juveniles and adults.
- Aquatic and riparian vegetation – This is the percent of shoreline coverage of aquatic or riparian vegetation along each average seasonal water surface elevation. This variable is used as an indicator of juvenile predator refuge, food availability, and cover.
- Overhanging shade – This is the percent of the shoreline coverage of shade along each average seasonal water surface elevation. This variable is used as an indicator of juvenile and adult predator refuge.

The SAM was used to quantify the responses of delta smelt to with-project conditions over a 50-year project period relative to the species and life stage responses under without-project (existing) conditions. The assessment followed the general steps outlined in the SAM User's Manual (Corps 2004). A detailed description of the data sources, methods, and assumptions used to characterize existing and with-project habitat conditions is presented in Appendix E.

The results of the SAM, as applied to the Southport EIP, for the spawning/incubation and larval/juvenile rearing life stages of delta smelt are described below and presented graphically in Appendix F. The SAM focuses on these life stages because of their potential presence in the Southport EIP Action Area and sensitivity to project effects.

Delta Smelt Spawning and Incubation. The Southport EIP would result in long-term gains in winter and spring habitat values (i.e., positive species responses) for delta smelt during the primary winter and spring spawning and incubation period (February–May). Winter and spring WRIs are projected to increase rapidly in years 2–5 and continue to increase over the 50-year with-project period. Between years 5 and 50, WRI values are predicted to increase by 1,509 to 2,336 linear feet, representing an 8% to 12% increase over baseline (existing) habitat values. These results reflect the positive

responses of delta smelt to the large and rapid gains in habitat values resulting from increases in floodplain area and shallow water habitat associated with the levee setback and constructed benches, and gradual increases in shoreline cover (aquatic and riparian vegetation) resulting from the growth of planted vegetation on the levee breaches, erosion protection sites, and remnant levee.

Delta Smelt Larval and Juvenile Rearing. The SAM results indicate that the responses of larval and juvenile delta smelt to changes in SRA cover, riparian, and floodplain habitat associated with the Southport EIP would be similar to those predicted for spawning and incubation (Appendix F, Figure F-2). Between years 5 and 50, winter and spring WRIs are projected to increase by 1,388 to 2,049 linear feet, representing a 9% to 13% increase over baseline (existing) habitat values in response to increases in floodplain area and shallow water habitat under with-project conditions. Virtually no change in WRIs under average summer flow conditions is predicted to occur under with-project conditions (Appendix F, Figure F-2). Based on the SAM response relationships, these results reflect the insensitivity of larval and juvenile delta smelt to changes in average substrate size and IWM levels along the average summer-flow shoreline under with-project conditions (see Appendix E, Table E-4).

#### Fish Stranding

Following periods of floodplain inundation, receding floodwaters may collect in existing ponds, ditches, borrow areas, and other depressions on the restored floodplain, resulting in fish stranding and high mortality rates due to lethal water temperatures, low dissolved oxygen, predation, and desiccation. WSAFCA will minimize fish stranding by developing and implementing a drainage and grading plan that minimizes the extent of ponding and facilitates complete drainage of the active floodplain to the main river. The final levee offset area design will include substantial grading and re-contouring of the restored floodplain as necessary to facilitate complete drainage and unimpeded fish passage to the main river as floodwaters recede from the levee offset area. Features with substantial stranding risk will be filled and/or graded to minimize this risk. Bees Lakes would remain hydraulically isolated from the main river. As described above, the mitigation and monitoring plan will evaluate the effectiveness of the grading and drainage features in preventing fish stranding and will include provisions for remediation should the design fail to meet established performance or success criteria.

#### Long-Term Hydraulic, Geomorphic, and Sediment Transport Conditions

The Southport EIP may adversely affect delta smelt and designated critical habitat as a result of local changes in hydraulic, geomorphic, and sediment transport conditions that may modify channel morphology, water depths and velocities, and suspended sediment and turbidity levels in the Sacramento River. As described in Appendix C-1 and C-2 of the Southport EIP Draft EIS/EIR (ICF International 2013), hydraulic modeling performed by MBK for Alternatives 2 and 5 (setback levee alternatives) indicate that the Southport EIP would not significantly affect water surface elevations or cause negative hydraulic effects in the Sacramento River under 100-year, 200-year, and 500-year flood events. In general, the risk of channel scour, bank erosion, and levee failure would be reduced relative to existing conditions because of proposed levee strengthening, increased bank stability, and reductions

in shear stress associated with the widened floodplain. Although local shear stresses would be reduced, these reductions are not expected to significantly alter erosion, deposition, and sediment transport rates in the main channel of the Sacramento River. Therefore, the Southport EIP is not likely to adversely affect delta smelt or critical habitat through long-term effects on hydraulic, geomorphic, and sediment transport conditions in the Sacramento River.

## **Indirect Effects**

### Operations and Maintenance

O&M activities are not part of the Federal action. Because O&M activities are conducted by DWR and local flood protection districts, the effects of these activities are not part of the Southport EIP. However, they are discussed in this BA because they are interrelated and interdependent to the Southport EIP.

O&M activities that require in-water work are expected to occur between July 1 and October 31 for the life of the project to maintain flood control and habitat features in the Southport EIP Action Area. Anticipated O&M actions include vegetation maintenance up to four times a year (mowing or applying herbicide), control of burrowing rodent activity (baiting with pesticide), site-specific slope repair, as needed (resloping and compacting), patrol road reconditioning up to once a year (placing, spreading, grading, and compacting aggregate base or substrate), regular visual inspections of the levee, and relief well monitoring. In addition, periodic rock placement may be needed to prevent or repair localized scouring on the levee slopes and in the offset areas. Potential impacts from slope repairs would be similar to those described for construction activities but would be infrequent, localized, and shorter in duration. Consequently, the potential for adverse effects on listed fish species or critical habitat would be lower and further minimized by application of the BMPs and other minimization and avoidance measures that are proposed during construction.

## **5.3 Giant Garter Snake**

### **5.3.1 West Sacramento GRR**

Potential effects to the giant garter snake and its habitat could occur during repairs to the Yolo Bypass levee, DWSC east and west levees, Sacramento River south levee and the South Cross levee. Giant garter snakes could be injured or crushed by construction equipment working in suitable aquatic and upland habitat or if soil or other materials are side-cast or fall into suitable aquatic habitat. Snakes could also be killed by construction vehicles traveling through the construction area. Fuel or oil spills from construction equipment into aquatic habitat could also cause illness or mortality of giant garter snakes. Trenches left open overnight could trap snakes moving through the construction area during the early morning hours. Noise and vibrations from construction equipment, and presence of human activity

during construction activities may also disturb giant garter snakes within the project area. Most construction activities will be limited to the snake's active period (May 1–October 1) when the potential for direct mortality is reduced because snakes can actively move and avoid danger. However, if work requires construction during the snakes dormant period (October 2–April 30) giant garter snakes, if present in the upland agricultural and grassland adjacent to the work area, could be injured or killed. Conservation measures discussed above would be implemented to reduce the potential for mortality during this time period.

The study area contains numerous aquatic or irrigation features that are or have the potential to be waters of the United States, including wetlands. These habitat features include, but are not limited to, emergent wetlands (approximately 86 acres), irrigated rice and grain crops (approximately 20 acres), open water (approximately 413 acres), and seasonal wetlands (0.3 acre). This includes open waters that are protected under Federal law from removal, filling, hydrological interruption, or other construction activities.

Direct effects including construction activities associated with this alternative would result in the loss of waters of the United States, including wetlands, as well as upland habitat and disruption of wildlife movement corridor. Except for the proposed levee work on the water side of the Sacramento River levees where high flows exclude this snake, this effect would be considered significant because fixing the levee in place would remove nearshore wetlands and upland habitat that provide suitable habitat ranging between marginal to optimal with low to moderate to high food, cover, and water values for the giant garter snake depending on the quantity and quality of the habitat. It also disturbs the aquatic environment as rock revetment is placed in the water.

In the short term, there are adverse effects due to temporary habitat disturbance to waterways providing habitat for the snake from construction activities to fix the levee in place (Table 25). Construction would result in the temporary disturbance up to 200 acres of suitable upland habitat in the project area, including the Southport EIP Action Area. Temporary loss of up to 200 acres of suitable upland habitat would occur adjacent to water features in fallow agricultural fields and grasslands in the borrow areas. The actual temporary impacts from borrow activities will be substantially less pending an analysis on the suitability of materials. Temporarily affected upland habitat would be restored to preproject conditions. It is estimated that 11 acres of temporary construction impacts to seasonal and permanent wetland habitat that provides foraging, breeding, and rearing habitat for the giant garter snake would also occur.

In the long term, it is estimated that a total of 20 acres of seasonal and permanent wetland habitat that provides foraging, breeding, and rearing habitat for the giant garter snake and up to 10 acres of non-native grassland (associated with the oak woodland habitat lost) habitat would be adversely affected by the construction activities to fix the levees in place (Table 25).

**Table 25. Effects on Giant Garter Snake Habitat in the West Sacramento Project Area.**

<b>Habitat</b>	<b>Temporary</b>	<b>Permanent</b>
Aquatic Habitat	11	20
Upland Habitat <sup>1</sup>	200 <sup>2</sup>	10

<sup>1</sup> Upland habitat consists of fallow agricultural fields and nonnative grasslands from borrow sites within 200 feet of aquatic habitat.

<sup>2</sup> The actual temporary impacts from borrow activities will be substantially less pending an analysis on the suitability of materials.

During post construction levee maintenance activities and maintenance of mitigation plantings, there are potential significant indirect effects to the giant garter snake. If driving on dirt roads in close proximity to the existing wetlands or other water body types and newly created mitigation plantings is necessary, it could disturb the giant garter snake due to vibration, noise, and dust covering the aquatic environment and wetlands. However, these effects are considered short term and it is not significant because the use of vehicles is reduced to one or two vehicles/trucks needed or there is a restricted limited use of heavy equipment needed later for levee repair.

Potential adverse indirect effects to the giant garter snake could occur as a result of the following post construction activities:

- O&M activities, including removal of weeds, tree and shrub trimming up to four times per year, and reconditioning of levee slopes and road with a bull dozer, as needed;
- Permanent altering of light and noise levels;
- Temporary alteration of flows if dewatering a portion of the water body and riparian floodplain/zone for levee repairs or installation of closure structures in the DWSC is necessary;
- Damage caused through toxicity associated with herbicides, insecticides, and rodenticides;
- Introduction of pet and human disturbance (including trash dumping);
- Increases or changes in habitat to attract non- native competitors or predators; and
- Introduction of invasive nonnative plant species onto disturbed and nearby degraded areas.

All project areas would be surveyed prior to final designs to determine the extent to which the species may be impacted. To minimize potential impacts to the species, work will occur between May 1 and October 1 when snakes are active and can move out of the construction area.

### 5.3.2 Southport EIP

As discussed in Chapter 3, suitable aquatic habitat for giant garter snake in the Southport EIP Action Area consists of irrigation and drainage ditches and emergent wetland, as shown in Appendix B, Figure 7. Figure 7 shows Bees Lakes as Adjacent Aquatic Habitat; although Bees Lakes is outside of the Southport EIP Action Area, it creates suitable upland habitat for giant garter snake within the Action Area. Most of the active fields in the Southport EIP Action Area are fallowed or planted in wheat, which does not require irrigation; therefore these ditches were not considered suitable for giant garter snake because they are dry during the snake's active season.

Suitable upland habitat consists of fallow agricultural fields and nonnative grassland in the Southport EIP Action Area. For the effects discussion below, impacts on suitable upland areas were calculated if they occur within 200 feet of suitable aquatic habitat.

#### **Direct Effects**

Construction of the Southport EIP would result in the temporary disturbance of 155 acres and the permanent loss 2.24 acres of suitable upland habitat in the Southport EIP Action Area (Table 26). Temporary loss of up to 155 acres of suitable upland habitat in the Southport EIP Action Area would occur in fallow agricultural fields and grasslands in the borrow areas. The actual temporary impacts from borrow activities will be substantially less pending an analysis on the suitability of materials. Temporarily affected upland habitat would be restored to preproject conditions within a maximum of two seasons (a season is defined as the calendar year between May 1 and October 1 [U.S. Fish and Wildlife Service 1997]), as described in Conservation Measure 16.

The permanent loss of 2.24 acres of suitable upland habitat would result from work in fallow agricultural fields and nonnative grasslands. Compensation would be required for permanent impacts on giant garter snake as described in Conservation Measure 18.

**Table 26. Effects on Giant Garter Snake Habitat in the Southport EIP Action Area.**

<b>Habitat</b>	<b>Temporary</b>	<b>Permanent</b>
Aquatic Habitat	0	0
Upland Habitat <sup>1</sup>	155 <sup>2</sup>	2.24

<sup>1</sup> Upland habitat consists of fallow agricultural fields and nonnative grasslands from borrow sites within 200 feet of aquatic habitat.

<sup>2</sup> The actual temporary impacts from borrow activities will be substantially less pending an analysis on the suitability of materials.

While there would be no temporary or permanent effects of suitable aquatic habitat for giant garter snake in the Southport EIP Action Area, disturbance or degradation of aquatic habitat could occur if soil or other materials are sidecast or fall into the habitat. Fuel or oil leaks or spills adjacent to aquatic habitat could also cause degradation of habitat. These potential effects would be avoided by installing

sediment and construction barrier fencing (Conservation Measure 12), locating staging areas away from aquatic habitat (Conservation Measure 13), implementing sediment and contaminant BMPs as required by the NPDES permit (SWPPP) (Conservation Measure 2), and preparing a frac-out plan and SPCCP (Conservation Measures 3 and 4).

Construction activities in suitable habitat could result in the injury, mortality, or disturbance of giant garter snakes. Giant garter snakes could be injured or crushed by construction equipment working in suitable aquatic and upland habitat or if soil or other materials are side-cast or fall into suitable aquatic habitat. Snakes could also be killed by construction vehicles traveling through the Southport EIP Action Area. Fuel or oil spills from construction equipment into aquatic habitat could also cause illness or mortality of giant garter snakes. Trenches left open overnight could trap snakes moving through the construction area during the early morning hours. Noise and vibrations from construction equipment, and presence of human activity during construction activities may also disturb giant garter snakes within the Southport EIP Action Area. Most construction activities will be limited to the snake's active period (May 1–October 1) when the potential for direct mortality is reduced because snakes can actively move and avoid danger. However, if work requires construction during the snakes dormant period (October 2–April 30) giant garter snakes, if present in the upland agricultural and grassland adjacent to the work area, could be injured or killed. Conservation Measure 16 would be implemented to reduce the potential for mortality during this time period.

Potential effects on giant garter snake would be minimized or avoided by conducting biological resources awareness training, conducting work during the active period (May 1–October 1) (Conservation Measure 1), installing exclusion fencing around suitable habitat (Conservation Measure 12), conducting preconstruction surveys and monitoring (Conservation Measure 14), and providing escape routes or covering open trenches (Conservation Measure 15). If work continued past October 1, additional preconstruction surveys and monitoring would be required (Conservation Measure 14).

### **Indirect Effects**

Construction of the Southport EIP is not expected to have any indirect effects on giant garter snake. Several indirect effects on giant garter snake and its habitat were considered but were determined to have no potential to occur as a result of the Southport EIP. Specifically, the following determinations were made.

There would be no increase of trash, hazardous waste, or off-road vehicle use due to increased human presence. The Southport EIP would not result in development or increased access to giant garter snake habitat.

The Southport EIP would not result in indirect effects on habitat suitability through changes in the length of inundation or other habitat modifications that would make the habitat less suitable for giant garter snake.

## **Effects from Operation and Maintenance**

Post-construction setback levees, adjacent levees, strengthening in place (slope flattening), seepage berms, slurry cutoff walls, riprap bank stabilization, and relief wells would be subject to typical O&M. O&M activities in the Southport EIP project area are conducted per the approved Corps O&M manual applicable to this reach. Such activities include hand and mechanical (mower) removal of weeds, spraying of weeds with approved pesticides, minimal tree or shrub trimming all up to four times a year, monthly control of burrowing rodent activity by baiting with pesticide, and reconditioning of levee slope and road with a bull dozer as needed.

Effects on giant garter snake and its habitat were considered but were determined to have no potential to occur as a result of the Southport EIP. Specifically, the following determinations were made.

- There would be no increased use of herbicides and/or pesticides from pre-project conditions as a result of the Southport EIP. Vegetation control would remain the same as existing conditions—typically twice per year. Herbicide and bait station use would also be at the same frequency as existing conditions.
- The Southport EIP would not result in an increase in potential mortality of giant garter snake due to an increase in vehicles traveling to the project components to conduct maintenance activities. Inspections are infrequent (flood control facilities four times per year; relief wells once per year, plus inspections after high water events), and travel would be along the existing levee road and paved roads to the levee. Patrol road recondition activities would typically be performed once per year and would include placing, spreading, grading, and compacting aggregate base or substrate. Erosion control and slope repair activities would include resloping and compacting; fill and repair of damage from rodent burrows would be treated similarly.

## **5.4 Ongoing Project Actions**

As described in Section 2.0, in-water construction work will be completed during established work windows for salmonids and Delta smelt. Maintenance activities may occur year-round in the dry areas. Such activities include hand and mechanical (mower) removal of weeds, spraying of weeds with approved pesticides, minimal tree or shrub trimming all up to four times a year, monthly control of burrowing rodent activity by baiting with pesticide, and reconditioning of levee slope and road with a bull dozer as needed.

## **5.5 Effects on the Environmental Baseline**

Effects of the proposed action include reductions in nearshore aquatic and riparian habitat that is used by aquatic and terrestrial species. Placement of revetment on earthen banks alters natural fluvial processes that sustain high-value nearshore and floodplain habitats in alluvial river systems. Effects are expected to be similar to effects described in Sections 5.1 through 5.3. Cumulative effects from these two projects, combined with the American River Common Features project and the SRBPP, on the environmental baseline are discussed in Section 5.7.2 below.

## **5.6 Effects on Essential Elements of Critical Habitat**

The project actions may affect designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, Delta smelt and green sturgeon. Potential impacts of the project actions on critical habitat for listed species are discussed separately for each species in Section 5.2.

## **5.7 Cumulative Effects**

### **5.7.1 ESA Cumulative Effects Analysis**

The ESA requires NMFS and USFWS to evaluate the cumulative effects of the proposed actions on listed species and designated critical habitat, and to consider cumulative effects in formulating Biological Opinions (USFWS and NMFS 2002a). The ESA defines cumulative effects as “those effects of future State or private actions, not involving Federal activities that are reasonably certain to occur within the action area” of the proposed action subject to consultation (USFWS and NMFS 2002b). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the Federal ESA. Federal actions, including hatcheries, fisheries, and land management activities are, therefore, not included. For the purposes of this BA, the area of cumulative effects analysis is defined as the Sacramento River watershed.

A number of other commercial and private activities, including hatchery operations, timber harvest, recreation, as well as urban and rural development, could potentially affect listed species in the Sacramento River basin. Levee maintenance activities by state agencies and local reclamation districts are likely to continue, although any effects on listed species will be addressed through Section 10 of the ESA. Ongoing non-federal activities that affect listed salmonids, Green Sturgeon, Delta Smelt, valley elderberry longhorn beetle, giant garter snake and their habitat, will likely continue in the short-term, at intensities similar to those of recent years. However, some activities associated with the State’s

proposed Central Valley Flood Protection Plan or state or local efforts to implement the ETL could result in increased effects on listed species. The extent and pace of those activities are not yet known.

Cumulative effects may also include non-federal rock revetment projects. Some non-federal rock revetment projects carried out by State or local agencies (e.g., reclamation districts) that do not fill wetlands or occur below the ordinary high water line will not need Section 404 (Clean Water Act) permits from the Corps and resulting Section 7 (ESA) consultation, but any effects on listed species should be addressed through Section 10 of the ESA. These types of actions are possible at many locations throughout the West Sacramento GRR study area, but are not included as part of the current project.

Potential cumulative effects on fish may include any continuing or future non-federal diversions of water that may entrain adult or larval fish or that may incrementally decrease outflows, thus changing the position of habitat for these species. Water diversions through intakes serving numerous small, private agricultural lands and duck clubs in the Delta, upstream of the Delta, and in Suisun Bay contribute to these cumulative effects. These diversions also include municipal and industrial uses and power production. Several new diversions are in various stages of action. The introduction of exotic species may also occur under numerous circumstances. Exotic species can displace native species that provide food for larval fish.

Potential cumulative effects on all species addressed in this BA could include: wave action in the water channel caused by boats that may degrade riparian and wetland habitat and erode banks; dumping of domestic and industrial garbage; land uses that result in increased discharges of pesticides, herbicides, oil, and other contaminants; and conversion of riparian areas for urban development. In addition, routine vegetation clearing and mowing associated with agricultural practices may affect or remove habitat for the valley elderberry longhorn beetle and giant garter snake.

### **5.7.2 Federal Cumulative Effects Analysis**

While cumulative effects analyses in ESA consultations are specifically to address non-federal actions as explained above, the following cumulative analysis of Federal actions is being provided to inform the agencies of federal actions affecting listed species in the general local area. The Corps has initiated consultation with USFWS and NMFS on four different Federal actions which could create a cumulative effect on listed species in the Sacramento area. These four projects include the West Sacramento Project, the Southport EIP, the American River Common Features Project, and the Sacramento River Bank Protection Project (SRBPP).

The purpose of the American River Common Features Project is to determine whether there is a Federal interest in modifying the authorized project for flood risk reduction in the Greater Sacramento Area at the confluence of the Sacramento and American Rivers. The proposed alternatives for this project include improving levees along the American River, NEMDC, Arcade, Dry/Robla, and Magpie Creeks to address identified seepage, stability, erosion, and height concerns. The levees along the

Sacramento River would be improved to address identified seepage, stability, and erosion concerns. Approximately one mile of levee raising would still be required on the Sacramento River. Due to environmental, real estate, and hydraulic constraints within the study area, the majority of the levees would be fixed in place. In addition, the project proposes to widen the Sacramento Weir and Bypass to divert more flows into the Yolo Bypass.

The SRBPP was authorized to protect the existing levees and flood control facilities of the SRFCP. The SRBPP is a long-range program of bank protection authorized by the Flood Control Act of 1960. The SRBPP directs the Corps to provide bank protection along the Sacramento River and its tributaries, including that portion of the lower American River bordered by Federal flood control project levees. Beginning in 1996, erosion control projects at five sites covering almost two miles of the south and north banks of the lower American River have been implemented. Additional sites at RM 149 and 56.7 on the Sacramento River totaling one-half mile have been constructed since 2001. During 2005 through 2007, 29 critical sites totaling approximately 16,000 linear feet were constructed under the Declaration of Flood Emergency by Governor Schwarzenegger. This is an ongoing project, and additional sites requiring maintenance will continue to be identified indefinitely until the remaining authority of approximately 24,000 linear feet is exhausted over the next 3 years. WRDA 2007 authorized an additional 80,000 linear feet of bank. For implementation of the 80,000 additional linear feet of bank protection, the Corps has submitted a biological assessment and initiated formal consultation with NMFS and USFWS.

Potential cumulative impacts from the combination of these projects to each of the listed species included in this consultation are below. During preconstruction engineering and design, the Corps designs will avoid impacts to special status species, where possible, or otherwise minimize effects to each of these species.

#### **Valley Elderberry Longhorn Beetle**

Concurrent construction of multiple projects over the next 10 to 15 years within the Sacramento Metropolitan area would likely cause mortality to beetles due to construction operations. Construction activities for the multiple projects would occur each year during the flight season of beetles. Since construction activities would be adjacent to known VELB locations it is likely that some mortality may occur. The exact number injured or killed is unknown but would likely be minimal due to the exceptional flight ability of the beetle to avoid construction vehicles. No designated critical habitat would be affected with the construction of any of the projects.

Shrubs within the each project footprint would be transplanted to areas in close proximity to the current locations. Additionally, compensation would be located within the vicinity of impacted shrubs. Transplanting of shrubs and planting of seedlings and natives within the project vicinity would provide connectivity for the beetle. Connectivity is a primary cause of the beetle decline and an important element in the recovery and sustainability for the beetle. The transplanting of shrubs and

compensation within the same area as the potential impacts would result in effects to the beetle but not result in jeopardy to the Valley Elderberry Longhorn Beetle.

### **Salmon, Steelhead, and Sturgeon**

The proposed projects could adversely modify critical habitat or contribute to the loss or degradation of sensitive habitats for listed species such as the Sacramento River winter-run Chinook salmon, Central Valley steelhead, Central Valley spring-run Chinook salmon, and green sturgeon in the greater project vicinity. However, with site specific erosion repair designs, retention of SRA through vegetation variances, and the installation of riparian plantings and instream large woody material, the proposed projects are expected to increase habitat values over time by increasing the amount of riparian habitat, SRA cover, and floodplain habitat available to listed fish over a broad range of flows.

The erosion repair activities of these combined projects would likely reduce the sediment supply for riverine reaches directly downstream because the erosion repair is holding the bank or levee in place. However, from a system sediment perspective, the bank material we are protecting in the project reaches is not a major source of sediment compared to the upstream reaches of the Sacramento, Feather, and especially the Yuba River systems. All of the available sediment in the American River watershed is being contained behind Folsom Dam. The site specific designs will be constrained from allowing any velocity increases outside the erosion repair site (Schlunegger 2014).

Site specific designs such as setback levees, IWM, and shallow bank slopes within the SRBPP, Common Features, West Sacramento, and Southport EIP projects would be incorporated to address erosion repair while including features for increasing habitat for listed fish. The levee setback component of the Southport EIP and West Sacramento projects would result in the restoration of historical Sacramento River floodplain in the project areas, with a diverse mosaic of seasonal floodplain, wetland, riparian, and upland habitat. The goals of the offset area restoration designs are to increase river-floodplain connectivity, restore ecologically functional floodplain habitat, and meet the flood risk-reduction objectives of the projects. Based on the SAM, establishing connectivity of the floodplain to the river will result in large and rapid gains in habitat quantity and quality that will fully compensate for initial habitat deficits on the existing levee and result in significant long-term species benefits (improved growth and survival) relative to existing conditions. Although not addressed by the SAM, these benefits will be enhanced over time by revegetation of the floodplain and development of a diverse mosaic of wetland, riparian and upland plant communities that will further improve the habitat and ecosystem functions of the restored floodplain. In addition to increasing the amount of structural cover available to fish along the shoreline, the installation of IWM is also expected to promote sediment deposition on the rock bench as observed at locations where similar designs have been used to address the compensation needs of listed fish species. Project actions are unlikely to result in long-term habitat losses to Sacramento River winter-run Chinook salmon, Central Valley steelhead, Central Valley spring-run Chinook salmon, and green sturgeon.

The American River Common Features and West Sacramento Projects would have initial cover losses due to project actions but will be partially offset by installing riparian plantings and native grasses along the lower slopes. These features will increase the availability of high quality shallow water habitat for juvenile Chinook salmon and steelhead, and possibly juvenile green sturgeon during the annual high-flow period (late fall, winter, and spring). Because of the vegetation variance that the Corps will be seeking, tree removal would be limited to no more than the upper one-half of the waterside of the levees therefore leaving the lower one-half or more of the trees in place on the Sacramento River within the study area. SRA would not be compromised, thus maximizing existing SRA values in the study area. The establishment and growth of planted riparian vegetation is expected to increase habitat values over time by increasing the extent of overhead cover available to listed fish species.

### **Delta Smelt**

The proposed projects, with the implementation of site specific designs, would provide long-term net benefits to delta smelt as explained above in for the other fish species. However, there are four specific significant threats to the delta smelt that have been identified by the USFWS: direct entrainments by State and Federal water export facilities, summer and fall increases in salinity, summer and fall increases in water clarity, or effects from introduced species.

Implementation of the various projects would not affect direct entrainments by State and Federal water export facilities. The only potential affect could be with the American River Common Features Project and the release of more water down the Sacramento Bypass into the Yolo Bypass during high water events. The excess water that would normally be moving downriver through the Sacramento area would enter the system farther down in the Delta area. Since adult delta smelt are moving up the system to spawn at this time this would not affect entrainment in the water export facilities. Summer and fall increases in salinity is driven more by low flow drought years and water releases in the Sacramento tributaries then site specific designs for erosion protection in the project areas. Summer and fall increases in water clarity are associated with, among other factors, invasive non-native clam species and non-native plant species, which are generally located down in the Delta below the project areas, that are filtering out vital chlorophyll and plankton that would normally increase turbidity which helps the delta smelt avoid predators. However, as mentioned above the erosion repair activities of these combined projects would likely reduce the sediment supply for riverine reaches directly downstream because the erosion repair is holding the bank or levee in place. However, as explained above, from a system sediment perspective, the bank material we are protecting in the project reaches is not a major source of sediment compared to the upstream reaches of the Sacramento, Feather, and especially the Yuba River systems.

### **Giant Garter Snake**

The giant garter snake could be affected by multiple projects being constructed within the Sacramento Metropolitan area over the next 10 to 15 years. Primarily habitat loss would occur on the West Sacramento side of the Sacramento River adjacent to the Sacramento Bypass and the West

Sacramento and Southport construction areas. Short term impacts would occur for a single construction season along haul routes and within borrow sites. To minimize potential impacts to snakes work within giant garter snake habitat would be conducted between May 1 and October 1 when snakes are active and can move out of the construction area. Snake mortality could occur during construction along haul routes, however, the snakes are mobile and would likely move out of the way from construction equipment. There would be a permanent loss a few irrigation canals and existing wetlands adjacent to the levees.

## **5.8 Conclusion and Effects Determination for Listed Species**

### **5.8.1 Conclusions and Determinations for the West Sacramento Project**

#### **Valley Elderberry Longhorn Beetle**

Because of the potential direct effects discussed in detail above, including the removal of up to 120 elderberry shrubs and the potential for injury or mortality of VELB during removal and transplantation, the West Sacramento project is likely to adversely affect VELB. In cases where work occurs within 20 feet of elderberry shrubs, the contractor will be instructed to avoid impacts to shrubs as much as possible. Any impacts to shrubs will be mitigated according to the guidelines outlined in Section 2.8.2.

The project will also result in long-term benefits to VELB as approximately 120 acres of floodplain habitat will be restored or enhanced as part of project implementation. In consideration of this information, the project actions are unlikely to result in long-term habitat losses to valley elderberry longhorn beetle, as long as the applicable mitigation and compensation measures are implemented.

#### **Fish Species**

Project effects on listed fish species include alteration of the designated critical habitat of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, Delta smelt, and green sturgeon. Project effects may include localized incidental take due to disturbance, displacement, or impairment of feeding or other essential behaviors of adult and juvenile salmon, steelhead, and green sturgeon during construction and O&M activities. Injury or mortality of juvenile salmonids, green sturgeon, and Delta smelt could occur if individuals are unable to readily move away from channel or nearshore areas directly affected by construction activities. Accidental discharge of toxic substances during construction could cause physiological impairment or mortality of listed fish and other aquatic species at or immediately downstream of project sites. Other potential stressors include noise, suspended sediment, turbidity, and sediment deposition generated during in-water construction activities. These effects could also occur in areas downstream of project sites, because noise and sediment may be propagated downstream. Restricting in-water activities to the August 1

through November 30 work window, and implementing BMPs, will minimize the potential for adverse effects.

Long-term project effects on the habitat of listed fish species include alteration of river hydraulics, removal of instream and overhead cover, and alteration of substrate conditions along the seasonal low- and high-flow shorelines of the Sacramento River erosion sites. Implementation of the project will result in temporary losses of instream structure and riparian vegetation along the summer-fall and winter-spring shorelines and will also limit long-term fluvial functioning necessary for the development and renewal of SRA habitat in the future.

Initial cover losses due to project actions discussed above will be partially offset by installing riparian plantings and native grasses along the lower slopes. The remaining losses will be compensated for by purchasing mitigation credits from local mitigation banks. These features will increase the availability of high quality shallow water habitat for juvenile Chinook salmon and steelhead, spawning and incubating Delta smelt, and possibly juvenile green sturgeon during the annual high-flow period (late fall, winter, and spring). Because we will not be removing any trees on the lower one-third of the waterside of the levees in the Sacramento River area, SRA will not be compromised thus maximizing existing SRA values in the study area. The establishment and growth of planted riparian vegetation is expected to increase habitat values over time by increasing the extent of overhead cover available to listed fish species.

In consideration of the above information, the project actions are not likely to result in long-term habitat losses to Sacramento River winter-run Chinook salmon, Central Valley steelhead, Central Valley spring-run Chinook salmon, Delta smelt, and green sturgeon as long as the applicable mitigation and compensation measures are implemented. This conclusion is based on the Corps' commitment to: (1) minimize temporary habitat losses through the incorporation of on-site mitigation features (e.g., vegetated riparian and wetland benches, riparian plantings, and no planned tree removal) in the project area measures; and (2) implementation of off-site habitat compensation measures (e.g., riparian planting, rock removal) prior to or concurrent with project construction. However, project actions may affect and are likely to adversely affect these focus species due to: (1) incidental take during construction and O&M activities; (2) fragmentation of existing natural bank habitats due to the placement of revetment; and (3) the potential loss of long-term fluvial functioning necessary for the development and renewal of shaded riverine aquatic habitat.

Section 7 of the Endangered Species Act requires that Federal agencies ensure, in consultation with the U.S. Fish and Wildlife Service, that any action they authorize, fund, or carry out is not likely to result in the destruction or adverse modification of critical habitat. Effects to critical habitat are discussed for each species in section 5.2.1. Based on those assessments, project actions:

- May adversely affect designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, and Green sturgeon;

- May adversely affect designated critical habitat for delta smelt within the West Sacramento GRR project area which includes the Sacramento River upstream to approximately RM 60 (U.S. Fish and Wildlife Service 2003a).

### **Giant Garter Snake**

To minimize the potential for adverse effects, giant garter snake habitat will be designated as an environmentally sensitive area delineated with signs or fencing, and if possible, avoided by all construction personnel. Additional measures and habitat compensation as outlined in Section 2.8.3 will also be implemented.

In consideration of the above information, the project actions are unlikely to result in long-term habitat losses to the giant garter snake, with implementation of the applicable mitigation and compensation measures. However, even with on-site mitigation and off-site compensation, the project actions may adversely affect giant garter snakes and their critical habitat due to: (1) take during construction and O&M activities; and (2) habitat fragmentation.

## **5.8.2 Determinations, Summary, and Conclusions for the Southport EIP**

### **Valley Elderberry Longhorn Beetle**

Because of the potential direct effects discussed in detail above, including the removal of 18 elderberry shrubs and the potential for injury or mortality of VELB during removal and transplantation, the Southport EIP is likely to adversely affect VELB. However, the project will result in substantial long-term benefits to VELB as approximately 120 acres of floodplain habitat will be restored or enhanced as part of project implementation.

### **Salmonids**

#### **Summary and Conclusions**

The Southport EIP is expected to result in adverse short-term, construction- and O&M-related effects on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, southern DPS North American green sturgeon, and their designated critical habitat. Potential effects may include physical injury or death and temporary modification of feeding, migration, or other essential activities. During in-water construction activities, injury or mortality of juvenile salmonids and green sturgeon could occur because of their proximity to in-water work areas (nearshore areas), limited ability to avoid direct contact with construction equipment and materials, and sensitivity to noise, turbidity, and suspended sediment. Barge operation and placement of rock (riprap) and temporary cofferdams in the river will cause underwater noise and physical

disturbance of the bed and water column of the river that could cause physical injury, death, entrapment, and displacement of individuals from preferred habitat. Temporary increases in suspended sediment and turbidity are expected to reach levels known to cause avoidance behavior in juvenile salmonids, potentially causing displacement of juveniles from cover and increased exposure to predators. Accidental discharge of toxic substances during construction could cause physiological impairment or mortality of individuals at or immediately downstream of construction sites.

Potential short-term effects on listed fish species may include injury or mortality of fish from rock placement; entrapment of fish within temporary cofferdams or turbidity barriers; temporary disruption of feeding, migration, and sheltering behavior, and displacement of fish from preferred habitat in response to noise, turbidity, and suspended sediment; and associated increases in predation risk. The timing of in-water construction activities is expected to minimize exposure of the most sensitive Chinook salmon and steelhead life stages (i.e., fry) which occur in the Southport EIP Action Area primarily in winter and spring following the onset of high flows (November through May). Adults and most juvenile winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and green sturgeon that may be present during the proposed construction window (July 1 through October 31) utilize deeper water and are expected to detect and move away from affected nearshore areas. Most construction activities potentially affecting these species will occur in Year 2 of the proposed construction period, thus avoiding or minimizing the potential for adverse effects on multiple year classes. Based on these considerations and the implementation of proposed conservation measures and BMPs, adverse effects resulting from construction and O&M activities will be limited to temporary harassment and potential injury or death of small numbers of juvenile winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and green sturgeon during in-water activities.

Long-term project effects on listed fish species include modification of the designated critical habitat of winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and green sturgeon. Habitat modification may affect behavior, growth, and survival, and the primary constituent elements of critical habitat, including freshwater rearing sites, foraging areas, and migration corridors. These modifications include substantial long-term increases in the quantity and quality of riparian, SRA cover, and floodplain habitat available to fish on the restored floodplain. Major objectives of the levee offset areas include restoring ecologically functional floodplain habitat based on the hydrological, hydraulic, and geomorphic characteristics and habitat functions of natural floodplains. Based on the SAM, establishing connectivity of the floodplain to the river will result in large and rapid gains in habitat quantity and quality that will fully compensate for initial habitat deficits on the existing levee and result in significant long-term species benefits (improved growth and survival) relative to existing conditions. Although not addressed by the SAM, these benefits will be enhanced over time by revegetation of the floodplain and development of a diverse mosaic of wetland, riparian, and upland plant communities that will further improve the habitat and ecosystem functions of the restored floodplain.

Initial habitat deficits associated with the loss of natural substrate and removal of existing riparian vegetation and IWM on the existing levee slope will be addressed onsite through the integration of engineered benches, IWM, biotechnical materials, and revegetation of the erosion repair sites, levee

breaches, and remnant levee. Based on the SAM, initial deficits in winter-spring habitat values will be fully offset in the first year of levee breach construction and repairs (Year 2) by increases in floodplain area and shallow water habitat on the restored floodplain and constructed benches, followed by long-term increases in habitat values associated with the growth of planted vegetation on the levee breaches, erosion protection sites, and remnant levee. The installation of IWM along the summer-fall shorelines of the erosion repair sites is sufficient to compensate or nearly compensate for initial deficits in fall habitat values although complete recovery may take 15 years or more depending on the success of shoreline plantings in creating shade and IWM along the summer-fall shoreline in future years. However, these deficits are not expected to significantly affect species survival and growth because of their small magnitude and the substantial increases in winter-spring habitat values discussed above. Additionally, planting the remnant levee is expected to effectively restore and potentially enhancing summer-fall habitat values along the existing levee slope.

An MMP for the offset areas is being developed on behalf of WSAFCA and will be approved by the Corps, NMFS, USFWS, and CDFW before implementation of the project. The MMP will include representative plans and cross sections of the Southport EIP elements; fish stranding and vegetation monitoring methods; habitat compensation and restoration success criteria; and a protocol for implementing remedial actions should any success criteria not be met. The existing O&M requirements and practices will also be incorporated into the plan. Annual monitoring reports that describe each year's monitoring activities and progress toward the success criteria would be submitted to the resource agencies during the course of the monitoring period. Monitoring would be conducted until the projected benefits of the compensation and restoration actions have been substantially achieved.

In summary, the Southport EIP will result in adverse, short-term construction- and O&M-related effects on Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, southern DPS North American green sturgeon, and the freshwater and migration primary constituent elements of critical habitat. These effects will be minimized by the proposed frequency, timing, and duration of in-water activities, and successful implementation of the proposed conservation measures and other BMPs described in the project description. Based on the SAM, the Southport EIP is expected to largely compensate for initial impacts on SRA cover and riparian habitat values on the existing waterside levee of the Sacramento River through the integration of engineered benches, IWM, biotechnical materials, and revegetation of the erosion repair sites, levee breaches, and remnant levee. The proposed levee offset and floodplain restoration plan is expected to substantially improve habitat values for listed fish species in the Southport EIP Action Area by restoring ecologically functional floodplain habitat based on the hydrological, hydraulic, and geomorphic characteristics and habitat functions of natural floodplains. With successful implementation of the MMP, the reconnection and restoration of floodplain habitat will result in significant long-term improvement in rearing and migration primary constituent elements and species responses (improved growth and survival), contributing to overall increases in the conservation value of critical habitat in the Southport EIP Action Area.

## **Effects Determination**

The Southport EIP is likely to adversely affect Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, and southern DPS North American green sturgeon and their designated critical habitat. Adverse effects would result from construction, operations, and maintenance activities, and initial losses of SRA cover and riparian habitat associated with erosion repairs, rock slope protection, and levee breach creation on the existing Sacramento River levee. Overall, the Southport EIP, including successful implementation of the MMP, will result in substantial long-term benefits to listed fish species and overall increases in the conservation value of critical habitat in the Southport EIP Action Area through restoration and enhancement of historic Sacramento River floodplain in the levee offset areas.

### **Delta Smelt**

The Southport EIP is likely to adversely affect delta smelt and its designated critical habitat. Adverse effects would result from construction, operations, and maintenance activities, and initial losses of SRA cover and riparian habitat associated with erosion repairs, rock slope protection, and levee breach creation on the existing Sacramento River levee. Overall, the Southport EIP, including successful implementation of the MMP, would result in substantial long-term benefits to delta smelt and overall increases in the conservation value of critical habitat in the Southport EIP Action Area through restoration and enhancement of historic Sacramento River floodplain in the offset areas.

### **Giant Garter Snake**

Because of the potential direct effects discussed in detail above, including the permanent loss of 2.24 acres of upland habitat and the potential for injury or mortality during construction, the Southport EIP is likely to adversely affect giant garter snake.

## **5.9 Effects on Essential Fish Habitat**

### **5.9.1 West Sacramento GRR**

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (U.S.C. 180 et seq.), requires that Essential Fish Habitat (EFH) be identified and described in Federal fishery management plans. Federal action agencies must consult with NMFS on any activity that they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies.

EFH of Pacific salmon, pursuant to section 305 (b) (2) of the MSA, require appropriate determinations for EFH as either: (1) will not adversely effect, or (2) may adversely affect. Important components of EFH for Chinook salmon spawning, rearing, and migration include:

- Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development;
- Freshwater rearing sites with:
  - Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
  - Water quality and forage supporting juvenile development; and
  - Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- Estuarine areas free of obstruction and excessive predation with:
  - Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater;
  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and
  - Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The West Sacramento GRR includes habitats on the Sacramento River, Yolo Bypass, and the Sacramento Deep Water Ship Channel that have been designated as EFH for Chinook salmon, a major contributor to Pacific Coast salmon fisheries. The Pacific Coast salmon fishery EFH extends along the Pacific Coast from Washington to Point Conception in California. Freshwater EFH includes all habitats currently and historically accessible to salmon and is based on descriptions of habitat used by coho and Chinook salmon. The EFH excludes areas above naturally occurring barriers such as waterfalls, which have been present for several hundred years, and impassible dams identified on large rivers (NMFS 1997). The following analysis of EFH does not include effects to the fish species, just the species habitat as defined in the MSA. Results for the effects of EFH for winter-run, spring-run, and fall/lt-fall-run Chinook salmon in the West Sacramento GRR study area were based on the SAM analysis detailed in Appendix G.

### **Effects of the Proposed Action on EFH**

Site specific project designs were unavailable for the West Sacramento project reach at the time of this SAM analysis. In an effort to fairly assess the impacts of the project action, a “worst case scenario” approach was taken in applying the SAM analysis. The following data sources were used to characterize SAM habitat conditions (as defined by bank slope, floodplain availability, substrate size, instream structure, aquatic vegetation, and overhanging shade) within the West Sacramento project area under existing or pre-project conditions:

- USACE’s Sacramento River revetment database – This database was used to stratify the project reach into subreaches that encompass relatively uniform bank conditions based on their general physical characteristics (USACE 2007). This database was used to characterize existing habitat conditions within individual subreaches where more recent data were unavailable.
- Aerial images of the West Sacramento project reach (Google™ Earth), provided current and historical images of bank conditions that were used to address gaps or uncertainties related to existing cover characteristics within individual subreaches.

The SAM employs six habitat variables to characterize near-shore and floodplain habitats of the winter-run, spring-run, and fall/lt-fall-run Chinook species:

- Bank slope—average bank slope of each average seasonal water surface elevation;
- Floodplain availability—ratio of wetted channel and floodplain area during the 2-year flood, to the wetted channel area during average winter and spring flows;
- Bank substrate size—the median particle diameter of the bank (i.e., D50) along each average seasonal water surface elevation;
- Instream structure—percent of shoreline coverage of instream woody material along each average seasonal water surface elevation;
- Aquatic vegetation—percent of shoreline coverage of aquatic or riparian vegetation along each average seasonal water surface elevation; and
- Overhanging shade—percent of the shoreline coverage of shade along each average seasonal water surface elevation.

### **Sacramento River SAM EFH Analysis**

The Sacramento River SAM analysis reach includes the entire right bank (west side) of the Sacramento River from the Sacramento Bypass to the confluence of the Sacramento River and the old Stone Locks near the Port of Sacramento. This reach also includes the short cut-off levee described as part of the Port South phase of the project.

#### **Short Term**

Short term construction activities may adversely affect Chinook EFH. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions most positively associated with fry and juvenile rearing and migration.

#### **Long Term**

Long term construction actions will not adversely affect EFH on the Sacramento River portion of the West Sacramento GRR study area. EFH is expected to show a long term positive response to project actions in the Sacramento River SAM analysis reach over the lifetime of the project. Positive EFH response would be most likely associated with long term growth of SRA (overhanging shade) and aquatic vegetation.

### **Yolo Bypass SAM EFH Analysis**

Although a SAM analysis for the Yolo Bypass SAM analysis reach was conducted, the results were excluded from the final report. Through discussion with NMFS, it was determined that the unique environmental conditions in the Yolo Bypass SAM analysis reach, exceed the applications of the SAM. The Yolo Bypass SAM analysis reach includes portions of the perennial tidal Toe Drain and portions of the Sacramento and Yolo Bypass levees that are only periodically inundated. During typical summer-fall conditions, SAM focus fish species which include Chinook salmon are generally absent from the Toe Drain (Harrel, 2003). During winter-spring conditions, assuming inundation, the Yolo Bypass provides a large amount of floodplain habitat. Under the “worst case scenario” assumptions, project actions along the Yolo Bypass SAM analysis reach would result in the removal of all trees and vegetation which would result in a determination of may adversely affect EFH; due to the abundance of floodplain habitat during inundation, it is highly unlikely that the loss of these shoreline habitat features would impact overall EFH that would be available and most likely utilized by Chinook salmon in the Yolo Bypass during winter-spring conditions. With this taken into consideration, the project effects will not adversely affect EFH in the Yolo Bypass.

## **Deep Water Ship Channel/Port SAM Analysis**

### **Short Term**

Short term construction activities may adversely affect Chinook EFH. Short term habitat deficits will result from the initial loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions most positively associated with fry and juvenile rearing and migration..

### **Long Term**

Long term construction effects may adversely affect EFH in the DWSC. Habitat deficits displayed a general trend toward increasing beyond the lifetime of the project. Long term habitat deficits will result from the permanent loss of aquatic vegetation and over hanging shade at fall/summer habitat conditions due to compliance with the Corps ETL.

## **5.9.2 Southport EIP**

The MSA, as amended (U.S.C. 180 et seq.), requires that EFH be identified and described in Federal fishery management plans. Federal action agencies must consult with NMFS on any activity that they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies.

EFH is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. NMFS defines these terms as follows.

- “Waters” includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate.
- “Substrate” includes sediment, hard bottom, structures underlying the waters, and associated biological communities.
- “Necessary” means habitat required to support a sustainable fishery and a healthy ecosystem.
- “Spawning, breeding, feeding, or growth to maturity” covers all habitat types used by a species throughout its life cycle.

Freshwater EFH for salmon consists of four major components: spawning and incubation habitat, juvenile rearing habitat, juvenile migration corridors, and adult migration corridors and adult holding habitat. Important attributes of EFH for spawning, rearing, and migration include suitable substrate composition; water quality (e.g., dissolved oxygen, nutrients, temperature); water quantity, depth and velocity; channel gradient and stability; food; cover and habitat complexity (e.g., large woody material, pools, channel complexity, aquatic vegetation); space; access and passage; and floodplain and habitat connectivity (Pacific Fishery Management Council 2003).

The Action Area of the Southport EIP is within the region identified as EFH for Pacific salmon in Amendment 14 of the Pacific Salmon FMPs. EFH in the Action Area consists of adult migration habitat and juvenile rearing and migration habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley fall-/late fall-run Chinook salmon, all of which are managed under the Pacific Coast Salmon FMP. Descriptions of these species are described in Chapter 3.

#### **Effects of the Proposed Action on EFH**

The effects of the Southport EIP on Pacific Coast salmon EFH would be similar to the effects of the Southport EIP on the designated critical habitat of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and California Central Valley steelhead, as discussed in the preceding BA. A summary of these effects and conclusions are presented below and applied to EFH.

The Southport EIP would result in short-term and long-term effects on Pacific coast salmon EFH. Short-term effects include construction-related increases in turbidity and suspended sediment in the Sacramento River. As discussed in the preceding BA, these effects would be temporary and localized and would be further minimized by the restriction of in-water construction activities to the low-flow period (July 1 and October 31) and compliance with Central Valley RWQCB turbidity objectives and other proposed erosion and sediment control BMPs (see Conservation Measures). The risk of spills or discharges of contaminants in the Sacramento River would be effectively minimized by implementation of a spill prevention and control plan.

Long-term effects on Pacific coast salmon EFH include modification of SRA cover, riparian, and floodplain habitat. Adverse effects resulting from the removal of riparian vegetation and installation of riprap on the waterside slope of the Sacramento River levee would be addressed through onsite integration of engineered benches, IWM, biotechnical materials, and re-vegetation at the erosion repair sites, levee breaches, and remnant levee. Based on the SAM, initial deficits in winter-spring habitat values would be fully offset in the first year of levee breach construction (year 3) by increases in floodplain area and shallow water habitat on the restored floodplain, followed by long-term increases in habitat values associated with the growth of planted vegetation on the erosion repair sites, levee breaches, and remnant levee. The installation of IWM along the summer-fall shorelines of the erosion repair sites is sufficient to compensate or nearly compensate for initial deficits in fall habitat values although complete recovery may take 15 years or more depending on the success of plantings in

creating shade and IWM along the summer-fall shoreline. Planting the remnant levee is expected to effectively restore and potentially enhance summer-fall habitat values along the existing levee slope. Overall, the Southport EIP, including successful implementation of the MMP, would compensate for adverse effects on EFH and result in substantial long-term increases in the quantity and quality of EFH for Chinook salmon through the restoration and enhancement of historic Sacramento River floodplain in the levee setback area.

## 6.0 References

- Adams, P. B., C. B. Grimes, J. E. Hightower, S. T. Lindley, and M. L. Moser. 2002. Status review for North American green sturgeon, *Acipenser medirostris*. National Marine Fisheries Service, Santa Cruz, California.
- Ahearn, D. S., J. H. Viers, J. F. Mount, and R. A. Dahlgren. 2006. Priming the productivity pump: flood pulse driven trends in suspended algal biomass distribution across a restored floodplain. *Freshwater Biology* 51, 1417–1433.
- Arnold, Richard A., PhD. 2011. Entomologist. Entomological Consulting Services Ltd., Pleasant Hill, CA. August 22 and 23, 2011–Written comments on the Draft Supplemental Biological Assessment for PG&E’s Valley Elderberry Longhorn Beetle Conservation Program.
- Barr, C. B. 1991. The distribution, habitat, and status of the valley elderberry longhorn beetle *Desmocerus californicus dimorphus*. U.S. Fish and Wildlife Service, Sacramento, California.
- Beechie, T.J., M. Liermann, E.M. Beamer, and R. Henderson. 2005. A classification of habitat types in a large river and their use by juvenile salmonids. *Transactions of the American Fisheries Society* 134: 717-729.
- Behnke, R. J. 1992. Native trout of western North America. American Fisheries Society, Bethesda, Maryland.
- Bell, M. C. 1986. Fisheries handbook of engineering requirements and biological criteria. U.S. Army Corps of Engineers. Fish Passage Development and Evaluation Program, North Pacific Division, Portland, Oregon.
- Bennett, W. A. 2005. Critical assessment of the delta smelt population in the San Francisco Estuary, California. *San Francisco Estuary & Watershed Science* 3: Article 1.  
<http://repositories.cdlib.org/jmi/sfews/vol3/iss2/art1/>

- Berg, L. 1982. The Effect of Exposure to Short-Term Pulses of Suspended Sediment on the Behavior of Juvenile Salmonids. Pages 177–196 in G. F. Hartman (ed.), Proc. Carnation Creek Workshop, A 10-Year Review, Pacific Biological Station, Nanaimo, BC.
- Berg, L., and T. G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment. *Canadian Journal of Fisheries and Aquatic Sciences* 42: 1410-1417.
- Bisson, P. B. and R. E. Bilby. 1982. Avoidance of suspended sediment by juvenile coho salmon. *North American Journal of Fisheries Management*.
- Bjornn, T. C. and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. *American Fisheries Society Special Publication*
- Bradley, C. E., and D. G. Smith. 1986. Plains cottonwood recruitment and survival on a prairie meandering river floodplain, Milk River, southern Alberta and northern Montana. *Canadian Journal of Botany* 64: 1433-1442.
- Brandes, P. L. and J. S. McLain. 2001. Juvenile Chinook salmon abundance, distribution, and survival in the Sacramento–San Joaquin Estuary. *Contributions to the Biology of Central Valley Salmonids*. R. L. Brown editor. California Department of Fish and Game. Fish Bulletin 179. Vol. 2:39–138.
- Brice, J. 1977. Lateral migration of the middle Sacramento River, California. *Water-Resources Investigations* 77-43. U. S. Geological Survey, Menlo Park, California.
- Brode, J. 1988. Natural history of the giant garter snake (*Thamnophis couchii gigas*). Pages 25-28 in J. F. DeListe, P. R. Brown, B. Kaufman and B. M. McGurty, editors. *Proceedings of the conference on California herpetology*. Special Publication No. 4. Southwestern Herpetologists Society.
- Brown, L.R., D. Michniuk 2007. Littoral fish assemblages of the alien-dominated Sacramento–San Joaquin Delta, California 1980–1983 and 2001–2003. *Estuaries and Coasts*. 30: 186–200.
- Bryant, M., and K. Souza. 2004. Summer townet survey and fall midwater trawl survey status and trends. *Interagency Environmental Program Newsletter* 17: 14-17.
- California Department of Fish and Game (CDFG). 1965. California Fish and Wildlife Plan. Volumes 1-3. Inland Fisheries Division, Sacramento, CA.
- California Department of Fish and Game (CDFG). 1987. Delta outflow effects on the abundance and distribution of San Francisco Bay fish and invertebrates, 1980–1985. Exhibit 60, Proceedings of the State Water Resources Control Board 1987 water quality/water rights hearings on the San Francisco Bay/Sacramento–San Joaquin Delta.

- California Department of Fish and Game (CDFG). 1998. A status review of the spring-run Chinook salmon (*Oncorhynchus tshawytscha*) in the Sacramento River drainage. Report to the Fish and Game Commission, Candidate Species Status Report 98-01. Sacramento.
- California Department of Fish and Game (CDFG). 2000. Central Valley anadromous fish-habitat evaluations: October 1998 through September 1999. Stream Evaluation Program, Technical Report No. 00-8. Prepared by CDFG, Habitat Conservation Division, Native Anadromous Fish and Watershed Branch for U. S. Fish and Wildlife Service, Central Valley Anadromous Fish Restoration Program.
- California Department of Fish and Game (CDFG). 2002. California Department of Fish and Game comments to NMFS regarding green sturgeon listing. Sacramento.
- California Department of Fish and Game (CDFG). 2003. The Vegetation Classification and Mapping Program; List of California Terrestrial Natural Communities Recognized by the California Natural Diversity Database. September 2003 edition. Wildlife and Habitat Data Analysis Branch. Sacramento, CA.
- California Department of Fish and Game (CDFG). 2006. Emergency sturgeon on regulations will take effect on Monday, March 20. CDFG News Release. 17 March.  
<http://www.dfg.ca.gov/news/news06/06030.html>
- California Department of Fish and Game. 2010. Grandtab, unpublished data, summaries of salmon and steelhead populations in the Central Valley of California.
- California Department of Fish and Wildlife. 2012. California Natural Diversity Database. RareFind 4. Search of Grays Bend, Taylor Monument, Rio Linda, Davis, Sacramento West, Sacramento East, Saxon, Clarksburg, and Florin quadrangles. Available:  
<<http://www.dfg.ca.gov/biogeodata/cnddb/mapsanddata.asp>> Accessed: September 25, 2012.
- California Department of Fish and Wildlife (CDFW). 2013a. California Natural Diversity Database (CNDDDB), Rarefind electronic database.  
[www.dfg.ca.gov/bdh/html/rarefind.html](http://www.dfg.ca.gov/bdh/html/rarefind.html).
- California Department of Fish and Wildlife (CDFW). 2013b. Fisheries Branch. Anadromous Resources Assessment. GrandTab. California Central Valley. Sacramento and San Joaquin River Systems. Chinook Salmon Escapement. Hatcheries and Natural Areas.  
[http://www.fws.gov/stockton/afpr/Documents/GrandTab\\_020111.pdf](http://www.fws.gov/stockton/afpr/Documents/GrandTab_020111.pdf)

- California Department of Fish and Wildlife (CDFW). 2013c. Resource Management. Inland and Anadromous Fisheries. Chinook Salmon.  
<http://www.dfg.ca.gov/fish/Resources/Chinook/>
- California Department of Water Resources. 2005. Fish Passage Improvement. Bulletin 250. June 2005.  
Available: [http://www.water.ca.gov/fishpassage/docs/b250/B250\\_frontpages.pdf](http://www.water.ca.gov/fishpassage/docs/b250/B250_frontpages.pdf)
- California Native Plant Society. 2008. Inventory of Rare and Endangered Plants of California. Available:  
<<http://cnps.web.aplus.net/cgi-bin/inv/inventory.cgi>>. Accessed: December 2010.
- California Native Plant Society. 2009. Inventory of Rare and Endangered Plants. Available:  
<<http://cnps.web.aplus.net/cgi-bin/inv/inventory.cgi>>. Accessed: June 24, 2009.
- California Native Plant Society. 2012. Inventory of Rare and Endangered Plants. Last revised: August 10, 2012. Available: <<http://cnps.web.aplus.net/cgi-bin/inv/inventory.cgi>>. Search of Grays Bend, Taylor Monument, Rio Linda, Davis, Sacramento West, Sacramento East, Saxon, Clarksburg, and Florin quadrangles. Accessed: September 25, 2012.
- Calkins, R. D., W. F. Durand, and W. H. Rich. 1940. Report of the board of consultants on the fish problem of the upper Sacramento River. Stanford University, Stanford, CA.
- cbec, inc. and ICF International. 2013. West Sacramento Southport EIP Task Order 4: Development of design criteria for sustainability of the levee offset area. Prepared for HDR Engineering, Inc. and West Sacramento Area Flood Control Agency.
- Central Valley Regional Water Quality Control Board. 2009. The Water Quality Control Plan for the California Regional Water Quality Control Board (Basin Plan) Central Valley Region—The Sacramento River Basin and The San Joaquin River Basin, fourth edition. September 15, 1998. Revised September 2009. Sacramento, CA.
- City of West Sacramento. 2000. *City of West Sacramento General Plan Background Document*. Adopted: May 3, 1990. Revised: June 14, 2000. City of West Sacramento, CA: City of West Sacramento Department of Community Development.
- Cramer, S. P., and D. B. Demko. 1997. The status of late-fall and spring Chinook salmon in the Sacramento River basin regarding the Endangered Species Act. Special Report. Submitted to National Marine Fisheries Service on behalf of Association of California Water Agencies and California Urban Water Agencies. Prepared by S. P. Cramer and Associates, Inc., Gresham, Oregon.
- Deng, X., J.P. Van Eenennaam, S. I. Doroshov. 2002. Comparison of early life stages and growth of green and white sturgeon. *Transactions of the American Fisheries Society* 28:237–248.

- Earley, J. T., D. J. Colby, and M. R. Brown. 2010. Juvenile Salmonid Monitoring in Clear Creek, CA, from October 2008 through September 2009. U.S. Fish and Wildlife Service, Red Bluff, CA.
- Eng, L. L. 1984. Rare, threatened and endangered invertebrates in California riparian systems. In: *California riparian systems. Ecology, conservation, and productive management*, (R. E. Warner and K. M. Hendrix eds.). Berkeley, Los Angeles, and London: University of California Press. 914-919pp.
- Environmental Laboratory. 1987. U.S. Army Corps of Engineers Wetlands Delineation Manual. (Technical Report Y-87-1.) Vicksburg, MS: U.S. Army Waterways Experiment Station.
- Fisher, R., G. Hansen, R. W. Hansen, and G. Stewart. 1994. Giant garter snake. Pages 284-287 in C. G. Thelander and M. Crabtree, editors. *Life on the edge: a guide to California's endangered natural resources, wildlife*. Biosystems Books, Santa Cruz, California.
- Fris, M. B., and R. W. DeHaven. 1993. A community-based habitat suitability index model for Shaded Riverine Aquatic Cover, selected reaches of the Sacramento River system. U. S. Fish and Wildlife Service, Sacramento Field Office, Sacramento, California.
- Gutreuter, S., and A.D. Bartels, K. Irons, and M.B. Sanheinrich. 1999. Evaluation of the flood-pulse concept based on statistical models of growth of selected fishes of the Upper Mississippi River system. *Canadian Journal of Fisheries and Aquatic Sciences* 56: 2282-2291.
- Hallock, R. J., and F. W. Fisher. 1985. Status of the winter-run Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento River. Office Report. California Department of Fish and Game, Anadromous Fisheries Branch, Sacramento.
- Hallock, R. J. 1987. Sacramento River system salmon and steelhead problems and enhancement opportunities. A report to the California Advisory Committee on Salmon and Steelhead Trout.
- Hansen, G. E., and J. M. Brode. 1980. Status of the giant garter snake, *Thamnophis couchi gigas*. Inland Fisheries Endangered Species Program Special Publication Report No. 80-5. California Department of Fish and Game, Sacramento.
- Harvey, C. 2002. Personal communication. California Department of Fish and Game, Redding, California.
- HDR, Inc. 2008. *West Sacramento Levee Evaluation Project, Problem Identification Report*. Draft. April. Folsom, CA. Prepared for the City of West Sacramento, West Sacramento, CA.
- HDR, Inc. 2009. *West Sacramento Levee Evaluation Program, Alternatives Analysis*. August to November. Folsom, CA. Prepared for the City of West Sacramento, West Sacramento, CA.

- Healey, M. C. 1991. Life history of Chinook salmon (*Oncorhynchus tshawytscha*), pp. 311–393. In C. Groot and L. Margolis, Pacific Salmon life histories. Vancouver, British Columbia: UBC Press. 564 pp.
- Hill, K. A., and J. D. Webber. 1999. Butte Creek spring-run Chinook salmon, *Oncorhynchus tshawytscha*, juvenile outmigration and life history 1995-1998. Inland Fisheries Administrative Report No. 99-5. California Department of Fish and Game, Sacramento Valley and Central Sierra Region, Rancho Cordova.
- Huxel, G. R. 2000. The effect of the Argentine ant on the threatened valley elderberry longhorn beetle. *Biological Invasions* 2:81-85.
- ICF International. 2013. *Southport Sacramento River Early Implementation Project Environmental Impact Statement/Environmental Impact Report*. Draft. November. (ICF 00071.11.) Sacramento, CA. Prepared for: U.S. Army Corps of Engineers, Sacramento, CA, and West Sacramento Area Flood Control Agency, West Sacramento, CA.
- Junk, W. J., P. B. Bayley, and R. E. Sparks. 1989. The flood pulse concept in river-floodplain systems. Pages 110–127 in D. P. Dodge (editor) *Proceedings of the International Large River Symposium*. Canadian Special Publication in Fisheries and Aquatic Sciences 106.
- Katibah, E. F. 1984. A brief history of riparian forests in the Central Valley of California. Pages 23-29 in R. E. Warner and K. M. Hendrix, editors. *California riparian systems: ecology, conservation, and productive management*. University of California Press, Berkeley.
- Kjelson, M. A., P. F. Raquel, and F. W. Fisher. 1982. Life history of fall-run juvenile Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento-San Joaquin estuary, California. Pages 393-411 in V. S. Kennedy, editor. *Estuarine comparisons*. Academic Press, New York.
- Lang, J., J. Jokerst, and G. Sutter. 1989. Habitat and Populations of the valley elderberry longhorn beetle along the Sacramento River. USDA Forest Service Gen. Tech. Rep. PSW-110.
- Lestelle, L.C., W.E. McConnaha, G. Blair, and B. Watson. 2005. Chinook salmon use of floodplain, secondary channel, and non-natal tributary habitats in rivers of western North America. Prepared by Mobrand-Jones & Stokes, Vashon, WA and Portland, OR. Prepared for Mid-Willamette Valley Council of Governments, U.S. Army Corps of Engineers, Oregon Department of Fish and Wildlife.
- Lindley, S.T., and M.S. Mohr. 2003. Modeling the effect of striped bass (*Morone saxatilis*) on the population viability of Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*). *Fisheries Bulletin* 101:321-331.

- Lloyd, D. S., J. P. Koenings, and J. D. La Perriere. 1987. Effects of turbidity in fresh waters of Alaska. *North American Journal of Fisheries Management*
- Mahoney, J. M., and S. B. Rood. 1998. Streamflow requirements for cottonwood seedling recruitment - an integrative model. *Wetlands* 18: 634-645.
- Matern, S. A., P. B. Moyle, and L. C. Pierce. 2002. Native and alien fishes in a California estuarine marsh: twenty-one years of changing assemblages. *Transactions of the American Fisheries Society* 131: 797-816.
- McEwan, D. R. 2001. Central Valley steelhead. Pages 1-43 *in* R. L. Brown, editor. *Contributions to the biology of Central Valley salmonids*. Fish Bulletin 179: Volume 1. California Department of Fish and Game, Sacramento.
- McEwan, D., and T. A. Jackson. 1996. Steelhead restoration and management plan for California. Management Report. California Department of Fish and Game, Inland Fisheries Division, Sacramento.
- Meehan, W. R., and T. C. Bjornn. 1991. Salmonid distributions and life histories. Pages 47-82 *in* W. R. Meehan, editor. *Influences of forest and rangeland management on salmonid fishes and their habitats*. American Fisheries Society Special Publication No. 19. Bethesda, Maryland.
- Mills, T. J., and F. Fisher. 1994. Central Valley anadromous sport fish annual run-size, harvest, and population estimates, 1967 through 1991. Inland Fisheries Technical Report. California Department of Fish and Game.
- Mills, T. J., D. R. McEwan, and M. R. Jennings. 1997. California salmon and steelhead: beyond the crossroads. Pages 91-111 *in* D. J. Stouder, P. A. Bisson and R. J. Naiman, editors. *Pacific salmon and their ecosystems: status and future options*. Chapman and Hall, New York.
- Missildine, B., R. Peters, R. Piaskowski, R. Tabor. 2001. Habitat Complexity, Salmonid Use, and Predation of Salmonids at the Bioengineered Revetment at the Maplewood Golf Course on the Cedar River, Washington. Miscellaneous report. U.S. Fish and Wildlife Service, Western Washington Office, Lacey, WA.
- Moyle, P. B. 2002. *Inland fishes of California*. Revised edition. University of California Press, Berkeley.
- Moyle, P. B., R. M. Yoshiyama, J. E. Williams, and E. D. Wikramanayake. 1995. Fish species of special concern in California. Final Report. Prepared by Department of Wildlife and Fisheries Biology, University of California, Davis for California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova.

- Murphy, M. L., and W. R. Meehan. 1991. Stream Ecosystems. Pages 17–46 in W. R. Meehan (ed.), Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, American Fisheries Society, Bethesda, MD, Special Publication 19.
- Myers, J. M., R. G. Kope, B. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dep. Commer., NOAA Tech. Memo NMFS-NWFSC-35, 443 p.
- National Marine Fisheries Service (NMFS). 1989. Endangered and threatened species; critical habitat; winter-run Chinook salmon. Federal Register 54: 32085-32088.
- National Marine Fisheries Service (NMFS). 1993a. Designated critical habitat; Sacramento River winter-run Chinook salmon. Federal Register 58: 33212-33219.
- National Marine Fisheries Service (NMFS). 1993b. Biological opinion addressing the potential effects on Sacramento River winter-run Chinook salmon from the operation of the Central Valley Project during 1992. NMFS, Southwest Region.
- National Marine Fisheries Service (NMFS). 1994. Endangered and threatened species; status of Sacramento River winter-run Chinook salmon. Federal Register 59: 440-450.
- National Marine Fisheries Service (NMFS). 1996a. Factors for decline: a supplement to the notice of determination for West Coast steelhead under the Endangered Species Act. NMFS, Protected Species Branch, Portland, Oregon and NMFS, Protected Species Management Division, Long Beach, California.
- National Marine Fisheries Service (NMFS). 1996b. Endangered and threatened species; endangered status for Umpqua River cutthroat trout in Oregon. Federal Register 61: 41514-41522.
- National Marine Fisheries Service (NMFS). 1997. Magnuson-Stevens Act provisions; essential fish habitat (EFH); final rule. Federal Register 62: 2343-2383.
- National Marine Fisheries Service (NMFS). 1998a. Endangered and threatened species: proposed endangered status for two Chinook salmon ESUs and proposed threatened status for five Chinook ESUs; proposed redefinition, threatened status, and revision of critical habitat for one Chinook salmon ESU; proposed designation of Chinook salmon critical habitat in California, Oregon, Washington, Idaho. Federal Register 63: 11481-11519.
- National Marine Fisheries Service (NMFS). 1998b. Endangered and threatened species: threatened status for two ESU's of steelhead in Washington, Oregon, and California. Federal Register 63: 13347-13371.

National Marine Fisheries Service (NMFS). 1999. Endangered and threatened species; threatened status for two Chinook salmon evolutionarily significant units (ESUs) in California. Federal Register 64: 50394-50415.

National Marine Fisheries Service (NMFS). 2000. Designated critical habitat: critical habitat for 19 evolutionarily significant units of salmon and steelhead in Washington, Oregon, Idaho, and California. Federal Register 65: 7764-7787.

National Marine Fisheries Service (NMFS). 2001. Biological opinion for Sacramento River Bank Protection Project. Contract 42E: proposed levee reconstruction at river mile 149.0, Colusa County, California and five sites along the mainstem Sacramento River. Sacramento, California.

National Marine Fisheries Service (NMFS). 2003. Endangered and threatened wildlife and plants: 12-month finding on a petition to list North American green sturgeon as a threatened or endangered species. Federal Register 68: 4433-4441.

National Marine Fisheries Service (NMFS). 2004. Endangered and threatened species: establishment of Species of Concern list, addition of species to Species of Concern list, description of factors for identifying Species of Concern, and revision of Candidate Species list Under the Endangered Species Act: notice. Federal Register 69: 19975-19979.

National Marine Fisheries Service (NMFS). 2005a. Endangered and threatened species; final listing determinations for 16 ESUs of West Coast salmon, and final 4(d) protective regulations for threatened salmonid ESUs. Federal Register 70: 37160-37204.

National Marine Fisheries Service (NMFS). 2005b. Endangered and threatened species; designation of critical habitat for 12 Evolutionarily Significant Units of west coast salmon and steelhead in Washington, Oregon, and Idaho. Federal Register 70: 52630-52858.

National Marine Fisheries Service (NMFS). 2005c. Endangered and threatened wildlife and plants: proposed threatened status for Southern Distinct Population Segment of North American green sturgeon. Federal Register 70: 17386-17401.

National Marine Fisheries Service (NMFS) NMFS. 2005d. Green sturgeon (*Acipenser medirostris*) status review update. NOAA Fisheries, Southwest Fisheries Science Center, Long Beach, California.

National Marine Fisheries Service (NMFS). 2005e. Endangered and threatened species: designation of critical habitat for seven evolutionarily significant units of Pacific salmon and steelhead in California, final rule. Federal Register 70: 52488-52586.

- National Marine Fisheries Service (NMFS). 2006a. Biological opinion for the Sacramento River Bank Protection Project, 14 critical levee erosion repairs. Prepared for the U. S. Army Corps of Engineers, Sacramento District, California.
- National Marine Fisheries Service (NMFS). 2006b. Federally listed and species of concern within the action area of the Sacramento River Bank Protection Project. Letter to AJ Keith, Aquatic Ecologist, Stillwater Sciences, Berkeley from Michael E. Aceituno, Area Supervisor, National Marine Fisheries Service, Sacramento. 22 August.
- National Marine Fisheries Service (NMFS). 2006c. Endangered and threatened wildlife and plants: threatened status for southern distinct population segment of North American green sturgeon: final rule. Federal Register 71: 17757-17766.
- National Marine Fisheries Service. 2006d. Biological opinion on the Sacramento River flood control project critical levee erosion repair project. Prepared by National Marine Fisheries Service, Southwest Region, Long Beach, California for U.S. Army Corps of Engineers, Sacramento District, Sacramento, California. File No. 151422SWR2006SA00115.
- National Marine Fisheries Service. 2008. Programmatic Consultation for Phase II of the Sacramento River Bank Protection Project. Biological Opinion. July. Southwest Region. Sacramento, CA.
- National Marine Fisheries Service. 2009. Public Draft Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of Central Valley Steelhead. Sacramento Protected Resources Division. October 2009.
- Newcombe, C.P., and J.O.T. Jensen. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management. 16:693-727.
- Pacific Fishery Management Council. 2002. Review of 2001 ocean salmon fisheries. Pacific Fishery Management Council, Portland, Oregon.
- Pacific Fishery Management Council. 2003. Pacific Coast salmon plan. Fishery management plan for commercial and recreational salmon fisheries off the coasts of Washington, Oregon and California as revised through Amendment 14 (adopted March 1999). Portland, Oregon. September 2003.
- Raleigh, R. F., T. Hickman, R. C. Soloman, and P. C. Nelson. 1984. Habitat suitability information: rainbow trout. Biological Report 82 (10.60). U.S. Fish and Wildlife Service. Washington, DC. (FWS/OBS-82/10.60, 64 pp.)

- Reynolds, F., T. J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley Streams: A Plan For Action. California Department of Fish and Game, Inland Fisheries Division.
- Roberts, M. D., D. R. Peterson, D. E. Jukkola, and V. L. Snowden. 2001. A pilot investigation of cottonwood recruitment on the Sacramento River. Draft report. The Nature Conservancy, Sacramento River Project, Chico, California.
- S. P. Cramer and Associates. 1995. Central Valley Project Improvement Act anadromous fish restoration program doubling plan-recommended actions for the Mokelumne River. Gresham, Oregon.
- Schlunegger, J. 2014. Personal communication. E-mail dated 13 May 14.
- Scott, M. L., G. T. Auble, and J. M. Friedman. 1997. Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. *Ecological Applications* 7: 677-690.
- Scott, M. L., P. B. Shafroth, and G. T. Auble. 1999. Responses of riparian cottonwoods to alluvial water table declines. *Environmental Management* 23: 347-358.
- Seesholtz, A., M. Manuel, and J. Van Eenennaam. 2012. 2011 and 2012 Lower Feather River Green Sturgeon Spawning Survey. Draft Report. Department of Water Resources, West Sacramento, CA.
- Servizi, J. A. and D. W. Martens. 1992. Sublethal responses of coho salmon (*Onchorhynchus kisutch*) to suspended sediments. *Canadian Journal of Fisheries and Aquatic Sciences* 49:1389–1395.
- Sigler, J. W., T. C. Bjornn, and F. H. Everest. 1984. Effects of chronic turbidity on density and growth of steelhead and coho salmon. *Transactions of the American Fisheries Society* 113:142–150.
- Slotten, D. G. 1991. Mercury Bioaccumulation in a Newly Impounded Northern California Reservoir [dissertation]. University of California, Davis. Available from Peter J. Shields, University Library, Davis, CA,
- Slater, D. W. 1963. Winter-run Chinook salmon in the Sacramento River, California with notes on water temperature requirements at spawning. Special Scientific Report—Fisheries 461. U. S. Fish and Wildlife Service.
- Sommer, T. 2002. Personal communication with A. J. Keith, Stillwater Sciences, Berkeley, California. California Department of Water Resources. 24 July.
- Sommer, T. R., M. L. Nobriga, W. C. Harrell, W. Batham, and W. J. Kimmerer. 2001. Floodplain rearing of juvenile Chinook salmon: evidence of enhanced growth and survival. *Canadian Journal of Fisheries and Aquatic Sciences* 58: 325-333.

- Sommer, T. R., W. C. Harrell, and M. L. Nobriga. 2005. Habitat use and stranding risk of juvenile Chinook salmon on a seasonal floodplain. *North American Journal of Fisheries Management* 25:1493–1504.
- Snider, B. and R. G. Titus. 2000. Timing, composition, and abundance of juvenile anadromous salmonid emigration in the Sacramento River near Knights Landing, October 1996-September 1997. California Department of Fish and Game, Habitat Conservation Division, Stream Evaluation Program Technical Report No. 00-04.
- Stillwater Sciences. 2006. Proposed approach for the Programmatic Biological Assessment for remaining SRBPP construction authority. Memorandum to Mike Dietl, U.S. Army Corps of Engineers from Laura Cholodenko and Noah Hume, Stillwater Sciences, California. 15 August.
- Swanson, C., and J. J. Cech. 1995. Environmental Tolerances and Requirements of Delta Smelt (*Hypomesus transpacificus*). Final report, Department of Water Resources. 77 pp.
- Sweeney, B. W., T. L. Bott, J. K. Jackson, L. A. Kaplan, J. D. Newbold, L. J. Standley, W. C. Hession, and R. J. Horwitz. 2004. Riparian deforestation, stream narrowing, and loss of stream ecosystem services. *Proceedings of the National Academy of Sciences USA* 101: 14132-14137. <http://www.pnas.org/cgi/reprint/101/39/14132>.
- Talley, T. S. 2005. Spatial Ecology and Conservation of the Valley Elderberry Longhorn Beetle. Ph.D. Dissertation, University of California, Davis. 105pp.
- Talley, T. S., M. Holyoak, and D. A. Piechnik. 2006a. The effects of dust on the federally threatened valley elderberry longhorn beetle. *Environmental Management* Vol. 37, No. 5, pp. 647-658.
- Talley, T. S., D. Wright, and M. Holyoak. 2006b. Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) 5-year review: summary and evaluation. Prepared for U. S. Fish and Wildlife Service, Sacramento Office, Sacramento, California. [http://www.fws.gov/sacramento/es/documents/VELB\\_5yr\\_review\\_Talley\\_etal.pdf](http://www.fws.gov/sacramento/es/documents/VELB_5yr_review_Talley_etal.pdf)
- Thomas, M.J., M.L. Peterson, N. Friedenberg, J.P. Van Eenennaam, J.R. Johnson, J.J. Hoover and A.P. Klimley. 2013. Stranding of Spawning Run Green Sturgeon in the Sacramento River: Post Rescue Movements and Potential Population-Level Effects. *North American Journal of Fisheries Management*. 33:2. 287-297.
- Thompson, K. 1961. Riparian forests of the Sacramento Valley, California. Pages 294-315 in R. S. Platt, editor. *Annals of the Association of American Geographers*.
- U.S. Army Corps of Engineers (Corps). 1989. Sacramento River Flood Control Project. Sacramento Urban Area Levee Reconstruction. Basis of Design, Volume 1. Prepared by Wahler Associates.

- U.S. Army Corps of Engineers (Corps). 1993. Biological Data Report for the Listed Species Potentially Affected by the Sacramento River Gradient Restoration Project – Glenn County, California. Unpublished report. Prepared by Beak Consultants.
- U.S. Army Corps of Engineers (Corps). 2000a. Guidelines for landscape planting and vegetation management at floodwalls, levees, and embankment dams. Washington, DC. 1 January. Engineering Regulation 1105-2-100.
- U.S. Army Corps of Engineers (Corps). 2000b. Biological assessment for the Sacramento River bank protection project; 42E, proposed levee reconstruction at river mile 149.0, Colusa County, California and at five other sites along the mainstem Sacramento River. USACE, Sacramento, California.
- U.S. Army Corps of Engineers. 2004. Standard assessment methodology for the Sacramento River bank protection project. Final report. Prepared by Stillwater Sciences, Davis, California and Dean Ryan Consultants & Designers, Sacramento, California for and in conjunction with U.S. Army Corps of Engineers and The Reclamation Board, Sacramento, California.
- U.S. Army Corps of Engineers. 2006. Sacramento River bank protection project revetment database. Web based ESRI ArcIMS GIS database queried December 2006.
- U.S. Army Corps of Engineers. 2008. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region. Version 2.0. September. Wetlands Regulatory Assistance Program. Environmental Laboratory (ERDC/EL TR-08-28). Vicksburg, MS.  
[http://www.usace.army.mil/missions/civilworks/regulatoryprogramandpermits/reg\\_supp.asp](http://www.usace.army.mil/missions/civilworks/regulatoryprogramandpermits/reg_supp.asp).
- U.S. Army Corps of Engineers (Corps). 2012. *Sacramento River Bank Protection Project, Phase II 80,000 Linear Feet Biological Assessment*. Draft. July. (ICF 00627.08.) Sacramento, CA. Prepared by ICF International, Sacramento, CA.
- U.S. Army Corps of Engineers (Corps). 2013. Corp's SMART Planning Guide.  
<http://planning.usace.army.mil/toolbox/smart.cfm?Section=1&Part=0>
- U.S. Army Corps of Engineers and Central Valley Flood Protection Board (Corps and CVFPB). 2009. *Project Management Plan for the West Sacramento Project General Reevaluation Report, California*. January. Sacramento, CA.
- U.S. Bureau of Reclamation (USBR). 1986. Central Valley fish and wildlife management study. Temperature and flow studies for optimizing Chinook salmon production, upper Sacramento River, California. Special report. Sacramento, California.

- U.S. Department of the Interior, Bureau of Reclamation. 1986. Central Valley fish and wildlife management study. Temperature and flow studies for optimizing Chinook salmon production, upper Sacramento River, California. Special report. Sacramento, California.
- U.S. Fish and Wildlife Service (USFWS). 1980. Listing the valley elderberry longhorn beetle as a threatened species with critical habitat. Federal Register 45: 52803-52806.
- U.S. Fish and Wildlife Service (USFWS). 1984. Recovery plan for the valley elderberry longhorn beetle. USFWS Endangered Species Program. Portland, Oregon.
- U.S. Fish and Wildlife Service (USFWS). 1993. Endangered and threatened wildlife and plants; determination of threatened status for the Delta smelt. Federal Register 58: 12854-12863.
- U.S. Fish and Wildlife Service (USFWS). 1994. Endangered and threatened wildlife and plants; critical habitat determination for the Delta smelt. Federal Register 59: 65256-65278.
- U.S. Fish and Wildlife Service (USFWS). 1995. Draft anadromous fish restoration plan: a plan to increase natural production of anadromous fish in the Central Valley of California. Prepared for the Secretary of the Interior by the U. S. Fish and Wildlife Service with assistance from the Anadromous Fish Restoration Program Core Group under authority of the Central Valley Project Improvement Act.
- U.S. Fish and Wildlife Service (USFWS). 1996. Recovery plan for the Sacramento-San Joaquin Delta native fishes. Technical/Agency Draft. Prepared by Delta Native Fishes Recovery Team, U. S. Fish and Wildlife Service, Region 1, Portland, Oregon.
- U.S. Fish and Wildlife Service (USFWS). 1997. Programmatic formal consultation for U.S. Army Corps of Engineers 404 permitted projects with relatively small effects on the giant garter snake within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo counties, CA. File number 1-1-F-97-149. Sacramento, California.
- U.S. Fish and Wildlife Service (USFWS). 1998. Fish and wildlife coordination act report for the Sacramento Bank Protection Project, lower American River sites 1, 2, and 4. Prepared by U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office, for U.S. Army Corps of Engineers, Sacramento District. June.
- U.S. Fish and Wildlife Service (USFWS). 1999a. Conservation guidelines for the valley elderberry longhorn beetle. Sacramento Fish and Wildlife Office. Sacramento, California.
- U.S. Fish and Wildlife Service (USFWS). 1999b. Draft recovery plan for the giant garter snake (*Thamnophis gigas*). Portland, Oregon.

- U.S. Fish and Wildlife Service (USFWS). 2002a. Recovery Plan for the California Red-legged Frog (*Rana aurora draytonii*). U.S. Fish and Wildlife Service, Portland, Oregon. viii + 173 pp.
- U.S. Fish and Wildlife Service. 2002b. Field data collection protocol for the riprapped banks. GIS, Sacramento River Bank Protection Project. Letter to Kenneth Hitch, U.S. Army Corps of Engineers, Sacramento District, California from David Harlow, USFWS, Sacramento, California. October 22.
- U.S. Fish and Wildlife Service (USFWS). 2003a. Delta smelt (*Hypomesus transpacificus*). Final critical habitat, Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo Counties, California. 1:109,000. USFWS, GIS Branch, Sacramento, California. 16 June.
- U.S. Fish and Wildlife Service (USFWS). 2003b. Formal Endangered Species Consultation on the Pacific Gas and Electric Company Transmission Separation Project, located in Plumas, Sequoia, and Sierra National Forests within Butte, Plumas, Madera and Fresno Counties; in Redding, Folsom, and Bakersfield Districts within Madera, Fresno, Amador, Calaveras, Tuolumne, Nevada, Placer, Butte, Yuba, Shasta, and Tehama Counties, California. June 27. Sacramento Fish and Wildlife Office. Sacramento, CA.
- U.S. Fish and Wildlife Service (USFWS). 2006a. Endangered species Section 7 Consultation for the U.S. Army Corps of Engineers' and California Department of Water Resources' proposed bank protection at 29 sites along the Sacramento and Bear Rivers, and Steamboat and Cache Sloughs, California. Letter to Colonel Ronald N. Light, District Engineer, U.S. Army Corps of Engineers, Sacramento, California from Kenneth Sanchez, Acting Field Supervisor, USFWS, Sacramento Fish and Wildlife Office, Sacramento, California. June 21.
- U.S. Fish and Wildlife Service (USFWS). 2006b. Endangered species Section 7 consultation for the U.S. Army Corps of Engineers' proposed Sacramento River bank protection project, 14 critical erosion sites along the Sacramento and Steamboat Slough, California. 1-1-07-F-0060. December.
- U.S. Fish and Wildlife Service (USFWS). 2006. Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*) 5-Year Review. September 2006.
- U.S. Fish and Wildlife Service (USFWS). 2011. Service to Consider Delisting of Valley Elderberry Longhorn Beetle. Last Revised: August 18, 2011. <http://www.fws.gov/cno/press/release.cfm?rid=254>
- U.S. Fish and Wildlife Service. 2011. List of endangered and threatened species that may occur in Yolo County. Last revised: April 29, 2010. Available: <[http://www.fws.gov/sacramento/es/spp\\_list.htm](http://www.fws.gov/sacramento/es/spp_list.htm)>. Accessed: July 15, 2011.

- U.S. Fish and Wildlife Service. 2012. List of endangered and threatened species that may occur in the Sacramento West Quadrangle. Last revised: September 18, 2011. Available: <[http://www.fws.gov/sacramento/es/spp\\_list.htm](http://www.fws.gov/sacramento/es/spp_list.htm)>. Accessed: September 25, 2012.
- U.S. Fish and Wildlife Service. 2013. List of endangered and threatened species that may occur in Yolo County. Last revised: September 18, 2011. Available: <[http://www.fws.gov/sacramento/es/spp\\_list.htm](http://www.fws.gov/sacramento/es/spp_list.htm)>. Accessed: January 3, 2013.
- U.S. Fish and Wildlife Service. 2014. List of endangered and threatened species that may occur in Yolo County. Last revised: September 18, 2011. Available: <[http://www.fws.gov/sacramento/es/spp\\_list.htm](http://www.fws.gov/sacramento/es/spp_list.htm)>. Accessed: January 16, 2014.
- U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 2002a. 402.12: biological assessments. Part 402 - Interagency cooperation--Endangered Species Act of 1973, as amended. Chapter IV--Joint regulations; Endangered Species Committee regulations. Pages 405-407 *in* Code of Federal Regulations, Title 50: wildlife and fisheries.
- U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities under Section 7 of the Endangered Species Act. Final. March 1998.
- U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 2002b. 402.02 definitions. Part 402 - Interagency cooperation--Endangered Species Act of 1973, as amended. Chapter IV--Joint regulations; Endangered Species Committee regulations. Pages 401-403 *in* Code of Federal Regulations, Title 50: wildlife and fisheries.
- Vogel, D. A., and K. R. Marine. 1991. Guide to upper Sacramento River Chinook salmon life history. Prepared by CH2M Hill, Redding, California for U. S. Bureau of Reclamation, Central Valley Project.
- Wang, J. C. S. 1986. Fishes of the Sacramento-San Joaquin estuary and adjacent waters, California: a guide to the early life histories. Technical Report 9. Prepared for the Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary by California Department of Water Resources, California Department of Fish and Game, U. S. Bureau of Reclamation and U. S. Fish and Wildlife Service.
- Wang, J. C. S. 1991. Early life stages and early life history of the delta smelt, *Hypomesus transpacificus*, in the Sacramento-San Joaquin Estuary, with comparison of early life stages of the longfin smelt, *Spirinchus thaleichthys*. Technical Report 28. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary.

- Wang, J. C. S., and R. L. Brown. 1993. Observations of early life stages of delta smelt, *Hypomesus transpacificus*, in the Sacramento-San Joaquin Estuary in 1991, with a review of its ecological status in 1988 to 1990. FS/BIO-IATR/93-35. Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary.
- Waters, T. F. 1995. Sediment in Streams: Sources, Biological Effects and Control. Bethesda, MD: American Fisheries Society.
- Welcomme, R. 1979. Fisheries ecology of floodplain rivers. London, Longmans. 317 pp.
- Williams, J.G. 2006. Central Valley salmon: a perspective on Chinook and steelhead in the Central Valley of California. San Francisco Estuary and Watershed Science 4(3): Article 2. Available at: <<http://escholarship.org/uc/item/21v9x1t7#page-1>>.
- Williams, J. G. 2009. Sacramento-San Joaquin Delta Regional Ecosystem Restoration Implementation Plan: Life-history Conceptual Model for Chinook Salmon and (*Oncorhynchus tshawytscha* and *O. mykiss*). Sacramento-San Joaquin Delta, Regional Ecosystem Restoration Implementation Plan.
- Wylie, G.D., M.L. Casazza, L.L. Martin, and M. Carpenter. 2002. Monitoring giant garter snakes at Colusa National wildlife refuge: 2002 progress report. Prepared by U.S. Geological Survey, Western Ecological Research Center for U.S. Fish and Wildlife Service and U.S. Bureau of Reclamation.
- Yoshiyama, R. M., F. W. Fisher, and P. B. Moyle. 1998. Historical abundance and decline of Chinook salmon in the Central Valley region of California. North American Journal of Fisheries Management 18: 487-521.

**West Sacramento GRR EIS/EIR  
Appendix C**

**Cultural Resources**

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**West Sacramento GRR EIS/EIR  
Appendix C**

**Cultural Resources**

**Enclosure 1**

**Final Programmatic Agreement**

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**PROGRAMMATIC AGREEMENT  
AMONG THE  
U.S. ARMY CORPS OF ENGINEERS AND  
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER, REGARDING THE  
WEST SACRAMENTO GENERAL REEVALUATION REPORT,  
YOLO COUNTY and SOLANO COUNTIES, CALIFORNIA**

**WHEREAS**, the United States Army Corps of Engineers, Sacramento District (Corps) is proceeding to implement aspects of the recommended plan in the West Sacramento General Reevaluation Report (GRR) Project (Project). The West Sacramento GRR project was authorized in the Water Resources Development Act 1992, Pub. L. No. 102-580, § 101(4), and the Energy and Water Development Appropriations Act of 1999, Pub. L. No. 105-245, 112 Stat. 1840 (1999) (project, as described in **Attachment 1: Description of the West Sacramento GRR and Projects**); and

**WHEREAS**, the Corps proposes to bring the 50 miles of perimeter levees surrounding West Sacramento into compliance with applicable Federal and State standards for levees protecting urban areas through implementing proposed levee improvements that would address adequate levee height, levee seepage, erosion, and stability conditions along the West Sacramento levee system located in Yolo and Solano Counties, California; and

**WHEREAS** the State of California Central Valley Flood Protection Board (CVFPB) is the non-Federal sponsor for the Project and the CVFPB has been invited to be a Concurring Party to this Programmatic Agreement (Agreement); and

**WHEREAS**, the Corps has determined that the Project activities constitute an Undertaking, as defined in 36 C.F.R. § 800.16(y), and therefore is subject to Section 106 of the National Historic Preservation Act of 1966, 54 U.S.C. § 306108 (NHPA); and

**WHEREAS**, pursuant to 36 C.F.R. § 800.4(b)(2), the Corps may implement the Project in phases as funding is available and construction authority is provided and, as a result, efforts to identify and evaluate Historic Properties and the determination of effects pursuant to 36 C.F.R. § 800.14(b)(1)(ii), for all phases and segments of the Project may be deferred until more specific project information for each phase is known; and

**WHEREAS**, the specific project design that may alter the levees will not be developed until after the Project has been approved for design, a determination of effect and, if necessary, an Historic Properties Treatment Plan (HPTP), cannot be developed until after approval and execution of this Agreement.

**WHEREAS**, this Agreement shall establish the process the Corps shall follow for compliance with 54 U.S.C. § 306108 (formerly 16 U.S.C. § 470f, referred to hereinafter as "Section 106"), taking into consideration the views of the Signatory and Concurring Parties; and

**WHEREAS**, a total of 14 historic properties are known to be present within the Area of Potential Effects (APE) and although extensive archaeological inventory has been completed within the APE under other projects, portions of the APE have not been inventoried; and

**WHEREAS**, the presence of levees, alluvial deposition, and other built environment features have obscured the presence of historic properties and a full assessment of archaeological sites cannot be made in advance of construction; and

**WHEREAS**, the levees of the Sacramento River are the one known potential Historic Property within the APE that will be affected by the Project; and

**WHEREAS**, the Corps is aware that there is a high probability for buried cultural resources that may not be identified prior to construction and that also may be eligible for inclusion in the NRHP, and therefore this Agreement documents a framework for managing post-review discoveries per 36 C.F.R. § 800.13; and

**WHEREAS**, in accordance with 36 C.F.R. §§ 800.2(c)(2)(ii)(A), 800.3(f)(2), and 800.14(b)(2)(i), the Corps has invited the Yocha Dehe Wintun Nation and United Auburn Indian Community to be concurring parties to this agreement and will continue to consult with them on its implementation; and

**WHEREAS**, the Corps shall make the terms and conditions of this Agreement part of the conditions of any contracts issued by the Corps for this Project; and

**WHEREAS**, the definitions set forth in 36 C.F.R. § 800.16 are incorporated herein by reference and apply throughout this Agreement; and

**WHEREAS**, the definitions for Signatory Parties set forth in 36 C.F.R. § 800.6(c)(1), and the definitions for Concurring Parties set forth in 36 C.F.R. § 800.6(c)(3), are incorporated herein by reference and apply throughout this Agreement; and

**WHEREAS**, in accordance with 36 C.F.R. § 800.14(b)(3), the Corps notified and invited the Advisory Council on Historic Preservation (ACHP) per 36 C.F.R. § 800.6(a)(1)(C) to participate in consultation to resolve potential adverse effects of the Project, including development of this Agreement, and the ACHP has declined to participate pursuant to 36 C.F.R. § 800.6(a)(1)(iii) in a letter dated August 7, 2012; and

**WHEREAS**, in accordance with 36 C.F.R. § 800.6(a)(4) and 36 C.F.R. § 800.14(b)(2)(ii), the Corps has notified the public of the Project and provided an opportunity for members of the public to comment on the Project and the Section 106 process as outlined in this Agreement; and

**NOW, THEREFORE**, the signatories agree that the Undertaking shall be implemented in accordance with the following stipulations in order to take into account the effects of the undertaking on Historic Properties and to satisfy the Corps' Section 106 responsibilities for all individual aspects of the undertaking.

The Corps shall ensure that the following measures are carried out:

## **STIPULATIONS**

### **I. TIME FRAMES AND REVIEW PROCEDURES**

For all documents and deliverables produced in accordance with the stipulations of this Agreement, the Corps shall provide a draft document to the SHPO, Concurring Parties, and Native American interested parties and Tribes for review. Any written comments provided by the SHPO, Concurring Parties, and Native American interested parties and Tribes, within thirty (30) calendar days from the date of receipt, shall be considered in the revision of the document or deliverable. The Corps shall document and report the written comments received for the document or deliverable and how comments were addressed. The Corps shall provide a revised final document or deliverable to the SHPO for concurrence. The SHPO shall have thirty (30) calendar days to respond. Failure of the SHPO, Concurring Parties, and Native American interested parties and Tribes to respond within thirty (30) calendar days of any submittal shall not preclude Corps from moving to the next step in this Agreement.

Should the SHPO object to the final document or deliverable submitted for concurrence, the Corps and SHPO shall consult for a period not to exceed fifteen (15) calendar days following the receipt of the SHPO's written objection in an effort to come to agreement on the issues to which the SHPO has objected. Should the SHPO and the Corps be

unable to agree on the issues to which the SHPO has objected, the SHPO and the Corps shall proceed in accordance with **Stipulation XV (Dispute Resolution)**, below. The timeframe to consult to resolve a disagreement or objection may be extended by mutual consent of the Corps and the SHPO.

## II. AREA OF POTENTIAL EFFECTS

The APE for Project activities shall include the construction footprint of the activity and a reasonable buffer determined through consultation between SHPO and the Corps, and shall take into account the likelihood of direct and indirect effects to Historic Properties resulting from the Project. **Attachment 2** includes an overall APE map for the Project. Because the Project will occur in phases, it may be necessary to further define the APE for each phase as phases are authorized and funded for design and construction. Prior to activities under **Stipulation IV (Identification and Evaluation)**, the Corps shall submit to the SHPO, Concurring Parties, and Native American interested parties and Tribes a map of the APE for the current phase and a description of the Project activities occurring for that phase, in accordance with **Stipulation I (Timeframes and Review Procedures)**. Revisions to the APE will not necessitate modifications to this Agreement.

A. For purposes of this Agreement, the APE for each phase shall be defined to meet, at a minimum, the following criterion:

The APE for any segment of the levees that are being improved as part of the phase of the Project shall include the levee segment and a corridor extending not less than 150 meters from the landside toe of the levee segment.

B. The APE also shall include:

- (1) The extent of all Project construction and excavation activity required to construct flood control facilities and to modify irrigation and drainage infrastructure; and
- (2) The additional right-of-way/easements obtained by the Corps as part of the Project's features; and
- (3) All areas used for excavation of borrow material and habitat creation; and
- (4) All construction staging areas, access routes, spoil areas, and stockpiling areas.

- C. After the APE has been defined and consulted on in accordance with **Stipulation II (Area of Potential Effects)** above, construction or other Project activities may require revisions to the APE. If the APE is revised, the Corps shall consult on that revision in accordance with **Stipulation I (Timeframes and Review Procedures)**, and the Corps shall determine the potential for Project activities in a revised APE to affect potential Historic Properties, in accordance with **Stipulation IV (Identification and Evaluation)**.

### III. HISTORIC PROPERTIES MANAGEMENT PLAN

The Corps, in consultation with the Signatories, Concurring Parties, and Native American interested parties and Tribes, shall develop a Historic Property Management Plan (HPMP), which provides the framework by which remaining identification, evaluation of eligibility, findings of effect, and resolution of adverse effect efforts to Historic Properties will occur. The HPMP shall include consideration of property types, treatment of property types, expected methodology for identification and evaluation of potential historic properties, potential templates for work plans, provisions for avoidance or protection of historic properties, and consideration for identification and treatment of human remains. The HPMP shall be appended to this Agreement (**Attachment 3**) and will form the basis for any Historic Property Treatment Plans (HPTPs) that may be required for one or more phases of the Project. The HPMP shall be developed after execution of the Agreement, but before construction commences. For the overall Project and individual phases, the HPMP shall be the means for the Corps to comply with 36 C.F.R. § 800.6 and provide standardized methods for dealing with unanticipated discoveries in accordance with 36 C.F.R. § 800.13(a). The HPMP may be amended and appended to this Agreement without amending the Agreement.

- A. **Review:** The Corps shall submit the Draft HPMP to the SHPO, Concurring Parties, and Native American interested parties and Tribes for review and comment pursuant to **Stipulation I (Timeframes and Review Procedures)**.
- B. **Historic Property Treatment Plans:** The Corps shall consult the SHPO, pursuant to 36 C.F.R. § 800.5, when the Corps has determined that a Project activity will result in adverse effects to a Historic Property. An HPTP specific to the phase of the Project or the Historic Property will be drafted to describe how the Corps intends to resolve adverse effects and that HPTP may be appended to the HPMP. HPTPs shall be consistent with the HPMP and may incorporate by reference historic contexts, methods, procedures, and research designs, as appropriate. When incorporating portions of the HPMP by reference, the HPTP shall at a minimum include the date of the HPMP and where the HPMP is available to be viewed.

(1) An HPTP may address individual or multiple Historic Properties or Historic Property types. An HPTP shall stipulate those actions the Corps shall take to resolve the adverse effects of the Project on Historic Properties within the project phase or specific action specified by the HPTP. For properties eligible under criteria specified in 36 C.F.R. § 60.4 (A) through (D), mitigation other than data recovery may be considered in the treatment plan (e.g., HABS/HAER, oral history, historic markers, exhibits, interpretive brochures or publications, or other means as deemed appropriate by the signatories). In addition to the SHPO, Concurring Parties, and Native American interested parties and Tribes the Corps may invite the interested public, in accordance with **Stipulation XIII (Public Consultation and Public Notice)**, to comment on the means of mitigation, as appropriate. HPTPs shall include specifications (including content and number of copies) for publication of brochures, pamphlets or synthesis reports for distribution to the general public. The Corps shall ensure that all provisions of an HPTP are carried out as stipulated in the HPTP.

(2) **Historic Context, Recordation, and Treatment of Levees:** The Sacramento levees are a known potential Historic Property within the APE that may be affected by the Project. Sections of the levees have been recorded and evaluated for their individual eligibility for listing in the NRHP but no overall historic context or evaluation of the levee system has been developed. In order to document the levees for evaluation, the Corps will develop a historic context and HPTP for recordation of the Sacramento and American River levees as historic structures within the APE in order to evaluate the effects of the Project on the levees. If a historic context and/or HPTP for the levees within the APE has already been developed, the Corps may incorporate it as deemed appropriate by the Corps. The HPTP shall consider the levees in the context of the entire Sacramento and American River levee systems. Additionally, the HPTP shall require the development of clear and specific criteria for determining: (1) recordation guidelines for the levees within the APE, (2) contributing and non-contributing elements of the levee system, (3) thresholds of adverse effect, and (4) treatment of adverse effects. The HPTP shall be developed after execution of the Agreement and before construction commences. The Corps shall submit the HPTP for review, in accordance with **Stipulation I (Timeframes and Review Procedures)**.

(3) HPTPs will be submitted and reviewed in accordance with **Stipulation I (Timeframes and Review Procedures)**, except for those HPTPs developed for Historic Properties discovered during construction activities, which shall follow

the review timeframes identified in **Stipulation IX (Discovery of Unknown Historic Properties)**. Circulation of an HPTP shall not include a recirculation of the HPMP.

**D. Reporting:** Reports and other data pertaining to the inventory of Historic Properties and the treatment of effects to Historic Properties will be distributed to Concurring Parties to this Agreement, Native American Tribes, and other members of the public, consistent with **Stipulation XIV (Confidentiality)** of this Agreement, unless parties have indicated through consultation that they do not want to receive a report or data.

**E. Amendments/Addendums/Revisions:** If an Historic Property type that is not covered by an existing HPTP is discovered within the APE subsequent to an initial inventory effort for a phase, or if there are previously unexpected effects to an Historic Property, and the Corps and SHPO agree that the Project may adversely affect the Historic Property, the Corps shall submit an addendum to the HPTP or a new HPTP to the SHPO and Concurring Parties for review and comment, and shall follow the provisions of **Stipulation IX (Discovery of Unknown Historic Properties)**. The HPTP may cover multiple discoveries for the same property type.

**F. Data Recovery:** If and when data recovery is proposed, the Corps, in consultation with the SHPO, shall ensure that HPTPs are developed consistent with the *Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation* and the ACHP's "Recommended Approach for Consultation on Recovery of Significant Information from Archaeological Sites" (ACHP, May 18, 1999).

**G. Final Phase Report Documenting Implementation of the Historic Properties Treatment Plan(s):** Within one year after the completion of all work for each phase of the Project, the Corps shall submit to the SHPO, Signatory Parties, Concurring Parties, and Native American interested parties and Tribes, a Final Phase Report documenting the results of all work prepared for that phase under the HPTPs, and the information learned from each of the Historic Properties. The submittal of the Final Phase Report shall be in accordance with **Stipulation I (Timeframes and Review Procedures)**.

#### **IV. PRE-HPMP APPROVAL IDENTIFICATION AND EVALUATION**

Should the HPMP not be finalized at the time that a phase of the Project may be proceeding to design and construction, the Corps shall consult with the Signatory Parties before issuing a notice to proceed on any phase of the Project. Should the

Signatory Parties agree that the work may proceed, the Corps shall comply with **Stipulation IV A., B., and C. (Identification and Evaluation)** and, as necessary, **Stipulation VI (Determination of Effects)**. The Corps shall complete any identification and evaluation, and as necessary, any assessment of effects to Historic Properties prior to proceeding with construction. If the Signatory Parties do not agree to proceed with the phase of the Project the Corps shall follow **Stipulation XV (Dispute Resolution)**.

**A. Identification of Potential Historic Properties:** An inventory of Historic Properties within the APE, consistent with the *Secretary of Interior's Standards and Guidelines for Archeology and Historic Preservation* (48 FR 44716–44740) will be initiated for the Project, or for individual phases of the Project, as construction details become available.

Survey recordation shall include features, isolates, and re-recordation of previously recorded sites, as necessary. The survey shall ensure that potential Historic Properties such as historical structures and buildings, historical engineering features, landscapes, viewsheds, and traditional cultural properties (TCPs) with significance to Native American communities, are recorded in addition to archeological sites. Recordation of historic structures, buildings, objects, and sites shall be prepared using the California Department of Parks and Recreation (DPR) 523 Site Record forms.

**B. Property Types Exempt from Evaluation:** Attachment 4 to this Agreement lists the property types that the Signatories agree shall be exempt from evaluation as determined by the Corps in consultation with the SHPO. The Corps shall evaluate all other identified properties in accordance with **Stipulation IV.C (Evaluation of Potential Historic Properties)**.

**C. Evaluation of Potential Historic Properties:** After recordation on DPR 523 Site Record forms, potential Historic Properties shall be evaluated by a qualified professional, per Stipulation VII below, for their eligibility for listing in the NRHP consistent with the *Secretary of Interior's Standards for Evaluation*, 36 C.F.R. § 60.4. In accordance with **Stipulation I (Timeframes and Review Procedures)**, the Corps shall submit a completed inventory and evaluation for each phase of Project work.

## V. GEOTECHNICAL INVESTIGATIONS

For the purposes of gathering engineering data and for project planning, it may be necessary for the Corps to conduct limited geotechnical investigations at areas within the APE.

A. The Corps may conduct geotechnical investigations (e.g., borings, potholing, or trenches) for planning and exploratory efforts. The Corps shall follow Stipulation V.A(1) and (2), or may follow Stipulation V.A(3) if unable to follow Stipulation V.A(1) and (2):

(1) A records and literature search and consultation with Native Americans has been conducted and it has been determined there are no known existing potential Historic Properties located within 50 feet of the areas identified for geotechnical investigations, and an archeological field survey of the areas identified for geotechnical investigations has been conducted and it has been determined there are no known potential Historic Properties present;

(2) A potential Historic Property is identified during the records and literature search or field survey and consultation process as being within an area where geotechnical investigation will occur, and the geotechnical investigation is relocated at least 50 feet outside the site boundaries; or

(3) Provisions for an archeological monitor meeting the qualifications described in **Stipulation VII.C. (Archeological Monitor Standards)** are included in the contract specifications for the geotechnical investigations. As appropriate, or when geotechnical activities may occur in sensitive areas, an archeological monitor will be present for all ground disturbing activities.

B. If potential Historic Properties are discovered during geotechnical investigations, **Stipulation IX (Discovery of Unknown Historic Properties)** shall be followed;

C. A Memorandum for Record shall be written documenting the results of the records and literature search, the archeological field survey, any decisions to relocate geotechnical investigation areas, the determination for inclusion of an archeological monitor for ground disturbing activities, and a record of communication with Native American interested parties and Tribes, as appropriate.

## VI. ASSESSMENT OF EFFECTS

Avoidance of adverse effects to Historic Properties is the preferred treatment approach. The Corps will consider redesign of Project elements in order to avoid Historic Properties and Project effects that may be adverse. However, it may not be feasible to redesign the Project in order to avoid adverse effects to Historic Properties.

The Corps will apply the criteria of adverse effect, pursuant to 36 C.F.R. § 800.5(a)(1), to all Historic Properties within the APE that will be affected by the Project. The Corps shall submit findings of effects in accordance with **Stipulation I (Timeframes and Review Procedures)**.

If effects to Historic Properties are found to be adverse, **Stipulation III (Historic Properties Management Plan)**, above, will be followed.

## VII. QUALIFICATIONS

- A. Professional Qualifications:** All technical work required for historic preservation activities implemented pursuant to this Agreement shall be carried out by or under the direct supervision of a person or persons meeting, at a minimum, the *Secretary of Interior's Professional Qualifications Standards* for archeology, architectural history, or history, as appropriate (48 FR 44739). "Technical work" here means all efforts to inventory, evaluate, and perform subsequent treatment such as data recovery excavation or recordation of potential Historic Properties that is required under this Agreement. This stipulation shall not be construed to limit peer review, guidance, or editing of documents by SHPO and associated Project consultants.
- B. Historic Preservation Standards:** Historic preservation activities carried out pursuant to this Agreement shall meet the *Secretary of Interior's Standards and Guidelines for Archaeology and Historic Preservation* (48 FR 44716-44740), as well as standards and guidelines for historic preservation activities established by the SHPO. The Corps shall ensure that all reports prepared pursuant to this Agreement will be provided to the Signatories, Concurring Parties, and Native American interested parties and Tribes and are distributed in accordance with **Stipulation XIV (Confidentiality)**, and meet published standards of the California Office of Historic Preservation, specifically, *Preservation Planning Bulletin* Number 4(a), "Archaeological Resources Management Reports (ARMR): Recommended Contents and Format" (December 1989).
- C. Archeological Monitor Standards:** Archeological monitoring activities required for exploratory, construction, or construction related ground disturbing activities implemented pursuant to this Agreement shall be carried out by a person meeting, at a minimum, the *Secretary of Interior's Professional Qualifications Standards* for prehistoric or historic archaeology, as appropriate (48 FR 44739). "Archeological monitoring" here includes monitoring ground disturbing activities that have been determined by the Corps to be occurring in areas potentially sensitive for Historic Properties or buried resources.

### VIII. NOTICES TO PROCEED WITH CONSTRUCTION

Notices to Proceed may be issued by the Corps for individual construction segments, defined by the Corps in its construction specifications, after a Historic Properties inventory has been completed [per **Stipulation III (Historic Properties Management Plan)** or **Stipulation IV (Identification and Evaluation)**], and prior to treatment of adverse effects on Historic Properties within the APE provided that:

- A. A plan to respond to inadvertent archeological discoveries is prepared by the Corps, and approved by SHPO, prior to the commencement of Project activities anywhere in the APE for that phase of the Project; and
- B. Project development activities do not encroach within 30 meters (100 feet) of the known boundaries of any Historic Property as determined from archeological site record forms, other documentation, or as otherwise defined in consultation with the SHPO and other parties, as appropriate; and
- C. An archeological monitor meeting the professional qualifications as described in **Stipulation VII (Qualifications)**, is present during any Project activities that are anticipated to extend either vertically or horizontally into any areas designated to be archeologically sensitive by the Corps, in consultation with SHPO, except in phases of construction for slurry walls where visual inspection of the construction area cannot be safely or feasibly accomplished.

### IX. DISCOVERY OF UNKNOWN HISTORIC PROPERTIES

The Corps is responsible for complying with 36 C.F.R. § 800.13(a) in the event of inadvertent discoveries of Historic Properties during implementation of the Project. The HPMP will provide procedures for complying with post review and inadvertent discoveries of Historic Properties. If the Corps authorizes work before the HPMP is finalized and there is a discovery of an unknown Historic Property, the Corps shall follow 36 C.F.R. § 800.13(b). Additionally, the following procedures shall be followed:

- A. **Workforce Training:** During implementation of Project activities, the Corps, or archeologists meeting the professional qualifications as described in **Stipulation VII (Qualifications)**, will provide training to all construction personnel, before they begin work, regarding proper procedures and conduct in the event that archeological materials are encountered during construction.

**B. Human Remains:** Treatment of human remains is governed by **Stipulation XII (Tribal Consultation and Treatment of Human Remains)**.

**X. CURATION**

To the extent that curation is determined to be appropriate mitigation to resolve adverse effects to Historic Properties, curation shall be conducted in accordance with 36 C.F.R. § 79, except those materials identified as Native American human remains and items associated with Native American burials. Archeological items and materials from State or privately owned lands shall be maintained in accordance with 36 C.F.R. § 79 until any specified analyses are complete. Although the Native American Graves Protection and Repatriation Act (NAGPRA) (25 U.S.C. § 3001 et seq.) does not apply to this Project, as there is no federally owned or administered property within the APE and the Corps will not be curating cultural materials subject to NAGPRA, this Agreement incorporates by reference the definitions for "human remains" and "funerary objects" set forth in 43 C.F.R § 10.2(d) and those definitions shall apply to actions under this Agreement. Further treatment of human remains is addressed in **Stipulation XII (Tribal Consultation and Treatment of Human Remains)**.

**XI. TRIBAL INVOLVEMENT**

- A.** In consultation with Native American interested parties and Tribes, the Corps will make a reasonable and good-faith effort to identify Historic Properties of traditional religious and cultural importance. The Corps shall ensure that consultation with Native American Tribes is initiated early with respect to the Project and continues throughout the Section 106 process.
- B.** In accordance with the guidance provided in National Register Bulletin 38 and Preservation Brief 36, the Corps will seek comments from all potentially interested Native American interested parties and Tribes in making determinations of NRHP eligibility for any Traditional Cultural Properties (TCPs) and Cultural Landscapes (as defined in Bulletin 38 and Preservation Brief 36). Review of documentation shall be consistent with **Stipulation I (Timeframes and Review Procedures)**.
- C.** Pursuant to 36 C.F.R. § 800.6(c)(2)-(3), the Corps shall consider requests by Native American Tribes to become Concurring Parties to this Agreement. In accordance with **Stipulation XIV (Confidentiality)**, Concurring Parties to this Agreement will receive documents produced under this Agreement, as appropriate.

D. Native American Tribes may choose not to sign this Agreement as a Concurring Party. Native American Tribes and individuals not acting as Concurring Parties to the Agreement will be contacted when the Corps identifies potential interest in a specific phase or action of the project or is contacted by a Native American individual or Native American Tribe expressing interest in the Project. The Corps will make a good faith effort to identify any Native American organizations and individuals with interest in the proposed treatment of Historic Properties. The identification effort may include contacting the Native American Heritage Commission (NAHC), using online databases, and using personal and professional knowledge. The Corps will then contact each identified organization and individual by mail, inviting them to consult about the specific treatment of Historic Properties. If interest from the contacted parties is received by the Corps, the Corps will proceed to consult in accordance with **Stipulation XI.A. (Tribal Involvement)**. Further consultation may also be carried out through either letters of notification, public meetings, site visits, and/or other method requested by a Native American interested party and Tribe. Where consultation is carried out outside of the normal Section 106 process, the Corps shall clearly state to the Tribes that the NEPA process includes compliance with Section 106. Failure of any contacted group to comment within thirty (30) calendar days shall not preclude the Corps from proceeding with the Project.

E. The Corps shall make a reasonable and good-faith effort to ensure that Native American Tribes, acting as either Concurring Parties or those expressing interest in the project, will be invited to participate in the development and implementation of the terms of this Agreement, including, but not limited to, the identification of the APE, identification of potential Historic Properties, determinations of eligibility, findings of effect, and the resolution of adverse effect for those Historic Properties. Review periods shall be consistent with **Stipulation I (Timeframes and Review Procedures)** except in situations involving unanticipated discoveries and treatment, which shall follow the review schedules of **Stipulation IX (Discovery of Unknown Historic Properties)**. The Corps shall ensure that all interested Native American reviewers shall receive copies of all final survey and evaluation reports.

## XII. TRIBAL CONSULTATION AND TREATMENT OF HUMAN REMAINS

There is no federally owned property within the designated APE, therefore NAGPRA would not apply. The CVFPB and landowner shall ensure that Native American human remains and grave goods encountered during the Undertaking that are located on state or private land are treated in accordance with the requirements in California State Health and Safety Code, Section 7050.5 and Public Resources Code 5097.98. If Native American human remains are encountered a clear means of identifying those remains

and grave goods will be described in the HPMP. Any procedures described in the HPTP regarding the handling or treatment of human remains will be coordinated with the landowner to ensure that they are consistent with Public Resources Code 5097.98. In the event that any Native American human remains or associated funerary items are identified, the Most Likely Descendant (MLD), as identified by the Native American Heritage Commission, shall be invited to advise the CVFPB and landowner in the treatment of any Native American human remains and items associated with Native American burials.

### **XIII. PUBLIC CONSULTATION AND PUBLIC NOTICE**

- A.** Pursuant to 36 C.F.R. § 800.6(c)(2)-(3), the Corps will consider requests by interested parties to become Concurring Parties to this Agreement. Within thirty (30) calendar days of the effective date of this Agreement, the Corps shall consult with the SHPO to compile a list of members of the interested public who shall be provided notice of this Agreement.
  
- B.** The interested public will be invited to provide input on the identification, evaluation, and proposed treatment of Historic Properties. This may be carried out through either letters of notification, public meetings, and/or site visits. Where consultation is carried out outside of the normal Section 106 process, the Corps shall clearly state to the public that the NEPA process includes compliance with Section 106. The Corps shall ensure that any comments received from members of the public are taken under consideration and incorporated where appropriate. Review periods shall be consistent with **Stipulation I (Timeframes and Review Procedures)**. In seeking input from the interested public, locations of Historic Properties will be handled in accordance with **Stipulation XIV (Confidentiality)**. In cases where the release of location information may cause harm to the Historic Property, this information will be withheld from the public in accordance with Section 304 of the NHPA (54 U.S.C. § 307103).

### **XIV. CONFIDENTIALITY**

Information regarding the nature and location of the archaeological sites and any other cultural resources discussed in this Agreement shall be kept confidential and limited to appropriate Corps personnel, Corps contractors, Native American tribes, the SHPO, and those parties involved in planning, reviewing and implementing this Agreement to the extent allowed by Section 304 of the NHPA (54 U.S.C. § 307103).

## XV. DISPUTE RESOLUTION

- A. Should any Signatory Party to this Agreement object in writing to any action proposed or carried out pursuant to this Agreement, the Corps will immediately notify the SHPO and the Concurring Parties of the objection and proceed to consult with the objecting party for a period of time, not to exceed thirty (30) calendar days, to resolve the objection. If the objection is resolved through consultation, the Corps may authorize the disputed action to proceed in accordance with the terms of such resolution. If the Corps determines that the objection cannot be resolved, the Corps shall forward all documentation relevant to the dispute to the ACHP. Within forty-five (45) calendar days after receipt of all pertinent documentation, the ACHP shall either:
- a. Advise the Corps that the ACHP concurs in the Corps' proposed response to the objection, whereupon the Corps will respond to the objection accordingly; or
  - b. Provide the Corps with recommendations, which the Corps shall consider in reaching a final decision regarding the objection; or
  - c. Notify the Corps that the ACHP will comment in accordance with the requirements of Section 106 of the NHPA, and proceed to comment. Any ACHP comment provided in response shall be considered by the Corps, pursuant to the requirements of Section 106 of the NHPA.
- B. Should the ACHP not exercise one of the options under **Stipulation XV.A. (Dispute Resolution)** within forty-five (45) calendar days after receipt of all submitted pertinent documentation, the Corps' responsibilities under Section 106 of the NHPA are fulfilled upon implementation of the proposed response to the objection.
- C. The Corps shall consider any ACHP recommendation or comment and any comments from the SHPO to this Agreement provided in accordance with this stipulation with reference only to the subject of the objection; the Corps' responsibility to carry out all actions under this Agreement that are not the subjects of the objection shall remain unchanged.
- D. The Corps shall provide the SHPO with a written copy of its final decision regarding any objection addressed pursuant to **Stipulation XV.A. (Dispute Resolution)**.
- E. At any time during implementation of the measures stipulated in this Agreement should an objection pertaining to the Agreement be raised by a Concurring Party,

Native American Tribe, or a member of the public, the Corps shall notify the Signatory and Concurring Parties and take the objection under consideration, consulting with the objecting party and, should the objecting party request, any of the Signatory and Concurring Parties to this Agreement, for no longer than fifteen (15) calendar days. The Corps shall consider the objection, and in reaching its decision, will consider all comments provided by the other parties. Within fifteen (15) calendar days following closure of the comment period, the Corps will render a decision regarding the objection and respond to the objecting party. The Corps will promptly notify the other parties of its decision in writing, including a copy of the response to the objecting party. The Corps' decision regarding resolution of the objection will be final. Following issuance of its final decision, the Corps may authorize the action that was the subject of the dispute to proceed in accordance with the terms of that decision. The Corps' responsibility to carry out all other actions under this Agreement shall remain unchanged.

## **XVI. NOTICES**

- A.** All notices, demands, requests, consents, approvals or communications from all parties to this Agreement to other parties to this Agreement shall be personally delivered, sent by United States Mail, or emailed. For communications sent by United States Mail, all parties shall be considered in receipt of the materials five (5) calendar days after deposit in the United States mail, certified and postage prepaid, return receipt requested.
- B.** Signatory and Concurring Parties agree to accept facsimiles or copies of signed documents and agree to rely upon such facsimiles or copies as if they bore original signatures.

## **XVII. AMENDMENTS, NONCOMPLIANCE, AND TERMINATION**

- A. Amendment:** Any Signatory Party to this Agreement may propose that the Agreement be amended, whereupon the Signatories shall consult for 30 days to consider such amendment. The Agreement may be amended only upon written concurrence of all Signatories.

All attachments to this Agreement, and other instruments prepared pursuant to this agreement including, but not limited to, the Project's description, initial cultural resource inventory report and maps of the APE, the HPMP, HPTPs, and monitoring and discovery plans, may be individually revised or updated through consultation consistent with **Stipulation I (Timeframes and Review Procedures)** and

agreement in writing of the Signatories without requiring amendment of this Agreement, unless the Signatories through such consultation decide otherwise. In accordance with **Stipulation XI (Tribal Involvement)** and **Stipulation XIII (Public Consultation and Public Notice)**, the Concurring Parties, interested Native American Tribes, and interested members of the public, will receive amendments to the Project's description, initial cultural resource inventory report and maps of the APE, the HPMP, HPTPs, and monitoring and discovery plans, as appropriate, and copies of any amendment(s) to the Agreement.

**B. Termination:** Only the Signatories may terminate this Agreement. If this Agreement is not amended as provided for in **Stipulation XVII.A. (Amendment)**, or if any Signatory proposes termination of this Agreement for other reasons, the Signatory proposing termination shall notify the other Signatory in writing, explain the reasons for proposing termination, and consult with the other Signatory to seek alternatives to termination, within thirty (30) calendar days of the notification.

Should such consultation result in an agreement on an alternative to termination, the Signatories shall proceed in accordance with that agreement.

Should such consultation fail, the Signatory proposing termination may terminate this Agreement by promptly notifying the other Signatory and Concurring Parties in writing.

Beginning with the date of termination, the Corps shall ensure that until and unless a new agreement is executed for the actions covered by this Agreement, such undertakings shall be reviewed individually in accordance with 36 C.F.R. § 800.4-800.6.

**C. Duration:** This Agreement shall remain in effect for a period of ten (10) years after the date it takes effect and shall automatically expire and have no further force or effect at the end of this ten-year period unless it is terminated prior to that time. No later than ninety (90) calendar days prior to the expiration date of the Agreement, the Corps shall initiate consultation to determine if the Agreement should be allowed to expire automatically or whether it should be extended, with or without amendments, as the Signatories may determine. Unless the Signatories unanimously agree through such consultation on an alternative to automatic expiration of this Agreement, this Agreement shall automatically expire and have no further force or effect in accordance with the timetable stipulated herein.

## **XVIII. ANNUAL REPORTING**

At the end of every calendar year following the execution of this Agreement, the Corps shall provide all parties to this Agreement a summary report detailing work carried out pursuant to its terms, if any. Such report shall describe progress made implementing the terms of the Agreement as well as include any scheduling changes proposed, any problems encountered, and any disputes and objections received in the Corps' efforts to carry out the terms of this Agreement. The Corps shall arrange a meeting with the Signatories within 30 days after the submission of the annual summary report to discuss the on-going implementation of the PA

**XIX. EFFECTIVE DATE**

This Agreement shall take effect on the date that it has been fully executed by the Corps and the SHPO.

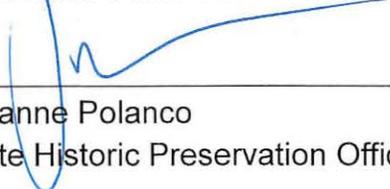
**EXECUTION** of this Agreement by the Corps and the SHPO, its transmittal to the ACHP, and subsequent implementation of its terms evidence that the Corps has afforded the ACHP an opportunity to comment on the undertaking and its effects on Historic Properties, that the Corps has taken into account the effects of the undertaking on Historic Properties, and that the Corps has satisfied its responsibilities under Section 106 of the NHPA and applicable implementing regulations for all aspects of the undertaking.

**SIGNATORY PARTIES:**

**U.S. Army Corps of Engineers**

By  Date 28 SEP 2015  
Michael J. Farrell  
Colonel, U.S. Army  
District Commander

**California State Office of Historic Preservation**

By  Date 1 Oct 2015  
Julianne Polanco  
State Historic Preservation Officer

PROGRAMMATIC AGREEMENT  
AMONG THE  
U.S. ARMY CORPS OF ENGINEERS AND  
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER, REGARDING THE  
WEST SACRAMENTO GENERAL REEVALUATION REPORT,  
YOLO COUNTY and SOLANO COUNTIES, CALIFORNIA

**CONCURRING PARTY**

**West Sacramento Flood Control Agency**

By \_\_\_\_\_ Date \_\_\_\_\_

PROGRAMMATIC AGREEMENT  
AMONG THE  
U.S. ARMY CORPS OF ENGINEERS AND  
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER, REGARDING THE  
WEST SACRAMENTO GENERAL REEVALUATION REPORT,  
YOLO COUNTY and SOLANO COUNTIES, CALIFORNIA

**CONCURRING PARTY:**

**Central Valley Flood Protection Board**

By \_\_\_\_\_ Date \_\_\_\_\_

PROGRAMMATIC AGREEMENT  
AMONG THE  
U.S. ARMY CORPS OF ENGINEERS AND  
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER, REGARDING THE  
WEST SACRAMENTO GENERAL REEVALUATION REPORT,  
YOLO COUNTY and SOLANO COUNTIES, CALIFORNIA

**CONCURRING PARTY:**

**Yocha Dehe Wintun Nation**

By \_\_\_\_\_ Date \_\_\_\_\_  
Marshall McKay

Chairman

PROGRAMMATIC AGREEMENT  
AMONG THE  
U.S. ARMY CORPS OF ENGINEERS AND  
THE CALIFORNIA STATE HISTORIC PRESERVATION OFFICER, REGARDING THE  
WEST SACRAMENTO GENERAL REEVALUATION REPORT,  
YOLO COUNTY and SOLANO COUNTIES, CALIFORNIA

**CONCURRING PARTY:**

**United Auburn Indian Community**

By \_\_\_\_\_ Date \_\_\_\_\_  
(Name)  
Chairman

**Attachment 1**

Project Description

## **Attachment 1**

### **West Sacramento General Reevaluation Report – Project Description**

#### **1.0 INTRODUCTION**

The primary objective of the West Sacramento Project General Reevaluation Report (GRR) is to determine the extent of Federal interest in reducing the flood risk within the study area. The purpose of the GRR is to bring the 50 miles of perimeter levees surrounding West Sacramento into compliance with applicable Federal and State standards for levees protecting urban areas. Proposed levee improvements would address adequate levee height, levee seepage, erosion, and stability conditions along the West Sacramento levee system.

#### **1.1 Scope of Environmental Analysis**

The West Sacramento Project GRR was by the United States Army Corps of Engineers (Corps) and includes the evaluation of the Federal interest in addressing seepage, slope stability, erosion, and height problems on the levees surrounding West Sacramento.

#### **1.2 Project Location and Study Area**

The West Sacramento Project GRR study area refers to the area that would be protected by the proposed levee improvements, including the city of West Sacramento itself, and the lands within WSAFCA's boundaries, which encompass portions of the Sacramento River, the Yolo Bypass, the Sacramento Bypass, and the Sacramento Deep Water Ship Channel (DWSC). The flood protection system associated with these waterways consists of over 50 miles of levees in Reclamation District (RD) 900, RD 537, DWR's Maintenance Area 4, and the DWSC, that completely surround the city. The city of West Sacramento is located in eastern Yolo County at the confluence of the American and Sacramento Rivers. The city lies within the natural floodplain of the Sacramento River, which bounds the city along the north and east. It is made up of a small amount of high ground north of Highway 50 along the Sacramento River, and reclaimed land protected from floods by levees and the Yolo and Sacramento Bypass systems. These bypasses divert floodflows around the city to the west. In addition to the area within the city limits (in Yolo County), the study area partially extends into Solano County on the extreme southwestern edge along the DWSC.

The DWSC provides a navigable passageway for commercial shipping to reach the Port of West Sacramento (formerly Port of Sacramento) from the Pacific Ocean via the San Francisco Bay, Delta, and connecting waterways. The DWSC water surface elevation is directly influenced by changes in water levels in the Delta at the south end of the Yolo Bypass, and is relatively insensitive to stage in the Sacramento River.

The DWSC and barge canal bisect the city into two subbasins, separating the developing Southport area from the more established neighborhoods of Broderick and Bryte to the north (City of West Sacramento 2000). The two subbasins are broken up into nine levee reaches based on location and fixes. The North Basin, which encompasses 6,100 acres, contains:

- Sacramento River north levee – 5.5 miles from the Sacramento Bypass south to the Stone Locks on the barge canal.
- Port north levee – 4.9 miles from the Stone Locks west to the Yolo Bypass levee.
- Yolo Bypass levee – 3.7 miles from the Port north levee north to the Sacramento Bypass.
- Sacramento Bypass levee – 1.1 miles from the Yolo Bypass levee to the Sacramento River.
- Sacramento Bypass training levee – 0.5 miles west into the Yolo Bypass from the Sacramento Bypass levee.

The South Basin, which encompasses 6,900 acres, contains:

## 1.6 Levee Overtopping

It is possible that a large enough flood event could occur that would overtop the levees. In past flooding, levees upstream have failed, relieving some of the pressure on the West Sacramento area. But as repairs to these levees are made, it increases the flood risk to West Sacramento as project levees could face the full brunt of the flood event. Because these levees were not built to modern engineering standards and levee failures upstream are assumed not to occur, levee overtopping would potentially lead to failure of the levee and cause devastating flooding.

## 2.0 The Proposed Project

### 2.1 Improve Levees with Setback Levee along Sacramento River South

Levee repairs would include the construction of new setback levees. The setback levees would be constructed roughly 500 feet west of the existing levee as shown on Plate 2-7. The existing levee may be degraded and breached in several places and/or the bank would need to be maintained in the current manner or could require erosion protection. The levee remediation measures proposed is summarized in Table 3-1 below.

**Table 2-1. Proposed Remediation Measures by Levee Reach.**

Levee Reach	Seepage Measures	Stability Measures	Overtopping Measures	Erosion Protection Measures
<b>North Basin</b>				
Sacramento River North	Cutoff Wall	Cutoff Wall	Levee raise	Bank Protection
Port North	---	---	Floodwall	---
Yolo Bypass *	Cutoff Wall	Cutoff Wall	---	---
Sacramento Bypass Training Levee	---	---	---	Bank Protection
<b>South Basin</b>				
Sacramento River South	Setback Levee, Cutoff Wall, Seepage Berm,	Setback Levee, Cutoff Wall, Seepage Berm	---	Setback Levee, Bank Protection
South Cross	Stability Berm, Relief Wells	---	Levee Raise	---
Deep Water Ship Channel East *	Cutoff Wall	Cutoff Wall	Levee Raise	Bank Protection
Deep Water Ship Channel West*	Cutoff Wall	Cutoff Wall	Levee Raise	---
Port South*	Cutoff Wall	Cutoff Wall	Levee Raise	---

\* The entire levee reach does not need remediation, only specific sections.

It is estimated that 9 million cy of borrow material would be needed to construct the project. Construction of the proposed project is to take approximately 19 years if each reach is constructed sequentially. The tentative schedule of construction is shown in Table 2-2 . The durations are for construction activities only, and do not include the time needed for design, right-of-way, utility relocation, etc.

		9,000	Height/Seepage	75 Foot Deep Slurry Wall
		75,300	Height	Embankment Fill
		100,000	Erosion Protection	Bank Protection

### 3.0 Description of Measures Proposed

Levees in the project area require improvements to address seepage, slope stability, overtopping, and erosion concerns. The measures proposed to improve the levees are described below and consist of: (1) seepage cutoff walls, (2) seepage berms, (3) stability berms, (4) levee raises, (5) flood walls, (6) relief wells, (7) sheet pile walls, (8) jet grouting, and (9) bank protection. The above measures would be implemented by fixing levees in place, constructing adjacent levees, or constructing a setback levee. It is possible that sheet pile walls, jet grouting, and relief wells would be used at various locations so they are also described below. Once a levee is modified, regardless of the measure implemented for the project, the levee would be brought into compliance with Corps levee design criteria. This would include slope flattening and/or crown widening, where required. The levee crown would be widened to 20 feet, and 3:1 landside and waterside slopes would be established where possible. If necessary, the existing levee centerline would be shifted landward, where necessary, in order to meet the Corps' standard levee footprint requirements.

#### Seepage and Slope Stability Measures

##### **Cutoff Walls**

To address seepage concerns, a cutoff wall would be constructed through the levee crown. The cutoff wall would be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach would depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of approximately 85 feet. For cutoff walls of greater depth, the DSM method would be utilized.

Prior to construction of either method of cutoff wall, the construction site and any staging areas would be cleared, grubbed, and stripped. The levee crown would be degraded to approximately half the levee height to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids (Figure 3-1). Excavated and borrow material (from nearby borrow sites) would be stockpiled at staging areas. Once the cutoff wall is complete, haul trucks, front end loaders, and scrapers would bring borrow materials to the site, which would then be spread evenly and compacted according to levee design plans. The levee would be hydroseeded once construction was completed.

##### Conventional Open Trench Cutoff Wall

A trench approximately 3 feet wide would be excavated at the top of levee centerline and into the subsurface materials up to 85 feet deep with a long boom excavator. As the trench is excavated, it would be filled with low density temporary bentonite water slurry to prevent cave in. The soil from the excavated trench would be mixed nearby with hydrated bentonite, and in some applications cement. The soil bentonite mixture would be backfilled into the trench, displacing the temporary slurry. Once the slurry has hardened, it would be capped and the levee embankment would be reconstructed with impervious or semi-impervious soil.

##### Deep Soil Mixing Cutoff Wall

The DSM method would require large quantities of cement bentonite grout. This would necessitate the use of a contractor-provided, on-site batch plant and deliveries of concrete aggregate, concrete sand, bentonite, and cement. The batch plant would be powered by generators or electricity from overhead power lines and would be located within the project area or in an adjacent staging area.



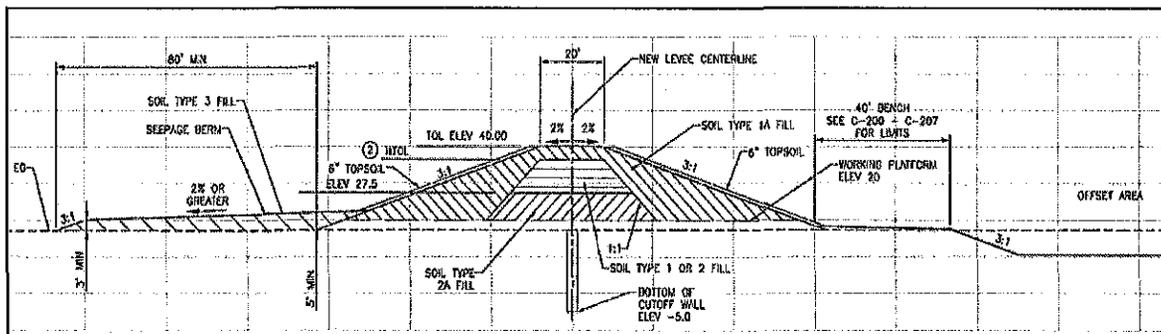


Figure 3-5. Setback Levee Improvement.

### Sheet Pile Wall

A sheet pile wall is proposed at the Stone Locks to tie together the levees on either side of the Barge Canal (Figure 3-6). A trench would be excavated along the sheet pile alignment to allow the pile to be driven to the proposed depth (below the existing levee grade). A driving template fabricated from structural steel would be placed to control the alignment as the sheet pile is installed. A hydraulic or pneumatically operated pile driving head attached to a crane would drive the sheet pile into the levee crown to the desired depth (up to 135 feet). An additional crane or excavator would be used to facilitate staging of the materials. The conditions of the site, driving pressure, hydrostatic loads, and corrosion considerations would determine the thickness and configuration of the sheet piles. If conditions indicate that corrosion is an issue, the sheet piles could be coated, oversized to provide additional thickness as a corrosion allowance, and/or provided with a cathodic protection system.

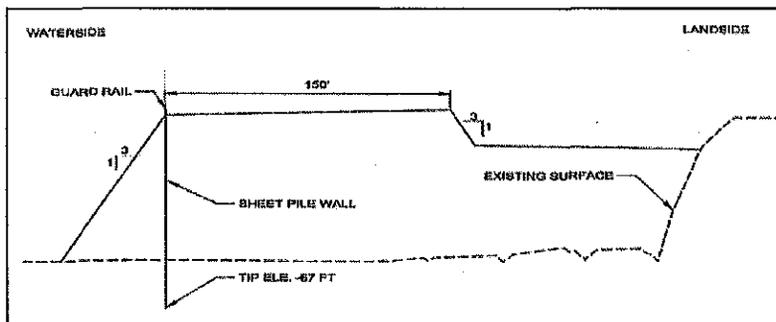


Figure 3-6. Sheet Pile Wall with Embankment Fill.

### Jet Grouting

Jet grouting typically is used in constructing a slurry cutoff wall to access areas other methods cannot. In this regard, it is typically a spot application rather than a treatment to be applied on a large scale. Jet grouting would be used around existing utilities not proposed for removal, and at bridges along the West Sacramento levees. It involves injecting fluids or binders into the soil at very high pressure. The injected fluid can be grout; grout and air; or grout, air, and water. Jet grouting breaks up soil and, with the aid of a binder, forms a homogenous mass that solidifies over time to create a mass of low permeability.

Equipment required for jet grouting consists of a drill rig fitted with a special drill string; a high pressure, high flow pump; and an efficient batch plant with sufficient capacity for the required amount of grout and water, supporting generators and air compressors, holding tanks, and water tanks, with bulk silos of grout typically used to feed large mixers. The high-pressure pump conveys the grout, air, and/or water through pipelines that run the length of the site through the drill string to a set of nozzles located just above the drill bit. Smaller equipment can be used in combination with the single phase-fluid system and can be permanently trailer-mounted to permit efficient mobilization and easy movement at the job site. Jet-grouted columns range from 1 to 16 feet in diameter and typically are interconnected to form

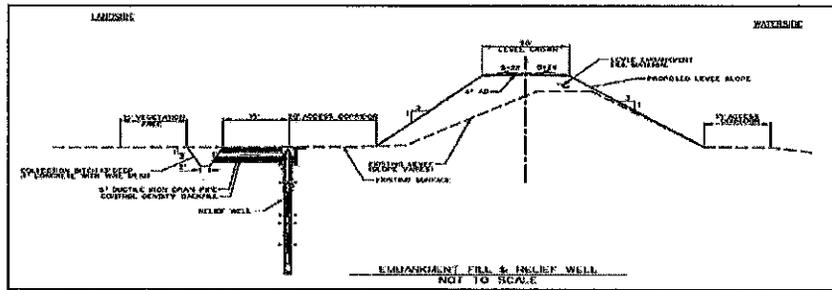


Figure 3-7. Fix in Place Levee Improvement with Relief Well.

## Overtopping Measures

### Levee Height Raise

To address identified height concerns, additional borrow material would be added after cutoff walls and levee reshaping improvements are completed (Figure 3-8). The additional material would be brought from nearby borrow sites, stockpiled in staging areas then hauled to the site with trucks and front end loaders. Material would be spread evenly and compacted according to levee design plans. The levee would be hydroseeded once construction was completed.

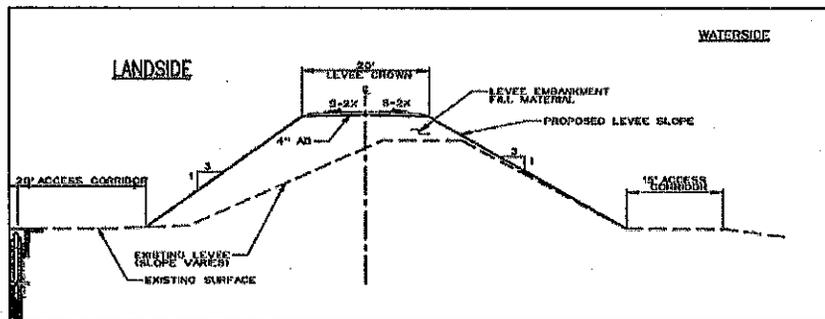


Figure 3-8. Levee Height Raise.

### Floodwalls

Floodwalls are proposed along the waterside hinge point of the Port north levee and along the selected levee alignment around the Port of West Sacramento. Floodwalls are an efficient, space-conserving method for containing unusually high water surface elevations. They are often used in highly developed areas, where space is limited. To begin the floodwall construction, the area would be cleared, grubbed, stripped, and excavation would occur to provide space to construct the footing for the floodwall. The floodwall would primarily be constructed from pre-fabricated materials, although it may be cast or constructed in place, and would be constructed almost completely upright. Floodwalls mostly consist of relatively short elements, making their connections very important to their stability. The floodwalls would be designed to disturb a minimal amount of waterside slope and levee crown for construction (Figure 3-9). The height of the floodwalls varies from 1 to 4 feet, as required by water surface elevations. The waterside slope would be re-established to its existing slope and the levee crown would grade away from the wall and be surfaced with aggregate base.

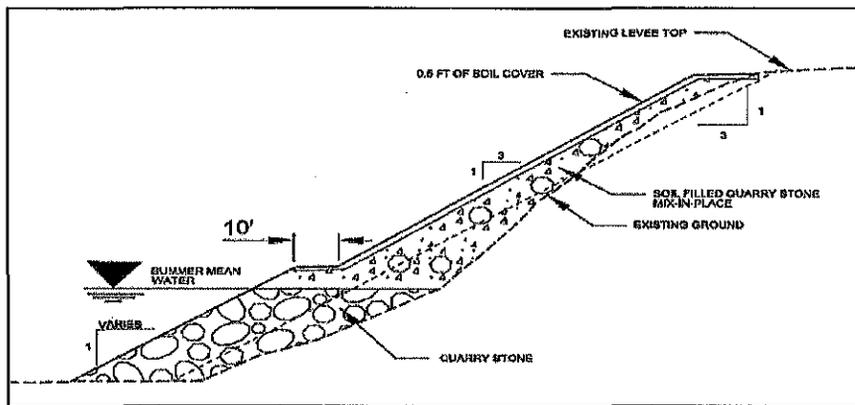


Figure 3-10. Bank Protection Typical Design.

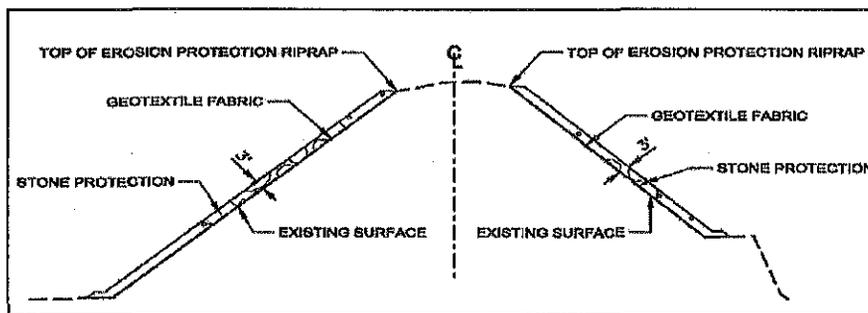


Figure 3-11. Bank Protection along Sacramento Bypass Training Levee.

### Levee Biotechnical Measures

In addition to the bank protection measure, biotechnical measures have been proposed for several reaches. This measure is being considered for lower velocity reaches to preserve existing vegetation. Under this measure, the Corps would use plant material and minimal amounts of rock to stabilize the eroded slope and prevent further loss of material.

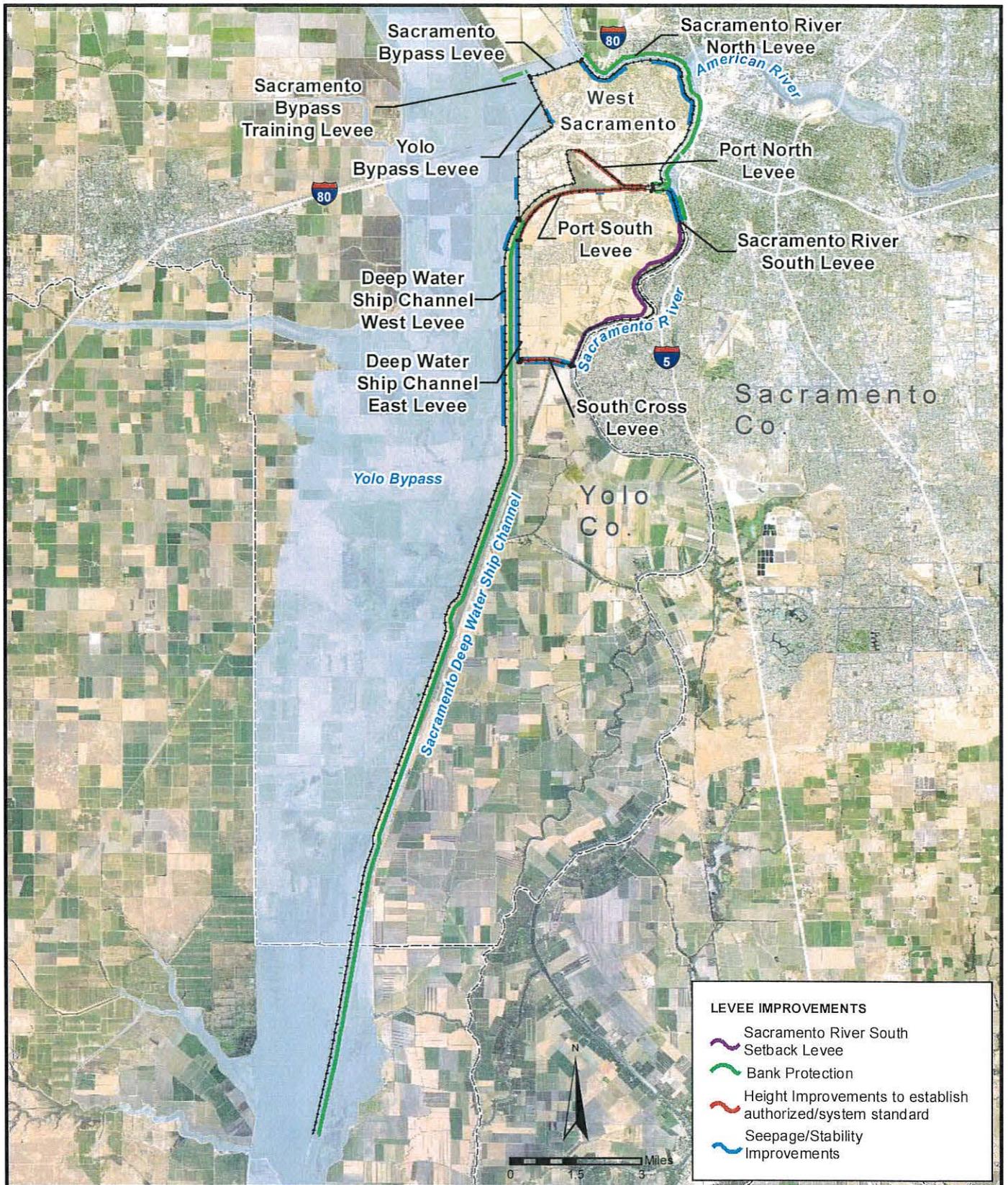
### Additional Construction Measures

In addition to the proposed levee improvements measures described above, the following measures and policies would be addressed during construction:

- The Corps' standard levee footprint would be established during construction of structural improvements on all levees that are out of compliance. The standard levee footprint consists of a 20 foot crown width and 3:1 waterside and landside slopes. If the 3:1 landside slope is not possible based on site specific conditions then a minimum 2:1 landside slope would be established with supporting engineering analysis.
- A 20 foot landside and waterside maintenance access would be established. In areas where 20 feet cannot be obtained, 10 feet is allowable.
- Utility encroachments such as structures, certain vegetation, power poles, pump stations, and levee penetrations (e.g., pipes, conduits, cables) would be brought into compliance with applicable Corps policy or removed depending on type and location. This measure would include the demolition of such features and relocation or reconstruction as appropriate on a case-by-case basis (or retrofit to comply with standards). Utilities replacements would occur via one of two methods: (1) a surface line over the levee prism or (2) a through-levee line equipped with positive closure devices.

**Attachment 2**

Area of Potential Effect  
Overview and Detail



**Legend**

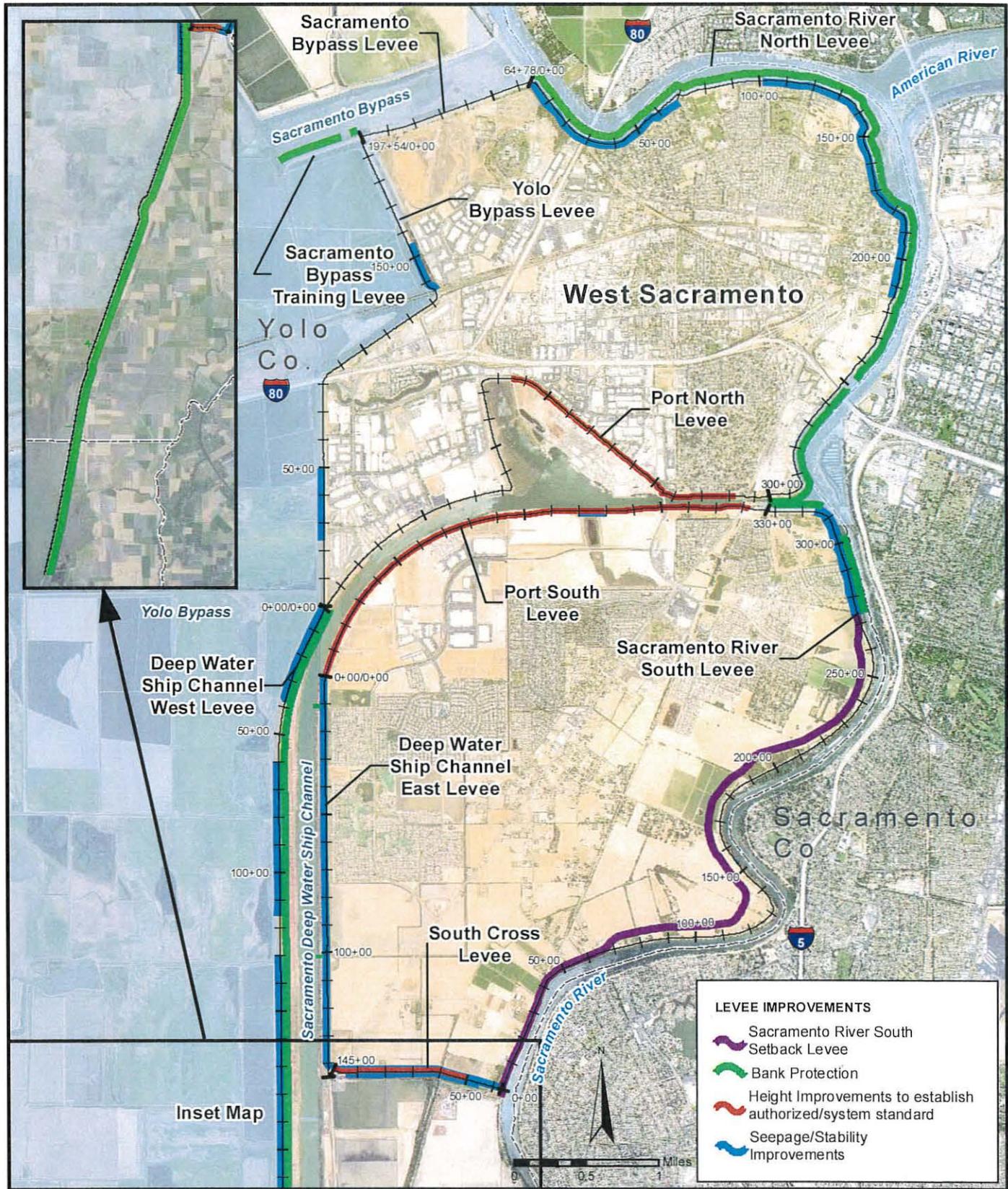
- Levee Centerline
- Floodways
- West Sacramento Project Area
- County Lines



**WEST SACRAMENTO GRR  
WEST SACRAMENTO, CALIFORNIA**

**AREA OF POTENTIAL  
EFFECTS**

**U.S. ARMY CORPS OF ENGINEERS  
SACRAMENTO DISTRICT**



- Legend**
- Levee Centerline
  - Floodways
  - West Sacramento Project Area
  - County Lines



WEST SACRAMENTO GRR  
WEST SACRAMENTO, CALIFORNIA

**AREA OF POTENTIAL EFFECTS**

U.S. ARMY CORPS OF ENGINEERS  
SACRAMENTO DISTRICT

**Attachment 3**

Historic Properties Management Plan  
(To be appended)

## **Attachment 4**

Property Types Exempt from Evaluation

This attachment defines categories of properties that do not warrant evaluation pursuant to Stipulation IV.B of this Agreement. Only individuals meeting the Secretary of the Interior's Professional Qualification Standards pursuant to Stipulation VII.A of this agreement are authorized to determine whether properties meet the requirements of this attachment and are therefore exempt from evaluation and consultation with SHPO. Exempted properties may be documented, if documentation is warranted, at a level commensurate with the nature of the property (e.g., DPR 523 Primary Form, Location Map, memo). The Corps Cultural Resources staff shall make any final determinations on level of documentation required under this agreement.

