EXECUTIVE SUMMARY

This Alternatives Report documents the formulation of alternatives to address flood damage reduction and ecosystem restoration in the Reno-Sparks metropolitan area in Washoe County, Nevada.

PROJECT HISTORY

In 1985, the U.S. Army Corps of Engineers (Corps) released a Feasibility Report and environmental impact statement that described a project to control flooding in the Reno-Sparks-Truckee Meadows area. The project was designed to convey a flow of 18,500 cfs through the Truckee River channel with levees, floodwalls, channel excavation, and bridge replacement, as needed.

The project was subsequently authorized by congress in the 1988 Water Resources Development Act. Following a reevaluation of project costs in 1991, the project was reclassified to the "deferred" category because the benefit/cost ratio dropped below 1.0, based on new methodology to calculate the ratio.

In 1997, the Corps conducted a reconnaissance study to assess the feasibility of reclassifying the project, based on updated data on project costs and benefits. The conclusions of the reconnaissance study and report was that (1) there continues to be a substantial demonstrated flood problem in the study area; (2) besides flood control, there is a need for environmental restoration and recreation features along the river consistent with a plan to reduce the risk of flooding; and (3) plans to help reduce flood problems and enhance recreation and environmental opportunities in the area appear economically feasible and locally desirable. In meetings and correspondence in 1997, the cities of Reno and Sparks and Washoe County supported continued efforts to identify a project to help reduce the risk of flooding in the area. The Corps reactivated the PED phase of the project in March 1998 with the first step to conduct a General Reevaluation Report (GRR).

In 1999, the Washoe County Board of Commissioners, with the support of the cities of Reno and Sparks, the Nevada State Legislature, and many local community organizations, enacted an 1/8 cent sales tax to be used for public safety and flood management for the Truckee Meadows region. The Community Coalition for Truckee River Flood Management was formed by the project sponsors, with the cooperation of the U.S. Army Corps of Engineers, in order to ensure direct community input into the design of a Flood Management Plan for Reno, Sparks, and the Truckee Meadows area. This Coalition is a diverse group, including over 25 local stakeholder organizations, 15 resource and regulatory agencies, and members of the public. The formal Community Coalition process was initiated in April 2000.

STUDY OBJECTIVES

Alternative plans have been formulated which address the problems and opportunities in the study area. These alternative plans have been formulated to meet the following planning objectives:

I Provide Flood Damage Reduction

II Provide Environmental Restoration

III Incorporate River Parkway and Recreation Opportunities

These objectives were defined by the Corps of Engineers and the Truckee River Flood Management Community Coalition.

NO-ACTION ALTERNATIVE AND CANDIDATE PLANS

There are five alternative projects assessed in this report, not including the No Action alternative. Alternatives 1-4 have similarities which are described below. Alternative 5 is the Truckee River Flood Management Community Coalition's most recent working draft version of its Concept Plan.

No-Action Alternative

Under this alternative, no future action would be taken by the Federal Government to increase flood protection in the study area. The existing flood control facilities, in both the downtown Reno and Truckee Meadows reaches, would continue to operate as described in the without project future condition. This alternative provides a baseline from which to evaluate the effects of all other alternatives.

Alternatives 1-4

Alternatives 1-4 all have four common elements: (1) a component which provides protection for the downtown Reno portion of the study area (Booth St. to US Hwy. 395); (2) an environmental restoration component; (3) physical barriers made up of levees, several of which are set back considerably from the river's edge, and floodwalls; and (4) replacement of two bridges in the Truckee Meadows portion of the study area (Pembroke Dr. and Longley Lane bridges). Floodwalls were used in reaches where land or structure constraints existed and to minimize the required right-of-way easements. Levees were used in reaches where open space/undeveloped land was available to accommodate the wider footprint.

Downtown Reno Flood Damage Reduction Component

Alternatives 1-4 all include the following measures designed to provide flood damage reduction benefits for the developed area bordering the Booth St. – Hwy. 395 (downtown Reno) reach of the Truckee River:

- Replacement of Sierra, Virginia, and Lake Street bridges, and
- Floodwalls.

Truckee Meadows Area Flood Damage Reduction

The four alternatives differ significantly in how they would provide flood protection for existing development downstream of Hwy. 395, and in the areas directly affected by flooding of Steamboat Creek and Boynton Slough. These areas are collectively referred to as the

"Truckee Meadows Reach", to distinguish it from the Booth St. – Hwy 395 area on the Truckee River (Downtown Reno reach.) Alternatives 1-4 differ with regard to whether or not they include the detention basin and channel benching both upstream and downstream of the confluence of Steamboat Creek and Truckee River ("upstream" and "downstream" channel benching). The heights of the floodwalls and levees may also differ between the alternatives.

Environmental Restoration Component

A conceptual habitat restoration component has been developed for the Truckee River between Interstate 395 and its confluence with Steamboat Creek and for Steamboat Creek downstream from Pembroke Lane. This component has been developed in conjunction with flood damage reduction plans for the project reach. Restoration actions include enhancing existing riparian habitat, creating riparian habitat, creating riparian transition habitat, and creating wetland habitat. In reaches of the river with limited space available, restoration actions focus on enhancing existing riparian habitat by planting native trees and shrubs among existing vegetation to create a continuous riparian corridor. Where proposed flood control features are setback from the river, creation of riparian habitat to create a wide, continuous riparian corridor is proposed. The width of the riparian corridor is increased in areas with available space by creating a riparian transition zone adjacent to riparian habitat. In addition, in alternative plans where channel benching is proposed, additional restoration is included on the benched banks. Creation of a wetland habitat is proposed along Steamboat Creek that includes a riparian area, wetlands, and deep-water areas.

River Parkway

Alternatives 1-4 will likely include recreationally oriented measures that would contribute to the river parkway planning objective. However, at the current level of project planning, details of such measures were not incorporated in this report.

Summary of Alternatives 1-4

Table ES-1 summarizes all major components of Alternatives 1-4. Although not currently defined, Alternatives 1-4 will likely incorporate River Parkway measures during future refinement of the alternatives.

TABLE ES-1

MEASURES INCORPORATED INTO ALTERNATIVES 1-4

Primary Objective	Measure	Alternative			
		1	2	3	4
Flood Damage Reduction – Downtown Reno Reach	Sierra Street Bridge Replacement	X	X	X	X
	Virginia Street Bridge Replacement	X	X	X	X
	Lake Street Bridge Replacement	X	X	X	X
	Floodwalls	X	X	X	X
Flood Damage Reduction – Truckee Meadows Reach	Replace Longley Lane Bridge	X	X	X	X
	Replace Pembroke Drive Bridge	X	X	X	X
	Floodwalls	X	X	X	X
	Levees/Setback Levees	X	X	X	X
	Channel Benching Upstream of Steamboat Confluence		X		X
	Channel Benching Downstream of Steamboat Confluence		X		X
	University Farms Detention Basin			X	X
	Dedication of Floodplain to Natural Storage	X	X		
Environmental Restoration	Interstate 395 to Greg Street	X	X	X	X
	Greg Street to South Mc Carran Boulevard	X	X	X	X
	South Mc Carran Boulevard to Steamboat Creek	X	X	X	X
	Steamboat Creek: Pembroke Drive to Kimlick Lane	X	X	X	X

Alternative 5 (Working Draft Coalition Concept Plan)

Alternative 5 is the most recent draft version of the Coalition's evolving Concept Plan. It combines a large number of flood damage reduction elements, environmental restoration elements, and river parkway elements. It also includes floodplain management measures, which the community would like to pursue with the local sponsors.

To facilitate comparison of Alternative 5 with Alternatives 1-4, Table 2 indicates which types of components discussed in Alternatives 1-4 are also present in Alternative 5. Alternative 5 is presented here in its own table because few if any of its elements are identical to those contained in Alts 1-4. It contains some of the same *types* of components, but the details of the components themselves (the measures or sets of measures) are not the same.

TABLE ES-2

COMPONENTS OF ALT. 5 SIMILAR IN TYPE TO THOSE IN ALTS. 1-4

Portion of Study Area	Component	Alternative				
		1	2	3	4	5
Overall	Environmental Restoration	X	X	X	X	X
	River Parkway[1]					X
Flood Damage Reduction - Downtown Reno Reach	Floodwalls	X	X	X	X	X
	Bridge Replacement	X	X	X	X	X
Flood Damage Reduction - Truckee Meadows Reach	Levees/Setback Levees	X	X	X	X	X
	Floodwalls	X	X	X	X	X
	Bridge Replacement	X	X	X	X	X
	Upstream Benching		X		X	
	Downstream Benching		X		X	X
	Detention Basin			X	X	
	Dedication of Floodplain to Natural Storage	X	X			X

[1] Although not currently included, this measure will likely be incorporated in Alternative Plans 1-4 in the future.

Alternative 5 also has a group of elements which are oriented at creating an envisioned Truckee River parkway and a group of elements oriented at floodplain management. At the level of specific measures, Alternative 5 includes elements not present in any of the other four alternatives at this time.

EVALUATION OF ALTERNATIVES

Expected accomplishments, effects, operation and maintenance requirements, and costs of the five candidate plans were assessed to the extent possible based upon available information. On the basis of this assessment, and to the extent possible, the alternatives were assigned relative qualitative ratings on the criteria of effectiveness, efficiency, completeness, and acceptability. Table ES-3 displays the relative ratings. As alternatives are further refined and additional analysis (e.g. hydraulic modeling) is conducted, these ratings are subject to change.

TABLE ES-3

RELATIVE EFFICIENCY, EFFECTIVENESS, COMPLETENESS, AND ACCEPTIBILITY OF ALTERNATIVES

Criterion	Alternative				
	1	2	3	4	5
Efficiency	High	Medium	Medium	Low	?
Effectiveness - Restoration	High	High	High	High	High
Effectiveness - Flood Damage Reduction	High	High	High	High	?
Effectiveness - River Parkway	?	?	?	?	High
Completeness	Low	Low	Medium	Medium	Medium
Acceptability	Low	Medium	Medium	Medium	High

CHAPTER 1

INTRODUCTION

1.1. PURPOSE AND SCOPE

This Alternatives Report is a precursor to a General Reevaluation Report (GRR). The principal purpose of the Alternatives Report is to formulate flood damage reduction and environmental restoration project alternatives and to present preliminary design and cost information for those alternatives. A secondary purpose is to serve as a basis of discussion for a U.S. Army Corps of Engineers (USACE) In-Progress Review (IPR) of efforts to address the threat of flooding in the Reno-Sparks-Truckee Meadows area. The Alternatives Report has been prepared making use of prior feasibility level planning and engineering studies for the study area.

The purpose of the GRR will be to appropriately affirm, reformulate, or modify the WRDA 1988 authorized plan, or portions of the plan, using current planning criteria and assessment of community needs. If reauthorization is necessary, the document will be processed in the same manner as a feasibility report and, therefore, will contain an engineering appendix and National Environmental Policy Act documentation. The document will also be used as the basis for a Federal commitment and supporting document for the project cooperation agreement.

The primary scope of the GRR study consists of the following:

- Develop objectives, constraints, and criteria for flood damage reduction, environmental restoration, and recreation measures considering flood hydrology, river mechanics, geomorphology, hydraulics, environmental habitat, existing recreation, residual land value, impacts to third parties, and operation and maintenance responsibilities for the new flood control project.
- Develop alternatives to reduce the impact of flooding, improve riverine and adjacent riparian habitat, and increase recreational opportunities in the project study area. Alternatives should be developed taking into consideration structural, non-structural, floodplain management and other measures. The development of the alternatives includes the following components: design, project layout, and first and annual cost estimates that include operation and maintenance costs for each of the studied alternatives.

1.2. PROJECT BACKGROUND

1.2.1. 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 1-1. Steamboat Creek is the largest tributary to the

Truckee River in the Reno area and enters the Truckee River near Vista. Evans and Dry Creek, two tributaries to Steamboat Creek, combine below Highway 395 to form Boynton Slough.

The primary study area is along the Truckee River through central Reno (Booth Street to Highway 395), Sparks (Highway 395 to Vista), and the Truckee Meadows area to the Vista Reefs. This 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.

The study area is divided into two portions: (1) the flood plain of the Truckee River between Booth Street and U.S. Highway 395 (Downtown Reno Reach); and (2) the floodplain of the Truckee River from Highway 395 to Vista, along with the nearby flood plains of Steamboat Creek and Boynton Slough (Truckee Meadows Reach). The latter reach includes the areas of Rosewood Estates and the Hidden Valley Estates. The Downtown Reno reach and the Truckee Meadows reach are shown in Plate 1-2.

1.2.2. Project History and Authority

The initial Truckee Meadows (Reno-Sparks Metropolitan Area), Nevada, investigation was authorized under a resolution adopted February 7, 1964, by the Senate Committee on Public Works. The resolution directed an investigation of water resource problems in the Truckee Meadows, Reno-Sparks Metropolitan area, and a project authorization under the Flood Control Act of 1954, which authorized interim channel improvements on the Truckee River and tributaries, California and Nevada, for flood control.

The Truckee Meadows Investigation resulted in an authorized project under the Water Resources Development Act of 1988, which reads:

"The project for flood control, Truckee Meadows, Nevada: Report of the Chief of Engineers, dated July 25, 1986, at a total cost of $78,400,000, with an estimated first Federal cost of $39,200,000 and an estimated non-Federal cost of $39,200,000; except that the Secretary is authorized to carry out fish and wildlife enhancement measures described in the District Engineers' Report, dated July 1985, at an additional cost of $4,140,000."

During subsequent preconstruction, 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, and the resultant change in the benefit/cost ratio. For this reason, the project was deferred. Due to significant residual flood threat and interest by local government, the Corps completed a Reconnaissance Reevaluation Report in August 1997. The conclusions of the reconnaissance study and report was that (1) there continues to be a substantial demonstrated flood problem in the study area; (2) besides flood control, there is a need for environmental restoration and recreation features along the river consistent with a plan to reduce the risk of flooding; and (3) plans to help reduce flood problems and enhance recreation and environmental opportunities in the area appear economically feasible and locally desirable. In meetings and correspondence in 1997, the cities of Reno and Sparks and Washoe County supported continued efforts to identify a project to help reduce the risk of flooding in the area. The Corps reactivated the PED phase

of the project in March 1998 with the first step to conduct a General Reevaluation Report (GRR). Baseline conditions were completed in July 1999.

1.2.3. Truckee River Flood Management Community Coalition

In 1999, the Washoe County Board of Commissioners, with the support of the cities of Reno and Sparks, the Nevada State Legislature, and many local community organizations, enacted an 1/8 cent sales tax to be used for public safety and flood management for the Truckee Meadows region. The Community Coalition for Truckee River Flood Management was formed by the project sponsors, with the cooperation of the U.S. Army Corps of Engineers, in order to ensure direct community input into the design of a Flood Management Plan for Reno, Sparks, and the Truckee Meadows area. This Coalition is a diverse group, including over 25 local stakeholder organizations, 15 resource and regulatory agencies, and members of the public. The formal Community Coalition process was initiated in April 2000.

1.2.4. Pertinent Studies and Reports

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.

1.2.4.1. 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.

Habitat Restoration Options for Truckee Meadows. Draft Report. September 1999.

Truckee River Fishery Restoration Plan: Fish Screens, Fish Ladders, and Riparian Shading. Draft Report. April 1999.

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. Evaluation of Floodwalls and Bridge Foundations, Downtown Reno, Nevada. January 1990.

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

Water Control Manual. Truckee River Basin Reservoirs, Truckee River, California and Nevada. July 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.

1.2.4.2. 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.

1.2.4.3. Other Agencies

City of Reno, Nevada. Cost/Benefit Analysis of Virginia Street Bridge Replacement. Downtown Reno, Truckee River. April 1998.

City of Reno Redevelopment Agency. Downtown Riverfront District Plan. August 1997.

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 2

PROBLEMS AND OPPORTUNITIES

This chapter describes the problems and opportunities associated with flooding and flood-related damages for the Reno-Sparks-Truckee Meadows area. Other issues in the study area include ecosystem restoration and recreation.

2.1. FLOODING

Existing flood control facilities through the Truckee Meadows area are unable to provide protection from 100-year flood events. The following sections highlight the critical factors relating to flood damage reduction through the study area.

2.1.1. Historical Flooding

The Reno-Sparks-Truckee Meadows area has a long history of floods. Early accounts indicate that flooding or periods of high water occurred during December 1861, January and February 1862, December 1867, January 1886, and May 1890. Melting snow, cloudbursts, and heavy general rains cause floods in the Reno-Sparks-Truckee Meadows area. Rain floods, which normally occur during the period of October through March (characterized by high peak flows and short duration), have caused the major flood problems in the area. Since 1900, significant damage from floods has occurred in 1907, 1909, 1928, 1937, 1950, 1955, 1963, 1986, and 1997. Since about 1960, flood control works, consisting of reservoirs and channel modifications, have reduced the magnitude and frequency of flooding in the area. The 1950, 1955, 1986, and 1997 floods were similar in magnitude and were the most damaging because they occurred after residential and business areas of Reno began to spread to the south, southwest, and southeast.

