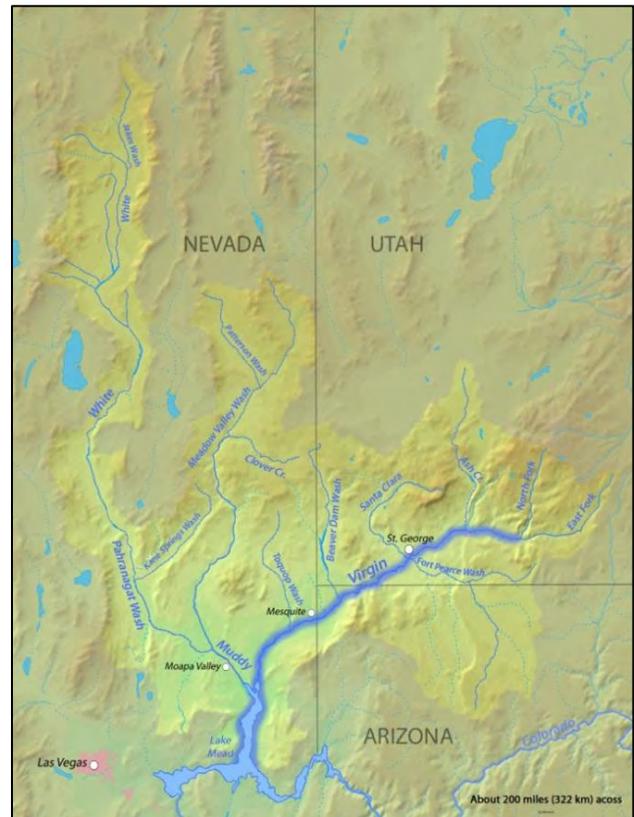


***Prospectus for an  
In-Lieu Fee Program for Watersheds of the  
Virgin River  
Muddy River  
Meadow Valley Wash***



Prepared by **Bureau of Land Management, Southern Nevada District Office**

for the **U.S. Army Corps of Engineers**

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## TABLE OF CONTENTS

- I. Introduction
- II. Objectives of the Program (§332.8(d)(2)(i))
- III. How the In-Lieu Fee Program Will Be Established and Operated (§332.8(d)(2)(ii)) 5
- IV. Proposed Service Area (§332.8(d)(2)(iii))
- V. General Need For and Technical Feasibility of the Proposed In-Lieu Fee Program (§332.8(d)(2)(iv))
- VI. Proposed Ownership Arrangements and Long-Term Management Strategy For In-Lieu Fee Project Sites (§332.8(d)(2)(v))
- VII. Qualifications of the Sponsor to Successfully Complete the Types of Mitigation Projects Proposed, Including Information Describing Any Past Activities. (§332.8(d)(2)(vi))
- VIII. Compensation Planning Framework (§§332.8(d)(2)(viii)(A) 12 and 332.8(c))
- IX. Fee Program Account (§332.8(d)(2)(viii)(B) and §332.8(i))
- X. In-Lieu Fee Program Credits (§332.8(o))
- XI. Advance Credits (§332.8(n))
- XII. References

### Appendices

- A. Contact Information
- B. Service Area Maps
- C. Parcel Information

Cover photos clockwise from right:

Map (Wikipedia <https://commons.wikimedia.org/wiki/File%3AVirginrivermap.jpg>; accessed 8-5-2015);

Muddy River (BLM photo);

Virgin River (BOR photo)

## **I. Introduction**

The U.S. Department of the Interior, Bureau of Land Management (BLM), has prepared this draft prospectus to support the creation of an In-Lieu Fee (ILF) Program for the Virgin River, Muddy River and Meadow Valley Wash in Clark County, southern Nevada. The ILF Program will guide management actions on public lands that are administered by the BLM Southern Nevada District Office (SNDO) and that will be set aside for habitat restoration, water conservation, prevention and control of unnatural soil erosion and water pollution prevention. The SNDO has field staff that will monitor and manage public lands, conduct educational programs and manage outdoor recreation, habitat restoration, fire management and other multiple uses of these public lands in Clark County and parts of Nye County, Nevada.

The SNDO is providing this prospectus for the purpose of establishing and managing an In-Lieu Fee Program within the District Office's jurisdictional area (or boundaries) for the benefit of the Virgin River, Muddy River, Meadow Valley Wash and other associated waterways in southern and eastern portions of Nevada, northwestern portion of Arizona and southwestern portion of Utah. The SNDO has been successful in establishing a previous ILF Program (Eglington Preserve) and has been carrying out mitigation and restoration projects on public lands in southern Nevada over the last twenty years. This prospectus includes the objectives of the proposed program, its establishment and operation, service area, and feasibility as well as the need for the program and the qualifications of the SNDO to provide these services.

## **II. Objectives of the Program (§332.8(d)(2)(i))**

A. The primary objective of projects developed and funded under this Program will be to replace functions and values of aquatic resources and associated habitats that have been degraded or destroyed as a result of activities conducted in compliance with or in violation of Section 404 of the Clean Water Act of 1972 and/or Section 10 of the River and Harbor Act of 1899. Specifically, the SNDO proposes to establish an In-Lieu Fee Program under the U.S. Army Corps of Engineers ("Army Corps") new rule found at 33 C.F.R. Part 332 for the purposes of offsetting environmental losses resulting from unavoidable impacts to waters of the United States due to permitted and unpermitted activities, and permanent and temporary impacts. In addition, the Program may be used to offset environmental losses resulting from unavoidable impacts related to activities regulated by the United States Fish and Wildlife Service (e.g., threatened or endangered fish or bird species), and the Nevada Department of Environmental Protection (e.g., 401 permits).

B. Objectives of the program include providing an In-Lieu Fee Program for landowners, developers, public and private entities and others in the service area that would require mitigation credits on SNDO-managed lands or lands to be acquired using Program funds.

Program objectives also include but are not limited to the following:

1. Promotion of appropriate land uses compatible with surrounding habitat. This refers to current or planned land uses that would impact surrounding lands such as new developments, bridge crossings or channel improvements. These land-use decisions can impact waterways.
2. Removal of exotic plants and animals from sensitive habitats.
3. Increase rare, threatened and endangered species monitoring and recovery efforts in restored habitats protected by legal mechanisms.
4. Propagate native fish and amphibians for impacts to waters and for placement in appropriate locations to maintain genetic diversity of these species.
5. Collect, document and inventory native seeds and plants for use in restoration projects in association with the program.
6. Create and manage habitats in sensitive riparian areas as either third party or primary managers on lands that are not identified for conservation under the Virgin River Species Habitat Conservation Plan ("VRHCP").
7. Build and maintain a fish barrier on the lower Virgin River, located at Halfway Wash, about 16 miles upstream from Lake Mead. The fish barrier was identified in the Virgin River Fishes Recovery Plan, prepared for the U.S. Fish and Wildlife Service by the Virgin River Recovery Team, as essential in the eradication of non-native species and the recovery of the endangered native species (USFWS 1995).

C. The In-Lieu Fee Program would allow additional resources (funding, restoration, maintenance, etc.) to be applied to sensitive habitat areas within lands the SNDO currently holds and manages or would purchase with Program funds. It would also allow for protection of wildlife linkages connecting county conservation lands, open space, other federal and tribal land and private holdings. These areas consist of riparian areas and waterways that are of importance to conservation. The Program would also provide a resource to landowners who are required to mitigate and provide for long-term maintenance to offset impacts associated with their project.

D. Some of the lands that the SNDO now manages include covered species as listed in the Clark County Multiple Species Habitat Conservation Plan (MSHCP), and actions that benefit these species would enhance and complement those conservation objectives in the MSHCP. The desert riparian/aquatic ecosystem provides habitat for 14 Covered Species and 12 High Priority Evaluation Species. Seven of the Covered Species and 9 of the High Priority Evaluation Species are water dependent and exclusively or primarily associated with the lowland riparian or aquatic ecosystem.

E. While locating ILF Program projects in all of the SNDO priority areas defined herein remains our goal, portions of some of these areas have already been included in or may be included into the Areas of Critical Environmental Concern (ACEC).

In addition, while many of the areas proposed for conservation by the BLM have sensitive or high habitat value, they may not always be considered priority due to their size (small) or location

(fragmented). Nevertheless, these areas are still of high conservative value as they provide connectivity and the potential for increasing their habitat quality, hydrology or functional values.

The proposed program would ensure no net loss of resources and, in some instances, increase the acreage of wetlands due to the creation of habitat through the program. Within the overall watershed area, mitigation sites for the enhancement, restoration or creation of habitat should be prioritized within the same sub-basin as the impacts are occurring, to the extent practicable.

### **III. How the In-Lieu Fee Program Will Be Established and Operated (§332.8(d)(2)(ii))**

A. Permittees will be approved by the Army Corps to pay monies into the Program fund to satisfy Army Corps compensatory mitigation requirements only after avoidance and minimization of project-related impacts to wetlands have been accomplished to the maximum extent practicable, and onsite compensatory mitigation opportunities have been evaluated and determined impracticable or ecologically less desirable. The Program will be open to compensatory mitigation for unavoidable impacts to aquatic resources resulting from projects authorized under an Army Corps standard Individual Permit, an Army Corps General/Nationwide Permit, permanent or temporary impacts, and from unauthorized activities in the watershed areas of the Virgin River, Muddy River or Meadow Valley Wash or their tributaries. In addition, the Program may also sell credits to offset environmental losses resulting from unavoidable impacts related to activities regulated by the United States Fish and Wildlife Service (e.g., threatened or endangered fish and avian species) and the Nevada Department of Environmental Protection (e.g., 401 permits).

B. Establishment of an In-Lieu Fee Program in the proposed service area would provide a much needed service for developers and managers that would include a site-specific set of success criteria to follow as well as detailed analysis of the work to be done on each ILF Program area proposed by the Program based upon location and watershed condition. The Program would also provide Army Corps and other permitting agencies a resource for mitigation to impacts to waters in the service area beyond invasive species removal and other mitigation. Mitigation for upland habitats, mesquite acacia woodlands, and alluvial communities, as well as impacts to fish and amphibians, would be included within the In-Lieu Fee Program.

C. Under the Program, BLM or a third party would monitor and manage habitats and restoration by both quantitative and qualitative assessment of the restoration sites, in addition to weed removal and restoration being conducted by SNDO staff or their contractors on public lands or lands targeted for acquisition by BLM using Program funds. BLM policy and regulations would ensure that both the restoration and the underlying land would continue to be protected and managed by BLM for their riparian and aquatic resource values.

D. In addition to the land the BLM already manages for the ILF Program, there are parcels to be acquired along the Virgin River, Muddy River and Meadow Valley Wash within the SNDO planning area. These additional lands would be added as funds from the Program become available and specific parcels become available. Targeted areas would be those in need of restoration and/or long-term protection due to impacts from off-roading, dumping, vandalism or development. Locations of Program projects

would be determined by a site-specific analysis of the restoration potential, current land ownership and habitat condition, location, density, diversity and environmental hazards.

E. SNDO has identified lands within its jurisdictional boundaries that would provide tracts contiguous with other nonfederal lands and riparian streamside habitat currently being managed for conservation, and thus would be appropriate for inclusion in the Program. These sites would be provided long-term protection and restoration by the BLM and its partners. In this way, conservation acreage would be increased on sensitive habitat, with those lands to be protected. These lands support listed and sensitive species such as relict leopard frog, southwestern willow flycatcher, woundfin, Virgin River chub, the desert sucker and the Meadow Valley dace. Further, some of these lands have regionally significant resources such as perennial waters, open water, wetlands or sensitive native fisheries habitat. Nearly all of the proposed lands would provide listed species habitat of significant value.

#### **IV. The Proposed Service Area (§332.8(d)(2)(iii))**

The service area falls within the overall area of the Virgin River watershed and its tributaries, including the following USGS 8-digit watershed sub-basins:

- a) 15010008 Upper Virgin (UT), 2130 square miles or 1,363,200 acres
- b) 15010009 Fort Pierce Wash (AZ, UT), 1690 square miles or 1,081,600 acres, which flows into:
- c) 15010010 Lower Virgin (AZ, NV, UT), 2070 square miles or 1,324,800 acres
- d) 15010011 White (NV), 2875 square miles or 1,840,229 acres, which is the hydrologic source of:
- e) 15010012 Muddy (NV), 1811 square miles or 1,159,379 acres
- f) 15010013 Meadow Valley Wash (NV, UT), 2536 square miles or 1,623,482 acres

See Appendix B hereto for area maps (5a through 5g).

Projects initially proposed for the ILF Program are currently limited to lands managed by the BLM SNDO, specifically the Lower Virgin, Muddy, and Meadow Valley Wash sub-basins. However, the entire Virgin River watershed area would benefit from the proposed actions, and other projects may be proposed within the larger service area in the future.

#### **V. The General Need For and Technical Feasibility of the Proposed In-Lieu Fee Program (§332.8(d)(2)(iv))**

A. Need.

Currently, there are two other In-Lieu Fee Programs in the SNDO area; one under the BLM (Eglington Preserve) and one under the Southern Nevada Water Authority (Clark County Wetlands Park). Both programs had sold all available credits by 2012. Because the economy in Southern Nevada and Southern Utah has begun recovering from the Great Recession and development has once again started up, we believe it has become necessary to create new ILF programs.

In the watershed area of the Virgin River and its tributaries, there are three areas proposed for projects under this ILF Program within the SNDO planning area, namely: Virgin River, Muddy River and Meadow

Valley Wash. Together, these areas contain many sensitive species of plants and wildlife. Examples of some of the sensitive residents are listed under each ILF Program area. Examples of sensitive habitat include aquatic, riverine, riparian, and mesquite acacia woodland.

#### B. Technical Feasibility.

As a federal public agency, the BLM has been serving Southern Nevada since its establishment in 1946 and as the General Land Office and Grazing Service (BLM's predecessors) since the mid 1800's. Because of its mission "to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations" (see Federal Land Policy and Management Act of 1976) and its staff, the SNDO currently has flexibility to (and currently does) protect and conserve many acres of public lands with critical environmental concern. It is our experience in land management that gives the BLM the capability to ensure that the biological and hydrologic functions of a site can be protected and maintained. For the ILF Program, the BLM plans to maintain management of the project sites following internal and national conservation policies, including the national guideline for Riparian Area Management (Technical Reference 1737-7). BLM would remove invasive species (plant and animal), reduce unnatural soil erosion, and secure and protect both small and large blocks of land to help connect project sites for wildlife movement between larger tracts of land already managed for conservation of resources. All of the initially proposed project sites for the ILF Program are near existing ACECs that contain sensitive or rare natural resources.

#### **VI. The Proposed Ownership Arrangements and Long-Term Management Strategy for In-Lieu Fee Project Sites (§332.8(d)(2)(v))**

Under the proposed Program with the SNDO, ownership arrangements would be provided by either (1) existing BLM managed lands, or (2) future lands purchased with Program funds to be owned and managed by BLM. Funding for long-term management, including monitoring and maintenance, would be secured through endowments funded by the Program as well as congressionally appropriated funds, if practicable.

#### **VII. Qualifications of the Sponsor to Successfully Complete the Types of Mitigation Projects Proposed, including Information Describing Any Past Such Activities by the Sponsor (§332.8(d)(2)(vi))**

A. Qualifications. The BLM SNDO has successfully established the Eglington Preserve ILF Program in 2004 and has managed the preserve successfully until its congressional conveyance to the USDI National Park Service (NPS). The "Carl Levin and Howard P. 'Buck' McKeon National Defense Authorization Act" transferred the area managed by the BLM to the NPS for the Tule Springs Fossil Beds National Monument in December of 2014. The last mitigation credit was sold in 2012. The SNDO conducts regular assessments on all of their active restoration sites, as well as trash removal, weed control, supplemental planting, fencing, signage, legal establishment of boundaries and other activities as site conditions dictate. District staff provides a diverse group of technical and administrative expertise with degrees and certifications in the following fields:

1. Plant Biology/Botany

2. Wildlife Biology
3. Hydrology
4. Engineering
5. Realty Acquisition and Land Examiner Law
6. Erosion and Sedimentation Control
7. Education
8. Project Administration
9. Archaeology
10. Recreation
11. Geology

Further, the District also has a large number of cooperators with whom it has worked over the decades conducting erosion control, water management, mitigation, restoration and other field and technical activities on public lands.

The SNDO is working on native seed development for southern Nevada ecoregions that are needed for restoration seed mixtures and emergency post-fire seeding mixes in wildlands to help maintain local genetic diversity. Further, the SNDO has received millions of dollars in Southern Nevada Public Land Management Act (SNPLMA) funds to conduct restoration activities, remove invasive aquatic species and promote the use of native plants for restoration projects over the last 15 years.

#### **VIII. The Compensation Planning Framework (§§332.8(d)(2)(viii)(A) & 332.8 (c))**

Strategies that will be used to select, secure and implement projects benefitting aquatic resources will involve the following.

##### **A. Section 332.8(c)(2)(i): The geographic service area, including watershed-based rationale for the delineation of each service area.**

(1) Virgin River: The geographic service area falls within the Upper and Lower Virgin River Watersheds (Maps 2a, 2b, 5b, 5c, 5d). While the Virgin River is one of the last undammed rivers in the western US, the creation of Lake Mead National Recreation Area has led to the introduction of many non-native invasive fish species, which have migrated up the entire river and have negatively impacted native fish species in Nevada, Arizona and Utah. The watershed has also been negatively impacted by the proliferation of exotic plant species, primarily tamarisk and Russian olive. Historic as well as contemporary unauthorized livestock grazing have further degraded watershed conditions. Urbanization in both basins has impacted many tributaries to the Virgin River. Consequently, there are specific restoration needs within the Lower Virgin River watershed (such as a fish barrier) that would benefit both the lower and upper watersheds. By including both watersheds in the service area for the Program, impacts within either watershed area would be offset by compensatory mitigation within this watershed, promoting the goal of no-net loss of functions across the watersheds. Implementation of mitigation in part funded by this program, however, is proposed only in the Nevada portion of the lower Virgin River watershed at this time.

(2) Muddy River: The geographic service area falls within the Muddy River and White River Watershed sub-basins (Maps 3a, 3b, 5e, 5f). Similar to the Virgin River, both sub-basins are part of the same flow system, the White River being the upper and the Muddy River being the lower watershed. Besides the proliferation of exotic plant species, similar to the Virgin River, both watersheds have been negatively impacted by agricultural and grazing practices, including salination, erosion, water diversions, stream channelization, and limited rural developments. The native fish species in the Muddy River have also experienced increased predation from non-native fish species. Consequently, there are specific restoration needs within the Muddy River watershed. By including both watersheds in the service area for the Program, impacts within both watersheds would be offset by compensatory mitigation within the Muddy River watershed, promoting the goal of no net loss of functions across the watersheds.

(3) Meadow Valley Wash: This watershed (Maps 4a, 4b, 5g) has lost many of its aquatic functions and values from external impacts in the watershed. The introduction of non-native plant and amphibian species has negatively impacted aquatic species. Agricultural developments, gravel mining, railroad, road and bridge construction have altered flow regimes and related aquatic functionalities. Consequently, there are specific restoration needs within the watershed. By including the entire watershed area in the service area for the Program, impacts within these watersheds would be offset by compensatory mitigation within this watershed, promoting the goal of no net loss of functions across the watersheds. Implementation of mitigation in part funded by this program, however, is proposed only in the SNDO-managed portion of the Meadow Valley Wash watershed at this time.

A watershed-based rationale for the creation of each proposed conservation area described in this section would be based upon what resources (wetland, riparian, ephemeral) would be best protected and how those resources would be conserved through the purchase and creation of new parcels and by restoring existing public lands that would benefit from long term maintenance or restoration. Many of the proposed restoration areas are on public lands in the lower parts of the watershed areas. At present, BLM resources and funding are limited for management of these areas. An ILF Program would thus provide the additional management and resources needed to ensure their viability over the long term and for future generations.

Protection of such lands would allow the BLM to secure and implement aquatic resource conservation by reducing threats to aquatic resources in these areas through the creation and management of these ILF Program areas. Many water bodies of the service area connect and wind their way through the alluvial fans and arroyos of the watersheds. This network provides lush habitat in Nevada's, Utah's, and Arizona's otherwise semi-arid and arid environments, and provides opportunities for recharging precious groundwater basins along the way. Keeping the network of stream channels healthy as functioning habitat also keeps it functioning optimally for providing other benefits. These habitat functions and values would be increased or maintained through the ILF Program.

**B. Section 332.8(c)(2)(ii): A description of the threats to aquatic resources in the service areas, including how the in-lieu fee program will help offset impacts resulting from those threats.**

The types of impacts expected stem from several sources, which will occur in the near future. Typical permit actions with minor amounts of impact have included maintenance, outfall structures, utility lines, temporary construction access, and storm water management. These types of activities would continue to have an extremely limited impact on aquatic resources. Activities with more substantial impacts include flood management activities, linear transportation projects, renewable energy projects, groundwater development, residential, commercial and institutional developments. The Program would help offset these impacts through more intelligent decision-making of compensatory mitigation through a watershed approach. The functions and values lost would be offset in a manner that would create a greater likelihood of restoration success.

Specific needs within the watersheds would be identified and compensatory mitigation would be directed at these areas. Consideration of nearby landscape stressors would allow for more effective site-selection in order to reduce indirect effects of surrounding land uses (buffers) on particular habitat functions. Particularly in the Virgin River watershed, rapid urbanization has artificially increased the rate of sedimentation and loss of habitat, negatively affecting water quality and wildlife habitat.

By helping to ensure these lands are properly managed, the ILF Program would provide the opportunity to increase aquatic resource values by targeting areas that require more intensive management strategies. Ecosystem restoration can include changing the flows in streams and rivers; restoring fish and wildlife habitat and controlling waste discharges.

A prerequisite for any project is the sustained ability for the watershed to maintain the functions and processes that support the native ecology of the watershed. This does not imply that the goal is to return the watershed to an undisturbed condition. Instead it implies an integration of human needs and ecological condition that allows the watershed to sustain ecological integrity over time while providing for sustainable community needs. It is recognized that watersheds are dynamic and the precise makeup of plants, animals, and other characteristics will change over time. Watershed management seeks to balance changes in community needs with these evolving ecological conditions.

Once the ILF Program is established, the BLM SNDO would conduct additional monitoring of the priority service area sites to determine current aquatic resource conditions, functional values and finalize acreages to be restored, enhanced or created and determine occupation by listed and sensitive species. All of the acreages listed under this ILF Program will be conserved through appropriate legal mechanisms established through the program and, thus, would receive management based upon their condition determined at the time of acquisition.

### **C. Section 332.8(c)(2)(iii): An analysis of historic aquatic resource loss in the service areas.**

1. Virgin River: Over the last 150 years, the Virgin River Watershed and its associated tributaries have come under increased stress. Aquatic losses from these drainages have been dramatic during that time. A total of 78 species in the Virgin River Basin, including 21 reptiles and amphibians, 31 birds, 5 fishes, 15 mammals, 4 invertebrates and 2 plants, are recognized as threatened or endangered pursuant to the federal Endangered Species Act or as threatened, endangered or sensitive by the states of Utah, Arizona or Nevada (Williams and Deacon 1998).

The lower Virgin River floodplain covers approximately 30,000 acres and flows approximately 50 miles from the Nevada-Arizona state line to the confluence with Lake Mead (U.S. Army Corps of Engineers 2008). Close to 86% of the area is owned and managed by federal and/or state agencies, including the BLM, National Park Service (NPS), and Nevada Department of Wildlife (NDOW). Cottonwood-willow galleries, shrub communities, and sedge-grasslands are common along the river corridor but are becoming displaced by the expansion of non-native invasive plant species. The native riparian plant communities now exist mostly as remnant patches amid a dense, continuous stand of various canopy-classes of the non-native invasive tree, tamarisk or saltcedar (*Tamarix ramosissima*) (Fred Phillips Consulting 2013). This increased hazardous fuel loading has contributed to large catastrophic wildland fires, including multiple fires along the Virgin River in 2005.

Proliferation of non-native annual grasses increases the threat of wildland fires that destroy the riparian and upland vegetation. This results in loss of watershed protection and leads to post-fire flooding that carries ash and debris into the river, resulting in die-off of fish and other aquatic species and deterioration of water quality. Such was the case in 2005.

Trespass by numerous stray cattle (more than 1,000 at times) over the past 20 years has resulted in overgrazing of riparian vegetation (including restoration plantings), trampling of shorelines, decreased soil stability, and contamination of water quality.

2. Muddy River: The Moapa Valley area is home to a wide variety of rare and endangered species, including fish, invertebrates, birds, and plants. One endangered fish inhabits the area: the Moapa dace (*Moapa coriacea*). These species can be found throughout the various springs, called the Muddy Springs, which feed the Muddy River.

Exotic plants, including salt cedar (*Tamarisk* spp.), Russian knapweed (*Acroptilon repens*), Malta star-thistle (*Centaurea melitensis*), Russian thistle (*Salsola tragus*), and five-hook bassia or kochia (*Bassia hyssopifolia*) are hindering natural vegetation recovery of the Muddy River floodplain since the cessation of agriculture (i.e. Perkins Ranch) and other prior land uses. Salt cedar (a tree species originating from Asia), Russian knapweed (a creeping herbaceous perennial originating from Asia), and Malta star-thistle (one of several invasive thistles from Europe and North Africa) are listed by the state of Nevada as noxious weed species (BLM 2014). Exotic animals have also contributed to the loss of native aquatic species, as introduced blue tilapia (*Oreochromis aurea*), red swamp crayfish (*Procambarus clarkii*), and American bullfrogs (*Rana catesbeiana*) prey on native fish.