### **Exempt Property Type 1: Archaeological Property Types and Features**

1. Isolated prehistoric finds consisting of fewer than three items per 100 m<sup>2</sup>
2. Isolated historic finds consisting of fewer than three artifacts per 100 m<sup>2</sup> (several fragments from a single glass bottle, and similar vessels are to be counted as one artifact)
3. Refuse scatters less than 50 years old (scatters containing no material that can be dated with certainty as older than 50 years old)
4. Features less than 50 years old (those known to be less than 50 years old through map research, inscribed dates, etc.)
5. Isolated refuse dumps and scatters over 50 years old that lack specific associations
6. Isolated mining prospect pits
7. Placer mining features with no associated structural remains or archaeological deposits
8. Foundations and mapped locations of buildings or structures more than 50 years old with few or no associated artifacts or ecofacts, and with no potential for subsurface archaeological deposits

### **Exempt Property Type 2: Minor, Ubiquitous, or Fragmentary Infrastructure Elements**

The following list does not apply to properties 50 years old or older that could be potentially important, nor does it apply to properties that may contribute to the significance of larger historic properties such as districts or cultural landscapes.

### **Water Conveyance and Control Features**

- Natural bodies of water providing a water source, conveyance, or drainage
- Modified natural waterways

- Concrete-lined canals less than 50 years old and fragments of abandoned canals
- Roadside drainage ditches and secondary agricultural ditches
- Small drainage tunnels
- Flood storage basins
- Reservoirs and artificial ponds
- Levees and weirs
- Gates, valves, pumps, and other flow control devices
- Pipelines and associated control devices
- Water supply and waste disposal systems
- Rip-rap

#### **Recent Transportation or Pedestrian Facilities**

- Railroad grades converted to other uses, such as roads, levees, or bike paths
- Bus shelters and benches
- Vista points and rest stops
- Bike paths, off-road vehicle trails, equestrian trails, and hiking trails
- Parking lots and driveways

#### **Highway and Roadside Features**

- Isolated segments of bypassed or abandoned roads
- Retaining walls
- Highway fencing, soundwalls, guard rails, and barriers
- Drains and culverts, excluding culverts assigned a Caltrans bridge number
- Cattle crossing guards
- Roadside landscaping and associated irrigation systems
- Signs and reflectors
- Telecommunications services, including towers, poles, dishes, antennas, boxes, lines, cables, transformers, and transmission facilities
- Utility services, including towers, poles, boxes, pipes, lines, cables, and transformers
- Oil and gas pipelines and associated control devices

#### **Adjacent Features**

- Fences, walls, gates, and gateposts

- Isolated rock walls and stone fences
- Telephone booths, call boxes, mailboxes, and newspaper receptacles
- Fire hydrants and alarms
- Markers, monuments, signs, and billboards
- Fragments of bypassed or demolished bridges
- Temporary roadside structures, such as seasonal vendors' stands
- Pastures, fields, crops, and orchards
- Corrals, animal pens, and dog runs
- Open space, including parks and recreational facilities
- Building and structure ruins and foundations less than 50 years old

#### **Movable or Minor Objects**

- Movable vehicles
- Stationary vehicles less than 50 years old or moved within the last 50 years
- Agricultural, industrial and commercial equipment and machinery
- Sculpture, statuary, and decorative elements less than 50 years old or moved within the last 50 years

**West Sacramento GRR**  
**EIS Cultural Resources Appendix**  
**Enclosure 2**  
Section 106 Consultation Record

**West Sacramento GRR and Southport Early Implementation Project**

**Record of Cultural Resources 106 Consultation**

The West Sacramento General Reevaluation Report ( West Sac GRR) project and the Southport Early Implementation Project (EIP) 408 were consulted on within a concurrent time frame. For the West Sacramento GRR project, a list of Tribes and individuals with interest in the area was obtained by the Corps through the Native American Heritage Commission. On this list, two Tribes and one individual were listed as possibly having interest in projects located in Yolo and Solono Counties.

For the Southport EIP project, the consultant for West Sacramento created a list of Tribes with interest in the area using other resources. The consultant's list contained 14 Tribes and individuals that may have interest in the project area. Letters were sent to all of the Tribes and Individuals on both of the lists. Because of this, if a Tribe or individual responded to the Corps' inquiry of interest about one project the Corps would always provide information about the other because the Southport EIP was part of the larger West Sac GRR. I explain this because the timeline for Tribal consultaion for the West Sacramento GRR project and the Southport EIP 408 are intertwined and both projects were explained while the Corps consulted. References to the Southport EIP are listed in the Consultation Record for the West Sac GRR.

Phone Call	Letter	Email	Site Visit	Meeting	Other	Date	From/To	Subject	Response
					X	5/1/2010		Record Search for West Sacramento GRR APE was conducted at the California Historical Resources Information Service, Sonoma State University by the Corps	
						7/10/2012	Letter from the Army Corps of Engineers, Sacramento District (Corps) to the California State Historic Preservation Officer (SHPO)	Initiating Consultaion, defining APE, request for meeting for the Southport Early Implementation Project (EIP)	

							4/17/2013	Letters to Yocha Dehe Wintun Nation, Cortina Band of Wintun Indian, Buena Vista Rancheria of Me-Wuk Indians, Enterprise Rancheria of Maidu Indians, Lone Band of Miwok Indians, Shingle Springs Band of Miwok Indian, Wilton Rancheria, Jackson Rancheria of Me-Wuk Indians, United Auburn Indian Community, Chicken Ranch Rancheria of Me-Wuk Indians, Cahil DeHe Band of Wintun Indians, Tsi-Akim Maidu, Wintun Environmental Agency, Rose Enos,	Initiation of with Tribes and individuals who may have interest in consultation for Southport Project EIP	
							4/26/2013	United Auburn Indian Community (UAIC) Marcos Guererro to the Corps	UAIC requests copies of cultural resources reports that were conducted for the Project Area.	
	X						5/3/2013	Letter from the Wilton Rancheria (Steve Hutchason) to the Corps for Southport Project	Wilton Rancheria requested a copy of all cultural resources reports for the Southport EIP	Mr. Hutchason was emailed by the Corps to let him know that no cultural resources reports had been written for the project.
							5/9/2013	Letter from the United Auburn Indian Community (the UAIC) to the Corps for the Southport Project	The UAIC requested a site visit of the project area, any reports from any cultural resources work that had been conducted in the area, and the need to have tribal monitors during survey.	
							5/17/2013	Letter from the Yocha Dehe Wintun Nation (YDWN) Marshall McKay to the Corps for the Southport Project	The YDWN requested the Corps to schedule a site visit to the project area.	
						X	6/6/2013	From the Native American Heritage Commission (NAHC) to the Corps	Received updated NAHC list of Tribal Contacts	
		X					7/8/2013	From the Corps (Shellie Sullo) to the YDWN (Marilyn Delgado)	The Corps provided Ms. Delgado with the Southport EIP PA.	

						7/8/2013	The Corps (Shellie Sullo)to UAIC ( Marcos Guererro)	The Corps provides the Draft Southport PA to UAIC	
		x				7/8/2013	From the Corps (Shellie Sullo) to the UAIC (Marcos Guererro)	An e-mail was written Mr. Guererro to request dates of his availability for a site visit.	
						7/8/2013	UAIC (Marcos Guererro) to the Corps	Provides dates available for a Site visit to West Sac GRR and Southport 408 project.	
		x				7/12/2013	From YDWN (James Sarmento) to the Corps	An email was written by Mr. Sarmento to introduce himself to the Corps and requested information from the Corps to familiarize himself with the project.	
		x				7/22/2013	The Corps to UAIC ( Marcos Guererro)	The Corps confirms meeting place and time for site visit for West Sacramento/Southport EIP project. August 6th.	
		x				7/26/2013	Wilton Rancheria to the Corps (Steve Hutchason)	Wilton Rancheria requested a site visit to the West Sacramento/Southport EIP project area.	
		x				8/5/2013	UAIC (Marcos Guererro) to the Corps	The UAIC informs the Corps that the Wilton Rancheria (Steve Hutchison) will be attending the site visit on 8/6/2013.	
			x			8/6/2013		Site visit of the Southport EIP and West Sac GRR APE with the Corps , City of West Sacramento, UAIC (Marcos Guererro), Wilton Rancheria (Steve Hutchason) , and ICF. YDWN was to attend but had to reschedule.	
			x			8/20/2013		Site visit of the Southport and West Sac GRR APE with the Corps, City of West Sacramento,ICF and YDWN (James Sarmento and Anthony Flores)	

	X					11/4/2013	Corps wrote letters to YDWN, Cortina Band of Wintun Indians	Based on the NAHC contact list, Letters were sent to the Tribes with interest specifically within the West Sac GRR APE. The letters let the Tribes know about the project, told them about the Programmatic Agreement (PA) being developed, and asked if they would like to conduct a site visit of the Area of Potential Effects (APE).	
	X					11/4/2013	Corps sends letter to California State Historic Preservation Office (SHPO)	A letter was sent to the SHPO to let them know about the project. It also told them about the Programmatic Agreement (PA) being developed and asked if they would like to conduct a site visit of the APE.	
				X		1/23/2014	Corps (Shellie Sullo and Sarah Ross Arrouzet) Meeting with SHPO - Jessica Tudor and Susan Stratton	The Corps provided a copy to and discussed the West Sac Draft PA ,the project description and the APE, Also talked about the Southport 408 project and how it differed from the GRR regarding who was doing the work.	
X		X				2/11/2014	Corps call to Buena Vista Rancheria and e-mail	Discussion between the Corps and Buena Vista Rancheria( Roselynn Lwenya) via telephone and followed up with an e-mail from the Corps to Buena Vista Rancheria. The Buena Vista defer to the YDWN regarding consultation for this project. But would like to review the Final PA for the West Sac GRR.	
		x				4/14/2014	Corps (Shellie Sullo) e-mail to and from SHPO office (Jessica Tudor)	The SHPO asked for clarification regarding proposed alternatives and for a WORD version of the PA.	

		x				5/15/2014	SHPO's office (Jessica Tudor) e-mailed the Corps (Shellie Sullo)	SHPO had reviewed and had some comments on the Draft PA. SHPO asked for a WORD version of the Draft Historic Properties Management Plan. The SHPO says they required additional time to let an architectural reviewer look at the PA and HPMP.	
				x		6/27/2014	Corps met with SHPO (Jessica Tudor and Kathleen Forrest ) at OHP	The Corps and the SHPO discussed the comments that were made by SHPO regarding the PA and how the SHPO would like the comments to be resolved.	
X						6/26/2014	The Corps (Shellie Sullo) talks to the Yocha Dehe (James Sarmento) about the Southport 408 project and the West Sac GRR	The Corps and the representative from the Yocha Dehe discuss the Southport EIP and the west Sac GRR projects in Yolo County, West Sacramento. The West Sacramento 408 project was also in the process of being reviewed by the Yocha Dehe. The Yocha Dehe requested the Draft PA and HPMP for the Southport EIP	
X						6/30/2014	The Corps calls UAIC and Wilton Rancheria (Hutchason)	The Corps called the UAIC and Wilton Rancheria to determine continued interest in the West Sac and Southport EIP projects. Wilton Rancheria defers to the Yocha Dehe	
		X				7/1/2014	UAIC to the Corps	An e-mail for UAIC "The UAIC defers all consultation for this project to Yocha Dehe".	
		X				7/2/2014	Corps provided the Draft PA and HPMP to the YDWN (James Sarmento) and Wilton Rancheria (Steve Hutchason)	The Draft PA and HPMP were provided to members of the Cultural Resources staff of the YDWN and Wilton Rancheria for their review. An invitation for a field visit was offered at this time.	

		X				7/3/2014	James Sarmento (YDWN) requests a Site Visit of the Project area with the Corps	In an e-mail, James Sarmento request to schedule a site visit of both the West Sac GRR and the Southport 408 footprint, Mr. Sarmento offers a dates of availability.	Ms. Sullo provides an reply on 7/3 that she will schedule the meeting including necessary personnel.
	X					7/7/2014	The Corps sends a letter to the YDWN, Wilton Rancheria, and Cortina Band of Wintun Indians	After informal conversations via e-mail and telephone between the Corps and the Tribes the Corps sent official correspondence asking if the Tribes would like to participate in developing the PA and the HPMP.	
	X					7/7/2014	The Corps sends a letter to the Advisory Council on Historic Preservation requesting their participation in developing the PA and the HPMP	The Corps asks if the Advisory Council would like to participate in developing the West Sac GRR PA and HPMP.	
		x				7/17/2014	The City of West Sacramento's Flood Risk Manager (Greg Fabun) to the Corps	Greg Fabun requests a copy of the Draft PA and HPMP	Ms Sullo provides copies of the Draft PA and HPMP on the same day.
			X			8/5/2014	The Corps, and WSFACA conduct a site visit with James Sarmento and Anthony Flores of the YDWN	The site visit included the footprint of both the Southport 408 project and the West Sac GRR project.	
			X			8/13/2014	Corps Fieldtrip with SHPO (Jessica Tudor) for ARCF and West Sac GRR footprint	The Corps Cultural resources leads for American River Common Features (Melissa Montag)and the West Sacramento GRR (Shellie Sullo) toured both project APEs with a representative from the SHPO's office.	
	X	x				8/18/2014	The Advisory Council replies to the Corps request for participation in development of the PA and HPMP	The Advisory Council chose to not participate in the development of the PA and HPMP.	

		X				8/19/2014	Anthony Flores (YDWN Tribal Monitor) to the Corps requesting information.	Mr. Flores requested a site form that was mentioned in our meeting and a copy of the map with the archaeological site locations.	Ms Sullo provides these references on 8/20
		x				9/16/2014	The YDWN (James Sarmento) to the Corps	The YDWN provides the corps a map with areas of concern within the footprint of the West Sac GRR and the Southport EIP. YDWN would recommend that there be Tribal monitors in these areas during construction.	
x						3/17/2015	The Corps talked with YDWN (James Sarmento) via phone and followed up with and e-mail	Corps provides YDWN the Southport EIP PA and HPMP and inquires when the Tribe could meet for a site visit of Southport and west Sac Footprint.	
		x				3/31/2015	The YDWN (James Sarmento) to the Corps	An e-mail from the YDWN to the Corps requesting a meeting at the YDWN offices to discuss the West Sac GRR and the Southport EIP.	
		X				3/10/2015	The Corps resubmits the PA and HPMP to the SHPO office and to the YDWN	Revised PA and HPMP incorporating the SHPO's and the Corp's Office of Counsel's comments.	
		X				4/8/2015	email between The Corps(Sullo) and the YDWN (Sarmento)	Coordination for meeting at the YDWN Offices and the Corps asking for comments on both West Sacramento projects PAs and HPMPs.	
X						5/6/2015	Call with the Sacramento District Tribal Liaison (Mark Gilfillan)	Mark Gilfillan had called the YDWN (Sarmento) on 5/6/2015 to discuss concerns about the Southport EIP PA and the West Sac GRR PA. Gilfillan provided the list of concerns to Shellie Sullo for her to address in a formal response to the YDWN at their scheduled meeting.	
		X				5/19/2015	YDWN to the Corps	James Sarmento send formal comments regarding the Southport EIP PA and Hemp with concerns about the documents.	

		X				5/20/2015	Corps to YDWN	Shellie Sullo asks James Sarmiento if his comment for the West Sac GRR PA and HPMP would be similar to those the YDWN provided for the Southport EIP.	James Sarmiento wrote that he imagined that the comments would be similar to the Southport EIP but would have formal comments to the Corps the next week.
				X		6/18/2015	Corps Meets with YDWN at YDWN offices	Topics of Discussion Southport EIP and West Sacramento GRR PAs and HPMPs, and Village Expressway 408. The full array of alternatives were discussed for the projects, the potential for impact to cultural resources, and a discussion of the comments that the YDWN provided the Corps regarding the PAs and HPMPs	
		X				6/19/2015	Corps Tribal Liaison to YDWN	The Corps provided response to the YDWN comments of concern for the West Sac and Southport projects.	
		x				7/9/2015	SHPO's office (Jessica Tudor) e-mailed the Corps (Shellie Sullo)	The SHPO office provided comments on the draft PA - not the HPMP.	
		X				7/15/2015	The Corps provides the SHPO with the Draft PA	The Corps incorporated the comments received from the SHPO into the Draft PA and sends it back to SHPO for review.	



**West Sacramento GRR**  
**EIS Cultural Resources Appendix**  
**Enclosure 3**  
Consultation with the SHPO



REPLY TO  
ATTENTION OF

**DEPARTMENT OF THE ARMY**  
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO  
CORPS OF ENGINEERS  
1325 J STREET  
SACRAMENTO, CALIFORNIA, 95814-2922

Environmental Resources Branch

Carol Roland-Nawi, Ph.D.  
State Historic Preservation Officer  
Office of Historic Preservation  
1725 23rd Street, Suite 100  
Sacramento, CA 95816

Dear Ms. Roland-Nawi:

The United States Army Corps of Engineers (Corps) is pursuing the West Sacramento General Reevaluation Report ("West Sacramento GRR" or "Project"), which consists of flood risk improvements to the City of West Sacramento's north and south basins as shown in Figure 1 (enclosed).

The study authority for the West Sacramento area was provided through Section 209 of the Flood Control Act of 1962 (Public Law 87-874). Specific project authority was provided in Section 101(4) of the Water Resources Development Act (WRDA) of 1992. This authorization was revised and supplemented through the Energy and Water Development Appropriations Act (EWDAA) of 1999 (Public Law 105-245). The authorization was later revised and supplemented through the Energy and Water Development Appropriations Act of 2010 (Public Law 111-85).

This Project will allow the Corps to improve the level of flood risk management for the City of West Sacramento in Yolo County. Because these improvements qualify as undertakings, compliance with Section 106 of the National Historic Preservation Act (NHPA, 16 US Code Section 470f) is required. This letter initiates consultation with your office pursuant to 36 CFR Part 800.3(c)(3).

The Project will occur in multiple phases over many years. Because of the nature of this phased approach, it is not practicable to complete the usual Section 106 process in advance of construction. The Corps is proposing the use of a programmatic agreement (PA) (enclosed) that would provide for phasing of the Section 106 process as authorized in 36 CFR Part 800.4(b) (2). The stipulations of the PA would require the Corps to perform the following steps for each construction phase or ancillary activity that is part of the larger Project:

- a. Define an area of potential effects (APE), in consultation with your office.

- b. Complete an inventory of each phase-specific APE.
- c. Evaluate identified resources and prepare findings of effect.
- d. Develop and implement treatment where necessary to resolve adverse effects.
- e. Provide reports to your office and other consulting parties, documenting these steps, subject to your approval.
- f. Provide guidance on inadvertent discoveries, objections to the PA, amendments, and dispute resolution.

The Corps will collaborate with signatories and consulting parties to develop a historic property management plan as a framework to manage the overall proposed cultural resource work and then a historic property treatment plan for all technical work to be completed under the PA. The plan will provide technical standards and methods necessary to implement the Section 106 process defined in the PA, and will serve as attachments to the PA, providing details that cannot be succinctly incorporated into the PA itself.

The Corps requests that you review and provide comments for the attached PA. If you have any questions or comments, please contact Ms. Shellie Sullo, Social Science Study Manager, at (916) 557-7628 or by email at: [shellie.sullo@usace.army.mil](mailto:shellie.sullo@usace.army.mil). Project specific questions should be directed to Cameron Sessions, Project Manager, at (916) 557-7896 or by email: [Cameron.l.sessions@usace.army.mil](mailto:Cameron.l.sessions@usace.army.mil).

Sincerely,



 Alicia E. Kirchner  
Chief, Planning Division

Enclosure

**West Sacramento GRR**  
**EIS Cultural Resources Appendix**  
**Enclosure 4**  
Consultation with the ACHP



DEPARTMENT OF THE ARMY  
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO  
1325 J STREET  
SACRAMENTO, CALIFORNIA 95814

REPLY TO  
ATTENTION OF

Environmental Resources Branch

**JUL 07 2014**

Mr. Reid Nelson  
Advisory Council on Historic Preservation  
Office of Federal Agency Programs  
Old Post Office Building  
1100 Pennsylvania Avenue, NW, Suite 803  
Washington, D.C. 20004

Dear Mr. Nelson:

We are writing in accordance with Section 106 of the National Historic Preservation Act of 1966 to inform you of the West Sacramento, California General Reevaluation Report ("West Sac GRR Project" or "Project") and to invite your participation in the Section 106 process (36 CFR § 800.2[b][1]). The initial study authority for the West Sacramento area was provided through Section 209 of the Flood Control Act of 1962, Public Law (PL) 87-874. The West Sac GRR Project was authorized in the Water Resources Development Act of 1992, PL 102-580 Sec. 101 (4), as amended by the Energy and Water Development of 1999, PL 105-245.

The U.S. Army Corps of Engineers (Corps) is undertaking the Project in partnership with its non-Federal sponsors, the West Sacramento Area Flood Control Agency (WSAFCA), and the Central Valley Flood Protection Board (CVFPB). This Project consists of flood risk reduction to the City of West Sacramento's north and south basins as shown in an Area of Potential Effect Map (APE), (Enclosure 1).

The West Sac GRR Project includes area that would benefit from proposed levee improvements, including the city of West Sacramento itself, and the lands within WSAFCA's boundaries, which encompass portions of the Sacramento River, the Yolo Bypass, the Sacramento Bypass, and the Sacramento Deep Water Ship Channel (DWSC). The proposed levee improvements would address seepage, slope stability, overtopping, and erosion concerns. The flood risk management system associated with these waterways consists of over 50 miles of levees in Reclamation District (RD) 900, RD 537, California Department of Water Resources' Maintenance Area 4, and the DWSC, that surround the city.

The Corps determined that it will not be possible to fully determine effects on historic properties prior to approval of the undertaking (36 CFR § 800.14[b][1][ii]). Therefore, the Corps intends to develop a programmatic agreement (PA) including your office, should you choose to participate, the State Historic Preservation Office, WSAFCA, and the CVFPB (36 CFR § 800.14[b][2]). In the course of developing the PA, the Corps will consult with the local sponsors, the Yocha Dehe Wintun Nation, the Wilton Rancheria, and interested Native American tribes.

Please find enclosed the Draft PA and the Draft Historic Properties Management Plan, which contains a description of the APE and the Project (Enclosures 2 and 3). Please provide comments on the PA and HPMP if you choose to participate within 30 calendar days of receipt of this letter. If you have any questions or comments please contact Ms. Shellie Sullo, Social Science Study Manager, U.S. Army Corps of Engineers Sacramento District, 1325 J Street, Sacramento, California 95814-2922. If you have any questions or would like additional information, please contact Ms. Sullo at (916) 557-7628 or by email at [shellie.sullo@usace.army.mil](mailto:shellie.sullo@usace.army.mil).

Sincerely,

A handwritten signature in black ink, appearing to read "Alicia E. Kirchner". The signature is fluid and cursive, with a large initial "A" and a long, sweeping underline.

Alicia E. Kirchner  
Chief, Planning Division

Enclosures

**West Sacramento GRR  
EIS Cultural Resources Appendix  
Enclosure 5**

Consultation with American Indian Tribes and Individuals



REPLY TO  
ATTENTION OF

**DEPARTMENT OF THE ARMY**  
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO  
CORPS OF ENGINEERS  
1325 J STREET  
SACRAMENTO, CALIFORNIA, 95814-2922

Environmental Resources Branch

**JUL 07 2014**

Andrew Franklin  
Chairperson  
Wilton Rancheria  
9300 W. Stockton Blvd.  
Suite 200  
Elk Grove, CA 95758

Dear Mr. Franklin:

We are writing in accordance with Section 106 of the National Historic Preservation Act of 1966 to inform you of the West Sacramento, California General Reevaluation Report ("West Sac GRR Project" or "Project") and to invite your participation in the Section 106 process. The initial study authority for the West Sacramento area was provided through Section 209 of the Flood Control Act of 1962, Public Law (PL) 87-874. The West Sac GRR Project was authorized in the Water Resources Development Act of 1992, PL 102-580 Sec. 101 (4), as amended by the Energy and Water Development of 1999, PL 105-245.

The U.S. Army Corps of Engineers (Corps) is undertaking the Project in partnership with its non-Federal sponsors, the West Sacramento Area Flood Control Agency (WSAFCA), and the Central Valley Flood Protection Board (CVFPB). This Project consists of flood risk management to the City of West Sacramento's north and south basins as shown in Enclosure 1: Area of Potential Effect Map (APE), which is enclosed.

The West Sac GRR Project includes area that would benefit from proposed levee improvements, including the city of West Sacramento itself, and the lands within WSAFCA's boundaries, which encompass portions of the Sacramento River, the Yolo Bypass, the Sacramento Bypass, and the Sacramento Deep Water Ship Channel (DWSC). The proposed levee improvements would address seepage, slope stability, overtopping, and erosion concerns. The flood risk management system associated with these waterways consists of over 50 miles of levees in Reclamation District (RD) 900, RD 537, California Department of Water Resources' Maintenance Area 4, and the DWSC, that completely surround the city.

We contacted the Native American Heritage Commission, who provided your name as being potentially interested in our proposed project. We are sensitive to traditional cultural properties and sacred sites, and make every effort to avoid them. Please let us know if you have knowledge of locations of archeological sites, or areas of traditional cultural value or concern in or near the West Sac GRR APE.

During previous discussions with your Executive Director of Environmental Resources, Steven Hutchason, about another project in the West Sacramento area (Southport 408), the larger West Sac GRR project was described. Mr. Hutchason asked that the Wilton Rancheria be informed as this Project progressed.

The Corps has determined that it will not be possible to fully determine the effects on historic properties prior to approval of the Project. Therefore, In accordance with (36 CFR § 800.14[b][1][ii]) the Corps is in the process of developing a Programmatic Agreement (PA) that would include the Wilton Rancheria, should you wish to participate as a concurring party. In the course of developing the PA we are also developing a Historic Properties Management Plan (HPMP) to guide the implementation of the PA. We have enclosed the PA and HPMP for your review and comment (Enclosures 2 and 3).

We ask that you review the PA and HPMP and provide your comments within 30 calendar days of receipt of this letter. If you have any questions or would like additional information, please contact Ms. Shellie Sullo, Social Science Study Manager, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814-2922. Ms. Sullo can also be reached by phone at: (916) 557-7682 or by e-mail at: [shellie.sullo@usace.army.mil](mailto:shellie.sullo@usace.army.mil). Project specific questions should be directed to Byron Lake, Project Manager. Mr. Lake can be reached by e-mail at: [bryon.l.lake@usace.army.mil](mailto:bryon.l.lake@usace.army.mil), or by phone at (916) 557-7890.

Sincerely,



Alicia E. Kirchner  
Chief, Planning Division

Enclosure



REPLY TO  
ATTENTION OF

**DEPARTMENT OF THE ARMY**  
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO  
CORPS OF ENGINEERS  
1325 J STREET  
SACRAMENTO, CALIFORNIA, 95814-2922

Environmental Resources Branch

**JUL 07 2014**

Marshall McKay, Chairperson  
Yocha Dehe Wintun Nation  
PO Box 18  
Brooks, CA 95606

Dear Mr. McKay:

We are writing in accordance with Section 106 of the National Historic Preservation Act of 1966 to inform you of the West Sacramento, California General Reevaluation Report ("West Sac GRR Project" or "Project") and to invite your participation in the Section 106 process. The initial study authority for the West Sacramento area was provided through Section 209 of the Flood Control Act of 1962, Public Law (PL) 87-874. The West Sac GRR Project was authorized in the Water Resources Development Act of 1992, PL 102-580 Sec. 101 (4), as amended by the Energy and Water Development of 1999, PL 105-245.

The U.S. Army Corps of Engineers (Corps) is undertaking the Project in partnership with its non-Federal sponsors, the West Sacramento Area Flood Control Agency (WSAFCA), and the Central Valley Flood Protection Board (CVFPB). This Project consists of flood risk management to the City of West Sacramento's north and south basins as shown in Enclosure 1: Area of Potential Effect Map (APE), which is enclosed.

The West Sac GRR Project includes area that would benefit from proposed levee improvements, including the city of West Sacramento itself, and the lands within WSAFCA's boundaries, which encompass portions of the Sacramento River, the Yolo Bypass, the Sacramento Bypass, and the Sacramento Deep Water Ship Channel (DWSC). The proposed levee improvements would address seepage, slope stability, overtopping, and erosion concerns. The flood risk management system associated with these waterways consists of over 50 miles of levees in Reclamation District (RD) 900, RD 537, California Department of Water Resources' Maintenance Area 4, and the DWSC, that completely surround the city.

We contacted the Native American Heritage Commission, who provided your name as being potentially interested in our proposed project. We are sensitive to traditional cultural properties and sacred sites, and make every effort to avoid them. Please let us

know if you have knowledge of locations of archeological sites, or areas of traditional cultural value or concern in or near the West Sac GRR APE.

During previous discussions with your Tribal Historic Preservation Officer, James Sarmento, about another project in the West Sacramento area (Southport 408), the larger West Sac GRR project was described. Mr. Sarmento asked that the Yocha Dehe be informed as this Project progressed.

The Corps has determined that it will not be possible to fully determine the effects on historic properties prior to approval of the Project. Therefore, In accordance with (36 CFR § 800.14[b][1][ii]) the Corps is in the process of developing a Programmatic Agreement (PA) that would include the Yocha Dehe Wintun Nation, should you wish to participate as a concurring party. In the course of developing the PA we are also developing a Historic Properties Management Plan (HPMP) to guide the implementation of the PA. We have enclosed the PA and HPMP for your review and comment (Enclosures 2 and 3).

We ask that you review the PA and HPMP and provide your comments within 30 calendar days of receipt of this letter. If you have any questions or would like additional information, please contact Ms. Shellie Sullo, Social Science Study Manager, U.S. Army Corps of Engineers, Sacramento District, 1325 J Street, Sacramento, California 95814-2922. Ms. Sullo can also be reached by phone at: (916) 557-7682 or by e-mail at: [shellie.sullo@usace.army.mil](mailto:shellie.sullo@usace.army.mil). Project specific questions should be directed to Byron Lake, Project Manager. Mr. Lake can be reached by e-mail at: [bryon.l.lake@usace.army.mil](mailto:bryon.l.lake@usace.army.mil), or by phone at (916) 557-7890.

Sincerely,



Alicia E. Kirchner  
Chief, Planning Division

Enclosure

**West Sacramento GRR EIS/EIR  
Appendix D**

**Air Quality Modeling**

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## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS DWSC East Levee (C&G Clear Vegetation)											
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)	
Grubbing/Land Clearing	2.3	13.0	25.7	135.4	1.4	134.0	29.1	1.3	27.9	2,587.0	
Grading/Excavation	-	-	-	-	-	-	-	-	-	-	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (pounds/day)</b>	2.3	13.0	25.7	135.4	1.4	134.0	29.1	1.3	27.9	2,587.0	
<b>Total (tons/construction project)</b>	0.0	0.0	0.1	0.3	0.0	0.3	0.1	0.0	0.1	5.7	

Notes: Project Start Year -> 2016  
 Project Length (months) -> 0  
 Total Project Area (acres) -> 28  
 Maximum Area Disturbed/Day (acres) -> 7  
 Total Soil Imported/Exported (yd<sup>3</sup>/day)-> 2000

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> WS DWSC East Levee (C&G Clear Vegetation)											
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)	
Grubbing/Land Clearing	1.1	5.9	11.7	61.5	0.6	60.9	13.2	0.6	12.7	1,175.9	
Grading/Excavation	-	-	-	-	-	-	-	-	-	-	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (kilograms/day)</b>	1.1	5.9	11.7	61.5	0.6	60.9	13.2	0.6	12.7	1,175.9	
<b>Total (megagrams/construction project)</b>	0.0	0.0	0.1	0.3	0.0	0.3	0.1	0.0	0.1	5.2	

Notes: Project Start Year -> 2016  
 Project Length (months) -> 0  
 Total Project Area (hectares) -> 11  
 Maximum Area Disturbed/Day (hectares) -> 3  
 Total Soil Imported/Exported (meters<sup>3</sup>/day)-> 1529

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.





Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust	1.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Grading/Excavation (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		6.7	134.0	0.3	27.9	0.1	
Fugitive Dust - Grading/Excavation		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	

Off-Road Equipment Emissions								
	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Excavators	0.51	3.49	5.58	0.27	0.25	716.08
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Tractors/Loaders/Backhoes	0.90	3.93	8.17	0.63	0.58	839.81
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	2.3	13.0	25.7	1.4	1.3	2587.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.1	0.0	0.0	5.7

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
0.00		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grading	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.0	0.0	0.1	0.0	0.0	5.7



## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS DWSC East Levee (G&E Import Rip Rap - Barge+)												
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	1.2	9.3	17.5	67.6	0.6	67.0	14.5	0.5	13.9	2,377.0		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (pounds/day)</b>	1.2	9.3	17.5	67.6	0.6	67.0	14.5	0.5	13.9	2,377.0		
<b>Total (tons/construction project)</b>	0.0	0.4	0.7	1.2	0.0	1.2	0.3	0.0	0.2	94.1		
Notes: Project Start Year -> 2016 Project Length (months) -> 4 Total Project Area (acres) -> 28 Maximum Area Disturbed/Day (acres) -> 7 Total Soil Imported/Exported (yd <sup>3</sup> /day)-> 0 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												
Emission Estimates for -> WS DWSC East Levee (G&E Import Rip Rap - Barge+)												
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	
Grading/Excavation	0.5	4.2	8.0	30.7	0.3	30.5	6.6	0.2	6.3	1,080.5		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (kilograms/day)</b>	0.5	4.2	8.0	30.7	0.3	30.5	6.6	0.2	6.3	1,080.5		
<b>Total (megagrams/construction project)</b>	0.0	0.3	0.6	1.1	0.0	1.1	0.2	0.0	0.2	85.4		
Notes: Project Start Year -> 2016 Project Length (months) -> 4 Total Project Area (hectares) -> 11 Maximum Area Disturbed/Day (hectares) -> 3 Total Soil Imported/Exported (meters <sup>3</sup> /day)-> 0 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS DWSC East Levee (G&E Import Rip Rap - Barge+)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	3.6	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	0.0	yd <sup>3</sup> /day
Soil Exported		yd <sup>3</sup> /day
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
	User Override of	Program Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.00	0.36
Grading/Excavation	3.60	1.62
Drainage/Utilities/Sub-Grade	0.00	1.08
Paving	0.00	0.54
<b>Totals</b>	<b>3.60</b>	<b>3.60</b>

Hauling emission default values can be overridden in cells C45 through C46.							
<b>Soil Hauling Emissions</b>							
<b>User Input</b>		User Override of Soil Hauling Defaults		Default Values			
Miles/round trip			30				
Round trips/day			0				
Vehicle miles traveled/day (calculated)				0			
<b>Hauling Emissions</b>		<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>
Emission rate (grams/mile)		0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)		0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day		0.0	0.0	0.0	0.0	0.0	0.0
Tons per construction period		0.00	0.00	0.00	0.00	0.00	0.00
Worker commute default values can be overridden in cells C60 through C65.							
<b>Worker Commute Emissions</b>							
		User Override of Worker Commute Default Values		Default Values			
Miles/ one-way trip			20				
One-way trips/day			2				
No. of employees: Grubbing/Land Clearing	0.00		10				
No. of employees: Grading/Excavation			15				
No. of employees: Drainage/Utilities/Sub-Grade	0.00		11				
No. of employees: Paving	0.00		13				
		<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>
Emission rate - Grubbing/Land Clearing (grams/mile)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)		0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)		0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving		0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period		0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust		2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02	
Tons per const. Period - Grading/Excavation	0.00	0.12	0.01	0.00	0.00	23.44	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	67.0	1.2	13.9	0.2	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	



	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
1.00	0	Cranes	0.97	8.27	13.69	0.48	0.45	1655.80
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
3.00		Plate Compactors	0.15	0.79	0.94	0.04	0.03	129.18
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	1.1	9.1	14.6	0.5	0.5	1785.0
	Grading	tons per phase	0.0	0.4	0.6	0.0	0.0	70.7



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.0	0.4	0.6	0.0	0.0	70.7

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes	500.00	226	10.00	8			
Crawler Tractors		208		8			
Crushing/Proc. Equipment		142		8			
Excavators		163		8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175		8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172		8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8	10.00	8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81		8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362		8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes		98	10.00	8			
Trenchers		81		8			
Welders		45		8			
	530						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS DWSC East Levee (Cutoff Wall SCB Conv'l Method)												
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	
Grading/Excavation	2.8	16.5	31.6	102.2	1.7	100.5	22.4	1.5	20.9	4,207.2		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (pounds/day)</b>	2.8	16.5	31.6	102.2	1.7	100.5	22.4	1.5	20.9	4,207.2		
<b>Total (tons/construction project)</b>	0.0	0.1	0.3	0.4	0.0	0.4	0.1	0.0	0.1	34.7		
Notes: Project Start Year -> 2016 Project Length (months) -> 1 Total Project Area (acres) -> 28 Maximum Area Disturbed/Day (acres) -> 7 Total Soil Imported/Exported (yd <sup>3</sup> /day)-> 0 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												
Emission Estimates for -> WS DWSC East Levee (Cutoff Wall SCB Conv'l Method)												
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	
Grading/Excavation	1.3	7.5	14.4	46.4	0.8	45.7	10.2	0.7	9.5	1,912.3		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (kilograms/day)</b>	1.3	7.5	14.4	46.4	0.8	45.7	10.2	0.7	9.5	1,912.3		
<b>Total (megagrams/construction project)</b>	0.0	0.1	0.2	0.4	0.0	0.3	0.1	0.0	0.1	31.5		
Notes: Project Start Year -> 2016 Project Length (months) -> 1 Total Project Area (hectares) -> 11 Maximum Area Disturbed/Day (hectares) -> 3 Total Soil Imported/Exported (meters <sup>3</sup> /day)-> 0 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS DWSC East Levee (Cutoff Wall SCB Conv'l Method)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.8	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd <sup>3</sup> /day
Soil Exported		yd <sup>3</sup> /day
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
	User Override of	Program Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.00	0.08
Grading/Excavation	0.75	0.34
Drainage/Utilities/Sub-Grade	0.00	0.23
Paving	0.00	0.11
<b>Totals</b>	<b>0.75</b>	<b>0.75</b>



Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust	1.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.03	1.45	0.12	0.03	0.02	296.01	
Tons per const. Period - Grading/Excavation	0.00	0.01	0.00	0.00	0.00	2.44	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	100.5	0.4	20.9	0.1	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	



	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
3.00	3	Excavators	1.54	10.46	16.75	0.82	0.76	2148.24
1.00		Forklifts	0.30	1.13	2.46	0.21	0.19	206.83
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Pumps	0.44	2.47	3.19	0.23	0.22	396.14
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	0.45	1.97	4.09	0.31	0.29	419.90
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	2.7	16.0	26.5	1.6	1.5	3171.1
	Grading	tons per phase	0.0	0.1	0.2	0.0	0.0	26.2



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.0	0.1	0.2	0.0	0.0	26.2

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.				
		Default Values		Default Values
Equipment		Horsepower		Hours/day
Aerial Lifts		63		8
Air Compressors		106		8
Bore/Drill Rigs		206		8
Cement and Mortar Mixers		10		8
Concrete/Industrial Saws		64		8
Cranes		226		8
Crawler Tractors		208		8
Crushing/Proc. Equipment		142		8
Excavators		163	10.00	8
Forklifts		89	10.00	8
Generator Sets		66		8
Graders		175		8
Off-Highway Tractors		123		8
Off-Highway Trucks		400		8
Other Construction Equipment		172	10.00	8
Other General Industrial Equipment		88		8
Other Material Handling Equipment		167		8
Pavers		126		8
Paving Equipment		131		8
Plate Compactors		8		8
Pressure Washers		26		8
Pumps		53		8
Rollers		81		8
Rough Terrain Forklifts		100		8
Rubber Tired Dozers		255		8
Rubber Tired Loaders		200		8
Scrapers		362		8
Signal Boards		20		8
Skid Steer Loaders		65		8
Surfacing Equipment		254		8
Sweepers/Scrubbers		64		8
Tractors/Loaders/Backhoes		98	10.00	8
Trenchers		81		8
Welders		45		8
	40			
<b>END OF DATA ENTRY SHEET</b>				

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS DWSC East Levee (G&E Cutoff Wall DSM)												
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	15.9	93.1	145.7	75.1	8.1	67.0	21.3	7.4	13.9	18,688.1		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (pounds/day)</b>	15.9	93.1	145.7	75.1	8.1	67.0	21.3	7.4	13.9	18,688.1		
<b>Total (tons/construction project)</b>	0.7	4.1	6.4	1.7	0.4	1.3	0.6	0.3	0.3	822.3		
Notes:	Project Start Year ->	2016										
	Project Length (months) ->	4										
	Total Project Area (acres) ->	28										
	Maximum Area Disturbed/Day (acres) ->	7										
	Total Soil Imported/Exported (yd <sup>3</sup> /day)->	0										
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												
Emission Estimates for -> WS DWSC East Levee (G&E Cutoff Wall DSM)												
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	7.2	42.3	66.2	34.1	3.7	30.5	9.7	3.4	6.3	8,494.6		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (kilograms/day)</b>	7.2	42.3	66.2	34.1	3.7	30.5	9.7	3.4	6.3	8,494.6		
<b>Total (megagrams/construction project)</b>	0.6	3.7	5.8	1.5	0.3	1.2	0.5	0.3	0.3	745.8		
Notes:	Project Start Year ->	2016										
	Project Length (months) ->	4										
	Total Project Area (hectares) ->	11										
	Maximum Area Disturbed/Day (hectares) ->	3										
	Total Soil Imported/Exported (meters <sup>3</sup> /day)->	0										
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS DWSC East Levee (G&E Cutoff Wall DSM)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	4.0	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd <sup>3</sup> /day
Soil Exported		yd <sup>3</sup> /day
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
	User Override of	Program Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.00	0.40
Grading/Excavation	4.00	1.80
Drainage/Utilities/Sub-Grade	0.00	1.20
Paving	0.00	0.60
<b>Totals</b>	<b>4.00</b>	<b>4.00</b>



Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust		2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02	
Tons per const. Period - Grading/Excavation	0.00	0.13	0.01	0.00	0.00	26.05	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	67.0	1.3	13.9	0.3	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	



	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
2.00		Aerial Lifts	0.15	2.16	2.32	0.10	0.09	446.54
2.00		Air Compressors	1.71	8.55	10.96	0.92	0.84	1269.86
2.00		Bore/Drill Rigs	0.92	9.50	13.22	0.39	0.36	2364.04
4.00		Cement and Mortar Mixers	0.34	1.77	2.11	0.09	0.08	289.41
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
2.00	3	Excavators	1.02	6.97	11.17	0.55	0.51	1432.16
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
4.00		Generator Sets	2.57	14.92	19.32	1.37	1.26	2435.33
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
2.00	1	Other Construction Equipment	1.72	8.99	18.27	0.96	0.88	1635.48
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
6.00		Pumps	3.28	18.49	23.94	1.75	1.61	2971.06
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Rough Terrain Forklifts	0.56	5.07	6.83	0.38	0.35	931.86
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
	2	Rubber Tired Loaders	1.31	7.79	16.28	0.56	0.51	1656.55
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Tractors/Loaders/Backhoes	0.72	3.15	6.54	0.50	0.46	671.85
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Welders	1.42	4.93	4.51	0.36	0.33	511.86
	Grading/Excavation	pounds per day	15.7	92.3	135.5	7.9	7.3	16616.0
	Grading	tons per phase	0.7	4.1	6.0	0.3	0.3	731.1



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.7	4.1	6.0	0.3	0.3	731.1

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.				
		Default Values		Default Values
Equipment		Horsepower		Hours/day
Aerial Lifts		63	10.00	8
Air Compressors		106	10.00	8
Bore/Drill Rigs		206	10.00	8
Cement and Mortar Mixers		10	10.00	8
Concrete/Industrial Saws		64		8
Cranes		226		8
Crawler Tractors		208	10.00	8
Crushing/Proc. Equipment		142		8
Excavators		163	10.00	8
Forklifts		89		8
Generator Sets		66	10.00	8
Graders		175		8
Off-Highway Tractors		123		8
Off-Highway Trucks		400		8
Other Construction Equipment		172	10.00	8
Other General Industrial Equipment		88		8
Other Material Handling Equipment		167		8
Pavers		126		8
Paving Equipment		131		8
Plate Compactors		8		8
Pressure Washers		26		8
Pumps		53	10.00	8
Rollers		81		8
Rough Terrain Forklifts		100	10.00	8
Rubber Tired Dozers		255		8
Rubber Tired Loaders		200	10.00	8
Scrapers		362		8
Signal Boards		20		8
Skid Steer Loaders		65		8
Surfacing Equipment		254		8
Sweepers/Scrubbers		64		8
Tractors/Loaders/Backhoes		98		8
Trenchers		81		8
Welders		45	10.00	8
	120			
<b>END OF DATA ENTRY SHEET</b>				

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS DWSC East Levee (C&G Tree Removal)											
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)	
Grubbing/Land Clearing	2.0	12.1	23.1	101.6	1.1	100.5	21.9	1.0	20.9	2,662.8	
Grading/Excavation	-	-	-	-	-	-	-	-	-	-	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (pounds/day)</b>	2.0	12.1	23.1	101.6	1.1	100.5	21.9	1.0	20.9	2,662.8	
<b>Total (tons/construction project)</b>	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	2.7	
Notes: Project Start Year -> 2016 Project Length (months) -> 0 Total Project Area (acres) -> 28 Maximum Area Disturbed/Day (acres) -> 7 Total Soil Imported/Exported (yd <sup>3</sup> /day)-> 800 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.											
Emission Estimates for -> WS DWSC East Levee (C&G Tree Removal)											
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)	
Grubbing/Land Clearing	0.9	5.5	10.5	46.2	0.5	45.7	10.0	0.5	9.5	1,210.3	
Grading/Excavation	-	-	-	-	-	-	-	-	-	-	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (kilograms/day)</b>	0.9	5.5	10.5	46.2	0.5	45.7	10.0	0.5	9.5	1,210.3	
<b>Total (megagrams/construction project)</b>	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	2.5	
Notes: Project Start Year -> 2016 Project Length (months) -> 0 Total Project Area (hectares) -> 11 Maximum Area Disturbed/Day (hectares) -> 3 Total Soil Imported/Exported (meters <sup>3</sup> /day)-> 612 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.											

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS DWSC East Levee (C&G Tree Removal)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.1	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd <sup>3</sup> /day
Soil Exported	800.0	yd <sup>3</sup> /day
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
	User Override of	Program Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.10	0.01
Grading/Excavation	0.00	0.05
Drainage/Utilities/Sub-Grade	0.00	0.03
Paving	0.00	0.02
<b>Totals</b>	<b>0.10</b>	<b>0.10</b>

Hauling emission default values can be overridden in cells C45 through C46.							
<b>Soil Hauling Emissions</b>							
<b>User Input</b>		User Override of					
	Soil Hauling Defaults	Default Values					
Miles/round trip	24.00	30					
Round trips/day	35.00	40					
Vehicle miles traveled/day (calculated)				840			
<b>Hauling Emissions</b>							
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day	0.0	0.0	0.0	0.0	0.0	0.0	
Tons per construction period	0.00	0.00	0.00	0.00	0.00	0.00	
Worker commute default values can be overridden in cells C60 through C65.							
<b>Worker Commute Emissions</b>							
		User Override of Worker					
	Commute Default Values	Default Values					
Miles/ one-way trip		20					
One-way trips/day		2					
No. of employees: Grubbing/Land Clearing	5.00	10					
No. of employees: Grading/Excavation	0.00	15					
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11					
No. of employees: Paving	0.00	13					
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650	
Emission rate - Grading/Excavation (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Grubbing/Land Clearing (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592	
Emission rate - Grading/Excavation (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000	
Pounds per day - Grubbing/Land Clearing	0.087	0.100	0.953	0.021	0.009	199.652	
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.001	0.000	0.000	0.220	
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000	
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000	
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000	
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000	
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000	
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000	
tons per construction period	0.000	0.000	0.001	0.000	0.000	0.220	

Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	1.00	2		80			
Grading/Excavation - Exhaust	0.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Grading/Excavation (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.03	1.45	0.12	0.03	0.02	296.01	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.15	
Pound per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		6.7	100.5	0.1	20.9	0.0	
Fugitive Dust - Grading/Excavation	0.00	0	0.0	0.0	0.0	0.0	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	

Off-Road Equipment Emissions								
	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Excavators	0.51	3.49	5.58	0.27	0.25	716.08
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	0.45	1.97	4.09	0.31	0.29	419.90
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	1.9	11.0	21.6	1.0	1.0	2167.1
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	2.4

	Default							
<b>Grading/Excavation</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	<i>Program-estimate</i>	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
0.00		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
0.00		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grading	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.0	0.0	0.0	0.0	0.0	2.4



## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS DWSC East Levee (C&G Strip to Spoils)											
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)	
Grubbing/Land Clearing	3.9	19.4	40.3	102.7	2.2	100.5	22.9	2.0	20.9	4,121.1	
Grading/Excavation	-	-	-	-	-	-	-	-	-	-	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (pounds/day)</b>	3.9	19.4	40.3	102.7	2.2	100.5	22.9	2.0	20.9	4,121.1	
<b>Total (tons/construction project)</b>	0.0	0.0	0.1	0.2	0.0	0.2	0.1	0.0	0.0	8.7	
Notes: Project Start Year -> 2016 Project Length (months) -> 0 Total Project Area (acres) -> 28 Maximum Area Disturbed/Day (acres) -> 7 Total Soil Imported/Exported (yd <sup>3</sup> /day)-> 1314 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.											
Emission Estimates for -> WS DWSC East Levee (C&G Strip to Spoils)											
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)	
Grubbing/Land Clearing	1.8	8.8	18.3	46.7	1.0	45.7	10.4	0.9	9.5	1,873.2	
Grading/Excavation	-	-	-	-	-	-	-	-	-	-	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (kilograms/day)</b>	1.8	8.8	18.3	46.7	1.0	45.7	10.4	0.9	9.5	1,873.2	
<b>Total (megagrams/construction project)</b>	0.0	0.0	0.1	0.2	0.0	0.2	0.0	0.0	0.0	7.9	
Notes: Project Start Year -> 2016 Project Length (months) -> 0 Total Project Area (hectares) -> 11 Maximum Area Disturbed/Day (hectares) -> 3 Total Soil Imported/Exported (meters <sup>3</sup> /day)-> 1005 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.											



Hauling emission default values can be overridden in cells C45 through C46.							
<b>Soil Hauling Emissions</b>							
<b>User Input</b>		User Override of					
	Soil Hauling Defaults	Default Values					
Miles/round trip	50.00	30					
Round trips/day	97.00	66					
Vehicle miles traveled/day (calculated)				4850			
<b>Hauling Emissions</b>	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day	0.0	0.0	0.0	0.0	0.0	0.0	
Tons per construction period	0.00	0.00	0.00	0.00	0.00	0.00	
Worker commute default values can be overridden in cells C60 through C65.							
<b>Worker Commute Emissions</b>							
		User Override of Worker					
	Commute Default Values	Default Values					
Miles/ one-way trip		20					
One-way trips/day		2					
No. of employees: Grubbing/Land Clearing		10					
No. of employees: Grading/Excavation	0.00	15					
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11					
No. of employees: Paving	0.00	13					
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650	
Emission rate - Grading/Excavation (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Grubbing/Land Clearing (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592	
Emission rate - Grading/Excavation (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000	
Pounds per day - Grubbing/Land Clearing	0.174	0.200	1.907	0.042	0.018	399.303	
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.004	0.000	0.000	0.878	
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000	
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000	
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000	
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000	
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000	
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000	
tons per construction period	0.000	0.000	0.004	0.000	0.000	0.878	

Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	1.00	2		80			
Grading/Excavation - Exhaust	0.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Grading/Excavation (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.03	1.45	0.12	0.03	0.02	296.01	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.29	
Pound per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		6.7	100.5	0.2	20.9	0.0	
Fugitive Dust - Grading/Excavation		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	

Off-Road Equipment Emissions								
	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Excavators	0.51	3.49	5.58	0.27	0.25	716.08
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Graders	1.33	4.35	12.98	0.73	0.67	838.78
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Tractors/Loaders/Backhoes	0.90	3.93	8.17	0.63	0.58	839.81
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	3.7	17.4	38.6	2.1	1.9	3425.8
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.1	0.0	0.0	7.5





	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.0	0.0	0.1	0.0	0.0	7.5

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes		226		8			
Crawler Tractors		208	10.00	8			
Crushing/Proc. Equipment		142		8			
Excavators		163	10.00	8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175	10.00	8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172		8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8		8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81		8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362		8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes		98	10.00	8			
Trenchers		81		8			
Welders		45		8			
	40						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS DWSC East Levee (G&E to Stockpile)				Total	Exhaust	Fugitive Dust	Total	Exhaust	Fugitive Dust	CO2 (lbs/day)
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	PM10 (lbs/day)	PM10 (lbs/day)	PM10 (lbs/day)	PM2.5 (lbs/day)	PM2.5 (lbs/day)	PM2.5 (lbs/day)	
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	-	-	-	-	-	-	-	-	-	-
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	-	-	-	-	-	-	-	-	-	-
Total (tons/construction project)	-	-	-	-	-	-	-	-	-	-
Notes:	Project Start Year ->	2016								
	Project Length (months) ->	0								
	Total Project Area (acres) ->	28								
	Maximum Area Disturbed/Day (acres) ->	7								
	Total Soil Imported/Exported (yd <sup>3</sup> /day)->	0								
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.										
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.										
Emission Estimates for -> WS DWSC East Levee (G&E to Stockpile)				Total	Exhaust	Fugitive Dust	Total	Exhaust	Fugitive Dust	CO2 (kgs/day)
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	PM10 (kgs/day)	PM10 (kgs/day)	PM10 (kgs/day)	PM2.5 (kgs/day)	PM2.5 (kgs/day)	PM2.5 (kgs/day)	
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	-	-	-	-	-	-	-	-	-	-
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	-	-	-	-	-	-	-	-	-	-
Total (megagrams/construction project)	-	-	-	-	-	-	-	-	-	-
Notes:	Project Start Year ->	2016								
	Project Length (months) ->	0								
	Total Project Area (hectares) ->	11								
	Maximum Area Disturbed/Day (hectares) ->	3								
	Total Soil Imported/Exported (meters <sup>3</sup> /day)->	0								
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.										
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.										





Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust		2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	







	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.0	0.0	0.0	0.0	0.0	0.0

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes		226		8			
Crawler Tractors		208	10.00	8			
Crushing/Proc. Equipment		142		8			
Excavators		163		8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175	10.00	8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172	10.00	8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8		8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81		8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362	10.00	8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes		98		8			
Trenchers		81		8			
Welders		45		8			
	40						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS DWSC East Levee (G&E Surfacing)												
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	7.8	36.1	111.6	71.8	4.8	67.0	18.1	4.2	13.9	14,463.1		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (pounds/day)</b>	<b>7.8</b>	<b>36.1</b>	<b>111.6</b>	<b>71.8</b>	<b>4.8</b>	<b>67.0</b>	<b>18.1</b>	<b>4.2</b>	<b>13.9</b>	<b>14,463.1</b>		
<b>Total (tons/construction project)</b>	<b>0.0</b>	<b>0.1</b>	<b>0.2</b>	<b>0.1</b>	<b>0.0</b>	<b>0.1</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>31.8</b>		
Notes:	Project Start Year ->	2016										
	Project Length (months) ->	0										
	Total Project Area (acres) ->	28										
	Maximum Area Disturbed/Day (acres) ->	7										
	Total Soil Imported/Exported (yd <sup>3</sup> /day)->	1536										
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												
Emission Estimates for -> WS DWSC East Levee (G&E Surfacing)												
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	3.5	16.4	50.7	32.7	2.2	30.5	8.2	1.9	6.3	6,574.1		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (kilograms/day)</b>	<b>3.5</b>	<b>16.4</b>	<b>50.7</b>	<b>32.7</b>	<b>2.2</b>	<b>30.5</b>	<b>8.2</b>	<b>1.9</b>	<b>6.3</b>	<b>6,574.1</b>		
<b>Total (megagrams/construction project)</b>	<b>0.0</b>	<b>0.1</b>	<b>0.2</b>	<b>0.1</b>	<b>0.0</b>	<b>0.1</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>28.9</b>		
Notes:	Project Start Year ->	2016										
	Project Length (months) ->	0										
	Total Project Area (hectares) ->	11										
	Maximum Area Disturbed/Day (hectares) ->	3										
	Total Soil Imported/Exported (meters <sup>3</sup> /day)->	1174										
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												





Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust	3.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.08	4.36	0.37	0.09	0.05	888.03	
Tons per const. Period - Grading/Excavation	0.00	0.01	0.00	0.00	0.00	1.95	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	67.0	0.1	13.9	0.0	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	



	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	3	Excavators	1.23	8.37	13.40	0.66	0.61	1718.59
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
2.00	2	Graders	2.67	8.70	25.95	1.46	1.34	1677.56
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.46	2.41	4.90	0.26	0.24	438.31
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Rollers	0.88	3.77	7.73	0.57	0.52	698.83
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Tractors/Loaders/Backhoes	0.90	3.93	8.17	0.63	0.58	839.81
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	7.1	32.8	72.0	4.0	3.7	6404.2
	Grading	tons per phase	0.0	0.1	0.2	0.0	0.0	14.1



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.0	0.1	0.2	0.0	0.0	14.1

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes		226		8			
Crawler Tractors		208	10.00	8			
Crushing/Proc. Equipment		142		8			
Excavators		163		8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175	10.00	8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172		8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8		8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81	10.00	8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362		8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes		98	10.00	8			
Trenchers		81		8			
Welders		45		8			
	40						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS DWSC East Levee (G&E Import Rip Rap - Truck)												
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	3.8	20.7	99.9	136.8	2.8	134.0	30.0	2.1	27.9	17,683.7		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (pounds/day)</b>	<b>3.8</b>	<b>20.7</b>	<b>99.9</b>	<b>136.8</b>	<b>2.8</b>	<b>134.0</b>	<b>30.0</b>	<b>2.1</b>	<b>27.9</b>	<b>17,683.7</b>		
<b>Total (tons/construction project)</b>	<b>0.2</b>	<b>1.0</b>	<b>4.6</b>	<b>2.9</b>	<b>0.1</b>	<b>2.8</b>	<b>0.7</b>	<b>0.1</b>	<b>0.6</b>	<b>817.0</b>		
Notes: Project Start Year -> 2016 Project Length (months) -> 4 Total Project Area (acres) -> 28 Maximum Area Disturbed/Day (acres) -> 7 Total Soil Imported/Exported (yd <sup>3</sup> /day)-> 3200												
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												
Emission Estimates for -> WS DWSC East Levee (G&E Import Rip Rap - Truck)												
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	1.7	9.4	45.4	62.2	1.3	60.9	13.6	1.0	12.7	8,038.0		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (kilograms/day)</b>	<b>1.7</b>	<b>9.4</b>	<b>45.4</b>	<b>62.2</b>	<b>1.3</b>	<b>60.9</b>	<b>13.6</b>	<b>1.0</b>	<b>12.7</b>	<b>8,038.0</b>		
<b>Total (megagrams/construction project)</b>	<b>0.2</b>	<b>0.9</b>	<b>4.2</b>	<b>2.6</b>	<b>0.1</b>	<b>2.5</b>	<b>0.6</b>	<b>0.1</b>	<b>0.5</b>	<b>741.0</b>		
Notes: Project Start Year -> 2016 Project Length (months) -> 4 Total Project Area (hectares) -> 11 Maximum Area Disturbed/Day (hectares) -> 3 Total Soil Imported/Exported (meters <sup>3</sup> /day)-> 2446												
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS DWSC East Levee (G&E Import Rip Rap - Truck)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	4.2	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	3200.0	yd <sup>3</sup> /day
Soil Exported		yd <sup>3</sup> /day
Average Truck Capacity	40.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
	User Override of	Program Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.00	0.42
Grading/Excavation	4.20	1.89
Drainage/Utilities/Sub-Grade	0.00	1.26
Paving	0.00	0.63
<b>Totals</b>	<b>4.20</b>	<b>4.20</b>

Hauling emission default values can be overridden in cells C45 through C46.							
<b>Soil Hauling Emissions</b>							
<b>User Input</b>		User Override of					
		Soil Hauling Defaults	Default Values				
Miles/round trip		50.00	30				
Round trips/day			80				
Vehicle miles traveled/day (calculated)				4000			
<b>Hauling Emissions</b>		<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>
Emission rate (grams/mile)		0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)		0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day		1.4	72.7	6.2	1.5	0.9	14800.5
Tons per construction period		0.06	3.36	0.29	0.07	0.04	683.78
Worker commute default values can be overridden in cells C60 through C65.							
<b>Worker Commute Emissions</b>							
		User Override of Worker					
		Commute Default Values	Default Values				
Miles/ one-way trip			20				
One-way trips/day			2				
No. of employees: Grubbing/Land Clearing		0.00	10				
No. of employees: Grading/Excavation			15				
No. of employees: Drainage/Utilities/Sub-Grade		0.00	11				
No. of employees: Paving		0.00	13				
		<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>
Emission rate - Grubbing/Land Clearing (grams/mile)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)		0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)		0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving		0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period		0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust	0.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	134.0	2.8	27.9	0.6	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	



	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
2.00	3	Excavators	1.02	6.97	11.17	0.55	0.51	1432.16
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	0.45	1.97	4.09	0.31	0.29	419.90
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	2.4	14.5	27.2	1.3	1.2	2883.2
	Grading	tons per phase	0.1	0.7	1.3	0.1	0.1	133.2



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.1	0.7	1.3	0.1	0.1	133.2



## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS South Levee (C&G Clear Vegetation)											
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)	
Grubbing/Land Clearing	2.3	13.0	25.7	135.4	1.4	134.0	29.1	1.3	27.9	2,587.0	
Grading/Excavation	-	-	-	-	-	-	-	-	-	-	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (pounds/day)</b>	2.3	13.0	25.7	135.4	1.4	134.0	29.1	1.3	27.9	2,587.0	
<b>Total (tons/construction project)</b>	0.0	0.0	0.1	0.3	0.0	0.3	0.1	0.0	0.1	5.7	

Notes: Project Start Year -> 2016  
 Project Length (months) -> 1  
 Total Project Area (acres) -> 28  
 Maximum Area Disturbed/Day (acres) -> 7  
 Total Soil Imported/Exported (yd<sup>3</sup>/day)-> 2000

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> WS South Levee (C&G Clear Vegetation)											
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)	
Grubbing/Land Clearing	1.1	5.9	11.7	61.5	0.6	60.9	13.2	0.6	12.7	1,175.9	
Grading/Excavation	-	-	-	-	-	-	-	-	-	-	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (kilograms/day)</b>	1.1	5.9	11.7	61.5	0.6	60.9	13.2	0.6	12.7	1,175.9	
<b>Total (megagrams/construction project)</b>	0.0	0.0	0.1	0.3	0.0	0.3	0.1	0.0	0.1	5.2	

Notes: Project Start Year -> 2016  
 Project Length (months) -> 1  
 Total Project Area (hectares) -> 11  
 Maximum Area Disturbed/Day (hectares) -> 3  
 Total Soil Imported/Exported (meters<sup>3</sup>/day)-> 1529

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.





Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust	1.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Grading/Excavation (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		6.7	134.0	0.3	27.9	0.1	
Fugitive Dust - Grading/Excavation		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	

Off-Road Equipment Emissions								
	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Excavators	0.51	3.49	5.58	0.27	0.25	716.08
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Tractors/Loaders/Backhoes	0.90	3.93	8.17	0.63	0.58	839.81
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	2.3	13.0	25.7	1.4	1.3	2587.0
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.1	0.0	0.0	5.7

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
0.00		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grading	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.0	0.0	0.1	0.0	0.0	5.7



## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS Sac South Levee (G&E Import Rip Rap - Barge+)												
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	1.2	9.3	17.5	67.6	0.6	67.0	14.5	0.5	13.9	2,377.0		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (pounds/day)</b>	1.2	9.3	17.5	67.6	0.6	67.0	14.5	0.5	13.9	2,377.0		
<b>Total (tons/construction project)</b>	0.0	0.4	0.7	1.2	0.0	1.2	0.3	0.0	0.2	94.1		
Notes: Project Start Year -> 2016 Project Length (months) -> 4 Total Project Area (acres) -> 28 Maximum Area Disturbed/Day (acres) -> 7 Total Soil Imported/Exported (yd <sup>3</sup> /day)-> 0												
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												
Emission Estimates for -> WS Sac South Levee (G&E Import Rip Rap - Barge+)												
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	0.5	4.2	8.0	30.7	0.3	30.5	6.6	0.2	6.3	1,080.5		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (kilograms/day)</b>	0.5	4.2	8.0	30.7	0.3	30.5	6.6	0.2	6.3	1,080.5		
<b>Total (megagrams/construction project)</b>	0.0	0.3	0.6	1.1	0.0	1.1	0.2	0.0	0.2	85.4		
Notes: Project Start Year -> 2016 Project Length (months) -> 4 Total Project Area (hectares) -> 11 Maximum Area Disturbed/Day (hectares) -> 3 Total Soil Imported/Exported (meters <sup>3</sup> /day)-> 0												
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS Sac South Levee (G&E Import Rip Rap - Barge+)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	3.6	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	0.0	yd <sup>3</sup> /day
Soil Exported		yd <sup>3</sup> /day
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
		Program
	User Override of	Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.00	0.36
Grading/Excavation	3.60	1.62
Drainage/Utilities/Sub-Grade	0.00	1.08
Paving	0.00	0.54
<b>Totals</b>	<b>3.60</b>	<b>3.60</b>

Hauling emission default values can be overridden in cells C45 through C46.							
<b>Soil Hauling Emissions</b>							
<b>User Input</b>		User Override of Soil Hauling Defaults		Default Values			
Miles/round trip			30				
Round trips/day			0				
Vehicle miles traveled/day (calculated)				0			
<b>Hauling Emissions</b>		<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>
Emission rate (grams/mile)		0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)		0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day		0.0	0.0	0.0	0.0	0.0	0.0
Tons per construction period		0.00	0.00	0.00	0.00	0.00	0.00
Worker commute default values can be overridden in cells C60 through C65.							
<b>Worker Commute Emissions</b>							
		User Override of Worker Commute Default Values		Default Values			
Miles/ one-way trip			20				
One-way trips/day			2				
No. of employees: Grubbing/Land Clearing	0.00		10				
No. of employees: Grading/Excavation			15				
No. of employees: Drainage/Utilities/Sub-Grade	0.00		11				
No. of employees: Paving	0.00		13				
		<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>
Emission rate - Grubbing/Land Clearing (grams/mile)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)		0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)		0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving		0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period		0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust		2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02	
Tons per const. Period - Grading/Excavation	0.00	0.12	0.01	0.00	0.00	23.44	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	67.0	1.2	13.9	0.2	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	



	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
1.00	0	Cranes	0.97	8.27	13.69	0.48	0.45	1655.80
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
3.00		Plate Compactors	0.15	0.79	0.94	0.04	0.03	129.18
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	1.1	9.1	14.6	0.5	0.5	1785.0
	Grading	tons per phase	0.0	0.4	0.6	0.0	0.0	70.7



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.0	0.4	0.6	0.0	0.0	70.7

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes	500.00	226	10.00	8			
Crawler Tractors		208		8			
Crushing/Proc. Equipment		142		8			
Excavators		163		8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175		8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172		8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8	10.00	8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81		8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362		8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes		98	10.00	8			
Trenchers		81		8			
Welders		45		8			
	530						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS Sac South Levee (Cutoff Wall SCB Conv'l Method)												
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	2.9	17.1	32.4	102.2	1.7	100.5	22.5	1.6	20.9	4,306.2		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (pounds/day)</b>	2.9	17.1	32.4	102.2	1.7	100.5	22.5	1.6	20.9	4,306.2		
<b>Total (tons/construction project)</b>	0.1	0.4	0.8	1.1	0.0	1.1	0.3	0.0	0.2	104.2		
Notes: Project Start Year -> 2016 Project Length (months) -> 2 Total Project Area (acres) -> 28 Maximum Area Disturbed/Day (acres) -> 7 Total Soil Imported/Exported (yd <sup>3</sup> /day)-> 0												
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												
Emission Estimates for -> WS Sac South Levee (Cutoff Wall SCB Conv'l Method)												
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	1.3	7.8	14.7	46.5	0.8	45.7	10.2	0.7	9.5	1,957.4		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (kilograms/day)</b>	1.3	7.8	14.7	46.5	0.8	45.7	10.2	0.7	9.5	1,957.4		
<b>Total (megagrams/construction project)</b>	0.1	0.4	0.7	1.0	0.0	1.0	0.2	0.0	0.2	94.5		
Notes: Project Start Year -> 2016 Project Length (months) -> 2 Total Project Area (hectares) -> 11 Maximum Area Disturbed/Day (hectares) -> 3 Total Soil Imported/Exported (meters <sup>3</sup> /day)-> 0												
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS Sac South Levee (Cutoff Wall SCB Conv'l Method)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	2.2	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd <sup>3</sup> /day
Soil Exported		yd <sup>3</sup> /day
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
		Program
	User Override of	Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.00	0.22
Grading/Excavation	2.20	0.99
Drainage/Utilities/Sub-Grade	0.00	0.66
Paving	0.00	0.33
<b>Totals</b>	<b>2.20</b>	<b>2.20</b>



Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust	1.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.03	1.45	0.12	0.03	0.02	296.01	
Tons per const. Period - Grading/Excavation	0.00	0.04	0.00	0.00	0.00	7.16	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	100.5	1.1	20.9	0.2	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	



	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
3.00	3	Excavators	1.54	10.46	16.75	0.82	0.76	2148.24
1.00		Forklifts	0.30	1.13	2.46	0.21	0.19	206.83
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Pumps	0.55	3.08	3.99	0.29	0.27	495.18
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	0.45	1.97	4.09	0.31	0.29	419.90
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	2.8	16.6	27.3	1.6	1.5	3270.2
	Grading	tons per phase	0.1	0.4	0.7	0.0	0.0	79.1



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.1	0.4	0.7	0.0	0.0	79.1

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.				
		Default Values		Default Values
Equipment		Horsepower		Hours/day
Aerial Lifts		63		8
Air Compressors		106		8
Bore/Drill Rigs		206		8
Cement and Mortar Mixers		10		8
Concrete/Industrial Saws		64		8
Cranes		226		8
Crawler Tractors		208		8
Crushing/Proc. Equipment		142		8
Excavators		163	10.00	8
Forklifts		89	10.00	8
Generator Sets		66		8
Graders		175		8
Off-Highway Tractors		123		8
Off-Highway Trucks		400		8
Other Construction Equipment		172		8
Other General Industrial Equipment		88		8
Other Material Handling Equipment		167		8
Pavers		126		8
Paving Equipment		131		8
Plate Compactors		8		8
Pressure Washers		26		8
Pumps		53	10.00	8
Rollers		81		8
Rough Terrain Forklifts		100		8
Rubber Tired Dozers		255		8
Rubber Tired Loaders		200		8
Scrapers		362		8
Signal Boards		20		8
Skid Steer Loaders		65		8
Surfacing Equipment		254		8
Sweepers/Scrubbers		64		8
Tractors/Loaders/Backhoes		98	10.00	8
Trenchers		81		8
Welders		45		8
	40			
<b>END OF DATA ENTRY SHEET</b>				

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS Sac South Levee (G&E Cutoff Wall DSM)				Total	Exhaust	Fugitive Dust	Total	Exhaust	Fugitive Dust	CO2 (lbs/day)
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	PM10 (lbs/day)	PM10 (lbs/day)	PM10 (lbs/day)	PM2.5 (lbs/day)	PM2.5 (lbs/day)	PM2.5 (lbs/day)	
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	-	-	-	-	-	-	-	-	-	-
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	-	-	-	-	-	-	-	-	-	-
Total (tons/construction project)	-	-	-	-	-	-	-	-	-	-
Notes:	Project Start Year ->	2016								
	Project Length (months) ->	0								
	Total Project Area (acres) ->	28								
	Maximum Area Disturbed/Day (acres) ->	7								
	Total Soil Imported/Exported (yd <sup>3</sup> /day)->	0								
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.										
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.										
Emission Estimates for -> WS Sac South Levee (G&E Cutoff Wall DSM)				Total	Exhaust	Fugitive Dust	Total	Exhaust	Fugitive Dust	CO2 (kgs/day)
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	PM10 (kgs/day)	PM10 (kgs/day)	PM10 (kgs/day)	PM2.5 (kgs/day)	PM2.5 (kgs/day)	PM2.5 (kgs/day)	
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	-	-	-	-	-	-	-	-	-	-
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	-	-	-	-	-	-	-	-	-	-
Total (megagrams/construction project)	-	-	-	-	-	-	-	-	-	-
Notes:	Project Start Year ->	2016								
	Project Length (months) ->	0								
	Total Project Area (hectares) ->	11								
	Maximum Area Disturbed/Day (hectares) ->	3								
	Total Soil Imported/Exported (meters <sup>3</sup> /day)->	0								
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.										
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.										

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS Sac South Levee (G&E Cutoff Wall DSM)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.0	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd <sup>3</sup> /day
Soil Exported		yd <sup>3</sup> /day
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
		Program
	User Override of	Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.00	0.00
Grading/Excavation	0.00	0.00
Drainage/Utilities/Sub-Grade	0.00	0.00
Paving	0.00	0.00
<b>Totals</b>	<b>0.00</b>	<b>0.00</b>



Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust		2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	







	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.0	0.0	0.0	0.0	0.0	0.0

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.				
		Default Values		Default Values
Equipment		Horsepower		Hours/day
Aerial Lifts		63	10.00	8
Air Compressors		106	10.00	8
Bore/Drill Rigs		206	10.00	8
Cement and Mortar Mixers		10	10.00	8
Concrete/Industrial Saws		64		8
Cranes		226		8
Crawler Tractors		208	10.00	8
Crushing/Proc. Equipment		142		8
Excavators		163	10.00	8
Forklifts		89		8
Generator Sets		66	10.00	8
Graders		175		8
Off-Highway Tractors		123		8
Off-Highway Trucks		400		8
Other Construction Equipment		172	10.00	8
Other General Industrial Equipment		88		8
Other Material Handling Equipment		167		8
Pavers		126		8
Paving Equipment		131		8
Plate Compactors		8		8
Pressure Washers		26		8
Pumps		53	10.00	8
Rollers		81		8
Rough Terrain Forklifts		100	10.00	8
Rubber Tired Dozers		255		8
Rubber Tired Loaders		200	10.00	8
Scrapers		362		8
Signal Boards		20		8
Skid Steer Loaders		65		8
Surfacing Equipment		254		8
Sweepers/Scrubbers		64		8
Tractors/Loaders/Backhoes		98		8
Trenchers		81		8
Welders		45	10.00	8
	120			
<b>END OF DATA ENTRY SHEET</b>				

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS Sac South Levee (C&G Tree Removal)											
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)	
Grubbing/Land Clearing	2.0	12.1	23.1	101.6	1.1	100.5	21.9	1.0	20.9	2,662.8	
Grading/Excavation	-	-	-	-	-	-	-	-	-	-	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (pounds/day)</b>	2.0	12.1	23.1	101.6	1.1	100.5	21.9	1.0	20.9	2,662.8	
<b>Total (tons/construction project)</b>	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.0	5.5	

Notes: Project Start Year -> 2016  
 Project Length (months) -> 0  
 Total Project Area (acres) -> 28  
 Maximum Area Disturbed/Day (acres) -> 7  
 Total Soil Imported/Exported (yd<sup>3</sup>/day)-> 800

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> WS Sac South Levee (C&G Tree Removal)											
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)	
Grubbing/Land Clearing	0.9	5.5	10.5	46.2	0.5	45.7	10.0	0.5	9.5	1,210.3	
Grading/Excavation	-	-	-	-	-	-	-	-	-	-	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (kilograms/day)</b>	0.9	5.5	10.5	46.2	0.5	45.7	10.0	0.5	9.5	1,210.3	
<b>Total (megagrams/construction project)</b>	0.0	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.0	5.0	

Notes: Project Start Year -> 2016  
 Project Length (months) -> 0  
 Total Project Area (hectares) -> 11  
 Maximum Area Disturbed/Day (hectares) -> 3  
 Total Soil Imported/Exported (meters<sup>3</sup>/day)-> 612

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.



Hauling emission default values can be overridden in cells C45 through C46.							
<b>Soil Hauling Emissions</b>							
<b>User Input</b>		User Override of					
	Soil Hauling Defaults	Default Values					
Miles/round trip	24.00	30					
Round trips/day	35.00	40					
Vehicle miles traveled/day (calculated)				840			
<b>Hauling Emissions</b>	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day	0.0	0.0	0.0	0.0	0.0	0.0	
Tons per construction period	0.00	0.00	0.00	0.00	0.00	0.00	
Worker commute default values can be overridden in cells C60 through C65.							
<b>Worker Commute Emissions</b>							
		User Override of Worker					
	Commute Default Values	Default Values					
Miles/ one-way trip		20					
One-way trips/day		2					
No. of employees: Grubbing/Land Clearing	5.00	10					
No. of employees: Grading/Excavation	0.00	15					
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11					
No. of employees: Paving	0.00	13					
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650	
Emission rate - Grading/Excavation (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Grubbing/Land Clearing (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592	
Emission rate - Grading/Excavation (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000	
Pounds per day - Grubbing/Land Clearing	0.087	0.100	0.953	0.021	0.009	199.652	
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.002	0.000	0.000	0.439	
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000	
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000	
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000	
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000	
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000	
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000	
tons per construction period	0.000	0.000	0.002	0.000	0.000	0.439	

Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	1.00	2		80			
Grading/Excavation - Exhaust	0.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Grading/Excavation (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.03	1.45	0.12	0.03	0.02	296.01	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.29	
Pound per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		6.7	100.5	0.2	20.9	0.0	
Fugitive Dust - Grading/Excavation	0.00	0	0.0	0.0	0.0	0.0	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	

Off-Road Equipment Emissions								
	Default							
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Excavators	0.51	3.49	5.58	0.27	0.25	716.08
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	0.45	1.97	4.09	0.31	0.29	419.90
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	1.9	11.0	21.6	1.0	1.0	2167.1
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.0	0.0	0.0	4.8

	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
0.00		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
0.00		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Grading	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.0	0.0	0.0	0.0	0.0	4.8

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes		226		8			
Crawler Tractors		208	10.00	8			
Crushing/Proc. Equipment		142		8			
Excavators		163	10.00	8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175		8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172		8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8		8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81		8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362		8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes		98	10.00	8			
Trenchers		81		8			
Welders		45		8			
	30						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS Sac South Levee (C&G Strip to Spoils)											
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)	
Grubbing/Land Clearing	3.9	19.4	40.3	102.7	2.2	100.5	22.9	2.0	20.9	4,121.1	
Grading/Excavation	-	-	-	-	-	-	-	-	-	-	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (pounds/day)</b>	3.9	19.4	40.3	102.7	2.2	100.5	22.9	2.0	20.9	4,121.1	
<b>Total (tons/construction project)</b>	0.0	0.0	0.1	0.2	0.0	0.2	0.1	0.0	0.0	10.2	
Notes:	Project Start Year ->	2016									
	Project Length (months) ->	1									
	Total Project Area (acres) ->	28									
	Maximum Area Disturbed/Day (acres) ->	7									
	Total Soil Imported/Exported (yd <sup>3</sup> /day)->	1389									
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.											
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.											
Emission Estimates for -> WS Sac South Levee (C&G Strip to Spoils)											
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)	
Grubbing/Land Clearing	1.8	8.8	18.3	46.7	1.0	45.7	10.4	0.9	9.5	1,873.2	
Grading/Excavation	-	-	-	-	-	-	-	-	-	-	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (kilograms/day)</b>	1.8	8.8	18.3	46.7	1.0	45.7	10.4	0.9	9.5	1,873.2	
<b>Total (megagrams/construction project)</b>	0.0	0.0	0.1	0.2	0.0	0.2	0.0	0.0	0.0	9.2	
Notes:	Project Start Year ->	2016									
	Project Length (months) ->	1									
	Total Project Area (hectares) ->	11									
	Maximum Area Disturbed/Day (hectares) ->	3									
	Total Soil Imported/Exported (meters <sup>3</sup> /day)->	1062									
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.											
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.											

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS Sac South Levee (C&G Strip to Spoils)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	1.2	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd <sup>3</sup> /day
Soil Exported	1389.0	yd <sup>3</sup> /day
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
	User Override of	Program Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.20	0.12
Grading/Excavation	0.00	0.54
Drainage/Utilities/Sub-Grade	0.00	0.36
Paving	0.00	0.18
<b>Totals</b>	<b>0.20</b>	<b>1.20</b>
Please note: You have entered a different number of months than the project length shown in cell C13.		

Hauling emission default values can be overridden in cells C45 through C46.							
<b>Soil Hauling Emissions</b>							
<b>User Input</b>		User Override of					
	Soil Hauling Defaults	Default Values					
Miles/round trip	50.00	30					
Round trips/day	97.00	69					
Vehicle miles traveled/day (calculated)				4850			
<b>Hauling Emissions</b>	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate (grams/trip)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day	0.0	0.0	0.0	0.0	0.0	0.0	
Tons per construction period	0.00	0.00	0.00	0.00	0.00	0.00	
Worker commute default values can be overridden in cells C60 through C65.							
<b>Worker Commute Emissions</b>							
		User Override of Worker					
	Commute Default Values	Default Values					
Miles/ one-way trip		20					
One-way trips/day		2					
No. of employees: Grubbing/Land Clearing		10					
No. of employees: Grading/Excavation	0.00	15					
No. of employees: Drainage/Utilities/Sub-Grade	0.00	11					
No. of employees: Paving	0.00	13					
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.147	0.194	1.744	0.047	0.020	443.650	
Emission rate - Grading/Excavation (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Paving (grams/mile)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Grubbing/Land Clearing (grams/trip)	0.505	0.323	4.200	0.004	0.003	95.592	
Emission rate - Grading/Excavation (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)	0.000	0.000	0.000	0.000	0.000	0.000	
Emission rate - Paving (grams/trip)	0.000	0.000	0.000	0.000	0.000	0.000	
Pounds per day - Grubbing/Land Clearing	0.174	0.200	1.907	0.042	0.018	399.303	
Tons per const. Period - Grub/Land Clear	0.000	0.000	0.004	0.000	0.000	0.878	
Pounds per day - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000	
Tons per const. Period - Grading/Excavation	0.000	0.000	0.000	0.000	0.000	0.000	
Pounds per day - Drainage/Utilities/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000	
Tons per const. Period - Drain/Util/Sub-Grade	0.000	0.000	0.000	0.000	0.000	0.000	
Pounds per day - Paving	0.000	0.000	0.000	0.000	0.000	0.000	
Tons per const. Period - Paving	0.000	0.000	0.000	0.000	0.000	0.000	
tons per construction period	0.000	0.000	0.004	0.000	0.000	0.878	

Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	1.00	2		80			
Grading/Excavation - Exhaust	0.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Grading/Excavation (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.03	1.45	0.12	0.03	0.02	296.01	
Tons per const. Period - Grub/Land Clear	0.00	0.01	0.00	0.00	0.00	1.76	
Pound per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		6.7	100.5	0.2	20.9	0.0	
Fugitive Dust - Grading/Excavation		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	

Off-Road Equipment Emissions								
Default								
Grubbing/Land Clearing	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Excavators	0.51	3.49	5.58	0.27	0.25	716.08
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Graders	1.33	4.35	12.98	0.73	0.67	838.78
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Tractors/Loaders/Backhoes	0.90	3.93	8.17	0.63	0.58	839.81
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grubbing/Land Clearing	pounds per day	3.7	17.4	38.6	2.1	1.9	3425.8
	Grubbing/Land Clearing	tons per phase	0.0	0.0	0.1	0.0	0.0	7.5





	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.0	0.0	0.1	0.0	0.0	7.5

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes		226		8			
Crawler Tractors		208	10.00	8			
Crushing/Proc. Equipment		142		8			
Excavators		163	10.00	8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175	10.00	8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172		8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8		8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81		8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362		8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes		98	10.00	8			
Trenchers		81		8			
Welders		45		8			
	40						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS Sac South Levee (G&E to Stockpile)				Total	Exhaust	Fugitive Dust	Total	Exhaust	Fugitive Dust	CO2 (lbs/day)
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	PM10 (lbs/day)	PM10 (lbs/day)	PM10 (lbs/day)	PM2.5 (lbs/day)	PM2.5 (lbs/day)	PM2.5 (lbs/day)	CO2 (lbs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	-	-	-	-	-	-	-	-	-	-
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (pounds/day)	-	-	-	-	-	-	-	-	-	-
Total (tons/construction project)	-	-	-	-	-	-	-	-	-	-
Notes:	Project Start Year ->	2016								
	Project Length (months) ->	0								
	Total Project Area (acres) ->	28								
	Maximum Area Disturbed/Day (acres) ->	7								
	Total Soil Imported/Exported (yd <sup>3</sup> /day)->	0								
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.										
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.										
Emission Estimates for -> WS Sac South Levee (G&E to Stockpile)				Total	Exhaust	Fugitive Dust	Total	Exhaust	Fugitive Dust	CO2 (kgs/day)
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	PM10 (kgs/day)	PM10 (kgs/day)	PM10 (kgs/day)	PM2.5 (kgs/day)	PM2.5 (kgs/day)	PM2.5 (kgs/day)	CO2 (kgs/day)
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	-	-	-	-	-	-	-	-	-	-
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-
Maximum (kilograms/day)	-	-	-	-	-	-	-	-	-	-
Total (megagrams/construction project)	-	-	-	-	-	-	-	-	-	-
Notes:	Project Start Year ->	2016								
	Project Length (months) ->	0								
	Total Project Area (hectares) ->	11								
	Maximum Area Disturbed/Day (hectares) ->	3								
	Total Soil Imported/Exported (meters <sup>3</sup> /day)->	0								
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.										
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.										

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS Sac South Levee (G&E to Stockpile)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.0	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd <sup>3</sup> /day
Soil Exported	0.0	yd <sup>3</sup> /day
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
	User Override of	Program Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.00	0.00
Grading/Excavation	0.00	0.00
Drainage/Utilities/Sub-Grade	0.00	0.00
Paving	0.00	0.00
<b>Totals</b>	<b>0.00</b>	<b>0.00</b>



Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust		2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	







	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.0	0.0	0.0	0.0	0.0	0.0

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes		226		8			
Crawler Tractors		208	10.00	8			
Crushing/Proc. Equipment		142		8			
Excavators		163		8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175	10.00	8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172	10.00	8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8		8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81		8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362	10.00	8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes		98		8			
Trenchers		81		8			
Welders		45		8			
	40						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS Sac South Levee (G&E to Spoils)												
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	
Grading/Excavation	5.3	25.2	107.2	70.6	3.6	67.0	16.9	2.9	13.9	16,827.5		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (pounds/day)</b>	5.3	25.2	107.2	70.6	3.6	67.0	16.9	2.9	13.9	16,827.5		
<b>Total (tons/construction project)</b>	0.2	0.9	3.8	1.2	0.1	1.1	0.3	0.1	0.2	592.3		
Notes:	Project Start Year ->	2016										
	Project Length (months) ->	3										
	Total Project Area (acres) ->	28										
	Maximum Area Disturbed/Day (acres) ->	7										
	Total Soil Imported/Exported (yd <sup>3</sup> /day)->	2229										
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												
Emission Estimates for -> WS Sac South Levee (G&E to Spoils)												
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	
Grading/Excavation	2.4	11.4	48.7	32.1	1.7	30.5	7.7	1.3	6.3	7,648.9		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (kilograms/day)</b>	2.4	11.4	48.7	32.1	1.7	30.5	7.7	1.3	6.3	7,648.9		
<b>Total (megagrams/construction project)</b>	0.2	0.8	3.4	1.1	0.1	1.0	0.3	0.1	0.2	537.3		
Notes:	Project Start Year ->	2016										
	Project Length (months) ->	3										
	Total Project Area (hectares) ->	11										
	Maximum Area Disturbed/Day (hectares) ->	3										
	Total Soil Imported/Exported (meters <sup>3</sup> /day)->	1704										
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS Sac South Levee (G&E to Spoils)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	3.2	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported		yd <sup>3</sup> /day
Soil Exported	2229.0	yd <sup>3</sup> /day
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<p><b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b></p>		
<p>Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.</p>		
		Program
	User Override of	Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.00	0.32
Grading/Excavation	3.20	1.44
Drainage/Utilities/Sub-Grade	0.00	0.96
Paving	0.00	0.48
<b>Totals</b>	<b>3.20</b>	<b>3.20</b>

Hauling emission default values can be overridden in cells C45 through C46.							
<b>Soil Hauling Emissions</b>							
<b>User Input</b>		User Override of					
		Soil Hauling Defaults		Default Values			
Miles/round trip				30			
Round trips/day				111			
Vehicle miles traveled/day (calculated)				3343.5			
<b>Hauling Emissions</b>							
		<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>
Emission rate (grams/mile)		0.16	8.25	0.70	0.17	0.10	1679.86
Emission rate (grams/trip)		0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day		1.2	60.8	5.2	1.2	0.7	12371.4
Tons per construction period		0.04	2.14	0.18	0.04	0.03	435.47
Worker commute default values can be overridden in cells C60 through C65.							
<b>Worker Commute Emissions</b>							
		User Override of Worker					
		Commute Default Values		Default Values			
Miles/ one-way trip				20			
One-way trips/day				2			
No. of employees: Grubbing/Land Clearing		0.00	10				
No. of employees: Grading/Excavation		10.00	15				
No. of employees: Drainage/Utilities/Sub-Grade		0.00	11				
No. of employees: Paving		0.00	13				
<b>Worker Commute Emissions</b>							
		<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>
Emission rate - Grubbing/Land Clearing (grams/mile)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/mile)		0.147	0.194	1.744	0.047	0.020	443.650
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/mile)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grubbing/Land Clearing (grams/trip)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Grading/Excavation (grams/trip)		0.505	0.323	4.200	0.004	0.003	95.592
Emission rate - Draining/Utilities/Sub-Grade (gr/trip)		0.000	0.000	0.000	0.000	0.000	0.000
Emission rate - Paving (grams/trip)		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grubbing/Land Clearing		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grub/Land Clear		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Grading/Excavation		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Grading/Excavation		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Drainage/Utilities/Sub-Grade		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Drain/Util/Sub-Grade		0.000	0.000	0.000	0.000	0.000	0.000
Pounds per day - Paving		0.000	0.000	0.000	0.000	0.000	0.000
Tons per const. Period - Paving		0.000	0.000	0.000	0.000	0.000	0.000
tons per construction period		0.000	0.000	0.000	0.000	0.000	0.000

Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust		2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02	
Tons per const. Period - Grading/Excavation	0.00	0.10	0.01	0.00	0.00	20.84	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	67.0	1.1	13.9	0.2	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	



	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00	3	Excavators	0.51	3.49	5.58	0.27	0.25	716.08
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Graders	1.33	4.35	12.98	0.73	0.67	838.78
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.46	2.41	4.90	0.26	0.24	438.31
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Tractors/Loaders/Backhoes	0.90	3.93	8.17	0.63	0.58	839.81
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	4.1	19.8	43.5	2.3	2.2	3864.1
	Grading	tons per phase	0.1	0.7	1.5	0.1	0.1	136.0



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.1	0.7	1.5	0.1	0.1	136.0

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes		226		8			
Crawler Tractors		208	10.00	8			
Crushing/Proc. Equipment		142		8			
Excavators		163	10.00	8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175	10.00	8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172		8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8		8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81		8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362		8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes		98	10.00	8			
Trenchers		81		8			
Welders		45		8			
	40						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS DWSC East Levee (G&E to Spoils)												
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	5.9	27.6	135.5	71.2	4.2	67.0	17.2	3.3	13.9	22,586.7		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (pounds/day)</b>	5.9	27.6	135.5	71.2	4.2	67.0	17.2	3.3	13.9	22,586.7		
<b>Total (tons/construction project)</b>	0.2	1.0	4.9	1.2	0.2	1.1	0.3	0.1	0.2	819.9		
Notes: Project Start Year -> 2016 Project Length (months) -> 3 Total Project Area (acres) -> 28 Maximum Area Disturbed/Day (acres) -> 7 Total Soil Imported/Exported (yd <sup>3</sup> /day)-> 1389 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												
Emission Estimates for -> WS DWSC East Levee (G&E to Spoils)												
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	2.7	12.5	61.6	32.4	1.9	30.5	7.8	1.5	6.3	10,266.7		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (kilograms/day)</b>	2.7	12.5	61.6	32.4	1.9	30.5	7.8	1.5	6.3	10,266.7		
<b>Total (megagrams/construction project)</b>	0.2	0.9	4.5	1.1	0.1	1.0	0.3	0.1	0.2	743.7		
Notes: Project Start Year -> 2016 Project Length (months) -> 3 Total Project Area (hectares) -> 11 Maximum Area Disturbed/Day (hectares) -> 3 Total Soil Imported/Exported (meters <sup>3</sup> /day)-> 1062 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												





Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust		2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02	
Tons per const. Period - Grading/Excavation	0.00	0.11	0.01	0.00	0.00	21.49	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	67.0	1.1	13.9	0.2	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	



	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00	3	Excavators	0.51	3.49	5.58	0.27	0.25	716.08
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Graders	1.33	4.35	12.98	0.73	0.67	838.78
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.46	2.41	4.90	0.26	0.24	438.31
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Tractors/Loaders/Backhoes	0.90	3.93	8.17	0.63	0.58	839.81
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	4.1	19.8	43.5	2.3	2.2	3864.1
	Grading	tons per phase	0.1	0.7	1.6	0.1	0.1	140.3



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.1	0.7	1.6	0.1	0.1	140.3

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes		226		8			
Crawler Tractors		208	10.00	8			
Crushing/Proc. Equipment		142		8			
Excavators		163	10.00	8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175	10.00	8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172		8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8		8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81		8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362		8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes		98	10.00	8			
Trenchers		81		8			
Welders		45		8			
	40						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS Sac South Levee (G&E Import Impervious Fill)											
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)	
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	
Grading/Excavation	9.2	55.1	135.8	105.5	5.0	100.5	25.2	4.3	20.9	17,970.3	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (pounds/day)</b>	<b>9.2</b>	<b>55.1</b>	<b>135.8</b>	<b>105.5</b>	<b>5.0</b>	<b>100.5</b>	<b>25.2</b>	<b>4.3</b>	<b>20.9</b>	<b>17,970.3</b>	
<b>Total (tons/construction project)</b>	<b>0.1</b>	<b>0.5</b>	<b>1.2</b>	<b>0.4</b>	<b>0.0</b>	<b>0.4</b>	<b>0.1</b>	<b>0.0</b>	<b>0.1</b>	<b>158.1</b>	
Notes: Project Start Year -> 2016 Project Length (months) -> 1 Total Project Area (acres) -> 28 Maximum Area Disturbed/Day (acres) -> 7 Total Soil Imported/Exported (yd <sup>3</sup> /day)-> 1241 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.											
Emission Estimates for -> WS Sac South Levee (G&E Import Impervious Fill)											
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)	
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	
Grading/Excavation	4.2	25.0	61.7	47.9	2.3	45.7	11.5	2.0	9.5	8,168.3	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (kilograms/day)</b>	<b>4.2</b>	<b>25.0</b>	<b>61.7</b>	<b>47.9</b>	<b>2.3</b>	<b>45.7</b>	<b>11.5</b>	<b>2.0</b>	<b>9.5</b>	<b>8,168.3</b>	
<b>Total (megagrams/construction project)</b>	<b>0.1</b>	<b>0.4</b>	<b>1.1</b>	<b>0.4</b>	<b>0.0</b>	<b>0.4</b>	<b>0.1</b>	<b>0.0</b>	<b>0.1</b>	<b>143.4</b>	
Notes: Project Start Year -> 2016 Project Length (months) -> 1 Total Project Area (hectares) -> 11 Maximum Area Disturbed/Day (hectares) -> 3 Total Soil Imported/Exported (meters <sup>3</sup> /day)-> 949 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.											

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS Sac South Levee (G&E Import Impervious Fill)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.8	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	1241.0	yd <sup>3</sup> /day
Soil Exported		yd <sup>3</sup> /day
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
	User Override of	Program Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.00	0.08
Grading/Excavation	0.80	0.36
Drainage/Utilities/Sub-Grade	0.00	0.24
Paving	0.00	0.12
<b>Totals</b>	<b>0.80</b>	<b>0.80</b>



Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust	1.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.03	1.45	0.12	0.03	0.02	296.01	
Tons per const. Period - Grading/Excavation	0.00	0.01	0.00	0.00	0.00	2.60	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	100.5	0.4	20.9	0.1	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	



	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00	3	Excavators	0.51	3.49	5.58	0.27	0.25	716.08
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Graders	1.33	4.35	12.98	0.73	0.67	838.78
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.46	2.41	4.90	0.26	0.24	438.31
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Rollers	0.44	1.89	3.86	0.28	0.26	349.42
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1	Scrapers	1.82	9.07	22.12	0.89	0.82	2010.03
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
3.00		Tractors/Loaders/Backhoes	3.07	25.30	39.19	1.36	1.25	5402.74
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	8.6	52.1	100.5	4.3	3.9	10786.5
	Grading	tons per phase	0.1	0.5	0.9	0.0	0.0	94.9



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.1	0.5	0.9	0.0	0.0	94.9

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes		226		8			
Crawler Tractors		208	10.00	8			
Crushing/Proc. Equipment		142		8			
Excavators		163	10.00	8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175	10.00	8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172		8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8		8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81	10.00	8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362	10.00	8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes	425.00	98	10.00	8			
Trenchers		81		8			
Welders		45		8			
	485						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS DWSC East Levee (G&E Import Impervious Fill)												
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	10.0	58.7	178.0	72.8	5.8	67.0	18.8	4.8	13.9	26,549.0		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (pounds/day)</b>	10.0	58.7	178.0	72.8	5.8	67.0	18.8	4.8	13.9	26,549.0		
<b>Total (tons/construction project)</b>	0.1	0.4	1.2	0.2	0.0	0.2	0.1	0.0	0.0	175.2		
Notes: Project Start Year -> 2016 Project Length (months) -> 1 Total Project Area (acres) -> 28 Maximum Area Disturbed/Day (acres) -> 7 Total Soil Imported/Exported (yd <sup>3</sup> /day)-> 1253 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												
Emission Estimates for -> WS DWSC East Levee (G&E Import Impervious Fill)												
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	4.6	26.7	80.9	33.1	2.6	30.5	8.5	2.2	6.3	12,067.7		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (kilograms/day)</b>	4.6	26.7	80.9	33.1	2.6	30.5	8.5	2.2	6.3	12,067.7		
<b>Total (megagrams/construction project)</b>	0.1	0.4	1.1	0.2	0.0	0.2	0.1	0.0	0.0	158.9		
Notes: Project Start Year -> 2016 Project Length (months) -> 1 Total Project Area (hectares) -> 11 Maximum Area Disturbed/Day (hectares) -> 3 Total Soil Imported/Exported (meters <sup>3</sup> /day)-> 958 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												

Road Construction Emissions Model		Version 7.1.2					
<b>Data Entry Worksheet</b>							
Note: Required data input sections have a yellow background.							
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.							
The user is required to enter information in cells C10 through C25.							
<b>Input Type</b>							
Project Name	WS DWSC East Levee (G&E Import Impervious Fill)						
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)					
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction					
Project Construction Time	0.6	months					
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock					
Project Length	1.5	miles					
Total Project Area	28.0	acres					
Maximum Area Disturbed/Day	6.7	acres					
Water Trucks Used?	1	1. Yes 2. No					
Soil Imported	1253.0	yd <sup>3</sup> /day					
Soil Exported		yd <sup>3</sup> /day					
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)					
To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.							
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>							
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.							
	User Override of	Program Calculated					
<b>Construction Periods</b>	Construction Months	Months					
Grubbing/Land Clearing	0.00	0.06					
Grading/Excavation	0.60	0.27					
Drainage/Utilities/Sub-Grade	0.00	0.18					
Paving	0.00	0.09					
<b>Totals</b>	<b>0.60</b>	<b>0.60</b>					



Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust		2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.06	2.91	0.25	0.06	0.03	592.02	
Tons per const. Period - Grading/Excavation	0.00	0.02	0.00	0.00	0.00	3.91	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	67.0	0.2	13.9	0.0	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	



	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
1.00	3	Excavators	0.51	3.49	5.58	0.27	0.25	716.08
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Graders	1.33	4.35	12.98	0.73	0.67	838.78
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.46	2.41	4.90	0.26	0.24	438.31
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Rollers	0.44	1.89	3.86	0.28	0.26	349.42
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1	Scrapers	1.82	9.07	22.12	0.89	0.82	2010.03
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
3.00		Tractors/Loaders/Backhoes	3.07	25.30	39.19	1.36	1.25	5402.74
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	8.6	52.1	100.5	4.3	3.9	10786.5
	Grading	tons per phase	0.1	0.3	0.7	0.0	0.0	71.2



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.1	0.3	0.7	0.0	0.0	71.2

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes		226		8			
Crawler Tractors		208	10.00	8			
Crushing/Proc. Equipment		142		8			
Excavators		163	10.00	8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175	10.00	8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172		8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8		8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81	10.00	8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362	10.00	8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes	425.00	98	10.00	8			
Trenchers		81		8			
Welders		45		8			
	485						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS Sac South Levee (G&E Import Random Fill/ Topsoil)												
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	18.9	113.0	293.3	77.4	10.4	67.0	22.9	8.9	13.9	40,499.3		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (pounds/day)</b>	18.9	113.0	293.3	77.4	10.4	67.0	22.9	8.9	13.9	40,499.3		
<b>Total (tons/construction project)</b>	0.8	4.7	12.1	1.7	0.4	1.2	0.6	0.4	0.3	1,670.6		
Notes:	Project Start Year ->	2016										
	Project Length (months) ->	4										
	Total Project Area (acres) ->	28										
	Maximum Area Disturbed/Day (acres) ->	7										
	Total Soil Imported/Exported (yd <sup>3</sup> /day)->	2555										
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												
Emission Estimates for -> WS Sac South Levee (G&E Import Random Fill/ Topsoil)												
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	-
Grading/Excavation	8.6	51.4	133.3	35.2	4.7	30.5	10.4	4.1	6.3	18,408.8		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	-
Paving	-	-	-	-	-	-	-	-	-	-	-	-
<b>Maximum (kilograms/day)</b>	8.6	51.4	133.3	35.2	4.7	30.5	10.4	4.1	6.3	18,408.8		
<b>Total (megagrams/construction project)</b>	0.7	4.2	11.0	1.5	0.4	1.1	0.6	0.3	0.2	1,515.3		
Notes:	Project Start Year ->	2016										
	Project Length (months) ->	4										
	Total Project Area (hectares) ->	11										
	Maximum Area Disturbed/Day (hectares) ->	3										
	Total Soil Imported/Exported (meters <sup>3</sup> /day)->	1953										
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS Sac South Levee (G&E Import Random Fill/ Topsoil)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	3.8	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	2555.0	yd <sup>3</sup> /day
Soil Exported		yd <sup>3</sup> /day
Average Truck Capacity	30.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
		Program
	User Override of	Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.00	0.38
Grading/Excavation	3.75	1.69
Drainage/Utilities/Sub-Grade	0.00	1.13
Paving	0.00	0.56
<b>Totals</b>	<b>3.75</b>	<b>3.75</b>



Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust	3.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.08	4.36	0.37	0.09	0.05	888.03	
Tons per const. Period - Grading/Excavation	0.00	0.18	0.02	0.00	0.00	36.63	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	67.0	1.2	13.9	0.3	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	







	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.7	4.3	8.3	0.4	0.3	901.3

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes		226		8			
Crawler Tractors		208	10.00	8			
Crushing/Proc. Equipment		142		8			
Excavators		163	10.00	8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175	10.00	8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172		8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8		8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81	10.00	8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362	10.00	8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes	425.00	98	10.00	8			
Trenchers		81		8			
Welders		45		8			
	485						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS DWSC East Levee (G&E Import Random Fill/ Topsoil)												
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	
Grading/Excavation	11.0	65.5	187.7	106.8	6.3	100.5	26.2	5.3	20.9	27,685.1		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (pounds/day)</b>	11.0	65.5	187.7	106.8	6.3	100.5	26.2	5.3	20.9	27,685.1		
<b>Total (tons/construction project)</b>	0.3	2.0	5.7	1.6	0.2	1.4	0.4	0.2	0.3	837.5		
Notes:	Project Start Year ->	2016										
	Project Length (months) ->	3										
	Total Project Area (acres) ->	28										
	Maximum Area Disturbed/Day (acres) ->	7										
	Total Soil Imported/Exported (yd <sup>3</sup> /day)->	1271										
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												
Emission Estimates for -> WS DWSC East Levee (G&E Import Random Fill/ Topsoil)												
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)		
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	-	
Grading/Excavation	5.0	29.8	85.3	48.6	2.9	45.7	11.9	2.4	9.5	12,584.2		
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (kilograms/day)</b>	5.0	29.8	85.3	48.6	2.9	45.7	11.9	2.4	9.5	12,584.2		
<b>Total (megagrams/construction project)</b>	0.3	1.8	5.1	1.4	0.2	1.2	0.4	0.1	0.3	759.6		
Notes:	Project Start Year ->	2016										
	Project Length (months) ->	3										
	Total Project Area (hectares) ->	11										
	Maximum Area Disturbed/Day (hectares) ->	3										
	Total Soil Imported/Exported (meters <sup>3</sup> /day)->	972										
PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.												
Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.												

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS DWSC East Levee (G&E Import Random Fill/ Topsoil)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	2.8	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	1271.0	yd <sup>3</sup> /day
Soil Exported		yd <sup>3</sup> /day
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
	User Override of	Program Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.00	0.28
Grading/Excavation	2.75	1.24
Drainage/Utilities/Sub-Grade	0.00	0.83
Paving	0.00	0.41
<b>Totals</b>	<b>2.75</b>	<b>2.75</b>



Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust	1.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.03	1.45	0.12	0.03	0.02	296.01	
Tons per const. Period - Grading/Excavation	0.00	0.04	0.00	0.00	0.00	8.95	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	100.5	1.4	20.9	0.3	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	



	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	3	Excavators	1.54	10.46	16.75	0.82	0.76	2148.24
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
1.00	2	Graders	1.33	4.35	12.98	0.73	0.67	838.78
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.46	2.41	4.90	0.26	0.24	438.31
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Rollers	0.44	1.89	3.86	0.28	0.26	349.42
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
1.00	1	Scrapers	1.82	9.07	22.12	0.89	0.82	2010.03
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
3.00		Tractors/Loaders/Backhoes	3.07	25.30	39.19	1.36	1.25	5402.74
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	9.6	59.1	111.7	4.8	4.4	12218.6
	Grading	tons per phase	0.3	1.8	3.4	0.1	0.1	369.6



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.3	1.8	3.4	0.1	0.1	369.6

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes		226		8			
Crawler Tractors		208	10.00	8			
Crushing/Proc. Equipment		142		8			
Excavators		163	10.00	8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175	10.00	8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172		8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8		8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81	10.00	8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362	10.00	8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes	425.00	98	10.00	8			
Trenchers		81		8			
Welders		45		8			
	485						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS Sac South Levee (G&E Surfacing)											
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)	
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	
Grading/Excavation	7.8	36.1	111.6	71.8	4.8	67.0	18.1	4.2	13.9	14,463.1	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (pounds/day)</b>	<b>7.8</b>	<b>36.1</b>	<b>111.6</b>	<b>71.8</b>	<b>4.8</b>	<b>67.0</b>	<b>18.1</b>	<b>4.2</b>	<b>13.9</b>	<b>14,463.1</b>	
<b>Total (tons/construction project)</b>	<b>0.0</b>	<b>0.2</b>	<b>0.6</b>	<b>0.2</b>	<b>0.0</b>	<b>0.2</b>	<b>0.1</b>	<b>0.0</b>	<b>0.0</b>	<b>79.5</b>	

Notes: Project Start Year -> 2016  
 Project Length (months) -> 1  
 Total Project Area (acres) -> 28  
 Maximum Area Disturbed/Day (acres) -> 7  
 Total Soil Imported/Exported (yd<sup>3</sup>/day)-> 1320

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Emission Estimates for -> WS Sac South Levee (G&E Surfacing)											
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)	
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	
Grading/Excavation	3.5	16.4	50.7	32.7	2.2	30.5	8.2	1.9	6.3	6,574.1	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (kilograms/day)</b>	<b>3.5</b>	<b>16.4</b>	<b>50.7</b>	<b>32.7</b>	<b>2.2</b>	<b>30.5</b>	<b>8.2</b>	<b>1.9</b>	<b>6.3</b>	<b>6,574.1</b>	
<b>Total (megagrams/construction project)</b>	<b>0.0</b>	<b>0.2</b>	<b>0.6</b>	<b>0.2</b>	<b>0.0</b>	<b>0.2</b>	<b>0.1</b>	<b>0.0</b>	<b>0.0</b>	<b>72.2</b>	

Notes: Project Start Year -> 2016  
 Project Length (months) -> 1  
 Total Project Area (hectares) -> 11  
 Maximum Area Disturbed/Day (hectares) -> 3  
 Total Soil Imported/Exported (meters<sup>3</sup>/day)-> 1009

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS Sac South Levee (G&E Surfacing)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	0.5	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	1320.0	yd <sup>3</sup> /day
Soil Exported		yd <sup>3</sup> /day
Average Truck Capacity	20.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
	User Override of	Program Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.00	0.05
Grading/Excavation	0.50	0.23
Drainage/Utilities/Sub-Grade	0.00	0.15
Paving	0.00	0.08
<b>Totals</b>	<b>0.50</b>	<b>0.50</b>



Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust	3.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.08	4.36	0.37	0.09	0.05	888.03	
Tons per const. Period - Grading/Excavation	0.00	0.02	0.00	0.00	0.00	4.88	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	67.0	0.2	13.9	0.0	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	



	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
	3	Excavators	1.23	8.37	13.40	0.66	0.61	1718.59
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
2.00	2	Graders	2.67	8.70	25.95	1.46	1.34	1677.56
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
	1	Other Construction Equipment	0.46	2.41	4.90	0.26	0.24	438.31
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Rollers	0.88	3.77	7.73	0.57	0.52	698.83
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
2.00		Tractors/Loaders/Backhoes	0.90	3.93	8.17	0.63	0.58	839.81
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	7.1	32.8	72.0	4.0	3.7	6404.2
	Grading	tons per phase	0.0	0.2	0.4	0.0	0.0	35.2



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.0	0.2	0.4	0.0	0.0	35.2

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes		226		8			
Crawler Tractors		208	10.00	8			
Crushing/Proc. Equipment		142		8			
Excavators		163		8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175	10.00	8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172		8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8		8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81	10.00	8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362		8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes		98	10.00	8			
Trenchers		81		8			
Welders		45		8			
	40						
<b>END OF DATA ENTRY SHEET</b>							

## Road Construction Emissions Model, Version 7.1.2

Emission Estimates for -> WS Sac South Levee (G&E Import Rip Rap - Truck)											
Project Phases (English Units)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	CO2 (lbs/day)	
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	
Grading/Excavation	3.8	20.7	99.9	136.8	2.8	134.0	30.0	2.1	27.9	17,683.7	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (pounds/day)</b>	<b>3.8</b>	<b>20.7</b>	<b>99.9</b>	<b>136.8</b>	<b>2.8</b>	<b>134.0</b>	<b>30.0</b>	<b>2.1</b>	<b>27.9</b>	<b>17,683.7</b>	
<b>Total (tons/construction project)</b>	<b>0.2</b>	<b>1.0</b>	<b>4.6</b>	<b>2.9</b>	<b>0.1</b>	<b>2.8</b>	<b>0.7</b>	<b>0.1</b>	<b>0.6</b>	<b>817.0</b>	
Notes: Project Start Year -> 2016 Project Length (months) -> 4 Total Project Area (acres) -> 28 Maximum Area Disturbed/Day (acres) -> 7 Total Soil Imported/Exported (yd <sup>3</sup> /day)-> 3200 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.											
Emission Estimates for -> WS Sac South Levee (G&E Import Rip Rap - Truck)											
Project Phases (Metric Units)	ROG (kgs/day)	CO (kgs/day)	NOx (kgs/day)	Total PM10 (kgs/day)	Exhaust PM10 (kgs/day)	Fugitive Dust PM10 (kgs/day)	Total PM2.5 (kgs/day)	Exhaust PM2.5 (kgs/day)	Fugitive Dust PM2.5 (kgs/day)	CO2 (kgs/day)	
Grubbing/Land Clearing	-	-	-	-	-	-	-	-	-	-	
Grading/Excavation	1.7	9.4	45.4	62.2	1.3	60.9	13.6	1.0	12.7	8,038.0	
Drainage/Utilities/Sub-Grade	-	-	-	-	-	-	-	-	-	-	
Paving	-	-	-	-	-	-	-	-	-	-	
<b>Maximum (kilograms/day)</b>	<b>1.7</b>	<b>9.4</b>	<b>45.4</b>	<b>62.2</b>	<b>1.3</b>	<b>60.9</b>	<b>13.6</b>	<b>1.0</b>	<b>12.7</b>	<b>8,038.0</b>	
<b>Total (megagrams/construction project)</b>	<b>0.2</b>	<b>0.9</b>	<b>4.2</b>	<b>2.6</b>	<b>0.1</b>	<b>2.5</b>	<b>0.6</b>	<b>0.1</b>	<b>0.5</b>	<b>741.0</b>	
Notes: Project Start Year -> 2016 Project Length (months) -> 4 Total Project Area (hectares) -> 11 Maximum Area Disturbed/Day (hectares) -> 3 Total Soil Imported/Exported (meters <sup>3</sup> /day)-> 2446 PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified. Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns H and I. Total PM2.5 emissions shown in Column J are the sum of exhaust and fugitive dust emissions shown in columns K and L.											

Road Construction Emissions Model		Version 7.1.2
<b>Data Entry Worksheet</b>		
Note: Required data input sections have a yellow background.		
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.		
The user is required to enter information in cells C10 through C25.		
<b>Input Type</b>		
Project Name	WS Sac South Levee (G&E Import Rip Rap - Truck)	
Construction Start Year	2016	Enter a Year between 2009 and 2025 (inclusive)
Project Type	1	1 New Road Construction 2 Road Widening 3 Bridge/Overpass Construction
Project Construction Time	4.2	months
Predominant Soil/Site Type: Enter 1, 2, or 3	2	1. Sand Gravel 2. Weathered Rock-Earth 3. Blasted Rock
Project Length	1.5	miles
Total Project Area	28.0	acres
Maximum Area Disturbed/Day	6.7	acres
Water Trucks Used?	1	1. Yes 2. No
Soil Imported	3200.0	yd <sup>3</sup> /day
Soil Exported		yd <sup>3</sup> /day
Average Truck Capacity	40.0	yd <sup>3</sup> (assume 20 if unknown)
<p>To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.</p>		
<b>The remaining sections of this sheet contain areas that can be modified by the user, although those modifications are optional.</b>		
Note: The program's estimates of construction period phase length can be overridden in cells C34 through C37.		
		Program
	User Override of	Calculated
<b>Construction Periods</b>	Construction Months	Months
Grubbing/Land Clearing	0.00	0.42
Grading/Excavation	4.20	1.89
Drainage/Utilities/Sub-Grade	0.00	1.26
Paving	0.00	0.63
<b>Totals</b>	<b>4.20</b>	<b>4.20</b>



Water truck default values can be overridden in cells C91 through C93 and E91 through E93.							
<b>Water Truck Emissions</b>	User Override of	Program Estimate of	User Override of Truck	Default Values			
	Default # Water Trucks	Number of Water Trucks	Miles Traveled/Day	Miles Traveled/Day			
Grubbing/Land Clearing - Exhaust	0.00	2		80			
Grading/Excavation - Exhaust	0.00	2		80			
Drainage/Utilities/Subgrade	0.00	1		40			
	<b>ROG</b>	<b>NOx</b>	<b>CO</b>	<b>PM10</b>	<b>PM2.5</b>	<b>CO2</b>	
Emission rate - Grubbing/Land Clearing (grams/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Emission rate - Grading/Excavation (grams/mile)	0.16	8.25	0.70	0.17	0.10	1679.86	
Emission rate - Draining/Utilities/Sub-Grade (gr/mile)	0.00	0.00	0.00	0.00	0.00	0.00	
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grub/Land Clear	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	
Pound per day - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Tons per const. Period - Drainage/Utilities/Subgrade	0.00	0.00	0.00	0.00	0.00	0.00	
Fugitive dust default values can be overridden in cells C110 through C112.							
<b>Fugitive Dust</b>	User Override of Max	Default	PM10	PM10	PM2.5	PM2.5	
	Acreage Disturbed/Day	Maximum Acreage/Day	pounds/day	tons/per period	pounds/day	tons/per period	
Fugitive Dust - Grubbing/Land Clearing		0	0.0	0.0	0.0	0.0	
Fugitive Dust - Grading/Excavation		6.7	134.0	2.8	27.9	0.6	
Fugitive Dust - Drainage/Utilities/Subgrade		0	0.0	0.0	0.0	0.0	



	Default							
Grading/Excavation	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
	0	Cranes	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Crawler Tractors	0.92	5.59	11.90	0.46	0.42	1031.11
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
2.00	3	Excavators	1.02	6.97	11.17	0.55	0.51	1432.16
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Pavers	0.00	0.00	0.00	0.00	0.00	0.00
		Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
		Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
0.00	1	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
1.00		Tractors/Loaders/Backhoes	0.45	1.97	4.09	0.31	0.29	419.90
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Grading/Excavation	pounds per day	2.4	14.5	27.2	1.3	1.2	2883.2
	Grading	tons per phase	0.1	0.7	1.3	0.1	0.1	133.2



	Default							
<b>Paving</b>	Number of Vehicles		ROG	CO	NOx	PM10	PM2.5	CO2
Override of Default Number of Vehicles	Program-estimate	Type	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day	pounds/day
		Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00
		Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00
		Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00
		Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00
		Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00
		Cranes	0.00	0.00	0.00	0.00	0.00	0.00
		Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Excavators	0.00	0.00	0.00	0.00	0.00	0.00
		Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00
		Graders	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00
		Off-Highway Trucks	0.00	0.00	0.00	0.00	0.00	0.00
		Other Construction Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other General Industrial Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Other Material Handling Equipment	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Pavers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	2	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00
		Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00
		Pumps	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Rollers	0.00	0.00	0.00	0.00	0.00	0.00
		Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00
		Rubber Tired Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Scrapers	0.00	0.00	0.00	0.00	0.00	0.00
0.00	3	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00
		Skid Steer Loaders	0.00	0.00	0.00	0.00	0.00	0.00
		Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00
		Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00
		Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00
		Trenchers	0.00	0.00	0.00	0.00	0.00	0.00
		Welders	0.00	0.00	0.00	0.00	0.00	0.00
	Paving	pounds per day	0.0	0.0	0.0	0.0	0.0	0.0
	Paving	tons per phase	0.0	0.0	0.0	0.0	0.0	0.0
<b>Total Emissions all Phases (tons per construction period) =&gt;</b>			0.1	0.7	1.3	0.1	0.1	133.2

Equipment default values for horsepower and hours/day can be overridden in cells C289 through C322 and E289 through E322.							
		Default Values		Default Values			
Equipment		Horsepower		Hours/day			
Aerial Lifts		63		8			
Air Compressors		106		8			
Bore/Drill Rigs		206		8			
Cement and Mortar Mixers		10		8			
Concrete/Industrial Saws		64		8			
Cranes		226		8			
Crawler Tractors		208	10.00	8			
Crushing/Proc. Equipment		142		8			
Excavators		163	10.00	8			
Forklifts		89		8			
Generator Sets		66		8			
Graders		175		8			
Off-Highway Tractors		123		8			
Off-Highway Trucks		400		8			
Other Construction Equipment		172		8			
Other General Industrial Equipment		88		8			
Other Material Handling Equipment		167		8			
Pavers		126		8			
Paving Equipment		131		8			
Plate Compactors		8		8			
Pressure Washers		26		8			
Pumps		53		8			
Rollers		81		8			
Rough Terrain Forklifts		100		8			
Rubber Tired Dozers		255		8			
Rubber Tired Loaders		200		8			
Scrapers		362		8			
Signal Boards		20		8			
Skid Steer Loaders		65		8			
Surfacing Equipment		254		8			
Sweepers/Scrubbers		64		8			
Tractors/Loaders/Backhoes		98	10.00	8			
Trenchers		81		8			
Welders		45		8			
	30						
<b>END OF DATA ENTRY SHEET</b>							

**West Sacramento GRR EIS/EIR  
Appendix E**

**HTRW Phase 1 Environmental Site Assessment**

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# PHASE 1 ENVIRONMENTAL SITE ASSESSMENT

## WEST SACRAMENTO LEVEE GENERAL REEVALUATION REPORT (GRR)

West Sacramento, CA

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Prepared by:



**US Army Corps  
of Engineers®**

May 2012

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**APPENDICES**

- Appendix A: Environmental Records Database Search - EDR Radius Map with  
GeoCheck
- Appendix B: Site Classification Report
- Appendix C: Interviews

## ACRONYMS

AST	Aboveground Storage Tank
ASTM	American Society for Testing and Materials
BTEX	Benzene, Toluene, Ethylbenzene, and total Xylenes
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation and Liability Information System
CESPK	US Army Corps of Engineers, Sacramento District
COCs	Contaminates of Concern
DCA	Di-chloro Ethane
DCE	Di-chloro Ethylene
DoD	Department of Defense
DTSC	Department of Toxic Substance Control
DWR	California Department of Water Resources
DWSC	Deep Water Ship Channel
EDR	Environmental Data Resources Inc.
ER	Engineering Regulation (US Army Corps of Engineers)
ESA	Environmental Site Assessment
FUDS	Formerly Used Defense Sites
GRR	General Reevaluation Report
HTRW	Hazardous, Toxic or Radioactive Waste
IAW	In accordance with
KMEP	Kinder Morgan Energy Partners
LUST	Leaking Underground Storage Tank
MTBE	Methyl tert-butyl ether
NEPA	National Environmental Policy Act
NFA	No further Action
NGVD29	National Geodetic Vertical Datum of 1929
NPL	National Priority List (Superfund Site)
PCB	Polychlorinated Biphenyl
PCE	Tetra-chloro ethylene
RCRA	Resource Conservation and Recovery Act
RD900	State of California Reclamation District 900
SVE/AS	Soil Vapor Extraction/Air Sparging
SWRCB	State Water Resources Control Board
TARP	Tesoro ARCO Remediation Project
TBA	Tert-butyl Alcohol
TCA	Tri-chloro ethane
TCE	Tri-chloro ethylene
TPH-d	Total Petroleum Hydrocarbons as Diesel
TPH-g	Total Petroleum Hydrocarbons as Gasoline
TSCA	Toxic Substance Control Act
USACE	United States Army Corps of Engineers
USEPA	US Environmental Protection Agency
USGS	US Geological Survey

## **1.0 EXECUTIVE SUMMARY**

The West Sacramento Levee General Reevaluation Report (GRR) project is currently performing a study along approximately 50.5 miles of the levee system that surround the City of West Sacramento and the Deep-Water Ship Channel.

The GRR is in the Feasibility Study phase of the Civil Works process, which requires a Phase 1 Environmental Site Assessment (ESA) be performed to identify environmental contamination at or near the project construction site. Contaminated sites have the potential to significantly impact future construction activities and need to be identified as early as possible.

Records review identified 788 environmental sites including nine sites that have the Hazardous, Toxic, Radiologic Waster (HTRW) concerns with the potential to affect future construction activities and eight sites with HTRW concerns that should not affect future construction activities. Regional contaminants from historic agriculture and mining sources are present and should be considered on a site specific basis if future construction activity generates soil for reuse or disposal.

This Phase 1 ESA identifies and generally describes locations where environmental conditions exist in proximity to the project levee. The purpose of the GRR is to identify deficiencies in the levee system and perform feasibility analysis on potential remedies for these deficiencies. Separate reports and construction plans will be developed for the chosen remedial alternatives. As the West Sacramento GRR project schedule approaches actual construction, an additional Phase 1 ESA may be necessary to provide up-to-date information necessary to comply with USACE Civil Works process.

## **2.0 INTRODUCTION**

### **2.1 Purpose**

The purpose of this Phase 1 ESA is to identify recognized HTRW environmental conditions, including the presence or likely presence of any hazardous substances or petroleum products under conditions that indicate an existing release, a past release, or the material threat of a release into structures, the ground, and groundwater or surface waters of the project site.

A Phase 1 ESA is required by the United States Army Corps of Engineers (USACE) *Engineering Regulation (ER) 1165-2-132; HAZARDOUS, TOXIC AND RADIOACTIVE (HTRW) GUIDANCE FOR CIVIL WORKS PROJECTS. ASTM 1527-05 - Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process* is widely used in the environmental industry and will be followed as applicable in this report.

The West Sacramento GRR will analyze the levee system surrounding the City of West Sacramento (hereafter referred to as “the City”) and the Deep Water Ship Channel for areas that need repair. These areas will be addressed in the future by using a range of alternatives developed from past levee construction and repair. The range of possible future construction activities may use techniques and methods that require soil and/or groundwater extraction, thereby creating possible contaminant exposure concerns.

### **2.2 Detailed Scope-of-Services**

The scope of this ESA is limited to assessing the environmental condition of the property associated with the levees surrounding the City of West Sacramento and reaches of the Deep Water Ship Canal West Levee to the south of the City. It also is concerned with identifying HTRW sites within the project boundaries and the surrounding area using commonly known and reasonably ascertainable information.

### 2.3 Limitations and Exceptions

The ESA does not include any sampling or testing of soil, air, water or building materials.

### 2.4 Special Terms and Conditions

The current West Sacramento GRR project does not involve purchase of property for commercial purposes, and as such, the conditions for the ASTM specifications are not completely applicable. The ASTM standard is used as a guide and sections that are not applicable are deleted or modified to meet the requirements of the project. Where applicable, the format and guidance recommended by ASTM is followed as stated in standard E 1527-05.

### 2.5 Site Definition

The approach of this report is to search environmental databases and produce a list of sites that have recognized environmental concerns in proximity to the project levee. Sites identified from the environmental database search are classified using the following criteria. The criteria are based on site characteristics that affect the potential of the site to impact future levee construction and repair activities.

**Table 1 - Site Characterization Definitions**

Type	Definition
1	Site with significant HTRW concerns that may impact future construction activities
2	Site with HTRW concerns that are not likely to have an impact on future construction activities
3	Site with no apparent HTRW concerns or concerns that have been remediated and closed in the past
4	Site location separated from project levee by hydraulic divide (Sacramento River)

Type 1 sites have current, significant HTRW concerns that may impact future construction activities. A significant HTRW concern for the West Sacramento GRR

study and future levee construction projects include soil contamination within the footprint of levee construction activities, or groundwater contamination present on the site that extends to areas of levee construction. Sites with currently undefined or ill-defined contaminant plumes that have the possibility to affect future activities are also included in this category. Most of these sites are currently undergoing assessment, active remediation, or monitoring activities that are under the regulation of the California State Water Resources Control Board (SWCRB), or the California Department of Toxic Substances Control (DTSC).

Type 2 sites have identified HTRW concerns that present a low potential to impact future construction activities. These sites are removed from the levee centerline and will not be included in future areas of construction activity. Current remediation measures on these sites have stabilized a groundwater contaminant plume, or removed a significant amount of the soil contamination present on the site. The combination of remediation measures and distance from the project centerline lead to the lower risk categorization of the site.

Type 3 sites have either been closed by a regulatory agency or have no historical evidence of potential HTRW problems. Sites located outside of the “Approximate Minimum Search Distance” defined in ASTM section 8.2.1 but included in the EDR records report are included in this site category as well.

Type 4 sites are not thought to affect project construction because of the presence of the Sacramento River which acts as a hydraulic divide barring the migration of contaminants in groundwater. It is the consensus of geologists and engineers at the Corps of Engineers that the Sacramento River does act as a hydraulic divide. The type of boundary condition used to model the interaction between ground and surface water varies with the stage in the river and whether the river acts as a losing or gaining stream. When the Sacramento River acts as a gaining stream at low stages (i.e. when groundwater flows in to the river from surrounding areas), groundwater flow gradients would prevent any surface water in the river from causing a significant impact to the project sites. During high stage periods the Sacramento River acts as a losing stream, where the water from the river flows

outward and recharges the groundwater in surrounding areas. At this point it may be possible for contaminants from sites across the river to affect the study area but delineation of contaminant sources would prove difficult.

The best reasonably ascertainable data available to evaluate potential impacts of surface water on the project sites comes from regional water quality boards. Review of the most recent water quality information showed that COCs in the Sacramento River included PCBs, mercury, and other agricultural related chemicals. Environmental impacts from PCBs was observed in fish tissue and seems to be a river wide problem that is regional (agriculture and mining) and best represented as area sources. Mercury contamination originates from the historic uses of the river basin for mining purposes. In general the Sacramento River should act as boundary for the site that would prevent the migration of contaminants across the river to the project site.

## **2.6 Guidance**

This report was prepared in accordance with ASTM E 1527-05, Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process; and ER 1165-2-132, HTRW Guidance for Civil Works Projects. Deviations from the approved guidance procedures are noted where appropriate in the report. Reasons for the deviations generally include the unavailability of required information and feasibility concerns associated with the study. All reasonably ascertainable information has been reviewed in the preparation of this report.

An electronic database search and field observations were conducted in order to compile information for this Phase 1 ESA. This assessment did not include sampling or analysis of environmental media.

### **3.0 SITE DESCRIPTION**

#### **3.1 Location and Legal Description**

The West Sacramento Levee system is a levee system that completely surrounds the City of West Sacramento separating the City into two basins. Levees “reaches” have been assigned to segments of the levee to assist with identification of specific locations (see Figure 1). Typically, a levee reach has name that corresponds to the geographic attribute of that particular levee segment.

#### **3.2 Site Vicinity General Characteristics**

The City is in San Joaquin Valley located immediately west of the City of Sacramento. The two cities are separated by the Sacramento River, which flows from north to south. The City contains a mix of residential, commercial, and industrial properties. Approximately 47,000 people reside in the City.

The City is separated into two distinct basins that are formed by the West Sacramento levee system, which protects the City from high water in the Sacramento River, the Yolo Bypass, and the Port of West Sacramento. The Deep Water Ship Channel (DWSC) divides the City into the northern and southern sub-basins.

The northern sub-basin is bordered by the Port North Area and DWSC North Levee on the south, the Sacramento River North Levee on the east, the Sacramento River North Levee and the Sacramento Bypass South Levee on the north, and the Yolo Bypass Levee on the west. Approximately 6100 acres are enclosed in the sub-basin including the majority of the industrial and commercial areas of the city. Large residential areas are also present in the central and northern parts of the sub-basin. Ground elevations in the sub-basin range from approximately elevation 34.0 ft (NGVD29) in the northeast to approximately 16.0-18.0 ft along the DWSC. Levee reaches in the basin include:

- **Sacramento River North Levee** extends for approximately 5.5 miles along the Sacramento River right bank from the Sacramento Bypass south to the confluence of the Barge Canal and the Sacramento River.
- **Sacramento Bypass Levee** extends for approximately 1.1 miles along the Sacramento Bypass left bank from the Sacramento Weir west to the Yolo Bypass Levee.
- **Yolo Bypass Levee** extends for approximately 3.7 miles along the Yolo Bypass left bank from the confluence of the Sacramento Bypass and the Yolo Bypass south to the Navigation Levee (DWSC West).
- **Port North Area** extends for approximately 4.9 miles along the DWSC right bank from the Barge Canal west to the bend in the Navigation Levee.

The southern sub-basin consists of approximately 6900 acres encircled by the Port South Levee on the north, the Sacramento River South Levee on the east, the South Cross Levee on the south, and the DWSC East Levee on the west. The southern sub-basin is primarily comprised of residential neighborhoods in the north and agricultural lands in the south. A large portion of the DWSC West Levee is also included in the study area.

- **Port South Levee** extends for approximately 4 miles along the DWSC left bank from the Barge Canal west past the bend in the DWSC.
- **DWSC West Levee** extends for approximately 21.4 miles along the DWSC right bank from the bend in the DWSC at the intersection of Port North Levee and Yolo Bypass Levee south to Miners Slough.
- **DWSC East Levee** extends for approximately 2.8 miles along the DWSC left bank from the end of Port South Levee south to South Cross Levee.
- **Sacramento River South Levee** extends approximately 5.9 miles along the Sacramento River right bank from the confluence of the Barge Canal and the Sacramento River south to the South Cross Levee.

- **South Cross Levee** extends along the South Cross levee for approximately 1.2 miles from Jefferson Boulevard to the Sacramento River where it intersects the southern end of Sacramento River South Levee.

### **3.3 Current Use of Property**

The West Sacramento Levee system property is a currently used a flood protection levee for the City of West Sacramento.

### **3.4 Descriptions of Structures, Roads, Other Improvements on the Site**

Roads along the West Sacramento levee system are a mix of gravel and paved roads that can be found along the levee crest and at the base of the levee. The levee system is crossed by six bridges at Interstate 80, I Street, Capitol Avenue, U.S. Highway 50 (Capitol City Freeway), South Jefferson Boulevard, and Industrial Boulevard. There are numerous residences and businesses built on the project site within the developed areas of the City.

### **3.5 Current Uses of Adjoining Properties**

Landside adjacent properties are a mix of light industrial, commercial properties, and residential housing in the northern sub-basin; the southern sub-basin includes residential subdivisions and agricultural lands near the southern edge of the study area. Waterside adjacent property is the undeveloped Sacramento River; the Yolo Bypass, which is a diversionary floodwater channel used during periods of high water; and the Deep Water Ship Channel which provides access to the Port of Sacramento from the Bay Area. There are several parks and recreational areas located between portions of the levee and the Sacramento River.

### **3.6 Completed Study Work**

At this point in the GRR process, a without project condition has been evaluated. During this phase an analysis was completed identifying specific deficiencies in the current levee system. Problems observed by levee reach include:

- **Sacramento River North Levee** - The levee in this reach has issues with seepage, stability, erosion, over-topping and vegetation.
- **Yolo Bypass Levee** - The levee in this reach has issues with seepage and stability.
- **Sacramento Bypass Levee** - The levee in this reach has issues with seepage, stability, and erosion.
- **Port North Area** - The reach has issues with overtopping and vegetation.
- **Sacramento River South Levee** - The levee in this reach has issues with seepage, stability, erosion, and vegetation.
- **Port South Levee** - The reach has issues with underseepage, levee overtopping and vegetation.
- **DWSC East Levee** – The levee in this reach has issues with seepage, stability and erosion.
- **DWSC West Levee** – The levee in this reach has issues with seepage, overtopping, and erosion.

### **3.7 Possible Remedial Alternatives**

There are several remedial actions being considered to fix the deficiencies observed on each levee reach. The majority of the deficiencies in the northern sub-basin will most likely be addressed by fix-in-place methods due to the limited availability of space surrounding the levees. Remedial alternatives used to address levee underseepage and overtopping will have the greatest potential to be affected by the presence of HTRW. Possible remedies to reduce underseepage include construction of a cut-off wall, installation of relief wells, construction of seepage berms, and installation of sheet pile walls.

Cut-off wall construction requires removal of the dam crest to construct a 30 foot wide workspace, trenching or drilling to remove unsuitable material, and replacement of this material. Trenching or drilling activities may proceed to great depths to find suitable foundation material. The deep excavations required for this method may encounter

potentially contaminated groundwater. The cutoff wall itself can either be constructed of a cement-bentonite-soil mixture, a bentonite-soil mixture, or a cement-bentonite mix.

Sheet pile walls require minimal removal of crown material and vegetation, reducing the area of environmental impact for a site. The walls consist of interlocking steel sheets driven in to a sound foundation material.

Relief wells are located on the landside toe of the levee and operate during flood conditions to reduce built-up pore water pressures that could cause instability in the levee. Drilling these wells would require evaluation of the proposed sites in relation to potential HTRW sites.

Seepage berms would be constructed on the land side of the levee and would extend the footprint of the levee by at least an additional 80 to 300 feet. Additional land would need to be acquired in many places for the installation of seepage berms. Because of this land requirement seepage berms are only a plausible alternative in the undeveloped areas around the Sacramento River South levee where additional land is available.

Levee overtopping may be prevented by the installation of a flood wall on the top of the levee or adjacent levee structures that increase the crest height. Construction of adjacent levees would raise the levee crest height to three feet above the 200-year flood elevation and would significantly increase the footprint of the levee section.

Any construction activities that include the disturbance of soil or removal of groundwater may encounter HTRW and project alternatives would need to consider the presence of contamination near the site. The current proposed and possible remedial alternatives for levee reaches were used to evaluate the likelihood of an identified HTRW site posing a risk to future construction activities.

## **4.0 User Provided Information**

### **4.1 Title Records**

Title records are not provided because the project site, including the levees and waterways, is essentially public land.

### **4.2 Environmental Liens or Activity and Use Limitations**

There are no NPL or proposed NPL sites located within the study area. There is one delisted NPL site, Jibboom Junkyard, located across the Sacramento River from the Site. Three CERCLIS sites are located within the study area including: La Quinta Inn and Jibboom Junkyard Super Fund Site across the Sacramento River; and Van Waters & Rogers, Inc. near the present site of Raley Field. There are no DoD sites within the study area. Two FUDS sites, the Sacramento District Engineer Yard and the Sacramento Army Depot, are included in the study area. There are no tribal lands included in the search area. No sites with state environmental liens are located within the study area.

### **4.3 Reason for Performing Phase 1**

A Phase 1 ESA for HTRW is required by USACE ER 1165-2-132 for all civil works projects during the reconnaissance phase. A Phase 1 ESA is also required by National Environmental Protection Act (NEPA) for all construction activities.

### **4.4 Other**

This ESA will follow the environmental industry practice of using the guidelines set forth in the USEPA rule concerning “All Appropriate Inquiries,” the *ASTM E 1527-05* standard, and USACE *Engineering Regulation (ER) 1162-2-132*. *ASTM E 1527-05* was designed to protect persons purchasing property from liability arising from adverse environmental conditions, but also may be used for other situations per section 4.2.1 of the standard.

## **5.0 RECORDS REVIEW**

### **5.1 Standard Environmental Record Sources**

Environmental Data Resources (EDR) conducted a records research of the study area consisting of 71 federal, state, public, and proprietary available data bases.

Figure 2 shows the EDR map used with the one mile buffer around the project levee. A complete copy of the EDR Report is included as Appendix A.

The report generated by EDR searched the following Federal environmental record sources:

- National Priority List (NPL), including current, proposed, de-listed, liens
- Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), including archived sites (CERC-NFRAP) and CERCLA Lien Information (LIENS 2)
- Resource Conservation and Recovery Act (RCRA), including transporters, storage and disposal (TSDF), large quantity generators (LQG), small quantity generators (SQG), conditionally exempt small quantity generators (CESQG), non-generators (NonGen) and the RCRA Administration Action Tracking System (RAATS)
- The Emergency Response Notification System (ERNS)
- The Hazardous Materials Incident Report System (HMIRS)
- The EPA's listing of brownfields properties (US BROWNFIELDS)
- Department of Defense sites (DOD) and Formerly used defense sites (FUDS)
- The Toxic Chemical Release Inventory (TRIS)
- Integrated Compliance Information System (ICIS)
- PCB Activity Database (PADS)

The following State and Local environmental record sources were searched:

- California Department of Health Services (CA BOND EXP. PLAN)
- Solid Waste Facilities/Landfill Sites (SWF/LF)
- California Water Resources Control Board Waste Discharge System (CA WDS)
- Water Management Database System (WMUDS/SWAT)
- Leaking Underground Storage Tank Incident Reports (LUST), Facility Inventory Database (CA FID UST), Underground Storage Tank Database (UST), Historical

- Underground Storage Tank Database (HIST UST) and the Aboveground Storage Tank Database (AST)
- California Regional Water Quality Control Board (SLIC)
- DTSC Liens (LIENS)
- California Hazardous Material Incident Report System (CHMIRS)
- Confirmed release sites involving DTSC (RESPONSE)
- Pollutant emissions data (AIRS)
- The DTSC database that identifies sites that have known contamination or sites that require further investigation (ENVIROSTOR)

There were no tribal records found that applied to the area in question.

## **5.2 Additional Environmental Records Sources**

Federal Sources:

- Corrective Action Report (CORRACTS)
- A listing of sites with engineering controls in place (USENG CONTROLS)
- A listing of sites with institutional controls in place (US INST CONTROL)
- Department of Transportation Office of Pipeline Safety incident and accident data (DOT OPS)
- A listing of clandestine drug lab locations (US CDL)
- Land Use Control Information System (LUCIS)
- A listing of sites that cleanup responsibility and standards have been established by U.S. District Courts (CONSENT)
- Uranium Mill Tailings sites (UMTRA)
- Open Dump Inventory (ODI)
- Torres Martinez Reservation Illegal Dump Site Locations (DEBRIS REGON 9)
- Mines Master Index File (MINES)
- Administrative cases and pesticide enforcement actions (FTTS) and (HIST FTTS)
- FIFRA-related reporting (SSTS)
- Material Licensing Tracking System (MLTS) and Radiation Information Database (RADINFO)
- Facility Index System (FINDS)

State and Local Sources:

- Known and potential hazardous substance sites (HIST Cal-Sites, formerly ASPIS and replaced by ENVIROSTOR)
- School Property Evaluation Program (SCH)

- Toxic Pits CEANUP Act Sites (Toxic Pits)
- Sites designated by LUST, SWF/LS and Cal-Sites (Cortese)
- Recycling facilities (SWRCY)
- Statewide Environmental Evaluation and Planning System (SWEEPS UST)
- Proposition 65 Database (Notify 65)
- Recorder Land Use Restrictions (DEED)
- DTSC low threat level properties (VCP)
- Dry cleaning-related facilities with EPA ID numbers (DRYCLEANERS)
- Clandestine Drug Labs (CDL)
- Well Investigation Program Case List (WIP)
- Extracts from hazardous waste manifests (HAZNET)
- List of waste tire haulers (HAULERS)

### **5.3 Historical Record Review**

Historic aerial, topographic, and fire maps were not obtained for this property due to the large scope of the project and the overwhelming amount of information that would be generated during a search of this magnitude. To fit within the scope and feasibility of this project maps would had to have been produced on so large of a scale that they would not produce useful information.

### **5.4 Regional Contaminant Considerations During Future Construction**

Environmental records searches are efficient ways to identify and track sites where past releases have occurred. Other types of contaminants unlikely to be picked up in an environmental records database search are considered in this report because they are associated with significant industries that were historically active in the region. Gold mining and large-scale agricultural activities are two historic activities that have produced regional contaminants in the project area and should be considered when future levee construction occurs.

The levee system around West Sacramento lies in a region that has a history of gold mining. The regional history of gold mining coupled with the regional agriculture land use and the historic use of dredge material from the rivers as levee construction material,

suggests there are some chemicals for which data collection would be useful to confirm if contaminants from these historic process are present. These include arsenic, mercury, pesticides and herbicides.

Additionally, based on the vehicular use of the existing levee crown, lead and petroleum hydrocarbons may have been released to the upper 3 feet of the roadway shoulder on the existing levee.

## **6.0 SITE RECONNAISSANCE**

### **6.1 Methodology and Limiting Conditions**

The study area site visit was conducted for the Phase 1 ESA by staff from the Environmental Engineering Section of the United States Army Corps of Engineers – Sacramento District.

The objective of the site visit was to identify recognizable environmental concerns in connection with the property. Common environmental concerns that were looked for include the following: asbestos; construction and demolition debris; drums; landfill or solid waste disposal sites; pits, ponds or lagoons; wastewater; fill dirt, depressions, mounds, or any artificial structures; PCB containing transformers; and the presence or likely presence of any hazardous substance or petroleum products on the property under conditions that indicate an existing release, a past release, or a material threat of a release on the property or into the ground, groundwater, or surface water of the property.

Although no obvious environmental concerns were noted from the site visit, it should be noted that a significant amount of the project levees exists in close proximity to industrial and commercial areas of West Sacramento and the ports.

### **6.2 Hazardous Materials Associated with Property Use**

No hazardous material(s) were encountered during the site visit.

### **6.3 Hazardous Substances Associated with Storage Containers**

No storage container(s) were encountered during the site visit.

### **6.4 Storage Tanks**

No Aboveground Storage Tank(s) (ASTs) was encountered during the site visit. Several ASTs at adjacent commercial and industrial properties were noted, but are outside the project boundary.

## **6.5 Indications of PCBs**

No electrical transformer(s) were encountered during the site visit

## **6.6 General Site Reconnaissance Report**

Access to the general public is controlled by a locked gate along the main access road. Trespassers on foot can gain entry to the areas and appeared to do so mainly for fishing in the slough on the waterside of the levee. The fence separating the landside property boundary from the commercial/industrial area was well maintained.

No evidence of solid waste disposal was noted.

This section of the levee had only grass and shrubs. No large trees were growing on the levee.

## **7.0 Interviews**

Ken Ruzich, the manager of Reclamation District 900 (RD 900), completed a questionnaire by email on April 20<sup>th</sup> 2012. Reclamation District 900 is responsible for the regular maintenance and upkeep of the levees in the majority of the City. RD 900 routinely applies herbicides to levees in accordance with a Yolo County permit and has not had any spills while Mr. Ruzich has been with RD 900. Over the years a few barrels and cans have been observed on the levee but they were either empty or self-contained and are not thought to be a concern. Miscellaneous items including trash and mattresses are sometimes observed on the levee and are properly disposed of by RD 900. Transformers replaced by RD 900 at the levee pumping station were originally placed in service and contained mineral oil as an insulator so PCB's were not thought to be present on any levee sites operated by RD 900 a copy of the interview questions and answers are included in Appendix C of this report.

## **8.0 Findings**

The EDR search identified 788 records of possible HTRW concerns within the study area. All of these sites were identified in the EDR search by a site identification-focus map number identifier. Many of the Site ID's had multiple records of possible HTRW associated with them so the total number of identified sites in the EDR report was 183.

Appendix B provides a summary of each site including its distance from the levee center line, levee station and reach, location in relation to the hydraulic divide, whether or not the site may affect future construction, and links to regulatory information. This information was used to focus the Phase 1 ESA to the potential effects of the identified HTRW sites on future construction activities. Further investigation in to potentially hazardous sites included review of available site information in the EnviroStor and GeoTracker databases maintained by the California Department of Toxic Substance Control (DTSC) and California State Water Resources Control Board (SWRCB) respectively. Reports from these databases were used to determine the possible impact identified sites may have on future construction activities. Characteristics used to classify the site included the suspected mass and volume of contaminants, their mobility within the soil-groundwater-air matrix, and the likelihood of traditional levee remediation measures impacting contaminated media.

Additionally there are numerous species of plants and animals that have been identified in the study area and are listed on federal or state watch lists. A complete listing of these identified species is included in a separate appendix to the planning document.

As previously discussed, sites were classified in one of four types according to the potential for harmful impacts on future construction activities. Tables 2 & 3 below provide a listing of all the Type 1 and Type 2 sites, respectively. Figure 3 provides a map showing the location of all Type 1 HTRW sites. The remaining Type 3 and 4 sites are identified in Appendix A and B.

**Table 2 - Type 1 HTRW Sites**

<b>Type 1 Sites – HTRW concerns that may impact future activities</b>						
<b>Site Name</b>	<b>EDR ID #</b>	<b>Distance from Centerline (miles)</b>	<b>Closest Levee Reach</b>	<b>Stationing Along Closest Reach</b>	<b>Address</b>	<b>Summary</b>
Bryte Landfill	7-1	0.5	Sacramento Bypass	0+00	50035 CR 126/ CR 126/ RD 124, West Sacramento, CA	Landfill used from the 1950's through the 1970's
State Department of Water Resources Maintenance Yard	11-2	0.00	Sacramento River North Levee	50+00	1450 Riverbank Rd., West Sacramento, CA 95605	Leaky underground storage tank with hydrocarbon plume located under the levee
Capitol Plating	27-2	0.13	Sacramento River North Levee	180+00	319 3 <sup>rd</sup> St., West Sacramento, CA 95605	Heavy metals and chlorinated solvents in the soil around the former facility
Van Waters and Rogers Inc./UNIVAR USA	44-5	0.00	Sacramento River North Levee	220+00	800-850 South River Rd., West Sacramento, CA 95691	Former chemical handling and storage facility with solvent contamination in soil and groundwater
Chevron #9-6726 and Epoch Truck Stop	70-4	0.13	Yolo Bypass	100+00	4790-4800 West Capitol Ave, West Sacramento, CA 95691	Co-mingled fuel plume located beneath to fuel dispensers
Shell Oil, Ramos Environmental, KMEP	86-5	0.13	Sacramento River North Levee	260+00	1509-1570 South River Road, West Sacramento, CA 95691	Previous storage, distribution, and recycling facilities for hydrocarbon compounds. Current soil and groundwater contamination
Port of Sacramento	94-5 & 99-5	0.25	Port North Area	160+00	2895 Industrial Blvd., West Sacramento, CA 95691	Ammonia and Nitrate plume associated with previous fertilizer storage and transport
Tesoro-ARCO Remediation Project (TARP)	101-5	0.13	Sacramento River North Levee	270+00	1700-1701 South River Road, West Sacramento, CA 95691	Large fuel storage and distribution terminal with associated hydrocarbon and VOC plume
Agrium U.S. Inc.	132-4	0.13	Port North Area	35+00	3961 Channel Drive, West Sacramento, CA 95691	Nitrogen contamination of groundwater related to previous storage and production of fertilizers

**Table 3 - Type 2 HTRW Sites**

<b>Type 2 Sites – HTRW concerns that are not likely to impact future activities</b>						
<b>Site Name</b>	<b>EDR ID #</b>	<b>Distance from Centerline (miles)</b>	<b>Closest Levee Reach</b>	<b>Stationing Along Closest Reach</b>	<b>Address</b>	<b>Summary</b>
Sacramento Stucco Company	56-5	0.25	Sacramento River North Levee	230+00	860 Riske Lane, West Sacramento, CA 95691	Heavy metal soil contamination on site from previous use as a reclamation factory for lead in batteries
Wabash National Trailer Company	57-5	0.38	Port North Area	140+00	3600 West Capitol Avenue, West Sacramento, CA 95691	Hydrocarbon and VOC contamination located beneath a former trailer wash rack located on the northwest corner of the site
4201-4275 West Capitol Avenue	60-4	0.19	Yolo Bypass	130+00	4201-4275 West Capitol Avenue, West Sacramento, CA 95691	Former junkyard and automotive repair facilities with possible soil contamination
Penske Truck Leasing	66-5	0.5	Port North Area	140+00	3009 Evergreen Ave, West Sacramento, CA 95691	Leaking underground storage tank site
West Sacramento CardLock	67-5	0.38	Port North Area	140+00	3022 Evergreen Ave, West Sacramento, CA 95691	Leaking underground storage tank site
Rick's ARCO	75-5	0.38	Sacramento River North Levee	260+00	1015 Jefferson Blvd, West Sacramento, CA 95691	Leaking underground storage tank site
7-Eleven #14,093	107-5	0.19	Sacramento River North Levee	265+00	1552 Jefferson Blvd, West Sacramento, CA 95691	Leaking underground storage tank site
USPS Vehicle Maintenance Facility	113-4	0.38	Port North Area	55+00	3780 Seaport Blvd, West Sacramento, CA 95799	Leaking underground storage tank site

## **9.0 Opinions**

All information used to form the following opinions was gathered from the most recent reporting information available in the Envirostor or GeoTracker databases. If no citation is given general information on the website was used.

### **9.1 Type 1 Sites**

EDR Site 7-1 the former Bryte Landfill will be included in the construction area for the possible Sacramento Bypass enlargement. This site served as a landfill and burn site for commercial and residential wastes collected in eastern Yolo County. Waste was reportedly dumped, burned, and leveled at the 16.69 acre site. Previous soil sampling at the site has shown elevated levels of lead, dioxins and PCBs (DTSC 2010). Further investigation will be required at this site to evaluate effects on the construction of the expanded Sacramento Bypass.

EDR Site 11-2 is a maintenance yard used by the State of California Department of Water Resources, Division of Flood Management. In September 2004 a leaking underground storage tank (LUST) was removed from the site. Subsequent sampling showed elevated levels of total petroleum hydrocarbons as gas and diesel, BTEX compounds, and MTBE. The plume currently exists directly below the maintenance yard and extends 500 feet to the east along the Sacramento River. The entire plume volume is located beneath the current levee in a coarse grained alluvium soil. There are currently 21 monitoring wells in place to gather data about the plume (DWR 2010). Any future construction work would be impacted by the presence of this plume and monitoring system.