The November 1950 flood resulted from a rapid succession of warm rainstorms that melted most of the early snow cover. A maximum peak flow of 19,900 cfs was recorded at Reno. The peak flow at Vista was estimated to be about 10,000 cfs. Most of the area flooded was agricultural lands, but many commercial and industrial establishments and residences were inundated. In the Truckee Meadows area, floodwaters inundated about 3,800 acres of agricultural lands, and destroyed or damaged crops, farm and ranch buildings, irrigation facilities, and utilities.

The December 1955 flood was due to a combination of 15 inches of melted snow on top of 13 inches of rain within a three-day period. The peak flows recorded at Reno and Vista were 20,800 cfs and 15,000 cfs, respectively. The flood inundated about 9,900 acres and caused severe flood damages in the cities of Reno and Sparks. Damages were reduced by half in comparison to the damages incurred during the 1950 flood event due to advanced preparations, flood fighting, and better channel conditions. The Reno-Tahoe Airport was inundated and air traffic was curtailed for several days.

The storms of February 1986 severely affected northwestern Nevada. The peak flows at Reno and Vista were 14,400 cfs and 15,200 cfs, respectively. Flood fighting with the use of 500,000 sandbags helped to greatly reduce the flood damages in downtown Reno.

In late December 1996, snowstorms built up a large (more than 180 percent of normal) snowpack in the higher elevations of the Sierra Nevada Mountain Range, as well as in the valleys along the eastern Sierra Nevada front. A subtropical storm system originating in the central Pacific Ocean near the Hawaiian Islands subsequently brought heavy, unseasonably warm rain to the Sierra Nevada Mountains on December 30, 1996, which lasted through January 3, 1997. The intense rainfall and snowmelt caused devastating floods throughout northern California and western Nevada. The peak flow at Reno was recorded at 18,200 cfs by the USGS. About $450 million in projected damages and two deaths were attributed to floodwaters along the Truckee River during this time. Flooding was extensive in downtown Reno, at the Reno/Tahoe International Airport, and in the industrial area of Sparks, Nevada.

2.1.2. Flood Damages

Major flooding in an urban environment has many adverse consequences, including monetary damages and loss of real property. Monetary loss is the primary way of depicting flood damages and assessing the effectiveness of flood protection alternatives. However, floods have many other disturbing, non-monetary effects. Among these are effects on public health and safety, damages from toxic and hazardous waste contamination, and loss of environmental resources in the flood plain. The following are brief descriptions of potential monetary and non-monetary consequences of flooding in Truckee Meadows area.

2.1.2.1. Public Health and Safety

Nearly 218,000 people currently reside within the flood plain of the cities of Reno and Sparks. The effect of levee failure and resultant flooding on human life would depend on the flood magnitude, population at risk, flood warning time, and evacuation routes. It would not be unreasonable to expect as many as 25 human fatalities during a very large flood. In addition to loss of life, major flooding could result in life-threatening injury and spread of some communicable diseases. Merely evacuating the flood plain in anticipation of a flood could result in traffic accidents and other injuries associated with the rapid displacement of nearly 218,000 people.

2.1.2.2. Contamination from Toxic, Hazardous, and Related Waste

Flooding would result in significant releases of toxic and hazardous substances from above-ground tanks and drums containing heating oil, fuel oil, liquid propane, and kerosene; agricultural chemicals such as herbicides, pesticides, solvents, and fertilizers; many commercial and industrial chemicals; and untreated wastewater. Widespread flooding could also result in groundwater contamination.

2.1.2.3. Flood Cleanup and Resources Consumption

Major flooding would likely generate larger quantities of flood-related debris, most of which would have to be hauled to local landfills. Also, rebuilding or relocating homes, businesses, and related infrastructure would require additional natural resources.

2.1.2.4. Property and Businesses

Damageable property in the Truckee Meadows flood plain consists of commercial, industrial, residential, and public buildings valued at about $5 billion. Additional effects on the day-to-day business of the Reno-Sparks Metropolitan area would be significant. Many businesses would be forced to close, at least temporarily, during flooding and cleanup afterward, resulting in lost revenues and wages.

Physical damages caused by inundation losses or flood fighting preparation costs are the main types of flood damages within the flood plain. Physical damages include damages to, or loss of, buildings and their contents, raw materials, goods in process, and finished products awaiting distribution. Other physical damages include damages to lot improvements such as damages to roads, utilities and bridges, and cleanup costs. Additional costs are incurred during flood emergencies for evacuation and reoccupation, flood fighting, and disaster relief. Loss of life or impairment of health and living conditions are intangible damages that cannot be evaluated in monetary terms and have not been included in this analysis.

Average annual equivalent damages are the expected value of damages for a given economic condition and point in time. They are determined by weighing the estimated damages from varying degrees of flooding by their probability of occurrence. Average annual equivalent flood damages are estimated at $31 million.

2.2. WATER SUPPLY

Sierra Pacific Power Company provides water service to a majority of the present population of the Truckee Meadows area under a water service franchise. Future water needs associated with increased urban development are projected to exceed water rights currently owned by Sierra Pacific Power Company.

Groundwater can be pumped during a drought year at a safe yield of 12,000 acre-feet a year, according to Sierra Pacific Power Company. However, in recent years, groundwater has been pumped at a rate higher than that recommended by Sierra Pacific Power Company for drought years.

2.3. ENVIRONMENTAL RESOURCES

The rapidly expanding industrial and residential development and farming in Truckee Meadows have resulted in a loss of valuable fish and wildlife habitat along the Truckee River. Below Vista, the Truckee River still supports a somewhat marginal population of coldwater fish. The threatened Lahontan cutthroat trout and endangered cui-ui require special management considerations for population recovery. Basic habitat quality problems are water temperature and nutrient load. Over the years, the marshlands, the seasonally

flooded areas, and the riparian vegetation along the Truckee River and Steamboat Creek have been greatly reduced. Over half of the bird species present in the study area are dependent upon riparian and marsh vegetation as a major habitat component.

As part of the environmental studies, a bird survey along the Truckee River and a Habitat Evaluation Procedure (HEP) analysis on baseline conditions have been completed. The HEP prepared by the U.S. Fish and Wildlife Service in 1993 will also be utilized. Restoration features will be evaluated to assist in the recovery of the endangered cui-ui, threatened Lahontan cutthroat trout, migratory waterfowl, as well as re-institution of more suitable instream flow to the Truckee River to benefit the endangered cui-ui and assist in the recruitment of cottonwood seedlings. The wildlife restoration plan is likely to be centered around setback levees downstream of highway 395 and along Steamboat Creek.

2.4. RECREATION

The Truckee River is the most important water-oriented recreation resource in the region. Demand for recreational facilities increases with population growth. The current number of recreational facilities in the study area is inadequate for existing and future demand. Additional public recreational access to the Truckee River is needed for fishing, swimming, rafting/tubing, picnicking, bicycling, walking, and jogging. There is also a demand for parks and paths in the Truckee Meadows area. Portions of the river have already been developed for recreational access. River resources in the city of Sparks are well developed, and Reno also has some developed features with additional planned recreational areas along the Truckee River (within the Central Reno reach). The opportunity exists to connect these developed features. Planned recreational developments by the cities of Reno and Sparks will assist in meeting the needs and demands for a river-oriented recreational corridor. Additional recreational developments would be required to fully satisfy this need for the area.

CHAPTER 3

EXISTING AND WITHOUT-PROJECT FUTURE CONDITIONS

This chapter describes the baseline conditions and future conditions without project in the study area, including topography, geology, seismicity, soils, climate, hydrology, groundwater, water supply, water quality, and hazardous, toxic and radiological waste. The biological characteristics, such as vegetation, fish, wildlife, and threatened and endangered species, are also discussed. This document also details air quality, population, and land use for Truckee Meadows.

3.1. EXISTING CONDITIONS (BASELINE)

The baseline conditions described in this report focus on issues that affect water surface elevation and related flood damages in the three reaches of the Truckee River.

3.1.1. Description of Area

The Truckee River basin in eastern California and western Nevada as shown on Figure 1-1 encompasses about 3,060 square miles. The drainage area upstream from Reno includes 1,067 square miles of mountainous terrain on the eastern slope of the Sierra Nevada Mountain Range, the crest of which forms the western boundary of the basin.

The Truckee River begins at the northwestern shore of Lake Tahoe, where flows are regulated by an outlet structure. The river flows from the lake north about 15 miles to the town of Truckee, California, then turns northeast for about 40 miles to Reno, Nevada. Near Sparks, Nevada, the Truckee River enters a vast pasture or overflow area known as Truckee Meadows. Below the cities of Sparks and Reno, the river flows about 50 miles east and north to Pyramid Lake, a remnant of prehistoric Lake Lahontan.

Truckee Meadows, the low pasture area encompassing an area of about 10,000 acres immediately south of the Reno-Sparks Metropolitan area, is at the bottom of a bowl-shaped area about 10 miles wide and 16 miles long between the Sierra Nevada Mountains on the west and the Virginia and Pah Rah Ranges on the east. The walls of the "bowl" rise sharply on all sides.

The cities of Reno and Sparks in Washoe County, Nevada are located in the Truckee Meadows area at an elevation of about 4,500 feet above sea level. Sparks is north of the Truckee River and immediately east of Reno in the Truckee Meadows. The topography is relatively flat, and much of the meadows area has become a flood plain for tributary streams. The flood plain is wide and expansive because a natural reef in the channel near Vista retards (acts as a bottleneck to all) outflows from the Truckee River. Through the meadows area, the river slope is very slight, with little change in elevation for several miles. Downstream from the meadows, the Truckee River flows through a narrow canyon, which in times of high flow acts as a dam with limited outflow potential. The river through this narrow canyon, often referred to as the Vista Reefs, has been widened and deepened in the past to carry flood

flows. During high flow, the backwater effect at the confluence of Steamboat Creek and the Truckee River is considerable.

3.1.2. Topography

The upper portion of the Truckee River basin is located on the east flank of the Sierra Nevada Mountain Range. This terrain is characterized by rugged rocky peaks, precipitous cliffs, steep canyons, and occasional small meadows and lakes. The lower portion of the basin consists of scattered valleys and dry lake beds separated by mountain ranges. Elevations within the basin range from 3,900 feet at Pyramid Lake to over 10,000 feet in the eastern Sierra Nevada Mountain Range, where most of the basin runoff originates.

The main tributaries of the upper Truckee watershed, below Lake Tahoe and above Reno, are the Little Truckee River, Squaw Creek, Prosser Creek, Donner Creek, and Martis Creek. Numerous lakes and reservoirs are located within the upper Truckee River watershed. Flood flows in the project area are significantly influenced by Lake Tahoe, Stampede, Boca, Prosser Creek, and Martis Creek Reservoirs.

3.1.3. Geology

Reno is located on the western edge of the Great Basin in a transitional region between the Basin and Range province and the Sierra Nevada province. Truckee Meadows is a structural basin bounded on the west by the Carson Range, on the east by the Virginian Range, on the south by the Steamboat Hills, and on the north by the Peavine Mountain block.

The Mesozoic age metavolcanic and metasedimentary rocks of the Peavine sequence are overlain by a thick sequence of Tertiary volcanic and epiclastic rocks consisting of lava flows, breccias, and tuffs. Fluviatile and lacustrine sediments were the initial deposits and consist of conglomerate, siltstone, sandstone, and diatomite. These are exposed along the margins of Truckee Meadows. The three major categories of Quaternary deposits in the Truckee Meadows region, representing a long established pattern of basin sedimentation, consist of glacial outwash deposits and Truckee River gravels, alluvial fan deposits around the perimeter of the basin, and fin-grained flood plain and lake deposits through the central and eastern part of Truckee Meadows.

The geologic structure of the area was produced by faulting and warping. Quaternary faults that trend due north are common and widespread northward through Reno and in the Mount Rose fan complex northwest of Steamboat Hills. Nearly all the faults are normal faults. Displacement along these faults varies from a few feet to about 50 feet. Higher scarps are present along the western edge of Virginia Lake southward to the northwest side of Steamboat Hills. Another prominent set of faults trending north to northeast is concentrated in a 2-mile-wide zone immediately northwest of the Truckee River in western Reno.

The Truckee River follows a winding eastward course through the Truckee River valley west of Reno and into the Truckee Meadows area. The entire area is underlain by late Pleistocene Donner Lake and Tahoe glacial outwash deposits. The Donner Lake outwash deposit ranges from about 30 feet thick at the west end of the basin to over 330 feet thick eastward under Reno. This glacial deposition overlays the bedrock. The Tahoe glacial outwash deposit lies above the Donner Lake outwash. Similarly, the Tahoe outwash ranges in thickness from

about 300 feet under the western part of Reno to over 1,000 feet beneath Sparks. The Truckee River has reworked the top portion of the outwash and deposited the material along the modern flood plain of the river, overlying earlier glacial outwash. Both glacial outwash deposits contain boulders as large as 16 feet in diameter. Portions of the outwash are overlain by flood plain and lacustrine deposits. The flood plain materials are primarily clayey silt, silt, and silty sand with interstitial lenses of either peat or clay-rich sediments.

3.1.4. Regional Seismicity and Faulting

The Reno area is considered to be seismically active. The estimated recurrence interval for the occurrence of a magnitude 7.0 event within a 60-mile radius of Reno is on the order of 75 years, and that of a 5.4 event within 20 miles of the city is 30 years.

Two major fault systems are responsible for most of the seismic activities in western Nevada. The Sierra Nevada Frontal System is an irregular zone of major and secondary faults extending from the Garlock Fault northward along the east side of the Sierra Nevada Mountain Range for more than 400 miles. A second major zone, possibly related to the Frontal system, is the 118 Meridian Zone that trends southwest of Winnemucca to at least Owens Valley. Reno lies between these two major zones.

A prominent set of northeast-trending faults occurs in northwest and central Reno. One northeast-trending fault crosses the Truckee River north of the Reno/Tahoe International Airport. Also, the east margin of Truckee Meadows is bounded by a fault. An obscured fault, with indications of fairly recent activity, may lie due north of the sewage facility that is located at the confluence of Steamboat Creek and the Truckee River. Areas underlain by glacial outwash and mainstem deposits of the Truckee River are believed to be potentially unstable and subject to slumps or ground disturbances along steep cuts or embankments during a major seismic event. Areas underlain by flood plain and lake deposits are subject to liquefaction, severe ground motion, and surface dislocation. This is especially dangerous in areas of groundwater discharge or where the soils are saturated.

Historically, the severe earthquakes in the area include those with magnitudes of 6.0 and 6.4 just south of Reno in 1914. The first had an intensity of VII (Modified Mercalli Scale) in the Truckee Meadows area. Two distinct shocks lasting from 6 to 30 seconds cracked buildings and toppled chimneys in the area. Two more earthquakes, both of magnitude 6.0, occurred near Virginia City in 1869 and near Verdi in 1948. In 1966, a quake of 5.7 was centered north of Truckee. In all, from 1940 to 1970, about 70 earthquakes with magnitude 4.0 or greater have occurred within a 62-mile radius of Reno.

3.1.5. Soils

The soils of the immediate Truckee Meadows region are highly varied. Soil development on bedrock is relatively minor due to the arid climate, which is not favorable for deep chemical weathering. Soils in alleviated valleys are mainly granular, containing abundant sand, silt, and gravel. Adjacent to the river, soils are dry with low organic content, generally consist of silts and clays with abundant gravel, and occur on variable slopes ranging from basin lowlands to steep mountain slopes. The soils are poorly to well drained with low to moderate permeability. Erosion potential is low to moderate. The expansive quality (shrink-swell capacity) is moderate to very high. Soils farther from the river in the meadows area are

generally composed of alluvium consisting of stream deposits. The soils are moist or wet with dark surface margins containing abundant organic matter. Slope is slight to moderate with good drainage. Permeability is low to rapid with low to moderately high erosion potential. The soil consists of clays, sands, and silts with occasional gravel. Clay soils have moderate to very high expansive quality (shrink-swell). Expansive soils are mostly highly plastic clays that undergo a significant volume increase with the addition of water. Clays of variable expansive qualities are present in many of the soils overlaying both alluvial deposits and bedrock.

3.1.6. Climate and Weather

The upper Truckee River basin is characterized by severe winters and short, mild summers. Precipitation is markedly less than on the adjacent western slopes of the Sierra Nevada Mountain Range. The climate within the Truckee Meadows area is generally dry and semiarid. The mean annual temperature in the city of Reno is 49^{o}F. Within the city, the temperature varies from a recorded maximum of about 104^{o}F to a recorded minimum of -16^{o}F.

Normal annual precipitation over the drainage area between Lake Tahoe and Vista varies from 8.0 to 70.0 inches, with a basin mean of 26.5 inches. Precipitation usually falls as snow from December to March above elevation 5,000 feet, but some storms produce rain up to the highest elevations of the basin. The mean annual precipitation for the city of Reno is 6.94 inches. Total snowfall for the city averages 25 inches per year, but snowpack seldom remains for more than 3 to 4 days.

3.1.7. Hydrology and Hydraulics

Most of the runoff from the Truckee River watershed is derived from the snowpack that accumulates over the high mountain areas during the winter and melts during the late spring and early summer. Hydrology of the basin was discussed in detail in the previously cited Truckee Meadows, Reconnaissance Reevaluation Report, dated October 27, 1997.

