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CHAPTER I INTRODUCTION

A. BACKGROUND

1. Study Area

The Truckee River originates at Lake Tahoe in eastern California, flows through the cities of Reno and Sparks in an easterly direction, and eventually drains into Pyramid Lake in northern Nevada, as shown in Plate 1. Steamboat Creek is the largest tributary to the Truckee River in the Reno area and enters the Truckee River near Vista. Evans and Dry Creeks, two tributaries to Steamboat Creek, combine below Highway 395 to form Boynton Slough.

The study area for the project is divided into three portions: (1) the floodplain of the Truckee River between Booth Street and U.S. Highway 395 (Downtown Reno Reach); (2) the floodplain of the Truckee River from Highway 395 to Vista, along with the nearby floodplains of Steamboat Creek and Boynton Slough (Truckee Meadows Reach); and (3) the floodplain of the Truckee River between Vista and Pyramid Lake (Lower River Reach).

This report specifically addresses flood damage reduction alternatives for the Truckee Meadows reach located along the Truckee River downstream of Highway 395 through Reno and Sparks to Vista. The study area for this report also includes Steamboat Creek, Boynton Slough, and the North Truckee Drain. The study area is located in Washoe County, Nevada. However, the measures considered encompassed the entire watershed from Lake Tahoe in California to Pyramid Lake in Nevada.

2. Project Objectives

The Truckee Meadows area is subject to severe flooding from the Truckee River and its primary tributary, Steamboat Creek, during periods of high rainfall and snowmelt runoff. This project is investigating opportunities for flood damage reduction, ecosystem restoration and recreation. This report specifically addresses the flood damage reduction aspects of the project.

3. Purpose and Scope

The purpose of this report is to provide feasibility level design details for three flood damage reduction alternatives to contain the design 100-year flood (flood with 1% chance of occurring in any year) for the Truckee Meadows area between Highway 395 to Vista:

- Alternative 1 – Levees and Floodwalls with 2,800 cfs Additional Downstream Flows,
- Alternative 2 – Levees, Floodwalls and Detention Basins with No Increase in Downstream Flows, and
- Alternative 3 – Channel Benching (Community Coalition) Alternative.

This report also presents feasibility level cost estimates for the flood damage reduction alternatives. This work was conducted under contract #DACW05-01-0-0018, Delivery Order

2, Mod 3. This report will provide information for other ongoing planning and environmental elements of the project.

4. Previous Studies and Projects

The Truckee Meadows project was authorized for construction in the Water Resources Development Act (WRDA) of 1988 based on a 1985 Feasibility Report. During pre-construction, engineering, and design (PED), a reevaluation of project benefits and costs determined that the project, as then formulated, was no longer feasible due primarily to significant increases in land costs. A re-analysis was completed in a reconnaissance study completed in August 1997. The Corps reactivated the PED phase of the project in March 1998 with the first step to conduct a General Re-evaluation Report and EIS (GRR/EIS). At the request of the local sponsors, a Community Coalition process was initiated in April 2000 to assist in the formulation and selection of project alternatives.

Numerous studies have been completed that relate to environmental restoration, water use, hydrology, flooding, and urban development within the Truckee Meadows area and the Truckee River watershed.

U.S. Army Corps of Engineers

Design and Cost Estimates for Flood Damage Reduction, Downtown Reno Reach, Truckee Meadows, Nevada - Feasibility Report. May 2000.

Truckee Meadows, Nevada, Information Paper. April 2000.

Progress Report. Truckee River FLO-2D Simulation Flooding under Existing Conditions. March 1999.

Truckee Meadows, Nevada. Reconnaissance Re-Evaluation Report. August 1997.

Truckee Meadows, Reno-Sparks Metropolitan Area, Nevada. Office Report. May 1991.

Truckee Meadows, Reno-Sparks Metropolitan Area, Nevada. Feasibility Report. February 1985.

Truckee Meadows, Reno-Sparks Metropolitan Area, Nevada. Documentation Report. October 1983.

Truckee Meadows Investigation (Reno-Sparks Metropolitan Area), Stage 2 Report. December 1979.

Plan of Study, Truckee Meadows Investigation, Nevada. July 1977.

Department of the Interior

U.S. Bureau of Reclamation. *Truckee-Carson River Basin Study. Western Water Policy Review Advisory Commission.* March 1997.

U.S. Geological Survey. *Environmental and Hydrological Settings of the Las Vegas Valley Area and the Carson and Truckee River Basins, Nevada and California. Water Resources Investigations Report 96-4087.* 1996.

Other Agencies

Washoe County Department of Comprehensive Planning. *Washoe County Comprehensive Plan, Volumes 1 and 2. Reno, Nevada. 1996.*

Nevada State Department of Water Resources. *1995 - 2015 Washoe County Comprehensive Regional Water Management Plan. Washoe County, Nevada. November 1996.*

Federal Emergency Management Agency. *Flood Insurance Study. Washoe County, Nevada. 1994.*

CHAPTER II
FLOOD DAMAGE REDUCTION MEASURES AND DESIGN CRITERIA

This chapter describes the measures incorporated into the three flood damage reduction alternatives. The measures have been divided into five categories: containment features, bridge and roadway modifications, channel modifications, storage/detention in the Truckee Meadows, and floodplain management.

A. CONTAINMENT MEASURES

Floodwalls and levees are physical barriers designed to prevent waters from floods of a specified magnitude (e.g. up to the 100-year event) from inundating developed areas where residents, businesses, and/or high value property are located.

1. Levees/Setback Levees

Levees are earthen flood control structures built high enough to contain a specific flood event (e.g. the 100-year flow), with an additional height to allow a margin of safety. A risk and uncertainty (R&U) factor of 4.5 feet was used in the design of the levees for the Truckee Meadows area. Required structure heights for the levees were determined by comparing the with project design water surface elevation plus R&U for a given alternative against the existing ground surface elevation. For the Truckee Meadows area, structure heights were determined at intervals of approximately 100-feet along the identified levee alignments. Levees were utilized in areas where ample space was available for their footprints. However, floodwalls were utilized in some highly urbanized and residential areas, as space was not available to construct levees.

The allowable slope of the levee is determined by the strength of the underlying ground, and the width of the levee at its base is determined, in turn, by both the required height and slopes. The allowable landside and waterside levee slopes are determined by the strength of the underlying soils, the levee fill material, and the width of the levee crown. Plate 2 provides typical levee cross sections. Table 1 provides levee design criteria for various reaches.

TABLE 1
LEEVE DESIGN CRITERIA

Reach	Landside Slope (horizontal to vertical)	Waterside Slope (horizontal to vertical)	Levee Crown Width (feet)
Truckee River	2:1	3:1	12
Detention Basin	2.5:1	3:1	12
Steamboat Creek	2.5:1	3:1	12
Boynton Slough	2.5:1	3:1	12

As shown in Plate 2, a 10 feet wide gravel roadway is located on top of the levee to provide access for maintenance and emergency operations.

2. Floodwalls

Floodwalls are typically reinforced concrete structures built high enough to contain a specific flood event (e.g. the 100-year flow) with additional height added to allow a margin of safety. A R&U factor of 4.5 feet was used in the design of the floodwalls for the Truckee Meadows area. Similar to the levees, required structure heights for the floodwalls were determined by comparing the with-project design water surface elevation plus R&U for a given alternative against the existing ground surface elevation. For the Truckee Meadows area, structure heights were determined at intervals of approximately 100-feet along the identified floodwall alignments. Floodwalls were utilized in areas where limited space was available for structure footprints, primarily used in highly urbanized and residential areas.

Plate 3 provides a typical cross section for floodwalls located along the Truckee River downstream from Highway 395, and along Boyton Slough, Steamboat Creek, and North Truckee Drain. Maintenance and emergency operations access for floodwalls is provided by a 10 foot wide right-of-way on the landside of the floodwall.

3. Seepage Remediation Requirements

Levee and floodwall failure due to underseepage is a concern in the Truckee Meadows area. Underseepage is the movement or flow of water beneath a levee or floodwall. Water seeping under the levee begins to erode the foundation materials, making it more susceptible to failure.