EDR Site 27-2 consists of the former Capitol Metal Plating facility located at 319 Third Street in West Sacramento. Prior to 2004 a building was present on site where metal stripping and plating activities took place. Previous investigations on the site revealed the presence of chromium, nickel, lead, copper, and cadmium at 0-5 feet bgs. Several soil removal activities have been completed at this location to remove significant

amounts of heavy metals that were causing health problems for workers on site. 1,2-DCA (Di-chloro ethane) was detected in shallow groundwater samples on site but was not observed offsite in the shallow aquifer material; however, 1,2 DCA was detected in groundwater samples taken from the deeper aquifers at approximately 40 and 60 feet bgs (URS 2004). The exact extent of the 1,2-DCA plume in the groundwater was not known in the 2005 report but does not appear to have a significant potential to affect future construction activities on the site. Additional investigations may be needed to review other available records and determine the current state of the Capitol Plating facility.

EDR Site 44-5 is located on the premises of Raley Field in West Sacramento. The site was previously used as a chemical storage and distribution center by Van Waters and Rogers, Inc. and Univar USA, Inc. Typical chemicals stored on site included PCE, 1,1,1 TCA, acetic acid, acetone, Texanol, diesel, and propylene glycol. Some spilling of these chemicals during repackaging and distribution occurred leading to contamination of the soil and groundwater by PCE, TCE, vinyl chloride, cis-1,2 DCE, and trans-1,2 DCE. A soil vapor extraction and air sparging system was installed and operated on the site from 1995 to 1997; current remedial measures on the site include bioremediation paired with a pump and treat groundwater system (Nichols 2012). The contaminant plume on the site appears to be contained by the current ground water pumping system in the upper stratigraphic layer and is located approximately 600 feet from the current levee site. The contaminants of concern on this site appear to be stable and located outside of the proposed levee construction impact area but additional testing may be prudent during forthcoming investigations.

EDR Site 70-4 is located just off of Interstate 80 in West Sacramento and is composed of a co-mingled hydrocarbon contaminant plume released by a LUST at the Chevron and former Epoch Truck stops along West Capitol Avenue. Contaminants of Concern (COCs) on this site include TPH-g, TPH-d, benzene, and MtBE. Remedial actions are proposed to start on this site in early 2012 (CWRQCB 2012). The contaminant plume on this site is located approximately 300 feet from the Yolo Bypass levee and does not appear to be migrating towards the levee. The prevailing groundwater flow gradient has

been observed to point to the southeast, or away from the levee. Currently this site does not pose a significant potential threat to construction activities but may need to be evaluated with respect to proposed construction measures.

EDR Site 86-5 is composed of sites owned by Shell Oil Company, Ramos Environmental, and Kinder Morgan Energy Partners (KMEP). Ramos Environmental currently has a permit to handle, consolidate, and store oily wastes and other hazardous materials. KMEP operates an oil pumping facility on the west side of South River Road near the western edge of the current levee embankment; a plume is associated with this site that is currently under monitored natural attenuation. COCs on the KMEP site include TPH-g, benzene, and MtBE. The contaminant plume appears to be contained to the central portion of the KMEP property in the upper stratigraphic layer and appears to be stable. (Arcadis 2002) This site is currently under monitored natural attenuation and the plume appears to be stable. The Shell Oil Company operates a fuel distribution facility between South River Road and the Sacramento River. This site is located almost entirely on the constructed levee embankment and includes 12 large above ground storage tanks. A contaminant plume consisting of TPH-g, TPH-d, benzene, MtBE, and tert-butyl alcohol (TBA) has been delineated below the site; this plume appears to be stable and is currently under monitored natural attenuation. Groundwater extraction occurred on site from 1996 until 2007 and passive product skimmers have been in operation since 2008. The groundwater flow gradient radiates out from the center of the site due to the weight of the fuel tanks and is partially directed towards the Sacramento River on the eastern portion of the site (CRA 2012). The effects of this contaminant plume would need further investigation in relation to proposed construction activities due to the proximity to the levee and groundwater flow conditions.

EDR Site 99-5 and Site 94-5 consists of a nitrogen associated contaminant plume located in the Port of Sacramento. Site 99-5 is listed as the Port of Sacramento Terminal and Site 94-5 is listed as the Fertilizer Washrack and Railcar Loading; both of the sites are associated with the nitrogen plume described in this section. COCs in this plume include ammonia and nitrate resulting from fertilizer spills associated with the railcar loading and

washing area at the Port. Nitrate has been observed in the perched aquifer to a depth of approximately 25 feet below ground surface(bgs); ammonia and nitrate have been observed in the semi-confined aquifer from a depth of 30 feet bgs to greater than 100 feet bgs. A large ground water extraction system is currently in place which conveys groundwater to a constructed wetland for treatment (GeoTrans 2009). The site may pose a concern to future levee construction activities near the Port due to the size of the plume and groundwater flow patterns directed towards the Deep Water Ship Channel on the south side of the site.

EDR Site 101-5 consists of the combined Tesoro ARCO Remediation Project (TARP) adjacent to the Sacramento River and the Tesoro fuel terminal located on the west side of South River Road. COCs associated with this site include TPH-g, TPH-d, benzene, and MtBE in the upper unconfined aquifer; along with TPH-g, TPH-d, benzene, and MtBE in the lower aquifer. Thousands of gallons of free product have been removed from the site and various remedial measures have been used on this site in the past including dual phase extraction, oxygen injection, and SVE/AS systems (Stantec 2011). The contaminant plume on this site currently appears to be stable and contained to the west of the Sacramento River, but additional investigation will be needed to identify impacts the site may have on future construction activities.

EDR Site 132-4 consists of a nitrate and ammonia plume at the Agrium U.S. nitrogen fertilizer production plant adjacent to the DWSC. There are ongoing extraction and disposal services occurring on this site but elevated concentrations of nitrate and ammonia are still observed near the DWSC. A total of 32 wells and piezometers have been installed in the shallow, perched and deeper confined aquifer on the site. The prevailing groundwater flow gradient in the deeper confined aquifer is directed towards the DWSC (HDR 2011). The effects of the nitrogen plume on any levee related construction activities would need to be investigated further.

## **9.2 Type 2 Sites**

EDR Site 56-5 is located on property owned by the Sacramento Stucco Company. This site was previously used as a lead battery reclamation facility in the 1970's. The use of this site as a reclamation facility resulted in significant amounts of soil contamination by lead and other heavy metals. Several remedial actions have been completed over the years to remove contaminated soils with a final removal activity scheduled to have been completed in 2008. There is limited current information available about this site but the contamination appears to be contained to the site and does not pose a concern to future levee construction activities (DTSC 2008).

EDR Site 57-5 consists of the Wabash National Trailer Company located on West Capitol Avenue. There is a plume of PCE and TCE located on the site that most likely originated from the cleaning of trailers in a wash rack on the northwest portion of the site that occurred until the late 1980's. Currently there are detectable concentrations of PCE, TCE and TPH which appear to be confined to the northern portion of the site. There are very small groundwater gradients and flows observed on the site. The contaminants observed on this site appear to be contained to the localized area and should not be of concern during future levee construction (Raney 2008).

EDR Site 60-4 consists of several former junk yards and automotive repair facilities located on the southern side of 4300 block of Capitol Avenue. Prior investigations found some concentrations above background of lead in the soil but these appear to be minor and localized within the site. This site should not pose any concern for future levee construction activities.

EDR Site 66-5 consisted of a small hydrocarbon plume on a Penske Truck Leasing, Co. property. This leak was small in nature and the LUST case is currently in the process of being closed by the Water Resources Control Board. This site is located approximately one half mile from the levee sites and should not be of concern during construction.

EDR Site 67-5 consists of a hydrocarbon plume located beneath the West Sacramento CardLock facility on Evergreen Avenue. The contaminant plume associated with this site appears to be confined to the site and immediate surrounding area and should not be of concern during future levee construction.

EDR Site 75-5 consists of a small hydrocarbon plume located under Rick's ARCO on Jefferson Boulevard. The main COC on this site is MTBE but the overall plume is small in extent and appears to be contained within the immediate vicinity of the site. This site should not be of concern to future construction activities on the levee.

EDR Site 107-5 consists of a hydrocarbon plume located under the 7-Eleven at 1552 Jefferson Boulevard. There have been SVE and groundwater water extraction systems operating on the site that appear to removing the contaminant mass on the site. Some of the contamination observed on this site may originate at the Tesoro fuel terminal located to the east of the site. Any contamination on this site will comingle with hydrocarbon plumes beneath the Tesoro and TARP sites before reaching possible areas of levee construction so this site itself will most likely not be a concern to future construction.

EDR Site 113-4 consists of a small hydrocarbon plume located beneath a United States Postal Service vehicle maintenance facility on Seaport Boulevard. High MtBE concentrations have also been observed on this site. The contaminant plume on this appears to be stable and should not impact future construction activities.

## 10.0 CONCLUSIONS

A Phase 1 Environmental Site Assessment was performed in accordance with the scope and limitations of ASTM E 1527-05 and USACE ER 1165-2-132 for the West Sacramento Levee GRR project. Any exceptions to, or deletions from, these practices have been outlined within the report. This assessment has identified sites with recognized environmental conditions at the locations shown in Table 4 below.

**Table 4 - Sites with Recognized Environmental Conditions**

Site Name	EDR ID #
Bryte Landfill	7-1
State Department of Water Resources Maintenance Yard	11-2
Capitol Plating	27-2
Van Waters and Rogers Inc./UNIVAR USA	44-5
Chevron #9-6726 and Epoch Truck Stop	70-4
Shell Oil, Ramos Environmental, KMEP	86-5
Port of Sacramento	94-5 & 99-5
Tesoro-ARCO Remediation Project (TARP)	101-5
Agrium U.S. Inc.	132-4

The historical land uses of the region may also contribute to residual contamination of the entire project area with agricultural fertilizers, herbicides, and pesticides as well as arsenic and mercury from mining operations in the region. Additional sampling will be required during subsequent investigations to determine if project areas have been impacted by these historical contaminants.

Due to the GRR process being a parent project that identifies the need for future actions, a Phase 1 ESA will need to be performed again, either at the appropriate GRR phase planning milestone, or at the beginning of actual construction activity. The subsequent Phase 1 ESA(s) will investigate if new sites have emerged and if existing sites still pose a threat to planned construction.

## 11.0 REFERENCES

American Society for Testing and Materials, 2005. Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process

[http://www.astm.org/cgi-bin/SoftCart.exe/STORE/filtrexx40.cgi?U+mystore+rbui8820+L+E1527:05+/usr6/htdocs/astm.org/DATABASE.CART/REDLINE\\_PAGES/E1527.htm](http://www.astm.org/cgi-bin/SoftCart.exe/STORE/filtrexx40.cgi?U+mystore+rbui8820+L+E1527:05+/usr6/htdocs/astm.org/DATABASE.CART/REDLINE_PAGES/E1527.htm)

Arcadis, 2012. Kinder Morgan Energy Partners, L.P. Combined Third and Fourth Quarter Semiannual and Annual 2011 Groundwater Monitoring Report. January 31.  
[http://geotracker.waterboards.ca.gov/esi/uploads/geo\\_report/7588932812/SL375133637.PDF](http://geotracker.waterboards.ca.gov/esi/uploads/geo_report/7588932812/SL375133637.PDF)

California Department of Toxic Substances Control, 2008. Sacramento Stucco, Removal Action Workplan. September 8.  
[http://www.envirostor.dtsc.ca.gov/regulators/deliverable\\_documents/1053800821/NOE\\_final%20SacStucco.pdf](http://www.envirostor.dtsc.ca.gov/regulators/deliverable_documents/1053800821/NOE_final%20SacStucco.pdf)

California Department of Toxic Substances Control, 2010. Site Screening Assessment. April 21.  
[http://www.envirostor.dtsc.ca.gov/regulators/deliverable\\_documents/9086042106/Old%20Bryte%20Landfill%20Approved%20Site%20Screen.pdf](http://www.envirostor.dtsc.ca.gov/regulators/deliverable_documents/9086042106/Old%20Bryte%20Landfill%20Approved%20Site%20Screen.pdf)

California Regional Water Quality Control Board, Central Valley Region, 2012. COMMINGLED PLUME, EPOCH TRUCK STOP AT 4790 WEST CAPITOL AVENUE, AND CHEVRON STATION NO. 9-6726 AT 4800 WEST CAPITOL AVENUE, WEST SACRAMENTO, YOLO COUNTY. January 17  
[http://geotracker.waterboards.ca.gov/regulators/deliverable\\_documents/8555892765/570215L013.pdf](http://geotracker.waterboards.ca.gov/regulators/deliverable_documents/8555892765/570215L013.pdf)

California Department of Water Resources, Division of Engineering, 2010. DWR SACRAMENTO MAINTENANCE YARD UNDERGROUND STORAGE TANK INVESTIGATION PHASE 3 SITE CHARACTERIZATION SUPPLEMENTAL DATA REPORT. October.  
[http://geotracker.waterboards.ca.gov/esi/uploads/geo\\_report/2646241188/T0611300022.PDF](http://geotracker.waterboards.ca.gov/esi/uploads/geo_report/2646241188/T0611300022.PDF)

Conestoga-Rovers and Associates, 2012. GROUNDWATER MONITORING AND REMEDIATION REPORT THIRD AND FOURTH QUARTERS 2011, SHELL SACRAMENTO TERMINAL 1509 SOUTH RIVER ROAD WEST SACRAMENTO, CALIFORNIA. February 1.  
[http://geotracker.waterboards.ca.gov/esi/uploads/geo\\_report/5832621276/SL373533625.PDF](http://geotracker.waterboards.ca.gov/esi/uploads/geo_report/5832621276/SL373533625.PDF)

HDR, 2011. Second Semi-Annual 2011 Groundwater Monitoring Report Agrium U.S., Inc., 3961 Channel Drive, West Sacramento, CA. September 22.  
[http://geotracker.waterboards.ca.gov/esi/uploads/geo\\_report/9616925835/SL205483017.PDF](http://geotracker.waterboards.ca.gov/esi/uploads/geo_report/9616925835/SL205483017.PDF)

GeoTrans, Inc., 2009. ANNUAL GROUNDWATER MONITOR WELL AND GROUNDWATER EXTRACTION TREATMENT SYSTEM PROGRESS REPORT FOR THE PORT OF SACRAMENTO, PORT OF SACRAMENTO FACILITY 2895 Industrial Boulevard West Sacramento, Yolo County, California. February 27.  
[http://geotracker.waterboards.ca.gov/esi/uploads/geo\\_report/7015221714/SL185492919.PDF](http://geotracker.waterboards.ca.gov/esi/uploads/geo_report/7015221714/SL185492919.PDF)

Nichols Consulting Engineers, 2012. 4<sup>th</sup> Quarter 2011 and Annual Groundwater Monitoring Report, Univar USA, Inc., 400 Ballpark Drive, West Sacramento, CA. January 25.  
[http://geotracker.waterboards.ca.gov/esi/uploads/geo\\_report/4394074797/SL205423013.PDF](http://geotracker.waterboards.ca.gov/esi/uploads/geo_report/4394074797/SL205423013.PDF)

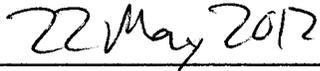
Stantec Consulting Corporation, 2011. 2011 ANNUAL SITE STATUS, GROUNDWATER MONITORING AND REMEDIAL SUMMARY REPORT FORMER TESORO FUEL TERMINAL, 1700 South River Road West Sacramento, California. November 1.  
[http://geotracker.waterboards.ca.gov/esi/uploads/geo\\_report/5002878844/SL0611357876.PDF](http://geotracker.waterboards.ca.gov/esi/uploads/geo_report/5002878844/SL0611357876.PDF)

Raney Geotechnical Inc., 2008. Fourth Quarter 2008 Groundwater Monitoring, Wabash National Trailers Property. November 17.  
[http://geotracker.waterboards.ca.gov/esi/uploads/geo\\_report/1792833626/SL0606729378.PDF](http://geotracker.waterboards.ca.gov/esi/uploads/geo_report/1792833626/SL0606729378.PDF)

URS, 2004. FORMER CAPITOL PLATING SITE, SITE SUMMARY INVESTIGATION REPORT. December.  
[http://www.envirostor.dtsc.ca.gov/regulators/deliverable\\_documents/9893262565/Site%20Summary%20Investigation%20Report.pdf](http://www.envirostor.dtsc.ca.gov/regulators/deliverable_documents/9893262565/Site%20Summary%20Investigation%20Report.pdf)

USACE, 1992. Water Resources Policies and Authorities: Hazardous, Toxic, and Radioactive Waste (HTRW) Guidance for Civil Works Projects, ER 1165-2-132  
<http://www.usace.army.mil/publications/eng-regs/er1165-2-132/toc.htm>

**12.0 Signatures of Environmental Professionals**

   
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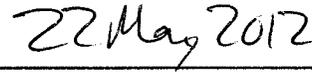
Rick McComb, P.E.  
Environmental Engineer, Environmental Engineering Section

### **13.0 Qualifications of Environmental Professional**

I declare that, to the best of my professional knowledge and belief, I meet the definition of Environmental Professional as defined in 40 CFR, Section 321.10.



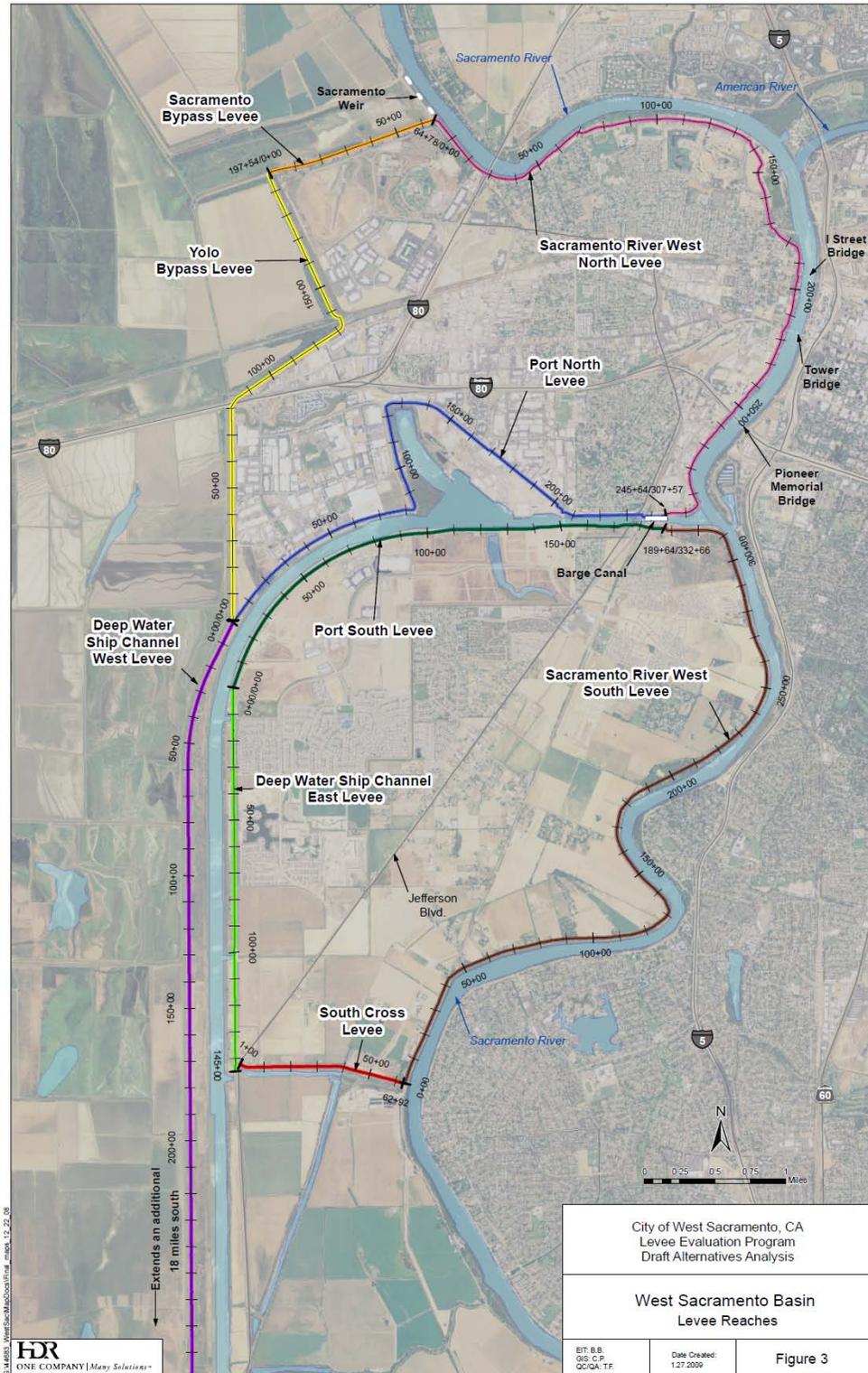
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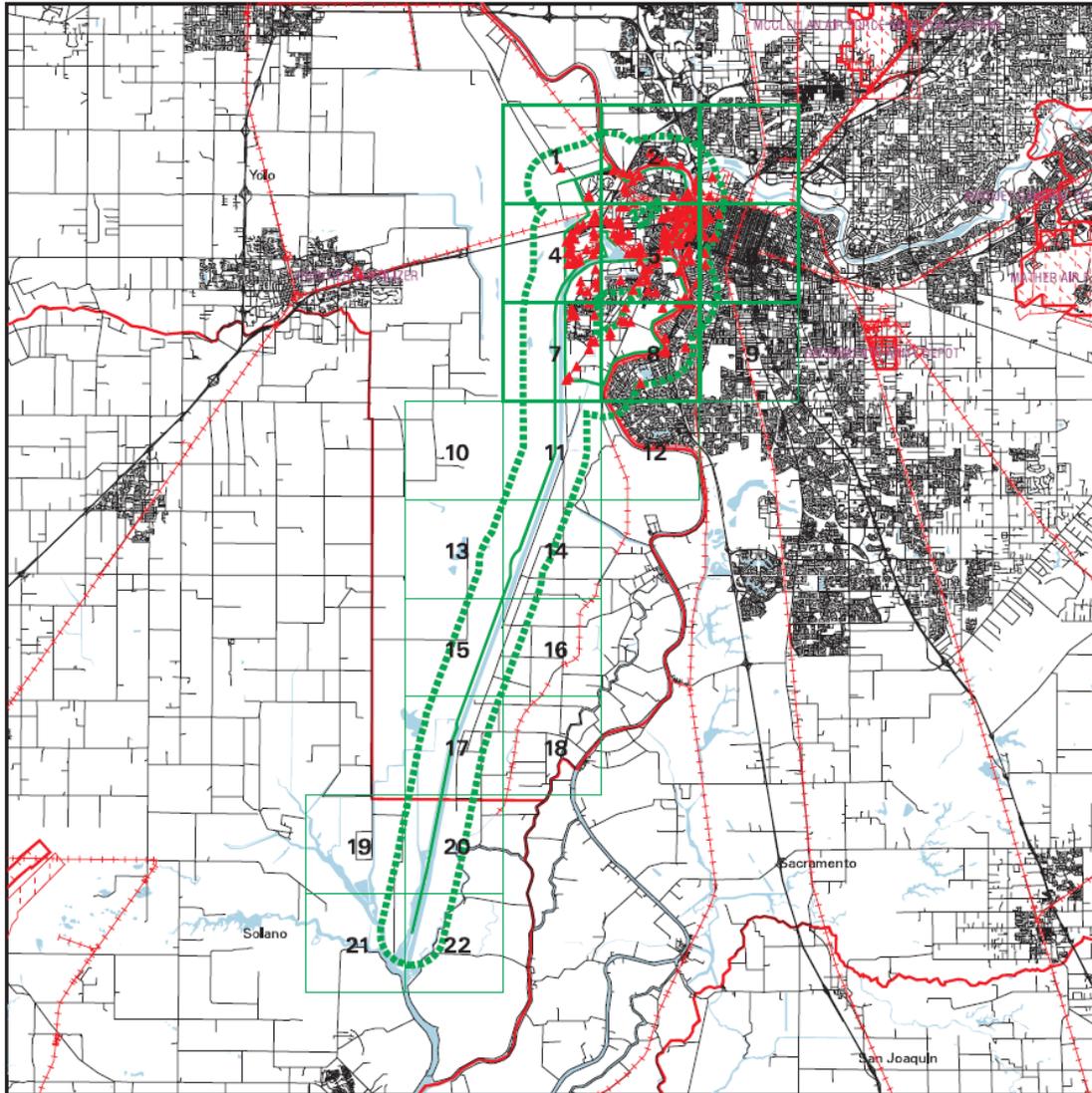
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Rick McComb, P.E.  
Environmental Engineer, Environmental Engineering Section

**Figure 1: West Sacramento GRR Levee Reaches and Project Area**



**Figure 2: EDR Site Map with Search Radius**



EDR DataMap® - Environmental Atlas

**West Sacramento GRR**

Legend

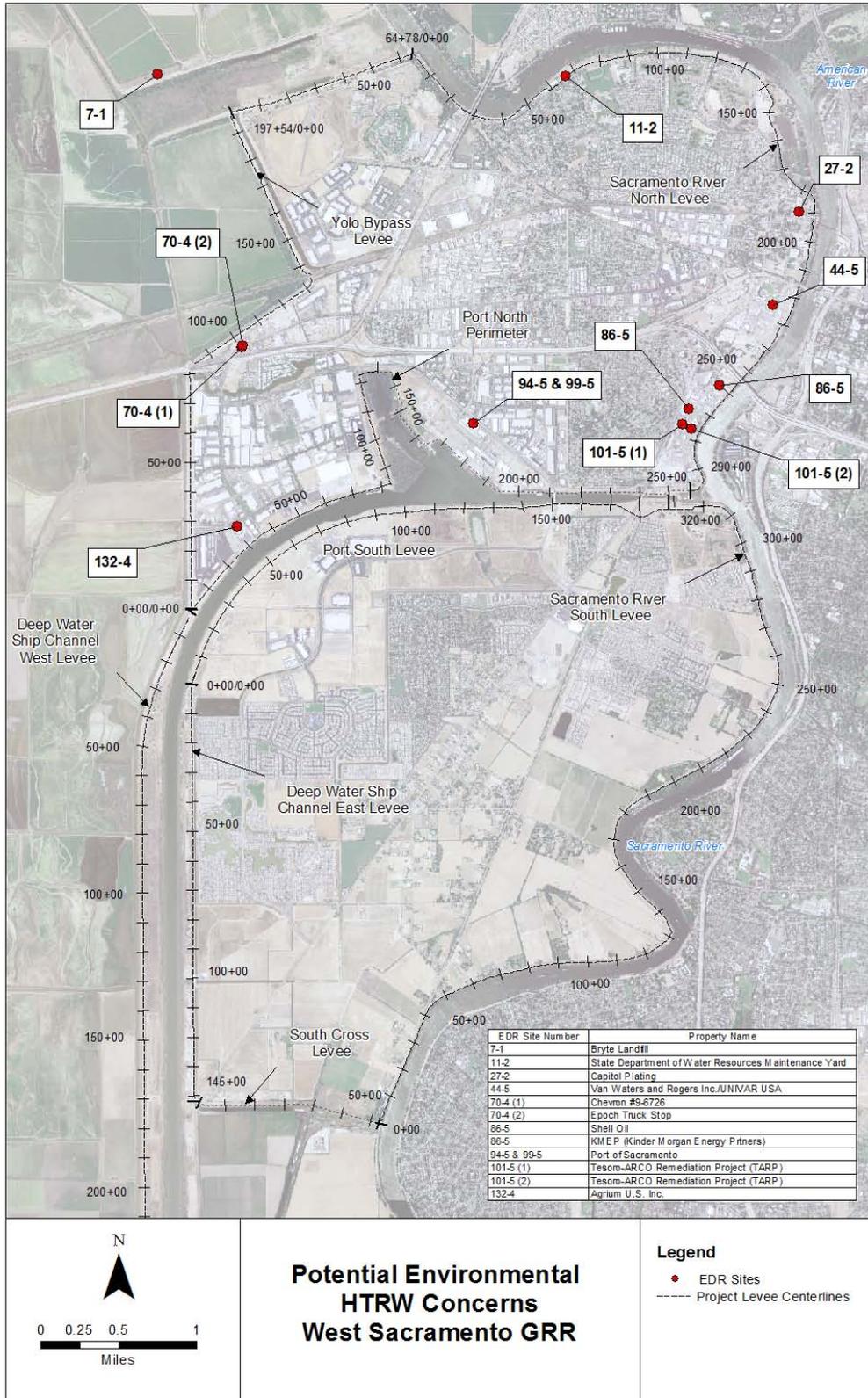
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|---------------|----------------|-------------------------|-------------------|--------------|
| Roads         | Waterways      | Powerlines              | Water             | Listed Sites |
| Major Roads   | Railroads      | Pipelines               | Superfund Sites   |              |
| Contour Lines | Study Boundary | Fault Lines             | Federal DOD Sites |              |
|               |                | Indian Reservations BIA |                   |              |

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Scale in Miles

**Figure 3: Potential Environmental HTRW Concerns**



**West Sacramento GRR EIS/EIR  
Appendix F**

**Final 404 (b)(1) Analysis**

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**SECTION 404(b)(1) WATER QUALITY EVALUATION**

**WEST SACRAMENTO PROJECT  
GENERAL REEVALUATION REPORT**

**YOLO COUNTY, CALIFORNIA**

This document constitutes the Statement of Findings, and review and compliance determination according to the Section 404(b)(1) guidelines for the proposed project described in the final EIS/EIR issued by the Sacramento District. This analysis has been prepared in accordance with 40 CFR Part 230- Section 404(b)(1) guidelines and USACE Planning Guidance Notebook, ER 1 105-2- 100.

## **I. Project Description**

### a. Proposed Project

Information on alternatives is taken from Section 2.0 of the final Environmental Impact Statement/Environmental Impact Report (EIS/EIR).

The West Sacramento General Reevaluation Report (GRR) project is a cooperative effort by the U.S. Army Corps of Engineers (Corps) and the Corps' non-federal sponsors the West Sacramento Area Flood Control Agency (WSAFCA). The Corps has completed a final EIS/EIR, dated September 2015. The final EIS/EIR will be referenced throughout the document to describe the existing conditions near the project site, as well as some potential impacts of the proposed project and the other alternatives.

The primary and permanent structures consist of roughly 50 miles of levees surrounding the City of West Sacramento. Staging areas on the landside of the levees would be cleared for construction use and concrete batch plants would be constructed on the landside of existing levees as necessary temporary structures to facilitate the construction of slurry walls along levee reaches.

The proposed project would require discharge of dredged or fill material into waters of the U.S. under Section 404 of the Clean Water Act. The following subsections describe the measures proposed for all three alternatives and identify any possible discharge of fill material associated with each measure. Additional information about the measures can be found in Section 2.1.3 of the final EIS/EIR

**Seepage and Slope Stability Measures** – To address seepage and slope stability concerns, several measures have been proposed including seepage or stability berms, construction of adjacent levees, construction of a setback levee and slurry cutoff walls. The slurry cutoff walls would be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall construction selected for each reach would depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of approximately 85 feet. For cutoff walls of greater

depth, the DSM method would be utilized. Prior to construction of the cutoff wall, the construction site and any staging areas would be cleared, grubbed, and stripped. The levee crown would be degraded up to half the levee height to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids.

Cutoff walls are proposed along the Sacramento River, the DWSC, and the Yolo Bypass. Because the cutoff wall would be installed directly into the levee, no fill material would be placed into waters of the U.S. by implementing this measure.

A seepage berm or stability berm would be constructed along the Sacramento River south levee and the South Cross levee in areas where it has been determined by geotechnical investigations that a seepage berm is more appropriate to address seepage than a cutoff wall. The seepage berm would extend out from the landside levee toe and would vary in width from 70 to 100 feet, tapering down from a five foot thickness, at the levee toe, to a three foot thickness, at the berm toe. The length of the seepage berm would depend on the seepage conditions along the levee reach. A stability berm would be constructed against the landside slope of the existing levee with the purpose of supplying support as a buttress. A stability berm is proposed along the South Cross levee. The height of the stability berm would generally be 2/3 of the levee height, and would extend for a distance determined by the structural needs of the levee along that reach. Construction would consist of clearing, grubbing, and stripping the ground surface. Depending on the action alternative, soil used to construct a berm would be stockpiled from levee degradation, excavated from nearby borrow pits, or trucked on site from off-site locations (if on-site material is not adequately available). During the degrading, soil would be stockpiled at the proposed berm site.

Construction of the seepage and stability berms would be installed on the landside of the levee to minimize placement of fill into waters of the U.S. However, there are wetlands and drainage canals along the toes of the South Cross levee and the Sacramento River south levee that would be impacted by construction of seepage and stability berms. The berms would be designed to avoid placement of fill in waters of the U.S. to the extent possible.

Constructing an adjacent levee is proposed along some sections of the Sacramento River south levee. The adjacent levee essentially adds material to increase the cross section of the levee, thereby allowing the prescribed 3:1 landside slopes and 20-foot-wide crown to be established. The adjacent levee would be constructed on the landward side of the levee and would make it possible to leave all waterside vegetation in place and minimize placement of fill into waters of the U.S. However, there are wetlands and drainage canals along the toe of the Sacramento River south levee that

would be impacted by construction of adjacent levees. The adjacent levee would be designed to avoid placement of fill in waters of the U.S. to the extent possible.

Construction of a setback levee is proposed for the Sacramento River south levee as part of Alternative 5. The typical offset distance of the setback levee from the existing levee is approximately 400 feet with a total length of roughly 4.25 miles, encompassing about 180 acres. The setback levee would include seepage berms in areas where it has been determined by geotechnical investigations that they are necessary to further reduce seepage. Some sections of the existing levee may be degraded to allow flow between the existing levee and the proposed setback levee.

Construction of the setback levee would cause temporary and permanent impacts to wetlands including drainage canals but would be designed to minimize impacts to waters of the U.S.

**Overtopping Measures** – Floodwalls are proposed along the waterside hinge point of the Port north levee and along the selected levee alignment around the Port of West Sacramento to reestablish height consistent with the system height. Construction activities would cause a temporary disturbance to provide space to construct the footing for the floodwall. Upon completion of the floodwall the waterside slope would be re-established to its existing slope and the levee crown would grade away from the wall and be surfaced with aggregate base. Levee raises would also occur on the Port South levee and the South Cross levee to reestablish system height and establish system height respectively. Additional material to increase levee height would be brought from nearby borrow sites, stockpiled in staging areas then hauled to the site with trucks and front end loaders. Material would be spread evenly and compacted according to levee design plans. The levee would be hydroseeded once construction was completed.

Construction activities would cause temporary and permanent impacts to waters of the U.S. at the toe of the existing levee as the levee footprint is increased to accommodate the increased levee height. The levee and staging areas would be designed to avoid placement of fill in waters of the U.S. to the extent possible.

**Erosion Protection Measures** - To reduce erosion concerns, bank protection would be placed on the waterside of levee slopes, along the river bank, and in the water along the Sacramento River levees, the Sacramento Bypass Training levee, and the DWSC west levee. Placement of rock would require clearing of understory vegetation and some trees along the Sacramento River levees. Construction could cause the displacement of soil, the introduction of contaminants, and the placement of up to 2 tons of rock into waters of the U.S.

**Construction of a Deep Water Ship Channel (DWSC) Closure Structure** As part of Alternative 3, a closure structure has been proposed. To enable construction of a closure structure, a temporary staging area with a batch plant and graving site would be constructed adjacent to the DWSC. Dredging the footprint of the closure structure is required to create a stable foundation prior to construction. The proposed closure structure, would involve the discharge of dredge material and rock material into approximately 16 acres of waters of the U.S.

#### b. Location

Location information is taken from Section 1.2 of the final EIS/EIR.

The West Sacramento GRR study area is located in the city of West Sacramento in eastern Yolo County at the confluence of the American and Sacramento Rivers. The city lies within the natural floodplain of the Sacramento River, which bounds the city along the north and east. In this document, the “project area” consists of the area that would be protected by the proposed levee improvements, including the city of West Sacramento itself, and the lands within WSAFCA boundaries, which encompass portions of the Sacramento River, the Yolo Bypass, the Sacramento Bypass, and the Sacramento DWSC. The DWSC and barge canal bisect the city into two subbasins, separating the developing Southport area from the more established neighborhoods of Broderick and Bryte to the north. The two subbasins are broken up into nine levee reaches based on location and fixes.

#### c. Purpose and need

The project purpose and objective is to provide flood risk management to the City of West Sacramento. Providing flood risk management would reduce loss of life and damage to property in the project area.

The Corps identified underseepage as an area of concern following storms in 1997 and, prompting levee reconstruction in the West Sacramento area between 1998 and 2002. Only recently, however, has the Corps issued revised Federal levee design criteria (Section 2.1.3) to provide a consistent approach for addressing potential levee underseepage. Recent engineering analysis has resulted in the identification of levees that don't meet Corps standards and the necessary improvements to provide an urban level of flood protection to West Sacramento. Changes in engineering standards that account for underseepage affected the level of performance for the completed West Sacramento Project. Hydraulic analysis also determined that the area is vulnerable to flooding in a less than 100-year flood event. While Federal standards were changing, the State of California also began developing new standards and criteria for protecting

urban areas to reduce flood risk. Bringing the West Sacramento project levees up to these standards would reduce risk of uncontrolled flooding in the study area that could result in significant damages and loss of life.

d. Authority

The study authority for the West Sacramento area was provided through Section 209 of the Flood Control Act of 1962, PL 87-874. The West Sacramento Project was authorized in WRDA 1992, PL 102-580 Sec. 101 (4), as amended by the Energy and Water Development of 1999, PL 105-245. The current estimated cost of the authorized project is \$53,040,000 under WRDA 2010, PL 111-85. The allowable (Sec. 902) cost limit is \$63,648,000 under Energy and Water development Appropriations Act, 2010, PL 111-85, Sec 118.

e. Alternatives [40 CFR 230.10]: Unless otherwise noted, the information is from the September 2015 final EIS/EIR.

*(1) No action:*

The No Action Alternative serves as a benchmark against which the effects and benefits of the action alternatives are evaluated. The No Action Alternative assumes that current conditions and operation and maintenance practices would be expected to continue to occur in the foreseeable future if the project were not implemented, based on current plans and consistent with available infrastructure and community services. The No Action alternative would have no impacts to wetlands or other waters of the U.S., however, this would not achieve the flood risk management objectives of the project, leaving the City of West Sacramento at risk. Enhanced public safety would also not be realized. This alternative is not practicable, as it would not meet the purpose and need of the proposed project.

*(2) Other project designs:*

**Alternative 1 - Improve Levees.**

Alternative 1 would include the construction of levee remediation measures to address: (1) seepage, (2) slope stability, (3) overtopping, and (4) erosion concerns identified for the Sacramento River, South Cross, DWSC, Port, Yolo Bypass, and Sacramento Bypass training levees. Plate 2-3 in the final EIS/EIR identifies the reaches where each measure would be required under Alternative 1. Levees would be improved through a combination of fix in place and adjacent levee construction. A description of the measures identified and construction methods can be found in Section 2.1.3 of the final EIS/EIR. Once a levee is modified, regardless of the measure implemented for the

alternative, the levee would be brought into compliance with Corps levee design criteria. A full description of Alternative 1 can be found in Section 2.3 of the final EIS/EIR.

This alternative has been retained as a potential alternative. Therefore, this alternative will be retained as a practicable alternative and an evaluation of the impacts of Alternative 1 will be discussed throughout this document in order to determine if it is the least environmentally damaging practicable alternative (LEDPA).

### **Alternative 3 - Improve Levees and DWSC Closure Structure.**

Alternative 3 would include all of the levee improvements discussed in Alternative 1, except that levee repairs on the Port north and Port south levees and portions of the DWSC east and west levees would be replaced by the construction of a closure structure in the DWSC. The Sacramento River, Yolo Bypass, and South Cross levees would be improved to address identified seepage, slope stability, erosion, and height concerns. The construction of a closure structure in the DWSC would provide flood protection to the Port of West Sacramento and the areas of the City located north of the structure, while eliminating miles of levee improvements both north and south of the closure structure. This is the only identified measure that would provide flood protection to the Port of West Sacramento, but it would require in water construction and the placement of dredge or fill material in waters of the U.S. A full description of Alternative 3 can be found in Section 2.4 of the EIS/EIR.

This alternative is considered practicable and will be retained. An evaluation of the impacts of Alternative 3 will be discussed throughout this document in order to determine if it is the least environmentally damaging practicable alternative (LEDPA).

### **Alternative 5 - Improve Levees and Sacramento River South Setback Levee.**

Alternative 5 would include the levee improvements discussed in Alternative 1, except for the levee fix along the Sacramento River south levee. Instead of the fix in place and/or adjacent levee fix along the entire reach, levee repairs would include the construction of a new setback levee. The setback levee would be roughly 5 miles long and would be constructed roughly 500 feet west of the existing levee. This alternative would reduce the amount of bank protection placed on the Sacramento River south levee. A full description of Alternative 5 can be found in Section 2.5 of the final EIS/EIR.

This alternative is considered practicable and will be retained. An evaluation of the impacts of Alternative 5 will be discussed throughout this document in order to determine if it is the least environmentally damaging practicable alternative (LEDPA).

f. General Description of Dredged or Fill Material*(1) General Characteristics of Material*

Fill is required below ordinary high water for the purpose of 1) placement of bank protection along the Sacramento River Levees, 2) installation of seepage berms, 3) construction of adjacent levees, 4) construction of sheet pile walls, 5) construction of flood walls, and 6) construction of the DWSC Closure Structure.

Fill materials for bank protection, seepage berms, and adjacent levees would consist of large stone riprap to armor the waterside slope. Completion of DWSC Closure Structure would require excavation and dredging of fines, and the placement of the concrete for the control structure. Substrate is mostly fine sand and silt.

The proposed fill for Alternatives 1, 3, and 5 would come from on-site construction or imported fill material.

The no action alternative would result in no changes.

*(2) Quantity of Material*

An unknown quantity of material would be dredged for the construction of the DWSC closure structure and removed to the designated disposal areas. Approximately 1.5 tons of rock would be placed within the Sacramento River for bank protection under Alternatives 1 and 3, and 2 tons would be placed for Alternative 5.

*(3) Source of Material*

Potential locations for borrow material, soil maps and land use maps were obtained for a 20-mile radius surrounding the project area. The criteria used to determine potential locations were based on current land use patterns, soil types from Natural Resources Conservation Service (NRCS), and Corps' criteria for material specifications. Borrow sites would be lands that are the least environmentally damaging. Sites would be selected by ensuring absence of wetland plants, soils, or hydrology. Sites with permanent wetlands or waters of the U.S. would not be selected for borrow. In addition, sites with endangered species habit would not be utilized for borrow material. Sites would also be selected and obtained from willing sellers. The data from land use maps and NRCS has not been field verified, therefore, to ensure that sufficient borrow material would be available for construction the Corps looked at all locations within the 20 miles radius for 20 times the needed material. This would allow for sites that do not meet specifications or are not available for extraction of material.

Rip rap for bank protection, seepage berms, and adjacent levees would be imported from a licensed, permitted facility that meets all Federal and State standards and requirements. Concrete material for the sheet pile walls and flood walls would be imported from a licensed, permitted facility or made by the on-site batch plant. The material would be transported along existing roadways and construction access roads.

g. Description of the Proposed Discharge Site

*(1) Location*

The location of the discharge sites would be in the designated disposal area on the west side of the DWSC and along the waterside levee slopes of the Sacramento River, South Cross levee, and DWSC.

*(2) Size*

In-water material will be placed at the DWSC, Sacramento River North Levee and South Levee, and South Cross levee. A wetland delineation has not been completed but wetlands and other waters are assumed to be jurisdictional under Section 404 of the Clean Water Act.

Construction activities associated with Alternative 1 would result in the loss of waters of the U.S., including wetlands, as well as upland habitat, vegetation, and the disruption of wildlife movement corridor. It is estimated that a total of 50 acres of seasonal and permanent wetland habitat, 25 acres of oak woodland habitat, 65 acres of riparian habitat, and 21 acres of shaded riverine aquatic cover (SRA) habitat that provide foraging, breeding, and rearing habitat for many fish and wildlife dependent upon vegetation, wetlands, and waters of the U.S. would be significantly affected by the construction activities to improve levees. If a variance is not obtained the impacts to riparian habitat would increase to roughly 94 acres.

Impacts for Alternative 3 would be the same as those discussed for Alternative 1 excluding impacts to the Port north and south levees and to portions of the DWSC east and west levees and including the addition of impacts from the construction of the closure structure in the DWSC. The DWSC closure structure would eliminate the need for construction on the Port north and south levees, the DWSC east levee from the closure structure north, and the DWSC west levee from the closure structure south, which would eliminate the construction related and permanent impacts in those areas. This would eliminate impacts to roughly 14 acres of riparian habitat and 3 acres of SRA habitat. If a variance is not obtained the impacts to riparian

vegetation would increase to 87 acres. The construction of the closure structure would not require the removal of any additional trees along the DWSC east levee, but would impact roughly 100 acres of fallow farmland and 25 acres open water.

Impacts for Alternative 5 would be similar to those discussed for Alternative 1 on all levee reaches except Sacramento River south. The construction of a setback levee in the Sacramento River south area would remove the impacts to waterside and landside vegetation along the Sacramento River south levee. The setback levee would also eliminate the need for construction of a seepage berm on the landside of the existing levee. It would allow vegetation to remain on the existing levee, removing roughly 5.5 miles of impacts and preventing removal of 21 acres of riparian habitat, 9 acres of oak woodland, and 6 acres of SRA habitat. Bank protection would still be placed on the waterside of the existing levee at breach locations to protect the levee in place and reduce hydraulic impacts. Impacts for all other reaches would be the same as discussed in Alternative 1. If a variance is not obtained the impacts to riparian vegetation would increase to 60 acres.

Alternatives 1, 3, and 5 would encompass the same disposal sites. However, Alternative 3 could generate a larger amount disposal material due to the closure structure. The no action/no project alternative would have no have impacts to disposal sites.

(3) *Type of Site*

The type of disposal site is a waterside levee slopes and river bed, previously disturbed designated dredge disposal sites.

(4) *Type of Habitat*

The following habitat types were identified at and around the study area. The study area consists of levees plus an approximate 500-foot wide buffer area on the land side of each levee reach.

Natural Communities

*Valley Foothill Riparian Habitat.* Most valley foothill riparian habitat in the study area (hereafter referred to as “riparian habitat”) occurs along the Sacramento River, but smaller riparian areas are found at all of the levees in the study area (Plate 3.6-2 from the final EIS/EIR). The total area encompassed by riparian habitat in the study area is approximately 239 acres. The overstory of the riparian habitat consists of mature, well-established trees: Fremont cottonwood (*Populus fremontii* ssp. *fremontii*), valley oak (*Quercus lobata*), black willow (*Salix gooddingii*), and box elder (*Acer negundo* var. *californicum*). During the reconnaissance-level field visits,

Oregon ash (*Fraxinus latifolia*), western sycamore (*Platanus racemosa*), and white alder (*Alnus rhombifolia*) were also observed. The shrub layer consists of smaller trees and shrubs; representative species observed were poison oak (*Toxicodendron diversilobum*), sandbar willow (*Salix exigua*), and Himalayan blackberry (*Rubus discolor*). The riparian habitat in the study area also contains heritage or landmark trees which the City defines as trees with a diameter breast height (DBH) greater than 75 inches, oaks with a DBH greater than 50 inches, and trees with historical significance. Elderberry shrubs (*Sambucus mexicana*), the host plant of the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), which is Federally listed as threatened, were observed in the riparian habitat along the Sacramento River north and south levees. Riparian habitat is listed as a sensitive natural community by the CNDDDB (2009).

*Grasslands and Prairies.* Grasslands and prairies consisting of non-native annual grassland cover approximately half of the study area and encompass a total of approximately 1,178 acres. The largest non-native annual grassland area occurs near the DWSC East, Port south, and DWSC west levees, but grasslands are scattered throughout the study area. The non-native annual grassland is dominated by naturalized annual grasses with intermixed perennial and annual forbs. Grasses commonly observed in the study area are foxtail barley (*Hordeum murinum ssp. leporinum*), ripgut brome (*Bromus diandrus*), Italian ryegrass (*Lolium multiflorum*), and soft chess (*Bromus hordeaceus*). Other grasses observed were wild oats (*Avena spp.*), Bermuda grass (*Cynodon dactylon*), and rattail fescue (*Vulpia myuros var. myuros*). Forbs commonly observed in annual grasslands in the study area are yellow star-thistle (*Centaurea solstitialis*), prickly lettuce (*Lactuca serriola*), bristly ox-tongue (*Picris echioides*), and sweet fennel (*Foeniculum vulgare*). Other forbs observed are perennial peppergrass (*Lepidium latifolium*), Italian thistle (*Carduus pycnocephalus*), horseweed (*Conyza canadensis*), black mustard (*Brassica nigra*), and fireweed (*Epilobium brachycarpum*). The annual grasslands in the study area contain a relatively large proportion of ruderal species, likely because of substantial disturbance from human activities.

*Emergent Wetlands.* There are approximately 86 acres of emergent wetlands within the study area. The largest areas of emergent wetlands (hereafter referred to as “marshes”) occur in the vicinity of the Turning Basin along the Port north and Port south levees. Marshes were also observed in the study area near the South Cross, Yolo Bypass, and DWSC West Levees. Smaller patches of freshwater marsh that are not shown at the mapping scale used by the Yolo Natural Heritage Project also have the potential to occur along the remaining levees (Yolo Natural Heritage Project 2009). Representative species observed in marshes in the study area were tules (*Scirpus sp.*), cattails (*Typha sp.*), and rushes (*Juncus sp.*). Marshes in the study area represent potentially jurisdictional waters of the United States (including wetlands)

that may be subject to regulation under CWA Section 404. Marsh habitat (i.e., coastal and valley freshwater marsh) is also recognized as a sensitive natural community by the CNDDDB (2009).

*Seasonal Wetlands.* Four small seasonal wetlands occur in the study area at the eastern end of the Port south levee, totaling approximately 0.3 acre. These wetlands appear to be inundated during wetter times of the year and ongoing and past disturbance contributed to the formation of three of the four seasonal wetlands that appear to have originated from tire tracks within the network of dirt trails in the basin south of South River Road. Representative plant species observed in the seasonal wetlands were hyssop loosestrife (*Lythrum hyssopifolium*), Mediterranean barley (*Hordeum marinum ssp. gussoneanum*), Italian ryegrass (*Lolium multiflorum*), and fiddle dock (*Rumex crispus*).

*Woodlands and Forest.* Small patches of woodland occur in the study area along the Sacramento River north and Sacramento River south levees, and at the junction of the Sacramento River south and South Cross levees. Woodland and forest encompass approximately 16 acres. These patches of woodland are distinguished from the riparian habitat by a predominance of valley oaks. The woodlands in the study area have a relatively open canopy and contain trees that have the potential to be considered heritage or landmark trees under the City of West Sacramento's Tree Preservation Ordinance.

*Open Water.* There are approximately 413 acres of open water within the study area. The largest areas are the Sacramento River, DWSC, Turning Basin, and Toe Drain but are not identified in blue due to their size. Smaller areas of open water occur in the study area near the Sacramento River north, DWSC east, Yolo Bypass, Port north, and Port south levees. Open water areas are essentially unvegetated.

#### Other Land Cover Types

The following land cover types are associated with human activities.

*Pasture.* Approximately 28 acres of pasture occur in small patches within the study area near the Sacramento River south and Port north levees and provide grazing areas for cattle and horses. Species commonly found in pastures in the region are dallisgrass (*Paspalum dilatatum*), soft chess, and annual bluegrass (*Poa annua*).

*Grain and Hay Fields.* Small fields used to produce grain and hay are located in the study area near the Sacramento River south levee and encompass approximately 68 acres. Although the specific crops were not discernible during the site visits, they were likely barley, oats, or alfalfa, which are commonly grown in the region.

*Deciduous Orchards.* Deciduous orchards in the study area are confined to a small area near the Sacramento River south levee that encompasses approximately 6 acres. At the time of the site visits, the area appeared to be unmaintained (i.e., inactive). Although the specific type of orchard crop could not be discerned, it was likely one of the orchard types commonly known from the region: almonds, walnuts, pears, peaches, or plums.

*Irrigated Grain Crops.* Approximately 20 acres of irrigated grain crops occur within the study area. These areas are associated with the DWSC west levee reach and appear to consist entirely of rice fields.

*Irrigated Hay Fields.* Two small irrigated hay fields occur in the study area near the South Cross levee and in the southern portion of the Sacramento River south levee. Irrigated hay fields encompass approximately 5 acres in study area. These fields are bounded on at least one side by an agricultural toe drain, which presumably carries water for irrigation of the fields. Although the specific crops were not discernible at the time of the site visits, the fields were likely barley, oats, or alfalfa, which are commonly grown in the region.

*Irrigated Row and Field Crops.* Irrigated row and field crops occur in the study area along the Yolo Bypass, Sacramento River South, and South Cross Levees and encompass approximately 239 acres. Most of the irrigated row and field crops along the Yolo Bypass Levee appear to be rice fields. At the time of the site visits, the specific crops grown in the remainder of the irrigated row and field crop areas could not be discerned, but they were most likely crops common to the region, such as tomatoes, safflower, sunflowers, melons, or strawberries.

*Unvegetated, Vacant, or Developed Areas.* Most of the approximately 724 acres that comprise the unvegetated, vacant, and developed areas in the study area occur north of the DWSC along the Sacramento River north, Yolo Bypass, Sacramento Bypass, and Port north levees. Vacant areas within the study area commonly contain ruderal species that have the ability to colonize disturbed areas: bristly ox-tongue, yellow star-thistle, common mallow (*Malva neglecta*), milk-thistle (*Silybum marianum*), prickly lettuce, chicory (*Cichorium intybus*), and perennial peppergrass. Vegetation in developed portions of the study area consists of ornamental species used for landscaping: English ivy (*Hedera helix*), crapemyrtle (*Lagerstroemia indica*), liquid amber (*Liquidamber styraciflua*), edible fig (*Ficus carica*), and privet (*Ligustrum sp.*).

*Invasive Plants.* Within the West Sacramento study area, invasive non-native plant species occur in all plant communities found within the project area and are rapidly expanding in the riparian zone. Areas dominated by non-native vegetation

are generally associated with recent human disturbance and include: abandoned, fallow, and active agricultural fields, borrow and staging areas, levee slopes, and areas subject to fire, frequent flood inundation, or scour. Non-native weeds dominate some areas, especially where they are found growing along the side slopes of the levees and portions of the construction footprint that are immediately adjacent to the toes of the levees on the land and waterside where the area has been previously disturbed. To a lesser degree where there is low diversity of plants found growing on top of and on the slopes of the levees, invasive plants are also found in other nearby plant communities such as riparian, riparian forest, riparian scrub, oak woodland, agriculture and grassland typically having greater plant diversity.

The areas dominated by invasive herbaceous plant species provide poor habitat quality for native wildlife such as voles, mice, garter snakes, jackrabbits, gophers, and for various native and non-native fish species found temporarily using the riparian zone during periods of inundation. The grassland areas also provide foraging habitat for raptors, coyotes, weasels, common kingsnakes, western rattlesnakes, ground squirrels, southern alligator lizards, and western fence lizards, as well as providing nesting and foraging habitat for migratory song birds. In the more upland areas of a flood plain and in areas extending upslope from it, blue elderberries (*Sambucus cerulea*) and other native shrubs and trees are associated with the grassland area.

Grasslands infested with yellow-star thistle (*Centaurea solstitialis*), pepperweed (*Lepidium latifolium*), and other non-native plants provide limited habitat value, but could be suitable sites for restoring native grasses. Native grasses provide higher value for wildlife. Mature non-native species that are not invasive could hinder and prevent the natural regeneration of native plants in portions of the Sacramento River ecosystem and provide habitat of lesser value to native wildlife species.

Several weed populations such as red sesbania (*Sesbania punicea*) is expanding rapidly along the shorelines of streams and ponds. Chinese tallow tree (*Triadica sebifera*), a recent invasive, is also expanding in riparian habitats, as are longer established invaders such as arundo (*Arundo donax*), Pampas grass (*Cortaderia selloana*), Spanish broom (*Spartium junceum*), French broom (*Genista monspessulana*), Himalayan blackberry (*Rubus armeniacus*), and tamarisk (*Tamarix ramosissima*). Tamarisk can rapidly colonize exposed bar surfaces and stream banks. Other common invasive weed plants include wild oats (*Avena fatua*), soft chess brome (*Bromus hordeaceus*), Italian ryegrass (*Lolium multiflorum*), rip-gut brome (*Bromus diandrus*), fennel (*Foeniculum vulgare*), mare's tail (*Conyza canadensis*), cocklebur (*Xanthium strumarium*), pyracantha (*Pyracantha sp.*), oleander (*Nerium oleander*), poison hemlock (*Conium maculatum*), mustard (*Brassica tournefortii*),

and foxtail (*Hordeum jubatum*). Chinese tallow tree, black locust (*Robinia pseudoacacia*), Siberian elm (*Ulmus pumila*), Chinese elm (*Ulmus parvifolia*), and tree-of-heaven (*Ailanthus altissima*) are common invasive tree species. These invasive species typically outcompete native plant species and can be introduced via construction equipment in disturbed areas.

(5) *Timing and Duration of Discharge*

Construction of the project would be conducted over eighteen years, beginning as early as 2017 and continuing through fall 2035. Timing of construction would correspond to low water levels, when feasible, to minimize impacts to water quality.

h. Description of Disposal Method

The description of the disposal methods within the proposed project area are excerpted below from the final EIS/EIR.

Along waterways, such as the Sacramento River, construction from a barge or from heavy equipment on the top of the levee would disturb the aquatic environment and require removal of some vegetation as rock revetment is placed on the slope and into the water where nearshore marsh vegetation could be found. Rock required within the channel, both below and slightly above the water line at the time of placement, would be placed by an excavator located on a barge. The excavator would construct a large rock berm in the water up to an elevation slightly above the mean summer water surface. A planting trench would be established on this rock surface for revegetation purposes. Construction would require two barges: one barge would carry the excavator, while the other barge would hold the stockpile of rock to be placed on the channel slopes.

Alternatives 1, 3, and 5 would utilize similar disposal methods. However, Alternative 3 would also include the disposal of dredged material from the construction of the closure structure at a designated disposal site. The no action/no project alternative would not require the disposal of materials.

**II. Factual Determinations**

a. Physical Substrate Determinations (Sections 230.11 (a) and 230.20)

(1) *Comparison of Existing Substrate and Fill*

The description of the current substrate within the proposed project area is taken from Section 3.2 of the final EIS/EIR.

Most of the soils in the project area are shallow to moderately deep, sloping, well-drained soils with very slowly permeable subsoils underlain with hardpan. These soils have good natural drainage, slow subsoil permeability, and slow runoff.

The project area generally consists of deep soils derived from alluvial sources, which range from low to high permeability rates and low to high shrink-swell potential. Soils range from low to high hazard ratings for construction of roads, buildings, and other structures related to soil bearing strength, shrink-swell potential, and the potential for cave-ins during excavation. Soils immediately adjacent to the Sacramento River are dominated by deep, nearly level, well-drained loamy and sandy soils. The natural drainage is good, and the soils have slow to moderate subsoil permeability. The river terraces consist of very deep, well-drained alluvial soils (NRCS, 2007-2012). The porous nature of the soils underneath the existing levee system is an important consideration for the design of levee improvements within the West Sacramento project area.

Kleinfelder (2007) also describes the levee soils and underlying foundation materials based on borings. The levee soils are typically silty sand and poorly graded clean sand. Beneath the levee materials, the typical profile consisted of a layer of fine-grained silt or clay (interpreted to be overbank deposits) underlain by up to 100 feet of sand and gravel, with interbedded silty sand and clayey sand layers. The main exception to the above typical profile is near the downstream end of the South Levee reach, where the levee is on an old railway grade. Drilling here showed a blanket of silt and clay extending at least 20 feet below the levee materials underlain by sand and/or gravel. These were interpreted to be floodbasin deposits, which appear to extend into the stream bank, overlying alluvium. The bottom of the flood basin deposits is at or above the thalweg elevation of the Sacramento River. The presence of these less-erodible deposits is thought to explain the straight, stable bank and narrow river section through the Clay Bend just near the downstream end of the South Levee reach.

Fill material used during project construction would come from borrow sources within a 20 miles radius of the study area and licensed, permitted facilities. Fill material would be of soils and granitic rock origin.

(2) *Changes to Disposal Area Elevation*

The description changes to the disposal sites within the proposed project area are taken from Section 3.4 of the final EIS/EIR.

The work in Alternative 1 primarily calls for landside fixes of levees that do not change in-channel geometry or characteristics; therefore, the hydraulics of the system does not change. A hydraulic analysis for placement of bank protection in the channel has not been completed at this time. However, during the feasibility level design phase, bank protection was reduced to preserve vegetation and reduce the rock footprint. The current design more closely matches the existing bank and it is anticipated that water surface elevation will not change as a result of the placement of bank protection. The designs will be updated during PED and will be refined to minimize affects to water surface elevation.

The closure structure under Alternative 3 and the resultant change in stages in the DWSC has not been analyzed with a hydraulic model. However, since the DWSC does not convey flood flows and is connected to the Yolo Bypass 15 miles downstream of the project area, it is assumed the water surface elevations in the project area (Sacramento River, Sacramento Bypass and Yolo Bypass) would not change with the addition of a closure structure on DWSC.

Alternatives 5 would cause similar effects as Alternative 1. The no action/no project alternative would not modify the substrate elevation or bottom contours.

(3) *Migration of Fill*

The description of materials and placement are taken from Section 3.5 of the final EIS/EIR.

Sacramento River North and South levee reaches, the Yolo Bypass, Sacramento Bypass Training levee, and the DWSC levee reaches include cutoff wall construction, bank protection placement, and slope reshaping that would require ground disturbing activities that would potentially cause erosion and soil disturbance, subsequently resulting in sediment transport and delivery to aquatic habitats. An increase in sedimentation and turbidity could occur in adjacent water bodies during earth moving activities and could be considered significant. These indirect effects would be reduced to less than significant with the implementation of BMPs discussed in Water Quality (Section 3.5).

Alternatives 1, 3, and 5 would produce similar impacts on erosion and accretion patterns that would be minimized with the use of BMP's. However, construction of the DWSC closure structure for Alternative 3 would cause greater sediment transportation and turbidity issues due to the additional in water work. Alternative 5 would produce fewer impacts along the Sacramento River south were construction would be setback from the waterway.

The no action alternative would not change any erosion and accretion patterns.

(4) *Duration and Extent of Substrate Change*

Alternatives 1, 3, and 5 would cause similar impacts to substrate. The proposed action would result in the removal of some native substrate, the permanent placement of rip rap and cause site soils to become compacted. With implementation of BMPs, effects to soil are considered minimal. Alternative 3 would cause additional impacts, increasing sediment transport and turbidity due to the in water construction work for the closure structure. The construction of the graving site and breaching of the levee would also introduce additional sediment into the system (See Section 2.4.2 for additional information). The no action/no project alternative would not modify the substrate.

(5) *Changes to Environmental Quality and Value*

Evidence of localized, accelerated erosion caused by wave action and channel flows was identified within the study area. Installation of rock slope protection as proposed under Alternative 1, 3, and 5 would substantially reduce bank erosion rates and improve overall levee stability. Construction of Alternative 1, 3, or 5 would cause impacts to vegetation and wildlife habitat, special status species and their habitat, and fisheries resources. Removal of riparian, oak woodland, SRA, and wetlands would reduce the quality of habitat in the area.

Alternative 3 would require dredging for the DWSC closure structure. Disposal sites selected are previously disturbed as designated disposal areas. Placement of material at these locations would be consistent with current land use.

Alternative 5 would cause similar changes in environmental quality and value as Alternative 1.

The no action alternative would not modify the environmental quality and value.

Additional information on vegetation and wildlife, fisheries resources, special status species and impacts to those resources can be found in Sections 3.6, 3.7, and 3.8 of the final EIS/EIR.

(6) *Actions to Minimize Impacts*

Construction would have minor, short-term impacts. Timing the project to occur during low flow periods and standard erosion prevention practices would be employed such as silt fences to contain turbidity. With the implementation of BMPs and avoidance, minimization, and mitigation measures discussed in Sections 3.5, 3.6, 3.7, and 3.8 of the final EIS/EIR the impacts to erosion and transport of soils and substrate would be minimized.

**b. Water Circulation, Fluctuation, and Salinity Determinations*****(1) Alteration of Current Patterns and Water Circulation***

Alternative 1 primarily calls for landside fixes of levees that does not alter the existing drainage pattern or stormwater drainage system; place housing within a 100-year flood hazard area; impede and/or redirect flood flows; or expose people or structures to significant risk of loss, injury, or death involving flooding.

The operation of the closure structure under Alternative 3 and the resultant change in stages in the DWSC has not been analyzed with a hydraulic model. However, since the DWSC does not convey flood flows and is connected to the Yolo Bypass 15 miles downstream of the project area, it is assumed the water surface elevations in the project area (Sacramento River, Sacramento Bypass and Yolo Bypass) would not change with the addition of a closure structure on DWSC. The stages and tidal prism in the DWSC downstream of the closure structure would not change; it is assumed when the closure structure is operating, the stages in the DWSC (upstream of the structure) would remain at a non-damaging stage of 16 feet (NAVD88). The operation of the DWSC closure structure will be further refined with the selection of the tentatively selected plan (TSP). The gate operation of the closure structure could be dependent on a number of conditions within the project area.

Due to time constraints, a setback levee under Alternative 5 has not been included in the hydraulic model used for the feasibility study and no stage information is available for direct comparisons of alternatives. The local sponsor has completed a hydraulic analysis with the setback levee as part of the 408 submittal. Based on this analysis, there is a slight increase in stage downstream of the setback at the Pocket (0.13 foot and 0.17 foot rise for the 100-year and 200-year, respectively) that was determined not to be a significant change. If the setback levee is selected as the TSP, the design will be further refined to ensure that the hydraulic impacts are considered to be below an acceptable threshold. The slight change in stage is not expected to impact the economic analysis because it is assumed the Expected Annual Damages (EAD) is not sensitive to small stage increases for less frequent events.

The no action alternative assumes no action would be taken. In the no action scenario, currents, circulation and drainage patterns of system would remain the same.

***(2) Interference with Water Level Fluctuation***

Because the Sacramento River system and the lower American River system is regulated by upstream dams which allow a specific amount of water to be released into systems, the practicable build alternatives and the no action/no project alternative would not change water level fluctuation patterns.

(3) *Salinity Gradients Alteration*

Salinity gradients would not be affected.

(4) *Effects on Water Quality*

The description of the current water quality condition of the study area is taken from Section 3.5 of the final EIS/EIR.

Surface water quality in the region is generally good. Possible types of contamination that can affect water quality include turbidity; pesticides and fertilizers from agricultural runoff; water temperature exceedances; and toxic heavy metals, such as mercury, copper, zinc, and cadmium from acid mine drainage (USGS 2000, DWR 2005). The portion of the Sacramento River within the project area is part of a 16-mile segment from Knights Landing to the Sacramento-San Joaquin Delta that is on the Section 303(d) list for mercury from abandoned mines and toxicity from unknown sources.

(a) *Water Chemistry*

Project activities involving concrete and concrete wash water have the potential to affect pH, turbidity, and hexavalent chromium in receiving waters. Concrete wash water tends to have relatively high pH (between 10 and 14). Approved BMPs for managing concrete wash water include curing / air drying, off hauling for treatment, and active treatment onsite using carbon dioxide or a stronger acid such as sulfuric or acid. Hexavalent chromium is present in Portland Cement Concrete (PCC) and PCC grindings. Active treatment systems (ATS) targeting pH and turbidity may not remove hexavalent chromium, unless they are augmented with ferrous sulfate or some other chemical agent to reduce hexavalent chromium to trivalent chromium.

Mitigation measures proposed for pH and turbidity would be development and implementation of an approved Stormwater Pollution Prevention Plan (SWPPP), including an ATS if needed to attain water quality objectives. To mitigate for hexavalent chromium risks, the ATS plan would include monitoring and treatment measures to attain no significant increase of hexavalent chromium in receiving waters.

(b) *Salinity*

The project would not change salinity levels.

(c) Clarity

Dredging and placement of fill materials would temporarily reduce clarity due to an increase in total suspended solids within the project area. Clarity is not expected to be substantially affected outside the immediate project area. However, the reduction of clarity caused by construction activities would be short in duration and would return to pre-construction levels upon project completion.

(d) Color

Dredging and placement of fill materials would temporarily induce a color change due to an increase in turbidity. However, conditions would return to pre-construction levels upon completion of the project.

(e) Odor

The project would not affect odor.

(f) Taste

The project would not affect taste.

(g) Dissolved Gas Levels

The proposed project would have temporary impacts on dissolved gas levels within the project vicinity. Development and implementation of an approved SWPPP would avoid significant negative effects.

(h) Temperature

Construction activities have the potential to create substantial turbidity, thus affecting water temperature. Proposed mitigation measures, specifically, conducting work during low flow periods and installing sediment barriers to reduce sediment from entering waterways would be required to control turbidity and the mobilization of pollutants that may be present in sediments.

(i) Nutrients

Release of suspended sediments from project activities could potentially cause turbidity thresholds to be exceeded. This could concurrently cause thresholds for metals and nutrients to be exceeded. Turbidity would be controlled outside the working area using a combination of BMPS as appropriate.

Development and implementation of an approved SWPPP would also prevent release of excess nutrients.

## (j) Eutrophication

The project is not expected to contribute excess nutrients into the stream or promote excessive plant growth due to BMPs and the high content of rock in disposal material.

(5) *Changes to Environmental Quality and Value*

Alternatives 1, 3, and 5 could impact the water quality during construction from earth moving operations, storage and handling of construction materials on site and the operation and maintenance of construction equipment on-site. Construction and associated materials, including solvents, paints, waste materials and fuels associated with operation and maintenance of construction equipment present on-site could introduce hazardous or toxic materials and silt and debris into surrounding waters, resulting in degradation of the water quality. Although there is risk of substantial effects to water quality during project construction, these effects would be short term and localized within the project area. Effective compliance with BMPs, containment plans, and CVRWQCB water quality thresholds is expected to lower risk of changes to environmental quality and value.

Construction of the DWSC closure structure under Alternative 3 would significantly affect water quality in the DWSC. Construction of the closure structure would require excavation of a graving site to construct the closure structure, construction of a ring levee surrounding the graving site, breaching the existing levee to float out constructed sections, dredging to create a platform for construction, placement of rock in the DWSC, and reconstruction of the levee. This soil disturbance at the graving site could cause sediment runoff into drainage canals that pump water into the DWSC. In addition, the graving site would be opened to the DWSC with the breaching of the levee and the float out of the sections of the closure structure, exposing the DWSC to loose sediment in the graving site and causing increases in turbidity. Construction of the platform in the DWSC would require dredging of material from the channel bottom and placement of that material at a spoils site. Dredging would cause increases in turbidity and suspended solids in the DWSC and could cause water quality issues from runoff at spoils sites. However, these impacts would be considered less than significant with implementation of mitigation measures.

As a beneficial positive effect to water quality under Alternative 5, restoring riparian and SRA habitat and ecological and fluvial functions would improve the water quality for native fish and other wildlife species by: 1) creating a localized incremental increase in DO levels and lowering of water temperatures preferred

by salmonids and other native fish species as SRA increases and the vegetation canopy becomes more diverse over time; 2) providing more root mass in the water column of nearshore areas to trap and filter out the fine sediments compared to current water quality conditions with little to no root mass in the water having negative effects to water quality (e.g., having lower DO and higher water temperature parameters); and 3) providing more hydraulic diversity that improves water quality (increase in DO and lowering of water temperature) benefitting a variety of native fish.

*(6) Actions to Minimize Impacts*

Construction and excavation would be timed with low water levels when possible to minimize impacts. The impacts to water quality due to construction activities would be minimized by compliance with thresholds of the Section 401 Water Quality Certification, issued by the Central Valley Regional Water Quality Control Board (CVRWQCB).

In addition, proposed mitigation measures would reduce the potential impacts of the proposed project on water quality. These mitigation measures are located in the Water Quality Section (3.5) of the final EIS/EIR.

The contractor would be required to produce compliance plans and implement the proposed mitigation measures during project construction, therefore, impacts to the water quality from project construction are expected to be minimal.

c. Suspended Particulate/Turbidity Determinations

*(1) Alteration of Suspended Particulate Type and Concentration*

During construction, risk is present for increased levels of turbidity as soils are exposed during rain events. In addition, the dredging of material and placement of fill materials could result in releases of suspended sediments and increased turbidity into the water. Exposed material could be eroded by wave action or storm runoff. The use of best management practices (BMP's), such as utilizing erosion control devices (silt fencing) within the project area, and side slope stabilization of exposed fills would minimize increases in suspended sediments or turbidity associated with the proposed project. Additional information on water quality is found in Section 3.5 final EIS/EIR.

The no action/no project alternative would result in the project not being completed, which would result in no impacts to suspended sediment and turbidity.

*(2) Particulate Plumes Associated with Discharge*

Earthwork would be performed during low flow periods to minimize particulate plumes. However, particulate plumes could occur from the placement of fill materials but are expected to be contained. Plumes would dissipate after construction activity is completed.

### *(3) Changes to Environmental Quality and Value*

Particulate plumes resulting from any construction activity under Alternative 1 would not persist after project completion. Particulates suspended within the disposal area are not expected to differ in type from particulates currently within the project area.

Under Alternative 3, the indirect effects would be the same as described for Alternative 1, but there could also be long term effects to water quality as the closure structure begins to deteriorate over time. Increased turbidity and metal contamination in the water column as iron or other metals in the closure structure corrodes would also impact water quality. In addition, maintenance activities would disturb the channel bottom during repairs.

The effects from Alternative 5 for the Sacramento River north, Sacramento Bypass, Yolo Bypass, DWSC, Port, and the South Cross Toe Drain would be the same as described above in Alternative 1. Effects along the Sacramento River south levee would be reduced due to the setback levee and the elimination of earth work and bank protection on the existing levee.

### *(4) Actions to Minimize Impacts*

Effects would be minimized by performing work during low water level periods when possible. As a result of contractor compliance with the CVWRQCB certification, consistent water quality monitoring, and mitigation measures listed in Section 3.5 of the final EIS/EIR, increases in sedimentation and turbidity are expected to be minimized and temporary.

### d. Contaminant Determinations

Construction activities for Alternative 1 would involve the use of hazardous materials such as fuels and lubricants to operate construction equipment and vehicles such as excavators, compactors, haul trucks, and loaders. Bentonite (a non-hazardous material) would be transported to sites where slurry cutoff wall construction would occur.

Impacts for Alternative 3 would be the same as Alternative 1, with the additional affects associated with the DWSC closure structure. Construction of a closure structure in the DWSC includes construction of a graving site to build the structure. The graving site would be excavated in an area that could have previously been used for agricultural purposes. The disturbance of the soil could

result in the release of different types of contaminants that exist in the soil into the environment, and specifically the DWSC during float out of the structure, significantly affecting water quality. These contaminants include pesticides, fertilizers, organic litter, and debris containing hazardous substances. In addition, contaminated dredge material could be exposed during excavation of the DWCS for the placement of the closure structure.

Impacts for Alternative 5 would be the same as Alternative 1 with the reduction in effects associated with the setback levee along the Sacramento River south levee.

Alternatives 1, 3, and 5 involves the use of borrow material. In order to ensure that there are no contaminants within the proposed borrow or fill material, BMPs listed in the Water Quality Section (Section 3.5) of the final EIS/EIR would be implemented. Provided these mitigation measures are implemented by the contractor, there would be minimal impacts to aquatic resources from contaminants.

The no action alternative would result in no impacts due to potential contaminants.

#### e. Aquatic Ecosystem and Organism Determinations

##### *(1) Effects on Plankton*

Plankton are drifting organisms that inhabit the pelagic zone of oceans, seas, or bodies of fresh water. Construction of the project would be temporary and short termed. With implementation of mitigation measures and BMPS, effects to plankton would be temporary and not significant.

##### *(2) Effects on Benthos*

Benthic organisms are found in the benthic zone which is the ecological region at the lowest level of a body of water such as an ocean or a lake, including the sediment surface and some sub-surface layers. Native benthic species would not be affected by the placement of fill material due to their location away from the levee slope where revetment placement would take place. Dredging would result in the complete removal of benthic organisms from the control structure site. Additional information on impacts to benthic organisms is in Section 3.7 of the final EIS/EIR.

### (3) Effects on Nekton

Nekton are actively swimming aquatic organisms that range in size and complexity from plankton to marine mammals. Descriptions of fish and other aquatic resources below are from Section 3.7 of the final EIS/EIR.

Native fish present in the West Sacramento study area can be separated into anadromous species and resident species. Native anadromous species include four runs of Chinook salmon, steelhead trout, and green sturgeon. All of these anadromous species are expected to use habitat in parts of the study area. Native resident species include but are not limited to Sacramento pikeminnow (*Ptychocheilus grandis*), Sacramento splittail (*Pogonichthys macrolepidotus*), Sacramento sucker (*Catostomus occidentalis*), hardhead (*Mylopharodon conocephalus*), California roach (*Lavinia symmetricus*), and rainbow trout (*O. mykiss*) and can be found throughout the study area in various aquatic habitats. Additional native and nonnative fish species potentially present in the study area can be seen in Table 3.7-1 of the final EIS/EIR.

Construction during the project may disturb soils and the nearshore environment, leading to increases in sediment in the nearshore aquatic habitat. This in turn may increase sedimentation (i.e., deposition of sediment on the substrate), suspended sediments, and turbidity. Increases in suspended solids and turbidity will generally be short-term in nature and not result in a substantial reduction in population abundance, movement, and distribution.

Due to the common footprints of the three alternatives, the impacts to fish and other aquatic organisms would be similar as for the proposed project. However, additional impacts to fish would result from the in water construction work associated with Alternative 3 and the construction of the DWSC closure structure. In water work would cause additional suspended sediments and turbidity in the DWSC.

The no-action alternative would result in no losses of habitat for fish and other aquatic organisms.

### (4) Effects on Aquatic Food Web

Description of ecological effects is taken from Section 3.7 of the final EIS/EIR.

Under Alternative 1, bank protection remediation measures, rock placement and vibration from construction equipment would most likely disturb the native

resident fish by increasing noise, water turbulence, and turbidity, causing them to move away from the area of placement. For some pelagic native juvenile species utilizing the near shore habitat for cover, moving away from that cover could put them at a slight increased risk of predation. Other measures for the Sacramento River North and South levee reaches, including cutoff wall construction, levee raises, and slope reshaping, would be constructed outside of the natural river channel with no direct significant effects to native fish species.

Alternative 3 would have similar effects from bank protection remediation measures as Alternative 1. Additional indirect effects from the permanent closure structure on the Deep Water Ship Channel could have potentially significant effects. During non-operational conditions overwater and in-water structures can alter underwater light conditions and provide potentially favorable holding conditions for adult fish, including species that prey on juvenile fishes. Permanent shading from the installation of piles and other structures in the DWSC could increase the number of predatory fish (e.g., striped bass, largemouth bass) holding in the study area and their ability to prey on resident native fish species.

Alternative 5 bank protection measures would be the same as those discussed for Alternative 1 for the existing levees except for the Sacramento River South levee. There would be a reduction of 6 acres of impacts to SRA habitat and 21 acres of impacts to riparian habitat as a result of the construction of the setback levee. Direct effects associated with a setback levee would not be considered significant because it entails construction of a new levee landward of the existing levee and would avoid construction in the waterside or riparian areas.

Implementation of BMP's and other mitigation measures proposed (Section 3.7) would result in minimal impacts on fish and aquatic wildlife habitat outside the immediate work area.

The no-action alternative would result in no effect to fish and other aquatic organisms.

#### *(5) Effects on Special Aquatic Sites*

##### *(a) Sanctuaries and Refuges*

No sanctuaries and refuges are within the project area.

##### *(b) Wetlands*

It is estimated that a total of 50 acres of seasonal and permanent wetland habitat would be significantly affected by the construction activities

to improve levees. The proposed project would involve the discharge of material and cause the permanent loss to the wetlands on the project site.

Four small seasonal wetlands occur in the study area at the eastern end of the Port south levee, totaling approximately 0.3 acre. These wetlands appear to be inundated during wetter times of the year and ongoing and past disturbance contributed to the formation of three of the four seasonal wetlands that appear to have originated from tire tracks within the network of dirt trails in the basin south of South River Road. Representative plant species observed in the seasonal wetlands were hyssop loosestrife (*Lythrum hyssopifolium*), Mediterranean barley (*Hordeum marinum ssp. gussoneanum*), Italian ryegrass (*Lolium multiflorum*), and fiddle dock (*Rumex crispus*).

(c) Mud Flats

No mud flats are within the project area.

(d) Vegetated Shallows

No vegetated shallows are within the project area.

(e) Coral Reefs

No coral reefs are within the project area.

(f) Riffle and Pool Complexes

No riffle and pool complexes are within the project area.

(6) *Threatened and Endangered Species*

Implementation of Alternative 1 could result in direct effects to VELB if elderberry shrubs are incidentally damaged by construction personnel or equipment. Impacts may also occur if elderberry shrubs need to be transplanted because they are located in areas that cannot be avoided by construction activities. Potential impacts due to damage or transplantation include direct mortality of beetles and/or disruption of their lifecycle.

The potential to affect giant garter snake and their habitat exists in the Yolo Bypass, Yolo Bypass Toe Drain, Deep Water Ship Channel East and West levee areas, and the South Cross levee area. Construction activities associated with this alternative would result in the loss of waters of the United States, including wetlands, as well as upland habitat and disruption of wildlife movement corridors. Except for the proposed levee work on the water side of the

Sacramento River levees where high flows exclude this snake, this effect would be considered significant because fixing the levee in place would temporarily remove nearshore wetlands and upland habitat that provide suitable habitat ranging between marginal to optimal with low to moderate to high food, cover, and water values for the GGS depending on the quantity and quality of the habitat.

Several special-status birds protected under the Migratory Bird Treaty Act (MBTA) including Swainson's hawk, white-tailed kite, northern harrier, bank swallow, tricolored blackbird, loggerhead shrike, and purple martin have potential to nest in or adjacent to the study area based on reported occurrences within a 10-mile radius.

In the study area, burrowing owls could nest in areas with non-native grasslands intermixed with barren ground and in unvegetated areas at farmland areas having berms or levees nearby. Construction activities, including grading and clearing activities within and adjacent to these lands cover types, could result in nesting failure, death of nestlings, or loss of eggs. In addition to some of the farm areas and larger levees that has burrowing owl habitat, up to 30.9 acres of oak woodland/non-native grassland habitat found on the landside of the levees with suitable soils supporting the nesting and foraging needs of the owl could be adversely affected.

Construction activities such as tree removal and trimming or construction noise could result in significant impacts on roosting hoary, Western red, and pallid bats, including the destruction of active roosts, the loss of individuals, or roost failure and the disruption of the wildlife movement corridor. In addition, nighttime construction activities, if needed, could disturb bats emerging from nearby roosts resulting in the disruption of foraging activities.

Direct and indirect significant effects to Chinook salmon, Central Valley steelhead, green sturgeon, delta smelt, Sacramento splittail, and river lamprey due to loss of SRA and riparian habitat from construction of bank protection activities and implementation of the Corps vegetation policy. Short-term indirect effects on fish species attributable to bank protection activities include water quality effects, such as turbidity and the release of contaminants into the river, and noise and disturbance. Long-term effects on fish habitat include loss of aquatic vegetation and SRA cover. Water quality effects, such as impacts from fuel leaks or contaminants, are detailed in the water quality analysis (Section 3.5).

Under Alternative 3, effects to VELB, GGS, special status migratory bird species, special status bat species, western burrowing owl, and western pond turtle would be the same as described for Alternative 1. The only difference under Alternative 3 would be a reduced impact to these species, because there would be no levee improvements occurring on the Port north levee, Port south levee, and some reaches of the DWSC east and west levees. Impacts to special status fish species from construction of the DWSC closure structure would be primarily due to the preparation of the foundation for the structure, because the closure structure would be constructed in the dry in a graving site adjacent to the DWSC and would be floated into the site upon completion. Activities that could potentially have a significant effect on special status fish species in the DWSC include pile driving of the foundation, increased turbidity during construction, and possible increased predation from the permanent presence of the structure.

Effects to special status species under Alternative 5 would be consistent with those described for Alternative 1. The only difference under Alternative 5 would be the proposed Sacramento River south setback levee rather than standard levee improvements proposed for Alternative 1. By constructing the setback levee, it would reduce the impacts to the riparian corridor along the river by 21 acres, reducing impacts to SRA by 6 acres, and reducing impacts to oak woodland by 9 acres. This would reduce the potential impacts to the majority of the special status species. Additional beneficial positive effects under Alternative 5 include: Restoring riparian and SRA habitat and ecological and fluvial functions would improve the habitat for native fish and other wildlife species by: 1) creating a localized incremental increase in DO levels and lowering of water temperatures preferred by salmonids and other native fish species as SRA increases and the vegetation canopy becomes more diverse over time; 2) providing more root mass in the water column of nearshore areas to trap and filter out the fine sediments compared to current water quality conditions with little to no root mass in the water having negative effects to water quality (e.g., having lower DO and higher water temperature parameters); and 3) providing more hydraulic diversity (increase in DO and lowering of water temperature) benefitting a variety of native fish.

The no action alternative would not result in direct impacts to endangered and/or threatened species.

#### *(7) Other Wildlife*

Alternative 1, 3, and 5 could have short-term effects on resident mammals, birds, reptiles, and amphibians. Noise from construction equipment and

increased human presence could temporarily displace some wildlife, and temporary alteration of riparian and aquatic habitat would occur.

To ensure that there would be no effect to migratory birds, preconstruction surveys would be conducted, if needed, in and around the project area. If any migratory birds are found, a protective buffer would be delineated, and USFWS and CDFG would be consulted for further actions. Recommendations proposed by the USFWS in their Fish and Wildlife Coordination Act Report.

The no action alternative would result in no direct impacts to endangered and/or threatened species.

#### *(8) Actions to Minimize Impacts*

Many mitigation measures to avoid and minimize impacts to the aquatic environment, as well as, compensatory mitigation measures in order to compensate for unavoidable impacts are proposed. The Corps would also conduct full wetland delineations within and adjacent to the project footprint in the Pre construction Engineering and Design (PED) phase once designs for each reach are developed. Designs would be developed to minimize current impacts to wetlands, but if wetland delineations determine that additional acreages of wetlands would be impacted, the Corps would avoid, minimize, or mitigate for the additional impacts and coordinate the impacts with the appropriate regulating agencies. Mitigation measures are listed in Section 3.5, 3.6, 3.7, and 3.8 of the final EIS/EIR and specifically include avoiding impacts to Waters of the United States to the maximum extent practicable by minimizing footprints in wetland areas, placing staging areas outside of wetlands, and incorporating requirements for avoidance of sensitive habitat within the bid specs.

#### f. Proposed Disposal Site Determinations

##### *(1) Mixing Zone Size Determination*

Not applicable.

##### *(2) Determination of Compliance with Applicable Water Quality Standards*

The fill material would not violate Environmental Protection Agency or State water quality standards or violate the primary drinking water standards of the Safe Drinking Water Act (42 USC 300f - 300j). Project design, compliance with State water quality thresholds and standard construction and erosion practices would preclude the introduction of substances into surrounding waters.

The proposed project would not affect existing or potential water supplies, nor would the other alternatives, including the no-action alternative.

*(3) Potential Effects on Human Use Characteristics*

a) Municipal and Private Water Supplies

The fill material would not violate Environmental Protection Agency or State water quality standards or violate the primary drinking water standards of the Safe Drinking Water Act (42 USC 300f – 300j).

Project design, compliance with State water quality thresholds and standard construction and erosion practices would preclude the introduction of substances into surrounding waters. Materials removed for disposal off-site would be disposed of in an appropriate landfill or other upland area.

b) Recreation and Commercial Fisheries

The study area is heavily used for recreational fishing. A description of these game fish is provided in the EIS/EIR Fisheries, Section 3.7.

Temporary disruption of these activities would occur during construction activities when the levee crown and adjacent construction and staging areas are closed to public access. Even if the recreation areas themselves are not closed, proximity to construction equipment and activities may degrade recreational experiences. However, this effect is temporary and there are alternative locations for these types of recreation activities in the city.

Alternatives 1 and 5 would result in similar impacts to recreational fisheries. Alternative 3 would result in additional impacts to recreational fisheries during in water construction of the closure structure. Portions of the DWSC would be closed to recreational access during in water construction, but the effects would be temporary.

The no-action alternative would result in no impacts to recreational fisheries.

c) Water-related recreation

In addition to recreational fishing, the study area is a popular location for picnicking, swimming and boating. Under Alternative 1 the placement of bank protection may require in-channel construction activities that could temporarily disrupt recreational boating and personal watercraft use including removal of some vegetation for rock placement. If the bank protection design incorporates a rock bench, in-channel construction

activities are likely to occur. Temporary disruption of recreational boating would result from the presence of construction vehicles, equipment, and personnel in and adjacent to the Sacramento River, as well as temporary construction effects on channel water quality (i.e., increased turbidity from suspended materials).

The Broderick Boat Ramp, located north of the I Street Bridge, is West Sacramento's only vehicle-accessible boat ramp, and provides the Sacramento region's only free, vehicle-accessible boat launch facility. Visitors must use the levee road to access the boat ramp, but temporary closure of the levee road may be necessary during project construction activities. Closure of the boat launch facility would conflict with the City's Department of Boating and Waterways (DBW) grant agreement requiring prior approval from the DBW before closing the facility to any recreational vehicle and reducing access to recreational boating opportunities in the project vicinity. However, with implementation of the avoidance, minimization, and mitigation measures below to preserve marina and boat launch access and to obtain approval for Broderick Boat Ramp closure.

Much of the recreation activity along the Port south levee occurs at the Barge Canal Recreational Access, a formal, City of West Sacramento facility. Because the boat ramp at the Barge Canal Recreational Access is the only public boat access to the barge canal or DWSC, temporary closure of this facility would block public boating access to these waters. The levee raise in this area would require removal of features on the landside of the levee to accommodate the landward expansion of the levee footprint. This could have permanent effects on the Barge Canal Recreational Access. However, with the implementation of the avoidance, minimization, and mitigation measures in Section 3.14.7 of the final EIS/EIR would reduce this effect.

In addition to the formal recreation facility (Sam Combs Park) located along the landside of the Port north levee, UC Davis and the River City Rowing Club operate rowing facilities and the Lake Washington Sailing and Outboard Clubs operate private water access areas out of the Port of West Sacramento. Other recreational use on or near the Port north levee is very limited, because most of the land is owned by industrial enterprises and access is restricted. Temporary disruption of these activities could occur during construction activities when the levee crown and adjacent construction and staging areas are closed to public access. Recreational boating on the barge canal and activities that take place in Sam Combs Park may be indirectly affected by proximity to construction equipment and construction activities that could degrade recreational experiences.

The Sacramento Yacht Club and the Sherwood Harbor Marina and RV Park are both located on the waterside of the Sacramento River south levee. These are the only two marinas located in West Sacramento. Both offer a large number of boat slips, and Sherwood Harbor is the only riverfront RV park in the Sacramento metropolitan area. Visitors must use the levee-top road (South River Road) to access the marinas, but temporary closure of the levee road may be necessary during project construction activities. Closure of the City's only marinas would substantially reduce the availability of existing recreational boating opportunities in the project vicinity.

The calm waters of the DWSC provide a unique recreation opportunity for non-motorized boaters, regional rowing clubs, and local sailing and outboard motor clubs. Temporary disruption of recreational boating would result from the presence of construction vehicles, equipment, and personnel in and adjacent to the DWSC, as well as temporary construction effects on channel water quality (i.e., increased turbidity from suspended materials).

Much of the recreation activity along the Port south levee occurs at the Barge Canal Recreational Access, a formal, City of West Sacramento facility. Because the boat ramp at the Barge Canal Recreational Access is the only public boat access to the barge canal or DWSC, temporary closure of this facility would block public boating access to these waters. The levee raise in this area would require removal of features on the landside of the levee to accommodate the landward expansion of the levee footprint. This could have permanent effects on the Barge Canal Recreational Access.

The impacts on recreation for Alternative 3 would be the same as those discussed in Alternative 1, with the addition of impacts associated with the construction of the DWSC Closure Structure. The construction of the DWSC Closure Structure would cause temporary disruption of recreational access to the DWSC for the UC Davis and the River City Rowing Clubs and the Lake Washington Sailing and Outboard Clubs out of the Port of West Sacramento. Public access to the DWSC via the Barge Canal Recreational Access point would also be temporarily unavailable.

Alternative 5 would have similar impacts to other water related recreation as Alternative 1.

The no-action alternative would result in no impacts to other water related recreation.

## d) Aesthetics

The major roads leading into West Sacramento and downtown Sacramento act as gateways and offer unique vistas of the contrasting landscape features. High rise buildings that can be seen over agriculture fields and residential development are softened by riparian corridors that line the waterways.

Construction activities under Alternative 1 would introduce considerable heavy equipment and associated vehicles, including dozers, graders, cranes, scrapers, and trucks into the views of adjacent residents, recreationists, motorists, and businesses. The equipment would be visible throughout the construction season. Presence of the equipment would temporarily degrade the visual quality of the study area. The construction impacts on aesthetics would be temporary, and would primarily affect local residents or recreationists in the immediate vicinity.

Construction has the potential to substantially degrade the existing visual character or quality of the levee reaches and surroundings for viewer groups for two other reasons: 1) a new levee embankment or flood structure (e.g., flood wall, adjacent levee raise, setback levee) would be present, and 2) construction would require the removal of all vegetation on the landside of the levees and the upper portion of the waterside of the levee. Depending on location and existing conditions, the addition of flood structures could degrade the visual character of the area and obstruct views. For example, a flood wall constructed along the Port north levee could obstruct views of the DWSC and Barge Canal and change the quality of the visual character of these areas. This would be considered a significant and potentially unavoidable effect.

Impacts for Alternative 3 would be the same as those discussed for Alternative 1 with the addition of visual impacts from the construction of and presence of the closure structure in the DWSC. Construction of the closure structure would introduce additional heavy equipment and associated vehicles, including dozers, graders, cranes, scrapers, and trucks into the DWSC east levee area. Residents, recreationists, motorists, and businesses would be exposed to visual impacts from equipment. Construction has the potential to permanently degrade the existing visual character or quality of the area for viewer groups because a new structure would be present in the DWSC. The addition of the closure structure could degrade the visual character of the area and obstruct views.

Alternative 5 would have the same effects as those of Alternative 1 with changes in impacts along the Sacramento River south levee due to construction of the setback levee. The construction of a new levee would change the visual character of this area for residents, motorists, and recreationists. The no-action alternative would not alter the aesthetics and therefore would have no impacts.

- e) Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves.

Not applicable.

g. Determination of Cumulative Effects on the Aquatic Ecosystem

Effects of the proposed action include reductions in nearshore aquatic and riparian habitat that is used by aquatic and terrestrial species. Placement of revetment on earthen banks alters natural fluvial processes that sustain high-value nearshore and floodplain habitats in alluvial river systems.

A number of other commercial and private activities, including hatchery operations, timber harvest, recreation, as well as urban and rural development, could potentially affect listed species in the Sacramento River basin. Levee maintenance activities by state agencies and local reclamation districts are likely to continue, although any effects on listed species will be addressed through Section 10 of the ESA. Ongoing non-federal activities that affect listed salmonids, Green Sturgeon, Delta Smelt, valley elderberry longhorn beetle, giant garter snake and their habitat, will likely continue in the short-term, at intensities similar to those of recent years. However, some activities associated with the State's proposed Central Valley Flood Protection Plan or state or local efforts to implement the ETL could result in increased effects on listed species.

Potential cumulative effects on fish may include any continuing or future non-federal diversions of water that may entrain adult or larval fish or that may incrementally decrease outflows, thus changing the position of habitat for these species. Water diversions through intakes serving numerous small, private agricultural lands and duck clubs in the Delta, upstream of the Delta, and in Suisun Bay contribute to these cumulative effects. These diversions also include municipal and industrial uses and power production. Several new diversions are in various stages of action. The introduction of exotic species may also occur under numerous circumstances. Exotic species can displace native species that provide food for larval fish.

Potential cumulative effects on all species discussed above could include: wave action in the water channel caused by boats that may degrade riparian and wetland habitat and erode banks; dumping of domestic and industrial garbage; land uses that result in increased discharges of pesticides, herbicides, oil, and other contaminants; and conversion of riparian areas for urban development. In addition, routine vegetation clearing and mowing associated with agricultural practices may affect or remove habitat for the valley elderberry longhorn beetle and giant garter snake.

#### h. Determination of Secondary Effects on the Aquatic Ecosystem

Under Alternative 1, 3, and 5 the existing levee structures would be degraded by one half to create a working platform for slurry wall installation. As the levee is degraded, all vegetation on the top half will be removed. Since these trees are located on the top half of the levee, they provide a small amount of SRA habitat, as well as habitat for many avian species. On the waterside of the levee there is little understory vegetation on the top half of the levee due to maintenance activities.

The placement of rock would not only reduce the risk of erosion, but would also anchor remaining trees in place and reduce the potential for trees falling over during a high flow event. The understory, which provides habitat for small rodents, ground nesting birds and waterfowl, and various reptiles, would be removed in order to provide a clean surface to place the rock.

Because the revetment is a hard surface it would not support the growth of large amounts of vegetation. However, some areas where revetment has been placed in the past do have berry vines and wild grape growing over the revetment and creating a low understory. In areas with a soil trench or soil placed over rock on the lower portion of the slope vegetation would be planted or allowed to establish naturally. The revetment would also provide basking areas for some small reptiles such as snakes and lizards. Because the riparian corridor and shaded river aquatic habitat left in place would still provide value to fish and wildlife species, and mitigation would be implemented for trees that were removed, impacts are consider less than significant.

On the landside of the levee all trees would be removed from the levee slope and within 15 feet of the levee toe to comply with the Corps ETL. Within this 15 feet, a 10-foot landside operations, maintenance, and

emergency access corridor would be established. If a vegetation variance is not received impacts to riparian habitat would be increased.

Risk exists for unintentional placement of dredge and/or fill material to be conducted outside of the proposed project area. Unintentional placement could result in additional adverse impacts to water quality, erosion and accretion patterns, aquatic and other wildlife habitat, recreation, aesthetics and air quality. In order to reduce the risk of such impacts, contract specifications would require the contractor to mark the project boundaries, and that the contractor install erosion control (i.e. silt fencing, silt curtains) where possible within any standing waters.

### **III. Findings of Compliance or Non-Compliance with the Restrictions on Discharge**

- (1) No significant adaptations of the guidelines were made relative to this evaluation.
- (2) No practicable alternative exists which meets the study objectives that does not involve discharge of fill into waters of the United States.
- (3) The discharges of fill materials will not cause or contribute to, after consideration of disposal site dilution and dispersion, violation of any applicable State water quality standards for waters. The discharge operations will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.
- (4) The placement of fill materials in the project area(s) will not jeopardize the continued existence of any species listed as threatened or endangered or result in the likelihood of destruction or adverse modification of any critical habitat as specified by the Endangered Species Act of 1973.
- (5) With the implementation of BMPs, avoidance, minimization, and mitigation measures discussed in Sections 3.5, 3.6, 3.7, and 3.8 of the final EIS, the placement of fill materials will not result in significant adverse effects on human health and welfare, including municipal and private water supplies; recreational and commercial fishing; fish, shellfish, and wildlife populations and habitat, and special aquatic sites. The life stages of aquatic species and other wildlife will not be adversely affected in the Sacramento River. Temporary inhibition of life stages will occur within a localized project area.

Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic, and economic values will not occur.

- (6) Appropriate steps to minimize potential adverse effects of the discharge on aquatic systems will be implemented through implementation of BMPs, avoidance, minimization, and mitigation measures discussed in Sections 3.5 of the final EIS/EIR.
- (7) On the basis of the guidelines the proposed disposal site for the discharge of dredged material is specified as complying with the requirements of the guidelines with the inclusion of appropriate and practicable conditions to minimize pollution or adverse effects to the aquatic ecosystem.

**West Sacramento GRR EIS/EIR  
Appendix G**

**Farmland Conversion Impact Rating Form 106**

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**FARMLAND CONVERSION IMPACT RATING  
FOR CORRIDOR TYPE PROJECTS**

<b>PART I (To be completed by Federal Agency)</b>	3. Date of Land Evaluation Request	4. Sheet 1 of _____
---	------------------------------------	---------------------

1. Name of Project	5. Federal Agency Involved
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2. Type of Project	6. County and State
--------------------	---------------------

<b>PART II (To be completed by NRCS)</b>	1. Date Request Received by NRCS	2. Person Completing Form
--	----------------------------------	---------------------------

3. Does the corridor contain prime, unique statewide or local important farmland? (If no, the FPPA does not apply - Do not complete additional parts of this form). YES <input type="checkbox"/> NO <input type="checkbox"/>	4. Acres Irrigated   Average Farm Size
---	--

5. Major Crop(s)	6. Farmable Land in Government Jurisdiction Acres: _____ %	7. Amount of Farmland As Defined in FPPA Acres: _____ %
------------------	---	--

8. Name Of Land Evaluation System Used	9. Name of Local Site Assessment System	10. Date Land Evaluation Returned by NRCS
--	---	---

<b>PART III (To be completed by Federal Agency)</b>	<b>Alternative Corridor For Segment</b>			
---	---	--	--	--

	Corridor A	Corridor B	Corridor C	Corridor D
--	------------	------------	------------	------------

A. Total Acres To Be Converted Directly				
---	--	--	--	--

B. Total Acres To Be Converted Indirectly, Or To Receive Services				
---	--	--	--	--

C. Total Acres In Corridor				
----------------------------	--	--	--	--

<b>PART IV (To be completed by NRCS) Land Evaluation Information</b>				
--	--	--	--	--

A. Total Acres Prime And Unique Farmland				
--	--	--	--	--

B. Total Acres Statewide And Local Important Farmland				
---	--	--	--	--

C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted				
---	--	--	--	--

D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value				
--	--	--	--	--

<b>PART V (To be completed by NRCS) Land Evaluation Information Criterion Relative value of Farmland to Be Serviced or Converted (Scale of 0 - 100 Points)</b>				
--	--	--	--	--

<b>PART VI (To be completed by Federal Agency) Corridor Assessment Criteria (These criteria are explained in 7 CFR 658.5(c))</b>	Maximum Points			
--	----------------	--	--	--

1. Area in Nonurban Use	15			
-------------------------	----	--	--	--

2. Perimeter in Nonurban Use	10			
------------------------------	----	--	--	--

3. Percent Of Corridor Being Farmed	20			
-------------------------------------	----	--	--	--

4. Protection Provided By State And Local Government	20			
--	----	--	--	--

5. Size of Present Farm Unit Compared To Average	10			
--	----	--	--	--

6. Creation Of Nonfarmable Farmland	25			
-------------------------------------	----	--	--	--

7. Availability Of Farm Support Services	5			
--	---	--	--	--

8. On-Farm Investments	20			
------------------------	----	--	--	--

9. Effects Of Conversion On Farm Support Services	25			
---	----	--	--	--

10. Compatibility With Existing Agricultural Use	10			
--	----	--	--	--

TOTAL CORRIDOR ASSESSMENT POINTS	160			
----------------------------------	-----	--	--	--

<b>PART VII (To be completed by Federal Agency)</b>				
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Relative Value Of Farmland (From Part V)	100			
--	-----	--	--	--

Total Corridor Assessment (From Part VI above or a local site assessment)	160			
---	-----	--	--	--

<b>TOTAL POINTS (Total of above 2 lines)</b>	<b>260</b>			
--	------------	--	--	--

1. Corridor Selected:	2. Total Acres of Farmlands to be Converted by Project:	3. Date Of Selection:	4. Was A Local Site Assessment Used?  YES <input type="checkbox"/> NO <input type="checkbox"/>
-----------------------	---	-----------------------	--

5. Reason For Selection:
--------------------------

Signature of Person Completing this Part:	DATE
---	------

**NOTE: Complete a form for each segment with more than one Alternate Corridor**

## CORRIDOR - TYPE SITE ASSESSMENT CRITERIA

The following criteria are to be used for projects that have a linear or corridor - type site configuration connecting two distant points, and crossing several different tracts of land. These include utility lines, highways, railroads, stream improvements, and flood control systems. Federal agencies are to assess the suitability of each corridor - type site or design alternative for protection as farmland along with the land evaluation information.

(1) How much land is in nonurban use within a radius of 1.0 mile from where the project is intended?

More than 90 percent - 15 points  
90 to 20 percent - 14 to 1 point(s)  
Less than 20 percent - 0 points

(2) How much of the perimeter of the site borders on land in nonurban use?

More than 90 percent - 10 points  
90 to 20 percent - 9 to 1 point(s)  
Less than 20 percent - 0 points

(3) How much of the site has been farmed (managed for a scheduled harvest or timber activity) more than five of the last 10 years?

More than 90 percent - 20 points  
90 to 20 percent - 19 to 1 point(s)  
Less than 20 percent - 0 points

(4) Is the site subject to state or unit of local government policies or programs to protect farmland or covered by private programs to protect farmland?

Site is protected - 20 points  
Site is not protected - 0 points

(5) Is the farm unit(s) containing the site (before the project) as large as the average - size farming unit in the County ?

(Average farm sizes in each county are available from the NRCS field offices in each state. Data are from the latest available Census of Agriculture, Acreage or Farm Units in Operation with \$1,000 or more in sales.)  
As large or larger - 10 points  
Below average - deduct 1 point for each 5 percent below the average, down to 0 points if 50 percent or more below average - 9 to 0 points

(6) If the site is chosen for the project, how much of the remaining land on the farm will become non-farmable because of interference with land patterns?

Acreage equal to more than 25 percent of acres directly converted by the project - 25 points  
Acreage equal to between 25 and 5 percent of the acres directly converted by the project - 1 to 24 point(s)  
Acreage equal to less than 5 percent of the acres directly converted by the project - 0 points

(7) Does the site have available adequate supply of farm support services and markets, i.e., farm suppliers, equipment dealers, processing and storage facilities and farmer's markets?

All required services are available - 5 points  
Some required services are available - 4 to 1 point(s)  
No required services are available - 0 points

(8) Does the site have substantial and well-maintained on-farm investments such as barns, other storage building, fruit trees and vines, field terraces, drainage, irrigation, waterways, or other soil and water conservation measures?

High amount of on-farm investment - 20 points  
Moderate amount of on-farm investment - 19 to 1 point(s)  
No on-farm investment - 0 points

(9) Would the project at this site, by converting farmland to nonagricultural use, reduce the demand for farm support services so as to jeopardize the continued existence of these support services and thus, the viability of the farms remaining in the area?

Substantial reduction in demand for support services if the site is converted - 25 points  
Some reduction in demand for support services if the site is converted - 1 to 24 point(s)  
No significant reduction in demand for support services if the site is converted - 0 points

(10) Is the kind and intensity of the proposed use of the site sufficiently incompatible with agriculture that it is likely to contribute to the eventual conversion of surrounding farmland to nonagricultural use?

Proposed project is incompatible to existing agricultural use of surrounding farmland - 10 points  
Proposed project is tolerable to existing agricultural use of surrounding farmland - 9 to 1 point(s)  
Proposed project is fully compatible with existing agricultural use of surrounding farmland - 0 points

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**West Sacramento GRR EIS/EIR  
Appendix H**

**Public Involvement**

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## **INTRODUCTION**

This appendix provides responses to public and agency comments on the West Sacramento Draft Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) and General Reevaluation Report (GRR), as received during the public comment period.

## **PUBLIC COMMENT SUMMARY**

The draft GRR and EIS/EIR was posted in the Federal Register on July 18, 2014 (Vol. 79, No. 138) and WSAFCA published a notice of completion with the State Clearinghouse (SCH #2009072055) on July 17, 2014. The draft GRR and EIS/EIR were circulated for a 45-day review to Federal, State, and local agencies; organizations; and members of the public from July 18, 2014 through September 1, 2014. The draft GRR and EIS/EIR were made available both on the Sacramento District, Corps of Engineers website as well as the website for the Central Valley Flood Protection Board. Hard copies of the draft GRR and EIS/EIR were provided to area libraries. Letters and/or DVD copies of the GRR and EIS/EIR were sent to interested parties, local residents, and to the agencies and elected officials listed in Section 6.4 of the EIS/EIR. Public workshops were held on August 19, 2014 at the West Sacramento City Hall Galleria located at 1110 West Capitol Avenue to provide additional opportunities for comments on the draft GRR and EIS/EIR. All comments received during the public review period were considered and incorporated into the final GRR and EIS/EIR as appropriate.

A total of 18 people attended the meetings. Comments were solicited through the use of court reporters at the meetings. Additionally, comments could be submitted through mail or electronic mail. Oral and written comments were made throughout the series of meetings by local, State, and Federal agencies, community organizations, and individuals.

During the Draft EIS public review period, a total of 55 comments were received from the public in the following manner:

- 11 different parties commented, including 2 Federal agencies, 3 State of California agency, 2 local agencies and organizations, and 4 private citizens.

A summary of the major issues from the public comments are included below. Original letters, e-mails follow. Responses to the public comments are included in the table that follows.

## **RESPONSES TO PRIMARY COMMENTS**

Public comments on the draft documents focused in part on: 1) ensuring receipt of all necessary permits; 2) ensuring consistency with applicable plans and policies; 3) clarification of impacts to waters

of the U.S.; 4) receipt of a vegetation variance and minimizing impacts to the environment; 5) coordinating for impacts to utilities, and 6) concerns about the setback levee and taking private property.

## **COMMENTS AND RESPONSES**

The following pages include all public comments received and the Corps' responses to those comments. The responses are annotated to refer back to the corresponding letters and comments that precede them.

**Responses to Comments**  
**West Sacramento General Reevaluation Report**  
**Draft Environmental Impact Statement/Environmental Impact Report**  
**Yolo County, California**

**A. Letter from the California Department of Transportation (Caltrans), dated August 25, 2014**

1. Comment: On page 223, Section 3.10.7 Avoidance, Minimization, and Mitigation Measures of the DEIR discusses the preparation of a construction traffic control plan for Alternative 1 through 5. If it is determined that traffic restrictions and detours are needed on or affecting State highways, a TMP or construction Traffic Impact Study may be required of the developer for approval by Caltrans prior to construction. TMPs must be prepared in accordance with Caltrans' *Manual on Uniform Traffic Control Devices*.

*Response: Prior to construction, the Corps would ensure that a traffic control plan is prepared for the selected plan. If necessary, a Traffic Impact Study would be completed. The Corps or its contractor would coordinate with Caltrans prior to construction to ensure that all impacts to State roadways are being addressed in the appropriate manner.*

2. Comment: Please be advised that any work or traffic control that would encroach onto the State Right of Way (ROW) requires an encroachment permit that is issued by Caltrans. To apply, a completed encroachment permit application, environmental documentation, and five sets of plans clearly indicating State ROW must be submitted to Bruce Capaul, District Office Chief, Office of Permits, Caltrans, District 3, 703 B Street, Marysville, CA 95901. Traffic-related mitigation measures should be incorporated into the construction plans prior to the encroachment permit process.

*Response: The Corps or its contractor would acquire all appropriate permits prior to the initiation of project construction.*

3. Comment: Please provide our office with copies of any further actions regarding this project.

*Response: The Corps will send all future mailings regarding this project to Caltrans.*

**B. Letter from the Central Valley Regional Water Quality Control Board (Central Valley RWQCB), dated July 30, 2014**

1. Comment: Dischargers whose project disturb one or more acres of soil or where projects disturb less than one acre but are part of a larger common plan of development that in total disturbs one or more acres, are required to obtain coverage under the General Permit for Storm Water Discharges Associated with Construction Activities (Construction General Permit), Construction General Permit Order No. 2009-009-DWQ. Construction activity subject to this permit includes clearing, grading, grubbing, disturbances to the ground, such as stockpiling, or excavation, but does not include regular maintenance activities performed to restore the original line, grade, or capacity of the facility. The Construction General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP).

*Response: The Corps or its contractor would acquire all appropriate permits prior to the initiation of project construction. The Corps will require its construction contractor to prepare a SWPPP prior to construction.*

2. Comment: The Phase I and II MS4 permits require the Permittees reduce pollutants and runoff flows from new development and redevelopment using Best Management Practices (BMPs) to the maximum extent practicable (MEP). MS4 Permittees have their own development standards, also known as Low Impact Development (LID)/post –construction standards that include a hydromodification component. The MS4 permits also require specific design concepts for LID/post-construction BMPs in the early stages of a project during the entitlement and CEQA process and the development plan review process.

*Response: The Corps or its contractor would acquire all appropriate permits prior to the initiation of project construction and the Corps will require its construction contractor to implement all appropriate BMPs.*

3. Comment: Storm water discharges associated with industrial sites must comply with the regulations contained in the Industrial Storm Water General Permit Order No. 97-03-DWQ.

*Response: The Corps or its contractor would acquire all appropriate permits prior to the initiation of project construction. The Corps would ensure that project construction complies with the requirements contained in the permits.*

4. Comment: If the project will involve the discharge of dredged or fill material in navigable waters or wetlands, a permit pursuant to Section 404 of the Clean Water Act may be needed from the United States Army Corps of Engineers (USACOE). If a Section 404 permit is required by the USACOE, the Central Valley Water Board will review the permit application

to ensure that discharge will not violate water quality standards. If the project requires surface water drainage realignment, the applicant is advised to contact the Department of Fish and Game for information on Streambed Alteration Permit requirements.

*Response: The Corps cannot issue a permit to itself. However, the Corps will ensure that the project complies with the regulations of Section 404 through the preparation of a Section 404(b)(1) analysis, which is included with the final EIS/EIR as Appendix F.*

5. Comment: If an USACOE permit, or any other federal permit, is required for this project due to the disturbance of waters of the United States (such as streams and wetlands), then a Water Quality Certification must be obtained from the Central Valley Water Board prior to initiation of project activities. There are no waivers for 401 Water Quality Certifications.

*Response: The Corps will ensure that prior to initiation of construction, a Section 401 Water Quality Certification is obtained, as necessary, for impacts to waters of the U.S.*

6. Comment: If USACOE determines that only non-jurisdictional waters of the State (i.e., “non-federal” waters of the State) are present in the proposed project area, the proposed project will require a Waste Discharge Requirement (WDR) permit to be issued by Central Valley Water Board. Under the California Porter-Cologne Water Quality Control Act, discharges to all waters of the State, including all wetlands and other waters of the State, including, but not limited to, isolated wetlands, are subject to State regulation.

*Response: The Corps or its contractor would acquire all appropriate permits prior to the initiation of project construction.*

7. Comment: If the proposed project includes construction dewatering and it is necessary to discharge the groundwater to waters of the United States, the proposed project will require coverage under a National Pollutant Discharge Elimination System (NPDES) permit. Dewatering discharges are typically considered a low or limited threat to water quality and may be covered under the General Order for *Dewatering and Other Low Threat Discharges to Surface Waters* (Low Threat General Order) or the General Order for *Limited Threat Discharges of Treated/Untreated Groundwater from Cleanup Sites, Wastewater from Superchlorination Projects, and Other Limited Threat Wastewaters to Surface Water* (Limited Threat General Order). A complete application must be submitted to the Central Valley Water Board to obtain coverage under these General NPDES permits.

*Response: The Corps or its contractor would acquire all appropriate permits prior to the initiation of project construction.*

**C. Letter from the Delta Stewardship Council, dated August 29, 2014**

1. Comment: The EIS/EIR should discuss any inconsistencies between the project and the Delta Plan, as required by 15125(d) of the California Environmental Quality Act (CEQA) Guidelines. Note, too, that the CEQA Guidelines' Appendix G states that a project that is inconsistent with any applicable land use plan, policy, or regulation may result in a finding of significant impact on biological resources.

*Response: The Corps has added language to Chapter 3, sections 3.3 and 3.6 of the EIS/EIR acknowledging the projects relationship to the Delta Plan. Consistent with Delta Stewardship Council's (DSC) comments, WSAFCA understands the need to complete the certification process for compliance with the Delta Plan's regulatory policies when acting as the local agency approving, funding, or carrying out a project that must certify consistency with the Delta Plan. While the Draft GRR EIS/EIR describes and analyzes the likely future flood risk reduction actions of the Corps and WSAFCA at a worst case level, WSAFCA will also conduct project-level CEQA analysis of any included action prior to implementation. As part of the project-level environmental analysis, WSAFCA will ensure that any future flood risk reduction project that is a covered action under the Delta Plan is consistent with the Delta Plan's Policies and Recommendations, and will prepare Consistency Determinations for these actions as directed by the Plan. As presently defined, the actions included in the Draft GRR EIS/EIR are expected to be consistent with the Delta Plan, as discussed in Chapter 5, Compliance with Laws and Regulations. Additional language regarding The Delta Plan has also been added to Chapter 5, section 5.2.*

2. Comment: In the Draft EIS/EIR, Subsection 6.4.2, we suggest replacing the "California Bay-Delta Authority" with the "Delta Stewardship Council."

*Response: California Bay-Delta Authority has been replaced with Delta Stewardship Council.*

3. Comment: The draft EIS/EIR identifies the potential land use and agricultural resource impacts and provides possible mitigation measures. In Section 3.3 Land Use and Agriculture, pages 68-69, it also recognizes various federal, state, and local regulations and plans. We commend your efforts on coordination and compliance with different federal, state, and local entities and their regulations. For this reason, the narrative at page 68-69 should be revised to include the Council and the Delta Plan. The Council is an independent State agency charged with furthering the achievement of the State's coequal goals and has specific jurisdiction over and regulations related to land use in the secondary zone of the Delta (23 California Code of Regulation [CCR] Section 5010).

*Response: The Land Use and Agriculture Section and the Compliance with Laws and Regulations chapter has been updated to include coordination and compliance with the Delta Stewardship Council and the Delta Plan.*

4. Comment: In addition, the possible alternatives listed in Section 3.3.3 through 3.3.6 should be verified for consistency with Delta Plan Policy DP P2 (23 CCR Section 5011), which calls for siting flood management infrastructure to avoid or reduce conflicts with local land uses when feasible.

*Response: The majority of the project would improve existing levees which are already acting as flood management structures. The location of the setback levee was selected by WSAFCA through their Southport Early Implementation Project, which requires approval from the Corps under 33 U.S.C. §408, to minimize impacts to private owners and maximize ecosystem restoration potential. Public lands were not available for use in this area. The proposed project is in compliance with local land use plans, such as the City of West Sacramento General Plan, the Southport Improvement Framework Plan, and the Central Valley Flood Protection Plan.*

5. Comment: This draft EIS/EIR provides biological resource impact assessments and identifies “Alternative 5 – Improve Levees and Sacramento River South Setback Levee” as the Net Economic Development (NED) Plan as well as the preferred plan. In the final EIS/EIR, please verify that the project and the possible outcomes will be consistent with policies identified in the Delta Plan. Such policies include Delta Plan Policy ER P2 (23 CCR Section 5006), which calls for restoring habitats at appropriate elevations; and Policy ER P4 (23 CCR Section 5008), which states that levee projects must evaluate and, where feasible, incorporate alternatives, including the use of setback levees, to increase floodplains and riparian habitats.

*Response: The actions defined in the EIS/EIR are expected to be consistent with the policies identified in the Delta Plan regarding restoring habitats at appropriate elevations and incorporating setback levees to increase floodplains and riparian habitats. Alternative 5 does incorporate a setback levee and increase the floodplain of the Sacramento River. Language has been added to Section 3.7.7, the Vegetation and Wildlife Section stating that the habitat will be restored at appropriate elevations consistent with Delta Plan policies. As part of the project-level environmental analysis, WSAFCA will also ensure that any future flood risk reduction project that is a covered action under the Delta Plan is consistent with the Delta Plan's Policies and Recommendations, and will prepare Consistency Determinations for these actions as directed by the Plan.*

6. Comment: The Delta Plan Reform Act specifically established a certification process for compliance with the Delta Plan’s regulatory policies (<http://deltacouncil.ca.gov/covered-actions>). According to the Delta Reform Act, it is the state or local agency approving, funding, or carrying out the project that must certify consistency with the Delta Plan. This certification is subject to appeal to the Council. A way to streamline the process and make full use of the EIS/EIR is to include the information and analysis needed to support the certification of Delta Plan consistency within the EIS/EIR, including potentially a draft certification as an appendix to the final EIS/EIR.

*Response: WSAFCA understands its obligation to ensure its actions are in compliance with the Delta Plan. The Corps is supportive of WSAFCA’s efforts to be consistent with the Delta Plan. See also response to Comment C.1. above.*

7. Comment: Please also note that the final Programmatic Environmental Impact Report (PEIR) for the Delta Plan includes a Mitigation Monitoring and Reporting Plan that describes the mitigation required for covered actions. If you should determine this project is a covered action, it will need to comply with the Delta Plan’s Policy GP1 (23 CCR Section 5002(b)(2)), which states, “Covered actions not exempt from CEQA must include applicable feasible mitigation measures identified in the Delta Plan’s PEIR or substitute mitigation measures that the proposing agency finds are equally or more effective.” Even if the project is not a covered action, we encourage consistency with the Delta Plan’s Policies and Recommendations, including Recommendation DP R16, which encourages recreation, such as levee-top trails or bank fishing on public lands. We commend you on proposing to provide West Sacramento residents with recreation opportunities that are compatible with implementation of this project’s flood risk reduction measures.

*Response: As part of any future project-level CEQA analysis conducted for the actions defined in this EIS/EIR, WSAFCA would comply with GP1 by including applicable feasible mitigation measures identified in the Delta Plan’s PEIR or equally effective substitute mitigation measures.*

**D. Letter from the Delta Stewardship Council, dated August 29, 2014, comments on the draft GRR**

1. Comment: The Council is the successor of the CALFED Bay-Delta Program. On page 1-22 of the Draft GRR, Subsection 1.5.1.7, we suggest replacing “Delta CALFED Program” with “Delta Stewardship Council and Delta Plan.” Please consider including the following language: “The Delta Reform Act (California Water Code Section 85212) created the Council as an independent agency of the State and charged the Council ‘to develop, adopt, and commence implementation of the Delta Plan.’”

*Response: The Corps has replaced “Delta CALFED Program” with “Delta Stewardship Council and Delta Plan” and added the following language to the GRR: “The Delta Reform Act (California Water Code Section 85212) created the Council as an independent agency of the State and charged the Council ‘to develop, adopt, and commence implementation of the Delta Plan.’”*

2. Comment: We encourage the USACE to consider Delta Plan Recommendation ER R4, Exempt Delta Levees from the U.S. Army Corps of Engineers’ Vegetation Policy. This recommendation suggests that the USACE should consider the ecosystem value of remaining riparian and shaded riverine aquatic habitat along Delta levees and agree with the California Department of Fish and Wildlife and the California Department of Water Resources on a variance that exempts Delta levees from the USACE’s levee vegetation policy where appropriate.

*Response: The Corps will consider Delta Plan Recommendation ER R4. The levees in the West Sacramento area are primarily urban levees which must maintain a higher level of protection due to the populations protected within. The Corps will be seeking a variance to the vegetation policy to allow trees to remain on the lower waterside slope, which would maintain ecosystem values and SRA habitat for the Sacramento River system.*

3. Comment: The Draft GRR identifies flood risk management as the only project purpose for both the authorized project and the general reevaluation study. Council staff acknowledges that USACE can play an important role in helping achieve the Delta Plan’s coequal goals of water supply reliability and ecosystem restoration while protecting and enhancing an evolving Delta. However, we are concerned that USACE only identified risk reduction as the single purpose of this project, which has prevented the USACE from simultaneously achieving risk reduction and habitat restoration goals. We encourage USACE to adopt a multiple benefits approach to explore and identify additional state-federal joint interests and to carry out projects that will provide significant contribution towards public safety, water supply reliability, ecosystem enhancement and restoration, and economic stability, all of which are vital components to California.

*Response: The authorized purpose of the West Sacramento Project was initially as a single-purpose flood risk management project. In earlier stages of the West Sacramento GRR study process the Corps considered including ecosystem restoration as a project purpose, particularly associated with a potential setback levee in Southport. In evaluating the opportunities in the study area, the Corps determined that the only feasible opportunity for ecosystem restoration in the study area is the Southport setback levee. In evaluating the setback levee opportunity, it was determined that there may be a need to use the setback area as mitigation for the overall project, as well as potentially other WSAFCA actions*

*in the area. As a result, the opportunity for ecosystem restoration seemed to be limited, so the Corps focused on flood risk management as the primary project purpose. USACE supports the opportunity to improve floodplain habitat associated with the Southport setback levee and has included as part of the project, best management measures to avoid, minimize, and mitigation for effects to vegetation and wildlife, fisheries, and special status species and their habitats as described in Sections 3.6, 3.7, and 3.8 of the EIS/EIR. This includes utilizing the setback area for project mitigation.*

**E. Letter from the United States Department of the Interior, Office of Environmental Policy and Compliance, dated September 2, 2014**

1. Comment: The Department of the Interior has received and reviewed the subject document and has no comments to offer.

*Response: Thank you for your review.*

**F. Letter from the United States Environmental Protection Agency, dated September 9, 2014**

1. Comment: The Avoidance, Minimization, and Mitigation Measures for the Vegetation and Wildlife section of the DEIS (Section 3.6.7) discusses compensation and standard minimization measures for the alternatives, but does not address how impacts to Waters of the United States would be avoided to the maximum extent practicable. The Section 404(b)(1) Water Quality Evaluation in Appendix F and the DEIS identify the preferred alternative as the Least Environmentally Damaging Practicable Alternative, but do not provide sufficient justification for how that determination was made. Recommendation: Clearly explain, in the FEIS, how the Corps would avoid impacts to wetlands and other waters of the U.S. to the maximum extent practicable. We recommend that the FEIS also include a more explicit discussion of how the preferred alternative was determined to be the LEDPA.

*Response: The Corps has added language to Section 3.6 of the EIS/EIR clarifying how impacts to wetlands and waters of the U.S. were determined and justification for the determination of the LEDPA. The Corps has also updated the mitigation measures in Section 3.6.7 to include wetland delineations in the pre construction engineering and design phase and to avoid and minimize impacts to wetlands where possible. In addition the Corps has updated the 404(b)(1) to clarify the justification for the determination of the LEDPA. The revised 404(b)(1) analysis is provided in Appendix F to the final EIS/EIR.*

2. Comment: The wetland acreages cited in the DEIS are estimates based on aerial imagery, vegetation type, and some field observations (page 106), but no official delineations have

yet been completed. EPA's experience is that on-the-ground delineations can be substantially different from estimates based on aerial imagery. The DEIS lists acres of wetlands impacted for each levee section, but does not provide tables or maps of wetland and riparian impact locations for the alternatives. Page 106 of the DEIS references Figure 3.6-1 as showing land cover types that are, or could be, wetlands or waters of the U.S.; but the Figure is absent from the DEIS. Additionally, the discussion of impacts does not clearly differentiate between permanent loss of acres and temporary impacts from construction. Recommendations: Explain, in the FEIS, when wetlands delineations will be conducted and how the impact analysis could be altered by any significant changes to the estimated quantity of impacted acreage. Provide maps and tables to more clearly communicate impacts to wetlands, waters of the U.S., and other habitat types. Show impact numbers broken out into permanent and temporary impacts. We recommend the inclusion of an additional table illustrating impacts for each alternative by habitat type.

*Response: The Corps has added language to Chapter 3, Section 3.6.7 of the EIS/EIR noting that wetland delineations will be conducted prior to construction and what impacts this would have if significant changes in acreages occur. The Corps has also included tables in section 3.6 of the final EIS/EIR that show both permanent and temporary impacts to wetlands and other habitat types by alternative. Plates for land type and waters of the US including wetlands have been included in the plates.*

3. Comment: The DEIS alternatives and impacts analysis repeatedly mention and rely upon a vegetation variance to be requested by the Sacramento District from the standard vegetation guidelines set forth in the Corps' Engineering Technical Letter (ETL) 1110-2-583. It appears that the variance would apply to the Sacramento River Levee and the Sacramento River South Levee sections of the project, but it is unclear whether both areas would be covered under a single variance or whether there would be multiple requests and evaluations. The range of impacts to riparian habitat would increase from 65 acres to 99 acres if the variance is not granted for the project. It further appears that the determination of the LEPDA relies upon the variance being issued. Recommendation: The FEIS should clarify the process for, and timing of, requesting a variance and the likelihood that it will be obtained. Include a commitment to conduct additional impact analysis should the variance not be obtained.

*Response: The Corps has expanded its discussion regarding the vegetation variance. The variance would allow riparian habitat to remain, whereas areas that do not receive a variance would require all habitat removed from the levee slopes. The Corps has clarified in the final EIS/EIR (Chapter 2 and Chapter 3, sections 3.6, 3.7, and 3.8) which reaches would receive a variance versus which locations would result in full removal of vegetation. In addition, the Corps has expanded its discussion of the analysis that was conducted to determine the*

*feasibility of the variance. If the variance is not granted on the project, the Corps would be required to do significant additional environmental analysis and coordination on the change in impact significance for these reaches.*

4. Comment: The DEIS discloses that there will be a significant temporal loss to riparian habitat as it will take many years for the newly planted trees and plants to mature for permanent mitigation. The DEIS does not specifically identify any mitigation for the temporal loss of riparian habitat. The document further acknowledges the value of heritage trees as natural assets in the project area and references a mitigation measure to comply with local ordinance requirements for removal permits (page 122) and to protect heritage trees that do not need to be removed. Recommendations: The FEIS should describe measures that could mitigate the temporal loss of riparian habitat, and clearly state whether or not such measures would be implemented. Commit to avoid removal of heritage and non-heritage mature trees in riparian habitat to the maximum extent practicable. Include, in the FEIS, details of the local ordinances and requirements for tree removal permits.

*Response: The Corps intends to mitigate riparian habitat at a 2:1 ratio to account for the temporal loss of this habitat, as is discussed in Chapter 3, section 3.6.7 of the EIS/EIR. The 2:1 ratio was developed in coordination with USFWS as discussed in Section 3.6 to mitigation for temporal loss of habitat. Heritage and mature trees would be avoided to the maximum extent practicable. The City of West Sacramento's Tree Preservation Ordinance is discussed in Chapter 5 on page 413 of the Draft EIS/EIR. Implementation of a variance to the Corps vegetation policy would allow mature trees to remain on the lower waterside slope.*

5. Comment: The DEIS provides numbers for riparian acres impacted, but it is unclear whether those acres include areas where erosion control rocks will be placed without removal of all trees and vegetation. Recommendation: Clearly identify the acreage or linear feet of waterside levee that would be hardscaped with rock, as opposed to those areas that will remain riparian habitat with some erosion control.

*Response: The Corps has expanded its discussion regarding the vegetation variance. The variance would allow riparian habitat to remain, whereas areas that do not receive a variance would require all habitat removed from the levee slopes. The Corps has clarified in the EIS/EIR (Chapter 2 and Chapter 3, sections 3.6, 3.7, and 3.8) which reaches would receive a variance versus which locations would result in full removal of vegetation. However, in some reaches, such as the Barge Canal in the Port North and Port South areas, there would be no erosion repair associated with the vegetation removal. Additionally, Table 1 in Appendix I includes total vegetation impacts, including linear feet of SRA and acreages of riparian habitat that will be impacted by the project by reach.*

6. Comment: EPA appreciates the Corps' apparent sensitivity to the need to avoid destruction of mature forests, wetlands, and shaded riverine aquatic habitat to the greatest extent possible. Where avoidance is not possible, mitigation is proposed, but discussed in general terms with no specific mitigation location identified. Recommendations: In the FEIS, identify and screen possible onsite and offsite habitat mitigation locations. Potential restoration sites in the vicinity might be found immediately upstream of the project area in and around the confluence of the American and Sacramento rivers and Steelhead Creek (e.g., Yolo County Park, Discovery Park, and Camp Pollock). Commit to implementing mitigation concurrently with the project impacts, and implementing riparian mitigation as early in the project as possible to help compensate for the temporal loss of riparian habitat. EPA would appreciate the opportunity to review and comment on the Corps' draft mitigation and monitoring plan when it becomes available. Give the lifespan of the project, the Corps has an opportunity to safeguard genetic diversity and resiliency in the North Delta ecosystem. EPA encourages the Corps to consider hiring a reputable nursery early in project implementation to collect acorns of the oldest and most vulnerable trees; seedlings could be propagated in the nursery for installation on-site or in mitigation areas while preserving the genetic material of the original mature trees. Frequency and yield of acorns from older trees can be limited, making early planning and implementation of this strategy particularly important. A similar strategy could be employed for native prairie species to secure the ecological value of native prairie habitat and the needs of the Western Burrowing Owl.

*Response: Thank you for the recommendations. We will consider our options for implementing mitigation as early in the process as possible. Additionally, the Corps will be requesting a variance from the Corps vegetation policy in order to allow the original mature trees to remain on the lower waterside slope, which would preserve these trees for propagation. The Corps will send the draft Mitigation and Monitoring Plan to the EPA when it becomes available.*

7. Comment: The Corps proposes perpetual protection for the establishment of elderberries and VELB habitat, but only short-term stewardship for other types of habitat subject to compensatory mitigation (page 121). Recommendation: In keeping with the federal compensatory mitigation rule, the Corps should commit in the FEIS to take measures to ensure that any mitigation sites established as part of this project are permanently protected and managed with appropriate conservation easements, stewardship endowments, and management plans.

*Response: The Corps will comply with the Federal compensatory mitigation rule.*

8. Comment: The DEIS for the current project states that Corps staff relied upon the previous DEIS for analysis, but does not provide references to or summaries of that analysis in the project description and impact analysis. Without such references to the Southport DEIS, it is difficult to understand if the current project is dependent upon implementation of the

Southport project or if the setback levee in the West Sacramento Project DEIS would proceed independent of that project. Recommendation: EPA recommends that the relationship between the Southport Sacramento River Early Implementation Project at the West Sacramento Project be clarified in the FEIS. Where the project description and environmental analysis relies on the Southport DEIS, the FEIS should provide summaries of and citations to the previous document. Where the description and analysis differ from the Southport project, those differences should be highlighted. The FEIS should also clearly describe the status of the Southport project and potential barriers to its implementation.

*Response: The relationship between the West Sacramento GRR and the Southport Sacramento River Early Implementation Project is explained in Section 1.3.1 of the EIS/EIR. The status of the Southport project and any barriers to its implementation is not relevant to the analysis of the GRR. More information about the Southport project is available to the public through the WSAFCA website ([https://www.cityofwestsacramento.org/city/flood/southport\\_eip/default.asp](https://www.cityofwestsacramento.org/city/flood/southport_eip/default.asp)). The Corps will edit the EIS/EIR prior to the final to ensure that the Southport EIS is properly cited, when used.*

9. Comment: Plate 2-1 provides a map of potential borrow sites, but neither the map nor the DEIS identify which borrow areas are existing dredged material stockpiles. Ongoing Corps projects generate the vast majority of dredged material in the Delta, and past Corps dredging accounts for most of the stockpiles of previously-dredged material around the Delta. This project represents an opportunity to access and reuse stockpiled dredged material. Recommendation: The FEIS should commit to maximize the use of already stockpiled dredged material and future maintenance material from the Deep Water Shipping Channel to the greatest extent possible. Early coordination between project managers for this project and the DWSC could further provide easily accessible dredged material for the project, thereby reducing environmental impacts.

*Response: Previously-dredged material is typically not suitable for levee construction. Existing stockpiled material, including dredged material, will be evaluated to determine its suitability for use in project construction.*

10. Comment: Air quality impacts could vary significantly depending on the location of the borrow sites. To help inform the planning process of borrow site selection throughout the project, the FEIS should include a discussion and summary table detailing the borrow site options and their comparative air quality impacts, and commit to selecting sites that minimize impacts.

*Response: The Corps identified potential borrow sites within a 20-mile radius of the project area. The air quality analysis conducted for this draft EIS/EIR*

*assumed a distance of 20 miles as a worst-case scenario for hauling of borrow material to the site. The Corps will evaluate potential borrow sites beginning with those nearest to the project area, and anticipates selecting borrow sites that would reduce the air quality impacts associated with this action during construction.*

11. Comment: Explore alternatives to riprap for erosion control. Discuss such alternative methods in the FEIS, including the extent to which each method would be compatible with the West Sacramento Project needs and the Corps' vegetation policy.

*Response: The bank protection design established in the project description of the draft EIS/EIR uses rip rap as the worst case scenario for environmental impacts. During the preconstruction engineering and design phase, the Corps will refine these designs on a site-specific basis based on the best available technical data. Other methods, including geotextile and biotechnical measures will be evaluated for erosion protection as part of this refinement.*

12. Comment: In light of the President's November 1, 2013 Executive Order 13653 "Preparing the United States for the Impacts of Climate Change," there is an opportunity with the West Sacramento Project to illustrate and maximize the climate-resilient benefits of levee design and floodplain restoration. The DEIS simply states, for each alternative, that the levee enhancements would improve resiliency, but provides few details. Recommendation: We recommend that the FEIS reference Executive Order 13653 in the discussion of the regulatory environment, and include a more detailed discussion about the impacts to climate change resiliency for each of the alternatives. For example, explain how the differences in the alternatives would change the level of resiliency, particularly for the setback levee in the preferred alternative.

*Response: The Corps will add EO 13653 to the Regulatory Setting for Climate Change (Section 3.12.1), and to the Laws and Regulations discussion in Chapter 5. The Corps will ensure that the Climate Change analysis in the FEIS is in compliance with EO 13653. Improving the levees to address the identified problems with erosion, stability, and seepage will make them more resilient to the potential impacts associated with climate change.*

13. Comment: In the FEIS, explain how the residual risk behind levees will be communicated to the public, and include a commitment to ensure that this occurs. Such communication should clearly convey: the level of protection provided by the levees during and after construction; the fact that levees may fail or be overtopped; and that the area is a floodplain, with indications of the depth of flooding when the levee fails or is overtopped. We recommend that the Corps also commit, in the FEIS, to commenting on the adequacy of the current City of West Sacramento Emergency Operations Plan to provide insights about

the project enhancements and residual risk. Consider seeking a voluntary commitment from the City to require flood insurance for structures protected by levees, as recommended by NLSC.

*Response: In Section 4.7 the GRR discusses the residual risk that will remain after implementation of the recommended plan:*

*“The recommended plan would substantially lessen the probability of an uncontrolled flood in the study area due to levee failure. After implementation of the TSP, West Sacramento will, however, have a remaining risk of flooding due to the chance of overtopping from a flood event that exceeds the design event. Depending on the size of the flood event the flooding depth in the majority of West Sacramento could be greater than 3 feet above ground elevation, with some areas having flood depths up to 23 feet. Shallower depths are expected to be adjacent to and possibly intermingled with the extreme depths. This is severe and deep floodplain flooding.”*

*The City of West Sacramento is a participant in the National Flood Insurance Program (NFIP). The City's Floodplain Management Ordinance, Title 18 of the City's Municipal Code, meets or exceeds FEMA's current floodplain management requirements. The City of West Sacramento is a participant in the Community Rating System (CRS). As a CRS participant, the City receives credit for flood-risk awareness information distributed to residents and property-owners throughout the City. This information, combined with the three funding sources that residents and property owners support for flood protection improvements, improves flood-risk awareness throughout the City.*

*The City of West Sacramento has developed a comprehensive flood warning system and evacuation plan. The City of West Sacramento utilizes stream gauges in the Sacramento River to determine the Flood Warning and Alert stages. The City monitors weather conditions and stream levels to determine the level of severity and evacuation triggers of potential flood events. The City monitors the gauge on the Sacramento River at the I Street Bridge. The levels of emergency evacuation identified by the City ranging from less severe to most severe include: Watch Stage, Warning Stage, Full Alert Stage, Emergency Stage, General Evacuation Stage, and Flooding Stage.*

*Hypothetical flood depth and rescue and evacuation area maps have been developed by the City of West Sacramento for two hypothetical levee failure locations, one in the North Basin and one in Southport as part of the Flood Emergency Evacuation Plan. The hypothetical flood depth maps depict both the maximum flood depths and the elapsed time from levee failure until an area is*

*inundated with floodwaters to a depth of 1 foot for the two levee failure locations on the levees surrounding West Sacramento. Depending on the levee failure location the elapsed time to get to 1 foot flood depths can range from 2 to 22 hours.*

*USACE will consider seeking a voluntary commitment from the City to require flood insurance for structures protected by levees.*

14. Comment: The DEIS mentions that the Corps met with the Yocha Dehe, Wilton Rancheria, United Auburn Indian Community of the Auburn Rancheria, and conferred with the Buena Vista Rancheria via phone, but provides no details or results of those meetings.  
Recommendation: The FEIS should include details of the meetings and phone consultations with the tribes affected by the project and discuss the impacts and mitigation measures identified through that consultation. It should also note whether ongoing consultation will continue through the duration of the project. Include the tribes in the distribution list for the FEIS and Record of Decision.

*Response: The Corps has included a summary of consultations with the Tribes affected by the project in Chapter 6 of the final EIS/EIR and Appendix C, the Cultural Resources Appendix. Consultations will continue in accordance with the Programmatic Agreement that is being prepared to manage the treatment of cultural resources and historic properties throughout the life of this project. The Tribes received the Draft EIS/EIR during public review and will remain on the distribution list for the FEIS and ROD.*

#### **G. Letter from Pacific Gas and Electric Company, dated August 1, 2014**

1. Comment: To promote the safe and reliable maintenance and operation of utility facilities, the California Public Utilities Commission (CPUC) has mandated specific clearance requirements between utility facilities and surrounding objects or construction activities. To ensure compliance with these standards, project proponents should coordinate with PG&E early in the development of their project plans. Any proposed improvement plans should provide for unrestricted utility access, and prevent easement encroachments that might impair the safe and reliable maintenance and operation of PG&E's facilities.

*Response: The Corps will require its construction contractor to meet appropriate clearance requirements during construction. The Non Federal Sponsor, WSAFCA would coordinate with PG&E regarding easements and access prior solicitation and award of project construction.*

2. Comment: Any proposed activities with the potential to change the grade above our pipelines (temporary or permanent) must be reviewed and approved by PG&E. Other

potential concerns include; 1) compaction over the pipelines due to heavy equipment; 2) Underground Service Alert (USA) location of facilities before excavation near easements; 3) changes in the drainage patterns that could undermine stability of soils around pipelines; and 4) future construction of additional facilities within easements.

*Response: Prior to initiation of construction, the Corps would require its contractor to coordinate with PG&E regarding any potential impacts to pipelines. A USA location search would be conducted prior to any excavation occurring. The project would not alter any existing drainage patterns. The only new facility being constructed under the tentatively selected plan is the setback levee. If there are pipelines in the footprint of the setback levee, WSAFCA would coordinate with PG&E during the PED phase, prior to solicitation and award for construction.*

3. Comment: Call 811 to have PG&E's underground facilities located and marked. Please note that PG&E standby personnel are required when potholing gas transmission facilities to confirm depths and/or when construction activities are taking place within five feet of a gas line.

*Response: The Corps will coordinate with PG&E prior to construction in the vicinity of any gas transmission facilities.*

4. Comment: For electric transmission and distribution facilities G.O. 95 clearances must be maintained at all times. As with Gas facilities, access to the facilities must be maintained for normal inspections, maintenance and operation of the facilities. Bollards must be installed by the requesting party in front of footings of towers located in areas vulnerable to vehicular traffic. Dust raised during construction could also increase opportunity for flash-overs.

*Response: The Corps will require its construction contractor to ensure that construction near any electric transmission facilities is conducted in compliance with all regulations and clearances required. The Corps will also require its construction contractor to implement BMPs during construction to reduce potential impacts from dust during construction activities.*

5. Comment: Relocations of PG&E's electric transmission facilities (50,000 volts and above) may also require formal approval from the California Public Utilities Commission. If required, this approval process may take up to two years to complete. Proponents of the levee improvement project with plans that may affect such electric transmission facilities should be referred to PG&E for additional information and assistance in the development of their project schedules.

*Response: The Corps will ensure that WSAFCA coordinates with PG&E and the California Public Utilities Commission, as needed, to ensure that any relocation plans for PG&E electric transmission facilities, if required by the project, are properly developed and approved prior to solicitation and award of the construction contract.*

6. Comment: We recommend that environmental documents for the proposed levee improvement project include an adequate evaluation of the cumulative impacts to utility systems, as well as an evaluation of the significance of PG&E's construction activities, as related the relocation of its facilities associated with the levee improvement project, for each resource category. This will assure the project's compliance with NEPA/CEQA and reduce potential delays to the project schedule.

*Response: The Corps has included further cumulative impact analysis on utility systems as a part of the Final EIS/EIR in Chapter 4, section 4.2.13, and if necessary, supplemental environmental analyses would be completed during PED if final designs indicate that need.*

7. Comment: The requesting party will be responsible for the costs associated with the relocation of existing PG&E facilities to accommodate the levee improvement project. Because the relocation of facilities requires long lead times and is not always feasible, the requesting party is encouraged to consult with PG&E as early in their planning stage as possible.

*Response: A separate assessment on every utility to be relocated would be conducted and a legal opinion would be obtained for each utility to determine who pays for relocations and to determine if a substitute facility is required. The Non Federal Sponsor, WSAFCA would be responsible for relocations of utilities and ensuring the performance of such relocations by working directly with the utility owner to move utilities or making arrangements to protect the utilities in place. The Non Federal Sponsor must pay for relocations to the extent that the purpose is ensuring the uninterrupted delivery of service (i.e. gas) and safety of its ongoing transmission. Arrangements for removal or relocation of utilities would be done prior to the award of the construction contract. If PG&E has a revocable permit issued from the CVFPB than PG&E would move the utility at their own expense. If PG&E owns an easement on the land than the WSAFCA would pay to have the utility relocated. The Corps would ensure that WSAFCA consults with PG&E as early as possible to keep the process moving.*

#### **H. E-mail from the Sacramento Marina, dated September 2, 2014**

1. Comment: Will the proposed change on the west side levees push more silt to the east side of the river depositing the silt into the entrance channel and launch ramp of the Sacramento Marina? We already must dredge annually at great expense and are trying to minimize this.

*Response: According to hydraulic modeling performed in the design phase (see attached memo), once construction of the setback levee is in place we should see an increase in velocities on the east bank across from the setback levee (which is just downstream of the marina). This comes with a caveat though: the increase in velocities would only be during events where the river exceeds a bank-full stage (since we are not altering the river's cross section below the natural floodplain elevation). During low flow conditions sedimentation should not be affected.*

2. Comment: Will the proposed change to the levee change the river flow taking away the silt from the east side of the river so we will be dredging less? Of course this would be ideal from our perspective.

*Response: See Response to question 1*

3. Comment: After the new levee is built is the existing levee going to be removed or allowed to slowly wash away giving the new levee behind it flood control and making the actual river wider at that location? If so is there a time line that the levee would be gone? This is asked with the understanding that river flows would be a major contributor and nobody can predict with absolute accuracy.

*Response: The existing levee will be degraded during construction. The attached memo has some figures which should give you a good idea of what the restored floodplain will look like.*

#### **I. Letter from Yokoyama Farm, dated September 1, 2014**

1. Comment: Other cost effective alternatives are available for 200 year flood control that will not destroy our property by construction of a setback levee. Even though WSAFCA claims that these alternatives are under consideration, they are currently proceeding with plans to build the setback levee on our property. WSAFCA has authorized contracted vendors to repeatedly contact me by phone demanding to inspect our home for appraisal, answer questions regarding land use, and approach family members for information regarding occupancy.

*Response: The Corps concurs that there are other alternatives presented in the study that could provide a similar level of protection; however, the setback levee is the alternative that maximizes the benefits gained from implementation of the project, and it is the only alternative that allows for environmental mitigation to be implemented in the project area.. Because a setback alternative would require acquisition of private property, WSAFCA and its contractors contacted potentially affected property owners to appraise property values and determine feasibility of a setback alternative and likely project costs. In August 2014, after full consideration of both setback and non-setback approaches, the WSAFCA board certified the Southport Final EIR was certified and adopted a setback levee alternative for the Southport levee reach. Ms. Yokoyama received a purchase offer from WSAFCA for her affected property in February 2015.*

2. Comment: The proposed setback levee has structural flaws including possible seismic instability and potential failure in a 200 year flood. These structural deficiencies have not been specifically addressed or shown to be resolved in the WSAFCA EIS-EIR. Publication of the MBK 2011 model showed setback levee failure, and now WSAFCA states that failure is not evident when the predictive model was reanalyzed. The setback levee construction needs evaluation by another engineer before declaring the design is safe.

*Response:*

*WSAFCA has designed the proposed setback levee to provide protection from the 200-year flood event. USACE has reviewed WSAFCA's preliminary design of the Southport setback levee and found it to meet all USACE levee standards. Additionally, the project has been reviewed by an independent external peer review panel to ensure that good science and sound engineering is practiced, and public health, safety, and welfare is protected. USACE will review the final designs to ensure that the levee design is compliant with USACE levee standards and will not adversely affect the functioning of the levee protection system.*

3. Comment: The collateral environmental consequences of the inter-levee area created by a setback levee outweigh the public good including the introduction of wildlife, especially mosquitoes that vector infectious human diseases that can cause epidemics in the metropolitan Sacramento region. Many examples of the incompatibility of urban wildlife populations with human populations are readily available throughout the area including the report this month of a mountain lion on the American River Trail. The WSAFCA negligently responds that mosquitoes will be insignificant and the proposed environmental area will prevent wildlife encroachment in residential areas. These issues need to be addressed by an urban wildlife ecologist.

*Response: Mosquito control in the project area is the responsibility of the Sacramento-Yolo Mosquito and Vector Control District, who schedule annual*

*spraying, as well as other measures such as the use of mosquitofish to manage mosquito populations. The inter-levee restoration area would be graded to ensure that water could drain back into the river to avoid excessive standing water for mosquito populations to develop as well as avoid other adverse environmental impacts such as fish stranding.*

4. Comment: The WSAFCA claim that the inter-levee area between the existing degraded levee and setback levee will create a sustainable ecological zone compatible with new wildlife habitats and spawning ground for fish is conceptual, biologically inaccurate, and needs documentation with examples from similar construction in highly urbanized areas.

*Response: This language does not appear in the draft EIS/EIR. However, the Corps has constructed setback levees in the past that have resulted in successful restoration areas, including along the Feather River near Marysville, California.*

5. Comment: The WSAFCA claim that human activities on the setback levee will not cause levee erosion is inconsistent with the current conditions on the levee bank. Multiple rutted trails created by people are visible from in any satellite image of the existing levee on our property and in the south area between the Barge Canal and the Sacramento River.

*Response: The Corps concurs that the erosion caused from human activities is an existing condition of the levee system due to informal unregulated access to the Sacramento River by recreationists. The Corps does not anticipate a change from this existing condition with-project, however the setback levee's distance from the river could limit this usage. Addressing this erosion is a responsibility of the local reclamation district or other maintaining agency.*

6. Comment: The WSAFCA EIS/EIR is misleading in representing our farmland as non-irrigated and inconsequential because we have built multiple agricultural wells on our land and on our neighbor's land to the north. Our farm operations have supported local families who have depended on year-round agricultural activities on our farm for decades, including production of high cash vegetable, melon, and field crops.

*Response: In the draft EIS/EIR, the Important Farmland Map (Plate 3.3-2) from November 2013 showed that the farmland is categorized as Farmland of Local Importance. The Corps ran an updated search on the California Department of Conservation Farmland Mapping and Monitoring Program website in October 2014, which showed the land categorized as Prime Farmland. The Corps has updated the Important Farmland Map for the Final EIS/EIR to reflect the State's updated farmland maps.*

7. Comment: The WSAFCA claim that the agency does not intend to create a mitigation bank from the inter-levee area on our land is false as they have already filed an application.

*Response: Currently, WSAFCA does not plan to create a mitigation bank within the inter-levee area. There are plans to use the inter-levee area for mitigation for the Federal project and other WSAFCA actions, but credits would not be made commercially available, as is typical for a mitigation bank.*

8. Comment: Construction of a setback levee will require more than 17 years as proposed in the EIS/EIR because no source of borrow material to construct the massive structure has been identified. No plan has been provided to begin mining the borrow that is synchronized with approval and construction deadlines. Thus, exposure to a potential 200 year flood event will be prolonged during the excessive construction period.

*Response: The 17 year construction period discussed in the EIS/EIR is for the entire West Sacramento levee system. The setback levee is estimated as a 4 year construction window. The Corps cannot begin excavating borrow sites until the project has been authorized by Congress and funding for construction has been authorized. However, the estimated construction schedule does take into account borrow operations. If WSAFCA is granted permission to alter the Federal levee, the setback levee could be constructed in advance of the greater Federal project, expediting flood risk management benefits for the city of West Sacramento.*

9. Comment: Attached comment letters regarding Southport EIS/EIR

*Response: The comments included in the attachments to this comment letter relating to the Southport EIS/EIR have been addressed in the final EIR for that project which was certified and adopted by the WSAFCA Board in August 2014. The document is available on WSAFCA's website at the following address.*

*[https://www.cityofwestsacramento.org/city/flood/southport\\_eip/environmental\\_studies.asp](https://www.cityofwestsacramento.org/city/flood/southport_eip/environmental_studies.asp)*

**J. Public Meeting Comment Sheet from Christine Amey, August 19, 2014**

1. Comment: I am a resident of the Washington District Nth of the Tower Bridge “specifically”. We are very excited to hear the property Nth of the boat ramp has recently been purchased with the hopes of developing by building residential on the levee, “on the flood plain”... We would like consideration made for the development of this location and support by the city to help make this project happen... We have been dealing with a blighted, run down infestation of homeless camps for years. The cost to periodically clear the area of trash runs high tax payer dollars... Tons of trash and debris... The area has been made unsafe for public use due to the hazardous materials left in camp sites and along the river... We understand that it may be (10) yrs before any funding is available to begin work on the levees Nth of the Tower Bridge... So we are asking this developer be able to develop the area (perhaps Units on stilts) building similar to Chevy’s on the East side. This would help the eradication of homeless camps and open up the river to the residents, to have the area developed and made available to the public by development.

*Response: Any decisions regarding future development would be determined by the Central Valley Flood Protection Board, with input from the Corps. The development decisions and the flood risk management project approvals are not related to one another, and the decision on whether or not to support development is not contingent on the project being approved and constructed.*

**K. Public Meeting Comment Sheet from John Freeman, August 19, 2014**

1. Sac River North Levee from Broderick Boat Ramp to I Street Bridge should be improved into walkable & bikeable pedestrian usable area.