Floods in the Truckee River Basin can be divided into three distinct types: general rain floods, cloudburst floods, and snowmelt floods. General rain floods, which occur during November through April, result from general rainstorms covering a large portion of the basin and are characterized by high peak flows and durations of 3 to 6 days. Cloudburst floods, which typically occur during summer months, are characterized by high peak flows on tributary streams with short duration and low volume. Snowmelt floods result from the melting of the snowpack during the late spring and early summer (April through July) and have relatively large volumes and long durations.

During this century, significant floods resulting from combined rainfall/snowmelt events occurred on the Truckee River in 1907, 1928, 1937, 1950, 1955, 1963, 1964, 1986, and 1997. Truckee River flows at the Reno gage during the most recent floods are summarized in Table 3-1.

TABLE 3-1

SUMMARY OF MOST RECENT FLOODS

Date of Flood	Peak Discharge (cfs)
November 1950	19,900
December 1955	20,800
February 1963	18,400
December 1964	11,300
February 1986	14,400
January 1997	21,500

3.1.7.1. Discharge Frequency

Recent studies have updated rain flood flow-frequency curves through water years 1998 at index points at Farad, Reno, and Vista. Frequency curves developed for the Truckee River represent unregulated and regulated conditions of water resource development. Unregulated conditions represent a runoff regime without Boca, Stampede, Prosser, and Martis Creek Reservoirs, but include the effects of Lake Tahoe, Independence Lake, and Donner Lake. Regulated conditions represent the effects of Boca, Stampede, Prosser, and Martis Creek Reservoirs. The frequency curves, which reflect existing conditions, were developed from records of historical events and hypothetical flood routings. For existing conditions, the historical record and hypothetical routings reflect reservoir flood operation in accordance with the current water control plan.

In the February 1985 USACE Feasibility Report and Environmental Impact Statement entitled "Truckee Meadows (Reno-Sparks Metropolitan Area) Nevada," the estimated discharge for a 1 in 100 year event at Reno was 18,500 cfs. This flow has been used by the Federal Emergency Management Agency (FEMA) to identify areas subject to flooding for flood insurance purposes. However, incorporating hydrologic data since the mid-1980's has resulted in higher estimated peak flows for specific frequency events. Peak flows for selected frequency events are shown in Table 3-2. The present day estimated 1 in 100 chance peak flow at the city of Reno gage in any given year is about 20,700 cfs, in which the discharge-frequency was developed using adjusted criteria in Bulletin 17B.

TABLE 3-2

ESTIMATED PEAK FLOW TRUCKEE RIVER AT RENO, NEVADA

Exceedance (chance of occurrence in any 1 year)	Peak Flow (cfs)
1/20	9,200
1/50	14,800
1/100	20,700
1/500	63,000

3.1.7.2. Flood Plains

The Reno-Sparks-Truckee Meadows area experienced high flows and storage of large volumes of water near or within town limits over a dozen times since the early 1900's, and most recently in January 1997.

The downtown section of Reno is partially in a steep-banked reach of the river. The reach through downtown Reno, also recognized as the central business district, consists of dense urban development with residential, commercial, and public uses, including casinos and hotels. The city of Reno is currently in the process of redeveloping several blocks of riverfront property in the downtown Reno reach. The flood plain will experience a sheetflow of water back into the river from basically two areas where water overflows the banks. During times of high flow, structures within the first several blocks of the river tend to become inundated to up to 6 feet or so when the river flows through this part of the city. This flow pattern has been documented more than once in recent times.

The downstream section of the area of interest begins just east of Highway 395. The river emerges from the more channelized upstream reach onto a broad plain historically known as the Truckee Meadows. It is this area that receives the greatest inundation of floodflows. This area effectively acts to attenuate large flood volumes for Truckee River flows. Flooding in this area is characterized as volume generated, with ponding due to hydraulic backwater effects backing up Steamboat Creek at its confluence with the Truckee River. This area has several distinct land uses. Included in this reach is the Reno/Tahoe International Airport to the south. Flooding around the airport consisted of sheetflow up to McCarran Boulevard. Also included in this area is the Truckee Meadows and the city of Sparks' industrial area. This is one of the most rapidly growing industrial areas that includes commercial and public uses as well. Flooding consists of both ponding and sheetflow. Farther southeast, the land use is predominantly rural cropland and comprises the land owned and operated by the University of Nevada Agricultural Experiment Station. Much of this land is used as pasture. Further south of the University Farms land, the area has grown rapidly over the past few years, and there is additional pressure to further develop the remaining lands, with the exception of the wetlands. Residential subdivisions in this area include Hidden Valley, Rosewood Lakes, Donner Springs, and Double Diamond, to name a few. Flood problems in this area are aggravated by flood flows from Steamboat Creek, Boynton Slough, and Dry Creek.

3.1.7.3. Flood Frequency

The estimated probability of flooding in the study area varies. For the reaches east of Highway 395, there is about a 1 in 15 (or about 7 percent) chance of flooding. For the downtown Reno reach, the probability of flooding in any given year under existing conditions is 1 in 45; the reduction in floodwall stability increases the probability of flooding in any year to a 1 in 26 (or about a 4 percent) chance of flooding. Flood plains for the 1 in 100 and 1 in 500 chance of occurrence are shown in Plate 3-1 and 3-2, respectively.

3.1.7.4. Average Annual Flood Damages

Average annual equivalent damages are the expected value of damages for a given economic condition and/or point in time. They are determined by weighing the estimated damages from varying degrees of flooding by their probability of occurrence. The average annual equivalent flood damages are currently estimated at $31 million.

3.1.8. Water Supply

The Truckee Meadows area depends primarily on the Truckee River for its water needs. Groundwater provides about 15 percent of the water needs. Water rights in Nevada are based on the doctrine of prior appropriations; that is, the one who is first to divert water from a stream preempts a right to the quantity withdrawn, provided that it is put to a beneficial use. The Sierra Pacific Power Company owns a portion of the water rights along the Truckee River and provides service to much of the Reno-Sparks Metropolitan area.

3.1.9. Groundwater

The groundwater resources of the basin are closely related to the surface water resources in that recharge of the groundwater supply comes mostly from surface water. Some groundwater recharge occurs directly from infiltrated precipitation. Except for Pyramid Lake Valley, the Truckee Meadows area is the major groundwater basin in the Truckee River drainage. An estimated 450,000 acre-feet of groundwater is present within 100 feet of the surface in the Truckee Meadows area.

The depth of the water table adjacent to the Truckee River through the city of Reno and Sparks is about 20 feet based on drilling/boring data found in foundation reports for construction throughout Reno. Groundwater depths vary considerably from about 4½ to 20 feet in the western portion of the study area to about 6 to 12 feet in Truckee Meadows.

3.1.10. Water Quality

Water quality in the Truckee River generally diminishes downstream from the city of Reno due primarily to residential, municipal, agricultural, and industrial uses. Concentrations of biochemical oxygen demand (BOD) are relatively constant along the Truckee River, and average values are below the State standards (3.0 mg/l). The total nitrogen concentration above the confluence with Steamboat Creek averages about 0.04 mg/l in comparison to the State Standard of 0.3 mg/l. The Truckee Meadows Water Reclamation Facility (TMWRF), located east of Sparks and downstream of Steamboat Slough, has not been able to consistently meet the waste load allocation for total nitrogen due to operational problems.

Over the past decade, total dissolved solids (TDS) concentrations in the Truckee River have commonly exceeded the State standard (90 mg/l) in the reaches just downstream from the city of Reno and Sparks. The river was in compliance with TDS standards in 1996 and 1997, largely due to the increase in flows and resulting dilution of nonpoint sources during these high-flow years. Concentrations of heavy metals in the Truckee River are relatively low. The pH of the Truckee River normally meets the State standards (7.0 to 8.5), ranging from 7.5 to 8.0 in most studies.

3.1.11. Hazardous, Toxic and Radiological Waste

Various hazardous materials have been detected in the study area. The most common contamination is perchloroethylene. Other contaminants included benzene, ethylbenzene, toluene, xylenes, and chloroform. Contamination levels ranged from nondetectable to a high of 480 parts per billion (ppb) in the tested sites. Areas of potential contamination in the downtown Reno area are mainly located north of the Truckee River between Keystone Street and Wells Avenue. An area south of the river, near the county courthouse, may also be contaminated.

Hazardous material may also be encountered in the region around the Reno/Tahoe International Airport. Tanks associated with the airport expansion may have caused soil contamination in the vicinity.

Areas of potential contamination have been identified in the Sparks area as well. There is soil and groundwater contamination at the tank farm located at the intersection of Pyramid and Interstate 80. Currently, a plume of petroleum is floating on the groundwater surface. The hazardous material is being cleaned up as mandated by a court order.

Most of the remaining study area is historically agricultural. Hazardous material is not expected to be present in these regions. Specifically, no hazardous material has been detected in the Huffaker Hills and Steamboat Creek areas. For the Truckee River area west of the city of Reno, there is no information currently available on hazardous material. Areas of contamination in this region are unknown.

3.1.12. Air Quality

The Truckee Meadows Air Basin, encompassing most of the Reno-Sparks Metropolitan area (except for Stead, Spanish Springs Valley, and Sun Valley to the north, Pleasant and Washoe Valleys to the south; and Verdi to the west), occasionally violates Federal air quality standards for carbon monoxide and particulates. Reno's air quality problem is exacerbated by topography, climate, and an inefficient transportation system. The air basin is small, and temperature inversions frequently trap pollutants.

The Reno area suffers from poor air quality, depending on the season of the year and on the occurrence of a temperature inversion layer above the basin. The mountains that enclose the basin commonly trap the cold air at the valley floor and prevent its dispersal. Automobile emissions are a major factor in the pollutant load of the basin. "Mobile sources" (an air quality term referring primarily to vehicular emissions) produce 95 percent of the total annual carbon monoxide emission in the Truckee Meadows Air Basin. Wood stoves and fireplaces contribute about 40 percent of the carbon monoxide produced by stationary sources during the winter heating season.

Ozone, a pollutant gas formed by complex chemical reactions of other gases, is also of concern in the Reno area. Ozone concentrations peak in summer; both intense sunlight and increased traffic emissions of nitrogen dioxide and unburned hydrocarbons contribute to ozone levels.

3.1.13. Vegetation, Fish, Wildlife, and Threatened and Endangered Species

3.1.13.1. Vegetation

Vegetation within the Truckee River watershed varies due to the wide range in elevation and climate. Native vegetation cover types are eastside yellow pine forest, sagebrush scrub, wet meadow, riparian scrub and cottonwood forest, marsh, and shadscale scrub.

The Truckee River region contains one of the principal areas of riparian growth in Nevada. A discontinuous ribbon of cottonwoods grows along the river. Removing trees to expand agricultural fields and pastures has reduced the width of the riparian habitat along the river. Much of the streamside vegetation was eliminated during the 1960's when the Truckee River was channelized from the city of Reno to Nixon.

In the Reno-Sparks Metropolitan area, ornamental species such as Lombardy poplar and elm have replaced indigenous vegetation. Stands of black cottonwood, Fremont's cottonwood, white alder, and willow are scattered in strips along the river. Herbaceous understory species include mugwort, horsetail, baltic rush, umbrella sedge, poison hemlock, weedy mustards, and lambsquarter.

In the Truckee Meadows area, the basic types of plant communities are the natural wetlands, irrigated and dry meadows, and degraded sagebrush areas. The wetlands are comprised of bulrush, cattail, spikerush, willows, and pond weed. The irrigated areas include sedges, Baltic rush, and various grasses. All or most of these plants can be termed phreatophytes-plants whose roots extend into the groundwater and consume (transpire) large amounts of water. The major species include black greasewood, green rabbitbush, western cottonwood, willow, and saltgrass. The dry meadows generally have saline and/or alkali soils, which support phreatophytic species such as fourwing saltbrush, saltgrass, rabbitbrush, and greasewood. In the Truckee Meadows area, the sagebrush communities have been replaced with annual weeds as a result of annual clearing to reduce fire hazards. The dominant species in the burned areas include Russian thistle, tumbleweed, and cheatgrass. The dominant plant species along the banks of Steamboat Slough are wide-leaved perppergrass and white top, both recognized as noxious weeds.

3.1.13.2. Fish

The Truckee River supports approximately 28 species of fish. Twelve species are considered game fish within the study area. Two species have special status designations – the Lahontan cutthroat trout, which is classified as threatened on the Federal Endangered list, and the cui-ui, which is classified as endangered on both the Federal and Nevada lists.

The Truckee River in Nevada from the California State line through the city of Reno is considered good trout water. The principal species of fish in this reach are rainbow trout, brown trout, brook trout, cutthroat trout, mountain whitefish, and mountain sucker.

Both the Nevada Division of Wildlife and the California Department of Fish and Game plan the Truckee River and its tributaries. The average annual planting for the California portion is 88,700 pounds and for the Nevada portion is 25,000 pounds. At one time, a fish hatchery operated by the Nevada Department of Fish and Game at Verdi supplied Kokanee, Lahontan

cutthroat, rainbow, brown, and brook trout to the streams and lakes of western Nevada. However, the hatchery is no longer in operation.

A major problem for the fishery downstream from the city of Reno is the warm water temperatures. The temperature increase, as much as 10° F between the city of Reno and Pyramid Lake, has been aggravated by loss of riparian vegetation, which allows heating of the water by direct sunlight. The United States Bureau of Reclamation (Reclamation) releases 600 to 800 cfs from Stampede Reservoir in an attempt to maintain lower temperatures in the summer. When water is available, this release significantly reduces the water temperature. Derby Dam, approximately 15 miles downstream from the city of Reno, began diverting water for irrigation in 1906. The dam blocks upstream migration of trout and the cui-ui. In addition, this diversion and others upstream have reduced the discharge downstream from Derby Dam, which ultimately flows into Pyramid Lake to approximately half the 470,000 to 570,000 acre-feet per year that would have occurred under natural conditions. Pyramid Lake needs an annual inflow of at least 440,000 acre-feet to maintain a stable water surface level; consequently, lake levels have been receding. However, runoff from the 1982-83 water year has substantially raised lake levels. A silt delta, which formed at the mouth of the Truckee River, blocked historical upstream migration of the cutthroat and cui-ui in the natural river channel. The U.S. Fish and Wildlife Service has constructed the Pyramid Lake Fishway as a migration route to spawning areas upstream from the silt delta.

3.1.13.3. Wildlife

A variety of wildlife species inhabit the riparian and other wetland habitats in the study area. The Truckee River and tributaries provide habitat for beaver, muskrat, and river otter. Steamboat Creek is one of only two locations where mink are found in Washoe County. Deer have used the Truckee Meadows area near the lower end of Steamboat Creek. The meadows, marshes, and riparian areas provide habitat for small mammals such as the dusky shrew, western jumping mouse, and longtail vole. The small mammals provide most of the food for predators such as weasels and hawks. There are 16 species of bats within the study area.

Waterfowl, including the Canadian goose, mallard, pintail, teal, canvas back, and redhead, use the Truckee River corridor and lower Truckee River in sufficient numbers to support sporadic hunting. In addition, the wetland areas provide wintering, migrating, and resident habitat for approximately 18 species of shorebirds, including killdeer, spotted sandpiper, willet, Wilson's Phalarope, long-billed curlew, greater yellowlegs, least sandpiper, and snowy plover.

The proximity of marsh, seasonally flooded meadow, and agricultural land produces significant rodent populations, which make the Truckee Meadows area attractive to raptors such as the barn owl, short-eared owl, marsh hawk, rough-legged hawk, ferruginous hawk, and American kestrel. The wetland areas are also excellent habitat for the black-crowned night heron, great blue heron, long-billed marsh wren, red-winged blackbirds, and sora and Virginia rails.

Riparian areas provide habitat for the following species: barn swallow, rough-winged swallow, northern flicker, black-billed magpie, Stellar's jay, northern oriole, Bewick's wren, song sparrow, red-winged blackbird, Canadian goose, mallard, and beaver.

3.1.13.4. Threatened and Endangered Species

The U.S. Fish and Wildlife Service, in cooperation with Reclamation and the Bureau of Indian Affairs, has studied alternatives to re-establish spawning runs of the threatened Lahontan cutthroat trout and the endangered cui-ui in Pyramid Lake. The study included determination of the migration behavior and the extent and quality of available spawning and nursery areas. Lahontan cutthroat trout had naturally spawned in the Truckee River well up into California and in streams feeding Lake Tahoe, while the cui-ui spawned as far up as the McCarran Ranch at Patrick. The principal reason for the decline of both species is that spawning habitat has been lost as a result of dams and diversions. Historically, these two fish were of great importance to the Paiute Indians as a source of food. In 1973, an active cui-ui propagation program was begun by the Pyramid Lake Paiute Tribe and the U.S. Fish and Wildlife Service. From 1973 to 1997, approximately 7.6 million fry were released into the lower Truckee River and Pyramid Lake. Marble Bluff Dam and the associated Pyramid Lake Fishway were completed in 1975 and represented a major step toward restoration of the cui-ui. In January 1978, the U.S. Fish and Wildlife Service published the approved Cui-ui Recovery Plan; the primary objective of the plan was to restore the species to a non-endangered status.