The Muddy River floodplain historically supported desert riparian habitat along the river banks, bounded by mesquite woodlands. In the late 1800s, Mormon settlers populated the Moapa Valley. Over time, streams were diverted and channelized for domestic and agricultural uses, and new plant species, including salt cedar, were introduced to the ecosystem. Once introduced, salt cedar replaced many native tree species and became a dominant species in the desert riparian habitat (USFWS, 1996). Because salt cedar stands develop into dense thickets, sediment accumulated in their extensive root systems and promoted further salt cedar growth. This may have contributed to the gradual narrowing and channelization of the river channel, and a lowering of the riparian water table, degrading the

moisture conditions favorable to native riparian woodland species. Channelization also removed any historic wetlands that would have been present in oxbow backwaters isolated from the main river channel as it moved within the floodplain or in low-lying areas where the river would widen and slow down. No wetlands are present today.

3. Meadow Valley Wash: The first European explorers passed through the region during the 1830s, via the Old Spanish Trail, which went through the nearby town of Glendale. By the 1850s, settlers had traveled up the Meadow Valley Wash, and began to use the area for agriculture. A land survey completed in September of 1881 delineates the Meadow Valley, and describes the surrounding area as “Level Table Land” with sagebrush and galleta grass, which should be interpreted liberally to describe shrubland dominated by creosote bush and burrobrush in this case. Surveyors often used sagebrush to describe a number of species and it is unlikely that entire plant communities would have changed from sagebrush to creosote since 1881. The presence of a perennial water source, hot springs, and mineral ore made the area favorable for settlement, ranching, mining, and agriculture.

Several areas of anthropogenic disturbance are present throughout the watershed. These include abandoned agriculture, gravel mining, dikes and other channel modifications, dirt roads, railroad grade and irrigation reservoirs. Indirect impacts of agricultural developments include increased alkalinity in the soils (caused by the application of irrigation water) on agricultural lands that may limit revegetation, invasion of weeds and introduced species (e.g. tamarisk), and moderate to severe rill/gully erosion of the newly abandoned agricultural lands.

Positioned along the Meadow Valley Wash, the Union Pacific railroad grade and adjacent maintenance road range from 20-25 meters wide, and cover many acres of the Meadow Valley Wash active floodplain. Direct impacts include the fill of active floodplain; restriction (or focusing through trestles) of alluvial transport from minor washes; and erosion of colluvial slopes. Indirect impacts include the confinement of the active, consequent increase in flood energy leading to increased scour, increased deposition downstream, and rill/gully and sheet erosion of adjacent stream terrace and alluvium in response to historical and ongoing maintenance.

Existing riparian vegetation within the Meadow Valley Wash floodplain is predominantly coyote willow (*Salix exigua*) with the occasional Gooddings willow (*Salix gooddingii*) and cottonwood (*Populus fremontii*). However, the shape and the density of tree canopies in the 1992-94 imagery when compared with the 2006 NAIP imagery indicate that riparian vegetation was dominated by tamarisk prior to the December 2004, January 2005 and December 2010 floods. In late December 2004 and early January 2005, the Meadow Valley Wash experienced a flood of record, which scoured and removed large portions of the existing riparian vegetation, which was mostly tamarisk, within the property. As a result, the existing riparian vegetation (willows and cottonwoods) is young and even-aged, and was presumably recruited in the spring of 2005.

The magnitude and timing of the 2004-05 and 2010-11 winter season floods appear essential for increasing the abundance of willow and cottonwood in the wash. Prior to the 2004-05 floods, a thick monoculture of tamarisk prevented establishment of other riparian plant types. Most willows and

cottonwoods colonize disturbed areas where competition is low. The winter floods of 2004-05 scoured existing riparian tamarisk leaving an opening of disturbed soils that had little competing vegetation.

The Meadow Valley Wash aquatic habitat is also impacted by two introduced amphibian species, namely the American bullfrog (*Rana catesbeiana*) and the red swamp crayfish (*Procambarus clarkii*).

Historic aquatic resource loss in the all of the service areas have come from:

- Stream channel alteration;
- Livestock grazing in riparian areas;
- Sedimentation;
- Exotic and invasive plant, fish and amphibian species;
- Improper agricultural practices; and
- Watershed changes resulting in cumulative affects to aquatic resources.

These impacts have combined to reduce the functions and values of aquatic resources in all three watersheds. However, some watersheds have been impacted more than others, especially those that occur within a municipality or urban area such as the upper and lower Virgin River watersheds. Chronic elevated water temperatures and high salinity and sediment loads are examples of water pollution that is not source-oriented and harder to control.

Because native freshwater fishes mostly live in many of the streams, the issue of chronic low-level pollution, besides the invasion of non-native fish, is of concern to biologists. Increases in the amount and quality of aquatic and riparian vegetation would improve the capacity of these waterways to reduce the amounts and concentrations of many of these pollutants.

**D. Section 332.8(c)(2)(iv): An analysis of current aquatic resource conditions in the service areas, supported by an appropriate level of field documentation.**

In addition to the analysis of current aquatic resource conditions presented for each of the proposed ILF Program areas, the following documentation is provided for additional support.

1. Aquatic resources are threatened by non-point source water pollution, off-road use, dumping, invasive species (both aquatic and terrestrial) and the decline and removal of native vegetation as well as other activities listed in Section C above. By creating an ILF Program on selected lands, the natural resource values of that land can be protected and become in line with BLM guidelines as stated in the Federal Land Policy and Management Act (FLPMA). Many of the drainages within the service areas have no long-term protection. By securing ILF Program areas, aquatic threats can be reduced or discouraged by preventing dumping and off-road damage, invasive species trapping/control, invasive plant species removal and promoting natural vegetation succession.

2. Historic aquatic losses have come from the removal and degradation of both riparian and ephemeral habitats. The no-net-loss of wetlands and other nationally based programs have tracked large reductions in wetland and riparian acreage over the last decade. According to the Status and Trends of Wetlands report by the US Fish and Wildlife Service: between 1950 and 1970, over 400,000 acres of wetlands were lost per year in the United States, and between 1980 and 2000, the rate declined to

290,000 per year, partially due to the passage of the Emergency Wetlands Resources Act of 1986. Between 2000 and 2008, an eighty percent decrease in losses to 58,000 acres was achieved. Although this is still a staggering number, it shows a decrease in lands lost, with those losses attributed to a lack of enforcement, protection and education of the public about the value and function of wetlands on private lands. Only 10% of historic wetlands and riparian areas in Southern Nevada are still remaining, with most of the wetlands and riparian remaining in federal ownership.

3. Current aquatic resource conditions in the SNDO jurisdictional area are poor to good, depending upon the location. From 1985 to 2000, “30% of the estimated freshwater wetland losses were due to urban development” (Status and Trends of Wetlands, US Fish and Wildlife Service Report, 2000). This national trend has also been seen in southern Nevada and continues today, but at a slower rate due to the economic conditions of the housing market. The following species have been identified as sensitive, rare, threatened, or endangered by the U.S. Department of Interior, the Nevada Department of Wildlife, the Utah Division of Wildlife Resources, and the Arizona Game and Fish Department, and are planned to be included in the Virgin River Habitat Conservation Plan (VRHCP). Federally listed endangered or threatened species (FE, FT) and State listed endangered or threatened species (SE, ST) are protected. Some species are considered sensitive by federal or state agencies and are designated as species of special concern (FSC or SSC, respectively), or candidate species for listing (C). Some of these are rare and have protected status in the state (SP).

All species listed below with FE, FT, SE, ST, SSC status, are planned to be included in the VRHCP. The absence of other VRHCP species does not indicate that they can’t be found in the respective watersheds. The species listed are those with recent documentation.

(a) Virgin River:

Fish

Speckled dace, *Rhinichthys osculus* (FSC, SSC [AZ])  
Virgin River chub, *Gila seminuda* (FE, SE [UT, AZ], SSC [NV])  
Virgin spinedace, *Lepidomeda mollispinis mollispinis* (C, SE [UT, AZ], C [NV])  
Woundfin, *Plagopterus argentissimus* (FE, SE [UT, AZ, NV])  
Desert sucker, *Catostomus clarkii* (C, SSC [UT])  
Flannelmouth sucker, *Catostomus latipinnis* (C, SSC [UT])

Wetland/Riparian dependent Birds

Southwestern willow flycatcher, *Empidonax traillii extimus* (FE, SSC [UT], SE [AZ])  
Yuma clapper rail, *Rallus longirostris yumanensis* (FE)  
Yellow-billed cuckoo, *Coccyzus americanus* (C, ST [AZ])  
American white pelican, *Pelecanus erythrorhynchos* (SSC [AZ])  
American bittern, *Botaurus lentiginosus* (C [AZ])  
Western least bittern, *Ixobrychus exilis* (C, SSC [UT], C [AZ])  
Great egret, *Casmerodius albus* (SE [AZ])

Snowy egret, *Egretta thula* (ST [AZ])  
White-faced ibis, *Plegadis chihi* (C)  
Belted kingfisher, *Ceryle alcyon* (C [AZ])

#### Amphibians

Pacific treefrog, *Hyla regilla* (SSC [UT])  
Relict leopard frog, *Rana onca* (C, SSC [UT])  
Southwestern toad, *Bufo microscaphus* (C, SSC [UT])  
Northern leopard frog, *Rana pipiens* (C [AZ])  
Lowland leopard frog, *Rana yavapaiensis* (C, SSC [UT], C [AZ])

#### Macroinvertebrates

Utah water scavenger beetle, *Chaetarthria utahensis* (C, SSC [AZ], C [UT])  
Tiger beetle, *Cicindela oregona* (C, SSC [UT])  
MacNeil sooty wing skipper, *Hesperopsis graciellae* (C, SSC [NV, AZ])  
Wet wall snail, *Physa zionis* (C, SSC [UT])  
Utah hydroporous diving beetle, *Hygrotus utahensis* (C, C [NV])  
Utah minute moss beetle, *Limnebius crassalus* (C, C [UT])  
Desert spring snail, *Pyrgulopsis deserta* (FSC)

#### Plants

Holmgren milkvetch, *Astragalus holmgreniorum* (C [UT], SSC [NV])  
Beaver Dam milkvetch, *Astragalus newberryi* var. *castoreus* (C)  
Hay's sedge, *Carex haysii* (C, SSC [UT])  
Virgin thistle, *Cirsium virginensis* (C, SSC [UT])  
Cliff jamesia, *Jamesia americana* (C, SSC [UT])  
Nevada goldenrod, *Solidago spectabilis* (C, SSC [UT])  
Zion tansy, *Sphaeromeria ruthiae* (C)  
Virgin phacelia, *Phacelia cephalotes* (C)

#### (b) Muddy River:

##### Fish

Moapa dace, *Moapa coriacea* (FE)  
Virgin River chub, *Gila seminuda* (FE [but not Muddy River population], SSC)  
Moapa speckled dace, *Rhinichthys osculus moapae* (FSC, SSC [NV])

##### Birds

Southwestern willow flycatcher, *Empidonax traillii extimus* (FE)  
Yuma clapper rail, *Rallus longirostris yumanensis* (FE)

Yellow-billed cuckoo, *Coccyzus americanus* (C)

#### Macroinvertebrates

MacNeil sooty wing skipper, *Hesperopsis graciellae* (C, SSC [NV])

#### (c) Meadow Valley Wash:

##### Fish

Meadow Valley speckled dace, *Rhinichthys osculus* (FSC)

Meadow Valley Wash desert sucker, *Catostomus clarki* ssp. (FSC, SSC [NV])

##### Birds

Southwestern willow flycatcher, *Empidonax traillii extimus* (FE)

Yuma clapper rail, *Rallus longirostris yumanensis* (FE)

Yellow-billed cuckoo, *Coccyzus americanus* (C)

Brewer's sparrow, *Spizella breweri* (SSC)

Loggerhead shrike, *Lanius ludovicianus* (SSC)

Ferruginous hawk, *Buteo regalis* (SSC)

Prairie falcon, *Falco mexicanus* (SSC)

##### Mammals

Desert bighorn sheep, *Ovis Canadensis nelson* (FSC)

**E. Section 332.8(c)(2)(v): A statement of aquatic resource goals and objectives for service areas, including a description of the general amounts, types and locations of aquatic resources the program will seek to provide.**

The goal of the Program is the rehabilitation or re-establishment (collectively known as restoration) of lost aquatic resource functions of riverine and riparian ecosystems, particularly as they relate to habitat, water quality, and flood control purposes. Rehabilitation or re-establishment is preferred because of the greater likelihood of success. In some cases, enhancement would be chosen if the functional benefits are clear and apparent. Lastly, establishment (creation) could be an option, but not as likely given the difficulties of trying to establish riverine or riparian systems in areas with very limited hydrology to successfully provide this type of credit. In locations with appropriate hydrology, creation would be considered.

All of the proposed service areas have ephemeral and perennial water resources that filter water flows from flood events and provide seasonal water sources that otherwise would not be present. Many of these areas would be enhanced by the planting of wetland plants that provide water-filtering benefits and that also provide sediment control through the growth of root masses.

## Virgin River

The Virgin River's headwaters are in Washington, Kane, and Iron Counties of Utah. The lower watershed includes portions of Mohave County, Arizona and Clark and Lincoln Counties, Nevada. Map 2a displays the watershed vicinity in Southwest Utah, Northwest Arizona, and Southeastern Nevada. Major tributaries to the Virgin River include: East Fork Virgin River, North Fork Virgin River, North Creek, La Verkin Creek, Ash Creek, Santa Clara River, Fort Pearce Wash and Beaver Dam Wash (Map 2b).

Forty eight percent (48%) of the watershed is in Utah, thirty four percent (34%) in Arizona and eighteen percent (18%) in Nevada. The entire watershed covers approximately 5,900 square miles. The study area is defined by three 8 digit hydrologic units (HUC) including the Upper Virgin River, Lower Virgin River, and Fort Pierce Wash (Maps 5a, 5b, 5c).

Most of the watershed is under public management. This includes lands managed by the Bureau of Land Management (BLM), National Park Service (NPS), U.S. Forest Service (USFS) and Bureau of Reclamation (BOR). Table 1 below displays land ownership and acres. While the majority of lands in the Arizona and Nevada portions of the watershed are BLM managed, Dixie National Forest includes the northern most portion of Washington County, UT, and Zion National Park is near the headwaters of the Virgin River in eastern Washington County.

Table 1. Land Ownership within the Virgin River Watershed

Ownership	Acres	Percent	Acres within SNDO
Bureau of Land Management	2,565,721	67	187,459
Private, City and County	535,002	14	20,812
US Forest Service	295,112	8	0
State Trust land	217,867	6	0
National Parks/Monuments	149,329	4	2,600
Tribal	33,697	<1	0
Bureau of Reclamation	13,856	<1	10,454
State Park/Recreation Area	7,535	<1	0
State Wildlife Reserves	578	<1	3,060
Total	3,818,697	100	224,385

The BLM manages 67 percent of the lands in the watershed, followed by USFS, State Trust, and National Parks, respectively. Merely 14 percent of the lands within the watershed are privately owned.

The watershed has been experiencing a significant level of development and population growth. Much of this development is occurring in lowland areas adjacent to floodplains and high flood hazard areas, which are also critically important habitats for protected and sensitive wildlife species. From 2000 to 2007, Nevada, Arizona and Utah had the top three population growth rates in the nation.

Current population in the watershed is approximately 200,000 and is projected to grow significantly in the future. The population in the Utah portion of the watershed was approximately 100,000 in the 2000

Census and is projected to be 425,000 by 2030 and 877,000 by 2060. In the lower watershed it is estimated that the current population of 17,000 could grow to 60,000 by 2021.

The watershed spans a diverse range of elevations and land cover from over 10,000 ft. high mountains in Southwest Utah to the Mojave Desert at nearly 1,200 ft. Higher elevations receive from 25 to 35 inches of precipitation annually and support conifer and aspen Forests. Middle elevations support both mountain shrub lands and Pinion/Juniper forests. Lower elevations within the watershed are semi-arid to hot desert rangelands and receive as little as 4 inches of precipitation annually.

This arid watershed spans the intersection of three physiographic regions including the Colorado Plateau, the Great Basin, and the Mojave Desert. The Virgin River crosses nearly 150 miles uninterrupted from the mountains above Zion National Park to Lake Mead and is the only intact river in the Mojave Desert in Nevada.

As one of the largest riparian corridors in the desert southwest, the Virgin River is home to more than 200 species of wildlife, which utilize the corridor as a residence or seasonal migration route. With its relatively good remaining habitat and service as a migration corridor, the Virgin River in Nevada is designated as an Important Bird Area by Audubon.

In 2008 the US Army Corp identified the top five issues in the Virgin River watershed. These were (1) floodplain management (technical, regulatory, environmental, communication, and education), (2) land use planning (i.e. lack of watershed wide plans), (3) invasive species (Tamarisk, cheat grass, Red shiner), (4) water availability (population growth and drought), and (5) river function (habitat, channel maintenance and endangered species).

Project proposals for Virgin River:

### Halfway Wash Fish Barrier.



Location: Halfway Wash confluence, Virgin River, Clark Co. NV

Acreage: Approx. 200 acres

Condition: Poor to Fair

Threats: Non-native aquatic species compete with or prey on native fish.

Goals: Removal of non-native fishes and prevent further upstream invasion.

**Threats** to this site (§332.8(c)(2)(ii)): The presence of non-native invasive aquatic species (e.g. fish) in the river pose a threat to native aquatic species, including threatened, endangered or sensitive fishes.

**Historic aquatic losses** (§332.8(c)(2)(iii)): Population decline of numerous species of fishes, amphibians, reptiles, birds, and invertebrates has led to listing or potential listing under the ESA or state protection.

**Current aquatic resources** (§332.8(c)(2)(iv)): The Virgin River includes 4 federally listed threatened or endangered species (2 fishes, 2 birds), 22 candidate species (3 fishes, 5 birds, 6 invertebrates, 7 plants), and 6 federal species of special concern (1 fish, 4 amphibians, 1 invertebrate).

**Preservation/restoration objectives** (§332.8(c)(2)(v)): Fish barriers play a central role in the re-establishment of native fish populations by preventing the current and future upstream migration of invasive, non-native fishes. Once a barrier is constructed, the non-native fish can be eradicated from the river upstream of the barrier and native populations can be re-introduced to the river. The barrier then prevents future invasion of non-native species, allowing the native fish populations to rebound.

The Bureau of Land Management (BLM) has assumed the task of overseeing the design and construction of multiple fish barriers. Based on an existing working relationship with the Provo Area Office of the Bureau of Reclamation (Reclamation), BLM was aware of Reclamation's design, contracting, construction, and construction management capabilities. Thus, BLM and Reclamation entered into an agreement whereby Reclamation would provide design, contracting, construction, and construction management services on behalf of BLM in order to construct a fish barrier on the lower Virgin River, once BLM obtains the permission from the State of Nevada.

The original scope of the agreement included designing, contracting, contract management, and construction of a single barrier on the Virgin River known as the Halfway Wash Fish Barrier (HWFB). However, funding was not sufficient to cover the cost of constructing the barrier, so the scope of the project was modified to include only design of the HWFB and the design and construction of two smaller fish barriers on the Muddy River. Construction of the HWFB would take place once construction funds

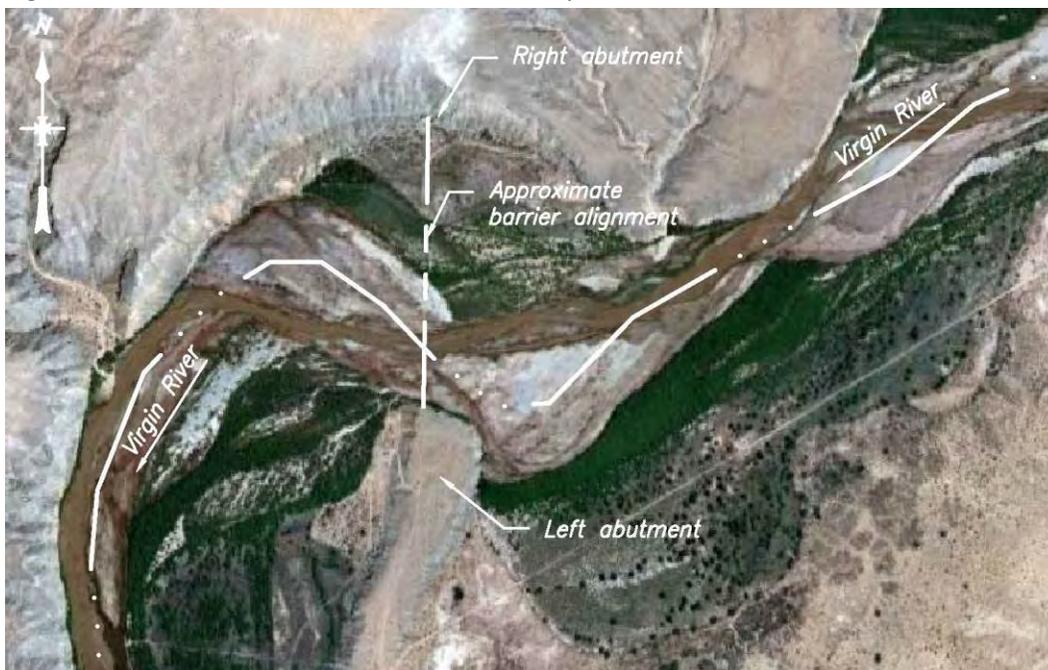
become available. The agreement between BLM and Reclamation identified three principal deliverables: (1) a complete set of construction drawings; (2) written specifications; and (3) an estimate of the cost to construct the fish barrier.

This Design Summary (Summary) has been prepared to document the design of the Halfway Wash Fish Barrier and provide support to the three deliverables identified above. Specifically, the Summary: (1) records major design decisions; (2) documents principal design calculations; (3) identifies tasks to be performed to prepare the construction contract solicitation; and (4) describes other pertinent design activities as necessary.

Located in an area known as Halfway Wash, approximately 16 miles upstream of Lake Mead (see Map 2c), this fish barrier will be the lowest barrier on the Virgin River. The Halfway Wash Fish Barrier will function as the “anchor” barrier on the Virgin River, allowing future removal of existing fish barriers upstream of Halfway Wash.

In this particular area, the river valley consists of a wide, relatively flat floor bounded by steep canyon walls. The Virgin enters the site from the northeast, flows almost due west as it crosses the barrier alignment, and then makes a sharp bend to the south (see Figure 1). The south abutment comprises a long, narrow “thumb” projecting northwards into the valley, and rises about 60 feet above the valley floor. The north abutment consists of concave cliffs and slopes rising more than 200 feet above the floor. The valley floor itself is about 1,600 feet wide with a maximum elevation change of about 10 feet. Under normal conditions, the main river channel meanders back and forth across the southern third of the valley floor. The northern two-thirds of the valley floor lie between four and eight feet higher than the main river channel and are normally dry. Only during very large flood events does the river occupy the entire width of the river valley.

Figure 1. Satellite view of the site of the Halfway Wash Fish Barrier. (BOR 2013)



Virgin River Restoration Plan projects (See Maps 2d, 2e.):  
(Fred Phillips Consulting, and Natural Channel Design, Inc., 2014)

Reach 1. **Mesquite Site.**



Location: Mesquite Site, Virgin River,  
Clark Co. NV

Acreage: Approx. 135 acres

Condition: Poor to Fair

Threats: Sedimentation, urban development,  
fire, exotic plants, trespass cattle.

Goals: Rebuild floodplain, reduce mid-channel  
sedimentation.

**Threats** to this site (§332.8(c)(2)(ii)): Primary threat is from sedimentation as a result of urbanization, runoff from urban and agricultural sites, exotic plant species, and wildland fire.

**Historic aquatic losses** (§332.8(c)(2)(iii)): Native plant composition has been altered by invasion of tamarisk, Sahara mustard and other weeds. Fish breeding habitat is reduced by sedimentation.

**Current aquatic resources** (§332.8(c)(2)(iv)): The Virgin River includes 4 federally listed threatened or endangered species (2 fishes, 2 birds), 22 candidate species (3 fishes, 5 birds, 6 invertebrates, 7 plants), and 6 federal species of special concern (1 fish, 4 amphibians, 1 invertebrate).

**Preservation/restoration objectives** (§332.8(c)(2)(v)):

**Geomorphological restoration:** The channel at this site is an overly wide D channel, with a failed dike and split flow. Rebuilding of a floodplain can be promoted by increasing roughness with vegetation. Willow trenches planted across the northern floodplain can be used to slow flows and promote deposition of sediment upon the floodplain. Trenches would be located in a manner which allows flood flows to return to the main channel through existing breaks in the failed dike. Trenches would also be planted to carry sediment in a more efficient manner, thus minimizing central bars and lateral migration.