*Response: Recreation improvements are not proposed as a part of the Federal project. The City of West Sacramento could implement these improvements separate from the flood risk management project.*

**DEPARTMENT OF TRANSPORTATION**

DISTRICT 3 – SACRAMENTO AREA OFFICE  
2379 GATEWAY OAKS DRIVE, STE 150 - MS 19  
SACRAMENTO, CA 95833  
PHONE (916) 274-0635  
FAX (916) 263-1796  
TTY 711



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August 25, 2014

032014YOL-0068  
03-YOL-VAR  
SCH# 2009072055

Mr. John Powderly  
West Sacramento Area Flood Control Agency  
1110 West Capitol Avenue  
West Sacramento, CA 95691

**West Sacramento Project – Draft Environmental Impact Report (DEIR)**

Dear Mr. Powderly:

Thank you for including the California Department of Transportation (Caltrans) in the environmental review process for the project referenced above. The United States Army Corps of Engineers, West Sacramento Area Flood Control Agency, and the State of California Central Valley Flood Protection Board are proposing to provide flood damage reduction to the City of West Sacramento by repairing the levees that surround the city. The following comments are based on the DEIR.

***Transportation Management Plan (TMP)***

On page 223, Section 3.10.7 Avoidance, Minimization, and Mitigation Measures of the DEIR discusses the preparation of a construction traffic control plan for Alternative 1 through 5. If it is determined that traffic restrictions and detours are needed on or affecting State highways, a TMP or construction Traffic Impact Study may be required of the developer for approval by Caltrans prior to construction. TMPs must be prepared in accordance with Caltrans' *Manual on Uniform Traffic Control Devices*. Further information is available for download at the following web address: <http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/pdf/camutcd2012/Part6.pdf>.

***Encroachment Permit***

Please be advised that any work or traffic control that would encroach onto the State Right of Way (ROW) requires an encroachment permit that is issued by Caltrans. To apply, a completed encroachment permit application, environmental documentation, and five sets of plans clearly indicating State ROW must be submitted to Bruce Capaul, District Office Chief, Office of Permits, Caltrans, District 3, 703 B Street, Marysville, CA 95901. Traffic-related mitigation measures should be incorporated into the construction plans prior to the encroachment permit process. See the website linked here for more information: <http://www.dot.ca.gov/hq/traffops/developserv/permits/>.

Mr. John Powderly / West Sacramento Area Flood Control Agency

August 25, 2014

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Please provide our office with copies of any further actions regarding this project. We would appreciate the opportunity to review and comment on any changes related to this development.

If you have any questions regarding these comments or require additional information, please contact Arthur Murray, Intergovernmental Review Coordinator at (916) 274-0616 or by email at: [arthur.murray@dot.ca.gov](mailto:arthur.murray@dot.ca.gov).

Sincerely,



ERIC FREDERICKS, Chief  
Office of Transportation Planning –South

c: Scott Morgan, State Clearinghouse



EDMUND G. BROWN JR.  
GOVERNOR

MATTHEW RODRIGUEZ  
SECRETARY FOR  
ENVIRONMENTAL PROTECTION

## Central Valley Regional Water Quality Control Board

30 July 2014

Ms. Anne Baker  
U.S. Army Corps of Engineers  
Sacramento District  
1325 J Street  
Sacramento, CA 95814

CERTIFIED MAIL  
7013 1710 0002 3644 6542

### **COMMENTS TO REQUEST FOR REVIEW FOR THE ENVIRONMENTAL IMPACT STATEMENT/ ENVIRONMENTAL IMPACT REPORT AND THE DRAFT GENERAL REEVALUATION REPORT, WEST SACRAMENTO PROJECT, YOLO COUNTY**

Pursuant to the Army Corps of Engineers' 7 July 2014 request, the Central Valley Regional Water Quality Control Board (Central Valley Water Board) has reviewed the *Request for Review for the Environmental Impact Statement/ Environmental Impact Report and the Draft General Reevaluation Report* for the West Sacramento Project, located in Yolo County.

Our agency is delegated with the responsibility of protecting the quality of surface and groundwaters of the state; therefore our comments will address concerns surrounding those issues.

#### **Construction Storm Water General Permit**

Dischargers whose project disturb one or more acres of soil or where projects disturb less than one acre but are part of a larger common plan of development that in total disturbs one or more acres, are required to obtain coverage under the General Permit for Storm Water Discharges Associated with Construction Activities (Construction General Permit), Construction General Permit Order No. 2009-009-DWQ. Construction activity subject to this permit includes clearing, grading, grubbing, disturbances to the ground, such as stockpiling, or excavation, but does not include regular maintenance activities performed to restore the original line, grade, or capacity of the facility. The Construction General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP).

For more information on the Construction General Permit, visit the State Water Resources Control Board website at:

[http://www.waterboards.ca.gov/water\\_issues/programs/stormwater/constpermits.shtml](http://www.waterboards.ca.gov/water_issues/programs/stormwater/constpermits.shtml).

### **Phase I and II Municipal Separate Storm Sewer System (MS4) Permits<sup>1</sup>**

The Phase I and II MS4 permits require the Permittees reduce pollutants and runoff flows from new development and redevelopment using Best Management Practices (BMPs) to the maximum extent practicable (MEP). MS4 Permittees have their own development standards, also known as Low Impact Development (LID)/post-construction standards that include a hydromodification component. The MS4 permits also require specific design concepts for LID/post-construction BMPs in the early stages of a project during the entitlement and CEQA process and the development plan review process.

For more information on which Phase I MS4 Permit this project applies to, visit the Central Valley Water Board website at:

[http://www.waterboards.ca.gov/centralvalley/water\\_issues/storm\\_water/municipal\\_permits/](http://www.waterboards.ca.gov/centralvalley/water_issues/storm_water/municipal_permits/).

For more information on the Phase II MS4 permit and who it applies to, visit the State Water Resources Control Board at:

[http://www.waterboards.ca.gov/water\\_issues/programs/stormwater/phase\\_ii\\_municipal.shtml](http://www.waterboards.ca.gov/water_issues/programs/stormwater/phase_ii_municipal.shtml)

### **Industrial Storm Water General Permit**

Storm water discharges associated with industrial sites must comply with the regulations contained in the Industrial Storm Water General Permit Order No. 97-03-DWQ.

For more information on the Industrial Storm Water General Permit, visit the Central Valley Water Board website at:

[http://www.waterboards.ca.gov/centralvalley/water\\_issues/storm\\_water/industrial\\_general\\_permits/index.shtml](http://www.waterboards.ca.gov/centralvalley/water_issues/storm_water/industrial_general_permits/index.shtml).

### **Clean Water Act Section 404 Permit**

If the project will involve the discharge of dredged or fill material in navigable waters or wetlands, a permit pursuant to Section 404 of the Clean Water Act may be needed from the United States Army Corps of Engineers (USACOE). If a Section 404 permit is required by the USACOE, the Central Valley Water Board will review the permit application to ensure that discharge will not violate water quality standards. If the project requires surface water drainage realignment, the applicant is advised to contact the Department of Fish and Game for information on Streambed Alteration Permit requirements.

If you have any questions regarding the Clean Water Act Section 404 permits, please contact the Regulatory Division of the Sacramento District of USACOE at (916) 557-5250.

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<sup>1</sup> Municipal Permits = The Phase I Municipal Separate Storm Water System (MS4) Permit covers medium sized Municipalities (serving between 100,000 and 250,000 people) and large sized municipalities (serving over 250,000 people). The Phase II MS4 provides coverage for small municipalities, including non-traditional Small MS4s, which include military bases, public campuses, prisons and hospitals.

### **Clean Water Act Section 401 Permit – Water Quality Certification**

If an USACOE permit, or any other federal permit, is required for this project due to the disturbance of waters of the United States (such as streams and wetlands), then a Water Quality Certification must be obtained from the Central Valley Water Board prior to initiation of project activities. There are no waivers for 401 Water Quality Certifications.

### **Waste Discharge Requirements**

If USACOE determines that only non-jurisdictional waters of the State (i.e., “non-federal” waters of the State) are present in the proposed project area, the proposed project will require a Waste Discharge Requirement (WDR) permit to be issued by Central Valley Water Board. Under the California Porter-Cologne Water Quality Control Act, discharges to all waters of the State, including all wetlands and other waters of the State including, but not limited to, isolated wetlands, are subject to State regulation.

For more information on the Water Quality Certification and WDR processes, visit the Central Valley Water Board website at:

[http://www.waterboards.ca.gov/centralvalley/help/business\\_help/permit2.shtml](http://www.waterboards.ca.gov/centralvalley/help/business_help/permit2.shtml).

### **Low or Limited Threat General NPDES Permit**

If the proposed project includes construction dewatering and it is necessary to discharge the groundwater to waters of the United States, the proposed project will require coverage under a National Pollutant Discharge Elimination System (NPDES) permit. Dewatering discharges are typically considered a low or limited threat to water quality and may be covered under the General Order for *Dewatering and Other Low Threat Discharges to Surface Waters* (Low Threat General Order) or the General Order for *Limited Threat Discharges of Treated/Untreated Groundwater from Cleanup Sites, Wastewater from Superchlorination Projects, and Other Limited Threat Wastewaters to Surface Water* (Limited Threat General Order). A complete application must be submitted to the Central Valley Water Board to obtain coverage under these General NPDES permits.

For more information regarding the Low Threat General Order and the application process, visit the Central Valley Water Board website at:

[http://www.waterboards.ca.gov/centralvalley/board\\_decisions/adopted\\_orders/general\\_orders/r5-2013-0074.pdf](http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2013-0074.pdf)

For more information regarding the Limited Threat General Order and the application process, visit the Central Valley Water Board website at:

[http://www.waterboards.ca.gov/centralvalley/board\\_decisions/adopted\\_orders/general\\_orders/r5-2013-0073.pdf](http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2013-0073.pdf)

If you have questions regarding these comments, please contact me at (916) 464-4684 or [tcleak@waterboards.ca.gov](mailto:tcleak@waterboards.ca.gov).



Trevor Cleak  
Environmental Scientist



**DELTA STEWARDSHIP COUNCIL**  
*A California State Agency*

980 NINTH STREET, SUITE 1500  
SACRAMENTO, CALIFORNIA 95814  
WWW.DELTACOUNCIL.CA.GOV  
(916) 445-5511

August 29, 2014

**Chair**  
Randy Fiorini

**Members**  
Aja Brown  
Frank C. Damrell, Jr.  
Phil Isenberg  
Patrick Johnston  
Larry Ruhstaller  
Susan Tatayon

Mr. John Powderly  
West Sacramento Area Flood Control Agency  
1110 West Capitol Avenue  
West Sacramento, CA 95691

**Executive Officer**  
Jessica R. Pearson

**RE: West Sacramento Project Draft Environmental Impact Statement /Environmental Impact Report**

Dear Mr. Powderly:

Thank you for the opportunity to comment on the West Sacramento Project Draft Environmental Impact Statement /Environmental Impact Report (EIS/EIR). Council staff appreciates the West Sacramento Project's goal of reducing flood risk for the city by proposing additional structural modifications to existing West Sacramento levees to address seepage, slope stability, erosion, and height concerns. This letter provides comments on the Draft EIS/EIR and the environmental information that is relevant to our agency's responsibility in connection with the proposed project.

State law directs the Delta Stewardship Council (Council) to provide "advice to local and planning agencies regarding the consistency of local and regional planning documents with the Delta Plan" (Water Code Section 85212). The Council adopted the Delta Plan on May 16, 2013, and the Plan's regulatory policies became effective on September 1, 2013. The Delta Plan, including its policies and recommendations, should be acknowledged in the final EIS/EIR's description of the project's environmental setting.

In addition, we recommend that the following matters be discussed or included in the final West Sacramento Project EIS/EIR:

- **Consistency with the Delta Plan.** The EIS/EIR should discuss any inconsistencies between the project and the Delta Plan, as required by 15125(d) of the California Environmental Quality Act (CEQA) Guidelines. Note, too, that the CEQA Guidelines' Appendix G states that a project that is inconsistent with any applicable land use plan, policy, or regulation may result in a finding of significant impact on biological resources.
- **Delta Stewardship Council and Delta Plan.** In the Draft EIS/EIR, Subsection 6.4.2, we suggest replacing the "California Bay-Delta Authority" with the "Delta Stewardship Council."

---

*"Coequal goals" means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place."*

It is important to note that the Delta Stewardship Council is the successor to the California Bay-Delta Authority and CALFED Bay-Delta Program. The Council oversees Delta activities by consulting with state, federal, and local agencies and ensuring that their projects and activities in the Delta are in compliance with the Delta Plan. The Plan can be found on the Council's web site at <http://deltacouncil.ca.gov/>."

- **Land Use and Agricultural Resources.** The draft EIS/EIR identifies the potential land use and agricultural resource impacts and provides possible mitigation measures. In Section 3.3 Land Use and Agriculture, pages 68 - 69, it also recognizes various federal, state, and local regulations and plans. We commend your efforts on coordination and compliance with different federal, state, and local entities and their regulations. For this reason, the narrative at page 68 - 69 should be revised to include the Council and the Delta Plan. The Council is an independent State agency charged with furthering the achievement of the State's coequal goals and has specific jurisdiction over and regulations related to land use in the secondary zone of the Delta (23 California Code of Regulation [CCR] Section 5010).

In addition, the possible alternatives listed in Section 3.3.3 through Section 3.3.6 should be verified for consistency with **Delta Plan Policy DP P2** (23 CCR Section 5011), which calls for siting flood management infrastructure to avoid or reduce conflicts with local land uses when feasible.

- **Biological Resources.** This draft EIS/EIR provides biological resource impact assessments and identifies "Alternative 5 - Improve Levees and Sacramento River South Setback Levee" as the Net Economic Development (NED) Plan as well as the preferred plan. In the final EIS/EIR, please verify that the project and the possible outcomes will be consistent with policies identified in the Delta Plan. Such policies include **Delta Plan Policy ER P2** (23 CCR Section 5006), which calls for restoring habitats at appropriate elevations; and **Policy ER P4** (23 CCR Section 5008), which states that levee projects must evaluate and, where feasible, incorporate alternatives, including the use of setback levees, to increase floodplains and riparian habitats.
- **Delta Plan Certification of Consistency.** The Delta Reform Act specifically established a certification process for compliance with the Delta Plan's regulatory policies (<http://deltacouncil.ca.gov/covered-actions>). According to the Delta Reform Act, it is the state or local agency approving, funding, or carrying out the project that must certify consistency with the Delta Plan. This certification is subject to appeal to the Council. A way to streamline the process and make full use of the EIS/EIR is to include the information and analysis needed to support the certification of Delta Plan consistency within the EIS/EIR, including potentially a draft certification as an appendix to the final EIS/EIR.

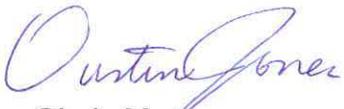
Please also note that the final Programmatic Environmental Impact Report (PEIR) for the Delta Plan includes a Mitigation Monitoring and Reporting Plan that describes the mitigation required for covered actions. If you should determine this project is a covered action, it will need to comply with the Delta Plan's Policy GP1 (23 CCR Section 5002(b)(2)), which

Ms. Anne Baker  
U.S. Army Corps of Engineers Sacramento District  
Page 3

USACE to adopt a multiple benefits approach to explore and identify additional state-federal joint interests and to carry out projects that will provide significant contribution toward public safety, water supply reliability, ecosystem enhancement and restoration, and economic stability, all of which are vital components to California.

In general, we appreciate USACE's interest to invest in flood safety improvements in the City of West Sacramento and welcome future opportunities to collaborate with your agency to identify, plan, and execute projects in the Delta. Thank you again for the opportunity to provide comments. We look forward to continuing to work with the USACE on this project as well as others. If you have any questions or would like additional information, please feel free to contact me or my staff, You Chen (Tim) Chao at [YouChen.Chao@deltacouncil.ca.gov](mailto:YouChen.Chao@deltacouncil.ca.gov) or (916) 445-0143.

Sincerely,

 FOR  
CINDY MESSER

Cindy Messer  
Deputy Executive Officer  
Delta Stewardship Council

cc: Mr. John Powderly, West Sacramento Area Flood Control Agency



**DELTA STEWARDSHIP COUNCIL**  
*A California State Agency*

980 NINTH STREET, SUITE 1500  
SACRAMENTO, CALIFORNIA 95814  
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(916) 445-5511

August 29, 2014

Ms. Anne Baker  
U.S. Army Corps of Engineers Sacramento District  
1325 J Street  
Sacramento, CA 95814

Chair  
Randy Fiorini

Members  
Aja Brown  
Frank C. Damrell, Jr.  
Phil Isenberg  
Patrick Johnston  
Larry Ruhstaller  
Susan Tatayon

**RE: Draft General Reevaluation Report for the West Sacramento Project**

Executive Officer  
Jessica R. Pearson

Dear Ms. Baker:

Thank you for the opportunity to comment on the U.S. Army Corps of Engineers (USACE) West Sacramento Project Draft General Reevaluation Report (GRR). Council staff commends the USACE's efforts in identifying additional federal interest in plans that reduce risk to the City of West Sacramento by proposing 50 miles of levee improvements to existing levees around the city and extending works down along the Sacramento Deep Water Ship Channel.

The Delta Stewardship Council (Council) is a state agency that was created by the California Legislature in 2009 to develop and implement a legally enforceable long-term management plan for the Delta. The Delta Plan, adopted on May 16, 2013, coordinates state and local actions to achieve the coequal goals of protecting and enhancing the Delta ecosystem and providing for a more reliable water supply for California. The coequal goals are to be achieved in a manner that protects and enhances the Delta as an evolving place by reducing flood risk and promoting a healthy economy that includes a mix of agriculture, tourism, recreation, and vital components of state and regional infrastructure. Federal agencies are not subject to the Council's jurisdiction. However, state law specifically directs the Council to provide "advice to local and regional planning agencies regarding the consistency of local and regional planning documents with the Delta Plan" (Water Code sec 85212). Therefore, any state or local agency serving as USACE's local sponsor that determines that a proposed activity done in partnership with USACE is a covered action under the Delta Plan would need to certify consistency with the Delta Plan's regulatory policies. In addition, we encourage the USACE and other federal agencies to use the Delta Plan as a guide for actions in the Delta.

### Comments

Based on our review of the Draft GRR for the West Sacramento Project, we recommend the following matters be discussed or included in the Final GRR. The comments provided in this letter are based on the Delta Reform Act and the Delta Plan.

---

*"Coequal goals" means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place."*

- CA Water Code §85054

Ms. Anne Baker  
U.S. Army Corps of Engineers Sacramento District  
Page 2

- **Delta Stewardship Council and Delta Plan.** The Council is the successor of the CALFED Bay-Delta Program. On page 1-22 of the Draft GRR, Subsection 1.5.1.7, we suggest replacing "Delta CALFED Program" with "Delta Stewardship Council and Delta Plan." Please consider including the following language: "The Delta Reform Act (California Water Code Section 85212) created the Council as an independent agency of the State and charged the Council 'to develop, adopt, and commence implementation of the Delta Plan.' The Delta Plan is a comprehensive, long-term management plan for the Delta. It creates legally enforceable regulatory policies as well as nonbinding recommendations to further the state's coequal goals for the Delta: improve statewide water supply reliability, and protect and restore a vibrant and healthy Delta ecosystem, all in a manner that preserves, protects and enhances the unique agricultural, cultural, and recreational characteristics of the Delta. The Delta Plan was adopted on May 16, 2013 and its regulatory policies became effective on September 1, 2013. The Plan can be found on the Council's web site at <http://deltacouncil.ca.gov/>."
- **Vegetation Policy.** On page 4-3 and page 4-4, the Draft GRR states:
  - The removal of landside trees to comply with the USACE Engineering Technical Letter (ETL) is inconsistent with the approach the State of California has taken in the Central Valley Flood Protection Plan and corresponding Programmatic Environmental Impact Report (PEIR). The USACE is currently working on a process to address the vegetation management strategy adopted by the State for feasibility studies.
  - The USACE intends to have a policy in place prior to the publication of the final West Sacramento Project EIS/EIR.
  - A vegetation variance will be requested for the Sacramento River portion of the project and a Vegetation Variance Request will be sought by the USACE Sacramento District.

We encourage the USACE to consider **Delta Plan Recommendation ER R4**, Exempt Delta Levees from the U.S. Army Corps of Engineers' Vegetation Policy. This recommendation suggests that the USACE should consider the ecosystem value of remaining riparian and shaded riverine aquatic habitat along Delta levees and agree with the California Department of Fish and Wildlife and the California Department of Water Resources on a variance that exempts Delta levees from the USACE's levee vegetation policy where appropriate.

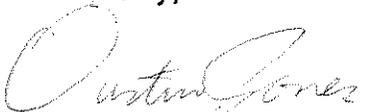
- **Multiple Benefits.** The Draft GRR identifies flood risk management as the only project purpose for both the authorized project and the general reevaluation study. Council staff acknowledges that USACE can play an important role in helping achieve the Delta Plan's coequal goals of water supply reliability and ecosystem restoration while protecting and enhancing an evolving Delta. However, we are concerned that USACE only identified risk reduction as the single purpose of this project, which has prevented the USACE from simultaneously achieving risk reduction and habitat restoration goals. We encourage

Ms. Anne Baker  
U.S. Army Corps of Engineers Sacramento District  
Page 3

USACE to adopt a multiple benefits approach to explore and identify additional state-federal joint interests and to carry out projects that will provide significant contribution toward public safety, water supply reliability, ecosystem enhancement and restoration, and economic stability, all of which are vital components to California.

In general, we appreciate USACE's interest to invest in flood safety improvements in the City of West Sacramento and welcome future opportunities to collaborate with your agency to identify, plan, and execute projects in the Delta. Thank you again for the opportunity to provide comments. We look forward to continuing to work with the USACE on this project as well as others. If you have any questions or would like additional information, please feel free to contact me or my staff, You Chen (Tim) Chao at [YouChen.Chao@deltacouncil.ca.gov](mailto:YouChen.Chao@deltacouncil.ca.gov) or (916) 445-0143.

Sincerely,

 FOR  
CINDY MESSER

Cindy Messer  
Deputy Executive Officer  
Delta Stewardship Council

cc: Mr. John Powderly, West Sacramento Area Flood Control Agency



# United States Department of the Interior

OFFICE OF THE SECRETARY  
Office of Environmental Policy and Compliance  
Pacific Southwest Region  
333 Bush Street, Suite 515  
San Francisco, CA 94104

IN REPLY REFER TO:  
(ER 14/441)

*Filed Electronically*

2 September 2014

Ms. Anne Baker  
U.S. Army Corps of Engineers  
Sacramento District  
1325 J Street  
Sacramento, CA 95814-2922

Subject: Review of the Draft Environmental Impact Statement (DEIS) for the West  
Sacramento Project, CA

Dear Ms. Baker:

The Department of the Interior has received and reviewed the subject document and has no comments to offer.

Thank you for the opportunity to review this project.

Sincerely,

Patricia Sanderson Port  
Regional Environmental Officer

cc:  
Regional Environmental Officer, San Francisco, CA  
OEPC Staff Contact, Loretta B. Sutton, (202) 208-7565



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION IX  
75 Hawthorne Street  
San Francisco, CA 94105-3901

SEP 09 2014

Ms. Anne Baker  
U.S. Army Corps of Engineers  
Sacramento District  
1325 J Street  
Sacramento, CA 95814-2922

Subject: West Sacramento Project Draft Environmental Impact Statement / Environmental Impact Report, Yolo County, California [CEQ# 20140193]

Dear Ms. Baker:

The Environmental Protection Agency has reviewed the Draft Environmental Impact Statement for the above project. Our review and comments are pursuant to the National Environmental Policy Act, Council on Environmental Quality regulations (40 CFR Parts 1500-1508), and our NEPA review authority under Section 309 of the Clean Air Act.

EPA acknowledges the need for reliable flood protection in the West Sacramento area and the need to address levee deficiencies as part of the West Sacramento Area Flood Control Agency and the State of California's Central Valley Flood Protection Board's overall flood risk management strategy. We further note that the purpose of the DEIS is to analyze the federal interest in protecting against a catastrophic failure of the levees that would result in major impacts to residents, infrastructure, and property. The West Sacramento Project DEIS, along with Early Implementation Projects for other levees, have provided an opportunity to consider flood protection holistically in the project area and to consider how levee design and maintenance can improve climate change resiliency.

The Southport Sacramento River Early Implementation Project DEIS released in November 2013 overlaps with part of the current proposed project. EPA submitted comments on that DEIS in January 2014. We were pleased that the Southport DEIS included a proposed setback levee, the use of dredged material from the Sacramento River Deep Water Ship Channel Project as a source of borrow material, and limited vegetation removal on the existing levees. This proposals and its environmental impacts are described briefly in the DEIS for the West Sacramento Project, but the document could benefit from references to the more detailed project description and environmental analysis from the Southport DEIS.

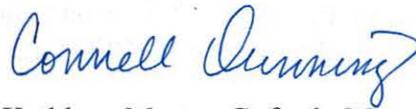
EPA has questions and concerns about impacts to wetlands and waters of the U.S. that could be resolved through clarification or additional information. We recommend that the Final EIS provide additional information as to how the preferred alternative was determined to be the Least Environmentally Damaging Practicable Alternative and how the Corps will avoid impacts to wetlands and waters of the U.S. We further recommend that the FEIS outline the timing for when wetlands delineations will be

conducted and describe a process for updating the impact analysis if the delineation is significantly different from expected.

In light of the above stated concerns, and as further described in the attached detailed comments, we have rated the DEIS action alternatives as *Environmental Concerns – Insufficient Information* (EC-2). Please see the enclosed “Summary of EPA Rating Definitions.”

We appreciate the opportunity to review this DEIS. Should you have any questions regarding our comments, please contact me at (415) 972-3521, or contact Jean Prijatel, the lead reviewer for the project. Jean can be reached at (415) 947-4167 or [prijatel.jean@epa.gov](mailto:prijatel.jean@epa.gov).

Sincerely,



FOR

Kathleen Martyn Goforth, Manager  
Environmental Review Section

Enclosures: Summary of EPA Rating Definitions  
EPA Detailed Comments

cc: Marshall McKay, Yoche Dehe Wintun Nation, Chairman  
Raymond Hitchcock, Wilton Rancheria, Chairman  
David Keyser, United Auburn Indian Community, Chairman  
Rhonda Morningstar Pope, Buena Vista Rancheria, Chairperson

## **SUMMARY OF EPA RATING DEFINITIONS\***

This rating system was developed as a means to summarize the U.S. Environmental Protection Agency's (EPA) level of concern with a proposed action. The ratings are a combination of alphabetical categories for evaluation of the environmental impacts of the proposal and numerical categories for evaluation of the adequacy of the Environmental Impact Statement (EIS).

### **ENVIRONMENTAL IMPACT OF THE ACTION**

#### ***"LO" (Lack of Objections)***

The EPA review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

#### ***"EC" (Environmental Concerns)***

The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce the environmental impact. EPA would like to work with the lead agency to reduce these impacts.

#### ***"EO" (Environmental Objections)***

The EPA review has identified significant environmental impacts that should be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

#### ***"EU" (Environmentally Unsatisfactory)***

The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potentially unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the Council on Environmental Quality (CEQ).

### **ADEQUACY OF THE IMPACT STATEMENT**

#### ***"Category 1" (Adequate)***

EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis or data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

#### ***"Category 2" (Insufficient Information)***

The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analysed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses, or discussion should be included in the final EIS.

#### ***"Category 3" (Inadequate)***

EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analysed in the draft EIS, which should be analysed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the NEPA and/or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

\*From EPA Manual 1640, Policy and Procedures for the Review of Federal Actions Impacting the Environment.



U.S. EPA DETAILED COMMENTS ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT FOR WEST SACRAMENTO PROJECT GENERAL REEVALUATION REPORT, YOLO COUNTY, SEPTEMBER 9, 2014

**Impacts to Waters of the United States**

The Avoidance, Minimization, and Mitigation Measures for the Vegetation and Wildlife section of the DEIS (Section 3.6.7) discusses compensation and standard minimization measures for the alternatives, but does not address how impacts to Waters of the United States would be avoided to the maximum extent practicable. The Section 404(b)(1) Water Quality Evaluation in Appendix F and the DEIS identify the preferred alternative as the Least Environmentally Damaging Practicable Alternative, but do not provide sufficient justification for how that determination was made.

**Recommendation:** Clearly explain, in the FEIS, how the Corps would avoid impacts to wetlands and other waters of the U.S. to the maximum extent practicable. We recommend that the FEIS also include a more explicit discussion of how the preferred alternative was determined to be the LEDPA.

The wetland acreages cited in the DEIS are estimates based on aerial imagery, vegetation type, and some field observations (page 106), but no official delineations have yet been completed. EPA's experience is that on-the-ground delineations can be substantially different from estimates based on aerial imagery.

The DEIS lists acres of wetlands impacted for each levee section, but does not provide tables or maps of wetland and riparian impact locations for the alternatives. Page 106 of the DEIS references Figure 3.6-1 as showing land cover types that are, or could be, wetlands or waters of the U.S.; but the Figure is absent from the DEIS. Additionally, the discussion of impacts does not clearly differentiate between permanent loss of acres and temporary impacts from construction.

**Recommendations:** Explain, in the FEIS, when wetlands delineations will be conducted and how the impact analysis could be altered by any significant changes to the estimated quantity of impacted acreage.

Provide maps and tables to more clearly communicate impacts to wetlands, waters of the U.S., and other habitat types. Show impact numbers broken out into permanent and temporary impacts. We recommend the inclusion of an additional table illustrating impacts for each alternative by habitat type.

**Impacts to Riparian Habitat**

The DEIS alternatives and impacts analysis repeatedly mention and rely upon a vegetation variance to be requested by the Sacramento District from the standard vegetation guidelines set forth in the Corps' Engineering Technical Letter (ETL) 1110-2-583. It appears that the variance would apply to the Sacramento River Levee and the Sacramento River South Levee sections of the project, but it is unclear whether both areas would be covered under a single variance or whether there would be multiple requests and evaluations. The range of impacts to riparian habitat would increase from 65 acres to 99 acres if the variance is not granted for the project. It further appears that the determination of the LEPDA relies upon the variance being issued.

**Recommendation:** The FEIS should clarify the process for, and timing of, requesting a variance and the likelihood that it will be obtained. Include a commitment to conduct additional impact analysis should the variance not be obtained.

The DEIS discloses that there will be a significant temporal loss to riparian habitat as it will take many years for the newly planted trees and plants to mature for permanent mitigation. The DEIS does not specifically identify any mitigation for the temporal loss of riparian habitat. The document further acknowledges the value of heritage trees as natural assets in the project area and references a mitigation measure to comply with local ordinance requirements for removal permits (page 122) and to protect heritage trees that do not need to be removed.

**Recommendations:** The FEIS should describe measures that could mitigate the temporal loss of riparian habitat, and clearly state whether or not such measures would be implemented.

Commit to avoid removal of heritage and non-heritage mature trees in riparian habitat to the maximum extent practicable. Include, in the FEIS, details of the local ordinances and requirements for tree removal permits.

The DEIS provides numbers for riparian acres impacted, but it is unclear whether those acres include areas where erosion control rocks will be placed without removal of all trees and vegetation.

**Recommendation:** Clearly identify the acreage or linear feet of waterside levee that would be hardscaped with rock, as opposed to those areas that will remain riparian habitat with some erosion control.

### **Habitat Mitigation**

EPA appreciates the Corps' apparent sensitivity to the need to avoid destruction of mature forests, wetlands, and shaded riverine aquatic habitat to the greatest extent possible. Where avoidance is not possible, mitigation is proposed, but discussed in general terms with no specific mitigation locations identified.

**Recommendations:** In the FEIS, identify and screen possible onsite and offsite habitat mitigation locations. Potential restoration sites in the vicinity might be found immediately upstream of the project area in and around the confluence of the American and Sacramento rivers and Steelhead Creek (e.g. Yolo County Park, Discovery Park, Camp Pollock).

Commit to implementing mitigation concurrently with the project impacts, and implementing riparian mitigation as early in the project as possible to help compensate for the temporal loss of riparian habitat.

EPA would appreciate the opportunity to review and comment on the Corps' draft mitigation and monitoring plan when it becomes available.

Given the lifespan of the project, the Corps has an opportunity to safeguard genetic diversity and resiliency in the North Delta ecosystem. EPA encourages the Corps to consider hiring a reputable nursery early in project implementation to collect acorns of the oldest and most vulnerable trees; seedlings could be propagated in the nursery for installation on-site or in mitigation areas while preserving the genetic material of the original mature trees. Frequency and yield of acorns from older trees can be limited, making early planning and implementation of this strategy particularly important. A similar strategy could be employed for native prairie species to secure the ecological value of native prairie habitat and the needs of the Western Burrowing Owl.

The Corps proposes perpetual protection for the establishment of elderberries and VELB habitat, but only short-term stewardship for other types of habitat subject to compensatory mitigation (page 121).

**Recommendation:** In keeping with the federal compensatory mitigation rule, the Corps should commit in the FEIS to take measures to ensure that any mitigation sites established as part of this project are permanently protected and managed with appropriate conservation easements, stewardship endowments, and management plans.

### **Setback Levee**

The preferred alternative proposes a setback levee for the Sacramento River South Levee section of the project. This concept was further analyzed in the Southport Sacramento River Early Implementation Project Environmental Impact Statement/Environmental Impact Report, which EPA commented on in January 2014. EPA encourages the use of setback levees, where possible, to provide opportunities for flood protection and floodplain and ecosystem restoration. The DEIS for the current project states that Corps staff relied upon the previous DEIS for analysis, but does not provide references to or summaries of that analysis in the project description and impact analysis. Without such references to the Southport DEIS, it is difficult to understand if the current project is dependent upon implementation of the Southport project or if the setback levee in the West Sacramento Project DEIS would proceed independent of that project.

**Recommendations:** EPA recommends that the relationship between the Southport Sacramento River Early Implementation Project at the West Sacramento Project be clarified in the FEIS. Where the project description and environmental analysis relies on the Southport DEIS, the FEIS should provide summaries of and citations to the previous document. Where the description and analysis differ from the Southport project, those differences should be highlighted. The FEIS should also clearly describe the status of the Southport project and potential barriers to its implementation.

### **Reuse of Dredged Material**

The proposed levee measures would use up to 9 million cubic yards of borrow material in their construction. Plate 2-1 provides a map of potential borrow sites, but neither the map nor the DEIS identify which borrow areas are existing dredged material stockpiles. Ongoing Corps projects generate the vast majority of dredged material in the Delta, and past Corps dredging accounts for most of the stockpiles of previously-dredged material around the Delta. This project represents an opportunity to access and reuse stockpiled dredged material.

**Recommendation:** The FEIS should commit to maximize the use of already stockpiled dredged material and future maintenance material from the Deep Water Shipping Channel to the greatest extent possible. Early coordination between project managers for this project and the DWSC could further provide easily accessible dredged material for the project, thereby reducing environmental impacts.

### **Air Quality**

The DEIS focuses the air quality analysis on borrow site activity and the construction impacts of the project, which would occur over eighteen years, with most levees under construction for one to three years each. Pollutants of concern are identified as ozone, carbon monoxide, and particulate matter, while the discussion also includes toxic air contaminants. Due to the location of the project area and the potential borrow sites, air quality analyses are included for the Yolo-Solano, Sacramento Metropolitan,

and Bay Area Air Quality Management Districts. The DEIS acknowledges that the air quality management districts' regulations may change over the duration of the project and commits to consulting with the districts prior to construction. The air quality analysis in the DEIS is based on a worst-case scenario for borrow sites and miles driven, as the borrow sites have yet to be confirmed.

**Recommendations:** Air quality impacts could vary significantly depending on the location of the borrow sites. To help inform the planning process of borrow site selection throughout the project, the FEIS should include a discussion and summary table detailing the borrow site options and their comparative air quality impacts, and commit to selecting sites that minimize impacts.

### **Alternatives for Erosion Control**

The DEIS includes rock slope protection (also known as riprap) for all of the alternatives. In 2004, the U.S. Fish and Wildlife Service published an updated report *Impacts of Riprapping to Aquatic Organisms and River Functioning, Lower Sacramento River, California*, which documents the negative effects of rock slope protection. Possible alternatives to riprapping are suggested in the FEMA brochure *Engineering with Nature: Alternative Techniques to Riprap Bank Stabilization*. Riprap alternatives include bio-engineering, hydro-seeding, controlled planting, and construction of engineered logjams.

**Recommendation:** Explore alternatives to riprap for erosion control. Discuss such alternative methods in the FEIS, including the extent to which each method would be compatible with the West Sacramento Project needs and the Corps' vegetation policy.

### **Climate Change**

The DEIS states that the action alternatives would improve the resiliency of the levee system with respect to the effects of climate change (beginning page 258), which could include changes to temperature and rainfall, increasing the risk of flooding. In light of the President's November 1, 2013 Executive Order 13653 "Preparing the United States for the Impacts of Climate Change," there is an opportunity with the West Sacramento Project to illustrate and maximize the climate-resilient benefits of levee design and floodplain restoration. The DEIS simply states, for each alternative, that the levee enhancements would improve resiliency, but provides few details.

**Recommendation:** We recommend that the FEIS reference Executive Order 13653 in the discussion of the regulatory environment, and include a more detailed discussion about the impacts to climate change resiliency for each of the alternatives. For example, explain how the differences in the alternatives would change the level of resiliency, particularly for the setback levee in the preferred alternative.

### **Residual Flood Risk**

Even with the proposed improvements to the West Sacramento levees, residual flood risk will remain for the properties protected by the levee system. The National Levee Safety Committee<sup>1</sup> recommends communicating residual risk behind levees on a regular basis, and the DEIS mentions that the General Reevaluation Report discusses educating the public about residual flood risk, but no such discussion is included in the DEIS.

**Recommendations:** In the FEIS, explain how the residual risk behind levees will be communicated to the public, and include a commitment to ensure that this occurs. Such communication should clearly convey: the level of protection provided by the levees during and

<sup>1</sup> [http://www.leveesafety.org/docs/NCLS-Recommendation-Report\\_012009\\_DRAFT.pdf](http://www.leveesafety.org/docs/NCLS-Recommendation-Report_012009_DRAFT.pdf)

after construction; the fact that levees may fail or be overtopped; and that the area is a floodplain, with indications of the depth of flooding when the levee fails or is overtopped. We recommend that the Corps also commit, in the FEIS, to commenting on the adequacy of the current City of West Sacramento Emergency Operations Plan to provide insights about the project enhancements and residual risk. Consider seeking a voluntary commitment from the City to require flood insurance for structures protected by levees, as recommended by NLSC.<sup>2</sup>

### **Consultation and Coordination with Tribal Governments**

Executive Order 13175 “Consultation and Coordination with Indian Tribal Governments” (November 6, 2000) directs federal agencies to establish tribal consultation and collaboration processes for the development of federal policies that have tribal implications, and is intended to strengthen the United States government-to-government relationships with Indian tribes. The DEIS mentions that the Corps met with the Yoche Dehe, Wilton Rancheria, United Auburn Indian Community of the Auburn Rancheria, and conferred with the Buena Vista Rancheria via phone, but provides no details or results of those meetings.

***Recommendation:*** The FEIS should include details of the meetings and phone consultations with the tribes affected by the project and discuss the impacts and mitigation measures identified through that consultation. It should also note whether ongoing consultation will continue through the duration of the project. Include the tribes in the distribution list for the FEIS and Record of Decision.

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<sup>2</sup> Recommendation #20, Levee Policy Challenges White Paper, 4/2007  
[http://www.floods.org/PDF/ASFPM\\_Levee\\_Policy\\_Challenges\\_White\\_Paper.pdf](http://www.floods.org/PDF/ASFPM_Levee_Policy_Challenges_White_Paper.pdf)





Pacific Gas and Electric Company  
Land Services  
343 Sacramento Street  
Auburn, CA 95603

8/1/14

U.S. Army Corps of Engineers  
Attn: Ms. Anne Baker  
1325 J Street  
Sacramento, California 95814

Re: West Sacramento Project – Draft EIS/EIR

Dear Ms. Baker:

Thank you for the opportunity to review the Draft Environmental Impact Statement/Environmental Impact Report for the proposed West Sacramento Project. PG&E has the following comments to offer.

PG&E owns and operates gas and electric facilities located within the project area. To promote the safe and reliable maintenance and operation of utility facilities, the California Public Utilities Commission (CPUC) has mandated specific clearance requirements between utility facilities and surrounding objects or construction activities. To ensure compliance with these standards, project proponents should coordinate with PG&E early in the development of their project plans. Any proposed improvement plans should provide for unrestricted utility access, and prevent easement encroachments that might impair the safe and reliable maintenance and operation of PG&E's facilities.

Any proposed activities with the potential to change the grade above our pipelines (temporary or permanent) must be reviewed and approved by PG&E. Other potential concerns include; 1) compaction over the pipelines due to heavy equipment; 2) Underground Service Alert (USA) location of facilities before excavation near easements; 3) changes in the drainage patterns that could undermine stability of soils around pipelines; and 4) future construction of additional facilities within easements.

**Call 811 to have PG&E's underground facilities located and marked. Please note that PG&E standby personnel is required when potholing gas transmission facilities to confirm depths and/or when construction activities are taking place within five feet of a gas line.**

For electric transmission and distribution facilities G.O. 95 clearances must be maintained at all times. As with the Gas facilities, access to the facilities must be maintained for normal inspections, maintenance and operation of the facilities. Bollards must be installed by the requesting party in front of footings of towers located in areas vulnerable to vehicular traffic. Dust raised during construction could also increase opportunity for flash-overs.

Relocations of PG&E's electric transmission facilities (50,000 volts and above) may also require formal approval from the California Public Utilities Commission. If required, this approval process may take up to two years to complete. Proponents of the levee improvement project with plans that may affect such electric transmission facilities should be referred to PG&E for additional information and assistance in the development of their project schedules.

We recommend that environmental documents for the proposed levee improvement project include an adequate evaluation of the cumulative impacts to utility systems, as well as an evaluation of the significance of PG&E's construction activities, as related to the relocation of its facilities associated with the levee improvement project, for each resource category. This will assure the project's compliance with NEPA/CEQA and reduce potential delays to the project schedule.

The requesting party will be responsible for the costs associated with the relocation of existing PG&E facilities to accommodate the levee improvement project. Because the relocation of facilities requires long lead times and is not always feasible, the requesting party is encouraged to consult with PG&E as early in their planning stage as possible.

PG&E remains committed to working with the city of West Sacramento to provide timely, reliable and cost effective gas and electric service. Please contact me at (530) 889-5150 if you have any questions regarding PG&E's comments. We would also appreciate being copied on future correspondence regarding this subject as this project develops.

Sincerely,



Seth Perez  
Land Agent

From: Keith Underwood <KUnderwood@cityofsacramento.org>  
Sent: Tuesday, September 2, 2014 4:16 PM  
To: Kirchner, Alicia E SPK  
Cc: Muha, Andrew T SPK  
Subject: [EXTERNAL] Questions regarding West Sacramento proposed levee changes

Hi Alicia

It was nice to meet and discuss the West Sacramento levee project with you today.

I do have a few questions about silt deposits with changing the levee on the west side of the Sacramento River at the confluence of the mouth to the Sacramento Marina and boat launch facility, Stone Lock (now closed) and where the proposed levee change is in West Sacramento.

- 1) Will the proposed change on the west side levees push more silt to the east side of the river depositing the silt into the entrance channel and launch ramp of the Sacramento Marina? We already must dredge annually at great expense and are trying to minimize this.
- 2) Will the proposed change to the levee change the river flow taking away the silt from the east side of the river so we will be dredging less? Of course this would be ideal from our perspective.
- 3) After the new levee is built is the existing levee going to be removed or allowed to slowly wash away giving the new levee behind it flood control and making the actual river wider at that location? If so is there a time line that the levee would be gone? This is asked with the understanding that river flows would be a major contributor and nobody can predict with absolute accuracy.

As discussed today in the meeting the reason for us to look into this is we are researching the feasibility of a wing dam or other structure to help with the displacement of silt away from the entrance to the Sacramento Marina and boat launch facility and this levee project may have some impact on that. I very much appreciate your time and expertise on this matter and look forward to hearing back when you have a chance.

Best regards

Keith Underwood

Marina Manager

Sacramento Marina

City of Sacramento

Office 808-5712

**YOKOYAMA FARM  
3000 SOUTH RIVER ROAD  
WEST SACRAMENTO, CA 95691**

September 1, 2014

Mr. Tyler Stalker  
US Army Corps of Engineers, Sacramento District  
1325 J Street; Sacramento, California 95814-2922

**RE: YOKOYAMA FARM COMMENTS ON THE USACE DRAFT EIS-EIR**

Dear Mr. Stalker,

On January 6, 2014, I submitted comments on the WSAFCA Southport Sacramento River EIP/EIS/EIR and have added the document to this letter. I was not contacted by WSAFCA that they had responded to my January comments, and only recently learned of their actions to approve the EIS/EIR. The construction of a Southport setback levee will destroy our home and farmland. After reviewing their broad, inconsistent and undocumented responses to my concerns, I find that they have dismissed major construction and environmental issues as follows:

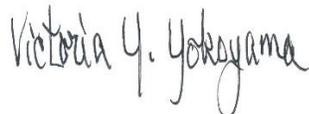
1. Other cost effective alternatives are available for 200 year flood control that will not destroy our property by construction of a setback levee. Even though WSAFCA claims that these alternatives are under consideration, they are currently proceeding with plans to build the setback levee on our property. WSAFCA has authorized contracted vendors to repeatedly contact me by phone demanding to inspect our home for appraisal, answer questions regarding land use, and approach family members for information regarding occupancy.
2. The proposed setback levee has structural flaws including possible seismic instability and potential failure in a 200 year flood. These structural deficiencies have not been specifically addressed or shown to be resolved in the WSAFCA EIS-EIR. Publication of the MBK 2011 model showed setback levee failure, and now WSAFCA states that failure is not evident when the predictive model was reanalyzed. The setback levee construction needs evaluation by another engineer before declaring the design is safe.
3. The collateral environmental consequences of the inter-levee area created by a setback levee outweigh the public good including the introduction of wildlife, especially mosquitoes that vector infectious human diseases that can cause epidemics in the metropolitan Sacramento region. Many examples of the incompatibility of urban wildlife populations with human populations are readily available throughout the area including the report this month of a mountain lion on the American River Trail. The WSAFCA negligently responds that mosquitos will be insignificant and the proposed environmental area will prevent wildlife encroachment in residential areas. These issues need to be addressed by an urban wildlife ecologist.

4. The WSAFCA claim that the inter-levee area between the existing degraded levee and setback levee will create a sustainable ecological zone compatible with new wildlife habitats and spawning ground for fish is conceptual, biologically inaccurate, and needs documentation with examples from similar construction in highly urbanized areas.
5. The WSAFCA claim that human activities on the setback levee will not cause levee erosion is inconsistent with the current conditions on the levee bank. Multiple rutted trails created by people are visible from in any satellite image of the existing levee on our property and in the south area between the Barge Canal and the Sacramento River.
6. The WSAFCA EIS/EIR is misleading in representing our farmland as non-irrigated and inconsequential because we have built multiple agricultural wells on our land and on our neighbor's land to the north. Our farm operations have supported local families who have depended on year-round agricultural activities on our farm for decades, including production of high cash vegetable, melon, and field crops.
7. The WSAFCA claim that the agency does not intend to create a mitigation bank from the inter-levee area on our land is false as they have already filed an application.
8. Construction of a setback levee will require more than 17 years as proposed in the EIS/EIR because no source of borrow material to construct the massive structure has been identified. No plan has been provided to begin mining the borrow that is synchronized with approval and construction deadlines. Thus, exposure to a potential 200 year flood event will be prolonged during the excessive construction period.

The setback levee plan has created the illusion of constructing a utopia for natural vegetation and wildlife that qualifies the project for state environmental funding. In reality, the setback levee will create a huge polluted, eroding channel supporting exotic species and the eventual trapping, poisoning, and slaughter of obnoxious wildlife. The WSAFCA plan was developed under secrecy, and I am perhaps the last hopeful landowner to respond to municipal, regional, and federal intent to proceed with construction of the setback levee. The setback levee will not be completed during my life time, and for the second time in the past several decades, Japanese Americans will be forcibly removed from our homes and land ending the legacy of our family heritage.

Please contact me if you have any questions and I appreciate your consideration.

Sincerely,

A handwritten signature in black ink that reads "Victoria Y. Yokoyama". The signature is written in a cursive, flowing style.

Victoria Y. Yokoyama

**YOKOYAMA FARM  
WEST SACRAMENTO, CALIFORNIA**

**January 6, 2014**

**RESPONSE TO WSAFCA SOUTHPORT SACRAMENTO RIVER EIP/EIS/EIR**

**by Victoria Y. Yokoyama**

**Submitted by Email and U.S. Mail to:**

**Ms. Tanis Toland  
U.S. Army Corps of Engineers  
1325 J Street  
Sacramento, CA 95814**

**A. History.**

Our farm is located on South River Road, north of Linden Road in Segment F of the West Sacramento Area Flood Control Agency (WSAFCA) Southport Sacramento River Early Implementation Project, Environmental Impact Statement, Environmental Impact Report (EIP/EIS/EIR) dated November 2013 (Fig. 1).

The Yokoyama farm is part of our heritage created by our parents, Harry Masaru and Aya Yokoyama who were born in Sacramento, and our grandparents who immigrated to Sacramento in the early 1900s. Our family was forcibly removed from California and placed in concentration camps during World War II (WWII) (Conrat 1972). Our grandparents, parents and children returned to their home in Sacramento after the war. In 1947 as tenant farmers they built their temporary first home in what is now considered Segment G of the EIS/EIR. In 1966, they purchased their land, and later built their dream home in its current location.

The Sacramento region is rich with Japanese American history which is rooted in farming (Maeda 2000). Our family farm has produced both field crops and high cash vegetable crops to supply local and regional markets with grain and fresh produce. At one time more than 100 leased acres were in production with green onions to fulfill domestic markets. Our future production will be focused on organic produce with an anticipated annual value of \$296,000-\$390,000 with local outlets including a farmer's fruit stand and retail grocery stores (Santa Ana 2012, Yolo County Agriculture Department 2013). Additionally, we will be involved in the promotion of agri-tourism (Lynch 2008) and specialty crop production research.

The West Sacramento levee system has never failed during Sacramento River high water events since my parents first farmed in the area. South River Road on top of the levee provides a tourist's vista of the Sacramento River and has been a popular attraction in California for many decades (Dillon 1982).

The WSAFCA EIP/EIS/EIR will destroy the integrity and history of the West Sacramento area by implementation of the proposed Alternative 5 with construction of a setback levee to meet the 200 year criteria for flood control. I am presenting justifications for alternatives to the Alternative Plan 5 for the Yokoyama Farm, and documenting inadequacies of the WSAFCA preferred Alternative 5 plan.

## **B. Confiscation and Loss of Our Home and Land.**

Under the WSAFCA Alternative Plan 5 our home and our fertile river frontage farmland will be condemned and destroyed (Fig. 2). A major street, Village Parkway will divide our land in half in a north-south direction isolating the eastern half from the western half of the farm. I have met with the WSAFCA staff regarding the Village Parkway construction through our property under their pretense that the street was mandatory regardless of levee plans. I have now learned after reviewing the EIS/EIR that Village Parkway is only mandatory in the WSAFCA preferred Alternative Plan 5. In highly questionable actions, the agency has sought property appraisals from many landowners affected by Alternative Plan 5 without regard to the outcome of the EIS/EIR.

Our family was removed from their home and farm in World War II and we do not intend to be forced to leave again. We propose an adjacent levee, cutoff wall, and narrow seepage berm as geotechnical engineering solutions to save our home and river frontage farmland. The alignment of Village Parkway Road atop the existing levee will prevent endangering and hindering farm operations, and prevent potential economic ruin of our farm.

## **C. Levee Improvement Methods to Prevent Personal Property Loss to the Yokoyama Farm in Segment F.**

### **1. Implementation of an Adjacent Levee and Narrow Seepage Berm.**

- a.** Geotechnical Environmental Water Resources Construction Services (ENGEO) conducted an independent geotechnical engineering study and their results show that alternative levee repair methods can be used to reduce the extreme loss of personal property on the Yokoyama Farm. The results of the ENGEO study (Appendix 1) clearly states that an adjacent levee with 100 foot wide seepage berm will result in superior mitigation against underseepage compared to the setback levee with seepage berm. Underseepage is the primary geotechnical issue in Segment F.
- b.** ENGEO and Seecon Financial and Construction (Seecon), the largest landowner in Segment F, developed a Hybrid Alternative Plan (Fig. 3) implementing an adjacent levee with narrow seepage berm. Seecon is our northern neighbor and the Yokoyama Farm and other West Sacramento farm families have been growing crops on their land for three generations. Although, our home is shown in the maintenance corridor in this plan, ENGEO has provided other levee repair techniques (Appendix 1) that can be implemented to save our house including a partially penetrating cutoff wall with

narrower seepage berm or relief wells. Relief wells are described and designated in the EIS/EIR for site specific conditions.

## **2. Implementation of an Adjacent Levee, Cutoff Wall, and Narrow Seepage Berm**

- a. A shallow cutoff wall in conjunction with a seepage berm was considered for evaluation for the Yokoyama Farm by the WSAFCA Board in a letter dated September 6, 2012. A hybrid combination will prevent the unacceptable, severe loss of personal property that will occur in Segment F with the use of a 300 foot wide seepage berm (Alternatives 1 and 3) or a setback levee and wide seepage berm (Alternatives 2, 4, and 5). Hybrid combinations have been implemented in several locations, notably the southern part of Segment B, to save homes and land in Alternative 1-5 plans. This would be a feasible plan for the Yokoyama Farm and is specified by ENGEO in Appendix 1 as a solution to prevent severe personal property loss to fulfill flood repair criteria.

## **3. Implementation of an Adjacent Levee and Cutoff Wall.**

- a. A cutoff wall was requested for consideration by WSAFCA for the Yokoyama Farm since the beginning of 2012. Segment G, north of Segment F will be provided with an 84 foot deep by 3 foot wide slurry cutoff wall for a subdivision of homes. This subdivision is on land that was previously farmed by our family since the end of WWII. Thirty to 40 foot cutoff walls have been provided in other segments of Alternatives 1-5, and used in the southern portion of Segment B to save homes. A cutoff wall in combination with other underseepage mitigation measures also need to be considered for our home and farmland in Segment F.

## **4. Maintain South River Road Atop of Existing Levee.**

- a. Alternative Plans 1 and 3 maintain South River Road in its present alignment atop the existing levee in most of the segments. Retention of South River Road in its current position would prevent the Yokoyama Farm from division into two isolated parcels (Fig. 2). Furthermore, the integrity and scenic beauty of this famous Sacramento Delta road (Dillon 1982) will enhance tourism in the area. Emergency and maintenance vehicles will also have access to the levee vicinity, a service not readily available with a setback levee.

## **D. Inadequacies of a Setback Levee in WSAFCA Alternatives 2, 4 and Preferred Alternative 5.**

### **1. Setback Levee Breached in 200 Year Flood Event.**

- a. The existing levees in West Sacramento have never been breached, but a setback levee is proposed by the WSAFCA in Alternative 2, 4 and Preferred Alternative 5 as a remedial solution for 200 year flood control. However, use of a setback levee will require removing portions of the existing levee to allow water to flow in and out of

the floodplain channel. The setback levee is no taller in height than the existing levee so in a 200 year flood event, the setback levee will be breached with water spilling over the top according to the 100 and 200 year flood 2D hydraulic model as reported by MBK Engineers, June 29, 2011.

## **2. Widen Flood Plain and Increase River Meandering.**

- a. Setback levees would be difficult or impossible to build in Segment F where the floodplain between levees is currently planned for urban development. Setback levees allow rivers to meander within the floodplain created by the levees (Bolton and Shellberg 2001). When the existing river channel is narrower or pinched downstream, and the setback levee widens the floodplain channel upstream, backwater is created during high flows contributing to aggradation and raising of the riverbed (Lai and Bountry 2007). The potential for river meandering and change in flow characteristics associated with pinching of the levee systems downstream (Bozkurt et al. 2000) needs to be addressed as flood protection will be compromised by the setback levees in the WSAFCA Alternatives 2, 4 and 5.

## **3. Lack of Borrow.**

- a. The source of borrow to build the 3.6 miles of setback levee in WSAFCA Alternative 5 is dubious and has not been committed to the project by any individuals or organizations. Although the Yokoyama Farm has been identified as a source of borrow, we will not allow the upper layers of prime farm soil or the fertile top soil to be removed or disturbed. Excavation, removal of soil, and further lowering of the land elevation at our location or at similar sites will aggravate underseepage conditions. Excavating the inter-levee area between the existing levee and the setback levee will result in permanent standing, underseepage water in the channel (National Technical Information Service 1956).

## **4. Conceptual Habitat Restoration in the Inter-levee or Offset Floodplain Area between the Existing and Setback Levees.**

### **a. Two Examples within the EIS/EIR of Previous Restoration Failures.**

1. The river side of the levee on our property in Segment F was reinforced with boulders and rock by the California Department of Water Resources (CDWR) in 2006. CDWR preserved the existing trees and native oaks on the riverbank, and planted native vegetation which was maintained with an irrigation system until established. Fencing and warning signs indicating the bank was under restoration were installed to prevent trespassing and damage. Today this section of the levee on the river side is rutted with human paths to the water edge. Fishermen have created artificial beaches. Discarded furniture, major appliances, tires, toxic waste, debris, rubbish and human waste has been dumped over the side of the levee. The garbage will never be removed by the city or county. The original fencing and much vegetation has been destroyed. Feral cats have removed the natural wildlife on the bank and raccoons are the prevalent wildlife species. The

site is commonly used by the homeless and for illegal drug activity. The West Sacramento Police Department has limited resources to respond to complaints.

2. The confluence of the Sacramento River and Barge Canal at the northeast corner of the WSAFCA EIS/EIR is shown in Fig. 4. Before the Barge Canal was opened in 1961, a flood basin was created at this corner with two additional levees on the north-south and east-west sides. Using his tractor, my father disked the base or footprint area for the two levees for their construction. The resultant basin was filled with sand dredged from the Sacramento River channel creating a sand dune area. A natural succession of trees, vegetation, and wildlife slowly inhabited the site. Once West Sacramento City began to expand, and homes were built south of the Barge Canal, the once pristine habitat was destroyed by human activity (Fig. 4).

**b. Degraded Ecosystems Formed by Setback Levees.**

The WSAFCA EIS/EIR does not demonstrate that the Alternative 5 plan will restore wildlife and speculates that new habitats will occur in the inter-levee between the existing and setback levees. Available literature shows that reconfiguring channels to add meanders in river restoration leads to a decrease in biodiversity because of biologically unsuitable flow regimes and degraded habitat (Palmer et al. 2009). Channelization tends to result in increased water temperatures, allows flora and fauna to be swept away during high flows, and during low flow or dry seasons contain insufficient water depth to sustain temperature and dissolved oxygen for living organisms (Bolton and Shellberg 2001). Human activities in the inter-levee or channel zone result in a reduction in habitat diversity affecting the abundance and diversity of wildlife that can be sustained (Simpson et al. 1982). With changes in optimal environmental conditions, stresses are placed on plants and animals limiting reproduction, survival, and growth (Lynch et al. 1977). The artificial inter-levee habitat would be of lower quality than natural wetlands and likely to be invaded by invasive species (Esty 2007).

**c. Future Economic Losses.**

The concept of restoration of habitat and biodiversity by re-configuring channels, in this case by use of setback levees, is not a wise investment (Palmer et al. 2009). The inevitable adjustments that occur in the channel may lead to extensive and costly maintenance to retain the engineering objectives (Bolton and Shellberg 2001). Conservation resources are limited and efforts to conserve riparian or any habitat must be feasible and compatible with human use (Hunter et al. 1999). The WSAFCA Alternative 5 plan is not feasible in Segment F, requires oversight responsibilities, and lacks specific resources for monitoring for compliance. These costs have not been considered or included in the WSAFCA EIS/EIR. Furthermore, cost overruns will be extreme considering that construction of a 2,200 foot setback levee on the northeast corner of the EIP/EIS/EIR cannot be completed after 3 years under construction (Fig. 4). Long term delays in setback levee construction will cause

unmeasurable and irreversible damage to existing riparian forests, native vegetation, wildlife, fish, and other aquatic life.

**d. Oppose WSAFCA Mitigation Bank**

The WSAFCA applied for a mitigation bank based on the inter-levee or offset floodplain in Alternative 5 without contacting affected home and landowners, and public comments were not solicited for the application. However, our comments concerning the deficiencies of the setback levee and proposed habitat restoration are addressed in this response to the WSAFCA EIS/EIR. The WSAFCA Alternative 5 will allow confiscation of private lands for a mitigation bank to sell credits to developers for profit. We oppose the mitigation bank and such actions by WSAFCA as unethical.

**e. Contamination of the Inter-levee Channel with Pollutants.**

The upper Sacramento River may be the source of organic and inorganic pollutants including pesticides (Taylor et al. 1996) and heavy metals that may collect in the inter-levee floodplain in WSAFCA Alternative 5 due to insufficient flushing by water flow through the channel. Pollutants will enter the plant and animal food chain and cause die backs of wildlife and protected species.

**f. Insufficient Environmental Conditions to Preserve Endangered Species.**

1. Habitat for many endangered species of shrimp, fish, and amphibians is not preserved by either the channel bed substrate, water flow patterns, or anticipated dry conditions during droughts and arid seasons in WSAFCA Alternative 5. Water flow characteristics in the inter-levee channel between the existing and setback levee are not well described. Stream flows are needed to remove undesirable accumulations of fines, sand, and other sediment, and periodic flushing is needed for gravel to create a suitable habitat for aquatic animals (Milhous 1998). Spawning gravel for salmon require high pressure, and short flows to remove fine sediments for embryos to survive (Wu 2000). In Alternative 5, the inter-levee channel will be dredged for borrow and the final stream bed is not described, so fish spawning is impossible.
2. Conservation of Swainson's hawks will not be enhanced by the inter-levee offset floodplain because the bird of prey requires agricultural habitats that include large tracts of alfalfa and grazed grasslands for foraging (Swolgaard et al. 2008). WSAFCA Alternative 5 will remove extensive tracts of farmland currently used for hay production reducing the protected species foraging habitat.

**g. Urban Wildlife Conflicts Created by an Inter-levee Restoration Area.**

1. Wild animals may be attracted to inter-levee area but can present a threat to human safety and cause property damage (National Wildlife Research Center 2010). Coyotes are common on the Yokoyama Farm. Predation on pets is the primary contributor to human-coyote conflict, and domestic cats or dog are consistently found in coyote dietary studies (Gehrt 2007). Mountain lions have been personally sighted and reported by others in the area.
2. Densely populated areas adjacent to the inter-levee area may exacerbate human-wildlife-pet disease transmission (Dunbar et al. 2007). Raccoons, opossums, skunks, coyotes, foxes, and bats utilizing the inter-levee area will be close to homes and may vector and transmit rabies, a fatal viral disease of humans and pets (National Wildlife Research Center 2010). Wildlife is also a source of internal and external parasites including worms, fleas, ticks, and mange mites that can transmit diseases such as canine distemper and heartworm (Dryden and Ridley 1999) to domestic animals.
3. Increased densities of wildlife associated with the inter-levee area can also result in a higher prevalence of diseases in urban wildlife that may be greater than what is found in rural habitats impairing reproduction, immune health, and survival (Ditchkoff et al. 2006). These adverse effects on wild mammals and birds may decimate desired species.
4. Mosquitoes will breed in the inter-levee channel water and create a biting nuisance to nearby communities including Sacramento on the opposite side of the river. Mosquitoes including *Culex* spp., *Anopheles* spp., and *Aedes* spp. are vectors of human diseases including western encephalitis, malaria, West Nile virus (Lawler and Lanzaro 2005) yellow fever, and dengue. Mosquitoes endanger the entire Sacramento Metropolitan Region, yet mosquito control methods are not presented in the WSAFCA Alternative 5 plan. Furthermore, underseepage in the dredged inter-levee channel will create continuous standing water for mosquito breeding.
5. Burrowing activities of California ground squirrels can potentially compromise a levee during a flood event (McGrann et al. 2013). The conversion of woodland habitats to grasslands on levees most likely will result in increased occurrence and abundance of ground squirrels and pocket gophers, and thereby increase the potential threat that their burrowing activities pose to levee integrity (Ordeñana et al. 2012). The land side of the setback levee in Alternative 5 will be grassy and without trees, and although not specified in the plan, will require control of ground squirrels. Rodenticide grain baits are currently used by the Yolo County Reclamation District 900 in multiple bait stations placed near the levee on the Yokoyama Farm. The use of toxic bait to control ground squirrels is associated with the death of cotton tail rabbits on our farm. Poisoned squirrels and rabbits will be eaten by predators and scavengers including dogs, coyotes, foxes, vultures, and hawks causing further animal deaths in the food chain.

## 5. Adverse Recreational Activities.

Fishing will cause severe erosion of the setback levee and remove fish that were intended to spawn in the inter-levee channel, which is a primary restoration objective of the WSAFCA Alternative 5. Habitat restoration requires decades of optimum environmental conditions and continuous maintenance, but human activities as described in 4.a.1 and Fig. 4 can destroy the inter-levee area within months. Access roads on top of the adjacent and setback levees in Alternatives 2, 4, and 5 would expedite the rapid deterioration of any potential natural habitat.

## E. Conclusions

The Yokoyama home and farmland, established by four generations of Japanese Americans in West Sacramento can be saved with the least amount of personal property damage by an adjacent levee and narrow berm, or cutoff wall and narrow berm, and/or additional measures such as relief wells to control underseepage and fulfill 200 year flood levee repair criteria. WSAFCA EIS/EIR Alternatives 1 and 3 will prevent Village Parkway Road from crossing the middle of the farm, splitting the land in half, and hampering farming operations that provide the family and others dependent on the farm for income.

The set-back levee utilized in Alternatives 2, 4, and the WSAFCA preferred Alternative 5 will not prevent a breach, and flood water will spill over the top in a 200 year flood event. The inter-levee channel created between the existing and set-back levees will not provide new habitats for endangered species, and will create severe human-wildlife conflicts as well as exposing people to dangerous communicable diseases in the region including the Sacramento Metropolitan area. Based on previous local restoration projects, any inter-levee habitat created by the set-back levee will be rapidly destroyed by human activity, shelter illegal activities, and will not be monitored or policed. The WSAFCA preferred Alternative 5 causes the greatest loss of personal property, and presents the greatest waste of taxpayer funds and government resources in the EIP/EIS/EIR.

## F. References

- Bolton, S. M. and J. Shellberg. 2001.** Ecological issues in floodplains and riparian corridors. Center for Streamside Studies, University of Washington, Seattle.
- Bozkurt, S., P. Dekens, R. Gartland, J. Gragg, J. Lawyer, and M. McGoogan. 2000.** Evaluation of Setback Levees on the Sacramento River. University of California, Santa Barbara.
- Conrat, M. and R. Conrat. 1972.** Executive order 9066. California Historical Society, San Francisco, California.
- Dillon, R. H. 1982.** Delta Country. Presidio Press, Novato, CA.

- Ditchkoff, S., S. T. Saalfeld, and C. J. Gibson. 2006.** Animal behavior in urban ecosystems: Modifications due to human-induced stress. *Urban Ecosystems* 9: 5-12.
- Dryden, M. W. and R. K. Ridley. 1999.** Potential health hazards of urban wildlife to humans and their pets. College of Veterinary Medicine, Kansas State University, Manhattan.
- Dunbar, M. R., R. T. Sterner, and S. R. Johnson. 2007.** Impacts of wildlife diseases in urban environments. Proceedings of the 12<sup>th</sup> Wildlife Damage Management Conference, April 9-12, 2007, Corpus Christi, Texas.
- Esty, A. 2007.** Banking on mitigation. *American Scientist*. 95: 1.
- Gehrt, S. E. 2007.** Ecology of coyotes in urban landscapes. Proceedings of the 12th Wildlife Damage Management Conference, April 9-12, 2007, Corpus Christi, Texas.
- Hunter, J. C., K. B. Willett, M. C. McCoy, J. F. Quinn, and K. E. Keller. 1999.** Prospects for preservation and restoration of riparian forests in the Sacramento Valley, California, USA. *Environmental Management* 24: 65-75.
- Lai, Y. G. and J. Bountry. 2007.** Numerical modeling study of levee setback alternatives for lower Dungeness River Washington. U.S. Department of the Interior, Bureau of Reclamation Technical Service Center, Denver, Colorado.
- Lawler, S. P. and G. C. Lanzaro. 2005.** Managing mosquitoes on the farm. University of California, Division of Agriculture and Natural Resources, Oakland, California. Publication 8158.
- Lynch, J. A., E. S. Corbett, and R. Hoopes. 1977.** Implications of forest management practices on the aquatic environment. *Fisheries* 2: 16-22.
- Lynch, L. 2008.** Desirability, Challenges, and Methods of Protecting Farmland. *Choices*. 23: 16-21.
- Maeda, W. 2000.** Changing dreams and treasured memories: A story of Japanese Americans in the Sacramento Region. Tom's Printing, Sacramento, CA. 274 pp.
- McGrann, M. C., D. H. Van Vuren, and M. A. Ordeñana. 2013.** Influence of adjacent crop type on occurrence of California ground squirrels on levees in the Sacramento Valley, California. *Wildlife Society Bulletin*.
- Milhous, R. T. 1998.** Modelling of instream flow needs: The link between sediment and aquatic habitat. *Regulated Rivers Research Management* 14: 79-94.
- National Technical Information Service. 1956.** Investigation of underseepage and its control, lower Mississippi River levees, Volume I. U. S. Department of Commerce, Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.

**National Wildlife Research Center. 2010.** Reducing urban wildlife conflicts. U. S. Department of Agriculture, Animal and Plant Health Inspection Service, Fort Collins, Colorado.

**Ordeñana, M. A., D. H. Van Vuren, and J. P. Draper. 2012.** Habitat associations of California ground squirrels and Botta's pocket gophers on levees in California. *Journal of Wildlife Management*. 76: 1712–1717.

**Palmer, M. A., H. L. Menninger, and E. Bernhardt. 2009.** River restoration, habitat heterogeneity and biodiversity: a failure of theory or practice? *Freshwater Biology* 55: 1-18.

**Santa Ana, R. 2012.** Study shows there's money in small-acreage vegetable production. *AgriLife Today*, Texas A & M University, College Station, Texas.

**Simpson, P. W., J. R. Newman, M. A. Keirn, R. M. Matter, and P. A. Guthrie. 1982.** Manual of stream channelization impacts on fish and wildlife. Fish and Wildlife Service, Washington, DC.

**Swolgaard, C. A., K. A. Reeves, and D. A. Bell. 2008.** Foraging by Swainson's Hawks in a vineyard-dominated landscape. *Journal of Raptor Research*. 42: 188-196.

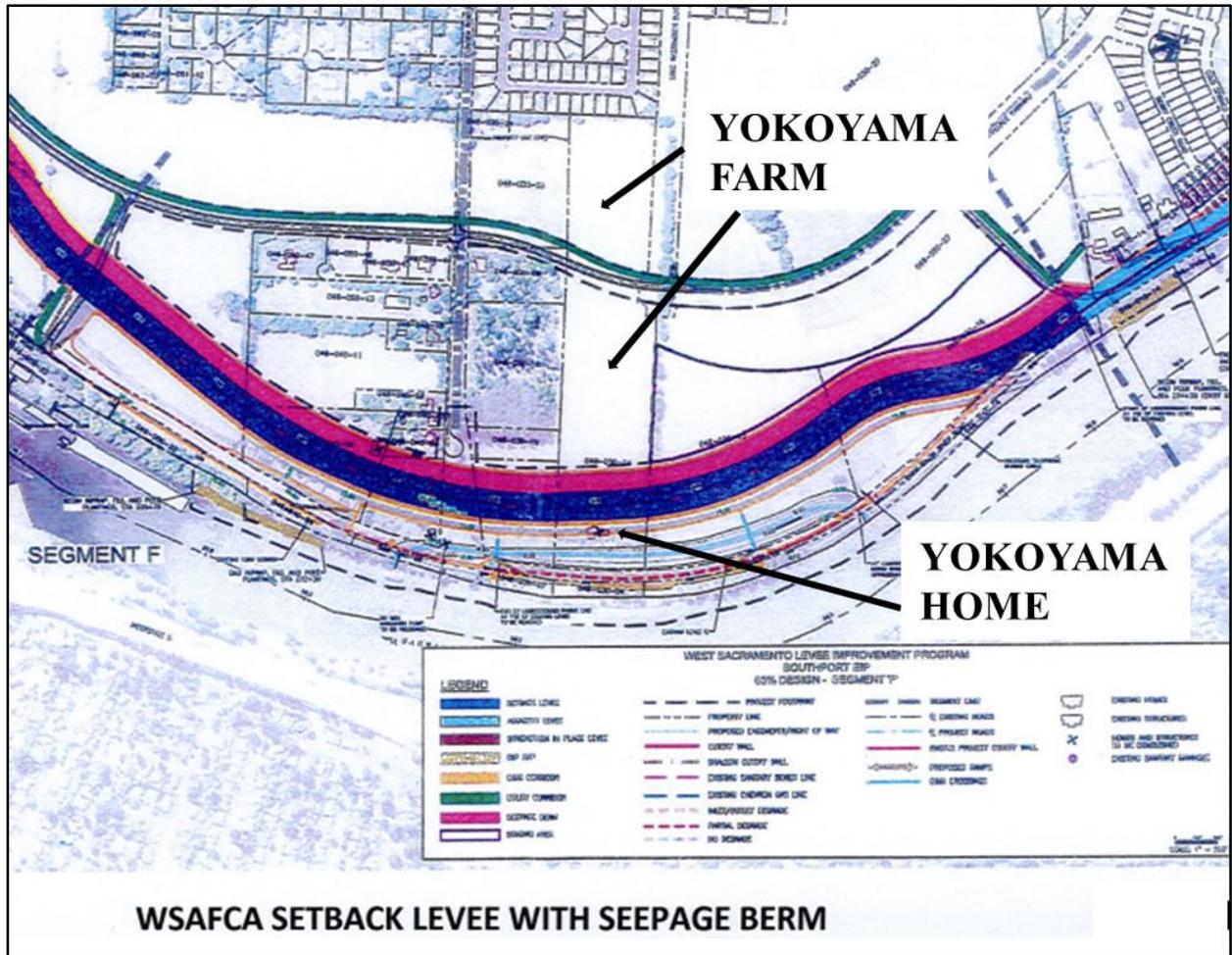
**Taylor, G. E. Jr., K. B. Schaller, J. D. Geddes, M. S. Gustin, G. B. Lorson, and G. C. Miller. 1996.** Microbial ecology, toxicology and chemical fate of methyl isothiocyanate in riparian soils from the upper Sacramento River. *Environmental Toxicology and Chemistry* 15: 1694-1701.

**Wu, F. C. 2000.** Modeling embryo survival affected by sediment deposition into salmonid spawning gravels: Application to flushing flow prescriptions. *Water Resources Research* 36: 1595-1603.

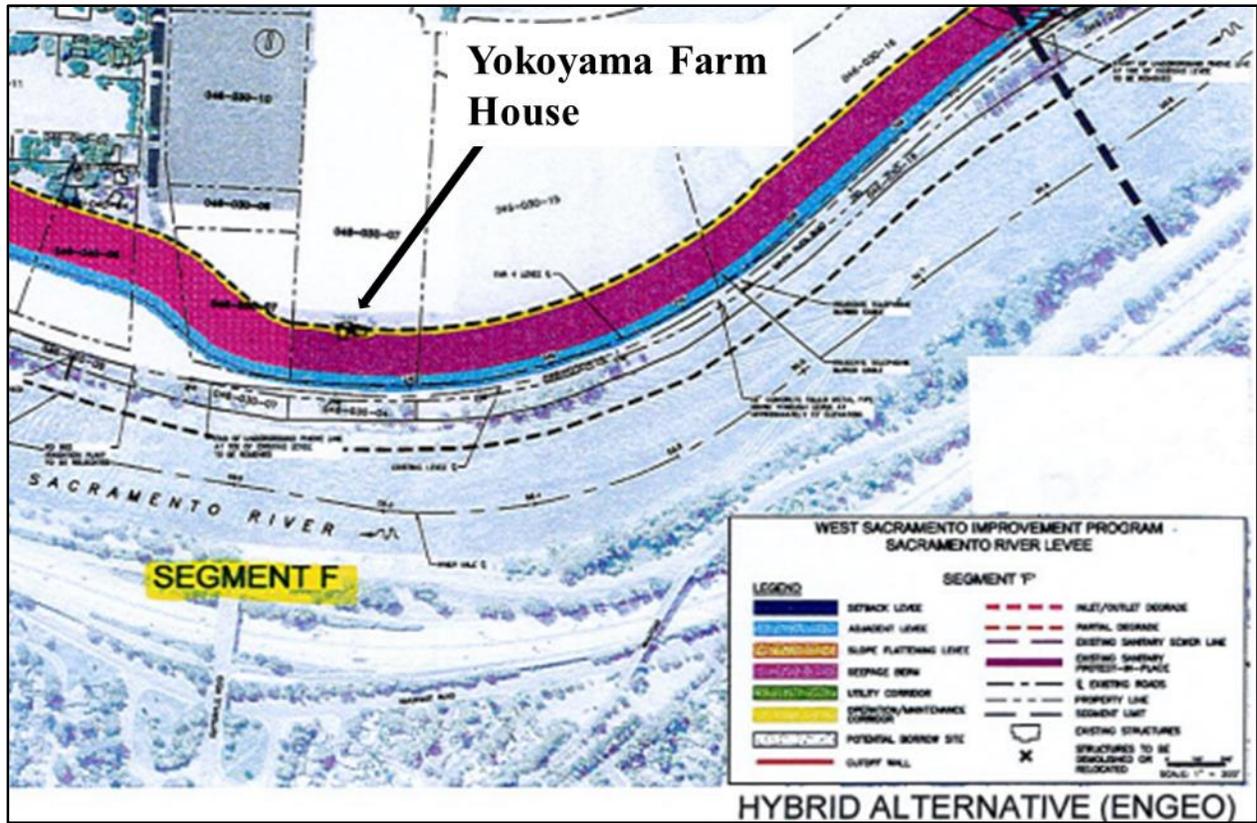
**Yolo County Agriculture Department. 2013.** Yolo County 2012 Agricultural Crop Report. Yolo County Department of Agriculture and Weights and Measures, Woodland, California.



**Fig. 1.** Location of the Yokoyama Farm in Segment F of the WSAFCA EIP/EIS/EIR on South River Road in West Sacramento. View is to the south from the Barge Canal.



**Fig. 2.** The Yokoyama house and farm in Segment F and the position of the setback levee and Village Parkway Road in the WSAFCA Alternative Plan 5 that will result in condemnation of the fourth generation Japanese American family home in the inter-levee floodplain, and division and loss of farmland established in 1966.



**Fig. 3.** Location of the Yokoyama farm and home in the Hybrid Alternative plan developed by ENGEO titled, “Seecon Proposed Adjacent Levee with Seepage Berm.” Additional measures described by ENGEO in Appendix 1 and the ENGEO/Seecon alternative plan will help save the Yokoyama family home and most of the river frontage farmland.



**Fig. 4.** Construction of the setback levee at the northeast corner of the WSAFCA EIP bordered by the Barge Canal on the north, Sacramento River on the east, and Jefferson Boulevard on the west. Work on the project began on April 6, 2011 and 3 years later, the 2,200 foot long setback levee has not yet been completed. The vacant area in the figure was created on the east by the setback levee, on the north by the barge canal levee, and on the west and south sides by existing levees. Off road vehicles, dirt bikers, paint ballers, hunters, and horseback riders have severely eroded trails into the area that is posted with no trespassing signs. Squatting by homeless people and illegal dumping is common. The closure of the South River Road to construct the setback levee has created a haven for drug dealers and crime due to isolation caused by the absence of regular traffic. An intent of the setback levee project was preservation of wildlife habitat, but few desirable native plants and wildlife find sanctuary in the vicinity.



GEOTECHNICAL  
ENVIRONMENTAL  
WATER RESOURCES  
CONSTRUCTION SERVICES

Project No.  
**9401.001.000**

January 8, 2013

President William Denton and  
Members of the Board of Directors  
West Sacramento Area Flood Control Agency  
110 West Capitol Avenue, 2<sup>nd</sup> Floor  
West Sacramento, CA 95691

Subject: Segment F Yokoyama Farm  
3000 South River Road  
West Sacramento, California

### **GEOTECHNICAL CONSIDERATIONS**

Honorable President Denton and Members of the Board:

On behalf of our client, Victoria Yokoyama, we reviewed the geotechnical information provided for Segment F of the Southport Early Implementation Project (EIP) in West Sacramento. The purpose of this letter is to highlight several important geotechnical engineering issues regarding the levee alternatives for Segment F.

The March 2012 Project Design report identifies two alternatives for Segment F, an Adjacent Levee with seepage berm and a Setback Levee with seepage berm. The design team's engineering analysis shows that the Adjacent Levee with seepage berm results in superior mitigation against underseepage when compared to the Setback Levee with seepage berm. While the Adjacent Levee was the preferred alternative earlier this year, due to State cost sharing, the design team and West Sacramento Area Flood Control Agency's (WSAFCA) selected the Setback Levee with seepage berm as the preferred alternative. As you know, the WSAFCA selection of the Setback Levee as the preferred alternative for Segment F will require acquisition of much of the Yokoyama property and demolition of their house.

From a geotechnical engineering perspective, if WSAFCA selects the Adjacent Levee with seepage berm for implementation, then the Yokoyama house can possibly be saved. The geotechnical information provided by the design team indicates that one of the primary geotechnical issues in Segment F is underseepage, which is to be mitigated with a seepage berm approximately 100 feet wide. It is our opinion that the footprint of a seepage berm associated with the Adjacent Levee can possibly be reduced such that the Yokoyama house can remain. This would require additional mitigation measures to reduce the exit gradient at the toe, such as a partially penetrating cutoff wall with narrower seepage berm or use of relief wells.

The use of relief wells was dismissed by the design team as technically infeasible for Segment F. Following our review of the subsurface data in Segment F, we conclude that there is a significant and continuous confining layer that can make relief wells a viable alternative. This is also confirmed and clearly shown on Exhibit G-69 of the BCI technical memorandum, dated February 27, 2012.

Appendix 1, cont.

West Sacramento Area Flood Control Agency  
Segment F Yokoyama Farm  
GEOTECHNICAL CONSIDERATIONS

9401.001.000  
January 8, 2013  
Page 2

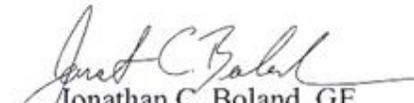
Based on our findings, we suggest that the merits of these potentially viable alternatives be considered by your design team.

If you have any questions or comments regarding this letter, please call and we will be glad to discuss them with you.

Sincerely,

ENGEO Incorporated

  
Mark M. Gilbert, GE

  
Jonathan C. Boland, GE

cc: Victoria Yokoyama



US Army Corps  
of Engineers  
Sacramento District

# Public Comment Sheet

Name: Christine Amey Phone: (916) 270-7444

Address: 600 William St West Sac. 95605

E-Mail: ameyca@gmail.com

## Comment/Question:

I am a resident of the Washington District N<sup>th</sup> of the Tower Bridge "specifically" We are very excited to hear the property N<sup>th</sup> of the boat camp has recently been purchased with the hopes of developing by building residential on the levee "on the flood plane". We would like consideration made for the development of this location and support by the city to help make this project happen.... We have been dealing with a blighted, <sup>blighted</sup> run down infestation of homeless camps for years. The cost to periodically

→

Clear the area of trash runs high tax  
payers dollars ..... tons of trash and debris

The area has been made unsafe for pub  
use due to the hazardous materials left in  
camp sites and along the river ....

We understand it may be (10) yrs before  
any funding is available to begin work on  
the levees with of the Tower bridge ... S  
we are asking this developer be able to  
develop the area (perhaps units on stilts)  
building similar to Cherry's on the East side  
this would help the eradication of homeless  
camps and open the river up to the  
residents, to have the area developed  
and made available to the public to



US Army Corps  
of Engineers ©  
Sacramento District

# Public Comment Sheet

Name: John Freeman Phone: 916 606-1772

Address: 210 3rd st

E-Mail: J.T.FREEMAN@LIVE.COM

## Comment/Question:

SAC River North Levee From Broderick Boat Ramp  
to I street Bridge should be improved  
into walkable & bikeable predistrian  
usable Area.



**DEPARTMENT OF THE ARMY**  
**U.S. ARMY ENGINEER DISTRICT, SACRAMENTO**  
**CORPS OF ENGINEERS**  
**1325 J STREET**  
**SACRAMENTO, CALIFORNIA 95814-2922**

CESPK-PD-RA (1102-2-1150a)

**JUL 06 2009**

MEMORANDUM FOR Commander, U.S. Army Records Management and Declassification Agency, ATTN: AAHS-RD, Army Federal Register Liaison (Ms. Brenda Bowen), Casey Building Room 102, 7701 Telegraph Road, Alexandria, VA 22315-3860

SUBJECT: Notice of Intent – West Sacramento Project, California, General Reevaluation Report, Environmental Impact Statement/Environmental Impact Report

Enclosed are three copies of our Notice of Intent (NOI) to prepare the Environmental Impact Statement/Environmental Impact Report for the West Sacramento Project, California, General Reevaluation Report. Please place the NOI in the Federal Register at the earliest possible time.

3 Encls  
1 CD

  
THOMAS C. CHAPMAN, P. E.  
COL, EN  
Commanding

CF: (with Enclosure)  
Commander, U.S. Army Corps of Engineers, South Pacific Division, 1455 Market Street,  
San Francisco, CA 94103

**BILLING CODE: 3720-58**

**DEPARTMENT OF DEFENSE**

**Department of the Army; Army Corps of Engineers**

**Notice of Intent to Prepare an Environmental Impact Statement/Environmental Impact Report for the West Sacramento Project, California, General Reevaluation Report**

**AGENCY:** Department of the Army, U.S. Army Corps of Engineers, DoD.

**ACTION:** Notice of intent.

**SUMMARY:** The action being taken is the preparation of an environmental impact statement/environmental impact report (EIS/EIR) for the West Sacramento Project, California, General Reevaluation Report (GRR). The GRR will re-evaluate the currently authorized plan as well as develop and evaluate opportunities to reduce flood risk, increase recreation, and restore the ecosystem along the Sacramento River in and around the City of West Sacramento.

**DATES:** A public scoping meeting will be held on July 21, 2009, from 3:00 to 5:00 and 6:30 to 8:00 at the West Sacramento City Hall, 1110 West Capitol Avenue, West Sacramento, CA. Send written comments by August 21, 2009 to the address below.

**ADDRESSES:** Send written comments and suggestions concerning this study to Mr. John Suazo, U.S. Army Corps of Engineers, Sacramento District,  
Attn: Planning Division (CESPK-PD-R), 1325 J Street, Sacramento, CA 95814.  
Requests to be placed on the mailing list should also be sent to this address.

**FOR FURTHER INFORMATION CONTACT:** Questions about the proposed action

and EIS/EIR should be addressed to John Suazo at (916) 557-6719, e-mail:

[john.suazo@usace.army.mil](mailto:john.suazo@usace.army.mil) or by mail to (see **ADDRESSES**).

**SUPPLEMENTARY INFORMATION:**

**1. Proposed Action.** The U.S. Army Corps of Engineers is preparing an EIS/EIR to analyze the impacts of a range of alternatives that would lessen the risk of flooding in and around the City of West Sacramento.

**2. Alternatives.** The EIS/EIR will address an array of flood risk management improvement alternatives along the entire West Sacramento basin. Alternatives analyzed during the investigation will include a combination of one or more flood protection measures. Potential measures include seepage berms, stability berms, setback levees, levee raises, and seepage cutoff walls.

**3. Scoping Process.** *a.* The Corps has initiated a process to involve concerned individuals, and local, State, and Federal agencies. A public scoping meeting will be held on July 21, 2009 to present information to the public and to receive comments from the public. The Draft EIS/EIR will be completed in conjunction with additional public meetings.

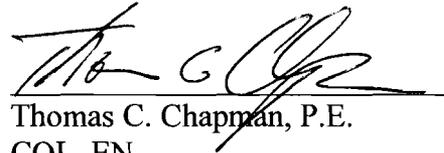
*b.* Significant issues to be analyzed in depth in the EIS include effects on hydraulic, wetlands and other waters of the U.S., vegetation and wildlife resources, special-status species, cultural resources, land use, fisheries, water quality, air quality, transportation, and socioeconomics; and cumulative effects of related projects in the study area.

c. The Corps is consulting with the State Historic Preservation Officer to comply with the National Historic Preservation Act, and the National Marine Fisheries Service and the U.S. Fish and Wildlife Service to comply with the Endangered Species Act.

d. A 45-day public review period will be provided for individuals and agencies to review and comment on the draft EIS/EIR. All interested parties are encouraged to respond to this notice and provide a current address if they wish to be notified of the draft EIS circulation.

**4. Availability.** The draft EIS/EIR is scheduled to be available for public review and comment in 2012.

2 Jul 09  
Date

  
Thomas C. Chapman, P.E.  
COL, EN  
Commanding

**Notice of Completion & Environmental Document Transmittal**

Mail to: State Clearinghouse, P.O. Box 3044, Sacramento, CA 95812-3044 (916) 445-0613  
 For Hand Delivery/Street Address: 1400 Tenth Street, Sacramento, CA 95814

SCH #

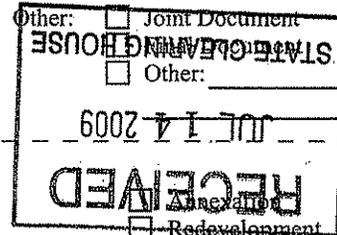
**Project Title:** West Sacramento Project, California, General Reevaluation Report (GRR)

Lead Agency: West Sacramento Area Flood Control Agency Contact Person: John Powderly  
 Mailing Address: 1110 West Capitol Avenue Second Floor Phone: (916) 617-4645  
 City: West Sacramento Zip: 95691 County: Yolo

**Project Location:** County: Yolo City/Nearest Community: West Sacramento  
 Cross Streets: various Zip Code: 95691+other  
 Longitude/Latitude (degrees, minutes and seconds): various ' various " N / various ' various " W Total Acres: \_\_\_\_\_  
 Assessor's Parcel No.: various Section: various Twp.: \_\_\_\_\_ Range: \_\_\_\_\_ Base: \_\_\_\_\_  
 Within 2 Miles: State Hwy #: \_\_\_\_\_ Waterways: \_\_\_\_\_  
 Airports: \_\_\_\_\_ Railways: \_\_\_\_\_ Schools: \_\_\_\_\_

**Document Type:**

- CEQA:  NOP  Draft EIR NEPA:  NOI  
 Early Cons  Supplement/Subsequent EIR  EA  
 Neg Dec (Prior SCH No.) \_\_\_\_\_  Draft EIS  
 Mit Neg Dec Other: \_\_\_\_\_  FONSI



**Local Action Type:**

- General Plan Update  Specific Plan  Rezone  
 General Plan Amendment  Master Plan  Prezone  
 General Plan Element  Planned Unit Development  Use Permit  
 Community Plan  Site Plan  Land Division (Subdivision, etc.)  Redevelopment  
 Coastal Permit  
 Other: Flood Protection

**Development Type:**

- Residential: Units \_\_\_\_\_ Acres \_\_\_\_\_  
 Office: Sq.ft. \_\_\_\_\_ Acres \_\_\_\_\_ Employees \_\_\_\_\_  
 Commercial: Sq.ft. \_\_\_\_\_ Acres \_\_\_\_\_ Employees \_\_\_\_\_  
 Industrial: Sq.ft. \_\_\_\_\_ Acres \_\_\_\_\_ Employees \_\_\_\_\_  
 Educational: \_\_\_\_\_  
 Recreational: \_\_\_\_\_  
 Water Facilities: Type \_\_\_\_\_ MGD \_\_\_\_\_  
 Transportation: Type \_\_\_\_\_  
 Mining: Mineral \_\_\_\_\_  
 Power: Type \_\_\_\_\_ MW  
 Waste Treatment: Type \_\_\_\_\_ MGD  
 Hazardous Waste: Type \_\_\_\_\_  
 Other: \_\_\_\_\_

**Project Issues Discussed in Document:**

- Aesthetic/Visual  Fiscal  Recreation/Parks  Vegetation  
 Agricultural Land  Flood Plain/Flooding  Schools/Universities  Water Quality  
 Air Quality  Forest Land/Fire Hazard  Septic Systems  Water Supply/Groundwater  
 Archeological/Historical  Geologic/Seismic  Sewer Capacity  Wetland/Riparian  
 Biological Resources  Minerals  Soil Erosion/Compaction/Grading  Growth Inducement  
 Coastal Zone  Noise  Solid Waste  Land Use  
 Drainage/Absorption  Population/Housing Balance  Toxic/Hazardous  Cumulative Effects  
 Economic/Jobs  Public Services/Facilities  Traffic/Circulation  Other: \_\_\_\_\_

**Present Land Use/Zoning/General Plan Designation:**

various

**Project Description:** (please use a separate page if necessary)  
 See attached

Note: The State Clearinghouse will assign identification numbers for all new projects. If a SCH number already exists for a project (e.g. Notice of Preparation or previous draft document) please fill in.

**Reviewing Agencies Checklist**

Lead Agencies may recommend State Clearinghouse distribution by marking agencies below with an "X".  
If you have already sent your document to the agency please denote that with an "S".

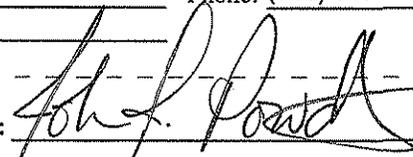
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| <input checked="" type="checkbox"/> Air Resources Board                   | <input checked="" type="checkbox"/> Office of Emergency Services             |
| <input checked="" type="checkbox"/> Boating & Waterways, Department of    | <input checked="" type="checkbox"/> Office of Historic Preservation          |
| <input type="checkbox"/> California Highway Patrol                        | <input checked="" type="checkbox"/> Office of Public School Construction     |
| <input type="checkbox"/> Caltrans District # _____                        | <input type="checkbox"/> Parks & Recreation, Department of                   |
| <input type="checkbox"/> Caltrans Division of Aeronautics                 | <input type="checkbox"/> Pesticide Regulation, Department of                 |
| <input type="checkbox"/> Caltrans Planning                                | <input checked="" type="checkbox"/> Public Utilities Commission              |
| <input checked="" type="checkbox"/> Central Valley Flood Protection Board | <input checked="" type="checkbox"/> Regional WQCB # <u>5</u>                 |
| <input type="checkbox"/> Coachella Valley Mtns. Conservancy               | <input checked="" type="checkbox"/> Resources Agency                         |
| <input type="checkbox"/> Coastal Commission                               | <input type="checkbox"/> S.F. Bay Conservation & Development Comm.           |
| <input type="checkbox"/> Colorado River Board                             | <input type="checkbox"/> San Gabriel & Lower L.A. Rivers & Mtns. Conservancy |
| <input checked="" type="checkbox"/> Conservation, Department of           | <input type="checkbox"/> San Joaquin River Conservancy                       |
| <input type="checkbox"/> Corrections, Department of                       | <input type="checkbox"/> Santa Monica Mtns. Conservancy                      |
| <input checked="" type="checkbox"/> Delta Protection Commission           | <input checked="" type="checkbox"/> State Lands Commission                   |
| <input checked="" type="checkbox"/> Education, Department of              | <input type="checkbox"/> SWRCB: Clean Water Grants                           |
| <input type="checkbox"/> Energy Commission                                | <input type="checkbox"/> SWRCB: Water Quality                                |
| <input checked="" type="checkbox"/> Fish & Game Region # <u>2</u>         | <input type="checkbox"/> SWRCB: Water Rights                                 |
| <input type="checkbox"/> Food & Agriculture, Department of                | <input type="checkbox"/> Tahoe Regional Planning Agency                      |
| <input type="checkbox"/> Forestry and Fire Protection, Department of      | <input type="checkbox"/> Toxic Substances Control, Department of             |
| <input type="checkbox"/> General Services, Department of                  | <input type="checkbox"/> Water Resources, Department of                      |
| <input type="checkbox"/> Health Services, Department of                   | Other: _____   |
| <input type="checkbox"/> Housing & Community Development                  | Other: _____   |
| <input type="checkbox"/> Integrated Waste Management Board                |  |
| <input checked="" type="checkbox"/> Native American Heritage Commission   |  |

**Local Public Review Period (to be filled in by lead agency)**

Starting Date July 14, 2009 Ending Date August 21, 2009

**Lead Agency (Complete if applicable):**

Consulting Firm: _____	Applicant: <u>West Sacramento Area Flood Control Agency</u>
Address: _____	Address: <u>1110 West Capitol Avenue 2nd Floor</u>
City/State/Zip: _____	City/State/Zip: <u>West Sacramento, CA 95691</u>
Contact: _____	Phone: <u>(916) 617-4645</u>
Phone: _____	

Signature of Lead Agency Representative:  Date: July 14, 2009

Authority cited: Section 21083, Public Resources Code. Reference: Section 21161, Public Resources Code.

# Notice of Preparation

To: State Clearinghouse, Responsible Agencies,  
Trustee Agencies, Interested Parties

(Agency)

See Distribution List

(Address)

From: West Sacramento Area Flood Control Agency

(Agency)

1110 West Capitol Avenue

(Address)

West Sacramento, CA 95691

## Subject: Notice of Preparation of a Draft Environmental Impact Statement/Environmental Impact Report

The United States Army Corps of Engineers (Corps) and the West Sacramento Area Flood Control Agency (WSAFCA) are preparing the West Sacramento Project, California General Reevaluation Report (GRR). The GRR will evaluate alternatives to reduce flood risk for the City of West Sacramento. The Corps, acting as the federal lead agency under the National Environmental Protection Act (NEPA), and WSAFCA, acting as lead agency under the California Environmental Quality Act (CEQA), have determined that an Environmental Impact Statement/Environmental Impact Report (EIS/EIR) will be prepared for the GRR. Responsible and trustee agencies under CEQA may include City of West Sacramento, Yolo County, California Department of Fish and Game, California Department of Water Resources, Central Valley Flood Protection Board, California Regional Water Quality Control Board, State Lands Commission, California Department of Parks and Recreation, and U.S. Fish and Wildlife Service.

WSAFCA and the Corps need to know your views regarding the scope and content of the environmental information in connection with the GRR. Due to the time limits mandated by state law, your response must be sent at the earliest possible date but not later than 30 days after receipt of this notice (i.e., no later than 5 p.m. on August 21, 2009). Please mail or otherwise deliver your comments to:

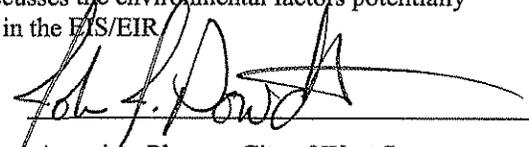
John Powderly, Associate Planner  
West Sacramento Flood Control Agency  
1110 West Capitol Avenue 2<sup>nd</sup> Floor  
West Sacramento, CA 95691  
916-617-4645  
Email: [johnp@cityofwestsacramento.org](mailto:johnp@cityofwestsacramento.org)

John Suazo, Biological Scientist  
Sacramento District  
U.S Army Corps of Engineers  
1325 J Street  
Sacramento, CA 95814  
916-557-6719  
Email: [john.suazo@usace.army.mil](mailto:john.suazo@usace.army.mil)

Please provide a name for a contact person in your agency. In addition to or instead of providing written comments, input may also be provided at two public scoping meetings to be held on July 21<sup>st</sup> at 3:00 p.m. and 6:30 p.m., at the City of West Sacramento City Hall in rooms 157 and 160, 1110 West Capitol Avenue, West Sacramento.

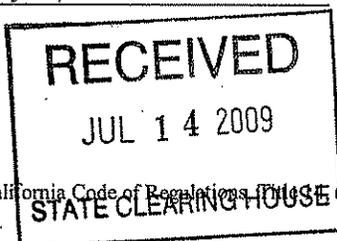
Attachment 1 provides the schedule and location of the public scoping meeting and a general description of the GRR along with a map of the GRR Study Area location. Attachment 2 discusses the environmental factors potentially affected by the project and the environmental topics to be addressed in the EIS/EIR.

Date: July 14, 2009

Signature: 

Title: Associate Planner, City of West Sacramento

Telephone: (916) 617-4645

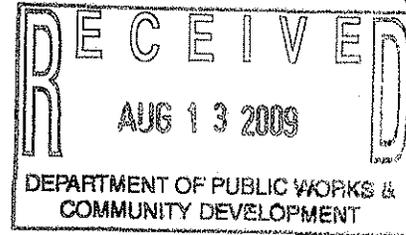


Reference: California Code of Regulations, Title 5 (CEQA Guidelines) Sections 15082(a), 15103, 15375.



California Natural Resources Agency  
DEPARTMENT OF FISH AND GAME  
North Central Region  
1701 Nimbus Road, Suite A  
Rancho Cordova, CA 95670  
(916) 358-2900  
<http://www.dfg.ca.gov>

ARNOLD SCHWARZENEGGER, Governor  
DONALD KOCH, Director



August 6, 2009

Mr. John Powderly  
City of West Sacramento  
1110 West Capitol Avenue  
West Sacramento, CA 95691

Dear Mr. Powderly:

The Department of Fish and Game (Department) has received and reviewed your Notice of Preparation (NOP) for the West Sacramento Project, California General Reevaluation Report (SCH # 2009072055). The project proposes to evaluate opportunities to reduce flood risk, increase recreation, and restore the ecosystem along the Sacramento River within the project area. Potential actions to be evaluated in the Environmental Impact Report (EIR) include raising the existing levees protecting the City of West Sacramento, construction of an adjacent setback levee, cutoff walls, seepage berms, stability berms, internal drainage relief wells, or sheet pile walls, slope flattening, placing stone protection, and vegetation removal.

Significant natural resources occur within the proposed project boundaries. Within these proposed project boundaries, the Sacramento River supports several fish species that utilize the river for immigration, emigration, spawning and/or rearing. These fish species include all runs of Chinook salmon (*Oncorhynchus tshawytscha*). Winter-run Chinook salmon are listed as endangered under both the state and federal Endangered Species Acts. Spring-run Chinook salmon are listed as threatened under both the state and federal Endangered Species Acts. In addition to Chinook salmon, the state and federally listed threatened Delta smelt (*Hypomesus transpacificus*) occurs within the proposed project boundaries. Other significant natural resources occurring within the proposed project boundaries include the state and federally listed threatened giant garter snake (*Thamnophis couchi gigas*) and the state listed threatened Swainson's hawk (*Buteo swainsoni*). Both of these species utilize the habitats associated with the levees in the proposed project area for all or part of their life cycles.

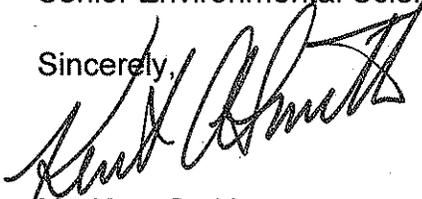
The DFG is providing comments in response to the NOP under the California Environmental Quality Act (CEQA) as both a responsible and trustee agency. As trustee for the state's fish and wildlife resources, the DFG has jurisdiction over the conservation, protection, and management of fish, wildlife, native plants, and habitat necessary for biologically sustainable populations of such species. In that capacity, DFG administers the California Endangered Species Act (CESA), the Native Plant Protection Act (NPPA), and other provisions of the California Fish and Game Code that affords protection to the state's fish and wildlife trust resources. The DFG recommends that the DEIR include discussion and evaluation of the following:

1. Analyze and discuss all reasonably foreseeable direct and indirect project related impacts on biological resources due to project implementation. The analysis should focus, in particular, on the presence of and potential habitats for all state and federal listed species and species of concern and the evaluation of direct, indirect and cumulative project impacts to these species and their respective habitat. This analysis should include discussion of adjacent habitats outside of the project area that support or could support listed species or species of concern and that may be impacted as a result of project implementation.
2. Identify and discuss potentially feasible mitigation measures to address all reasonably foreseeable project related impacts on biological resources. This should include identification of mitigation measures that minimize and fully mitigate all project impacts to state and federally listed species and species of concern. Analysis should include discussion of the ability to conserve natural resources on site that may be achieved through project design and take avoidance measures and offsite mitigation obtained through acquisition of existing natural resources.
3. Specifically address project impacts to both jurisdictional and non-jurisdictional wetlands, measures designed to mitigate these impacts and the consistency of this analysis to the existing Yolo County General Plan.
4. Identification of any offsite infrastructure improvements required as part of this project and evaluation of potential project impacts due to these activities. Subsequently, the DEIR should identify and analyze potentially feasible mitigation measures that avoid or substantially lessen, minimize and fully mitigate, all reasonably foreseeable direct and indirect impacts to biological resources.
5. Specifically address project impacts to Chinook salmon, Swainson's hawks, and giant garter snakes and the habitats utilized by these species.
6. Evaluation of the development of the proposed plan areas contribution to habitat fragmentation and population isolation of all plant and animal populations including but not limited to listed species and species of concern. Include identification of potentially feasible mitigation measures that will avoid or substantially lessen these impacts.
7. Development of alternative development/design scenarios for the proposed project that will achieve the project objectives, and which will avoid or substantially lessen the project-related impacts on biological resources.

In addition to the requested discussion and analysis, the Department recommends that this project coordinate with Yolo County's Natural Heritage Program to ensure compatibility with the program's habitat conservation goals and objectives. Coordination should occur with Ms. Maria Wong, Executive Director, Yolo County Habitat/Natural Community Conservation Plan JPA. Ms. Wong can be reached via telephone at (530) 406-4880, or by mail at 120 West Main Street, Suite C, Woodland, CA 95695.

Thank you for the opportunity to review this project. If the Department can be of further assistance, please contact Mr. James Navicky (916) 358-2926, or Mr. Jeff Drongesen, Senior Environmental Scientist, at (916) 358-2919.

Sincerely,



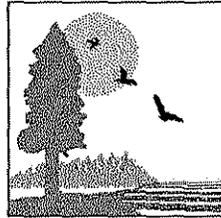
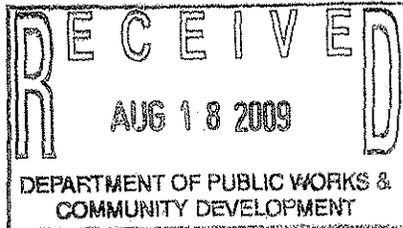
Mr. Kent Smith  
Habitat Conservation Program Manager

cc: Mr. Jeff Drongesen  
Mr. James Navicky  
Department of Fish and Game  
North Central Region  
1701 Nimbus Road  
Rancho Cordova, CA 95670

Ms. Maria Wong  
Executive Director  
Yolo County Habitat/Natural Community Conservation Plan JPA  
120 West Main Street, Suite C  
Woodland, CA 95695

**CALIFORNIA STATE LANDS COMMISSION**

100 Howe Avenue, Suite 100-South  
Sacramento, CA 95825-8202



August 12, 2009

**PAUL D. THAYER**, Executive Officer

(916) 574-1800 FAX (916) 574-1810

Relay Service From TDD Phone **1-800-735-2929**  
from Voice Phone **1-800-735-2922**

Contact Phone: (916) 574-1900

Contact FAX: (916) 574-1885

File Ref: SCH# 2009072055

John Powderly  
West Sacramento Area Flood Control Agency  
1110 West Capitol Avenue, Second Floor  
West Sacramento, CA 95691

**Subject: West Sacramento Project, California, General Reevaluation Report (GRR)  
Draft Environmental Impact Statement/ Environmental Impact Report**

Dear Mr. Powderly:

The California State Lands Commission (CSLC) staff has reviewed the Notice of Preparation (NOP) of a Draft Environmental Impact Statement/ Environmental Impact Report dated July 14, 2009, pertaining to the proposed West Sacramento Project, California, General Reevaluation Report (GRR). For this project, the CSLC is both a Responsible and a Trustee agency.

As general background, the State acquired sovereign ownership of all tidelands and submerged lands and beds of navigable waterways upon its admission to the United States in 1850. The State holds these lands for the benefit of all the people of the State for statewide Public Trust purposes of waterborne commerce, navigation, fisheries, water-related recreation, habitat preservation and open space. The State owns sovereign fee title to tide and submerged lands landward to the mean high tide line (MHTL) as they existed in nature, prior to fill or artificial accretions. On navigable non-tidal waterways, the State holds fee ownership of the bed landward to the ordinary low water mark and a Public Trust easement landward to the ordinary high water mark, as they last naturally existed. The State's sovereign interests are under the jurisdiction of the CSLC.

The current project is to address improving up to 50 miles of federal flood protection levees surrounding West Sacramento. The improvements will increase the level of flood protection to achieve a minimum of 200-year flood protection. Improvements to the levee system will result in disturbance and the potential loss of riparian habitat along sections of the proposed project. These changes, along with those proposed for the other levee system enhancements in the Sacramento Valley, will result in a cumulative loss of riparian vegetation and shaded riverine aquatic habitat along the river bank, which will be difficult to mitigate and may result in secondary impacts to the listed runs of salmonids and listed avian species. The CSLC recommends that the West Sacramento Area Flood Control Agency (WSAFCA) work very closely with the resources agencies (i.e., California Department of Fish and Game (CDFG), U.S.

Fish and Wildlife Service (USFWS), and NOAA Fisheries) and with local representatives of adjoining landowners (such as the Sacramento River Conservation Area Forum) to address these cumulative impacts and to design appropriate mitigation/conservation areas. Other types of mitigation, such as avoidance, both in time and space (such as construction work windows), will also need to be considered.

Queries of the Natural Diversity Database (CNDDDB) and the USFWS Special Status Species Database should be conducted to identify any special-status plant or wildlife species that may occur in the region. Their potential for occurrence on the project site or in the project area should be included in the DEIS/ DEIR.

One of the major stressors of the Sacramento River system is introduced species. Therefore, the DEIS/DEIR should consider a range of alternatives for prevention programs for terrestrial and aquatic invasive species (including quarantine, early detection, and early response) to slow the introduction of invasive species, such as the Quagga mussel, into high demand and sensitive areas. As part of the alternatives analysis, the design of the proposed project should take into consideration the current and proposed aquatic invasive species prevention programs. In addition, in light of the recent decline of pelagic organisms and in order to protect at-risk fish species, the DEIR/DEIS should examine the objectives of the project and determine if the project would favor non-native fisheries within the Sacramento River.

An evaluation of the noise and vibration impacts on fish and birds from construction activities in the water, as well as construction on the levees and land-side supporting structures of the Sacramento River and flood control facilities, should be included in the DEIS/DEIR. Mitigation measures may be needed that would include species-specific work windows as defined by CDFG, USFWS, and NOAA Fisheries.

The Central Valley Flood Protection Board (CVFPB) encroachment permit may be required as well as a geotechnical evaluation of the proposed project locations. Placing rock riprap within the channels of the Sacramento River channel will require coordination with the CVFPB as well as with the US Army Corps of Engineers (US ACE) to alter Federal flood protection levees (33 USC 408). Additional coordination with the CVFPB and the US ACE may include working within the established flood season windows.

Any construction activities along the water-side bank should consider water quality issues, such as increased turbidity and sedimentation, and make all the necessary arrangements to reduce or mitigate for these concerns.

An evaluation of potential submerged cultural resources in the project area will need to be undertaken. Any submerged archaeological site or submerged historic resource remaining in state waters for more than 50 years is presumed to be significant. The title to all abandoned shipwrecks and all archaeological sites and historic or cultural resources on or in the tide and submerged lands of California is vested in the state and under the jurisdiction of the CSLC. The CSLC maintains a shipwrecks database of known and potential vessels located on the state's tide and submerged lands; however, the location of many shipwrecks remains unknown. The recovery of objects from any submerged archaeological site or shipwreck requires a salvage permit under Public Resources Code (PRC) section 6309. On statutorily granted tide and submerged lands, a permit may be issued only after consultation with the local grantee and a determination by the CSLC that the proposed salvage operation is not inconsistent with the purposes of the legislative grant. A Code of Federal Regulations section 106 evaluation should

be made, as well, to determine any potential terrestrial cultural resources in the project areas where construction can occur.

Greenhouse gas emissions information consistent with the California Global Warming Solutions Act (AB 32) should be included in the DEIS/DEIR. This would include a determination of the greenhouse gases that will be emitted as a result of construction and ongoing maintenance of the levee system, a determination of the significance of those impacts, and mitigation measures to reduce any impacts found to be significant.

An evaluation of the temporary and permanent loss of recreation resources in the specific areas during the construction of the Sacramento River levee and flood control facilities improvements should be included in the DEIS/DEIR. These impacts should include mitigation measures, which might include alternative public access points, for the residents and tourists of the area.

The DEIS/DEIR should discuss the potential changes and impacts to current transportation routes into and out of areas during the construction of the proposed Sacramento River levee improvements and flood control facilities. Once again, these impacts should include mitigation measures for the residents and tourists of the area.

As a responsible agency, the CSLC will need to rely on this document for the issuance of a lease, and therefore, we hope that you consider our comments prior to adoption of the final EIS/EIR. Please contact Diane Jones, Public Land Manager, at 916-574-1843 or by email at [jonesd@slc.ca.gov](mailto:jonesd@slc.ca.gov) for information about our leasing requirements. For questions and comments related to the environmental review, please contact Christopher Huitt at (916) 574-1938 or by e-mail at [huittc@slc.ca.gov](mailto:huittc@slc.ca.gov). If you have any questions involving the Shipwreck and Historic Maritime Resources Program please contact Staff Counsel Pam Griggs at (916) 574-1854 or by email at [griggsp@slc.ca.gov](mailto:griggsp@slc.ca.gov).

Sincerely,



Marina R. Brand, Acting Chief  
Division of Environmental Planning  
and Management

cc: Office of Planning and Research  
Diane Jones, CSLC  
Chris Huitt, CSLC

**West Sacramento GRR EIS/EIS  
Appendix I**

**Habitat Mitigation and Monitoring Plan  
Mitigation Calculations  
Cost Effective/Incremental Cost Analysis**

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**West Sacramento GRR EIS/EIS  
Appendix I**

**Enclosure 1**  
Habitat Mitigation Monitoring and  
Adaptive Management Plan

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# Habitat Mitigation Monitoring and Adaptive Management Plan

## West Sacramento General Reevaluation Report



December 2015



**US Army Corps  
of Engineers.**



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## **Appendices**

Appendix A – Cost Effectiveness and Incremental Cost Analysis

## Acronyms and Abbreviations

AAHU	Average Annual Habitat Unit
BA	biological assessment
BO	biological opinion
BPWG	Bank Protection Working Group
Corps	U.S. Army Corps of Engineers
County Parks	Sacramento County Department of Parks and Recreation
EIS/EIR	environmental impact statement/environmental impact report
ERDC	Engineer Research and Development Center
ETL	Engineering Technical Letter
GRR	general reevaluation report
GGs	giant garter snake
HEC-EFM	Hydrologic Engineering Center Ecosystem Function Model
HMMAMP	Habitat Mitigation, Monitoring, and Adaptive Management Plan
HSI	Habitat Suitability Index
HU	Habitat Units
IEP	Interagency Ecological Program
IWG	Interagency Working Group
IWM	instream woody material
NMFS	National Marine Fisheries Service
NEMDC	Natomas East Main Drainage Canal
PCE	primary constituent elements
PED	preconstruction engineering and design
RM	river mile
sDPS	southern distinct population segment
SRA	shaded riverine aquatic habitat
SMART	specific, measurable, attainable, realistic, and timely
SMWSE	summer mean water surface elevation
SWIF	System Wide Improvement Framework
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
VELB	valley elderberry longhorn beetle
WRDA	Water Resources Development Act
WMWSE	winter mean water surface elevation

## 1.0 INTRODUCTION

### 1.1 Purpose and Goals

Mitigation for habitat loss is a requirement to compensate for the loss of habitat due to a Federal action. Section 906(d) of the Water Resources Development Act of 1986 states that project alternatives must support recommendations with a specific plan to mitigate fish and wildlife losses. Additionally, the Endangered Species Act states that the purpose of compensatory mitigation is to offset environmental losses resulting from unavoidable impacts.

The primary purpose of vegetation and habitat monitoring is to determine the level of ecological function at each mitigation site as a part of an overall plan to create sites that offset the loss of habitat affected by construction of the proposed project. This Habitat Mitigation Monitoring and Adaptive Management Plan (HMMAMP) describes the types of habitats that will be impacted, the potential impacts caused by the project, and describes the types and amounts of mitigation that would be established in order to compensate for habitat losses. This plan also establishes methods to evaluate the success of these sites and includes adaptive management measures to be implemented if success criteria are not being met in order to ensure that the goals and requirements of the project's required mitigation are accomplished. This HMMAMP is a living document and will be modified as part of an adaptive management strategy to allow for the accomplishment of the goals and requirements in a constantly changing environment. This HMMAMP will accompany the final EIS/EIR, and will be updated throughout the design phase as detailed design efforts allow for finalizing the mitigation plans

The goal of the HMMAMP is to ensure that the conservation values of the mitigation sites are maintained in good condition in perpetuity. The plan's biological goals are to: (1) preserve the abundance and diversity of native species (particularly special status species) in the established habitats; (2) protect the habitat features from the effects of indiscriminate land use that may adversely impact mitigation habitats; and (3) restore any adverse condition within the mitigation habitat areas that may affect or potentially affect these areas. Monitoring would be conducted in a manner compatible with the type of mitigation site. Mitigation requirements are provided by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) through biological opinions (BOs) received through the Endangered Species Act Section 7 consultation process.

The HMMAMP would be implemented by U.S. Army Corps of Engineers (Corps) staff through coordination with USFWS and NMFS. Monitoring would be conducted by qualified biologists from the Corps, USFWS, the Department of Water Resources (DWR), and the West Sacramento Area Flood Control Agency (WSAFCA) as necessary. Upon completion of the monitoring when habitat mitigation is determined to be successful, the land would be turned over to the non-Federal sponsor to be maintained in perpetuity.

## 1.2 Project Description

The Environmental Impact Statement/Environmental Impact Report (EIS/EIR) prepared for the West Sacramento General Reevaluation Report (West Sacramento GRR) describes the environmental resources in the project area; evaluates the direct, indirect, and cumulative environmental effects of the three alternative plans; and identifies avoidance, minimization, and mitigation measures. Most potential adverse effects would be either short term or would be avoided or reduced using best management practices.

The proposed project is located in and around the city of West Sacramento in eastern Yolo County, California. West Sacramento is located at the confluence of the Sacramento and American Rivers in the northern portion of California's Central Valley. The city lies within the natural floodplain of the Sacramento River, which bounds the city along the north and east. The study area consists of the city of West Sacramento and the lands within West Sacramento Area Flood Control Agencies (WSAFCA) boundaries, which encompass portions of the Sacramento River, the Yolo Bypass, the Sacramento Bypass, and the Sacramento Deep Water Ship Channel (DWSC). The DWSC and barge canal bisect the city into two subbasins, separating the developing Southport area from the more established neighborhoods of West Sacramento, Broderick and Bryte to the north. The two subbasins are broken up into eight levee reaches based on location and fixes.

The purpose of the West Sacramento GRR is to evaluate alternatives to reduce the flood risk in the City of West Sacramento. There is a high probability that flows in the American or Sacramento Rivers or within the Yolo Bypass will stress the network of levees protecting the study area to the point that levees could fail. The consequences of such a levee failure would be catastrophic since the inundated area is highly urbanized and the flooding could be up to 20 feet deep.

The West Sacramento Project area includes approximately 50 miles of levees that surround the City of West Sacramento broken up into 8 reaches in 2 basins. The North Basin, which encompasses 6,100 acres, contains:

- Sacramento River north levee – 5.5 miles from the Sacramento Bypass south to the Stone Locks on the barge canal.
- Yolo Bypass levee – 3.7 miles from the Barge Canal north to the Sacramento Bypass.
- Sacramento Bypass levee – 1.1 miles from the Yolo Bypass levee to the Sacramento River.
- Sacramento Bypass training levee – 0.5 miles west into the Yolo Bypass from the Sacramento Bypass levee.

The South Basin, which encompasses 6,900 acres, contains:

- Sacramento River south levee – 5.9 miles south along the Sacramento River from the Stone Locks to the South Cross levee (just north of the waste water treatment plant).
- South Cross levee – 1.2 miles across the South Basin from the Sacramento River to the DWSC.
- DWSC east levee – 2.8 miles from the South Cross levee north to the point where it bends east.
- Port south levee – 4.0 miles east from the bend in the DWSC east levee to the Stone Locks.
- DWSC west levee – 21.4 miles from the Barge Canal south to Miners Slough.

A vegetation variance is being sought to allow for vegetation to remain on the lower portion of the waterside levee slope of the Sacramento River Levee. A complete summary of the proposed measures is shown on Table 1.

The Recommended Plan for the West Sacramento GRR is to Improve Levees and construct a setback levee in the Southport area along the Sacramento River South Levee. The levees in the project area would be improved to address identified seepage, stability, and erosion. The measures that would be implemented for the levees in the North Basin would be: (1) installation of cutoff walls to address seepage and slope stability concerns; and (2) erosion protection to address erosion concerns. The measures that would be implemented for the levees in the South Basin would be: (1) installation of cutoff walls, stability berms, seepage berms, relief wells, or setback levees to address seepage and slope stability concerns; and (2) erosion protection to address erosion concerns. Due to environmental, real estate, and hydraulic constraints within the study area, the majority of the levees would be fixed in place.

The Recommended Plan is the least environmentally damaging alternative as it results in less riparian habitat removal along the Sacramento River with the implementation of the setback levee. Additionally, habitat could be created in the setback area. The exact location and amount of habitat to be created would be evaluated during the design phase of the project.

**Table 1. Proposed Measures for the West Sacramento GRR Recommended Plan.**

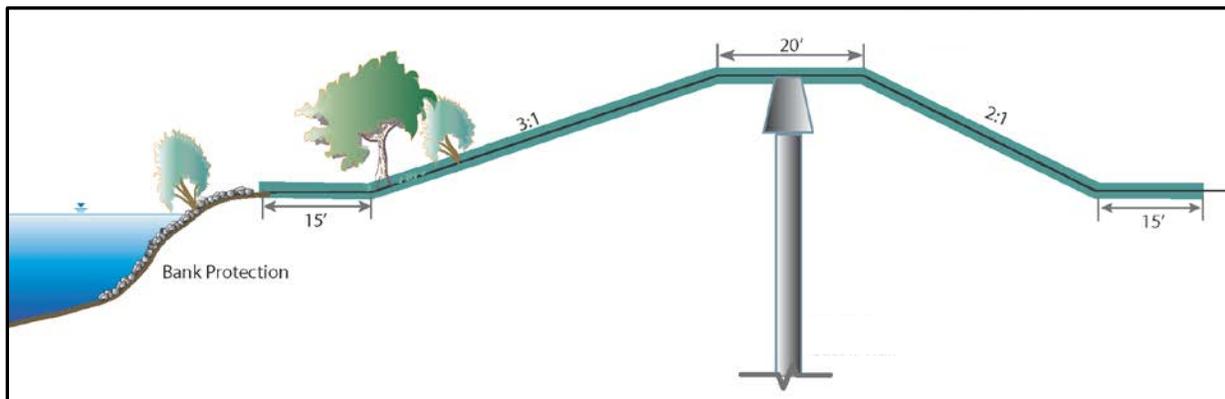
Levee Reach	Length of Reach (feet)	Length of Measure (feet)	Improvement	Measure
Sacramento River North Levee	30,700	15,000	Erosion Protection	Bank Protection
		11,000	Seepage	30 Foot Deep Slurry Wall
		1,500	Seepage	80 Foot Deep Slurry Wall
		500	Seepage	45 Foot Deep Slurry Wall
		5,500	Seepage	110 Foot Deep Slurry Wall
Stone Locks	570	550		Embankment Fill, Sheet Pile Wall
Yolo Bypass	19,749	2,500	Seepage	40 Foot Deep Slurry Wall
		2,000	Seepage	100 Foot Deep Slurry Wall
Sacramento Bypass Training Levee	3,000	3,000	Erosion Protection	Bank Protection
Sacramento River South Levee	31,000	31,000	Seepage/Erosion	Setback Levee 80 Foot Deep Slurry Wall 70 Foot Berm Bank Protection
South Cross Levee	6,273	1,100	Stability	Stability Berm and Embankment Fill
		5,000	Seepage	Relief Wells
DWSC East Levee	17,171	1,500	Seepage	120 Foot Deep Slurry Wall
		7,100	Seepage	130 Foot Deep Slurry Wall
		6,000	Seepage	50 Foot Deep Slurry Wall
Port South	1,000	1,000	Seepage	70 Foot Deep Slurry Wall
DWSC West Levee	100,260	9,000	Seepage	85 Foot Deep Slurry Wall
		7,000	Seepage	50 Foot Deep Slurry Wall
		9,000	Seepage	75 Foot Deep Slurry Wall
		100,000	Erosion Protection	Bank Protection

### 1.3 Description of Proposed Protective Measures

#### 1.3.1 Bank Protection

This measure consists of placing rock revetment on the river's bank, and in some locations on the levee slope, to prevent erosion (Figure 1). When necessary, the eroded portion of the bank would be filled and compacted prior to the rock placement. The sites would be prepared by clearing and stripping the site prior to construction. Small vegetation and loose materials would be removed. In

most cases, large vegetation would be permitted to remain at these sites. Temporary access ramps would be constructed, if needed, using imported borrow material that would be trucked on site.



**Figure 1. Bank Protection Typical Design.**

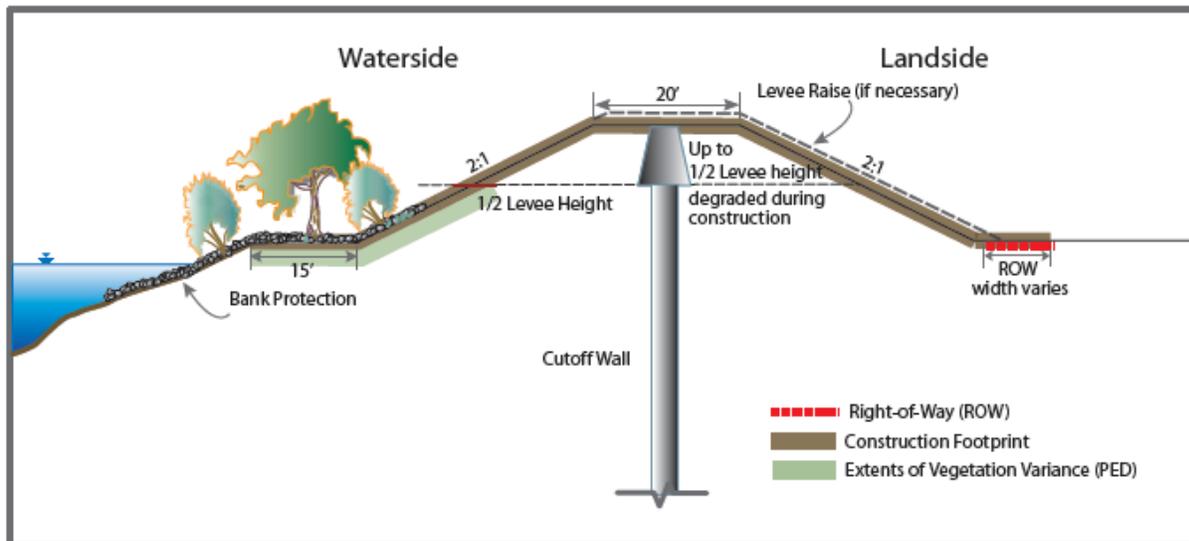
### 1.3.2 Levee Geometry

Where the existing levee cross section does not meet the levee design requirements, slope flattening or crown widening. This improvement measure addresses problems with slope stability, geometry, and levee toe and crest access and maintenance. To begin levee embankment grading, the area would be cleared, grubbed, stripped, and, where necessary, portions of the existing embankment would be excavated to allow for bench cuts and keyways to tie in additional embankment fill. The existing levee centerline would be shifted landward where necessary in order to meet the Corps standard levee footprint requirements. The levee crown patrol road would be re-established and a new toe access corridor would be added 10 feet landward of the levee toe.

### 1.3.3 Cutoff Walls

To address seepage concerns, a cutoff wall would be constructed through the levee crown (Figure 2). A cutoff wall is a water resistant barrier that is constructed vertically into the levee and is designed to prevent through and underseepage in the levee. The cutoff wall would be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach would depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of approximately 80 feet. For cutoff walls of greater depth, the DSM method would be utilized.

Prior to construction of either method of cutoff wall, the construction site and any staging areas would be cleared, grubbed, and stripped. The levee crown would be degraded up to half the levee height to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids.



**Figure 2. Fix-in-place with Cutoff Wall.**

After construction of flood risk reduction features are completed, the indirect effects to levee slopes and mitigation areas providing grassland habitat would occur during O&M consisting of levee maintenance and minor repair activities where local construction work would repair a small erosion site. These post construction activities include mowing, herbicide application, hand weeding, or physical removal of the grassland using equipment after the project has been handed over to the non-Federal sponsor.

## 1.4 Types of Habitats Impacted

A variety of different habitat types occur within the study area that would be impacted by the West Sacramento GRR Recommended Plan and would require mitigation to compensate for project impacts. The habitats include; giant garter snake upland habitat, shaded riverine aquatic habitat, valley foothill riparian habitat, oak woodland, valley elderberry longhorn beetle, and green sturgeon benthic habitat. These habitats are briefly described below.

### 1.4.1 Giant Garter Snake Upland Habitat

The giant garter snake inhabits marshes, sloughs, ponds, small lakes, low gradient streams, other waterways and agricultural wetlands such as irrigation and drainage canals and rice fields, and the adjacent uplands. Essential habitat components consist of: (1) adequate water during the snake's active period, (early spring through mid-fall) to provide a prey base and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat; (3) upland

habitat for basking, cover, and retreat sites; and (4) higher elevation uplands for cover and refuge from flood waters.

Disturbed soil surfaces such as levee slopes should be hydroseeded to prevent erosion and restore upland habitat for giant garter snake. USFWS recommends a mix of at least 20 to 40 percent native grasses such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.); 2 to 10 percent native forbs; 5 percent rose clover (*Trifolium hirtum*); and 5 percent alfalfa (*Medicago sativa*). Approximately 40 to 68 percent of the mixture may be non-aggressive European annual grasses such as wild oats (*Avena sativa*), wheat (*Triticum* spp.), and barley (*Hordeum vulgare*). The Corps will not include aggressive non-native grasses, such as perennial ryegrass (*Lolium perenne*), cheatgrass (*Bromus tectorum*), fescue (*Festuca* spp.), giant reed (*Arundo donax*), medusa-head (*Taeniatherum caput-medusae*), or Pampas grass (*Cortaderia selloana*) in the hydroseed mix.

#### **1.4.2 Shaded Riverine Aquatic Habitat**

Shaded Riverine Aquatic (SRA) habitat is defined as the near shore aquatic area occurring at the interface between a river and adjacent woody riparian habitat. The principal attributes of this valuable cover type include: (1) the adjacent bank being composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water; and (2) the water containing variable amounts of woody debris, such as leaves, logs, branches and roots, as well as variable depths, velocities, and currents. SRA occurs throughout the study area along the riverbanks and levees and is contained within the other identified habitat types in these areas.

#### **1.4.3 Valley Foothill Riparian Habitat**

Most valley foothill riparian habitat in the study area (hereafter referred to as “riparian habitat”) occurs along the American and Sacramento Rivers, but smaller riparian areas are found at all of the levees in the study area. The overstory of the riparian habitat consists of mature, well-established trees: Fremont cottonwood (*Populus fremontii*), valley oak (*Quercus lobata*), black willow (*Salix gooddingii*), and box elder (*Acer negundo* var. *californicum*). During the surveys, Oregon ash (*Fraxinus latifolia*), western sycamore (*Platanus racemosa*), and white alder (*Alnus rhombifolia*) were also observed. The shrub layer consists of smaller trees and shrubs; representative species observed were poison oak (*Toxicodendron diversilobum*), sandbar willow (*Salix exigua*), and California blackberry (*Rubus ursinus*). Elderberry shrubs (*Sambucus mexicana*), the host plant of the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), which is Federally listed as threatened, were observed in the riparian habitat along the American and Sacramento Rivers.

#### **1.4.4 Valley Elderberry Longhorn Beetle Habitat**

The valley elderberry longhorn beetle (beetle) is completely dependent on its host plant, elderberry (*Sambucus* spp.), which is a common component of the remaining riparian forests and adjacent upland habitats of California's Central Valley. These forests consist of several canopy layers with a dense undergrowth (Katibah, 1983). Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), willows (*Salix* spp.), and valley oak (*Quercus lobata*) are common upper canopy species. The shrub layer consists of smaller trees and shrubs; representative species observed were poison oak (*Toxicodendron diversilobum*), sandbar willow (*Salix exigua*), and California blackberry (*Rubus ursinus*). Studies have found that the beetle is more abundant in dense native plant communities with a mature overstory and a mixed understory.

#### **1.4.5 Oak Woodland**

Valley oak woodland is dominated with valley oak, interior live oak, box elder, white alder, Oregon ash, and black walnut. Shrubs in this habitat type include California grape (*Vitis californica*), California blackberry (*Rubus ursinus*), and blue elderberry (*Sambucus cerulea*). Oak woodlands are typically found on higher or upland portions of the study area than the riparian habitat discussed above.

#### **1.4.6 Green Sturgeon Benthic Habitat**

Little is known about juvenile green sturgeon freshwater rearing. Green sturgeon are presumed to be generalist, opportunistic benthic feeders. Benthic substrate needs to include abundant prey items within estuarine habitats and soft bottom substrates for juvenile, subadult, and adult life stages. Prey species for juvenile, subadult, and adult green sturgeon within bays and estuaries primarily consist of benthic invertebrates and fishes, including crangonid shrimp, burrowing thalassinidean shrimp (particularly the burrowing ghost shrimp), amphipods, isopods, clams, annelid worms, crabs, sand lances, and anchovies. These prey species are critical for the rearing, foraging, growth, and development of juvenile, subadult, and adult green sturgeon within the bays and estuaries. The benthic substrate should include sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of elevated levels of contaminants (e.g., selenium, PAHs, and pesticides) that can cause adverse effects on all life stages of green sturgeon.

### **1.5 Environmental Baseline**

The West Sacramento action area includes the mainstem Sacramento River from the South Cross levee (river mile [RM] 51) upstream to the Sacramento Weir and Bypass RM 63). It also includes the Yolo Bypass levee from the Sacramento Weir to the Port of West Sacramento (Port), the Port North and Port South levees, the DWSC east levee from the Port down to the South Cross levee, the South

Cross levee, and the DWSC west levee from the Port 19 miles south to Liberty Island.

Downstream from the Sacramento Weir, the Sacramento River is moderately sinuous (average sinuosity of 1.3), with the channel confined on both sides by man-made levees enhanced by decades of man-made additions. The channel in this reach is of uniform width, is not able to migrate, and is typically narrower and deeper relative to the upstream reach due to scour caused by the concentration of shear forces acting against the channel bed (Brice 1977).

The natural bank and adjacent floodplain is composed of silt- to gravel-sized particles with poor to high permeability. Historically, the flow regimes caused the deposition of a gradient of coarser to finer material, and longitudinal fining directed downstream (sand to bay muds). The deposition of these alluvial soils historically accumulated to form extensive natural levees and splays along the rivers, 5 to 20 feet above the floodplain for as far as 10 miles from the channel (Thompson 1961). The present day channels consist of fine-grained cohesive banks that erode due to natural processes as well as high flow events (Corps 2012).

Seasonal high flows enter the adjacent Yolo Bypass from this reach of the Sacramento River via the Sacramento Bypass. Tidal influence emanating from Suisun Bay extends up the Sacramento River for 80 miles to Verona, with greater tidal variations occurring downstream during low river stages in summer and fall.

## **1.6 Potential Project Impacts**

A vegetation variance is being sought by the Sacramento District to comply with ETL 1110-2-583 on the waterside of the Sacramento River north levee. The vegetation variance request requires the Corps to show that the safety, structural integrity, and functionality of the levee would be retained if the vegetation were to remain in place. This would allow most of the trees on the lower one half of the waterside slope to remain in place, reducing the impacts to vegetation and wildlife. This would be a beneficial effect to vegetation and wildlife, as compliance with the ETL in the study area would otherwise require the removal of all vegetation. Vegetation impacts throughout the project area would occur in the proposed construction footprint.

Infestation of invasive weeds has an influence on hydraulic roughness during high-flow events, decreases the capacity of the floodway, and adversely affects bank erosion and sedimentation processes. The Corps would remove the noxious weeds from the various plant communities prior to construction. For each of the action alternatives, direct effects to stands of grassland habitat with invasive plants would result from clearing and grubbing and rock placement activities once levee improvements and construction begin. The total number of acres of grassland affected would be refined during the design phase.

The estimated impacts for the habitats discussed above and special-status species impacts as established in the BOs are shown below on Table 2.

**Table 2. Impacts for West Sacramento GRR Recommended Plan**

	GGS Upland ***	GGS Aquatic ***	Riparian	SRA Habitat ***	Elderberry Shrubs **	Oak Woodland *	Shallow Water **	Wetlands	Soft Bottom Benthic **
<b>North Basin</b>									
Sacramento River North Levee			22 acres (38 if no variance)	10 acres 33,333 LF	42 acres	8 acres	5 acres	5 acres	10 Acres
Yolo Bypass	5 acres	2 acres	2 acres		12 acres			2.5 acres	
Sacramento Bypass Training Levee	5 acres		3 acres		1 acres			2.5 acres	
<b>South Basin</b>									
South Cross Levee	4 acres	10 acres	5 acres		8 acres	4 acres		10 acres	
Deep Water Ship Channel East Levee	10 acres	10 acres	2 acres		3 acres			10 acres	
Port South Levee	2 acres	1 acre						1 acre	
Deep Water Ship Channel West Levee	20 acres				5 acres				
Sacramento River South Levee (Alt 5)	155 acres		4 acres	2 acres 6,666 LF	36 acres	4 acres	9 acres	5 acres	
<b>TOTAL (Alt 5)</b>	<b>201 acres</b>	<b>23 acres</b>	<b>38 acres (60 acres-no variance)</b>	<b>12 acres 40,000 LF</b>	<b>193 shrubs (107 acres)</b>	<b>16 acres</b>	<b>14 acres</b>	<b>36 acres</b>	<b>10 acres</b>

\*State Listed \*\*Federal Listed \*\*\*State and Federal Listed

## 1.7 Habitat Evaluation

For the purposes of evaluating the impacts of the West Sacramento GRR Recommended Plan on fish and wildlife resources in the project area, with a reliance on existing information in the spirit of SMART Planning, the Habitat Evaluation Procedures (HEP) for the *American River Watershed Investigation, Common Features Modifications, Mayhew Drain Site Project* were relied upon as a reference baseline. The HEP for the Mayhew Drain Site Project was conducted in 2005 to quantify anticipated impacts to fish and wildlife and their habitats, and to determine mitigation needs for the project. This HEP was selected for the West Sacramento GRR because the habitat type and value at the Mayhew site is consistent with the habitat that occurs throughout the West Sacramento GRR project area.

The HEP provided information for two general types of wildlife habitat comparisons: 1) the relative value of different areas at the same point in time; and 2) the relative value of the same areas at future points in time. By combining the two types of comparisons, the impacts of proposed project on wildlife habitat were quantified and compensation needs (in terms of acreage) for the project were determined. The assumption that habitat for selected wildlife species or communities can be numerically described by a model produces a Habitat Suitability Index (HSI). The HSI, a value from 0.0 to 1.0, provides a measure of habitat quality for a sample area in terms of suitability for the particular species or community being evaluated.

For the Mayhew Drain project, the Northern oriole Riparian woodland model was used because it best suited the habitat type in the project area. The quantity part of the formula is any measure of area which is appropriately sized for the study. The product of these two measures is comparable to "habitat value" which equals habitat quantity multiplied by habitat quality. This formula is expressed as a Habitat Unit (HU).

$$\text{Habitat Type} \times \text{Habitat Area} = \text{Habitat Value}$$

The Average Annual Habitat Units (AAHUs) over the life of the project can then used to determine mitigation needs. The model, variables measured and data collection methods used for the Mayhew Drain Project are shown below in Table 3. For the West Sacramento GRR Recommended Plan, data was estimated visually and using google earth.

**Table 3. HSI model, Variables, and Data Collection Methods.**

HSI Model and Cover-Type	HSI Model Variables	Data Collection Method
Northern oriole Riparian Woodland	V1 – Average height of deciduous tree canopy	Visual estimation
	V2- Percent deciduous tree crown cover	Densimeter along belt transects
	V3 – Stand width	Estimated using aerial photos

Since it is not possible to empirically determine habitat quality and quantity for future years, future HSI values were projected. This was accomplished by increasing or decreasing specific baseline variables and/or HSI values for each evaluation element for the Northern oriole based on best professional knowledge of performance at other mitigation sites, literature on plant growth, and conditions at reference sites. To predict changes in the HSI for each future scenario, it was necessary to make assumptions regarding baseline and future values within project impact and compensation areas. The assumptions made for the West Sacramento GRR with project can be seen in Table 4 and without project can be seen in Table 5 below.

**Table 4. HSI Variables for the West Sacramento GRR Recommended Plan Based on Habitat Values.**

HEP - FUTURE WITH-PROJECT							
Time	Variables			Suitability Index			Output
	V1	V2	V3	SI-V1	SI-V2	SI-V3	HSI
TY1	20	25%	2	0.60	1.00	1.00	0.84
TY2	10	25%	2	0.30	1.00	1.00	0.67
TY25	20	75%	2	0.60	0.75	1.00	0.77
TY50	35	75%	2	1.00	0.75	1.00	0.91
HSI = (V1*V2*V3) <sup>1/3</sup>				Average			0.80

**Table 5. HSI Variables for the West Sacramento Without Project Based on Habitat Values.**

HEP - FUTURE WITHOUT-PROJECT							
Time	Variables			Suitability Index			Output
	V1	V2	V3	SI-V1	SI-V2	SI-V3	HSI
TY1	35	75%	2	1.00	0.75	1.00	0.91
TY2	35	75%	2	1.00	0.75	1.00	0.91
TY25	35	75%	2	1.00	0.75	1.00	0.91
TY50	35	75%	2	1.00	0.75	1.00	0.91
HSI = (V1*V2*V3) <sup>1/3</sup>				Average			0.91

The HSI value of 0.80 in Table 4 results from a temporal loss of habitat value and function from the removal of existing mature riparian habitat. This is due to the lower values given to mitigation plantings during the establishment period. The West Sacramento GRR Recommended Plan proposes to implement riparian habitat mitigation at a 2:1 ratio. A 2:1 mitigation ratio is a reasonable requirement for implementation of mitigation for this habitat type, because the proposed project will decrease the connectivity of existing habitat along the Sacramento River system. Additionally, temporal loss of onsite habitat results in a reduction in value and function of the new vegetation within the mitigation areas as it grows to maturity. This also accounts for the loss of other services that riparian vegetation provides, including:

- An essential food source for fish and wildlife, including ESA species;
- Aquatic resting and refugia for resident and migratory fish species;
- Large woody debris recruitment;
- Nesting and rearing habitat for terrestrial wildlife species;
- Nutrients for the ecological system;
- Shade for the river which maintains water temperatures and dissolved oxygen concentrations; and,
- Increased habitat value for VELB.

The above-listed functions and services associated with a newly created acre of habitat are usually expected to be less than those associated with natural habitat. As a result the 2:1 mitigation ratio is appropriate to compensate for the loss of mature riparian habitats.

To determine whether the proposed mitigation amounts were cost effective, a Cost Effective /Incremental Cost Analysis (CE/ICA) was conducted. The CE/ICA report is included with this document as Appendix A. The Mayhew HEP and the Northern oriole HSI model variables were referenced to establish habitat values for the CE/ICA. The cost for mitigation was calculated based on construction on site, purchasing credits at a local mitigation bank, or a combination of both. The cost for mitigation was estimated for five scenarios for the purposes of the CE/ICA for all three alternatives. These scenarios included: (1) maximized on- and off-site habitat creation; (2) maximizing the use of credits at a local mitigation bank; (3) a combination of on-site, off-site, and a mitigation bank at a 2:1 ratio; (4) a combination of on-site, off-site, and a mitigation bank at a 1:1 ratio; and (5) a combination of on-site, off-site, and a mitigation bank at a 3:1 ratio. Per the discussion above and the results shown in Table 4, the loss in ecological value associated with on-/off-site mitigation was reduced to an overall 0.8 habitat value. The Recommended Plan is the Alternative 5 Combination Plan with a 2:1 ratio, because it is the smallest mitigation proposal that accomplishes the terms and conditions of the Biological Opinions, and the CE/ICA determined that it was a cost effective plan.

## **1.8 Proposed Mitigation Measures**

The preparation of mitigation plans, including objectives, plan design, determination of success criteria, and monitoring needs would be coordinated with Federal and State resource agencies to the greatest extent practicable. Mitigation objectives are specific actions to be taken to avoid and minimize adverse affects, such as Best Management Practices, compliance with Federal and State regulatory laws, and environmental commitments. Mitigation objectives include the identification of specific amounts of mitigation required to compensate for remaining unavoidable losses.

Items below present a summary of environmental commitments that the Corps would implement as part of the West Sacramento GRR project to mitigate by avoiding and minimizing impacts and to meet the requirements, terms and conditions specified in the BOs.

- A vegetation variance is being sought by the Sacramento District to comply with ETL 1110-2-583 in order to exempt the Sacramento River north levee from vegetation removal in the lower third of the waterside of the levee prior to final construction and design phase. The West Sacramento GRR Recommended Plan will be complying with the ETL on landside of the levees. This approval process is in alignment with the Corps' Levee Safety Program's goal of maintaining public safety as the primary objective and assuring application of consistent and well documented approaches. As a result, vegetation removed under the West Sacramento GRR Recommended Plan would be limited to the footprint necessary in order to construct the proposed measures. Disturbance or removal of trees or larger woody vegetation would be replaced with native riparian species, outside of the vegetation free zone, as established in the ETL.
- The Corps would use a rock soil mixture to facilitate re-vegetation of the proposed project area. A (70:30) rock to soil ratio would be implemented. The soil-rock mixture would be placed on top of the of the rock revetment to allow native riparian vegetation to be planted to ensure that SRA habitat lost is replaced or enhanced.
- Vegetation removal, particularly tree removal, would be conducted between September 16 and January 31, to the extent feasible, to minimize potential loss of active bird nests and bat maternity roosts.
- Construction would be scheduled when listed terrestrial and aquatic species would be least likely to occur in the project area, approximately May or June through October, depending on the species present on a site-specific basis. If construction needs to extend into the timeframe that species are present, the Corps would coordinate with the resource agencies.

In addition to the mitigation measures described above, the Corps would implement compensatory mitigation, as described below.

The mitigation acreages for West Sacramento GRR were calculated using a combination of site surveys and aerial photography from Google Earth to determine where the project footprint impacted different habitat types. The habitat types included: riparian, SRA, giant garter snake (GGS), valley elderberry longhorn beetle (VELB), vernal pools, and Delta smelt shallow water. The acreages of each impacted habitat type were then broken up by reach.

Table 6 describes the types and amounts of habitat that would be potentially impacted by the project, the duration of the impacts, the amount of mitigation in total acreage per the USFWS and NMFS BOs and the recommendations of the USFWS Coordination Act Report, and projected costs as estimated according to existing mitigation prices.

Costs are displayed showing the difference between the estimate for on site mitigation or mitigation at a bank. Currently, permanent impacts to GGS uplands and aquatic habitat, vernal pools, Delta smelt spawning and shallow water habitat, and wetlands are proposed to occur at a mitigation bank. Riparian, SRA, elderberry, oak woodland, and green sturgeon are proposed to occur on site.

**Table 3: Environmental Effects and Proposed Mitigation for the Tentatively Selected Plan.**

Habitat Type	Potential Impacts	Duration of Impact	Mitigation/ Compensation (Acres/Linear Feet)	Cost On- or Off- Site in the Study Area	Cost at a Mitigation Bank
GGS Upland and Aquatic	201 Acres	Single Construction Season	201 Acres	\$1,005,000	
GGS Upland and Aquatic	23 Acres	Permanent	69 Acres		\$4,140,000
Riparian	38 Acres	Permanent	38 Acres 38 Acres	\$2,090,000	\$2,850,000
Shaded Riverine Aquatic Habitat (ESA Fish Species)	40,000 Linear Feet (12 acres)	Single Construction Season (Different Levee Reaches)	12 Acres- 40,000 Linear Feet	\$660,000	
Shallow Water Habitat (ESA Fish Species)	14 Acres	Permanent	14 Acres	\$770,000	
Elderberry Shrubs	193 Shrubs 1,991 Stems (107 Acres)	Permanent	31 Acres 1,107 Credits at a Bank	\$2,635,000	\$4,981,000
Oak Woodland	16 Acres	Permanent	10 Acres On Site 22 Acres Bank	\$500,000	\$1,650,000
Wetlands	36 Acres	Permanent	72 Acres		\$9,360,000
Soft Bottom Benthic	10 Acres	Permanent	10 Acres	\$1,500,000	
<b>Total</b>	<b>457 Acres</b>		<b>586 Acres</b>	<b>\$9,160,000</b>	<b>\$22,981,000</b>
				<b>Total</b>	<b>\$32,141,500</b>

## 1.9 Location of Mitigation and Compensation Sites

WRDA 2007 Section 2036(c) directs the Corps to, where appropriate, first consider the use of an approved mitigation bank to compensate for wetland impacts. Credits for additional habitat types, including riparian zones, is also permitted, if credits are available and the use of them is deemed appropriate. As discussed above, the Corps proposes to purchase credits at a mitigation bank for permanent impacts to GGS uplands and aquatic habitat, , and wetlands. As a result, these habitat types are not discussed further in this document, because the mitigation bank would be responsible for all site establishment, monitoring, adaptive management measures, and for achieving mitigation success.

The onsite mitigation proposed for the West Sacramento GRR Recommended Plan consists of riparian, SRA, oak woodland, elderberry habitats, all of which are components of the riparian habitat corridor along the Sacramento River. Section 4.a.3 of WRDA 2007 Section 2036(c) implementation guidance states that credits for riparian habitat may be purchased at a mitigation bank, but are not required to be as a first order preference. All of these habitats contribute to the riparian corridor of the Sacramento River. As described in Section 1.7 above, the removal of 173 acres of riparian, oak woodland, VELB and SRA habitat under the West Sacramento GRR Recommended Plan could adversely effect ESA species within the project area if the function and services provided by riparian habitat is relocated away from the Sacramento River corridor. Additionally, credits are not available for the quantity of riparian habitat being removed for the West Sacramento GRR and mitigation requirements would likely increase if the projects proposed all mitigation offsite. As a result, it is appropriate to select on- and off-site mitigation within the study area for these habitat types rather than purchasing credits at a mitigation bank.

Upon completion of construction, sites with preexisting habitat would be restored to pre-construction conditions, where feasible. Sites compatible with on-site mitigation such as the 201 acres of upland GGS habitat and 40,000 linear feet of SRA habitat would be restored in place. Riparian habitat, elderberry compensation, and oak woodland habitat would be mitigated on-and off-site within the project area to the greatest extent practicable.

On-site mitigative features are proposed as part of the bank protection construction to mitigate for impacts to SRA habitat. These features would be designed on a site-specific basis during the design phase and would include a planting berm as shown on Figure 1 above. Riparian vegetation installed on the planting berm would include large woody species such as Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), and valley oak (*Quercus lobata*), white alder (*Alnus rhombifolia*), and box elder (*Acer negundo* var. *californicum*); shrub-scrub species such as elderberry (*Sambucus* spp.), redbud (*Cercis canadensis*), and coyote brush (*Baccharis pilularis*); and understory species such as California rose (*Rosa californica*), California blackberry (*Rubus ursinus*), and wild grape (*Vitis californica*); and native grasses such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.).

The Corps is committed to implementing project conservation and mitigation as detailed in the BOs, however site selection and real estate coordination has not occurred at this time for onsite and offsite mitigation and would be determined during the design phase of the project. This HMMAMP will accompany the final EIS/EIR, and will be updated throughout the design phase as detailed design efforts allow for finalizing the mitigation plans. The HMMAMP will be coordinated with the Services during the design phase and updated as needed. The Corps would go through the following process in order to determine sites for implementing compensation for impacts to riparian habitat, including VELB compensation sites:

- The Corps would assess opportunities to purchase credits at a mitigation bank as a first option.
- The Corps would assess opportunities for on-site compensation to replace the habitat value and function impacted within the study area.
- If on-site compensation is not possible, the Corps would evaluate opportunities to implement mitigation in the West Sacramento area at existing mitigation sites or create new mitigation sites in coordination with the City of West Sacramento and WSAFCA.

Although much of the mitigation would occur on-site, for riparian, SRA, elderberries, oak woodland, and green sturgeon benthic habitat, some mitigation would be compensated for through the purchase of credits from approved mitigation or conservation banks. Mitigation bank credits are available for riparian habitat, elderberry savanna, and oak woodland on the Sacramento River. Mitigation bank credits would also be used to compensate for project related impacts to GGS aquatic and upland habitat, shallow water (Delta smelt) habitat, and wetland habitat.

### **1.10 Compensation Timing**

Compensation timing refers to the time between the initiation of construction at a particular site and the attainment of the habitat benefits to targeted species from designated compensation sites. For example, compensation time would be the time required for on-site plantings to provide significant amounts of shade or structural complexity from instream woody material recruitment to provide habitat for fish species. Significant long-term benefits have often been considered as appropriate to offset small short-term losses in habitat for listed species in the past, as long as the overall action contributes to recovery of the listed species. The authority to compensate prior to or concurrent with project construction is given under WRDA 1986 (33 United States Code [USC] § 2283). Additionally, ER 1105-2-100, Appendix C states that authorized ecological resource mitigation activities and features should occur before construction of the project, concurrent with the acquisition of lands, or concurrent with the physical construction of the project.