Due to underseepage concerns, design of levees and floodwalls in the Truckee Meadows area may also require some type of seepage remediation. Five types of seepage remediation are proposed for the Truckee Meadows area. These include:

- Relief wells with a surface collection ditch
- Seepage berm
- Drainage Blanket
- Impervious Berm
- Cutoff Wall

Plate 4 provides a typical relief well and collection ditch detail. Plate 5 shows a typical section of a relief well system with a floodwall. Plate 6 shows a typical section of a relief well system with a levee. Plate 7 provides typical cross sections of a seepage berm for both levee and floodwall containment structures. Plate 8 provides typical cross sections of a drainage blanket for levee and floodwall containment structures. Plate 9 shows a typical cross section for an impervious berm for a levee. Plate 10 provides a typical cross section of a cutoff wall for levee and floodwall containment structures.

Access for operation and maintenance activities is provided by a 10 feet wide right-of-way located on the landside of the seepage remediation facility. For relief wells, 14 feet is provided for maintenance access between the containment structure and the relief well, as shown in Plates 5 and 6 for floodwalls and levees, respectively. Plates 5 and 6 also illustrate the 10 feet wide access for operation and maintenance of the relief well collection ditch. Plate 7 shows the 10 feet wide right-of-way for maintenance access at the landside toe of the seepage berm for both levees and floodwalls. Similarly, Plate 8 shows the 10 feet wide right-of-way for maintenance

access at the landside toe of the drainage blanket for both levees and floodwalls. The 10 feet wide right-of-way located at the landside toe of the impervious berm is shown in Plate 9 for a levee. As shown in Plate 10, a 10 feet wide right-of-way is provided at the levee toe for maintenance access as the cutoff wall is located beneath the levee. Plate 10 also illustrates the 10 feet wide right-of-way provided on the landside of the floodwall for maintenance access.

Table 2 provides the recommended seepage control measures at various design water surfaces for both levees and floodwalls located in the Truckee Meadows area. The design water surface is defined as the vertical distance above the landside ground at the levee or floodwall. These seepage control measures are required to reduce excessive seepage exit gradients and ensure the stability of the flood control structure during a flood event. Table 2 also lists the design water surface for which seepage control measures are not required. For water surfaces below this maximum stage, the calculated seepage exit gradients are within the Corps' allowable limits and therefore do not require remediation. The study area was divided into 12 reaches. The reaches in Table 2 are based on geographical location and subsurface conditions.

TABLE 2
RECOMMENDED SEEPAGE CONTROL MEASURES

Reach No.	Reach	DWS for which no seepage control measures are required	Corresponding Seepage Control Measures for Various Design Water Surface (DWS) Ranges		
			$4' < \text{DWS} \leq 10'$ Relief Wells spaced at 200'	$10' < \text{DWS} \leq 15'$ Relief Wells spaced at 100'	$15' < \text{DWS} \leq 20'$ Relief Wells spaced at 75'
1	Truckee River (left bank) Vista to North Truckee Drain	$\text{DWS} \leq 4'$	$4' < \text{DWS} \leq 10'$ Relief Wells spaced at 200'	$10' < \text{DWS} \leq 15'$ Relief Wells spaced at 100'	$15' < \text{DWS} \leq 20'$ Relief Wells spaced at 75'
2	Truckee River (left bank) North Truckee Drain to 5000' upstream of North Truckee Drain	$\text{DWS} \leq 6'$	$6' < \text{DWS} \leq 10'$ Relief Wells spaced at 400'	$10' < \text{DWS} \leq 15'$ Relief Wells spaced at 200'	$15' < \text{DWS} \leq 20'$ Relief Wells spaced at 100'
3	Truckee River (left bank) - 5000' upstream of North Truckee Drain to Greg St.	$\text{DWS} \leq 3'$	$3' < \text{DWS} \leq 6'$ 3' high x 50' wide seepage berm	$6' < \text{DWS} \leq 10'$ Relief Wells spaced at 75'	$10' < \text{DWS} \leq 15'$ Relief Wells spaced at 50'
4	Truckee River (left bank) - Greg St. to Glendale Ave.	$\text{DWS} \leq 3'$	$3' < \text{DWS} \leq 10'$ 20' wide drainage blanket	$10' < \text{DWS} \leq 15'$ 40' wide drainage blanket	----
5	Truckee River (right bank) McCarran Blvd. to Greg St.	----	$0' < \text{DWS} \leq 4'$ 10' wide drainage blanket	$4' < \text{DWS} \leq 10'$ 3' high x 50' wide seepage berm	$10' < \text{DWS} \leq 15'$ 4' high x 100' wide seepage berm
6	Truckee River (right bank) Greg St. to Hwy 395	$\text{DWS} \leq 6'$	$6' < \text{DWS} \leq 15'$ 20' wide drainage blanket	----	----
7	Detention Basin West & South Levee	$\text{DWS} \leq 6'$	$6' < \text{DWS} \leq 10'$ 5' high x 200' wide seepage berm	$10' < \text{DWS} \leq 15'$ 7' high x 200' wide seepage berm	$15' < \text{DWS} \leq 20'$ 9' high x 200' wide seepage berm
8	Detention Basin North Levee	$\text{DWS} \leq 4'$	$4' < \text{DWS} \leq 10'$ 5' high x 200' wide impervious berm	$10' < \text{DWS} \leq 15'$ 7' high x 200' wide impervious berm	$15' < \text{DWS} \leq 20'$ 10' high x 200' wide impervious berm
9	Detention Basin East Levee	$\text{DWS} \leq 10'$	$10' < \text{DWS} \leq 20'$ 40' deep slurry cutoff wall	----	----
10	Boynton Slough both banks	$\text{DWS} \leq 5'$	$5' < \text{DWS} \leq 10'$ 30' deep slurry cutoff wall	$10' < \text{DWS} \leq 20'$ 40' deep slurry cutoff wall	----
11	Steamboat Creek both banks	$\text{DWS} \leq 5'$	$5' < \text{DWS} \leq 10'$ 30' deep slurry cutoff wall	$10' < \text{DWS} \leq 20'$ 40' deep slurry cutoff wall	----
12	North Truckee Drain	$\text{DWS} \leq 5'$	$5' < \text{DWS} \leq 10'$ Relief Wells spaced at 200'	$10' < \text{DWS} \leq 15'$ Relief Wells spaced at 100'	$15' < \text{DWS} \leq 20'$ Relief Wells spaced at 75'

B. BRIDGE AND ROADWAY MODIFICATION MEASURES**1. Rock Boulevard Bridge Widening on the Truckee River**

This measure consists of removing the existing Rock Boulevard Bridge and constructing a new bridge across the Truckee River at this location. The existing bridge would be replaced with a structure with a larger cross-sectional flow area that would better facilitate passage of a 100-year flood event. The existing Rock Boulevard Bridge is approximately 57 feet wide, spanning a total of 264 feet. The new structure would be similar in design to the existing structure, 57 feet wide and approximately 461 feet between bridge abutments.

2. Mc Carran Boulevard Bridge Widening on the Truckee River

This measure consists of removing the existing Mc Carran Boulevard Bridge and constructing a new bridge across the Truckee River at this location. The new structure would have a larger cross-sectional flow area to better facilitate passage of a 100-year flood event. The existing Mc Carran Boulevard Bridge structure is approximately 57 feet wide spanning a total of 210 feet. The new structures would be similar in design to the existing structure, 57 feet wide and approximately 465 feet between bridge abutments.

3. Lowering Pembroke Drive on Steamboat Creek

This measure consists of lowering approximately 560 feet of Pembroke Drive by two (2) feet. The roadway section to be lowered is located immediately west of the Pembroke Drive Bridge over Steamboat Creek. The elevation of the existing Pembroke Drive profile averages 4,393 feet along the roadway section proposed to be lowered. The lowering of this roadway section reduces backwater effects on both Steamboat Creek and Boynton Slough upstream from the Pembroke Drive Bridge.

C. CHANNEL MODIFICATION MEASURES**1. Benching**

This measure involves excavating a benched area along portions of the south (right) and north (left) banks of the Truckee River between Greg Street to downstream of Vista. Vertically, the excavation would extend down to a level corresponding to the maximum water surface elevation (WSE) associated with the two year flow under existing conditions. The two-year flow has a 50% probability of occurring in any given year. Since this level is above that which occurs throughout most of the year, excavation to the two-year WSE would create a bench or above the low-flow channel bed, which would be inundated during higher winter and spring flow events. The measure is intended to increase the flood flow channel capacity and thereby potentially reduce water surface elevations in the Truckee Meadows area during a flood. Plate 11 provides a typical cross section of benching along the Truckee River.