Other Threatened and Endangered species located in the study area include the bald eagle, American peregrine falcon, and the Steamboat buckwheat. The bald eagle, a Federally listed threatened species, historically inhabited all of the North American continent and used breeding grounds on most of the continent. Breeding grounds have decreased and now only include Alaska, Canada, the Pacific Northwest states, and the Great Lake states, Florida, and Chesapeake Bay. The American peregrine falcon, a Federally listed endangered species, is one of the most widely distributed of all bird species. Peregrines have been recorded in nearly every major land mass with the exception of Antarctica, and have bred over most of this range. The American peregrine falcon has historically nested throughout North America from the boreal forest south into Mexico wherever suitable nesting and foraging habitat occurred.

The Steamboat buckwheat is federally listed as endangered. The plant is known from a single location, the Steamboat Spring thermal area, Washoe County, Nevada. This area is approximately 10 miles south of downtown Reno. The geographical extent of the taxon occurs as a single population consisting of 7 colonies scattered over approximately 200 acres. The population is bisected by U.S. Highway 395 at the town of Steamboat. The majority of plants occur within one area of 100 acres on the west side of the highway. Steamboat buckwheat is abundant where it occurs with individual plants numbering between 10,000 and 15,000. Steamboat buckwheat has a rather limited set of environmental conditions under which it grows. The most important is endemic to sinter soils. Too much moisture is reported to be detrimental.

Species of concern that may be located within the study area are shown in Table 3-3.

TABLE 3-3

SPECIES OF CONCERN THAT MAY OCCUR WITHIN THE VICINITY OF TRUCKEE MEADOWS, NEVADA

Common Name	Scientific Name	Federal	State
Plants			
Sierra Valley ivesia	*Ivesia aperta var. aperta*	X	
Webber's ivesia	*Ivesia webberi*	X	
Nevada oryctes	*Oryctes nevadensis*	X	
Tahoe yellowcress	*Rorippa subumbellata*	X	X
Mammals			
Pygmy rabbit	*Brachylagus idahoensis*	X	
California wolverine	*Gulo gulo luteus*	X	
Sierra Nevada snowshoe hare	*Lepus americanus tahoensis*	X	
Sierra Nevada red fox	*Vulpes vulpes necator*	X	
Spotted bat	*Euderma maculatum*	X	
Small-footed myotis	*Myotis ciliolabrum*	X	
Long eared myotis	*Myotis evotis*	X	
Fringed myotis	*Myotis thysanodes*	X	
Long-legged myotis	*Myotis volans*	X	
Yuma myotis	*Myotis yumanensis*		X
Pale Townsend's big-eared bat	*Plecotus townsendii pallescens*	X	
Pacific Townsend's big-eared bat	*Plecotus townsendii townsendii*	X	
Reptiles			
Northwestern pond turtle	*Clemmys marmorata marmorata*	X	
Amphibian			
Mountain yellow-legged frog	*Rana Muscosa*	X	
Birds			
Northern goshawk	*Accipiter gentilis*	X	
Western burrowing owl	*Athene cunicularia hypugea*	X	
Black tern	*Chlidonias niger*	X	
Least bittern	*Ixobrychus exilis hesperis*	X	
White faced ibis	*Plegadis chihi*	X	
California spotted owl	*Strix occidentalis occidentalis*	X	
Tri-colored blackbird	*Agelaius Tricolor*	X	

3.1.14. Population

The population growth in Washoe County, Nevada since the last census was compiled in 1990 shows population estimates of 157,000, 61,000, and 306,000 for Reno, Sparks, and Washoe County, respectively. The population in the urbanized areas of the cities of Reno

and Sparks is estimated at 218,000. The growth in tourist and industrial business has caused an attraction to Reno and Sparks, resulting in a concentration of 71 percent of Washoe County's population in this area.

3.1.15. Land Use

Much of the Reno-Sparks Metropolitan and Truckee Meadows study area is urbanized or planned for future urban uses. Land use within the area varies and includes residential (single-family, multiple-family, mobile home), commercial, industrial, public, and agricultural. Single-family residential units are the most numerous housing structures in the entire study area. There are also many multiple residential units (apartment buildings and condominium complexes) and mobile homes in the area. The planned future residential land use pattern in the study area ranges from low density, rural residential (one dwelling unit per 10 acres) to medium density residential (three dwelling units per acres).

Commercial land use includes retail trade, service-oriented establishments, and motor freight transportation facilities. A majority of the service-oriented establishments, such as the hotels and motels associated with the casinos, are located in downtown Reno. The Reno/Tahoe International Airport is located on the eastern boundary of Reno. Many local and long distance trucking firms have established offices/terminals in the Reno-Sparks area due to its excellent geographic proximity to the western states. Eastern and southern Sparks have a high degree of industrial land use. Manufacturers, wholesale trade establishments, and warehouses are located there. Overall, public lands and properties comprise almost one-third of the study area. Public land use includes communication and utility services, as well as transportation, recreation, and educational services.

Agriculture is primarily located in the southern and eastern parts of the Truckee Meadows area; however, urban development pressures are intensifying in these areas. The main crop is hay, especially alfalfa hay. Much of the land is pasture used for cattle grazing.

3.1.16. Pertinent Water Resource Projects

Following is a description of the existing water resource projects in the Truckee River Basin that can have an influence on a flood control project in the Reno-Sparks Metropolitan area.

3.1.16.1. Upstream Reservoirs

There are numerous lakes and reservoirs in the upper Truckee River watershed. Several that significantly influence floodflows along the river in the city of Reno are Lake Tahoe and Stampede, Boca, Prosser Creek, and Martis Creek Reservoirs. Martis Creek Dam and Lake are owned by the Corps of Engineers (COE). Reclamation owns Prosser Creek Dam and Reservoir and Stampede and Boca Dams and Reservoirs. The COE and Reclamation mutually agree upon the flood control operating principles for the Truckee River basin reservoirs. However, the COE is responsible for providing the flood control regulations. The physical features for each are shown in Table 3-4, and highlights of each are described below.

TABLE 3-4

PRINCIPAL LAKES AND RESERVOIRS PROVIDING FLOOD PROTECTION IN THE TRUCKEE RIVER WATERSHED

Lake/ Reservoir	Drainage Area (sq. mi.)	Surface Area [1] (sq. mi.)	Total Storage (ac-ft)	Storage capacity per foot [2] (ac-ft/ft)	Flood Control Volume [3] (acre-ft)	January 1997 Flood Control Release [4]
Lake Tahoe	506	190.7	122,160,000	122,000	744,600	2,500
Stampede	136	5.4	226,500	3,349	22,100	2,075 [5]
Boca	172	1.5	41,140	930	8,000	0
Prosser	50	1.2	29,800	533	20,000	5
Martis	39	1.2	20,400	505	15,000	374

[1] Surface area at gross pool. Lake Tahoe surface area at maximum permissible elevation.
[2] Storage capacity per foot of depth. For flood control reservoirs, average value for Flood Control/Joint Use Pool.
[3] Volume in Flood Control/Joint Use Pool. Lake Tahoe value is volume between natural rim and maximum permissible elevation. Lake Tahoe is not drawn down to natural rim to provide flood control space.
[4] Outflow at time of peak flow at Farad.
[5] Inflow to Boca Reservoir.

3.1.16.1.1. Lake Tahoe

Lake Tahoe is the first point at which flow of the Truckee River can be controlled. Lake Tahoe covers 192 square miles, averages 990 feet in depth, and is the tenth deepest lake in the world. The lake drains an area of 506 square miles and occupies an unusually large portion of its drainage area. This means that much of the precipitation falling in the drainage basin falls directly on the lake's surface, with tributary inflow contributing a small portion of inflow. Lake Tahoe is both a natural lake of great beauty and a storage reservoir for the Truckee River. The lake could provide all the carryover storage that the area would need for the long term, but most of the water has been dedicated to in-place, nonconsumptive use. Although Lake Tahoe is a natural lake, it is controlled by a small dam constructed 400 feet downstream from the natural outlet rim at the northwestern edge of the lake, which has a crest elevation of 6,223 feet. Lake Tahoe has a capacity of about 122,160,000 acre-feet, but the dam, constructed in 1913 by the Truckee River General Electric Company, regulates the lake level to fluctuate a maximum of 6.1 feet, yielding a usable storage capacity of 744,600 acre-feet.

3.1.16.1.2. Stampede Project

Stampede was constructed by Reclamation, and is operated for flood control and water supply. At the gross pool (elevation 5,948.7 feet), Stampede Reservoir is about 5 miles long, has a surface area of 3,440 acres, and a total capacity of 226,500 acre-feet. Stampede Dam is constructed of rolled earth and rockfill and has a height of 232 feet above its streambed. It has a crest length of 1,511 feet, crest width of 40 feet, and a crest elevation of 5,970.0 feet. The outlet works are located in the right abutment and consist of a trash-racked vertical shaft intake structure with sill elevation at 5,765.0 feet. The tower directs flow into a 12-foot diameter circular tunnel upstream from the gate chamber. The capacity of the outlet works is 2,740 cfs when the water surface is at elevation 5,963.3 feet. The ungated spillway is located

in the right abutment of the dam. The spillway crest is at elevation 5,948.7 feet and has a length of 15 feet. The spillway discharge capacity is 3,060 cfs within the reservoir and is at elevation 5,963.0 feet.

3.1.16.1.3. Boca Project

The Washoe County Water Conservation District operates Boca Dam and Reservoir. It was constructed by Reclamation, and is operated for water supply, hydropower, and flood control. Boca Reservoir has a total capacity of 41,140 acre-feet and a surface area of 980 acres at gross pool elevation 5,605.0 feet. Boca Dam has a zoned, rolled earthfill embankment and a rockfilled face. The structure rises about 100 feet above the streambed.

3.1.16.1.4. Martis Creek Project

The Corps of Engineers constructed the Martis Creek project in 1972 primarily for flood control. Primary features include a reservoir, main dam, spillway, and outlet works. At the gross pool (elevation 5,838.0 feet), Martis Creek extends about 2 miles upstream from the dam. The reservoir capacity is 20,400 acre-feet; at this level, the reservoir covers a surface area of 768 acres. The Martis Creek Dam is a rolled earthfill dam with maximum height above the streambed of 113 feet and a crest length of 2,670 feet. The elevation of the top of the main dam is 5,858.0 ngvd; 5.1 feet of freeboard is provided above the spillway design flood pool. The dam has a crest width of 20 feet. The outlet works are located in the right abutment of the dam. A 5-foot by 5-foot shaft intake with sill elevation 5,780.0 feet leads to a 4-foot-square reinforced concrete conduit, which has a discharge capacity of 580 cfs at gross pool (elevation 5,838.0 feet). Two service and two emergency hydraulic slide gates, all 3 feet by 4 feet, are provided for the control of flows. The ungated spillway has a crest length of 25 feet and crest elevation of 5,838 feet and is located 600 feet beyond the left end of the dam embankment. Spillway flows discharge through an ogee spillway structure and re-enter Martis Creek at a point downstream from the dam. The Martis Creek discharge capacity of the spillway is 4,060 cfs.

3.1.16.2. Truckee River and Tributaries Project

Initial flood control work on the Truckee River began with the Truckee River and Tributaries project, which was authorized under the Flood Control Act of 1954. Construction of channel improvements as part of the Truckee River and Tributaries project was completed in 1960. Other project features included enlarging the Truckee River channel for approximately 3,200 feet downstream from the existing structure at Lake Tahoe; increasing the capacity of the outlet at Lake Tahoe from 1,600 cfs to 2,500 cfs at lake level 6,228.0 feet and from 2,100 cfs to 3,300 cfs at lake level 6229.1 feet; providing downstream channel improvements from Lake Tahoe to Truckee; enlarging the Truckee River channel through the Truckee Meadows area by widening and straightening to increase the channel capacity from 3,000 cfs to 6,000 cfs; and clearing and snagging from Vista to Pyramid Lake to compensate for increased flows through the Truckee Meadows area (overflow area).

3.1.16.3. Reno Flood Warning Project

The COE is currently conducting a Section 205 study for the Reno Flood Warning System, Nevada with Washoe County and the cities of Reno and Sparks. The study has resulted in a

selected plan that includes expanding the network of gages used for forecasting stages in the mainstem of the Truckee River, adding gages in the tributary catchments and providing FLOOD Watch for forecasting tributary stages, providing the STORM Watch data filing and display tool for local jurisdictions, and developing the preparedness plan for the Reno-Sparks Metropolitan area. This plan would increase the flood warning time from 8 to 14 hours on the Truckee River and from zero to two hours for the North Truckee Drain and Steamboat Creek basins. The plan would allow the River Forecast Center to improve the accuracy of its flood forecasts for the mainstem Truckee River, provide local jurisdictions with STORM Watch data for monitoring tributary stream levels, and improve flood response planning and implementation.

3.2. WITHOUT-PROJECT (NO ACTION) FUTURE CONDITIONS

The purpose of this section is to address projected future conditions without any changes to the facilities in the three reaches of the Truckee River. The future conditions are projected to a time period of 50 years from existing conditions, or the year 2050.

Under future without project conditions, no Federal action would be taken to alleviate flood problems in the study/project areas. The existing flood threat would continue at current conditions/levels. Topography, climate, geology, regional seismicity and faulting, and soils are not expected to significantly change in the future. Other conditions influenced by the rapidly expanding area population are expected to change.

3.2.1. Floodwalls, Flooding, and Flood Damages

Under future without project conditions, the existing floodwalls, levees, and bridges would serve as flood control facilities for the two reaches. The existing floodwalls in the downtown reach are at the end of their useful life, and would likely fail in the next 50 years if not replaced or rehabilitated. Flood damages could occur more frequently as a result of floodwall failure.

3.2.2. Bridges

The existing bridges in the downtown Reno reach were found to be structurally sound as reported in the USACE's 1990 Evaluation of Floodwalls and Bridge Foundations, Downtown Reno, Nevada. However, several of the structures, most notably the Virginia Street Bridge, will likely need to be replaced or rehabilitated within the next 50 years.

Structural evaluation for bridges located downstream of the downtown Reno reach, including Pembroke Drive, Longley Lane, Glendale Avenue, Greg Street, Rock Boulevard, and Mc Carran Boulevard, has not been completed as part of this study.

3.2.3. Hydrology and Water Quality

The upper Truckee basin is characterized by good water quality conditions because there are few substantial contributing water sources from human activity. However, in the lower basin, concentrations of dissolved constituents increase due to increasing runoff from developed areas and human activity. Currently, agricultural runoff provides a continuous

input of dissolved constituents. Future urban growth will likely cause a shift from a continuous input throughout the year from agricultural return flows to a predominance of seasonal loading during the winter runoff period.

Future urban growth will also likely impact the hydrology of the study or project area. As land use changes from agricultural to urban, the hydrographs from these developed areas would likely be altered.

3.2.4. Downtown Reno Re-Development Plans

The Reno Redeveopment Agency has plans that will impact future conditions in the downtown Reno reach of the Truckee River. Several structures have been identified for improvements, which may include flood proofing and other flood damage reduction measures.

CHAPTER 4

PLAN FORMULATION

This chapter summarizes the process and results of formulating measures and alternatives to reduce flood related damages for the Reno-Sparks-Truckee Meadows area, and to provide environmental restoration and recreation benefits.

4.1. PROCESS

The plan formulation process essentially consists of the following tasks:

- Define objectives that a planned project would aim to achieve. These objectives would be oriented toward remedying problems and taking advantage of opportunities in the study area.
- Define constraints and criteria for formulating and evaluating implementable plans. Effective solutions should not violate the constraints and should satisfy the criteria.
- Identify measures to address the planning objectives.
- Screen the measures against the constraints and criteria.
- From the measures which survive screening, formulate alternative plans to address the planning objectives.
- Evaluate and compare the alternatives and recommend a preferred plan.

This report will not identify a recommended plan. This step will be undertaken in future reports in conjunction with more in-depth evaluation and comparison of alternatives.

4.2. PLANNING OBJECTIVES

A planned project which definitively addresses the problems and opportunities in the study area should aim to achieving the following objectives:

I Flood Protection / Flood Damage Reduction

Improve flood protection for residential, industrial, commercial, and public property in the study area.

Reduce the potential for loss of life from flooding in the study area.

- Provide maximum level of protection consistent with federal participation and community financial capability.
- Eliminate the need for FEMA flood insurance requirements within the study area.

II Environmental Restoration

Promote a *living river* concept by preserving and enhancing fish and wildlife habitat, water quality, and natural geomorphic characteristics of the River.

Restore environmental resources consistent with the flood damage reduction objective.

- Maximize future restoration opportunities.
- Create wetlands and floodplain riparian terraces to maximize riverine fish and wildlife habitat.
- Weave terraces/overflow channels through the greenbelt corridor.
- Re-establish a more natural river floodplain.
- Improve water quality through development of wetlands.
- Arrest erosion of banks and berms at sites along the Truckee River.
- Allow migration of terrestrial and aquatic species, especially the passage of fish.
- Modify near stream land use, instream, and flood control activities to reduce disturbance of riparian corridor.
- When possible, set aside the low flood plain as open space.
- Fill gaps in riparian forest caused by flow modifications.
- Maximize the value of existing habitats of fair and good quality.