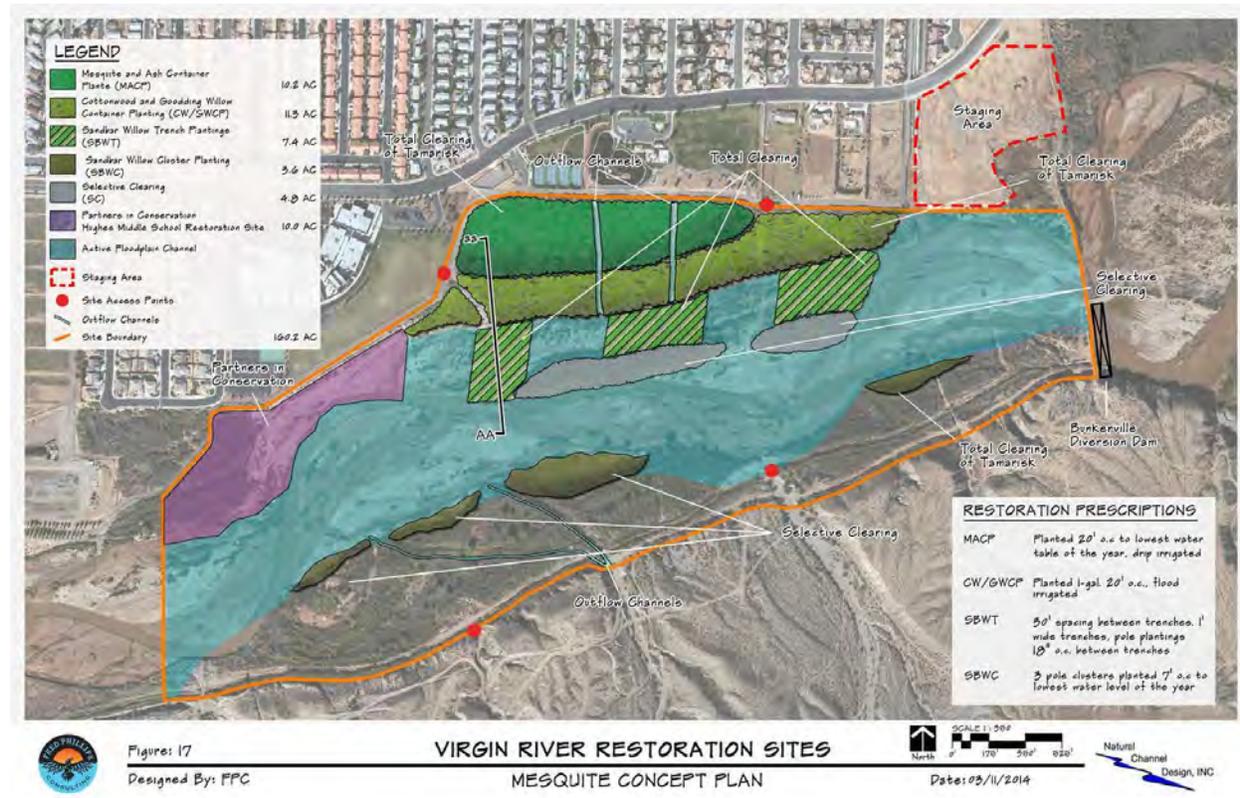
**Invasive species removal:** Total clearing by bulldozing can be used to remove dense stands of tamarisk along the margin of the active floodplain and in overbank zones of the northern section. Total clearing would also remove existing arrowweed in the transitional zone where sandbar willow trenches will be installed. Clearing quailbush along with tamarisk will decrease competition for other native grasses and plants. Burning is not recommended in this area due to its proximity to urban communities and the risk for impaired air quality. Selective clearing would be employed to retain native vegetation in and around the existing islands of cottonwood-willow and to remove established and sprouting tamarisk.

**Native plant restoration:** This will include sandbar willow trench planting along toe and bank zones of the southern section, sandbar willow cluster planting on the south side along the bankline, mesquite

and ash container planting within upland and transitional zone, and cottonwood and Goodding's willow container planting in transition zone between mesquite, and sandbar willow trench plantings.

Monitoring and maintenance: In order to maintain proper function of the willow trenches to help redirect floodwater to the main channel, these areas will require thinning. Large cottonwood and Goodding's willow trees should be removed from the active channel to prevent flooding in a high flow event. Continuing monitoring for and control of invasive species will be needed to help native plants establish. Regular monitoring of native plantings will be needed to assess survival and project success.

Figure 2. Mesquite site plan. (Fred Phillips Consulting, and Natural Channel Design, Inc. 2014)



Reach 1. **Hughes Property Site.**



Location: Hughes Property, Virgin River, Clark Co. NV

Acreage: Approx. 34 acres

Condition: Poor to Fair

Threats: Erosion, exotic weeds, wildland fire, trespass cattle.

Goals: Stabilize terrace erosion, weed control, establish native plant production for restoration.

**Threats** to this site (§332.8(c)(2)(ii)): Erosion and no

**Historic aquatic losses** (§332.8(c)(2)(iii)): Loss of bank and terrace soil through erosion, loss of native vegetation on terrace due to conversion to agriculture and invasive weeds.

**Current aquatic resources** (§332.8(c)(2)(iv)): The Virgin River includes 4 federally listed threatened or endangered species (2 fishes, 2 birds), 22 candidate species (3 fishes, 5 birds, 6 invertebrates, 7 plants), and 6 federal species of special concern (1 fish, 4 amphibians, 1 invertebrate).

**Preservation/restoration objectives** (§332.8(c)(2)(v)):

**Geomorphological restoration:** A 10-foot tall vertical cut bank along the entire site has receded into a former agricultural field, now proposed as a nursery for native plants to be used for various restoration projects along the Virgin River floodplain. Proposed restoration includes bank sloping and planting with pole plantings, vertical bundles, and native grasses to strengthen the bank against erosion. The toe of the bank can be protected and built out with a combination of brush revetment and brush spurs which will lower velocities at the toe and collect sediments to build the toe. To direct irrigation return flows away from the cut bank and into the river, an unlined collection ditch is proposed along the length of the bank, located a short distance (20 feet) back from the top of the bank, and a rock lined chute located at the downstream end of the site where shear stress is lowest.

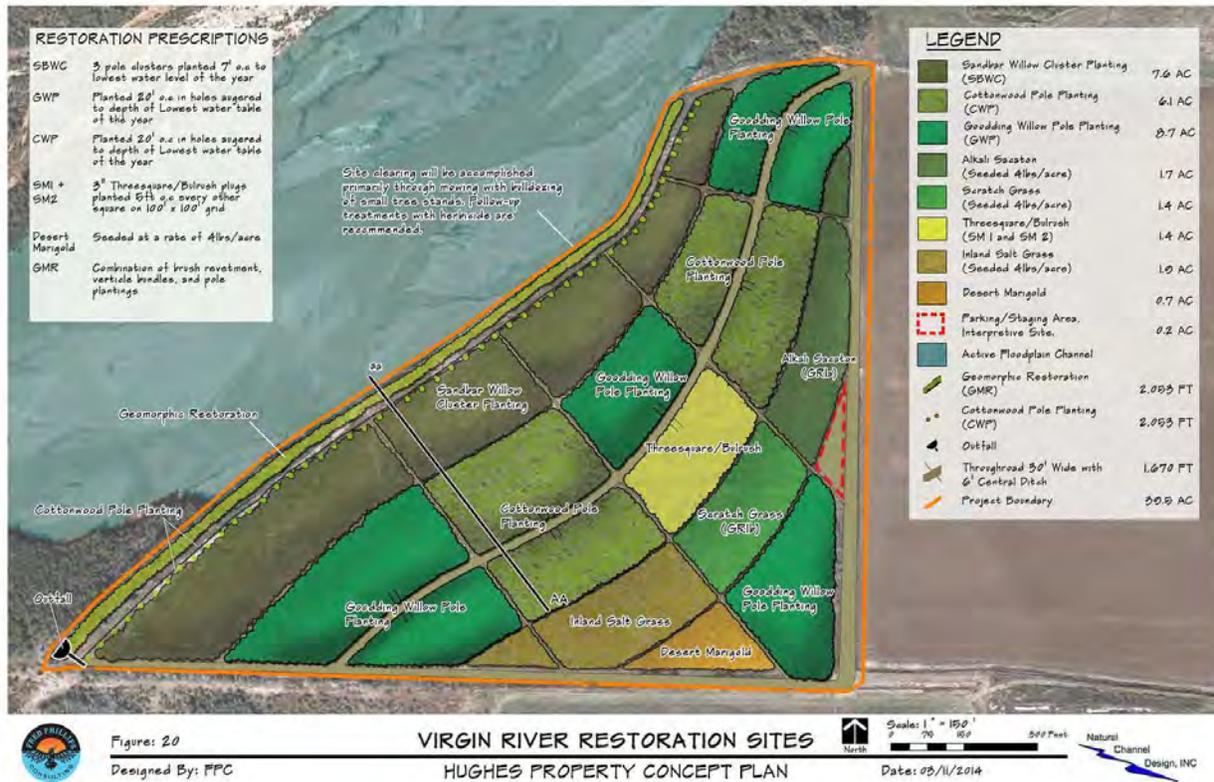
**Invasive species removal:** Total clearing is recommended to remove tamarisk and other non-native plant species, including bulldozing stands of trees, mowing and herbicide treatment for smaller weeds, and herbicide treatments for resprouting plants.

**Native plant restoration:** Cottonwoods and willows can be planted along the collection ditch. The former agricultural field would be revegetated with native plant communities. Specimens, seeds, or cuttings of native plants along the river corridor can be collected and planted in the former agricultural field, and can be used for propagation or transplanting for restoration.

**Monitoring and maintenance:** Bankline maintenance, including removal of invasive weeds and replanting native plants as necessary, will be required to make sure it is stable. Continued monitoring

for and control of invasive weeds on the terrace, and fencing off the site is recommended to prevent trespass cattle from entering.

Figure 3. Hughes Property site plan. (Fred Phillips Consulting, and Natural Channel Design, Inc. 2014)



## Reach 2. Virgin River Tamarisk Working Group Site.



Location: Virgin River Tamarisk Working Group site, Virgin River, Clark Co. NV

Acreage: Approx. 57 acres

Condition: Fair to good

Threats: Invasive weeds, wildland fire, trespass cattle.

Goals: Weed control, bank stabilization, native planting and backwater restoration.

**Threats** to this site (§332.8(c)(2)(ii)): Invasive weeds including tamarisk, and bank damage and loss of native vegetation from trespass cattle.

**Historic aquatic losses** (§332.8(c)(2)(iii)): Flooding and historic dam construction and removal have altered the river flow and widened the channel. Wildland fire has resulted in spread of invasive weeds.

**Current aquatic resources** (§332.8(c)(2)(iv)): The Virgin River includes 4 federally listed threatened or endangered species (2 fishes, 2 birds), 22 candidate species (3 fishes, 5 birds, 6 invertebrates, 7 plants), and 6 federal species of special concern (1 fish, 4 amphibians, 1 invertebrate).

### **Preservation/restoration objectives** (§332.8(c)(2)(v)):

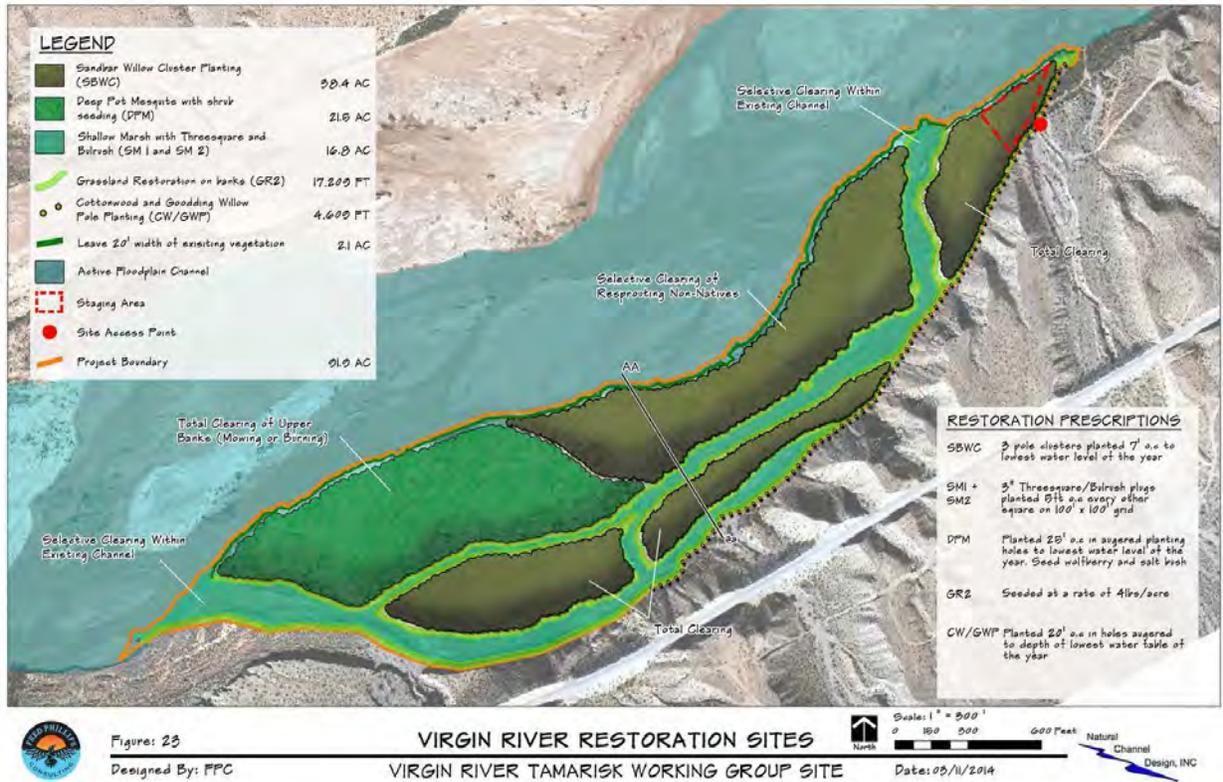
**Geomorphological restoration**: The project site is on the south side of the river in a relatively straight section of stream, across from the confluence of a relatively large wash in a shallow scallop in the canyon wall. The site consists of a low terrace (3-4 feet above the channel invert) at approximately bank full elevation. A flood channel passes through the terrace near the base of the cliff. Very large flows from the wash can potentially deliver large quantities of sediment to the river and force flows back to the south. Restoration work at the site could be endangered by scouring floods if this occurred. A 20-foot wide band of existing vegetation will be left along the main river channel bankline to protect the site from significant fluctuations in the river level.

**Invasive species removal**: Thick stands of arrowweed on the upper banks, including much dead on the eastern portion of the site, would be removed to allow for other emerging riparian vegetation to establish. Total clearing using foliar spraying and prescribed burning is recommended. OHV with a mowing attachment could be used on larger shrubs, followed by foliar spraying. Selective clearing is recommended along the backwater channels, using foliar spraying of non-native shrubs and hand clearing of smaller (<6 inch) invasive plants.

**Native plant restoration**: Recommended sandbar willow cluster planting on upper bank zone, shallow marsh seeding along backwater channel, deep pot mesquite planting with shrub seeding, grassland restoration with alkali sacaton and scratchgrass, and cottonwood and Goodding's willow pole planting along the southern border along the backwater channel edge.

Monitoring and maintenance: Photo monitoring is recommended for a few years post-restoration to evaluate survivability and success of restoration efforts. Invasive species maintenance will be required until native vegetation has established. Mesquites need to be protected from animal browsing with tree tube protectors.

Figure 4. Virgin River TWG site plan. (Fred Phillips Consulting, and Natural Channel Design, Inc. 2014)



## Reach 2. Toquop Site.



Location: Toquop site, Virgin River, Clark Co. NV

Acreage: Approx. 166 acres

Condition: Poor to Fair

Threats: Invasive weeds, wildland fire, trespass cattle.

Goals: Geomorphic restoration of river structure, invasive weed control, native planting.

**Threats** to this site (§332.8(c)(2)(ii)): Invasive weeds include tamarisk, Sahara mustard and Russian thistle.

**Historic aquatic losses** (§332.8(c)(2)(iii)): Invasive weeds have displaced native plant species and altered the river's flow, resulting in a restricted channel.

**Current aquatic resources** (§332.8(c)(2)(iv)): The Virgin River includes 4 federally listed threatened or endangered species (2 fishes, 2 birds), 22 candidate species (3 fishes, 5 birds, 6 invertebrates, 7 plants), and 6 federal species of special concern (1 fish, 4 amphibians, 1 invertebrate).

### **Preservation/restoration objectives** (§332.8(c)(2)(v)):

Geomorphological restoration: Strategic floodplain clearing is proposed to restore the geomorphic structure of the river, by removing vegetation at the southern edge of the upper terrace to allow the river channel to expand in the future, lessening the current constriction of the river through the site. This site is located on the northern side of the river, across the river from the highway and downstream of the confluence with Toquop Wash. The existing condition is a multi-thread D channel with wide, low bars on either side of the river. A push-up diversion and ditch run along the south side of the river near the base of the canyon wall. There is a higher terrace feature on the upstream side of the site that was burned in 2009. A low swale and groundwater feed a deep, off channel pond and marsh system located on the northern side of the site at the base of the canyon wall.

The low terrace on the site will be inundated at relatively frequent flood events and should be considered part of the current active channel. However, the channel is wider than reference and the margins can be planted because velocities along the margin of the channel will be lower during all but the very large flood events. The low flow channel can be stabilized in place by planting wetland plugs along the banks and low terraces. Care would be taken to ensure that the planting lines provide for the minimum radius of curvature towards the downstream end of the site.

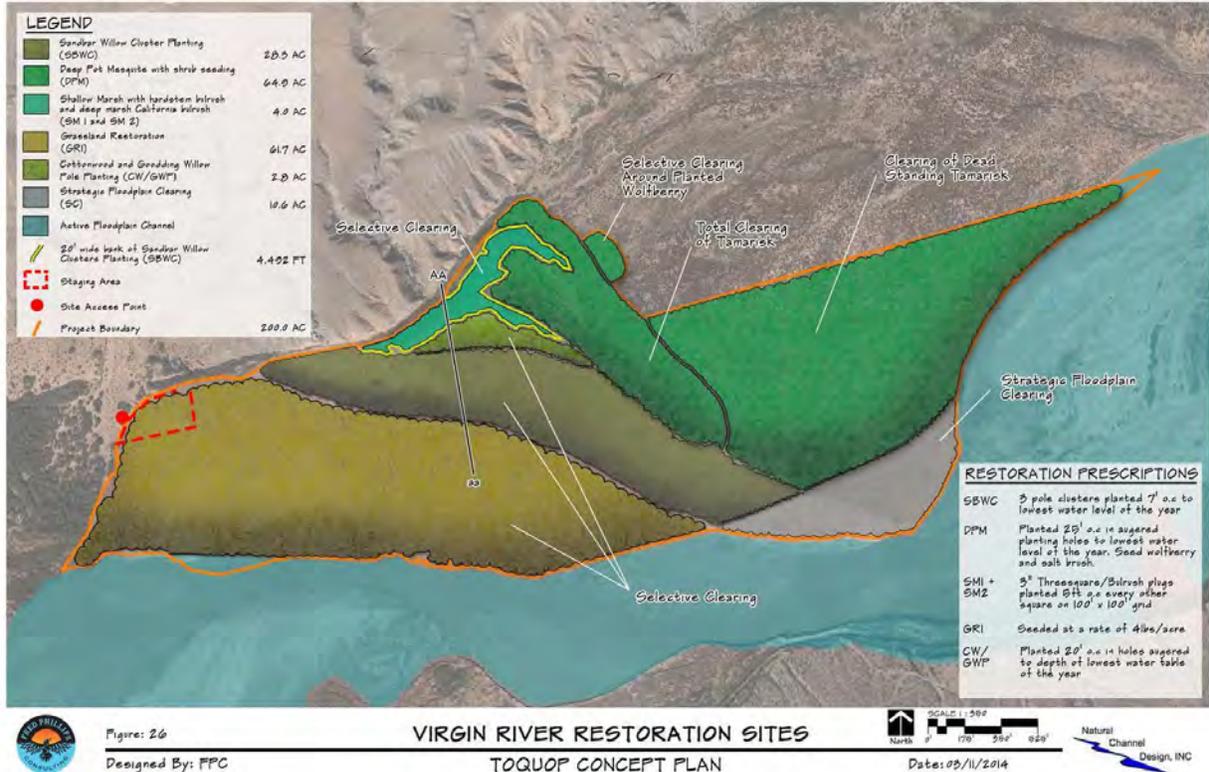
Invasive species removal: Total clearing is recommended for the upper terrace where dead standing tamarisk covers the majority of the area. Bulldozing would be used in the majority of the upper terrace

where large standing snags were left by the 2009 fire. Cut-stump treatment of a dense tamarisk stand along the western edge of the upper terrace would be used to remove large tamarisk trees where access may be limited. Selective clearing is recommended in and around the existing marsh and along the active floodplain where native grasses and some native trees are resprouting. This could include weed whipping to remove large marsh grasses around the existing marsh area, hand clearing to remove resprouting tamarisk in the lower bank zone, and spot foliar spraying for more mature invasive plants growing in the lower bank zone and marsh.

Native plant restoration: Sandbar willow cluster planting would be implemented around the existing marsh and in the active floodplain margin. Grassland restoration would include seeding and plugs. The shallow marsh would be planted with Olney's threesquare and California bulrush on the active floodplain. Deep pot mesquite would be planted on the upper terrace, and cottonwood and Goodding's willow pole plantings in the buffer zone along the southern edge of the existing marsh.

Monitoring and maintenance: Recolonizing trees in the strategic floodplain will need to be removed to insure proper function. Vegetation monitoring, including photo documentation, will be necessary to assess plant survivability and project success. Long-term weed maintenance and control may be needed to remove invasive plant species until native vegetation is established.

Figure 5. Toquop site plan. (Fred Phillips Consulting, and Natural Channel Design, Inc. 2014)



### Reach 3. Halfway Wash Site.



Location: Halfway Wash site, Virgin River, Clark Co. NV

Acreage: Approx. 92 acres

Condition: Poor to Fair

Threats: Invasive weeds, wildland fire, trespass cattle, high salt content.

Goals: Invasive weed control, reconnect backwater channel, restore marsh.

**Threats** to this site (§332.8(c)(2)(ii)): Invasive weeds include tamarisk, camelthorn and Sahara mustard. Saturated soils increase salinity, impacting water quality and altering vegetation species composition.

**Historic aquatic losses** (§332.8(c)(2)(iii)): Invasive weeds and soil salinity have resulted in loss of native plant species and increased fire threat.

**Current aquatic resources** (§332.8(c)(2)(iv)): The Virgin River includes 4 federally listed threatened or endangered species (2 fishes, 2 birds), 22 candidate species (3 fishes, 5 birds, 6 invertebrates, 7 plants), and 6 federal species of special concern (1 fish, 4 amphibians, 1 invertebrate).

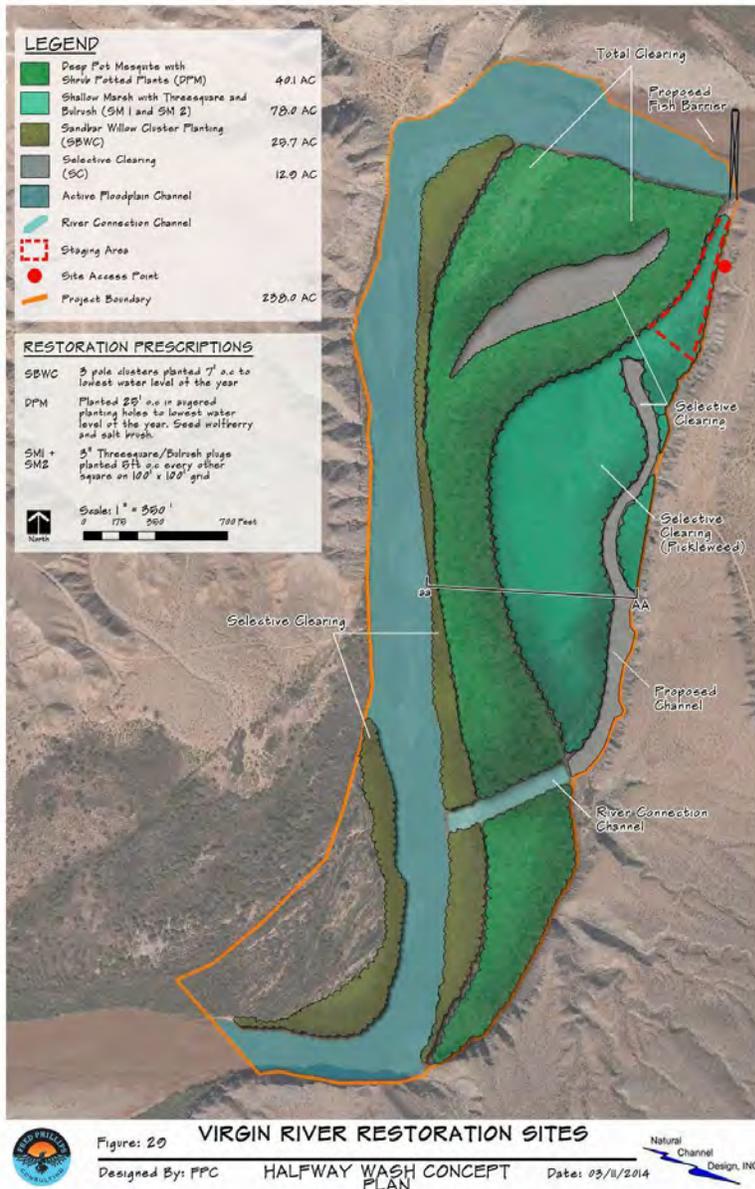
**Preservation/restoration objectives** (§332.8(c)(2)(v)):

**Geomorphological restoration:** This site is located just downstream of the proposed Halfway Wash fish barrier. There is a manmade oxbow at the site, and this backwater channel needs to be reconnected to the river and the shallow marsh restored. The radius of curvature at this site is controlled by a bedrock cliff. The channel is forced into a very tight meander as the flow turns south. Recommendations include planting the point bar adjunct to the tight meander with soft type vegetation that will not impede flow or the spreading of flood flows across the point bar. The area downstream of the point bar on the western side of the channel could be planted while still maintaining an active channel width of approximately 500 feet. The D channel of this site is relatively stable and it should be expected that the surface of the point bar will be somewhat dynamic as it will likely be flooded every 2 years, on average.

**Invasive species removal:** Total clearing is recommended in areas with dense monocultures of tamarisk, including bulldozing due to the size and density of tamarisk at this site, cut stump treatment along border areas to prevent damage to existing native vegetation, and prescribed burning in the southern part of the tamarisk stand where few native trees are present. Selected clearing is recommended in and around existing screwbean mesquites and within the low lying area next to the oxbow, as well as along the bankline, where sandbar willows currently grow. Methods may include mowing to allow native grasses a competitive advantage, hand clearing to control resprouting tamarisk, and cut-stump to clear tamarisk while retaining native willows.