2. North Truckee Drain Re-Alignment

The existing confluence of the North Truckee Drain with the Truckee River is located immediately upstream of the Steamboat Creek confluence. Relocating the confluence of the North Truckee Drain downstream from Steamboat Creek would reduce the extent of the backwater experienced at the Steamboat Creek/ Truckee River confluence. The re-alignment would relocate the confluence approximately 4,500 feet downstream on the Truckee as shown in Plate 12. The re-alignment of North Truckee Drain requires the construction of new conveyance facilities. The realigned section would consist of approximately 1,865 feet of concrete lined channel upstream of East Greg Street; 3,450 feet of 10 foot by 20 foot, single barrel box culvert from East Greg Street to approximately 500 feet upstream of the new Truckee River confluence; and 500 feet of new concrete lined channel immediately upstream of the new confluence.

3. Extension of Airport Culvert on Boynton Slough

Due to backwater effects, containment of flows by levees and floodwalls in the Truckee Meadows area can increase water surface elevations, relative to existing conditions, in some reaches. Moderate increases in water surface elevations along Boynton Slough near the Reno International Airport occur can not be contained by the existing natural topography of the area. Levees can not be utilized in the vicinity of the Reno International Airport because levees must maintain a 10:1 side slope to meet airport regulations and space is limited in this area. An existing culvert conveys Boynton Slough flows beneath portions of the runways at the airport. In lieu of levees, extension of this culvert will be required under at least one of the alternatives. This measure would extend the existing triple-barrel box culvert approximately 1,795 feet. The internal dimension of each barrel are approximately 8 foot high by 12 foot wide. As the box culvert would be aligned along the existing channel alignment, minimal excavation would be required.

D. STORAGE / DETENTION MEASURES IN TRUCKEE MEADOWS VICINITY

1. University of Nevada, Reno Farms Detention Basin

An enclosed detention facility at University of Nevada, Reno Farms (UNR Farms) was included as part of the project authorized in 1988. This facility would divert and store some of the Truckee River flood flows in order to reduce the peak discharge and volume of water carried downstream. This would reduce backwater accumulating upstream of the Truckee River's natural constriction at the Vista reefs, reducing the water surface elevations during a flood in much of the Truckee Meadows area. The detention facility may also reduce peak discharge downstream from the reefs.

The University of Nevada, Reno Farms Detention Facility would be located immediately downstream of the Mc Carran Boulevard on the south (right) bank of the Truckee River. This facility would include a reinforced concrete inlet weir, a reinforced concrete outlet weir, and a leveed storage area, as shown in Plate 13. Flows from the Truckee River would be diverted into the UNR Farms Detention Facility by a 500 feet long weir located on the south (right) bank approximately 1550 feet downstream from Mc Carran Boulevard. The crest elevation of the

inlet weir would be 4,396.0 feet. Approximately 22,040 feet of levees would be required to construct the storage area, including

- North Levee – 6,670 feet
- East/South Levee – 7,800 feet
- West Levee – 7,570 feet

The estimated relationships between water surface elevation and storage volume are shown in Table 3 for the UNR Farms Detention Facility.

TABLE 3
**ELEVATION AND STORAGE RELATIONSHIPS FOR UNIVERSITY OF NEVADA,
RENO FARMS DETENTION FACILITY**

Elevation (Feet)	Storage (acre-feet)
4379.9	0
4381.6	1
4383.2	3
4384.8	6
4386.4	10
4388	32
4389.6	191
4391.1	666
4392.7	1381
4394.3	2225
4395.9	3095
4397.5	3968
4399.9	5278

2. Huffaker Hills Detention Facility

This measure consists of an on-stream, flood control detention facility at Huffaker Hills. This facility would store some of the Steamboat Creek flood flows in order to reduce the peak discharge and volume of water carried downstream. This would reduce backwater accumulating upstream of the Truckee River's natural constriction at the Vista reefs during floods, reducing the water surface elevations in much of the Truckee Meadows area.

The maximum storage capacity of the facility would be about 1,002 acre-feet. The Huffaker Hills detention facility would be located on Steamboat Creek approximately 5 river miles upstream from the Truckee River confluence at Mira Loma Road (not to be confused with Mira Loma Drive, located downstream). The spillway crest elevation of the proposed detention facility would be 4,428 feet. Two low-level outlets would pass flows of up to approximately 500 cfs with minimal back water effects. These low-level outlets would consist of a culvert with approximately 185 square feet of cross sectional area and an elevation of 4,412 at the center of the outlet. At the crest elevation of 4,428 feet, this facility would inundate approximately 270

acres. The detention structure would be similar in design to the RCC (roller compacted concrete) dam structure evaluated in the U.S. Army Corps *Truckee Meadows Office Report* dated May 1991.

The relationships between water surface elevation and storage volume are shown in Table 4 for the Huffaker Hills Detention Facility.

TABLE 4
ELEVATION AND STORAGE RELATIONSHIPS FOR HUFFAKER HILLS
DETENTION FACILITY

Elevation (feet)	Storage (acre-feet)
4412.0	0.0
4414.0	0.4
4416.0	3
4418.0	15
4420.0	50
4422.0	126
4424.0	273
4426.0	559
4427.0	790
4427.6	922
4428.0	1002
4430.0	1562

3. Mustang Ranch Detention Facility

The Mustang Ranch Detention Facility would be located immediately downstream from the community of Lockwood on the south (right) bank of the Truckee River. This offstream storage facility would divert and store some of the Truckee River flood flows in order to reduce the peak discharge and volume of water carried downstream. This facility would include an ogee inlet weir, a leaved earthen diversion channel, and a leaved storage area, as shown in Plate 15. The ogee weir would be approximately 1,000 feet in length and the crest elevation would range from 4,344 to 4,341 feet. An earth-lined trapezoidal channel would convey flows from the weir into the leaved storage area. The diversion channel would be approximately 6,950 feet in length and would require approximately 6,950 feet of levee along the northern (right) bank, and 440 feet of levee along the south (left) bank. Approximately 4,160 feet of levees would be required to construct the storage area. The maximum water surface elevation in the storage area would be 4342 feet. Approximately 70 acres would be inundated and the maximum capacity would be just under 1,200 acre-feet. The relationships between water surface elevation and storage volume are shown in Table 5 for the Mustang Ranch Detention Facility.

TABLE 5
ELEVATION AND STORAGE RELATIONSHIPS FOR MUSTANG RANCH
DETENTION FACILITY

Elevation (feet)	Storage (acre-feet)
4312.5	0
4314.5	1
4319.4	20
4321	46
4322.6	87
4325.8	193
4327.5	256
4330.7	401
4333.9	585
4337.2	813
4338.8	937
4340.4	1064
4342.0	1193

E. FLOODPLAIN MANAGEMENT MEASURES

1. Floodproof Structures

Preventing or reducing flood damages to a facility or structure located in a flood zone is referred to as flood proofing. Flood proofing allows for continued use of the structure and is defined as “any combination of changes or adjustments incorporated in the design, construction, or alteration of individual buildings or properties that will reduce flood damages.”

This measure would include raising existing structures in the Boynton Slough/Pembroke Drive area. Raising the structure refers to elevating a building so that either the entire floorspace or the occupied portion is above specified flood water surface elevations. There are three main techniques for raising a structure. One technique is to extend the walls of the structure upward, place fill above the existing base floor, and lay a new floor on top of the fill. If the fill is at or above the one-percent event floodplain, flood insurance will not be required by federal law. This technique is most appropriate for structures with concrete or masonry walls. Since the space below the new floor is filled, wall openings below the new floor are not required.

Another technique involves converting the existing lower area of a structure to non-inhabitable space and adding an additional level for living space above the lower level. The lower area can be used for storage or parking. This technique is most appropriate for structures with concrete or masonry walls. Openings in the lower level would allow floodwater to enter and exit the structure so that external water pressure can be equalized. The final technique is to lift the entire structure, including the floor. This technique is appropriate for all types of walls and is most commonly applied in areas of swift moving floodwater or waves. The structure is essentially “jacked up” to a desired height and openings in the lower level allow water to flow freely through the structure.

The costs to elevate a structure is primarily dependent on (1) the size, condition, and construction type (frame or masonry) of the structure; (2) the height of elevation required and the type of foundation needed to support the structure; (3) the need for structural rehabilitation; (4) the type, condition, and location of mechanical and utility systems; and (5) the requirements for structure access including handicapped access.