III River Parkway

Enhance the river as an accessible, multi-use recreational parkway and as an aesthetic and economic asset to the community and region.

- Expand open space, trails, and recreation amenities along the Truckee River.
- Build on downtown Reno Redevelopment plans.
- Maximize public river access from Booth Street to Vista.
- Maximize long-term public ownership of a River Greenbelt corridor.
- Develop a continuous pedestrian and bicycle trail system.
- Include a kayak course.
- Include attractive, quality design features to enhance the river and the Downtown environment.

Each of these objectives have been presented first with a heading to designate the overall theme, then with a statement of the fundamental objective, followed by bulleted sub-objectives which emphasize specific desirable aspects of the objective.

Many of these objectives were defined by the Truckee River Flood Management Community Coalition, which has involved the local public and stakeholders extensively in its efforts. The Coalition's goals and objectives are discussed more fully later in this chapter, after the section on constraints and criteria. Other objectives not put forward directly by the Coalition appeared in prior USACE project documents.

4.3. CONSTRAINTS AND CRITERIA

Planning objectives define what a project being planned should achieve. Additional planning parameters include constraints and criteria. Constraints are limitations upon measures and alternatives that should be met in order to be seriously considered for implementation. Criteria are factors used to evaluate potential solutions, either during screening of potential measures or during evaluation and comparison of alternative plans. As was the case with the planning objectives described above, several of the following planning parameters were defined by the Community Coalition, although they were not specifically labeled as "constraints" or "criteria" by the Coalition. (See the discussion of the Coalition's goals and objectives, later in this chapter.) A few of the other following constraints appeared in prior USACE project documents, although not specifically labeled as "constraints" at the time.

4.3.1. Constraints

Fundamental to the plan formulation process is an understanding of the constraints that are faced in planning a project that could achieve the stated objectives in the study area. Proposed limitations on and specifications for potential solutions include the following:

4.3.1.1. General

- The project must be planned so as to adhere to numerous laws, regulations, Executive orders, and policies. Relevant environmental laws include the National Environmental Policy Act, Endangered Species Act, Clean Air Act, and Clean Water Act. The project must also conform to federal water resources policies, principles and guidelines.

4.3.1.2. Environmental Constraints

Environmental constraints include:

- Project operation and maintenance practices, including debris management, should be environmentally sensitive.
- Maintain water table necessary to sustain vegetation.
- Preserve existing vegetation.
- Utilize bio-technical and habitat-friendly river bank treatments.
- Preserve archeological resources.
- No net loss of aquatic or riparian habitat.
- Ensure that the project design, construction, and operation does not:

  - Increase waterborne concentrations of nutrients, turbidity, toxic pollutants, or total dissolved solids
  - Increase discharge of untreated urban runoff,
  - Increase potential for hazardous material to enter the river,
  - Increase river temperatures, or
  - Decrease dissolved oxygen.
- Impacts downstream of the study area should be avoided, or, if any, mitigated. Downstream impacts to avoid include:
  - Increasing downstream flood flows and water surface elevations,
  - Inducing or exacerbating erosion,
  - Negatively impacting Lahontan cutthroat trout, cui-ui, and their habitats, and
  - Damaging other aquatic or riparian habitat.
- Set levees and floodwalls back from existing habitat and vegetation.

4.3.1.3. Flood Damage Reduction Constraints

Flood damage reduction constraints include:

- Maintain views in Steamboat Creek residential areas.
- Design bank slopes to be safe for public use and emergency access.
- Project should not have intensive labor requirements during a flooding emergency.
- Minimize debris accumulation during flood events.
- Low recurring operations and maintenance requirements.

4.3.1.4. Financial Constraints

Financial constraints include:

- Local cost sharing contribution should not exceed known or allowed local revenues.
- Total costs should not exceed maximum authorized for Federal cost sharing.
- Compensate University of Nevada, Reno and other owners appropriately for use/acquisition of land for flood purposes.

4.3.1.5. Other Concerns

Additional implementation related concerns have also been expressed:

- Work within existing or modified Federal Authorization.
- Utilize local resources.
- Include a finance plan in the Operation and Maintenance budget.

- Identify what entity/entities will be responsible for maintenance.
- Ensure equitable property assessment based on benefit.

4.3.2. Criteria

Criteria relating to the problems and opportunities in the study area provide the basis for objectively and consistently evaluating measures and alternative plans. There are four general criteria used in the evaluation of alternative plans for Federal water resources projects: (1) completeness, (2) effectiveness, (3) efficiency, and (4) acceptability. With the exception of the first (completeness), these criteria will also be used during the screening of potential measures, prior to evaluation of alternative plans.

Completeness refers to the degree to which an alternative plan of action encompasses all elements necessary for implementation. A complete plan is not dependent upon other measures or alternatives for successful execution. Since no one measure is expected to achieve all objectives, measures are not screened with this criterion. *Effectiveness* is the degree to which an alternative achieves objectives. It encompasses technical feasibility, which is a prerequisite to effectiveness, and reliability. *Efficiency* relates to the use of scarce economic resources. Relative cost is the principal indicator of efficiency. *Acceptability* reflects the degree of support from sponsors, affected people, and other key stakeholders as well as the extent to which an alternative is consistent with the protection of the environment. In addition to environmental concerns, a chief worry of the community, especially residential property owners, is the preservation of real estate values, views, and landscape aesthetics.

4.3.3. Truckee River Flood Management Community Coalition "Goals and Objectives"

The Truckee River Flood Management Community Coalition defined a set of goals and objectives to frame and direct its activities. Its "Goals and Objectives" document contains five principal goals and multiple objectives for each goal. The document's contents are reproduced below in Table 4-1.

Three of the Coalition's five goal statements have been adopted into this document as planning objectives I (Flood Protection), II (Environmental Restoration), and III (River Parkway). The two goals "Financial Feasibility" and "Floodplain Management," however, were not adopted as planning objectives, because these concerns will be addressed by other aspects of the plan formulation process. The Coalition's Financial Feasibility goal is addressed explicitly by the application of the efficiency evaluation criterion and implicitly by the inclusion or exclusion of costly measures in Alternative 5 (the Coalition Plan). The Coalition's Floodplain Management goal is addressed during the definition of measures and their placement into alternatives. It is also expected to be addressed through local-federal partnership commitments regarding execution of the project. There is also an opportunity to address the advantages of the inclusion of floodplain management measures during the evaluation of the completeness and long term effectiveness of alternative plans.

Many of the specific objectives that are bulleted in the Coalition's "Goals and Objectives" have been retained in this report as bulleted sub-objectives under the larger planning objectives. However, some of the items listed as objectives by the Coalition in its document

are better treated in a formal planning report as constraints and accordingly have been placed in the constraints section of the chapter. In addition, some of the Coalition's specific objectives appear to be *work* objectives (tasks the Coalition set out for itself), but are not *planning* objectives, i.e. they are not outcomes that the planned civil project is expected to achieve.

4.4. MEASURES

Measures are divided into three general categories of objectives according to the objective toward which each measure appears to most greatly contribute:

- Flood damage reduction,
- Environmental restoration, and
- River parkway.

Measures may contribute to more than one objective. They have been placed into these categories principally for ease of presentation. Measures are occasionally also referred to as elements, indicating that they are potential elements of a project alternative.

Table 4-2 lists measures considered for achieving the objective of flood damage reduction in the study area. These measures have been further subdivided into five groups:

- Storage / detention;
- Increasing channel flow capacity;
- Reducing flow constrictions at bridges;
- Floodwalls / levees; and
- Floodplain management.

TABLE 4-1

TRUCKEE RIVER FLOOD MANAGEMENT COMMUNITY COALITION GOALS AND OBJECTIVES

Flood Protection

Goal: Protect residential, industrial, commercial, and public property from flood damage.

Objectives:

- Gain maximum level of protection within the Benefit-to-Cost policies for federal C.O.E. financial participation.
- Pursue additional levels of protection through other revenues/programs.
- Identify properties for long-term acquisition.
- Identify structures/facilities that will require elevation/relocation.
- Include environmentally sensitive debris management in the Operation and Maintenance plan.

Environmental Restoration

Goal: Promote a living river concept by preserving and enhancing fish and wildlife habitat, water quality, and natural geomorphic characteristics of the River.

Objectives:

- Maximize future restoration opportunities.
- Set-back levees/floodwalls from existing habitat and vegetation.
- Maintain water table necessary to sustain vegetation.
- Utilize bio-technical and habitat-friendly river bank treatments.
- Create wetlands and floodplain riparian terraces to maximize riverine fish and wildlife habitat.
- Preserve existing vegetation and weave terraces/overflow channels through the greenbelt corridor.
- Preserve archeological resources.
- Re-establish a more natural river floodplain.
- Improve water quality through development of wetlands.
- Develop an integrated hydraulics, water quality, geomorphological hydro-dynamic model to confirm the effects of proposed channel modifications. (NOTE: Any Vista Reefs modification must be analyzed to prove that no downstream flood or habitat damage will occur).
- Ensure that there will be no net loss of aquatic or riparian habitat as a result of the flood project.
- Ensure that project design, construction, and operation does not:
  - Increase waterborne concentrations of nutrients, turbidity, or toxic pollutants
  - Increase discharge of untreated urban runoff,
  - Increase potential for hazardous material to enter the River,
  - Increase River temperatures, or
  - Decrease dissolved oxygen.

River Parkway

Goal: Enhance the river as an accessible, multi-use recreational parkway and as an aesthetic and economic asset to the community and region.

Objectives:

- Expand open space, trails, and recreation amenities along the Truckee River.
- Build on downtown Reno Redevelopment plans.
- Maximize public river access from Booth Street to Vista.
- Maintain views in Steamboat Creek residential areas.
- Maximize long-term public ownership of a River Greenbelt corridor.
- Develop a continuous pedestrian and bicycle trail system.
- Include a kayak course.
- Design bank slopes to be safe for public use and emergency access.
- Include attractive, quality design features to enhance the river and the Downtown environment.

TABLE 4-1 CONTINUED

TRUCKEE RIVER FLOOD MANAGEMENT COMMUNITY COALITION GOALS AND OBJECTIVES

Financial Feasibility

Goal: Ensure a financially feasible plan.

Objectives:

- Work within existing or modified Federal Authorization.
- Utilize local resources.
- Stay within maximum U.S. Army Corps of Engineers allowed project cost.
- Do not exceed known allowed local revenues:
  - Local sales tax,
  - Potential NDOT funding for bridges,
  - Known grant sources,
  - Feasibility assessment on benefiting properties, and
  - Airport authority property acquisition.
- Include a finance plan in the Operation and Maintenance budget.
- Identify what entity/entities will be responsible for maintenance.
- Compensate University of Nevada, Reno and other owners appropriately for use/acquisition of land for flood purposes.
- Ensure equitable property assessment based on benefit.

Floodplain Management

Goal: Protect project investment by ensuring that floodplain development does not increase flood water levels in the project area.

Objectives:

- Alter floodplain development ordinance and make zoning adjustments where necessary.
- Establish a floodplain, watershed, and project management entity for Project implementation and long term management.
- Streamline floodplain permit process.
- Provide long-term education for public agencies and the public.

TABLE 4-2

FLOOD DAMAGE REDUCTION MEASURES

Storage / Detention	New upstream reservoirs
	Upstream detention with weirs
	Upstream, off-channel detention
	Increasing flood control storage at upstream reservoirs
	Tahoe re-operation (precautionary release)
	Enclosed detention facility at University Farms
	Huffaker Hills detention facility
	Bella Vista Ranch storage
	Delayed release of Truckee River peak
	Dedication of floodplain to natural storage
Increase Channel Flow Capacity	Downtown Reno bypass channel
	Channelization between Keystone and Virginia Streets.
	Channelization under downtown Reno bridges
	Channelization – Glendale Park area
	Benching upstream of Steamboat confluence
	Channel widening (excavation to channel bottom)
	Channel deepening at Vista reefs
	Benching downstream of Steamboat confluence
Reduce Flow Constrictions At Bridges	Replacement of downtown Reno bridges
	In-kind replacement of Virginia St. bridge
	Improvement of Virginia St. bridge
	Wells Ave lower bridge removal
	Causeways at Rock and Mc Carran Boulevards.
	Replace bridges at Pembroke Drive and Longley Lane
	Culverts around existing downtown Reno bridges
	Culverts around new bridges (Sierra, Virginia, Lake, Center Streets.)
Floodwalls, Levees	Floodwalls
	Setback floodwalls
	Movable barrier floodwall system
	Modular floodwalls
	Tilt-up floodwalls
	Levees
	Setback levees
Modify Other Infrastructure	Remove / relocate diversion structures
	Relocate N. Truckee Drain outlet
	Reduce width of Riverside Drive
	Install road closure bladders
Floodplain Management Measures	Flood-proofing
	Flood warning system
	Floodplain regulation and administration
	Stormwater regulation and administration
	Education

Table 4-3 lists measures considered for achieving the objective of environmental restoration in the study area.

TABLE 4-3

ENVIRONMENTAL RESTORATION MEASURES

Environmental Restoration Measures
Floodplain restoration, University Farms area
Floodplain restoration, Edison area
Bank stabilization – "biotech" methods
Replacement of rip-rap with biotech bank stabilization
Channel modifications for Lahontan cutthroat trout habitat
Bella Vista Ranch Restoration
Education on floodplains as natural systems
Interstate 395 to Greg Street
Greg Street to South Mc Carran Boulevard
South Mc Carran Boulevard to Steamboat Creek
Steamboat creek: Pembroke Drive to Kimlick Lane
Silva Ranch Road near Verdi
Dorotskar Park area
Fisherman's Park - West

Table 4-4 lists measures considered for achieving the river parkway objective.

TABLE 4-4

RIVER PARKWAY MEASURES

River Parkway Measures
Create new parkland
New bicycle trails
Channel modifications for kayak course
Relocate sewer pipeline crossings
Removal of rubble

4.4.1. Descriptions of Measures

4.4.1.1. Flood Damage Reduction

The following discussion describes measures considered by the USACE, local sponsors, and the Community Coalition for achieving the objective of flood damage reduction in the study area.

4.4.1.1.1. Storage / Detention Upstream of Reno

Upstream storage or detention measures would contribute to flood damage reduction by allowing for the storage or detention of peak flows from the Truckee River or its tributaries that would otherwise continue downstream through Reno and into the Truckee Meadows area and contribute to flooding.

New Upstream Reservoirs (On-Stream Storage with Dams)
Several relatively large capacity upstream storage facilities along the Truckee River have been considered, plus a combination of smaller sites. As shown in Plate 4-1, the majority of the sites are located within California. These are on-stream reservoirs that would be created by placing a dam on the river. Table 4-5 lists the principal sites, along with a description of their proposed locations and storage capacities.

TABLE 4-5

PROPOSED NEW UPSTREAM RESERVOIRS

Site	Description
Lawton Dam and Reservoir	Located on the Truckee River about 3.5 miles upstream from Reno; 35,000 acre-foot reservoir with earthfill dam
Hirschdale Dam and Reservoir	Located on the Truckee River 1 mile downstream from Hirschdale; 28,000 acre-foot earthfill dam and reservoir.
Verdi Dam and Reservoir	Located on the Truckee River at Verdi; 160 ft high earthen dam, 37,000 acre-foot reservoir for recreation and flood control
Scaled down Verdi Dam	Dry dam, flood control only, 18,000 AF capacity
Truckee Dam and Reservoir	Located on the Truckee River near the town of Truckee, California; 38,000 acre-foot reservoir with earthfill dam
Gateway Dam and Reservoir	Located on the Truckee River near Gateway, 1 mile upstream from the town of Truckee; this 20,000 acre-foot reservoir and dam.
Truckee River Tributary Reservoirs	Located upstream from Reno on tributary streams, such as Dog Creek, Hunter Creek, Bronco Creek, Gray Creek, and other small tributaries, as many as 10 reservoirs required to provide control equal to storage on the main stem, since the drainage areas are a small percentage of the total drainage basin.

Upstream Detention with Weirs
This measure consists of in-stream detention upstream of Reno, as does the immediately prior measure. Rather than relying upon impounding dams, this measure would rely upon weirs. A proportional weir would detain flood flows up to a predetermined level, but would also allow low flows to pass through. This measure consists of a series of small in-stream detention facilities between Lawton and the California border.

Upstream, Off-Channel Detention
This measure consists of creating a storage facility that would divert flood flows for storage off the main stem of the Truckee River, upstream of Reno. Four sites were examined: E. Truckee, Union Bend, North Flat, and Fleisch.

Increasing Flood Control Storage at Upstream Reservoirs
This measure consists of increasing the effective flood control storage space in Stampede, Prosser Creek, and Martis Creek Reservoirs.

Spillways are not gated at Stampede and Prosser Creek Reservoirs. Raising the spillways provides an increase in storage space in the reservoirs before the spillway crest is overtopped. Both a 5-foot and a 10-foot raise were considered at each reservoir. A 5-foot spillway raise at Stampede and Prosser Creeks results in an increase of about 17,600 and 3,900 acre-feet of storage, respectively. A 10-foot raise results in an increased capacity of about 36,000 and 8,300 acre-feet, respectively. The spillways at both dams would require lengthening to maintain adequate outlet capacity.