## 2.0 Mitigation and Management Strategy

The purpose of this HMMAMP is to present conceptual mitigation proposals, establish performance standards, and outline adaptive management tasks and costs. Conceptual mitigation proposals are based on the habitat impacts described above. Performance standards are established below for each habitat type, and monitoring would be conducted with the intent of meeting those standards. Over the 3 to 5 year site establishment period, improvements in field and analytic techniques may lead to changes in the monitoring methodology. While this vegetation and habitat monitoring methodology protocol builds on past years' experiences, it is likely that other opportunities for improvement will be identified in the future that should be incorporated into the protocol. In the future, there may be a determination that specific performance standards have been met and that associated monitoring tasks could cease. Similarly, it could be determined that a monitoring task was not returning useful information, and therefore not worth the expense of continuation.

Monitoring must be closely integrated with the adaptive management. The application of adaptive management principles to mitigation projects by modifying mitigation objectives during the monitoring period is a reasonable and foreseeable alternative. Unrealistic expectations or inaccurate assumptions can lead to the establishment of inappropriate project objectives. It is possible that a decision to modify success criteria might be reached based on results after several years of monitoring. In addition to modifying project objectives, there is a potential for changes to or adaptation of management actions based on monitoring results. The purpose of adaptive management is to enable strategic changes to improve the mitigation sites to functioning habitat.

Vegetation and habitat variable monitoring and data collection would occur annually by a qualified biologist, botanist, or habitat restoration specialist using the protocol described below and shown in Table 8 to determine the success of riparian revegetation plantings and overall habitat development.

The project's compensation objective is to directly mitigate for the loss of habitat value that results from construction impacts. This plan focuses on establishing successful and diverse habitats that provide an ecological value consistent with mature existing habitat conditions in the study area. The specific habitats focused on within the sections below are the habitats that would be created by the Corps on-site or off-site, including GGS upland habitat, habitat for VELB, and habitat for green sturgeon. In addition, mitigation sites would be created which present a combination of riparian, oak woodland, and SRA habitats, which are highly related and provide value to a number of listed species, including VELB, Western yellow-billed cuckoo, and fish species.

**Table 8. Summary of On-site Habitat Types and Monitoring Recommendations.**

Habitat	Monitoring Variable	Method to be Used	Spacing/number of Samples	Data to be Collected	Success Criteria
GGS Upland	Total Herbaceous Species Cover	Visual estimates of cover within 1 square meter (m <sup>2</sup> ) sampling quadrats	One quadrat randomly located in each planting zone	Herbaceous species composition, total cover, and observation of GGS	Meeting 75% native species present and 95% overall cover onsite within 1 year
Riparian Habitat	Vegetation Species Cover (Ground and Canopy)	Line-intercept estimates of ground and overhead canopy cover with visual estimates of vigor	Monitoring transects; number of transects and spacing dependent on site length	Woody species composition, growth, and natural recruitment	75% vegetative cover after 5 years
SRA Habitat	Shaded Riverine Aquatic (SRA) Cover	Line-intercept estimates of canopy cover overhanging the river	Transect parallel to the shoreline along summer mean water surface elevation (SMWSE); length of transect dependent on site length	Woody species composition and percentage of canopy cover overhanging river (shade)	75% vegetative cover after 5 years
Elderberry	Elderberry and Native Vegetation Health and Vigor (VELB habitat)	Visual assessment of vegetation health and vigor; census of VELB and exit holes	Total census of elderberry shrubs and native vegetation, census of VELB and exit holes	Total survival of elderberry and native vegetation, census of VELB and exit holes	Survivability of 60% of shrubs*
Oak Woodland Habitat	Woody Species Overhead Canopy Cover	Line-intercept estimates of overhead canopy cover and visual estimates of vigor	Monitoring transects; number of transects and spacing dependent on site length	Woody species composition, growth, and natural recruitment	75% vegetative cover after 5 years
Green Sturgeon Benthic Habitat	In-water slope and substrate	Substrate sampling and visual assessment of slope/substrate conditions.	Monitoring the width and depth of the river at regular intervals throughout the project area.	Substrate content, percentage of fines, slope defining measurements.	Slope (H:V) of 2:1 with substrate at average of 0-10 inches.

\*60% survivability is the established survival criteria for elderberry shrubs in the USFWS Conservation Guidelines for the Valley Elderberry Longhorn Beetle (1999)

## 2.1 GGS Uplands Mitigation

### 2.1.1 Objectives and Implementation Strategy

The primary objective of upland habitat mitigation is to restore upland refugia habitat for the giant garter snake (*Thamnophis gigas*) (GGS) in a manner consistent with adjacent equitable habitat. Upland refugia habitat is generally considered native grasslands with space appropriate for basking, cover, and retreat sites for GGS. Upland refugia is also considered higher elevation areas for cover and refuge from flood waters. Upland refugia restoration would take place on grasslands adjacent to GGS wetland habitat as well as levee slopes for higher elevation refuge. These conservation and restoration measures are taken from the Guidelines for Restoration and/or Replacement of Giant Garter Snake Habitat (USFWS, 1997).

Restoring GGS habitat includes minimizing the potential impacts of project activities to the existing habitat. Use of silt fencing and protective mats to prevent runoff and reduce the possibility of individual GGS from entering the project area is recommended. Designation of environmentally sensitive areas and providing worker awareness training is also recommended. Construction activities should be 200 feet from GGS aquatic habitat, and should occur between May 1 and October 1. Project areas should be surveyed for GGS 24 hours prior to ground disturbing activities, and surveys should be repeated if a lapse in construction activity of two weeks or greater has occurred. If aquatic habitat must be removed as part of the construction activities, any dewatering would occur after April 15 and dewatered habitat would be left dry for at least 15 consecutive days.

Upon the completion of construction, the area would be regraded to the preexisting contour. Upland refugia would be hydroseeded with native grasses. USFWS recommends a mix of native grass seeds such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.). Additional native plant seeds consistent with adjacent habitat may be used at the discretion of USFWS. Permanent irrigation would not need to be established for this habitat type, however the site would require periodic watering in drought conditions.

### 2.1.2 Success Criteria

Monitoring of GGS upland habitat would focus on: (1) the percentage cover of native species, and (2) the percentage of overall vegetative cover. The restored habitat would be considered successful if 75 percent of the vegetation on site consists of native species. Additionally, the overall vegetative cover on site must be 95 percent.

### **2.1.3 Mitigation Monitoring Strategy**

Restored habitat should be monitored for one year following implementation. Surveys would involve a general overview of the condition of the site, an estimate of ground cover, and a passive (observation only) GGS survey to determine potential habitat use. A ground cover survey would occur to determine the ground cover percent of native and non-native species. Ground cover surveys, if determined by the Corps to be needed to evaluate the success of the mitigation area, would involve the use of a one square meter quadrat placed haphazardly in the restored areas. Once placed, all herbaceous vegetation within the quadrat would be recorded to species level. The percent of cover by native and non-native species would be determined in addition to the percent of total cover.

Monitoring reports documenting the restoration effort would be submitted to USFWS upon completion of the restoration implementation and one year from restoration implementation. Monitoring reports would include photos, the timing of the completion of the restoration, what materials were used in the restoration, plantings (if specified), and justification of any substitutions to USFWS recommended guidelines. Monitoring reports would also include recommendations for additional remedial actions, if necessary.

### **2.1.4 Adaptive Management Strategy**

If the habitat is not meeting the success criteria established above, then adaptive management would be implemented in order to ensure that the habitat establishment is successful. The following subsections identify triggers that would indicate the need to implement adaptive management measures and the measures that would be implemented accordingly.

#### **Adaptive Management Triggers**

- Desired Outcome: Increase percent cover of GGS upland habitat.

Trigger: 95% cover is not achieved within one year.

- Desired Outcome: Decrease percent of non-native invasive species that outcompete natives.

Trigger: Non-native percent cover of more than 25% within one year.

#### **Adaptive Management Measures**

If the triggers established above occur, the following measures would be implemented for GGS upland habitat in order to adaptively manage the site for success.

- If the performance criteria are not met within one year, additional monitoring would be implemented in order to ensure that the site is successful.
- If non-native species are outcompeting the native species, measures would be implemented to manage presence of invasive species, including mowing and selective removal of non-native species at optimal times for native growth.
- If non-native species are outcompeting the native species and targets for overall cover are not being met, then revegetation of native species would occur.
- Supplemental watering if targets for overall cover are not being met.

These measures are described further in the Adaptive Management Plan (Section 3.0) below.

## **2.2 Riparian, Oak Woodland, and Shaded Riverine Aquatic Habitat**

### **2.2.1 Objectives and Implementation Strategy**

The primary objective of riparian habitat mitigation is to compensate for impacted habitat types and community types, and reduce erosion rates within the alluvial floodplain. Native plant communities and streambank vegetation would be represented in species density appropriate to the surrounding area. As native vegetation matures, it helps to stabilize stream banks and shorelines; provides food, shelter, shade, and access to adjacent habitats; nursery habitat; pathways for movement by resident and nonresident aquatic, semi-aquatic, and terrestrial organisms; and improves and protects water quality by reducing the amount of sediment and other pollutants such as pesticides, organic materials, and nutrients in surface runoff. The long term goal of riparian mitigation is to provide habitat similar to the habitat that was impacted by project construction. These improvements would enhance nesting opportunities for native bird species, and provides opportunities to satisfy VELB compensation. Oak woodland and SRA habitat are considered components of riparian habitat with specific functions within the ecosystem.

Riparian vegetation would include large woody species such as Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), valley oak (*Quercus lobata*), white alder (*Alnus rhombifolia*), and box elder (*Acer negundo* var. *californicum*); shrub-scrub species such as elderberry (*Sambucus* spp.), redbud (*Cercis Canadensis*), and coyote brush (*Baccharis pilularis*); and understory species such as California rose (*Rosa californica*), California blackberry (*Rubus ursinus*), and wild grape (*Vitis californica*); and native grasses such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.). Native trees and shrubs provide a buffer to adjacent urban and industrial land uses, and provide habitat structure for wildlife. Leaf litter and large organic debris would create a variety of microhabitats, increasing species diversity and potentially creating a prey base for larger predators.

SRA habitat consists of riparian trees and shrubs growing on the bank and over-hanging the channel that provide instream shade for the water column adjacent to the bank and deposit insects, organic matter, and nutrients into the river. Shade from the vegetation helps to cool water temperatures in the river. SRA is especially important to juvenile salmonids as they migrate down the river to the sea. Terrestrial insects that live on riparian vegetation fall into the river and provide an important food source for fish. Proposed SRA mitigation would occur on the planting berms designed into the bank protection sites along the American and Sacramento Rivers, as shown in Figures 1 and 2 above. Riparian trees and shrubs would be installed in the planting berms, and existing large trees would be protected in place on the lower waterside slope of the levee. Implementation of this SRA habitat mitigation, including protecting large trees in place, is part of the recommended plan and is reliant on the approval of a vegetation variance, which will be sought during the design phase of the project.

The primary objective of oak woodland mitigation, which would occur in the upland zone of the riparian habitat, is the establishment of mature valley oaks and savannah. Planting would generally occur during the late fall when the plants are dormant and soils are moist. Establishment of woody vegetation would likely require multiple techniques including transplants, cuttings, acorn plantings, and seedlings.

Riparian and oak woodland mitigation sites would likely require fencing to protect establishing habitats from recreation, wildlife, and other potential damages. Sites would have irrigation during the establishment period, and would be watered as needed until the vegetation is established and self-sustaining. Mowing would occur periodically to ensure that weed species do not shade out new plantings.

SRA habitat would be established in planting berms along the river. These sites could require beaver fencing. Sites would have temporary irrigation during the summer, and would be watered as needed until the vegetation is established and self-sustaining. A weed eater would be used to ensure that weed species do not shade out new plantings.

### **2.2.2 Success Criteria**

Monitoring of riparian, oak woodland, and SRA habitats would focus on: (1) the percent cover of native plant species; (2) presence of at least five native species contributing to structural diversity; (3) percentage of canopy cover over water; and (4) decrease percent cover of non-native invasive species that out-compete natives. Additionally, an inventory of wildlife species would be recorded during annual monitoring. Table 9 establishes the percentages required to meet these performance standards. If the habitat is meeting these performance standards, conditions should be consistent enough to estimate community composition and general success of planting efforts. Table XX establishes the percentages required to meet these performance standards.

**Table 9. Riparian, Oak Woodland, and SRA Habitat Performance Standards.**

Performance Standard	Quantitative Measure
Percent cover of native plant species	75%
Structural diversity	At least five native species contributing to 75% canopy and 50% shrub cover
Percent of canopy cover over water per LF	75%
Percent cover of non-native species	Less than 15%

### 2.2.3 Mitigation Monitoring Strategy

The following monitoring procedures will provide the information necessary to evaluate the success of riparian, oak woodland, and SRA habitat mitigation. Vegetation sampling will occur annually for the duration of the monitoring period. Sampling will occur during spring months, at the peak of growing season, and will consist of permanent field monitoring plots along one or more transects either perpendicular to the river or parallel to the floodplain slope. Plots will be located randomly within each site, and the distance between plots and along transects will be site specific. Woody species with overhead canopy cover that falls along the vegetation monitoring transect, including those that were planted, have recruited naturally to the site, or were existing at the site prior to planting efforts would be recorded. Monitoring will measure percent cover of native and non-native plant species, structural diversity, and percent cover over water. Photograph stations are also important for documenting vegetation conditions. All plots and photograph stations will be documented via Global Positioning System (GPS) coordinates to maintain consistency throughout the monitoring period.

Additionally, field personnel would visually estimate the height (+/- 2 feet) of each tree and shrub that provides overhead canopy cover. Exact heights are not necessary, since there is no tree height criterion included in this protocol. Rather, approximate tree heights would be visually assessed to monitor tree growth over time. Data collected would include species name, location (feet) along the vegetation monitoring transect (upper extent of canopy and lower extent of canopy), whether the tree or shrub is planted (P), recruited (R), or existing (E), height (feet), and vigor as determined using the metric outlined in Table 10, below.

**Table 10. Estimation of General Health and Vigor for Plant Species.**

Visual Estimate of Foliage	Vigor Category	Value
81 percent (or greater) of foliage appears to be healthy	Excellent	4
51 to 80 percent of foliage appears to be healthy	Good	3
25 to 50 percent of foliage appears to be healthy	Fair	2
Less than 25 percent of foliage appears to be healthy	Poor	1
Dead	Dead	0

General observations, such as fitness and health of plantings, native plant species recruitment, and signs of drought stress would be noted during the surveys. Additionally, potential soil erosion, flood damage, vandalism and intrusion, trampling, and pest problems would be qualitatively identified. A visual check of irrigation infrastructure and fencing would also be conducted. A general inventory of all wildlife species observed and detected using the mitigation site would be documented. Nesting sites and other signs of wildlife use of the newly created habitat would be recorded.

Monitoring reports documenting the restoration effort would be prepared following the first monitoring period and would continue annually until the site has met the success criteria. Monitoring reports would include photos, the timing of the completion of the restoration, what materials were used in the restoration, and plantings (if specified). Monitoring reports would also include recommendations for additional adaptive management measures, if necessary. Following this initial establishment period, any subsequent monitoring activities would be the responsibility of the local maintaining agency, and would focus primarily on general and biological inspections for the purposes of fire management and habitat evaluation.

#### **2.2.4 Adaptive Management Strategy**

If the habitat is not meeting the success criteria established above, then adaptive management would be implemented in order to ensure that the habitat establishment is successful. The following subsections identify triggers that would indicate the need to implement adaptive management measures and the measures that would be implemented accordingly.

##### **Adaptive Management Triggers**

- Desired Outcome: Increase percent cover of native riparian habitat.

Triggers: If 50% cover of native riparian habitat is not achieved within 3 years, or 75% cover of native riparian habitat is not achieved within 5 years.

- Desired Outcome: Maintain appropriate structural diversity of native riparian habitats.

Trigger: Suitable structural diversity is not achieved, if canopy cover and/or shrub cover does not achieve 50% within 5 years.

- Desired Outcome: Increase percent vegetative cover over water per linear foot to support native fish.

Trigger: If percent cover over water is not 30% within 3 years, and 50% within 5 years.

- Desired Outcome: Decrease percent cover of non-native invasive species that outcompete natives.

Trigger: If non-native percent cover is greater than 15% during the monitoring period.

### **Adaptive Management Measures**

If the triggers established above occur, the following measures would be implemented for riparian, oak woodland, and SRA habitat in order to adaptively manage the site for success.

- Replanting may be needed if triggers for vegetative cover, vegetative cover over water, and/or structural diversity are being met. Monitoring results should be used to assess the underlying cause of inadequate cover, which may require that additional adaptive management actions be implemented to support successful replanting. Adaptive management actions could include targeted revegetation, such as replanting varieties of species that are exhibiting the greatest growth and survival, or planting at elevations that are exhibiting the greatest growth and survival.
- Nonnative species management may be needed if monitoring results show that the triggers for nonnative species present are met, or if nonnative species are impacting the survival of native species. Adaptive management measures may include adjustments to nonnative control methods, such as plant removal, grading of site to remove nonnative roots, or mowing and selective removal of non-native species at optimal times for native growth.
- Irrigation and/or supplemental water may be needed if vegetation is not meeting success criteria, or if species are exhibiting signs of water stress. Assessment of monitoring results may show that drought conditions are causing poor establishment or die off of planted vegetation. Adaptive management actions would include supplemental water to support achievement of percent cover criteria and structural diversity.
- Plant protection may be needed if triggers for vegetative cover and/or structural diversity are being met. If monitoring results show that plantings are failing due to predation or trampling from human use, then adaptive management actions would include plant cages or protective fencing that could be installed to protect plantings.

## 2.3 Elderberry Shrubs

### 2.3.1 Objectives and Implementation Strategy

The primary objective of elderberry shrub mitigation is to compensate for the adverse effects of the project on habitat important to the Federally listed valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB). Where possible, conservation areas would connect with adjacent habitat in order to prevent isolation of beetle populations. Removal, transplanting, and establishment of elderberry shrubs would be coordinated with USFWS and would follow the USFWS Conservation Guidelines for the valley elderberry longhorn beetle (USFWS, 1999).

Elderberry shrubs with one or more stems measuring one inch or greater in diameter at ground level must be transplanted if they cannot be avoided by the proposed project. Elderberry shrubs should be transplanted when they are dormant, typically from November to the first two weeks in February. Transplanting during the non-growing season would reduce shock to the plant and increase transplantation success. Most transplants require watering through the first summer.

Elderberry stems measuring greater than one inch in diameter are considered habitat for the VELB and trimming or removal of stems would require coordination and mitigation. Each elderberry stem that is adversely affected must be replaced in the conservation area with elderberry seedlings or cuttings as specified by USFWS. Seedlings and cuttings should be obtained from local sources. If the project site is in the vicinity of the conservation area, cuttings may be obtained from elderberry shrubs to be transplanted.

Mitigation site planting areas must be at least 1,800 square feet for each elderberry transplant. As many as five additional elderberry plantings (cuttings or seedlings) and up to five associated native species plantings may also be planted within the 1,800 square foot area with the transplant. Studies have found that the VELB is more abundant in dense native plant communities with a mature overstory and a mixed understory. Therefore, a mix of native riparian species such as Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), valley oak (*Quercus lobata*), box elder (*Acer negundo*), white alder (*Alnus rhombifolia*), and California button willow (*Cephalanthus occidentalis californica*) would be planted along with the elderberry shrubs. Stock of saplings, cuttings, and seedlings would be obtained from local sources. Planting or seeding the area with native herbaceous species is also encouraged. Weeds and other non-native plants would be removed by mechanical means at least once a year or at the discretion of USFWS.

No pesticides, herbicides, fertilizers, or other chemical agents would be used in or within 100 feet of the conservation area. Fencing would be placed around the conservation area during the establishment period of the elderberry shrubs. Signs would be posted on the fence stating the status of

the VELB and the purpose of the habitat. The conservation area would be protected in perpetuity as habitat for the VELB. Conservation areas may be transferred to resource agencies or appropriate private organizations for long term management. Biologists and law enforcement personnel from the California Department of Fish and Wildlife and USFWS must be given complete access to the project site to monitor transplanting activities. Personnel from these agencies must also be given complete access to the conservation area to monitor the beetle and its habitat in perpetuity.

### 2.3.2 Success Criteria

After the first year, it is anticipated that the sites would be evaluated to determine the level of project success and apply adaptive management, if necessary. If the habitat meets the below performance standards for three consecutive years, depending on physical site characteristics, conditions should be consistent enough to estimate community composition and general success of planting efforts. Three consecutive years of success should indicate that the project sites are self-sustaining and should not require supplemental irrigation or intensive weed control. Following this initial establishment period, any subsequent monitoring activities would be the responsibility of the local maintaining agency, and would focus primarily on general and biological inspections for the purposes of fire management and habitat evaluation.

Monitoring of elderberry habitats would focus on a minimum survival rate of at least 60 percent of the elderberry shrubs. Within one year of discovery that survival has dropped below 60 percent, additional plantings would be installed to bring survival above this level. Monitoring of associated riparian habitat would focus on: (1) the percent cover of native plant species; (2) presence of at least five native species contributing to structural diversity; and (3) decrease percent cover of non-native invasive species that out-compete natives. Additionally, an inventory of wildlife species would be recorded during annual monitoring. Table 11 establishes the percentages required to meet these performance standards. If the habitat is meeting these performance standards, conditions should be consistent enough to estimate community composition and general success of planting efforts.

**Table 11. Elderberry and Associated Riparian Habitat Performance Standards.**

Performance Standard	Quantitative Measure
Percent survivability of elderberry shrubs	60%
Percent cover of native riparian species	75%
Structural diversity	At least 5 native species contributing to 75% canopy and 50% shrub cover
Percent cover of non-native species	Less than 15%

### **2.3.3 Mitigation and Monitoring Strategy**

Monitoring would be conducted annually per the USFWS Conservation Guidelines for the valley elderberry longhorn beetle (USFWS, 1999). Two surveys would be conducted by qualified biologists between February 14 and June 30 of each year until the mitigation has met the success criteria. Surveys would include:

1. An evaluation of the elderberry plants and associated native plants on the site, including the number of plants, their size and condition.
2. Presence of the adult beetles, including the number of beetles observed, their condition, behavior, and their precise locations.
3. Presence of beetle exit holes in elderberry stems, noting their locations and estimated ages.
4. An evaluation of the adequacy of the fencing, signs, and weed control efforts in the avoidance and conservation areas.
5. A general assessment of the habitat, including any real or potential threats to the beetle and its host plants, such as erosion, fire, excessive grazing, off-road vehicle use, vandalism, excessive weed growth, etc.

A written report presenting and analyzing the data from the project monitoring would be prepared following the surveys, and would be submitted by December 31 of the same year to USFWS. The report would address the status and progress of the transplanted and planted elderberry shrubs, associated native plants and trees, and any failings of the conservation plan and the steps taken to correct them. Any observations of beetles or fresh exit holes must be noted. Copies of original field notes, raw data, and photographs of the conservation area would be included with the report. A vicinity map of the site and maps showing where the individual adult beetles and exit holes were observed would also be included. The survival rate, condition, and size of the elderberry and associated native plants would be analyzed in the report. Real and likely future threats would be addressed along with suggested remedies and preventative measures (such as limiting public access, more frequent removal of invasive non-native vegetation, etc.).

### **2.3.4 Adaptive Management Strategy**

If the habitat is not meeting the success criteria established above, then adaptive management would be implemented in order to ensure that the habitat establishment is successful. The following subsections identify triggers that would indicate the need to implement adaptive management measures and the measures that would be implemented accordingly.

**Adaptive Management Triggers**

- Desired Outcome: Increase percent survivability of elderberry shrubs.

Triggers: If 60% survivability is not achieved during the monitoring period.

- Desired Outcome: Increase percent cover of native riparian habitat.

Triggers: If 50% cover of native riparian habitat is not achieved within 3 years, or 75% cover of native riparian habitat is not achieved within 5 years.

- Desired Outcome: Maintain appropriate structural diversity of native riparian habitats.

Trigger: Suitable structural diversity is not achieved, if canopy cover and/or shrub cover does not achieve 50% within 5 years.

- Desired Outcome: Decrease percent cover of non-native invasive species that outcompete natives including elderberry shrubs.

Trigger: If non-native percent cover is greater than 15% during the monitoring period.

**Adaptive Management Measures**

If the triggers established above occur, the following measures would be implemented for VELB habitat in order to adaptively manage the site for success.

- Replanting may be needed if triggers for vegetative cover and/or survivability are being met. Monitoring results should be used to assess the underlying cause of inadequate cover or survival, which may require that additional adaptive management actions be implemented to support successful replanting. Adaptive management actions could include targeted revegetation, such as replanting at elevations that are exhibiting the greatest growth and survival.
- Nonnative species management may be needed if monitoring results show that the triggers for nonnative species present are met, or if nonnative species are impacting the survival of native species including elderberry shrubs. Adaptive management measures may include adjustments to nonnative control methods, such as plant removal, grading of site to remove nonnative roots, or mowing and selective removal of non-native species at optimal times for native growth.
- Irrigation and/or supplemental water may be needed if vegetation is not meeting success criteria, or if species are exhibiting signs of water stress. Assessment of monitoring results

may show that drought conditions are causing poor establishment or die off of planted vegetation. Adaptive management actions would include supplemental water to support achievement of percent cover criteria and structural diversity.

- Plant protection may be needed if triggers for vegetative cover and/or survivability are being met. If monitoring results show that plantings are failing due to predation or trampling from human use, then adaptive management actions would include plant cages or protective fencing that could be installed to protect plantings.

These measures are described further in the Adaptive Management Plan (Section 3.0) below.

## **2.4 Green Sturgeon**

### **2.4.1 Objectives and Implementation Strategy**

The West Sacramento GRR Recommended Plan will restore existing or create new habitat to compensate for the quality and quantity of green sturgeon habitat (including soft bottom benthic substrate) permanently impacted by project construction. If possible, this would occur at a mitigation bank, however currently no mitigation banks in the Sacramento area provide credits for green sturgeon habitat.

If onsite mitigation is not possible, and there are no mitigation banks available, then compensation for green sturgeon habitat would occur within the north Delta in as close of a proximity to the study area as possible. The non-Federal sponsor supports green sturgeon mitigation, has the capability to implement the mitigation, and would participate in implementation of this mitigation in coordination with the Corps. Based on current best available science, there are limited opportunities for habitat creation within the study area. Created or restored habitat would be designed in coordination with NMFS and would be based on the primary constituent elements (PCEs) of critical habitat such as food availability, water flow, water quality, migration corridors, and sediment quality. Successful establishment of onsite mitigation or creation of offsite habitat will be determined through the success criteria in Section 2.6.3 below.

### **2.4.2 Success Criteria**

The overall performance standard for green sturgeon habitat is based on the establishment of slope and substrate, with a focus on a suitable range of conditions for rearing juvenile green sturgeon developed from SAM. Slope and substrate are critical components of habitat for rearing juvenile green sturgeon. Slope is used as an indicator of shallow water refuge for juveniles as well as food and resting areas. Substrate size is used as an indicator of juvenile refuge from predators, suitable predator habitat,

and food availability for juvenile and adult life stages of focus fish. Table 12 below establishes the suitable range of substrate and slope that must be met for each year of monitoring. Slope and substrate would be monitored yearly along with other potential variables discussed below. The monitoring will continue until all performance standards have been achieved for three consecutive years.

**Table 12. Green Sturgeon Habitat Performance Standards.**

	Acceptable Range
Slope (H:V)	>2:1
Substrate (average size, inches)	0 – 10

Note: Based on outputs from the SAM model. The Corps, in coordination with NMFS, determined that these outputs from the SAM model are the most likely outputs that would remain relevant to sturgeon with improved baseline condition data.

As stated previously, there is insufficient knowledge of the species' relationship to many habitat attributes; however, there may be opportunities to incorporate additional habitat attributes into the evaluation process. Experts at the Corps Engineering Research and Design Center would be engaged in order to develop a post-construction sampling and monitoring plan that would be refined during PED based on any improvements in the understanding of the species at that time. Potential habitat attributes that could be incorporated into success criteria following preconstruction monitoring and the development of the EFM model include:

- Food Resources – Benthic invertebrates and fishes (various species of shrimp, amphipods, isopods, clams, annelid worms, crabs, sand lances, and anchovies) can be measured in terms of biomass loss, gain, or recovery rate. The impact on the benthic environment can be quantified within the footprint and adjacent to the footprint. Grab samples would be collected at various points of the river. These samples would be analyzed in order to determine the bed material and any change in presence of benthic food sources (clams, invertebrates, etc.) that resulted from construction.
- Water Flow – Although levee improvement projects are unlikely to impact water flow, there may be some localized increase in flow over revetment that could affect the swimming or foraging habits of green sturgeon. These changes can be assessed through a physical or hydraulic model. This monitoring should be paired with a fish tracking study to assess the species presence/ association with habitat/project features in the project area.
- Water Depth – A diversity of water depth is necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages of green sturgeon and salmonids. Water depth impacted by levee construction or bank armoring can be measured impact through a direct physical quantification of changes to shallow and deep water habitat.
- Water Quality – Although levee improvement projects are unlikely to impact long term water quality, sediment quality, or migratory corridors, baseline conditions of these resources could be determined in order to develop a greater understanding of how these resources

could impact normal behavior, growth, and viability of all life stages of green sturgeon and other fish species. Water Quality monitoring would involve testing water temperature, salinity, oxygen content, and other chemical characteristics within the project reach.

### **2.4.3 Mitigation Monitoring Strategy**

The mitigation monitoring strategy will focus on the successful establishment of critical habitat elements, including slope and substrate. Post-construction monitoring would continue until the mitigation site has met the success criteria for three consecutive years. Slope would be monitored on an annual basis using range finding technologies. Slope will be sampled in varying distances perpendicular to the shoreline to assess slope ratio and depth. Substrate can vary seasonally and therefore will be monitored bi-annually before and after high flows. Substrate would be evaluated through direct physical samples. Substrate will be sampled in varying distances perpendicular to the shoreline to assess the content of benthic material.

A post-construction monitoring report would be produced annually following monitoring. The report would summarize and analyze all monitoring activities with overall evaluation of the performance of the success criteria. Additional results, analysis, proposed adaptive management measures, and associated costs would be incorporated into the monitoring report.

### **2.4.4 Adaptive Management Strategy**

If the habitat is not meeting the success criteria established above, then adaptive management would be implemented in order to ensure that the habitat establishment is successful. The following subsections identify triggers that would indicate the need to implement adaptive management measures and the measures that would be implemented accordingly.

#### **Adaptive Management Triggers**

- Desired Outcome: Maintain slope gradient of greater than 2H:1V.

Triggers: If slope is less than 2H:1V during the monitoring period.

- Desired Outcome: Maintain acceptable range of substrate conditions to provide benthic habitat.

Triggers: If average substrate sizes are composed of cobbles larger than 10 inches during the monitoring period.

**Adaptive Management Measures**

If the triggers established above occur, the following measures would be implemented for green sturgeon benthic habitat in order to adaptively manage the site for success.

- Slope regrading may be needed if monitoring results show that the trigger for slope angle is met. Adaptive management measures may include grading to recontour slope angle to 2H:1V or greater.
- Sediment management measures may be needed if the trigger for substrate is met. If monitoring results show that average substrate composition is larger than 10 inches, then the following measures may be implemented. Measures may include gravel augmentation, sediment catching measures, and/or introduction of fines.

### 3.0 Adaptive Management Costs

This section outlines the feasibility level adaptive management costs for the West Sacramento GRR Recommended Plan. The adaptive management plan for this project reflects a level of detail consistent with the project Feasibility Study. The primary intent is to develop adaptive management costs appropriate for and specific to the project's adaptive management measures and monitoring strategies, as described in Section 2.0 of this document. The specified management actions allow estimation of the adaptive management program costs for the project.

#### 3.1 Adaptive Management Costs

The cost for implementation of this plan are provided at October 2015 price levels and prior to contingency. The cost for implementing the monitoring plan proposed above is approximately \$2.85 million and is shown on Table 13 below.

**Table 13. Monitoring Costs for the West Sacramento GRR Recommended Plan.**

Monitoring	Assumed Tasks for Monitoring	Frequency	Cost Assumptions	Total Cost for 5 Years
<i>Vegetation Monitoring</i>	Assume monitoring of mitigation sites, including transects for percent cover of natives and non-natives, structural diversity, and canopy cover over water using transect/plot monitoring. Assume vegetation mapping, inventories of general wildlife, and observations of damage to habitat would be recorded. Assume monitoring of all parameters would be done concurrently during each monitoring event.	Annually for 5 Years	Monitoring: Cost estimate based on standard establishment contract, including monitoring cost and annual report from contractor. Assume \$50,000 per year for 4 biologists to survey mitigation sites	\$972,000
<i>Green Sturgeon Habitat Monitoring</i>	Assume monitoring of slope and in-channel habitat elements including substrates (i.e., composition and percentage of fines)	Annually for 5 Years	Monitoring: Assume monitoring of 8 reaches for 5 years	\$1,875,000
			<b>TOTAL MONITORING</b>	<b>\$2,847,000</b>

The cost for the adaptive management plan is approximately \$3.45 million and is shown on Table 14 below.

**Table 14. Adaptive Management Costs for the West Sacramento GRR Recommended Plan.**

<b>Adaptive Management Measures</b>	<b>Assumed Tasks for Adaptive Management</b>	<b>Cost Assumptions</b>	<b>Total Cost for 5 Years</b>
<i>Irrigation/Supplemental Water</i>	Apply supplemental irrigation to water stressed plants	Assuming \$900 per acre per year for 5 years	\$675,500
<i>Re-planting</i>	Assume that assume 25% of vegetation may require replanting over 5 years.	Cost of vegetation was estimated at \$5,000 per planted acre	\$1,665,000
<i>Plant Protection &amp; Fencing</i>	Assume 10,000 plant cages and 10,000 feet of fencing may be needed.	Assume \$10/plant cage; \$3/linear foot for fencing; plus \$50,000 installation. Costs referenced from existing restoration contracts.	\$280,000
<i>Slope Regrading and Sediment Management</i>	Recontouring or existing slopes and gravel augmentation	Assume regading and gravel augmentation at 25% of mitigation site at \$35 per CY	\$641,500
<i>Annual Report</i>	Produce annual report	Assume \$37,500 per report, annually for 5 years	\$190,000
		<b>TOTAL ADAPTIVE MANAGEMENT</b>	<b>\$3,451,500</b>
		<b>TOTAL MONITORING AND ADAPTIVE MANAGEMENT</b>	<b>\$6,298,500</b>

The combined monitoring and adaptive management costs at October 2015 price levels, as included in the certified total project cost summary under the 06 "fish and wildlife facilities" account, total \$6.3 million for the Recommended Plan.

## 4.0 References

- Brice, J. 1977. Lateral migration of the middle Sacramento River, California. Water-Resources Investigations 77-43. U. S. Geological Survey, Menlo Park, California.
- Katibah, E.F. 1983. A Brief History of Riparian Forests in the Great Central Valley of California. California Riparian Systems Conference (in press).
- Thompson, K. 1961. Riparian forests of the Sacramento Valley, California. Pages 294-315 in R. S. Platt, editor. Annals of the Association of American Geographers.
- U.S. Army Corps of Engineers (Corps). 2012. Sacramento River Bank Protection Project, Phase II 80,000 Linear Feet Biological Assessment. Draft. July. (ICF 00627.08.) Sacramento, CA. Prepared by ICF International, Sacramento, CA.
- U.S. Fish and Wildlife Service (USFWS). 1997. Programmatic formal consultation for U.S. Army Corps of Engineers 404 permitted projects with relatively small effects on the giant garter snake within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo counties, CA. File number 1-1-F-97-149. Sacramento, California.
- U.S. Fish and Wildlife Service (USFWS). 1999. Conservation Guidelines for the Valley Elderberry Longhorn Beetle. U.S. Department of the Interior, Fish and Wildlife Service. Sacramento Fish and Wildlife Office. July 1999. [http://www.fws.gov/sacramento/es/Survey-Protocols-Guidelines/Documents/velb\\_conservation.pdf](http://www.fws.gov/sacramento/es/Survey-Protocols-Guidelines/Documents/velb_conservation.pdf)

**West Sacramento GRR EIS/EIS  
Appendix I**

**Enclosure 2**  
Mitigation Calculations

## **Mitigation for West Sacramento GRR**

### Development of Compensatory Mitigation Acreages for Alternatives 1, 3, and 5

Mitigation for habitat loss is a requirement to compensate for the loss of habitat due to a Federal action. Section 2036(a) of the Water Resources Development Act of 2007 states that project alternatives must support recommendations with a specific plan to mitigate fish and wildlife losses. Additionally, the Endangered Species Act states that the purpose of compensatory mitigation is to offset environmental losses resulting from unavoidable impacts (40 CFR 230.93 (a)(1)).

The West Sacramento GRR study area includes 50 miles of levees in Reclamation District (RD) 900, RD 537, DWR's Maintenance Area 4, and the DWSC, that completely surround the city. The study area is separated into two basins. The north basin encompasses 6,100 acres and contains the following levee reaches: 5.5 miles along the Sacramento River north levee, 3.7 miles along the Yolo Bypass levee, 1.1 miles along the Sacramento Bypass levee and .5 miles along the Sacramento Bypass training levee. The South Basin encompasses 6,900 acres and includes the following levee reaches: 5.9 miles along the Sacramento River south levee, 1.2 miles along the South Cross levee, 2.8 miles along the Deep Water Ship Channel (DWSC) east levee, 1 mile along the Port south levee, and 21.4 miles along the DWSC west levee.

The mitigation acreages for West Sacramento GRR were calculated using a combination of site surveys and aerial photography from Google Earth to determine where the project footprint impacted different habitat types. The habitat types included: riparian, oak woodland, wetland, shaded riverine aquatic (SRA), giant garter snake (GGS), and valley elderberry longhorn beetle (VELB). The acreages of each impacted habitat type were then broken up by reach in order to show differences between the three Alternatives. Impacts caused by the construction of this project are shown in Tables 1 and 2 below.

**Table 1. Impacts for West Sac GRR – Alt 1 and 5**

	GGS Upland ***	GGS Aquatic ***	Riparian	SRA Habitat ***	Elderberry Shrubs **	Oak Woodland *	Shallow Water **	Wetlands	Soft Bottom Benthic **
<b>North Basin</b>									
Sacramento River North Levee			22 acres (38 if no variance)	10 acres 33,333 LF	42 acres	8 acres	5 acres	5 acres	10 Acres
Port North Levee									
Yolo Bypass	5 acres	2 acres	2 acres		12 acres			2.5 acres	
Sacramento Bypass Training Levee	5 acres		3 acres		1 acres			2.5 acres	
<b>South Basin</b>									
South Cross Levee	4 acres	10 acres	5 acres		8 acres	4 acres		10 acres	
Deep Water Ship Channel East Levee	10 acres	10 acres	2 acres		3 acres			10 acres	
Port South Levee	2 acres	1 acre						1 acre	
Deep Water Ship Channel West Levee	20 acres				5 acres				
Sacramento River South Levee <b>(Alt 1)</b>			25 acres (38 if no variance)	8 acres 26,664 LF	72 acres	8 acres	14 acres	5 acres	10 acres
<b>TOTAL (Alt 1)</b>	<b>46 acres</b>	<b>23 acres</b>	<b>59 acres (88 acres-no variance)</b>	<b>18 acres 60,000 LF</b>	<b>257 shrubs (143 acres)</b>	<b>20 acres</b>	<b>19 acres</b>	<b>36 acres</b>	<b>20 acres</b>
Sacramento River South Levee <b>(Alt 5)</b>	155 acres		4 acres	2 acres 6,666 LF	36 acres	4 acres	9 acres	5 acres	
<b>TOTAL (Alt 5)</b>	<b>201 acres</b>	<b>23 acres</b>	<b>38 acres (54 acres-no variance)</b>	<b>12 acres 40,000 LF</b>	<b>193 shrubs (107 acres)</b>	<b>16 acres</b>	<b>14 acres</b>	<b>36 acres</b>	<b>10 acres</b>

\*State Listed \*\*Federal Listed \*\*\*State and Federal Listed

**Table 2. Impacts for West Sac GRR – Alt 3**

	GGS Upland ***	GGS Aquatic ***	Riparian	SRA Habitat ***	Elderberry Shrubs **	Oak Woodland *	Shallow Water **	Wetlands	Soft Bottom Benthic **
<b>North Basin</b>									
Sacramento River North Levee			22 acres (38 if no variance)	10 acres 33,333LF	42 acres	8 acres	5 acres	5 acres	10 acres
Port North Levee									
Yolo Bypass	5 acres	2 acres	2 acres		12 acres			2.5 acres	
Sacramento Bypass Training Levee	5 acres		3 acres		1 acres			2.5 acres	
<b>South Basin</b>									
South Cross Levee	4 acres	10 acres	5 acres		8 acres	4 acres		10 acres	
Deep Water Ship Channel East Levee	4 acres	4 acres						10 acres	
Port South Levee					1 acre				
Deep Water Ship Channel West Levee	5 acres				5 acres				
Sacramento River South Levee (Alt 3)			25 acres (38 if no variance)	8 acres 26,664LF	72 acres	8 acres	14 acres	5 acres	10 acres
<b>TOTAL (Alt 3)</b>	<b>23 acres</b>	<b>16 acres</b>	<b>57 acres (86 acres-no variance)</b>	<b>18 acres 60,000 LF</b>	<b>254 shrubs (141 acres)</b>	<b>20 acres</b>	<b>19 acres</b>	<b>35 acres</b>	<b>20 acres</b>

\*State Listed \*\*Federal Listed \*\*\*State and Federal Listed

The cost for mitigation was estimated for five scenarios for the purposes of the CE/ICA for all three alternatives. These scenarios included: (1) maximized on- and off-site habitat creation; (2) maximizing the use of credits at a local mitigation bank; (3) a combination of on-site, off-site, and a mitigation bank at a 2:1 ratio; (4) a combination of on-site, off-site, and a mitigation bank at a 1:1 ratio; and (5) a combination of on-site, off-site, and a mitigation bank at a 3:1 ratio. Per the discussion above and the results shown in Table 4, the loss in ecological value associated with on-/off-site mitigation was reduced to an overall 0.8 habitat value. The Recommended Plan is the Alternative 5 Combination Plan with a 2:1 ratio, because it is the smallest mitigation proposal that accomplishes the terms and conditions of the Biological Opinions, and the CE/ICA determined that it was a cost effective plan. Projected mitigation costs for both habitat creation and mitigation bank credits are shown in Table 3, below.

**Table 3. Mitigation Costs**

	GGU Upland ***	GGU Aquatic ***	Riparian	SRA Habitat***	Elderberry Shrubs**	Oak Woodland *	Shallow Water **	Wetlands	Soft Bottom Benthic
Mitigation Cost at a Bank per acre	\$60,000	\$60,000	\$75,000	\$75/LF	\$4,500/ credit	\$75,000	\$130,000	\$130,000	----
Mitigation Cost on Site per acre	\$5000	----	\$55,000	\$55,000 \$3,333/LF	\$85,000	\$50,000	\$55,000	\$130,000	\$150,000

The cost for credits at a mitigation bank were obtained by contacting local mitigation banks to determine their prices per acre or credit for each of the habitat types needed for the GRR. These costs were then combined for each reach and Alternative to determine and overall mitigation cost per Alternative. These mitigation costs were included in the overall project cost for each alternative and are shown in Table 3 above.

The 2:1 combination alternative is likely the most implementable solution. It takes into account all required mitigation for the project per the NMFS and USFWS Biological Opinions, and assesses the implementation based on a reasonable estimate of on site mitigation, combined with using a mitigation bank. However, due to the loss of habitat value and function while new on site habitat is growing, the ecological value associated with onsite mitigation was reduced to an overall 80% habitat value for all scenarios based on the results of the associated HEP analysis, which was relied on for the purposes of this analysis.

For the purposes of evaluating the impacts of the West Sacramento GRR Recommended Plan on fish and wildlife resources in the project area, with a reliance on existing information in the spirit of SMART Planning, the Habitat Evaluation Procedures (HEP) for the *American River Watershed Investigation, Common Features Modifications, Mayhew Drain Site Project* were relied upon as a reference baseline. The HEP for the Mayhew Drain Site Project was conducted in 2005 to quantify anticipated impacts to fish and wildlife and their habitats, and to determine mitigation needs for the project. This HEP was selected for the West Sacramento GRR because the habitat type and value at the Mayhew site is consistent with the habitat that occurs throughout the West Sacramento GRR project area.

The HEP provided information for two general types of wildlife habitat comparisons: 1) the relative value of different areas at the same point in time; and 2) the relative value of the same areas at future points in time. By combining the two types of comparisons, the impacts of proposed project on wildlife habitat were quantified and compensation needs (in terms of acreage) for the project were determined. The assumption that habitat for selected wildlife species or communities can be numerically described by a model produces a Habitat Suitability Index (HSI). The HSI, a value from 0.0 to 1.0, provides a measure of habitat quality for a sample area in terms of suitability for the particular species or community being evaluated.

For the Mayhew Drain project, the Northern oriole Riparian woodland model was used because it best suited the habitat type in the project area. The quantity part of the formula is any measure of area which is appropriately sized for the study. The product of these two measures is comparable to "habitat value" which equals habitat quantity multiplied by habitat quality. This formula is expressed as a Habitat Unit (HU).

$$\text{Habitat Type} \times \text{Habitat Area} = \text{Habitat Value}$$

The Average Annual Habitat Units (AAHUs) over the life of the project can then be used to determine mitigation needs. The model, variables measured and data collection methods used for the Mayhew Drain Project are shown below in Table 4. For the West Sacramento GRR Recommended Plan, data was estimated visually and using Google Earth.

**Table 4. HSI model, Variables, and Data Collection Methods.**

<b>HSI Model and Cover-Type</b>	<b>HSI Model Variables</b>	<b>Data Collection Method</b>
Northern oriole Riparian Woodland	V1 – Average height of deciduous tree canopy	Visual estimation
	V2- Percent deciduous tree crown cover	Densiometer along belt transects
	V3 – Stand width	Estimated using aerial photos

Since it is not possible to empirically determine habitat quality and quantity for future years, future HSI values were projected. This was accomplished by increasing or decreasing specific baseline variables and/or HSI values for each evaluation element for the Northern oriole based on best professional knowledge of performance at other mitigation sites, literature on plant growth, and conditions at reference sites. To predict changes in the HSI for each future scenario, it was necessary to make assumptions regarding baseline and future values within project impact and compensation areas. The assumptions made for the West Sacramento GRR with project can be seen in Table 5 and without project can be seen in Table 6 below.

**Table 5. HSI Variables for the West Sacramento GRR Recommended Plan Based on Habitat Values.**

<b>HEP - FUTURE WITH-PROJECT</b>							
<b>Time</b>	<b>Variables</b>			<b>Suitability Index</b>			<b>Output</b>
	<b>V1</b>	<b>V2</b>	<b>V3</b>	<b>SI-V1</b>	<b>SI-V2</b>	<b>SI-V3</b>	<b>HSI</b>
TY1	20	25%	2	0.60	1.00	1.00	0.84
TY2	10	25%	2	0.30	1.00	1.00	0.67
TY25	20	75%	2	0.60	0.75	1.00	0.77
TY50	35	75%	2	1.00	0.75	1.00	0.91
HSI = (V1*V2*V3) <sup>1/3</sup>				Average			0.80

**Table 6. HSI Variables for the West Sacramento Without Project Based on Habitat Values.**

HEP - FUTURE WITHOUT-PROJECT							
Time	Variables			Suitability Index			Output
	V1	V2	V3	SI-V1	SI-V2	SI-V3	HSI
TY1	35	75%	2	1.00	0.75	1.00	0.91
TY2	35	75%	2	1.00	0.75	1.00	0.91
TY25	35	75%	2	1.00	0.75	1.00	0.91
TY50	35	75%	2	1.00	0.75	1.00	0.91
HSI = (V1*V2*V3)^1/3						Average	0.91

The HSI value of 0.80 in Table 5 results from a temporal loss of habitat value and function from the removal of existing mature riparian habitat. This is due to the lower values given to mitigation plantings during the establishment period. The West Sacramento GRR Recommended Plan proposes to implement riparian habitat mitigation at a 2:1 ratio. A 2:1 mitigation ratio is a reasonable requirement for implementation of mitigation for this habitat type, because the proposed project will decrease the connectivity of existing habitat along the Sacramento River system. Additionally, temporal loss of onsite habitat results in a reduction in value and function of the new vegetation within the mitigation areas as it grows to maturity. This also accounts for the loss of other services that riparian vegetation provides, including:

- An essential food source for fish and wildlife, including ESA species;
- Aquatic resting and refugia for resident and migratory fish species;
- Large woody debris recruitment;
- Nesting and rearing habitat for terrestrial wildlife species;
- Nutrients for the ecological system;
- Shade for the river which maintains water temperatures and dissolved oxygen concentrations; and,
- Increased habitat value for VELB.

The above-listed functions and services associated with a newly created acre of habitat are usually expected to be less than those associated with natural habitat. As a result the 2:1 mitigation ratio is appropriate to compensate for the loss of mature riparian habitats.

Tables 7, 8, and 9 below show the environmental effects and proposed mitigation for each of the three alternatives. Note that some habitat types are adjusted to 2:1 and 3:1 to comply with the terms and conditions of the Biological Opinions.

**Table 7. Environmental Impacts of and Proposed Mitigation/Compensation for the West Sacramento GRR<sup>1</sup> Alternative 5.**

Habitat Type	Potential Impacts	Duration of Impact	Mitigation/Compensation (Acres/Linear Feet)	Cost
GGS Upland and Aquatic	201 Acres	Single Construction Season	201 Acres (5k/ac)	\$1,005,000
GGS Upland and Aquatic	23 Acres	Permanent	69 Acres (60k/ac)	\$4,140,000
Riparian	38 Acres	Permanent	38 Acres (55k/ac) 38 Acres (75k/ac)	\$4,940,000
Shaded Riverine Aquatic Habitat (ESA Fish Species)	40,000 Linear Feet (12 acres)	Single Construction Season (Different Levee Reaches)	12 Acres- 40,000 Linear Feet Self Mitigating with on-site planting <sup>2</sup>	\$660,000
Shallow Water Habitat (ESA Fish Species)	14 Acres	Permanent	14 Acres (55k/ac)	\$770,000
Elderberry Shrubs	193 Shrubs 1,991 Stems (107 Acres)	Permanent	31 Acres (85k/ac) 1,107 credits (69 Acres) (4.5k/credit)	\$7,616,500
Oak Woodland	16 Acres	Permanent	10 Acres (50k/ac) 22 Acres (75k/ac)	\$2,150,000
Wetlands	36 Acres	Permanent	72 Acres (130k/ac)	\$9,360,000
Soft Bottom Benthic	10 Acres	Permanent	10 Acres(150k/ac)	\$1,500,000
<b>Total</b>	<b>457 Acres</b>		<b>586 Acres</b>	<b>\$32,141,500</b>

Notes:

<sup>1</sup> Assumes variance from USACE's vegetation guidance is granted for Sacramento River.

<sup>2</sup> The SRA habitat being impacted would be minimal due to the assumed approval of a vegetation variance. Trees providing SRA will be left in place and the sites will be planted with an approved planting pallet that provides additional SRA habitat once established. Repairs using the Sacramento Back Protection Project repair are considered self mitigating. If additional mitigation is required by NMFS or USFWS, the cost is estimated to be \$144 per linear foot.

**Environmental Impacts of and Proposed Mitigation/Compensation  
for the West Sacramento GRR<sup>1</sup> Alternative 1**

<b>Habitat Type</b>	<b>Potential Impacts</b>	<b>Duration of Impact</b>	<b>Mitigation/Compensation (Acres/Linear Feet)</b>	<b>Cost</b>
GGs Upland and Aquatic	46 Acres	Single Construction Season	Restore 46 Acres (5k/ac)	\$230,000
GGs Upland and Aquatic	21 Acres	Permanent	63 Acres (60k/ac)	\$3,780,000
Riparian	59 Acres	Permanent	38 Acres (55k/ac) 21 Acres (75k/ac)	\$3,665,000
Shaded Riverine Aquatic Habitat (ESA Fish Species)	63,400 Linear Feet (19 acres)	Single Construction Season (Different Levee Reaches)	19 Acres- 64,000 Linear Feet Self Mitigating with on-site planting <sup>2</sup>	\$1,056,000
Shallow Water Habitat (ESA Fish Species)	19 Acres	Permanent	19 Acres (55k/ac)	\$1,045,000
Elderberry Shrubs	257 Shrubs (143 Acres)	Permanent	31 Acres (85k/ac) 1,792 credits (4.5k/credit) (112 acres)	\$10,699,000
Oak Woodland	20 Acres	Permanent	10 Acres (50k/ac) 30 Acres (75k/ac)	\$2,750,000
Wetlands	36 Acres		72 Acres (130k/ac)	\$9,360,000
<b>Total</b>	<b>363 Acres</b>		<b>461 Acres</b>	<b>\$35,585,000</b>

**Environmental Impacts of and Proposed Mitigation/Compensation  
for the West Sacramento GRR<sup>1</sup> Alternative 3.**

Habitat Type	Potential Impacts	Duration of Impact	Mitigation/Compensation (Acres/Linear Feet)	Cost
GGs Upland and Aquatic	20 Acres	Single Construction Season	Restore 20 Acres (5k/ac)	\$100,000
GGs Upland and Aquatic	19 Acres	Permanent	57 Acres (60k/ac)	\$3,420,000
Riparian	57 Acres	Permanent	38 Acres (55k/ac) 76 Acres (75k/ac)	\$7,790,000
Shaded Riverine Aquatic Habitat (ESA Fish Species)	60,000 Linear Feet (18 acres)	Single Construction Season (Different Levee Reaches)	18 Acres- 60,000 Linear Feet Self Mitigating with on-site planting <sup>2</sup>	\$1,574,925
Shallow Water Habitat (ESA Fish Species)	19 Acres	Permanent	14 Acres (55k/ac) 5 Acres (130k/ac)	\$1,420,000
Elderberry Shrubs	254 Shrubs (141 Acres)	Permanent	31 Acres (85k/ac) 1,760 credits (4.5k/credit) (110 Acres)	\$10,555,000
Oak Woodland	20 Acres	Permanent	10 Acres (50k/ac) 30 Acres (75k/ac)	\$2,750,000
Wetlands	36 Acres		72 Acres (130k/ac)	\$9,360,000
Green Sturgeon	20 Acres	Permanent	20 Acres (150k/ac)	\$3,000,000
<b>Total</b>	<b>330 Acres</b>		<b>481 Acres</b>	<b>\$30,969,925</b>

In order to establish a basis of comparison for this Cost Estimate, the “Without Project Condition” is assumed to be of such low habitat value that there would be 0 AAHU’s without implementing compensatory mitigation. The “With Project Condition” is the completed mitigation as designed. On site costs were estimated using the average of costs for other onsite mitigation the District has constructed for projects in the region. Due to the temporal loss of habitat value and function while new on site habitat is growing, the ecological value associated with onsite mitigation was reduced to an overall 80% habitat value.

The Mitigation Outputs and Cost tables below compare the Average Annual Habitat Units (AAHU’s) and costs between the five scenarios.

**WEST SACRAMENTO GRR MITIGATION OUTPUTS ALTERNATIVE 1**

***On Site Alt 1***

<b><i>Increment</i></b>	<b><i>Habitat Restored</i></b>			
	<b><i>Acres</i></b>	<b><i>AAHU's Without Project</i></b>	<b><i>AAHU's With Project</i></b>	<b><i>Net Change in AAHU's</i></b>
Riparian	38	0	30.4	30.4
Oak Woodland	10	0	8	8
Wetlands	20	0	16	16
Shallow Water habitat	14	0	11.2	11.2
SRA	12	0	9.6	9.6
GGs	48	0	38.4	38.4
Green Sturgeon	20	0	16	16
VELB	31	0	24.8	24.8
<b><i>Grand Total:</i></b>	<b>193</b>		<b>154.4</b>	<b>154.4</b>

***Mitigation Bank Alt 1***

<b><i>Increment</i></b>	<b><i>Habitat Restored</i></b>			
	<b><i>Acres</i></b>	<b><i>AAHU's Without Project</i></b>	<b><i>AAHU's With Project</i></b>	<b><i>Net Change in AAHU's</i></b>
Riparian	59	0	47.2	47.2
Oak Woodland	20	0	16	16
Wetlands	36	0	28.8	28.8
Shallow Water habitat	19	0	15.2	15.2
SRA	19	0	15.2	15.2
GGs	21	0	16.8	16.8
Green Sturgeon	20	0	16	16
VELB	143	0	114.4	114.4
<b><i>Grand Total:</i></b>	<b>337</b>	<b>0</b>	<b>269.6</b>	<b>269.6</b>

***Alt 1 Combination Onsite and Bank 1:1 Mitigation***

<b><i>Increment</i></b>	<b><i>Habitat Restored</i></b>				
	<b><i>Acres on Site</i></b>	<b><i>Acres at Bank</i></b>	<b><i>AAHU's Without Project</i></b>	<b><i>AAHU's With Project</i></b>	<b><i>Net Change in AAHU's</i></b>
Riparian	38	21	0	47.2	47.2
Oak Woodland	10	10	0	16	16
Wetlands	20	16	0	28.8	28.8
Shallow Water habitat	14	5	0	15.2	15.2
SRA	12	7	0	15.2	15.2
GGs	48	21	0	55.2	55.2
Green Sturgeon	20	0	0	16	16
VELB	31	112	0	114.4	114.4
<b><i>Grand Total:</i></b>	<b>193</b>	<b>192</b>	<b>0</b>	<b>308</b>	<b>308</b>

**Alt 1 Combination Onsite and Bank Recommended Plan 2:1 Mitigation**

<b>Increment</b>	<b>Habitat Restored</b>				
	<b>Acres on Site</b>	<b>Acres at Bank</b>	<b>AAHU's Without Project</b>	<b>AAHU's With Project</b>	<b>Net Change in AAHU's</b>
Riparian	38	80	0	94.4	94.4
Oak Woodland	10	30	0	32	32
Wetlands	20	52	0	57.6	57.6
Shallow Water habitat	14	5	0	15.2	15.2
SRA	12	7	0	15.2	15.2
GGs	48	63	0	88.8	88.8
Green Sturgeon	20	0	0	16	16
VELB	31	134	0	132	132
<b>Grand Total:</b>	<b>193</b>	<b>371</b>	<b>0</b>	<b>451.2</b>	<b>451.2</b>

**Alt 1 Combination Onsite and Bank 3:1 Mitigation**

<b>Increment</b>	<b>Habitat Restored</b>				
	<b>Acres on Site</b>	<b>Acres at Bank</b>	<b>AAHU's Without Project</b>	<b>AAHU's With Project</b>	<b>Net Change in AAHU's</b>
Riparian	38	139	0	141.6	141.6
Oak Woodland	10	50	0	48	48
Wetlands	20	88	0	86.4	86.4
Shallow Water habitat	14	5	0	15.2	15.2
SRA	12	45	0	45.6	45.6
GGs	48	63	0	88.8	88.8
Green Sturgeon	20	0	0	16	16
VELB	31	134	0	132	132
<b>Grand Total:</b>	<b>193</b>	<b>524</b>	<b>0</b>	<b>573.6</b>	<b>573.6</b>

**Onsite Costs Alt 1**

<b>Increment</b>	<b>Onsite Costs Alt 1</b>	
	<b>Onsite Cost/Acre</b>	<b>Cost All Onsite</b>
Riparian	\$55,000	\$2,090,000
Oak Woodland	\$50,000	\$500,000
Wetlands	\$130,000	\$2,600,000
Shallow Water habitat	\$55,000	\$770,000
SRA	\$55,000	\$660,000
GGs	\$5,000	\$240,000
Green Sturgeon	\$150,000	\$3,000,000
VELB	\$85,000	\$2,635,000
<b>Grand Total:</b>	<b>\$585,000</b>	<b>\$12,495,000</b>

<i>Increment</i>	<b>Mitigation Bank Costs Alt 1</b>			
	<i>Bank Cost/ Acre</i>			<i>Cost at a Bank</i>
Riparian	\$75,000			\$4,425,000
Oak Woodland	\$75,000			\$1,500,000
Wetlands	\$130,000			\$4,680,000
Shallow Water habitat	\$130,000			\$2,470,000
SRA	\$75	\$75/lf-46,000lf	70,000	\$5,250,000
GGs	\$5,000			\$105,000
Geen Sturgeon	\$150,000			\$3,000,000
VELB	\$4,500	Credit	16	\$10,296,000
<b>Grand Total:</b>	<b>\$569,575</b>			<b>\$31,726,000</b>

<i>Increment</i>	<b>Combination Onsite and Mitigation Bank Costs Alt 1</b>				
	<i>Onsite Cost/ Acre</i>	<i>Bank Cost/ Acre</i>	<i>Cost on Site</i>	<i>Cost at a Bank</i>	<i>Total Cost</i>
Riparian	\$55,000	\$75,000	\$2,090,000	\$1,575,000	\$3,665,000
Oak Woodland	\$50,000	\$75,000	\$500,000	\$750,000	\$1,250,000
Wetlands	\$130,000	\$130,000	\$2,600,000	\$2,080,000	\$4,680,000
Shallow Water habitat	\$55,000	\$130,000	\$770,000	\$650,000	\$1,420,000
SRA	\$55,000	\$75	\$660,000	\$1,749,825	\$2,409,825
GGs	\$5,000	\$60,000	\$240,000	\$1,260,000	\$1,500,000
Geen Sturgeon	\$150,000		\$3,000,000		\$3,000,000
VELB	\$85,000	\$4,500	\$2,635,000	\$8,064,000	\$10,699,000
<b>Grand Total:</b>	<b>\$585,000</b>		<b>\$12,495,000</b>	<b>\$16,128,825</b>	<b>\$28,623,825</b>

<i>Increment</i>	<b>Combination Onsite and Mitigation Bank Costs 2:1 Alt 1</b>				
	<i>Onsite Cost/ Acre</i>	<i>Bank Cost/ Acre</i>	<i>Cost on Site</i>	<i>Cost at a Bank</i>	<i>Total Cost</i>
Riparian	\$55,000	\$75,000	\$2,090,000	\$6,000,000	\$8,090,000
Oak Woodland	\$50,000	\$75,000	\$500,000	\$2,250,000	\$2,750,000
Wetlands	\$130,000	\$130,000	\$2,600,000	\$6,760,000	\$9,360,000
Shallow Water habitat	\$55,000	\$130,000	\$770,000	\$650,000	\$1,420,000
SRA	\$55,000	\$75	\$660,000	\$1,749,825	\$2,409,825
GGs	\$5,000	\$60,000	\$240,000	\$3,780,000	\$4,020,000
Geen Sturgeon	\$150,000		\$3,000,000		\$3,000,000
VELB	\$85,000	\$4,500	\$2,635,000	\$9,648,000	\$12,283,000
<b>Grand Total:</b>	<b>\$585,000</b>		<b>\$12,495,000</b>	<b>\$30,837,825</b>	<b>\$43,332,825</b>

<i>Increment</i>	<b>Combination Onsite and Mitigation Bank Costs 2:1 Alt 1</b>				
	<i>Onsite Cost/Acre</i>	<i>Bank Cost/Acre</i>	<i>Cost on Site</i>	<i>Cost at a Bank</i>	<i>Total Cost</i>
Riparian	\$55,000	\$75,000	\$2,090,000	\$10,425,000	\$12,515,000
Oak Woodland	\$50,000	\$75,000	\$500,000	\$3,750,000	\$4,250,000
Wetlands	\$130,000	\$130,000	\$2,600,000	\$11,440,000	\$14,040,000
Shallow Water habitat	\$55,000	\$130,000	\$770,000	\$650,000	\$1,420,000
SRA	\$55,000	\$75	\$660,000	\$11,248,875	\$11,908,875
GGs	\$5,000	\$60,000	\$240,000	\$3,780,000	\$4,020,000
Green Sturgeon	\$150,000		\$3,000,000		\$3,000,000
VELB	\$85,000	\$4,500	\$2,635,000	\$9,648,000	\$12,283,000
<b>Grand Total:</b>	<b>\$585,000</b>		<b>\$12,495,000</b>	<b>\$50,941,875</b>	<b>\$63,436,875</b>

### WEST SACRAMENTO GRR MITIGATION OUTPUTS ALTERNATIVE 3

#### Alt 3 On Site

<i>Habitat Type</i>	<b>Habitat Restored</b>			
	<i>Acres</i>	<i>AAHU's Without Project</i>	<i>AAHU's With Project</i>	<i>Net Change in AAHU's</i>
Riparian	38	0	30.4	30.4
Oak Woodland	10	0	8	8
Wetlands	20	0	16	16
Shallow Water habitat	14	0	11.2	11.2
SRA	12	0	9.6	9.6
GGs	20	0	16	16
Green Sturgeon	20	0	16	16
VELB	31	0	24.8	24.8
<b>Grand Total:</b>	<b>165</b>		<b>132.0</b>	<b>132.0</b>

#### Alt 3 Mitigation Bank

<i>Habitat Type</i>	<b>Habitat Restored</b>			
	<i>Acres</i>	<i>AAHU's Without Project</i>	<i>AAHU's With Project</i>	<i>Net Change in AAHU's</i>
Riparian	57	0	45.6	45.6
Oak Woodland	20	0	16	16
Wetlands	50	0	40	40
Shallow Water habitat	19	0	15.2	15.2
SRA	18	0	14.4	14.4
GGs	20	0	16	16
Green Sturgeon	20	0	16	16
VELB	177	0	141.6	141.6
<b>Grand Total:</b>	<b>381</b>	<b>0</b>	<b>304.8</b>	<b>304.8</b>

<b>Alt 3 Combination Onsite and Bank 1:1 Mitigation</b>						
<b>Habitat Type</b>	<b>Habitat Restored</b>					<b>Net Change in AAHU's</b>
	<b>Acres on Site</b>	<b>Acres at Bank</b>	<b>AAHU's Without Project</b>	<b>AAHU's With Project</b>	<b>Net Change in AAHU's</b>	
Riparian	38	19	0	45.6	45.6	28
Oak Woodland	10	10	0	16	16	15.2
Wetlands	20	15	0	28	28	14.4
Shallow Water habitat	14	5	0	15.2	15.2	31.2
SRA	12	6	0	14.4	14.4	16
GGS	20	19	0	31.2	31.2	112.8
Green Sturgeon	20	0	0	16	16	279.2
VELB	31	110	0	112.8	112.8	0
<b>Grand Total:</b>	<b>165</b>	<b>184</b>	<b>0</b>	<b>279.2</b>	<b>279.2</b>	<b>496.8</b>

<b>Alt 3 Combination Onsite and Bank 2:1 Mitigation</b>						
<b>Habitat Type</b>	<b>Habitat Restored</b>					<b>Net Change in AAHU's</b>
	<b>Acres on Site</b>	<b>Acres at Bank</b>	<b>AAHU's Without Project</b>	<b>AAHU's With Project</b>	<b>Net Change in AAHU's</b>	
Riparian	38	72	0	88	88	56
Oak Woodland	10	30	0	32	32	15.2
Wetlands	20	50	0	56	56	14.4
Shallow Water habitat	14	5	0	15.2	15.2	61.6
SRA	12	6	0	14.4	14.4	16
GGS	20	57	0	61.6	61.6	112.8
Green Sturgeon	20	0	0	16	16	396
VELB	31	110	0	112.8	112.8	0
<b>Grand Total:</b>	<b>165</b>	<b>330</b>	<b>0</b>	<b>396.0</b>	<b>396</b>	<b>672</b>

<b>Alt 3 Combination Onsite and Bank 3:1 Mitigation</b>						
<b>Habitat Type</b>	<b>Habitat Restored</b>					<b>Net Change in AAHU's</b>
	<b>Acres on Site</b>	<b>Acres at Bank</b>	<b>AAHU's Without Project</b>	<b>AAHU's With Project</b>	<b>Net Change in AAHU's</b>	
Riparian	38	133	0	136.8	136.8	61.6
Oak Woodland	10	50	0	48	48	16
Wetlands	20	85	0	84	84	112.8
Shallow Water habitat	14	5	0	15.2	15.2	488.8
SRA	12	6	0	14.4	14.4	0
GGS	20	57	0	61.6	61.6	0
Green Sturgeon	20	0	0	16	16	0
VELB	31	110	0	112.8	112.8	0
<b>Grand Total:</b>	<b>165</b>	<b>446</b>	<b>0</b>	<b>488.8</b>	<b>488.8</b>	<b>679.2</b>

<b>Increment</b>	<b>Onsite Costs Alt 3</b>	
	<b>Onsite Cost/ Acre</b>	<b>Cost All Onsite</b>
Riparian	\$55,000	\$2,090,000
Oak Woodland	\$50,000	\$500,000
Wetlands		\$0
Shallow Water habitat	\$55,000	\$770,000
SRA	\$55,000	\$660,000
GGs	\$60,000	\$1,200,000
Geen Sturgeon	\$150,000	\$3,000,000
VELB	\$85,000	\$2,635,000
<b>Grand Total:</b>	<b>\$510,000</b>	<b>\$10,855,000</b>

<b>Increment</b>	<b>Mitigation Bank Costs Alt 3</b>			
	<b>Bank Cost/ Acre</b>			<b>Cost at a Bank</b>
Riparian	\$75,000			\$4,275,000
Oak Woodland	\$75,000			
Wetlands	\$130,000			\$6,500,000
Shallow Water habitat	\$130,000			\$2,470,000
SRA	\$75	\$75/lf-46,000lf	64,000	\$4,800,000
GGs	\$60,000			\$1,200,000
Geen Sturgeon	\$150,000			\$3,000,000
VELB	\$4,500	Credit	16	\$12,744,000
<b>Grand Total:</b>	<b>\$624,575</b>			<b>\$34,989,000</b>

<b>Increment</b>	<b>Combination Onsite and Mitigation Bank Costs 1:1 Alt 3</b>				
	<b>Onsite Cost/ Acre</b>	<b>Bank Cost/ Acre</b>	<b>Cost on Site</b>	<b>Cost at a Bank</b>	<b>Total Cost</b>
Riparian	\$55,000	\$75,000	\$2,090,000	\$1,425,000	\$3,515,000
Oak Woodland	\$50,000	\$75,000	\$500,000	\$750,000	\$1,250,000
Wetlands	\$130,000	\$130,000	\$2,600,000	\$1,950,000	\$4,550,000
Shallow Water habitat	\$55,000	\$130,000	\$770,000	\$650,000	\$1,420,000
SRA	\$55,000	\$75	\$660,000	\$1,499,850	\$2,159,850
GGs	\$60,000	\$60,000	\$1,200,000	\$1,140,000	\$2,340,000
Geen Sturgeon	\$150,000		\$3,000,000		\$3,000,000
VELB	\$85,000	\$4,500	\$2,635,000	\$7,920,000	\$10,555,000
<b>Grand Total:</b>	<b>\$640,000</b>		<b>\$13,455,000</b>	<b>\$15,334,850</b>	<b>\$28,789,850</b>

<i>Increment</i>	<b>Combination Onsite and Mitigation Bank Costs 2:1 Plan Alt 3</b>				
	<i>Onsite Cost/ Acre</i>	<i>Bank Cost/ Acre</i>	<i>Cost on Site</i>	<i>Cost at a Bank</i>	<i>Total Cost</i>
Riparian	\$55,000	\$75,000	\$2,090,000	\$5,400,000	\$7,490,000
Oak Woodland	\$50,000	\$75,000	\$500,000	\$2,250,000	\$2,750,000
Wetlands	\$130,000	\$130,000	\$2,600,000	\$6,500,000	\$9,100,000
Shallow Water habitat	\$55,000	\$130,000	\$770,000	\$650,000	\$1,420,000
SRA	\$55,000	\$75	\$660,000	\$1,499,850	\$2,159,850
GGS	\$60,000	\$60,000	\$1,200,000	\$3,420,000	\$4,620,000
Geeen Sturgeon	\$150,000		\$3,000,000		\$3,000,000
VELB	\$85,000	\$4,500	\$2,635,000	\$7,920,000	\$10,555,000
<b>Grand Total:</b>	<b>\$640,000</b>		<b>\$13,455,000</b>	<b>\$27,639,850</b>	<b>\$41,094,850</b>
<i>Increment</i>	<b>Combination Onsite and Mitigation Bank Costs 3:1 Alt 3</b>				
	<i>Onsite Cost/ Acre</i>	<i>Bank Cost/ Acre</i>	<i>Cost on Site</i>	<i>Cost at a Bank</i>	<i>Total Cost</i>
Riparian	\$55,000	\$75,000	\$2,090,000	\$9,975,000	\$12,065,000
Oak Woodland	\$50,000	\$75,000	\$500,000	\$3,750,000	\$4,250,000
Wetlands	\$130,000	\$130,000	\$2,600,000	\$11,050,000	\$13,650,000
Shallow Water habitat	\$55,000	\$130,000	\$770,000	\$650,000	\$1,420,000
SRA	\$55,000	\$75	\$660,000	\$1,499,850	\$2,159,850
GGS	\$60,000	\$60,000	\$1,200,000	\$3,420,000	\$4,620,000
Geeen Sturgeon	\$150,000		\$3,000,000		\$3,000,000
VELB	\$85,000	\$4,500	\$2,635,000	\$7,920,000	\$10,555,000
<b>Grand Total:</b>	<b>\$640,000</b>		<b>\$13,455,000</b>	<b>\$38,264,850</b>	<b>\$51,719,850</b>

**WEST SACRAMENTO GRR MITIGATION OUTPUTS ALTERNATIVE 5**

***Alt 5 On Site***

<b><i>Increment</i></b>	<b><i>Habitat Restored</i></b>			
	<b><i>Acres</i></b>	<b><i>AAHU's Without Project</i></b>	<b><i>AAHU's With Project</i></b>	<b><i>Net Chnge in AAHU's</i></b>
Riparian	38	0	30.4	30.4
Oak Woodland	10	0	8	8
Wetlands	20	0	16	16
Shallow Water habitat	14	0	11.2	11.2
SRA	12	0	9.6	9.6
GGs	201	0	160.8	160.8
Green Sturgeon	10	0	8	8
VELB	31	0	24.8	24.8
<b><i>Grand Total:</i></b>	<b>336</b>		<b>268.8</b>	<b>268.8</b>

***Alt 5 Mitigation Bank***

<b><i>Increment</i></b>	<b><i>Habitat Restored</i></b>			
	<b><i>Acres</i></b>	<b><i>AAHU's Without Project</i></b>	<b><i>AAHU's With Project</i></b>	<b><i>Net Change in AAHU's</i></b>
Riparian	38	0	30.4	30.4
Oak Woodland	16	0	12.8	12.8
Wetlands	36	0	28.8	28.8
Shallow Water habitat	14	0	11.2	11.2
SRA	12	0	9.6	9.6
GGs	23	0	18.4	18.4
Green Sturgeon	10	0	8	8
VELB	107	0	85.6	85.6
<b><i>Grand Total:</i></b>	<b>256</b>	<b>0</b>	<b>204.8</b>	<b>204.8</b>

**Alt 5 Combination Onsite and Bank 1:1 Mitigation**

<b>Increment</b>	<b>Habitat Restored</b>				
	<b>Acres on Site</b>	<b>Acres at Bank</b>	<b>AAHU's Without Project</b>	<b>AAHU's With Project</b>	<b>Net Change in AAHU's</b>
Riparian	38	0	0	30.4	30.4
Oak Woodland	10	6	0	12.8	12.8
Wetlands	20	16	0	28.8	28.8
Shallow Water habitat	14	0	0	11.2	11.2
SRA	12	0	0	9.6	9.6
GGG	201	23	0	179.2	179.2
Green Sturgeon	10	0		8	8
VELB	31	69	0	80	80
<b>Grand Total:</b>	<b>336</b>	<b>114</b>	<b>0</b>	<b>360</b>	<b>360</b>

**Alt 5 Combination Onsite and Bank 2:1 Mitigation Recommended Plan**

<b>Increment</b>	<b>Habitat Restored</b>				
	<b>Acres on Site</b>	<b>Acres at Bank</b>	<b>AAHU's Without Project</b>	<b>AAHU's With Project</b>	<b>Net Change in AAHU's</b>
Riparian	38	38	0	60.8	60.8
Oak Woodland	10	22	0	25.6	25.6
Wetlands	20	52	0	57.6	57.6
Shallow Water habitat	14	0	0	11.2	11.2
SRA	12	0	0	9.6	9.6
GGG	201	69	0	216	216
Green Sturgeon	10	0	0	8	8
VELB	31	69	0	80	80
<b>Grand Total:</b>	<b>336</b>	<b>250</b>	<b>0</b>	<b>468.8</b>	<b>468.8</b>

**Alt 5 Combination Onsite and Bank 3:1 Mitigation**

<b>Increment</b>	<b>Habitat Restored</b>				
	<b>Acres on Site</b>	<b>Acres at Bank</b>	<b>AAHU's Without Project</b>	<b>AAHU's With Project</b>	<b>Net Change in AAHU's</b>
Riparian	38	76	0	91.2	91.2
Oak Woodland	10	38	0	38.4	38.4
Wetlands	20	88	0	86.4	86.4
Shallow Water habitat	14	0	0	11.2	11.2
SRA	12	24	0	28.8	28.8
GGG	201	69	0	216	216
Green Sturgeon	10	0	0	8	8
VELB	31	69	0	80	80
<b>Grand Total:</b>	<b>336</b>	<b>364</b>	<b>0</b>	<b>560</b>	<b>560</b>

<i>Increment</i>	<b>On Site Costs Alt 5</b>	
	<i>Onsite Cost/ Acre</i>	<i>Cost All Onsite</i>
Riparian	\$55,000	\$2,090,000
Oak Woodland	\$50,000	\$500,000
Wetlands	\$130,000	\$2,600,000
Shallow Water habitat	\$55,000	\$770,000
SRA	\$55,000	\$660,000
GGs	\$5,000	\$1,005,000
Green Sturgeon	\$150,000	\$1,500,000
VELB	\$85,000	\$2,635,000
<b>Grand Total:</b>	<b>\$585,000</b>	<b>\$11,760,000</b>

<i>Increment</i>	<b>Mitigation Bank Costs Alt 5</b>			
	<i>Bank Cost/ Acre</i>			<i>Cost at a Bank</i>
Riparian	\$75,000			\$2,850,000
Oak Woodland	\$75,000			\$1,200,000
Wetlands	\$130,000			\$4,680,000
Shallow Water habitat	\$130,000			\$1,820,000
SRA	\$75	\$75/lf-46,000lf	50,000	\$3,750,000
GGs	\$60,000			\$1,380,000
Green Sturgeon	\$150,000			\$1,500,000
VELB	\$4,500	Credit	16	\$7,704,000
<b>Grand Total:</b>	<b>\$624,575</b>			<b>\$24,884,000</b>

<i>Increment</i>	<b>Combination Onsite and Mitigation Bank Costs Alt 5</b>				
	<i>Onsite Cost/ Acre</i>	<i>Bank Cost/ Acre</i>	<i>Cost on Site</i>	<i>Cost at a Bank</i>	<i>Total Cost</i>
Riparian	\$55,000	\$75,000	\$2,090,000	\$0	\$2,090,000
Oak Woodland	\$50,000	\$75,000	\$500,000	\$450,000	\$950,000
Wetlands	\$130,000	\$130,000	\$2,600,000	\$2,080,000	\$4,680,000
Shallow Water habitat	\$55,000	\$130,000	\$770,000	\$0	\$770,000
SRA	\$55,000	\$75	\$660,000	\$0	\$660,000
GGs	\$60,000	\$60,000	\$12,060,000	\$1,380,000	\$13,440,000
Green Sturgeon	\$150,000		\$1,500,000		\$1,500,000
VELB	\$85,000	\$4,500	\$2,635,000	\$4,968,000	\$7,603,000
<b>Grand Total:</b>	<b>\$640,000</b>	<b>\$474,575</b>	<b>\$22,815,000</b>	<b>\$8,878,000</b>	<b>\$31,693,000</b>

<i>Increment</i>	<b>Combination Onsite and Mitigation Bank Costs Recommended Plan:1 Alt 5</b>				
	<i>Onsite Cost/ Acre</i>	<i>Bank Cost/ Acre</i>	<i>Cost on Site</i>	<i>Cost at a Bank</i>	<i>Total Cost</i>
Riparian	\$55,000	\$75,000	\$2,090,000	\$2,850,000	\$4,940,000
Oak Woodland	\$50,000	\$75,000	\$500,000	\$1,650,000	\$2,150,000
Wetlands	\$130,000	\$130,000	\$2,600,000	\$6,760,000	\$9,360,000
Shallow Water habitat	\$55,000	\$130,000	\$770,000	\$0	\$770,000
SRA	\$55,000	\$75	\$660,000	\$0	\$660,000
GGs	\$60,000	\$60,000	\$12,060,000	\$4,140,000	\$16,200,000
Green Sturgeon	\$150,000		\$1,500,000		\$1,500,000
VELB	\$85,000	\$4,500	\$2,635,000	\$4,968,000	\$7,603,000
<b>Grand Total:</b>	<b>\$640,000</b>	<b>\$474,575</b>	<b>\$22,815,000</b>	<b>\$20,368,000</b>	<b>\$43,183,000</b>

<i>Increment</i>	<b>Combination Onsite and Mitigation Bank Costs 2:1 Alt 5</b>				
	<i>Onsite Cost/ Acre</i>	<i>Bank Cost/ Acre</i>	<i>Cost on Site</i>	<i>Cost at a Bank</i>	<i>Total Cost</i>
Riparian	\$55,000	\$75,000	\$2,090,000	\$5,700,000	\$7,790,000
Oak Woodland	\$50,000	\$75,000	\$500,000	\$2,850,000	\$3,350,000
Wetlands	\$130,000	\$130,000	\$2,600,000	\$11,440,000	\$14,040,000
Shallow Water habitat	\$55,000	\$130,000	\$770,000	\$0	\$770,000
SRA	\$55,000	\$75	\$660,000	\$1,800	\$661,800
GGs	\$60,000	\$60,000	\$12,060,000	\$4,140,000	\$16,200,000
Green Sturgeon	\$150,000		\$1,500,000		\$1,500,000
VELB	\$85,000	\$4,500	\$2,635,000	\$4,968,000	\$7,603,000
<b>Grand Total:</b>	<b>\$640,000</b>	<b>\$474,575</b>	<b>\$22,815,000</b>	<b>\$29,099,800</b>	<b>\$51,914,800</b>

The following pages include the outputs from the CE/ICA IWR Plan software. The Recommended Plan is the Alternative 5 Combination Plan with a 2:1 ratio, because it is the smallest mitigation proposal that accomplishes the terms and conditions of the Biological Opinions, and the CE/ICA determined that it was a cost effective plan.

**West Sacramento GRR EIS/EIS  
Appendix I**

**Enclosure 4**  
Cost Effective/Incremental Cost Analysis Report

# West Sacramento GRR Cost Effective and Incremental Cost Analysis

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## Metadata:

**Planning Study Name:** West Sacramento GRR

**Planning Study Description:**

**Planning Set Name:** CEICA Analysis 2

**Planning Set Description:** Planning set generated by Cost Effective/Incremental Cost Analysis.

**Parent Set Name:** Planning Set 1

**CE/ICA Analysis Variables: Output**

**Variable = Output Cost Variable =**

Cost

The following section presents a summary of benefit-cost analyses performed during development of the West Sacramento GRR. The Institute for Water Resources Planning Suite version IWR Planning Suite 2.0.8.1 (Uncertainty Beta), release 04 Mar 2013 was used to produce information summarized in the following pages. Likewise, the following are metadata for the file(s) from which the information presented in the following pages was produced:

File Name	File Date	Module	Module Version
PlanningStudy3.mdb	12/7/2015	Plan Editor	2.0.8.1

## References:

- Rogers, C., Robinson, M., Skaggs, L., & Heisey, S. (2006, November). IWR Planning Suite User's Guide. Alexandria, VA, United States of America: United States Army Corps of Engineers.
- Brandreth, B., & Skaggs, L. (2002, October). Lessons Learned from Cost Effectiveness and Incremental Cost Analyses. *IWR Report 02-R-5*. Alexandria, Virginia, United States of America: U.S. Army Corps of Engineers.
- Orth, K. (1994, October). Cost Effectiveness Analysis for Environmental Planning: Nine EASY Steps. *IWR Report 94-PS-2*. Alexandria, Virginia, United States of America: U.S. Army Corps of Engineers.
- Robinson, R., Hansen, W., Orth, K., & Franco, S. (1995, May). Evaluation of Environmental Investments Procedures Manual. *IWR Report 95-R-1*. Alexandria, Virginia, United States of America: U.S. Army Corps of Engineers.

## Benefit-Cost Analysis Variable Definitions:

The following table provides a summary of the variables used during development of benefit-cost analyses performed during development of the West Sacramento GRR. The table provides a summary of variables, units, definitions, and any formulas/computations (where relevant) associated with individual variables that are dependent on values of multiple user-provided values costs or benefits.

Planning Study Variable Properties					
Name	Units	Description	Type	Derived Function (if applicable)	Allowable Range
Cost	\$1000	Cost in \$1000	Currency		Any
Output	HU	Output in Habitat Units	Decimal		Any

## Costs and Benefits Summary:

The following table provides a summary of average annual equivalent monetary costs and benefits, and average annual non-monetary costs and benefits considered during development of each alternative in West Sacramento GRR. In addition to annualized costs and benefits considered during development of cost-benefit analyses, total cost and total benefits associated with each alternative are also shown (reflected as present value) for each alternative.

### Total and Average Cost

12/7/2015

11:04:38AM

#### All Plan Alternatives

Planning Set: CEICA Analysis 2

Counter	Output Name	HU	Cost \$1000	Average Cost
1	No Action Plan	0.00	0.00	
2	Alternative 3 On Site	132.00	10,855.00	82.23
3	Alternative 1 On Site	154.40	12,495.00	80.93
4	Alternative 5 Mitigation Bank	204.80	24,884.00	121.50
5	Alternative 5 On Site	268.80	11,760.00	43.75
6	Alternative 1 Mitigation Bank	269.60	31,726.00	117.68
7	Alternative 3 Combo 1:1	279.20	28,790.00	103.12
8	Alternative 3 Mitigation Bank	304.80	34,989.00	114.79
9	Alternative 1 Combo 1:1	308.00	28,624.00	92.94
10	Alternative 5 Combo 1:1	360.00	31,693.00	88.04
11	Alternative 3 Combo 2:1	396.00	41,095.00	103.78
12	Alternative 1 Combo 2:1	451.20	43,333.00	96.04
13	Alternative 5 Combo 2:1	468.80	43,183.00	92.11
	Recommended Plan			
14	Alternative 3 Combo 3:1	488.80	51,720.00	105.81
15	Alternative 5 Combo 3:1	560.00	51,915.00	92.71
16	Alternative 1 Combo 3:1	573.60	63,437.00	110.59

## Incremental Costs and Benefits Summary:

The following table provides a summary of incremental costs and benefits associated with each alternative considered during development of the West Sacramento GRR. For each of the considered alternatives, it shows the "added" cost associated with delivery of benefits exceeding the "next-best" cost-effective alternative.

### Incremental Cost of Best Buy Plan Combinations (Ordered By Output)

12/7/2015

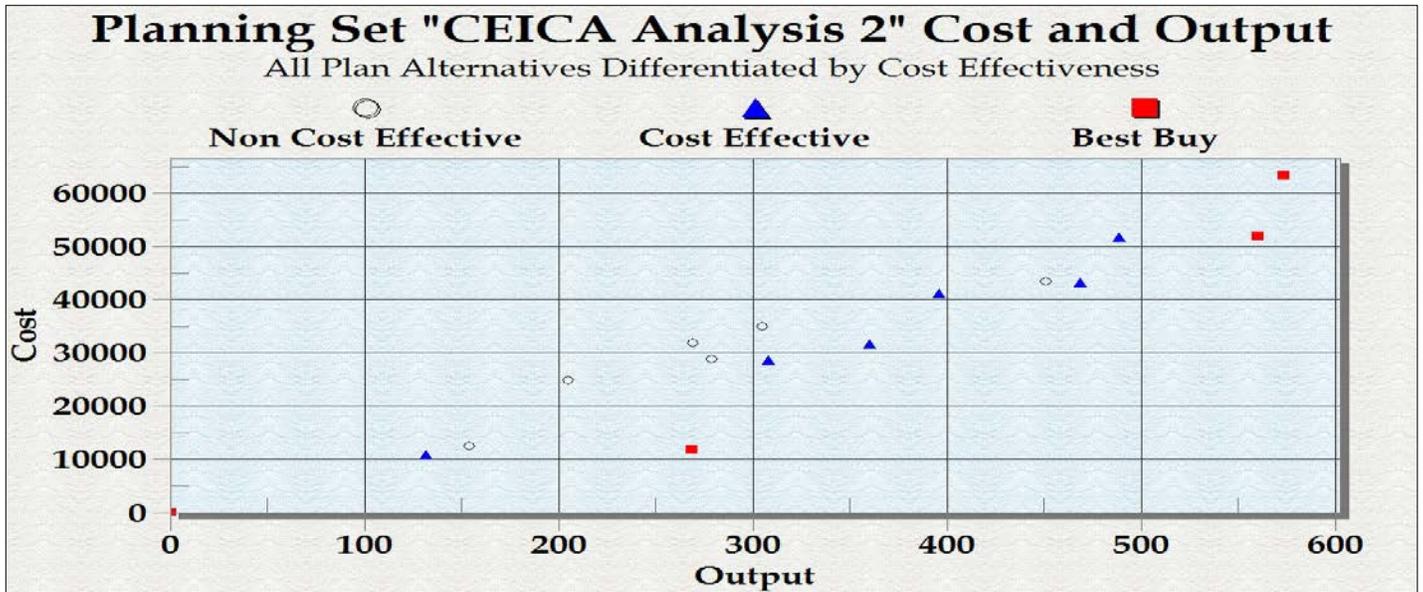
11:04:39AM

Planning Set: CEICA Analysis 2

Counter	PlanAlternative	Output (HU)	Cost (\$1000)	Average Cost (\$1000 / HU)	Incremental Cost (\$1000)	Inc. Output (HU)	Inc. Cost Per Output
1	No Action Plan	0.00	0.00				
2	Alternative 3 On Site	132.00	10,855.00	82.2348	10,855.0000	132.0000	82.2348
3	Alternative 1 On Site	154.40	12,495.00	80.9262	1,640.0000	22.4000	73.2143
4	Alternative 5 Mitigation Bank	204.80	24,884.00	121.5039	12,389.0000	50.4000	245.8135
5	Alternative 5 On Site	268.80	11,760.00	43.7500	-13,124.0000	64.0000	-205.0625
6	Alternative 1 Mitigation Bank	269.60	31,726.00	117.6780	19,966.0000	0.8000	24,957.5000
7	Alternative 3 Combo 1:1	279.20	28,790.00	103.1160	-2,936.0000	9.6000	-305.8333
8	Alternative 3 Mitigation Bank	304.80	34,989.00	114.7933	6,199.0000	25.6000	242.1484
9	Alternative 1 Combo 1:1	308.00	28,624.00	92.9351	-6,365.0000	3.2000	-1,989.0625
10	Alternative 5 Combo 1:1	360.00	31,693.00	88.0361	3,069.0000	52.0000	59.0192
11	Alternative 3 Combo 2:1	396.00	41,095.00	103.7753	9,402.0000	36.0000	261.1667
12	Alternative 1 Combo 2:1	451.20	43,333.00	96.0395	2,238.0000	55.2000	40.5435
13	Alternative 5 Combo 2:1 Recommended Plan	468.80	43,183.00	92.1139	-150.0000	17.6000	-8.5227
14	Alternative 3 Combo 3:1	488.80	51,720.00	105.8101	8,537.0000	20.0000	426.8500
15	Alternative 5 Combo 3:1	560.00	51,915.00	92.7054	195.0000	71.2000	2.7388
16	Alternative 1 Combo 3:1	573.60	63,437.00	110.5945	11,522.0000	13.6000	847.2059

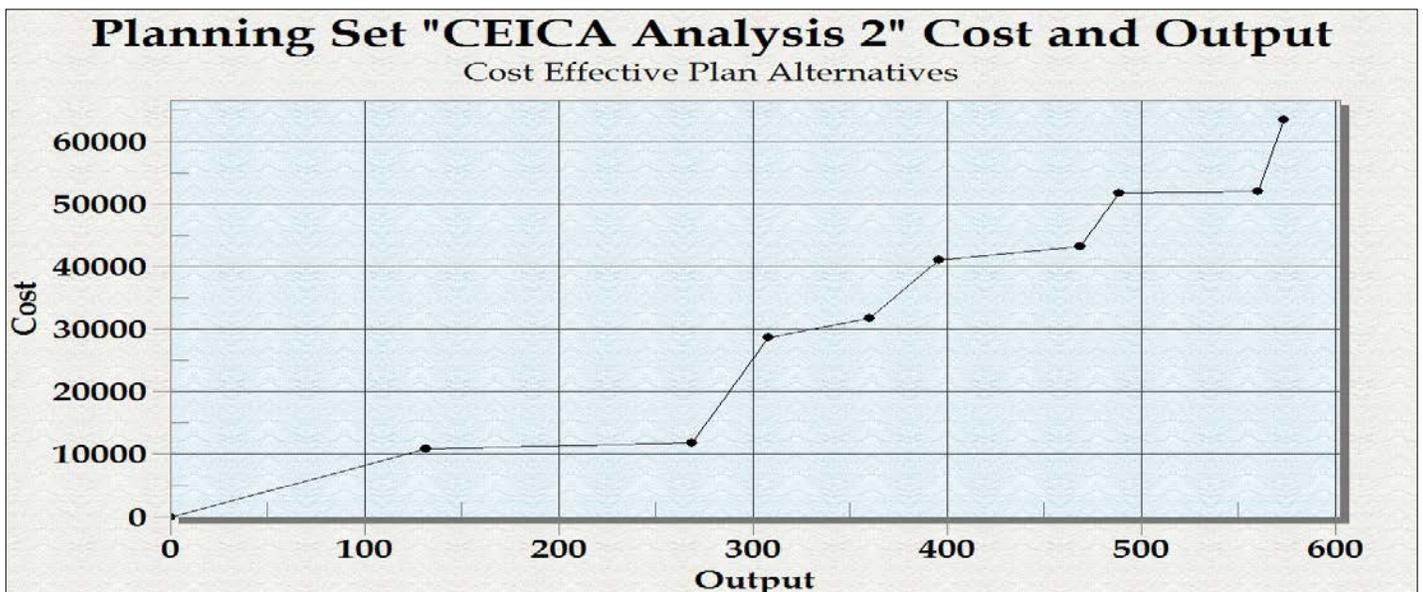
### Chart of Alternatives:

This chart provides an illustration of costs and benefits associated with alternatives generated during development of the West Sacramento GRR. Alternatives are charted based on their benefit (x-axis) and cost (y-axis) coordinates.



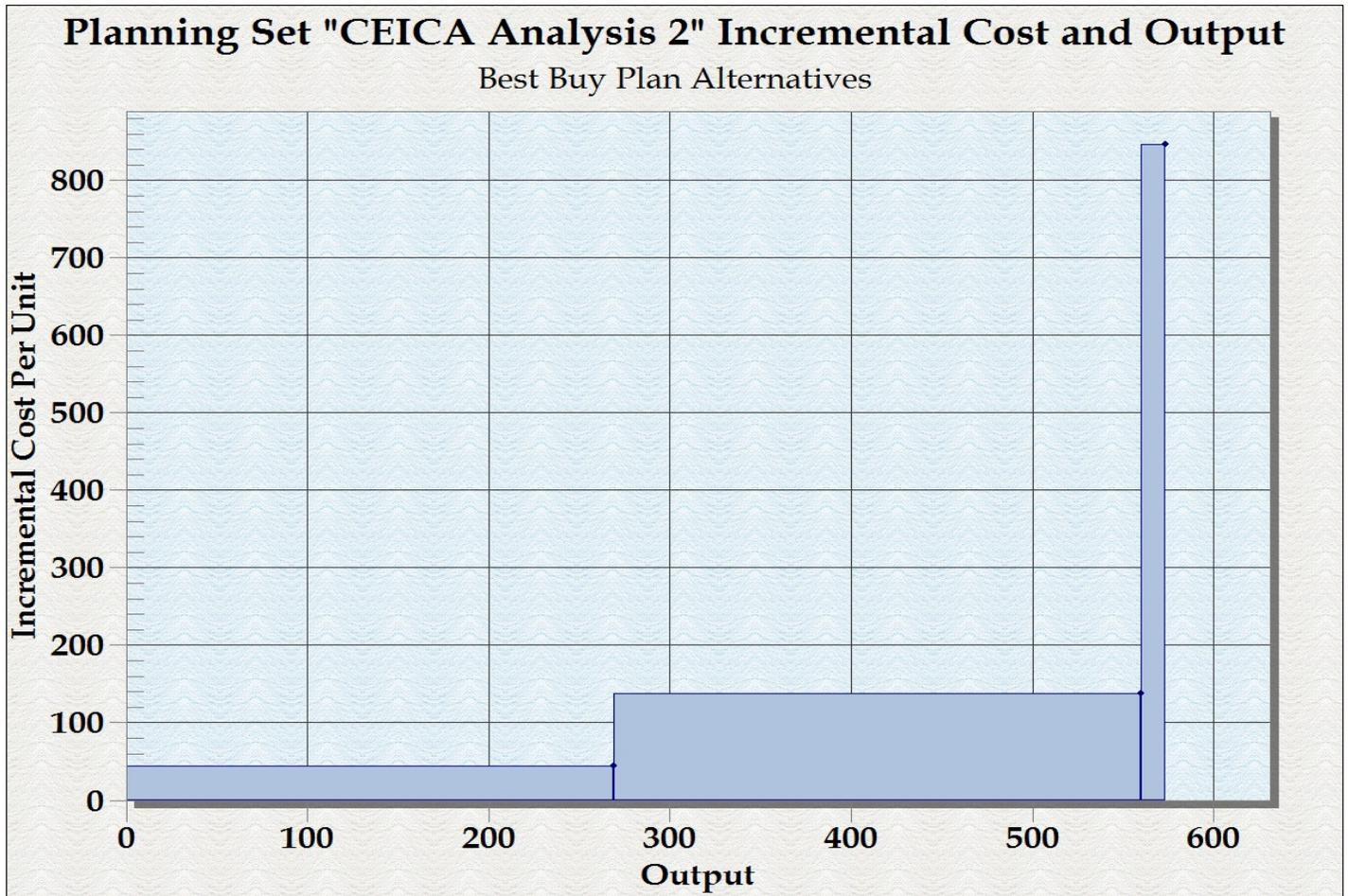
### Chart of Cost-Effective Alternatives:

This chart provides an illustration of costs and benefits associated with cost-effective alternatives considered during development of the West Sacramento GRR. Alternatives are charted based on their benefit (x-axis) and cost (y-axis) coordinates. The depicted alternatives have been identified among the most cost-effective of the alternatives considered during development of the West Sacramento GRR.



### Chart of Incremental Costs and Benefits of Alternatives:

This chart provides an illustration of costs and benefits associated with alternatives considered during development of the West Sacramento GRR. The magnitudes of incremental benefits (width of rectangle) and incremental costs (height of rectangle) are represented to illustrate the relative magnitudes of each alternative's "added" costs associated with benefits exceeding the "next-best" cost-effective alternative.



**West Sacramento GRR EIS/EIR  
Appendix J**

**Final Biological Opinions**

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**West Sacramento GRR EIS/EIR  
Appendix J**

**Final Biological Opinions  
Enclosure 1**

**USFWS Biological Opinion**

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# United States Department of the Interior



In Reply Refer to:  
08ESMF00-  
2014-F-0434-R001

FISH AND WILDLIFE SERVICE  
Sacramento Fish and Wildlife Office  
2800 Cottage Way, Suite W-2605  
Sacramento, California 95825-1846

Ms. Alicia E. Kirchner  
Chief, Planning Division  
U.S. Army Corps of Engineers  
1325 J Street  
Sacramento, California 95814

DEC 02 2015

Subject: Reinitiation of the West Sacramento Project General Reevaluation Report, Yolo County, California

Dear Ms. Kirchner:

This letter is in response to the U.S. Army Corps of Engineers (Corps) November 19, 2015, request for reinitiation of formal consultation with the U.S. Fish and Wildlife Service (Service) on the West Sacramento Project General Reevaluation Report (West Sacramento GRR Project or project) in Yolo County, California. Your request was received by mail from the Corps by the Service on November 23, 2015. The Corps has provided a clarification on the conservation measures for the federally-listed threatened giant garter snake (*Thamnophis gigas*). The revised conservation measures will cause a change in the effects analysis. To aid the reading of the revised biological opinion the Service is revising text within the document. Changed text will be bolded. This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act), and in accordance with the implementing regulations pertaining to interagency cooperation (50 CFR 402).

The purpose of the West Sacramento GRR Project is to evaluate flood risk and provide improvements to flood management for the City of West Sacramento. It includes the Southport Project, which is to be completed as an early implementation project by the West Sacramento Area Flood Control Agency (WSAFCA) upon permission from the Corps, pursuant to Section 14 of the River and Harbors Act of 1899 (33 U.S.C. 408). Pursuant to 50 CFR 402.12(j), you submitted the biological assessment for our review and requested concurrence with the findings presented therein. These findings conclude that the proposed project may affect, and is likely to adversely affect the federally-threatened giant garter snake (*Thamnophis gigas*) (snake), federally-threatened valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (beetle), and federally-threatened delta smelt (*Hypomesus transpacificus*) (smelt), as well as delta smelt critical habitat.

In considering your request, we based our evaluation of the biological assessment's findings on the following: (1) your consultation request and biological assessment received November 24, 2014; (2) site visits with Service, Corps, WSAFCA, ICF International (ICF) representatives, and others; (3) numerous meetings with the Service, Corps, National Marine Fisheries Service (NMFS), WSAFCA, ICF, and others; (4) e-mail correspondence and other communication between the Service and the Corps; and (5) other information available to the Service. A complete administrative record is on file at the Sacramento Fish and Wildlife Office.

**Consultation History**

- May 26, 2011* The Service attended a stakeholders meeting outlining preliminary plans for the Southport Early Implementation Project (Southport Project). The Southport Project was planned to proceed in advance of the other portions of the West Sacramento GRR Project.
- August 15, 2011* WSAFCA held a stakeholder meeting and field visit for the Southport Early Implementation Project of the West Sacramento GRR Project, which the Service and the Corps attended.
- February 12, 2013* The Corps provided the Service a draft biological assessment prepared by ICF for the Southport Project.
- February 21, 2013* The Service provided comments on the draft biological assessment for the Southport Project. The comments centered on the need to include the delta smelt in the biological assessment.
- June 3, 2013* The Service attended a meeting and site visit along with representatives from WSAFCA, ICF, NMFS, the California Department of Fish and Wildlife (CDFW), and others to review the proposed plans for the Southport Project.
- June 5, 2013* The Service received a formal consultation request for the Southport Project from the Corps, dated June 4, 2013, along with a biological assessment.
- August 27, 2013* The Corps hosted a meeting with the Service, NMFS, WSAFCA, and ICF. Mike Hendrick (NMFS) noted that NMFS would be preparing an insufficiency letter based on the project design noted in the Southport Project biological assessment.
- September 4, 2013* Harry Kahler (Service) e-mailed Tanis Toland (Corps) noting that in lieu of impending changes to the Southport Project description, work on the consultation would be suspended until the project description was updated.
- December 18, 2013* The Service attended a meeting at ICF discussing design modifications to the Southport Project that addressed concerns raised in NMFS insufficiency letter and previous meetings.
- January 23, 2014* The Service received from the Corps a draft biological assessment for the West Sacramento GRR Project. The biological assessment did not contain information regarding the Southport Project.
- March 20, 2014* The Corps hosted a meeting attended by the Service and NMFS to discuss the inter-relatedness of concurrent projects – the Southport Project, the West Sacramento West Sacramento GRR Project, the Sacramento River Bank Protection Project, and the American River Watershed Investigation, Common Features, General Reevaluation Report Project.
- April 21, 2014* The Corps hosted a meeting attended by the Service and NMFS. The Service recommended that the Southport Project and the West Sacramento GRR Project be included in one biological opinion.

- June 9, 2014* The Service received a request from the Corps to initiate formal consultation on the West Sacramento GRR Project. The initiation letter and biological assessment included the Southport Project.
- June 19, 2014* The Service conveyed to the Corps via telephone and e-mail that effects to smelt and smelt critical habitat are quantified in terms of acreage, rather than in linear feet of river, as is the case for salmonids. The Service requested the Corps provide the acreage of smelt shallow water habitat that is to be affected by the West Sacramento GRR Project.
- July 23, 2014* The Service sent a letter to the Corps detailing the need for more information regarding the amount of smelt habitat that will be impacted by the project and the amount of smelt habitat that will be created.
- September 24, 2014* The Service received a response from the Corps, dated September 23, 2014, describing the amount of smelt shallow water habitat that will be impacted by the West Sacramento GRR Project and the amount that will be created by the Southport Project.
- October 16, 2014* The Corps held a meeting with the Service and NMFS, stating that they would be seeking incidental take coverage from Section 9 of the Act for the West Sacramento GRR Project as a whole, rather than taking a programmatic approach.
- October 20, 2014* The Service downloaded an updated biological assessment from the Corps' FTP site.
- October 27, 2014* The Corps sent via electronic mail a copy of a letter to the Service that officially withdrew the June 4, 2013, request for consultation for the Southport Project based on updated information regarding the West Sacramento GRR Project Plans.
- November 21, 2014* The Corps sent via electronic mail a new request to initiate formal consultation for the West Sacramento GRR Project. An electronic link was included that provided access to the November 2014 final biological assessment.
- November 24, 2014* The Service received by mail the signed request to initiate formal consultation for the West Sacramento GRR Project along with the biological assessment that addressed concerns raised by the Service and NMFS following the initiation request received June 9, 2014.
- November 25, 2014* The Service requested and received, via electronic mail and telephone conversations, clarification regarding the identification and selection of potential sites for construction borrow material. The Corps explained that although potential borrow sites are identified for the West Sacramento GRR Project, the sites are subject to field verification for suitability.
- November 19, 2015* **The Corps sent a letter requesting reinitiation with the Service on the West Sacramento GRR Project.**

*December 1, 2015* The Corps sent an electronic mail to the Service with a request to revise the Conservation Measures for valley elderberry longhorn beetle.

## BIOLOGICAL OPINION

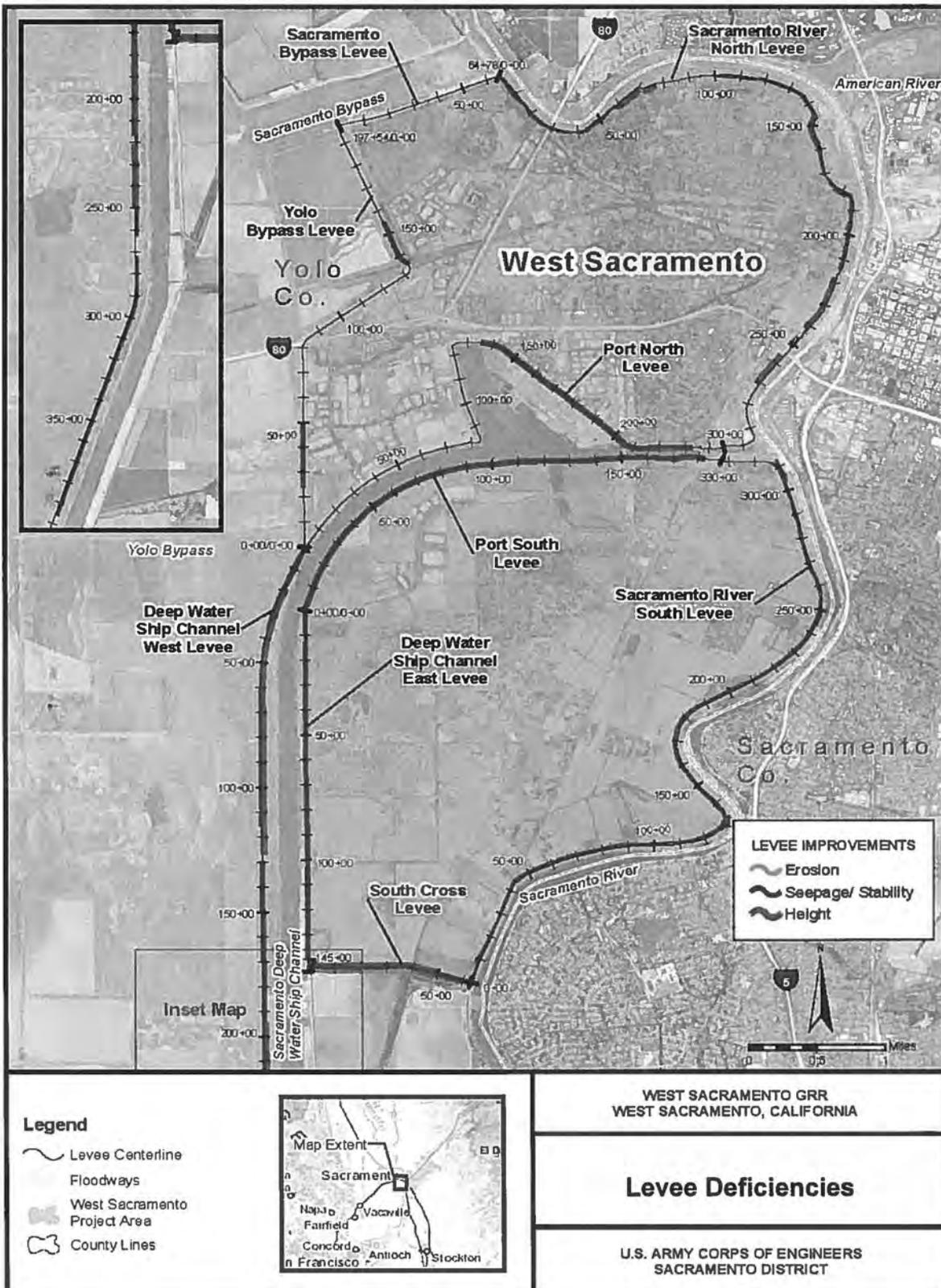
### Description of the Action

In 2006, a comprehensive evaluation of West Sacramento levees was completed by WSAFCA, in conjunction with the California Department of Water Resources, to determine the current level of flood protection provided by the levee system, to identify the magnitude and severity of levee deficiencies, and to propose flood risk reduction measures (HDR 2008). Results of the comprehensive evaluation revealed multiple levee deficiencies that would require substantial improvements to meet flood protection standards as implemented federally by the Corps. Furthermore, Senate Bill 5 signed in 2007 by Governor Arnold Schwarzenegger requires that urban areas such as West Sacramento achieve 200-year level flood protection by 2025.

The West Sacramento GRR Project is a Corps feasibility study of the improvements needed to provide West Sacramento with 200-year level flood protection. Its primary purpose is to assess and address the levee deficiencies on the nearly 50 miles of levees surrounding West Sacramento. Improvements to levees will be made incrementally, rather than altogether as one large project. In fact, three levee reaches with severe deficiencies have already been constructed by WSAFCA as Early Implementation Projects at the I Street Bridge, the CHP Academy, and The Rivers sites, all progressing in advance of the West Sacramento GRR Project. A fourth Early Implementation Project, known as the Southport Project, is included herein as part of the West Sacramento GRR Project.

West Sacramento is divided into two basins by levees, a north basin of about 6,100 acres and a south basin of about 6,900 acres. Deficiencies identified among different levee reaches of each basin generally include seepage, slope stability, erosion, and height insufficiencies (Figure 1). Construction will occur sequentially through each levee reach over a 19-year period, beginning with the Sacramento River South Levee. As a proposed Early Implementation Project, the Southport Project design along the Sacramento River South levee reach is more refined and detailed than the rest of the West Sacramento GRR Project. The proposed levee remediation measures vary among the nine levee reaches of the two basins and are summarized in Table 1.

**Figure 1.** West Sacramento General Reevaluation Report Project levee deficiencies, City of West Sacramento, Yolo County, California (Corps 2014b).



**Table 1.** Proposed remediation by levee reach, West Sacramento General Reevaluation Report, City of West Sacramento, Yolo County, California (Corps 2014b).

Levee Reach	Construction Sequence and Duration*	Seepage Remediation	Stability Remediation	Overtopping Remediation	Erosion Protection
NORTH BASIN					
Sacramento River North	3 (2 years)	Cutoff Wall	Cutoff Wall	Levee Raise	Bank Protection
Port North	9 (2 years)	---	---	Floodwall	---
Yolo Bypass	4 (1 year)	Cutoff Wall	Cutoff Wall	---	---
Sacramento Bypass Training Levee	2 (1 year)	---	---	---	Bank Protection
SOUTH BASIN					
South Cross	8 (2 years)	Stability Berm, Relief Wells	---	Levee Raise	---
Deep Water Ship Channel East	7 (3 years)	Cutoff Wall	Cutoff Wall	Levee Raise	Bank Protection
Deep Water Ship Channel West	5 (3 years)	Cutoff Wall	Cutoff Wall	Levee Raise	---
Port South	6 (1 year)	Cutoff Wall	Cutoff Wall	Levee Raise	---
Sacramento River South	1 (3 years)**	Setback Levee, Cutoff Wall, Seepage Berm	Setback Levee, Cutoff Wall, Seepage Berm	---	Setback Levee, Bank Protection

\* Construction throughout all levee reaches is scheduled to occur sequentially over a 19-year period.

\*\* Construction of flood-risk reduction measures will require 3 years; contouring and restoration of the associated offset floodplain area will require an additional 3 years.

## Operation and Maintenance

As construction along levee reaches throughout the West Sacramento GRR Project area is completed, re-sloping and compacting will occur as needed. After construction, piezometers will be installed at various locations along the levees to monitor groundwater levels. Monthly visual inspections by driving along access roads on the crown will monitor levee conditions. Access roads will be maintained yearly with new aggregate base or substrate if necessary. Upon completion of construction, levees will be maintained per the approved operations and maintenance (O&M) manual applicable to each levee reach throughout the West Sacramento GRR Project area. Levees are expected to be mowed up to four times a year to control vegetation. Herbicide applications will be used as needed. Burrowing mammal activity will be controlled monthly by baiting with pesticides.

Details of each specific construction measures are described below, followed by descriptions of the deficiencies and corrective construction measures for each levee reach of the West Sacramento GRR Project.

## **Construction Methods**

Several construction methods will be used to alleviate seepage, slope stabilization concerns, overtopping, and erosion. In addition, some general construction measures will be implemented throughout the West Sacramento GRR Project, regardless of the specific corrective measures that will be applied. Flood risk reduction measure construction activities will primarily occur during the typical construction season for flood control projects, April 15 to October 31.

### General Construction Measures

#### *Standard Levee Footprint*

On all levees that are out of compliance with Corps policies, a standard levee footprint will be established during construction. The standard levee footprint consists of a 20-foot crown with 3 horizontal:1 vertical (3H:1V) levee slopes. If a 3H:1V landside slope is not possible given the site-specific conditions, then a minimum slope of 2H:1V will be established. Also, a 20-foot-wide maintenance access buffer will be established on both the landside and waterside levee toes. If 20 feet is not possible, given site-specific conditions, then a minimum of 10 feet will be designed as a buffer. All encroachments into the levee footprint will be brought into compliance with Corps policy or removed. Encroachments include buildings, certain vegetation, utility poles, and pump stations, as well as underground pipes, conduits, and cables. Bringing into compliance generally means relocation, reconstruction, or retrofitting. Any utility lines found within the levee footprint will either be relocated above the new levee prism, or equipped with positive closure devices for through-lines. Private encroachments will be removed by the non-Federal sponsor (WSAFCA) or property owner prior to construction.

#### *Vegetation Policy Compliance*

The Corps has established and plans to follow guidelines for landscape planting and vegetation management at levees, floodwalls, embankment dams, and appurtenant structures, as described in Engineering Technical Letter (ETL) 1110-2-583 (Corps 2014a). The primary purpose of the vegetation-free zone is to provide a reliable corridor of access to, and along, flood control structures. A three-dimensional vegetation-free zone will surround all levees, floodwalls, embankment dams, and critical appurtenant structures in all flood damage reduction systems. The vegetation-free zone applies to all vegetation except perennial grass species, which are permitted for the purpose of erosion control. The vegetation free zone extends 15 feet from both landside and waterside levee toes, and 8 feet vertically.

A variance from the vegetation policy is being sought for work along the Sacramento River North and Sacramento River South levee reaches. Along much of the Sacramento River within the project area, the distance between the levee toe and the river waterline is sufficient to allow vegetation to remain along the riverbank without a variance. However, in some places, trees will be thinned along the Sacramento River North Reach to allow placement of rock slope protection, and therefore would require a variance.

### *Borrow Materials*

A maximum estimate of 9 million cubic yards of borrow material will be needed to construct the West Sacramento GRR Project. Because most of the project is in the preliminary stages of design, detailed studies of each levee reach borrow needs have not been completed. A worst case scenario was evaluated for the volume of borrow material needed. Actual volumes exported from any single borrow site may be adjusted to match demands for fill.

To identify potential locations for borrow material, soil maps and land use maps were obtained for a 20-mile radius surrounding the West Sacramento GRR Project area (Figure 2). The criteria used to determine potential locations were based on current land use patterns, soil types from U.S. Soil Conservation Service (SCS), and the Corps' criteria for material specifications. The data from the land use maps and the SCS will be field verified. To reduce impacts, the closest identified potential borrow sites will be evaluated for suitability first, with additional sites being evaluated as needed. Any identified potential borrow sites outside of the City of West Sacramento that may affect federally-listed species, or may adversely modify designated federally-listed species critical habitat, will not be used for borrow material. Borrow sites will only be obtained from willing sellers.

The excavation limits on the borrow sites will provide a minimum buffer of 50 feet from the edge of the site boundary. From this setback, the slope from the existing grade down to the bottom of the excavation will be no steeper than 3H:1V. Excavation depths from the borrow sites will be determined based on available suitable material and local groundwater conditions. The borrow sites will be stripped of top material and excavated to appropriate depths. Once material is extracted, borrow sites will be returned to their existing use whenever possible, or these lands could be used to mitigate for project effects, if appropriate.

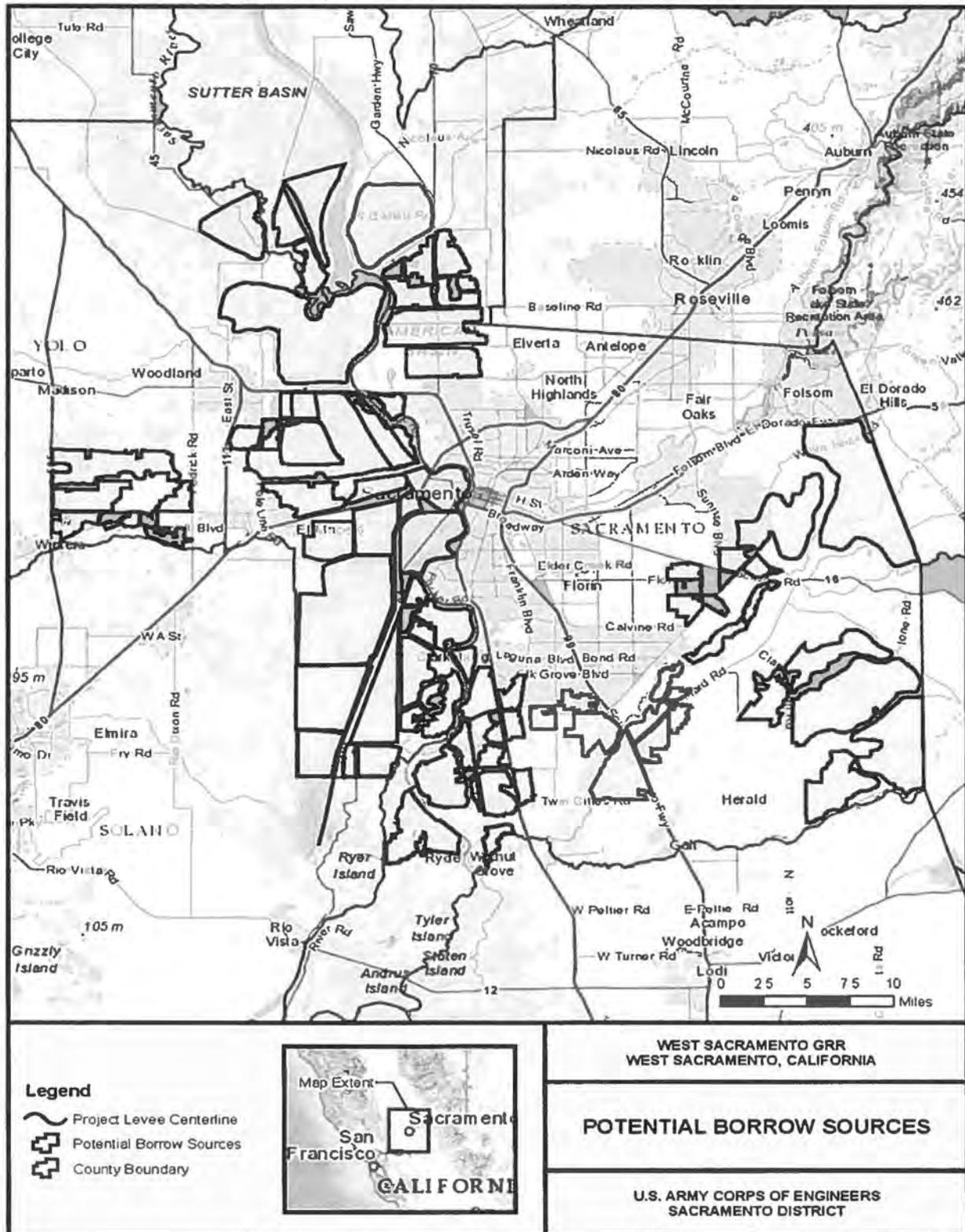
### Seepage Remediation and Slope Stabilization

#### *Slurry Cutoff Walls*

Conventional Open Trench Cutoff Wall: A 3-foot-wide trench is dug from the top of the levee centerline up to 85 feet deep into the substrate materials. As the trench is excavated, it is filled with a temporary bentonite slurry to prevent cave-ins. To form the wall, the soil from the excavation is mixed with hydrated bentonite or cement and backfilled into the trench, displacing the temporary slurry. Once the permanent soil-slurry mix is hardened, the levee embankment is reconstructed and capped with an impervious or semi-impervious soil. Heavy equipment to be used for cutoff walls includes bulldozers, haulers, excavators, scrapers, rollers, and water trucks.

Clamshell Method Cutoff Wall: The clamshell method is similar to the conventional open trench method, yet also employs a dragline crane with a clamshell bucket. The initial trench is excavated and backfilled as described for the conventional open trench method, yet the dragline crane and clamshell bucket is used when the trench becomes too deep to complete conventionally. The bentonite grout is mixed with the native soil and poured in the trench as the clamshell is removed. Cement is added to the mix at times to add strength and decrease curing time.

**Figure 2.** Potential Locations for Borrow Material within a 20-mile Radius of the West Sacramento General Reevaluation Report Project action area, California, 2014.



Deep Soil Mixing Cutoff Wall: At the wall site a crane with two to four augers will drill through the levee crown to a depth of up to 140 feet. High-pressure hoses will carry the grout from the batching plant to the wall site, where the grout is injected through the augers and mixed with native soils. As the drilling apparatus progresses along the levee crown, a series of overlapping columns of grout mixture are left to form the wall.

Because large quantities of a cement-bentonite grout are used, a contractor-provided onsite batch plant is necessary. The batch plant will consist of an aggregate storage system, an aggregate rescreen system if needed, a rewashing facility if needed, the batching system, cement storage, ice manufacturing, and the grout mixing and loading system. All aggregate used within the batch plant operations will be obtained from local commercial sources and delivered to the site. When the wall has hardened it is capped and the levee embankment is reconstructed with impervious or semi-impervious materials.

Jet Grouting: Jet grouting typically is used in constructing a slurry cutoff wall to access areas other methods cannot. Jet grouting will be used around existing utilities not proposed for removal, and at bridges along the project levees. It involves injecting fluids or binders into the soil at very high pressure to a maximum depth of about 130 feet. The injected fluid can be grout; grout and air; or grout, air, and water. Jet grouting breaks up soil and, with the aid of a binder, forms a homogenous mass that solidifies over time to create a mass of low permeability.

Equipment required for jet grouting consists of a drill rig complete with a high flow pump and portable batch plant. Jet-grouted columns range from 1 to 16 feet in diameter and typically are interconnected to form cutoff barriers or structural sections. A construction crew usually consists of a site supervisor, pump operator, batch plant operator, chuck tender, and driller, and can construct two 6-foot diameter 50-foot columns per day consisting of about 100 cubic yards of grout injected per 8-hour shift.

To provide a wide enough working platform on the levee crown, the upper portion of some segments of the levee may require degradation with a paddle wheel scrapper. Material will be scraped and stockpiled at a nearby stockpile area. Hauling at the work area will involve scraper runs along the levee to the staging area, and grout, bentonite, and water deliveries to the batch plant.

### *Landside Berms*

Seepage Berm: Seepage berms are constructed in areas where geotechnical investigations indicate that safely releasing seepage water on the landside is more appropriate than a cutoff wall. Generally a seepage berm extends outward from the landside toe of the levee to a width of 70 to 100 feet. The berm is about 5 feet high at the levee toe and tapers to about 3 feet high at the berm toe. The length of the berm is dependent upon the levee seepage concerns.

To construct a seepage berm, the ground is first cleared, grubbed and stripped. If the soil is found to be adequate for berm construction during levee degradation, it will be stockpiled for use later. Otherwise, soils from nearby borrow pits will be used, or if necessary, trucked onsite from other locations. A bulldozer and front-end loader will be used at borrow sites to load haul trucks. Motor graders will be used onsite to grade materials dumped by haul trucks. The fill material is placed in 1- to 2-foot lifts for compaction by sheepsfoot rollers. The width of the berm is dependent on the permeability of the fill material. Water trucks are used to aid compaction and decrease dust emissions. Upon completion, berms are hydroseeded with a native seed mix of grass and forbs. Additionally, some seepage berms are constructed with a drainage relief trench at the toe of the berm. Generally, a drainage trench is made with loose gravel or sand beneath the toe of the berm.

materials to allow the drainage of permeated water. Also, a 15-foot vegetation free zone running parallel to the seepage berm is designed to allow O&M access.

**Stability Berm:** Stability berms are constructed along the landside toe of levees with the purpose of providing support to the levee as a buttress. The height of a stability berm is usually  $2/3$  the height of the levee, and the length is dependent on the structural needs of the levee reach. The construction of stability berms is similar to the construction of seepage berms. Plans for the South Cross levee reach include a stability berm.

#### *Adjacent Levees*

Adjacent levee designs essentially widen the existing levee, thereby allowing the adjacent levee geometry to be restructured on the landside to a 3H:1V slope, and also adding stability. Because adjacent levees are constructed on the landside, the waterside levee slopes are generally left with existing vegetation in place.

The first construction phase includes clearing, grubbing, and stripping the work site and any construction staging areas, if necessary. A trapezoidal trench is cut at the toe of the slope and the levee embankment then is cut in a stair-step fashion to allow the new material to be keyed into the existing material. As with berm construction, bulldozers excavate and stockpile material from a nearby borrow site. Front-end loaders load haul trucks with the borrow material, and the haul trucks subsequently transport it to the adjacent levee site. After the haul trucks dump the material, dozers level it as needed. Sheepsfoot rollers compact the material, and water trucks distribute water over the material to ensure proper moisture for compaction. The landside levee will be graded at a 3H:1V slope, and the levee crown will be at least 20 feet wide. The slope may be track-walked with a dozer. The levee crown will be finished with an aggregate base or paved road, depending on the type and level of access desired. Either condition will require importation of material with dump trucks, placement with a loader and motor grader, and compaction. A paver will be required for asphalt placement.

#### *Sheet Pile Wall*

A sheet pile wall is proposed at the Stone Locks to tie together the levees on both sides of the Barge Canal at the end of the Sacramento River Deep Water Ship Channel. A trench will be excavated along the sheet pile alignment to allow the pile to be driven to the proposed depth. A driving template fabricated from structural steel will control the alignment as the sheet pile is installed. A hydraulic or pneumatically operated pile driving head attached to a crane drives the sheet pile into the levee crown to the desired depth (up to 135 feet). An additional crane or excavator may be used to facilitate staging of the materials. The conditions of the site, driving pressure, hydrostatic loads, and corrosion considerations will determine the thickness and configuration of the sheet piles.

#### *Relief Wells*

Relief wells are used to address underseepage and will be applied only on site-specific conditions rather than as a segment-wide application. They will be located along adjacent and setback levee toes in the South Basin and only in segments where geotechnical analyses have identified continuous sand and gravel layers and the presence of an adequate impermeable layer. Relief wells are passive systems that are constructed near the levee landside toe to provide a low-resistance pathway for under-seepage to exit to the ground surface in a controlled and observable manner. Relief wells generally are spaced at 50- to 150-foot intervals, dependent on the amount of underseepage, and extend to depths of up to 150 feet. Areas for relief well construction are cleared, grubbed, and

stripped. During relief well construction, a typical well-drilling rig will be used to drill to the required depth and construct the well beneath the ground surface. The drill rig likely will be an all-terrain, track-mounted rig that could access the well locations from the levee toe.

Areas along the levee toe may be used to store equipment and supplies during construction of each well. Construction of each well and the lateral drainage system typically takes 10 to 20 days. Additional time may be required for site restoration.

### Overtopping Remediation

#### *Levee Height Raise*

Height deficiencies are constructed as needed following the completion of cutoff wall installation and levee geometry corrections. The required additional materials will come from identified borrow pits, stockpiled in staging areas, and hauled to the site with trucks and front end loaders. The levee will be hydroseeded once construction is complete.

#### *Floodwalls*

Floodwalls are proposed along the Port North levee around the Port of West Sacramento. To begin the floodwall construction, the area will be cleared, grubbed, stripped, and excavation will occur to provide space to construct the footing for the floodwall. The floodwall largely will be constructed from pre-fabricated materials, although it may be cast or constructed in place, and will be constructed almost completely upright. The height of the floodwalls varies from 1 to 4 feet, as required by water surface elevations. The waterside slope will be re-established to its existing slope and the levee crown will grade away from the wall and be surfaced with an aggregate base.

### Erosion Protection

#### *Levee Slope Revetment*

The primary erosion protection measure consists of waterside armoring of the levees to prevent erosion and subsequent damage to the levee. This measure consists of placing rock revetment on the river bank, and in some locations on the levee slope, to prevent erosion. The extent of the revetment will be based on site-specific analysis. Along the Sacramento Bypass Training levee, revetment will be placed on both sides of the levee to protect the levee in place when the Sacramento and Yolo Bypasses contain water. When necessary, eroded portions of the bank will be filled and compacted prior to the rock placement. The sites will be prepared by clearing and stripping the site prior to construction. Rock revetment will be placed around existing trees on the lower portion of the slope. Trees on the upper portion of the slope will be removed during degrading of levees for slurry cutoff walls and bank protection will be placed following reconstruction of the levee. Temporary access ramps will be constructed, if needed, using imported borrow material that will be trucked on site.

Revetment will be imported from an offsite location via haul trucks or barges. Revetment transported by haul trucks will be temporarily stored at a staging area located in the immediate vicinity of the construction site. A loader will be used to move revetment from the staging area to an excavator that will place the material on site. Rock required on the upper portions of the slopes will be placed by an excavator located on top of the levee. Rock placement from atop the levee will require one excavator and one loader for each placement site.

Revetment transported by barges will not be staged, but placed directly on site by an excavator. Rock required within the channel, both below and slightly above the water line at the time of placement, will be placed by an excavator located on a barge. The excavator will construct a large rock berm in the water up to an elevation slightly above the mean summer water surface. Construction will require two barges: one barge will carry the excavator, while the other barge will hold the stockpile of rock to be placed on the channel slopes.

The bank protection will be placed on the existing bank at a slope varying from 2V:1H to 3V:1H depending on site specific conditions. After rock placement is complete, a small planting berm will be constructed in the rock, when feasible, to allow for some revegetation of the site outside of the vegetation free zone required by ETL 1110-2-583.

#### *Levee Biotechnical Measures*

Biotechnical measures will be implemented along lower velocity reaches to preserve existing vegetation. Biotechnical measures include the use of plant material and minimal amounts of rock to stabilize the eroded slope and prevent further loss of levee materials.

#### *Setback Levee*

A setback levee is an entirely new section of levee built at some distance inland from the existing levee section to be replaced. The new levee section is constructed to meet current design standards for height and geometry. Similar to the levee slope stabilization methods, a setback levee construction site is first cleared, grubbed, stripped, and all encroachments into the alignment are removed. Materials are stockpiled at staging areas after being removed and hauled from borrow sites. Heavy equipment is used to manipulate materials on site. Once the designed height is reached, a slurry cutoff wall is put in the levee crown via the conventional slot trench method or clamshell method, depending on the necessary depth. Topsoil is added and the new levee section is hydroseeded. An all-weather, aggregate base is constructed on the levee crown.

#### **North Basin Levee Reaches**

Table 2 shows the extent to which each construction measure will occur within each levee reach in the North Basin. Refer to Figure 1 for the approximate location of each proposed improvement.

#### Sacramento River North

The Sacramento North levee reach extends 5.5 miles from the Sacramento Bypass southward to the William Stone lock structure at the north end of the Sacramento River Deep Water Ship Channel. It is scheduled as the third reach for construction of the project. Slurry cutoff walls will be installed to different depths along the reach to address seepage and slope stability concerns. The conventional open trench method will be used to install walls up to 85 feet deep. A deep slurry method will be used for walls that are installed to a depth greater than 85 feet. Also, to alleviate height deficiencies in some areas, the levee geometry will be restructured with fill materials. Erosion concerns along nearly the entire length of the Sacramento North levee reach will be addressed by bank protection measures. In general, bank protection will involve the placement of rock on the existing bank at a slope between 2V:1H to 3V:1H, depending on specific site conditions.

**Table 2.** The construction length, improvement, and construction measure of each levee reach within the North Basin of the West Sacramento General Reevaluation Report, City of West Sacramento, Yolo County, California (Corps 2014b).

North Basin Levee Reach	Length of Levee Reach (feet)	Length of Measure (feet)	Improvement	Measure
Sacramento River North Levee and Stone Lock Closure	31,270	30,000	Erosion	Bank Protection
		11,000	Seepage	Slurry Cutoff Wall to 30 feet
		1,500		Slurry Cutoff Wall to 80 feet
		500		Slurry Cutoff Wall to 45 feet
		5,500		Slurry Cutoff Wall to 110 feet
		4,600	Height	Embankment Fill
		550	Stone Lock Closure	Embankment Fill, Sheet Pile Wall
Port North Levee	23,225	8,500	Height	Floodwall, 4-10 feet
		14,000	Height	Embankment Fill
Yolo Bypass Levee	19,749	2,500	Seepage	Slurry Cutoff Wall to 40 feet
		2,000	Seepage	Slurry Cutoff Wall to 100 feet
Sacramento Bypass Training Levee	3,000	3,000	Erosion	Bank Protection

Additionally, the William Stone lock structure will be closed and the Sacramento River Deep Water Ship Channel barge canal will be blocked from the Sacramento River via a new levee embankment and sheet pile wall. A coffer dam will be constructed on the east side of the lock structure, and the new levee and sheet pile wall will be built within the dry area. The new levee will permanently connect the North and South Basins. It will require the relocation of three utility poles, two storm drains, and the removal of concrete infrastructure.

#### Port North

The Port North levee work is scheduled as the final reach of the West Sacramento GRR Project, extending 4.9 miles west from the William Stone lock structure at the Sacramento River. Work through the levee reach generally involves the construction of flood walls through the Port of West Sacramento to alleviate overtopping concerns (see Figure 1).

#### Yolo Bypass

To address seepage and slope stability problems, slurry cutoff walls will be constructed at two points along the Yolo Bypass levee. A conventional open trench cutoff construction method will be used to install cutoff walls in two places to depths of 40 feet and 100 feet. The Yolo Bypass levee is scheduled as the fourth levee reach to be addressed in the West Sacramento GRR Project.

### Sacramento Bypass Training Levee

Most of the south levee of the Sacramento Bypass was reconstructed as the CHP Academy Early Implementation Project in 2011. However, a 3,000-foot portion of the south levee that lies to the west of the CHP Academy Project is scheduled as the second levee reach to be addressed by the current West Sacramento GRR Project. Bank protection is proposed to address erosion issues.

### **South Basin Levee Reaches**

Table 3 shows the extent to which each construction measure will occur within each levee reach in the South Basin. Refer to Figure 1 for the approximate location of each proposed improvement.

### South Cross

The South Cross levee reaches west from the Sacramento River at the Riverview area of West Sacramento, to the Sacramento River Deep Water Ship Channel. Plans include a landside berm to address stability issues and a levee raise to address height concerns. It is scheduled as the eighth of the nine levee reaches to be addressed by construction under the project.

### Sacramento River Deep Water Ship Channel East

The east levee along the Sacramento River Deep Water Ship Channel protects the South Basin from inundation. Noted deficiencies in the east levee are seepage, slope stability, and insufficient height. Slurry cutoff walls will be installed to address the seepage and slope stability issues. In reconstructing the levee prism to address height concerns, the irrigation ditch at the landside toe of the levee will be moved landward, and will be replaced by two 48-inch diameter pipes in the area adjacent to existing housing development. The Sacramento River Deep Water Ship Channel east levee is scheduled as the seventh levee reach for construction of the project.

### Port South

The Port South levee has overtopping and seepage issues, as well as slope stability problems in a few areas. To alleviate the stability and seepage concerns, a seepage berm will be constructed. Also, relief wells will be added in certain areas to control additional seepage. The levee will be raised as well to address overtopping concerns. The Port South levee will be the sixth levee reach scheduled for construction in the project.

### Sacramento River Deep Water Ship Channel West

The west levee along the Sacramento River Deep Water Ship Channel provides a barrier between the ship channel and the Yolo Bypass. As a worst-case scenario, levee deficiencies at various locations along nearly 19 miles of the levee will be addressed. Slurry cutoff walls and seepage berms will be constructed to control seepage issues, and the levee will be raised to address overtopping concerns. On the west side of the levee, facing the Yolo Bypass, rock slope protection will be used to address erosion concerns. The Sacramento River Deep Water Ship Channel west levee is scheduled as the fifth reach for construction in the project.

**Table 3.** The construction length, improvement, and construction measure of each levee reach within the South Basin of the West Sacramento General Reevaluation Report, City of West Sacramento, Yolo County, California (Corps 2014b).

South Basin Levee Reach	Length of Levee Reach (feet)	Length of Measure (feet)	Improvement	Measure
South Cross Levee	6,273	1,100	Stability/Height	Stability Berm Embankment Fill
		5,000	Seepage/Height	Relief Wells Embankment Fill
Deep Water Ship Channel East Levee	17,171	1,500	Seepage	Slurry Cutoff Wall to 120 feet
		7,100	Seepage	Slurry Cutoff Wall to 130 feet
		2,600	Height	Embankment Fill
Port South Levee	16,262	15,600	Height	Embankment Fill
		1,000	Seepage	Slurry Cutoff Wall to 70 feet
Deep Water Ship Channel West Levee	100,260	9,000	Height/Seepage	Slurry Cutoff Wall to 85 feet
		7,000	Height/Seepage	Slurry Cutoff Wall to 50 feet
		9,000	Height/Seepage	Slurry Cutoff Wall to 75 feet
		75,300	Height	Embankment Fill
		100,000	Erosion	Bank Protection
Sacramento River South Levee	31,000	31,000	Seepage/Erosion	Setback Levee Bank Protection Slurry Cutoff Wall to 80 feet 70-foot Wide Seepage Berm

Sacramento River South – The Southport Project

The Southport Project, an Early Implementation Project along the Sacramento River South levee, will be the first levee reach to be addressed in the project. Construction is scheduled to begin in 2015 by the city of West Sacramento, in advance of the overall West Sacramento GRR Project. The Southport Project is proposed to construct flood risk reduction measures along the Sacramento River South levee in order to provide 200-year level of performance consistent with the State mandate for urbanized areas, as well as to provide opportunities for ecosystem restoration and public recreation.

The Southport Project is divided into eight segments, A-G, from south to north (Appendix A). Table 4 outlines the construction measures to be built in each section.

**Table 4.** Levee remediation measures of the Southport Project portion of the West Sacramento GRR Project, West Sacramento, Yolo County, California.

Southport Segment	Length (linear feet)	Remediation Measures
A	4,830	Slurry cutoff wall
B	115	Slurry cutoff wall
	1,955	Slurry cutoff wall and seepage berm
	3,490	Setback levee, slurry cutoff wall, seepage berm, bank stabilization at levee breach
C	4,490	Setback levee, slurry cutoff wall, seepage berm, toe rock and bank stabilization at levee breaches
	940	Setback levee, slurry cutoff wall, seepage berm, bank stabilization at erosion sites, waterside toe rock upstream and downstream of erosion sites
D	1,985	Setback levee, slurry cutoff wall, waterside toe rock upstream of erosion sites
E	995	Setback levee and slurry cutoff wall
	2,297	Setback levee, slurry cutoff wall, and seepage berm
F	5,583	Setback levee, slurry cutoff wall, seepage berm, bank stabilization and waterside toe rock at decommissioned levee breach, waterside toe rock and bank stabilization at other decommissioned levee breach
G	2,795	Slurry cutoff wall and bank stabilization at erosion site

The Southport project involves the following elements:

- Construction of flood risk reduction measures, including seepage berms, slurry cutoff walls, setback levees, rock and biotechnical slope protection, and encroachment removal;
- Partial degrade of the existing levee, forming a decommissioned “remnant levee;”
- Construction of an offset floodplain area using setback levees, supplying about 160 acres in total for subsequent habitat restoration of riparian and floodplain habitats;
- Construction of breaches in the remnant levee to open up the offset areas to Sacramento River flows;
- Road construction;
- Drainage system modifications; and
- Utility line relocations.

The levee flood risk reduction measure footprint includes the following elements: a waterside O&M easement where available, the levee from toe to toe, a seepage berm, and the landside O&M easement. The waterside and landside O&M easements will be assumed to be 20 feet wide and unpaved. The landside O&M easement follows the toe of the levee or the landside toe of seepage berms, where present. The utility corridor is included largely within the Village Parkway right-of-way. In Segment G, where existing residences are close to the existing levee, the landside O&M easement will vary from about a few feet to 100 feet between the proposed flood risk reduction measure toe and the existing residential lot lines. In Segment A, the landside O&M easement

coincides with South River Road. For segments where a suitable impermeable tie-in layer was not identified from the geotechnical explorations, a seepage berm will be constructed. Where a tie-in layer was located, a cutoff wall at the associated depth will be constructed. For levee reaches where a seepage berm will be constructed to address underseepage, a shallow cutoff wall also will be installed in lieu of an inspection trench.

A setback levee will be constructed in levee Segments B through F. A setback levee is an entirely new section of levee constructed at some distance behind the landside of the existing levee. The obsolete levee sections will remain in place and be breached to create an offset area containing two separate floodplains for the Sacramento River. The new section of levee will be tied into the existing levee to the south and north and become the Federal project levee. Once the foundation of the new setback is built up to a suitable elevation, a slurry cutoff wall will be constructed using either the conventional slot trench method or clamshell method.

The new levee section will be constructed to meet current design standards, including height and slope requirements. Levee slopes will be graded to a 3H:1V slope, and a crown at least 20 feet wide created. Topsoil will then be placed on the levee slopes and hydroseeded. For the purpose of levee inspection and emergency vehicle access, an aggregate base, all-weather levee-top patrol road will be constructed. Seepage berms for the Southport Project will vary from 50 to 100 feet in width. Lateral length will depend on seepage conditions along the area of identified levee deficiency.

#### *Southport Project Bank Erosion Sites*

Three bank erosion sites requiring repairs were identified in the project reaches along the Sacramento River; two sites are in Segment C and the third site is in Segment G (Appendix A). The Segment C sites will not be subject to the Corps vegetation policy, as they will be on the remnant levee; however, the Segment G site will be located on the Federal project levee and will comply with the vegetation policy. The repairs at all three sites are designed to protect against erosional forces that threaten levee stability, such as wind, waves, boat wake, and fluvial forces.

#### *Southport Project Remnant Levee Sites*

The two erosion sites on the remnant levee are C1 and C2. Once the setback levees for the Southport Project are complete, the existing levee in Segment C will no longer be part of the Federal project levee. Site C1 has a top length of 160 linear feet, while Site C2 has a length of 547 linear feet. Remediation at Site C1 will address a scour hole that has formed on the slope between elevations of -33 feet, North American vertical datum of 1988 (NAVD 88), and +11 feet NAVD 88, as well as slumping that has occurred at the base of the slope. Remediation at Site C2 will address general erosion problems that have been created by wave erosion.

Design and Construction: Erosion site repairs on the remnant levee are designed both to control erosion and to maintain existing vegetation and instream woody material. This will be accomplished by incorporating rock benches that serve as buffers against erosion while providing space for planting riparian vegetation and creating a platform to support aquatic habitat features (Appendix A). Rock will be placed onto the levee slope from the waterside by means of barges; one barge will hold the stockpile of rock to be placed, and a second barge will hold the crane that will place the rock on the channel slopes. A backhoe will be used from the bank to adjust the rock. Clean rock fill will be placed over existing riprap between elevations of -33 feet NAVD 88 and +5 feet NAVD 88, and type C graded stone will be placed over the clean rock fill in a 2.5-foot thick layer with a 2H:1V slope from the toe of the slope to an elevation of +7 feet NAVD 88. The clean rock fill and graded stone at the top of the erosion site will be placed to form a planting bench at an

elevation of +7 feet NAVD 88 to match the average annual low-water surface elevation, and the bench will have an average width of about 10 feet. At Site C1, stone will be placed at the upstream and downstream ends of the site to address problems created by a scour hole along the site.

After the rock is placed along the slope of the erosion sites, a 1-foot thick layer of 0.75-inch crushed clean rock will be placed at the upslope end of the stone bench to create a filter between the topsoil and the stone bench. Topsoil then will be placed above the newly constructed bench at a 3H:1V slope to meet the existing bank, and coir fabric will be placed over the soil to keep it in place. Topsoil will be placed from a barge, similar to the process for placing the rock. Pole plantings will be hand-placed in the planting bench between elevations of +7 feet NAVD 88 and +11.5 feet NAVD 88. Beaver fencing will be installed at the upslope and downslope extents of the topsoil installation. Instream woody material will be anchored along the remnant levee erosion sites to achieve at least 40% shoreline coverage, and placed between 1 and 3 feet below the elevation of the average annual low water surface. Instream woody material will likely come from trees removed in other portions of the project area, and will be selected based on suitability for the site. Existing vegetation and riprap at the erosion site will be retained.

The two erosion sites on the remnant levee are located on the outer bank of a bend in the river and are therefore subject to greater erosive forces. Rock will be placed along the toe of the bank (toe rock) at both sites, as well as upstream and downstream of the erosion sites to further protect the bank of the remnant levee. The toe rock will begin about 850 feet upstream of Site C1, will extend through both erosion sites, and will terminate about 300 feet downstream of Site C2. Portions of this area are currently riprapped, and the additional toe rock to be placed will be limited to areas where there is currently no rock below an elevation of +7 feet NAVD 88.

#### *Southport Project Active Levee Erosion Site*

Site G3 is located in Segment G and therefore will remain as part of the Federal project levee. Site G3 includes 410 linear feet of repairs to the top of the erosion scarp and the creation of a planting bench and vegetated slope to protect against boat wake and fluvial erosion.

The design, construction equipment, methods, and materials for Site G3 are similar to those described for Sites C1 and C2. However, Site G3 will require additional rock armoring and soil fill (up to elevation +25 feet NAVD 88) to repair the erosion scarp and meet Federal levee protection standards. The proposed design includes riprap toe protection, earth and rock fill to restore the levee prism between elevation -10 feet NAVD 88 and +25 feet NAVD 88, a soil-covered 10-foot-wide planting bench (10H:1V slope) and bank (3H:1V slope) planted with pole cuttings and large container plantings, and instream woody material anchored between 1 and 3 feet below the elevation of the average annual low water surface. The planting bench will be 15 feet outside the minimum levee template.

#### *Southport Project Encroachment Removal*

Levee standards for vegetation and encroachments require removing encroachments, such as structures, levee penetrations (e.g., pipes, conduits, cables), power poles, pump stations, and similar features, from the levee footprint. Encroachment removal includes demolition, relocation, retrofitting, or reconstruction as appropriate on a case-by-case basis. Existing pilings within the river at Oak Knoll Bend also will be removed.

Encroachment removal techniques will be implemented based on the needs of the specific encroaching feature. Smaller encroachments will be removed, relocated, or retrofitted by manual

labor of small crews (about 2 to 10 workers) using hand tools. Larger encroachments require machinery such as an excavator, skid-steer, and bulldozer. The removal of sections of two-lane asphalt road will be required. Piling removal requires a barge with a crane for removal or cutting at the mud line. Dump trucks will be used for hauling and disposal of removed material at an offsite, permitted commercial source within 10 miles of the project area.

#### *Southport Project Remnant Levee Degrade*

With the construction of the setback levee, most of the decommissioned levee in Segments B through F will be degraded to provide additional borrow material for constructing seepage berms or for reclamation of other borrow areas. The remnant levee in Segment E will remain to maintain access to Sherwood Harbor Marina and Sacramento Yacht Club. Similarly, although the roadway will be removed up to the Sacramento Yacht Club, the levee will not be degraded on Segment F south of breach N2 to help protect the marinas during high flow events.

Prior to excavation, the area to be degraded will be cleared, grubbed, and stripped. The remnant levee will be degraded to an elevation of +30 feet NAVD 88, with a crown width of 20 feet and a landside slope of 3H:1V. Front-end loaders will load haul trucks with the excavated material. Haul trucks will transport the material to stockpile areas in the staging areas for later use for berms, or to borrow areas for use in site restoration. Material used for borrow area restoration will be spread evenly using motor graders and compactors. Disturbed areas will be planted as part of the offset area restoration plantings, and an unpaved O&M corridor will be established along the landside toe of the remnant segments.

#### *Southport Project Levee Breaches*

Portions of the remaining decommissioned levee will be breached to allow Sacramento River flows into two separate floodplain areas within the offset area during high flow events (Appendix A). The northern floodplain area breaches, from north to south, are North 1 (N1) and North 2 (N2) (both in Segment F), and the southern floodplain area breaches, from north to south, are South 1 (S1) (Segment C), South 2 (S2) (Segment C), and South 3 (S3) (Segment B). Construction of the breaches will occur during the summer–fall period to comply with Central Valley Flood Protection Board regulations. Both floodplain areas will be distinct from the existing Bees Lakes, which also will remain on the waterside of the new setback levee alignment.

Breaches S3 and N1 will be created in the third construction year and the remaining breaches will be completed 2 years later. Staggering the breaches will allow offset area restoration vegetation to establish before being exposed to flows. Until breaches S1, S2 and N2 are constructed, culverts will be installed at their proposed locations to drain the offset floodplain area. The culverts also will balance the hydraulic pressure on both sides of the degraded levee and to minimize fish stranding. Each culvert will be 54 inches in diameter and about 140 feet long. The culverts will be placed at about +7 NAVD in order to fully drain the offset floodplain area. To construct the breaches, the existing levee will be degraded with excavators to an elevation of +10 feet NAVD 88. Existing revetment in good condition will be retained below +10 NAVD 88. The breach shoulders will be armored with rock from the existing riprap on the waterside, over the degraded remnant levee crown, and down the landside slope. A 25-foot riprap apron then will extend out from the landside toe of the breach shoulder at an elevation of roughly +10 NAVD 88, as well as from the toe of the shoulder in the breach. All rock for the shoulder and apron armoring will be placed in a layer about 2.5 feet thick.

In-water construction activities are scheduled between July 1 and October 31, when water elevations in the Sacramento River along the project area are typically at the average annual low water elevation of +6.7 feet NAVD 88 to +7.1 feet NAVD 88. Installation of temporary cofferdams may be necessary prior to culvert installation to prevent river flows from entering the construction area. At a minimum, sandbags will be used to construct the cofferdam and water will be pumped out of the inundated construction area. Cofferdams will be constructed using sheet pile walls or other methods, and typically will extend up- and downstream of the end of the culverts to provide a temporary work area.

The upstream shoulder of breach N1 and the downstream shoulder of breach S3 have slightly different erosion control measures than the other breach shoulders. Breaches N1 and S3 are located at the sites where the new setback levee alignment deviates from the old, decommissioned levee alignment. Rock armoring will be placed on the slope of the waterside of the setback levee and will transition along the remnant levee segment.

On the waterside of the breaches, new riprap will be placed from the toe of the bank slope up to an elevation of +7 feet NAVD 88 in areas where the existing riprap is lacking. Breaches N1, N2, S1, and S2 also will have rock placed along portions of the base of the bank to further protect it from erosive forces. Coir fabric will be placed between elevations of +7 feet NAVD 88 and +10 feet NAVD 88, and will be planted with species suitable to create a vegetated bench. Coir fabric also will be placed in the zone between the edge of the +10 feet NAVD 88 elevation and the centerline of the breach, with jute netting continuing landward of the termination of the coir fabric for 100 feet. This area also will be planted with cuttings, rootstock, or container plants.

Rock will be placed onto the levee slope from atop the degraded levee, from the breach sill, from the waterside by means of barges, or by a combination of the three methods. Rock required within the channel, both below and slightly above the surface of the water at the time of placement, will be placed by a crane located on a barge and then spread by an excavator located on top of the levee or in the breach sill. Construction requires two barges—one barge to carry the crane and another to hold the stockpile of rock to be placed on the channel slopes—and one excavator located in the breach. Rock required on the upper portions of the slopes will be placed by an excavator located on top of the levee. Rock placement from atop the levee requires one excavator for each potential placement site. Loaders will haul rock from a permitted source within 25 miles of the project area and dump it within 100 feet of the levee breach. An excavator will move the rock from the stockpile to the waterside of the levee.