CHAPTER III FLOOD DAMAGE REDUCTION ALTERNATIVES

A. OVERVIEW OF FLOOD DAMAGE REDUCTION ALTERNATIVES

Three flood damage reduction alternatives are described in this report:

- Alternative 1 – Levees and Floodwalls with 2,800 cfs Additional Downstream Flows
- Alternative 2 – Levees, Floodwalls and Detention Basins with No Increase in Downstream Flows
- Alternative 3 – Channel Benching (Community Coalition) Alternative

The approach to reducing flood damages in the Truckee Meadows area varies among the three alternatives. The components of each alternative are summarized in Table 6, 7 and 8 and are described briefly below.

**TABLE 6
MEASURES INCORPORATED INTO ALTERNATIVES**

Measure Type	Measure	Alternative		
		1	2	3
Containment Features	Floodwalls	X	X	X
	Levees/Setback Levees	X	X	X
	Seepage Remediation	X	X	X
Bridge and Roadway Modifications	Widen Rock Boulevard Bridge			X
	Widen Mc Carran Bridge	X	X	X
	Lower Pembroke Drive			X
Channel Modification	Channel Benching			X
	North Truckee Drain Re-Alignment		X	X
	Extension of Airport Culverts on Boynton Slough	X		
Storage/Detention in Truckee Meadows Vicinity	Huffaker Hills Detention Basin		X	X
	University of Nevada, Reno Farms Detention Facility		X	
	Mustang Ranch Detention Facility		X	X
Floodplain Management	Floodproofing single family residences near Boynton Slough			X

Alternative 1, the Levees and Floodwall Alternative with 2,800 cfs Additional Downstream Flows, accomplishes flood damage reduction in the Truckee Meadows area by primarily containing the flows with levees and floodwalls. Alternative 1 does not include any detention facilities or channel benching, as shown in Table 6. Because flows are contained, Alternative 1 has the highest design water surface elevations relative to the other alternatives, as shown in Table 7. Also as a result of the containment of flows, Alternative 1 increases downstream flows by approximately 2,800 cfs in comparison to existing conditions, as shown in Table 8. Due to the increase in downstream flows, Alternative 1 requires ecosystem restoration in the lower reach (Vista to Pyramid Lake) of the Truckee River to attenuate the additional flood flows.

Alternative 2, the Levee, Floodwall and Detention Basin Alternative with No Increase in Downstream Flows, accomplishes flood damage reduction in the Truckee Meadows area by capturing peak flows in detention facilities and by containing flows with levees and floodwalls. Alternative 2 does not include any channel benching, as shown in Table 6. Water surface elevations for alternative 2 are shown in Table 7. Through the use of flood water detention facilities, Alternative 2 does not increase downstream flows. Since downstream flows are not increased, this alternative does not require ecosystem restoration in the lower reach (Vista to Pyramid Lake) of the Truckee River.

Alternative 3, the Channel Benching (Community Coalition) Alternative, accomplishes flood damage reduction in the Truckee Meadows area by enlarging the flow area of the existing channel by benching and by capturing peak flows in detention facilities. As a result of the channel benching, Alternative 3 has the lowest water surface elevations in most areas relative to the other alternatives. But due to increases in downstream flows, Alternative 1 requires ecosystem restoration in the lower reach (Vista to Pyramid Lake) of the Truckee River to attenuate the additional flood flows.

TABLE 7
WATER SURFACE ELEVATIONS DATA AND COMPARISONS FOR EXISTING
CONDITIONS, 1997 FLOOD EVENT AND ALTERNATIVES

	Truckee River					Steamboat Creek			North Truckee Drain
	Greg Street	Rock Boulevard	Mc Carran Boulevard	Steamboat Creek Confluence	Downstream Railroad Bridge	Pembroke Drive	Mira Loma Drive	University Farms	Lincoln
<i>100 Year Flood Water Surface Elevations (feet)</i>									
1997 flood event	4428.5	4416.5	4401.0	4395.9	4380.5	4397.1	4397.5	4397.0	4396.4
Existing Conditions - 100 year flood event	4427.9	4416.1	4400.9	4395.6	4380.3	4396.6	4396.8	4396.3	4396.9
Alternative 1	4428.0	4416.4	4402.5	4397.3	4381.0	4398.1	4398.3	4398.0	4398.5
Alternative 2	4428.0	4416.2	4401.6	4396.2	4380.6	4397.1	4397.3	4400.0	4395.9
Alternative 3	4426.2	4414.2	4399.5	4394.4	4381.2	4395.4	4395.8	4395.3	4396.4
<i>Difference in 100 Year Flood Water Surface Elevations from Existing Conditions (feet)</i>									
Alternative 1	0.07	0.23	1.60	1.72	0.67	1.44	1.47	1.71	1.55
Alternative 2	0.07	0.09	0.77	0.58	0.28	0.46	0.52	3.68	-1.02
Alternative 3	-1.68	-1.90	-1.35	-1.23	0.83	-1.22	-0.98	-1.02	-0.56
<i>Note: Elevations are referenced to NGVD29 and were derived from HEC-RAS model simulations.</i>									

TABLE 8
100 YEAR PEAK FLOW DATA AND COMPARISONS FOR EXISTING CONDITIONS,
1997 FLOOD EVENT AND ALTERNATIVES

	Truckee River Flow at Vista (cfs)	Truckee River Flow at Downstream Railroad (cfs)
<i>100 Year Flood Peak Flows</i>		
1997 flood event	20,691	20,684
Existing Conditions - 100 year flood event	20,171	20,163
Alternative 1	22,999	22,176
Alternative 2	20,552 ⁽¹⁾	21,332
Alternative 3	22,767 ⁽¹⁾	23,654
<i>Increase in 100 Year Flood Peak Flows from Existing Conditions</i>		
Alternative 1	2,828	2,813
Alternative 2	381 ⁽¹⁾	1,169 ⁽²⁾
Alternative 3	2,596 ⁽¹⁾	3,491 ⁽²⁾
<i>Note:</i>		
<i>(1) Peak flow values do not include North Truckee Drain flows because this alternative involves relocating the North Truckee Drain confluence downstream from the Vista index point</i>		
<i>(2) Downstream Railroad index point is located upstream of the Mustang Ranch Detention Facility which is incorporated into this alternative.</i>		

B. ALTERNATIVE 1 - LEVEE AND FLOODWALL ALTERNATIVE WITH 2,800 CFS ADDITIONAL DOWNSTREAM FLOWS

Alternative 1, the Floodwalls and Levees Alternative with 2,800 cfs Additional Downstream Flows, provides flood damage reduction for existing development in the Truckee Meadows reach by incorporating the following measures:

- Floodwalls/Levees/Setback Levees;
- Mc Carran Bridge Widening on the Truckee River; and
- Extension of Airport Culvert on Boynton Slough

Plate 16 illustrates Alternative 1 project features along the Truckee River from Highway 395 to Mc Carran Boulevard. Plate 17 illustrates project features along the Truckee River from Mc Carran Boulevard to Vista including proposed features along North Truckee Drain. Project features for Steamboat Creek and Boynton Slough are illustrated in Plate 18.

1. Floodwalls/Levees/Setback Levees

This alternative requires floodwalls and levees on both banks of the Truckee River, Steamboat Creek, Boynton Slough and North Truckee Drain. A summary of levee and floodwall data by reach, including structure length and average structure height, is shown in Table 9. These facilities also include seepage remediation features.

TABLE 9
SUMMARY OF LEVEE AND FLOODWALL STRUCTURES FOR ALTERNATIVE 1 –
LEVEE AND FLOODWALLS WITH 2,800 CFS ADDITIONAL DOWNSTREAM
FLOWS

Water Course	Reach Description	Total Structure Length (feet)	Average Structure Height (feet)	Structure Type (s)	Seepage Mitigation
Truckee River	North (left) Bank Glendale Avenue to Greg Street	2,895	10.2	Levees and Floodwalls	Drainage Blanket
	North (left) Bank Greg Street to 5,000 feet upstream of North Truckee Drain	16,532	7.6	Levees and Floodwalls	Relief Wells and Seepage Berms
	North (left) Bank 5,000 feet upstream of North Truckee Drain to North Truckee Drain	5,782	9.2	Levees	Relief Wells
	North (left) Bank North Truckee Drain to Vista	4,347	8.5	Levees	Relief Wells
	South (right) Bank Highway 395 to Greg Street	5,492	8.5	Levees and Floodwalls	Drainage Blanket
	South (right) Bank Greg Street to Mc Carran Boulevard	10,098	7.1	Levees and Floodwalls	Seepage Berm
Steamboat Creek	West (left) Bank Upstream of Boynton Slough	9,215	9.8	Levees and Floodwalls	Cutoff Wall
	West (left) Bank Boynton Slough to Truckee River (Detention Basin West Levee)	9,093	9.9	Levees	Seepage Berm
	East (right) Bank	9,529	11.7	Floodwalls	Cutoff Wall
Boynton Slough	North (left) Bank	8,363	8.3	Levees and Floodwalls	Cutoff Wall
	South (right) Bank	10,179	8.0	Levees and Floodwalls	Cutoff Wall
North Truckee Drain	West (right) Bank	9,426	10.0	Floodwalls	Relief Wells
	East (left) Bank	9,362	9.3	Floodwalls	Relief Wells

Attachment 1 provides estimated data about the levee and floodwalls for Alternative 1, including:

- Levee and floodwall alignments and lengths,
- Required structure heights,
- Levee and floodwall footprints, and
- Seepage remediation requirements, features, and footprints.