At Martis Creek, the concept is to increase the allowable flood control storage space by 5,000 acre-feet.

Reoperation of Lake Tahoe (Precautionary Release)
This measure consists of releasing water from Lake Tahoe when its water surface is high and the long-term forecast is for significant precipitation. The idea is to release water from Tahoe sufficiently in advance of a flood event so as to create additional room for storm inflows. This would prevent a recurrence of the situation encountered during the 1997 flood when releases from Tahoe contributed to flooding in Reno. Purchase of water rights has been suggested as one means by which to enable such releases to be implemented.

4.4.1.1.2. Storage / Detention in Truckee Meadows Vicinity

The following two measures focus on storing flood flows in the Truckee Meadows area. Measures that would store water on the Truckee River and its tributaries, upstream of Reno, have already been described.

University Farms Detention Basin
An enclosed detention facility at University Farms was included as part of the project authorized in 1988. This measure 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 result in a lower volume of backwater accumulating upstream of the Truckee River's constriction at the Vista reefs, potentially reducing the water surface elevations during a flood in much of the Truckee Meadows area. The detention facility may also reduce peak discharge downstream of the reefs.

Huffaker Hills Detention Facility
A 6,300 acre-foot flood-control-only detention basin at Huffaker Hills with a diversion tunnel was suggested for consideration in 1991 as an alternative to the University Farms detention basin previously authorized. The Huffaker Hills detention facility would be located off of Steamboat Creek approximately 5 river miles upstream from the Truckee River confluence, not far from the intersection of Rio Poco Rd. and Mira Loma Road (not to be confused with Mira Loma Drive, which is further north).

Bella Vista Ranch Storage
Developing the ability to store Steamboat Creek flows at the current Bella Vista Ranch, located between Mira Loma Drive and Rio Poco Rd., has been suggested as a potential measure.

Delayed Release of Truckee River Peak
A participant at Community Coalition meetings presented the concept of detaining the peak of the Truckee River flood hydrograph on the south side of a levee, which would separate the Truckee River floodplain from the floodplain of Steamboat Creek. The detained water would be released after the flood peak had passed.

Dedication of Floodplain to Natural Storage
This measure involves the permanent dedication of land in the floodplain to uses that would not interfere with flood flows. For undeveloped land, it would require the purchase of the land itself or of a permanent flood easement. For land that is already populated, it would involve acquisition by purchase, relocation of the population, and removal of any improvements which might pose a liability or contribute debris to flood flows if left standing. Lands acquired in this manner could be devoted to agriculture, parks, natural areas, or open space.

The following areas have been identified as candidate sites:

- Edison Area, Greg Street to Mc Carran Boulevard along the south bank of the Truckee River extending north to nearly Mill Street (includes proposed restoration area);
- Franklin Way to Larkin Circle along north bank of Truckee River to East Greg Street;
- University Farms area which is confined by the south bank of Truckee River from Mc Carran Boulevard to confluence with Steamboat Creek, Steamboat Creek from the Pembroke Drive to the confluence of the Truckee River, and a proposed levee which runs parallel to Mc Carran Boulevard from the Truckee River to Pembroke Drive;
- Huffaker Hills Area located south of Huffaker Narrows; and
- Bella Vista Ranch, below Rio Poco Road (restoration potential suggested but not detailed).

4.4.1.1.3. Increase Channel Flow Capacity

The following measures focus on increasing the flow capacity of the Truckee River during high flow events by directly modifying the channel itself.

Downtown Reno Bypass Channel
This measure consists of constructing a new channel to bypass the downtown Reno reach of the Truckee River. A bypass would divert excess flood flows upstream of downtown Reno, pass them through a new channel, and return the flow to the Truckee River below the downtown area.

Channelization Between Keystone and Virginia Streets
This measure consists of reconstructing the river channel upstream of the Arlington Avenue, Sierra Street and Virginia Street Bridges. This alternative would remove the concrete grade control structure, located upstream of the Arlington Avenue bridge, along with associated sediment upstream of Arlington Avenue and regrade the channel bottom between Keystone and Virginia Street bridges to create a uniform channel slope. This measure would reduce velocity variances, prevent localized scour and reduce water surface elevations upstream of Arlington Avenue.

Channelization Under Downtown Reno Bridges
This measure consists of reconstructing the river channel beneath selected bridges in the study area, deepening the river channel between the bridge footings. The purpose would be to increase the cross-sectional area beneath the bridge structures, facilitating passage of large flows during flood events.

Two variations of this measure have been assessed. The first variation includes excavation of the Truckee River channel near Booth Street and Arlington Ave bridges, as part of the 1988 authorized project. The second variation consists of reconstructing the river channel beneath selected bridges in the study area, deepening the river channel between the bridge footings. This alternative would remove material and regrade the channel floor beneath and immediately upstream of the Arlington, Sierra, Virginia, Center, and Lake Street Bridges.

Glendale Park Area Channelization
This measure, a component of the 1988 authorized project, involves excavation of a bench up to 200 ft horizontally, and 5 to 10 ft vertically, along the north (left) bank of the Truckee River in the vicinity of Glendale Park.

Benching Upstream of Steamboat Confluence ("Upstream" Benching)
This measure involves excavating a benched area on the south (right) bank of the Truckee River downstream of Mc Carran Blvd., up to 200 feet wide from the channel centerline. Vertically, the excavation would extend down to a level corresponding to the water surface elevation (WSE) associated with the two year flow under existing conditions. (The two-year flow is the maximum discharge one would expect to see once within a two-year period. The two-year flow has a 50% probability of occurring in any given year). Since this level is significantly above that which occurs throughout most of the year, excavation to the two year WSE would create a bench or terrace of land above the channel bed, which would be inundated during high flow events. The measure would be intended to increase the high flow channel capacity and thereby potentially reduce water surface elevations in the Truckee Meadows area during a flood.

Channel Widening
This measure involves channel widening in the Mc Carran Blvd. to Steamboat Creek reach of the Truckee River. Unlike benching, this measure involves excavation of the river bank down to the level of the channel bottom.

Channel Deepening at Vista Reefs
The Vista Reefs are located at the downstream end of the study area and consist of bedrock that outcrops from the riverbed. The river cross section narrows as the river enters the Truckee River Canyon. These horizontal and vertical controls of the cross section constrict the movement of water out of the Truckee Meadows and into the canyon, causing a large backwater effect upstream of the constriction during a flood. The proposed measure consists of lowering the elevation of the outcropping, i.e. excavating downward. Since the Truckee River backwater extends a significant distance up both the Truckee River and Steamboat Creek, any reduction in Truckee River backwater would be likely to reduce the extent of flooding in much of the Truckee Meadows area.

Benching Downstream of Steamboat Confluence ("Downstream" Benching)
On the Truckee River, from the Steamboat Creek confluence to a point of Vista, portions of both the north and south banks would be excavated. This measure would be intended to

increase the high flow channel capacity in order to reduce water surface elevations in the Truckee Meadows area during a flood event. There are two variations of the benching proposed. Under one variation, excavation would extend downward to the two year water surface elevation, horizontally up to 200 ft from the channel centerline, and downstream as far as the first railroad bridge beyond Vista. Under a second variation, the excavation would extend downward to the five year water surface elevation, horizontally up to 300 ft from the channel centerline, and downstream as far as the second railroad bridge beyond Vista.

4.4.1.1.4. Reduce Flow Constrictions at Bridges

Several bridges restrict the passage of flood flows in the Truckee River, Boynton Slough, and Steamboat Creek. The following measures focus on reducing these bottlenecks.

Replacement of Downtown Reno Bridges
This measure consists of removing the existing bridge structures and constructing new bridges across the Truckee River in the downtown Reno area. The existing bridges would be replaced with structures with a larger cross-sectional flow area that would facilitate passage of a 100-year flood event. Replacement has been proposed at the following bridges:

- Sierra Street,
- Virginia Street,
- Lake Street, and
- Arlington Avenue.

At Sierra, Virginia, and Lake Streets the new structures would be similar in design to the existing Center Street Bridge with two piers and minimal deck height. Plate 4-2 illustrates the existing and proposed cross sections for the Sierra Street Bridge. Plates 4-3 and 4-4 illustrate cross sections for the existing and proposed Virginia and Lake Street Bridges, respectively.

The replacement of Virginia Street bridge would not only be similar in profile to the Center Street bridge, but would also be similar in width, approximately 66 feet wide and with four lanes of traffic and no parallel parking lanes. This is a reduced width in comparison with the existing Virginia Street bridge, which is 80 feet wide, providing four lanes of traffic, two lanes of parallel parking, and a pedestrian sidewalk in each direction. The Virginia Street Bridge is currently listed on the National Historic Register of Historic Places. This measure would salvage architectural components, such as the original iron and concrete railing, and relocate these items to the new bridge.

At Arlington Avenue the north span would be replaced with a structure similar in design to the existing Center Street Bridge, with minimal deck height but a single pier. The south span would be replaced with a clear span, i.e. a span with no pier or other supports within the river channel.

In-kind Replacement of Virginia Street Bridge
This measure would replace the Virginia Street. Bridge with one which is similar in profile to the existing Center Street Bridge (two piers and minimal deck height), but would be similar in kind to the existing bridge with respect to deck width and travel capacity. The existing

Virginia Street Bridge is 80 feet wide, providing four lanes of traffic, two lanes of parallel parking, and a pedestrian sidewalk in each direction.

The Virginia Street Bridge is currently listed on the National Historic Register of Historic Places. This measure would salvage architectural components, such as the original iron and concrete railing, and relocate these items to the new bridge. This measure is identical to the more economical replacement of Virginia Street Bridge, just described in the prior measure, except for the bridge's deck width and travel capacity.

Hydraulic Improvement of Virginia Street Bridge
This potential element to the Coalition plan involves an undetermined modification to the existing bridge in order to increase cross sectional flow area. It may involve replacement of the bridge in a manner similar to that described as the in-kind replacement measure, but the nature of the change to the existing bridge is still a subject of discussion.

Wells Avenue Lower Bridge Removal
This measure consists of removing the existing lower Wells Avenue Bridge without replacing the structure. The upper bridge would be left as is. This would provided for unimpeded flow at Wells Avenue, and alleviate the back-water effects that currently occur during flood events at the lower structure.

Causeways at Rock Street and Mc Carran Boulevard
This measure would replace the existing bridges with new causeways in order to increase the cross sectional area available for flood flows under the structures.

Replace Bridges at Pembroke Drive and Longley Lane
This measure involves the replacement of two bridges in the lower Steamboat Creek watershed - the bridge over Steamboat Creek at Pembroke Drive and the bridge over Boynton Slough at Longley Lane.

Culverts Around Existing Downtown Reno Bridges
This measure provides for the installation of culverts that direct excess flow around the abutments of bridges that currently restrict passage of the 100-year flow. Culverts would divert flow immediately upstream of the bridge and return the flow to the river channel immediately downstream of the bridge structure. These culverts could be located on either the north, south, or both banks at the various bridge locations. The culverts would be roughly 10 feet by 10 feet precast concrete structures. The installation of culverts around the abutments of the bridge would enlarge the flow area, thus increasing the channel capacity. Culverts would be placed around the abutments at Sierra, Virginia, Center, and Lake Streets.

Culverts Around New Downtown Reno Bridges
This measure provides for the installation of culverts that direct excess flow around redesigned bridge abutments, thereby increasing flow capacity. Culverts would divert flow immediately upstream of the bridge and return the flow to the river channel immediately down stream of the bridge structure. These culverts could be located on either the north, south or both banks at new bridge locations. The installation of culverts around the abutments of the bridge would enlarge the flow area, thus increasing the channel capacity.

4.4.1.1.5. Floodwalls / Levees

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

Floodwalls
This measure consists of removing most of the existing floodwalls through the downtown Reno reach and constructing new vertical concrete floodwalls. Floodwalls would also be used in portions of the Truckee Meadows reach.

Plate 4-5 shows a floodwall cross sections for the Downtown Reno reach. Plate 4-6 provides a typical cross section for floodwalls in the Truckee Meadows reach.

Floodwalls can be aesthetically enhanced, with additional cost, by architectural and artistic elements such as:

- tinted concrete facing
- murals on facing
- raised architectural details on facing
- architectural details around and near storm drain outlets

Setback Floodwalls
Setback floodwalls are simply floodwalls which are set back a significant distance from the river's edge. Relative to levees close to the river's edge, setback floodwalls increase somewhat the capacity of the high flow channel that they bound.

Modify Existing Floodwalls
This measure entails upgrading the existing floodwalls along the downtown Reno reach of the Truckee River, but does not go so far as complete replacement.

Movable Barrier Floodwall System (MBFS)
The MBFS is an automatic levee/floodwall system that theoretically operates solely by the buoyant forces of water. The system consists of a series of gasketed composite walls weighing approximately 20 lbs. per cubic foot that are fitted inside a double-sided concrete channel trough. The moving walls are constructed of composite fiberglass and polyester materials. The MBFS is designed to keep at least 50% of its height inside the concrete channel when fully extended to provide support. The MBFS is estimated to last between 50 to 75 years.

Modular Floodwalls
Modular floodwalls consist of interlocking panels assembled on a ground surface level base system. The system typically consists of a concrete base with a guide and gasketed lock mechanism. Before flood events, light weight wall panels are manually installed into the existing base system and locked into place. The wall panels are removed when the flood danger has passed.

Tilt-Up Floodwalls
Tilt-up floodwalls consist of concrete footings and/or base with hinged walls. The hinged walls, typically steel, lay flat against the ground surface when not in use. During flood

events, these structures are raised to an angle near 90^{o} with the ground surface, raising the effective height of flood control structure.

Levees
Levees are earthen flood control structures built high enough to prevent a specific flood event (e.g. the 100-year flow) from overtopping it, plus an additional height to allow a margin of safety. 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. A layer of aggregate is often placed at the crest of the levee to provide firmer support for maintenance and inspection vehicles. Plate 4-7 shows a levee cross section.

Setback Levees
Setback levees are simply levees which are set back a significant distance from the river's edge. Relative to levees that sit at the river's edge, setback levees increase somewhat the capacity of the high flow channel that is bounded by the levees.

4.4.1.1.6. Modify Other Infrastructure

Remove or Relocate Diversion Structures
This measure encompasses removal of the diversion structure which is located just upstream of the northern Arlington Ave. bridge, relocation of the Glendale Ditch intake to a point further upstream, and relocation of the Pioneer Ditch intake. The intention is to reduce the potential for these structures to contribute to the restriction of channel discharge capacity during a flood event. The element of this measure which focuses on the diversion structure in the vicinity of Arlington Ave. differs from the "channelization between Keystone and Virginia Streets." measure in that it does not involve regrading of the channel bottom.

Relocate North Truckee Drain Outlet
Currently the North Truckee Drain empties into the Truckee River just upstream of the Truckee's confluence with Steamboat Creek. Relocation of the N. Truckee Drain outlet to a point further downstream might reduce somewhat the extent of the backwater experienced at the Steamboat / Truckee confluence, particularly if the new Drain outlet were located where the channel capacity had been increased through the "downstream" benching measure.

Reduce Width of Riverside Drive
Under this proposal, Riverside Dr. would be converted to a one-way road and the number of lanes reduced by 50%. This would expand somewhat the area that could be allowed to flood, and enable floodwalls in that location to be set back a slightly greater distance than if no change were made to the road.

Install Road Closure Bladders
There are several locations where road crossings interrupt the continuity of proposed floodwall containment lines. With this measure, inflatable bladders would be installed at those points where a temporary barrier would be needed to provide a continuous defense against flood waters. The bladders would be activated only during a major flood event.

4.4.1.1.7. Floodplain Management Measures

The types of measures presented above (storage, channelization, and physical barriers) focus on preventing floodwaters from reaching developed areas. Floodplain management measures

focus on managing the resources within the floodplain so as to minimize the likelihood that the floodwaters will result in loss of life or significant property damage.

Flood-Proofing
Flood proofing of structures can take one of a few forms. It may involve raising existing structures so that occupiable portions are above the expected flood level. Raising structures above the flood level is possible if the lower portion of the structure is not used or used only for parking or storage. The lower portion is expected to flood and where exterior walls are present (as opposed to support by piers) the equalization of hydrostatic forces on exterior walls is attained by allowing entry and exit of floodwater. Flood-proofing could also entail the use of a terraced plaza or stepped approach leading up to the elevated portion of a building. Flood proofing could also involve the construction of walls or levees around individual homes or pockets of homes to hold back floodwater.

Flood Warning System
A flood warning system helps protect people located in a floodplain by warning them of an impending flood shortly before it occurs so that they can be safely removed from the hazard area.

Floodplain Regulation and Administration
A number of potential elements to the Coalition Concept Plan have been proposed which involve regulation or administration of the floodplains.