Monitoring and maintenance: Invasive plant species will need to be kept clear from the created backwater channel to allow for continued water passage. Recolonizing invasive weeds will require spot treatment until the native vegetation is established. Fencing to exclude trespass cattle is recommended to protect restoration work and native plantings. Vegetation monitoring, including photo documentation, may be necessary to assess plant survivability and project success.

Figure 6. Halfway Wash site plan. (Fred Phillips Consulting, and Natural Channel Design, Inc. 2014)



### Reach 3. Upper Mormon Mesa Site.



Location: Upper Mormon Mesa site, Virgin River, Clark Co. NV

Acreage: Approx. 127 acres

Condition: Poor to Fair

Threats: Invasive weeds, wildland fire, trespass cattle.

Goals: Restore channel geomorphology, invasive weed control.

**Threats** to this site (§332.8(c)(2)(ii)): Invasive weeds include tamarisk, camelthorn and Sahara mustard. Dense tamarisk stands have forced river flow above its floodplain and increased fire hazardous fuels.

**Historic aquatic losses** (§332.8(c)(2)(iii)): Invasive weeds have resulted in loss of native plant species and increased fire threat.

**Current aquatic resources** (§332.8(c)(2)(iv)): The Virgin River includes 4 federally listed threatened or endangered species (2 fishes, 2 birds), 22 candidate species (3 fishes, 5 birds, 6 invertebrates, 7 plants), and 6 federal species of special concern (1 fish, 4 amphibians, 1 invertebrate).

#### **Preservation/restoration objectives** (§332.8(c)(2)(v)):

**Geomorphological restoration:** The stream channel at this site is perched above the adjacent floodplain, apparently forced to the edge of the valley by dense stands of tamarisk. At the downstream end of the site, the channel must turn nearly 120 degrees to fall back down to the valley bottom. This condition has added to the dynamic and unstable nature of the system. Strategic floodplain clearing is recommended to help stabilize the river channel and help guide the river channel back towards the center of the canyon. The southern bank will be stripped of tamarisk and the stream will be allowed to erode the bank back toward a more favorable radius of curvature.

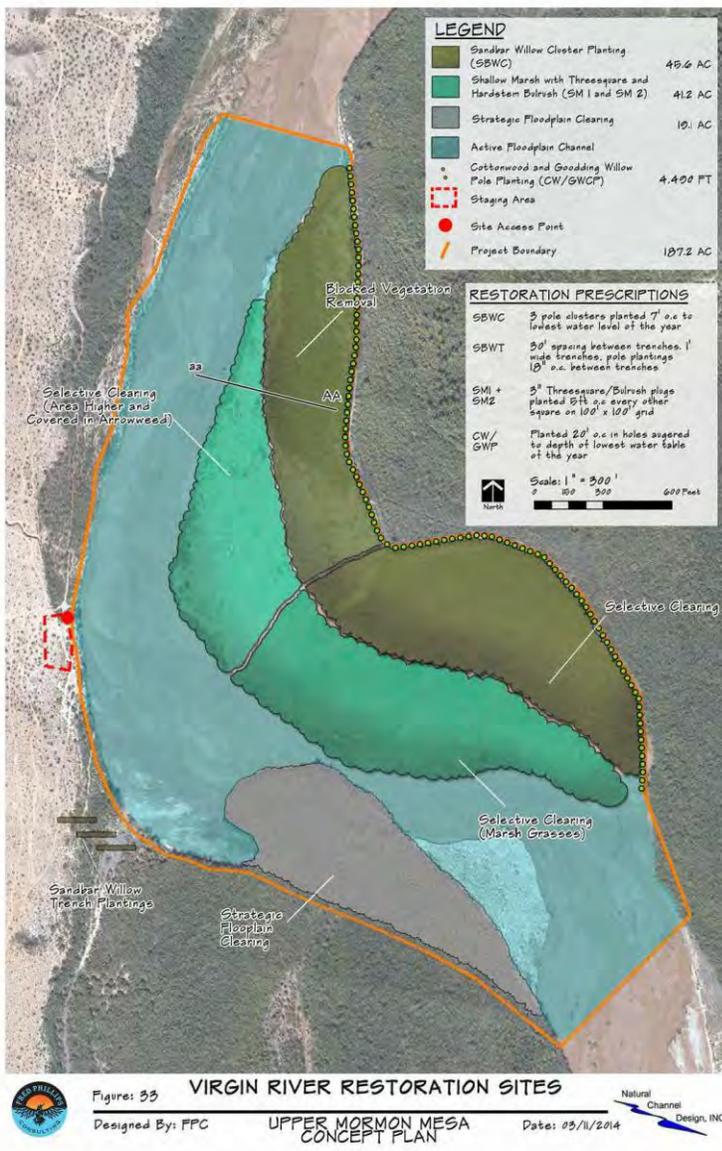
**Invasive species removal:** Selective floodplain clearing will be implemented in strategic areas of dense tamarisk monocultures. Blocked vegetation removal (no more than 10 acre areas) will be used for a smaller stand of tamarisk at the northeastern portion of the site to limit disturbance to adjacent existing habitat for the endangered southwestern willow flycatcher; work will be performed outside of the active breeding season. Cut-stump treatment will be used in less dense stands along the existing stand of tamarisk, to help retain desired native vegetation. Mowing may be used to treat large arrowweed shrubs along the eastern bank adjacent to tamarisk to reduce competition with planted native vegetation; mowing operations also will take place outside of the active flycatcher breeding season.

**Native plant restoration:** Sandbar willow cluster planting will be used along the bankline to help stabilize the banks and in the floodplain terrace. Sandbar willow trench plantings will be placed at the lower outside bank just upstream of the strategic clearing zone. Shallow marsh plugs (bulrush) will be

used along the toe of the bank slope. Cottonwood and Goodding's willow pole planting will take place along the edge of the upper terrace. Camelthorn also occurs at this site and will be treated chemically.

Monitoring and maintenance: Invasive vegetation will need to be removed from the active floodplain where strategic floodplain clearing occurs. The planted brush trenches will have to be cleared to maintain their function. Sandbar willow clusters and grass plugs will require minimal maintenance if planted in or close to the lowest groundwater of the year. However, monitoring and removal of the recolonizing invasive camelthorn and tamarisk will be required to ensure project success. Spot treatment using a backpack sprayer with herbicide will be the most effective method of control.

Figure 7. Upper Mormon Mesa site plan. (Fred Phillips Consulting and Natural Channel Design, Inc. 2014)



#### Reach 4. Lower Mormon Mesa Site.



Location: Lower Mormon Mesa site, Virgin River, Clark Co. NV

Acreage: Approx. 123 acres

Condition: Poor to Fair

Threats: Invasive weeds, soil erosion, wildland fire, trespass cattle.

Goals: Restore channel geomorphology, invasive weed control.

**Threats** to this site (§332.8(c)(2)(ii)): Invasive weeds include tamarisk, camelthorn and Sahara mustard. Dense tamarisk stands have forced river flow away from its floodplain and increased fire threat.

**Historic aquatic losses** (§332.8(c)(2)(iii)): Invasive weeds have resulted in loss of native plant species and increased fire threat.

**Current aquatic resources** (§332.8(c)(2)(iv)): The Virgin River includes 4 federally listed threatened or endangered species (2 fishes, 2 birds), 22 candidate species (3 fishes, 5 birds, 6 invertebrates, 7 plants), and 6 federal species of special concern (1 fish, 4 amphibians, 1 invertebrate).

**Preservation/restoration objectives** (§332.8(c)(2)(v)):

**Geomorphological restoration**: This site is within the Lake Mead National Recreation Area, administered by the National Park Service, and is located just north of the high water mark boundary for Lake Mead. Dense stands of tamarisk have caused the stream channel to become disconnected from its floodplain. As a result, energy from flood flows is not dissipated across a floodplain, but rather concentrated upon the weak streambanks, accelerating erosion. Revegetation efforts at this site will not encroach into the 500 foot active channel width but will take place within the narrow corridor created by the dense tamarisk.

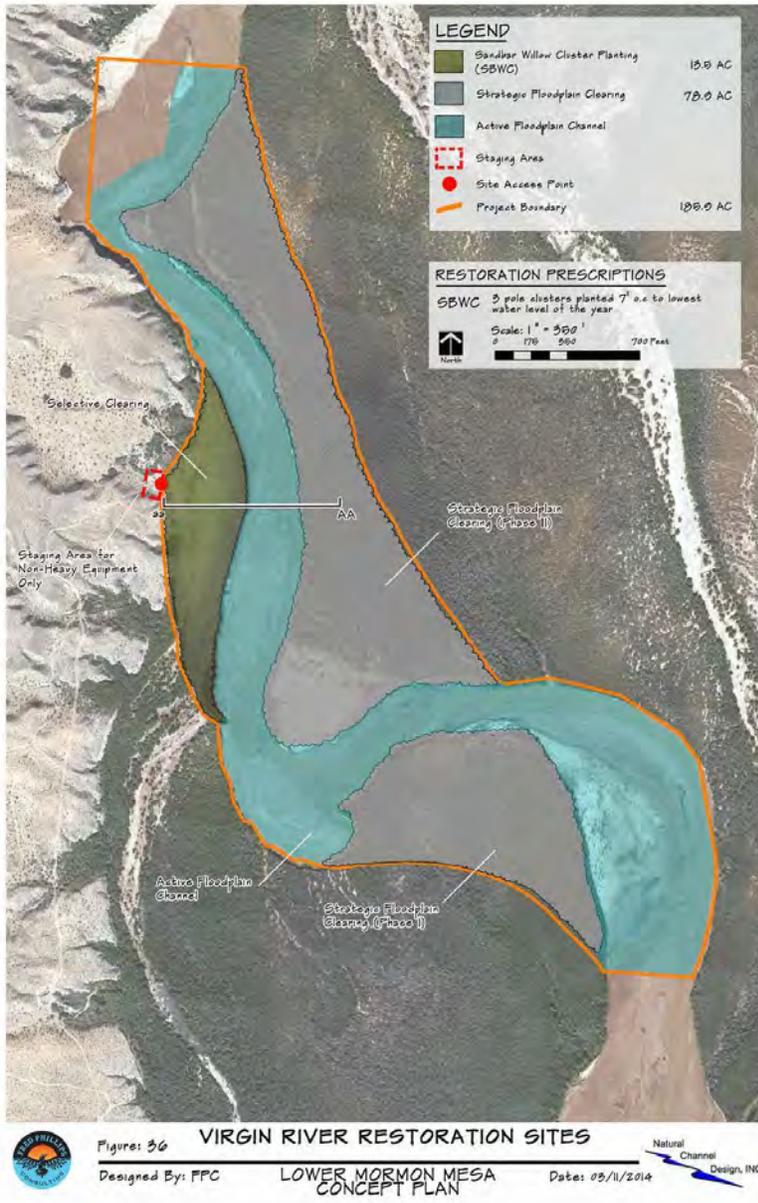
**Invasive species removal**: Strategic floodplain clearing will occur in areas of dense tamarisk monocultures, using prescribed burning where appropriate on both sides of the river, and bulldozing where accessible on both sides of the river. Bulldozing may also be used to help grade some sites to allow for realignment of the active channel and reconnection with the floodplain. Selective clearing may be used along the western bank where sandbar can be planted. Cut-stump treatment will be used for large tamarisk trees where access may be an issue. Mowing may be used to remove large arrowweed bushes. Camelthorn also occurs at this site and will be controlled by chemical means.

**Native plant restoration**: Sandbar willow cluster planting will be used on the bankline to help direct water back to the channel and stabilize banklines.

**Monitoring and maintenance**: Invasive vegetation will have to be removed in the active floodplain where strategic floodplain clearing occurs. The sandbar willow clusters will require minimal

maintenance if planted in or close to the lowest groundwater of the year. However, monitoring and removal of the recolonizing invasive camelthorn and tamarisk will be required to ensure project success. Spot treatment using a backpack sprayer with herbicide will be the most effective method of control.

Figure 8. Lower Mormon Mesa site plan. (Fred Phillips Consulting and Natural Channel Design, Inc. 2014)



## Muddy River

The Muddy River originates from a series of more than 20 thermal springs in an area known as Warm Springs, about 8 miles northwest of the town of Moapa in Clark County, Nevada. These springs are the terminal discharge point of the White River ground-water flow system (Eakin, 1966), which originates in northeastern Nevada. There are six major spring groups: Cardy Lamb, Baldwin, Muddy, Apcar, Pederson, and Plummer. Some of the springs are within the Moapa Valley National Wildlife Refuge, managed by the U.S. Fish and Wildlife Service. Other springs and headwaters are on private land or within the Warm Springs Natural Area, managed by the Southern Nevada Water Authority. Average water temperature at the springs is 89°F (32°C).

Below this area, the river flows through some private land parcels and the former Perkins Ranch, a portion of which is now owned and managed by Clark County and a portion of which is under BLM management. Downstream of the Perkins Ranch site, the river flows through the Moapa River Indian Reservation, managed by the Moapa Band of Paiutes. The river continues to flow southeast through private lands, including a power generating plant, to Moapa and Glendale, then beyond past the towns of Logandale and Overton, then discharges into Lake Mead, a total of 26 to 32 miles in length, depending on the lake water level. Prior to construction of Hoover Dam, the Muddy River flowed into the Virgin River upstream of the confluence of the Virgin and Colorado Rivers. The Meadow Valley Wash flows into the Muddy River from the north at Glendale, south of Moapa. Table 2 below displays land ownership and acres. (Also see Maps 3a, 3b.)

Table 2. Land Ownership within the Muddy River Watershed

Ownership	Acres	Percent	Acres within SNDO
Bureau of Land Management	736,255	64	456,671
National Wildlife Refuge	262,270	23	262,270
Tribal	70,666	6	70,666
Private	51,851	4	28,095
State Parks	17,482	2	17,482
Clark County	13,918	1	13,918
Bureau of Reclamation	3,243	<1	3,243
State Wildlife Management Area	3,069	<1	3,069
National Parks	435	<1	435
Department of Defense	190	<1	190
Total	1,159,379	100	856,039

Groundwater discharging at Muddy River springs (the terminus of the White River flow system) is a mixture of 40 percent (14k afa) from Pahrnagat Valley, 38 percent (14k afa) from the Sheep Range and 22 percent (8k afa) from the southern Meadow Valley Wash (Harrill and Prudic 1998).

Since the mid-1800s, the river has become deeply entrenched and channelized. Water has been diverted for agriculture irrigation, domestic supply, and power generation. Except for 50- and 100-year flood events, water has not escaped its banks into the floodplain in the past century; until the two

flooding events in September of 2014. Increased non-native vegetation, mostly tamarisk, and woody debris raised water levels above the river banks by slowing the flow of the Muddy River. Volume wise these floods were only about 20-year events.

Endemic aquatic species include: federally endangered Moapa dace (*Moapa coriacea*) and Virgin River chub (*Gila seminuda*) (although the Muddy River population of Virgin River chub is not currently included in the listing), as well as Moapa speckled dace (*Rhinichthys osculus moapae*), Moapa White River springfish (*Crenichthys baileyi moapae*), Moapa naucorid (*Limnocoris moapensis*), Moapa pebble snail (*Pyrgulopsis avernalis*), Moapa riffle beetle (*Microcyllloepus moapus*) and Moapa Warm Springs riffle beetle (*Stenelmis moapa*).

Much of the upper Muddy River area historically has been managed for private agricultural and recreational use. The BLM managed portion of the Perkins Ranch site includes old irrigation infrastructure that is now dysfunctional. The elevated roadway of Hillside Drive and a damaged, concrete-lined irrigation ditch create an artificial berm that restricts water flowing from side drainages into the Muddy River. These berms disrupt normal hydrologic conditions and foster weed establishment by trapping runoff. Exotic plants have colonized areas of side drainages upstream of the berms.

Exotic plants, including salt cedar (*Tamarisk* spp.), Russian knapweed (*Acroptilon repens*), Malta star-thistle (*Centaurea melitensis*), Russian thistle (*Salsola tragus*), and five-hook bassia or kochia (*Bassia hyssopifolia*) are hindering natural vegetation recovery of the Muddy River floodplain since the cessation of agriculture and other prior land uses. Salt cedar, Russian knapweed, and Malta star-thistle are listed by the state of Nevada as noxious weed species.

Project Proposals for Muddy River:

**Perkins Ranch Site.**



Location: Perkins Ranch site, Muddy River, Clark Co. NV

Acreage: Approx. 204 acres

Condition: Poor to Fair

Threats: Invasive weeds, wildland fire.

Goals: Restore side drainages, decommission and restore roads, invasive weed control.

**Threats** to this site (§332.8(c)(2)(ii)): Old agricultural berms block flow from side drainages and increase weeds. Invasive weeds include tamarisk, Russian knapweed, Malta starthistle, Russian thistle, kochia.

**Historic aquatic losses** (§332.8(c)(2)(iii)): Invasive weeds have displaced native plant species and increased fire hazard.

**Current aquatic resources** (§332.8(c)(2)(iv)): The Muddy River includes habitat for 4 federally listed threatened or endangered species (2 fishes, 1 bird, 1 reptile), and 6 BLM sensitive species (3 birds, 4 reptiles, several mammals (bats)).

**Preservation/restoration objectives** (§332.8(c)(2)(v)): Approximately 204 acres of the 407 acres of BLM managed lands at this site are proposed for restoration. (See Map 3c.) Objectives for the Perkins Ranch site include:

Geomorphological restoration: Strategic restoration of the floodplain is proposed to connect the geomorphic structure of the river to the eastern floodplain with the project site. By geomorphologically connecting the eastern edge of the lower terrace it would allow the river channel to adjust in the future, lessening the current constriction of the river through the site. This would potentially create 10-50 acres of willow flycatcher habitat. The existing condition is a single-thread D ditch. Creating a multi-thread channel with wide, low bars on either side of the river, below the existing upper fish barrier is an option that requires further study and investigation. There is a higher terrace feature on the upstream side of the site. A low marsh system could be created south of this higher terrace located on the eastern side of the site. The potential marsh/low terrace on the site could be inundated at relatively frequent flood events and could be considered part of a future active channel. Care would be taken to ensure that the geomorphological alterations would not impair existing water rights or lead to potential flooding of private property.

The artificial barriers that cross the tributary side washes that flow into the Muddy River will be removed to restore hydrologic function. The barriers would be removed by knocking down portions of the berm, including the road and old irrigation canal where they cross each of the drainages, to allow water to flow unimpeded to the Muddy River. One additional berm located 950 feet upstream of the roadway in one side drainage will also be removed. Fill material from the berms will be removed by truck, or spread out along the wash where it originated upstream and downstream of the barrier depending on the location of depressions within the wash. Standard erosion control measures will be employed to reduce the likelihood of increased sedimentation in the Muddy River following rain events, and disturbed areas will be revegetated using standard restoration techniques. A maze of user-created roads and tracks crossing the parcel would be decommissioned and restored using standard disturbance restoration techniques. These may include ripping compacted roadways with a skid-steer ripper attachment of similar device, seeding or planting native vegetation, using horizontal or vertical mounds to serve as catchments for native seeds and nurse structure seedlings, and installing barriers or signs to discourage illegal off-road driving.

**Invasive species removal:** Salt cedar (*Tamarix* species) and other invasive plants that interfere with normal hydrologic function will be controlled by chemical treatment and/or mechanical means as appropriate. Removal of the berms and other artificial barriers will help prevent pooling of water, reducing the probability of reinvasion by weeds.

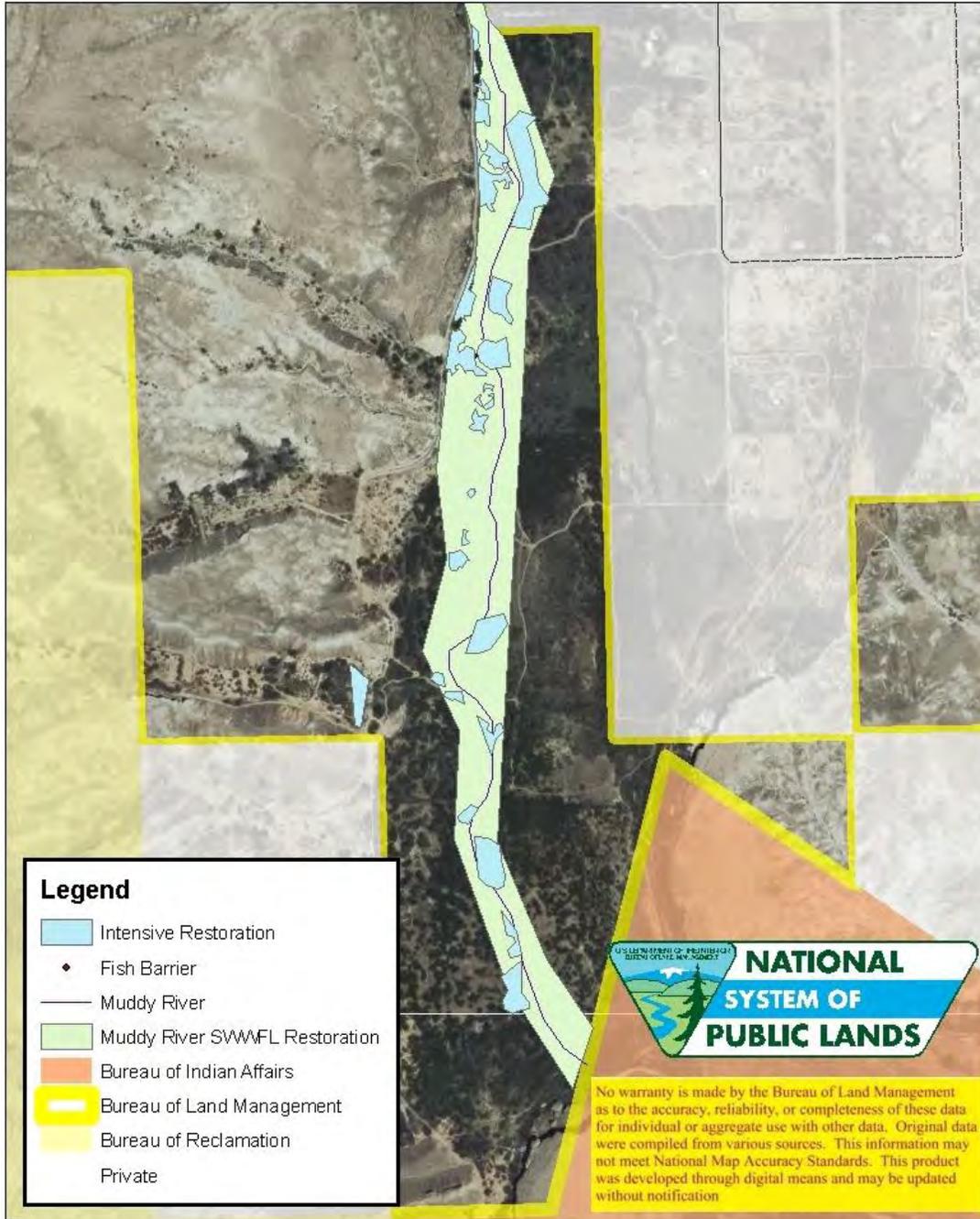
**Native plant restoration:** Restoration with native riparian plants will be implemented to maintain bank stabilization, rebuild habitat structure, and help prevent reinvasion of weeds. This may include seeding, plants or cuttings. Plants and seeds should be harvested or transplanted from local watershed sources, or other BLM approved areas, or nursery propagated. Recommended species include coyote willow and Gooddings willow for wetter areas using vertical trenching or pole planting; Fremont cottonwood and velvet ash for the upper riparian terrace using container plants grown from local seeds; seep willow, squaw bush, saltgrass, alkali sacaton, and other native species throughout the riparian terrace using tube stock plants; small plugs of saltgrass and alkali sacaton may be transplanted if populations are found on site. Upland areas of former agricultural lands should be revegetated with drought tolerant species such as honey mesquite, screwbean mesquite, four-wing saltbush, blackbrush, saltgrass and alkali sacaton using container grown plants. Broadcast seeding of native seeds using handheld tools can also be implemented in upland areas. Where practical, simple test wells would be installed at various intervals of proximity to moving water to develop a ground water profile. Depth to water would determine the best plant species for each site.

**Monitoring and maintenance:** Supplemental watering will be required to support most native plantings until they are established; drip irrigation is proposed where conditions allow, supplied by a 1,000 to 3,000 gallon water tank, placed slightly above the elevation of the plants, that would need to be refilled monthly. The irrigation system will need regular monitoring and repair to maintain proper function, and can be removed after 2 to 3 growing seasons. Vertical deep-root irrigation pipes may be used where drip irrigation is impractical, and hand watering would be needed. Some plants need to have wire cages or tube protectors installed to prevent browsing by wildlife until they are established, at which time the

cages or protectors can be removed. Monitoring and control of invasive plants will be necessary to prevent re-invasion until native vegetation is established.

Figure 9: Muddy River Perkins Ranch Restoration (BLM. 2013. PowerPoint)

## Muddy River SWWFL Restoration



### Meadow Valley Wash

The Meadow Valley Wash begins in the Wilson Creek Range in Lincoln County to the north of the proposed ILF Program area. The wash flows south for approximately 110 miles, eventually emptying into the Muddy River near the town of Moapa, Nevada (see Maps 4a, 4b). Table 3 below displays land ownership and acres.

Table 3. Land Ownership within the Meadow Valley Wash Watershed

Ownership	Acres	Percent	Acres within SNDO
Bureau of Land Management	1,558,194	96	49,386
Private	52,568	3	1,994
Forest Service	9,849	<1	0
State Parks	2,829	<1	0
County	23	<1	23
Tribal	19	<1	19
Total	1,623,482	100	51,422

The Stuart Ranch property is a 280-acre area of sensitive habitat located on BLM lands within the Meadow Valley Wash, approximately 10 miles northwest of the town of Moapa. The site was purchased by the BLM in 2007, using SNPLMA funds, for the purpose of protection, preservation and restoration of the site's natural and cultural resources. Natural resources include a riparian corridor which can be protected and restored for habitat for rare and endangered species such as southwestern willow flycatcher, the Meadow Valley Wash speckled dace, and the Meadow Valley Wash desert sucker. Cultural resources in the site include approximately 60 Native American petroglyph panels and the remains of a historic ranch house.