2. Mc Carran Boulevard Bridge Widening on the Truckee River

This alternative includes modifications to the Mc Carran Boulevard Bridge on the Truckee River. As previously described, this measure would widen the Mc Carran Boulevard Bridge opening to approximately 465 feet. Plate 19 provides upstream and downstream hydraulic cross sections for the proposed Mc Carran Boulevard Bridge.

3. Extension of Airport Culvert on Boynton Slough

Due to the containment of flood flows throughout the Truckee Meadows area under Alternative 1, an increase in water surface elevations are observed throughout the area, including near the Reno International Airport on Boynton Slough. Natural topography does not provide for containment of the increased water surface elevations. Levees and floodwalls can not be utilized in this area due to airport regulations requiring structures adjacent to the runways must have a 10:1 side slope. Thus, this alternative includes extending the existing airport culvert approximately 1,795 feet to accommodate the increased water surface elevation due to backwater.

4. Cost Estimate

A summary of the estimated construction cost for Alternative 1 is included in Table 10, and annualized costs are provided in Table 11. All cost estimating work uses September 2002 price levels and 6 5/8% interest rate. Attachment 4 provides detailed quantity and cost data for measures incorporated into Alternative 1.

TABLE 10
FIRST COST PRELIMINARY COST ESTIMATE – ALTERNAIVE 1

Code	Description	Unit	Quantity	Unit Cost	Total Cost
01	Lands and Damages				
	Land Acquisition - Levees and Floodwalls	Lump Sum	1	\$44,512,929	\$44,513,000
	Land Acquisition - Borrow and Disposal Sites	Lump Sum	1	\$11,502,089	\$11,502,000
	Severance Damages	Lump Sum	1	\$5,348,308	\$5,348,000
	Relocations (Businesses)	Lump Sum	1	\$3,750,000	\$3,750,000
	Administrative Costs	Lump Sum	1	\$9,240,000	\$9,240,000
	Subtotal				\$74,353,000
	Contingency and Unlisted Items (20%)				\$14,871,000
	<i>Subtotal for Lands and Damages</i>				\$89,224,000
02	Relocations				
	Mc Carran Boulevard Bridge Widening	Lump Sum	1	\$9,192,296	\$9,192,296
	Subtotal				\$9,192,296
	Contingency and Unlisted Items (20%)				\$1,838,500
	<i>Subtotal for Relocations</i>				\$11,030,796
06	Fish and Wildlife Facilities				
	Mitigation	Lump Sum	1	\$14,896,765	\$14,897,000
	Subtotal				\$14,897,000
	Contingency and Unlisted Items (20%)				\$2,979,400
	<i>Subtotal for Fish and Wildlife Facilities</i>				\$17,876,400
09	Channels and Canals				
	Bovton Slough Channel Enclosure/Box Culvert	Lump sum	1	\$3,886,864	\$3,886,864
	Subtotal				\$3,886,864
	Contingency and Unlisted Items (20%)				\$777,400
	<i>Subtotal for Channels and Canals</i>				\$4,664,264
11	Levees and Flood Walls				
	Mobilization and Demobilization	Lump Sum	1	\$200,000	\$200,000
	Levees	Lump Sum	1	\$22,528,364	\$22,528,364
	Floodwalls	Lump Sum	1	\$17,803,954	\$17,803,954
	Seepage Mitigation - Relief Wells	Lump Sum	1	\$4,382,923	\$4,382,923
	Seepage Mitigation - Cutoff Walls	Lump Sum	1	\$17,593,346	\$17,593,346
	Seepage Mitigation - Seepage Berm	Lump Sum	1	\$5,747,189	\$5,747,189
	Seepage Mitigation - Drainage Blanket	Lump Sum	1	\$197,821	\$197,821
	Disturbed Area (Clearing Grubbing/Seeding)	Lump Sum	1	\$1,227,114	\$1,227,114
	Subtotal				\$69,680,710
	Contingency and Unlisted Items (20%)				\$13,936,000
	<i>Subtotal for Levees and Floodwalls</i>				\$83,616,710
18	Cultural Resources Preservation				
	Cultural Resources	Lump Sum	1	\$993,000	\$993,000
	Subtotal				\$993,000
	Contingency and Unlisted Items (20%)				\$198,600
	<i>Subtotal for Cultural Resources Preservation</i>				\$1,191,600
SUBTOTAL					\$207,603,770
30	Planning Engineering and Design	Lump Sum	1	\$14,206,000	\$14,206,000
31	Construction Management	Lump Sum	1	\$9,470,000	\$9,470,000
TOTAL FIRST COST					\$231,279,770

Major assumptions and basis for the preceding estimate of total first costs are detailed below.

- This alternative increases downstream flood flows by approximately 2,800 cfs at Vista. The above cost estimate does not include costs for downstream restoration required to attenuate increased downstream flood flows.
- Lands and Damages Costs (excluding Huffaker Hills and Mustang Ranch Detention Facilities) are based on estimates from November 2000 *In-Progress Review Report*.

- Fish and Wildlife Facilities (mitigation costs) are estimated at 15% of total costs for accounts 02, 09, and 11.
- Cultural resources preservation costs are estimated at 1% of total costs for accounts 02, 09 and 11.
- Planning, engineering, and design costs are estimated as 12% of total cost for accounts 02, 06, 09, 11, and 18.
- Construction management is estimated at 8% of total costs for accounts 02, 06, 09, 11, and 18.

TABLE 11

**COST AMORTIZATION FOR ALTERNATIVE 1 – LEVEES AND FLOODWALLS
ALTERNATIVE WITH 2,800 CFS ADDITIONAL DOWNSTREAM FLOWS**

Description	Cost
Total First Cost	\$231,279,770
Interest During Construction (6 5/8%)	\$40,229,872
Total First Investment	\$271,510,000
Amortized Annual Costs (6 5/8 % over 50 years)	\$18,746,041
Annual O&M Costs including 20% Contingency	\$1,071,705
Total Annual Cost	\$19,818,000

Assumptions and basis for the preceding annualized cost estimates are detailed below:

- Project is amortized over 50 year life.
- Interest during construction is provided through the half-way point of construction, which is estimated to be 5 years.

**C. ALTERNATIVE 2 - FLOODWALLS, LEVEES, AND DETENTION FACILITIES
ALTERNATIVE WITH NO INCREASE IN DOWNSTREAM FLOWS**

Alternative 2 provides flood damage reduction for existing development in the Truckee Meadows reach by incorporating the following measures.

- Floodwalls/Levees/Setback Levees,
- Mc Carran Bridge Modification,
- North Truckee Drain Realignment,
- University of Nevada, Reno Farms Detention Facility (UNR Farms),
- Huffaker Hills Detention Facility, and
- Mustang Ranch Detention Facility.

Plate 20 illustrates project features for Alternative 2 along the Truckee River from Highway 395 to Mc Carran Boulevard. Plate 21 illustrates project features along the Truckee River from Mc

Carran Boulevard to Vista and includes proposed features along North Truckee Drain. Project features for Steamboat Creek and Boynton Slough, excluding Huffaker Hills Detention Facility, are illustrated in Plate 22.

1. Floodwalls/Levees/Setback Levees

This alternative requires floodwalls and levees on both banks of the Truckee River, Steamboat Creek, Boynton Slough and North Truckee Drain. A summary of levee and floodwall by reach, including structure length and average structure height, is shown in Table 12. These facilities also include seepage remediation features.