#### *Southport Project Offset Floodplain Area Restoration*

The offset floodplain area refers to the two expanded floodways located between the proposed setback levee and the decommissioned, remnant levee that will be created when portions of the existing levee are breached (Appendix A). Project activities in this area will include floodplain and riparian habitat restoration and borrow excavation. The offset floodplain areas will be planted to provide mitigation for vegetation removed as part of construction.

If suitable for reuse, excavated material will be used in construction of the setback levee and seepage berms. Following excavation, the offset area will be graded to allow the creation and restoration of riverine floodplain and riparian habitats. Excavation in the offset areas may require groundwater management, done by pumping water out of excavated areas.

After the first two levee breaches are constructed and before the final three breaches are made, restoration plantings will be established in the offset floodplain areas during the fall, winter, and

spring. Swales will be constructed in both offset floodplain areas, and the surrounding areas will be graded to create drainage to the swales as river stages decrease. Temporary and permanent erosion control measures such as jute netting, coconut fiber with net, live brush mattresses, and native turf will be used as appropriate to protect graded areas.

After breaches N2, S1, and S3 are constructed, three permanent cellular berms will be built across the offset area, between the setback levee and the remnant levee. The berms will be downstream of breaches N1, S1, and S2, and will create separate cells that will have independent drainage once water levels drop below the crest of the cellular berms. Material excavated from the breaches will be used to construct the cellular berms and construct terrain features. Berms will have a top elevation of +20 feet, top width of 20 feet, and side slopes no steeper than 10H:1V; they will overtop once water levels reach +20.0 feet NAVD 88. Floodplain upstream and downstream of the berms will be graded to drain away from the berms and to the closest existing levee breach location. Elevations in the offset floodplain area will vary from about +7.0 feet NAVD 88 to +20.0 feet NAVD 88 in order to provide broad habitat variability for a range of environmental and hydrodynamic conditions.

Habitats in the offset floodplain areas will be upland grasslands, riparian forest, shaded riverine aquatic habitat, and seasonal wetlands. Plants selected for establishment of each of the target plant communities were based on how the plants associate in nature, and the elevations at which these plants were observed growing along the Southport levee. A vegetation stratification survey on the Southport levee conducted by ICF in March of 2012 helped further inform and refine the restoration target plant communities. In the survey, different species of plants were observed to favor different elevation ranges based on species preferences and adaptations. The restoration design intends to mimic this vegetative stratification. Vegetation communities will include emergent marsh, riparian willow scrub, riparian cottonwood forest, mixed riparian woodland, elderberry shrubs and associated native plants for valley elderberry longhorn beetle habitat, and grassland. Planting of the offset area will take place in the fall following finish-grading operations and construction of the flood control features. Features of the offset area that are not finished in any given year will be kept free of vegetation to keep future construction areas clear.

Both container plants and pole cuttings may be used and will be spaced at regular intervals throughout the offset floodplain areas. Both overstory and understory species will be installed to mimic the natural structure of riparian forests along the Sacramento River. Supplemental irrigation will be provided for several years during the 3-year plant establishment period and then discontinued; irrigation water could possibly be pumped from the river or from an adjacent water supply by agreement with the owner. To avoid trampling or disturbing the plantings during the establishment period, signs will be posted at appropriate intervals providing notice that access to the restoration areas is not allowed.

A network of seasonal wetland swales will be excavated within the offset floodplain area cells and will inundate during high-water events on the Sacramento River to provide habitat for special-status native fish species. The swales will be constructed to elevations that provide shallow, low-velocity, off-channel habitat in the spring during high-water periods. Floodplain inundation is expected to occur at the 1-year recurrence interval event at depths between 0.5 and 3 feet, and at the 2-year recurrence interval event at depths ranging from 9 to 12 feet. Swale margins will be gently sloping to maximize edge habitat during flood events. Instream woody material structures will be installed in some of the swales to provide cover from predators. In larger flood events during the winter and spring, the upper riparian terraces will be inundated and provide additional areas of habitat for fish as well as contribute to the productivity of the river ecology.

The created swales will have several connections to the main river channel at the breach locations in order to maximize connectivity and minimize potential stranding as floodwaters recede. The swales will fully dewater by early summer in a given year, on average, to discourage use by nonnative fish. Areas of upland grassland in the offset floodplain area will serve as potential floodplain rearing habitat for native fish during periods of high flows, as well as foraging habitat for raptors during periods of low water.

O&M access to the offset areas will be provided by O&M corridors at the waterside toe of the setback levee and by unpaved O&M roads that cross the cellular berms. At a minimum, turnaround areas will be located at the breach shoulders.

#### *Southport Project Offset Area and Remnant Levee Revegetation*

Revegetation of the offset areas and remnant levee is proposed as a means to mitigate for construction effects. The riparian willow scrub target plant community will be established in zones with proper soil hydrology, between +8 feet and +10 feet NAVD 88. In the offset area, riparian willow scrub will be established just upslope from the constructed swales in a band width varying from about 10 to 150 feet. On the remnant levee, riparian willow scrub will be established in a narrow band varying from about 5 to 20 feet in width outside of the canopy of the existing trees that will remain. The plants selected for the riparian willow scrub planting are intended to establish a self-sustaining mix of riparian scrub dominated by four species of willows. The plant material installed could be container grown plants, cuttings, or a mixture of both. The areas within the offset area will be seeded, and the areas on the remnant levee with established herbaceous cover will not be seeded.

#### *Southport Project Road Construction, Marina Access, and Bees Lakes*

Village Parkway will be extended southward from its current intersection with Lake Washington Boulevard to Gregory Avenue near the project area's southern extent, moving South River Road traffic to the landside of the Sacramento River South Levee and to the future Village Parkway alignment. The existing alignment of South River Road in Segment A will be retained, as will the railroad abutments at the southern end of Segment A. However, a detour or permanent realignment of South River Road will be constructed at the south end of Segment A to maintain access on South River Road south of the project area during and after construction. Access roads will be built in Segment B to connect residences to the new Village Parkway alignment. At the project's northern extent, South River Road will be demolished. Where practicable, culverts will be constructed in ditches that are crossed by proposed roadways. Drainage ditches will be constructed along both sides of the new Village Parkway alignment, with an average width of 5 feet.

To maintain access between Sherwood Harbor Marina and Sacramento Yacht Club, South River Road will continue in its current alignment on the existing levee at Segment E and a portion of Segment F. However, to maintain access to the marinas, two new roads will be routed over the levee crown, across the offset area, and across the decommissioned levee. The two access roads will be constructed to the north and south of the Bees Lake area. While the embankments will not be part of the flood risk-reduction features, they will prevent hydraulic surface connectivity between Bees Lakes and the Sacramento River. Linden and Davis Roads will be connected to the new Village Parkway alignment to restore traffic circulation, and a cul-de-sac will be added at the end of Linden Road, past the intersection with Village Parkway.

Dual access ramps will be constructed along the levee alignment to provide O&M and emergency access to the levee-top patrol road. One ramp will be in Segment B where South River Road currently descends from the existing levee to meet Gregory Avenue; one ramp in Segment C; one ramp in Segment D at the terminus of Davis Road; one ramp in Segment F at the terminus of

Linden Road; and one ramp in Segment G near the northern end of the project alignment. Access to the levee-top patrol road also will be provided where the Sherwood Harbor Marina and Sacramento Yacht Club access road embankments cross the proposed setback levee crown. Access ramps will be gated and will have “no parking” signs.

#### *Southport Project Construction Schedule*

Construction of the Southport Project will occur in more than one annual construction season, with construction of flood risk–reduction measures beginning in April of 2015, and finishing in 2017. Construction and restoration of the offset floodplain area will continue after 2017, with final remnant levee breaches constructed in 2020. Some of the Village Parkway construction and utility relocations may occur earlier, but most of the work for those portions of the project will be done in 2015. A description of construction activities and tentative construction year is provided below.

#### 2015:

- Village Parkway construction and utility relocation will be completed.
- Construction of the entire length of the new setback levee will begin with the foundation and working platform. Construction of the cutoff wall will follow if weather allows.

#### 2016:

- The setback levee cutoff wall and remaining buildup of the setback levee will be constructed to a finished elevation of +40 feet NAVD 88.
- South River Road will be detoured at south end of Segment A.
- Seepage berms will be constructed following completion of the setback levee segments.
- Segment A and the southern portion of Segment B will be degraded to an elevation of +32 feet NAVD 88, and in Segment G the levee will be degraded to an elevation of +34.5 feet NAVD 88. Cutoff walls will then be constructed in these segments, tying into the setback levee cutoff walls in Segments B and F. The levee crown in Segment A and the southern portion of Segment B will then be built back up to a finished elevation of +39 feet NAVD 88, and the levee in Segment G will be built back up to a finished elevation of +40 feet NAVD 88. The slurry cutoff wall toe will be at an elevation of -5 feet NAVD 88 through Segments A, B, C, and D; at 0 feet NAVD 88 for Segments E, F, and the southern portion of G; and will be at -67 feet NAVD 88 for the remainder of Segment G.
- The remnant levee in Segments B, C, D, and F will be degraded to an elevation of +30 feet NAVD 88, and will have a 20-foot-wide crown. Remnant levee degrading will be concurrent with setback levee and seepage berm construction.
- Offset floodplain area grading will begin.
- Erosion site repairs at C1, C2, and G3 will be constructed.

#### 2017:

- Offset area grading will be completed. Culverts will be installed through the remnant levee at breaches N2, S1, and S2 to allow Sacramento River water flow into the offset floodplain areas.
- Breaches N1 and S3 will be constructed.
- Offset area planting will begin.

#### 2018:

- Offset area planting will continue.

2019:

- The three remaining breaches and the offset area cellular berms will be constructed, and the southern offset area will be contoured.

2020:

- Offset area planting will be completed.

At the end of each construction season, the levee system will be restored, at a minimum, to the level of flood risk–reduction performance existing at the project outset. During construction Years 1 and 2, “tie-ins” will be built connecting the existing levee to newly constructed segments, as needed. These tie-ins will be achieved by benching the existing levee and installing compacted lifts to completely bond the new and existing levee materials. During the flood season, maintenance of the flood risk–reduction structures will be undertaken by the maintaining agency, RD 900.

*Southport Project Sources of Borrow Material*

To meet borrow material demands for constructing the flood risk–reduction measures, multiple sources may be used, including the following.

- Embankment fill material excavated from the existing levee structure as part of construction.
- Material excavated from the offset areas.
- Material excavated from borrow sites located on open land within the city, or close to the city limits.
- Dredged material previously removed from the Sacramento River Deep Water Ship Channel (presently stockpiled on high-terrace, upland benches adjacent to the west of the channel).
- Material purchased from permitted commercial borrow locations within 20 miles of the project site (as described on pages 7-8).

*Southport Project Vegetation Removal*

Vegetation clearing activities entail removing larger woody vegetation, such as trees and shrubs. Grubbing activities consist of removing roots, and stripping activities requires excavating about 6 inches of organic material from the levee surface. Vegetation on the decommissioned levee segments along the Sacramento River levee will be retained where feasible, with the exception of the five breach locations. However, some vegetation will be removed as part of construction of the new setback levee, seepage berms, and the landside utility O&M corridor.

*Southport Project Staging Areas and Equipment Access*

Five staging areas are designated for the Southport Project. The staging areas are located on the landside of the levee at Segments C, D, and E, and occupy about 25.2 acres in total (Appendix A). Areas where seepage berms are proposed also may be used for staging until construction begins on the seepage berms. To facilitate project construction, temporary earthen ramps will be constructed to permit equipment access between the levee crown and each staging area. The earthen ramps will not affect any delineated water bodies and will be removed when construction is complete.

*Southport Project Operations and Maintenance*

Following construction of the Southport Project, only the rock slope protection, native vegetation, and other biotechnical features will be permanent. Anticipated O&M actions include regular visual inspections of the site, vegetation maintenance and irrigation for up to 3 years, and periodic repairs, as needed, to prevent or repair localized scour along the bank and rock toe of the site. The previously mentioned O&M activities that pertain to the project as a whole will also occur along Sacramento River South levee reach following the Southport Project construction.

**Conservation Measures**

As part of the West Sacramento GRR Project description, the Corps and WSAFCA have committed to implementing the following conservation measures to avoid and minimize potential effects on the snake, beetle, smelt, and smelt critical habitat. A number of measures will be applied to the entire project or specific actions, and other measures may be appropriate at specific locations within the study area. Avoidance activities to be implemented during final design and construction include, but are not limited to:

- Avoiding vegetation removal to the extent feasible.
- Avoiding, to the extent possible, grubbing and contouring activities.
- Identifying all habitats containing, or with a substantial possibility of containing, listed terrestrial, wetland, and plant species in the potentially affected project areas. To the extent practicable, efforts will be made to minimize effects by modifying engineering design to avoid potential direct and indirect effects.
- Incorporating sensitive habitat information within project bid specifications.
- Incorporating requirements for contractors to avoid identified sensitive habitats within project bid specifications.

General Conservation Measures

- The Corps will seek a variance exempting the Sacramento River levee reaches from vegetation removal as per ETL 1110-2-583 in the lower one-third of the waterside of the levee prior to final construction and design phase. Construction will require removal of vegetation on the upper two-thirds of the waterside and landside slope. Full ETL vegetation compliance will occur on the Sacramento and Yolo Bypasses, Yolo Bypass Toe Drain, South Cross Toe Drain, and the Sacramento River Deep Water Ship Channel, Barge Canal, and Port of West Sacramento levee reaches.
- The Corps will use a rock soil mixture (a 70:30 rock to soil ratio) to facilitate re-vegetation of the Sacramento River project sites that require bank protection work. The soil-rock mixture will be placed on top of the of the rock revetment along the Sacramento River levees to allow native riparian vegetation to be planted and ensure that shaded riverine aquatic habitat is replaced or enhanced.
- In addition to an approved vegetation variance, the Corps will avoid the removal of existing vegetation in the proposed project area. To the extent possible, disturbance or removal of trees or larger woody vegetation will be replaced onsite with native riparian species, except in the vegetation-free zone, as established in ETL 1110-2-583.
- Best management practices will be implemented to prevent slurry seeping out to the river and require a piping system on the landside.
- Construction materials such as portable equipment, vehicles, and supplies, will be stored at designated construction staging areas and barges, exclusive of any riparian and wetlands areas.

- All liquid chemicals and supplies will be stored at a designated impermeable membrane fuel and refueling station.
- Erosion control measures, including a Storm Water Pollution Prevention Program and a Water Pollution Control Program, will be implemented to minimize soil or sediment from entering the river. The measures shall be installed, monitored for effectiveness, and maintained throughout construction operations to minimize any effects to federally-listed fish and their designated critical habitat.
- Construction will be scheduled when listed terrestrial and aquatic species will be least likely to occur in the project area.
- Site access will be limited to the smallest area possible in order to minimize disturbance.
- Litter, debris, and unused materials will be removed from the project area daily. Such materials or waste will be deposited at an appropriate disposal or storage site.
- Any spills of hazardous materials will be cleaned up within 24 hours and reported to the resource agencies. Any such spills, and the success of the efforts to clean them up, shall also be reported in post-construction compliance reports.
- A Corps-appointed biologist will serve as the point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species. The representative shall be identified to the employees and contractors during an all employee education program conducted by the Corps.
- Screen any water pump intakes, as specified by NMFS and Service screening specifications. Water pumps will maintain an approach velocity of 0.2 feet per second or less when working in areas that may support delta smelt.

#### Giant Garter Snake Conservation Measures

The following measures will be implemented to minimize effects on giant garter snake habitat that occurs within 200 feet of any construction activity. These measures are based on Service guidelines for restoration and standard avoidance measures (Service 1997).

- **To the maximum extent possible, all construction activity within giant garter snake aquatic and upland habitat within 200 feet of aquatic habitat will be conducted during the snake's active period (May 1–October 1). During this time frame, potential for injury and mortality are lessened because snakes are actively moving and avoiding danger. The construction season is typically from April 15 to October 31, subject to weather and other conditions. Because some construction may extend into the giant garter snakes dormant period (October 2 to April 30), additional protective measures will be implemented at these locations. All of the following minimization measures must be implemented in order for work to continue past the October 1 deadline:**
  - **The Corps shall contact the Service on or before August 15, to determine if any additional measures are needed to minimize effects to the snake.**
  - **Work activities must commence on or before September 15.**
  - **A Service-approved biologist will be on-site daily to monitor all construction activities associated with the project throughout the entire extension period.**
  - **All emergent vegetation and vegetation within 200 feet of suitable aquatic habitat will be cleared prior to the giant garter snake**

- hibernation period (i.e., vegetation clearing must be completed by October 1).
- Snake exclusion fencing must be completely installed prior to the October 1 deadline.
- Construction personnel will participate in a Service-approved worker environmental awareness program.
- Staging areas will be located at least 200 feet from suitable snake habitat;
- Any dewatered habitat will remain dry for at least 15 consecutive days after April 15 and prior to excavating or filling of the dewatered habitat;
- Vegetation clearing within 200 feet of the banks of suitable snake aquatic habitat will be limited to the minimum area necessary. Avoided snake habitat within or adjacent to the action area will be flagged and designated as an environmentally sensitive area, to be avoided by all construction personnel;
- The movement of heavy equipment within 200 feet of the banks of suitable snake aquatic habitat will be confined to designated haul routes to minimize habitat disturbance; and
- Prior to ground-disturbing activities within 200 feet of suitable habitat, a Service-approved biological monitor will conduct a preconstruction survey of suitable aquatic and upland habitat and inspect exclusion and orange barrier fencing to ensure they are both in good working order each morning. Should there be any interruption in work for greater than 2 weeks, a biologist will survey the project area again no later than 24 hours prior to the restart of work. If any snakes are observed within the construction area at any other time during construction the biological monitor will be contacted to survey the site for giant garter snakes. The biological monitor will have the authority to stop construction activities until appropriate corrective measures have been completed or it is determined that the snake will not be harmed. Giant garter snakes encountered during construction activities will be allowed to move away from construction activities on their own. If they are unable to move away on their own, trapped or injured, giant garter snakes will only be removed by Service-permitted personnel and will be placed in the nearest suitable habitat that is outside of the construction area. The biological monitor will immediately report these activities to the Service by phone and will provide a written account of the details of the incident within 24 hours.
- Snake habitat within 200 feet of construction activities will be designated as an environmentally sensitive area and delineated with signs or fencing. This area will be avoided by all construction personnel.
- To reduce the likelihood of snakes entering the construction area, exclusion fencing and orange barrier fencing will be installed along the portions of the construction area that are within 200 feet of suitable aquatic and upland habitat. The exclusion and barrier fencing will be installed during the active period for giant garter snakes to reduce the potential for injury and mortality during this activity.
  - The construction specifications will require a provision to retain a qualified biologist to identify the areas that are to be avoided during construction. Areas adjacent to the directly affected area required for construction, including staging and access, will be fenced off to avoid disturbance in these areas. Before construction, the contractor will work with the qualified biologist to identify the locations for the barrier fencing and will place flags or flagging around the areas to be protected to indicate the locations of the barrier fences. The protected area will be clearly identified on the construction specifications.

Exclusionary fencing will be placed, at least 10 days prior to the beginning of ground disturbing activities after May 1, to exclude giant garter snakes from entering areas where upland disturbance (borrow sites and levees) will occur during the active season (May 1 to October 1). The fencing will be installed the maximum distance practicable from the aquatic habitat areas.

- The barrier fencing will consist of 4-foot-tall erosion fencing buried at least 6–8 inches below ground level. The exclusion fencing will be commercial-quality, tightly-woven polypropylene fabric, orange in color, and 4 feet high (Tensor Polygrid or equivalent). The fencing will be tightly strung on posts with a maximum of 10-foot spacing. Prior to fencing installation, the fence line will be mowed (with a minimum height of 6 inches) in order to conduct a surface survey of potential burrows. Fence staking will be installed on the inside of the exclusion area. One-way escape funnels will be installed every 50 to 100 feet and sealed along the fence line to provide an escape for any giant garter snake that may be within the exclusion area. The fencing will enclose the entirety of the site, or additional exclusionary fencing can be extended 200 to 400 feet beyond the proposed entrance area.
- Barrier and exclusion fences will be inspected daily by a qualified biological monitor during ground-disturbing activities. Once all initial ground-disturbing activities are completed, the biological monitor will perform weekly checks of the site for the duration of construction in order to ensure that construction barrier fences and exclusion fences are in good order, trenches are being covered, project personnel are conducting checks beneath parked vehicles prior to their movement, and that all other required biological protection measures are being complied with. The biological monitor will document the results of monitoring on construction monitoring log sheets, which will be provided to the Service within 1 week of each monitoring visit. Monitoring will continue until project construction is complete or until the fences are removed, as approved by the biological monitor and the resident engineer. The biological monitor will be responsible for ensuring that the buffer area fences around giant garter snake habitat are maintained throughout construction. Biological inspection reports will be provided to the project lead and the Service.
- To avoid the entrapment of snakes, all excavated areas more than 1 foot deep will be provided with one or more escape ramps constructed of earth fill or wooden planks at the end of each workday. If escape ramps cannot be provided, then holes or trenches will be covered with plywood or other hard material. The biological monitor or construction personnel designated by the contractor will be responsible for thoroughly inspecting trenches for the presence of giant garter snakes at the beginning of each workday. If any snakes become trapped, the Service-approved biological monitor will be contacted to relocate the snake, and no work will occur in that area until approved by the biological monitor.

If any giant garter snake habitat is affected by construction, the following measures will be implemented to compensate for the habitat loss:

- Habitat temporarily affected for one season (155 acres of upland habitat disturbed for borrow in the Southport area, 5 acres of upland habitat on Sacramento Bypass

training levees, 5 acres of upland habitat on the Yolo Bypass levee, 20 acres of upland habitat on the Sacramento River Deep Water Ship Channel (DWSC) west levee, 10 acres of upland habitat on the DWSC east levee, 4 acres of upland habitat on the South Cross levee, and 2 acres of aquatic habitat along the Port South) will be restored after construction by applying appropriate erosion control techniques and replanting/ seeding with appropriate native plants. If for any reason construction extends into another active season the Corps will replace the habitat on-site and purchase credits at a ratio of 1:1 at a Service approved conservation bank.

- Habitat temporarily affected three or more seasons will be restored and twice as much habitat will be created.
- Habitat permanently affected (10 acres of aquatic habitat along the DWSC east levee, 10 acres of aquatic habitat along the South Cross levee, 2.24 acres of upland habitat in the setback area and 1 acre of aquatic habitat along the Port South levee) will be compensated for through the purchase of 69.72 acres of credits at a Service approved conservation bank.
- One year of monitoring will be conducted for the 201 acres that are temporarily affected.
- The Corps will purchase credits at a conservation bank prior to any permanent disturbance of giant garter snake habitat
- A biological monitor will be on-site during all ground disturbing activities at borrow site 2.

#### Conservation Measures for the Southport Project

Because the Southport Project along the Sacramento River South levee is scheduled as an Early Implementation Project it will be the first construction project under the West Sacramento GRR Project, and therefore conservation measures have been established in greater detail. The Corps and WSAFCA have committed to implementing the following conservation measures as part of the Southport Project.

#### *Southport Project General Conservation Measures*

#### Conduct mandatory biological awareness training for all project personnel and implement general requirements:

Before any ground-disturbing work (including vegetation clearing and grading) occurs in the Southport Project action area, a Service-approved biologist will conduct a mandatory biological resources awareness training for all construction personnel about Federally listed species that could potentially occur onsite. The training will include the natural history, representative photographs, and legal status of each Federally listed species and avoidance and minimization measures to be implemented. Proof of personnel attendance will be provided to the Service within 1 week of the training. If new construction personnel are added to the Southport Project, the contractor will ensure that the new personnel receive the mandatory training before starting work. The subsequent training of personnel can include videotape of the initial training and/or the use of written materials rather than in-person training by a biologist. Elements of the training that will be followed by construction personnel are listed below:

- Where suitable habitat is present for listed species, WSAFCA will clearly delineate the construction limits through the use of survey tape, pin flags, orange barrier fencing, or other means, and prohibit any construction-related traffic outside these boundaries.

- Project-related vehicles will observe the posted speed limit on hard-surfaced roads and a 10-mile-per-hour speed limit on unpaved roads during travel in the project construction area.
- Project-related vehicles and construction equipment will restrict off-road travel to the designated construction areas.
- All food-related trash will be disposed of in closed containers and removed from the project construction area at least once per week during the construction period. Construction personnel will not feed or otherwise attract fish or wildlife to the project area.
- No pets or firearms will be allowed in the project area.
- To prevent possible resource damage from hazardous materials, such as motor oil or gasoline, construction personnel will not service vehicles or construction equipment outside designated staging areas.
- Any worker who inadvertently injures or kills a federally-listed species or finds one dead, injured, or entrapped will immediately report the incident to the biological monitor and construction foreman. The construction foreman will immediately notify WSAFCA, who will provide verbal notification to the Service within 1 working day. WSAFCA will follow up with written notification to the Service within 5 working days. The biological monitor will follow up with WSAFCA to ensure that the wildlife agencies were notified.

#### Prepare and implement a Stormwater Pollution Prevention Plan

Because ground disturbance would be greater than 1 acre, WSAFCA will obtain coverage under the U.S. Environmental Protection Agency's (EPA's) National Pollutant Discharge Elimination System (NPDES) general construction activity stormwater permit. The Central Valley Regional Water Quality Control Board administers the NPDES stormwater permit program in Yolo County. Obtaining coverage under the NPDES general construction activity permit generally requires that the project applicant prepare a stormwater pollution prevention plan that describes the Best Management Practices that will be implemented to control accelerated erosion, sedimentation, and other pollutants during and after project construction. The SWPPP will be prepared prior to commencing earth-moving construction activities.

The plan likely will include, but not be limited to, one or more of the following standard erosion and sediment control practices:

- The construction contractor will conduct all construction activities during the typical construction season to avoid ground disturbance during the rainy season. To the extent possible, equipment and materials will be staged in areas that have already been disturbed. No equipment or materials would be stored in the floodway during the flood season.
- The construction contractor will minimize ground disturbance and the disturbance/destruction of existing vegetation. This will be accomplished in part through the establishment of designated equipment staging areas, ingress and egress corridors, and equipment exclusion zones prior to the commencement of any grading operations.
- Grading spoils generated during the construction will be temporarily stockpiled in staging areas. Silt fences, fiber rolls, or similar devices will be installed around the base of the temporary stockpiles to intercept runoff and sediment during storm events. If necessary, temporary stockpiles may be covered with an appropriate geotextile to increase protection from wind and water erosion.
- The construction contractor may install silt fences, fiber rolls, or similar devices to prevent sediment-laden runoff from leaving the construction area.
- The construction contractor may install silt fences, drop inlet sediment traps, sandbag barriers, and/or other similar devices.

- The construction contractor will install structural and vegetative methods to permanently stabilize all graded or otherwise disturbed areas once construction is complete. Structural methods may include the installation of biodegradable fiber rolls and erosion control blankets. Vegetative methods may involve the application of organic mulch and tackifier and/or the application of an erosion control native seed mix.

#### Prepare and Implement a Bentonite Slurry Spill Contingency Plan (Frac-Out Plan)

Before excavation begins, WSAFCA will ensure the contractor will prepare and implement a bentonite slurry spill contingency plan (BSSCP) for any excavation activities that use pressurized fluids (other than water). If the contractor prepares the plan, it will be subject to approval by the Corps, NMFS, and WSAFCA before excavation can begin. The BSSCP will include measures intended to minimize the potential for a frac-out (“fracture-out event”) associated with excavation and tunneling activities; provide for the timely detection of frac-outs; and ensure an organized, timely, and minimum-effect response in the event of a frac-out and release of excavation fluid (bentonite). The BSSCP will require, at a minimum, the following measures:

- If a frac-out is identified, all work will stop, including the recycling of the bentonite fluid. In the event of a frac-out into water, the location and extent of the frac-out will be determined, and the frac-out will be monitored for 4 hours to determine whether the fluid congeals (bentonite will usually harden, effectively sealing the frac-out location).
- NMFS, CDFW, and the Central Valley Regional Water Quality Control Board will be notified immediately of any spills and will be consulted regarding clean-up procedures. A Brady barrel will be on site and used if a frac-out occurs. Containment materials, such as straw bales, also will be on site prior to and during all operations, and a vacuum truck will be on retainer and available to be operational on site within a 2-hour notice. The site supervisor will take any necessary follow-up response actions in coordination with agency representatives. The site supervisor will coordinate the mobilization of equipment stored at staging areas (e.g., vacuum trucks), as needed.
- If the frac-out has reached the surface, any material contaminated with bentonite will be removed by hand to a depth of 1 foot, contained, and properly disposed of, as required by law. The drilling contractor will be responsible for ensuring that the bentonite is either properly disposed of at an approved Class II disposal facility or properly recycled in an approved manner.
- If the bentonite fluid congeals, no other actions, such as disturbance of the streambed, will be taken that potentially would suspend sediments in the water column.
- The site supervisor has overall responsibility for implementing this BSSCP. The site supervisor will be notified immediately when a frac-out is detected. The site supervisor will be responsible for ensuring that the biological monitor is aware of the frac-out; coordinating personnel, response, cleanup, and regulatory agency notification and coordination to ensure proper clean-up; coordinating disposal of recovered material; and timely reporting of the incident. The site supervisor will ensure all waste materials are properly containerized, labeled, and removed from the site to an approved Class II disposal facility by personnel experienced in the removal, transport, and disposal of drilling mud.
- The site supervisor will be familiar with the contents of this BSSCP and the conditions of approval under which the activity is permitted to take place. The site supervisor will have the authority to stop work and commit the resources necessary to implement this plan. The site supervisor will ensure that a copy of this plan is available onsite and accessible to all construction personnel. The site supervisor will ensure that all workers are properly trained and familiar with the necessary procedures for response to a frac-out prior to the commencement of excavation operations.

### Prepare and Implement a Spill Prevention, Control, and Counter-Measure Plan

A spill prevention, control, and counter-measure plan (SPCCP) is intended to prevent any discharge of oil into navigable water or adjoining shorelines. WSAFCA or its contractor will develop and implement an SPCCP to minimize the potential for and effects from spills of hazardous, toxic, or petroleum substances during construction and operation activities. The SPCCP will be completed before any construction activities begin. Implementation of this measure will comply with state and Federal water quality regulations. The SPCCP will describe spill sources and spill pathways in addition to the actions that will be taken in the event of a spill (e.g., an oil spill from engine refueling will be immediately cleaned up with oil absorbents). The SPCCP will outline descriptions of containments facilities and practices such as double-walled tanks, containment berms, emergency shutoffs, drip pans, fueling procedures, and spill response kits. It will describe how and when employees are trained in proper handling procedure and spill prevention and response procedures. WSAFCA will review and approve the SPCCP before onset of construction activities and routinely inspect the construction area to verify that the measures specified in the SPCCP are properly implemented and maintained. WSAFCA will notify its contractors immediately if there is a noncompliance issue and will require compliance. If a spill is reportable by regulation, the contractor's superintendent will notify WSAFCA, and WSAFCA will take action to contact the appropriate safety and cleanup crews to ensure that the SPCCP is followed. If an appreciable spill occurs and results determine that project activities have adversely affected surface or groundwater quality, a detailed analysis will be performed by a registered environmental assessor or professional engineer to identify the likely cause of contamination. This analysis will conform to American Society for Testing and Materials standards and will include recommendations for reducing or eliminating the source or mechanisms of contamination. Based on this analysis, WSAFCA and its contractors will select and implement measures to control contamination, with a performance standard that surface water quality and groundwater quality must be returned to baseline conditions.

### Monitor Turbidity in Adjacent Water Bodies

WSAFCA or its contractor will monitor turbidity in the adjacent water bodies, where applicable criteria apply, to determine whether turbidity is being affected by construction and ensure that construction does not affect turbidity levels, which ultimately increase the sediment loads. The Water Quality Control Plan for the Central Valley Regional Water Quality Control Board (Basin Plan) contains turbidity objectives for the Sacramento River. WSAFCA or its contractor will monitor ambient turbidity conditions upstream during construction and adhere to the Surface Water Quality Ambient Monitoring Program requirements for turbidity monitoring. Monitoring will continue approximately 300 feet downstream of construction activities to determine whether turbidity is being affected by construction. Grab samples will be collected at a downstream location that is representative of the flow near the construction site. If there is a visible sediment plume being created from construction, the sample will represent this plume. Monitoring will occur hourly when construction encroaches into the Sacramento River. If construction does not encroach into the river, the monitoring will occur once a week on a random basis. If turbidity limits exceed Basin Plan standards, construction-related earth-disturbing activities will slow to a point that results in alleviating the problem. WSAFCA will notify the Central Valley Regional Water Quality Control Board of the issue and provide an explanation of the cause.

### Prepare and implement a Mitigation and Monitoring Plan (MMP)

A draft MMP for the restoration areas is being developed and will be approved by the Corps, NMFS, Service, and CDFW before implementation of the Southport Project. The restoration objectives of the plan are listed below:

- Provide compensatory mitigation credits for effects on protected land cover-types and to special-status species and potential habitat for these species.
- Maximize shaded riverine aquatic cover/nearshore habitat, over and above current erosion stabilization efforts using biotechnical methods.
- Enhance setback ecological values using topographic and vegetation/habitat heterogeneity.
- Restore portions of the historic Sacramento River floodplain (i.e., waters of the United States).
- Restore riparian and oak woodland habitat on the restored floodplain that will create continuous habitat corridors for fish and wildlife movement.
- Design habitat features to minimize future maintenance obligations (e.g., reduce opportunities for sediment and debris accumulation).
- Design floodplain planting and vegetation management schemes to avoid undesirable hydraulic and sediment transport effects to the offset levee and offset area.
- Comply with current Corps levee vegetation policy to balance habitat needs with flood management objectives.

The monitoring objectives of the MMP are listed below:

- Monitor and evaluate the hydrologic and hydraulic performance of the restored floodplain relative to the ecological design criteria for the target species.
- Monitor and evaluate the success of the riparian/floodplain plantings and other habitat features in compensating, restoring, or enhancing fish and wildlife habitat values on the levee slopes and offset areas.
- Monitor and evaluate the effectiveness of the grading and drainage features in preventing fish stranding.
- Monitor the occurrence and extent of potential sedimentation and scour that may compromise the success of the habitat restoration and mitigation components of the project.

#### *Valley Elderberry Longhorn Beetle Conservation Measures for the Southport Project*

Conservation measures for beetle for the Southport Project are based on the Service's Conservation Guidelines (Service 1999a).

Fence Elderberry Shrubs to be Protected and Monitor Fencing during Construction: Elderberry shrubs and clusters within 100 feet of the construction area that will not be removed will be protected during construction. A qualified biologist (i.e., with elderberry/beetle experience), under contract with WSAFCA, will mark the elderberry shrubs and clusters that will be protected during construction. Orange construction barrier fencing will be placed at the edge of the respective buffer areas. The buffer area distances will be proposed by the biologist and approved by Service. No construction activities will be permitted within the buffer zone other than those activities necessary to erect the fencing. Signs will be posted every 50 feet along the perimeter of the buffer area fencing. The signs will contain the following information:

*"This area is habitat of the valley elderberry longhorn beetle, a threatened species, and must not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment."*

In some cases, where the elderberry shrub dripline is within 10 feet of the work area, k-rails will be placed at the shrub's dripline to provide additional protection to the shrub from construction equipment and activities. Temporary fences around the elderberry shrubs and k-rails at shrub driplines will be installed as the first order of work. Temporary fences will be furnished,

constructed, maintained, and later removed, as shown on the plans, as specified in the special provisions, and as directed by the project engineer. Temporary fencing will be 4 feet high, commercial-quality woven polypropylene, and orange in color.

Buffer area fences around elderberry shrubs will be inspected weekly by a qualified biological monitor during ground-disturbing activities and monthly after ground-disturbing activities until project construction is complete or until the fences are removed, as approved by the biological monitor and the resident engineer. The biological monitor will be responsible for ensuring that the contractor maintains the buffer area fences around elderberry shrubs throughout construction. Biological inspection reports will be provided to the project lead and Service.

Conduct Stem Counts Prior to Elderberry Shrub Transplantation: Surveys of elderberry shrubs to be transplanted will be conducted by a qualified biologist prior to transplantation. The biologist will survey the area surrounding the shrub to be transplanted to ensure that there are not additional elderberry shrubs that need to be removed. Surveys will consist of counting and measuring the diameter of each stem at ground level and examining elderberry shrubs for the presence of beetle exit holes. Survey results and an analysis of the number of elderberry seedlings/cuttings and associated native plants based on the survey results will be submitted to Service. Elderberry seedlings/cuttings and associated native plants will be planted prior to transplantation of elderberry shrubs. The data collected during the surveys prior to transplantation will be used to determine if compensation requirements or take limits are being exceeded, and if additional plantings are necessary. Because construction of the Southport project will occur over multiple years, elderberry survey data for each year will be used to rectify any discrepancies in compensation and to ensure full compensation of effects on the beetle. Surveys for the beetle are valid for a period of 2 years (Service 1999a).

Water the construction area to control dust: The construction contractor will ensure that the project construction area will be watered as necessary to prevent dirt from becoming airborne and accumulating on elderberry shrubs within the 100-foot buffer.

Compensate for direct effects on valley elderberry longhorn habitat: Before construction begins, compensation will be implemented for direct effects on elderberry shrubs by transplanting shrubs that cannot be avoided to a Service-approved conservation area. Elderberry seedlings or cuttings and associated native species will also be planted in the conservation area. Each elderberry stem measuring 1 inch or greater in diameter at ground level that is adversely affected will be replaced in the conservation area, with elderberry seedlings or cuttings at a ratio ranging from 1:1 to 8:1 (new plantings to affected stems). The numbers of elderberry seedlings/cuttings and associated riparian native trees/shrubs to be planted as replacement habitat are determined by stem size class of affected elderberry shrubs, presence or absence of exit holes, and whether the shrub lies in a riparian or non-riparian area. Stock of either seedlings or cuttings will be obtained from local, Service-approved sources. At the discretion of the Service, shrubs that are unlikely to survive transplantation because of poor condition or location, or a plant that will be extremely difficult to move because of access problems, may be exempted from transplantation. In cases in which transplantation is not possible, minimization ratios will be increased to offset the additional habitat loss.

The relocation of elderberry shrubs will be conducted according to Service-approved procedures outlined in the Conservation Guidelines (Service 1999a). Elderberry shrubs within the project construction area that cannot be avoided will be transplanted during the plant's dormant phase, which is November through the first 2 weeks of February. A qualified biological monitor will remain onsite while the shrubs are being transplanted.

### *Proposed Conservation Area*

About 120 acres of riparian habitat in the Offset floodplain area will be restored or enhanced as part of the project implementation. Based on the Conservation Guidelines (Service 1999a), a total of 13.51 acres of the floodplain will be riparian habitat required for beetle compensation plantings for the Southport Project.

Evidence of the beetle occurrence in the conservation area, the condition of the elderberry shrubs in the conservation area, and the general condition of the conservation area itself will be monitored over a period of 10 consecutive years or for 7 years over a 15-year period from the date of transplanting. Monitoring reports will be provided to the Service in each of the years in which monitoring is required. As specified in the Conservation Guidelines, the report will include information on timing and rate of irrigation, growth rates, and survival rates and mortality.

To meet the success criteria specified in the Conservation Guidelines, a minimum survival rate of 60% of the original number of elderberry replacement plantings and associated native plants must be maintained throughout the monitoring period.

### **Action Area**

The action areas is defined in 50 CFR § 402.02, as “all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action.” For the purposes of the effects assessment, the action area encompasses the Sacramento River from the Sacramento Bypass downstream to the South Cross Levee, the Sacramento Deep Water Ship Channel and the Port of West Sacramento, and the Sacramento and Yolo Bypasses (Figure 1).

The City of West Sacramento is bisected into two basins by the Sacramento River Deep Water Ship Channel and the Port of West Sacramento, and is contained within the levees of the West Sacramento GRR Project. The north basin encompasses 6,100 acres, while the south basin is 6,900 acres. Potential borrow areas, transportation routes, and staging areas have been identified within the city, as well as within 20 miles of West Sacramento. The potential borrow areas identified in Figure 2 are also part of the action area.

The action area also includes the perennial waters extending 200 feet perpendicular from shorelines adjacent to construction areas, and 1,000 feet downstream of the in-water construction areas. These distances represent the extent to which turbidity and sedimentation from the West Sacramento GRR Project may affect the waters.

### **Analytical Framework for the Jeopardy and Adverse Modifications Determinations**

#### Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis in this biological opinion relies on four components: (1) the Status of the Species, which evaluates snake, beetle, and smelt range-wide conditions, the factors responsible for these conditions, and the survival and recovery needs of each species; (2) the Environmental Baseline, which evaluates the condition of the snake, beetle, and smelt in the action area, the factors responsible for these conditions, and the relationship of the action area to the survival and recovery of each species; (3) the Effects of the Action, which determines the direct and indirect effects of the proposed Federal action and the effects of any interrelated or interdependent activities on the snake, beetle, and smelt; and (4) the Cumulative

Effects, which evaluates the effects of future, non-Federal activities in the action area on the snake, beetle, and smelt.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the current status of the snake, beetle, and smelt, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of recovery of each species in the wild.

The jeopardy analysis in this biological opinion places an emphasis on consideration of the range-wide survival and recovery needs of the snake, beetle, smelt, as well as the role of the action area in the survival and recovery of each species as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

#### Adverse Modification Determination

This biological opinion does not rely on the regulatory definition of “destruction or adverse modification” of critical habitat at 50 CFR 402.2. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this biological opinion relies on four components: (1) the Status of the Critical Habitat, which evaluates the range-wide condition of critical habitat for the smelt in terms of primary constituent elements (PCE)s, the factors responsible for that condition, and the intended recovery function of the critical habitat at the provincial and range-wide scale; (2) the Environmental Baseline, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the Effects of the Action, which determines the direct and indirect effects of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units and; (4) Cumulative Effects which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on smelt critical habitat are evaluated in the context of the range-wide condition of the critical habitat at the provincial and range-wide scales, taking into account any cumulative effects, to determine if the critical habitat range-wide will remain functional (or will retain capable habitat) to serve its intended recovery role for the smelt.

The analysis in this biological opinion places an emphasis on using the intended range-wide recovery function of smelt critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

#### **Status of the Species**

##### Giant Garter Snake

Please refer to the Giant Garter Snake (*Thamnophis gigas*) 5-year Review: Summary and Evaluation for the current status of the species (Service 2006).

### *Environmental Baseline*

Suitable habitat for the snake exists along the western border of both the North and South Basins of the West Sacramento GRR Project. In the North Basin, some additional suitable habitat can be found along the Sacramento Bypass. In the South Basin, drainages along the toe of the South Cross Levee may also provide habitat for the snake. However, most of the developed and undeveloped lands within the City of West Sacramento do not provide suitable habitat for the snake.

There are 28 occurrence records of the snake within 5 miles of the City of West Sacramento (CDFW 2014b). The closest occurrences are about 1.5 miles west of the Sacramento Bypass Training Levee, while 11 occurrences are to the north in the Natomas Basin, across the Sacramento River from West Sacramento. There are 77 CNDDDB occurrences within 10 miles of West Sacramento (CDFW 2014b). Seven of the occurrence records within 10 miles of West Sacramento are across the Sacramento River and southeast of the City of Sacramento, near Elk Grove. Giant garter snakes are apparently absent from larger rivers, and from wetlands with sand, gravel, or rock substrates (R. Hansen 1980; Rossman and Stewart 1987; Brode 1988; G. Hansen 1988; Brode and Hansen 1992). Potential snake upland habitat is generally considered upland habitats within 200 feet of snake aquatic habitat. The Sacramento Bypass to the north, the Yolo Bypass to the west, and the South Cross Levee drainage canal to the south of the action area do provide suitable habitat for the snake. In the North Basin, work along the Sacramento Bypass Training Levee and Yolo Bypass Levees will border the Yolo Bypass, an area of agricultural and natural wetlands that provides suitable aquatic snake habitat. In the South Basin, work along the South Cross Levee, and along with the Sacramento Bypass west levee can provide suitable upland snake habitat. The Sacramento River generally does not offer suitable habitat.

### Valley Elderberry Longhorn Beetle

For the most recent comprehensive assessment of the range-wide status of the beetle, please refer to the *Withdrawal of the Proposed Rule to Remove the Valley Elderberry Longhorn Beetle from the Federal List of Endangered and Threatened Wildlife; Proposed Rule, Withdrawal* (Service 2014a).

### *Environmental Baseline*

The majority of lands within North and South Basins of West Sacramento are urban and suburban lands in private ownership. Suitable habitat for the beetle (i.e., elderberry shrubs) occurs throughout the City of West Sacramento. Although the status of the beetle and its habitat on most of these private lands is unknown, there are documented occurrences of beetles in both the North and South Basins (CDFW 2014b). In the South Basin, occurrence number 208 near river mile 52 of the Sacramento River, and occurrence number 209 along a railroad access north of Davis road, have identified both male and female beetles. At occurrence number 209, one female was observed laying eggs in 2006 (CDFW 2014b). In the North Basin, occurrences 18, 28, 29, and 56 have all documented elderberry shrubs with exit holes in stems, a sign of beetle presence.

### Delta Smelt

#### *Listing Status*

The Service proposed to list the smelt as threatened with proposed critical habitat on October 3, 1991 (Service 1991). The Service listed the smelt as threatened on March 5, 1993, and designated critical habitat for this species on December 19, 1994 (Service 1994). The smelt was one of eight fish species addressed in the Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes

(Service 1995). This recovery plan is currently under revision. A 5-year status review of the smelt was completed on March 31, 2004 (Service 2004). The 2004 review affirmed the need to retain the smelt as a threatened species. A 12-month finding on a petition to reclassify the delta smelt was completed on April 7, 2010 (Service 2010). After reviewing all available scientific and commercial information, the Service determined that re-classifying the smelt from a threatened to an endangered species was warranted but precluded by other higher priority listing actions (Service 2010).

### *Distribution*

The smelt is endemic to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta) in California, and is restricted to the area from San Pablo Bay upstream through the Delta in Contra Costa, Sacramento, San Joaquin, Solano, and Yolo counties (Moyle 2002). Their range extends from San Pablo Bay upstream to Verona on the Sacramento River and Mossdale on the San Joaquin River. The smelt was formerly considered to be one of the most common pelagic fish in the upper Sacramento-San Joaquin Estuary.

### *Description*

Delta smelt are a small, slender bodied fish of the Osmeridae (smelts) (Moyle 2002). They are nearly translucent with a steely-blue sheen to their sides and a pronounced odor reminiscent of cucumber (Moyle 2002). Although delta smelt have been recorded to reach lengths of up to 120 mm (4.7 in) (Moyle 2002), catch data from 1992 - 2004 showed mean fork length to be  $54.1 \pm .01$  mm (Bennett 2005; Sweetnam 1999). Delta smelt are also identifiable by their relatively large eye to head size (Moyle 2002) and their small, translucent adipose fin located between the dorsal and caudal fins. Occasionally one chromatophore may be found between the mandibles, but most often there is none (Moyle 2002).

The delta smelt is one of six species currently recognized in the *Hypomesus* genus (Bennett 2005). Genetic analyses have confirmed that delta smelt presently exists as a single intermixing population (Stanley et al. 1995; Trenham et al. 1998; Fisch et al. 2011). Within the genus, delta smelt are most closely related to surf smelt (*H. pretiosus*), a species common along the western coast of North America. The wakasagi (*H. nipponensis*), an anadromous western Pacific smelt species introduced to Central Valley reservoirs in 1959, is thought to be seasonally sympatric with the delta smelt in the estuary (Trenham et al. 1998). Despite morphological similarities, allozyme studies have demonstrated that wakasagi and delta smelt are genetically distinct and presumably derived from different marine ancestors (Stanley et al. 1995).

### *Life History*

Adult delta smelt spawn during the late winter and spring months, with most spawning occurring during April through mid-May (Moyle 2002). Spawning occurs primarily in sloughs and shallow edge areas in the Delta and has been recorded in Suisun Marsh and the Napa River (Moyle 2002). Most spawning occurs at temperatures between 12-18°C. Spawning may occur at temperatures up to 22°C, but hatching success of the larvae is very low (Bennett 2005). Fecundity of females ranges from about 1,200 to 2,600 eggs, and is correlated with female size (Moyle 2002). In captivity, females survive after spawning and develop a second clutch of eggs (Mager et al. 2004) and field collections of ovaries containing eggs of different size and stage indicate that this also occurs in the wild (Adib-Samii 2008). While most adults do not survive to spawn a second season, a small percentage do (<5 percent) (Moyle 2002; Bennett 2005) and are typically larger (90-110 mm Standard Length [sdl]). These females may contribute disproportionately to the population's egg supply (Moyle 2002 and references therein) since two-year-old females may have 3-6 times as many ova as first year spawners.

The locations in the Delta where newly hatched larvae are present most likely indicates spawning occurrence and most of what is known about delta smelt spawning habitat in the wild is inferred from the location of spent females and young larvae captured in the DFW's Spring Kodiak Trawl (SKT) (CDFW 2014a) and 20-mm Survey, respectively. In the laboratory, delta smelt spawned at night (Baskerville-Bridges et al. 2000; Mager et al. 2004). Other smelts, including marine beach spawning species and estuarine populations are secretive spawners, entering spawning areas during the night and leaving before dawn. If this behavior is exhibited by delta smelt, then delta smelt distribution based on the SKT, which is conducted during daylight hours in offshore habitats, may reflect general regions of spawning activity, but not actual spawning sites.

Delta smelt spawning has only been directly observed in the laboratory. Consequently, what is known about the mechanics of smelt spawning is derived from laboratory observations and observations of related smelt species. Delta smelt eggs are 1 millimeter diameter and are adhesive and negatively buoyant (Moyle 2002; Mager et al. 2004; Wang 1986; Wang 2007). Laboratory observations indicate that delta smelt are broadcast spawners, discharging eggs and milt close to the bottom over substrates of sand and/or pebble in current (DWR and Reclamation 1994; Brown and Kimmerer 2002; Lindberg et al. 1997; Wang 2007). Spawning over gravel or sand can also aid in the oxygenation of smelt eggs and eggs that are laid in silt or muddy substrates might get buried or smothered, preventing their oxygenation from water flow (Lindberg pers. comm. 2011). The eggs of surf smelts and other beach spawning smelts adhere to sand particles, which keeps them negatively buoyant but not immobile, as the sand may "tumble" them with water currents and turbulence (Hay 2007). It is not known whether delta smelt eggs "tumble incubate" in the wild, but tumbling of eggs may moderately disperse them, which might reduce predation risk within a localized area.

Mager et al. (2004) reported that embryonic development to hatching takes 11-13 days at 14-16° C for delta smelt, and Baskerville-Bridges et al. (2000) reported hatching of delta smelt eggs after 8-10 days at temperatures between 15-17° C. Wang (2007) reported high hatching rates at temperatures between 14-17° C. At hatching and during the succeeding three days, larvae are buoyant, swim actively near the water surface, and do not react to bright direct light (Mager et al. 2004). As development continues, newly hatched delta smelt become semi-buoyant.

Analyses of otoliths indicate larval delta smelt grow to twice their size after 40 days (Bennett 2005), and by 70 days, most wild fish were 30-40 mm long and beyond the larval stage. This suggests there is a strong selective pressure for rapid larval growth in nature, a situation that is typical for fish in general (Houde 1987). Successful feeding seems to depend on a high density of food organisms and turbidity, and increases with stronger light conditions (Baskerville-Bridges et al. 2000; Mager et al. 2004; Baskerville-Bridges et al. 2004). The food available to larval smelt is constrained by mouth gape and status of fin development. Larval smelt cannot capture as many kinds of prey as larger individuals, but all life stages have small gapes that limit their range of potential prey. Prey availability is also constrained by habitat use, which affects what types of prey are encountered. Larval smelt are visual feeders and their ability to see prey in the water is enhanced by turbidity (Baskerville-Bridges et al. 2004). Thus, smelt diets are largely comprised of small crustacea that inhabit the estuary's turbid, low-salinity, open-water habitats (i.e., zooplankton). Larval smelt have particularly restricted diets (Nobriga 2002) and they do not feed on the full array of zooplankton with which they co-occur; they mainly consume three copepods, *Eurytemora affinis*, *Pseudodiaptomus forbesi*, and freshwater species of the family Cyclopidae. Further, the diets of first-feeding smelt larvae are largely restricted to the larval stages of these copepods; older, larger life stages of the copepods are increasingly targeted as the smelt larvae grow, their gape increases, and they become stronger swimmers.

The triggers for, and the duration of, delta smelt larval movement from spawning areas to rearing areas are not known. Most larvae gradually move downstream toward the two parts per thousand isohaline (X2), where X2 is scaled as the distance in kilometers from the Golden Gate Bridge (Jassby et al. 1995). Young-of-the-year smelt rear in the low-salinity zone (LSZ) from late spring through fall and early winter. Once in the rearing area growth is rapid, and juvenile fish are 40-50 mm sdl by early August (Erkkila et al. 1950; Ganssle 1966; Radtke 1966). They reach adult size (55-70 mm sdl) by early fall (Moyle 2002) and smelt growth slows considerably (only 3-9 mm total) during the fall months, presumably because most of the energy ingested is being directed towards gonadal development (Erkkila et al. 1950; Radtke 1966).

Population Dynamics and Abundance Trends- CDFW conducts several long-term monitoring surveys that have been used to index the relative abundance of smelt. The 20-mm Survey (CDFW 2014a) has been conducted every year since 1995 and samples April-June, targeting late-stage smelt larvae. The summer townet survey (TNS) has been conducted nearly every year between June-August, since 1959, and targets 38-mm striped bass, but collects similar-sized juvenile smelt. The FMWT has been conducted nearly every year since 1967, and like the TNS, the survey targets age-0 striped bass but collects smelt > 40 mm in length. The FMWT samples from September through December. The smelt catch data and relative abundance indices derived from these sampling programs have been used in numerous publications (e.g., Stevens and Miller 1983; Moyle et al. 1992; Jassby et al. 1995; Kimmerer 2002b; Dege and Brown 2004; Bennett 2005; Feyrer et al. 2007; Sommer et al. 2007; Kimmerer 2008; Newman 2008; Nobriga et al. 2008; Kimmerer et al. 2009; Mac Nally et al. 2010; Thomson et al. 2010; Feyrer et al. 2011; Maunder and Deriso 2011) and the abundance index time series documents the long-term decline of the smelt.

At all life stages, delta smelt are found in greatest abundance in the water column and usually not in close association with the shoreline. They inhabit open, surface waters of the Delta and Suisun Bay, where they presumably aggregate in loose schools where conditions are favorable (Moyle 2002). In years of moderate to high Delta outflow, delta smelt larvae are abundant in the Napa River, Suisun Bay and Montezuma Slough, but the degree to which these larvae are produced by locally spawning fish versus the degree to which they originate upstream and are transported by tidal currents to the bay and marsh is uncertain.

Sampling of larval delta smelt in 1989 and 1990 suggested that spawning occurred in the Sacramento River; in Georgiana, Prospect, Beaver, Hog, and Sycamore sloughs; in the San Joaquin River adjacent to Bradford Island and Fisherman's Cut; and possibly other areas (Wang 1991). However, in recent years, the densest concentrations of both spawners and larvae have been recorded in the Cache Slough/Sacramento Deepwater Ship Channel complex in the North Delta. Some delta smelt spawning occurs in the Napa River, Suisun Bay and Suisun Marsh during wetter years (Sweetnam 1999; Wang 1991; Hobbs et al. 2007). Early stage larval delta smelt have also been recorded in Montezuma Slough near Suisun Bay (Wang 1986).

The timing of spawning may affect delta smelt population dynamics. Lindberg (2011) has suggested that smelt larvae that hatch early, around late February, have an advantage over larvae hatched during late spawning in May. Early season larvae have a longer growing season and may be able to grow larger faster during more favorable habitat conditions in the late winter and early spring. An early growing season may result in higher survivorship and a stronger spawning capability for that generation. Larvae hatched later in the season have a shorter growing season which effectively reduces survivorship and spawning success for the following spawning season.

Early statistical assessments of delta smelt population dynamics concluded that at best, the relative abundance of the adult delta smelt population had only a very weak influence on subsequent juvenile abundance (Sweetnam and Stevens 1993). Thus, early attempts to describe abundance variation in

delta smelt ignored stock-recruit effects and researchers looked for environmental variables that were directly correlated with interannual abundance variation (e.g., Stevens and Miller 1983; Moyle et al. 1992; Sweetnam and Stevens 1993; Herbold 1994; Jassby et al. 1995). Because delta smelt live in a habitat that varies in size and quality with Delta outflow, the authors cited above searched for a linkage between Delta outflow (or X2) and the TNS and FMWT indices. Generally, these analyses did not find strong support for an outflow-abundance linkage, which led to a prevailing conceptual model that multiple interacting factors had caused the delta smelt decline (Moyle et al. 1992; Bennett and Moyle 1996; Bennett 2005). It has also recently been noted that delta smelt's FMWT index is partly influenced by concurrent environmental conditions (Feyrer et al. 2007; 2011). This may be a partial explanation for why few analyses could consistently link springtime environmental conditions to delta smelt's fall index.

Delta smelt abundance plays an important role in subsequent abundance (Bennett 2005; Maunder and Deriso 2011). Bennett (2005) assessed data from CDFW's FMWT and TNS, and concluded that two-year-old delta smelt might play an important role in delta smelt population dynamics, that it was not clear whether juvenile production was a density-independent or -dependent function of adult abundance, and that adult production is a density-dependent function of juvenile abundance. He also concluded that the carrying capacity of the estuary to support this life-stage transition had declined over time. These conclusions are also supported by Maunder and Deriso (2011).

Delta smelt population dynamics may have also changed over time. Previous publications have reported a delta smelt step-decline during 1981-1982 (Kimmerer 2002b; Thomson et al. 2010). Prior to this decline, the stock-recruit data are consistent with "Ricker" type density-dependence where increasing adult abundance resulted in decreased juvenile abundance. Since the decline, recruitment has been positively and essentially linearly related to prior adult abundance, suggesting that reproduction has been basically density-independent for about the past 30 years. This means that since the early 1980s, more adults translates into more juveniles and fewer adults translates into fewer juveniles without being "compensated for" by density-dependence.

In contrast to the transition among generations, the weight of scientific evidence strongly supports the hypothesis that, at least over the history of Interagency Ecological Program fish monitoring, delta smelt has experienced density-dependence during the juvenile stage of its life cycle (Bennett 2005; Maunder and Deriso 2011). This has been inferred because, statistically, the FMWT index does not increase linearly with increases in the TNS index. Rather, the best-fitting relationships between the TNS index and the FMWT index show the FMWT indices approach an asymptote as the TNS indices increases, or possibly even declines at the highest TNS indices.

From a species conservation perspective, the most relevant aspect of this juvenile density dependence is that the carrying capacity of the estuary for delta smelt has declined (Bennett 2005). Thus, the delta smelt population decline has occurred for two basic reasons. First, the compensatory density-dependence that historically enabled juvenile abundance to rebound from low adult numbers stopped happening. The reason is still not known, but the consequence of the change is that for the past several decades, adult abundance drives juvenile production in a largely density-independent manner. Thus, if numbers of adults or adult fecundity decline, juvenile production will also decline (Kimmerer 2011). Second, because juvenile carrying capacity has declined, juvenile production hits a "ceiling" at a lower abundance than it once did. This limits adult abundance and possibly per capita fecundity, which cycles around and limits the abundance of the next generation of juveniles. The mechanism causing carrying capacity to decline is likely due to the long-term accumulation of deleterious habitat changes – both physical and biological – during the summer-fall (Bennett et al. 2008; Feyrer et al. 2007; 2011; Maunder and Deriso 2011).

### *Habitat*

The existing physical appearance and hydrodynamics of the Delta have changed substantially from the environment in which native fish species like delta smelt evolved. The Delta once consisted of tidal marshes with networks of diffuse dendritic channels connected to floodplains of wetlands and upland areas (Moyle 2002). The in-Delta channels were further connected to drainages of larger and smaller rivers and creeks entering the Delta from the upland areas. In the absence of upstream reservoirs, freshwater inflow from smaller rivers and creeks and the Sacramento and San Joaquin Rivers were highly seasonal and more strongly and reliably affected by precipitation patterns than they are today. Consequently, variation in hydrology, salinity, turbidity, and other characteristics of the Delta aquatic ecosystem was greater in the past than it is today (Kimmerer 2002a). The following is a brief description of the changes that have occurred to delta smelt's habitat.

Changes to the LSZ: There have been documented changes to the delta smelt's LSZ habitat that have led to present-day habitat conditions. The close association of delta smelt with the San Francisco estuary LSZ has been known for many years (Stevens and Miller 1983; Moyle et al. 1992). Peterson (2003) developed a conceptual model that hypothesized how, "stationary and dynamic components of estuarine habitats" interacted to influence fisheries production in tidal river estuaries. Peterson's model suggests that when the dynamic and static aspects of estuarine habitat sufficiently overlap, foraging, growth, density, and survival are all high, and that enables fish production to outpace losses to predators. The result is high levels of successful recruitment of new individuals. The model also hypothesizes that when the dynamic and static aspects of an estuarine habitat do not sufficiently overlap, foraging, growth, density, and survival are impaired such that losses to predators increase and recruitment of new individuals decreases. This model was developed specifically for species spawned in marine environments that were subsequently transported into estuaries. However, the concept of X2, which was developed in the San Francisco estuary to describe how freshwater flow affected estuarine habitat (Jassby et al. 1995), played a role in the intellectual development of Peterson's model.

Current information indicates the most suitable delta smelt habitat is when low-salinity water is near 20°C, highly turbid, oxygen saturated, low in contaminants, supports high densities of calanoid copepods and mysid shrimp (Moyle et al. 1992; Lott 1998; Nobriga 2002), and occurs over comparatively static 'landscapes' that support sandy beaches and bathymetric variation that enables the fish and their prey to aggregate (Kimmerer et al. 2002a; Bennett et al. 2002; Hobbs et al. 2006). Almost every component listed above has been degraded over time and the Service has determined that this accumulation of habitat change is the fundamental reason or mechanism that has caused delta smelt to decline.

Alterations to estuarine bathymetry and salinity distribution- The position of the LSZ, where delta smelt rear, has changed over the years. The first major change in the LSZ was the conversion of the landscape over which tides oscillate and river flows vary (Moyle et al. 2010). Most of the historic wetlands within the system were diked and reclaimed for agriculture or other human uses by 1920 (Atwater et al. 1979) and channels were dredged to accommodate shipping traffic from the Pacific Ocean and San Francisco Bay to ports in Sacramento and Stockton. These changes left Suisun Bay and the confluence of the Sacramento-San Joaquin Rivers as the largest and most bathymetrically variable places in the LSZ. This region remained a highly productive nursery for many decades (Stevens and Miller 1983; Moyle et al. 1992; Jassby et al. 1995); however, the deepened channels required more freshwater outflow to maintain the LSZ in the large Suisun Bay and at the confluence than was once required (Gartrell 2010).

The construction of the Central Valley Water Project and the State Water Project not only provided water supply for urban, agricultural and industrial users, but also provided water needed to combat salinity intrusion into the Delta, which was observed by the early 20th century. California's demand for freshwater continues to increase and the seasonal salinity intrusion perpetually reduces the temporal overlap of the LSZ (indexed by X2) within the Suisun Bay, especially in the fall (Feyrer et al. 2007; 2011). Consequently, a major habitat change in the Delta has been in the frequency with which the LSZ is maintained in Suisun Bay for any given amount of precipitation. There was a step-decline in the LSZ in 1977 from which it has never recovered for more than a few years at a time. Based on model forecasts of climate change and water demand, this trend is expected to continue (Feyrer et al. 2011).

Summer and fall environmental quality has decreased overall in the Delta because outflows are lower and water transparency is higher. The confluence of the Sacramento and San Joaquin Rivers has, as a result, become increasingly important as a rearing location for delta smelt, with physical environmental conditions constricting the species range to a relatively narrow area (Feyrer et al. 2007; Nobriga et al. 2008). This has increased the likelihood that most of the juvenile population is exposed to chronic and cyclic environmental stressors, or catastrophic events. For instance, all seven delta smelt collected during the September 2007 fall mid-water trawl (FMWT) survey were captured at statistically significantly higher salinities than what will be expected based upon historical distribution data generated by Feyrer et al. (2007). During the same year, the annual bloom of toxic cyanobacteria (*Microcystis aeruginosa*) spread far downstream to the west Delta and beyond during the summer (Lehman et al. 2005), and this has been suggested as an explanation for the anomaly in the distribution of delta smelt relative to water salinity levels (USBR 2008).

Turbidity: From 1999 to present, the Delta experienced a change in estuarine turbidity that culminated in an estuary-wide step-decline in 1999 (Schoellhamer 2011). Since delta smelt associate with highly turbid waters, there is a negative correlation between the frequency of delta smelt occurrence in trawls during the summer, fall and early winter, at a given sampling station with increasing clarity, or Secchi depth (Feyrer et al. 2007, Nobriga et al. 2008). This is very consistent with behavioral observations of captive delta smelt (Nobriga and Herbold 2008). Few daylight trawls catch delta smelt at Secchi depths over 0.50 m and capture probabilities for delta smelt are highest at 0.40 m or less. Turbid waters are thought to increase foraging efficiency (Baskerville-Bridges et al. 2004) and reduce the risk of predation for delta smelt.

Temperature: Delta smelt of all sizes are found in the main channels of the Delta and Suisun Marsh and the open waters of Suisun Bay where the water is well oxygenated and temperatures are usually less than 25° C in summer (Nobriga et al. 2008). Swanson and Cech (1995) and Swanson et al. (2000) indicate delta smelt tolerate a range of temperatures (<8° C to >25° C), however warmer water temperatures >25° C restrict their distribution more than colder water temperatures (Nobriga and Herbold 2008). Currently, delta smelt are subjected to thermally stressful temperatures every summer, and all available regional climate change projections predict central California will be warmer still in the coming decades (Dettinger 2005). Water temperatures are presently above 20°C for most of the summer in core habitat areas, sometimes even exceeding the nominal lethal limit of 25°C for short periods. Coldwater fishes begin to have behavioral impairments (Marine and Cech 2004) and lose competitive abilities (Taniguchi et al. 1998) prior to reaching their thermal tolerance limits. Thus, the estuary can already be considered thermally stressful to delta smelt and can only become more so if temperatures warm in the coming decades.

Foraging Ecology: Delta smelt feed primarily on small planktonic crustaceans, and occasionally on insect larvae (Moyle 2002). Historically, the main prey of delta smelt was the euryhaline copepod *Eurytemora affinis* and the euryhaline mysid *Neomysis mercedis*. The slightly larger *Pseudodiaptomus forbesi*

has replaced *E. affinis* as a major prey source of delta smelt since its introduction into the Bay-Delta (Moyle 2002). Another smaller copepod, *Limnithona tetraspina*, was introduced to the Bay-Delta in the mid-1990s and is now one of the most abundant copepods in the LSZ, but not abundant in delta smelt diets. *Acartiella sinensis*, a calanoid copepod species that invaded the Delta at the same time as *L. tetraspina*, also occurs at high densities in Suisun Bay and in the western Delta over the last decade. Delta smelt eat these newer copepods, but *Pseudodiaptomus* remains their dominant prey (Baxter et al. 2008).

River flows influence estuarine salinity gradients and water residence times and thereby affect both habitat suitability for benthos and the transport of pelagic plankton upon which delta smelt feed. High tributary flow leads to lower residence time of water in the Delta, which generally results in lower plankton biomass (Kimmerer 2004). Higher residence times, which result from low tributary flows, can result in higher plankton biomass, but water diversions, overbite clam grazing (Jassby et al. 2002), and possibly contaminants (Baxter et al. 2008) remove a lot of plankton biomass when residence times are high. Delta smelt cannot occupy much of the Delta anymore during the summer (Nobriga et al. 2008) and there is a potential disconnect between regions of high zooplankton abundance in the Delta and delta smelt distribution.

Aquatic Macrophytes: For many decades, the Delta's waterways were turbid and growth of submerged plants was apparently unremarkable. That began to change in the mid-1980s, when the Delta was invaded by the non-native plant, *Egeria densa*, a fast-growing aquatic macrophyte that has now taken hold in many shallow habitats throughout the Delta (Brown and Michniuk 2007; Hestir 2010). The large canopies formed by *E. densa* and other non-native species of submerged aquatic vegetation (SAV) have physical and biological consequences for the ecosystem (Kimmerer et al. 2008) and delta smelt. First, the dense nature of SAV promotes sedimentation of particulate matter from the water column, which increases water transparency that then limits the amount of habitat available for delta smelt (Feyrer et al. 2007; Nobriga et al. 2008). Second, dense SAV canopies provide habitat for a suite of non-native fishes that occupy the Delta, displacing native fishes (Nobriga et al. 2005; Brown and Michniuk 2007) and increasing predation pressure on delta smelt. Third, the rise in SAV over the last three decades has led to a shift in the dominant trophic pathways that fuel fish production in the Delta. Until the latter 1980s, the food web of most fishes was often dominated by mysid shrimp (Feyrer et al. 2003) that were subsidized by phytoplankton food sources (Rast and Sutton 1989). Most littoral and demersal fishes of the Delta have diets dominated by the epibenthic amphipods that eat SAV detritus or the epiphytic algae attached to SAV (Grimaldo et al. 2009). Lastly, SAV can overwhelm littoral habitats (inter-tidal shoals and beaches) where delta smelt may spawn making them unsuitable for spawning.

Predators: Nothing is known about the historic predators of delta smelt or their possible influence on delta smelt population dynamics. Fish eggs and larvae can be opportunistically preyed upon by many invertebrate and vertebrate animals. The eggs and newly-hatched larvae of delta smelt are thought to be prey for Mississippi silversides (Bennett 2005), and potentially yellowfin goby, centrarchids, and Chinook salmon. Centrarchid fishes and Chinook salmon smolts released in the Delta for research may prey on larval delta smelt (Brandes and McLain 2001; Nobriga and Chotkowski 2000) and studies during the early 1960s found delta smelt were an occasional, but rare, prey fish for striped bass, black crappie and white catfish (Turner and Kelley 1966). Since delta smelt were a comparatively rare fish historically, it is not surprising that they were also a rare prey item.

The introduction of striped bass into the San Francisco Estuary in 1879 added a permanently resident, large piscivorous fish to the LSZ. The LSZ is a habitat not known to have had an equivalent predator prior to the establishment of striped bass (Moyle 2002). The current influence

of striped bass and other predators on delta smelt population dynamics is unknown, mainly because predator effects on rare prey are extremely difficult to quantify. Delta smelt were observed in the stomach contents of striped bass and other fishes in the 1960s (Stevens 1963; Turner and Kelley 1966), but have not been in more recent studies (Feyrer et al. 2003; Nobriga and Feyrer 2007).

Potential native predators of juvenile and adult delta smelt will have included numerous bird and fish species, which may be reflected in delta smelt's life-history. Annual fish species, also known as "opportunistic strategists", are adapted to high mortality rates in the adult stage (Winemiller and Rose 1992). This high mortality is usually due to predation or highly unpredictable environmental conditions, both of which could have characterized the ancestral niche of delta smelt.

Predation is a common source of density-dependent mortality in fish populations (Rose et al. 2001), thus, it is possible that predation was a mechanism that historically generated the density-dependence observation in delta smelt population dynamics that has been noted by Bennett (2005) and Maunder and Deriso (2011). As is the case with other fishes, the vulnerability of delta smelt to predators may be influenced primarily by habitat suitability. It is widely documented that pelagic fishes, including many smelt species, experience lower predation risks under turbid water conditions (Thetmeyer and Kils 1995; Utne-Palm and Stiansen 2005; Horpilla et al. 2004.). Growth rates, a result of feeding success plus water temperature, are also well known to affect fishes' cumulative vulnerability to predation (Sogard 1997).

Competition: It has been hypothesized that delta smelt are adversely affected by competition from other introduced fish species that use overlapping habitats, including Mississippi silversides, (Bennett and Moyle 1996) striped bass, and wakasagi (Sweetnam 1999). Laboratory studies show that delta smelt growth is inhibited when reared with Mississippi silversides (Bennett 2005) but there is no empirical evidence in the wild to support this conclusion.

The LSZ historically had the highest primary productivity and is where zooplankton populations were historically most dense (Knutson and Orsi 1983; Orsi and Mecum 1996). However, since the introduction of the overbite clam, this has not always been true (Kimmerer and Orsi 1996). There is some speculation that the overbite clam competes with delta smelt for copepod nauplii (Nobriga and Herbold 2008) but it is unknown how intensively overbite clam grazing and delta smelt directly compete for food.

Contaminants: Contaminants can change ecosystem functions and productivity through numerous pathways. However, contaminant loading and its ecosystem effects within the Delta are not well understood. Although a number of contaminant issues were first investigated during the Pelagic Organism Decline (POD) years, concern over contaminants in the Delta is not new. Current science suggests the possible link between contaminants and the POD may be the effects of contaminant exposure on prey items, resulting in an indirect effect on the survival of POD species (Johnson et al. 2010). Pyrethroids are of particular interest because use of these pesticides has increased within the Delta watershed (Amweg et al. 2005, Oros and Werner 2005). Urban source waters with pyrethroid pesticides have shown toxicity to the amphipod *Hyalella azteca*, and high mortality rates and swimming impairment in fishes (Weston and Lydy 2010).

The association of delta smelt spawning with turbid winter runoff and the association of pesticides including pyrethroids with sediment is of potential concern. Persistent confinement of the spawning population of delta smelt to the Sacramento River increases the likelihood that a substantial portion of the spawners will be affected by a catastrophic event or localized chronic threat. For instance, large volumes of highly concentrated ammonia released into the Sacramento River from the Sacramento Regional County Sanitation District may affect embryo survival or inhibit prey

production. Further, agricultural fields in the Yolo Bypass and surrounding areas are regularly sprayed by pesticides, and water samples taken from Cache Slough sometimes exhibited toxicity to *H. azteca* (Werner et al. 2008; 2010). The extent to which delta smelt larvae are exposed to contaminants varies with flow entering the Delta, where flow pulses during spawning increase exposure to many pesticides (Kuivila and Moon 2004) but decrease ammonia concentrations from wastewater treatment plants. The thresholds of toxicity for delta smelt for most of the known contaminants have not been determined, but the exposure to a combination of different compounds increases the likelihood of adverse effects.

#### *Delta Smelt Critical Habitat*

The Service designated critical habitat for the delta smelt on December 19, 1994 (Service 1994). The geographic area encompassed by the designation includes all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the legal Delta (as defined in section 12220 of the California Water Code). Critical habitat is defined in section 3 of the Act as: (1) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features (a) essential to the conservation of the species and (b) that may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by a species at the time it is listed, upon determination that such areas are essential for the conservation of the species. In determining which areas to designate as critical habitat, the Service considers those physical and biological features that are essential to a species' conservation and that may require special management considerations or protection (50 CFR 424.12(b)). The Service is required to list the known PCEs together with the critical habitat description. Such physical and biological features include, but are not limited to, the following:

1. Space for individual and population growth, and for normal behavior;
2. Food, water, air, light, minerals, or other nutritional or physiological requirements;
3. Cover or shelter;
4. Sites for breeding, reproduction, rearing of offspring, or dispersal; and
5. Generally, habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species.

The PCEs defined for the delta smelt were derived from its biological needs. In designating critical habitat for the delta smelt, the Service identified the following primary constituent elements essential to the conservation of the species: physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration. Specific areas that have been identified as important delta smelt spawning habitat include Barker, Lindsey, Cache, Prospect, Georgiana, Beaver, Hog, and Sycamore sloughs and the Sacramento River in the Delta, and tributaries of northern Suisun Bay.

1. Physical habitat is defined as the structural components of habitat. Because delta smelt is a pelagic fish, spawning substrate is the only known important structural component of habitat. It is possible that depth variation is an important structural characteristic of pelagic habitat that helps fish maintain position within the estuary's LSZ (Bennett et al. 2002, Hobbs et al. 2006).
2. Water is defined as water of suitable quality to support various delta smelt life stages with the abiotic elements that allow for survival and reproduction. Delta smelt inhabit open

waters of the Delta and Suisun Bay. Certain conditions of temperature, turbidity, and food availability characterize suitable pelagic habitat for delta smelt and are discussed in detail in the Status of the Species section above. Factors such as high entrainment risk and contaminant exposure can degrade this PCE even when the basic water quality is consistent with suitable habitat.

3. River flow is defined as transport flow to facilitate spawning migrations and transport of offspring to LSZ rearing habitats. River flow includes both inflow to and outflow from the Delta, both of which influence the movement of migrating adult, larval, and juvenile delta smelt. Inflow, outflow, and Old and Middle Rivers flow influence the vulnerability of delta smelt larvae, juveniles, and adults to entrainment at Banks and Jones. River flow interacts with the fourth PCE, salinity, by influencing the extent and location of the highly productive LSZ where delta smelt rear.
4. Salinity is defined as the LSZ nursery habitat. The LSZ is where freshwater transitions into brackish water; the LSZ is defined as 0.5-6.0 parts per thousand salinity (psu) (Kimmerer 2004). The 2 psu X2 is a specific point within the LSZ where the average daily salinity at the bottom of the water is 2 psu (Jassby et al. 1995). By local convention the location of the LSZ is described in terms of the distance from the 2 psu X2 to the Golden Gate Bridge; X2 is an indicator of habitat suitability for many San Francisco Estuary organisms and is associated with variance in abundance of diverse components of the ecosystem (Jassby et al. 1995, Kimmerer 2002b). The LSZ expands and moves downstream when river flows into the estuary are high. Similarly, it contracts and moves upstream when river flows are low. During the past 40 years, monthly average X2 has varied from San Pablo Bay (45 kilometers) to as far upstream as Rio Vista on the Sacramento River (95 kilometers). At all times of year, the location of X2 influences both the area and quality of habitat available for delta smelt to successfully complete their life cycle. In general, delta smelt habitat quality and surface area are greater when X2 is located in Suisun Bay. Both habitat quality and quantity diminish as the LSZ moves more frequently and further upstream, toward the confluence.

### *Environmental Baseline*

Delta smelt critical habitat extends along the Sacramento River to the I Street Bridge, and marks the eastern boundary of both basins of the West Sacramento Project. Delta smelt critical habitat also includes the Sacramento River Deep Water Ship Channel, which extends along the western boundary of the West Sacramento GRR Project South Basin and separates the North and South Basins at the Port of Sacramento.

Monitoring surveys along the Sacramento River adjacent to project construction areas have confirmed the presence of the smelt in trawl surveys (Service 2014b) and shallow water seine net surveys (Service 2014c). Trawl surveys conducted in March and April from Sherwood Harbor at River Mile 55, adjacent to the Sacramento River South levee, have recorded 51 smelt (Service 2012b). Similarly, one smelt was identified in a seine net survey at Sherwood Harbor in 2014, and over 50 smelt were netted between river miles 43 and 49, just downstream of the project South Basin, between 2012 and 2014 (Service 2014c). The surveys were conducted between November and April of successive years. The seine net surveys also noted 7 records of smelt adjacent to the project North Basin in February and March 2014, between river miles 60 and 62 (Service 2014c).

The Sacramento River Deep Water Ship Channel also provides suitable spawning habitat for the smelt (CDFW 2014c). At survey station 719, about 12 miles downstream of the South Cross Levee in the Sacramento Deep Water Ship Channel, March, 2014, 20mm surveys noted 48.84 smelt per

10,000 cubic meters, which is the highest catch rate of smelt in the Delta at that period. SKT trawl surveys during March and April of the past 3 years also showed the highest catch rates in the Delta (CDFW 2014a), demonstrating the importance of the Sacramento River Deep Water Ship Channel as a smelt spawning ground. In dry years, river flows can be expected to be relatively low, and hence the LSZ nursery habitat would move much further upstream, toward the project construction area.

## Effects of the Proposed Action

### *Giant Garter Snake*

Construction activities of the West Sacramento GRR Project, such as fill removal, grading, fill placement, wall construction, and vehicle movement will permanently degrade 23.24 acres of snake habitat, and results in temporary effects to 201 acres (Table 5). Permanent effects include the direct loss of snake habitat, while temporary effects result from seasonal construction activities that will be restored upon completion of the construction activities at each levee reach. The breakout for specific effects due to the Southport Project portion of the West Sacramento GRR Project are noted in Appendix B.

Table 5. Effects on giant garter snake (*Thamnophis gigas*) habitat in the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.

Habitat	Temporary Effects	Permanent Effects
Aquatic Habitat	2	21
Upland Habitat	199 <sup>1</sup>	2.24

<sup>1</sup> The estimate is based on a worst-case scenario when considering necessary borrow material.

The Corps has proposed to keep temporary effects to within one season (May 1 to October 1) which will minimize the temporal effects to the giant garter snake. Upon completion of temporary disturbance to habitat the Corps and WSAFCA will return the disturbed area to pre-project conditions. The Corps has proposed to compensate for the permanent loss of snake habitat through the purchase of 69.72 snake credits from a Service-approved conservation bank.

Habitat affected by the snake includes rice fields, which offer many similarities to the historical, natural wetlands of the area around the City of West Sacramento. Open agricultural fields within the action area of the West Sacramento GRR Project are largely fallow or planted in wheat. These fields are not irrigated with standing water in a manner that mimics the natural wetlands used by the giant garter snake. Although the drainage canals offer little in terms of prey base and vegetative cover, the drains lining the agricultural fields can provide avenues for snake travel.

### *Valley Elderberry Longhorn Beetle*

As an Early Implementation Project, the Southport Project area along the South Sacramento River Levee was surveyed for elderberry shrubs 2011-2013. Surveys identified 41 shrubs containing 424 stems within the action area (Appendix B). An estimate of 18 shrubs (including 4 on inaccessible private lands) will be directly affected by construction activities, and will be removed and transplanted to the project offset floodplain area riparian zone if possible.

Transplanting the elderberry shrubs may cause them to die, become stressed, or become unhealthy due to transplanting. This may reduce the shrub's quality as habitat for the beetle, or impair production of habitat-quality stems in the future. Branches containing larvae may be cut, broken, or

crushed during the transplantation process. These effects to the shrubs may cause the beetle to be harmed, harassed, injured, or killed.

The remaining 23 elderberry shrubs within 100 feet of construction activities will be protected during construction activities by implementing the listed Conservation Measures for the beetle. These measures will reduce the likelihood that the health and survival of the elderberry shrubs would be adversely affected by project activities to the point that take of the beetle is not reasonably likely to occur.

For the West Sacramento GRR Project as a whole, shrub counts were extrapolated to provide reasonable effects estimates for the complete project (Table 6). An estimated 215 elderberry shrubs will be affected by the West Sacramento GRR Project. To provide a worst-case scenario for analyses, all shrubs are assumed to be in riparian habitat and with evidence of beetle presence (holes in stems). Based on the results of these analyses, 118.42 acres will be required for elderberry and associated native species compensation plantings (Service 1999a). As part of the proposed conservation measures, the Corps is planning to use at least 13.51 acres of the Southport Project offset area riparian zone as an area for elderberry compensation plantings for the Southport Project portion of the West Sacramento GRR Project. The suitability of the offset area riparian zone for additional compensation will be dependent on site-specific conditions; additional compensation for the beetle will be acquired offsite.

#### *Delta Smelt and Delta Smelt Critical Habitat*

Potential spawning habitat includes shallow channel edge waters of the Sacramento River and Sacramento River Deep Water Ship Channel. Potential construction-related effects to smelt physical

**Table 6.** Estimates of elderberry shrubs affected by the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.<sup>1</sup>

Location	Stem Diameter	Holes	Number of Stems	Elderberry Ratios	Elderberry Plantings	Associate Ratios	Associate Plantings
Riparian	≥ 1 inch and ≤ 3 inches	Yes	1,524	4:1	5,588	2:1	10,580
Riparian	> 3 inches and < 5 inches	Yes	391	6:1	2,160	2:1	4,032
Riparian	≥ 5 inches	Yes	303	8:1	2,237	2:1	4,109
Totals <sup>2</sup>			2,218		9,985		18,721

<sup>1</sup> Information based on the Conservation Guidelines for the Valley Elderberry Longhorn Beetle (Service 1999a).

<sup>2</sup> Southport Project effects are included.

habitat would include disruption of spawning activities, disturbance or mortality of eggs and newly hatched larvae, alteration of spawning and incubation habitat, and loss of shallow water habitat for spawning. The Corps has estimated that 13.35 acres of shallow water habitat that may be used for spawning or dispersal will be permanently lost through the completion of the West Sacramento GRR Project. In contrast, 118.81 acres of suitable delta smelt shallow water habitat will be created by the project in the Southport Project offset area, for a net gain of 105.46 acres of shallow water habitat. The floodplain is designed to contain water during months (December – May) when smelt larva are most likely to be present.

The West Sacramento GRR Project could detrimentally affect delta smelt by increasing turbidity, increasing noise, reducing water quality, creating predator habitat, restricting channels, and changing water velocities. Re-suspended sediments may contain toxic substances which may interfere with the development of young delta smelt. The substrate upon which delta smelt may depend for egg attachment and refugia may become silted over or removed by the proposed actions. As shallow water habitat is removed and turbidity increased, the delta smelt's feeding, breeding, and sheltering would likely be reduced as food sources associated with the aquatic plants and found in the water column is destroyed, and habitat used for spawning substrate and refugia is eliminated.

Rock slope protection can limit the lateral mobility of a river channel, increase flow velocities (Sedell et al. 1990), limit sediment transport, and thus eliminate bankside refugia areas (Gregory et al. 1991). In turn, many of the streamside effects of increased velocity are transferred downstream (Larsen and Greco 2002). Although work along the Sacramento River includes additional rock slope protection, the negative effects to shallow water habitat, both at the project construction areas and downstream along the Sacramento River, are expected to be offset by the creation of the riparian and floodplain area of the Southport Project. The offset floodplain area is designed to absorb much of the increased flow energy, instead of having it transferred downstream. The floodplain area is expected to provide more space for population growth, additional cover or shelter, and additional habitat that is, for the most part, protected from large fluctuations in river velocities.

Adult delta smelt migrate upstream between December and January and spawn between January and July, with a peak in spawning activity between April and mid-May (Moyle 2002). The above effects are reduced by the restriction of project in-water work to time periods when delta smelt eggs, larvae, and juveniles are not present and delta smelt adults are rarely present or present in low numbers, between August 1 and November 30. In addition, the above effects are further greatly reduced by the creation of suitable shallow water habitat in the Southport Project offset floodplain area.

However, the creation of the Southport Project offset floodplain area could introduce increased predation and competition from exotic species. Fishes introduced to the Sacramento-San Joaquin Delta, such as the largemouth bass (*Micropterus salmoides*) and smallmouth bass (*M. dolomieu*), thrive as predators in warm, shallow water habitat. Such introduced fish may increase predation pressure upon the delta smelt in newly designed shallow water habitat. Reduced feeding efficiency and ingestion rates due to introduced competition into the designed smelt habitat, such as from the wagasaki (*Hypomesus nipponensis*), could weaken and slow the growth of young delta smelt and make them more vulnerable to starvation and predation.

### **Cumulative Effects**

Cumulative effects are those effects of future State, Tribal, county, local agency, and private actions that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the Act.

The California Department of Finance (2013) has projected the population within Sacramento County to rise 65% from 2010 levels to 2060, while Yolo County similarly is expected to experience nearly 66% growth over the same period. The West Sacramento GRR Project will afford increased flood protection for a growing community, which in turn could increase human-based pressures incrementally on the federally-listed species. For example, drainage areas that may now be used by snakes as travel corridors may cease to be useful for snakes with the onset of increased human activity in close proximity to waterways with no appropriate snake cover. Also, project effects to the snake, beetle, and smelt are expected to extend for several years as project construction progresses

sequentially over time. To minimize unavoidable effects to the federally-listed species, the Corps has proposed several compensatory measures that will be implemented and maintained in perpetuity.

Cumulative effects on the delta smelt and its designated critical habitat include the effects of point and non-point source chemical contaminant discharges. These contaminants include numerous pesticides and herbicides associated with discharges related to agricultural and urban activities. Implicated as potential sources of mortality for delta smelt, these contaminants may adversely affect delta smelt reproductive success and survival rates. Spawning habitat may also be affected if submersed aquatic plants used as substrates for adhesive egg attachment are lost due to toxic substances.

Additional cumulative effects may result from diversions of water that may entrain adult or larval fish or that may change outflows incrementally, either excluding delta smelt from Sacramento River flow or shifting the position of the delta smelt from its preferred habitat.

### **Conclusion**

After reviewing the current status of the snake, beetle, smelt, and smelt critical habitat, the environmental baseline for the action area covered in this biological opinion, the effects of the proposed project, the cumulative effects, and the proposed conservation measures, it is the Service's biological opinion that the West Sacramento GRR Project, as proposed, is not likely to jeopardize the continued existence of these species. Also, the project will not result in net destruction or adverse modification of smelt critical habitat. The Service reached this conclusion because the anticipated level of take of the snake, beetle, and smelt, upon analyses of project effects in relation the environmental baseline for these species, will not rise to levels precluding the recovery of these species, or reduce the likelihood of survival of these species.

The West Sacramento GRR Project will contribute to the conservation of the snake by preserving suitable snake habitat at a conservation bank. Also, the description of the West Sacramento GRR Project contains the Southport Project, which includes the creation of an offset floodplain area that will provide riparian habitat with space for transplanting elderberry shrubs displaced by the project. Any additional offsite areas necessary for elderberry compensation will be protected in perpetuity. In addition, the offset floodplain area will provide a net gain in the amount of suitable smelt shallow water habitat during the spring months, when the area is most likely to be used by the smelt for feeding and reproduction.

### **INCIDENTAL TAKE STATEMENT**

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service regulations at 50 CFR 17.3 as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the same regulations as an act which actually kills or injures wildlife. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of

the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

### **Amount or Extent of Take**

The Service anticipates incidental take of giant garter snakes will occur in the form of disturbance, harm, and harassment. Incidental take also may occur in the form of injury or death to snakes occupying levee holes or crevices unseen during construction. Within the West Sacramento GRR Project action area, effects to snakes at individual levee reaches will vary. Giant garter snakes are secretive and sensitive to human activities. Individual snakes are difficult to detect unless they are observed, undisturbed, at a distance. Most close-range observations represent chance encounters that are difficult to predict. In instances in which the total number of individuals anticipated to be taken cannot be determined, the Service may use the amount of habitat impacted as a surrogate; because the take of individuals anticipated will result from the destruction of the snake habitat, the quantification of suitable habitat serves as a direct surrogate for the snakes that will be lost. Over the course of project construction, the Service anticipates that all giant garter snakes found in 241 acres of habitat will be disturbed, harassed, harmed, or killed by project activities resulting in temporary impacts and permanent impacts, especially from dewatering, channel reconfiguration, and use of heavy equipment within or near aquatic habitat. Thirty acres of giant garter snake habitat may be permanently lost over the course of project construction.

Implementation of the West Sacramento GRR Project will result in the incidental take of the beetle resulting from project impacts to 215 elderberry shrubs with 2,218 stems one inch or greater in diameter at ground level. The life stage affected by this action will be the beetle larvae living within the stems of the elderberry shrubs. The life cycle of the beetle takes 1 or 2 years to complete, during which it spends most of its life in the larval stage. It is not possible to know how many beetle larvae are in the stems of any elderberry shrub, therefore the Service cannot quantify the total number of beetles that we anticipate will be taken as a result of the proposed action. Because the take of individuals anticipated will result from the destruction of the elderberry shrubs, the quantification of suitable habitat serves as a direct surrogate for the beetles that will be lost. Therefore, the Service anticipates take incidental to this project as the 215 elderberry shrubs with 2,218 stems one inch or greater in diameter at ground level that could potentially be destroyed.

The Service anticipates that incidental take of delta smelt will occur. However, the Service anticipates that any take of delta smelt will be difficult to detect and quantify for a number of reasons: they have a relatively small body size; they are relatively secretive; their presence in the Delta and associated areas coincides with relatively turbid conditions, which makes their detection difficult. Therefore, it is not possible to provide precise numbers of delta smelt that could be injured, harassed, harmed, or killed from the project. The Service anticipates that all delta smelt inhabiting up to 13.35 acres of shallow water habitat may be harmed, harassed, injured, or killed as a result of the project. Low mortality is anticipated because of the work restriction windows. Because

the species is wide-ranging and its distribution varies from one year to the next, take may vary from year to year over the 19-year construction period. Additionally, losses of the species may be masked by seasonal fluctuations in fish presence. Upon implementation of the following reasonable and prudent measure, incidental take associated with the project in the form of harm, harassment, injury, or mortality to delta smelt, the Corps will become exempt from the prohibitions described under section 9 of the Act.

### **Effect of the Take**

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the snake, beetle, or smelt. Also, the West Sacramento GRR Project will not result in the destruction or adverse modification of designated critical habitat for the delta smelt.

### **Reasonable and Prudent Measure**

The Service has determined that the following reasonable and prudent measure is necessary and appropriate to minimize the effects of the proposed project on the snake, beetle, and smelt:

1. All conservation measures proposed in the biological assessment, and as re-stated in the project description section of this biological opinion, must be fully implemented and adhered to. Further, this Reasonable and Prudent Measure shall be supplemented by the Terms and Conditions listed below.

### **Terms and Conditions**

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must ensure compliance with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are nondiscretionary.

1. The Service shall be informed of any changes in project construction scheduling as soon as possible. Should the project schedule be altered from that described herein, the Corps must immediately reinitiate formal consultation as per 50 §CFR 402.16.
2. The Corps shall comply with the latest Conservation Guidelines for the Valley Elderberry Longhorn Beetle (Service 1999a). The Corps shall check with the Service before each construction season to ensure that any and all updates to these guidelines are incorporated into the project. The Service shall be informed of conservation area monitoring plans to ensure that success criteria outlined in these guidelines are accurately assessed.
3. To monitor whether the amount or extent of incidental take anticipated from implementation of the proposed project is approached or exceeded, the Corps shall adhere to the following reporting requirement. Should this anticipated amount or extent of incidental take be exceeded, the Corps must immediately reinitiate formal consultation as per 50 §CFR 402.16.
  - a. For those components of the action that will result in habitat degradation or modification whereby incidental take in the form of harm is anticipated, the Corps will provide monthly updates to the Service with a precise accounting of the total acreage of habitat impacted. Updates shall also include any information about proposed changes in project implementation that result in habitat disturbance not described in the Project Description and not analyzed in this biological opinion.

## CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities that can be implemented to further the purposes of the Act, such as preservation of endangered species habitat, implementation of recovery actions, or development of information or data bases. The Service is providing the following conservation recommendations:

1. The Corps should communicate with the Service to ensure that the most up to date plans for the recovery of each federally-listed species are recognized and followed:
  - a. The Corps should work with the Service to assist us in meeting the goals of the latest Recovery Plan for the valley elderberry longhorn beetle, which currently is the Valley Elderberry Longhorn Beetle Recovery Plan (Service 1984);
  - b. The Corps should work with the Service to assist us in meeting the goals of the latest Recovery Plan for the giant garter snake, which currently is the 1999 Draft Recovery Plan for the Giant Garter Snake (*Thamnophis gigas*) (Service 1999b); and
  - c. The Corps should work with the Service to assist us in meeting the goals of the latest Recovery Plan for the delta smelt, which currently is the 1996 Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes (Service 1996).
2. The Corps and WSAFCA should monitor the effectiveness of the offset floodplain area in providing spawning and rearing habitat, as well the effectiveness of the floodplain in providing juvenile and adult transport and migration

So the Service can be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendation.

## REINITIATION - CLOSING STATEMENT

This concludes formal consultation on the West Sacramento Project General Reevaluation Report Project in Yolo County, California. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (a) if the amount or extent of taking specified in the incidental take statement is exceeded; (b) if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (c) if the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or (d) if a new species is listed or critical habitat designated that may be affected by the identified action.

If you have questions regarding the West Sacramento West Sacramento GRR Project, please contact Jennifer Hobbs (Jennifer\_hobbs@fws.gov), Fish and Wildlife Biologist at (916)414-6541, or Doug Weinrich (douglas\_weinrich@fws.gov), Assistant Field Supervisor.

Sincerely,

  
 Jennifer M. Norris  
Field Supervisor

Enclosure:

cc:

Sarah Ross Arrouzet, Corps of Engineers, Sacramento, California  
Maria Rae, National Marine Fisheries Service, Sacramento, California  
Howard Brown, National Marine Fisheries Service, Sacramento, California  
John Powderly, City of West Sacramento, West Sacramento, California

## REFERENCES

- Adib-Samii, J. 2008. Personal communication via e-mail with Victoria Poage, Service, re: water temperature thresholds for collection of delta smelt in routine survey sampling, October 8, 2008.
- Amweg, E.L., D.P. Weston, & N.M. Ureda. 2005. Use and toxicity of pyrethroid pesticides in the Central Valley, California, USA. *Environmental Toxicology and Chemistry* 24:966-972.
- Atwater, B.F, S.G. Conard, J.N. Dowden, C.W. Hedel, R.L. MacDonald, and W. Savage. 1979. History, landforms, and vegetation of the estuary's tidal marshes. Pages 347-386 in *San Francisco Bay: The Urbanized Estuary – Investigations into the Natural History of San Francisco Bay and Delta With Reference to the Influence of Man*. Pacific Division of the American Association for the Advancement of Science. San Francisco, California.
- Baskerville-Bridges, B., J.C. Lindberg, J.P. Van Eenannaam, and S. Doroshov. 2000. Contributed Paper to the Interagency Ecological Program for the San Francisco Estuary: Progress and development of delta smelt culture: Year-end report 2000. *IEP Newsletter* 14:24-30.
- Baskerville-Bridges, B., J.C. Lindberg, and S.I. Doroshov. 2004. The effect of light intensity, alga concentration, and prey density on the feeding behavior of delta smelt larvae. Pages 219-228 in F. Feyrer, L.R. Brown, R.L. Brown and J.J. Orsi, *editors*. *Early life history of fishes in the San Francisco Estuary and watershed*. American Fisheries Society Symposium 39, Bethesda, Maryland.
- Baxter, R., R. Breuer, L. Brown, M. Chotkowski, F. Feyrer, M. Gingras, B. Herbold, A. Mueller-Solger, M. Nobriga, T. Sommer, and K. Souza. 2008. Pelagic organism decline progress report: 2007 synthesis of results. Available online at <[http://www.science.calwater.ca.gov/pdf/workshops/POD/IEP\\_POD\\_2007\\_synthesis\\_report\\_031408.pdf](http://www.science.calwater.ca.gov/pdf/workshops/POD/IEP_POD_2007_synthesis_report_031408.pdf)>
- Bennett, W.A. 2005. Critical assessment of the delta smelt population in the San Francisco Estuary, California. *San Francisco Estuary and Watershed Science* 3(2). 71 pages.
- Bennett, W.A. and P.B. Moyle. 1996. Where have all the fishes gone? Interactive factors producing fish declines. Pages 519-541 in Hollibaugh, JT, *editor*. *San Francisco Bay: the ecosystem*. Pacific Division of the American Association for the Advancement of Science. San Francisco, California.
- Bennett, W.A., W.J. Kimmerer, and J.R. Burau. 2002. Plasticity in vertical migration by native and exotic fishes in a dynamic low-salinity zone. *Limnology and Oceanography* 47:1496-1507.
- Bennett, W.A., J.A. Hobbs, and S. Teh. 2008. Interplay of environmental forcing and growth-selective mortality in the poor year-class success of delta smelt in 2005. Final Report to the Interagency Ecological Program. Available online at <[http://www.water.ca.gov/iep/docs/pod/Bennett\\_DeltaSmelt\\_Report.pdf](http://www.water.ca.gov/iep/docs/pod/Bennett_DeltaSmelt_Report.pdf)>
- Brandes, Patricia L. and J.S. McLain. 2001. Juvenile Chinook salmon abundance, distribution, and survival in the Sacramento-San Joaquin Estuary. *Contributions to the biology of Central Valley salmonids*. *Fish Bulletin* 179(2). 100 pages.

- Brode, J. 1988. Natural history of the giant garter snake (*Thamnophis couchii gigas*). Pages 25-28, In Proceedings of the conference on California herpetology, H. F. DeListe, P. R. Brown, B. Kaufman, and B. M. McGurty (eds). Southwestern Herpetologists Society, Special Publication No. 4.
- Brode, J., and G. Hansen. 1992. Status and future management of the giant garter snake (*Thamnophis gigas*) within the southern American Basin, Sacramento and Sutter counties, California. California Department of Fish and Game, Inland Fisheries, Division.
- Brown, R.L. and W.J. Kimmerer. 2002. Delta smelt and CALFED's Environmental Water Account: A summary of the 2002 delta smelt workshop. Prepared for the CALFED Science Program, October 2002.
- Brown, L.R. and D. Michniuk. 2007. Littoral fish assemblages of the alien-dominated Sacramento-San Joaquin Delta, California, 1980-1983 and 2001-2003. *Estuaries and Coasts* 30:186-200.
- California Department of Finance. 2013. Report P-1: Summary population projections by race/ethnicity and by major age groups, Sacramento, California. Available online at <<http://www.dof.ca.gov/research/demographic/reports/projections/P-1/>>.
- [CDFW] California Department of Fish and Wildlife. 2014a. Spring Kodiak Trawl Survey. Available online at <<http://www.delta.dfg.ca.gov/data/skt/>>
- \_\_\_\_\_. 2014b. RAREFIND. California Natural Diversity Data Base, Natural Heritage Division, Sacramento, California.
- \_\_\_\_\_. 2014c. California Department of Fish and Wildlife. 2014c. 20mm Survey. Available online at <<http://www.delta.dfg.ca.gov/data/skt/>>
- \_\_\_\_\_. and U.S. Bureau of Reclamation (USBR). 1994. Biological Assessment - Effects of the Central Valley Project and State Water Project on Delta Smelt and Sacramento Splittail. Prepared for U.S. Fish and Wildlife Service, Sacramento, California. 230 pages.
- [Corps] U.S. Army Corps of Engineers. 2014a. Guidelines for landscape planting and vegetation management at levees, floodwalls, embankment dams, and appurtenant structures. April 30, 2014 Engineering Technical Letter 1110-2-583. Sacramento, California.
- \_\_\_\_\_. 2014b. Biological Assessment, West Sacramento, California, general reevaluation study and section 408 permission. Sacramento, California.
- Dege, M. and L.R. Brown. 2004. Effect of outflow on spring and summertime distribution and abundance of larval and juvenile fishes in the upper San Francisco Estuary. *American Fisheries Society Symposium* 39:49-65.
- Dettinger, M.D. 2005. From climate-change spaghetti to climate-change distributions for 21st Century California. *San Francisco Estuary and Watershed Science* 3(1). 14 pages. Available online at <<http://repositories.cdlib.org/jmie/sfews/vol3/iss1/art4>>
- Erkkila, L.F., J.F. Moffett, O.B. Cope, B.R. Smith, and R.S. Nelson. 1950. Sacramento-San Joaquin

- Delta fishery resources: effects of Tracy pumping plant and delta cross channel. U.S. Fish and Wildlife Services Special Report, Fisheries 56. 109 pages.
- Feyrer, F., B. Herbold, S.A. Matern, and P.B. Moyle. 2003. Dietary shifts in a stressed fish assemblage: consequences of a bivalve invasion in the San Francisco Estuary. *Environmental Biology of Fishes* 67:277-288.
- Feyrer, F., M.L. Nobriga, and T.R. Sommer. 2007. Multi-decadal trends for three declining fish species: habitat patterns and mechanisms in the San Francisco Estuary, California, USA. *Canadian Journal of Fisheries and Aquatic Sciences* 64:723-734.
- Feyrer, F., K. Newman, M.L. Nobriga and T.R. Sommer. 2011. Modeling the effects of future outflow on the abiotic habitat of an imperiled estuarine fish. *Estuaries and Coasts*: 34:120-128.
- Fisch, K.M., J.M. Henderson, R.S. Burton and B. May. 2011. Population genetics and conservation implications for the endangered delta smelt in the San Francisco Bay-Delta. *Conservation Genetics* 12:1421-1434.
- Ganssle, D. 1966. Fishes and decapods of San Pablo and Suisun bays. Pages 64-94 in D.W. Kelley *editor*, *Ecological studies of the Sacramento-San Joaquin Estuary*, Part 1.
- Gartrell, G. 2010. Technical issues related to Delta fall salinity, Delta hydrodynamics, and salvage of delta smelt in the Sacramento-San Joaquin Delta. Technical Memorandum submitted to the Natural Research Council Committee on Sustainable Water and Environmental Management in the California Bay-Delta.
- Gregory, S.V., F.J. Swanson, W.A. McKee, and K.W. Cummins. 1991. An ecosystem perspective of riparian zones. *Bioscience* 41:540-551.
- Grimaldo, L.F., A.R. Stewart, and W. Kimmerer. 2009. Dietary segregation of pelagic and littoral fish assemblages in a highly modified tidal freshwater estuary. *Marine and Coastal Fisheries* 1:200-217.
- HDR, Inc. (HDR). 2008. West Sacramento Levee Evaluation Project, Problem Identification Report, Draft, April. Prepared for the City of West Sacramento. Folsom, California.
- Hansen, G. E. 1988. Review of the status of the giant garter snake (*Thamnophis couchi gigas*) and its supporting habitat during 1986-1987. Final report for California Department of Fish and Game, Contract C-2060. Unpublished. 31 pp.
- Hanson, R. 1980. Western aquatic garter snakes in central California: an ecological and evolutionary perspective. Master's thesis, Department of Biology, California State University, Fresno. 78 pp.
- Hay, D. 2007. Spawning biology of eulachons, longfins and some other smelt species Sacramento, November 15, 2007, Powerpoint presentation. Available online at <[http://www.science.calwater.ca.gov/pdf/workshops/workshop\\_smelt\\_presentation\\_Hay\\_111508.pdf](http://www.science.calwater.ca.gov/pdf/workshops/workshop_smelt_presentation_Hay_111508.pdf)>.

- Herbold, B. 1994. Habitat requirements of delta smelt. Interagency Ecological Studies Program Newsletter, Winter 1994. California Department of Water Resources, Sacramento, California.
- Hestir, E. 2010. Trends in estuarine water quality and submerged aquatic vegetation invasion. PhD dissertation, University of California at Davis, Davis, California.
- Hobbs, J.A., W.A. Bennett, and J. Burton. 2006. Assessing nursery habitat quality for native smelts (*Osmeridae*) in the low-salinity zone of the San Francisco Estuary. *Journal of Fish Biology* 69:907-922.
- Hobbs, J.A, W.A. Bennett, J. Burton, and M. Gras. 2007. Classification of larval and adult delta smelt to nursery areas by use of trace elemental fingerprinting. *Transactions of the American Fisheries Society* 136:518-527.
- Horpilla, J., A. Liljendahl-Nurminen, and T. Malinen. 2004. Effects of clay turbidity and light on the predator-prey interaction between smelts and chaoborids. *Canadian Journal of Fisheries and Aquatic Sciences* 61:1862-1870.
- Houde, E.D. 1987. Subtleties and episodes in the early life of fishes. *Journal of Fish Biology* 35 (Supplement A): 29-38.
- Jassby, A.D., J.E. Cloern, and B.E. Cole. 2002. Annual primary production: patterns and mechanisms of change in a nutrient-rich tidal ecosystem. *Limnology and Oceanography* 47:698-712.
- Jassby, A.D., W.J. Kimmerer, S.G. Monismith, C. Armor, J.E. Cloern, T.M. Powell, J.R. Schubel, and T.J. Vendlinski. 1995. Isohaline position as a habitat indicator for estuarine populations. *Ecological Applications* 5:272-289.
- Johnson, M.L., I. Werner, S. Teh, and F. Loge. 2010. Evaluation of chemical, toxicological, and histopathologic data to determine their role in the pelagic organism decline. Interagency Ecological Program. Available online at <[http://www.water.ca.gov/iep/docs/contaminant\\_synthesis\\_report.pdf](http://www.water.ca.gov/iep/docs/contaminant_synthesis_report.pdf)>
- Kimmerer, W.J. 2002a. Physical, biological and management responses to variable freshwater flow into the San Francisco Estuary. *Estuaries* 25:1275-1290.

- \_\_\_\_\_. 2002b. Effects of freshwater flow on abundance of estuarine organisms: physical effects or trophic linkages. *Marine Ecology Progress Series* 243:39-55.
- \_\_\_\_\_. 2004. Open water processes of the San Francisco Estuary: from physical forcing to biological processes. *San Francisco Estuary and Watershed Science* 2(1). 142 pages. Available online at <http://repositories.cdlib.org/jmie/sfew/vol2/iss1/art1>
- \_\_\_\_\_. 2008. Losses of Sacramento River Chinook salmon and delta smelt to entrainment in water diversions in the Sacramento-San Joaquin Delta. *San Francisco Estuary and Watershed Science* 6(2). 27 pages.
- \_\_\_\_\_. 2011. Modeling delta smelt losses at the South Delta export facilities. *San Francisco Estuary and Watershed Science* 9(1). 9 pages.
- Kimmerer, W.J., E.S. Gross, and M.L. MacWilliams. 2009. Is the response of estuarine nekton to freshwater flow in the San Francisco Estuary explained by variation in habitat volume? *Estuaries and Coasts* 32:375-389.
- Kimmerer, W.J. and J.J. Orsi. 1996. Causes of long-term declines in zooplankton in the San Francisco Bay estuary since 1987. Pages 403-424 in J. T. Hollibaugh (*editor*) *San Francisco Bay: the ecosystem*. AAAS, San Francisco, CA.
- Kuivila, K.M. and G.E. Moon. 2004. Potential exposure of larval and juvenile delta smelt to dissolved pesticides in the Sacramento-San Joaquin Delta, California. *American Fisheries Society Symposium* 39:229-242.
- Larsen, E.W., and S.E. Greco. 2002. Modeling channel management impacts on river migration: A case study of Woodson Bridge State Recreation Area, Sacramento River, California, USA. *Environmental Management* 30:209-224.
- Lehman, P.W., G. Boyer, C. Hall, S. Waller, and K. Gehrts. 2005. Distribution and toxicity of a new colonial *Microcystis aeruginosa* bloom in the San Francisco Bay Estuary, California. *Hydrobiologia* 541:87-99.
- Lindberg, J. 2011. Personal communication during a meeting conducted by Brian Hansen, Sacramento Fish and Wildlife Office, Sacramento California.
- Lindberg, J., B. Baskerville-Bridges, J.P. Van Eenennaam, and S.I. Doroshov. 1997. Status of delta smelt culture. *Interagency Ecological Studies Program for the Sacramento-San Joaquin Estuary Newsletter*, Summer 1997.
- Lott, J. 1998. Feeding habits of juvenile and adult delta smelt from the Sacramento-San Joaquin River Estuary. *Interagency Ecological Program Newsletter* 11(1):14-19.
- Mac Nally, R., Thomson, J.R., Kimmerer, W.J., Feyrer, F., Newman, K.B., Sih, A., Bennett, W.A., Brown, L., Fleishman, E., Culberson, S.D., and G. Castillo. 2010. Analysis of pelagic species decline in the upper San Francisco Estuary using multivariate autoregressive modeling (MAR). *Ecological Applications* 20:1417-1430.
- Mager, R.C., S.I. Doroshov, J.P. Van Eenennaam, and R.L. Brown. 2004. Early life stages of delta smelt. Pages 169-180 in F. Feyrer, L.R. Brown, R.L. Brown and J.J. Orsi, *editors*, *Early life*

- history of fishes in the San Francisco Estuary and watershed. American Fisheries Society Symposium 39, Bethesda, Maryland.
- Marine, K.R. and J.J. Cech, Jr. 2004. Effects of high water temperature on growth, smoltification, and predator avoidance in juvenile Sacramento River Chinook salmon. *North American Journal of Fisheries Management*: 24:198–210.
- Maunder, M.N and R.B. Deriso. 2011. A state–space multistage life cycle model to evaluate population impacts in the presence of density dependence: illustrated with application to delta smelt (*Hypomesus transpacificus*). *Canadian Journal of Fisheries and Aquatic Science* 68:1285–1306.
- Moyle, P.B. 2002. *Inland fishes of California*. University of California Press, Berkeley and Los Angeles, California.
- Moyle, P.B., B. Herbold, D.E. Stevens, and L.W. Miller. 1992. Life history and status of delta smelt in the Sacramento-San Joaquin Estuary, California. *Transactions of the American Fisheries Society* 121:67-77.
- Moyle, P.B., Bennett, W.A., Fleenor, W.E., and Lund, J.R. 2010. *Habitat variability and complexity in the Upper San Francisco Estuary*, Delta Solutions, Center for Watershed Sciences, University of California. Available online at: <<http://deltasolutions.ucdavis.edu>>
- Newman, K.B. 2008. Sample design-based methodology for estimating delta smelt abundance. *San Francisco Estuary and Watershed Science* 6(3). 18 pages.
- Nobriga, M.L. 2002. Larval delta smelt diet composition and feeding incidence: environmental and ontogenetic influences. *California Fish and Game* 88:149-164.
- Nobriga, M.L. and F. Feyrer. 2007. Shallow-water piscivore-prey dynamics in California's Sacramento-San Joaquin Delta. *San Francisco Estuary and Watershed Science* 5: Available online at <<http://repositories.cdlib.org/jmie/sfew/vol5/iss2/art4>>
- Nobriga, M. and M. Chotkowski. 2000. Recent historical evidence of centrarchid increases and tule perch decrease in the Delta. *Interagency Ecological Program Newsletter* 13:23-27.
- Nobriga, M.L., F. Feyrer, R.D. Baxter, and M. Chotkowski. 2005. Fish community ecology in an altered river delta: spatial patterns in species composition, life history strategies and biomass. *Estuaries* 28:776-785.
- Nobriga, M.L., and B. Herbold. 2008. Conceptual model for delta smelt (*Hypomesus transpacificus*) for the Delta Regional Ecosystem Restoration and Implementation Plan (DRERIP). U.S. Fish and Wildlife Service, Sacramento, California.

- Nobriga, M.L., T.R. Sommer, F. Feyrer, and K. Fleming. 2008. Long-term trends in summertime habitat suitability for delta smelt, *Hypomesus transpacificus*. *San Francisco Estuary and Watershed Science* 6(1). 15 pages.
- Oros, D.R. and I. Werner. 2005. Pyrethroid Insecticides: an analysis of use patterns, distributions, potential toxicity and fate in the Sacramento-San Joaquin Delta and Central Valley. White Paper for Interagency Ecological Program. SFEI Contribution 415, San Francisco Estuary Institute, Oakland, California.
- Orsi, J.J. and W.L. Mecum. 1996. Food limitation as the probable cause of a long-term decline in the abundance of *Neomysis mercedis* the opossum shrimp in the Sacramento-San Joaquin estuary. Pages 375-401 in Hollibaugh, JT (*editor*), *San Francisco Bay: the ecosystem*. American Association for the Advancement of Science, San Francisco.
- Peterson, M.S. 2003. A conceptual view of environment-habitat-production linkages in Tidal Riverine Estuaries. *Fisheries Science* 11:291-313.
- Radtke, L.D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta with observations on food of sturgeon, in *Ecological studies of the Sacramento-San Joaquin Delta, Part II*, in: S.L. Turner and D.W. Kelley, *editors*, *Ecological Studies of the Sacramento-San Joaquin Estuary*, pages 115-129. California Department of Fish and Game Fish Bulletin 136.
- Rast, W. and J. Sutton. 1989. Stable isotope analysis of striped bass food chain in Sacramento-San Joaquin Estuary, California, April-September, 1986. Water Resources Investigations Report 88-4164, U.S. Geological Survey, Sacramento, California. 62 pages.
- Rose, K.A., J.H. Cowan, K.O. Winemiller, R.A. Myers, and R. Hilborn. 2001. Compensatory density-dependence in fish populations: importance, controversy, understanding, and prognosis. *Fish and Fisheries* 2:293-327.
- Rossman, D., and G. Stewart. 1987. Taxonomic reevaluation of *Thamnophis couchii* (Serpentes: Colubridae). Occasional Papers of the Museum of Zoology, Louisiana State University, Baton Rouge, Louisiana. No. 63. 25 pp.
- Sedell, J.R., G.H. Reeves, F.R. Hauer, J.A. Stanford, and C.R. Hawkins. 1990. Role of refugia in recovery from disturbances: modern fragmented and disconnected river systems. *Environmental Management* 14:711-724.
- Schoellhamer, D.H. 2011. Sudden clearing of estuarine waters upon crossing the threshold from transport as an erodible sediment pool is depleted: San Francisco Bay, 1999. *Estuaries and Coasts* 34:885-899.
- [Service] U.S. Fish and Wildlife Service. 1984. Valley Elderberry Longhorn Beetle Recovery Plan, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 70 pages.

- \_\_\_\_\_. 1991. Endangered and threatened wildlife and plants: Proposed threatened status for the delta smelt. Federal Register 56:50075-50084.
- \_\_\_\_\_. 1993. Endangered and threatened wildlife and plants: Determination of threatened status for the delta smelt. Federal Register 58:12854-12864.
- \_\_\_\_\_. 1994. Endangered and threatened wildlife and plants: Critical habitat determination for the delta smelt. Federal Register 59:65256-65279.
- \_\_\_\_\_. 1996. Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 208 pages.
- \_\_\_\_\_. 1997. Programmatic formal consultation for the U.S. Army Corps of Engineers 404 permitted projects with relatively small effects on the giant garter snake within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo, counties, California. File number 1-1-F-97-149, Sacramento, California.
- \_\_\_\_\_. 1999a. Conservation Guidelines for the Valley Elderberry Longhorn Beetle. Sacramento Fish and Wildlife Office, Sacramento, California.
- \_\_\_\_\_. 1999b. Draft recovery plan for the giant garter snake (*Thamnophis gigas*). U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 207 pages.
- \_\_\_\_\_. 2006. Giant Garter Snake (*Thamnophis gigas*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 46 pages.
- \_\_\_\_\_. 2010. Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition to Reclassify the Delta Smelt From Threatened to Endangered Throughout its Range. Federal Register 75:17667-17680.
- \_\_\_\_\_. 2014a. Withdrawal of the Proposed Rule to Remove the Valley Elderberry Longhorn Beetle from the Federal List of Endangered and Threatened Wildlife. Proposed Rule; Withdrawal. Federal Register 79:55879-55917.
- \_\_\_\_\_. 2014b. Sacramento trawls CHN &POD species 2012-2015. The Delta Juvenile Fish Monitoring Program, Stockton Fish and Wildlife Office, Lodi, California. Available online at: < <http://www.fws.gov/stockton/jfmp/>>
- \_\_\_\_\_. 2014c. Beach seines CHN &POD species 2012-2015. The Delta Juvenile Fish Monitoring Program, Stockton Fish and Wildlife Office, Lodi, California. Available online at: < <http://www.fws.gov/stockton/jfmp/>>
- Sogard, S.M. 1997. Size-selective mortality in the juvenile stage of teleost fishes: a review. Bulletin of Marine Science 60:1129-1157.

- Sommer, T.R., C. Armor, R. Baxter, R. Breuer, L. Brown, M. Chotkowski, S. Culberson, F. Feyrer, M. Gingras, B. Herbold, W. Kimmerer, A. Mueller-Solger, M. Nobriga, and K. Souza. 2007. The collapse of pelagic fishes in the upper San Francisco Estuary. *Fisheries* 32:270-277.
- Stanley, S.E., P.B. Moyle, and H.B. Shaffer. 1995. Allozyme analysis of delta smelt, *Hypomesus transpacificus*, and longfin smelt, *Spirinchus thaleichthys*, in the Sacramento-San Joaquin estuary. *Copeia* 1995:390-396.
- Stevens, D.E. 1963. Food habits of striped bass, *Morone saxatilis* (Walbaum), in the Sacramento-Rio Vista area of the Sacramento River. Master's Thesis. University of California at Davis, Davis, California.
- Stevens, D.E. and L.W. Miller. 1983. Effects of river flow on abundance of young Chinook salmon, American shad, longfin smelt, and delta smelt in the Sacramento-San Joaquin river system. *North American Journal of Fisheries Management* 3:425-437.
- Swanson, C. and J.J. Cech, Jr. 1995. Environmental tolerances and requirements of the delta smelt, *Hypomesus transpacificus*. Final Report. California Department of Water Resources Contracts B-59499 and B-58959. Davis, California.
- Swanson, C., D.V. Baxa, P.S. Young, J.J. Cech, and R.P. Hedrick, R. P. 2002. Reduced swimming performance in delta smelt infected with *Mycobacterium* spp. *Journal of Fish Biology* 61:1012-1020.
- Sweetnam, D.A. 1999. Status of delta smelt in the Sacramento-San Joaquin Estuary. *California Fish and Game* 85:22-27.
- Sweetnam, D.A., and D.E. Stevens. 1993. Report to the Fish and Game Commission: A status review of the delta smelt (*Hypomesus transpacificus*) in California. Candidate Species Status Report 93-DS. Sacramento, California. 98 pages plus appendices.
- Taniguchi, Y., F.J. Rahel, D.C. Novinger, and K.G. Gerow. 1998. Temperature mediation of competitive interactions among three fish species that replace each other along longitudinal stream gradients. *Canadian Journal of Fisheries and Aquatic Sciences* 55:1894-1901.
- Thetmeyer, H. and U. Kils. 1995. To see and not be seen: the visibility of predator and prey with respect to feeding behaviour. *Marine Ecology Progress Series* 126:1-8.
- Thomson, J.R., W.J. Kimmerer, L.R. Brown, K.M. Newman, Mac Nally, R., Bennett, W.A., Feyrer, F. and E. Fleishman. 2010. Bayesian change point analysis of abundance trends for pelagic fishes in the upper San Francisco Estuary. *Ecological Applications* 20:1431-1448.
- Trenham, P.C., H.B. Shaffer, and P.B. Moyle. 1998. Biochemical identification and assessment of population subdivision in morphometrically similar native and invading smelt species (*Hypomesus*) in the Sacramento-San Joaquin Estuary, California. *Transactions of the American Fisheries Society* 127:417-424.

- Turner, J.L., Kelley, DW (*editors*). 1966. Ecological studies of the Sacramento-San Joaquin Delta, part II, fishes of the Delta. California Department of Fish and Game Fish Bulletin 136.
- [USBR] U.S. Bureau of Reclamation. 2008. OCAP Biological Assessment on the Continued Long-term Operations of the Central Valley Project and the State Water Project.
- Utne-Palm, A.C., and J.E. Stiansen. 2005. Effect of larval ontogeny, turbulence and light on prey attack rate and swimming activity in herring larvae. *Journal of Experimental Marine Biology and Ecology* 268:147-170. Available online at <<http://jeb.biologists.org/cgi/content/full/208/5/831>>
- Wang, J.C.S. 1986. Fishes of the Sacramento-San Joaquin Estuary and adjacent waters, California: a guide to the early life stages. Interagency Ecological Studies Program Technical Report 9. 183 pages.
- \_\_\_\_\_. 1991. Early life stages and early life history of the delta smelt, *Hypomesus transpacificus*, in the Sacramento-San Joaquin Estuary, with comparison of early life stages of the longfin smelt, *Spirinchus thaleichthys*. Interagency Ecological Studies Program Technical Report 28. 58 pages.
- \_\_\_\_\_. 1986. Fishes of the Sacramento-San Joaquin Estuary and adjacent waters, California: a guide to the early life stages. Interagency Ecological Studies Program Technical Report 9. Sacramento, California.
- \_\_\_\_\_. 2007. Spawning, early life stages, and early life histories of the Osmerids found in the Sacramento-San Joaquin Delta of California. Tracy Fish Facilities Studies California Volume 38. U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, California.
- Werner, I., L. Deanovic, D. Markiewicz, M. Stillway, N. Offer, R. Connon, and S. Brander. 2008. Pelagic organism decline (POD): Acute and chronic invertebrate and fish toxicity testing in the Sacramento-San Joaquin Delta, 2006-2007. Final report to the Interagency Ecological Program. Available online at <[http://www.science.calwater.ca.gov/pdf/workshops/POD/2008\\_final/Werner\\_POD2006-07Tox\\_Final\\_Report.pdf](http://www.science.calwater.ca.gov/pdf/workshops/POD/2008_final/Werner_POD2006-07Tox_Final_Report.pdf)>
- Werner, I., D. Markiewicz, L. Deanovic, R. Connon, S. Beggel, S. Teh, M. Stillway, C. Reece. 2010. Pelagic organism decline (POD): Acute and chronic invertebrate and fish toxicity testing in the Sacramento-San Joaquin Delta, 2008-2010. Final report to the Interagency Ecological Program. Available online at <[http://www.science.calwater.ca.gov/pdf/workshops/POD/Werner%20et%20al\\_2010\\_POD2008-2010\\_Final%20Report.pdf](http://www.science.calwater.ca.gov/pdf/workshops/POD/Werner%20et%20al_2010_POD2008-2010_Final%20Report.pdf)>
- Weston, B.P. and M.J. Lydy. 2010. Urban and agricultural sources of pyrethroid insecticides to the Sacramento-San Joaquin Delta of California. *Environmental Science and Technology* 44:1833-1840.

Winemiller, K.O. and Rose, K.A. 1992. Patterns of life-history diversification in North American fishes: implications for population regulation. *Canadian Journal of Fisheries and Aquatic Sciences* 49:2196-2218.



**APPENDIX A**  
**SOUTHPORT EARLY IMPLEMENTATION PROJECT**  
**Project Plan View**







**APPENDIX B**

**SOUTHPORT EARLY IMPLEMENTATION PROJECT**

**Project Effects on Federally-Listed Species Within  
U.S. Fish and Wildlife Service Jurisdiction**



**Table B-1.** Effects on giant garter snake (*Thamnophis gigas*) in the Southport Early Implementation Project action area of the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.

Habitat	Temporary Effects	Permanent Effects
Aquatic Habitat	0	0
Upland Habitat	155	2.24

**Table B-2.** Estimates of elderberry shrubs affected by the Southport Project Early Implementation Project of the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.<sup>1</sup>

Location	Stem Diameter	Holes	Number of Stems	Elderberry Ratios	Elderberry Plantings	Associate Ratios	Associate Plantings
Non-riparian	≥ 1 inch and ≤ 3 inches	No	6	1:1	6	1:1	6
		Yes	135	2:1	270	2:1	540
Non-riparian	> 3 inches and < 5 inches	No	1	2:1	2	1:1	2
		Yes	22	4:1	88	2:1	176
Non-riparian	≥ 5 inches	No	1	3:1	3	1:1	3
		Yes	37	6:1	222	2:1	444
Riparian	≥ 1 inch and ≤ 3 inches	No	110	2:1	220	1:1	220
		Yes	25	4:1	100	2:1	200
Riparian	> 3 inches and < 5 inches	No	46	8:1	138	1:1	138
		Yes	10	6:1	60	2:1	120
Riparian	≥ 5 inches	No	27	4:1	108	1:1	108
		Yes	4	8:1	32	2:1	64
Totals			424		1,249 <sup>2</sup>		2,021 <sup>2</sup>

<sup>1</sup> Information based on the Conservation Guidelines for the Valley Elderberry Longhorn Beetle (Service 1999a).

<sup>2</sup> Plantings require 588,600 square feet or 13.51 acres.

**Table B-3.** Effects on delta smelt (*Hypomesus transpacificus*) critical habitat in the Southport Early Implementation Project action area of the West Sacramento General Reevaluation Report Project, West Sacramento, Yolo County, California.

Shallow Water Habitat Created	Shallow Water Habitat Affected
118.81 acres	8.49 acres (0.04 permanently)



**West Sacramento GRR EIS/EIR  
Appendix J**

**Final Biological Opinions  
Enclosure 2**

**NMFS Biological Opinion**

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UNITED STATES DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
NATIONAL MARINE FISHERIES SERVICE  
West Coast Region  
650 Capitol Mall, Suite 5-100  
Sacramento, California 95814-4700

SEP 8 2015

Refer to NMFS No: WCR-2014-1375

Ms. Alicia Kirchner  
Acting Regional Resources Manager  
Department of the Army  
United States Army Corps of Engineers  
Sacramento District  
1325 J Street  
Sacramento, California 95814-2922

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, for the West Sacramento General Reevaluation Study (West Sacramento GRS)

Dear Ms. Kirchner:

Thank you for your letter of November 24, 2014, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 *et seq.*) for the West Sacramento GRS.

This letter also transmits NMFS's essential fish habitat (EFH) conservation recommendations for Pacific salmon as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended (16 U.S.C. 1801 *et seq.*).

Based on the best available scientific and commercial information, the Biological Opinion (BO) concludes that the West Sacramento GRS is not likely to jeopardize the continued existence of the federally listed threatened Central Valley (CV) spring-run Chinook salmon evolutionarily significant unit (ESU) (*Oncorhynchus tshawytscha*), endangered Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*), or threatened California CV steelhead distinct population segment (DPS) (*O. mykiss*) or the threatened Southern DPS (sDPS) of North American green sturgeon (*Acipenser medirostris*), and is not likely to destroy or adversely modify their designated critical habitats. For the above species, NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the project.

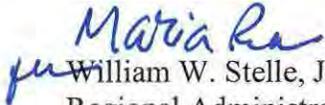
The EFH consultation concludes that the proposed action would adversely affect the EFH of Pacific salmon in the action area. The EFH consultation adopts the ESA reasonable and prudent measures and associated terms and conditions from the BO and includes additional conservation recommendations specific to the adverse effects to fall- and late fall-run Chinook salmon (*O. tshawytscha*) EFH.



The U.S. Army Corps of Engineers (Corps) has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed written response to NMFS within 30 days of receipt of these conservation recommendations, and 10 days in advance of any action, that includes a description of measures adopted by the Corps for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR 600.920(j)). If unable to complete a final response within 30 days, the Corps should provide an interim written response within 30 days before submitting its final response. In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the West Sacramento GRS and the measures needed to avoid, minimize, or mitigate (also referred to as compensate by NMFS) such effects.

Please contact Howard Brown at the NMFS California Central Valley Office, 916-930-3608, or at [Howard.Brown@noaa.gov](mailto:Howard.Brown@noaa.gov), if you have any questions concerning this section 7 consultation, or if you require additional information.

Sincerely,

  
William W. Stelle, Jr.  
Regional Administrator

Enclosure

CC: File ARN 151422WCR214SA00214

**Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation.**

West Sacramento GRS  
 NMFS Consultation Number: 2014-SA00214

Action Agency: U.S. Army Corps of Engineers (Corps)

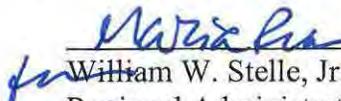
Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?*	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
CV spring-run Chinook salmon ESU ( <i>Oncorhynchus tshawytscha</i> )	Threatened	Yes	No	No
Sacramento River winter-run Chinook salmon ESU ( <i>O. tshawytscha</i> )	Endangered	Yes	No	No
California CV steelhead DPS ( <i>O. mykiss</i> )	Threatened	Yes	No	No
Southern DPS of North American green sturgeon ( <i>Acipenser medirostris</i> )	Threatened	Yes	No	No

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

  
 William W. Stelle, Jr.  
 Regional Administrator

Date: 9/8/15

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## List of Acronyms

<b>BA</b>	Biological Assessment
<b>BCSSRP</b>	Battle Creek Salmon and Steelhead Restoration Program
<b>BMP</b>	Best Management Practices
<b>BO</b>	Biological Opinion
<b>BSSCP</b>	Bentonite Slurry Spill Contingency Plan
<b>CCV</b>	California Central Valley
<b>CDFG</b>	California Department of Fish and Game
<b>CDFW</b>	California Department of Fish Wildlife
<b>CEQA</b>	California Environmental Quality Act
<b>cfs</b>	Cubic Feet per Second
<b>CNFH</b>	Coleman National Fish Hatchery
<b>Corps</b>	US Army Corps of Engineers
<b>CRR</b>	Cohort Replacement Rate
<b>CV</b>	Central Valley
<b>CVP</b>	Central Valley Project
<b>CVFPB</b>	Central Valley Flood Protection Board
<b>CWA</b>	Clean Water Act
<b>CWT</b>	Coded Wire Tag
<b>dbh</b>	Diameter at Breast Height
<b>DCC</b>	Delta Cross Channel
<b>Delta</b>	Sacramento-San Joaquin Delta
<b>DO</b>	Dissolved Oxygen
<b>DPS</b>	distinct population segment
<b>DWR</b>	California Department of Water Resources
<b>DWSC</b>	Deep Water Ship Channel
<b>EFH</b>	Essential Fish Habitat
<b>EIP</b>	Early Implementation Project
<b>EPA</b>	Environmental Protection Agency
<b>ESA</b>	Endangered Species Act
<b>ESU</b>	Evolutionarily Significant Unit
<b>ETL</b>	Engineering Technical Letter
<b>FRFH</b>	Feather River Fish Hatchery
<b>GCID</b>	Glenn-Colusa Irrigation District
<b>GRS</b>	General Reevaluation Study
<b>HU</b>	Hydrologic Unit
<b>ITS</b>	Incidental Take Statement
<b>IWM</b>	Instream Woody Material
<b>JPE</b>	Juvenile Production Estimate
<b>Kelts</b>	Post-Spawning Steelhead
<b>lf</b>	Linear Feet
<b>LSNFH</b>	Livingston Stone National Fish Hatchery
<b>LWM</b>	Large Woody Material
<b>mm</b>	millimeter

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<b>MMP</b>	Mitigation and Monitoring Plan
<b>MSA</b>	Magnuson-Stevens Fishery Conservation and Management Act
<b>nDPS</b>	Northern Distinct Population Segment
<b>NEPA</b>	National Environmental Policy Act
<b>NMFS</b>	National Marine Fisheries Service
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>NPDES</b>	National Pollutant Discharge Elimination System
<b>NTUs</b>	Nephelometric Turbidity Units
<b>O&amp;M</b>	Operation and Maintenance
<b>PAHs</b>	Polycyclic Aromatic Hydrocarbons
<b>PCB</b>	Polychlorinated Biphenyl
<b>PCE</b>	primary constituent elements
<b>PL</b>	Public Law
<b>PVA</b>	Population Viability Analysis
<b>RBDD</b>	Red Bluff Diversion Dam
<b>RD</b>	Reclamation District
<b>Reclamation</b>	United States Department of the Interior, Bureau of Reclamation
<b>RM</b>	River Mile
<b>RWQB</b>	Regional Water Quality Control Board
<b>SAM</b>	Standard Assessment Methodology
<b>SDFPF</b>	Skinner Delta Fish Protection Facility
<b>sDPS</b>	Southern Distinct Population Segment
<b>SJRRP</b>	San Joaquin River Restoration Program
<b>SPCCP</b>	Spill Prevention, Control, and Counter-Measure Plan
<b>SRA</b>	Shaded Riverine Aquatic
<b>SRBPP</b>	Sacramento River Bank Protection Project
<b>SRFCP</b>	Sacramento River Flood Control Project
<b>SWP</b>	State Water Project
<b>SWPPP</b>	Storm Water Pollution Prevention Plan
<b>SWRCB</b>	State Water Resources Control Board
<b>TCP</b>	Temperature Compliance Point
<b>TFCF</b>	Tracy Fish Collection Facility
<b>TRT</b>	Technical Review Team
<b>USACE</b>	United State Army Corps of Engineers
<b>USFWS</b>	United States Fish and Wildlife Service
<b>VSP</b>	Viable Salmonid Populations
<b>VVR</b>	Vegetation Variance Request
<b>WRDA</b>	Water Resources Development Act
<b>WRO</b>	Water Rights Order
<b>WSAFCA</b>	West Sacramento Area Flood Control Agency

Note: Throughout this document there are references cited as CDFG. This refers to the California Department of Fish and Game. This name was changed to California Department of Fish and Wildlife on January 1, 2013. However, for consistency on publications, references prior to January 1, 2013, will remain CDFG.

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## INTRODUCTION

The U.S. Army Corps of Engineers (Corps) proposes to implement flood risk management improvements under the West Sacramento General Reevaluation Study (West Sacramento GRS). The purpose of this Biological Opinion (BO) is to analyze the potential effects from the West Sacramento GRS on listed threatened or endangered species and on designated critical habitat, within the project's area of effect (action area).

### 1.1 West Sacramento GRS Project Study Area

The West Sacramento Project study area refers to the area that will be protected by the proposed levee improvements, including the city of West Sacramento itself and the lands within West Sacramento Area Flood Control Agency (WSAFCA) boundaries, which encompass portions of the Sacramento River, the Yolo Bypass, and the Sacramento Deep Water Ship Channel (DWSC). The flood protection system associated with these waterways consists of over 50 miles of levees. These levees surround West Sacramento, with the exception of intersecting waterways (the barge canal and DWSC). The City of West Sacramento is located in eastern Yolo County at the confluence of the American and Sacramento rivers. The city lies within the natural floodplain of the Sacramento River, which bounds the city along the north and east. It is made up of a small amount of high ground north of Highway 50 along the Sacramento River, and reclaimed land protected from floods by levees and the Yolo Bypass system. The Yolo Bypass diverts flood flows around the city to the west. In addition to the area within the city limits (in Yolo County), the study area partially extends into Solano County on the extreme southwestern edge along the DWSC. The West Sacramento Project study area and the problems identified for improvement are shown on Figure 1.

The study area is within the bounds of the Legal Delta as defined by the State of California under the Delta Protection Act (Section 12220 of the Water Code). The Legal Delta is further subdivided into a primary zone and secondary zone for land use planning and resource protection purposes. Most of West Sacramento is in the secondary zone, while the extreme northern part of the city is outside of any of these Delta planning areas. The study reach along the DWSC west levee is the only portion of the study area within the primary zone.

The DWSC and barge canal bisect the city into two subbasins, separating the developing Southport area from the more established neighborhoods of Broderick and Bryte to the north (City of West Sacramento 2000). The two subbasins are broken up into nine levee reaches based on location and fixes. The North Basin, which encompasses 6,100 acres, contains:

1. Sacramento River north levee – 5.5 miles from the Sacramento Bypass south to the stone lock structure on the DWSC.
2. Port north levee – 4.9 miles from the stone lock structure west to the Yolo Bypass levee.
3. Yolo Bypass levee – 3.7 miles from the Port north levee north to the Sacramento Bypass. Sacramento Bypass Training levee – 0.5 miles west into the Yolo Bypass from the Sacramento Bypass levee.

The South Basin, which encompasses 6,900 acres, contains:

2. Sacramento River south levee – 5.9 miles south along the Sacramento River from the DWSC stone lock structure to the South Cross levee (just north of the waste water treatment plant).
3. South Cross levee – 1.2 miles across the South Basin from the Sacramento River to the DWSC.
4. DWSC east levee – 2.8 miles from the South Cross levee north to the point where it bends east.
5. Port south levee – 4.0 miles east from the bend in the DWSC east levee to the stone lock structure.
6. DWSC west levee – 21.4 miles from the intersection of the Port north levee and the Yolo Bypass levee south to Miners Slough.

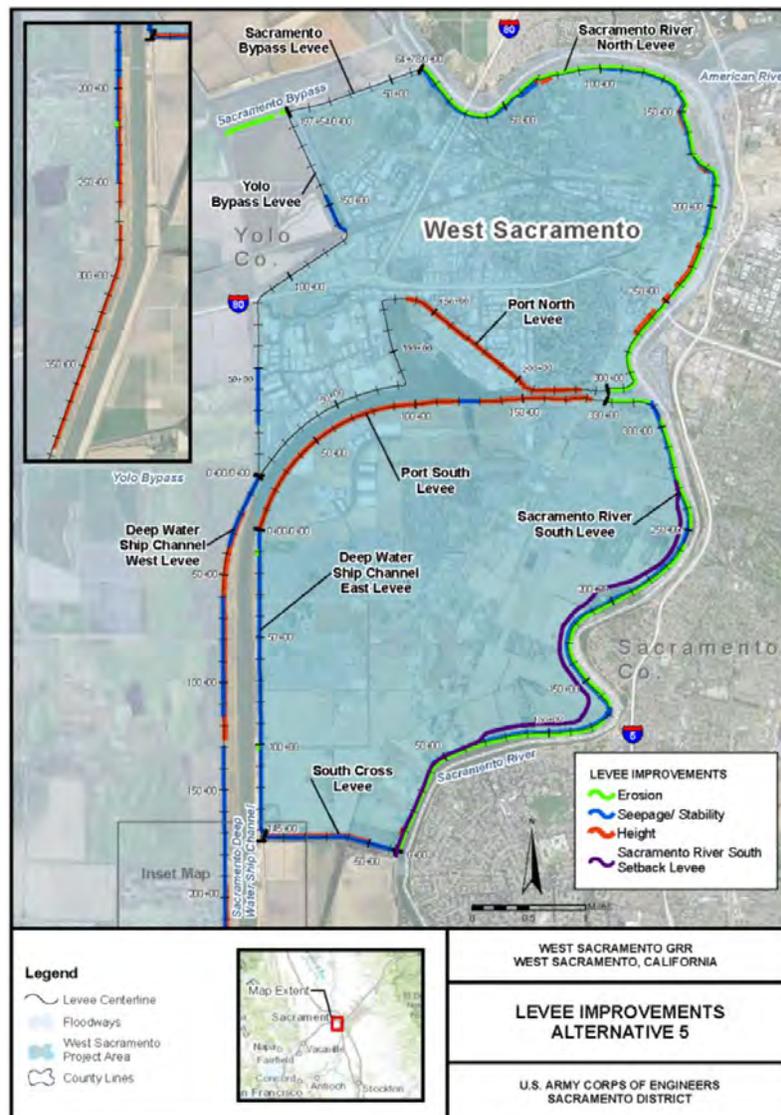


Figure 1. West Sacramento GRS Study Area (Corps 2014).

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## **1.2 Background, Authority and Policy**

The National Marine Fisheries Service (NMFS) prepared the BO and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR part 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System, <https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts>. A complete record of this consultation is on file at the NMFS California Central Valley Office.

### **1.2.1 Background**

According to the Corps BA, the current levee system does not adequately protect the city of West Sacramento during a 100-year event. The history of the Sacramento River Flood Control Project (SRFCP) dates back to the mid-1800s with the initial construction of levees along the Sacramento, American, Feather, and Yuba rivers. This levee system has been characterized by a history of levee failure, followed by improvement. This continued until the California Legislature authorized a comprehensive plan for controlling the floodwaters of the Sacramento River and its tributaries in the Flood Control Act of 1911. Federal participation in the SRFCP began shortly after authorization in 1917 and continued for approximately 40 years.

Historically, from the mid-1800s onward, most hydraulic engineers at the Federal, State, and local level thought that the most effective way to control flood flows in the river system was to construct levees close to the main channel. The record floods of 1907 and 1909 forced a reevaluation of this historic approach. It was clear from the size of these flood events in relation to existing channel capacities that major bypass systems were needed to control excess flood flows. These bypasses were designed to divert flood flows away from urban centers. Throughout the SRFCP, the frequency that flow starts to divert from the Sacramento River to the bypass system varies between a 3-year to 5-year flood event.

The series of storms that struck California in February of 1986 resulted in the flood of record for many areas in northern and central California. As a result of the problems experienced during the 1986 flood, the Corps initiated a study of the levees comprising the SRFCP that were impacted by the flood. Due to the large scale of the study, the review was split into five phases. The first phase of this study included West Sacramento and was documented through an Initial Appraisal Report titled, Sacramento Urban Area Levee Reconstruction Project, California dated May 1988. This phase included the review of approximately 110 miles of levee and recommended the repair of 34 miles.

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The 1986 flood also exposed structural problems and identified the inability of the existing levees to provide flood protection to the Sacramento metropolitan area. As a result, the Corps, in cooperation with the State of California, initiated the study titled, Sacramento Metropolitan Area, California, Feasibility Report. This report was published in February 1992 and indicated the existing flood control system in the study area provided significantly less than a 100-year level of protection. The study went on to recommend a program of improvements. The repairs recommended by the Sacramento Metropolitan Area, California, Feasibility Report were authorized in the Water Resources Development Act (WRDA) of 1992 (Public Law [PL] 102-580).

The Corps was preparing construction plans and specifications for the levee repairs authorized in the WRDA of 1992, when the 1997 New Year's Day Flood occurred. It was one of the largest experienced in northern California since the beginning of the measured record in 1906. In the wake of the 1997 flood, the Corps identified underseepage as an area of greater concern in the design and repair of levees. This resulted in a number of design revisions to the levee repairs recommended in the West Sacramento Project Design Memorandum. These design revisions and the associated increase to the total estimated project cost were captured in a supplemental authorization through the Energy and Water Development Appropriation Act of 1999 (PL 105-245).

There are two additional flood management Corps projects related to the West Sacramento GRS that provide additional context; the American River Common Features Project, and the Sacramento Bank Protection Project (SRBPP) Phase II 80,000 linear feet (lf). Many of the proposed elements associated with the American River Common Features and SRBPP are anticipated to be similar in nature to proposed elements with the West Sacramento GRS. The American River Common Features Project area will include the lower 8 miles of the American River and the east bank of the Sacramento River from the confluence of the American River downstream to the vicinity of Freeport, California. It will also include widening the Sacramento bypass and weir. Potential impacts associated with vegetation removal and bank armoring associated with the American River Common Features could further degrade this area of the Sacramento River watershed. These potential impacts in combination with potential impacts associated with the West Sacramento GRS could degrade the overall health of the lower Sacramento River watershed.

The Corps has initiated consultation for the Sacramento Bank Protection Project Phase II project. Sacramento Bank Protection Project Phase II will cover up to 80,000 lf of bank protection as part of the SRFCP. A number of the potential bank protection sites are located in the general vicinity of the West Sacramento GRS. These projects have the potential to increase the bank armoring and could exacerbate any impacts associated with the West Sacramento GRS.

### **1.2.2 Authority and Policy**

According to the Corps' BA, they have no discretion in regards to the continuing existence and operation of the flood control structures of the SRFCP. The assert to have responsibility to maintain Civil Works structures so that they continue to serve their congressionally authorized purposes is inherent in the authority to construct them and is, according to the Corps, non-

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discretionary. The Corps also asserts that only Congressional actions to de-authorize the structures can alter or terminate this responsibility and thereby allow the maintenance of the structures to cease.

The Corps BA also claims that it has a non-discretionary duty to maintain the SRFCP and the fact the Corps perpetuates the projects existence is not an action subject to consultation. The Federal government maintains oversight but has no ownership of or direct responsibilities for performing maintenance of the Federal levee system, except for few select features that continue to be owned and operated by the Corps. However, the Corps asserts they do have discretion in regard to how and where maintenance actions are performed. The discretion lies within the authorities of the SRBPP and section 408 of the Rivers and Harbors Act. The Corps is seeking additional authorities that will include discretion over future flood risk reduction projects associated with the West Sacramento GRS and the American River Common Features.

Considering these exceptions, the Corps maintains that the majority of levees, channels, and related flood risk management structures are owned, operated, and maintained by the State of California and local levee and reclamation districts as governed by Corps Operations and Maintenance (O&M) manuals. The Corps points to the May 1955 Standard O&M manual for the SRFCP as the primary O&M manual for the area. The levees of the West Sacramento and Common Features Projects are part of the SRFCP and therefore covered in the 1955 O&M manual.

The BA states that following completion of construction, the Corps will prepare a supplement to the 1955 O&M manual which will specify maintenance requirements for these projects. Because the Corps does have discretion in how and when levee maintenance activities are performed (as opposed to the results of maintenance), maintenance is a discretionary activity that is part of the proposed action subject to consultation.

Typical maintenance activities would include vegetation control through mowing, herbicide application, and/or slope dragging; rodent control; patrol road maintenance; and erosion control and repair. Vegetation control typically would be performed twice a year. Herbicide and bait station application would be conducted under county permit by experts licensed by the state for pest control. Erosion control and slope repair activities would include re-sloping and compacting; fill and repair of damage from rodent burrows would be treated similarly.

To meet Federal Flood Control Regulations (33 CFR 208.10) and state requirements (California Water Code Section 8370), the Federal Flood Risk Management facilities are inspected four times annually, at intervals not exceeding 90 days. The California Department of Water Resources (DWR) would inspect the system twice a year, and the local maintaining authorities would inspect it twice a year and immediately following major high water events. The findings of these inspections would be reported to the Central Valley Flood Protection Board's (CVFPB) Chief Engineer through DWR's Flood Project Integrity and Inspection Branch.

Each federal agency has an obligation to insure that any discretionary action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or destroy or adversely modify its critical habitat. Furthermore, under Section 2 of the

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ESA, it is declared that all Federal agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of the ESA. In regards to species and critical habitat compensation, the Corps has the authority to compensate prior to or concurrent with project construction impacts. This authority is given under WRDA 1986 (33 USC §§ 2201–2330).

The West Sacramento Project is being proposed in accordance with the principles that have been outlined in the Corps' SMART Planning Guide (Corps 2013). SMART Planning requires that all feasibility studies should be completed within a target of 18 months (to no more than three years at the greatest), at a cost of no more than \$3 million, utilizing 3 levels of vertical team coordination, and of a "reasonable" report size. All designs associated with the West Sacramento Project use the largest footprint to evaluate affects to listed species. The larger footprint will look at the maximum extent the project could affect species in the action area.

The Corps proposes to construct the West Sacramento Project levee improvement measures to comply with the Engineering Technical Letter (ETL) 1110-2-571 Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures. The vegetation requirements include a vegetation-free zone on the levee slopes and crown, 15 feet from both landside and waterside levee toes, and 8 feet vertically.

The levees within the study area require seepage, slope stability, height, and erosion improvements in order to meet Corps levee safety criteria. In order to protect existing vegetation and allow for revegetation to occur, the Corps must apply for and issue itself with a vegetation variance. The vegetation variance will be sought during the preconstruction engineering and design phase to allow vegetation to remain on the lower 2/3 of the waterside slope and out 15 feet from the waterside toe. If the Corps grants itself a variance, the variance would allow for vegetation to remain in these areas. No vegetation would be permitted on the landside slope or within 15 feet of the landside toe. To show that the safety, structural integrity, and functionality of the levee would be retained with a variance, an evaluation of underseepage and waterside embankment slope stability was completed by Corps engineers.

The Corps' preliminary analysis for the vegetation variance was conducted by analyzing two index points. These two index points were chosen for the vegetation variance analyses because they were considered to be representative of the most critical channel and levee geometry, underseepage, slope stability conditions, and vegetation conditions of the respective basins. The analysis incorporated tree fall and scour on the cross-section geometry of the index points by using a maximum depth of scour for cottonwoods as approximately 11.0 feet; the associated soil removed was projected at a 2:1 slope from the base of the scour toward both the landside, and waterside slopes. The base scour width was equal to the maximum potential diameter at breast height (dbh) of cottonwoods (12.0 feet) projected horizontally at a depth of 11.0 feet below the existing ground profile. The results show that the tree fall and scour did not significantly affect levee performance and that the levee would meet Corps seepage and slope stability criteria when the seepage and slope stability improvement measures are in place ("with-project" conditions). Therefore, it is a reasonable conclusion that allowing vegetation to remain on the lower waterside levee slope would not affect the safety, structural integrity, and functionality of the Sacramento River levee.

As a result of the geotechnical analysis, the Corps would request a vegetation variance of themselves for the Sacramento River portion of future projects that come from the GRS. In many cases along the Sacramento River levees, the levee is far enough back from the water's edge to allow vegetation providing shaded riverine aquatic cover to remain on the bank with no vegetation variance necessary. However, in Sacramento River north reach, vegetation along the bank will be thinned in order to place rock on the bank for erosion protection. No woody vegetation would be permitted on the landside slope or within 15 feet of the landside toe for purposes of providing access for levee inspections and flood repair response. Refer to Table 1 for reach specific information regarding presence or absence of a vegetation variance.

**Table 1: West Sacramento Project Vegetation Variance Assumptions.**

Repair Reach	Vegetation Variance	No Vegetation Variance
Sacramento River North	X	
Port North		X
Yolo Bypass *		X
Sacramento Bypass Training Levee		X
Sacramento River South	X	
South Cross		X
Deep Water Ship Channel East *		X
Deep Water Ship Channel West*		X
Port South		X

\*Vegetation is sparse in these reaches. Individual tree removal will be analyzed.

Approximately 50 acres of primarily landside riparian vegetation will be removed, both to provide for the construction footprint, and to comply with ETL. In addition, approximately 5,000 linear feet (lf) of shoreline habitat will be removed from the Port north and south levees along the Barge Canal due to ETL compliance.

The standard O&M activities will be adjusted to reflect any vegetation variance. Under the adjusted O&M manual, large trees that were protected in place under the variance will be allowed to remain on the waterside slopes, but smaller shrubs will be removed and grasses will be regularly mowed to allow for inspection and access.

The initial study authority for the West Sacramento area was provided through Section 209 of the Flood Control Act of 1962, PL 87-874. The West Sacramento Project was authorized in WRDA 1992, PL 102-580 Sec. 101 (4), as amended by the Energy and Water Development of 1999, PL 105-245. It was reauthorized on October 28, 2009, with a total project cost of \$53,040,000 under WRDA 2010, PL 111-85.

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### 1.3 Consultation History

NMFS received a request for initiation of consultation on June 10, 2014. However, the initial request did not contain an appropriate effects determination. The Biological Assessment (BA) was missing necessary information to perform a species impact analysis. After phone conversations, emails, and inter-agency meetings, the Corps agreed to send out a revised initiation letter along with an updated BA. The revised initiation letter was dated November 24, 2014. The revised BA was delivered on November 24, 2014 (Corps 2014) and determined that the West Sacramento GRS will adversely affect threatened Central Valley (CV) spring-run Chinook salmon evolutionarily significant unit (ESU) (*Oncorhynchus tshawytscha*), endangered Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*), threatened California CV (CCV) steelhead distinct population segment (DPS) (*O. mykiss*), and threatened Southern DPS (sDPS) of North American green sturgeon (*Acipenser medirostris*), and their designated critical habitats. Additionally, the Corps has determined that the West Sacramento Project may adversely affect Essential Fish Habitat (EFH) pursuant to the Magnuson-Stevens Fishery Management Act. The Corps also states that there is an expectation that the West Sacramento GRS (particularly the Southport EIP project) may benefit long-term EFH quality in the action area.

For much of this process, coordination with the Corps occurred independently on the Southport EIP and the portions of the West Sacramento GRS that occur outside the Southport EIP. On April 21, 2014, an interagency meeting was held to discuss the BAs for both actions. In part, as a result of that meeting, the Corps decided to combine the two BAs because the two projects were determined to be too related to be considered in two separate consultations. The Corps and WSAFCA, consulted with NMFS regarding proposed actions that may affect Federally listed species and their habitat.