Human-caused disturbances include: recently abandoned (pre-1994) agricultural developments (diversion of the Meadow Valley Wash, irrigation ditches, dikes, and pond) that have resulted in increased soil alkalinity and moderate to severe rill/gully erosion; and railroad track and maintenance road positioned along the west flank of Meadow Valley Wash resulting in a confined wash and active floodplain, restricting alluvial transport from minor washes, and erosion of colluvial slopes, increased energy leading to increased scour, increased deposition where the wash is unconfined, and rill/gully and sheet erosion of adjacent stream terrace and alluvium.

Project Proposals for Meadow Valley Wash:

**Stuart Ranch Site.** (See Maps 4c, 4d.)



Location: Stuart Ranch site, Meadow Valley Wash, Clark Co. NV

Acreage: Approx. 280 acres

Condition: Poor to Fair

Threats: Invasive weeds, wildland fire.

Goals: Restore connection to ephemeral side channels, invasive weed control.

**Threats** to this site (§332.8(c)(2)(ii)): Invasive weeds include tamarisk, perennial pepperweed, and Russian knapweed.

**Historic aquatic losses** (§332.8(c)(2)(iii)): Now abandoned agricultural activities altered hydrology of the site, increased soil erosion. Invasive weeds displaced native plant species and increased fire hazard.

**Current aquatic resources** (§332.8(c)(2)(iv)): This portion of the Meadow Valley Wash includes habitat for 4 federally listed threatened or endangered species (1 fish, 2 birds, 1 reptile), 1 candidate species (bird) and 3 BLM sensitive species (2 fishes, 1 mammal).

**Preservation/restoration objectives** (§332.8(c)(2)(v)): The SNDO contracted Otis Bay Ecological Consultants to develop the Stuart Ranch Biophysical Assessment and Ecological Recovery Plan, completed in 2010. Objectives for ecosystem restoration include: reform/restore ephemeral channels that were filled and leveled for agricultural fields and reconnecting them to the Meadow Valley Wash; construct crossings over the ephemeral washes to allow for uninterrupted water and sediment flow; remove invasive, non-native plants species and replace with site-appropriate native vegetation alliances (Otis Bay Ecological Consultants, 2010).

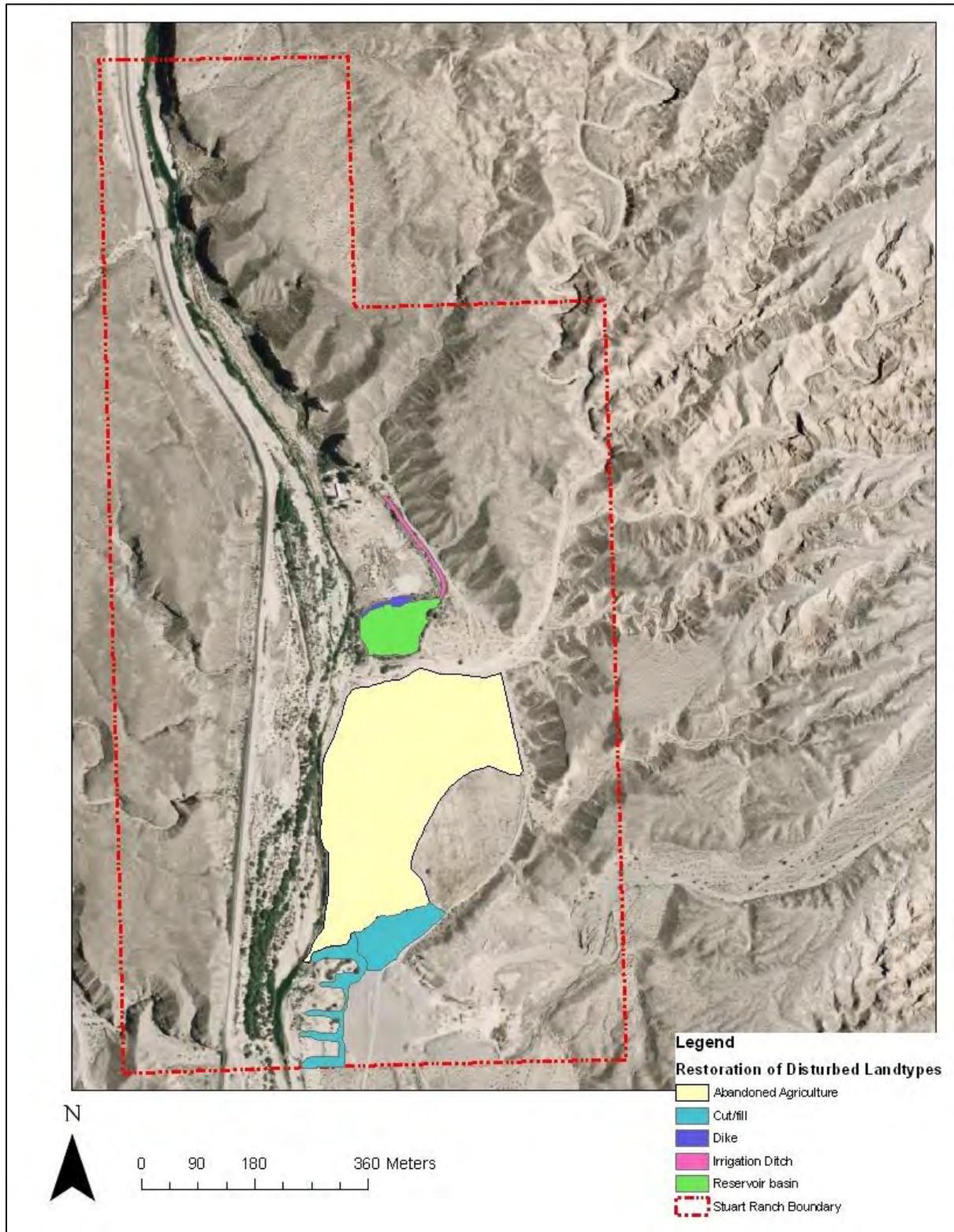
Geomorphological restoration: Reform ephemeral channels No. 1 and No. 2 (Map 4e) and reconnect them to the Meadow Valley Wash; Grade channels No. 3 and No. 4 into alluvial fans and allow them to naturally develop over a long period of time; Remove pond dikes and grade soil from the dikes into the landscape in a naturalized condition; Construct crossings over the ephemeral washes to allow for uninterrupted water and sediment flow. Other recommendations include: The area around the gravel cut/fill area that is not retained as a parking lot should be graded to mimic natural topography; Irrigation ditch located south of the petroglyph sites should be filled and graded to match the surrounding natural slopes; Remains of an old reservoir basin and dike should be graded to create a hillock feature; Hillocks and swales should be added in appropriate areas of abandoned agricultural fields to increase habitat diversity and complexity, thus increasing biological richness.

Invasive species removal: Tamarisk species are dominant in some areas and will be removed using mechanical and chemical treatments. This work will be completed in conjunction with replanting of native willows in order to maintain potential habitat for the endangered southwestern willow flycatcher, and work will be done outside the breeding season. Other invasive plant species include perennial pepperweed (*Lepidium latifolium*), Russian knapweed (*Acroptilon repens*) and possibly an exotic thistle species (*Cirsium* spp.). These weeds will be controlled by mowing, solarization, and herbicide treatments, as manual and mechanical methods alone have proven to be ineffective in controlling these species. Follow-up treatments will be necessary for several seasons to ensure complete control. Replanting with native species is important to reduce the likelihood of re-invasion or re-establishment.

Native plant restoration: Within the wash area, tamarisk will be replaced with riparian species including willow (*Salix* spp.) and baccharis (*Baccharis* spp.). Other riparian plants will include alkali sacaton (*Sporobolus airoides*) and scraggrass (*Muhlenbergia asperifolia*). In the higher terraces or xeroriparian sites, mesquite (*Prosopis* spp.), desert willow (*Chilopsis linearis*), catclaw (*Acacia greggii*) and other appropriate native species will be planted. Upland areas will include white bursage (*Ambrosia dumosa*), creosote (*Larrea tridentata*), sweetbush (*Bebbia juncea*), Indian ricegrass (*Achnatherium hymenoides*), James' galleta (*Pleuraphis jamesii*), big galleta (*Pleuraphis rigida*), and other appropriate native species. Ground surface preparation and vertical mulching are recommended.

Monitoring and maintenance: Upland plantings will require supplemental watering for 2 to 3 growing seasons until plants are established. If drip irrigation is used, the system will need regular monitoring and maintenance to ensure proper function. Some plants may need protection from browsing by wildlife, such as wire cages or tree tubes, until established. Monthly monitoring and treatment for weeds is recommended for the first year after restoration, then quarterly for as long as funding permits. Since tamarisk is abundant immediately upstream from the site, continued long term monitoring and treatments on this site will be necessary to prevent re-establishment.

Figure 10: Stuart Ranch site plan (Otis Bay Ecological Consultants. 2010. Stuart Ranch Final Report)



### Other Potential Sites within the Service Area

Other water sources within these watersheds are natural springs, seeps, urban runoff and groundwater. These all contribute to the location, density and structure of riparian and wetland vegetation. Specific project proposals for this In-Lieu Fee program will be developed for these sites in the future if needed.

### **F. Section 332.8(c)(2)(vi): A prioritization strategy for selecting and implementing compensatory mitigation activities.**

While all of the proposed areas have significant natural values, some of the areas currently provide good habitat for sensitive and listed species, while other areas will provide that habitat once restored or created. Most of these areas are not currently slated for development, but nearby land uses impact their ability to function properly. Sites that have the highest potential for negative impacts will be preserved first. The prioritization strategy for the In-Lieu Fee Program will be to identify project sites within the proposed areas that have the highest habitat value for conservation and active management. The goal will be to acquire mitigation fees in the service areas, and to restore the identified riparian habitats. Specifically, the SNDO will:

- 1. Restore aquatic resources on any SNDO identified ILF mitigation sites described above.** Virgin River is the highest priority due to the greatest threat to resources and sensitive species. However, work in this area is restricted at this time due to safety concerns associated with the recent unresolved cattle grazing issue. Therefore, Virgin River reaches will be restored only after this issue has been resolved. Until work can resume in the Virgin River area, the initial priority will be restoration of aquatic resources on lands along the Muddy River. The second priority will be given to the Meadow Valley Wash site. The Virgin River sites will be prioritized as needed and depending on the estimated cost of each project and the amount of funding available at the time.
- 2. Identify adjacent or neighboring lands in need of immediate conservation,** and to acquire and preserve such lands. This would include purchase of lands that have been negatively impacted by anthropogenic activities or have degraded aquatic and related habitat, and which are not currently protected. While no such areas are identified in particular in this document, parcels of land to be acquired would have to be located along one of the three riverine and riparian areas listed above. The availability of suitable parcels, however, is rather stochastic in nature.
- 3. Creation of habitat and restoration, enhancement and long-term management** of habitat lands will be conducted once mitigation credits have been recorded. In this phase, focus will be placed upon habitats that are not currently under imminent threat from human activity, that have invasive weeds and/or that have other conserved lands near or adjacent to the proposed restoration site.

Since the areas currently under conservation that BLM manages in the SNDO are limited, acquiring additional parcels for conservation needs to be a priority. The SNDO will use the USGS “Aquatic Species and Habitat Assessment Protocol for Southwest Ecoregion Rivers, Streams and Creeks” for both

amphibians and fishes to determine the quality and quantity of species present. Assessment protocol for native fishes will be used from the Nevada Department of Wildlife to assess native fish populations and conditions.

**G. Section 332.8(c)(2)(vii): An explanation of how any preservation objectives identified in paragraph (c)(2)(v) of this section and addressed in the prioritization strategy in paragraph (c)(2)(vi) satisfy the criteria for use of preservation in 332.3(h).**

Preservation will be only one type of the compensatory mitigation credits that the Program seeks to serve (with other credit activities being enhancement, restoration, creation and passive regeneration as described in Section VIII E. herein). The main component of the preservation strategy will be to preserve, create, restore and/or enhance aquatic resources in combination with long-term maintenance of the preserved land. The SNDO will set aside endowment funds sufficient to cover the long-term maintenance requirements.

Section 332.8(c)(2)(vii) requests applicants to address the preservation criteria enumerated in Section 332.3(h). Accordingly, the SNDO provides the following information:

**1. The resources to be preserved provide important physical, chemical or biological functions for the watershed.**

All of the areas proposed for protection, or already protected by the SNDO, have biological functions considered essential for the continued health of the subject watersheds. The prioritization strategy will allow the District to focus first on enhancement, establishment and restoration of resources on lands already preserved by the SNDO. These resources include riverine habitats that are native resources for Moapa dace, Virgin River chub, Moapa speckled dace and many other species of the Virgin River, Muddy River, White River and Meadow Valley Wash watersheds. In addition, wetland and riparian resources will be protected that support Southwestern Willow Flycatcher, Yuma clapper rail, Yellow-billed cuckoo and other listed and sensitive species. Currently, the bulk of the aquatic reaches within the proposed conservation areas do not have adequate aquatic values (chemical or biological) due to degraded stream substrates, dumping, diversions, fill and other activities, all of which have decreased the function of the waterways. Providing creation, enhancement, restoration and protection of these areas will greatly increase both the function and value of the aquatic resources. If these resources are not preserved, increased degradation will continue to occur and increase non-point source pollution, erosion and sedimentation.

**2. The resources to be preserved contribute significantly to the ecological sustainability of the watershed. In determining the contribution of those resources to the ecological sustainability of the watershed, the district engineer must use appropriate quantitative assessment tools, where available.**

The preservation objectives implemented through the prioritization strategy above will contribute significantly to the ecological sustainability of the watersheds. The SNDO will use a wetland function assessment methodology, such as the USGS "Aquatic Species and Habitat Assessment Protocol for Southwest Ecoregion Rivers, Streams and Creeks" or other similar assessment program, in each of

the SNDO's proposed ILF Program mitigation areas to determine habitat quality and quantity, and the areas that would require enhancement, restoration or creation. A Habitat Monitoring and Mitigation Plan (HMMP) already exists for the Virgin River, but will also be developed for the Muddy River and Meadow Valley Wash to follow the recommendations of the assessment. However, it is likely that even when such a methodology is used, there may be instances where unforeseen circumstances occur and adaptive management of these sites is necessary. In these instances, best management practices for the site will be used based upon site assessment at the time of the problem. It should be noted that acreages should be used to determine compensatory mitigation requirements in place of linear stream feet where appropriate, or where adequate stream conditions exist to help assess aquatic resource functions.

**3. Preservation is determined by the district engineer to be appropriate and practicable.**

While the district engineer must make the final determination, SNDO staff has initially determined that the preservation of these geographic conservation areas is appropriate and practical for the watersheds. This initial determination seems consistent with resource agency objectives in the area insofar as agency permits and other requirements continue to focus on the Virgin River, Muddy River, White River and Meadow Valley Wash watershed aquatic and riparian areas that are identified by the SNDO in the Program. Habitat areas that are severely fragmented, will be developed or have incompatible overlying restrictions will not be considered for inclusion in the program.

**4. The resources are under threat of destruction or adverse modifications.**

The resources that will be considered for the Program are under threat of adverse modification and/or destruction from outside impacts. The extent and type of threats vary from property to property, and can be discussed in more detail as specific lands are proposed for acquisition. Many of the potential areas have sensitive or rare habitat such as Moapa dace, Virgin River chub, Moapa speckled dace and Southwestern Willow Flycatcher habitat. Many of these areas are under threat of removal, degradation or extirpation of species. (See analysis on pages 13-14).

**5. The preserved sites will be permanently protected through an appropriate real estate or other legal instrument (e.g., conservation easement or designation).**

BLM national and district policies and guidance provide that riparian and aquatic resources on public lands are to be managed for the conservation of those resources. SNDO is committed to the long term management and protection of these sites as a priority. Sites especially along the Muddy and Virgin Rivers may be nominated for designation as ACECs once "Relevance and Importance Values" are met. In addition, the SNDO will establish accounts (through one or more endowments established through payment of mitigation credits) to pay for long-term maintenance of all preserved lands. Preservation will normally be completed in advance or in conjunction with aquatic resources restoration, enhancement and establishment activities as described above. Focus will also be placed on the creation of buffers in upland and riparian areas to enhance the physical and biological characteristics of the protected aquatic resources.

**H. Section 332.8(c)(2)(viii): A description of any public and private stakeholder involvement in plan development and implementation, including, where appropriate, coordination with federal, state, tribal and local aquatic resource management and regulatory authorities.**

The SNDO will develop a MOU between BLM and a third party to help coordinate mitigation efforts on lands controlled by BLM. Depending on the needs of the project in question, the SNDO would plan to involve Clark County, the Southern Nevada Water Authority, the Moapa Band of Paiutes Native American tribe, private landowners neighboring the mitigation site and public entities (i.e. Moapa Water District), as appropriate. Presently, there are no SNDO projects involving the Moapa Band of Paiutes Native American tribe on the Moapa River Reservation.

**I. Section 332.8(c)(2)(ix): A description of the long term protection and management strategies for activities conducted by the in-lieu fee program or sponsor.**

Project sites will be managed on a long-term basis. BLM national and district policies and guidance provide that riparian and aquatic resources on public lands are to be managed for the conservation of those resources. SNDO is committed to the long term management and protection of these sites as a priority. Long-term maintenance of the project sites will be funded by an endowment established and funded by sales of credits to permittees.

**J. Section 332.8(c)(2)(x): A strategy for periodic evaluation and reporting on the progress of the program in achieving the goals and objectives in paragraph (c)(2)(v) of this section, including a process for revising the planning framework as necessary.**

The SNDO will draft an annual report that (1) briefly evaluates the current state of each project site and (2) reports on the progress of the program in achieving the goals and objectives set forth for each geographic service area encompassing those project sites. The annual report may contain photographs, as appropriate. When and where practicable, adaptive management will be used in the event potential problems are identified. Reports will be provided to the U.S. Army Corps of Engineers, and to any other regulatory agency upon request.

**K. Section 332.8(c)(2)(xi): Any other information deemed necessary for effective compensation planning by the district engineer.**

Information necessary for effective compensation planning, such as title reports and parcel maps for lands already under SNDO control can be found in Appendix C. The Meadow Valley Wash site (Stuart Ranch) has been nominated as an Area of Critical Environmental Concern (ACEC) in the preferred alternative under the current Las Vegas and Pahrump Field Offices Resources Management Plan Revision (BLM, in Press).

**IX. In-Lieu Fee Program Account – Section §332.8(d)(2)(viii)(B) and §332.8(i)**

Upon approval of this In-Lieu Fee Program, a third independent party will establish a Program Account for receiving and disbursing funds for the purpose of providing compensatory mitigation for permits authorized by the District Engineer of the U.S. Army Corps of Engineers.

A. Use of Funds:

The Program Account may only be used for the selection, design, acquisition, implementation and management of In-Lieu Fee Program compensatory mitigation projects, except for a small percentage, to be determined by the District Engineer in consultation with the Interagency Review Team (IRT), which can be used for administrative costs.

B. Funding Approval:

Proposed In-Lieu Fee Program projects will be submitted to the District Engineer for funding approval. Disbursements from the Program Account may only be made upon receipt of written authorization from the District Engineer, after the District Engineer has consulted with the IRT. The District Engineer has the authority to direct those funds to alternative compensatory mitigation projects in cases where the SNDO does not provide compensatory mitigation in accordance with the time frame specified in Section 332.8(n)(4).

C. Annual report:

The SNDO, or the third party Program Account Administrator, will provide annual reports to the District Engineer and the IRT. Annual reports will include:

1. All income received, disbursements, and interest earned by the program account;
2. List of all permits for which In-Lieu Fee Program funds were accepted, including:
  - a. Corps permit number (or state permit number as appropriate),
  - b. Service area in which the authorized impacts are located,
  - c. Amount of authorized impacts,
  - d. Amount of required compensatory mitigation,
  - e. Amount paid to the In-Lieu Fee Program,
  - f. Date the funds were received from the permittee.
3. Description of In-Lieu Fee Program expenditures from the Program Account, such as costs of land acquisition, planning, construction, monitoring, maintenance, contingencies, adaptive management, and administration;
4. Balance of advance credits and released credits at the end of the report period for each service area; and
5. Any other information required by the District Engineer.

D. Audits:

All books, accounts, reports, files and other records relating to the In-Lieu Fee Program Account are subject to audit and will be made available at reasonable times for inspection and audit by the District Engineer.

**X. ILF Program Credits – §Section 332.8(o)**

A. Units of Measure:

The principal units for credits and debits are acres, linear feet, functional assessment units, or other suitable metrics of particular resource types. Functional assessment units or other suitable metrics may be linked to acres or feet.

B. Assessment:

Where practicable, an appropriate assessment method (e.g. hydrogeomorphic approach to wetlands functional assessment, index of biological integrity) or other suitable metric must be used to assess and describe the aquatic resource types that will be restored, established, enhanced and/or preserved by the mitigation bank or In-Lieu Fee Program.

C. Credit production:

The number of credits must reflect the difference between pre- and post-compensatory mitigation project site conditions, as determined by a functional or condition assessment or other suitable metric.

D. Credit value:

Once a credit is debited (sold or transferred to a permittee), its value cannot change.

E. Credit costs:

1. The cost of compensatory mitigation credits provided by the In-Lieu Fee Program will be determined by SNDO.
2. The cost per unit of credit must include the expected costs associated with the restoration, establishment, enhancement and/or preservation of aquatic resources in that service area. These costs must be based on full cost accounting, and include, as appropriate, expenses such as land acquisition, project planning and design, construction, plant materials, labor, legal fees, monitoring and remediation or adaptive management activities (including short-term monitoring and maintenance of projects implemented), as well as administration of the In-Lieu Fee Program. The cost per unit of credit must also take into account contingency costs appropriate to the stage of project planning, including uncertainties in construction and real estate expenses. The cost per unit of credit must also take into account the resources necessary for the long term management and protection of the In-Lieu Fee Program project. In addition, the cost per unit of credit must include financial assurances that are necessary to ensure successful completion of In-Lieu Fee Program projects.

F. Credits provided by preservation:

These credits should be specified as acres, linear feet, or other suitable metrics of preservation of a particular resource type. In determining the compensatory mitigation requirements for Department of Army (DA) permits using In-Lieu Fee programs, the District Engineer may apply a higher mitigation ratio

if the requirements are to be met through the use of preservation credits. In determining this higher ration, the District Engineer must consider the relative importance of both the impacted and the preserved aquatic resources in sustaining watershed functions.

G. Credits provided by riparian areas, buffers and uplands:

These credits should be specified as acres, linear feet, or other suitable metrics of riparian area, buffer, and uplands, respectively. Non-aquatic resources can only be used as compensatory mitigation for impacts to aquatic resources authorized by DA permits when those resources are essential to maintaining the ecological viability of adjoining aquatic resources. In determining the compensatory mitigation requirements for DA permits using In-Lieu Fee programs, the District Engineer may authorize the use of riparian area, buffer, and/or upland credits if he determines that these areas are essential to sustaining aquatic resource functions in the watershed and are the most appropriate compensation for the authorized impacts.

H. Credit release schedule:

1. Release of credits must be tied to performance-based milestones (e.g. construction, planting, establishment of specified plant and animal communities). The credit release schedule should reserve a significant share of the total credits for release only after full achievement of ecological performance standards. When determining the credit release schedule, factors to be considered may include, but are not limited to:
  - a. Method of providing compensatory mitigation credits (e.g. restoration),
  - b. Likelihood of success,
  - c. Nature and amount of work needed to generate the credits, and
  - d. Aquatic resource type(s) and function(s) to be provided by the In-Lieu Fee Program project.

The District Engineer will determine the credit release schedule, including the share to be released only after full achievement of performance standards, after consulting with the IRT. Once released, credits may only be used to satisfy compensatory mitigation requirements of a DA permit if the use of credits for a specific permit has been approved by the District Engineer.

2. For single-site mitigation banks, the terms of the credit release schedule must be specified in the mitigation banking instrument. The credit release schedule may provide for an initial debiting of a limited number of credits once the instrument is approved and other appropriate milestones are achieved (per Section 332.8(m)).
3. For In-Lieu Fee Program projects and umbrella mitigation bank sites, the terms of credit release schedule must be specified in the approved mitigation plan. When an In-Lieu Fee Program project or umbrella mitigation bank site is implemented and is achieving the performance-based milestones specified in the credit release schedule, credits are generated in accordance with the credit release schedule for the approved mitigation plan. If the In-Lieu Fee Program project or umbrella mitigation bank site does not achieve those performance-based milestones, the District Engineer may modify the credit release schedule, including reducing the number of credits.

I. Credit release approval:

Credit releases for mitigation banks and In-Lieu Fee Program projects must be approved by the District Engineer. In order for credits to be released, SNDO or the third party Program Account Administrator must submit documentation to the District Engineer demonstrating that the appropriate milestones for credit release have been achieved and requesting the release. The District Engineer will provide copies of this documentation to the IRT members for review, and may determine a site visit is necessary to assess whether the applicable credit release milestones have been achieved.

J. Suspension and termination:

If the District Engineer determines that the mitigation bank or In-Lieu Fee Program is not meeting performance standards of complying with the terms of the instrument, appropriate actions may include, but are not limited to, suspending credit sales, adaptive management, decreasing available credits, utilizing financial assurances, and terminating the instrument.