- Establishment of a Regional Floodplain Administration Agency, to:
  - Operate and maintain an early warning system
  - Maintain structural flood control facilities, including debris management
  - Monitor performance of the selected project
  - Administer hydraulic modeling and flood data systems
  - Administer floodplain ordinances
  - Secure and administer funding for floodplain open space acquisition in near and long term
- Potential 100 yr. floodplain elements
  - Reducing the density of new development in upstream tributary areas
  - Requiring elevation of new buildings in the floodplain, a few feet above the FEMA minimum
- Potential 500 yr. floodplain elements
  - Requiring or providing financial incentives for new and existing development in the 500 yr. flood plain to elevate or floodproof structures.
  - Providing financial incentives for existing development to relocate out of the 500 yr. floodplain
  - Preventing critical facilities from siting in 500 yr. floodplain.

- Requiring ground level of new buildings to remain open to flood inundation

Stormwater Regulation and Administration
The Coalition also proposed the following potential elements to its Concept Plan, focusing on the regulation and administration of stormwater.

- Requiring new development in the Truckee River and Steamboat Creek watersheds to detain any increase in peak flow over pre-developed conditions and to contain any increased volume of stormwater.
- Establishing a regional agency to administer area-wide detention options for new development.

Education
The Coalition has proposed the following educational measures ("elements") for indirectly contributing to flood damage reduction and environmental restoration:

- Disseminating information on flood hazard areas, elevation, and flood-proofing
- Educating the public about floodplain management and flood awareness
- School awareness programs
- Full disclosure of flood hazard to homebuyers

4.4.1.2. Environmental Restoration

The following measures or potential plan elements are intended to contribute to environmental restoration. Although several of the following site-specific elements have already been identified as candidate locations for the "natural floodplain storage" measure, the following descriptions emphasize the aspects of the elements' potential contribution to the environmental restoration objective.

Interstate 395 to Greg Street
This measure consists of enhancing riparian habitat, creating new riparian habitat and augmenting riparian areas with riparian transition vegetation from Interstate 395 to Greg Street along both banks of the river. Upstream from Glendale Avenue existing riparian habitat on the north bank of the river would be enhanced by planting additional tress and shrubs among the existing vegetation and extending the riparian habitat upslope with additional plantings. Riparian transition zone plant species would be used to extend the riparian corridor to the bike path next to Galletti Road. Downstream of Glendale Avenue, restoration actions would be conducted on both sides of the river. Riparian species would be planted among the existing vegetation to create a continuous band of vegetation about 50 feet wide. On the south side of the river between Glendale Avenue and Greg Street, the existing riparian vegetation would be enhanced by planting riparian trees and shrubs among the existing vegetation as on the north bank of the river. Adjacent to the Hilton Hotel parking lot additional cottonwoods, willows, alders and other riparian species would be planted.

Greg Street to South Mc Carran Boulevard
On the south side of the river, the potential for setback levees provides considerable space for habitat restoration. Like the I-395 to Greg Street measure, this measure would consist of

enhancing riparian vegetation, creating additional riparian vegetation and creating riparian transition zone habitat. Restoration on the south side of the river would be more extensive than on the north bank. On the north side of the river, restoration would primarily be limited to enhancing existing vegetation.

South Mc Carran Boulevard to Steamboat Creek
Two of the flood control measures under consideration include widening the Truckee River channel on the south side between South Mc Carran Boulevard and Steamboat Creek to increase channel capacity. This restoration measure includes creating riparian habitat between South Mc Carran Boulevard and Steamboat Creek in the proposed widened channel. If channel widening is not included in the selected plan, this measure would be modified to retain existing vegetation. The end result for either scenario would be the creation of a similar amount of riparian habitat.

In addition to habitat restoration on the mainstem Truckee River, a wetland complex would be created between Steamboat Creek and the Truckee River. The Steamboat Creek channel would be relocated to the west and would provide water to a newly created emergent wetland complex adjacent to the new channel's west bank. Riparian trees and shrubs would be planted adjacent to the wetland margins and the new Steamboat Creek channel. Riparian species would be planted along the western edge of the wetland complex, between the wetland complex and the new Steamboat Creek channel, and along the eastern edge of the new Steamboat Creek channel.

Steamboat Creek: Pembroke Drive to Kimlick Lane
This restoration measure consists of creating a wetland complex that would link to the wetland complex created downstream from Kimlick Lane described for the South Mc Carran Boulevard to Steamboat Creek measure. A wetland would be created west of Steamboat Creek just upstream from Kimlick Lane. The wetland would consist of areas of emergent vegetation, deep water and two or more islands to provide nesting areas for waterfowl. Riparian species would be planted along edges of the wetland, on the islands and between the wetland complex and Steamboat Creek. A short channel would connect the wetland complex to Steamboat Creek that would supply water to the wetland. Water levels in the wetland complex would be controlled with control gates at upstream and downstream locations.

Silva Ranch Road Near
Under this measure, riparian trees and shrubs would be planted on the north and south banks of the river just downstream of Verdi in the area bordered by Silva Ranch and the Southern Pacific Railroad. Plants would be installed among and adjacent to existing riparian vegetation. Upland species would be planted adjacent to and intermixed with the riparian species on the north bank; this would increase the effective width of the riparian corridor. As part of this measure, a small emergent wetland could be created on the south bank in areas that include bank excavation.

Dorotskar Park Area
This site is located upstream of the Reno/Sparks metropolitan area. Dorotskar Park is located on the north bank of the river. The Southern Pacific Railroad forms the northern boundary. Riparian trees and shrubs would be planted interspersed among the existing riparian vegetation along the north and south banks. Additionally, on the south bank, riparian species

would be planted between the river and the Last Chance Ditch, and on the north bank, riparian species would be planted to increase vegetation.

Fisherman's Park - West
Fisherman's Park is located just upstream of Interstate 395 on the north bank between existing industrial development and the river. For this measure, riparian and upland species would be planted among existing riparian vegetation. This measure would increase the effective size of the riparian corridor.

Floodplain Restoration, University Farms Area
This measure, a proposed element of the Coalition Concept Plan, would provide for restoration of approximately 165 acres of land in the University Farms area, from the south bank of the Truckee River to Cleanwater Way. The restoration concept includes preservation of existing riparian vegetation, establishment of low and intermediate terrace riparian vegetation zones, creation of wetlands, establishment of a point bar in the river, and dedication of the remaining land as a riparian transition zone (zone of transition from non-riparian to riparian vegetation). Use of the wetlands for research by the University of Nevada, Reno and/or for wastewater treatment is also being considered. Plate 4-8 is an illustration of the zone concepts.

Floodplain Restoration, Edison Area
This measure would entail restoration of 175 acres of land from the south bank of the Truckee River almost to Mill Street, between Rock and Mc Carran Boulevards. The restoration concept includes preservation of existing riparian vegetation, establishment of low and intermediate terrace riparian vegetation zones, establishment of a point bar in the river, and creation of a new river meander. The remainder of the land would be dedicated to serve as a riparian transition zone or as a new park.

Bella Vista Ranch Restoration
This potential plan element involves the dedication of approximately 290 acres of land, below Short Lane, to permanent natural storage of Steamboat Creek flood waters. This land has also been identified as an opportunity for restoration, but the restoration aspects have yet to be detailed.

Bank Stabilization - Biotech Methods
This potential plan element involves the use of vegetation and/or landscape shaping to stabilize river banks to prevent or arrest mass wasting (i.e. slumping, landsliding) or erosion. The term "biotech" is used to distinguish the intended techniques from those that rely upon armoring with rip-rap, gabions, rock, concrete blocks, etc. The south bank of the Truckee River between Booth Street and Keystone Ave is one example of a potential area where this measure could be used.

Replacement of Rip Rap with Biotech Bank Stabilization
This measure involves the removal of existing bank armoring and stabilizing the river bank, as needed, with vegetative and/or landscape shaping methods. The Booth St. – Hwy 395 reach of the Truckee River is one example of an area where application of this measure is proposed.

Channel Modifications for Lahontan Cutthroat Trout Habitat
This measure / element would enhance portions of a stream channel for use as Lahontan cutthroat trout habitat. Creation of pools and/or riffles has been suggested as one aspect of this measure. It would probably also require attention to the placement and composition of riparian vegetation, channel bed material, and stream morphology dynamics.

Education
This measure would complement the floodplain education programs described earlier by focusing educational efforts on the benefits of flooding to natural systems and on the functions and importance of watersheds.

4.4.1.3. River parkway

The following measures / elements would contribute to the river parkway objective, providing increased recreational opportunity and/or enhancing the Truckee River as an aesthetic and economic asset.

Create New Park Land
This potential plan element would involve the acquisition of land, and dedicating its use as public park. Where there are existing residences or businesses, relocation assistance would also be needed. As no flood protection would be envisioned for these new park areas, this measure might also contribute to flood damage reduction.

Proposed new park areas include:

- Greg St. – Mc Carran Blvd., a portion of the land between the south bank of the Truckee River and Mill Street
- Greg St. & Sparks Blvd. area, at and near the current location of the Pick & Pull auto salvage yard
- Second St. – Hwy 395, south bank of Truckee River, a new parkway, including a strip along existing bicycle trail and a triangular area between Kuenzli Street and the river, near Manuel St. Incorporation of restoration efforts proposed for the south bank of the river.
- East of National Automobile Museum, downtown Reno, south bank of Truckee River
- East of Harrah's parking garage, downtown Reno, north bank
- North of Kuenzli Street bridge, downtown Reno, north bank
- East of RGJ building

New Bicycle Trails
New segments of bicycle trail are envisioned along the Truckee River. Proposed stretches include:

- Greg St. to Mc Carran Blvd., along south bank and across Mc Carran bridge, mirroring and linking with existing bicycle trail on north bank

- Parallel to East Greg St., along north bank, from location west and south of Sparks Blvd terminus to Larkin Circle, extending existing trail

Channel Modifications for Kayak Course
River enthusiasts are pursuing efforts to establish a kayak course in the vicinity of Wingfield and Riverside Parks. This potential plan element involves modifying the southern portion of the Truckee River channel in conjunction with development of the kayak course.

Relocate Sewer Pipeline Crossings
Two exposed sewer pipelines cross the Truckee River between Wells Ave. and Hwy 395 above the low flow channel. The crossings are not aesthetically pleasing and contribute to the public health threats posed by a major flood. This measure calls for either removing or transforming the crossings to inverted siphons so that the pipelines cross the river below the channel. Removal of the crossings would require rerouting the conveyed sewage. Changing the crossings to inverted siphons would require pump stations if gravity control is insufficient.

Removal of Rubble
This measure would remove waste concrete or other rubble where it lies on the Truckee River banks due to improper disposal and where the material was not intended for bank stabilization. The general area targeted for this measure is between Lake Street and Glendale Avenue with a site below Wells Avenue specifically identified.

4.4.2. Screening of Measures

As indicated earlier, each measure considered has been divided into three categories according to the planning objective toward which it is intended to most greatly contribute:

- Flood damage reduction
- Environmental restoration
- River parkway.

Measures were assessed against the criteria of expected effectiveness, expected efficiency, and expected acceptability, relying upon specific professional analyses as well as judgement. Descriptions of how the flood damage reduction measures were assessed relative to the screening criteria are presented first, followed in turn by the environmental restoration and river parkway measures.

4.4.2.1. Screening of Flood Damage Reduction Measures

4.4.2.1.1. Storage / Detention Measures Upstream Of Reno

New Upstream Reservoirs
The existing risk of flooding in Reno is 1 in 26 chance in any year. As shown in Table 4-6, the upstream detention dams could result in increased level of protection in Reno ranging from a 1 in 45 to a 1 in 100 chance of flooding in any year. Very preliminary construction costs (excluding lands, easements, rights-of-way, relocation, and environmental mitigation) were updated to 1999 price levels and would range from about $67 million for a relatively low reduction in flood risk to about $670 million for a 1 in 100 chance of flooding in any

year. It is believed that once other costs are added, the total costs significantly exceed potential flood damage reduction benefits.

TABLE 4-6

SCREENING OF NEW UPSTREAM RESERVOIRS

Site	Percent Chance of Exceedence in any year	Description with Implementation Requirements	Cost Without LERRDs or Mitigation[1] ($ million)
Lawton Dam and Reservoir	1 in 100	Located on the Truckee River about 3.5 miles upstream from Reno; 35,000 acre-foot reservoir with earthfill dam; relocation of about 7 miles of SPRR track required; reconstruction of 1 mile of Interstate Highway 80; and abandonment of the existing Washoe powerplant.	$245
Hirschdale Dam and Reservoir	1 in 75	The 28,000 acre-foot dam and reservoir would be located on the Truckee River 1 mile downstream from Hirschdale with earthfill dam; relocation of about 5.5 miles of SPRR double track; reconstruction of 1 mile of Interstate 80.	$112
Truckee Dam and Reservoir	1 in 45	Located on the Truckee River near the town of Truckee, California, a 38,000 acre-foot reservoir with earthfill dam; relocation of about 6 miles of SPRR double track; reconstruction of 1 mile of Interstate 80.	$134
Gateway Dam and Reservoir	1 in 45	This 20,000 acre-foot reservoir and dam would be constructed on the Truckee River near Gateway, 1 mile upstream from the town of Truckee; relocation of about 5.5 miles of State Highway 89.	$67
Truckee River Tributary Reservoirs above Reno	1 in 45	Storage on tributary streams, such as Dog Creek, Hunter Creek, Bronco Creek, Gray Creek, and other small tributaries upstream from Reno, as many as 10 reservoirs required to provide control equal to storage on the main stem, since the drainage areas are a small percentage of the total drainage basin.	$67 each or $670 total

[1] Relative construction costs were derived as part of Truckee Meadows Investigation updated to 1998 price levels. Neither land costs (lands, easements, rights-of-way, relocation), nor environmental mitigation were included.

Construction of the originally proposed Verdi Dam (37,000 AF) was estimated to cost $32 million in 1966 dollars. This cost has previously been updated to roughly $146 million in 1996 dollars.

Cost estimates for a scaled down version of Verdi Dam (18,000 AF) have not been developed as there is no preliminary design upon which costs could be based.

Beyond the issue of costs vs. level of flood protection, recent planning experiences in other areas suggest that it is unlikely that there would be the degree of institutional support necessary to improve a flood detention dam on the Truckee River or other major tributary. Accordingly, this measure is expected to have low efficiency (i.e. high cost relative to flood protection benefit) and low acceptability to stakeholders.

Upstream Detention with Weirs
Six potential sites for either on-stream or off-channel detention were initially considered. Potential storage at any one of the six sites considered was up to 1500 AF. Target volumes of over 4,000 AF were considered necessary to provide significant flood protection for Reno and downstream areas. Due to the relatively small amount of storage that any one facility would provide, these options were judged to have low expected effectiveness.

The concept of using a series of several small on-stream storage areas from Lawton to the California border has been suggested but not thoroughly evaluated. However, permanent in-channel structures would visually impact the river channel and could interfere with recreational uses of the river. They could also pose a barrier to the movement of terrestrial wildlife.

Upstream, Off-Channel Detention
Four smaller sites for off-channel storage have been evaluated: E. Truckee; Union Bend; North Flat; Fleisch. At two of these sites (E. Truckee and North Flat) variations have also been considered, raising the total number of options considered to seven. Potential water storage ranged from 900 AF to nearly 12,000 AF, with costs ranging from $17 million to $94 million in 1996 dollars.

In comparison, to reduce a peak flow of 18,500 cfs (a flow which was previously thought to represent the 100-year event at the gaging station closest to downtown Reno) to 14,000 cfs would require a storage volume of approximately 4,400 acre feet.

Issues such as land ownership, real estate costs, site specific constraints, and environmental issues were not evaluated in these estimates.

Based primarily on the relatively high diversion structure costs, real estate costs, and/or only a slight reduction in the flood risk to Reno, this measure would be expected to have low efficiency.

Increasing Flood Control Storage at Upstream Reservoirs
Preliminary costs to raise the spillway at Stampede for a 5- and 10-foot raise were estimated at $10 million and $36 million, respectively. At Prosser Creek, the costs were about $8 million and $60 million, respectively.

Reoperation and spillway raising of Stampede and Prosser Creek Dams and increasing the allowable flood control storage in Martis Creek Reservoir would only provide benefits during low probability events; for example, 1 in 400 chance of occurring in any given year. No increase in flood benefits during higher probability events (1 in 100 chance) would be realized. This is evidenced by the January 1997 flood event (close to a 100 yr. flood event, with a probability of occurring in any given year of close to 1 in 100), in which no releases were being made into the Truckee River from Prosser, Boca, and Stampede Dams. During the 1997 event, additional flood control capacity at those reservoirs would not have reduced the magnitude of flooding in the Reno-Sparks-Truckee Meadows area.

Flood control space at Martis Creek Reservoir is limited to less than half of gross capacity due to geotechnical concerns. Thus, there is uncertainty regarding the feasibility of expanding available flood control storage at Martis Creek Reservoir.

This measure would be expected to have low effectiveness and low efficiency.

Reoperation of Lake Tahoe (Precautionary Release)
The 1997 flood was the only recorded time when maximum releases from Lake Tahoe contributed to peak flood flows in the Truckee River during a large rain flood event in the Lake Tahoe Basin. For all other significant rain flood events in the Tahoe Basin, there was sufficient space in the lake to absorb inflows. In addition 1997 was one of only five years since the completion of the current Tahoe dam in which discharge from Lake Tahoe into the Truckee River exceeded 2000 cfs for one day or more.