1. 2008 through 2010—NMFS staff participated in site visits and meetings associated with WSAFCA's overall levee improvements program, leading to completed consultations for The Rivers, and California Highway Patrol Academy projects.
2. May 26, 2011—NMFS staff participated in the kick-off of an environmental stakeholder group for the Southport EIP.
3. August 15, 2011—NMFS staff participated in an informal meeting of the Southport EIP environmental stakeholder group and attended a field visit led by WSAFCA.
4. November 14, 2011—NMFS staff participated in an environmental stakeholder group meeting on project alternatives development.
5. March 28, 2013—NMFS staff participated in National Environmental Policy Act/California Environmental Quality Act (NEPA/CEQA) scoping meeting.
6. June 4, 2013—Corps requested initiation of consultation with NMFS on the Southport EIP.
7. August 27, 2013 – NMFS staff met with WSAFCA and Corps staff to discuss project design and BA comments.
8. September 30, 2013 – NMFS staff correspondence requested additional information from the Corps to support consultation.
9. December 11 and 18, 2013— NMFS staff participated in public meetings on the Southport EIP Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR).

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10. December 18, 2013 – NMFS staff participated in an environmental stakeholder group meeting on project design development.
  11. June 10, 2014 – NMFS received an initiation letter from the Corps for the West Sacramento Project, General Reevaluation Report.
  12. September 9, 2014 – NMFS delivered an insufficiency letter to the Corps requesting a revised BA and initiation letter.
  13. October and November 2014 – The Corps and NMFS had a number of meetings, phone calls, emails, and related correspondence with the purpose of producing a revised BA and updated initiation letter.
  14. November 24, 2014 – NMFS received a revised initiation letter and BA for the West Sacramento, General Reevaluation Study.
  15. On March 5, 2015, the Corps requested NMFS to issue separate BOs for the Southport EIP and the West Sacramento GRS to facilitate the construction schedule of the Southport EIP which is planned to start construction in summer of 2015.
  16. On March 19, NMFS met with the Corps, and WSAFCA staff to discuss coordination of these projects as two separate consultations. WSAFCA and the Corps clarified that although they requested separate BOs for each action, the projects are only related in that the reclaimed floodplain area of the Southport EIP may be used to offset some of the unavoidable adverse effects of future West Sacramento GRS-related actions.
  17. On March 19, 2015, NMFS initiated formal consultation on the West Sacramento GRS.
  18. On July 1, 2015, NMFS transmitted a draft BO to the Corps for review pursuant to the draft interagency SMART planning guidelines. The draft BO concluded that the proposed action is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead or destroy adversely modify their designated critical habitat and that the proposed action is likely to jeopardize the continued existence of sDPS green sturgeon and it will destroy or adversely modify their designated critical habitat. The conclusion regarding green sturgeon.
  19. NMFS and the Corps met on July 14 and 15, 2015, and again on August 11, 2015 to discuss Corps comments on the draft BO. The meeting discussions focused on the draft Reasonable and Prudent Alternative, Reasonable and Prudent Measures and Terms and Conditions. During the final meeting the NMFS and the Corps discussed options for integrated the RPA actions into the proposed action.
  20. On August 27, the Corps transmitted a letter the NMFS adopting the green sturgeon conservation measures that were previously referred to as the Reasonable and Prudent Alternative in the draft jeopardy BO as part of the proposed action.

#### **1.4 Proposed Action**

“Action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02).

The Corps has identified a number of problems associated with the flood risk management system protecting the city of West Sacramento and surrounding areas. There is a high probability that flows in the American and Sacramento rivers will stress the network of levees protecting West Sacramento to the point that levees could fail. Such a levee failure would flood a highly urbanized area.

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Levees in the West Sacramento GRS action area require improvements to address seepage, slope stability, overtopping, and erosion concerns. The measures proposed to improve the levees consist of: (1) seepage cutoff walls, (2) seepage berms, (3) stability berms, (4) levee raises, (5) flood walls, (6) relief wells, (7) sheet pile walls, (8) jet grouting, and (9) bank protection. The above measures will be implemented by fixing levees in place, constructing adjacent levees, or constructing a setback levee. It is possible that sheet pile walls, jet grouting, and relief wells will be used at various locations so they are also described below. Once a levee is modified, regardless of the measure implemented for the alternative, the levee will be brought into compliance with Corps levee design criteria. This will include slope flattening and/or crown widening, where required. The levee crown will be widened to 20 feet, and 3:1 landside and waterside slopes will be established where possible. If necessary, the existing levee centerline will be shifted landward in order to meet the Corps' standard levee footprint requirements.

For more details on the potential levee repairs listed above and in Table 1, refer to the West Sacramento, California General Reevaluation Study and Section 408 Permission, specifically Chapter 2 (Corps 2014).

In addition to the proposed levee improvements measures, the following measures and policies will apply to all of the levee repair alternatives, and will be addressed during construction:

1. The Corps' standard levee footprint will be established during construction of structural improvements on all levees that are out of compliance. The standard levee footprint consists of a 20 foot crown width and 3:1 waterside and landside slopes. If the 3:1 landside slope is not possible based on site specific conditions then a minimum 2:1 landside slope will be established with supporting engineering analysis.
2. A 20 foot landside and waterside maintenance access will be established. In areas where 20 feet cannot be obtained, 10 feet will be allowable.
3. Utility encroachments such as structures, certain vegetation, power poles, pump stations, and levee penetrations (e.g., pipes, conduits, cables) will be brought into compliance with applicable Corps policy or removed depending on type and location. This measure will include the demolition of such features and relocation or reconstruction as appropriate on a case-by-case basis (or retrofit to comply with standards). Utilities replacements will occur via one of two methods: (1) a surface line over the levee prism, or (2) a through-levee line equipped with positive closure devices.
4. Private encroachments shall be removed by the non-federal sponsor prior or property owner prior to construction.

The O&M of the levees in the West Sacramento area are the responsibility of the local maintaining agencies, including Reclamation District (RD) 900, RD 537, DWR's Maintenance Area 4, and the Corps. The applicable O&M Manual for the West Sacramento levees is the Standard O&M Manual for the Sacramento River Flood Control Project. Typical levee O&M in the West Sacramento area includes the following actions:

1. Vegetation maintenance up to four times a year by mowing or applying herbicide.
2. Control of burrowing rodent activity monthly by baiting with pesticide.
3. Slope repair, site-specific and as needed, by re-sloping and compacting.

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4. Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.
  5. Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.

For levee repair sites with a vegetation variance, the O&M manual will be adjusted to reflect the variance. Under the adjusted O&M manual, large trees that were protected in place under the variance will be allowed to remain on the waterside slopes, but smaller shrubs will be removed and grasses will be regularly mowed to allow for inspection and access.

Flood risk reduction construction activities will primarily occur during the April 15 to October 31 time frame, although extension of the CVFPB encroachment permit may be sought if weather conditions permit. However, construction activities, including, but not limited to, structure and vegetation removal, roadway removal and replacement, revegetation, and utility removal and replacement, regardless of the construction season will be subject to the conditions of environmental and encroachment permits and authorizations to be issued by the California Department of Fish and Wildlife (CDFW), CV Regional Water Quality Control Board (RWQCB), CVFPB, the Corps, US Fish and Wildlife Service (USFWS), NMFS, Yolo County, City of West Sacramento, and others.

Construction of the West Sacramento Project is proposed to take approximately 19 years if each reach is constructed sequentially. The construction reaches have been prioritized based on a variety of factors, including the condition of the levee, the potential damages that will occur due to levee failure, and construction feasibility considerations, such as the availability of equipment at any given time. A summary of the flood risk reduction measures proposed as part of this study are included in Table 2.

**Table 2. Proposed Measures for the West Sacramento Project**

	<b>Extent of Action</b>	<b>Proposed Measure</b>
North Basin		
Sacramento River North Levee *	5.5 miles from the Sacramento Bypass south to the stone lock structure on the DWSC.	<ul style="list-style-type: none"> <li>• Construct bank protection</li> <li>• Install cutoff walls</li> <li>• Construct levee raise</li> </ul>
West Sacramento Port North Levee **	4.9 miles from the stone lock structure west to the Yolo Bypass levee.	<ul style="list-style-type: none"> <li>• Construct floodwalls</li> </ul>
Yolo Bypass **	3.7 miles from the Port North levee north to the Sacramento Bypass.	<ul style="list-style-type: none"> <li>• Install cutoff walls</li> </ul>
Sacramento Bypass Training Levee **	1.1 miles from the Yolo Bypass levee to the Sacramento River.	<ul style="list-style-type: none"> <li>• Construct bank protection</li> </ul>
Sacramento River South Levee *	5.9 miles south along the Sacramento River from the DWSC stone lock structure to the South Cross levee.	<ul style="list-style-type: none"> <li>• Construct bank protection</li> <li>• Install cutoff walls</li> <li>• Construct levee raise</li> <li>• Construct seepage berm</li> <li>• Construct setback levee</li> </ul>
South Cross Levee **	1.2 miles across the South Basin from the Sacramento River to the DWSC.	<ul style="list-style-type: none"> <li>• Install cutoff walls</li> <li>• Construct seepage berms</li> <li>• Levee Raise</li> </ul>
Deep Water Ship Channel East Levee **	2.8 miles from the South Cross levee north to the point where it bends east.	<ul style="list-style-type: none"> <li>• Construct floodwalls</li> <li>• Levee raise</li> <li>• Construct bank protection</li> </ul>
West Sacramento Port South Levee **	4.0 miles east from the bend in the DWSC east levee to the stone lock structure.	<ul style="list-style-type: none"> <li>• Install cutoff walls</li> <li>• Construct levee raise</li> </ul>
Deep Water Ship Channel West Levee **	21.4 miles from the intersection of the Port North levee and the Yolo Bypass levee south to Miners Slough.	<ul style="list-style-type: none"> <li>• Install cutoff walls</li> <li>• Construct seepage berms</li> <li>• Levee raise</li> <li>• Construct bank protection</li> <li>• Construct closure structure</li> </ul>
South Cross Levee **	1.2 miles across the South Basin from the Sacramento River to the DWSC.	<ul style="list-style-type: none"> <li>• Install cutoff walls</li> <li>• Construct seepage berms</li> <li>• Levee Raise</li> </ul>

\* Will establish compliance with Corps vegetation requirements for upper 2/3 slopes of the levee, with a variance allowing the lower 1/3<sup>rd</sup> waterside vegetation to stay.

\*\* Will establish compliance with Corps vegetation requirements. ETL 1110-2-571

The tentative schedule of construction is shown in Table 3. The durations are for construction activities only, and do not include the time needed for design, right-of-way, utility relocation, etc.

Analysis of total linear feet (lf) of shaded riverine aquatic (SRA) habitat in the West Sacramento Project area was conducted (Table 4). The Sacramento Bypass Training levee, Yolo Bypass, and South Cross levee reaches were not evaluated because there is minimal, if any, SRA associated with these reaches. There also could be the potential for habitat removal in the Sacramento Bypass during the widening process but will wait for analysis and future ESA consultation once future designs are presented.

**Table 3. West Sacramento Project Construction Sequence and Duration**

<b>Constructing Sequence</b>	<b>Constructing Duration</b>
River South Levee	4 years
Sacramento Bypass Training Levee	1 years
Sacramento River North Levee	2 years
Yolo Bypass	1 years
DWSC West	3 years
Port South	1 years
DWSC East	3 years
South Cross	2 years
Port North	2 years

**Table 4. SRA Reach Specific Summary**

<b>Project Reach</b>	<b>Linear Feet</b>
Port North Levee	2,468
Port South Levee	2,602
Sacramento River North Levee	27,241
Sacramento River South Levee	16,047
<b>Total SRA</b>	<b>48,358</b>

The Corps will need to remove some SRA habitat in order to place rock along the river bank, but more than half of the existing SRA habitat along the 11 miles of Sacramento River levees will remain in place. A variance will also be sought for these levee reaches, allowing 34 acres of riparian habitat on the lower one-third of the slope to 15 feet waterward of the waterside levee toe to remain in place.

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## 1.11 Conservation Actions

The Corps will seek to avoid and minimize construction effects on listed species and their critical habitat to the extent feasible, and will implement on-site, and off-site compensation actions as necessary. Compensation time is the time required for on-site plantings to provide significant amounts of shade or structural complexity. Depending on project impacts, a project may incorporate various habitat and species benefits to compensate for short-term losses in habitat for listed species. Long-term compensation to offset short-term losses is generally not an option for the loss of critical habitats under the ESA (USFWS 1998a). The Corps uses the following compensation time periods (based loosely on life expectancy) as guidelines for compensation:

- Green sturgeon, 15 years;
  - Chinook salmon, 5 years; and
  - Central Valley steelhead, 4 years (Corps 2012).
1. Implement best management practices (BMPs) to prevent slurry seeping out to river and require piping system on land side only.
  2. The Corps will incorporate compensation for SRA habitat losses either by project constructed compensation sites or in combination with purchase of credits at a NMFS approved conservation bank where appropriate.
  3. The Corps will seek an ETL-approved vegetation variance exempting the Sacramento River sites from vegetation removal in the lower one-third of the waterside of the levee prior to final construction and design phase. Construction may require removal of vegetation on the upper two-thirds of the waterside and landside slope. Full ETL compliance will occur on the Sacramento and Yolo bypasses, Yolo Bypass Toe Drain, South Cross levee, and the DWSC, Barge Canal, and Port of West Sacramento levee reaches.
  4. The Corps will use a rock soil mixture to facilitate re-vegetation of the project sites that require bank protection work. A (70:30) rock to soil ratio will be implemented. The soil-rock mixture will be placed on top of the of the rock revetment along the Sacramento River levees to allow native riparian vegetation to be planted to insure that SRA habitat lost is replaced or enhanced.
  5. In addition to an approved vegetation variance, the Corps will minimize the removal of existing vegetation in the proposed project area. Disturbance or removal of trees or larger woody vegetation will be replaced with native riparian species, outside of the vegetation-free zone, as established in the ETL.
  6. Levee repair designs will be analogous to those developed for an SRBPP repair site. These levee repair designs include installation of IWM, native vegetation planting, incorporation of soil with the rock, etc.
  7. Construction will be scheduled when listed terrestrial and aquatic species will be least likely to occur in the project area. If construction needs to extend into the timeframe that species are present coordination with the resource agencies will occur.
  8. Stockpile construction materials such as portable equipment, vehicles, and supplies, at designated construction staging areas and barges, exclusive of any riparian and wetlands areas.

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9. Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a containment system.
  10. Erosion control measures including Storm Water Pollution Prevention Program (SWPPP) and Water Pollution Control Program that minimize soil or sediment from entering the river. BMPs shall be installed, monitored for effectiveness, and maintained throughout construction operations to minimize effects to federally listed fish and their designated critical habitat.
  11. Site access will be limited to the smallest area possible in order to minimize disturbance.
  12. Litter, debris, unused materials, equipment, and supplies will be removed from the project area daily. Such materials or waste will be deposited at an appropriate disposal or storage site.
  13. Immediately (within 24 hours) cleanup and report any spills of hazardous materials to the resource agencies. Any such spills, and the success of the efforts to clean them up, shall also be reported in post-construction compliance reports.
  14. Designating a Corps-appointed representative as the point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped threatened or endangered species. This representative shall be identified to the employees and contractors during an all employee education program conducted by the Corps.
  15. Vegetation removed as a part of ETL compliance will be compensated on site, outside of the vegetation-free zone, to the extent feasible. When on-site compensation is not feasible, compensation is proposed at local conservation banks with available credits. If credits are not available locally, then compensation is proposed to occur within the West Sacramento city limits.
  16. The Corps will compensate for any short and longer term impacts through additional onsite compensation, purchase of compensatory conservation credits, or development of suitable created aquatic habitat.
  17. Screen any water pump intakes.

A number of measures will be applied to the entire West Sacramento Project or specific actions, and other measures may be appropriate at specific locations within the West Sacramento Project study area. Avoidance activities to be implemented during final design and construction may include, but are not limited to, the following:

1. Identifying all habitats utilized by listed terrestrial, wetland, and plant species in the potentially affected project areas. To the extent practicable efforts will be made to minimize effects by modifying engineering design to avoid potential direct and indirect effects.
2. Incorporating sensitive habitat information into project bid specifications.
3. Incorporating requirements for contractors to avoid identified sensitive habitats into project bid specifications.
4. Minimizing vegetation removal to the extent feasible.
5. Minimizing, to the extent possible, grubbing and contouring activities.

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## 1.12 Additional Conservation Measures for sDPS Green Sturgeon

In response to the draft BO and through collaboration with NMFS, the Corps has updated the project description in the Environmental Impact Statement/Environmental Impact Report (EIS/EIR) and will implement the following additional measures that have been coordinated with NMFS to reduce impacts to green sturgeon habitat.

1. The Corp's final EIS/EIR for the West Sacramento Project shall include a proposal to develop a green sturgeon habitat, mitigation, and monitoring plan (HMMP) with the specific elements that are described below.

The goal of developing the HMMP is to ensure that adverse impacts of future West Sacramento projects on sDPS green sturgeon are sufficiently mitigated in order to allow for the growth, survival, and recovery of the species in the study area.

2. The green sturgeon HMMP shall be developed in coordination with the Interagency Ecological Program (IEP) green sturgeon project work team and consulted on with NMFS prior to the construction of any work within the designated critical habitat of sDPS green sturgeon related to the West Sacramento Project. The HMMP should focus on filling important data gaps on green sturgeon life history and micro and macro habitat ecology in both the Sacramento River and the north Delta within the project impact area, in regard to how bank stabilization measures proposed in the West Sacramento Project affect sturgeon ecology and survival.

The goal of this conservation measure is to leverage the resources of the IEP to help develop an HMMP that utilizes and applies the best available scientific expertise and information available.

3. The Corps shall either refine the Standard Assessment Methodology (SAM) or develop an alternative green sturgeon survival and growth response model based on using and updating the existing Hydrologic Engineering Center Ecosystem Function Model that reflects green sturgeon's preference for benthic habitat and that accounts for the physical loss of habitat from revetment footprints instead of the convention used by the SAM where the fish response is evaluated at the intersect of seasonal water surface elevations. The new modeling may include hydraulic modeling, but must be capable of evaluating green sturgeon survival in response to levee repair projects in the project impact area and the effects on all habitat conditions, not exclusively flow changes. Development of the model shall be initiated at the start of the preconstruction engineering and design (PED) phase of the West Sacramento Project and shall be peer reviewed by sturgeon experts on the IEP, other academia with sturgeon expertise, and be consulted on with NMFS.

The goal of this measure is to develop a functional assessment methodology using the best available scientific expertise and information available to model the effects of future West Sacramento Project actions and evaluate the performance of mitigation actions relative to the survival and growth of sDPS green sturgeon that are exposed to such actions.

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4. The HMMP shall also restore or compensate for the number of acres and ecological function of soft bottom benthic substrate for sDPS green sturgeon permanently lost to project construction. This mitigation shall be coordinated with the Interagency Working Group or a Bank Protection Working Group and must be carried out within the lower Sacramento River/North Delta in order to offset the adverse modification to designated critical habitat. The restored habitat must be capable of providing abundant benthic prey, freshwater or estuarine areas with adequate water quality, temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth and viability of all life stages. It should also provide safe and unobstructed migratory pathways necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats. The restoration/mitigation shall be initiated prior to commencement of construction within the designated critical habitat of sDPS green sturgeon for the West Sacramento Project and the updated model should be used to validate performance. The restoration site and plan shall be developed in coordination with the IEP and be consulted on with NMFS.

The goal is to ensure the spatial and temporal ecological impacts from project-related permanent loss of critical habitat for green sturgeon and critical for juvenile green sturgeon migration are fully compensated.

5. The green sturgeon HMMP shall also be developed with measurable objectives for completely offsetting all adverse impacts to all life stages of sDPS green sturgeon (as modeled using refined approaches described in Measure C, above, and considering design refinements that occur in the PED phase of project implementation).

The goal of this measure is to develop "SMART" objectives for mitigation. "SMART" objectives are specific (target a specific area for improvement), measurable (quantify or suggest an indicator of progress), attainable (specify who will do the work and if possible how), realistic (state what results can realistically be achieved, given available resources) and timely (specify when the results can be achieved) habitat performance objectives for green sturgeon mitigation.

6. Mitigation actions shall be initiated prior to the construction activities affecting sDPS green sturgeon and their critical habitat. Specific mitigation plans may be developed during project design engineering to reduce the specific impacts of levee construction actions.

The goal of this measure is to ensure that mitigation coincides with project implementation and minimizes, to the maximum extent possible, extended temporal effects.

7. The sDPS green sturgeon HMMP will include measurable performance standards at agreed upon intervals and will be monitored for a period of at least ten years following construction. If additional monitoring is necessary, the monitoring shall be included in the project operations and maintenance plan and carried out by the local sponsor. The

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HMMP will include adaptive management strategies for correcting any mitigation measures that do not meet performance standards.

The goal of this measure is to provide a reasonable amount of time to measure performance standards after mitigation occurs to ensure that it meets the objectives of the HMMP.

### **1.13 Interrelated and Interdependent Actions**

“Interrelated actions” are those that are part of a larger action and depend on the larger action for their justification. “Interdependent actions” are those that have no independent utility apart from the action under consideration (50 CFR 402.02). In this case, there are no interrelated or interdependent actions.

Although the West Sacramento GRS is associated with the Southport EIP in that some of the riparian habitat impacts of West Sacramento will be mitigated at the Southport location, they are not interrelated or interdependent because neither project depends on the other for their justification and they both have independent utility.

The specific association of the two projects is that the Southport EIP will include the development of a NMFS-approved MMP that will include an accounting plan to quantify the extent of Southport offsets and the potential for future offsets available for the West Sacramento GRS. The MMP will provide the accounting plan that will link the amount of offset area available at the Southport EIP with West Sacramento impacts.

### **1.14 Action Area**

“Action area” means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

The action area for the West Sacramento GRS includes the Sacramento River from the Sacramento Bypass down to the South Cross levee, the Sacramento DWSC and Port of West Sacramento, and the Sacramento and Yolo bypasses.

The action area includes perennial waters of the Sacramento River extending 200 feet perpendicular from the average summer-fall shoreline and 1,000 feet downstream from proposed in-water construction areas. This represents the potential area of turbidity and sedimentation effects based on the reported limits of visible turbidity plumes in the Sacramento River during similar construction activities (NMFS 2008).

## **ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT**

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, Federal agencies must ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their

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designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions will affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures and terms and conditions to minimize such impacts.

## **2.1 Analytical Approach**

This BO includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that will be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

The adverse modification analysis considers the impacts of the Federal action on the conservation value of designated critical habitat. This BO does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.<sup>1</sup>

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

1. Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.
2. Describe the environmental baseline in the action area.
3. Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
4. Describe any cumulative effects in the action area.
5. Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.
6. Reach jeopardy and adverse modification conclusions.
7. If necessary, define a reasonable and prudent alternative to the proposed action.

### **2.1.1 Use of Analytical Surrogates**

The effects of the West Sacramento GRS are primarily analyzed using Standard Assessment Methodology (SAM). The Corps provided the background data, assumptions, analyses, and assessment of habitat compensation requirements for the federally protected fish species relevant to this consultation.

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<sup>1</sup> Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

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The SAM was designed to address a number of limitations associated with previous habitat assessment approaches and provide a tool to systematically evaluate the impacts and compensation requirements of bank protection projects based on the needs of listed fish species.

It is a computational modeling and tracking tool that evaluates bank protection alternatives by taking into account several key factors affecting threatened and endangered fish species. By identifying and then quantifying the response of focal species to changing habitat conditions over time, project managers, biologists and design engineers can make changes to project design to avoid, minimize, or compensate for impacts to habitat parameters that influence the growth and survival of target fish species by life stage and season. The model is used to assess species responses as a result of changes to habitat conditions, either by direct quantification of bank stabilization design parameters (*e.g.*, bank slope, substrate).

In 2003, the Corps established a program to carry out “a process to review, improve, and validate analytical tools and models for USACE Civil Works business programs”. Reviews are conducted to ensure that planning models used by the Corps are technically and theoretically sound, computationally accurate, and in compliance with the Corps planning policy. As such, all existing and new planning models developed by the Corps are required to be certified through the appropriate Planning Center of Expertise and Headquarters in accordance with Corps rules and procedures.

The assumptions, model variables, and modeling approaches used in the SAM have been developed to be adapted and validated through knowledge gained from monitoring and experimentation within the SRBPP while retaining the original overall assessment method and framework. The first update to the SAM included the addition of sDPS green sturgeon as well as a number of modifications to modeled-species responses based upon updated literature reviews and recent monitoring efforts at completed bank protection sites (Stillwater Sciences 2009, USACE 2009).

In late 2010, the certification process for the SAM was initiated by the Corps, Sacramento District in coordination with the Ecosystem Planning Center of Expertise. The process entailed charging a panel of six experts to review the SAM, along with the SAM (version 3.0). The Review Panel was composed of a plan formulation expert, fisheries biologist, aquatic ecologist, geomorphologist/geologist, population biologist/modeling expert, and software programmer. A major advantage of the SAM is that it integrates species life history and seasonal flow-related variability in habitat quality and availability to generate species responses to project actions over time. The SAM systematically evaluates the response of each life stage to habitat features affected by bank protection projects.

The SAM quantifies habitat values in terms of a weighted species response index (WRI) that is calculated by combining habitat quality (*i.e.*, fish response indices) with quantity (*i.e.*, bank length or wetted area) for each season, target year, and relevant species/life stage. The fish response indices are derived from hypothesized relationships between key habitat attributes (described below) and the species and life stage responses. Species response indices vary from 0 to 1, with 0 representing unsuitable conditions and 1 representing optimal conditions for survival, growth, and/or reproduction. For a given site and scenario (*i.e.*, with or without project), the SAM uses

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these relationships to determine the response of individual species and life stages to the measured or predicted values of each habitat attribute for each season and target year, and then multiplies these values together to generate an overall species response index. This index is then multiplied by the linear feet or area of shoreline to which it applies to generate a weighted species response index expressed in feet or square feet. The species WRI provides a common metric that can be used to quantify habitat values over time, compare project conditions to existing conditions, and evaluate the effectiveness of on-site and off-site compensation actions.

The WRI represent an index of a species growth and survival based on a 30-day exposure to post project conditions over the life of the project. As such, negative SAM values can be used as a surrogate to quantify harm to a target fish species by life stage and season. Also, although SAM values represent an index of harm to a species, since the values are expressed as “weighted bankline feet” or “weighted area”, these values can be used to help quantify compensatory conservation actions such as habitat restoration, and are used for that purpose in this BO.

During the process of this consultation, the Corps and NMFS identified several short comings with the SAM as a tool for reliably forecasting the growth and survival of green sturgeon. The primary short coming is that the SAM evaluates habitat conditions at the seasonal water surface intersect with the river bank. While this is considered an effective point for measuring salmon and steelhead habitat, green sturgeon have a greater affinity for benthic habitat than shoreline habitat. Further, during discussions between the Corps and NMFS, it was widely agreed upon that levee repair actions in the West Sacramento Study Area are likely to only affect the juvenile rearing life stage and probably have little to no adverse impacts on the adult life stages of green sturgeon because spawning habitat is not present and adults that are migrating upstream are probably more influenced by impacts that affect swimming speed and upstream passage than shoreline habitat manipulations. Because of this, NMFS has decided to use the SAM as a proxy for quantifying habitat disturbance and harm and use as an ecological surrogate for quantifying the amount and extent of take for juvenile rearing and migrating green sturgeon, but the precision is not as sharp as for salmon and steelhead. Therefore, a new model will be developed to determine compensatory mitigation actions and tracking performance.

### **2.1.2 Compensation Timing**

As described in the proposed action, projects such as this often propose compensation for unavoidable short-term effects to species and impacts to habitat. These compensation timeframes are generally based on anticipated SAM response time. Under the Corps BA, compensation timing is defined and in practice adopts an approach that the SAM modeled impact at the proposed timing (Green sturgeon: 15 years: Chinook salmon, 5 years: Central Valley steelhead, 4 years) is sufficient to compensate for project effects. NMFS adopts a slightly different approach to the analysis of the BO in that the compensation time should be a target for avoiding exposure of more than one generation of a population with a multiple age class structure. Negative SAM-modeled values beyond those years, especially at winter and spring water surface elevations, may have significant effects to the species and impacts to critical habitat that would reduce the species survival and recovery in the wild or substantially reduce the conservation value of the species because the adverse effects (reduced growth and survival of individuals) would begin to reduce the number of reproducing individuals across multiple

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generations. In some cases, negative SAM values extend beyond these compensation periods, in which case offsite compensatory mitigation can reduce the long-term effects to a species survival and recovery by creating high quality habitat conditions in areas that provide high ecological value for the species. Because we have determined the SAM model is not a strong representation of green sturgeon growth and survival response, we are applying the implementation of the USACE Green Sturgeon Conservation Measures As key actions necessary to both avoid reducing the survival and recovery of the species in the wild and reducing the conservation value of critical habitat, instead of applying a specific compensation time period for green sturgeon. As such, this BO applies the following compensation timing as general targets for avoiding such long-term effects to salmon and steelhead:

1. Chinook salmon, 5 years;
2. Central Valley steelhead, 4 years

## **2.2 Rangewide Status of the Species and Critical Habitat**

This BO examines the status of each species that will be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The BO also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

One factor affecting the rangewide status of the CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, CCV steelhead, and the North American green sturgeon, and aquatic habitat at large is climate change.

The following federally listed species and designated critical habitats occur in the action area and may be affected by the proposed action:

**Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*)** Listed as endangered (70 FR 37160, June 28, 2005)

**Sacramento River winter-run Chinook salmon designated critical habitat**  
(June 16, 1993, 58 FR 33212)

**CV spring-run Chinook salmon ESU (*O. tshawytscha*)**  
Listed as threatened (70 FR 37160, June 28, 2005)

**CV spring-run Chinook salmon designated critical habitat** (70 FR 52488, September 2, 2005)

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**CCV steelhead DPS (*O. mykiss*)**

Listed as threatened (71 FR 834, January 5, 2006)

**CCV steelhead designated critical habitat**

(70 FR 52488, September 2, 2005)

**Southern DPS of North American green sturgeon (*Acipenser medirostris*)**

Listed as threatened (71 FR 17757, April 7, 2006)

**Southern DPS of North American green sturgeon designated critical habitat (74 FR 52300, October 9, 2009)**

Critical habitat designations identify those physical and biological features of the habitat that are essential to the conservation of the species and that may require special management consideration or protection. Within the West Sacramento GRS this includes the river water, river bottom, and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent is defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of one to two years on the annual flood series) used by listed salmonids and sturgeon.

NMFS has recently completed an updated status review of five Pacific salmon ESUs and one steelhead DPS, including Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon and CCV steelhead, and concluded that the species' status should remain as previously listed (76 FR 50447; August 15, 2011). The 2011 status reviews (NMFS 2011a, 2011b, 2011c) additionally stated that, although the listings should remain unchanged, the status of these populations have worsened over the past five years since the 2005/2006 reviews and recommended that status be reassessed in two to three years as opposed to waiting another five years.

### **2.2.1 Sacramento River Winter-run Chinook salmon**

The Sacramento River winter-run Chinook salmon (winter-run *Oncorhynchus tshawytscha*) ESU, currently listed as endangered, was listed as a threatened species under emergency provisions of the ESA on August 4, 1989 (54 FR 32085) and formally listed as a threatened species in November 1990 (55 FR 46515). On January 4, 1994 (59 FR 440), NMFS re-classified winter-run as an endangered species. NMFS concluded that winter-run in the Sacramento River warranted listing as an endangered species due to several factors, including: (1) the continued decline and increased variability of run sizes since its first listing as a threatened species in 1989; (2) the expectation of weak returns in future years as the result of two small year classes (1991 and 1993); and (3) continued threats to the "take" of winter-run (August 15, 2011, 76 FR 50447).

On June 28, 2005, NMFS concluded that the winter-run ESU was "in danger of extinction" due to risks to the ESU's diversity and spatial structure and, therefore, continues to warrant listing as an endangered species under the ESA (70 FR 37160). In August 2011, NMFS completed a 5-year status review of five Pacific salmon ESUs, including the winter-run ESU, and again

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determined that the species' status should remain as "endangered" (August 15, 2011, 76 FR 50447). The 2011 review concluded that although the listing remained unchanged since the 2005 review, the status of the population had declined over the past five years (2005–2010).

The winter-run ESU currently consists of only one population that is confined to the upper Sacramento River (spawning downstream of Shasta and Keswick dams) in California's CV. In addition, an artificial propagation program at the Livingston Stone National Fish Hatchery (LSNFH) produces winter-run that are considered to be part of this ESU (June 28, 2005, 70 FR 37160). Most components of the winter-run life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the habitat blockage in the upper Sacramento River. All historical spawning and rearing habitats have been blocked since the construction of Shasta Dam in 1943. Remaining spawning and rearing areas are completely dependent on cold water releases from Shasta Dam in order to sustain the remnant population.

## **Life History**

### **1. Adult Migration and Spawning**

Winter-run exhibit a unique life history pattern (Healey 1994) compared to other salmon populations in the CV (*i.e.*, spring-run, fall-run, and late-fall run), in that they spawn in the summer, and the juveniles are the first to enter the ocean the following winter and spring. Adults first enter San Francisco Bay from November through June (Hallock and Fisher 1985) and migrate up the Sacramento River, past the RBDD from mid-December through early August (NMFS 1997). The majority of the run passes RBDD from January through May, with the peak passage occurring in mid-March (Hallock and Fisher 1985). The timing of migration may vary somewhat due to changes in river flows, dam operations, and water year type (Table 5; Yoshiyama *et al.* 1998, Moyle 2002).

Winter-run tend to enter freshwater while still immature and travel far upriver and delay spawning for weeks or months upon arrival at their spawning grounds (Healey 1991). Spawning occurs primarily from mid-May to mid-August, with the peak activity occurring in June and July in the upper Sacramento River reach (50 miles) between Keswick Dam and RBDD (Vogel and Marine 1991). Winter-run deposit and fertilize eggs in gravel beds known as redds excavated by the female that then dies following spawning. Average fecundity was 5,192 eggs/female for the 2006–2013 returns to LSNFH, which is similar to other Chinook salmon runs [*e.g.*, 5,401 average for Pacific Northwest (Quinn 2005)]. Chinook salmon spawning requirements for depth and velocities are broad, and the upper preferred water temperature is between 55–57°F (13–14°C) degrees (Snider *et al.* 2001). The majority of winter-run adults return after three years.

**Table 5.** The temporal occurrence of adult (a) and juvenile (b) winter-run in the Sacramento River. Darker shades indicate months of greatest relative abundance.

Winter run relative abundance	High				Medium				Low			
<b>a) Adults freshwater</b>												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin <sup>a,b</sup>	Medium	Low	Low	Low	Medium	Medium						
Upper Sacramento River spawning <sup>c</sup>	Low	Low	Low	Low	Medium	High	High	Medium	Low	Low	Low	Low
<b>b) Juvenile emigration</b>												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River at Red Bluff <sup>d</sup>	Low	Low	Low	Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium
Sacramento River at Knights Landing <sup>e</sup>	High	Medium	Low	Medium	High							
Sacramento trawl at Sherwood Harbor <sup>f</sup>	Medium	High	High	Low	Medium	High						
Midwater trawl at Chipps Island <sup>g</sup>	Medium	Medium	High	High	Low							

Sources: <sup>a</sup> (Yoshiyama *et al.* 1998); (Moyle 2002); <sup>b</sup> (Myers *et al.* 1998); <sup>c</sup> (Williams 2006); <sup>d</sup> (Martin *et al.* 2001); <sup>e</sup> Knights Landing Rotary Screw Trap Data, CDFW (1999-2011); <sup>f,g</sup> Delta Juvenile Fish Monitoring Program, USFWS (1995-2012)

## 2. Eggs/Fry Emergence

Winter-run incubating eggs are vulnerable to adverse effects from floods, flow fluctuations, siltation, desiccation, disease, predation during spawning, poor gravel percolation, and poor water quality. The optimal water temperature for egg incubation ranges from 46–56°F (7.8–13.3°C) and a significant reduction in egg viability occurs in mean daily water temperatures above 57.5°F (14.2°C; Seymour 1956, Boles 1988, USFWS 1998, EPA 2003, Richter and Kolmes 2005, Geist *et al.* 2006). Total embryo mortality can occur at temperatures above 62°F (16.7°C; NMFS 1997). Depending on ambient water temperature, embryos hatch within 40-60 days and alevin (yolk-sac fry) remain in the gravel beds for an additional 4–6 weeks. As their yolk-sacs become depleted, fry begin to emerge from the gravel and start exogenous feeding in their natal stream, typically in late July to early August and continuing through October (Fisher 1994).

## 3. Juvenile/Outmigration

Juvenile winter-run have been found to exhibit variability in their life history dependent on emergence timing and growth rates (Beckman *et al.* 2007). Following spawning, egg incubation,

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and fry emergence from the gravel, juveniles begin to emigrate in the fall. Some juvenile winter-run migrate to sea after only 4 to 7 months of river life, while others hold and rear upstream and spend 9 to 10 months in freshwater. Emigration of juvenile winter-run fry and pre-smolts past RBDD (RM 242) may begin as early as mid-July, but typically peaks at the end of September (Table 5), and can continue through March in dry years (Vogel and Marine 1991, NMFS 1997).

#### 4. Estuarine/Delta Rearing

Juvenile winter-run emigration into the estuary/Delta occurs primarily from November through early May based on data collected from trawls in the Sacramento River at Sherwood Harbor (West Sacramento), RM 57 (USFWS 2001). The timing of emigration may vary somewhat due to changes in river flows, Shasta Dam operations, and water year type, but has been correlated with the first storm event when flows exceed 14,000 cfs at Knights Landing, RM 90, which trigger abrupt emigration towards the Delta (del Rosario *et al.* 2013). Residence time in the Delta for juvenile winter-run averages approximately 3 months based on median seasonal catch between Knights Landing and Chipps Island. In general, the earlier juvenile winter-run arrive in the Delta, the longer they stay and rear, as peak departure at Chipps Island regularly occurs in March (del Rosario *et al.* 2013). The Delta serves as an important rearing and transition zone for juvenile winter-run as they feed and physiologically adapt to marine waters (smoltification). The majority of juvenile winter-run in the Delta are 104 to 128 millimeters (mm) in size based on USFWS trawl data (1995-2012), and from 5 to 10 months of age, by the time they depart the Delta (Fisher 1994, Myers *et al.* 1998).

#### 5. Ocean Rearing

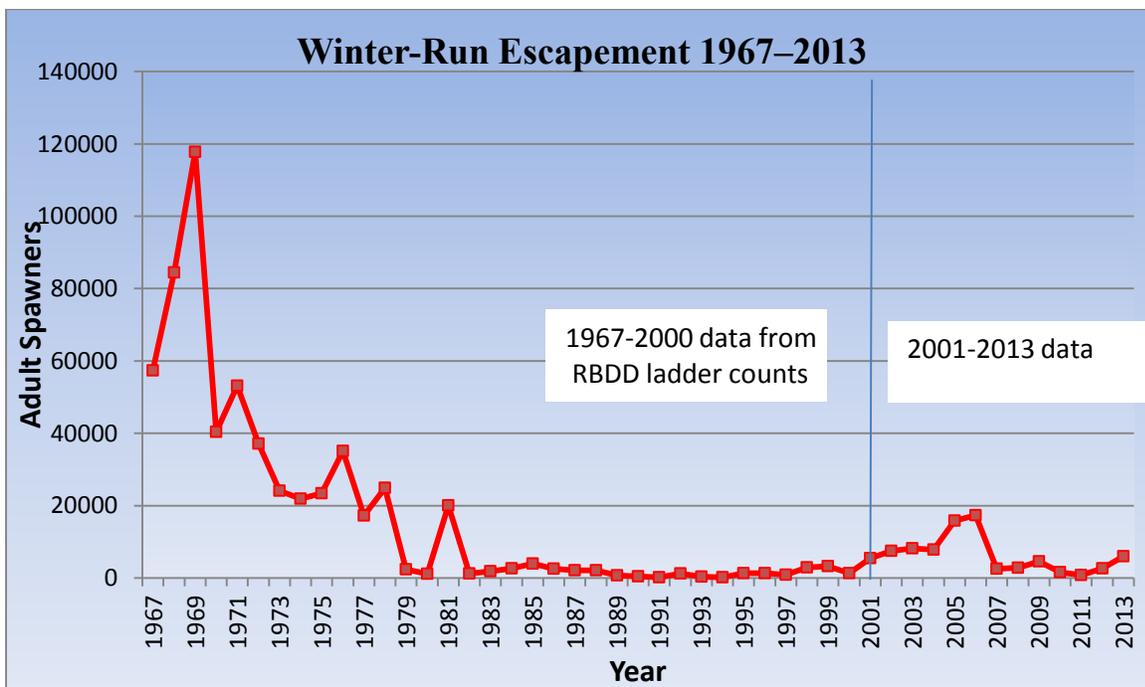
Winter-run smolts enter the Pacific Ocean mainly in spring (March–April), and grow rapidly on a diet of small fishes, crustaceans, and squid. Salmon runs that migrate to sea at a larger size tend to have higher marine survival rates (Quinn 2005). The diet composition of Chinook salmon from California consist of anchovy, rockfish, herring, and other invertebrates (in order of preference, Healey 1991). Most Chinook from the Central Valley move northward into Oregon and Washington, where herring make up the majority of their diet. However winter-run, upon entering the ocean, tend to stay near the California coast and distribute from Point Arena southward to Monterey Bay. Winter-run have high metabolic rates, feed heavily, and grow fast, compared to other fishes in their range. They can double their length and increase their weight more than ten-fold in the first summer at sea (Quinn 2005). Mortality is typically highest in the first summer at sea, but can depend on ocean conditions. Winter-run abundance has been correlated with ocean conditions, such as periods of strong up-welling, cooler temperatures, and El Nino events (Lindley *et al.* 2009). Winter-run spend approximately 1-2 years rearing in the ocean before returning to the Sacramento River as 2-3 year old adults. Very few winter-run Chinook salmon reach age 4. Once they reach age 3, they are large enough to become vulnerable to commercial and sport fisheries.

## Description of Viable Salmonid Population (VSP) Parameters

### 1. Abundance

Historically, winter-run population estimates were as high as 120,000 fish in the 1960s, but declined to less than 200 fish by the 1990s (NMFS 2011). In recent years, since carcass surveys began in 2001 (Figure 3), the highest adult escapement occurred in 2005 and 2006 with 15,839 and 17,296, respectively. However, from 2007 to 2012, the population has shown a precipitous decline, averaging 2,486 during this period, with a low of 827 adults in 2011 (Figure 3). This recent declining trend is likely due to a combination of factors such as poor ocean productivity (Lindley *et al.* 2009), drought conditions from 2007-2009, and low in-river survival (NMFS 2011a). In 2013, the population increased to 6,075 adults, well above the 2007–2012 average, but below the high for the last ten years.

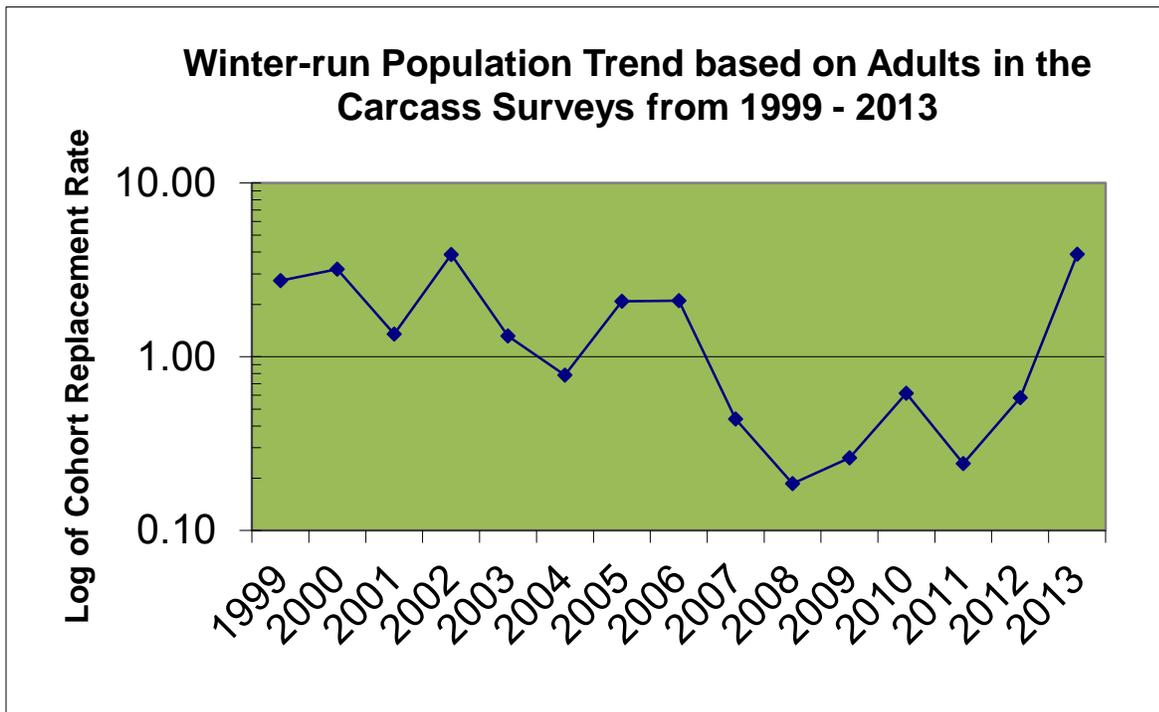
Although impacts from hatchery fish (*i.e.*, reduced fitness, weaker genetics, smaller size, less ability to avoid predators) are often cited as having deleterious impacts on natural in-river populations (Matala *et al.* 2012), the winter-run conservation program at LSNFH is strictly controlled by the USFWS to reduce such impacts. The average annual hatchery production at LSNFH is approximately 176,348 per year (2001–2010 average) compared to the estimated natural production that passes RBDD, approximately 4.7 million (2002–2010 average, Poytress and Carrillo 2011). Therefore, hatchery production typically represents approximately 3-4 percent of the total in-river juvenile production in any given year.



**Figure 3.** Winter-run Chinook salmon escapement numbers 1970-2013, includes hatchery broodstock and tributaries, but excludes sport catch. RBDD ladder counts used pre-2000, carcass surveys post 2001 (3).

## 2. Productivity

ESU productivity was positive over the period 1998–2006, and adult escapement and juvenile production had been increasing annually until 2007, when productivity became negative (Figure 4) with declining escapement estimates. The long-term trend for the ESU, therefore, remains negative, as the productivity is subject to impacts from environmental and artificial conditions. The population growth rate based on cohort replacement rate (CRR) for the period 2007–2012 suggests a reduction in productivity (Figure 4), and indicates that the winter-run population is not replacing itself. In 2013, winter-run experienced a positive CRR, possibly due to favorable in-river conditions in 2011 (a wet year), which increased juvenile survival to the ocean.



**Figure 4.** Winter-run population trend using cohort replacement rate derived from adult escapement, including hatchery fish, 1986–2013.

An age-structured density-independent model of spawning escapement by Botsford and Brittnacher (1998) assessing the viability of winter-run found the species was certain to fall below the quasi-extinction threshold of three consecutive spawning runs with fewer than 50 females (Good *et al.* 2005). Lindley and Mohr (2003) assessed the viability of the population using a Bayesian model based on spawning escapement that allowed for density dependence and a change in population growth rate in response to conservation measures found a biologically significant expected quasi-extinction probability of 28 percent. Although the growth rate for the winter-run population improved up until 2006, it exhibits the typical variability found in most endangered species populations. The fact that there is only one population, dependent upon cold-water releases from Shasta Dam, makes it vulnerable to periods of prolonged drought (NMFS 2011). Productivity, as measured by the number of juveniles entering the Delta, or juvenile production estimate (JPE), has declined in recent years from a high of 3.8 million in 2007 to 1.1

million in 2013 (Table 6). Due to uncertainties in the various factors, the JPE was updated in 2010 with the addition of confidence intervals (Cramer Fish Sciences model), and again in 2013 with a change in survival based on acoustic tag data (NMFS 2014). However, juvenile winter-run productivity is still much lower than other Chinook salmon runs in the Central Valley and in the Pacific Northwest (Michel 2010).

**Table 6.** Winter-run adult and juvenile population estimates based on RBDD counts (1986–2001) and carcass counts (2001–2013), with corresponding 3-year-cohort replacement rates.

<b>Return Year</b>	<b>Adult Population Estimate<sup>a</sup></b>	<b>Cohort Replacement Rate<sup>b</sup></b>	<b>NMFS-calculated Juvenile Production</b>
1986	2596		
1987	2185		
1988	2878		
1989	696	0.27	
1990	430	0.20	
1991	211	0.07	
1992	1240	1.78	40,100
1993	387	0.90	273,100
1994	186	0.88	90,500
1995	1297	1.05	74,500
1996	1337	3.45	338,107
1997	880	4.73	165,069
1998	2992	2.31	138,316
1999	3288	2.46	454,792
2000	1352	1.54	289,724
2001	8224	2.75	370,221
2002	7441	2.26	1,864,802
2003	8218	6.08	2,136,747
2004	7869	0.96	1,896,649
2005	15839	2.13	881,719
2006	17296	2.10	3,556,995
2007	2542	0.32	3,890,534
2008	2830	0.18	1,100,067
2009	4537	0.26	1,152,043
2010	1,596	0.63	1,144,860
2011	827	0.29	332,012
2012	2,674	0.59	162,051
2013	6,075	3.88	1,196,387
<b>median</b>	<b>2,542</b>	<b>0.95</b>	<b>412,507</b>

<sup>a</sup> Population estimates include adults taken into the hatchery and were based on ladder counts at RBDD until 2001, after which the methodology changed to carcass surveys (CDFG 2012).

<sup>b</sup> Assumes all adults return after three years. NMFS calculated a CRR using the adult spawning population, divided by the spawning population three years prior. Two year old returns were not used.

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<sup>c</sup> JPE estimates include survival estimates from the spawning gravel to the point where they enter the Delta (Sacramento I St Bridge), but does not include through-Delta survival.

### 3. Spatial Structure

The distribution of winter-run spawning and initial rearing historically was limited to the upper Sacramento River (upstream of Shasta Dam), McCloud River, Pitt River, and Battle Creek, where springs provided cold water throughout the summer, allowing for spawning, egg incubation, and rearing during the mid-summer period (Slater 1963 *op. cit.* Yoshiyama et al. 1998). The construction of Shasta Dam in 1943 blocked access to all of these waters except Battle Creek, which currently has its own impediments to upstream migration (*i.e.*, a number of small hydroelectric dams situated upstream of the Coleman Fish Hatchery weir). The Battle Creek Salmon and Steelhead Restoration Project (BCSSRP) is currently removing these impediments, which should restore spawning and rearing habitat for winter-run in the future. Approximately 299 miles of former tributary spawning habitat upstream of Shasta Dam is inaccessible to winter-run. Yoshiyama *et al.* (2001) estimated that in 1938, the upper Sacramento River had a “potential spawning capacity” of approximately 14,000 redds equal to 28,000 spawners. Since 2001, the majority of winter-run redds have occurred in the first 10 miles downstream of Keswick Dam. Most components of the winter-run life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the construction of Shasta Dam.

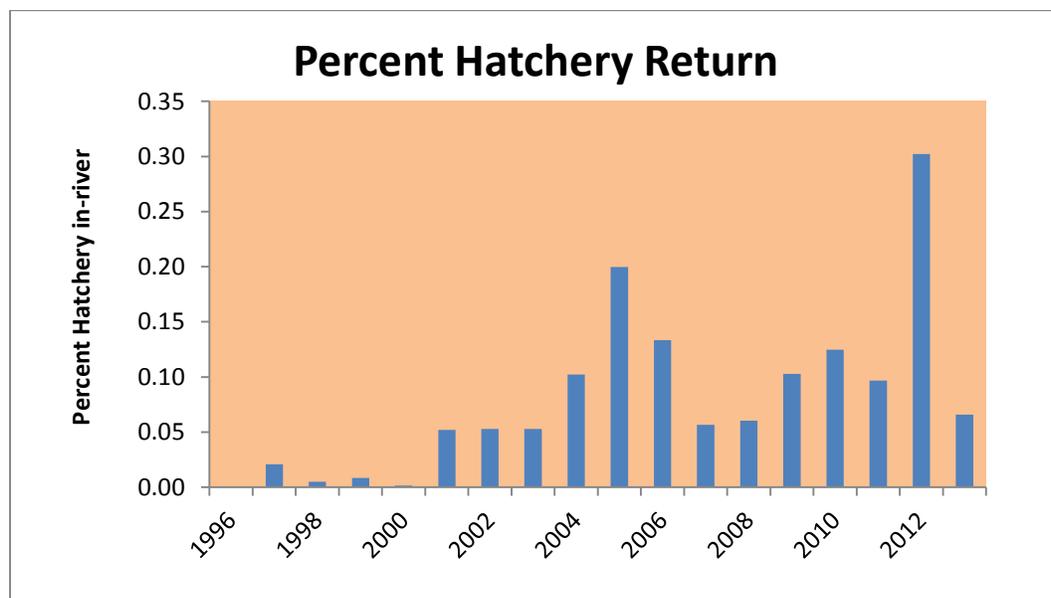
The greatest risk factor for winter-run lies within its spatial structure (NMFS 2011). The remnant and remaining population cannot access 95% of their historical spawning habitat, and must therefore be artificially maintained in the Sacramento River by: (1) spawning gravel augmentation, (2) hatchery supplementation, and, (3) regulating the finite cold-water pool behind Shasta Dam to reduce water temperatures. Winter-run require cold water temperatures in the summer that simulate their upper basin habitat, and they are more likely to be exposed to the impacts of drought in a lower basin environment. Battle Creek is currently the most feasible opportunity for the ESU to expand its spatial structure, but restoration is not scheduled to be completed until 2017 (BCSSRP). The draft CV Salmon and Steelhead Recovery Plan includes criteria for recovering the winter-run Chinook salmon ESU, including re-establishing a population into historical habitats upstream of Shasta Dam (NMFS 2009b). Additionally, NMFS (2009a) included a requirement for a pilot fish passage program upstream of Shasta Dam.

### 4. Diversity

The current winter-run population is the result of the introgression of several stocks (*e.g.*, spring-run and fall-run Chinook) that occurred when Shasta Dam blocked access to the upper watershed. A second genetic bottleneck occurred with the construction of Keswick Dam which blocked access and did not allow spatial separation of the different runs (Good *et al.* 2005). Lindley *et al.* (2007) recommended reclassifying the winter-run population extinction risk from low to moderate, if the proportion of hatchery origin fish from the LSNFH exceeded 15 percent due to the impacts of hatchery fish over multiple generations of spawners. Since 2005, the percentage of hatchery winter-run recovered in the Sacramento River has only been above 15 percent in two years, 2005 and 2012 (Figure 5).

Concern over genetic introgression within the winter-run population led to a conservation

program at LSNFH that encompasses best management practices such as: (1) genetic confirmation of each adult prior to spawning, (2) a limited number of spawners based on the effective population size, and (3) use of only natural-origin spawners since 2009. These practices reduce the risk of hatchery impacts on the wild population. Hatchery-origin winter-run have made up more than 5 percent of the natural spawning run in recent years and in 2012, it exceeded 30 percent of the natural run (Figure 5). However, the average over the last 16 years (approximately 5 generations) has been 8 percent, still below the low-risk threshold (15%) used for hatchery influence (Lindley *et al.* 2007).



**Figure 5.** Percentage of hatchery-origin winter-run Chinook salmon naturally spawning in the Sacramento River (1996–2013). Source: CDFW carcass surveys, 2013.

### Summary of Sacramento River Winter-run Chinook Salmon ESU Viability

There are several criteria (only one is required) that would qualify the winter-run ESU at moderate risk of extinction, and since there is still only one population that spawns downstream of Keswick Dam, that population would be at high risk of extinction in the long-term according to the criteria in Lindley *et al.* (2007). Recent trends in those criteria are: (1) continued low abundance (Figure 3); (2) a negative growth rate over 6 years (2006–2012), which is two complete generations (Figure 4); (3) a significant rate of decline since 2006; and (4) increased risk of catastrophe from oil spills, wild fires, or extended drought (climate change). The most recent 5-year status review (NMFS 2011) on winter-run concluded that the ESU had increased to a high risk of extinction. In summary, the most recent biological information suggests that the extinction risk for the winter-run ESU has increased from moderate risk to high risk of extinction since 2005, and that several listing factors have contributed to the recent decline, including drought and poor ocean conditions (NMFS 2011).

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## **Critical Habitat: Essential Features for Sacramento River Winter-run Chinook Salmon**

NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212). Critical habitat was delineated as the Sacramento River from Keswick Dam at river mile (RM) 302 to Chipps Island, RM 0, at the westward margin of the Sacramento-San Joaquin Delta (Delta), including Kimball Island, Winter Island, and Brown's Island; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge from San Pablo Bay to the Golden Gate Bridge. In the Sacramento River, critical habitat includes the river water, river bottom, and the adjacent riparian zone.

Critical habitat for winter-run is defined as specific areas (listed below) that contain the physical and biological features considered essential to the conservation of the species. This designation includes the river water, river bottom (including those areas and associated gravel used by winter-run as spawning substrate), and adjacent riparian zone used by fry and juveniles for rearing (June 16, 1993, 58 FR 33212). NMFS limits "adjacent riparian zones" to only those areas above a stream bank that provide cover and shade to the near shore aquatic areas. Although the bypasses (*e.g.*, Yolo, Sutter, and Colusa) are not currently designated critical habitat for winter-run, NMFS recognizes that they may be utilized when inundated with Sacramento River flood flows and are important rearing habitats for juvenile winter-run. Also, juvenile winter-run may use tributaries of the Sacramento River for non-natal rearing. Critical habitat also includes the estuarine water column and essential foraging habitat and food resources used by winter-run as part of their juvenile outmigration or adult spawning migration.

The following is the status of the physical and biological habitat features that are considered to be essential for the conservation of winter-run (June 16, 1993, 58 FR 33212):

1. Access from the Pacific Ocean to Appropriate Spawning Areas

Adult migration corridors should provide satisfactory water quality, water quantity, water temperature, water velocity, cover, shelter and safe passage conditions in order for adults to reach spawning areas. Adult winter-run generally migrate to spawning areas during the winter and spring. At that time of year, the migration route is accessible to the appropriate spawning grounds on the upper 60 miles of the Sacramento River, however much of this migratory habitat is degraded and they must pass through a fish ladder at the Anderson-Cottonwood Irrigation Dam (ACID). In addition, the many flood bypasses are known to strand adults in agricultural drains due to inadequate screening (Vincik and Johnson 2013). Since the primary migration corridors are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic conservation value to the species.

2. The Availability of Clean Gravel for Spawning Substrate

Suitable spawning habitat for winter-run exists in the upper 60 miles of the Sacramento River between Keswick Dam and Red Bluff Diversion Dam (RBDD). However, the majority of spawning habitat currently being used occurs in the first 10 miles downstream of Keswick Dam.

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The available spawning habit is completely outside the historical range utilized by winter-run upstream of Keswick Dam. Because Shasta and Keswick dams block gravel recruitment, the U.S. Bureau of Reclamation (Reclamation) annually injects spawning gravel into various areas of the upper Sacramento River. With the supplemented gravel injections, the upper Sacramento River reach continues to support a small naturally-spawning winter-run Chinook salmon population. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

3. Adequate River Flows for Successful Spawning, Incubation of Eggs, Fry Development and Emergence, and Downstream Transport of Juveniles

An April 5, 1960, Memorandum of Agreement between Reclamation and the CDFW originally established flow objectives in the Sacramento River for the protection and preservation of fish and wildlife resources. In addition, Reclamation complies with the 1990 flow releases required in State Water Resource Control Board (SWRCB) Water Rights Order (WRO) 90-05 for the protection of Chinook salmon. This order includes a minimum flow release of 3,250 cubic feet per second (cfs) from Keswick Dam downstream to RBDD from September through February during all water year types, except critically dry.

4. Water Temperatures at 5.8–14.1°C (42.5–57.5°F) for Successful Spawning, Egg Incubation, and Fry Development

Summer flow releases from Shasta Reservoir for agriculture and other consumptive uses drive operations of Shasta and Keswick dam water releases during the period of winter-run migration, spawning, egg incubation, fry development, and emergence. This pattern, the opposite of the pre-dam hydrograph, benefits winter-run by providing cold water for miles downstream during the hottest part of the year. The extent to which winter-run habitat needs are met depends on Reclamation's other operational commitments, including those to water contractors, Delta requirements pursuant to State Water Rights Decision 1641 (D-1641), and Shasta Reservoir end of September storage levels required in the NMFS 2009 biological opinion on the long-term operations of the CV Project and State Water Project (CVP/SWP, NMFS 2009a). WRO 90-05 and 91-1 require Reclamation to operate Shasta, Keswick, and Spring Creek Powerhouse to meet a daily average water temperature of 13.3°C (56°F) at RBDD. They also provide the exception that the water temperature compliance point (TCP) may be modified when the objective cannot be met at RBDD. Based on these requirements, Reclamation models monthly forecasts and determines how far downstream 13.3°C (56°F) can be maintained throughout the winter-run spawning, egg incubation, and fry development stages.

In every year since WRO 90-05 and 91-1 were issued, operation plans have included modifying the TCP to make the best use of the cold water available based on water temperature modeling and current spawning distribution. Once a TCP has been identified and established in May, it generally does not change, and therefore, water temperatures are typically adequate through the summer for successful winter-run egg incubation and fry development for those redds constructed upstream of the TCP (except for in some critically dry and drought years). However, by continually moving the TCP upstream, the value of that habitat is degraded by reducing the spawning area in size and imprinting upon the next generation to return further upstream.

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## 5. Habitat and Adequate Prey Free of Contaminants

Water quality conditions have improved since the 1980s due to stricter standards and Environmental Protection Agency (EPA) Superfund site cleanups (see Iron Mountain Mine remediation under Factors). No longer are there fish kills in the Sacramento River caused by the heavy metals (*e.g.*, lead, zinc and copper) found in the Spring Creek runoff. However, legacy contaminants such as mercury (and methyl mercury), polychlorinated biphenyls (PCB), heavy metals and persistent organochlorine pesticides continue to be found in watersheds throughout the CV. In 2010, the EPA, listed the Sacramento River as impaired under the Clean Water Act, section 303(d), due to high levels of pesticides, herbicides, and heavy metals ([http://www.waterboards.ca.gov/water\\_issues/programs/tmdl/2010state\\_ir\\_reports/category5\\_report.shtml](http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml)). Although most of these contaminants are at low concentrations in the food chain, they continue to work their way into the base of the food web, particularly when sediments are disturbed and previously entombed compounds are released into the water column.

Adequate prey for juvenile salmon to survive and grow consists of abundant aquatic and terrestrial invertebrates that make up the majority of their diet before entering the ocean. Exposure to these contaminated food sources such as invertebrates may create delayed sublethal effects that reduce fitness and survival (Laetz *et al.* 2009). Contaminants are typically associated with areas of urban development, agriculture, or other anthropogenic activities (*e.g.*, mercury contamination as a result of gold mining or processing). Areas with low human impacts frequently have low contaminant burdens, and therefore lower levels of potentially harmful toxicants in the aquatic system. Freshwater rearing habitat has a high intrinsic conservation value even if the current conditions are significantly degraded from their natural state.

## 6. Riparian and Floodplain Habitat that Provides for Successful Juvenile Development and Survival

The channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento River system typically have low habitat complexity, low abundance of food organisms, and offer little protection from predators. Juvenile life stages of salmonids are dependent on the natural functioning of this habitat for successful survival and recruitment. Ideal habitat contains natural cover, such as riparian canopy structure, submerged and overhanging large woody material (LWM), aquatic vegetation, large rocks and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Riparian recruitment is prevented from becoming established due to the reversed hydrology (*i.e.*, high summer time flows and low winter flows prevent tree seedlings from establishing). However, there are some complex, productive habitats within historical floodplains [*e.g.*, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa)] and flood bypasses (*i.e.*, fish in Yolo and Sutter bypasses experience rapid growth and higher survival due to abundant food resources) seasonally available that remain in the system. Nevertheless, the current condition of degraded riparian habitat along the mainstem Sacramento River restricts juvenile growth and survival (Michel 2010, Michel *et al.* 2012).

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7. Access Downstream so that Juveniles Can Migrate from the Spawning Grounds to San Francisco Bay and the Pacific Ocean

Freshwater emigration corridors should be free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. Migratory corridors are downstream of the Keswick Dam spawning areas and include the mainstem of the Sacramento River to the Delta, as well as non-natal rearing areas near the confluence of some tributary streams.

Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. Unscreened diversions that entrain juvenile salmonids are prevalent throughout the mainstem Sacramento River and in the Delta. Predators such as striped bass (*Morone saxatilis*) and Sacramento pikeminnow (*Ptychocheilus grandis*) tend to concentrate immediately downstream of diversions, resulting in increased mortality of juvenile Chinook salmon.

Water pumping at the CVP/SWP export facilities in the South Delta at times causes the flow in the river to move back upstream (reverse flow), further disrupting the emigration of juvenile winter-run by attracting and diverting them to the interior Delta, where they are exposed to increased rates of predation, other stressors in the Delta, and entrainment at pumping stations. NMFS' biological opinion on the long-term operations of the CVP/SWP (NMFS 2009a) sets limits to the strength of reverse flows in the Old and Middle Rivers, thereby keeping salmon away from areas of highest mortality. Regardless of the condition, the remaining estuarine areas are of high conservation value because they provide factors which function as rearing habitat and as an area of transition to the ocean environment.

### **2.2.2 Central Valley Spring-run Chinook salmon**

In August 2011, NMFS completed an updated status review of five Pacific Salmon ESUs, including CV spring-run Chinook salmon, and concluded that the species' status should remain as previously listed (76 FR 50447). The 2011 Status Review (NMFS 2011b) additionally stated that although the listings will remain unchanged since the 2005 review, and the original 1999 listing (64 FR 50394), the status of these populations has worsened over the past five years and recommended that the status be reassessed in two to three years as opposed to waiting another five years.

CV spring-run Chinook salmon were listed as threatened on September 16, 1999, (64 FR 50394). This ESU consists of spring-run Chinook salmon occurring in the Sacramento River basin. The Feather River Fish Hatchery (FRFH) spring-run Chinook salmon population has been included as part of the CV spring-run Chinook salmon ESU in the most recent modification of the CV spring-run Chinook salmon listing status (70 FR 37160). Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005, (70 FR 52488), and includes the action area for the Proposed Action. It includes stream reaches of the Feather and Yuba rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the main stem of the Sacramento River

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from Keswick Dam through the Delta; and portions of the network of channels in the northern Delta.

Historically spring-run Chinook salmon were the second most abundant salmon run in the CV and one of the largest on the west coast (CDFG 1990, 1998). These fish occupied the upper and middle reaches (1,000 to 6,000 feet elevation) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1874, Rutter 1904, Clark 1929). The CV Technical Review Team (TRT) estimated that historically there were 18 or 19 independent populations of CV spring-run Chinook salmon, along with a number of dependent populations, all within four distinct geographic regions (diversity groups) (Lindley *et al.* 2004). Of these 18 populations, only 3 extant populations currently exist (Mill, Deer, and Butte creeks on the upper Sacramento River) and they represent only the northern Sierra Nevada diversity group. All populations in the basalt and porous lava diversity group and the southern Sierra Nevada diversity group have been extirpated. The northwestern California diversity group did not historically contain independent populations, and currently contains two or three populations that are likely dependent on the northern Sierra Nevada diversity group populations for their continued existence.

Construction of low elevation dams in the foothills of the Sierras on the Mokelumne, Stanislaus, Tuolumne, and Merced rivers, was thought to have extirpated CV spring-run Chinook salmon from these watersheds of the San Joaquin River, as well as on the American and Yuba rivers of the Sacramento River basin. However, observations in the last decade suggest that perhaps a naturally occurring population may still persist in the Stanislaus and Tuolumne rivers (Franks, personal communication, 2012), as well as in the Yuba River. Documented naturally-spawning populations of CV spring-run Chinook salmon are currently restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and the Yuba River (CDFG 1998).

## **Life History**

Adult CV spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River beginning in March (Yoshiyama 1998). Spring-run Chinook salmon move into tributaries of the Sacramento River (*e.g.* Butte, Mill, Deer creeks) beginning as early as February in Butte Creek and typically mid-March in Mill and Deer creeks (Lindley *et al.* 2004). Adult migration peaks around mid-April in Butte Creek, and mid-to end of May in Mill and Deer creeks, and is complete by the end of July in all three tributaries (Lindley *et al.* 2004) (Table 7). Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama *et al.* 1998).

Spring-run Chinook salmon spawning occurs between September and October (Moyle 2002). Between 56 and 87 percent of adult spring-run Chinook salmon that enter the Sacramento River basin to spawn are 3 years old (Calkins *et al.* 1940, Fisher 1994).

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Spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002) and the emigration timing is highly variable, as they may migrate downstream as young-of-the-year or as juveniles or yearlings. The modal size of fry migrants at approximately 40 millimeters (mm) between December and April in Mill, Butte, and Deer creeks reflects a prolonged emergence of fry from the gravel (Lindley *et al.* 2004). Studies in Butte Creek, (Ward *et al.* 2003, McReynolds *et al.* 2007) found the majority of CV spring-run Chinook salmon migrants to be fry, which occurred primarily during December, January, and February; and that these movements appeared to be influenced by increased flow. Small numbers of CV spring-run Chinook salmon were observed to remain in Butte Creek to rear and migrated as yearlings later in the spring. Juvenile emigration patterns in Mill and Deer creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer creek juveniles typically exhibit a later young-of-the-year migration and an earlier yearling migration (Lindley *et al.* 2004). CDFW (CDFG 1998) observed the emigration period for spring-run Chinook salmon extending from November to early May, with up to 69 percent of the young-of-the-year fish outmigrating through the lower Sacramento River and Delta during this period. Peak movement of juvenile CV spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and again in March and April. However, juveniles also are observed between November and the end of May (Snider and Titus 2000).

Once juveniles emerge from the gravel they initially seek areas of shallow water and low velocities while they finish absorbing the yolk sac and transition to exogenous feeding (Moyle 2002). Many also would disperse downstream during high-flow events. As is the case in other salmonids, there is a shift in microhabitat use by juveniles to deeper faster water as they grow larger. Microhabitat use can be influenced by the presence of predators which can force fish to select areas of heavy cover and suppress foraging in open areas (Moyle 2002).

**Table 7.** The temporal occurrence of adult (a) and juvenile (b) CV spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance.

<b>(a) Adult migration</b>												
<b>Location</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>
Sac. River basin <sup>a,b</sup>			■	■	■	■	■	■	■	■	■	■
Sac. River mainstem <sup>c</sup>		■	■	■	■	■	■	■	■			
Mill Creek <sup>d</sup>			■	■	■	■	■	■				
Deer Creek <sup>d</sup>			■	■	■	■	■	■				
Butte Creek <sup>d</sup>		■	■	■	■	■	■	■				
<b>(b) Adult Holding</b>												
		■	■	■	■	■	■	■	■	■	■	■
<b>(c) Adult Spawning</b>												
								■	■	■	■	■
<b>(d) Juvenile migration</b>												
<b>Location</b>	<b>Jan</b>	<b>Feb</b>	<b>Mar</b>	<b>Apr</b>	<b>May</b>	<b>Jun</b>	<b>Jul</b>	<b>Aug</b>	<b>Sep</b>	<b>Oct</b>	<b>Nov</b>	<b>Dec</b>
Sac. River Tribs <sup>e</sup>	■	■	■	■						■	■	■
Upper Butte Creek <sup>f</sup>	■	■	■	■	■	■	■			■	■	■
Mill, Deer, Butte Creeks <sup>d</sup>	■	■	■	■	■	■	■			■	■	■
Sac. River at RBDD <sup>c</sup>	■	■	■	■	■						■	■
Sac. River at KL <sup>g</sup>	■	■	■	■	■	■					■	■
Relative Abundance:	■	=	High	■	=	Medium	■	=	Low			

Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. Most young of the year spring-run Chinook salmon emigrate during the first spring after they hatch.

Sources: <sup>a</sup>Yoshiyama *et al.* (1998); <sup>b</sup>Moyle (2002); <sup>c</sup>Myers *et al.* (1998); <sup>d</sup>Lindley *et al.* (2004); <sup>e</sup>CDFG (1998); <sup>f</sup>McReynolds *et al.* (2007); Ward *et al.* (2003); <sup>g</sup>Snider and Titus (2000)

### Description of VSP Parameters

Like the winter-run Chinook salmon population, the CV spring-run Chinook salmon population fails to meet the “representation and redundancy rule” since there are only one demonstrably viable populations in one diversity group (northern Sierra Nevada) out of the three diversity groups that historically contained them. Over the long term, these remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount

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Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other.

### 1. Abundance

The CV drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). The San Joaquin River historically supported large runs of spring-run Chinook salmon, suggested to be one of the largest runs of any Chinook salmon on the West Coast with estimates averaging 200,000 – 500,000 adults returning annually (CDFG 1990). Construction of Friant Dam began in 1939 and was completed in 1942, which blocked access to upstream habitat.

The FRFH spring-run Chinook salmon population has been included in the ESU based on its genetic linkage to the natural population and the potential development of a conservation strategy for the hatchery program. On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to the FRFH. Since 1954, spawning escapement has been estimated using combinations of in-river estimates and hatchery counts, with estimates ranging from 2,908 in 1964 to 2 fish in 1978 (DWR 2001). Spring-run estimates after 1981 have been based solely on salmon entering the hatchery during the month of September. The 5-year moving averages from 1997 to 2006 had been more than 4,000 fish, but from 2007 to 2011, the 5-year moving averages have declined each year to a low of 1,783 fish in 2011 (CDFG 2012). However, coded wire tag (CWT) information from these hatchery returns has indicated that fall-run and spring-run Chinook salmon have overlap (DWR 2001). In addition, genetic testing has indicated substantial introgression has occurred between fall-run and spring-run Chinook salmon populations within the Feather River system due to temporal overlap and hatchery practices (DWR 2001). Because Chinook salmon have not always been spatially separated in the FRFH, spring-run and fall-run Chinook salmon have been spawned together, thus compromising the genetic integrity of the spring-run Chinook salmon stock (Good *et al.* 2005; DWR draft Hatchery Genetic Management Plan 2010). For the reasons discussed above, the Feather River spring-run Chinook salmon population numbers are not included in the following discussion of ESU abundance.

In addition, monitoring of the Sacramento River mainstem during spring-run Chinook salmon spawning timing indicates some spawning occurs in the river. Here, the lack of physical separation of spring-run Chinook salmon from fall-run Chinook salmon is complicated by overlapping migration and spawning periods. Significant hybridization with fall-run Chinook salmon makes identification of spring-run Chinook salmon in the mainstem very difficult to determine, but counts of early spawning Chinook salmon redds are typically used as an indicator of abundance. Less than 15 redds per year were observed in the Sacramento River from 1989 to 1993, during September aerial redd counts (USFWS 2003). Redd surveys conducted in September between 2001 and 2011 have observed an average of 36 salmon redds from Keswick Dam downstream to the RBDD, ranging from three to 105 redds (CDFG, unpublished data, 2011). Therefore, even though physical habitat conditions can support spawning and incubation, spring-run Chinook salmon depend on spatial segregation and geographic isolation from fall-run Chinook salmon to maintain genetic diversity. With the onset of fall-run Chinook salmon

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spawning occurring in the same time and place as potential spring-run Chinook salmon spawning, it is likely to have caused extensive introgression between the populations (CDFG 1998). For these reasons, Sacramento River mainstem spring-run Chinook salmon are not included in the following discussion of ESU abundance trends.

Sacramento River tributary populations in Mill, Deer, and Butte creeks are likely the best trend indicators for the CV spring-run Chinook salmon ESU as a whole because these streams contain the primary independent populations within the ESU. Generally, these streams have shown a positive escapement trend since 1991, displaying broad fluctuations in adult abundance, ranging from 1,013 in 1993 to 23,788 in 1998. Tributary numbers during 2005 to 2011 showed a downturn; however, 2012 and 2013 showed an increase to 10,810 and 18,499 fish, respectively. Escapement numbers for 2013 increased in most tributary populations, which resulted in the second highest number of spring-run Chinook salmon returning to the tributaries since 1960. Escapement numbers are dominated by Butte Creek returns, which have averaged over 7,000 fish from 1995 to 2005. During this same period, adult returns on Mill and Deer creeks have averaged 780 fish, and 1,464 fish respectively. From 2001 to 2005, the CV spring-run Chinook salmon ESU has experienced a trend of increasing abundance in some natural populations, most dramatically in the Butte Creek population (Good *et al.* 2005). Although trends were generally positive during this time, annual abundance estimates display a high level of fluctuation, and the overall number of CV spring-run Chinook salmon remains well below estimates of historic abundance.

In 2002 and 2003, mean water temperatures in Butte Creek exceeded 21°C for 10 or more days in July (Williams 2006). These persistent high water temperatures, coupled with high fish densities, precipitated an outbreak of Columnaris Disease (*Flexibacter columnaris*) and Ichthyophthiriasis (*Ichthyophthirius multifiliis*) in the adult spring-run Chinook salmon over-summering in Butte Creek. In 2002, this contributed to the pre-spawning mortality of approximately 20 to 30 percent of the adults. In 2003, approximately 65 percent of the adults succumbed, resulting in a loss of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek due to the disease. Since 2005, abundance numbers in most of the tributaries have declined. From 2006 to 2009, adult returns indicate that population abundance is declining from the peaks seen in the 5 years prior for the entire Sacramento River basin.

For Mill Creek the 2009, return of 220 spring-run Chinook salmon was the lowest return since 1997. Assuming the 2012, spring-run Chinook salmon return was primarily of three year old fish, then those 768 Chinook salmon represent a significant increase over the 2009, parent year. The 2013 estimate was 644, which was an increase from 2010 estimate of 482. The Mill Creek population of spring-run Chinook salmon is currently at a moderate risk of extinction, due to the significant decline in abundance from prior to 2008 through 2011. However, with the increase in abundance in 2012 and 2013, this trend may be improving. The Deer Creek abundance of spring-run Chinook salmon experienced a significant decline starting in 2008, with an increase in 2012 and 2013.

The abundance of spring-run Chinook salmon in Clear Creek was lower in 2010, 2011, and from 2005 through 2011, abundance numbers in most of the tributaries declined. Adult returns from 2006 to 2009, indicate that population abundance for the entire Sacramento River basin was

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declining from the peaks seen in the five years prior to 2006. Declines in abundance from 2005 to 2011, placed the Mill Creek and Deer Creek populations in the high extinction risk category due to the rates of decline, and in the case of Deer Creek, also the level of escapement (NMFS 2011). Butte Creek had sufficient abundance to retain its low extinction risk classification, but the rate of population decline in years 2006 through 2011 was nearly sufficient to classify it as a high extinction risk based on this criteria. Nonetheless, the watersheds identified as having the highest likelihood of success for achieving viability/low risk of extinction include, Butte, Deer and Mill creeks (NMFS 2011). Some other tributaries to the Sacramento River, such as Clear Creek and Battle Creek have seen population gains in the years from 2001 to 2009, but the overall abundance numbers have remained low. Year 2012 appeared to be a good return year for most of the tributaries with some, such as Battle Creek, having the highest return on record (799). Additionally, 2013 adult escapement numbers combined for Butte, Mill and Deer creeks increased (over 17,000), which resulted in the second highest number of spring-run Chinook salmon returning to the tributaries since 1998. 2014 adult escapement was lower than 2013 to be lower, with an adult escapement of just over 5,000 fish, which indicates a highly fluctuating and unstable ESU.

### 1. Productivity

The 5-year geometric mean for the extant Butte, Deer, and Mill creek spring-run Chinook salmon populations ranged from 491 to 4,513 fish, indicating increasing productivity over the short-term and was projected to likely continue into the future (Good *et al.* 2005). However, as mentioned in the previous paragraph, the next five years of adult escapement to these tributaries has seen a cumulative decline in fish numbers and the CRR has declined in concert with the population declines. The productivity of the Feather River and Yuba River populations and contribution to the CV spring-run ESU currently is unknown.

### 2. Spatial Structure

With only one of four diversity groups currently containing viable populations, the spatial structure of CV spring-run Chinook salmon is severely reduced. Butte Creek spring-run Chinook salmon cohorts have recently utilized all currently available habitat in the creek; and it is unknown if individuals have opportunistically migrated to other systems. The persistent populations in Clear Creek and Battle Creek, with habitat restoration completed and underway are anticipated to add to the spatial structure of the CV spring-run Chinook salmon ESU if they can reach viable status in the basalt and porous lava and northwestern California diversity group areas. The spatial structure of the spring-run Chinook salmon ESU would still be lacking with the extirpation of all San Joaquin River basin spring-run Chinook salmon populations. Plans are underway to re-establish a spring-run Chinook salmon experimental population downstream of Friant Dam in the San Joaquin River, as part of the San Joaquin River Settlement Agreement. This would be done with Feather River Hatchery stock. Interim flows for this began in 2009.. Its long-term contribution to the CV spring-run Chinook salmon ESU is uncertain. It is clear that further efforts would need to involve more than restoration of currently accessible watersheds to make the ESU viable. The draft CV Recovery Plan calls for reestablishing populations into historical habitats currently blocked by large dams, such as a population upstream of Shasta

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Dam. It also calls to facilitate passage of fish upstream and downstream of Englebright Dam on the Yuba River (NMFS 2009b).

### 3. Diversity

The CV spring-run Chinook salmon ESU is comprised of two genetic complexes. Analysis of natural and hatchery spring-run Chinook salmon stocks in the CV indicates that the northern Sierra Nevada diversity group spring-run Chinook salmon populations in Mill, Deer, and Butte creeks retains genetic integrity as opposed to the genetic integrity of the Feather River population, which has been somewhat compromised. The Feather River spring-run Chinook salmon have introgressed with the fall-run Chinook salmon, and it appears that the Yuba River population may have been impacted by FRFH fish straying into the Yuba River. Additionally, the diversity of the spring-run Chinook salmon ESU has been further reduced with the loss of the majority, if not all, of the San Joaquin River basin spring-run Chinook salmon populations. Efforts underway, like the San Joaquin Restoration Project, are needed to improve the diversity of the CV spring-run Chinook salmon ESU.

#### **Summary of CV Spring-run Chinook salmon DPS Viability**

Lindley et al. (2007) indicated that the spring-run Chinook salmon populations in the CV had a low risk of extinction in Butte and Deer creeks, according to their population viability analysis (PVA) model and other population viability criteria (i.e., population size, population decline, catastrophic events, and hatchery influence, which correlate with VSP parameters abundance, productivity, spatial structure, and diversity). The Mill Creek population of spring-run Chinook salmon was at moderate extinction risk according to the PVA model, but appeared to satisfy the other viability criteria for low-risk status. However, the CV spring-run Chinook salmon population failed to meet the “representation and redundancy rule” since there are only demonstrably viable populations in one diversity group (northern Sierra Nevada) out of the three diversity groups that historically contained them. Over the long term, these remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other. One large event could eliminate all three populations.

In the 2011 California CV status review for spring-run Chinook salmon, NMFS identified the status of CV spring-run Chinook salmon ESU as having probably deteriorated since the 2005 status review and Lindley et al.’s (2007) assessment, with two of the three extant independent populations (Deer and Mill creeks) of spring-run Chinook salmon slipping from low or moderate extinction risk to high extinction risk. Since the abundance of some populations is improving, though this is based on only two years (2012 and 2013), the extinction risk of Sacramento tributary populations generally has improved from high to moderate.

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## Critical Habitat and Primary Constituent Elements for CV Spring-Run Chinook Salmon

Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005, (70 FR 52488). Critical habitat for CV spring-run Chinook salmon includes stream reaches of the Feather, Yuba and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of one to two years on the annual flood series) (Bain and Stevenson 1999; 70 FR 52488). Critical habitat for CV spring-run Chinook salmon is defined as specific areas that contain the primary constituent elements (PCEs) essential to the conservation of the species. Following are the inland habitat types used as PCEs for CV spring-run Chinook salmon.

### 1. Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the CV for Chinook salmon is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for CV spring-run Chinook salmon occurs on the mainstem Sacramento River between RBDD and Keswick Dam and in tributaries such as Mill, Deer, and Butte creeks; as well as the Feather and Yuba rivers, Big Chico, Battle, Antelope, and Clear creeks. However, little spawning activity has been recorded in recent years on the Sacramento River mainstem for spring-run Chinook salmon. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

### 2. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile salmonid development; and natural cover such as shade, submerged and overhanging large woody material, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees [*i.e.*, primarily located upstream of the City of Colusa]) and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from piscivorous fish and birds. Freshwater rearing habitat also has a high intrinsic conservation value even if the current

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conditions are significantly degraded from their natural state. Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

### 3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks, and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For adults, upstream passage through the Delta and much of the Sacramento River is not a problem, yet a number of challenges exist on many tributary streams. For juveniles, unscreened or inadequately screened water diversions throughout their migration corridors and a scarcity of complex in-river cover have degraded this PCE. However, since the primary migration corridors are used by numerous populations, and are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic conservation value to the species.

### 4. Estuarine Areas

Estuarine areas free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover such as submerged and overhanging large woody material, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging.

The remaining estuarine habitat for these species is severely degraded by altered hydrologic regimes, poor water quality, reductions in habitat complexity, and competition for food and space with exotic species. Regardless of the condition, the remaining estuarine areas are of high conservation value because they provide factors which function to provide predator avoidance, as rearing habitat and as an area of transition to the ocean environment.

#### **2.2.3 California Central Valley steelhead**

CCV steelhead were listed as threatened on March 19, 1998, (63 FR 13347). Following a new status review (Good *et al.* 2005) and after application of the agency's hatchery listing policy, the NMFS reaffirmed its status as threatened and also listed several hatchery stocks as part of the DPS in 2006 (71 FR 834). In June 2004, after a complete status review of 27 west coast salmonid ESUs, the NMFS proposed that CCV steelhead remain listed as threatened (69 FR 33102). On January 5, 2006, NMFS reaffirmed the threatened status of the CCV steelhead and applied the DPS policy to the listed steelhead ESUs because the resident and anadromous life forms of *O.*

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*mykiss* remain “markedly separated” as a consequence of physical, ecological and behavioral factors, and therefore warranted delineation as a separate DPS (71 FR 834). On August 15, 2011, the NMFS completed another 5-year status review of CCV steelhead and recommended that the CCV steelhead DPS remain classified as a threatened species (NMFS 2011a).

Critical habitat was designated for CCV steelhead on September 2, 2005, (70 FR 52488). Critical habitat includes the stream channels to the ordinary high water line within designated stream reaches such as those of the American, Feather, and Yuba rivers, and Deer, Mill, Battle, Antelope, and Clear creeks in the Sacramento River basin; the Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers in the San Joaquin River basin; and the Sacramento and San Joaquin rivers and Delta. Currently the CCV steelhead DPS and its designated critical habitat extends up the San Joaquin River upstream to the confluence with the Merced River.

## **Life History**

### **1. Migratory Forms Present in CV**

Steelhead in the CV historically consisted of both summer-run and winter-run migratory forms, based on their state of sexual maturity at the time of river entry and the duration of their time in freshwater before spawning. Between 1944 and 1947, annual counts of summer-run steelhead passing through the Old Folsom Dam fish ladder during May, June, and July ranged from 400 to 1,246 fish (Gerstung 1971). After 1950, when the fish ladder at Old Folsom Dam was destroyed by flood flows, summer-run steelhead were no longer able to access their historic spawning areas, and either perished in the warm water downstream of Old Folsom Dam or hybridized with winter-run steelhead. Only winter-run (ocean maturing) steelhead currently are found in California CV rivers and streams (Moyle 2002; McEwan and Jackson 1996). Summer-run steelhead have been extirpated due to a lack of access to suitable holding and staging habitat, such as coldwater pools in the headwaters of CV streams, presently located upstream of impassible dams (Lindley *et al.* 2006).

### **2. Age Structure**

Juvenile steelhead (parr) rear in freshwater for one to three years before outmigrating to the ocean as smolts (Moyle 2002). The time that parr spend in freshwater is related to their growth rate, with larger, faster-growing members of a cohort smolting at an earlier age (Peven *et al.* 1994; Seelbach 1993). Hallock *et al.* (1961) aged 100 adult steelhead caught in the Sacramento River upstream of the Feather River confluence in 1954, and found that 70 had smolted at age-2, 29 at age-1, and one at age-3. Seventeen of the adults were repeat spawners, with three fish on their third spawning migration, and one on its fifth. Age at first maturity varies among populations. In the CV, most steelhead return to their natal streams as adults at a total age of two to four years (Hallock 1961, McEwan and Jackson 1996).

### **3. Egg to Parr Stages**

Steelhead eggs hatch in three to four weeks at 10°C to 15°C (Moyle 2002). The length of time it takes for eggs to hatch depends mostly on water temperature. After hatching, alevins remain in

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the gravel for an additional two to five weeks while absorbing their yolk sacs, and emerge in spring or early summer (Barnhart 1986). Fry emerge from the gravel usually about four to six weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Upon emergence, fry inhale air at the stream surface to fill their air bladders, absorb the remains of their yolks in the course of a few days, and start to feed actively, often in schools (Barnhart 1986; NMFS 1996).

The newly emerged juveniles move to shallow, protected areas associated within the stream margin (McEwan and Jackson 1996). As steelhead parr increase in size and their swimming abilities improve, they increasingly exhibit a preference for higher velocity and deeper mid-channel areas (Hartman 1965; Everest and Chapman 1972; Fontaine 1988).

#### 4. Preferred Juvenile Habitat

Productive juvenile rearing habitat is characterized by complexity, primarily in the form of cover, which can be deep pools, woody debris, aquatic vegetation, or boulders. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Meehan and Bjornn 1991). Optimal water temperatures for growth range from 15°C to 20°C (McCullough *et al.* 2001, Spina 2006).

#### 5. Smolt Migration

Juvenile steelhead will often migrate downstream as parr in the summer or fall of their first year of life (USFWS 2002), but this is not a true smolt migration (Loch *et al.* 1988). Smolt migrations occur in the late winter through spring, when juveniles have undergone a physiological transformation to survive in the ocean, and become slender in shape, bright silvery in coloration, with no visible parr marks. Emigrating steelhead smolts use the lower reaches of the Sacramento River and the Delta primarily as a migration corridor to the ocean. There is little evidence that they rear in the Delta or on floodplains, though there are few behavioral studies of this life-stage in the CV.

#### 6. Ocean Behavior

Unlike Pacific salmon, steelhead do not appear to form schools in the ocean (Behnke 1992). Steelhead in the southern part of their range appear to migrate close to the continental shelf, while more northern populations may migrate throughout the northern Pacific Ocean (Barnhart 1986).

#### 7. Adult Run-Timing and Spawning Habitat

CCV steelhead generally leave the ocean from August through April (Busby *et al.* 1996), enter freshwater from August to November with a peak in September (Hallock 1961), and spawn from December to April, with a peak in January through March, in rivers and streams where cold, well oxygenated water is available (Table 8; Williams 2006; Hallock *et al.* 1961; McEwan and Jackson 1996). Timing of upstream migration is correlated with higher flow events, such as freshets, and the associated change in water temperatures (Workman *et al.* 2002). Adults

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typically spend a few months in freshwater before spawning (Williams 2006). Female steelhead construct redds in suitable gravel and cobble substrate, primarily in pool tailouts and heads of riffles.

#### 8. Fecundity

The number of eggs laid per female is highly correlated with adult size, though the strain of the fish can also play a role. Adult steelhead size depends on the duration of and growth rate during their ocean residency (Meehan and Bjornn 1991). CCV steelhead generally return to freshwater after one to two years at sea (Hallock *et al.* 1961), and adults typically range in size from two to twelve pounds (Reynolds *et al.* 1993). Steelhead about 55 cm long may have fewer than 2,000 eggs, whereas steelhead 85 cm long can have 5,000 to 10,000 eggs, depending on the stock (Meehan and Bjornn 1991). The average for Coleman National Fish Hatchery (CNFH) since 1999 is about 3,900 eggs per female (USFWS 2011).

#### 9. Iteroparity

Unlike Pacific salmon, steelhead are iteroparous, meaning they are capable of spawning multiple times before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; and repeat spawners tend to be biased towards females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners were relatively numerous (17.2 percent) in Waddell Creek. Null *et al.* (2013) found between 36 percent and 48 percent of kelts released from CNFH in 2005 and 2006 survived to spawn the following spring, which is in sharp contrast to what Hallock (1989) reported for CNFH in the 1971 season, where only 1.1 percent of adults were fish that had been tagged the previous year. Most populations have never been studied to determine the percentage of repeat spawners. Hatchery steelhead are typically less likely than wild fish to survive to spawn a second time (Leider *et al.* 1986).

#### 10. Kelts

Post-spawning steelhead (kelts) may migrate downstream to the ocean immediately after spawning, or they may spend several weeks holding in pools before outmigrating (Shapovalov and Taft 1954). Recent studies have shown that kelts may remain in freshwater for an entire year after spawning (Teo *et al.* 2011), but that most return to the ocean (Null *et al.* 2013).

#### 11. Population Dynamics

Historic CCV steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 adults (McEwan 2001). Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River upstream of the Feather River. Steelhead counts at the RBDD declined from an average of 11,187 for the period from 1967 to 1977, to an average of approximately 2,000 through the early 1990's, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD

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counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

About 80 percent of the historical spawning and rearing habitat once used by anadromous *O. mykiss* in the CV is now upstream of impassable dams (Lindley *et al.* 2006). The extent of habitat loss for steelhead most likely was much higher than that for salmon because steelhead were undoubtedly more extensively distributed. Due to their superior jumping ability, the timing of their upstream migration which coincided with the winter rainy season, and their less restrictive preferences for spawning gravels, steelhead could have utilized at least hundreds of miles of smaller tributaries not accessible to the earlier-spawning salmon (Yoshiyama *et al.* 1996). Steelhead were found as far south as the Kings River (and possibly Kern river systems in wet years) (McEwan 2001). Native American groups such as the Chunut people have had accounts of steelhead in the Tulare Basin (Latta 1977).

Nobriga and Cadrett (2003) compared CWT and untagged (wild) steelhead smolt catch ratios at Chipps Island trawl from 1998 through 2001 to estimate that about 100,000 to 300,000 steelhead smolts are produced naturally each year in the CV. Good *et al.* (2005) made the following conclusion based on the Chipps Island data:

*“If we make the fairly generous assumptions (in the sense of generating large estimates of spawners) that average fecundity is 5,000 eggs per female, 1 percent of eggs survive to reach Chipps Island, and 181,000 smolts are produced (the 1998-2000 average), about 3,628 female steelhead spawn naturally in the entire CV. This can be compared with McEwan’s (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s.”*

Existing naturally produced steelhead stocks in the CV are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill creeks and the Yuba River. Populations may exist in Big Chico and Butte creeks and a few wild steelhead are produced in the American and Feather rivers (McEwan and Jackson 1996). Clear Creek steelhead spawner abundance has not been estimated.

Until recently, CCV steelhead were thought to be extirpated from the San Joaquin River system. Monitoring has detected small numbers of steelhead in the Stanislaus, Mokelumne, and Calaveras rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995. A counting weir has been in place in the Stanislaus River since 2002 and in the Tuolumne River since 2009 to detect adult salmon, and have also detected *O. mykiss* passage. In 2012, 15 adult *O. mykiss* were detected passing the Tuolumne River weir and 82 adult *O. mykiss* were detected at the Stanislaus River weir (FishBio 2012a,b). In addition, rotary screw trap sampling has occurred since 1995 in the Tuolumne River, but only one juvenile *O. mykiss* was caught during the 2012 season (FishBio 2012b). Rotary screw traps are well known to be very inefficient at catching steelhead smolts, so the actual numbers of smolts could be much higher. Rotary screw trapping on the Merced River has occurred since 1999. A fish counting weir was installed on this river in 2012. Since installation, one adult *O. mykiss* has been reported passing the weir. Juvenile *O. mykiss* were not reported

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captured in the rotary screw traps on the Merced River until 2012, when a total of 381 were caught (FishBio 2013). The unusually high number of *O. mykiss* captured may be attributed to a flashy storm event that rapidly increased flows over a 24 hour period. Zimmerman *et al.* (2009) has documented CCV steelhead in the Stanislaus, Tuolumne, and Merced rivers based on otolith microchemistry.

CDFW conducts annual Kodiak trawl sampling on the San Joaquin River near Mossdale. Based on these catches, as well as rotary screw trap efforts in all three tributaries, Marston (2004) stated that it is “clear from this data that *O. mykiss* do occur in all the tributaries as migrants and that the vast majority of them occur on the Stanislaus River.” Mossdale Kodiak trawl catches continue to occur and are still being conducted by CDFW. The low adult returns to these tributaries and the low numbers of juvenile emigrants captured suggest that existing populations of CCV steelhead on the Tuolumne, Merced, and lower San Joaquin rivers are severely depressed. The loss of these populations would severely impact CCV steelhead spatial structure and further challenge the viability of the CCV steelhead DPS.

In the Mokelumne River, East Bay Municipal Utilities District has included steelhead in their redd surveys on the Lower Mokelumne River since the 1999-2000 spawning season (NMFS 2011a). Based on data from these surveys, the overall trend suggests that redd numbers have slightly increased over the years (2000-2010). However, according to Satterthwaite *et al.* (2010), it is likely that most of the *O. mykiss* spawning in the Mokelumne River are non-anadromous (or resident) fish rather than steelhead. The Mokelumne River steelhead population is supplemented by Mokelumne River Hatchery production. In the past, this hatchery received fish imported from the Feather River and Nimbus hatcheries (Merz 2002). However, this practice was discontinued 11 years ago for Nimbus stock, and 3 years ago for Feather River stock. Recent results show that the Mokelumne River Hatchery steelhead are closely related to Feather River fish, suggesting that there has been little carry-over of genes from the Nimbus stock.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show a decline, an overall low abundance, and fluctuating return rates. Lindley *et al.* (2007) developed viability criteria for CV salmonids. Using data through 2005, Lindley *et al.* (2007) found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The most recent status review of the CCV steelhead DPS (NMFS 2011a) found that the status of the population appears to have worsened since the 2005 status review (Good *et al.* 2005), when it was considered to be in danger of extinction. Analysis of data from the Chipps Island monitoring program indicates that natural steelhead production has continued to decline and that hatchery origin fish represent an increasing fraction of the juvenile production in the CV. Since 1998, all hatchery produced steelhead in the CV have been adipose fin clipped (ad-clipped). Since that time, the trawl data indicates that the proportion of ad-clip steelhead juveniles captured in the Chipps Island monitoring trawls has increased relative to wild juveniles, indicating a decline in natural production of juvenile steelhead. In recent years, the proportion of hatchery produced juvenile steelhead in the catch has exceeded 90 percent and in 2010 was 95 percent of the catch.

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Because hatchery releases have been fairly consistent through the years, this data suggests that the natural production of steelhead has been declining in the CV.

Salvage of juvenile steelhead at the CVP and SWP fish collection facilities has also shown a shift towards reduced natural production. In the past decade, there has been a decline in the percentage of salvaged juvenile steelhead that are naturally produced from 55 percent in 1998 down to 22 percent in 2010 (NMFS 2011a).

In contrast to the data from Chipps Island and the CVP and SWP fish collection facilities, some populations of wild CCV steelhead appear to be improving (Clear Creek) while others (Battle Creek) appear to be better able to tolerate the recent poor ocean conditions and dry hydrology in the CV compared to hatchery produced fish (NMFS 2011a). Since 2003, fish returning to the CNFH have been identified as wild (adipose fin intact) or hatchery produced (Ad-clipped). Returns of wild fish to the hatchery have remained fairly steady at 200-300 fish per year, but represent a small fraction of the overall hatchery returns. Numbers of hatchery origin fish returning to the hatchery have fluctuated much more widely; ranging from 624 to 2,968 fish per year. The returns of wild fish remained steady, even during the recent poor ocean conditions and the 3-year drought in the CV, while hatchery produced fish showed a decline in the numbers returning to the hatchery (NMFS 2011a). Furthermore, the continuing widespread distribution of wild steelhead in the CV provides the spatial distribution necessary for the DPS to survive and avoid localized catastrophes. However, these populations are frequently very small, and lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011a).

**Table 8.** The temporal occurrence of (a) adult and (b) juvenile CCV steelhead at locations in the CV. Darker shades indicate months of greatest relative abundance.

(a) Adult migration and holding

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<sup>1,3</sup> Sac. River												
<sup>2,3</sup> Sac R at Red Bluff												
<sup>4</sup> Mill, Deer Creeks												
<sup>6</sup> Sac R. at Fremont Weir												
<sup>6</sup> Sac R. at Fremont Weir												
<sup>7</sup> San Joaquin River												

(b) Juvenile migration

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<sup>1,2</sup> Sacramento River												
<sup>2,8</sup> Sac. R at KL												
<sup>9</sup> Sac. River @ KL												
<sup>10</sup> Chippis Island (wild)												
<sup>8</sup> Mossdale												
<sup>11</sup> Woodbridge Dam												
<sup>12</sup> Stan R. at Caswell												
<sup>13</sup> Sac R. at Hood												

Relative Abundance:  = High  = Medium  = Low

Sources: <sup>1</sup>Hallock 1961; <sup>2</sup>McEwan 2001; <sup>3</sup>USFWS unpublished data; <sup>4</sup>CDFG 1995; <sup>5</sup>Hallock *et al.* 1957; <sup>6</sup>Bailey 1954; <sup>7</sup>CDFG Steelhead Report Card Data 2007; <sup>8</sup>CDFG unpublished data; <sup>9</sup>Snider and Titus 2000; <sup>10</sup>Nobriga and Cadrett 2003; <sup>11</sup>Jones and Stokes Associates, Inc., 2002; <sup>12</sup>S.P. Cramer and Associates Inc. 2000 and 2001; <sup>13</sup>Schaffter 1980, 1997.

**Description of VSP Parameters**

1. Abundance

All indications are that natural CCV steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (Good *et al.* 2005; NMFS 2011a); the long-term trend remains negative. Comprehensive steelhead population monitoring has not taken place in the CV, despite 100 percent marking of hatchery steelhead since 1998. Efforts are underway to improve this deficiency, and a long term adult escapement monitoring plan is being

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considered (Eilers *et al.* 2010). Hatchery production and returns are dominant over natural fish and include significant numbers of non-DPS-origin Eel/Mad River steelhead stock. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

## 2. Productivity

An estimated 100,000 to 300,000 naturally produced juvenile steelhead are estimated to leave the CV annually, based on rough calculations from sporadic catches in trawl gear (Good *et al.* 2005). The Mossdale trawls on the San Joaquin River conducted annually by CDFW and USFWS capture steelhead smolts, although usually in very small numbers. These steelhead recoveries which represent migrants from the Stanislaus, Tuolumne, and Merced rivers suggest that existing populations of CCV steelhead on these tributaries are severely depressed. In addition, the Chipps Island midwater trawl dataset from the USFWS provides information on the trend (Williams *et al.* 2011).

## 3. Spatial Structure

Steelhead appear to be well-distributed throughout the CV (Good *et al.* 2005; NMFS 2011a). In the San Joaquin River Basin, steelhead have been confirmed in all of the tributaries: Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers. Zimmerman *et al.* (2009) used otolith microchemistry to show that *O. mykiss* of anadromous parentage occur in all three major San Joaquin River tributaries, but at low levels, and that these tributaries have a higher percentage of resident *O. mykiss* compared to the Sacramento River and its tributaries. The efforts to provide passage of salmonids over impassable dams may increase the spatial diversity of CCV steelhead populations if the passage programs are implemented for steelhead. In addition, the San Joaquin River Restoration Program (SJRRP) calls for a combination of channel and structural modifications along the San Joaquin River downstream of Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of spring-run and fall-run Chinook salmon. If the SJRRP is successful, habitat improved for spring-run Chinook salmon could also benefit CCV steelhead (NMFS 2011a).

## 4. Diversity

CCV steelhead abundance and growth rate continue to decline, largely the result of a significant reduction in the diversity of habitats available to CCV steelhead (Lindley *et al.* 2006). Recent reductions in population size are also supported by genetic analysis (Nielsen *et al.* 2003). Garza and Pearse (2008) analyzed the genetic relationships among CCV steelhead populations and found that unlike the situation in coastal California watersheds, fish downstream of barriers in the CV were more closely related to downstream of barrier fish from other watersheds than to *O. mykiss* upstream of barriers in the same watershed. This pattern suggests the ancestral genetic structure is still relatively intact upstream of barriers, but may have been altered below barriers by stock transfers. The genetic diversity of CCV steelhead is also compromised by hatchery

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origin fish, which likely comprise the majority of the spawning run, placing the natural population at a high risk of extinction (Lindley *et al.* 2007). There are four hatcheries (CNFH, FRFH, Nimbus Fish Hatchery, and Mokelumne River Fish Hatchery) in the CV which combined release approximately 600,000 yearling steelhead smolts each year. These programs are intended to compensate for the loss of steelhead habitat caused by dam construction, but hatchery origin fish now appear to constitute a major proportion of the total abundance in the DPS. Two of these hatchery stocks (Nimbus and Mokelumne River hatcheries) originated from outside the DPS (from the Eel and Mad rivers) and are not presently considered part of the DPS.

### **Summary of CCV Steelhead DPS Viability**

All indications are that natural CCV steelhead have continued to decrease in abundance over the past 25 years (Good *et al.* 2005; NMFS 2011a). The long-term trend remains negative. Hatchery production and returns are dominant over natural fish. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show a decline, an overall low abundance, and fluctuating return rates. Lindley *et al.* (2007) developed viability criteria for CV salmonids. Using data through 2005, Lindley *et al.* (2007) found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The widespread distribution of wild steelhead in the CV provides the spatial distribution necessary for the DPS to survive and avoid localized catastrophes. However, these populations are frequently very small, and lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011a). The most recent status review of the CCV steelhead DPS (NMFS 2011a) found that the status of the population appears to have worsened since the 2005 status review (Good *et al.* 2005), when it was considered to be in danger of extinction.

### **Critical Habitat and Primary Constituent Elements for CCV Steelhead**

Critical habitat was designated for CCV steelhead on September 2, 2005 (70 FR 52488). Critical habitat for CCV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries, and the waterways of the Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a

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recurrence interval of 1 to 2 years on the annual flood series) (Bain and Stevenson 1999; 70 FR 52488). Critical habitat for CCV steelhead is defined as specific areas that contain the PCE and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for CCV steelhead. PCEs for CCV steelhead include:

1. Freshwater Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most of the available spawning habitat for steelhead in the CV is located in areas directly downstream of dams due to inaccessibility to historical spawning areas upstream and the fact that dams are typically built at high gradient locations. These reaches are often impacted by the upstream impoundments, particularly over the summer months, when high temperatures can have adverse effects upon salmonids spawning and rearing downstream of the dams. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and survival; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging LWM, log jams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees [*i.e.*, primarily located upstream of the City of Colusa]) and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Freshwater rearing habitat also has a high conservation value even if the current conditions are significantly degraded from their natural state. Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks, and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow the upstream and downstream passage of adults, and the emigration of smolts.

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Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For this reason, freshwater migration corridors are considered to have a high conservation value even if the migration corridors are significantly degraded compared to their natural state.

#### 4. Estuarine Areas

Estuarine areas free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover such as submerged and overhanging LWM, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging. Estuarine areas are considered to have a high conservation value as they provide factors which function to provide predator avoidance and as a transitional zone to the ocean environment.

#### **2.2.4 Southern DPS of North American Green Sturgeon**

The following section entails the status of the species for the Southern distinct population segment of North American green sturgeon (sDPS green sturgeon). This section establishes the life history and viability for sDPS green sturgeon, and discusses their critical habitat. The critical habitat analysis is approached by examining the PCEs of that critical habitat, and this analysis considers separately freshwater and estuarine environments. Throughout this analysis of life history, viability, and critical habitat, the focus is upon the CV of California. Therefore, not all aspects of sDPS green sturgeon are presented; for example, the PCEs for the critical habitat in the marine environment are not included.

1. Listed as threatened on June 6, 2006 (71 FR 17757)
2. Critical habitat designated October 9, 2009 (74 FR 52300)

#### **Life History**

Our understanding of the biology of the sDPS of green sturgeon is evolving. In areas where information is lacking, inferences are sometimes made from what is known about the Northern distinct population segment (nDPS) green sturgeon and, to a lesser extent, from other sturgeon species, especially the sympatric white sturgeon (*Acipenser transmontanus*). Green sturgeon are long lived, iteroporous, anadromous fish. They may live up to 60-70 years; green sturgeon captured in Oregon have been age-estimated using a fin-spine analysis up to 52 years (Farr and Kern 2005). The green sturgeon sDPS includes those that spawn south of the Eel River. Until recently, it was believed that the green sturgeon sDPS was composed of a single spawning population on the Sacramento River. However, recent research conducted by DWR has revealed spawning activity in the Feather River (Seesholtz, A. M., M. J. Manuel, and J. P. Van Eenennaam). 2015. First documented spawning and associated habitat conditions for green sturgeon in the Feather River, California. *Environmental Biology of Fishes* 98:905-912.

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Additionally, there is some evidence of spawning in the Yuba River downstream of Daguerre Point Dam (Cramer Fish Sciences 2013).

Laboratory studies have provided some important information about about larval sturgeon diet and habitat use. Green sturgeon larvae hatch from fertilized eggs after approximately 169 hours at a water temperature of 15° C (59° F) (Van Eenennaam *et al.* 2001, Deng *et al.* 2002). Studies conducted at the University of California, Davis by Van Eenennaam *et al.* (2005) using nDPS juveniles indicated that an optimum range of water temperature for egg development ranged between 14° C (57.2°F) and 17° C (62.6°F). Temperatures over 23 °C (73.4°F) resulted in 100 percent mortality of fertilized eggs before hatching. Eggs incubated at water temperatures between 17.5° C (63.5°F) and 22° C (71.6°F) resulted in elevated mortalities and an increased occurrence of morphological abnormalities in those eggs that did hatch. At incubation temperatures below 14° C (57.2°F), hatching mortality also increased significantly, and morphological abnormalities increased slightly, but not statistically so (Van Eenennaam *et al.* 2005).

Young green sturgeon appear to rear for the first one to two months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002). Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in June and July at lengths ranging from 24 to 31 mm fork length, indicating they are approximately two weeks old (CDFG 2002, USFWS 2002). Growth is rapid as juveniles reach up to 300 mm the first year and over 600 mm in the first 2 to 3 years (Nakamoto *et al.* 1995). Juvenile green sturgeon have been salvaged at the Federal and State pumping facilities (which are located in the southern region of the Delta), and sampled in trawling studies by the CDFW during all months of the year (CDFG 2002). The majority of these fish that were captured in the Delta were between 200 and 500 mm indicating they were from 2 to 3 years of age, based on Klamath River age distribution work by Nakamoto *et al.* (1995). The lack of a significant proportion of juveniles smaller than approximately 200 mm in Delta captures indicates juvenile sDPS green sturgeon likely hold in the mainstem Sacramento River for up to 10 months, as suggested by Kynard *et al.* (2005). Both nDPS and sDPS green sturgeon juveniles tested under laboratory conditions, with either full or reduced rations, had optimal bioenergetic performance (*i.e.*, growth, food conversion, swimming ability) between 15°C (59° F) and 19° C (66.2° F), thus providing a temperature related habitat target for conservation of this rare species (Mayfield and Cech 2004). This temperature range overlaps the egg incubation temperature range for peak hatching success previously discussed.

Green sturgeon are opportunistic feeders that consume a variety of prey items. The diet of larval green sturgeon is unknown, but may be similar to that of larval white sturgeon which includes macrobenthic invertebrates, including various insect larvae, oligochaetes, and decapods (NMFS 2009). In the San Francisco Bay Delta Estuary, juvenile green sturgeon feed on shrimp, amphipods, isopods, clams, annelid worms, and an assortment of crabs and fish (Ganssle 1966; Radtke 1966). Post-spawn adult green sturgeon in freshwater most likely feed on benthic prey species (*e.g.*, lamprey ammocoetes, crayfish). In coastal bays and estuaries, adult and subadult green sturgeon feed on shrimp, clams, and benthic fish (Moyle *et al.* 1995; Moser and Lindley 2007; Dumbauld *et al.* 2008). In the nearshore marine environment, prey resources likely include species similar to those of coastal bays and estuaries.

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There is a fair amount of variability (1.5 – 4 years) in the estimates of the time spent by juvenile green sturgeon in freshwater before making their first migration to sea. Nakamoto *et al.* (1995) found that nDPS green sturgeon on the Klamath River migrated to sea, on average by age three and no later than by age four. Moyle (2002) suggests juveniles migrate out to sea before the end of their second year, and perhaps as yearlings. Laboratory experiments indicate that both nDPS and sDPS green sturgeon juveniles may occupy fresh to brackish water at any age, but they are physiologically able to completely transition to saltwater at around 1.5 years in age (Allen and Cech 2007). In studying nDPS green sturgeon on the Klamath River, Allen *et al.* (2009) devised a technique to estimate the timing of transition from fresh water to brackish water to seawater by taking a bone sample from the leading edge of the pectoral fin and analyzing the ratios of strontium and barium to calcium. The results of this study indicate that green sturgeon move from freshwater to brackish water (such as the estuary) at ages 0.5–1.5 years and then move into seawater at ages 2.5–3.5 years. Table 9 shows the migration timing of various life stages throughout the CV, Delta, San Francisco Bay, and into the Pacific Ocean.

In the summer months, multiple rivers and estuaries throughout the sDPS range are visited by dense aggregations of green sturgeon (Moser and Lindley 2007, Lindley *et al.* 2011). Capture of green sturgeon as well as tag detections in tagging studies have shown that green sturgeon are present in San Pablo Bay and San Francisco Bay at all months of the year (Kelly *et al.* 2007, Heublein *et al.* 2009, Lindley *et al.* 2011). An increasing amount of information is becoming available regarding green sturgeon habitat use in estuaries and coastal ocean, and why they aggregate episodically (Lindley *et al.* 2008, Lindley *et al.* 2011). Genetic studies on green sturgeon stocks indicate that almost all of the green sturgeon in the San Francisco Bay ecosystem belong to the sDPS (Israel and Klimley 2008).

Green sturgeon do not mature until they are at least 15–17 years of age (Beamesderfer *et al.* 2007). Therefore, it would not be expected that a green sturgeon returning to freshwater would be younger than this. However, once mature, green sturgeon appear to make spawning runs once every few years. Erickson and Hightower (2007) found that nDPS green sturgeon returned to the Rogue River 2–4 years after leaving; it is presumed that sDPS green sturgeon display similar behavior and return to the Sacramento River or Feather River system to spawn every 2–5 years. Adult sDPS green sturgeon begin their upstream spawning migrations into freshwater as early as late February with spawning occurring between March and July (CDFG 2002, Heublein 2006, Heublein *et al.* 2009, Vogel 2008). Peak spawning is believed to occur between April and June in deep, turbulent, mainstem channels over large cobble and rocky substrates featuring crevices and interstices (Van Eenennaam *et al.* 2001). Poytress *et al.* (2012) conducted spawning site and larval sampling in the upper Sacramento River from 2008–2012 and has identified a number of confirmed spawning locations (Figure 6). Green sturgeon fecundity is approximately 50,000 to 80,000 eggs per adult female (Van Eenennaam *et al.* 2001). They have the largest egg size of any sturgeon. The outside of the eggs are mildly adhesive, and are more dense than those of white sturgeon (Kynard *et al.* 2005, Van Eenennaam *et al.* 2009).

Post spawning, green sturgeon may exhibit a variety of behaviors. Ultimately they will return to the ocean, but how long they take to do this and what they do along the way are open questions. Illustrating the spectrum of behavioral choices, Benson *et al.* (2007) conducted a study in which 49 nDPS green sturgeon were tagged with radio and/or sonic telemetry tags and tracked

manually or with receiver arrays from 2002 to 2004. Tagged individuals exhibited four movement patterns: upstream spawning migration, spring outmigration to the ocean, or summer holding, and outmigration after summer holding.

**Table 9.** The temporal occurrence of (a) adult, (b) larval (c) juvenile and (d) subadult coastal migrant sDPS of green sturgeon. Locations emphasize the CV of California. Darker shades indicate months of greatest relative abundance.

(a) Adult-sexually mature ( $\geq 145 - 205$  cm TL for females and  $\geq 120 - 185$  cm TL old for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Sac. River <sup>a,b,c,i</sup>	Low	Low	Medium	High	High	High	Medium	Medium	Medium	Low	Low	Low
SF Bay Estuary <sup>d,h,i</sup>	Low	Low	Medium	Low	Low	Low						

(b) Larval and juvenile ( $\leq 10$  months old)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RBDD, Sac River <sup>e</sup>	Low	Low	Low	Low	Medium	High	High	High	Medium	Low	Low	Low
GCID, Sac River <sup>e</sup>	Low	Low	Low	Low	Medium	High	High	High	Medium	Low	Low	Low

(c) Older Juvenile ( $> 10$  months old and  $\leq 3$  years old)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
South Delta <sup>*f</sup>	Low											
Sac-SJ Delta <sup>f</sup>	Low											
Sac-SJ Delta <sup>e</sup>	Low											
Suisun Bay <sup>e</sup>	Low											

(d) Sub-Adult/non-sexually mature (approx. 75 cm to 145 cm for females and 75 to 120 cm for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pacific Coast <sup>c,g</sup>	Low											

Relative Abundance:  = High  = Medium  = Low

\* Fish Facility salvage operations

Sources: <sup>a</sup>USFWS (2002); <sup>b</sup>Moyle *et al.* (1992); <sup>c</sup>Adams *et al.* (2002) and NMFS (2005);

<sup>d</sup>Kelly *et al.* (2007); <sup>e</sup>CDFG (2002); <sup>f</sup>IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; <sup>g</sup>Nakamoto *et al.* (1995); <sup>h</sup>Heublein (2006); <sup>i</sup>CDFG Draft Sturgeon Report Card (2007)

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## Threats and Stressors

Green sturgeon are long lived, and thus face environmental and anthropocentric stressors that may affect the probability that they reach reproductive maturity. Males are observed to reproduce as early as 14 years old, while females grow older prior to maturing as early as 16 years old (Van Eenennaam et al. 2005). Both males and females occupy all types of aquatic environments- freshwater, estuarine, and marine. Numerous environmental factors potentially limit green sturgeon survival during the earliest stages of their life cycle while in freshwater. This period is called the “critical age” in fishes due to its relevance in survival and recruitment of individuals into the adult population (Hardy and Litvak 2004). Recruitment failure of the earliest life history stages may be a significant bottleneck for other North American acipenserids such as Pallid sturgeon and the white sturgeon in Upper Columbia and Kootenai rivers, the populations of which have numerous reproductive adults, but few recently surviving wild juveniles (Duke et al. 1999, Hildebrand et al. 1999, Korman and Walters 2001) .

There are many potential limiting factors during this early life period. They are the following: 1) warm water temperatures, 2) insufficient flows, 3) decreased dissolved oxygen, 4) lack of rearing habitat, and 5) increased predation. Water is released from Shasta Dam to maintain daily temperatures below 18° C downstream to a temperature compliance point, which in 2007 was maintained at Jellys Ferry and Balls Ferry to facilitate the incubation of eggs of spawning winter-run Chinook. This maintenance of cool water temperatures benefits green sturgeon spawning upstream of Red Bluff Diversion Dam. Temperature records from acoustic telemetry receivers along the mainstem have not been analyzed, but may provide data for assessing whether temperatures are limiting survival of embryos, larvae or juveniles downstream of RBDD. Once larvae grow into juveniles, their survival may be limited by lack of habitat, insufficient food, and possibly contaminants. Juveniles are fairly tolerant of variable temperature and dissolved oxygen, and are likely mobile enough to select favorable habitats (see Ecology sections). It is possible that juveniles can also be entrained in water diversions for farmland irrigation, although their benthic behavior likely limits this impact, and this is not well understood.

The members of the older age classes principally face anthropocentric threats to their survival in estuarine and marine environments. Once within the estuary, juveniles might accumulate pollutants such as methyl-mercury and pyrethroids, whose uptake is enhanced by the benthic feeding orientation of green sturgeon. Pyrethroids also may limit the availability of prey for young green sturgeon due to their effect of very low dosages on zooplankton and bottom-dwelling organisms. The size of the populations of subadults and adults have been potentially limited by human fisheries and barriers to spawning areas which may prevent them from racing the most optimal spawning habitats. Harvest can cause abrupt declines in green sturgeon adult abundance. Even an amount as small as 10% additional mortality over the green sturgeon’s life-span can reduce population abundance by 50% and adult abundance by 90% (Beamesderfer et al. 2007). An additional simulated increase in mortality of 20% over natural mortality resulted in no green sturgeon surviving to adulthood. These forms of mortality could include human and nonhuman sources of direct mortality, and are not well quantified for the Southern DPS. Of greater concern, might be even much smaller additional mortality rates’ influence on green sturgeon’s reproductive potential. Additional rates of only 2-3% annual mortality over green

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sturgeon's life cycle reduced egg production to levels making sturgeon stocks extremely susceptible to overfishing (Beamesderfer et al. 2007).

Modification of the riverscape has resulted in loss of spawning habitat, rearing habitat, and increased barriers to migration. Larvae, juveniles, and adults life history stages are all benthic in orientation and all require deep habitats for dispersal, holding, and spawning. Successful fertilization and survival of embryos seems to require spawning habitats reflecting specific water quality and quantity parameters, which have been negatively impacted by construction of dams and channelization of the river. Riparian habitats provide allochthonous contributions to the river food web that indirectly support juvenile prey items. It is possible that modifications in temperature regime controlled by the Shasta Dam temperature control device may benefit green sturgeon spawning above Red Bluff Diversion Dam, but more research is necessary to understand the impacts of temperature on the distribution and success of green sturgeon spawning.

Channelization of the estuary has likely negatively impacted the amount of subtidal and intertidal habitat available for green sturgeon foraging. These habitats have been lost along San Pablo and Suisun bays, where subadult and adult green sturgeon are commonly found. These estuarine habitats are likely important for growth during the juvenile, coastal migrant, and adults life stages. Invasive plant species in the estuary have likely impacted the quantity of shallow habitat available to coastal migrant and adult green sturgeon, and alterations of the food web due to invasive species have also likely shifted green sturgeon estuarine diet.

### **Future Research**

One conclusion of the NMFS BRT assessing the status of green sturgeon was that “it is essential that immediate efforts be undertaken to implement population monitoring for the DPS using methods that directly assess population status” (NMFS 2005). Although laboratory studies have yielded much information on the physiological needs of the species, field studies have yet to be completed applying this information to identifying adult spawning, larval survival, juvenile rearing, and juvenile smoltification. Information is necessary about the life history diversity, abundance, population growth rate, foraging behavior and temporal presence of Sacramento River green sturgeon.

Managers should develop research and monitoring to estimate the riverine larval and juvenile populations for a period of time reflecting the potential variation in physical and biological processes influencing recruitment. These results will give managers an idea for the effect of management on critical habitats, influence of adult demography on recruitment dynamics, and the actual production of green sturgeon in younger cohorts. Estimates derived from these types of studies may be a good indication for spawning and abundance, which are not negatively influenced by the impact of entrainment, operations, and harvest. If estimates of young riverine fish are known, then adaptive research evaluating the impacts of anthropogenic stressors on older life history stages will allow managers to assess the actual effects of these anthropogenic stressors. Currently, abundance derived from harvest or operational entrainment data does not allow managers to determine if these impacts are causing declines in abundance or just reflect the natural production of spawning adults.

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The distribution of spawning adults as well as a characterization of their spawning habitat within the Sacramento River should be completed. This will provide insight into the density of spawning adults and influence spawning aggregation have to the juvenile population, the rates of egg and larval mortality, and the potential loss of this spawning habitat by flow and temperature modification in the system. In 2008, UCD, BOR, and FWS initiated tracking green sturgeon as they move within the upper mainstem and collected eggs at spawning sites. Additional funding is necessary to adequately monitor spawning movements and increased egg and larval collection sites along the Sacramento riverscape to evaluate green sturgeon habitat relationships.

Little is known about green sturgeon food selection and foraging behavior making the predictability of where preferred food is available low. As green sturgeon move into lower riverine reaches, the estuary and marine environments, food resources are not well understood (Israel and Klimley 2008). If native food sources have declined due to invasive species occupying their habitat or pollutants reducing available food, finding sufficient food may be problematic for juvenile green sturgeon. There is a need to investigate further the effects of selenium and other contaminants on green sturgeon and to find ways to reduce sources. Recent evidence indicates adult white sturgeon may be accumulating selenium in concentrations detrimental to reproduction, presumably by consuming the introduced overbite clam (Linville 2006).

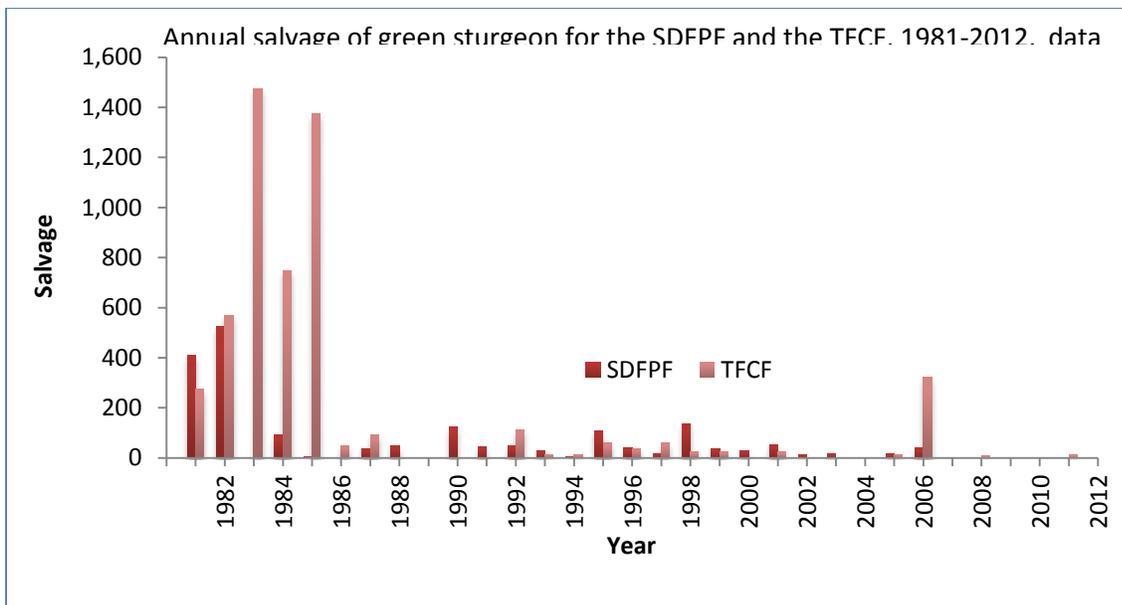
Support should be provided for priority research guided by the Interagency Ecological Program Sturgeon Work Team. This conceptual model should indicate that much is already known about the basic biology of green sturgeon from laboratory studies and can serve as the basis for developing hypotheses for testing in field studies. The next research step should be to discern the importance of this biology on population viability within the watershed. A systematically applied research program attempting to study the critical periods and habitats of green sturgeon in riverine and estuarine environments will provide managers with information on the actual utilization, status, and abundance of different life history stages of green sturgeon in the Sacramento River. Once these field observations are completed, our larger and more comprehensive understanding for the basic ecology of the species will permit the development of a population viability model, which could prioritize the above-mentioned risks to the population and guide management decisions (Israel and Klimley 2008).

### **Description of Viability Parameters for sDPS Green Sturgeon**

As an approach to determining the conservation status of salmonids, NMFS has developed a framework for identifying attributes of a VSP. The intent of this framework is to provide parties with the ability to assess the effects of management and conservation actions and ensure their actions promote the listed species' survival and recovery. This framework is known as the VSP concept (McElhany *et al.* 2000). The VSP concept measures population performance in term of four key parameters: abundance, population growth rate, spatial structure, and diversity. Although the VSP concept was developed for Pacific salmonids, the underlying parameters are general principles of conservation biology and can therefore be applied more broadly; here we adopt the VSP concept for sPDS green sturgeon.

## 1. Abundance

Abundance is one of the most basic principles of conservation biology, and from this measurement other parameters can be related. In applying the VSP concept, abundance is examined at the population level, and therefore population size is perhaps a more appropriate term. Population estimates of the green sturgeon sDPS are in development. A decrease in sDPS green sturgeon abundance has been inferred from the amount of take observed at the south Delta pumping facilities; the Skinner Delta Fish Protection Facility (SDFPF) and the Tracy Fish Collection Facility (TFCF) (Figure 7). There are, however, uncertainties with the data in figure 7. Adams et al. (2007) describe that while the numbers of green sturgeon still were higher in the pre 1986 period, it appears that the expansion procedure exaggerated that difference. These entrainment estimates suffer from problems of species identification (green sturgeon were not identified until 1981 at the federal facility), and the estimates are expanded catches from brief sampling periods.



**Figure 7.** Annual salvage of green sturgeon for the SDFPF and the TFCF from 1981 to 2012. Data source: <http://ftp.delta.dfg.ca.gov/salvage>

Adult spawning population estimates in the upper Sacramento River (above RBDD), using sibling based genetics, indicates 10-28 spawners contributed to juvenile production per year between 2002-2006 (Israel and May 2010). This is a minimum estimate of the effective adult spawning population because sampling was limited, may have preferentially selected for larvae spawning immediately above RBDD, and did not include animals spawning downstream of the RBDD. Fish monitoring efforts at RBDD and Glen Colusa Irrigation District (GCID) on the upper Sacramento River have captured anywhere between 0 and 2,068 juvenile green sturgeon per year, between 1986 and 2000 (Adams *et al.* 2002).

In determining the conservation status of sDPS green sturgeon, a few notes with regards to population size are crucial. Population(s) should be large enough to survive environmental variations, catastrophes, and anthropogenic perturbations. Also, the population(s) should be

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sufficiently large to maintain long term genetic diversity (McElhany *et al.* 2000). Our understanding of the status of sDPS green sturgeon towards these concerns is developing.

Because of their long life span, green sturgeon abundance is particularly sensitive to increased mortality. Even relatively small increases in annual mortality can substantially reduce adult abundance due to cumulative effects accruing over a number of years. Because of their delayed age of maturation, cumulative impacts may severely reduce the population's reproduction potential.

Beamesderfer *et al.* (2007) used the life table model to evaluate the sensitivity of the population to additional mortality rates when applied to different life stages. The analyses showed that low rates of additional mortality (2% to 5%), when applied across multiple life stages, can result in abrupt declines in green sturgeon population numbers and reproductive potential.

## 2. Productivity

For long-lived species such as sturgeon, abundance, age structure, and sex ratios are particularly powerful indicators of long-term productivity patterns. Viable sturgeon populations are characterized by a broad distribution of size classes and ages. In order for sDPS green sturgeon to rebound from being threatened to a viable status, its population growth rate will need to be positive until some equilibrium population size is reached, at which point the growth rate should stabilize.

Productivity and recruitment information for sDPS green sturgeon is an area that requires additional research; existing data is too limited to be presented as robust estimates. Incidental catches of larval green sturgeon in the mainstem Sacramento River and of juvenile green sturgeon at the south Delta pumping facilities suggest that green sturgeon are successful at spawning, but that annual year class strength may be highly variable (Beamesderfer *et al.* 2007, Lindley *et al.* 2007). In general, sturgeon year class strength appears to be episodic with overall abundance dependent upon a few successful spawning events (NMFS 2010). It is unclear if the population is able to consistently replace itself. This is significant because the VSP concept requires that a population meeting or exceeding the abundance criteria for viability should, on average, be able to replace itself (McElhany *et al.* 2000). More research is needed to establish green sturgeon sDPS productivity.

## 3. Spatial Structure

Green sturgeon, as a species, are known to range from Baja California to the Bering Sea along the North American continental shelf. During the late summer and early fall, subadults and nonspawning adult green sturgeon frequently can be found aggregating in estuaries along the Pacific coast (Emmett 1991, Moser and Lindley 2007). Based on genetic analyses and spawning site fidelity (Adams *et al.* 2002, Israel *et al.* 2004), green sturgeon are comprised of at least two DPSs.

1. A nDPS consisting of populations originating from coastal watersheds northward of and including the Eel River (*i.e.* Klamath, Rogue, and Umpqua rivers), and

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2. A sDPS consisting of populations originating from coastal watersheds south of the Eel River.

Throughout much of their range, sDPS and nDPS green sturgeon are known to co-occur, especially in northern estuaries and over-wintering grounds. However, those green sturgeon that are found within the inland waters of the Central Valley, California are almost entirely sDPS green sturgeon (Israel and Klimley 2008).

Adams *et al.* (2007) summarizes information that suggests green sturgeon may have been distributed upstream of the locations of present-day dams on the Sacramento and Feather rivers. In the California CV, sDPS green sturgeon are known to range from the Delta to the Sacramento River up to Keswick Dam, the Feather River up to the fish barrier structure downstream of Oroville Dam, and the Yuba River up to Daguerre Point Dam. Additional habitat may have historically existed in the San Joaquin River basin. Anecdotal evidence from anglers suggest sDPS green sturgeon presence in the San Joaquin River. Since implementation of the Sturgeon Report Card in 2007, anglers have reported catching 177 white sturgeon and 7 green sturgeon on the San Joaquin River upstream from Stockton (Dubois, J., M. D. Harris, and J. Mauldin. 2014. 2013 Sturgeon Fishing Report Card: Preliminary Data Report. CDFW Bay Delta Region, Stockton, CA, May 8, 2014).

In applying the VSP concept to sDPS green sturgeon, it is important to look at the within-population spatial diversity. Ongoing research is being conducted to determine if the green sturgeon sDPS is composed of a single population, or perhaps several populations. It is known that sDPS green sturgeon spawn in the mainstem Sacramento River, the Feather River, and the Yuba River; but it is not yet known if these spawning areas represent individual populations, sub-populations, or if they are all part of one single population. However, it is encouraging to note that at least this level of spatial diversity exists; when sDPS green sturgeon were originally listed as threatened under the ESA, the only known spawning locations at the time were those on the mainstem Sacramento River.

#### 4. Diversity

The VSP concept identifies a variety of traits that exhibit diversity within and among populations, and this variation has important effects on population viability (McElhany *et al.* 2000). For sDPS green sturgeon, such traits include, but are not limited to fecundity, age at maturity, physiology, and genetic characteristics. On a species-wide scale, studies have examined the genetic differentiation between sDPS and nDPS green sturgeon (Israel *et al.* 2004).

Although the population structure of sDPS green sturgeon is still being refined, it may be the case that only a single population exists. This may have the effect of providing for lower diversity than if two or more populations existed. Lindley *et al.* (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population.

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## **Summary of sDPS Green Sturgeon Viability**

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010a). Viability is defined as an independent population having a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year timeframe (McElhany et al. 2000). The best available scientific information does not indicate that the extinction risk facing sDPS green sturgeon is negligible over a long term (~100 year) time horizon; therefore the sDPS is not believed to be viable. To support this statement, the population viability analysis (PVA) that was done for sDPS green sturgeon in relation to stranding events (Thomas et al. 2013) may provide some insight. While this PVA model made many assumptions that need to be verified as new information becomes available, it was alarming to note that over a 50-year time period the DPS declined under all scenarios where stranding events were recurrent over the lifespan of a green sturgeon.

Although the population structure of sDPS green sturgeon is still being refined, it is currently believed that only one population of sDPS green sturgeon exists. Lindley et al. (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population, and if this were to be applied to sDPS green sturgeon directly, it could be said that sDPS green sturgeon face a high extinction risk. However, the position of NMFS, upon weighing all available information (and lack of information) has stated the extinction risk to be moderate (NMFS 2010a).

There is a strong need for additional information about sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their habitat needs.

## **Southern DPS of North American Green Sturgeon Critical Habitat**

Critical habitat was designated for the sDPS green sturgeon on October 9, 2009 (74 FR 52300). A full and exact description of all sDPS green sturgeon critical habitat, including excluded areas, can be found at 50 CFR 226.219. Critical habitat includes the stream channels and waterways in the Delta to the ordinary high water line. Critical habitat also includes the main stem Sacramento River upstream from the I Street Bridge to Keswick Dam, the Feather River upstream to the fish barrier dam adjacent to the Feather River Fish Hatchery, and the Yuba River upstream to Daguerre Dam. Coastal marine areas include waters out to a depth of 60 fathoms, from Monterey Bay in California, to the Strait of Juan de Fuca in Washington. Coastal estuaries designated as critical habitat include San Francisco Bay, Suisun Bay, San Pablo Bay, and the lower Columbia River estuary. Certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) are also included as critical habitat for sDPS green sturgeon.

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Critical habitat for sDPS green sturgeon includes principal biological or physical constituent elements within the defined area that are essential to the conservation of the species. PCEs for sDPS green sturgeon have been designated for freshwater riverine systems, estuarine habitats, and nearshore coastal areas. In keeping with the focus on the California CV, we will limit our discussion to freshwater riverine systems and estuarine habitats.

## **Freshwater Riverine Systems**

### **1. Food Resources**

Abundant food items for larval, juvenile, subadult, and adult life stages for sDPS green sturgeon should be present in sufficient amounts to sustain growth, development, and support basic metabolism. Although specific information on food resources for green sturgeon within freshwater riverine systems is lacking, they are presumed to be generalists and opportunists that feed on similar prey as other sturgeons (Israel and Klimley 2008). Seasonally abundant drifting and benthic invertebrates have been shown to be the major food items of shovelnose and pallid sturgeon in the Missouri River (Wanner *et al.* 2007), lake sturgeon in the St. Lawrence River (Nilo *et al.* 2006), and white sturgeon in the lower Columbia River (Muir *et al.* 2000). As sturgeons grow, they begin to feed on oligochaetes, amphipods, smaller fish, and fish eggs as represented in the diets of lake sturgeon (Nilo *et al.* 2006), pallid sturgeon (Gerrity *et al.* 2006), and white sturgeon (Muir *et al.* 2000).

### **2. Substrate Type or Size**

Critical habitat in the freshwater riverine system should include substrate suitable for egg deposition and development, larval development, subadults, and adult life stages. For example, spawning is believed to occur over substrates ranging from clean sand to bedrock, with preferences for cobble (Emmett *et al.* 1991, Moyle *et al.* 1995). Eggs are likely to adhere to substrates, or settle into crevices between substrates (Van Eenennaam *et al.* 2001, Deng *et al.* 2002). Larvae exhibited a preference for benthic structure during laboratory studies (Van Eenennaam *et al.* 2001, Deng *et al.* 2002, Kynard *et al.* 2005), and may seek refuge within crevices, but use flat-surfaced substrates for foraging (Nguyen and Crocker 2006).

### **3. Water Flow**

An adequate flow regime is necessary for normal behavior, growth, and survival of all life stages in the upper Sacramento River. Such a flow regime should include stable and sufficient water flow rates in spawning and rearing reaches to maintain water temperatures within the optimal range for egg, larval, and juvenile survival and development (11°C - 19°C) (Mayfield and Cech 2004, Van Eenennaam *et al.* 2005, Allen *et al.* 2006). Sufficient flow is also needed to reduce the incidence of fungal infestations of the eggs, and to flush silt and debris from cobble, gravel, and other substrate surfaces to prevent crevices from being filled in and to maintain surfaces for feeding. Successful migration of adult green sturgeon to and from spawning grounds is also dependent on sufficient water flow. Spawning in the Sacramento River is believed to be triggered by increases in water flow to about 14,000 cfs [average daily water flow during spawning months: 6,900 – 10,800 cfs; Brown (2007)]. In Oregon's Rogue River, nDPS green

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sturgeon have been shown to emigrate to sea during the autumn and winter when water temperatures dropped below 10° C and flows increased (Erickson *et al.* 2002). On the Klamath River, the fall outmigration of nDPS green sturgeon has been shown to coincide with a significant increase in discharge resulting from the onset of the rainy season (Benson *et al.* 2007). On the Sacramento River, flow regimes are largely dependent on releases from Shasta Dam, thus the operation of this dam could have profound effects upon sDPS green sturgeon habitat.

#### 4. Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics are necessary for normal behavior, growth, and viability of all life stages. Suitable water temperatures would include: stable water temperatures within spawning reaches; temperatures within 11°C - 17°C (optimal range = 14°C - 16°C) in spawning reaches for egg incubation (March-August) (Van Eenennaam *et al.* 2005); temperatures below 20°C for larval development (Werner *et al.* 2007); and temperatures below 24°C for juveniles (Mayfield and Cech 2004, Allen *et al.* 2006). Suitable salinity levels range from fresh water (< 3 ppt) for larvae and early juveniles to brackish water (10 ppt) for juveniles prior to their transition to salt water. Prolonged exposure to higher salinities may result in decreased growth and activity levels and even mortality (Allen and Cech 2007). Adequate levels of dissolved oxygen (DO) are needed to support oxygen consumption by early life stages (ranging from 61.78 to 76.06 mg O<sub>2</sub> hr<sup>-1</sup> kg<sup>-1</sup> for juveniles, Allen and Cech (2007). Suitable water quality would also include water with acceptably low levels of contaminants (*i.e.*, pesticides, organochlorines, selenium, elevated levels of heavy metals, *etc.*) that may disrupt normal development of embryonic, larval, and juvenile stages of green sturgeon. Poor water quality can have adverse effects on growth, reproductive development, and reproductive success. Studies on effect of water contaminants upon green sturgeon are needed; studies performed upon white sturgeon have clearly demonstrated the negative impacts contaminants can have upon white sturgeon biology (Foster *et al.* 2001a, 2001b, Feist *et al.* 2005, Fairey *et al.* 1997, Kruse and Scarnecchia 2002). Legacy contaminants such as mercury still persist in the watershed and pulses of pesticides have been identified in winter storm discharges throughout the Sacramento River basin, and the CV and Delta.

#### 5. Migratory Corridor

Safe and unobstructed migratory pathways are necessary for adult green sturgeon to migrate to and from spawning habitats, and for larval and juvenile green sturgeon to migrate downstream from spawning and rearing habitats within freshwater rivers to rearing habitats within the estuaries. Unobstructed passage throughout the Sacramento River up to Keswick Dam (RM 302) is important, because optimal spawning habitats for green sturgeon are believed to be located upstream of the RBDD (RM 242).

#### 6. Depth

Deep pools of ≥ 5 m depth are critical for adult green sturgeon spawning and for summer holding within the Sacramento River. Summer aggregations of green sturgeon are observed in these pools in the upper Sacramento River upstream of GCID. The significance and purpose of these aggregations are unknown at the present time, but may be a behavioral characteristic of green

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sturgeon. Adult green sturgeon in the Klamath and Rogue rivers also occupy deep holding pools for extended periods of time, presumably for feeding, energy conservation, and/or refuge from high water temperatures (Erickson *et al.* 2002, Benson *et al.* 2007). As described above approximately 54 pools with adequate depth have been identified in the Sacramento River upstream of the GCID location.

## 7. Sediment Quality

Sediment should be of the appropriate quality and characteristics necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants [*e.g.*, elevated levels of heavy metals (*e.g.*, mercury, copper, zinc, cadmium, and chromium), polycyclic aromatic hydrocarbons (PAHs), and organochlorine pesticides] that can result in negative effects on any life stage of green sturgeon or their prey. Based on studies of white sturgeon, bioaccumulation of contaminants from feeding on benthic species may negatively affect the growth, reproductive development, and reproductive success of green sturgeon. The Sacramento River and its tributaries have a long history of contaminant exposure from abandoned mines, separation of gold ore from mine tailings using mercury, and agricultural practices with pesticides and fertilizers which result in deposition of these materials in the sediment horizons in the river channel. The San Joaquin River is a source for many of these same contaminants, although pollution and runoff from agriculture are the predominant driving force. Disturbance of these sediment horizons by natural or anthropogenic actions can liberate sequestered contaminants into the river. This is a continuing concern throughout the watershed.

### **For Estuarine Habitats**

#### 1. Food Resources

Abundant food items within estuarine habitats and substrates for juvenile, subadult, and adult life stages are required for the proper functioning of this PCE for green sturgeon. Green sturgeon feed primarily on worms, mollusks, and crustaceans (Moyle 2002). Radtke (1966) studied the diet of juvenile sDPS green sturgeon and found their stomach contents to include a mysid shrimp, amphipods, and other unidentified shrimp. These prey species are critical for the rearing, foraging, growth, and development of juvenile, subadult, and adult green sturgeon within the bays and estuaries. Currently, the estuary provides these food resources, although annual fluctuations in the population levels of these food resources may diminish the contribution of one group to the diet of green sturgeon relative to another food source.

Invasive species are a concern because they may replace the natural food items consumed by green sturgeon. The Asian overbite clam (*Corbula amurensis*) is one example of a prolific invasive clam species in the Delta. It has been observed to pass through white sturgeon undigested (Kogut 2008).

#### 2. Water Flow

Within bays and estuaries adjacent to the Sacramento River (*i.e.*, the Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to

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successfully orient to the incoming flow and migrate upstream to spawning grounds is required. Sufficient flows are needed to attract adult green sturgeon to the Sacramento River from the bay and to initiate the upstream spawning migration into the upper river. The specific quantity of flow required is a topic of ongoing research.

### 3. Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, is necessary for normal behavior, growth and viability of all life stages. Suitable water temperatures for juvenile green sturgeon should be below 24°C (75°F). At temperatures above 24°C, juvenile green sturgeon exhibit decreased swimming performance (Mayfield and Cech 2004) and increased cellular stress (Allen *et al.* 2006). Suitable salinities in the estuary range from brackish water (10 ppt) to salt water (33 ppt). Juveniles transitioning from brackish to salt water can tolerate prolonged exposure to salt water salinities, but may exhibit decreased growth and activity levels (Allen and Cech 2007), whereas subadults and adults tolerate a wide range of salinities (Kelly *et al.* 2007). Subadult and adult green sturgeon occupy a wide range of DO levels, but may need a minimum DO level of at least 6.54 mg O<sub>2</sub>/l (Kelly *et al.* 2007, Moser and Lindley 2007).

Suitable water quality also includes water free of contaminants (*e.g.*, pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal development of juvenile life stages, or the growth, survival, or reproduction of subadult or adult stages. In general, water quality in the Delta and estuary meets these criteria, but local areas of the Delta and downstream bays have been identified as having deficiencies. Discharges of agricultural drain water have also been implicated in local elevations of pesticides and other related agricultural compounds within the Delta and the tributaries and sloughs feeding into the Delta. Discharges from petroleum refineries in Suisun and San Pablo bay have been identified as sources of selenium to the local aquatic ecosystem (Linville *et al.* 2002).

### 4. Migratory Corridor

Safe and unobstructed migratory pathways are necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats. Within the waterways comprising the Delta, and bays downstream of the Sacramento River, safe and unobstructed passage is needed for juvenile green sturgeon during the rearing phase of their life cycle. Passage within the bays and the Delta is also critical for adults and subadults for feeding and summer holding, as well as to access the Sacramento River for their upstream spawning migrations and to make their outmigration back into the ocean. Within bays and estuaries outside of the Delta and the areas comprised by Suisun, San Pablo, and San Francisco bays, safe and unobstructed passage is necessary for adult and subadult green sturgeon to access feeding areas, holding areas, and thermal refugia, and to ensure passage back out into the ocean. Currently, safe and unobstructed passage has been diminished by human actions in the Delta and bays. The CVP and SWP, responsible for large volumes of water diversions, alter flow patterns in the Delta due to export pumping and create entrainment issues in the Delta at the pumping and Fish Facilities. Power generation facilities in Suisun Bay create risks of entrainment and thermal barriers through their operations of cooling water

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diversions and discharges. Installation of seasonal barriers in the South Delta and operations of the radial gates in the Delta Cross Channel (DCC) facilities alter migration corridors available to green sturgeon. Actions such as the hydraulic dredging of ship channels and operations of large ocean going vessels create additional sources of risk to green sturgeon within the estuary. Commercial shipping traffic can result in the loss of fish, particularly adult fish, through ship and propeller strikes.

#### 5. Water Depth

A diversity of depths is necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages. Subadult and adult green sturgeon occupy deep ( $\geq 5$  m) holding pools within bays, estuaries, and freshwater rivers. These deep holding pools may be important for feeding and energy conservation, or may serve as thermal refugia (Benson *et al.* 2007). Tagged adults and subadults within the San Francisco Bay estuary primarily occupied waters with depths of less than 10 meters, either swimming near the surface or foraging along the bottom (Kelly *et al.* 2007). In a study of juvenile green sturgeon in the Delta, relatively large numbers of juveniles were captured primarily in shallow waters from 3 – 8 feet deep, indicating juveniles may require shallower depths for rearing and foraging (Radtke 1966).

Currently, there is a diversity of water depths found throughout the San Francisco Bay estuary and Delta waterways. Most of the deeper waters, however, are composed of artificially maintained shipping channels, which do not migrate or fluctuate in response to the hydrology in the estuary in a natural manner. Shallow waters occur throughout the Delta and San Francisco Bay. Extensive “flats” occur in the lower reaches of the Sacramento and San Joaquin river systems as they leave the Delta region and are even more extensive in Suisun and San Pablo bays. In most of the region, variations in water depth in these shallow water areas occur due to natural processes, with only localized navigation channels being dredged (*e.g.*, the Napa River and Petaluma River channels in San Pablo Bay).

#### 6. Sediment Quality

Sediment quality (*i.e.*, chemical characteristics) is necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants (*e.g.*, elevated levels of selenium, PAHs, and organochlorine pesticides) that can cause negative effects on all life stages of green sturgeon (see description of *sediment quality* for riverine habitats above).

### **Summary of the Conservation Value of Green Sturgeon Critical Habitat**

The current condition of critical habitat for the green sturgeon sDPS is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the survival and recovery of the species, especially in the upstream riverine habitat. In particular, passage and water flow PCEs have been impacted by human actions, substantially altering the historical river characteristics in which the green sturgeon sDPS evolved. The habitat values proposed for green sturgeon critical habitat have suffered similar types of degradation as described for winter-run Chinook salmon critical habitat. In addition, the alterations to the lower Sacramento River and delta Delta may have a particularly strong impact on the survival and

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recruitment of juvenile green sturgeon due to the protracted rearing time in the delta and estuary. Loss of individuals during this phase of the life history of green sturgeon represents losses to multiple year classes, which can ultimately impact the potential population structure for decades.

### **2.3 Environmental Baseline**

The “environmental baseline” includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

The environmental baseline describes the status of listed species and critical habitat in the action area, to which we add the effects of the West Sacramento GRS, to consider the effects of the proposed Federal actions within the context of other factors that impact the listed species. The effects of the proposed Federal action are evaluated in the context of the aggregate effects of all factors that have contributed to the status of listed species and, for non-Federal activities in the action area, those actions that are likely to affect listed species in the future, to determine if implementation of the West Sacramento GRS is likely to cause an appreciable reduction in the likelihood of both survival and recovery or result in destruction or adverse modification of critical habitat.

Reaches throughout the West Sacramento GRS planning area historically provided both shallow and deeper water habitat. Channel confining levees and upstream reservoirs that maintain year-round outflow have eliminated much of the adjacent shallow water floodplain habitat. Many native fish species are adapted to rear in flooded, shallow water areas that provide abundant cover and prey. As a consequence of habitat alterations, and the introduction of non-native species and pollutants, some native fish species are now extinct while most others are reduced in numbers (Moyle 2002).

A majority of the discussion in this BO will focus on the Sacramento River as the potential impacts to the Yolo Bypass, DWSC, Barge Canal, and Sacramento Bypass are minimal. This will be analyzed in the Effects section.

The Sacramento River watershed receives winter/early spring precipitation in the form of rain and snow (at higher elevations). Prior to the construction and operation of any reservoirs, winter rainfall events caused extensive flooding and spring snowmelt resulted in high flows during spring and early summer. Summer and fall flows were historically low. Currently, much of the total runoff is captured and stored in reservoirs for gradual release during the summer and fall months. High river flows occur during the winter and spring, but these are usually lower than during pre-European settlement times; summer and fall low flows are sustained by releases from upstream reservoirs.

The flood risk management system protecting the City of West Sacramento has been identified as insufficient by the Corps. According to the Corps, there is a high probability that flows in the American and Sacramento rivers will stress the network of levees protecting West Sacramento to

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the point that levees could fail. Failure of these levees could inundate highly urbanized areas up to 20 feet deep.

Sixteen land cover types were identified in the West Sacramento GRS project area. Nine of the land cover types are considered natural communities: all four riparian habitats, emergent marsh, valley oak woodland, walnut woodland, nonnative annual grassland, pond, and perennial drainage. The other cover types are associated with human activities: all three agricultural field types, walnut orchard, agricultural ditch, and developed/landscaped.

Despite the impaired status of the Sacramento River in the proposed project action area, the value of the lower Sacramento River as a migratory corridor for CV spring-run Chinook salmon, CCV steelhead, Sacramento River winter-run Chinook salmon, and sDPS green sturgeon is high primarily because it contains habitat elements that support the rearing and growth of juveniles and the successful upstream migration of adults. The West Sacramento GRS will occur downstream of the confluence of major watersheds, including the American, Yuba, and Feather river and watersheds further upstream such as Butte Creek and Battle Creek. Thus, the action area is also within the migratory corridor for the fish that utilize all the aforementioned watersheds.

Anticipated climate change may affect spatial and temporal precipitation patterns along with the intensity and duration of precipitation within the Sacramento River watershed. The effect of climate change is anticipated to be more winter and less spring and summer run-off within the watershed. In addition, expected run-off is anticipated to be warmer, possibly affecting the ability to meet downstream water temperature objectives to protect salmon, steelhead, and green sturgeon. This combined with more precipitation as rain will affect future operations of all reservoirs within the California CV. A change in the run-off pattern within the Sacramento River watersheds will likely affect reservoir storage and downstream river flows due to more frequent spillway releases.