**XI. Advance Credits – §Section 332.8(n)**

- A. If approved by the District Engineer, advance credits may be made available to permittees. The number of advance credits will be determined by the District Engineer, in consultation with the IRT, and will be specified for each service area. The number of advance credits will be based on the following considerations:
1. The Compensation Planning Framework,
  2. SNDO's past performance for implementing aquatic resource restoration, establishment, enhancement, and/or preservation activities in the proposed service area or other areas, and
  3. The projected financing necessary to begin planning and implementation of In-Lieu Fee Program projects.
- B. To determine the appropriate number of advance credits for a particular service area, the District Engineer may require SNDO/Administrator to provide confidential supporting information that will not be made available to the general public. Examples of confidential supporting information may include prospective In-Lieu Fee Program project sites.
- C. As released credits are produced by In-Lieu Fee Program projects, they must be used to fulfill any advance credits that have already been provided within the project service area before any remaining released credits can be sold or transferred to permittees. Once previously provided advance credits have been fulfilled, an equal number of advance credits will be re-allocated to SNDO/Administrator for sale or transfer to fulfill new mitigation requirements, consistent with the terms of the instrument. The number of advance credits available to SNDO/Administrator at any time to sell or transfer to permittees in a given service area is equal to the number of advance credits specified in the instrument, minus any that have already been provided but not yet fulfilled.

- D. Land acquisition and initial physical and biological improvements must be completed by the third full growing season after the first advance credit in that service area is secured by a permittee, unless the District Engineer determines that more or less time is needed to plan and implement an In-Lieu Fee Program project. If the District Engineer determines that there is a compensatory mitigation deficit in a specific service area by the third growing season after the first advance credit in that service area is sold, and determines that it would not be in the public interest to allow the SNDO additional time to plan and implement an In-Lieu Fee Program project, the District Engineer will direct the SNDO to disburse funds from the In-Lieu Fee Program Account to provide alternative compensatory mitigation to fulfill those compensation obligations.
  
- E. The SNDO is responsible for complying with the terms of the In-Lieu Fee Program instrument. If the District Engineer determines, as a result of review of annual reports on the operation of the In-Lieu Fee Program, that SNDO is not performing in compliance with this instrument, the District Engineer may take appropriate disciplinary action, which may include suspension of credit sales, to ensure compliance. Permittees that secured credits from the In-Lieu Fee Program are not responsible for In-Lieu Fee Program compliance.

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## APPENDIX A

### Contact Information

#### **U.S. Bureau of Land Management, Southern Nevada District Office**

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Jason Deters, Senior Regulatory Project Manager (acting)

Jason.deters@usace.army.mil

435-986-3979

## APPENDIX B

### Service Area Maps

1. ILF Proposed Service Area
  - a. Overview of Proposed Service Area
  - b. Land Ownership – Proposed Service Area
  - c. Proposed Project Locations - Overview
2. Virgin River
  - a. Virgin River Watershed
  - b. Land Ownership – Virgin River Watershed
  - c. Halfway Wash Fish Barrier – Location and Vicinity
  - d. Nevada Reaches – Virgin River
  - e. Virgin River Project Sites
3. Muddy River
  - a. Muddy River Watershed
  - b. Land Ownership – Muddy River Watershed
  - c. Perkins Ranch Project Area
  - d. Perkins Ranch Project Sites
4. Meadow Valley Wash
  - a. Meadow Valley Wash Watershed
  - b. Land Ownership – Meadow Valley Watershed
  - c. Stuart Ranch Vicinity
  - d. Stuart Ranch Project Sites
  - e. Stuart Ranch Ephemeral Channels
5. USGS HUC-8 Hydrologic Units
  - a. Hydrologic Unit 1510100 Lower Colorado River-Lake Mead
  - b. Hydrologic Unit 151010008 Upper Virgin
  - c. Hydrologic Unit 151010009 Fort Pierce Wash
  - d. Hydrologic Unit 151010010 Lower Virgin
  - e. Hydrologic Unit 151010011 White
  - f. Hydrologic Unit 151010012 Muddy
  - g. Hydrologic Unit 151010013 Meadow Valley Wash

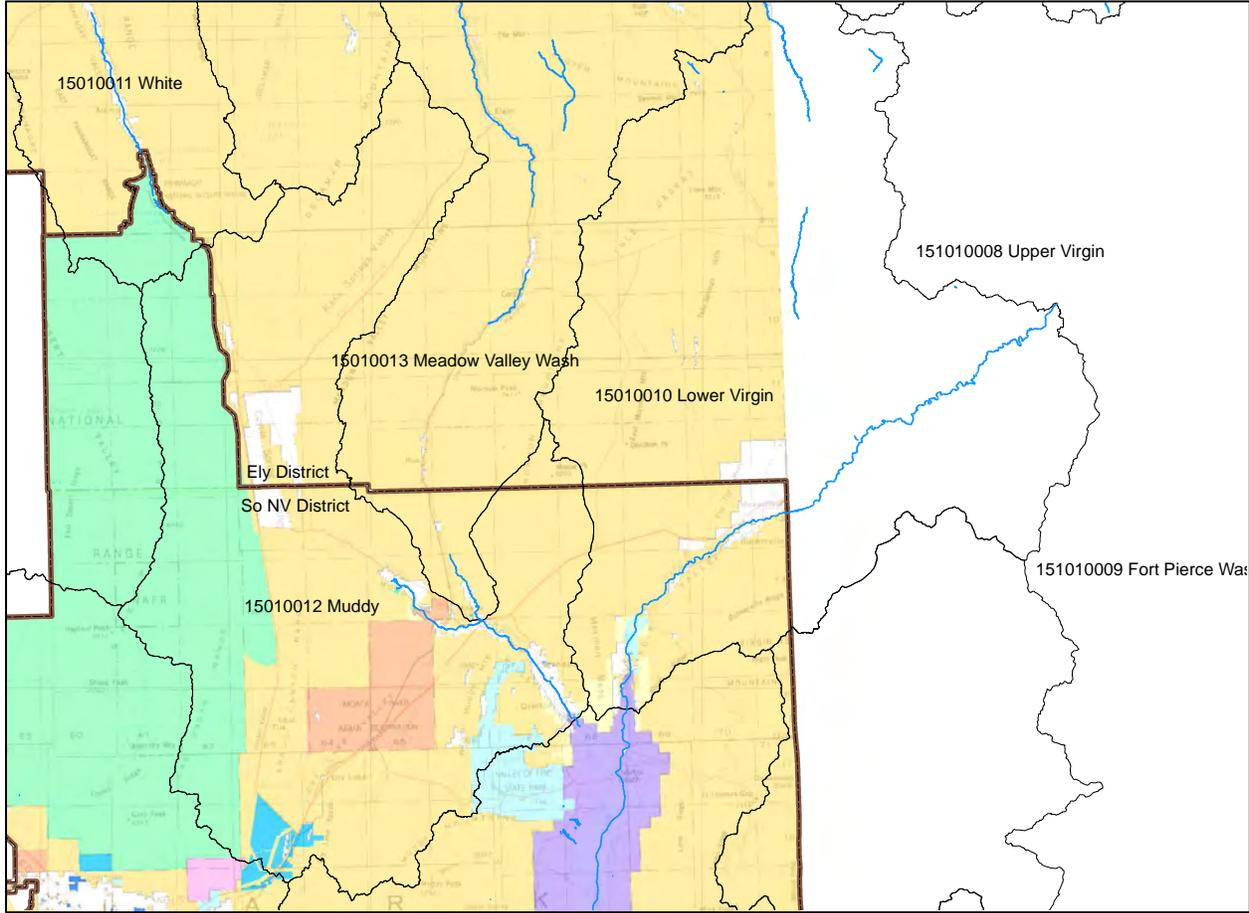
Map 1a

Overview of Proposed Service Area

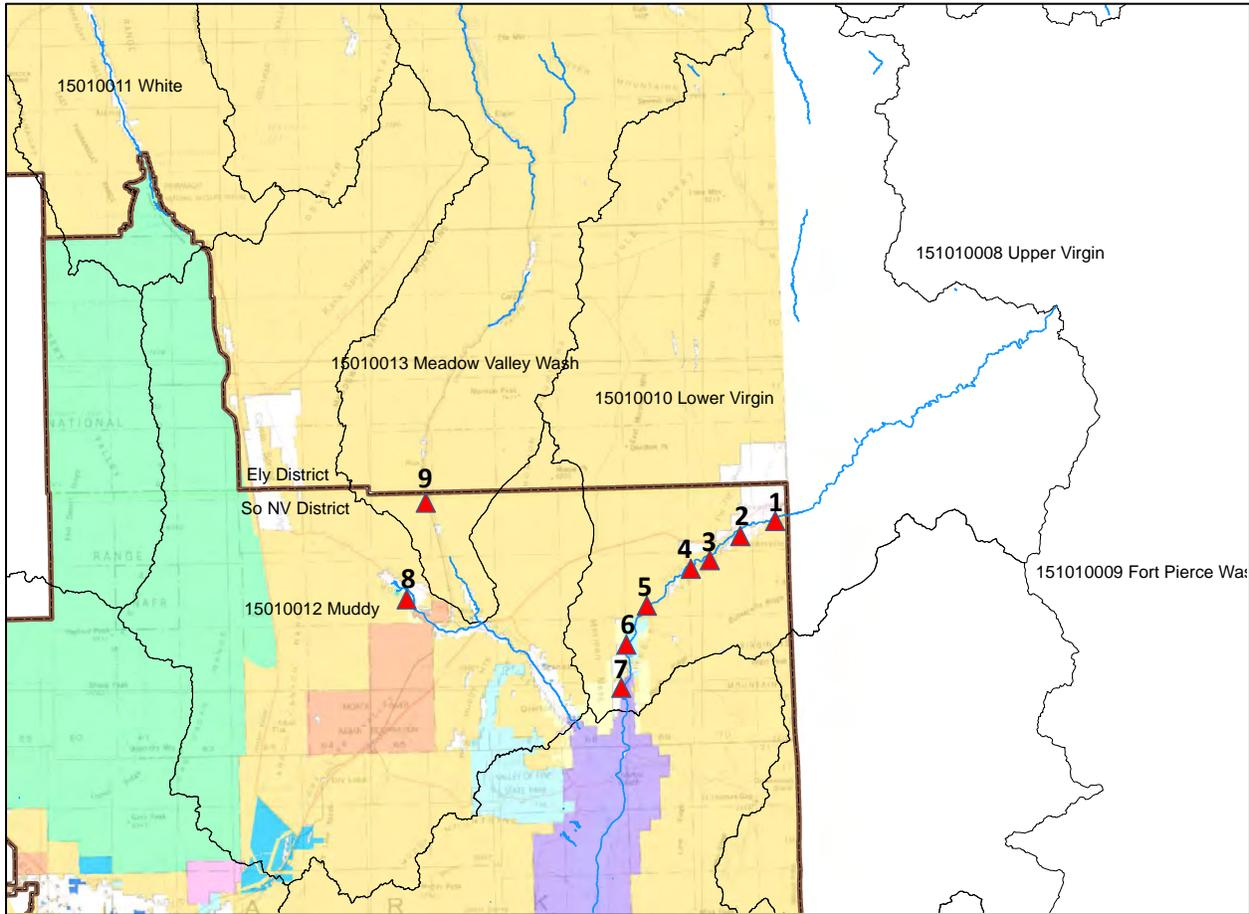


(Wikipedia – <https://commons.wikimedia.org/wiki/File%3AVirginrivermap.jpg>; accessed 8-5-2015)

Map 1b Land ownership – Proposed Service Area



Map 1c Proposed Project Locations – Overview



▲ Proposed project location

Virgin River:

- 1 Mesquite site
- 2 Hughes property
- 3 VRTWG
- 4 Toquop
- 5 Halfway Wash
- 6 Upper Mormon Mesa
- 7 Lower Mormon Mesa

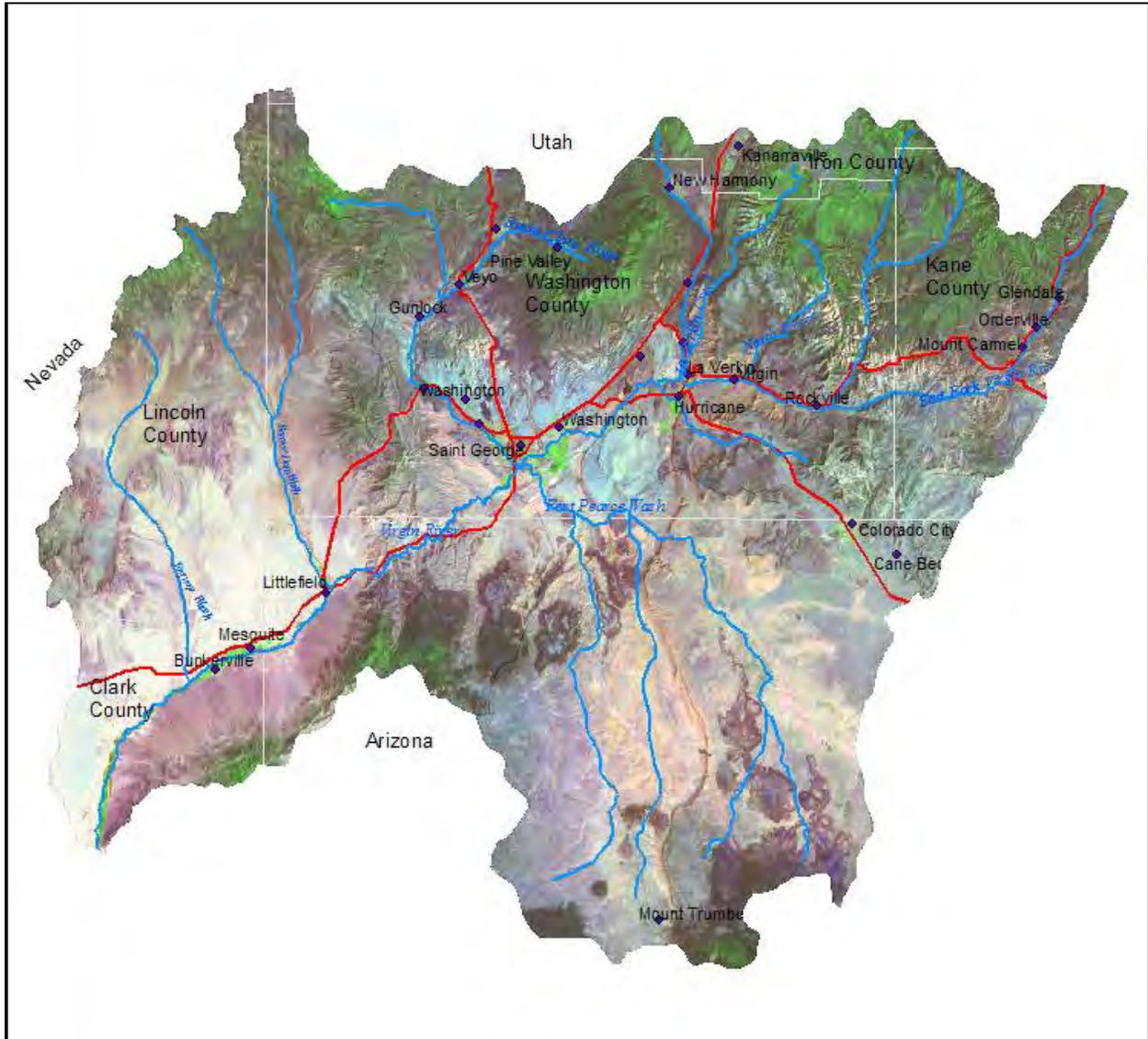
Muddy River:

- 8 Perkins Ranch

Meadow Valley Wash:

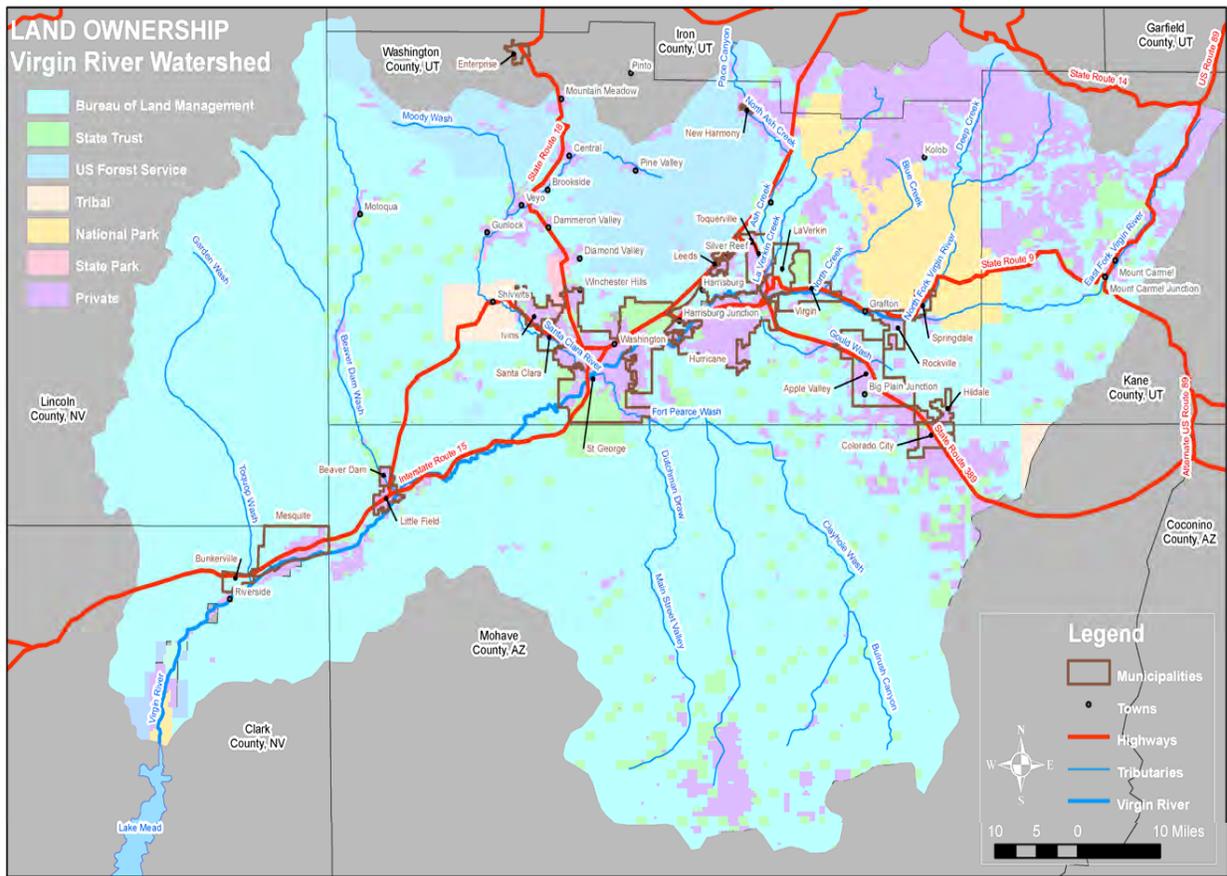
- 9 Stuart Ranch

Map 2a Virgin River Watershed



(U.S. Army Corps of Engineers. 2008. Virgin River Watershed - Comprehensive Analysis )

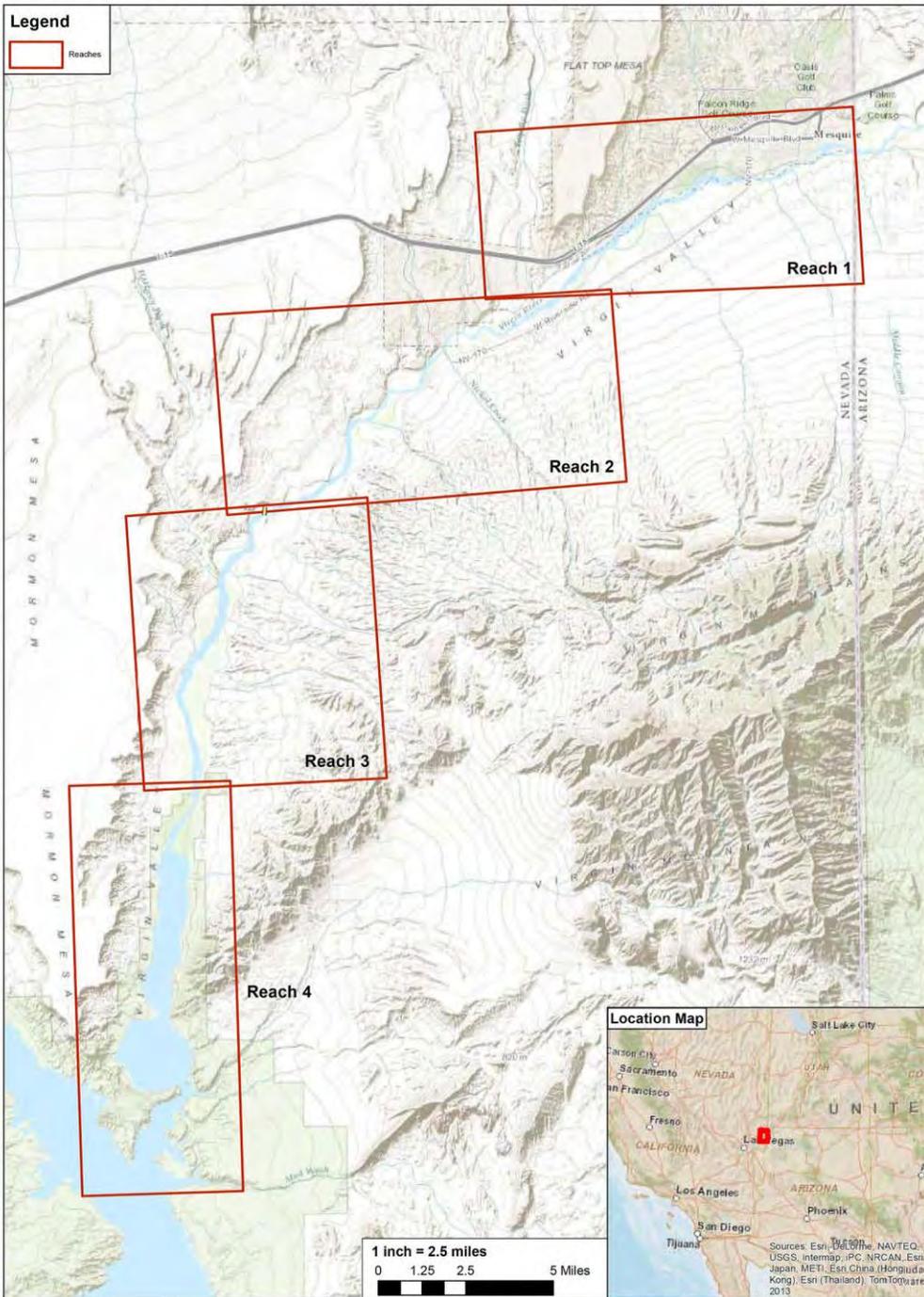
Map 2b Land Ownership – Virgin River Watershed



(U.S. Army Corps of Engineers. 2008. Virgin River Watershed - Comprehensive Analysis)



(BOR – Halfway Wash Fish Barrier Design Documents – Drawing 3153-418-4)



### VIRGIN RIVER RESTORATION

Figure 1 VIRGIN RIVER IN NEVADA



Prepared by:  
Fred Phillips Consulting, LLC



Background imagery provided by ESRI™

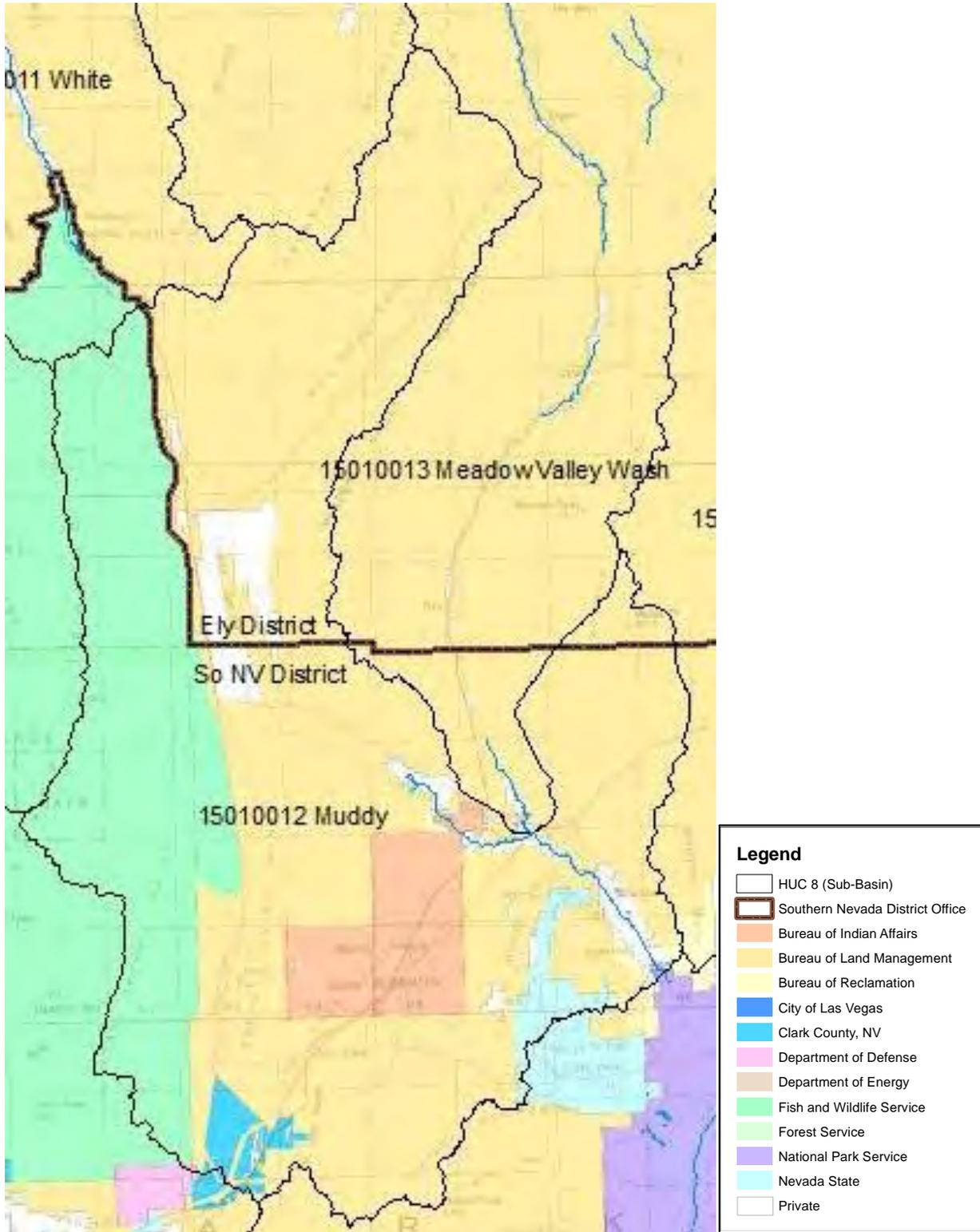
(Fred Phillips Consulting, LLC; Final Virgin River Restoration Plan)