TABLE 12
SUMMARY OF LEVEE AND FLOODWALL STRUCTURES FOR ALTERNATIVE 2 –
LEVEES, FLOODWALLS AND DETENTION FACILITIES WITH NO INCREASE IN
DOWNSTREAM FLOWS

Water Course	Reach Description	Total Structure Length	Average Structure Height (feet)	Structure Type (s)	Seepage Mitigation
Truckee River	North (left) Bank Glendale Avenue to Greg Street	2,895	10.3	Levees and Floodwalls	Drainage Blanket
	North (left) Bank Greg Street to 5,000 feet upstream of North Truckee Drain	16,532	7.1	Levees and Floodwalls	Relief Wells and Seepage Berms
	North (left) Bank 5,000 feet upstream of North Truckee Drain to North Truckee Drain	5,782	7.8	Levees Only	Relief Wells
	North (left) Bank North Truckee Drain to Vista	4,347	7.4	Levees Only	Relief Wells
	South (right) Bank Highway 395 to Greg Street	5,492	8.5	Levees and Floodwalls	Drainage Blanket
	South (right) Bank Greg Street to McCarran Boulevard	10,198	7.0	Levees and Floodwalls	Seepage Berm
Steamboat Creek	West (left) Bank Upstream of Boynton Slough	9,148	9.0	Levees and Floodwalls	Cutoff Wall
	East (right) Bank	9,529	10.2	Floodwalls Only	Cutoff Wall
Boynton Slough	North (left) Bank	8,363	7.5	Levees and Floodwalls	Cutoff Wall
	South (right) Bank	10,179	7.5	Levees and Floodwalls	Cutoff Wall
North Truckee Drain	West (right) Bank	9,210	6.8	Floodwalls Only	Relief Wells
	East (left)Bank	9,128	7.4	Floodwalls Only	Relief Wells

Attachment 2 provides detailed data for the levee and floodwalls for Alternative 2, including:

- Levee and floodwall alignments and lengths,
- Required structure heights,
- Levee and floodwall footprints, and
- Seepage remediation requirements, features, and footprints.

2. Mc Carran Boulevard Bridge Widening on the Truckee River

This alternative includes modifications to the Mc Carran Boulevard Bridge on the Truckee River. As previously described, this measure would widen the Mc Carran Boulevard Bridge opening to approximately 465 feet in width. Plate 19 provides upstream and downstream hydraulic cross sections for the proposed Mc Carran Boulevard Bridge.

3. North Truckee Drain Realignment

Re-alignment of the North Truckee Drain from its existing confluence with the Truckee River near the Truckee Meadows Water Reclamation Facility (TRWRF) to downstream from Vista is included in this alternative. As previously described, the re-alignment would relocate the confluence approximately 4,500 feet downstream from its existing outlet and requires the construction of new conveyance facilities, including concrete lined channel and box culverts, as shown in Plate 12.

4. University of Nevada, Reno Farms Detention Facility

This alternative incorporates a detention facility located immediately downstream from Mc Carran Boulevard and adjacent to Steamboat Creek. As previously described, the University of Nevada, Reno Farms Detention Facility would divert and store Truckee River flood flows in order to reduce the peak discharge and volume of water carried downstream. This facility would include a reinforced concrete inlet weir, an outlet weir, and a leveed storage area, as shown in Plate 13. The estimated water surface elevation in the detention facility is approximately 4399.9 feet for the 100-year event. This correlates to a storage volume of 5,278 acre-feet. Attachment 2 includes detailed data for the UNR Farms Detention Facility levees, a summary of this data is provided in Table 13.

TABLE 13
SUMMARY OF LEVEE STRUCTURES FOR UNIVERSITY OF NEVADA, RENO
FARMS DETENTION FACILITY

Reach Description	Total Structure Length (feet)	Average Structure Height (feet)	Structure Type (s)	Seepage Mitigation
West Levee	8,569	11.4	Levees	Seepage Berm
North Levee	6,667	12.2	Levees	Impervious Berm
East/South Levee	9,596	12.5	Levees	Cutoff Wall

5. Huffaker Hills Detention Facility

Huffaker Hills Detention Facility is included in this alternative and is shown in Plate 14. As described previously, this facility reduces peak flows on Steamboat Creek through the use of an on-stream detention facility located approximately 5 miles upstream of the confluence of the Truckee River and Steamboat Creek.

6. Mustang Ranch Detention Facility

This alternative includes the Mustang Ranch Detention Facility located immediately downstream from the community of Lockwood on the south (right) bank of the Truckee River, as shown in Plate 15. As previously described, this facility includes an inlet weir, a leeved earthen channel, a leeved storage area, and an outlet weir. The approximate inundation area of the storage facility is 70 acres.

7. Cost Estimates

A summary of the estimated construction cost for Alternative 2 is included in Table 14, and annualized costs are presented in Table 15. All cost estimating work uses September 2002 price levels and 6 5/8% interest rate. Attachment 4 provides detailed quantity and cost data for measures incorporated into Alternative 2.

TABLE 14
FIRST COST PRELIMINARY COST ESTIMATE – ALTERNATIVE 2

Account	Description	Unit	Quantity	Unit Cost	Total Cost
01	Lands and Damages				
	Land Acquisition - Levees and Floodwalls	Lump Sum	1	\$44,569,235	\$44,569,000
	Land Acquisition - Mustang Ranch Detention Facility	Lump Sum	1	\$3,493,360	\$3,493,000
	Land Acquisition - Huffaker Hills Detention Facility	Lump Sum	1	\$600,000	\$600,000
	Land Acquisition - Borrow and Disposal Sites	Lump Sum	1	\$11,502,089	\$11,502,000
	Severance Damages	Lump Sum	1	\$5,348,308	\$5,348,000
	Relocations (Businesses)	Lump Sum	1	\$3,750,000	\$3,750,000
	Administrative Costs	Lump Sum	1	\$9,240,000	\$9,240,000
	Subtotal				\$78,502,000
	Contingency and Unlisted Items (20%)				\$15,700,000
	<i>Subtotal for Lands and Damages</i>				\$94,202,000
02	Relocations				
	Mc Carran Boulevard Bridge Widening	Lump Sum	1	\$9,192,296	\$9,192,296
	Subtotal				\$9,192,296
	Contingency and Unlisted Items (20%)				\$1,838,500
	<i>Subtotal for Relocations</i>				\$11,030,796
06	Fish and Wildlife Facilities				
	a. Mitigation	Lump Sum	1	\$22,100,089	\$22,100,000
	Subtotal				\$22,100,000
	Contingency and Unlisted Items (20%)				\$4,420,000
	<i>Subtotal for Fish and Wildlife Facilities</i>				\$26,520,000
09	Channels and Canals				
	North Truckee Drain Re-Alienment	Lump Sum	1	\$10,969,192	\$10,969,192
	Subtotal				\$10,969,192
	Contingency and Unlisted Items (20%)				\$2,193,800
	<i>Subtotal for Fish and Wildlife Facilities</i>				\$13,162,992
11	Levees and Flood Walls				
	Mobilization and Demobilization	Lump Sum	1	\$200,000	\$200,000
	Levees	Lump Sum	1	\$19,501,696	\$19,501,696
	Floodwalls	Lump Sum	1	\$35,824,151	\$35,824,151
	Seepage Mitigation - Relief Wells	Lump Sum	1	\$3,915,873	\$3,915,873
	Seepage Mitigation - Cutoff Walls	Lump Sum	1	\$21,423,505	\$21,423,505
	Seepage Mitigation - Seepage Berm	Lump Sum	1	\$5,770,477	\$5,770,477
	Seepage Mitigation - Drainage Blanket	Lump Sum	1	\$197,821	\$197,821
	Seepage Mitigation - Impervious Berm	Lump Sum	1	\$7,978,501	\$7,978,501
	Disturbed Area (Clearing Grubbing/Seeding)	Lump Sum	1	\$1,699,597	\$1,699,597
	Subtotal				\$96,511,620
	Contingency and Unlisted Items (20%)				\$19,302,000
	<i>Subtotal for Levees and Floodwalls</i>				\$115,813,620
15	Floodway Control and Diversion Structures				
	Huffaker Hills Detention Facility	Lump sum	1	\$4,250,882	\$4,250,882
	UNR Farms Detention Facility Inlet and Outlet	Lump sum	1	\$929,535	\$929,535
	Mustang Ranch Detention Facility Diversion	Lump sum	1	\$925,000	\$925,000
	Subtotal				\$6,105,417
	Contingency and Unlisted Items (20%)				\$1,221,100
	<i>Subtotal for Cultural Resources Preservation</i>				\$7,326,517
18	Cultural Resources Preservation				
	Cultural Resources	Lump Sum	1	\$1,473,000	\$1,473,000
	Subtotal				\$1,473,000
	Contingency and Unlisted Items (20%)				\$294,600
	<i>Subtotal for Cultural Resources Preservation</i>				\$1,767,600
SUBTOTAL					\$269,823,525
30	Planning Engineering and Design	Lump Sum	1	\$21,075,000	\$21,075,000
31	Construction Management	Lump Sum	1	\$14,050,000	\$14,050,000
TOTAL FIRST COST					\$304,948,525

Major assumptions and basis for the preceding estimate of total first costs are detailed below.