This same flood management system impacts the natural meander and ecosystem of the Sacramento River. The West Sacramento Project study area includes the mainstem Sacramento River 11.4 miles from the Sacramento Bypass south to the South Cross Levee. The proposed project area also includes the Yolo Bypass, DWSC, Barge Canal, Port of West Sacramento, upper Yolo Bypass toe drain, and the South Cross toe drain. Downstream from the American River confluence, the Sacramento River is moderately sinuous, with the channel confined on both sides by levees enhanced by decades of additions. The channel in this reach is of uniform width, is not able to migrate, and is typically narrower and deeper relative to the upstream reach due to scour caused by the concentration of shear forces acting against the channel bed (Brice 1977). There is a short reach of setback levee in this reach, on the west bank of the Sacramento River at RM 57.2. The setback levee at RM 57.2 was constructed by the Corps under the SRBPP.

The natural banks and adjacent floodplains of the Sacramento River are composed of silt-to gravel-sized particles with poor to high permeability. Historically, the flow regimes caused the deposition of a gradient of coarser to finer material, and longitudinal fining directed downstream (sand to bay muds). The deposition of these alluvial soils historically accumulated to form extensive natural levees and splays along the river, 5 to 20 feet above the floodplain for as far as

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10 miles from the channel (Thompson 1961). The present day channels consist of fine-grained cohesive banks that erode due to natural processes as well as high flow events (Corps 2012).

Seasonal high flows enter the adjacent Yolo Bypass from this reach of the Sacramento River via the Sacramento Bypass. Tidal influence emanating from Suisun Bay extends up the Sacramento River for 80 miles to Verona, with greater tidal variations occurring downstream during low river stages in summer and fall.

The West Sacramento Project study area consists of primarily riparian scrub-shrub habitat. Early riparian habitat may be called scrub-shrub. Scrub-shrub generally refers to areas where the woody riparian canopy is composed of trees or shrubs approximately 20 feet high. Species that are typically found in these habitats include young cottonwood (*Populus trichocarpa*), willow (*Salix spp.*), elderberry (*Sambucus spp.*), buttonbush (*Cephalanthus occidentalis*), Himalaya blackberry (*Rubus armeniacus*), wild grape (*Vitis vinifera*), and poison oak (*Toxicodendron spp.*).

Riparian forest typically has a dominant overstory of cottonwood, California sycamore (*Platanus racemosa*), or valley oak (*Quercus lobata*). Species found in the scrub-shrub will make up the sub canopy and could also include white alder and box elder. Layers of climbing vegetation make up part of the subcanopy, with wild grape being a major component, but wild cucumber and clematis are also found in riparian communities.

The herbaceous ruderal habitat is found on most levees along the Sacramento River. It occurs on the levees and also within gaps in the riparian habitats. Plant species include wild oats (*Avena spp.*), soft chess (*Bromus hordeaceus*), riggut brome (*Bromus hordeaceus*), red brome (*Bromus madritensis*), wild barley (*Bromus hordeaceus*), and foxtail fescue (*Festuca megalura*). Common forbs include broadleaf filaree (*Erodium spp.*), red stem filaree (*Erodium spp.*), turkey mullein (*Eremocarpus setigerus*), clovers (*Trifolium spp.*), and many others. The majority of these plants are not native to the project area.

Riparian recruitment and establishment models (Mahoney and Rood 1998; Bradley and Smith 1986) and empirical field studies (Scott et al. 1997, 1999) emphasize that hydrologic and fluvial processes play a central role in controlling the elevational and lateral extent of riparian plant species. These processes are especially important for pioneer species that establish in elevations close to the active channel, such as cottonwood and willows (*Salix spp.*). Failure of cottonwood recruitment and establishment is attributed to flow alterations by upstream dams (Roberts et al. 2001) and to isolation of the historic floodplain from the river channel. In addition, many of these formerly wide riparian corridors are now narrow and interrupted by levees and weirs. Finally, draining of wetlands, conversion of floodplains to agricultural fields, and intentional and unplanned introduction of exotic plant species have altered the composition and associated habitat functions of many of the riparian communities that are able to survive under current conditions.

A key element of the environmental baseline is the construction of the Southport EIP which will occur between 2015 and 2021. The project will include a 1,900 foot long set-back levee, the

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breaching of the existing levee, and the seasonal inundation and restoration of approximately 120 acres of historic floodplain habitat.

Although there are some short-term and small SAM modeled WRI deficits associated with Southport, the effects of these deficits are small, occur during seasons when fish abundance is low or they are not present at all, and is of short duration. In the case of fry and juvenile rearing and migration for all species, the SAM modeled WRI values show significant increases in the growth and survival of individuals, such that the incremental effects of the action are not expected to increase the extinction risk of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon and ESU CCV steelhead and green sturgeon DPS or reduce the conservation value of their designated critical habitat.

Furthermore, at the Southport EIP, the anticipated growth and survival of salmon, steelhead and green sturgeon rearing and juvenile migration are substantially positive and demonstrate how integrating NMFS high priority recovery actions, such as setback levee construction and restoration of floodplain habitat can contribute to an increase in the production and abundance of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon and ESU CCV steelhead and green sturgeon DPS.

### **2.3.1 Status of the Species in the Action Area**

The action area, which encompasses portions of the lower Sacramento River, the DWSC, Port of West Sacramento, and the Sacramento and Yolo bypasses, and associated floodplains and riparian areas at and adjacent to the proposed construction sites functions as a migratory corridor for CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, CCV steelhead, and sDPS of North American green sturgeon. The action area is also used for rearing and adult feeding.

#### **1. Presence of CCV Steelhead in the Action Area**

The CCV steelhead DPS final listing determination was published on January 5, 2006 (71 FR 834) and included all naturally spawned populations of steelhead (and their progeny) downstream of natural and manmade barriers in the Sacramento and San Joaquin rivers and their tributaries. FRFH steelhead are also included in this designation. All adult CCV steelhead originating in the Sacramento River watershed will have to migrate through the action area in order to reach their spawning grounds and to return to the ocean following spawning. Likewise, all CCV steelhead smolts originating in the Sacramento River watershed will also have to pass through the action area during their emigration to the ocean. The waterways in the action area also are expected to provide some rearing benefit to emigrating steelhead smolts. The CCV steelhead DPS occurs in both the Sacramento River and the San Joaquin River watersheds. However the spawning population of fish is much greater in the Sacramento River watershed and accounts for nearly all of the DPS' population.

CCV steelhead smolts will first start to appear in the action area in November. This is based on the records from the CVP and SWP fish salvage facilities, as well as the fish monitoring program in the northern and central Delta. Their presence increases through December and January, peaks

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in February and March, and declines in April. By June, the emigration has essentially ended, with only a small number of fish being salvaged through the summer at the CVP and SWP. Adult steelhead are expected to move through the action area throughout the year with the peak of upriver immigration expected to occur August through November. There is potential exposure to adult steelhead moving back downstream in a post-spawn condition (kelts) through the action area during the February to May period. It is expected that more kelts will be observed earlier in the period (February) due to the timing of spawning in the Sacramento River basin.

Based on the temporal presence of adult and juvenile steelhead in the lower Sacramento River, the timing of the proposed project, and the location of the action area, it is likely that adult steelhead will be using the action area as a migration corridor during construction. Additionally, it is likely that juvenile steelhead may be emigrating through the action area during construction. Depending on the water year type and the timing of high flows in the Sacramento River basin, adult and/or juvenile CCV steelhead may be present in the Yolo Bypass and the Sacramento Bypass. It is possible that any CCV steelhead (particularly adults) that are in the Delta may enter into the DWSC and the subsidiary bays.

## 2. Presence of CV spring-run Chinook salmon in the Action Area

A similar application of the CVP and SWP salvage records and the northern and Central Delta fish monitoring data to the presence of CV spring-run Chinook salmon indicates that juvenile spring-run Chinook salmon first begin to appear in the action area in December and January, but that a significant presence does not occur until March and peaks in April. By May, the salvage of juvenile CV spring-run Chinook salmon declines sharply and essentially ends by the end of June. The data from the northern and central Delta fish monitoring programs indicate that a small proportion of the annual juvenile spring-run emigration occurs in January and is considered to be mainly composed of older yearling spring-run juveniles based on their size at date. Adult spring-run Chinook salmon are expected to start entering the action area in approximately January. Low levels of adult migration are expected through early March. The peak of adult spring-run Chinook salmon movement through the action area is expected to occur between April and June with adults continuing to enter the system through the summer. Currently, all known populations of CV spring-run Chinook salmon inhabit the Sacramento River watershed.

Based on the temporal presence of CV spring-run Chinook salmon in the lower Sacramento River, the timing of the proposed project, and the location of the action area, it is likely that adult and juvenile CV spring-run Chinook salmon will be using the action area. Depending on the water year type and the timing of high flows in the Sacramento River basin, adult and/or juvenile CV spring-run Chinook salmon may be present in the Yolo Bypass and the Sacramento Bypass. It is possible that any CV spring-run Chinook salmon (particularly adults) that are in the Delta may enter into the DWSC and the subsidiary bays.

## 3. Presence of Sacramento River winter-run Chinook salmon in the Action Area

The temporal occurrence of Sacramento River winter-run Chinook salmon smolts and juveniles within the action area are best described by a combination of the salvage records of the CVP and SWP fish collection facilities and the fish monitoring programs conducted in the northern and

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central Delta. Based on salvage records at the CVP and SWP fish collection facilities, juvenile Sacramento River winter-run Chinook salmon are expected in the actions area starting in December. Their presence peaks in March and then rapidly declines from April through June. The majority of winter-run juveniles will enter the action area during February through June. Presence of adult Chinook salmon is interpolated from historical data. Adult winter-run Chinook salmon are expected to enter the action area starting in January, with the majority of adults passing through the action area between February and April.

Based on the temporal presence of Sacramento River winter-run Chinook salmon in the lower Sacramento River, the timing of the proposed project, and the location of the action area, it is likely that adult and juvenile Sacramento River winter-run Chinook salmon will be using the action area. Depending on the water year type and the timing of high flows in the Sacramento River basin, adult and/or juvenile Sacramento River winter-run Chinook salmon may be present in the Yolo Bypass and the Sacramento Bypass. It is possible that any Sacramento River winter-run Chinook salmon (particularly adults) that are in the Delta may enter into the DWSC and the subsidiary bays.

#### 4. Presence of North American green sturgeon in the Action Area

The Sacramento River is an important migratory corridor for larval and juvenile sturgeon during their downstream migration to the San Francisco Bay Delta and Estuary. The San Francisco Bay Delta and Estuary provides year-round rearing habitat for juveniles, as well as foraging habitat for non-spawning adults and subadults in the summer months (NMFS 2008).

Detailed information regarding historic and current abundance, distribution and seasonal occurrence of North American green sturgeon in the action area is limited due to a general dearth of green sturgeon monitoring. The action area is located on the main migratory route for adults moving upstream to spawn, post spawn adults migrating back to the ocean, juvenile outmigrants, and rearing subadults. Juvenile green sturgeon from the sDPS are routinely collected at the SWP and CVP salvage facilities throughout the year. Based on the salvage records, green sturgeon may be present during any month of the year, and have been particularly prevalent during July and August. Adult green sturgeon begin to enter the Delta in late February and early March during the initiation of their upstream spawning run. The peak of adult entrance into the Delta appears to occur in late February through early April with fish arriving upstream in April and May. Adults continue to enter the Delta until early summer (June-July) as they move upriver to spawn. It is also possible that some adult green sturgeon will be moving back downstream in April and May through the action area, either as early post spawners or as unsuccessful spawners. Some adult green sturgeon have been observed to rapidly move back downstream following spawning, while others linger in the upper river until the following fall. It is possible that any of the adult or sub-adult sturgeon that inhabit the Delta may swim into the DWSC.

Similar to the salmonid species, depending on the water year type, it is possible that sturgeon will enter the Sacramento and Yolo bypass.

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### 2.3.2 Status of Critical Habitat within the Action Area

The action area occurs within the CALWATER Hydrologic Unit (HU) for the Sacramento Delta Subbasin, designated HU 5510. Designated critical habitat for Sacramento River winter-run Chinook salmon (June 16, 1993, 58 FR 33212), CV spring-run Chinook salmon (September 2, 2005, 70 FR 52488), CCV steelhead (September 2, 2005, 70 FR 52488) and the sDPS of green sturgeon (October 9, 2009, 74 FR 52300) occur in this hydrologic unit. The HU includes portions of the Sacramento River and the DWSC. The critical habitat analytical review team (CHART) concluded that it contained one or more PCEs for both the CCV steelhead DPS and CV spring-run Chinook salmon ESU (NMFS 2005). The PCEs for steelhead and spring-run Chinook salmon habitat within the action area include freshwater rearing habitat and freshwater migration corridors. The features of the PCEs included essential to the conservation of the CCV steelhead DPS and CV spring-run Chinook salmon include the following: sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions necessary for salmonid development and mobility, sufficient water quality, food and nutrients sources, natural cover and shelter, migration routes free from obstructions, no excessive predation, holding areas for juveniles and adults, and shallow water areas and wetlands. Habitat within the action area is primarily utilized for freshwater rearing and migration by CCV steelhead and CV spring-run Chinook salmon juveniles and smolts and for adult freshwater migration. No spawning of CCV steelhead or CV spring-run Chinook salmon occurs within the action area.

Critical habitat for winter-run Chinook salmon includes the Sacramento River reach within the action area. Critical habitat elements include the river water, river bottom, and adjacent riparian zone used by fry and juveniles for rearing. Downstream migration of juveniles and upstream migration of adults should not be impeded or blocked. Adequate forage base is required to provide food for emigrating juvenile winter-run.

In regards to the designated critical habitat for the sDPS of green sturgeon, the action area includes PCEs concerned with: adequate food resources for all life stages; water flows sufficient to allow adults, subadults, and juveniles to orient to flows for migration and normal behavioral responses; water quality sufficient to allow normal physiological and behavioral responses; unobstructed migratory corridors for all life stages; a broad spectrum of water depths to satisfy the needs of the different life stages present in the estuary; and sediment with sufficiently low contaminant burdens to allow for normal physiological and behavioral responses to the environment.

The general condition and function of the aquatic habitat has already been described in the *Status of the Species and Critical Habitat* section of this BO. The substantial degradation over time of several of the essential critical elements has diminished the function and condition of the freshwater rearing and migration habitats in the action area. It has only rudimentary functions compared to its historical status. The channels of the lower Sacramento River have been riprapped with coarse stone slope protection on artificial levee banks and these channels have been straightened to enhance water conveyance through the system. The extensive riprapping and levee construction has precluded natural river channel migrations. The natural floodplains have essentially been eliminated, and the once extensive wetlands and riparian zones have been “reclaimed” and subsequently drained and cleared for farming.

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Even though the habitat has been substantially altered and its quality diminished through years of human actions, its conservation value remains high for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. All juvenile winter-run and spring-run Chinook salmon, sDPS green sturgeon, as well as those CCV steelhead smolts originating in the Sacramento River basin must pass into and through the Sacramento Delta HU to reach the lower Delta and the ocean. A large fraction of these fish will likely pass downstream through the action area within the Sacramento River channel. Likewise, adults migrating upstream to spawn must pass through Sacramento Delta HU to reach their upstream spawning areas on the tributary watersheds or main stem Sacramento River. A large proportion of the population is expected to move through the action area within the main channel of the Sacramento River. Therefore, it is of critical importance to the long-term viability of the Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon ESUs, the sDPS of green sturgeon, and the Sacramento River basin portion of the CCV steelhead DPS to maintain a functional migratory corridor and freshwater rearing habitat through the action area and the Sacramento Delta subbasin HU in general.

### **2.3.4 Factors Affecting the Species and Habitat in the Action Area**

The action area encompasses a small portion of the area utilized by the Sacramento River winter-run and CV spring-run Chinook salmon ESUs, and the CCV steelhead DPS as well as the sDPS of North American green sturgeon. Many of the factors affecting these species throughout their range are discussed in the *Rangewide Status of the Species and Critical Habitat* section of this BO, and are considered the same in the action area. This section will focus on the specific factors in the action area that are most relevant to the proposed project.

The magnitude and duration of peak flows during the winter and spring are reduced by water impoundment in upstream reservoirs affecting listed salmonids in the action area. Instream flows during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies. Overall, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices require peak flood discharges to be held back and released over a period of weeks to avoid overwhelming the flood control structures downstream of the reservoirs (*i.e.* levees and bypasses). Consequently, managed flows in the main stem of the river often truncate the peak of the flood hydrograph and extended the reservoir releases over a protracted period. These actions reduce or eliminate the scouring flows necessary to mobilize gravel and clean sediment from the spawning reaches of the river channel.

High water temperatures also limit habitat availability for listed salmonids in the lower Sacramento River. High summer water temperatures in the lower Sacramento River can exceed 72°F (22.2°C), and create a thermal barrier to the migration of adult and juvenile salmonids (Kjelson *et al.* 1982). In addition, water diversions at the dams (*i.e.* Friant, Goodwin, La Grange, Folsom, Nimbus, and other dams) for agricultural and municipal purposes have reduced in-river flows below the dams. These reduced flows frequently result in increased temperatures during the critical summer months which potentially limit the survival of juvenile salmonids in these tailwater sections (Reynolds *et al.* 1993). The elevated water temperatures compel many salmon juveniles to migrate out of the valley floor systems before summer heat makes the tailwaters

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unsuitable for salmonids. Those fish that remain either succumb to the elevated water temperatures or are crowded into river reaches with suitable environmental conditions.

Levee construction and bank protection have affected salmonid habitat availability and the processes that develop and maintain preferred habitat by reducing floodplain connectivity, changing riverbank substrate size, and decreasing riparian habitat and shaded riverine aquatic (SRA) cover. Individual bank protection sites typically range from a few hundred to a few thousand linear feet in length. Such bank protection generally results in two levels of impacts to the environment: (1) site-level impacts which affect the basic physical habitat structure at individual bank protection sites; and (2) reach-level impacts which are the accumulative impacts to ecosystem functions and processes that accrue from multiple bank protection sites within a given river reach. Revetted embankments result in loss of sinuosity and braiding and reduce the amount of aquatic habitat. Impacts at the reach level result primarily from halting erosion and controlling riparian vegetation. Reach-level impacts which cause significant impacts to fish are reductions in new habitats of various kinds, changes to sediment and organic material storage and transport, reductions of lower food-chain production, and reduction in large woody debris (LWD).

The use of rock armoring limits recruitment of LWD (*i.e.*, from non-riprapped areas), and greatly reduces, if not eliminates, the retention of LWD once it enters the river channel. Riprapping creates a relatively clean, smooth surface which diminishes the ability of LWD to become securely snagged and anchored by sediment. LWD tends to become only temporarily snagged along riprap, and generally moves downstream with subsequent high flows. Habitat value and ecological functioning aspects are thus greatly reduced, because wood needs to remain in place to generate maximum values to fish and wildlife. Recruitment of LWD is limited to any eventual, long-term tree mortality and whatever abrasion and breakage may occur during high flows. Juvenile salmonids are likely being impacted by reductions, fragmentation, and general lack of connectedness of remaining near shore refuge areas.

Point and non-point sources of pollution resulting from agricultural discharge and urban and industrial development occur upstream of, and within the action area. The effects of these impacts are discussed in detail in the *Rangewide Status of the Species and Critical Habitat* section. Environmental stressors as a result of low water quality can lower reproductive success and may account for low productivity rates in fish (*e.g.* green sturgeon, Klimley 2002). Organic contaminants from agricultural drain water, urban and agricultural runoff from storm events, and high trace element (*i.e.* heavy metals) concentrations may deleteriously affect early life-stage survival of fish in the Sacramento River (USFWS 1995). Principle sources of organic contamination in the Sacramento River are rice field discharges from Butte Slough, Reclamation District 108, Colusa Basin Drain, Sacramento Slough, and Jack Slough (USFWS 1995). Other impacts to adult migration present in the action area, such as migration barriers, water conveyance factors, water quality, NIS, *etc.*, are discussed in the *Rangewide Status of the Species and Critical Habitat* section.

As previously stated in the *Rangewide Status of the Species and Critical Habitat* section, the transformation of the Sacramento River from a meandering waterway lined with a dense riparian corridor, to a highly leveed system under varying degrees of control over riverine erosional

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processes resulted in homogenization of the river, including effects to the river's sinuosity. These impacts likely included the removal of valuable pools and holding habitat for North American green sturgeon. In addition, the change in the ecosystem as a result of the removal of riparian vegetation and LWD likely reduce access to floodplain and offchannel rearing habitat, reduced the quantity and quality of benthic habitat and reduced the abundance prey items rearing, foraging and holding habitat. A major factor in the decline of sDPS green sturgeon, and the primary reason for listing this species, was the alteration of its adult spawning and larval rearing habitat in California's Sacramento River Basin (71 FR 17757, April 7, 2006).

## **2.4 Effects of the Action**

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

To evaluate the effects of the West Sacramento GRS, NMFS examined the potential proposed actions in the designated action areas. We analyzed construction-related impacts and the expected short- and long-term fish response to habitat modifications using the SAM. We also reviewed and considered the Corps proposed conservation measures. This assessment relied heavily on the information from the Corps BA developed for the West Sacramento GRS, and available monitoring data from other CV fish studies.

In general, the footprint for the West Sacramento Project consists of the flood risk management system protecting the city of West Sacramento and surrounding areas. This will include structure upgrades, levee deconstruction, and adjacent staging areas. The continued existence of any new or improved flood management structures, associated critical habitat disturbance, vegetation removal, and operational aspects may adversely affect several life stages of CV spring-run Chinook salmon, CCV steelhead, Sacramento River winter-run Chinook salmon, and the sDPS of North American green sturgeon in the action area.

The assessment will consider the nature, duration, and extent of the potential actions relative to the migration timing, behavior, and habitat requirements of federally listed CV spring-run Chinook salmon, CCV steelhead, Sacramento River winter-run Chinook salmon, and sDPS of North American green sturgeon. Specifically, this assessment will consider the potential impacts resulting from the construction and subsequent O&M activities. Effects of the West Sacramento Project on aquatic resources include both short- and long-term impacts. Short-term effects, which are related primarily to construction activities (*i.e.*, increased suspended sediment and turbidity), may last several hours to several weeks. Long-term impacts may last months or years and generally involve physical alteration of the river bank and riparian vegetation adjacent to the water's edge.

The West Sacramento Project construction activities may increase noise, turbidity, suspended sediment, and sediment deposition that may disrupt feeding or temporarily displace fish from preferred habitat or impair normal behavior. Construction activities will also introduce rip rap

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material into the water column that may injure, harm, or kill listed fish. Some of these effects may occur downstream of the construction activities because noise and sediment may be propagated downstream. Substantial increases in suspended sediment could temporarily bury substrates and submerged aquatic vegetation that supports invertebrates for feeding juvenile fish.

The bank armoring and some of the levee repairs will also contribute to the continued confinement of the riverine system that in turn negatively impacts listed fish species and their designated critical habitat. Even with an ETL variance in place, adopting the ETL as part of the proposed project may have long-term impacts to critical habitat and listed species. Additionally, despite the assumption of a variance, there are uncertainties as to the subsequent O&M activities and their impacts.

Since specific project designs were not available at the time of this analysis, impacts are characterized using “worst case scenario” assumptions. With-project conditions were assumed to be analogous a typical SRBPP repair site (bank armoring paired with onsite restoration features including a planted riparian bench and installed IWM). A Vegetation Variance Request (VVR) was assumed to be in place. Project actions along the Yolo Bypass, Sacramento Bypass, and DWSC, Port North, and Port South reaches, including slurry wall construction, slope stabilization, and levee raises were assumed to result in removal of all woody and herbaceous vegetation and armoring of both summer-fall and winter-spring shorelines.

The West Sacramento project reach will be implemented in increments. The timing of each project sub-reach (Table 3) is based on the proposed schedule provided in the BA (USACE 2014). Some of the project increments will be of varying length, thereby impacting the subsequent analysis.

#### **2.4.1 Construction Related Effects**

NMFS expects that adult and juvenile CCV steelhead, adult winter-run Chinook salmon, adult spring-run Chinook salmon, and adult and juvenile green sturgeon may be present in the action area (although in low numbers because the construction window avoids periods of peak abundance) during construction activities. Only those fish that are holding adjacent to or migrating past the Southport EIP sites will be directly exposed or affected by construction activities. Those fish that are exposed to the effects of construction activities will encounter short-term (*i.e.*, minutes to hours) construction-related noise, physical disturbance, and water quality changes that may cause injury or harm by increasing the susceptibility of some individuals to predation by temporarily disrupting normal behaviors, and affecting sheltering abilities. If an adult salmonid were to enter the action area, they will likely exhibit avoidance behavior in response to construction and associated activities.

Larger fish will likely respond to construction activities by quickly swimming away from the construction sites, and will escape injury. Toxic substances used at construction sites, including gasoline, lubricants, and other petroleum-based products could enter the waterway as a result of spills or leakage from machinery and injure listed salmonids, and green sturgeon. Petroleum products also tend to form oily films on the water surface that can reduce DO available to aquatic

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organisms. NMFS expects that adherence to BMPs that dictate the use, containment, and cleanup of contaminants will minimize the risk of introducing such products to the waterway.

Green sturgeon move to estuaries and the lower reaches of rivers between late winter and early summer, and ascend rivers to spawn in the spring and early summer. Adult green sturgeon may leave the rivers soon after spawning or hold in the river through the fall or winter (Heublein et al. 2009). Movement and foraging during downstream migration occurs at night for both larvae (approximately 10 days post-hatch) and juveniles (73 FR 52084; Cech *et al.* 2000, as cited in Reclamation 2008). Juvenile emigration reportedly occurs from May through September. Juvenile will experience the greatest exposure to construction activities.

Direct effects are defined as “the direct or immediate effects of the Proposed Action on the species or its habitat” (USFWS and NMFS, March 1998). Direct effects associated with in-river construction work will involve equipment and activities that will produce pressure waves, and create underwater noise and vibration, thereby temporarily altering in-river conditions.

Any increases in turbidity will most likely disrupt feeding and migratory behavior activities of juvenile salmonids (though their abundance is expected to be low). Turbidity and sedimentation events are not expected to affect visual feeding success of green sturgeon, as they are not believed to utilize visual cues (Sillman *et al.* 2005). Green sturgeon, which can occupy waters containing variable levels of suspended sediment and thus turbidity, are not expected to be impacted by the slight increase in the turbidity levels anticipated from the pile driving action as explained above. The construction activities are unlikely to impact any deepwater areas where the species spawn and hold.

NMFS expects that actual physical damage or harassment to listed fish species will be low during the months of construction. Adults will not sustain any physical damage due to construction because their size, preference for deep water, and their crepuscular migratory behavior will enable them to avoid most temporary, nearshore disturbance that occurs during typical daylight construction hours.

#### **2.4.2 Standard Assessment Methodology Analysis**

West Sacramento Project impacts were analyzed using SAM. The Corps provided the background data, assumptions, analyses, and assessment of habitat compensation requirements for the federally protected fish species relevant to this consultation. The Corps also included analysis for fall-run and late-fall run Chinook salmon.

The Sacramento River SAM analysis reach includes the entire right bank (west side) of the Sacramento River from the Sacramento Bypass to the confluence of the Sacramento River and the old Stone Locks near the Port of Sacramento. This reach also includes the short cut-off levee described as part of the Port South phase of the project. The response of all runs of Chinook salmon, steelhead, and green sturgeon were included in the analysis of this reach.

As described in the *Analytical Approach* section of the BO, during the process of this consultation, the Corps and NMFS identified several short comings with the SAM as a tool for

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reliably forecasting the growth and survival of green sturgeon. The primary short coming is that the SAM evaluates habitat conditions at the seasonal water surface intersect with the river bank. While this is considered an effective point for measuring salmon and steelhead habitat, green sturgeon have a greater affinity for benthic habitat than shoreline habitat. Further, during discussions between the Corps and NMFS, it was widely agreed upon that levee repair actions in the West Sacramento Study Area are likely to only affect the juvenile rearing life stage and probably have little to no adverse impacts on the adult life stages of green sturgeon because spawning habitat is not present and adults that are migrating upstream are probably more influenced by impacts that affect swimming speed and upstream passage than shoreline habitat manipulations. Because of this, NMFS has decided to use the SAM as a temporary proxy for quantifying habitat disturbance and harm that will ultimately be replaced by a more precise model as proposed by the Corps in the *Proposed Action* section of this BO.

The following data sources were used to characterize SAM habitat conditions (as defined by bank slope, floodplain availability, substrate size, instream structure, aquatic vegetation, and overhanging shade) within the West Sacramento Project area under baseline conditions:

1. The Corps' Sacramento River revetment database.
2. Aerial images of the West Sacramento Project reach (Google™ Earth).

The SAM employs six habitat variables to characterize near-shore and floodplain habitats of listed fish species:

1. Bank slope;
2. Floodplain availability;
3. Bank substrate size;
4. Instream structure;
5. Aquatic vegetation; and
6. Overhanging shade.

The following describes how input values for each of these attributes were derived for existing conditions in the SAM assessment.

1. **Bank Slope:** Existing bank slopes (rise-over-run ratio) were extrapolated from cross sections along the Sacramento River and existing SAM analyses performed on regionally analogous sites. Bank slope along all sub-reaches was assumed to be 2.5 for existing conditions.
2. **Floodplain Availability:** The SAM attribute of floodplain inundation ratio, which represents floodplain availability, was assumed to have a value of 1, reflecting the absence of significant floodplain habitat above the winter-spring shoreline under existing conditions.
3. **Bank Substrate Size:** The median substrate size along the summer-fall and winter-spring shorelines of the project reach was determined by referencing the Revetment Database (USACE 2004) and current and historical aerial images.

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4. **Instream Structure:** The shoreline coverage of IWM along the average summer-fall and winter-spring shorelines of the West Sacramento project reach were determined by referencing the revetment database (USACE 2004). The revetment database uses four classes of instream structure, based on ranges of percent shoreline having IWM.
  5. **Overhanging Shade:** The extent of overhanging shade along the summer-fall and winter-spring shorelines was determined through analysis of current and historic aerial images. Summer-fall conditions were analyzed using imagery from late summer and early fall months, typically representative of low water conditions. Winter-spring conditions were analyzed using imagery from late winter and early spring months, typically representative of high water conditions.

The following describes how input values for each of the SAM habitat attributes were derived for with-project conditions:

1. **Bank Slope:** With-project bank slopes (rise-over-run ratio) were based on the description of project actions for each sub-reach. Bank slopes for the SAC sub-reach were assumed to be analogous to SRBPP repair sites.
2. **Floodplain Availability:** Levee repair and bank stabilization actions typically do not increase floodplain availability (with exception of constructing setback levees). The West Sacramento project reaches being analyzed under this SAM do not include construction of any setback levees; therefore, the SAM attribute of floodplain inundation ratio, which represents floodplain availability, was assumed to lack significant floodplain habitat above the winter-spring shoreline under existing conditions.
3. **Bank Substrate Size:** The median substrate size along the summer-fall and winter-spring shorelines of the project reach were based on the description of project actions for each reach. Bank substrate size along the Sacramento River reach was assumed to be analogous to SRBPP repair sites. Project actions at all other sub-reaches were expected to result in placement of 10 inch rock revetment along both summer-fall and winter-spring shorelines.
4. **Instream Structure:** The shoreline coverage of IWM along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. IWM coverage along the SAC sub-reach was assumed to be analogous to SRBPP repair sites (installation of 40 percent shoreline coverage at summer-fall shoreline). Project actions at all other sub-reaches were not expected to result in a change in available IWM along both summer-fall and winter-spring shorelines; IWM values for these sub-reaches will mirror existing condition values.
5. **Aquatic Vegetation:** The shoreline coverage of aquatic vegetation along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. Aquatic vegetation along the Sacramento River was assumed to be analogous to SRBPP repair sites. The vegetation growth model below

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that was applied to the Sacramento River was taken from a previous SAM analysis conducted for Sacramento RM 62.5R (USACE 2008).

- 6. Overhanging Shade:** The shoreline coverage of overhanging shade along the average summer-fall and winter-spring shorelines was based on the description of project actions for each sub-reach. Overhanging shade along the Sacramento River was assumed to be analogous to SRBPP repair sites. It was assumed that a variance will be in place allowing for retention of woody vegetation along the lower 2/3 of the levee slope (applies to Sacramento River only). As the result of constructing a planted bench, it was assumed that the with-project seasonal shoreline will be shifted away from the existing shade providing canopy. Under this assumption, existing summer-fall values for overhanging shade were taken as the starting point for with-project winter-spring conditions. The with-project winter-spring values were further reduced by 75 percent (winter) and 25 percent (spring) to account for defoliation. As a final step, these winter-spring values were reduced by 20 percent to account for trees removed for construction equipment access. With-project overhanging shade values were expected to start at 0 percent as the result of a constructed bench shifting the shoreline away from the existing canopy. The shade growth model used was taken from a previous SAM analysis conducted for Sacramento RM 62.5R (USACE 2008).

Project actions at all other sub-reaches were expected to result in a complete removal of woody vegetation without revegetation efforts. For these sub-reaches, a value of 0 percent shoreline coverage of overhanging shade was applied throughout the life of the project along both summer-fall and winter-spring shorelines.

Portions of the proposed project area were excluded from the SAM analysis. The South Cross levee was excluded because it lacked hydrologic connectivity to the surrounding river and does not provide fish habitat. Several portions of the DWSC, Port South Levee, and Port North Levee were excluded because the levees are set back from the shoreline and project actions are not expected to affect shoreline habitat. A portion of the lower Sacramento River, immediately north of the Southport EIP portion of the project, was excluded because it is currently being repaired as part of the SRBPP. For more information on the SAM analysis, refer to the Appendix G of the BA (Corps 2014).

### 2.4.3 SAM Results

The SAM results presented below and in Table 10 and 11 are based on a “worst case scenario” analysis, as developed by the Corps. Table 10 and 11 show negative WRI values, but there are several areas where the action will result in improved conditions for salmon and steelhead. These are discussed below, and are summarized in the Corps BA in Appendix G, Table 42. The with-project conditions for the focus fish species and life stages were evaluated over a 50-year assessment timeline with baseline habitat values for each species and life stage described by pre-project conditions. Biological responses of each focus fish species life stage and average seasonal water surface elevation were predicted within each habitat unit and for each time step, based on habitat variable values and fish residency determined *West Sacramento Project SAM Analysis October 2014* from region-specific timing tables (USACE 2012b). This analysis

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automatically includes or excludes particular life stages of the focus fish by assessing the river mile locations of each bank repair site, with the encoded timing tables. In general, as calculated, positive differences between the existing and with-project responses are considered to result in improved growth and survival for the focus fish species (i.e., the bank repair action produced superior conditions than pre-project conditions). Negative values indicate the bank repair actions produced inferior conditions when compared with pre-project conditions and reduced growth and survival over a 30 day exposure period. In almost all cases, regardless of the integrated conservation and compensation measures (i.e., installation of IWM, planting riparian habitat, and construction of engineered floodplain) there is a short-term temporal negative habitat impact associated with many of the bank repair activities, mainly because new levee configurations move the river bank away from existing, protected riparian vegetation and because it takes several years for newly planted riparian vegetation to growth out over the river channel and create overhanging shade and other benefits to aquatic habitat such as a source of macroinvertebrate production.

### **Sacramento River**

NMFS reviewed the SAM results provided by the Corps. Details of the SAM results can be found in Appendices E-G of the BA (Corps 2014) and in the main content of the BA. This includes tables and graphs of the SAM results from year 0 (beginning of construction) to year 50. Table 10 summarizes all negative West Sacramento Project SAM WRI values for Chinook salmon, steelhead, and green sturgeon. It is important to note that when interpreting SAM results, year 0 refers to the year of construction.

The impacts will occur along approximately 5.5 miles of the west bank of the Sacramento River and an revetment will cover at least 17 acres of small substrate benthic habit (assuming that an average revetment width of 25 feet below the fall water surface elevation. The main factors driving SAM deficits are the short-term reduction in riparian habitat and instream woody material, and the conversion of small substrate to rock revetment. For sturgeon, the most significant habitat change affecting SAM results is the conversion of small substrate to revetment. For salmon and steelhead, conditions improve over time after IWM is placed at the site and the end of construction, and as riparian habitat matures.

### **Summary of CV spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, CCV steelhead and sDPS green sturgeon effects by water surface elevation:**

#### ***At fall water surface elevations:***

Reduced growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead are expected for up to 10 years after any construction activities associated with the West Sacramento Project due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effects are greatest in year 6 for each species at -85 WRI, -85, and -122, respectively, and is reduced to -24, -24, and -11, respectively, by year 10. Following year 10, the SAM modeled habitat conditions exceed baseline conditions and

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improved growth and survival conditions are expected. By year 50, improved conditions for fry and juvenile and juvenile migration rearing reach 451 above baseline.

Reduced growth and survival of juvenile migrating (smolts) CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 15 years after any construction activities associated with the West Sacramento Project due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this adverse effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 7 for each species at -774 WRI, -774, and -777, respectively, and is reduced to -335, -335, and -441, respectively, by year 15. Between years 15 and 25, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival conditions are expected. By year 50, improved conditions for fry and juvenile and juvenile migration rearing reach 565 ft above baseline.

Shoreline habitat conditions for fry and juvenile rearing sDPS green sturgeon is expected to improve for the life of the project compared to baseline. The improved conditions begin at year 0 (immediately after construction) and increase to 1,521 WRI by year 50.

Shoreline habitat conditions from levee repairs could adversely affect the growth and survival of juvenile migrating green sturgeon for at least 50 years after any construction activities associated with the West Sacramento Project due to impacts associated with changes in bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this adverse effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect starts at year 6 at -53 WRI and reaches -650 WRI and does not recover over the life of the project.

***At winter water surface elevations:***

Reduced survival of adult migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -627 WRI, and -1,235, respectively, and is reduced to -72, -72, and -93, respectively, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and improved survival is expected. After year two, survival will increase over baseline from 121 at year 3 to 430 feet at year 50.

Reduced growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 1 year after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -183 WRI, -183, and -349, respectively, and is reduced to -2 for CCV steelhead by year 2. Following year 1 (and year 2 for CCV steelhead), the SAM modeled habitat

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conditions exceed baseline conditions improved growth and survival is expected. After year one, survival and growth values improve to 42 at year one for salmon and 416 by year two for steelhead, and reach 3,882 for salmon and 2,642 for steelhead by year 50.

Reduced growth and survival of juvenile migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -2,392 WRI, -2,392, and -1,972, respectively, and is reduced to -272, -272, and -282, respectively, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected. After year two, survival and growth values improve to 492 for salmon and 319 by year three for steelhead, and reach 3,882 for salmon and 2,646 for steelhead by year 50.

Reduced survival of adult resident CCV steelhead (kelts) is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this adverse effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 at -1,235 WRI, and is reduced to -93, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and improved survival is expected. After year two, survival and growth values improve to 302 for steelhead, and reach 1,578 for steelhead by year 50.

Shoreline habitat conditions from levee repairs could adversely affect the growth and survival of fry and juvenile rearing sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The adverse effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect reaches -2,264 WRI at year 0 and does not recover over the life of the project. The SAM value is -317 at year 50.

***At spring water surface elevations:***

The SAM displays reduced survival of adult migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 3 years (2 years for CCV steelhead) after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this adverse effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -773 WRI, -773, and -1,464, respectively, and is reduced to -67, -67, and -377, respectively, by year 3 (year 2 for CCV steelhead). These effects are considered to be insignificant because, although modeled as a result of a reduction in IWM and riparian habitat, the actual survival of adults is unlikely to be affected because there will be no increase in predation, and the upstream migration will not be impeded by any structural features that influence upstream migration. Following year 3 (year 2 for CCV steelhead), the SAM modeled habitat conditions exceed baseline conditions and improved survival is expected. Following year 2, the SAM modeled habitat conditions exceed baseline

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conditions and improved survival is expected. After year two, survival will increase over baseline from 74 at year 4 to 707 at year 50.

Reduced growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 1 year after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -316 WRI, -316, and -550, respectively, and is reduced to -57, -57 and -213, respectively, by year 1. Following year 1, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected. After year one, survival and growth values improve to 330 at year two for salmon and 335 for steelhead, and reach 2,228 for salmon and 2,813 for steelhead by year 50.

Reduced growth and survival of fry and juvenile migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -2,639 WRI, -2,639, and -2,206, respectively, and is reduced to -312, -312, and -455, respectively, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected. After year one, survival and growth values improve to 586 at year three for salmon and 225 for steelhead, and reach 4,104 for salmon and 2,841 for steelhead by year 50.

Reduced survival of adult resident CCV steelhead is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 at -1,464 WRI, and is reduced to -377, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions improved survival is expected. Following year 2, the SAM modeled habitat conditions exceed baseline conditions improved survival. After year two, survival and growth values improve to 330 for steelhead, and reach 4,104 for steelhead by year 50.

Shoreline habitat conditions from levee repairs could adversely affect the growth and survival of fry and juvenile rearing sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The effects are quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of the adverse effect is -2,264 WRI at year 0 and does not recover over the life of the project. The SAM value is -317 at year 50.

Shoreline habitat conditions from levee repairs could adversely affect the growth and survival of juvenile migrating sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The effects are quantified in the SAM table 42 of the 2014 Corps BA and

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summarized in Table 10 of this BO. The adverse effect reaches -650 WRI at year 50 and does not recover over the life of the project.

***At summer water surface elevations:***

Reduced survival of adult migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -847 WRI, -847, and -1,644, respectively, and is reduced to -34, -34, and -18, respectively, by year 10, 11, 15. Following year 10, 10 and 6, the SAM modeled habitat conditions exceed baseline conditions and improved survival is expected. The maximum benefits are displayed in table 10.

Reduced growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 11 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 1 for each species at -168, WRI, -168, and -315, respectively, and is reduced to -24, -11, and -11 respectively, for each species. Following year 11 the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected. After year one, survival and growth values improve to 445, 445 and 871.

Reduced growth and survival of juvenile migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 for each species at -2,392 WRI, -2,392, and -1,972, respectively, and is reduced to -272, -272, and -282, respectively, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and improved growth and survival is expected. After year two, survival and growth values improve to 492 for salmon and 319 by year three for steelhead, and reach 3,882 for salmon and 2,646 for steelhead by year 50.

Reduced survival adult residence CCV steelhead is expected for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The amount and extent of this adverse effect is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect is greatest in year 0 at -1,235 WRI, and is reduced to -93, by year 2.

Following year 2, the SAM modeled habitat conditions exceed baseline conditions and improved survival is expected. After year two, survival and growth values improve to 302 for steelhead, and reach 1,578 for steelhead by year 50.

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Shoreline habitat conditions from levee repairs could adversely affect the growth and survival of fry and juvenile rearing sDPS green sturgeon for at 3 years after project construction due to impacts to riparian habitat, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The effects are quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect reaches -1,544 WRI at year 0 and recovers by year 3.

Shoreline habitat conditions from levee repairs could adversely affect the growth and survival of juvenile migrating sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, and bank substrate size along 5.5 miles of the west bank of the Sacramento River. The effects are quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The adverse effect reaches -650 WRI at year 50 and does not recover over the life of the project.

### **Deep Water Ship Channel/Port**

Although not a primary migration corridor, the DWSC/Port are utilized by all species for rearing and upstream migration. The West Sacramento Ship Locks, as currently operated under a “decommissioned status”, block upstream migration of all species. The DWSC/Port are accessible and provide utilized habitat for juvenile migration, and fry and juvenile rearing life stages for salmon, steelhead and sturgeon due to tidal action in the north Delta.

In the DWSC/Port SAM analysis reach, SAM modeled habitat deficits occur for Chinook salmon for all life stages and all seasons, for the life of the project. As previously mentioned, NMFS assumes the same values for steelhead and values twice as high for green sturgeon. SAM modeled values never recover over baseline (Table 11 and Table 43 of Appendix G in the BA). These deficits are expected to cause a reduction in the growth and survival of all species and life stages, during all seasons, for 50 years after project construction due to loss of vegetation and overhanging shade as well as the armoring of the shoreline with rock revetment. Table 11 summarizes the maximum deficits for Chinook salmon, steelhead and green sturgeon. NMFS assessment of adverse effects to all species is summarized in the following paragraphs:

Reduced survival of adult migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for at least 50 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The adverse effect is greatest at year 50 at -316 WRI during fall, -124 during winter, -272 during spring, and -316 during summer.

Reduced growth and survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for at least 50 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The adverse effect is greatest at year 50 at -157 WRI during fall, -202 during winter, -299 during spring, and -157 during summer.

Reduced growth and survival of juvenile migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead is expected for at least 50 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The adverse effect is greatest at

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year 50 at -744 WRI during fall, -1,506 during winter, -1,709 during spring, and -744 during summer.

The SAM modelled fish response for green sturgeon shows slight improvements to fry and juvenile rearing at all seasonal water surface elevations and no change from baseline for juvenile migration and adult residence. This response is primarily due to the small footprint of in-channel levee repair actions in the DWSC/Port and that in-water repairs will reduce the bank substrate size compared to existing conditions.

The DWSC/Port are not natural aquatic features (they are anthropomorphic features) and currently are considered low quality for rearing, growth and migration, especially for salmon and steelhead. They are also not primary migration corridors for Chinook salmon, steelhead and green sturgeon, and considered to be low value for salmon and steelhead in their current form. Green sturgeon, however, may rear in freshwater and estuarine environments for 1 to four years and, although there are data gaps on how this species utilizes the Deep Water Ship Channel, it is likely that it is used for foraging and growth, and therefore important of the productivity of the species.

The Corps has proposed to offset the adverse effects in the Deep Water Ship Channel with onsite compensation at the Southport setback site and along other reaches of the Sacramento River within the West Sacramento River project, or through conservation credit purchases. These offsets are likely to improve growth and survival of Chinook salmon, steelhead at higher value habitats in the Delta and along their primary migration corridor of the Sacramento River.

### **Yolo Bypass**

The proposed action in the Yolo Bypass includes the construction of levee cutoff walls. Typically these do not result in effects to aquatic or nearshore riparian habitat. However, the ETL element of the action does not include a VVR and the Corps SAM analysis concludes that some vegetation may be removed during cutoff wall construction. Although riparian vegetation is not a key feature that drives juvenile fish survival and production in the bypass, it does play a role in shading the toe drain and providing structural recruitment to the toe drain and is an important element of aquatic macroinvertebrate breeding habitat adjacent to water bodies. The Corps additional conservation measures state that any disturbance or removal of vegetation will be replaced outside of the ETL vegetation free zone. This replacement will minimize the effect related to cutoff wall construction.

**Table 10: West Sacramento Project Maximum SAM Modeled WRI Deficits and Duration of Deficits by Species, Life-Stage, and Season**

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Values
<b>Spring-Run Chinook Salmon</b>				
Fall	Adult Migration	No Deficit	NA	1,004
	Fry and Juvenile Rearing	-85	10	451
	Juvenile Migration	-774	15	565
Winter	Adult Migration	-627	2	430
	Fry and Juvenile Rearing	-183	1	1,440
	Juvenile Migration	-2,392	2	3,882
Spring	Adult Migration	-773	3	707
	Fry and Juvenile Rearing	-316	2	2,228
	Juvenile Migration	-2,692	3	4,104
Summer	Adult Migration	-847	10	963
	Fry and Juvenile Rearing	-168	11	445
	Juvenile Migration	-1,696	15	508
<b>Winter-Run Chinook Salmon</b>				
Fall	Adult Migration	No Deficit	NA	1,004
	Fry and Juvenile Rearing	-85	10	451
	Juvenile Migration	-774	15	565
Winter	Adult Migration	-627	3	430
	Fry and Juvenile Rearing	-183	1	1,440
	Juvenile Migration	-2,392	3	3,882
Spring	Adult Migration	-773	3	707
	Fry and Juvenile Rearing	-316	2	2,228
	Juvenile Migration	-2,639	3	4,104
Summer	Adult Migration	-847	10	963
	Fry and Juvenile Rearing	-168	11	445

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## **Implementation of the Corps proposed Green Sturgeon Conservation Measures**

The implementation of the Corp's Green Sturgeon Conservation Measures will serve several purposes to address scientific uncertainty about the species in the study area and to provide compensatory mitigation for the adverse effects related to shoreline and benthic habitat impacts. The HMMP will ensure that adverse impacts of future West Sacramento projects are sufficiently compensated in order to allow for the growth, survival and recovery of the species in the study area. Coordination of the HMMP with the IEP will leverage green sturgeon scientific expertise to ensure selected mitigation actions fully address the micro- and macro-ecological and survival needs of the species in the study area. Refinement of the SAM or development of alternative green sturgeon survival and response model using the Corps' Hydrologic Ecosystem Function Model, in consultation with NMFS and the IEP, will result in new modeling capacity that more accurately evaluates adverse project actions and the beneficial effects of mitigation actions relative to the growth and survival of green sturgeon in the study area. Restoring and compensating for the number of acres and ecological function of impacted benthic habitat and the initiation of this compensatory mitigation in the study area prior to the commencement of levee construction will reduce the impact of levee construction actions. The development of SMART compensatory mitigation objectives will ensure that all of the ecological impacts of levee construction actions are fully addressed.

<b>CCV Steelhead</b>				
Fall	Adult Migration	No Deficit	NA	2,309
	Fry and Juvenile Rearing	-122	10	883
	Juvenile Migration	-777	15	559
	Adult Residence	No Deficit	NA	2,309
Winter	Adult Migration	-1,235	3	1,578
	Fry and Juvenile Rearing	-349	2	1,980
	Juvenile Migration	-1,973	3	2,646
	Adult Residence	-1,235	3	1,578
Spring	Adult Migration	-1,464	3	1,923
	Fry and Juvenile Rearing	-550	1	2,813
	Juvenile Migration	-2,206	3	2,841
	Adult Residence	-1,464	3	1,923
Summer	Adult Migration	-1,644	6	2,227
	Fry and Juvenile Rearing	-315	11	871
<b>Southern DPS Green Sturgeon</b>				
Fall	Fry and Juvenile Rearing	No Deficit	NA	1,661
	Juvenile Migration	-650	50+ years	No Benefit
Winter	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	-2,264	50+ years	No Benefit
	Adult Residence	-5,516	50+ years	No Benefit
Spring	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	-2,264	50+ years	No Benefit
	Juvenile Migration	-650	50+ years	No Benefit
	Adult Residence	NA	NA	NA
Summer	Adult Migration	-650	50+ years	No Benefit
	Fry and Juvenile Rearing	-1,544	3	1,447
	Juvenile Migration	-650	50+ years	No Benefit
	Adult Residence	NA	NA	NA

**Table 11: Deep Water Ship Channel / Port Maximum SAM modeled WRI Deficits and Duration of Deficits by Species, Life-Stage, and Season**

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)	Maximum WRI Values
<b>Spring-Run Chinook Salmon</b>				
Fall	Adult Migration	-316	50+ years	No Benefit
	Fry and Juvenile Rearing	-157	50+ years	No Benefit
	Juvenile Migration	-744	50+ years	No Benefit
Winter	Adult Migration	-124	50+ years	No Benefit
	Fry and Juvenile Rearing	-202	50+ years	No Benefit
	Juvenile Migration	-1506	50+ years	No Benefit
Spring	Adult Migration	-272	50+ years	No Benefit
	Fry and Juvenile Rearing	-299	50+ years	No Benefit
	Juvenile Migration	-1709	50+ years	No Benefit
<b>Winter-run Chinook Salmon</b>				
Fall	Adult Migration	-316	50+ years	No Benefit
	Fry and Juvenile Rearing	-157	50+ years	No Benefit
	Juvenile Migration	-744	50+ years	No Benefit
Winter	Adult Migration	-124	50+ years	No Benefit
	Fry and Juvenile Rearing	-202	50+ years	No Benefit
	Juvenile Migration	-1506	50+ years	No Benefit
Spring	Adult Migration	-272	50+ years	No Benefit
	Fry and Juvenile Rearing	-299	50+ years	No Benefit
	Juvenile Migration	-1709	50+ years	No Benefit
<b>CV Steelhead</b>				
Summer	Adult Migration	-505	50+ years	No Benefit
	Fry and Juvenile Rearing	-327	50+ years	No Benefit
	Juvenile Migration	-798	50+ years	No Benefit
	Adult Residence	-505	50+ years	No Benefit

Fall	Adult Migration	-504	50+ years	No Benefit
	Fry and Juvenile Rearing	-327	50+ years	No Benefit
	Juvenile Migration	-798	50+ years	No Benefit
	Adult Residence	-505	50+ years	No Benefit
Winter	Adult Migration	-232	50+ years	No Benefit
	Fry and Juvenile Rearing	-408	50+ years	No Benefit
	Juvenile Migration	-1328	50+ years	No Benefit
	Adult Residence	-232	50+ years	No Benefit
Spring	Adult Migration	-452	50+ years	No Benefit
	Fry and Juvenile Rearing	-574	50+ years	No Benefit
	Fry and Juvenile Rearing	-1544	50+ years	No Benefit
	Adult Residence	-452	50+ years	No Benefit
<b>Green Sturgeon</b>				
Fall	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	No Deficit	NA	108
	Fry and Juvenile Rearing	No Deficit	No Deficit	No Benefit
	Adult Residence	No Deficit	No Deficit	No Benefit
Winter	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	No Deficit	No Deficit	108
	Fry and Juvenile Rearing	No Deficit	No Deficit	No Benefit
	Adult Residence	No Deficit	No Deficit	No Benefit
Spring	NA	NA	NA	NA
	Fry and Juvenile Rearing	No Deficit	No Deficit	108
	Fry and Juvenile Rearing	No Deficit	No Deficit	No Benefit
	Adult Residence	NA	NA	NA
Summer	Adult Migration	NA	NA	NA
	Fry and Juvenile Rearing	No Deficit	No Deficit	108
	Fry and Juvenile Rearing	No Deficit	No Deficit	No Benefit
	Adult Residence	NA	NA	NA

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#### 2.4.4 Project Effects on Critical Habitat

For CV spring-run Chinook salmon and steelhead, the project generally will have short term impacts on the freshwater rearing and freshwater rearing PCEs of critical habitat. For winter-run Chinook salmon, and for winter-run Chinook salmon impacted essential features of critical habitat that will be affect include the river water, river bottom, and adjacent riparian zone used by fry and juveniles for rearing. The SAM model, which models fish response, also serves as a good proxy for measuring impact to these species critical habitat because it the model evaluates changes to important attributes of PCEs and essential features including overhanging shade, substrate size, instream woody material, bank slope and instream aquatic vegetation. The changes to these features are recognized in Table 10 above. In general, impacts to critical habitat will generally last between 1 and 10 years, and in almost all cases they improve each year and eventually exceed baseline conditions over the life of the project. For these reasons, we do not expect the proposed action to reduce the conservation value of the critical habitat.

Because the proposed action occurs along the lower Sacramento River at the convergence of the north Delta, the action area includes both freshwater and estuarine habitat types. For green sturgeon, this means there are freshwater and estuarine including:

##### Freshwater

- a) Food resources. Abundant prey items for larval, juvenile, subadult, and adult life stages.
- b) Substrate type or size (*i.e.*, structural features of substrates). Substrates suitable for egg deposition and development (*e.g.*, bedrock sills and shelves, cobble and gravel, or hard clean sand, with interstices or irregular surfaces to “collect” eggs and provide protection from predators, and free of excessive silt and debris that could smother eggs during incubation), larval development (*e.g.*, substrates with interstices or voids providing refuge from predators and from high flow conditions), and feeding of juveniles, subadults, and adults (*e.g.*, sand/mud substrates).

##### Estuarine

- a) Food resources. Abundant prey items within estuarine habitats and substrates for juvenile, subadult, and adult life stages.

The Corps estimates that approximately 19 acres of soft substrate habitat below the ordinary high water mark will be permanently lost to rock revetment. This is a conceptual estimate that will be further refined during the preliminary engineering design (PED) phase before construction begins. This loss of habitat is expected to adversely affect benthic substrate and impair food resources for all life stages; and the quantity of sediment to allow for normal physiological and behavioral responses to the environment. Similar to salmon and steelhead, the SAM serves as a reasonable proxy for measuring impacts to critical habitat. For most life stages and season water surface elevations, the SAM show immediate adverse effects that continue to decline for the life of the project. However, the Corps’ Green Sturgeon Conservation Measures will reduce the impact on critical habitat by providing compensatory mitigation within the action area.

Specifically, the HMMP shall also restore or compensate for the number of acres and ecological function of soft bottom benthic substrate for sDPS green sturgeon permanently lost to project

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construction. This compensation will be carried out within the lower Sacramento River/North Delta in order to offset the adverse modification to designated critical habitat. The restored habitat will be capable of providing abundant benthic prey, freshwater or estuarine areas with adequate water quality, temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth and viability of all life stages. It will also provide safe and unobstructed migratory pathways necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats.

## **2.5 Cumulative Effects**

“Cumulative effects” are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

### **2.5.1 Water Diversions and Agricultural Practices**

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found along the West Sacramento GRS action area. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile listed anadromous species. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a CV database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001).

Agricultural practices in the action area may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow. Grazing activities from cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the associated watersheds. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect listed salmonid and sDPS green sturgeon reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000; Daughton 2003).

### **2.5.2 Aquaculture and Fish Hatcheries**

More than 32-million fall-run Chinook salmon, 2-million spring-run Chinook salmon, 1-million late fall-run Chinook salmon, 0.25-million winter-run Chinook salmon, and 2-million steelhead are released annually from six hatcheries producing anadromous salmonids in the CV. All of these facilities are currently operated to mitigate for natural habits that have already been permanently lost as a result of dam construction. The loss of this available habitat results in dramatic reductions in natural population abundance which is mitigated for through the operation of hatcheries. Salmonid hatcheries can, however, have additional negative effects on ESA-listed salmonid populations. The high level of hatchery production in the CV can result in high harvest-

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to-escapements ratios for natural stocks. California salmon fishing regulations are set according to the combined abundance of hatchery and natural stocks, which can lead to over-exploitation and reduction in the abundance of wild populations that are indistinguishable and exist in the same system as hatchery populations. Releasing large numbers of hatchery fish can also pose a threat to wild Chinook salmon and steelhead stocks through the spread of disease, genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production. Impacts of hatchery fish can occur in both freshwater and the marine ecosystems. Limited marine carrying capacity has implications for naturally produced fish experiencing competition with hatchery production. Increased salmonid abundance in the marine environment may also decrease growth and size at maturity, and reduce fecundity, egg size, age at maturity, and survival (Bigler *et al.* 1996). Ocean events cannot be predicted with a high degree of certainty at this time. Until good predictive models are developed, there will be years when hatchery production may be in excess of the marine carrying capacity, placing depressed natural fish at a disadvantage by directly inhibiting their opportunity to recover (NPCC 2003).

### **2.5.3 Increased Urbanization**

Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, will not require Federal permits, and thus will not undergo review through the ESA section 7 consultation process with NMFS.

Increased urbanization also is expected to result in increased recreational activities in the region. Among the activities expected to increase in volume and frequency is recreational boating. Boating activities typically result in increased wave action and propeller wash in waterways. This potentially will degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially re-suspending contaminated sediments and degrading areas of submerged vegetation. This in turn will reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and green sturgeon moving through the system. Increased recreational boat operation is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the associated water bodies.

### **2.5.4 Global Climate Change**

The world is about 1.3°F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (IPCC 2001). Much of that increase likely will occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in

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the Pacific (Noakes 1998). Using objectively analyzed data Huang and Liu (2000) estimated a warming of about 0.9°F per century in the Northern Pacific Ocean.

Sea levels are expected to rise by 0.5 to 1.0 meters in the northeastern Pacific coasts in the next century, mainly due to warmer ocean temperatures, which lead to thermal expansion much the same way that hot air expands. This will cause increased sedimentation, erosion, coastal flooding, and permanent inundation of low-lying natural ecosystems (*e.g.*, salt marsh, riverine, mud flats) affecting listed salmonid and green sturgeon PCEs. Increased winter precipitation, decreased snow pack, permafrost degradation, and glacier retreat due to warmer temperatures will cause landslides in unstable mountainous regions, and destroy fish and wildlife habitat, including salmon-spawning streams. Glacier reduction could affect the flow and temperature of rivers and streams that depend on glacier water, with negative impacts on fish populations and the habitat that supports them.

Summer droughts along the South Coast and in the interior of the northwest Pacific coastlines will mean decreased stream flow in those areas, decreasing salmonid survival and reducing water supplies in the dry summer season when irrigation and domestic water use are greatest. Global warming may also change the chemical composition of the water that fish inhabit: the amount of oxygen in the water may decline, while pollution, acidity, and salinity levels may increase. This will allow for more invasive species to overtake native fish species and impact predator-prey relationships (Peterson and Kitchell 2001, Stachowicz *et al.* 2002).

In light of the predicted impacts of global warming, the CV has been modeled to have an increase of between +2°C and +7°C by 2100 (Dettinger *et al.* 2004, Hayhoe *et al.* 2004, Van Rheezen *et al.* 2004, Stewart 2005), with a drier hydrology predominated by rainfall rather than snowfall. This will alter river runoff patterns and transform the tributaries that feed the CV from a spring and summer snowmelt dominated system to a winter rain dominated system. It can be hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. This will truncate the period of time that suitable cold-water conditions exist downstream of existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures downstream of reservoirs, such as Lake Shasta, could potentially rise above thermal tolerances for juvenile and adult salmonids (*i.e.* Sacramento River winter-run Chinook salmon and CCV steelhead) that must hold and/or rear downstream of the dam over the summer and fall periods.

### **2.5.5 Rock Revetment and Levee Repair Projects**

Cumulative effects include non-Federal riprap projects. Depending on the scope of the action, some non-Federal riprap projects carried out by state or local agencies do not require Federal permits. These types of actions and illegal placement of riprap occur within the Sacramento River watershed. For example, most of the levees have roads on top of the levees which are either maintained by the county, reclamation district, owner, or by the state. Landowners may utilize roads at the top of the levees to access part of their agricultural land. The effects of such

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actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic to simplified habitats that affect salmonids in ways similar to the adverse effects associated with the West Sacramento Project.

## 2.6 Integration and Synthesis

The *Integration and Synthesis* section is the final step of NMFS' assessment of the risk posed to species and critical habitat as a result of the proposed action. In this section, NMFS performs two evaluations: whether, given the environmental baseline and status of the species and critical habitat, as well as future cumulative effects, it is reasonable to expect the proposed action is not likely to: (1) reduce the likelihood of both survival and recovery of the species in the wild; and (2) result in the destruction or adverse modification of designated critical habitat (as determined by whether the critical habitat will remain functional to serve the intended conservation role for the listed anadromous species or retain its current ability to establish those features and functions essential to the conservation of the species).

The *Analytical Approach* described the analyses and tools we have used to complete this analysis. This section is based on analyses provided in the *Status of the Species*, the *Environmental Baseline*, and the *Effects of the Proposed Action*.

In our *Status of the Species* section, NMFS summarized the current likelihood of extinction of each of the listed species. We described the factors that have led to the current listing of each species under the ESA across their ranges. These factors include past and present human activities and climatological trends and ocean conditions that have been identified as influential to the survival and recovery of the listed species. Beyond the continuation of the human activities affecting the species, we also expect that ocean condition cycles and climatic shifts will continue to have both positive and negative effects on the species' ability to survive and recover. The *Environmental Baseline* reviewed the status of the species and the factors that are affecting their survival and recovery in the action area. The *Effects of the Proposed Action* reviewed the exposure of the species and critical habitat to the proposed action and interrelated and interdependent actions, cumulative effects. NMFS then evaluated the likely responses of individuals, populations, and critical habitat. The *Integration and Synthesis* will consider all of these factors to determine the proposed action's influence on the likelihood of both the survival and recovery of the species, and on the conservation value of designated critical habitat.

The criteria recommended for low risk of extinction for Pacific salmonids are intended to represent a species and populations that are able to respond to environmental changes and withstand adverse environmental conditions. Thus, when our assessments indicate that a species or population has a moderate or high likelihood of extinction, we also understand that future adverse environmental changes could have significant consequences on the ability of the species to survive and recover. Also, it is important to note that an assessment of a species having a moderate or high likelihood of extinction does not mean that the species has little or no chance to survive and recover, but that the species faces moderate to high risks from various processes that can drive a species to extinction. With this understanding of both the current likelihood of extinction of the species and the potential future consequences for species survival and recovery,

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NMFS will analyze whether the effects of the proposed action are likely to in some way increase the extinction risk each of the species faces.

In order to estimate the risk to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and green sturgeon as a result of the proposed action, NMFS uses a hierarchical approach. The condition of the ESU or DPS is reiterated from the *Status of the Species* section of this BiOp. We then consider how the status of populations in the action area, as described in the *Environmental Baseline*, is affected by the proposed action. Effects to individuals is summarized, and to the consequence of those effects is applied to establish risk to the diversity group, ESU, or DPS.

In designating critical habitat, NMFS considers the physical and biological features (essential features) within the designated areas that are essential to the conservation of the species and that may require special management considerations or protection. Such requirements of the species include, but are not limited to: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring, and generally; and (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species [see 50 CFR § 424.12(b)]. In addition to these factors, NMFS also focuses on the principal biological or physical constituent elements within the defined area that are essential to the conservation of the species. Primary constituent elements may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

The basis of the “destruction or adverse modification” analysis is to evaluate whether the proposed action results in negative changes in the function and role of the critical habitat in the conservation of the species. As a result, NMFS bases the critical habitat analysis on the affected areas and functions of critical habitat essential to the conservation of the species, and not on how individuals of the species will respond to changes in habitat quantity and quality.

### **2.6.2 Status of the Sacramento River Winter-run Chinook Salmon ESU**

There are several criteria (only one is required) that would qualify the winter-run ESU at moderate risk of extinction, and since there is still only one population that spawns downstream of Keswick Dam, that population would be at high risk of extinction in the long-term according the criteria in Lindley *et al.* (2007). Recent trends in those criteria are: (1) continued low abundance (Figure 3) ; (2) a negative growth rate over 6 years (2006–2012), which is two complete generations (Figure 4); (3) a significant rate of decline since 2006; and (4) increased risk of catastrophe from oil spills, wild fires, or extended drought (climate change). The most recent 5-year status review (NMFS 2011) on winter-run concluded that the ESU had increased to a high risk of extinction. In summary, the most recent biological information suggests that the extinction risk for the winter-run ESU has increased from moderate risk to high risk of extinction since 2005 (last review), and that several listing factors have contributed to the recent decline, including drought and poor ocean conditions (NMFS 2011).

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### **2.6.3 Status of the CV Spring-run Chinook Salmon ESU**

The CV spring-run Chinook salmon ESU is at moderate risk of extinction (Lindley *et al.* 2007). The most recent viability assessment of CV spring-run Chinook salmon was conducted during NMFS' 2011 status review (NMFS 2011b). This review found that the biological status of the ESU has worsened since the last status review. In the 2011, the ESU as a whole could not be considered viable because there were no extant viable populations in the three other diversity groups. In addition, Mill, Deer, and Butte creeks are close together geographically, decreasing the independence of their extinction risks due to catastrophic disturbance. These and other conditions covered in the 2011 status review have not changed since 2011. While the abundance for some populations appears to be slightly improving, the ESU is still demonstrating a high variability in adult abundance (especially in Butte Creek), we cannot say based on the trend over the past three years that the risk of extinction for the ESU has improved.

### **2.6.4 Summary of the Status of the CCV Steelhead DPS**

All indications are that natural Central Valley steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (Good *et al.* 2005; NMFS 2011); the long-term trend remains negative. Hatchery production and returns are dominant over natural fish, and one of the four hatcheries is dominated by Eel/Mad River origin steelhead stock. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin-clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show an overall very low abundance, and fluctuating return rates. Lindley *et al.* (2007) developed viability criteria for Central Valley salmonids. Using data through 2005, Lindley *et al.* (2007) found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The widespread distribution of wild steelhead in the Central Valley provides the spatial structure necessary for the DPS to survive and avoid localized catastrophes. However, most wild CCV populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011). The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

The CCV steelhead DPS is at high risk of extinction (NMFS 2011c), and the extinction risk is increasing. The most recent viability assessment of CCV steelhead was conducted during NMFS' 2011 status review (NMFS 2011c). This review found that the biological status of the ESU has

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worsened since the last status review recommend that its status be reassessed in two to three years as opposed to waiting another five years, if it does not respond positively to improvements in environmental conditions and management actions.

### **2.6.5 Summary of the Status of the Green Sturgeon southern DPS**

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010a).

Although the population structure of sDPS green sturgeon is still being refined, it is currently believed that only one population of sDPS green sturgeon exists. Lindley et al. (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population, and if this were to be applied to sDPS green sturgeon directly, it could be said that sDPS green sturgeon face a high extinction risk. However, the position of NMFS, upon weighing all available information (and lack of information) has stated the extinction risk to be moderate (NMFS 2010a).

Adult green sturgeon migrate through the action area to reach upstream spawning habitat. Early larval drift and rearing is also likely to occur upstream from the action area near spawning sites. As juveniles migrate downstream toward the ocean, they become more oriented to benthic environments. Juvenile green sturgeon migrate toward seawater portions of natal estuaries as early as one and a half years old (75cm TL, Allen and Cech 2007). Juvenile and subadult green sturgeon may rear in freshwater and brackish water for up to three years. During laboratory experiments, juvenile green sturgeon select low light habitats and are primarily inactive during daylight hours, while they seemed to forage actively during night (Kynard et al. 2005). Juvenile green sturgeon were captured during the summer in shallow shoals (1-3 m deep) in the lower San Joaquin River (Radtke 1966), and are assumed to occupy similar habitats along the lower Sacramento River.

There is a strong need for additional information about sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their micro- and macro-habitat ecology.

### **2.6.6 Summary of Status of the Environmental Baseline and Cumulative Effects in the Action Area**

The action area is used by most diversity groups and populations of the salmon, steelhead and green sturgeon ESUs and DPSs that are the subject of this BO. Salmon, steelhead and green sturgeon use the action area as an upstream and downstream migration corridor and for rearing.

Within the action area, the essential features of freshwater rearing and migration habitats for salmon, steelhead and green sturgeon have been transformed from a meandering waterway lined with a dense riparian vegetation, to a highly leveed system under varying degrees of constraint of

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riverine erosional processes and flooding. Levees have been constructed near the edge of the river and most floodplains have been completely separated and isolated from the Sacramento River (USFWS 2000). Severe long-term riparian vegetation losses have occurred in this part of the Sacramento River, and there are large open gaps without the presence of these essential features due to the high amount of riprap (USFWS 2000). The change in the ecosystem as a result of halting the lateral migration of the river channel, the loss of floodplains, the removal of riparian vegetation and IWM have likely affected the functional ecological processes that are essential for growth and survival of salmon, steelhead and green sturgeon in the action area.

The Southport EIP is a levee setback project that was consulted on in 2015 and will go to construction in 2016. The project will breach the existing levee at several sites and will result in the inundation of approximately 120 acres of historic floodplain habitat. Construction of the project will result in some short-term adverse effects to salmon, steelhead and green sturgeon, but after approximately 5 years post Southport construction, and prior to the construction of West Sacramento GRS actions, the WRI values will improve the existing (2015) baseline of the actions area for Chinook salmon and steelhead. Specifically, in the case of fry and juvenile rearing and migration for all species, the SAM modeled WRI values show increases in the growth and survival of individuals, such that the incremental effects of the Southport EIP are not expected to increase the extinction risk of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon and ESU CCV steelhead and green sturgeon DPS or reduce the conservation value of their designated critical habitat.

Furthermore, the anticipated growth and survival of salmon, steelhead and green sturgeon rearing and juvenile migration are positive and demonstrate how integrating NMFS high priority recovery actions, such as setback levee construction and restoration of floodplain habitat can contribute to an increase in the production and abundance of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon and ESU CCV steelhead and green sturgeon DPS.

The *Cumulative Effects* section of this BO describes how continuing or future effects such as non-Federal water diversions, the discharge of point and non-point source chemical contaminant discharges, and climate change affect the species in the action area. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitat conditions that reduce the carrying capacity of the rearing and migratory corridors.

### **2.6.7 Summary of Project Effects on Sacramento River Winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS Green Sturgeon Individuals**

#### **1. Construction and O&M-related Effects**

During construction and O&M, some injury or death to individual fish could result from rock placement (crushing), or predation related to displacement of individuals away from the shoreline or at the margins or turbidity plumes. These construction type actions will occur during summer and early fall months, when the abundance of individual salmon and steelhead is low and should result in correspondingly low levels of injury or death.

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Green sturgeon adults may be migrating downstream through the area during construction (Heublein et al. 2009) and juveniles may be in the area May through September (noted in section 2.4.1, pg. 83). Adults and subadults would likely respond to construction activities by quickly swimming away, escaping injury, but juveniles are not strong swimmers and will experience the greatest exposure and may encounter short-term construction-related noise, physical disturbance, and water quality changes that may cause injury or harm by increasing the susceptibility of some individuals to predation by temporarily disrupting normal behaviors and affecting sheltering abilities.

## 2. Long-term Effects Related to the Presence of Project Features

For juvenile and outmigrating salmon and steelhead, the proposed action will result in short- and long-term adverse effects to individual salmon and steelhead that are exposed to the project features along the Sacramento River. These adverse effects are indexed by SAM model results and expressed as WRI deficits. The long term WRI deficits are highest at fall and summer water surface elevations. We interpret those flow conditions to be consistent with summer and fall months, which are seasons during which individual Sacramento River winter-run, CV spring-run and CCV steelhead is low (fall), or they are absent. For other seasonal water surface elevations, there will be short term reductions in survival and growth as indicated by WRI values, but these values will increase above baseline and result in beneficial conditions that exceed baseline values.

SAM modeled WRI values for adult salmon and steelhead migration and steelhead residence (outmigrating post spawning adults) are deficits at winter, spring and summer water surface elevations. These effects are considered to be *de minimus* because, although modeled as a result of a reduction in IWM and riparian habitat, the actual survival of adults is unlikely to be affected because there will be no increase in predation, and the upstream migration will not be impeded by any structural features that influence upstream migration.

Details regarding the extent of juvenile green sturgeon rear in this reach of the river is not clear, but all juvenile sDPS must pass through the area on their migration to the estuary and ocean (unless they wash into the Yolo Bypass during a flood event). Levee repair actions in the West Sacramento Study Area are likely to only affect the juvenile rearing life stage and probably have little to no adverse impacts on the adult life stages of green sturgeon because spawning habitat is not present in the action area and upstream migrating adults are probably more influenced by impacts that affect swimming speed and upstream passage than shoreline habitat manipulations. The levee repair actions will cause long-term reductions in shoreline habitat features for juvenile rearing and migrating green sturgeon and a loss of several acres of benthic habitat that is most likely used for foraging.

The implementation of the Corp's Green Sturgeon Conservation Measures will serve several purposes to address scientific uncertainty about the species in the study area and to provide compensatory mitigation for the adverse effects related to shoreline and benthic habitat impacts. The HMMP will ensure that adverse impacts of future West Sacramento projects are sufficiently compensated in order to allow for the growth, survival and recovery of the species in the study area. Coordination of the HMMP with the IEP will leverage green sturgeon scientific expertise

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to ensure selected mitigation actions fully address the micro- and macro-ecological and survival needs of the species in the study area. Refinement of the SAM or development of alternative green sturgeon survival and response model using the Corps' Hydrologic Ecosystem Function Model, in consultation with NMFS and the IEP, will result in new modeling capacity that more accurately evaluates adverse project actions and the beneficial effects of mitigation actions relative to the growth and survival of green sturgeon in the study area. Restoring and compensating for the number of acres and ecological function of impacted benthic habitat and the initiation of this compensatory mitigation in the study area prior to the commencement of levee construction will reduce the impact of levee construction actions. The development of SMART compensatory mitigation objectives will ensure that all of the ecological impacts of levee construction actions are fully addressed.

The SAM modeled deficits for the Sacramento River Deep Water Ship Channel and the Port of Sacramento are negative and correspond to reduced growth and survival of all life stages of salmon, steelhead for the entire life of the project (50 years). The channel and the port are not along the primary migration corridor and are generally not considered to be high value rearing or migratory habitats for salmon and steelhead. However the Corps has proposed to offset the negative WRI values through habitat enhancements or through the purchase of a NMFS approved conservation bank at sites that are of a higher conservation value for the species. Offsetting these deficits at high value areas will mean that the reduced growth and survival of the species in the Deep Water Ship Channel and the Port of Sacramento will not contribute to a reduction in the production and abundance of the winter-run Chinook salmon ESU or the CV spring-run Chinook salmon and CCV steelhead DPSs. It is uncertain what the deficits will mean to sDPS green sturgeon due to uncertainty of the value of this habitat to the species.

#### **2.6.8 Summary of Project Effects on Sacramento River Winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS Green Sturgeon Critical Habitat**

Within the action area, the relevant PCEs of the designated critical habitat for listed salmonids are migratory corridors and rearing habitat, and for green sturgeon the six PCEs include food resources, water flow, water quality, migratory corridors, water depth, and sediment quality.

Based on SAM modeled WRIs, we expect small reductions in the value of PCEs for salmon and steelhead freshwater rearing due to the temporary loss of riparian habitat, the conversion of natural substrate river banks with revetment and the short term loss of IWM, but these reductions are at fall and summer water surface elevations and not at water surface elevations when the habitat use is the highest and most significant. Additionally, as planted vegetation begins to grow, the quality of rearing habitat will improve over baseline. There will also be SAM modeled WRI deficits for adult migration-related PCEs for all species. These deficits are temporary and eventually increase over baseline, so over time we do not expect these effects to reduce the conservation value of critical habitat.

The current condition of critical habitat for the green sturgeon sDPS in the action area is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the survival and recovery of the species. In particular, passage and water flow

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PCEs have been impacted by human actions, substantially altering the historical river characteristics in which the green sturgeon sDPS evolved.

The Corps estimates that approximately 19 acres of soft substrate habitat below the ordinary high water mark will be permanently lost to rock revetment. This is a conceptual estimate that will be further refined during the PED phase before construction begins. This loss of habitat is expected to adversely affect benthic substrate and impair food resources for all life stages; and the quantity of sediment to allow for normal physiological and behavioral responses to the environment. Similar to salmon and steelhead, the SAM serves as a reasonable proxy for measuring impacts to critical habitat. For most life stages and season water surface elevations, the SAM show immediate adverse effects that continue to decline for the life of the project. However, the Corps' Green Sturgeon Conservation Measures will reduce the impact on critical habitat by providing compensatory mitigation within the action area. Specifically, the HMMP shall also restore or compensate for the number of acres and ecological function of soft bottom benthic substrate for sDPS green sturgeon permanently lost to project construction. This compensation will be carried out within the lower Sacramento River/North Delta in order to offset the adverse modification to designated critical habitat. The restored habitat will be capable of providing abundant benthic prey, freshwater or estuarine areas with adequate water quality, temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth and viability of all life stages. It will also provide safe and unobstructed migratory pathways necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats.

The proposed action will permanently destroy up to 19 acres of critical habitat but also includes implementation of a comprehensive suite of conservation measures that will fill important data gaps, address existing modeling insufficiencies and implement compensatory measures with the goal of maintaining green sturgeon growth, survival and recovery in the action area through measures that will be developed in coordination with the IEP's green sturgeon project work team and in consultation with NMFS. The measures will be undertaken prior to or concurrent with project implementation. For these reasons, we expect the proposed action will not reduce the conservation value of critical habitat for sDPS green sturgeon.

### **2.6.9 Summary**

Although there are some short-term and SAM modeled WRI deficits for salmon and steelhead, the effects of these deficits, when added to the environmental baseline and cumulative effects in the action area are small, occur during seasons when fish abundance is low or they are not present at all, and is of short duration. In the case of fry and juvenile rearing and migration for all species, the SAM modeled WRI values show significant increases in the growth and survival of individuals over baseline conditions between years 0 and 13, especially at winter spring water surface elevations, which represent a shoreline area where most emigrating salmon and steelhead would be exposed. Because the WRI measure growth and survival values recover rather quickly and generally exceed baseline conditions, the incremental effects of the action are not expected to increase the extinction risk of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon and ESU CCV steelhead and or reduce the conservation value of their designated critical habitat.

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Furthermore, the anticipated growth and survival of salmon, steelhead rearing and juvenile migration are substantially positive and demonstrate how integrating NMFS high priority recovery actions, such as riparian habitat enhancement, engineered floodplain features (benches), integrated instream woody material contribute to an increase in the production and abundance of the Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon and ESU CCV steelhead.

The project will result in unavoidable impacts to the shoreline and benthic habitat of green sturgeon. However, the Corps' proposed Green Sturgeon Conservation Measures are expected to make significant contributions to monitor the species, address important data gaps in the action area, improve species growth and survival modeling and use the modeling to develop and track the performance of compensatory mitigation with the goal of fully addressing the loss of micro and macro-ecological impacts of the levee construction work in a manner that maintains the growth, survival and recovery of the species. The measures also address critical habitat PCEs and will ensure the conservation value of critical habitat is not reduced.

## **2.7 Conclusion**

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS green sturgeon or destroy or adversely modify their designated critical habitat.

## **2.8 Incidental Take Statement**

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any grant, contract or permit, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps: (1) fails to assume and implement the terms and conditions, or (2) fails to require the permittee, contractor, or grantee to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to

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the permit, contract or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement (50 CFR §402.14(i)(3)).

### **2.8.1 Amount or Extent of Take**

NMFS anticipates incidental take of adult and juvenile listed CV spring-run Chinook salmon, CCV steelhead, and juvenile sDPS of North American green sturgeon and juvenile Sacramento River winter-run Chinook salmon in the action area through the implementation of the proposed action.

NMFS cannot, using the best available information, quantify the anticipated incidental take of individual Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon because of the variability and uncertainty associated with the population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use of the project area. However, it is possible to describe the general programmatic conditions and ecological surrogates using negative SAM WRI values.

Accordingly, NMFS is quantifying take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon incidental to the action resulting from short-term construction impacts, as well as long-term impacts as indexed by the SAM model.

The amount and extent of take described below is in the form of harm due to habitat impacts that will reduce the growth and survival of individuals from predation, or by causing fish to relocate and rear in other locations and reduce the carrying capacity of the existing habitat. This SAM values represent the extent of habitat impacts that will harm fish. As described in the *Analytical Approach* and the *Effects Analysis Sections* of this BO, the SAM values represent an index of fish response to habitat variables to which fish respond including bank slope, bank substrate size, instream structure, overhanging shade, aquatic vegetation and floodplain availability. Positive SAM values represent a positive growth and survival response and negative values index negative growth and survival. There is not a stronger ecological surrogate based on the information available. Due to a lack of site-specific fish data, the exact number of fish that will be affected is not known. The following level of incidental take from program activities is anticipated:

#### **Incidental Take Associated with Construction:**

1. Take of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS of North American green sturgeon in the form of injury and death from predation caused by construction-related turbidity that extends up to 100 feet from the shoreline, and 1,000 feet downstream, along all project reaches for levee construction activities.

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2. Take of juvenile and smolt Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon, in the form of harm or injury of fish from O&M actions is expected from habitat-related disturbances from the annual placement of up to 600 cubic yards of material per site for the extent of the project life (*i.e.*, 50 years). Approximately 60 percent of the 600 cubic yards will be at or below the ordinary high water mark, or approximately 360 cubic yards. Take will be in the form of harm to the species through modification or degradation of the PCEs for rearing and migration that reduces the carrying capacity of habitat.

### **Incidental Take Associated with Exposure to Project Facilities along the Sacramento River**

#### ***At fall water surface elevations:***

1. Take in the form of harm to fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for up to 10 years after any construction activities associated with the West Sacramento Project due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 6 for each species at -85 WRI, -85, and -12, respectively, and is reduced to -24, -24, and -11, respectively, by year 10. Following year 10, the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.
2. Take in the form of harm to juvenile migrating (smolts) CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for up to 15 years after any construction activities associated with the West Sacramento Project due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 7 for each species at -774 WRI, -774, and -777, respectively, and is reduced to -335, -335, and -441, respectively, by year 15. Between years 15 and 25, the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.
3. Take in the form of harm to juvenile migrating green sturgeon for at least 50 years after any construction activities associated with the West Sacramento Project due to impacts associated with changes in bank substrate size and loss of benthic habitat. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm reaches -650 WRI at year 50 and does not recover over the life of the project.

#### ***At winter water surface elevations:***

1. Take in the form of harm to fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for up to 1 year after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent

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of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 0 for each species at -183 WRI, -183, and -349, respectively, and is reduced to -2 for CCV steelhead by year 2. Following year 1 (and year 2 for CCV steelhead), the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.

2. Take in the form of harm to juvenile migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 0 for each species at -2,392 WRI, -2,392, and -1,972, respectively, and is reduced to -272, -272, and -282, respectively, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.
3. Take in the form of harm to adult residence CCV steelhead for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 0 at -1,235 WRI, and is reduced to -93, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.
4. Take in the form of harm to fry and juvenile rearing sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, and bank substrate size and loss of benthic habitat. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is -2,264 WRI at year 0 and does not recover over the life of the project. The SAM value is -317 at year 50.

***At spring water surface elevations:***

1. Take in the form of harm to fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for up to 1 year after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 0 for each species at -316 WRI, -316, and -550, respectively, and is reduced to -57, -57, and -213, respectively, by year 1. Following year 1, the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.
2. Take in the form of harm to fry and juvenile migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 0

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for each species at -2,639 WRI, -2,639, and -2,206, respectively, and is reduced to -312, -312, and -455, respectively, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.

3. Take in the form of harm to adult residence CCV steelhead for up to 2 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is greatest in year 0 at -1,464 WRI, and is reduced to -377, by year 2. Following year 2, the SAM modeled habitat conditions exceed baseline conditions and harm from habitat modification is not expected.
4. Take in the form of harm to fry and juvenile rearing sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, bank substrate size and loss of benthic habitat. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is -2,264 WRI at year 0 and does not recover over the life of the project. The SAM value is -317 at year 50.
5. Take in the form of harm to juvenile migrating sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, bank substrate size and loss of benthic habitat. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is -650 WRI at year 50 and does not recover over the life of the project.

**At summer water surface elevations:**

1. Take in the form of harm to fry and juvenile rearing sDPS green sturgeon for at 3 years after project construction due to impacts to riparian habitat, bank substrate size and loss of benthic habitat. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm reaches -1,544 WRI at year 0 and recovers by year 3.
2. Take in the form of harm to juvenile migrating sDPS green sturgeon for at least 50 years after project construction due to impacts to riparian habitat, bank substrate size and loss of benthic. The amount and extent of harm is quantified in the SAM table 42 of the 2014 Corps BA and summarized in Table 10 of this BO. The amount and extent of harm is -650 WRI at year 50 and does not recover over the life of the project.

**Incidental Take Associated with Project Features along the Sacramento Deep Water Ship Channel**

1. Take in the form of harm related to reduced survival of adult migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for at least 50 years after project construction due to impacts to riparian habitat, IWM, and bank substrate

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size. The adverse effect is greatest at year 50 at -316 WRI during fall, -124 during winter, -272 during spring, and -316 during summer. The adverse response for green sturgeon is likely twice these values.

2. Take in the form of harm related to reduced survival of fry and juvenile rearing CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for at least 50 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The adverse effect is greatest at year 50 at -157 WRI during fall, -202 during winter, -299 during spring, and -157 during summer. The adverse response for green sturgeon is likely twice these values.
3. Take in the form of harm related to reduced survival of juvenile migrating CV spring-run Chinook salmon, winter-run Chinook salmon, and CCV steelhead for at least 50 years after project construction due to impacts to riparian habitat, IWM, and bank substrate size. The adverse effect is greatest at year 50 at -744 WRI during fall, -1,506 during winter, -1,709 during spring, and -744 during summer. The adverse response for green sturgeon is likely twice these values.

### **2.8.2 Effect of the Take**

In the BO, NMFS determined that the amount or extent of anticipated take is not likely to result in jeopardy to the Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and sDPS green sturgeon or destruction or adverse modification of their critical habitat.

### **2.8.3 Reasonable and Prudent Measures**

“Reasonable and prudent measures” are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1. Measures shall be taken to ensure that future flood risk reduction projects related to the West Sacramento GRS minimize, to the maximum extent practicable, any adverse effects on federally listed salmon, steelhead and green sturgeon that are subject to this consultation.
2. Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures through the HMMP to ensure their effectiveness.
3. Measures shall be taken to minimize the impacts of bank protection and setback levee construction by implementing integrated conservation measures that provide beneficial growth and survival conditions for salmonids, and the sDPS of North American green sturgeon.
4. Measures shall be taken to insure that contractors, construction workers, and all other parties involved with these projects implement the projects as proposed in the biological assessment and this BO.

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5. Measures shall be taken to ensure that riparian habitat within the study area is preserved and protected to the maximum extent feasible for protection of fish habitat features that are the subject of this BO.

#### **2.8.4 Terms and Conditions**

The terms and conditions described below are non-discretionary, and the Corps or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:  
*Measures shall be taken to ensure that future flood risk reduction projects related to the West Sacramento GRS minimize, to the maximum extent practicable, any adverse effects on federally listed salmon, steelhead and green sturgeon that are subject to this consultation.”*
  - a. The Corps shall participate in an existing IWG or work with other agencies to participate in a new BPWG to coordinate stakeholder input into future flood risk reduction actions associated with the West Sacramento River GRS. The BPWG will hold technical deliberations over proposed bank protection, including the need (basis of/for design), purpose and proposed designs (emphasis on avoidance and fish-friendly designs). Membership in the BPWG will be subject to agency decisions to participate, but should at a minimum include participation from resource agency staff (USFWS, NMFS, CDFW), DWR and WSAFCA (local sponsors).
  - b. The Corps shall coordinate with NMFS during PED as future flood risk reduction actions are designed to ensure conservation measures are incorporated to the extent practicable and feasible and projects are designed to maximize ecological benefits.
  - c. For the Deep Water Ship Channel, the Corps shall avoid removing riparian vegetation to the maximum extent practicable, and, where feasible, shall shift levee alignments landward and away from the water.
  - d. The Corps shall include as part of the HMMP, and in consultation with NMFS, a Riparian Corridor Improvement Plan with the overall goal of compensating for the impacts to the ecological function and value of the existing levee system within the GRS study area.
2. The following terms and conditions implement reasonable and prudent measure 2:  
*“Measures shall be taken to maintain, monitor, and adaptively manage all conservation measures through the HMMP to ensure their effectiveness.”*
  - a. The Corps shall develop a HMMP with an overall goal of ensuring the conservation measures achieve a high level of ecological function and value. The HMMP shall include specific goals and objectives and a clear strategy for maintaining all of the

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- project conservation elements for the life of the project. The HMMP shall be consulted on with NMFS prior to the onset of any riverside construction, including the placement of in-water revetment or removal or riparian vegetation.
- b. The HMMP measures shall be monitored by the Corps for 10 years following construction and shall update their O&M manual to ensure the HMMP is adopted by the local sponsor to ensure the goals and objectives of the conservation measures are met for the life of the project.
  - c. The HMMP shall include specific goals and objectives and a clear strategy for achieving full compensation for all project-related impacts on the affected species described above.
  - d. The HMMP shall include a compensatory mitigation accounting plan to ensure the tracking of compensatory measures associated with future West Sacramento GRS projects as described in the proposed action.
  - e. The Corps shall continue to coordinate with NMFS during all phases of construction, implementation, and monitoring by hosting annual meetings and issuing annual reports throughout the construction period as described in the HMMP.
  - f. The Corps shall host an annual meeting and issue annual reports for five years following completion of project construction. The purpose is to ensure that conservation features of the project are developing consistent with the MMP.
  - g. The Corps shall update their O&M Manual to ensure that the self-mitigating elements of the HMMP with the goal of meeting SAM values.
3. The following terms and conditions implement reasonable and prudent measure 3:  
*“Measures shall be taken to minimize the impacts of bank protection and setback levee construction by implementing integrated onsite and offsite conservation measures that provide beneficial growth and survival conditions for salmonids, and the sDPS of North American green sturgeon.”*
- a. The Corps shall ensure that, for salmon and steelhead, the maximum SAM WRI deficits for each seasonal water surface elevation as determined appropriate with input from the IWG or the BPWG are fully offset in either the Southport offset area through habitat improvements along the future West Sacramento GRS project or through the purchase of credits at a NMFS approved conservation bank (as described in the BA).
  - b. The Corps shall minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable, and where appropriate, removed IWM will be anchored back into place or if not feasible, new IWM will be anchored in place.
  - c. The Corps shall ensure that the planting of native vegetation will occur as described in the Corps 2014 BA and within this BO. All plantings must be provided with the appropriate amount of water to ensure successful establishment.
4. The following terms and conditions implement reasonable and prudent measure 4:  
*“Measures shall be taken to insure that contractors, construction workers, and all other parties involved with these projects implement the projects as proposed in the biological assessment and this BO.”*

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- a. The Corps shall provide a copy of this BO, or similar documentation, to the prime contractor, making the prime contractor responsible for implementing all requirements and obligations included in these documents and to educate and inform all other contractors involved in the project as to the requirements of this BO. A notification that contractors have been supplied with this information will be provided to the reporting address below.
  - b. A NMFS-approved Worker Environmental Awareness Training Program for construction personnel shall be conducted by the NMFS-approved biologist for all construction workers prior to the commencement of construction activities. The program shall provide workers with information on their responsibilities with regard to Federally-listed fish, their critical habitat, an overview of the life-history of all the species, information on take prohibitions, protections afforded these animals under the ESA, and an explanation of the relevant terms and conditions of this BO. Written documentation of the training must be submitted to NMFS within 30 days of the completion of training.
  - c. The Corps shall consider installing IWM along future flood risk reduction projects associated with the West Sacramento GRS at 40 to 80 percent shoreline coverage at all seasonal water surface elevations in coordination with the IWG or the BPWG. The purpose is to maximize the refugia and rearing habitats for juvenile fish.
5. The following terms and conditions implement reasonable and prudent measure 5: *“Measures shall be taken to ensure that riparian habitat within the study area is preserved and protected to the maximum extent feasible for protection of fish habitat features that are the subject of this BO.”*
- a. The Corps shall develop a Vegetation Variance in consultation with NMFS that protects all vegetation, in place, and allows planting low-risk vegetation on the lower 1/3 slope of the levee system.
  - b. The Corps shall develop a Vegetation Variance for all elements of West Sacramento River GRS that are adjacent to habitat that is occupied by federally listed salmon, steelhead and green sturgeon, including the main channel of the Sacramento River (as proposed), the DWSC/Port area, and the Yolo Bypass.

## **2.9 Conservation Recommendations**

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1. The Corps should integrate the 2017 California Central Valley Flood Protection Plan’s Conservation Strategy into all flood risk reduction projects they authorize, fund, or carry out.

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2. The Corps should prioritize and continue to support flood management actions that set levees back from rivers and in places where this is not technically feasible, repair in place actions should pursue land-side levee repairs instead of waterside repairs.
  3. The Corps should consult with NMFS in the review of ETL variances for future projects that require ETL compliance.
  4. The Corps should develop ETL vegetation variances for all flood management actions that are adjacent to any anadromous fish habitat.
  5. The Corps should use all of their authorities, to the maximum extent feasible to implement high priority actions in the NMFS Central Valley Salmon and Steelhead Recovery Plan. High priority actions related to flood management include setting levees back from river banks, increasing the amount and extent of riparian vegetation along reaches of the Sacramento River Flood Control Project.
  6. The Corps should encourage cost share sponsors and applicants to develop floodplain and riparian corridor enhancement plans as part of their projects.
  7. The Corps should seek out opportunities for setback levee and other flood management activities that promote overall riverine system restoration.
  8. The Corps should support and promote aquatic and riparian habitat restoration within the Sacramento River and other watersheds, especially those with listed aquatic species. Practices that avoid or minimize negative impacts to listed species should be encouraged.
  9. The Corps should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid habitat restoration projects.
  10. The Corps should continue to work with NMFS and other agencies and interests to restore fish passage to support the improved growth, survival and recovery of native fish species in the Yolo Bypass and other bypasses within the Sacramento River Flood Control Project.
  11. The Corps should coordinate with the IEP to further evaluate the ecosystem function of the SDWSC/Port and consider developing a study to re-operate the Jefferson Ship Locks to enhance fish passage for salmon, steelhead and sturgeon and estuarine habitat values.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

## **2.10 Reinitiation of Consultation**

This concludes formal consultation for the West Sacramento River GRS. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) the amount or extent of incidental taking specified in the incidental take statement is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

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## **MAGNUSON-STEVENSON FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION**

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific coast salmon (PFMC 1999) contained in the fishery management plans developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

The proposed action is described in detail in Section 1.3 of the West Sacramento River GRS BO.

### **3.1 Essential Fish Habitat Affected by the Project**

The action area for the EIP has been identified as EFH for Pacific coast salmon. Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), CV spring-run Chinook salmon (*O. tshawytscha*), and CV fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Pacific coast salmon fishery management plan that occur within the proposed action area.

This BO addresses Sacramento River winter-run and CV spring-run Chinook salmon (*O. tshawytscha*). The Sacramento River winter-run and CV spring-run Chinook salmon are listed under both ESA and the MSA and potentially will be affected by the Southport EIP. This EFH consultation will concentrate on CV fall-/late fall-run Chinook salmon (*O. tshawytscha*) because their habitat is covered under the MSA but not covered in subject BO.

The Habitat Areas of Particular Concern (HAPCs) in the action area include complex channels, floodplain habitats and constrained channels with large woody debris.

### **3.2 Adverse Effects on Essential Fish Habitat**

The effects of the proposed action on Pacific Coast salmon EFH will be similar to those discussed in the *Effects of the Action* section (2.4) for Sacramento River winter-run and CV spring-run Chinook salmon. Based on the information provided, NMFS concludes that the proposed action would adversely affect EFH for federally managed Pacific salmon. A summary of the effects of the proposed action on EFH for Chinook salmon are discussed below.

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Adverse effects to the HAPCs of Pacific salmon EFH resulting from the proposed action construction activities may contribute sediment, increase turbidity, and increase localized sound levels, including areas downstream and upstream of the construction site. These impacts will occur only during the time when construction is occurring in or adjacent to the water column. There is potential for toxic compounds to be introduced into EFH during construction. This could occur at any time during the construction, both during in-water and out-of-water phases. All of the above impacts will be short-term. Construction activities may also eliminate or alter habitat that is essential to the life-cycle of Pacific salmon. For example, the addition of rock revetment to a previously vegetated bank may eliminate juvenile rearing habitat. These habitat impacts are better illustrated in Table 12 of this EFH consultation and Table 43 of the Corps BA that summarizes SAM deficits for the West Sacramento River GRS.

For example, some SAM WRI values typically show small deficits that recover, for example fry and juvenile rearing in the fall. Conversely, some SAM values show long-term benefits (no deficits) such as fall-run Chinook salmon adult migration in the fall.

**Table 12: West Sacramento Project Maximum SAM Deficits and Duration of Deficits by Species, Life-Stage, and Season**

Season	Life Stage	Maximum WRI Deficits	Duration of Deficit (in years)
<b>Fall-run Chinook Salmon</b>			
Fall	Adult Migration	No deficit	NA
	Fry and Juvenile Rearing	-85	10
	Juvenile Migration	NA	NA
Winter	Adult Migration	-455	3
	Fry and Juvenile Rearing	-183	3
	Juvenile Migration	-2,392	2
Spring	Adult Migration	NA	NA
	Fry and Juvenile Rearing	-316	3
	Juvenile Migration	No data	No data
<b>Late Fall-run Chinook Salmon</b>			
Fall	Adult Migration	No deficit	NA
	Fry and Juvenile Rearing	-85	10
	Juvenile Migration	-774	15
Winter	Adult Migration	-627	3
	Fry and Juvenile Rearing	-183	2
	Juvenile Migration	-2,392	3
Spring	Adult Migration	-773	4
	Fry and Juvenile Rearing	-316	2
	Juvenile Migration	No data	No data

### 3.3 Essential Fish Habitat Conservation Recommendations

Fully implementing these EFH conservation recommendations will protect, by avoiding or minimizing the adverse short-term habitat effects described in section 3.2. The Corps should mitigate for WRI deficits by offsetting the maximum deficits. Below is a summary of WRI that should be mitigated to minimize the adverse effects of the Southport EIP to Pacific coast salmon species. The Corps and WSAFCA should offset deficits either onsite or at a NMFS approved conservation bank. The mitigation should be at a 1:1 ratio if conducted prior to the compensation timing schedule described in the *Analytical Approach* section of the BO, or at a 3:1 ratio if carried out any later.

1. The maximum impact from the West Sacramento Project to adult fall-run Chinook salmon habitat is -455 WRI for 3 years.

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2. The maximum impact from the West Sacramento Project to juvenile fall-run Chinook salmon habitat is -2,392 WRI for 2 years.
  3. The maximum impact from the West Sacramento Project to adult late-fall run Chinook salmon habitat is -773 WRI for 4 years.
  4. The maximum impact from the West Sacramento Project to juvenile late-fall run Chinook salmon habitat is -2,392 WRI for 3 years.

### **3.4 Statutory Response Requirement**

As required by section 305(b)(4)(B) of the MSA, the Corps must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, compensate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

### **3.5 Supplemental Consultation**

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

## **4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW**

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

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## 4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Corps. Other interested users could include WSAFCA, USFWS, CDFW, or DWR. Individual copies of this opinion were provided to the Corps and WSAFCA. This opinion will be posted on the Public Consultation Tracking System web site (<https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts> ). The format and naming adheres to conventional standards for style.

## 4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

## 4.3 Objectivity

Information Product Category: Natural Resource Plan

**Standards:** This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

**Best Available Information:** This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and the EFH consultation contain more background on information sources and quality.

**Referencing:** All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

**Review Process:** This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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## 5. REFERENCES

- Adams, P. B., C. B. Grimes, J. E. Hightower, S. T. Lindley, and M. L. Moser. 2002. Status review for North American green sturgeon, *Acipenser medirostris*. National Marine Fisheries Service. 58 pages.
- Adams, P.B., C. Grimes, J.E. Hightower, S.T. Lindley, M.L. Moser, and M.J. Parsley. 2007. Population status of North American green sturgeon, *Acipenser medirostris*. *Environmental Biology of Fishes* 79:339-356.
- Allen, P. J., B. Hodge, I. Werner, and J. J. Cech. 2006. Effects of ontogeny, season, and temperature on the swimming performance of juvenile green sturgeon (*Acipenser medirostris*). *Canadian Journal of Fisheries and Aquatic Sciences* 63:1360-1369.
- Allen, P. J. and J. J. Cech Jr. 2007. Age/size effects on juvenile green sturgeon, *Acipenser medirostris*, oxygen consumption, growth, and osmoregulation in saline environments. *Environmental Biology of Fishes* 79:211-229.
- Allen PJ, Barth CC, Peake SJ, Abrahams MV, Anderson WG. 2009. Cohesive social behavior shortens the stress response: the effects of con specifics on the stress response in lake sturgeon *Acipenser fulvescens*, *J Fish Biol* 74:90 – 104.
- Bailey, E.D. 1954. Time pattern of 1953-54 migration of salmon and steelhead into the upper Sacramento River. California Department of Fish and Game unpublished report. 4pp.
- Bain, M.B., and N.J. Stevenson, editors. 1999. Aquatic habitat assessment: common methods. American Fisheries Society, Bethesda, Maryland.
- Barnhart, R.A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest), steelhead. U.S. Fish and Wildlife USFWS, Biological Report 82 (11.60). 21 pages.
- Beamesderfer, R.C.P., M.L. Simpson, and G.J. Kopp. 2007. Use of life history information in a population model for Sacramento green sturgeon. *Environmental Biology of Fishes*. 79 (3-4): 315-337.
- Beckman, B. R., B. Gadberry, P. Parkins, K. L. Cooper, and K. D. Arkush. 2007. State-Dependent Life History Plasticity in Sacramento River Winter-Urn Chinook Salmon (*Oncorhynchus Tshawytscha*): Interactions among Photoperiod and Growth Modulate Smolting and Early Male Maturation. *Canadian Journal of Fisheries and Aquatic Sciences* 64:256-271.
- Behnke, R.J. 1992. Native trout of western North America. *Am. Fish. Soc. Monog.* 6, 275 p. American Fisheries Society, Bethesda, Maryland.

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- Benson, R. L., S. Turo, and B. W. McCovey Jr. 2007. Migration and movement patterns of green sturgeon (*Acipenser medirostris*) in the Klamath and Trinity rivers, California, USA. *Environmental Biology of Fishes* 79:269-279.
- Bigler, B.S., D.W. Wilch, and J.H. Helle. 1996. A review of size trends among North Pacific salmon (*Oncorhynchus spp.*). *Canadian Journal of Fisheries and Aquatic Sciences*. 53:455-465.
- Boles, G. L. 1988. Water Temperature Effects on Chinook Salmon with Emphasis on the Sacramento River: A Literature Review. California Department of Water Resources, 48 pp.
- Botsford, L. W. and J. G. Brittnacher. 1998. Viability of Sacramento River Winter-Run Chinook Salmon. *Conservation Biology* 12(1):65-79.
- Bradley, C. E., and D. G. Smith. 1986. Plains cottonwood recruitment and survival on a prairie meandering river floodplain, Milk River, southern Alberta and northern Montana. *Canadian Journal of Botany* 64: 1433-1442.
- Brice, J. 1977. Lateral migration of the middle Sacramento River, California. *Water-Resources Investigations* 77-43. U. S. Geological Survey, Menlo Park, California.
- Brown, K. 2007. Evidence of spawning by green sturgeon, *Acipenser medirostris*, in the upper Sacramento River, California. *Environmental Biology of Fishes* 79:297-303.
- Busby, P. J., T. C. Wainwright, G. J. Bryant., L. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon and California. U.S. Department of Commerce, National Oceanic and Atmospheric Administration Technical Memo NMFS-NWFSC-27. 261 pages.
- California Department of Fish and Game. 1990. Status and management of spring-run chinook salmon. Page 33 in I. F. D. California Department of Fish and Game, editor., Sacramento, CA.
- California Department of Fish and Game. 1991. Lower Yuba River Fisheries Management Plan. Final Report. Stream Evaluation Report Number 91-1. February 1991.
- California Department of Fish and Game. 1995. Adult steelhead counts in Mill and Deer Creeks, Tehama County, October 1993-June 1994. Inland Fisheries Administrative Report Number 95-3
- California Department of Fish and Game California Steelhead Fishing Report-Restoration Card: A Report to the Legislature. July 2007.
- California Department of Fish and Game. 1998. A status review of the spring-run run Chinook salmon in the Sacramento River drainage. Report to the Fish and Game Commission. Candidate species status report 98-1. June 1998. Sacramento, California. 394 pages.

- 
- California Department of Fish and Game. 2002. California Department of Fish and Game comments to NMFS regarding green sturgeon listing. 79 pages plus appendices.
- California Department of Fish and Game. Unpublished data. 2011. Aerial salmon redd survey excel tables.
- California Department of Fish and Game. 1999-2011. Knights Landing Rotary Screw Trap Data.
- California Department of Fish and Game. 2012. Grandtab Spreadsheet of Adult Chinook Escapement in the Central Valley. <http://www.calfish.org/tabid/104/Default.aspx>.
- California Department of Water Resources. 2001. Initial Information Package, Relicensing of the Oroville Facilities, California.
- California Department of Water Resources. 2004. Evaluation of the timing, magnitude and frequency of water temperatures and their effects on Chinook salmon egg and alevin survival. SP-F10, Task 2C, Final Report Oroville Facilities relicensing FERC Project 2100. California Department of Water Resources, Sacramento, CA.
- California Department of Water Resources. 2010. Draft Hatchery and Genetic Management Plan. December 2010.
- Calkins, R.D., W.F. Durand, and W.H. Rich. 1940. Report of the Board of Consultants on the fish problem of the upper Sacramento River. Stanford University, Stanford, CA, 34 pages.
- cbec, inc. and ICF International. 2013. West Sacramento Southport EIP Task Order 4: Development of design criteria for sustainability of the levee offset area. Prepared for HDR Engineering, Inc. and West Sacramento Area Flood Control Agency.
- Central Valley Regional Water Quality Control Board. 2009. The Water Quality Control Plan for the California Regional Water Quality Control Board (Basin Plan) Central Valley Region—The Sacramento River Basin and The San Joaquin River Basin, fourth edition. September 15, 1998. Revised September 2009. Sacramento, CA.
- Clark, G.H. 1929. Sacramento-San Joaquin salmon (*Oncorhynchus tshawytscha*) fishery of California Division of Fish and Game. Fish Bulletin 17. p 1–73.
- Cramer Fish Sciences. 2013. Memo: Green Sturgeon Observations at Daguerre Point Dam, Yuba River, CA. June 7, 2011.
- Daughton, C.G. 2003. Cradle-to-cradle stewardship of drugs for minimizing their environmental disposition while promoting human health. I. Rationale for and avenue toward a green pharmacy. Environmental Health Perspectives 111:757-774.

- 
- del Rosario, R. B., Y. J. Redler, K. Newman, P. L. Brandes, T. Sommer, K. Reece, and R. Vincik. 2013. Migration Patterns of Juvenile Winter-Run-Sized Chinook Salmon (*Oncorhynchus Tshawytscha*) through the Sacramento–San Joaquin Delta. *San Francisco Estuary and Watershed Science* 11(1):1-22.
- Deng, X., J. P. Van Eenennaam, and S. I. Doroshov. 2002. Comparison of early life stages and growth of green and white sturgeon. *In*: W. Van Winkle, P.J. Anders, D.H. Secor, and D.A. Dixon, editors, *Biology, management, and protection of North American sturgeon*, pages 237-248. American Fisheries Society, Symposium 28, Bethesda, Maryland.
- Dettinger, M.D., D.R. Cayan, M.K. Meyer, and A.E. Jeton. 2004. Simulated hydrological responses to climate variations and changes in the Merced, Carson, and American River basins, Sierra Nevada, California, 1900-2099. *Climatic Change* 62:283-317.
- DuBois, J., M. Gingras, and R. Mayfield. 2009. 2008 sturgeon fishing report card: preliminary data report. California Department of Fish and Game, Stockton, California.
- DuBois, J., B. Beckett, and T. Matt. 2010. 2009 sturgeon fishing report card: preliminary data report. California Department of Fish and Game, Stockton, California.
- DuBois, J., T. Matt, and T. MacColl. 2011. 2010 sturgeon fishing report card: preliminary data report. California Department of Fish and Game, Stockton, California.
- DuBois, J., T. MacColl, and E. Haydt. 2012. 2011 sturgeon fishing report card: preliminary data report. California Department of Fish and Game, Stockton, California.
- Dubrovsky, N.M., D.L. Knifong, P.D. Dileanis, L.R. Brown, J.T. May, V. Connor, and C.N. Alpers. 1998. Water quality in the Sacramento River basin. U.S. Geological Survey Circular 1215.
- Dubrovsky, N.M., C.R. Kratzer, L.R. Brown, J.M. Gronberg, and K.R. Burow. 2000. Water quality in the San Joaquin-Tulare basins, California, 1992-95. U.S. Geological Survey Circular 1159.
- Dumbauld, B.R., Holden, D.L., and Langness, O.P. 2008. Do sturgeon limit burrowing shrimp populations in Pacific Northwest Estuaries? *Environmental Biology of Fishes*. 83: 283-296.
- Eilers, C.D., J. Bergman, and R. Nielson. 2010. A comprehensive monitoring plan for steelhead in the California Central Valley. California Department of Fish and Game. Fisheries Branch, administrative report number 2010-2. October 2010.
- Emmett, R. L., S. A. Hinton, S. L. Stone, and M. E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in West Coast estuaries, Volume II: Species life history summaries. ELMR Report No. 8. NOAA/NOS Strategic Environmental Assessments Division, Rockville, Maryland. 329 pages.

- 
- Environmental Protection Information Center, Center for Biological Diversity, and Waterkeepers Northern California. 2001. Petition to list the North American green sturgeon (*Acipenser medirostris*) as an endangered or threatened species under the endangered species act. National Marine Fisheries Service.
- Erickson, D.L. and J.E. Hightower. 2007. Oceanic distribution and behavior of green sturgeon. *American Fisheries Society Symposium* 56:197-211.
- Erickson, D. L., J. A. North, J. E. Hightower, J. Weber, L. Lauck. 2002. Movement and habitat use of green sturgeon *Acipenser medirostris* in the Rogue River, Oregon, USA. *Journal of Applied Ichthyology* 18:565-569.
- Everest, F.H., and D.W. Chapman. 1972. Habitat selection and spatial interaction by juvenile Chinook salmon and steelhead trout in two Idaho streams. *Journal of the Fisheries Research Board of Canada* 29: 91-100.
- Fairey, R., K. Taberski, S. Lamerdin, E. Johnson, R. P. Clark, J. W. Downing, J. Newman, and M. Petreas. 1997. Organochlorines and other environmental contaminants in muscle tissues of sportfish collected from San Francisco Bay. *Marine Pollution Bulletin* 34:1058-1071.
- Farr, Ruth A., Kern, Chris J. 2005. Final Summary Report: Green Sturgeon Population Characteristics in Oregon. Project Number: F-178-R. Oregon Department of Fish and Wildlife. 73 pages.
- Feist, G. W., M. A. H. Webb, D. T. Gundersen, E. P. Foster, C. B. Schreck, A. G. Maule, and M. S. Fitzpatrick. 2005. Evidence of detrimental effects of environmental contaminants on growth and reproductive physiology of white sturgeon in impounded areas of the Columbia River. *Environmental Health Perspectives* 113:1675-1682.
- Federal Energy Regulatory Commission. 2007. Final Environmental Impact Statement. Oroville Facilities. May 18, 2007.
- FishBio. 2012a. San Joaquin Basin Newsletter. Volume 2012. Issue 15.
- FishBio. 2012b. San Joaquin Basin Newsletter. Volume 2012. Issue 15.
- FishBio. 2013. Unpublished data. Section 10(a)(1)(A) Permit #16531. Annual Report submitted to NMFS through Applications and Permits for Protected Species database. <https://apps.nmfs.noaa.gov>.
- Fisher, F. W. 1994. Past and Present Status of Central Valley Chinook Salmon. *Conservation Biology* 8(3):870-873.

- 
- Fontaine, B.L. 1988. An evaluation of the effectiveness of instream structures for steelhead trout rearing habitat in the Steamboat Creek basin. Masters Thesis. Oregon State University, Corvallis, Oregon.
- Foster, E. P., M. S. Fitzpatrick, G. W. Feist, C. B. Schreck, and J. Yates. 2001a. Gonad organochlorine concentrations and plasma steroid levels in white sturgeon (*Acipenser transmontanus*) from the Columbia River, USA. *Bulletin of Environmental Contamination and Toxicology* 67:239-245.
- Foster, E. P., M. S. Fitzpatrick, G. W. Feist, C. B. Schreck, J. Yates, J. M. Spitsbergen, and J. R. Heidel. 2001b. Plasma androgen correlation, EROD induction, reduced condition factor, and the occurrence of organochlorine pollutants in reproductively immature white sturgeon (*Acipenser transmontanus*) from the Columbia River, USA. *Archives of Environmental Contamination and Toxicology* 41:182-191.
- Franks, Sierra. NMFS. Personal Communication, 2012.
- Geist, D. R., C. S. Abernethy, K. D. Hand, V. I. Cullinan, J. A. Chandler, and P. A. Groves. 2006. Survival, Development, and Growth of Fall Chinook Salmon Embryos, Alevins, and Fry Exposed to Variable Thermal and Dissolved Oxygen Regimes. *Transactions of the American Fisheries Society* 135:1462-1477.
- Gerrity, P. C., C. S. Guy, and W. M. Gardner. 2006. Juvenile pallid sturgeon are piscivorous: a call for conserving native cyprinids. *Transactions of the American Fisheries Society* 135:604 - 609.
- Gerstung, E. 1971. Fish and Wildlife Resources of the American River to be affected by the Auburn Dam and Reservoir and the Folsom South Canal, and measures proposed to maintain these resources. California Department of Fish and Game.
- Gleason, E., M. Gingras, and J. DuBois. 2008. 2007 sturgeon fishing report card: preliminary data report. California Department of Fish and Game, Stockton, California.
- Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESU of West Coast salmon and steelhead. U.S. Department of Commerce, NOAA Technical Memo. NMFS-NWFSC-66, 598 pages.
- Hallock, R.J., D.H. Fry, and D.A. LaFaunce. 1957. The use of wire fyke traps to estimate the runs of adult salmon and steelhead in the Sacramento River. California Fish and Game. Volume 43, No. 4, pages 271-298.
- Hallock, R. J. and F. W. Fisher. 1985. Status of Winter-Run Chinook Salmon, *Oncorhynchus Tshawytscha*, in the Sacramento River. 28 pp.
- Hallock, R.J. 1989. Upper Sacramento River Steelhead, *Oncorhynchus mykiss*, 1952-1988. A report to the U.S. Fish and Wildlife USFWS.

- 
- Hallock, R. J., W. F. Van Woert, and L. Shapovalov. 1961. An evaluation of stocking hatchery-reared steelhead rainbow trout (*Salmo gairdnerii gairdnerii*) in the Sacramento River system. California Department of Fish and Game. Fish Bulletin No. 114. 74 pages.
- Hartman, G.F. 1965. The role of behavior in the ecology and interaction of under-yearling coho salmon (*Oncorhynchus kistuch*) and steelhead trout (*Salmo gairdnerii*). Journal of the Fisheries Research Board of Canada 22: 1035-1081.
- Harvey, C. 2002. Personal communication. California Department of Fish and Game, Redding, California.
- Hatchery Scientific Review Group (HSRG). 2004. California Hatchery Review Report. Prepared for the US Fish and Wildlife Service and Pacific State Marine Fisheries Commission.
- Hayhoe, K.D. Cayan, C.B. Field, P.C. Frumhoff, E.P. Maurer, N.L. Miller, S.C. Moser, S.H. Schneider, K.N. Cahill, E.E. Cleland, L. Dale, R. Drapek, R.M. Hanemann, L.S. Kalkstein, J. Lenihan, C.K. Lunch, R.P. Neilson, S.C. Sheridan, and J.H. Verville. 2004. Emissions pathways, climate change, and impacts on California. Proceedings of the National Academy of Sciences of the United States of America. 101(34)12422-12427.
- Healey, M. C. 1991. Life History of Chinook Salmon (*Oncorhynchus Tshawytscha*). Pages 311-394 in Pacific Salmon Life Histories, C. Groot and L. Margolis, editors. UBC Press, Vancouver.
- Healey, M. C. 1994. Variation in the Life-History Characteristics of Chinook Salmon and Its Relevance to Conservation of the Sacramento Winter Run of Chinook Salmon. Conservation Biology 8(3):876-877.
- Herren, J.R. and S.S. Kawasaki. 2001. Inventory of water diversions in four geographic areas in California's Central Valley. Pages 343-355. In: Contributions to the Biology of Central Valley Salmonids. R.L. Brown, editor. Volume. 2. California Fish and Game. Fish Bulletin 179.
- Heublein, J.C. 2006. Migration of green sturgeon *Acipenser medirostris* in the Sacramento River. Master of Science Thesis. California State University, San Francisco. October 2006. 63 pages.
- Heublein, J.C., J.T. Kelly, C.E. Crocker, A.P. Klimley, and S.T. Lindley. 2009. Migration of green sturgeon, *Acipenser medirostris*, in the Sacramento River. Environmental Biology of Fish 84: 245-258.
- Huang, B. and Z. Liu. 2000. Temperature Trend of the Last 40 Years in the Upper Pacific Ocean. Journal of Climate 4:3738-3750.

- 
- ICF International. 2013. *Southport Sacramento River Early Implementation Project Environmental Impact Statement/Environmental Impact Report*. Draft. November. (ICF 00071.11.) Sacramento, CA. Prepared for: U.S. Army Corps of Engineers, Sacramento, CA, and West Sacramento Area Flood Control Agency, West Sacramento, CA.
- Intergovernmental Panel on Climate Change. 2001. *Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change* [Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, New York, USA. 881 pages.
- Israel, J.A., J.F. Cordes, M.A. Blumberg, and B. May. 2004. Geographic patterns of genetic differentiation among collections of green sturgeon. *North American Journal of Fisheries Management* 24:922-931.
- Israel, J.A. and Klimley A.P. 2008. Life History Conceptual Model for North American Green Sturgeon (*Acipenser medirostris*). December 27, 2008. Reviewed.
- Israel, J.A. and B. May. 2010. "Indirect genetic estimates of breeding population size in the polyploid green sturgeon (*Acipenser medirostris*)". *Molecular Ecology* 19:1058-1070.
- Jones and Stokes Associates, Inc. 2002. Foundation runs report for restoration action gaming trials. Prepared for Friant Water Users Authority and Natural Resource Defense Council.
- Garza, J. C. and Pearse, D. E. 2008. Population genetic structure of *Oncorhynchus mykiss* in the California Central Valley. Report to California Department of Fish and Game.
- Kelly, J.T., A.P. Klimley, and C.E. Crocker. 2007. Movements of green sturgeon, *Acipenser medirostris*, in the San Francisco Bay Estuary, CA. *Environmental Biology of Fishes* 79(3-4): 281-295.
- Kjelson, M.A., P.F. Raquel, and F.W. Fisher. 1982. Life history of fall-run juvenile Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento-San Joaquin estuary, California, pp. 393-411. *In*: V.S. Kennedy (ed.). *Estuarine comparisons*. Academic Press, New York, NY.
- Kjelson, M. A., P. F. Raquel, and F. W. Fisher. 1982. Life history of fall-run juvenile Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento-San Joaquin estuary, California. Pages 393-411 *in* V. S. Kennedy, editor. *Estuarine comparisons*. Academic Press, New York.
- Klimley, A.P. 2002. Biological assessment of green sturgeon in the Sacramento-San Joaquin watershed. A proposal to the California Bay-Delta Authority.

- 
- Kogut, N. 2008. Overbite clams, *Corbula amerensis*, defecated alive by white sturgeon, *Acipenser transmontanus*. *California Fish and Game* 94:143-149.
- Kruse, G.O. and D.L. Scarnecchia. 2002. Assessment of bioaccumulated metal and organochlorine compounds in relation to physiological biomarkers in Kootenai River white sturgeon. *Journal of Applied Ichthyology* 18:430-438.
- Kynard, B., E. Parker, and T. Parker. 2005. Behavior of early life intervals of Klamath River green sturgeon, *Acipenser medirostris*, with note on body color. *Environmental Biology of Fishes* 72:85-97.
- Laetz, C. A., D. H. Baldwin, T. K. Collier, V. Hebert, J. D. Stark, and N. L. Scholz. 2009. The Synergistic Toxicity of Pesticide Mixtures: Implications for Risk Assessment and the Conservation of Endangered Pacific Salmon. *Environmental Health Perspectives*, Vol. 117, No.3:348-353.
- Latta, F.F. 1977. *Handbook of Yokuts Indians*. Bear State Books, Santa Cruz, California. 765 pp.
- Leider, S.A., M.W. Chilcote, and J.J. Loch. 1986. Movement and survival of presmolt steelhead in a tributary and the mainstem of a Washington river. *North American Journal of Fisheries Management* 6: 526-531.
- Lindley, S. and M. Mohr. 2003. Modeling the Effect of Striped Bass (*Morone saxatilis*) on the Population Viability of Sacramento River Winter-Run Chinook Salmon (*Oncorhynchus tshawytscha*). *Fishery Bulletin* 101(2):321-331.
- Lindley, S.T., R. Schick, B.P. May, J.J. Anderson, S. Greene, C. Hanson, A. Low, D. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2004. Population structure of threatened and endangered Chinook salmon ESU in California's Central Valley basin. Public review draft NMFS Southwest Science Center. Santa Cruz, CA.
- Lindley, S. T., R. Schick, A. Agrawal, M. Goslin, T. Pearson, E. Mora, J.J. Anderson, B. May, S. Greene, C. Hanson, A. Low, D. McEwan, R.B. MacFarlane, C. Swanson, and J. G. Williams. 2006. Historical population structure of California Central Valley steelhead and its alteration by dams. *San Francisco Estuary and Watershed Science* 4(1)(3):1-19. <http://repositories.cdlib.org/jmie/sfews/vol4/iss1/art3>
- Lindley, S.T., R. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. P. May, D. R. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2007. Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin Basin. *San Francisco Estuary and Watershed Science* 5(1), Article 4: 26 pages. California Bay-Delta Authority Science Program and the John Muir Institute of the Environment.

- 
- Lindley, S.T., M.L. Moser, D.L. Erickson, M. Belchik, D.W. Welch, E.L. Rechisky, J.T. Kelley, J. Heublein and A.P. Klimley. 2008. Marine migration of North American green sturgeon. Transactions of the American Fisheries Society. 137:182-194.
- Lindley, S. T., M. S. M. C. B. Grimes, W. Peterson, J. Stein, J. T. Anderson,, L.W. Botsford, D. L. Bottom, C. A. Busack, T. K. Collier, J. Ferguson, J. C. Garza,, D. G. H. A. M. Grover, R. G. Kope, P. W. Lawson, A. Low, R. B. MacFarlane,, M. P.-Z. K. Moore, F. B. Schwing, J. Smith, C. Tracy, R. Webb,, and T. H. W. B. K. Wells. 2009. What Caused the Sacramento River Fall Chinook Stock Collapse?
- Lindley, S. T., D. L. Erickson, *et al.* 2011. "Electronic Tagging of Green Sturgeon Reveals Population Structure and Movement among Estuaries." Transactions of the American Fisheries Society 140(1): 108-122.
- Linville, R.G., S.N. Luoma, L. Cutter, and G.A. Cutter. 2002. Increased selenium threat as a result of invasion of the exotic bivalve *Potamocorbula amurensis* into the San Francisco Bay-Delta. Aquatic Toxicology 57: 51-64.
- Lister, D.B. and H.S. Genoe. 1970. Stream habitat utilization by cohabiting underyearlings of (*Oncorhynchus tshawytscha*) and coho (*O. kisutch*) salmon in the Big Qualicum River, British Columbia. J. Fish. Res. Board Can. 27:1215-1224.
- Loch, J.J., S. A. Leider, M. W. Chilcote, R. Cooper, and T. H. Johnson. 1988. Differences in yield, emigration timing, size, and age structure of juvenile steelhead from two small western Washington streams. California Fish and Game 74:106–118
- Mahoney, J. M., and S. B. Rood. 1998. Streamflow requirements for cottonwood seedling recruitment -an integrative model. Wetlands 18: 634-645.
- Marston. 2004. Personal Communication with Mike Aceituno. Senior Biologist/Supervisor, CDFG.
- Martin, C. D., P. D. Gaines, and R. R. Johnson. 2001. Estimating the Abundance of Sacramento River Juvenile Winter Chinook Salmon with Comparisons to Adult Escapement. U.S. Fish and Wildlife Service.
- Matala, A. P., S. R. Narum, W. Young, and J. L. Vogel. 2012. Influences of Hatchery Supplementation, Spawner Distribution, and Habitat on Genetic Structure of Chinook Salmon in the South Fork Salmon River, Idaho. North American Journal of Fisheries Management 32(2):346-359.
- Mayfield, R.B. and J.J. Cech, Jr. 2004. Temperature Effects on green sturgeon bioenergetics. Transactions of the American Fisheries Society 133:961-970.

- 
- McCullough, D., S. Spalding, D. Sturdevant, M. Hicks. 2001. Issue Paper 5. Summary of technical literature examining the physiological effects of temperature on salmonids. Prepared as part of U.S. EPA Region 10 Temperature Water Quality Criteria Guidance Development Project. EPA-910-D-01-005. Available at <http://yosemite.epa.gov/R10/WATER.NSF/1507773cf7ca99a7882569ed007349b5/ce95a3704aeb5715882568c400784499?OpenDocument>
- McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. NOAA Tech. Memo. NMFS-NWFSC-42. U.S. Dept. of Commerce. National Oceanic and Atmospheric Administration. National Marine Fisheries Service. 156 pages.
- McEwan, D. 2001. California Central Valley steelhead. *In* R .L. Brown (editor), Contributions to the Biology of Central Valley Salmonids, Volume 1, pages 1-44. California Department of Fish and Game, Fish Bulletin 179.
- McEwan, D. and T. A. Jackson. 1996. Steelhead restoration and management plan for California. California Department of Fish and Game. Sacramento, California. 234 pages.
- McReynolds, T. R., C. E. Garman, P. D. Ward, and S. L. Plemons. 2007. Butte and Big Chico Creeks Spring-Run Chinook Salmon, *Oncorhynchus tshawytscha*, Life History Investigation 2005-2006. *in* California Department of Fish and Game, editor.
- Meehan, W. R. and T. C. Bjornn. 1991. Salmonid distributions and life histories. *In* W. R. Meehan, editor, Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, pages 47-82. American Fisheries Society Special Publication 19. American Fisheries Society. Bethesda, Maryland. 751 pages.
- Merz, J.E. 2002. Seasonal feeding habits, growth, and movement of steelhead trout in the lower Mokelumne River, California. *California Fish and Game* 88(3): 95-111.
- Michel, C. J. 2010. River and Estuarine Survival and Migration of Yearling Sacramento River Chinook Salmon (*Oncorhynchus Tshawytscha*) Smolts and the Influence of Environment. Master's Thesis. University of California, Santa Cruz, Santa Cruz.
- Michel, C. J., A. J. Ammann, E. D. Chapman, P. T. Sandstrom, H. E. Fish, M. J. Thomas, G. P. Singer, S. T. Lindley, A. P. Klimley, and R. B. MacFarlane. 2012. The Effects of Environmental Factors on the Migratory Movement Patterns of Sacramento River Yearling Late-Fall Run Chinook Salmon (*Oncorhynchus Tshawytscha*). *Environmental Biology of Fishes*.
- Moser, M.L. and S.T. Lindley. 2007. Use of Washington estuaries by subadult and adult green sturgeon. *Environmental Biology of Fishes*. 79:243-253.

- 
- Moyle, P.B., P.J. Foley, and R.M. Yoshiyama. 1992. Status of green sturgeon, *Acipenser medirostris*, in California. Final report sent to NMFS, Terminal Island, California by UC Davis Department of Wildlife and Fisheries Biology. 12 pages.
- Moyle, P.B., R.M. Yoshiyama, J.E. Williams, and E.D. Wikramanayake. 1995. Fish Species of Special Concern in California. Second edition. Final report to CA Department of Fish and Game, contract 2128IF.
- Moyle, P.B. 2002. Inland fish of California, 2nd edition. University of California Press, Berkeley, California.
- Muir, W. D., G. T. McCabe, Jr., M. J. Parsley, and S. A. Hinton. 2000. Diet of first feeding larval and young-of-the-year white sturgeon in the lower Columbia River. Northwest Science 74:25-33.
- Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lieberheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. Technical Memorandum NMFS-NWFSC-35. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 443 pages.
- Nakamoto, R. J., T. T. Kisanuki, and G. H. Goldsmith. 1995. Age and growth of Klamath River green sturgeon (*Acipenser medirostris*). U.S. Fish and Wildlife USFWS. Project # 93-FP-13. 20 pages.
- National Marine Fisheries Service. 1996. Factors for decline: a supplement to the notice of determination for west coast steelhead under the Endangered Species Act. National Marine Fisheries Service, Protected Resource Division, Portland, OR and Long Beach, California.
- National Marine Fisheries Service. 1997. NMFS Proposed Recovery Plan for the Sacramento River Winter-Run Chinook Salmon. U.S. Department of Commerce, 340 pp.
- National Marine Fisheries Service. 2005. Green sturgeon (*Acipenser medirostris*) status review update, February 2005. Biological review team, Santa Cruz Laboratory, Southwest Fisheries Science Center. 31 pages.
- National Marine Fisheries Service. 2009a. Biological opinion and Conference opinion on the Long-Term Operations of the Central Valley Project and State Water Project. National Marine Fisheries Service, Southwest Region. June 4, 2009
- National Marine Fisheries Service. 2009b. Public Draft Central Valley Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon, and the Distinct Population Segment of California Central Valley Steelhead. Southwest Region Protected Resources Division, 273 pp.

- 
- National Marine Fisheries Service. 2010. Letter from Rodney R. McGinnis, NMFS, to Mark Helvey, NMFS, transmitting the 2010 Biological Opinion on the proposed action of continued management of west coast ocean salmon fishery in accordance with the Pacific Coast Salmon Fishery Plan. April 30, 2010. 95 pages.
- National Marine Fisheries Service. 2010a. Federal Recovery Outline North American Green Sturgeon Southern Distinct Population Segment. Page 23.
- National Marine Fisheries Service. 2011. 5-Year Review: Summary and Evaluation of Sacramento River Winter-Run Chinook Salmon. U.S. Department of Commerce, 38 pp.
- National Marine Fisheries Service. 2011a. Central Valley Recovery Domain. 5-Year Review: Summary and Evaluation of *Sacramento River Winter-run Chinook Salmon ESU*. National Marine Fisheries Service, Southwest Region. 38 pages.
- National Marine Fisheries Service. 2011b. Central Valley Recovery Domain. 5-Year Review: Summary and Evaluation of *Central Valley Spring-run Chinook Salmon ESU*. National Marine Fisheries Service, Southwest Region. 34 pages.
- National Marine Fisheries Service. 2011c. Central Valley Recovery Domain. 5-Year Review: Summary and Evaluation of *Central Valley Steelhead DPS*. National Marine Fisheries Service, Southwest Region. 34 pages.
- National Marine Fisheries Service. 2014. Winter-Run Chinook Salmon Juvenile Production Estimate for 2014. Page 14 in National Marine Fisheries Service, editor., Sacramento, CA.
- Nielsen, J.L., S. Pavey, T. Wiacek, G.K. Sage, and I. Williams. 2003. Genetic analyses of Central Valley trout populations, 1999-2003. Final Technical Report to the California Department of Fish and Game, Sacramento, California. December 8, 2003.
- Nilo, P., S. Tremblay, A. Bolon, J. Dodson, P. Dumont, and R. Fortin. 2006. Feeding Ecology of Juvenile Lake Sturgeon in the St. Lawrence River System. *Transactions of the American Fisheries Society* 135:1044 – 1055.
- Noakes, D. J. 1998. On the coherence of salmon abundance trends and environmental trends. *North Pacific Anadromous Fishery Commission Bulletin*, pages 454-463.
- Nobriga, M. and P. Cadrett. 2003. Differences among hatchery and wild steelhead: evidence from Delta fish monitoring programs. *Interagency Ecological Program for the San Francisco Estuary Newsletter* 14:3:30-38.
- Northwest Power and Conservation Council (NPCC), 2003. Columbia River Basin Fish and Wildlife Program. Available at <http://www.nwcouncil.org/library/2003/2003-20/default.htm>.

- 
- Null, R.E. Niemela KS, Hamelberg SF. 2013. Post-spawn migrations of hatchery-origin *Oncorhynchus mykiss* kelts in the Central Valley of California. *Environ Biol Fish.* doi: 10.1007/s10641-012-0075-5.
- Nguyen, R.M., and Crocker, C.E. 2006. The effects of substrate composition of foraging behavior and growth rate of larval green sturgeon, *Acipenser medirostris*. *Environ. Biol. Fish* 76: 129 - 138.
- Pacific Fishery Management Council. 1999. Description and identification of essential fish habitat, adverse impacts and recommended conservation measures for salmon. Amendment 14 to the Pacific Coast Salmon Plan, Appendix A. Pacific Fisheries Management Council, Portland, Oregon.
- Peterson, J. H. and J. F. Kitchell. 2001. Climate regimes and water temperature changes in the Columbia River: Bioenergetic implications for predators of juvenile salmon. *Canadian Journal of Fisheries and Aquatic Sciences.* 58:1831-1841.
- Peven, C.M., R.R. Whitney, and K.R. Williams. 1994. Age and length of steelhead smolts from mid-Columbia River basin, Washington. *North American Journal of Fisheries Management* 14: 77-86.
- Poytress, W.R., J.J. Gruber, D.A. Trachtenbarg, and J.P. Van Eenennaam. 2009. 2008 Upper Sacramento River Green Sturgeon Spawning Habitat and Larval Migration Surveys. Annual Report of U.S. Fish and Wildlife Service to US Bureau of Reclamation, Red Bluff, CA.
- Poytress, W. R. and F. D. Carrillo. 2011. Brood-Year 2008 and 2009 Winter Chinook Juvenile Production Indices with Comparisons to Juvenile Production Estimates Derived from Adult Escapement., 51 pp.
- Poytress, W. R., J. J. Gruber, and J. P. Van Eenennaam. 2012. 2011 upper Sacramento River Green Sturgeon spawning habitat and larval migration surveys. Final Annual Report to U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, Red Bluff, California.
- Quinn, T. P. 2005. *The Behavior and Ecology of Pacific Salmon and Trout.* University of Washington Press, Canada.
- Radtke, L. D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta with observations on food of sturgeon, in *Ecological studies of the Sacramento-San Joaquin Delta, Part II.* (J. L. Turner and D. W. Kelley, comp.). California Department of Fish and Game Fish Bulletin 136:115-129.

- 
- Reiser, D.W., and T.C. Bjornn. 1979. Influence of forest and rangeland management on anadromous fish habitat in western North America: Habitat requirements of anadromous salmonids. U.S. Department of Agriculture, Forest Service General Technical Report PNW-96. Pacific Northwest Forest and Range Experimental Station, Portland, Oregon. 54 pp.
- Reynolds, F. L., T. J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley streams: a plan for action. California Department of Fish and Game, Inland Fisheries Division, Sacramento, California.
- Richter, A. and S. A. Kolmes. 2005. Maximum Temperature Limits for Chinook, Coho, and Chum Salmon, and Steelhead Trout in the Pacific Northwest. *Reviews in Fisheries Science* 13:23-49:28.
- Roberts, M. D., D. R. Peterson, D. E. Jukkola, and V. L. Snowden. 2001. A pilot investigation of cottonwood recruitment on the Sacramento River. Draft report. The Nature Conservancy, Sacramento River Project, Chico, California.
- Rutter, C. 1904. Natural history of the quinnat salmon. Investigations on Sacramento River, 1896-1901. *Bulletin of the U.S. Fish Commission*. 22:65-141.
- Satterthwaite, W.H, M.P. Beakes, E.M. Collins, D.R. Swank, J.E. Merz, R.G. Titus, S.M. Sogard, and M. Mangel. 2010. State-dependent life history models in a changing (and regulated) environment: steelhead in the California Central Valley. *Evolutionary Applications* 3: 221-243.
- Seymour, A. H. 1956. Effects of Temperatuer on Young Chinook Salmon. University of Washington.
- S.P. Cramer and Associates, Inc. 2000. Stanislaus River data report. Oakdale California.
- S.P. Cramer and Associates, Inc. 2001. Stanislaus River data report. Oakdale California.
- Schaffter, R. 1980. Fish occurrence, size, and distribution in the Sacramento River near Hood, California during 1973 and 1974. California Department of Fish and Game.
- Schaffter, R. 1997. White sturgeon spawning migrations and location of spawning habitat in the Sacramento River, California. *California Department of Fish and Game* 83:1-20.
- Schreiber, M.R. 1962. Observations on the food habits of juvenile white sturgeon. *California Fish and Game* 48:79-80.
- Scott, M. L., G. T. Auble, and J. M. Friedman. 1997. Flood dependency of cottonwood establishment along the Missouri River, Montana, USA. *Ecological Applications* 7: 677-690.
- Scott, M. L., P. B. Shafroth, and G. T. Auble. 1999. Responses of riparian cottonwoods to alluvial watertable declines. *Environmental Management* 23: 347-358.

- 
- Seesholtz, A. M., M. J. Manuel, and J. P. Van Eenennaam. 2015. First documented spawning and associated habitat conditions for green sturgeon in the Feather River, California. *Environmental Biology of Fishes* 98:905-912.
- Seelbach, P.W. 1993. Population biology of steelhead in a stable-flow, low-gradient tributary of Lake Michigan. *Transactions of the American Fisheries Society* 122: 179-198.
- Shapovalov, L. and A.C. Taft 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. California Department of Fish and Game, Fish Bulletin 98:1-375.
- Sillman, A.J., A.K. Beach, D.A. Dahlin, and E.R. Loew. 2005. Photoreceptors and visual pigments in the retina of the fully anadromous green sturgeon (*Acipenser medirostris*) and the potamodromous pallid sturgeon (*Scaphirhynchus albus*). *Journal of Comparative Physiology*. 191:799-811.
- Slater, D. W. 1963. Winter-Run Chinook Salmon in the Sacramento River, California with Notes on Water Temperature Requirements at Spawning. US Department of the Interior, Bureau of Commercial Fisheries.
- Snider, B. and R. G. Titus. 2000. Timing, composition, and abundance of juvenile anadromous salmonid emigration in the Sacramento River near Knights Landing, October 1996-September 1997. California Department of Fish and Game, Habitat Conservation Division, Stream Evaluation Program Technical Report No. 00-04.
- Snider, B., B. Reavis, and S. Hill. 2001. Upper Sacramento River Winter-Run Chinook Salmon Escapement Survey, May-August 2000. California Department of Fish and Game, Stream Evaluation Program Technical Report No. 01-1.
- Spina, A.P. 2006. Thermal ecology of juvenile steelhead in a warm-water environment. *Environmental Biology of Fishes* 80: 23-34.
- Stachowicz, J. J., J. R. Terwin, R. B. Whitlatch, and R. W. Osman. 2002. Linking climate change and biological invasions: Ocean warming facilitates non-indigenous species invasions. *PNAS*, November 26, 2002. 99:15497–15500.
- Stewart, I. T., D. R. Cayan, and M. D. Dettinger. 2005. Changes toward earlier streamflow timing across western North America. *Journal of Climate* 18: 1136-1155.
- Stillwater Sciences. 2009. Sacramento River bank protection project fisheries monitoring report, 2007–2008. Final Report. Prepared by Stillwater Sciences, Berkeley, California for U.S. Army Corps of Engineers, Sacramento District, California

- 
- Stone, L. 1874. Report of operations during 1872 at the U.S. salmon-hatching establishment on the McCloud River, and on the California Salmonidae generally; with a list of specimens collected. Report to U.S. Commissioner of Fisheries for 1872-1873, 2:168-215.
- Teo, S.L., Sandstrom, P.T., Chapman, E.D., Null, R.E., Brown, K., Klimley, A.P., Block, B.A. 2011. Archival and acoustic tags reveal the post-spawning migrations, diving behavior, and thermal habitat of hatchery-origin Sacramento River steelhead kelts (*Oncorhynchus mykiss*). Environ Biol Fish DOI 10.1007/s10641-011-9938-4.
- Thomas, Michael J., Peterson, M.L., Friedenber, J.P., Van Eenennaam, J.P., Johnson, J.R., Hoover, J.H., Klimley, P. 2013. Stranding of Spawning Run Green Sturgeon in the Sacramento River: Post-Rescue Movement and Potential Population-Level Effects. North American Journal of Fisheries Management. Volume 33, Issue 2, 2013.
- Thompson, K. 1961. Riparian forests of the Sacramento Valley, California. Pages 294-315 in R. S. Platt, editor. Annals of the Association of American Geographers.
- U.S. Army Corps of Engineers. 2004. Standard assessment methodology for the Sacramento River bank protection project. Final report. Prepared by Stillwater Sciences, Davis, California and Dean Ryan Consultants & Designers, Sacramento, California for and in conjunction with U.S. Army Corps of Engineers and The Reclamation Board, Sacramento, California.
- U.S. Army Corps of Engineers. 2008. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region. Version 2.0. September. Wetlands Regulatory Assistance Program. Environmental Laboratory (ERDC/EL TR-08-28). Vicksburg, MS. [http://www.usace.army.mil/missions/civilworks/regulatoryprogramandpermits/reg\\_supp.asp](http://www.usace.army.mil/missions/civilworks/regulatoryprogramandpermits/reg_supp.asp).
- U.S. Army Corps of Engineers. 2009. 2008 Monitoring of vegetation establishment, instream woody material retention, and bank cover attributes at 29 bank repair sites and one elderberry compensation site, Sacramento River bank protection project. Final Report. Contract W91238-07-C-0002. Prepared by Stillwater Sciences, Berkeley, California for U.S. Army Corps of Engineers, Sacramento District, California.
- U.S. Army Corps of Engineers. 2012a. Standard Assessment Methodology for the Sacramento River Bank Protection Project, 2010–2012 Certification Update, Final. Prepared for U.S. Army Corps of Engineers, Sacramento District by Stillwater Sciences, Berkeley, California. Contract W91238-09-P-0249 Task Order 3.
- U.S. Army Corps of Engineers (Corps). 2012b. *Sacramento River Bank Protection Project, Phase II 80,000 Linear Feet Biological Assessment*. Draft. July. (ICF 00627.08.) Sacramento, CA. Prepared by ICF International, Sacramento, CA.
- U.S. Army Corps of Engineers (Corps). 2013. Corp's SMART Planning Guide. <http://planning.usace.army.mil/toolbox/smart.cfm?Section=1&Part=0>

- 
- U.S. Army Corps of Engineers (Corps). 2014. Biological Assessment. West Sacramento, California, General Reevaluation Study and Section 408 Permission. November 2014.
- U.S. Bureau of Reclamation. 2008. Draft Biological Assessment on the Continued Long-term Operations of the Central Valley Project and the State Water Project. U.S. Bureau of Reclamation, Mid-Pacific Region, Sacramento, CA August 2008.
- U.S. Environmental Protection Agency. 2003. Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002
- U.S. Fish and Wildlife Service. 1995. Working paper on restoration needs: habitat restoration actions to double natural production of anadromous fish in the Central Valley of California. Volumes 1-3. Prepared by the Anadromous Fish Restoration Program Core Group for the U.S. Fish and Wildlife Service, Stockton, California.
- U.S. Fish and Wildlife Service. 1998a. The Effects of Temperature on Early Life-Stage Survival of Sacramento River Fall-Run and Winter-Run Chinook Salmon. Northern Central Valley Fish and Wildlife Office, 49 pp.
- U.S. Fish and Wildlife Service. 1998b. Central Valley Project Improvement Act tributary production enhancement report. Draft report to Congress on the feasibility, cost, and desirability of implementing measures pursuant to subsections 3406(e)(3) and (e)(6) of the Central Valley Project Improvement Act. U.S. Fish and Wildlife Service, Central Valley Fish and Wildlife Restoration Program Office, Sacramento, California.
- U.S. Fish and Wildlife Service. 2001. Final Restoration Plan for the Anadromous Fish Restoration Program. U.S. Fish and Wildlife Service, 146 pp.
- U.S. Fish and Wildlife Service. 2002. Spawning areas of green sturgeon *Acipenser medirostris* in the upper Sacramento River California. U.S. Fish and Wildlife Service, Red Bluff, California.
- U. S. Fish and Wildlife. 2003. Abundance and survival of juvenile Chinook salmon in the Sacramento-San Joaquin Estuary: 1999. Annual progress report. 68 pages.
- U.S. Fish and Wildlife. 2011. Biological assessment of artificial propagation at Coleman National Fish Hatchery and Livingston Stone National Fish Hatchery: program description and incidental take of Chinook salmon and steelhead. Prepared by U.S. Fish and Wildlife Service, Red Bluff, California and the U.S. Fish and Wildlife Service, Coleman National Fish Hatchery Complex, Anderson, California.
- U.S. Fish and Wildlife and National Marine Fisheries Service. 1998. Endangered Species Consultation Handbook: Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act. March 1998. Final.

- 
- Van Eenennaam, J. P., J. Linares-Casenave, X. Deng, and S. I. Doroshov. 2005. Effect of incubation temperature on green sturgeon embryos, *Acipenser medirostris*. *Environmental Biology of Fishes* 72:145-154.
- Van Eenennaam, J. P., M. A. H. Webb, X. Deng, S. I. Doroshov, R. B. Mayfield, J. J. Cech, D. C. Hillemeier, and T. E. Willson. 2001. Artificial spawning and larval rearing of Klamath River green sturgeon. *Transactions of the American Fisheries Society* 130:159-165.
- Van Eenennaam, J.P., J. Linares-Casenave, J-B. Muguet, and S.I. Doroshov. 2009. Induced artificial fertilization and egg incubation techniques for green sturgeon. Revised manuscript to *North American Journal of Aquaculture*.
- Van Rheenen, N.T., A.W. Wood, R.N. Palmer, D.P. Lettenmaier. 2004. Potential implications of PCM climate change scenarios for Sacramento-San Joaquin river basin hydrology and water resources. *Climate Change* 62:257-281.
- Vincik, R. and J. R. Johnson. 2013. A Report on Fish Rescue Operations at Sacramento and Delevan Nwr Areas, April 24 through June 5,2013. California Department of Fish and Wildlife, 1701 Nimbus Road, Rancho Cordova, CA 95670.
- Vogel, D. and K. Marine. 1991. Guide to Upper Sacramento River Chinook Salmon Life History. U.S. Department of the Interior, 91 pp.
- Vogel, D.A. 2008. Evaluation of adult sturgeon migration at the Glenn-Colusa Irrigation District Gradient Facility on the Sacramento River. Natural Resource Scientist, Inc. May 2008. 33 pages.
- Wanner, G.A., D. A. Shuman, M. L. Brown, and D. W. Willis. 2007. An initial assessment of sampling procedures for juvenile pallid sturgeon in the Missouri River downstream of Fort Randall Dam, South Dakota and Nebraska. *Journal of Applied Ichthyology* 23:529 - 538.
- Ward, P.D., T.R. McReynolds, and C.E. Garman. 2003. Butte and Big Chico Creeks spring-run Chinook salmon, *Oncorhynchus tshawytscha* life history investigation, 2001-2002. California Department of Fish and Game, Inland Fisheries Administrative Report.
- Werner, I., J. Linares-Casenave, J.P. Van Eenennaam, and S.I. Doroshov. 2007. The effect of temperature stress on development and heat-shock protein expression in larval green sturgeon (*Acipenser medirostris*). *Environmental Biology of Fishes* 79:191-200.
- Williams, J.G. 2006. Central Valley salmon: a perspective on Chinook salmon and steelhead in the Central Valley of California. *San Francisco Estuary and Watershed Science* 4(3): Article 2. 416 pages. Available at: <http://repositories.cdlib.org/jmie/sfews/vol4/iss3/art2>.
- Williams, T. H., S. T. Lindley, B.C. Spence, and D.A. Boughton. 2011. Using viability criteria to assess status of Pacific salmon and steelhead in California. National Marine Fisheries Service. Southwest Fisheries Science Center. Santa Cruz, CA.

- 
- Workman, R. D., D. B. Hayes, and T. G. Coon. 2002. A model of steelhead movement in relation to water temperature in two Lake Michigan tributaries. *Transactions of the American Fisheries Society* 131:463–475.
- Yoshiyama, R. M., E. R. Gerstung, F. W. Fisher, and P. B. Moyle. 1996. Historical and present distribution of Chinook salmon in the Central Valley drainage of California. Sierra Nevada Ecosystem Project: final report to Congress. *In Assessments, commissioned reports, and background information, volume 3, pages 309-362.* University of California, Center for Water and Wildland Resources, Davis, California.
- Yoshiyama, R. M., F. W. Fisher, and P. B. Moyle. 1998. Historical abundance and decline of Chinook salmon in the Central Valley Region of California. *North American Journal of Fisheries Management* 18:487-521.
- Yoshiyama, R. M., E. R. Gertstung, F. W. Fisher, and P. B. Moyle. 2001. Historical and Present Distribution of Chinook Salmon in the Central Valley Drainage of California. *Fish Bulletin* 179(1):71-176.
- Zimmerman, C.E., G.W. Edwards, and K. Perry. 2009. Maternal origin and migratory history of *Oncorhynchus mykiss* captured in rivers of the Central Valley, California. *Transactions of the American Fisheries Society*. 138:280-291.

#### **Federal Register Cited**

- 54 FR 149. 1989. Endangered and Threatened Species; Critical Habitat; Winter-Run Chinook Salmon. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *Federal Register*, Pages 32085-32088.
- 55 FR 214. 1990. Endangered and Threatened Species; Sacramento River Winter-Run Chinook Salmon. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *Federal Register*, Pages 46515-46523.
- 58 FR 114. 1993. Designated Critical Habitat; Sacramento River Winter-Run Chinook Salmon. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *Federal Register*, Pages 33212-33219.
- 59 FR 2. 1994. Endangered and Threatened Species; Status of Sacramento River Winter-Run Chinook Salmon. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *Federal Register*, Pages 440-450.

- 
- 63 FR 11482-11520. March 9, 1998. Endangered and Threatened Species: Proposed Endangered Status for Two Chinook Salmon ESUs and Proposed Chinook Salmon ESUs; Proposed Redefinition, Threatened Status, and Revision of Critical Habitat for One Chinook Salmon ESU; Proposed Designation of Chinook Salmon Critical Habitat in California, Oregon, Washington, Idaho.
- 63 FR 13347. March 19, 1998. Final Rule: Notice of Determination. Endangered and Threatened Species: Threatened Status for Two ESUs of Steel head in Washington, Oregon, and California. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *Federal Register*, Volume 63 pages 13347-13371.
- 64 FR 50394. November 15, 1999. Final Rule: Threatened Status for Two Chinook Salmon Evolutionary Significant Units in California. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *Federal Register*, Volume 64 pages 50394-50415.
- 69 FR 33102. June 14, 2004. Proposed Rule: Endangered and Threatened Species: Proposed Listing Determinations for 27 ESUs of West Coast Salmonids. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *Federal Register*, Volume 69 pages 33102-33179.
- 70 FR 37160-37204. June 28, 2005. Final Rule: Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *Federal Register*, Volume 70 pages 37160-37204.
- 70 FR 52488. September 2, 2005. Final Rule: Endangered and Threatened Species: Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *Federal Register*, Volume 70 pages 52487-52627.
- 71 FR 834. January 5, 2006. Final Rule: Endangered and Threatened Species: Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *Federal Register*, Volume 71 pages 834-862.
- 71 FR 17757. April 7, 2006. Final Rule: Endangered and Threatened Wildlife and Plants: Threatened Status for Southern Distinct Population Segment of North American Green Sturgeon. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *Federal Register*, Volume 71 pages 17757-17766.

---

74 FR 52300. October 9, 2009. Endangered and Threatened Wildlife and Plants: Final Rulemaking to Designate Critical Habitat for the Threatened Southern Distinct Population Segment of North American Green Sturgeon. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. *Federal Register*, Volume 71 pages 17757-17766.

76 FR 50447-50448. August 15, 2011. Endangered and Threatened Species; 5-Year Reviews for 5 Evolutionarily Significant Units of Pacific Salmon and 1 Distinct Population Segment of Steelhead in California.