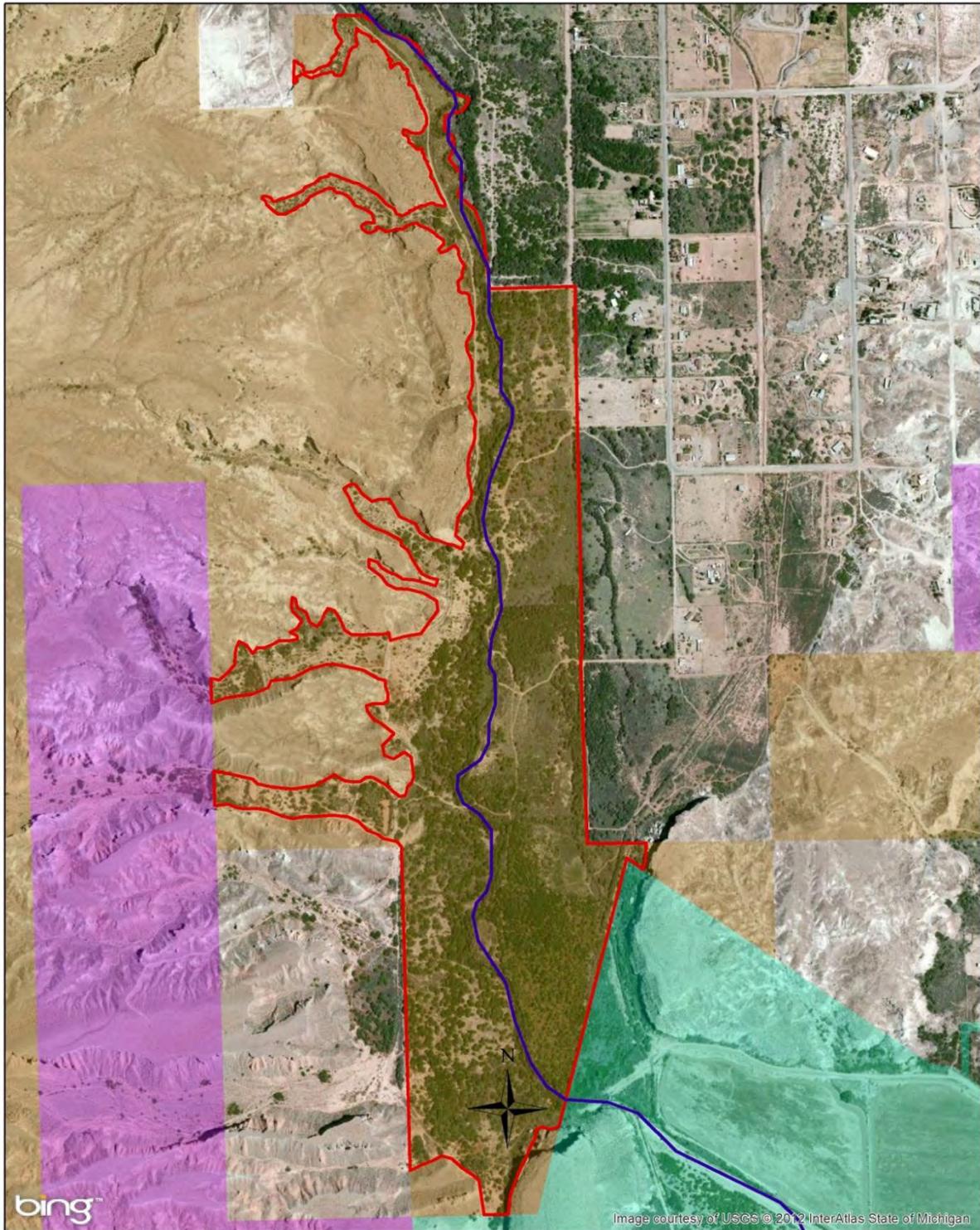


Map 3a Muddy River Watershed



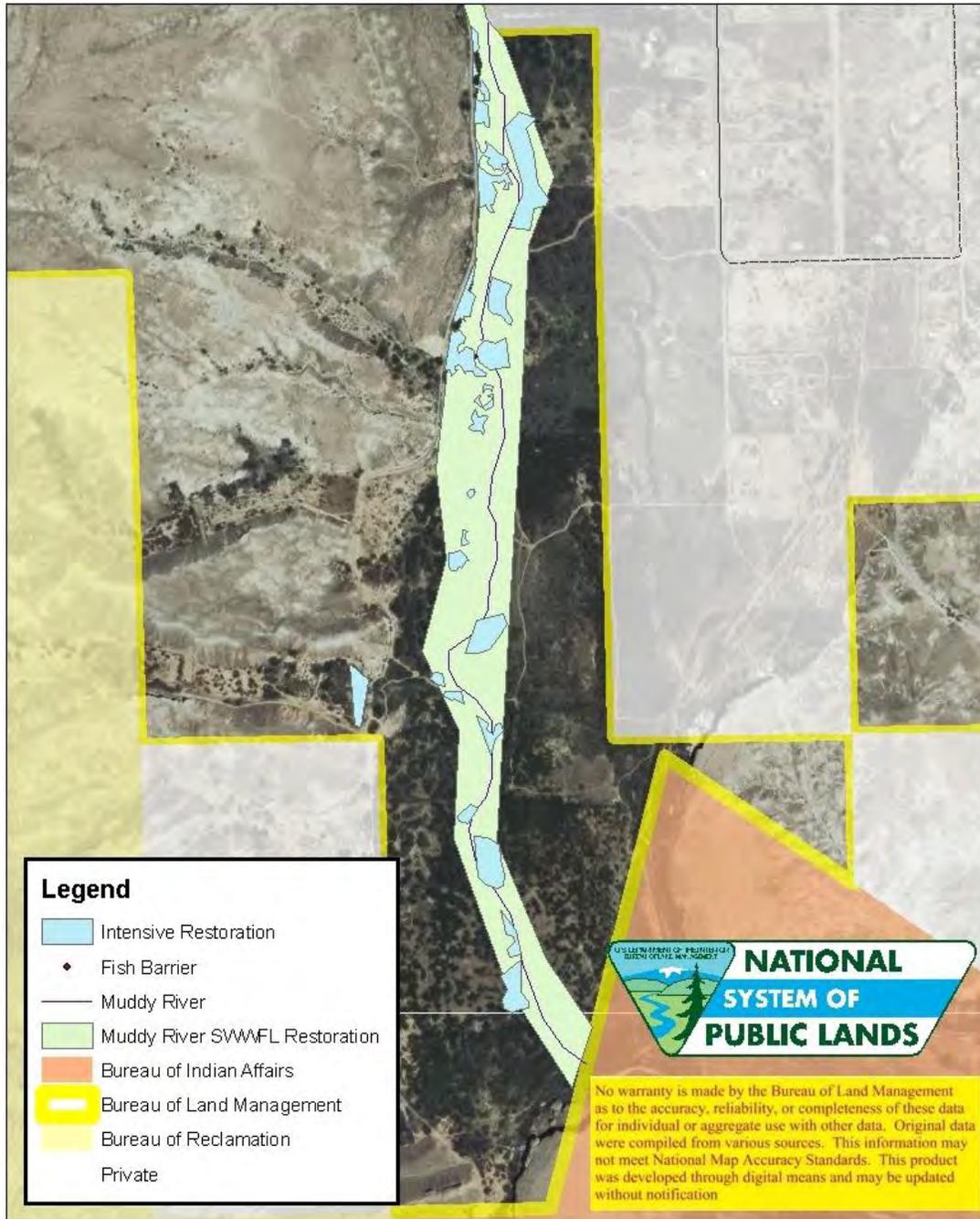
(USGS - [http://nevada.usgs.gov/water/lakes\\_rivers/muddy\\_river.htm](http://nevada.usgs.gov/water/lakes_rivers/muddy_river.htm); accessed 8-4-2015)



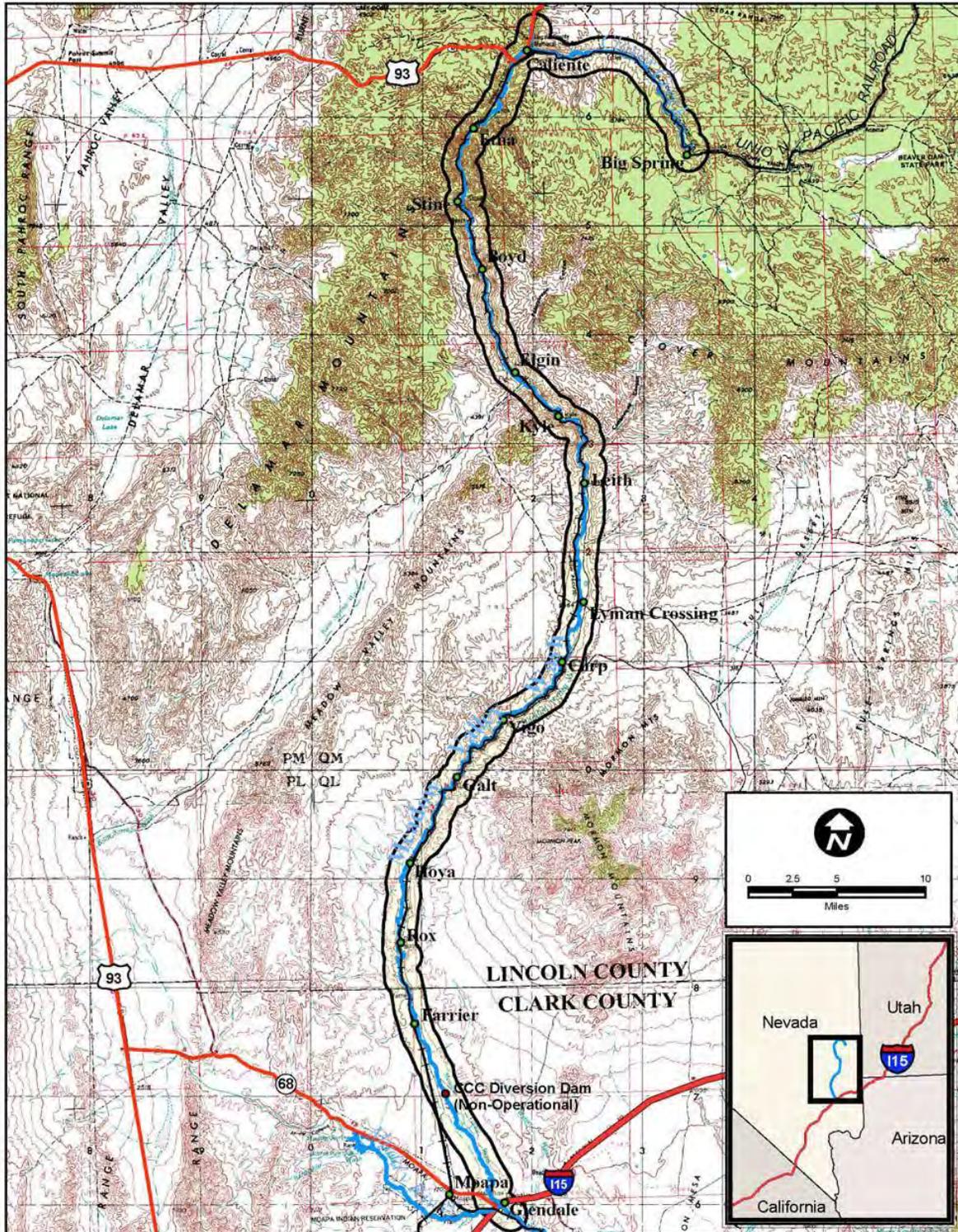


(BLM. 2014. Final Muddy River Environmental Assessment)

# Muddy River SWWFL Restoration

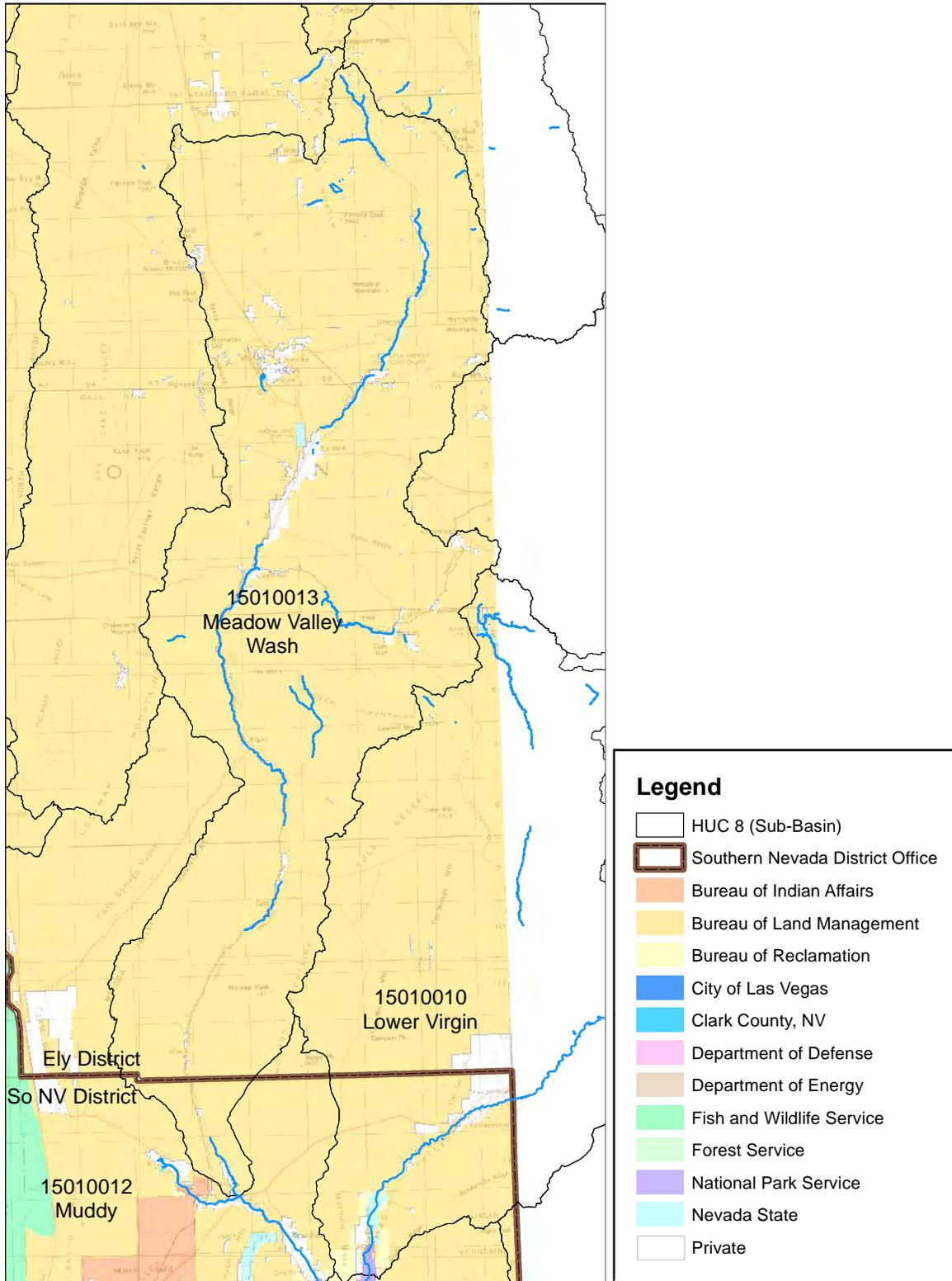


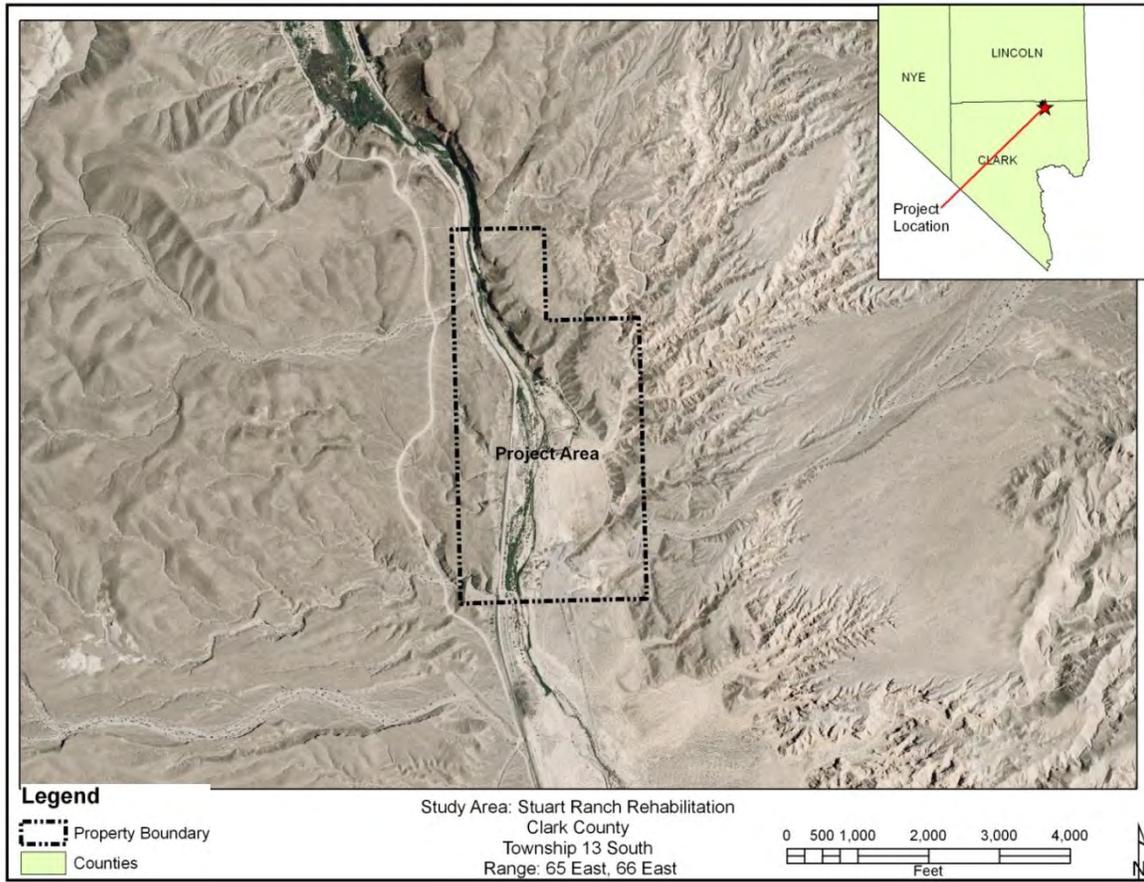
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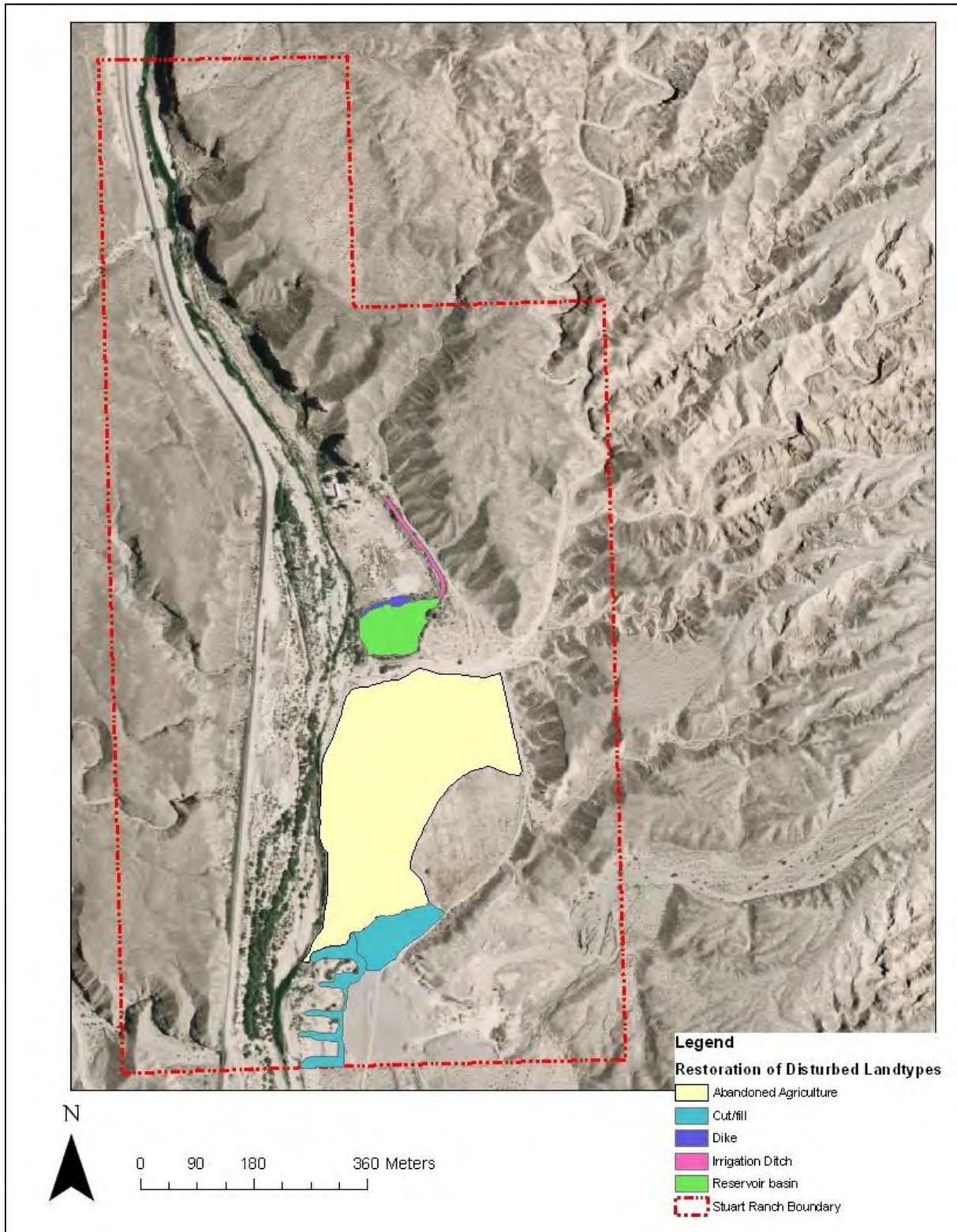
Map 4b