- Lands and Damages Costs (excluding Huffaker Hills and Mustang Ranch Detention Facilities) based on estimates from November 2000 *In-Progress Review Report*.
- Fish and Wildlife Facilities (mitigation costs) are estimated at 15% of total costs for accounts 02, 09, 11 and 15.
- Cultural resources preservation costs are estimated at 1% of total costs for accounts 02, 09, 11 and 15.
- Planning, engineering, and design costs are estimated as 12% of total cost for accounts 02, 06, 09, 11, 15 and 18.
- Construction management is estimated at 8% of total costs for accounts 02, 06, 09, 11, 15 and 18.

TABLE 15

COST AMORTIZATION FOR ALTERNATIVE 2 – LEVEES, FLOODWALLS AND DETENTION BASIN ALTERNATIVE WITH NO INCREASE IN DOWNSTREAM FLOWS

Description	Cost
Total First Cost	\$304,948,525
Interest During Construction (6 5/8%)	\$53,044,156
Total First Investment	\$357,993,000
Amortized Annual Costs (6 5/8 % over 50 years)	\$24,717,142
Annual O&M Costs including 20% Contingency	\$1,245,860
Total Annual Cost	\$25,963,000

Assumptions and basis for the preceding annualized cost estimates are detailed below.

- Project amortized over 50-year life.
- Interest during construction is provided through the half-way point of construction, which is estimated to be 5 years.

D. ALTERNATIVE 3 - CHANNEL BENCHING (COMMUNITY COALITION) ALTERNATIVE

Alternative 3 provides flood damage reduction for existing development in the Truckee Meadows reach by incorporating the following measures:

- Floodwalls/ Levees/Setback Levees,
- Rock Boulevard Bridge Widening,
- Mc Carran Boulevard Bridge Widening,
- Channel Benching,

- North Truckee Drain Realignment,
- Huffaker Hills Detention Facility, and
- Mustang Ranch Detention Facility.

1. Floodwalls/Levees/Setback Levees

This alternative requires floodwalls and levees on both banks of the Truckee River and North Truckee Drain. This alternative also includes floodwalls along the east bank of Steamboat Creek. No levees are proposed under this alternative for the west bank of Steamboat Creek or either bank of Boynton Slough. Although portions of these areas may be below the 100 year water surface elevations, the Community Coalition does not desire levees and floodwalls in these areas. Due to the incorporation of channel benching in this alternative, with project water surface elevations in these areas, Steamboat Creek and Boynton Slough, are lower than existing condition and the 1997 flood event.

A summary of levee and floodwall data by reach, including structure length and average structure height, is shown in Table 16. These facilities also included seepage remediation features.

TABLE 16
SUMMARY OF LEVEE AND FLOODWALL STRUCTURES FOR ALTERNATIVE 3 –
CHANNEL BENCHING (COMMUNITY COALITION) ALTERNATIVE

Water Course	Reach Description	Total Structure Length (feet)	Average Structure Height (feet)	Structure Type (s)	Seepage Mitigation
Truckee River	North (left) Bank Glendale Avenue to Greg Street	2,895	9.7	Levees and Floodwalls	Drainage Blanket
	North (left) Bank Greg Street to 5,000 feet upstream of North Truckee Drain	16,432	6.0	Levees and Floodwalls	Relief Wells and Seepage Berms
	North (left) Bank 5,000 feet upstream of North Truckee Drain to North Truckee Drain	5,782	7.1	Levee Only	Relief Wells
	North (left) Bank North Truckee Drain to Vista	4,347	6.4	Levees	Relief Wells
	South (right) Bank Highway 395 to Greg Street	5,492	8.1	Levees and Floodwalls	Drainage Blanket
	South (right) Bank Greg Street to McCarran Boulevard	10,035	5.7	Levees and Floodwalls	Seepage Berm
Steamboat Creek	East (right) Bank	2,757	7.9	Floodwalls Only	Cutoff Wall
North Truckee Drain	West (right) Bank	9,210	6.7	Floodwalls	Relief Wells
	East (left) Bank	9,128	7.0	Floodwalls	Relief Wells

Attachment 3 provides detailed data for the levee and floodwalls for Alternative 3 including:

- Levee and floodwall alignments and lengths,
- Required structure heights,
- Levee and floodwall footprints, and
- Seepage remediation requirements, features, and footprints.

2. Rock Boulevard Bridge Widening on the Truckee River

This alternative includes modifications to the Rock Boulevard Bridge on the Truckee River. As previously described, this measure would widen the opening of the Rock Boulevard Bridge opening to approximately 465 feet in width. Plate 26 provides upstream and downstream hydraulic cross sections for the proposed Rock Boulevard Bridge.

3. Mc Carran Boulevard Bridge Widening on the Truckee River

This alternative includes modifications to the Mc Carran Boulevard Bridge on the Truckee River. As previously described, this measure would widen the Mc Carran Boulevard Bridge to approximately 465 feet in width. Plate 27 provides upstream and downstream hydraulic cross sections for the proposed Mc Carran Boulevard Bridge for the channel benching alternative. Due to the incorporation of channel benching, the flow area of the new Mc Carran Boulevard Bridge is larger for Alternative 3 than the other alternatives.

4. Channel Benching

This alternative includes channel benching from approximately Greg Street to downstream from Vista, as shown in Table 17. The concept is to create two benches, a higher and a lower terrace within a 350 foot-wide area from Greg Street to downstream of Vista. The elevation of the lower bench would be set at the two-year flow level. The high bench would be constructed two feet above the lower bench. However, in some areas a single bench may be constructed at the two-year flow level. Approximately 5.9 miles of the channel will be benched along the south bank of the Truckee River, involving a land area of approximately 163 acres. Approximately 1.1 miles of the channel will be benched on the north bank of the Truckee River, primarily downstream of Vista, involving a land area of approximately 8.5 acres.

TABLE 17

**CHANNEL BENCHING ELEVATIONS AND WIDTHS FOR ALTERNATIVE 3 –
CHANNEL BENCHING (COMMUNITY COALITION) ALTERNATIVE**

Reach Description	River Station	Low Bench		High Bench	
		Width (ft)	Elevation (ft)	Width (ft)	Elevation (ft)
<i>Truckee River North (Left) Bank</i>					
2650 feet downstream of Rock Blvd.	29635.3	40	4401	57	4403
5400 feet downstream the Confluence of the Truckee and Steamboat Creek	7406.4	261	4380	not applicable	not applicable
9500 feet downstream the Confluence of the Truckee and Steamboat Creek	3339.9	97	4376	not applicable	not applicable
10000 feet downstream the Confluence of the Truckee and Steamboat Creek	2774.2	73	4376	not applicable	not applicable
<i>Truckee River South (right) Bank</i>					
700 feet downstream of Greg Street	34676.9	195	4416	82	4418
100 feet upstream of Rock Street	32391.4	204	4408	82	4410
500 feet downstream of Rock Street	31795.1	179	4406	82	4409
2650 feet downstream of Rock Street	29635.3	97	4401	81	4403
3500 feet downstream of Rock Street	28777.2	195	4399	82	4401
1350 feet upstream of McCarran Street	27150.4	224	4396	82	4398
350 feet upstream of McCarran Street	26167.2	209	4394	84	4396
1550 feet downstream of McCarran Street	24232.1	214	4389	82	4392
4550 feet downstream of McCarran Street	21263.3	170	4386	83	4388
6000 feet downstream of McCarran Street	19871.7	214	4384	82	4386
4600 feet upstream of Confluence of the Truckee and the North Truckee Drain	17967.0	173	4383	83	4386
500 feet upstream of Confluence with North Truckee Drain	13849.4	201	4381	83	4383
Confluence of Steamboat Creek	12793.1	102	4380	not applicable	not applicable
4000 feet downstream from Confluence with Steamboat Creek	8745.7	373	4379	not applicable	not applicable
5400 feet downstream from Confluence with Steamboat Creek	7406.4	113	4378	not applicable	not applicable
10000 feet downstream from Confluence with Steamboat Creek	2774.2	69	4390	not applicable	not applicable
10500 feet downstream from Confluence with Steamboat Creek	2220.2	83	4376	not applicable	not applicable
<i>Note: Elevations are referenced to NGVD29 and were derived from HEC-RAS model simulation.</i>					

5. North Truckee Drain Realignment

Re-alignment of the North Truckee Drain from its existing confluence with the Truckee River near the Truckee Meadows Water Reclamation Facility (TRWRF) to downstream of Vista is included in this alternative. As previously described, the re-alignment would relocate the confluence approximately 4,500 feet downstream from its existing outlet and requires the construction of new conveyance facilities, including concrete lined channel and box culverts, as shown in Plate 12.