Land Ownership – Meadow Valley Wash Watershed

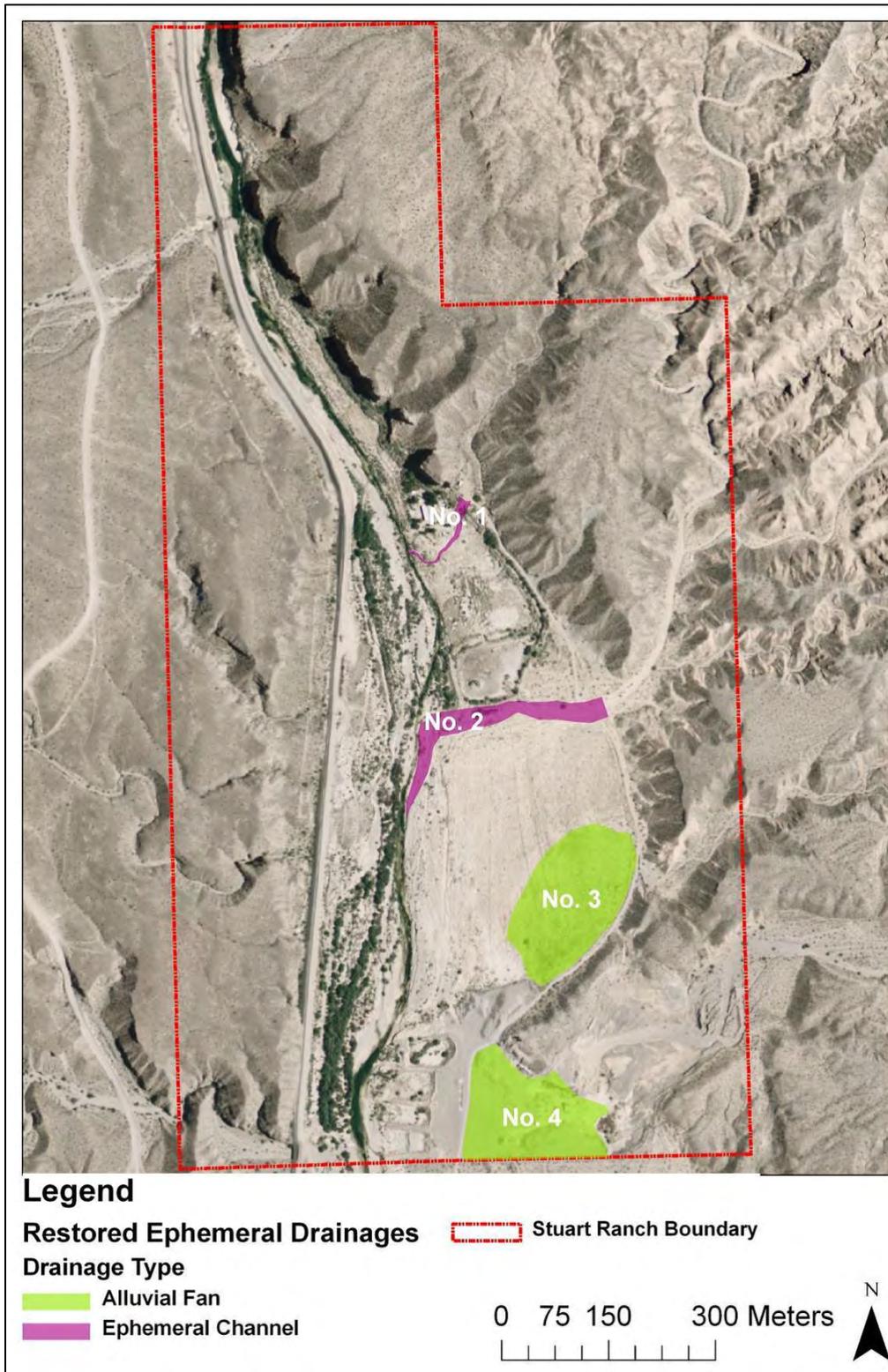




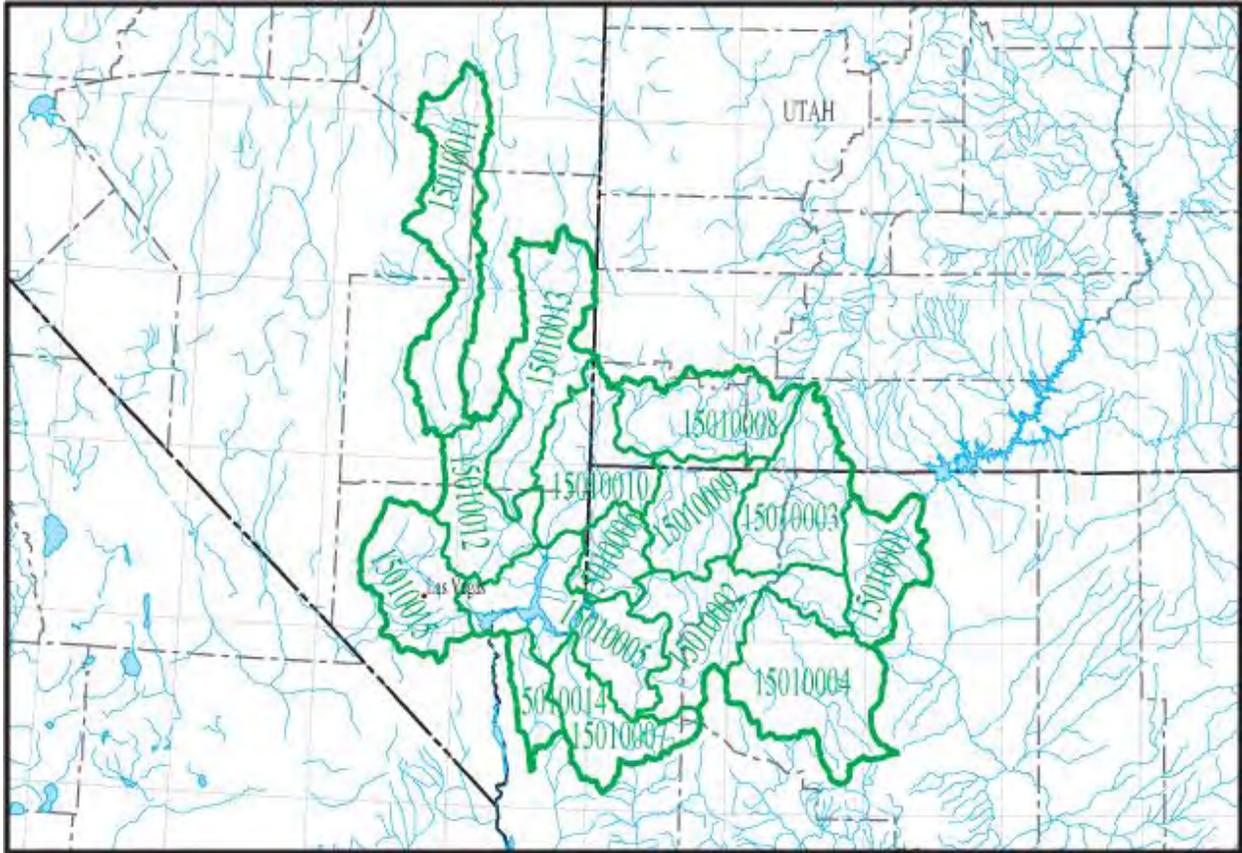
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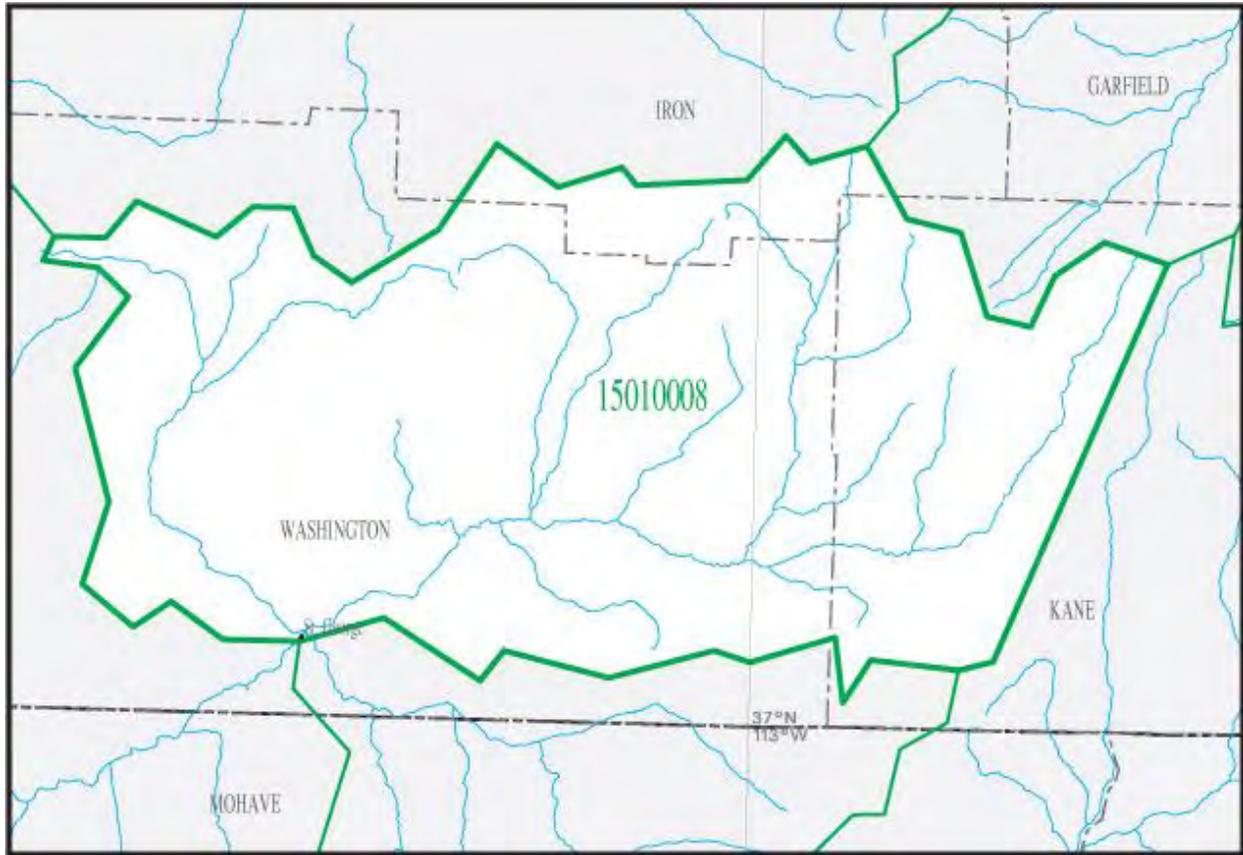
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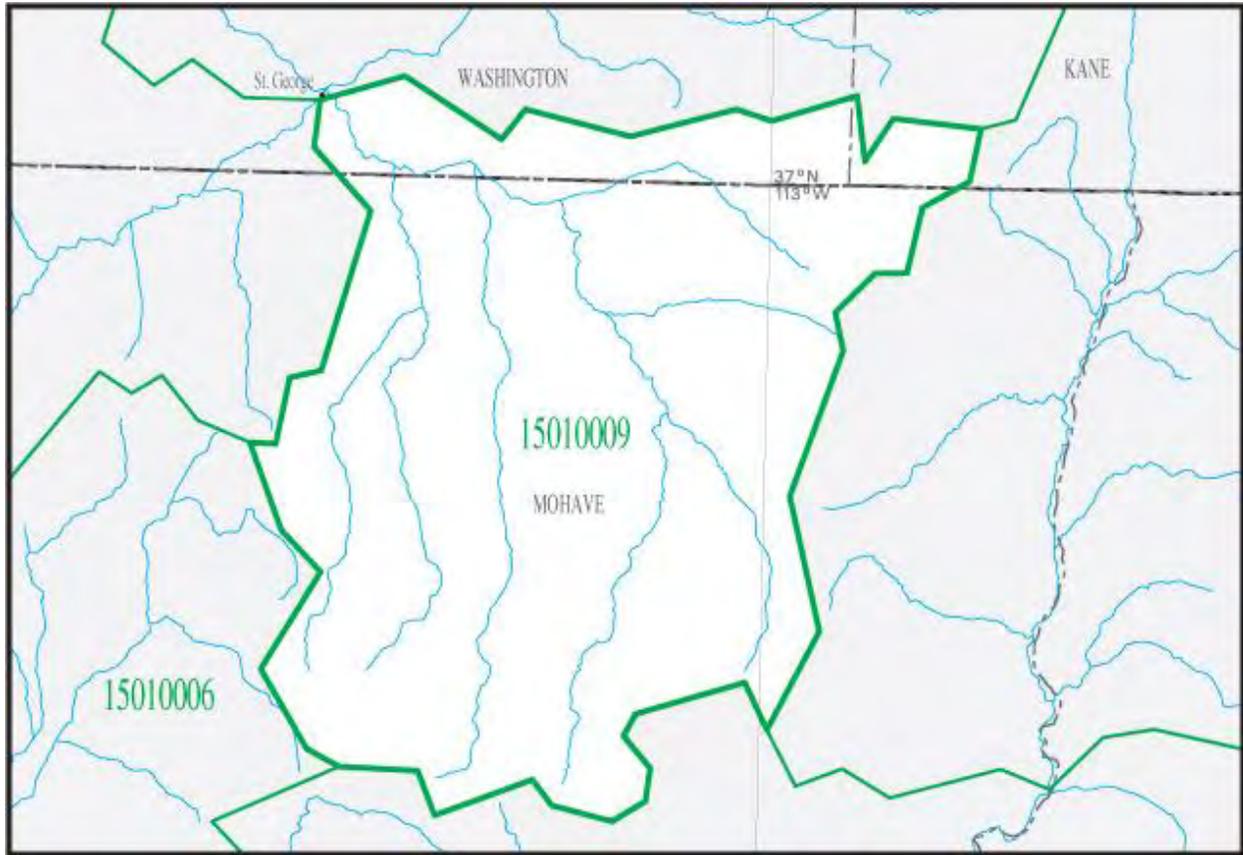
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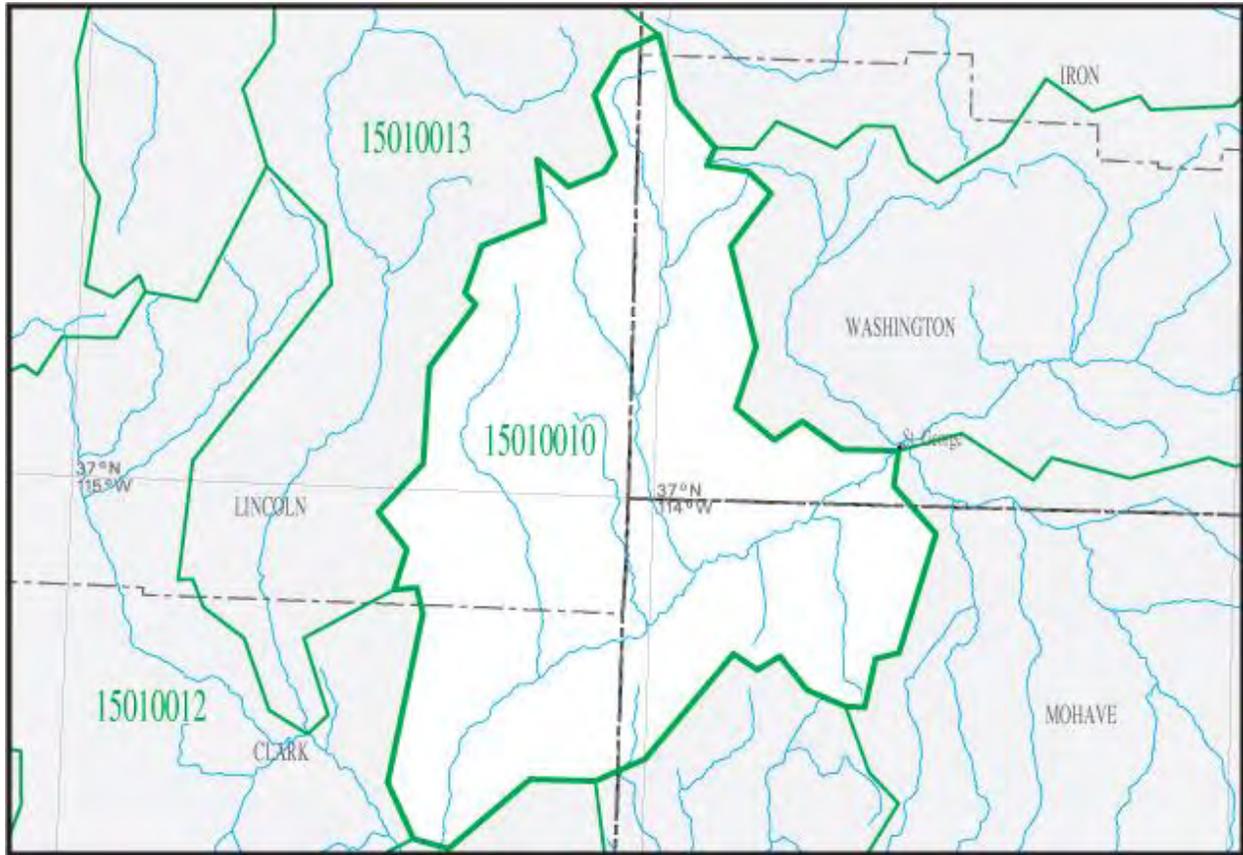
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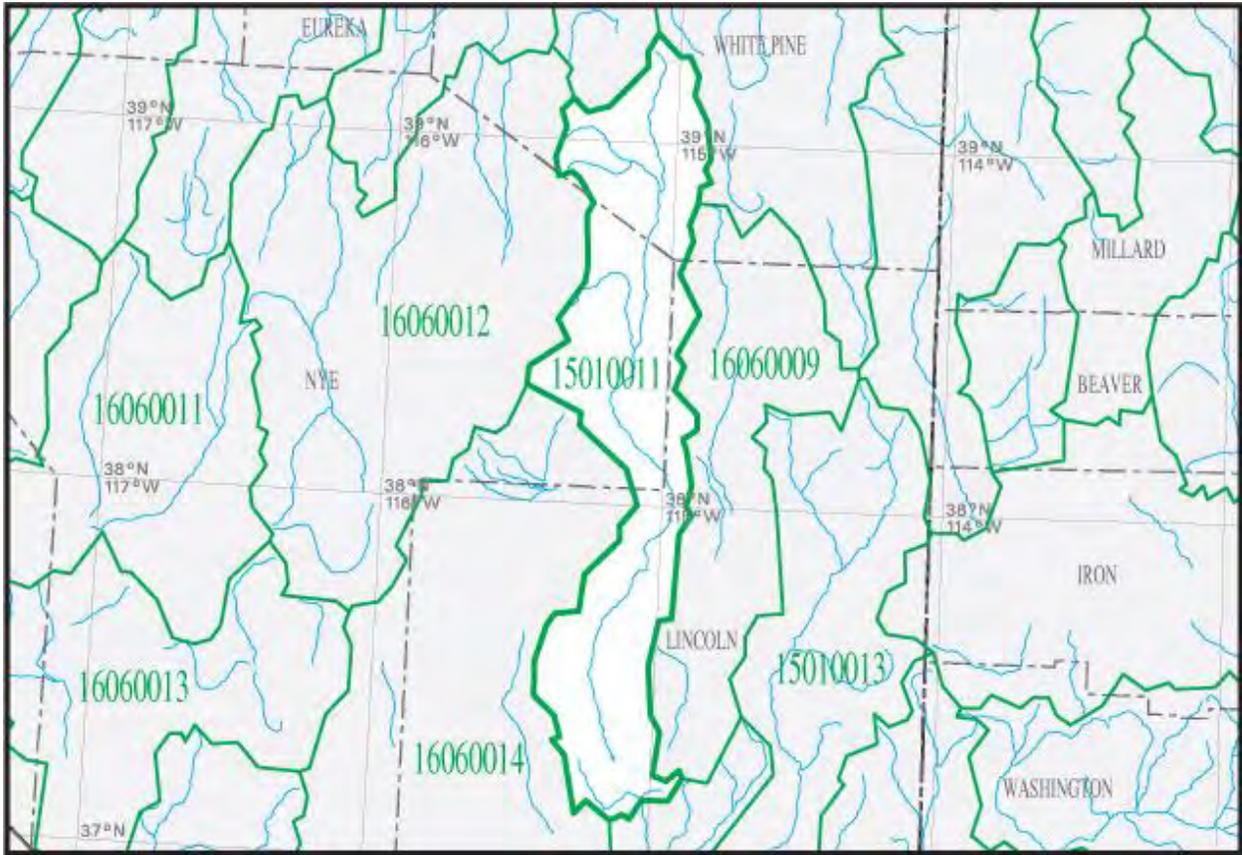
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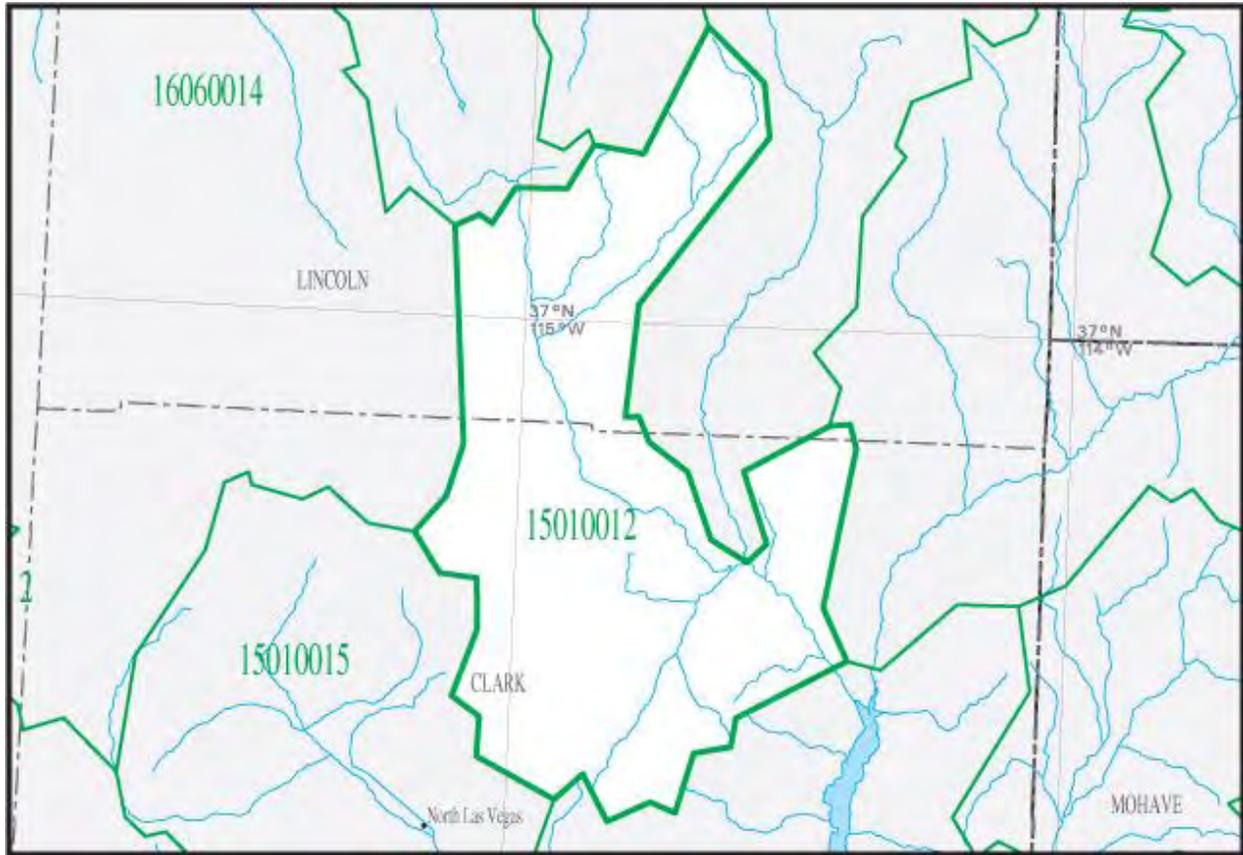
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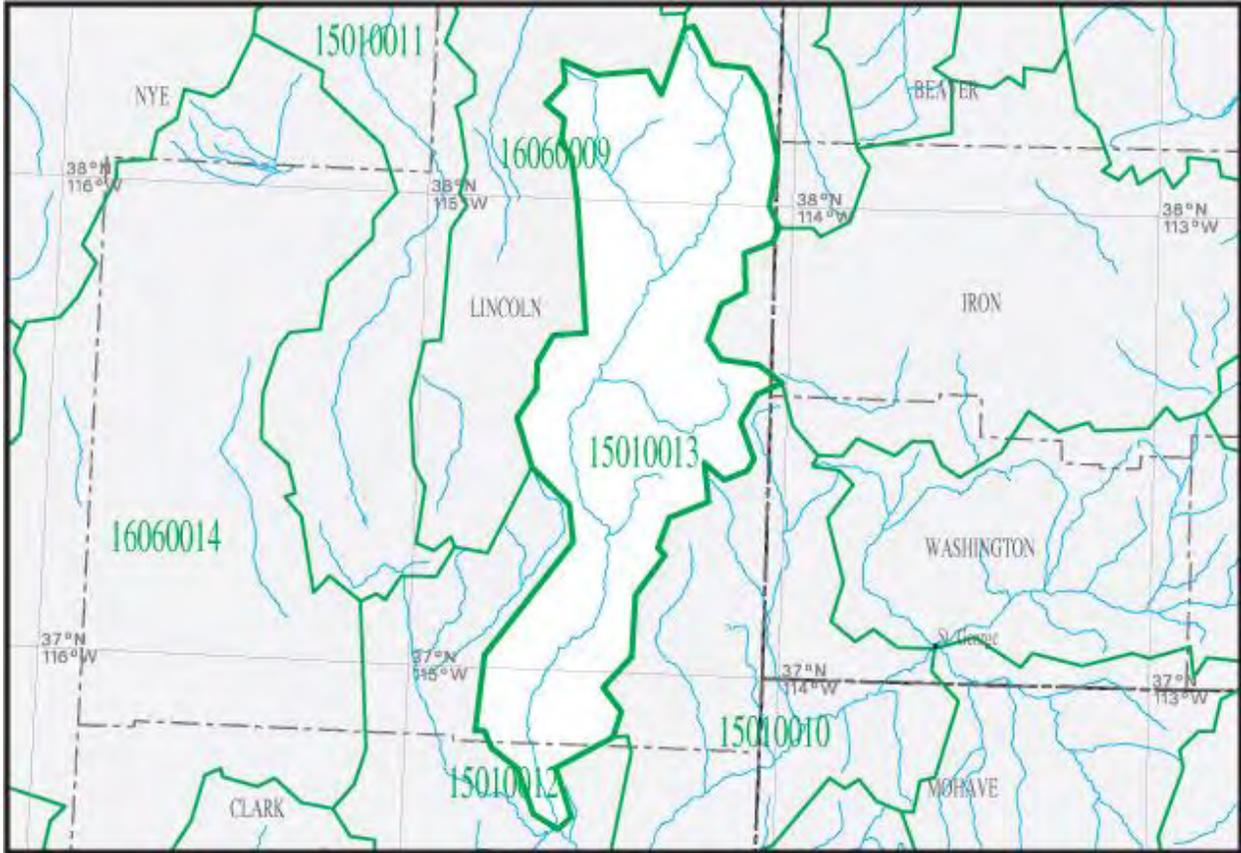
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## APPENDIX C

### Parcel Information

from Clark County, NV GIS Management Office

1. Virgin River
  - a. Halfway Wash Fish Barrier site
  - b. Mesquite site
  - c. Hughes Property site
  - d. Virgin River Tamarisk Working Group site
  - e. Toquop site
  - f. Halfway Wash site
  - g. Upper Mormon Mesa site
  - h. Lower Mormon Mesa site
2. Muddy River
  - a. Perkins Ranch site
3. Meadow Valley Wash
  - a. Stuart Ranch site