6. Huffaker Hills Detention Facility

Huffaker Hills Detention Facility is included in this alternative and is shown in Plate 14. As described previously, this facility reduces peak flows on Steamboat Creek through the use of an on-stream detention facility located approximately 5 miles upstream of the Truckee River confluence.

7. Mustang Ranch Detention Facility

This alternative includes the Mustang Ranch Detention Facility located immediately downstream from the community of Lockwood on the south (right) bank of the Truckee River, as shown in Plate 15. As previously described, this facility includes an inlet weir, leveed earthen channel, leveed storage area, and outlet weir. The approximate inundation area of the storage area would be approximately 70 acres.

8. Floodproofing

The channel benching plan requires floodproofing of 59 residences in the Boynton Slough and Pembroke Drive areas, as shown in Plate 25. The method of floodproofing would probably vary from structure to structure, but all would be raised to at least the 100-year flood elevation.

9. Cost Estimates

A summary of the estimated construction cost for Alternative 3 is included in Table 18, and annualized costs are presented in Table 19. All cost estimating work uses September 2002 price levels and 6 5/8% interest rate. Attachment 4 provides detailed quantity and cost data for measures incorporated into Alternative 3.

TABLE 18
FIRST COST PRELIMINARY COST ESTIMATE – ALTERNATIVE 3

Account	Description	Unit	Quantity	Unit Cost	Total Cost
01	Lands and Damages				
	Land Acquisition - Levees and Floodwalls	Lump sum	1	\$44,568,300	\$44,568,000
	Land Acquisition - Mustang Ranch Detention Facility	Lump sum	1	\$3,493,360	\$3,493,000
	Land Acquisition - Huffaker Hills Detention Facility	Lump sum	1	\$600,000	\$600,000
	Land Acquisition - Borrow and Disposal Sites	Lump sum	1	\$11,502,089	\$11,502,000
	Severance Damages	Lump sum	1	\$5,348,196	\$5,348,000
	Relocations (Businesses)	Lump sum	1	\$3,750,000	\$3,750,000
	Administrative Costs	Lump sum	1	\$9,240,000	\$9,240,000
				Subtotal	\$78,501,000
				Contingency and Unlisted Items (20%)	\$15,700,000
				<i>Subtotal for Lands and Damages</i>	\$94,201,000
02	Relocations				
	Rock Boulevard Bridge Replacement	Lump sum	1	\$9,113,223	\$9,113,223
	Mc Carran Boulevard Bridge Relocation	Lump sum	1	\$9,192,296	\$9,192,296
	Lowering Pembroke Drive	Lump sum	1	\$103,473	\$103,473
	Floodproofing in area north of Boynton Slough	Lump sum	1	\$2,065,000	\$2,065,000
				Subtotal	\$20,473,992
				Contingency and Unlisted Items (20%)	\$4,094,800
				<i>Subtotal for Relocations</i>	\$24,568,792
06	Fish and Wildlife Facilities				
a.	Mitigation	Lump sum	1	\$18,684,470	\$18,684,000
				Subtotal	\$18,684,000
				Contingency and Unlisted Items (20%)	\$3,736,800
				<i>Subtotal for Fish and Wildlife Facilities</i>	\$22,420,800
09	Channels and Canals				
	North Truckee Drain Re-Alignment	Lump sum	1	\$10,969,192	\$10,969,192
	Channel Benching	Lump sum	1	\$32,848,075	\$32,848,075
				Subtotal	\$43,817,267
				Contingency and Unlisted Items (20%)	\$8,763,500
				<i>Subtotal for Channels and Canals</i>	\$52,580,767
11	Levees and Flood Walls				
	Mobilization and Demobilization	Lump Sum	1	\$200,000	\$200,000
	Levees	Lump Sum	1	\$9,363,963	\$9,363,963
	Floodwalls	Lump Sum	1	\$17,319,864	\$17,319,864
	Seepage Mitigation - Relief Wells	Lump Sum	1	\$3,360,169	\$3,360,169
	Seepage Mitigation - Cutoff Walls	Lump Sum	1	\$1,333,832	\$1,333,832
	Seepage Mitigation - Seepage Berm	Lump Sum	1	\$899,266	\$899,266
	Seepage Mitigation - Drainage Blanket	Lump Sum	1	\$186,721	\$186,721
	Disturbed Area (Clearing Grubbing/Seeding)	Lump Sum	1	\$742,243	\$742,243
				Subtotal	\$33,406,058
				Contingency and Unlisted Items (20%)	\$6,681,000
				<i>Subtotal for Levees and Floodwalls</i>	\$40,087,058
15	Floodway Control and Diversion Structures				
	Huffaker Hills Detention Facility	Lump sum	1	\$4,250,882	\$4,250,882
	Mustang Ranch Detention Facility Diversion	Lump sum	1	\$925,000	\$925,000
				Subtotal	\$5,175,882
				Contingency and Unlisted Items (20%)	\$1,035,200
				<i>Subtotal for Floodway and Diversion Structures</i>	\$6,211,082
18	Cultural Resources Preservation				
	Cultural Resources	Lump Sum	1	\$1,234,000	\$1,234,000
				Subtotal	\$1,234,000
				Contingency and Unlisted Items (20%)	\$246,800
				<i>Subtotal for Cultural Resources Preservation</i>	\$1,480,800
				SUBTOTAL	\$241,349,897
30	Planning Engineering and Design	Lump Sum	1	\$17,658,000	\$17,658,000
31	Construction Management	Lump Sum	1	\$11,772,000	\$11,772,000
				TOTAL FIRST COST	\$270,779,897

Major assumptions and basis for the preceding estimate of total first costs are detailed below:

- This alternative increases downstream flood flows by approximately 2,400 cfs at Wadsworth. The above cost estimate does not include costs for downstream restoration required to attenuate increased downstream flood flows.
- Channel benching costs represent flood damage reduction components including clearing and grubbing, excavation, etc. These estimates do not include costs for ecosystem restoration features such as plantings.
- Lands and Damages Costs (excluding Huffaker Hills and Mustang Ranch Detention Facilities) are based on estimates from November 2000 *In-Progress Review Report*.
- Fish and Wildlife Facilities (mitigation costs) are estimated at 15% of total costs for accounts 02, 09, 11 and 15.
- Cultural resources preservation costs are estimated at 1% of total costs for accounts 02, 09, 11 and 15.
- Planning, engineering, and design costs are estimated as 12% of total cost for accounts 02, 06, 09, 11, 15 and 18.
- Construction management is estimated at 8% of total costs for accounts 02, 06, 09, 11, 15 and 18.

TABLE 19
COST AMORTIZATION FOR ALTERNATIVE 3 – CHANNEL BENCHING
(COMMUNITY COALITION) ALTERNATIVE

Description	Cost
Total First Cost	\$270,779,897
Interest During Construction (6 5/8%)	\$47,100,707
Total First Investment	\$317,881,000
Amortized Annual Costs (6 5/8 % over 50 years)	\$21,947,664
Annual O&M Costs including 20% Contingency	\$900,589
Total Annual Costs	\$22,848,000

Assumptions and basis for the preceding annualized cost estimates are detailed below:

- Project is amortized over 50 year life.
- Interest during construction is provided through the half-way point of construction, which is estimated to be 5 years.