Since in most flood situations one would not expect this circumstance to recur, this measure would be unlikely to consistently contribute to flood damage reduction. In addition, the rearrangement of operating rules for Lake Tahoe releases would probably be an institutionally complex and challenging task. There is a high degree of uncertainty regarding the feasibility and institutional acceptability of implementing this measure. This measure is consequently expected to have low effectiveness and low acceptability.

4.4.2.1.2. Storage / Detention Measures within Truckee Meadows Area

University Farms Detention Basin
An enclosed detention facility at University Farms was included as part of the project authorized in 1988. The idea is to store some of the Truckee River flood flows in order to reduce the peak discharge and volume of water carried downstream. This would result in a lower volume of backwater accumulating upstream of the Truckee's constriction at the Vista reefs.

This measure has potential to reduce flood water surface elevations in the Truckee Meadows area and to reduce downstream peak discharge during a flood. It has been retained for potential incorporation into an alternative.

Huffaker Hills Detention Facility
The Huffaker Hills site was determined to be economically inefficient and technically unacceptable. The Huffaker Hills area is experiencing rapid residential and commercial development growth and real estate costs are nearly fourteen times that of University Farms. In addition to high real estate costs, geologic investigations revealed that materials at the dam site are not suitable for a dam foundation. Four earthquake faults are known to occur along a needed diversion tunnel alignment. The geologic investigations revealed that additional support would be required for the tunnel because of the shallowness of the cover and unknown variables, such as weathering, fracturing and other physical properties. The serious doubts regarding technical feasibility give it low expected effectiveness and acceptability.

Bella Vista Ranch Storage
No evaluations of this option are available. Any constructed facility, however, would not be likely to have high economic efficiency. It is deferred for potential future reconsideration.

Delayed Release of Truckee River Peak
Consideration of the hydraulics indicate that the water surface elevation on the south side of any single levee separating the Truckee River floodplain from the Steamboat Creek floodplain in the vicinity of the University Farms would not be appreciably lower than those of the Truckee River's flood water. Consequently, there would be no available storage capacity to make this feasible, and is considered to have low expected effectiveness.

Dedication of Floodplain to Natural Storage
Two developed areas were considered for the purposes of screening. One was the Sparks Auto Wrecking facility located at Larkin Circle and the second was the East Sparks Industrial building located at Spice Island Drive. Both locations are considered representative of damageable property in the study area. Other facilities could have been considered. For the Sparks Auto Wrecking facility located on about 6 acres of land, the value of structures was estimated at approximately $200,000 and the land value with improvements was approximately $3 million. For the east Sparks Industrial buildings located on about 22 acres of land, the value of structures was approximately $2.4 million and the land value was nearly $8 million. The costs to relocate these structures from just land acquisition costs, not to mention the other costs associated with relocation of these structures, would far exceed the benefits from the reduction of flood damages. Flood plain evacuation of structures from the flood plain would not be economically feasible for developed areas and is rated as having low efficiency.

However, dedication of specific property in the floodplain may be appropriate in undeveloped areas. Dedication of undeveloped areas to the natural floodplain has appeal to the local community and provides opportunity for complementary environmental restoration and/or river parkway elements. Thus, this measure has been retained.

4.4.2.1.3. Increase Channel Flow Capacity

Reno Bypass Channel
This measure is problematic due to the unavailability of land (low technical feasibility, a component of effectiveness) and associated high costs (low efficiency) to construct a bypass channel. The acceptability to existing businesses and property owners in the downtown Reno area is also expected to be low.

Channelization between Keystone and Virginia Streets
Modeling of this measure with HEC-RAS indicated that it was effective at reducing water surface elevations between Keystone and Arlington Avenues. Thus, it has localized hydraulic benefit that would not extend to the Reno redevelopment area or the Truckee Meadows area. It would therefore be expected to have limited (low) effectiveness.

In addition, there is uncertainty regarding hydraulic effects beyond the immediate term and regarding the geomorphologic impacts. . Little factual information is available for estimating redeposition rates. Incurring cost without a fair measure of certainty regarding effectiveness and acceptability makes this measure unsuitable for inclusion in an alternative plan. The measure is consequently eliminated.

Channelization Under Downtown Reno Bridges
Modeling of channelization near Booth St. and Arlington Ave. bridges indicated that only a small, localized reduction in water surface elevation would be achieved by this measure, relative to a scenario with containment structures only. In addition, concerns have been raised that the channelization, which was part of the 1988 authorized project, may not be compatible with local aesthetic concerns. This variation of the measure has been eliminated from further consideration.

One potential problem with deepening the channel floor beneath and immediately upstream of the Arlington, Sierra, Virginia, Center, and Lake Street Bridges involves sediment

redepositing in these areas after initial dredging and regrading. This variation of the measure was dropped from further consideration because of the minimal effects on lowering water surface elevations through the study area and potential O&M considerations.

This measure has low expected effectiveness and acceptability.

Glendale Park Area Channelization
This measure would reduce water surface elevations only in a localized area between Glendale Park and Rock Blvd, relative to a scenario with containment structures only. Since excavation in general is a costly undertaking, this measure would be both ineffective for the Truckee Meadows area as a whole and inefficient in terms of the hydraulic benefit relative to the cost. In addition, local acceptability is questionable, due to aesthetic concerns. This measure has consequently been eliminated.

Benching Upstream of Steamboat Confluence
Analysis of a benching alternative indicated that a significant reduction in water surface (3 ft for a flow of 26,000 cfs) could be achieved near Mc Carran Blvd. relative to a scenario with containment structures only. This measure has been retained for further consideration.

Channel Widening
Excavation of the river banks down to the level of the channel bottom over an extended reach of the river would seriously impact the low flow channel in that reach. This measure is considered unacceptable for environmental reasons and has been eliminated from further consideration.

Channel Deepening at Vista reefs
There have been efforts in the past to improve the flow past Vista by lowering the elevation of the outcropping. Recent studies have indicated that these actions may have resulted in downcutting of the Truckee River up to 15 feet up at Mc Carran Boulevard. This measure would also drastically impact the existing channel in the immediate area over which it is implemented. Consequently, it has been considered environmentally unacceptable and has been eliminated.

Benching Downstream of Steamboat Confluence
Since this measure would result in a terrace above the existing low flow river channel; it does not pose the same environmental concerns as excavation down to or beyond the existing channel bottom. A benching measure in the Vista area could reduce flood water surface elevations at several points along the Truckee River, relative to a scenario with containment structures only. The potential to provide hydraulic benefit makes this measure suitable for further consideration.

4.4.2.1.4. Reduce Flow Constrictions at Bridges

Replacement of Downtown Reno Bridges
Replacement of the Arlington Avenue bridge was dropped from further consideration because of the minimal effects on lowering water surface elevation in relation to cost (low effectiveness, low efficiency). Replacement of Sierra, Virginia, and Lake Streets bridges have been retained, as they would effectively pass a 100 yr. flow.

In-Kind Replacement of Virginia Street Bridge
This measure was eliminated from further consideration in this report because its higher cost carries no additional flood protection benefit. It is an inefficient measure.

Improvement of Virginia Street Bridge
The uncertainty regarding what this measure entails makes it difficult to evaluate with regard to effectiveness and efficiency. However, the Community Coalition favors this element at this point in time, thus it is considered to have high local acceptability.

Wells Ave Lower Bridge Removal
Although this measure does reduce back-water effects immediately up stream of the existing structure, it does not affect flood related damages. Thus, the measure was dropped from further consideration because of the minimal reduction in flood related damages in relation to cost (low effectiveness and efficiency).

Causeway at Rock Boulevard
This measure was not carried forward by the Coalition into its Concept Plan. It is considered to have low acceptability.

Causeway at Mc Carran Blvd.
This measure has been carried forward by the Coalition into its Concept Plan. It is considered to have high acceptability.

Culverts Around New Bridges (Sierra, Virginia, Lake, Center Streets)
Modeling of this measure indicated that it could reduce water surface elevations relative to existing conditions. However, because debris accumulation could reduce the culverts' flow capacity, there is uncertainty regarding its reliability (an aspect of effectiveness) and it poses potential O&M burdens that are not desired by sponsoring agencies (low acceptability). Some uncertainty is also associated with the hydraulic design of these structures.

Culverts Around Existing Bridges
This measure combined with the cross-sectional flow areas of the existing bridges would not pass 100-year flows. The culverts would also be costly and difficult to design at the existing bridges. Consequently, this measure is considered to have low effectiveness and efficiency and will not be carried forward into an alternative plan.

4.4.2.1.5. Floodwalls / Levees

Floodwalls (Traditional)
For the flows for which they are designed to contain, floodwalls can provide reliable flood protection if designed and constructed properly. This measure was retained.

Modify Existing Floodwalls
The existing floodwalls are reaching the end of their useful life. It is not known how the existing floodwalls could be modified so as to extend their useful life. This measure is rated as having uncertain effectiveness and medium acceptability. It is deferred for potential future reconsideration.

Movable Barrier Floodwall System
This measure was dropped from further study due primarily to the estimated high cost and relatively short expected life. Also, there is a significant degree of uncertainty related to the technical feasibility of this measure because MBFS have never been installed and have no performance history. The measure is considered to have low efficiency and acceptability.

Modular Floodwalls
This measure was eliminated from further consideration due to the high labor requirements before and after flood events (low acceptability).

Tilt-Up Floodwalls
This measure was eliminated from further consideration due to the high labor requirements before and after flood events (low acceptability).

Setback Floodwalls
Retained for the same reasons as floodwalls. Where setback of a floodwall would be feasible, provide hydraulic benefit, and not be cost prohibitive, setback floodwalls would be used in preference to floodwalls that immediately border the river channel.

Levees
For the flows for which they are designed to contain, levees can provide reliable flood protection if sited, designed and constructed properly. This measure was retained.

Setback Levees
Retained. Where feasible and cost effective setback levees would be used in preference to levees located immediately above stream banks.

4.4.2.1.6. Modify Other Infrastructure

Remove or Relocate Diversion Structures
This measure has been carried forward by the Coalition into its Concept Plan. It is considered to have high local acceptability.

Relocate North Truckee Drain Outlet
Relocation of the N. Truckee Drain outlet to a point further downstream would be likely to reduce somewhat the extent of the backwater experienced at the Steamboat / Truckee confluence, particularly if the new Drain outlet were located where the channel capacity had been increased through the "downstream" benching measure. This element has medium expected effectiveness and high local acceptability, as evidenced by the Coalition carrying it forward into its Concept Plan.

Reduce Width of Riverside Drive
Marginally increasing the area allowed to flood by scaling back Riverside Dr. would not be expected to significantly reduce flooding in the downtown Reno portion of the study area and would probably have no effect on flooding in the Truckee Meadows area. It is unclear how effective this measure would be, but it is expected that it would have high cost relative to benefit (i.e. low efficiency). However, this element has support from the community as evidenced by its inclusion in the Coalition's Concept Plan. It is considered to have high local acceptability.

Install Road Closure Bladders
Road closure bladders would be expected to have high effectiveness, as they tie off lines of physical defense from flood waters where floodwalls could not be erected and installation of levees would require redesign of a roadway. This element's inclusion into the Coalition's Concept Plan is evidence of high local acceptability.

4.4.2.1.7. Floodplain Management Measures

Flood-Proofing
For developed portions of Truckee Meadows, there is little opportunity to construct 'ring levees' without extensive relocations. Flood proofing of structures within the flood plain as a stand alone measure would not be economically feasible due to the large flood plain, large numbers of residential, commercial, industrial, and industrial structures in the flood plain, high flood depths, and the high costs associated with flood proofing. However, as a selectively used measure it could have high effectiveness, although the costs make it relatively inefficient. Evidence of its high local acceptability is this element's inclusion in the Coalition Concept Plan.

Flood Warning System
As mentioned in Chapter 2, the USACE is implementing the Reno Flood Warning System, Nevada in conjunction with Washoe County and the cities of Reno and Sparks. This system is being implemented independently of this plan formulation process so is not considered to part of this project. Consequently, it is eliminated from further consideration.

Floodplain Regulation and Administration
The group of potential elements placed under this measure heading appear to have a high level of acceptability to the community, as evidenced by their inclusion in the Coalition Concept Plan.

Stormwater Regulation and Administration
The two potential elements placed under this measure heading appear to have a high level of acceptability to the community, as evidenced by their inclusion in the Coalition Concept Plan.

Education
The group of potential elements placed under this measure heading appear to have a high level of acceptability to the community, as evidenced by their inclusion in the Coalition Concept Plan.

4.4.2.2. Screening Results

Measures were assessed against the criteria of expected effectiveness, expected efficiency, and expected acceptability, relying upon prior analyses and professional judgement. A qualitative rating of low, medium, or high was assigned to each, where possible. Where a lack of information prevented a reasonable judgement from being made, no qualitative rating was assigned. Table 4-7 summarizes the results of the application of the screening criteria to the flood damage reduction measures. A question mark has been inserted where no qualitative rating was assigned.

TABLE 4-7

FLOOD DAMAGE REDUCTION MEASURES – RESULTS FROM APPLYING SCREENING CRITERIA

Measure	Effectiveness	Efficiency	Acceptability
Storage / Detention			
New upstream reservoirs	?	Low	Low
Upstream detention with weirs	Low	?	?
Upstream, off-channel detention	?	Low	?
Increasing flood control storage at upstream reservoirs	Low	Low	Medium
Tahoe re-operation (precautionary release)	Low	High	Low
Enclosed detention facility at University Farms	Medium	Medium	Medium
Huffaker Hills detention facility	Low	Low	Low
Bella Vista Ranch storage	?	?	?
Dedication of floodplain to natural storage	Medium	Low	High
Delayed release of Truckee River peak	Low	Medium	Medium
Increase Channel Flow Capacity			
Downtown Reno bypass channel	Low	Low	Low
Channelization between Keystone and Virginia Streets.	Low	?	?
Channelization under downtown Reno bridges	Low	?	Low
Channelization – Glendale Park area	Low	?	Low
Benching upstream of Steamboat confluence	Medium	Medium	Medium
Channel widening (excavation to channel bottom)	Medium	Medium	Low
Channel deepening at Vista reefs	High	Medium	Low
Benching downstream of Steamboat confluence	High	Medium	Medium
Reduce Constrictions At Bridges			
Replacement of Arlington Ave bridge	Low	Low	Medium
Replacement of Sierra St., Lake St. bridges	High	Medium	High
Replacement of Virginia St. bridge	High	Medium	Medium
In-kind replacement of Virginia St. bridge	High	Low	Medium
Improvement of Virginia St. bridge	?	?	High
Wells Ave lower bridge removal	Low	Low	Medium
Causeway at Rock Blvd.	?	?	Low
Causeway at Mc Carran Blvd.	?	?	High
Replace bridges at Pembroke Drive and Longley Lane	High	Medium	Medium
Culverts around existing downtown Reno bridges	Low	Medium	Low
Culverts around new bridges (Sierra, Virginia, Lake, Center Streets.)	?	Medium	Low
Floodwalls, Levees			
Floodwalls	High	Medium	Medium
Setback floodwalls	High	Medium	Medium
Modify Existing Floodwalls	?	?	?
Movable barrier floodwall system	?	Low	Low
Modular floodwalls	?	Medium	Low
Tilt-up floodwalls	?	Medium	Low
Levees	High	Medium	Medium
Setback levees	High	Medium	Medium
Modify Other Infrastructure			
Remove / relocate diversion structures	?	Medium	High
Relocate N. Truckee Drain outlet	Medium	Medium	High
Reduce width of Riverside Drive	Low	Low	High
Install road closure bladders	High	Medium	High
Floodplain Management Measures			
Flood-proofing	High	Low	High
Flood warning system	Being independently implemented		
Floodplain regulation and administration	Medium	?	High
Stormwater regulation and administration	Medium	?	High
Education	?	?	High

Measures which were determined to have low expected acceptability were eliminated from further consideration (i.e. rejected). Measures which appeared to have high acceptability were carried forward for incorporation into alternative plans. Measures which were expected to have high or medium effectiveness, and did not have low acceptability were also selected for inclusion in an alternative. Measures which were neither rejected nor selected were set aside for potential future reconsideration. Tables 4-8, 4-9, and 4-10 list those measures that have been selected, rejected, and set aside for potential future consideration, respectively.

TABLE 4-8

SELECTED FLOOD DAMAGE REDUCTION MEASURES (CARRIED FORWARD INTO ALTERNATIVES)

Measure	Effectiveness	Efficiency	Acceptability
Storage / Detention			
Enclosed detention facility at University Farms	High	Medium	Medium
Dedication of Floodplain for Natural Storage			
Increase Channel Flow Capacity			
Benching upstream of Steamboat confluence	Medium	Medium	Medium
Benching downstream of Steamboat confluence	High	Medium	Medium
Reduce Constrictions At Bridges			
Replacement of Sierra St., Lake St. bridges	High	Medium	High
Replacement of Virginia St. bridge	High	Medium	Medium
Improvement of Virginia St. bridge	?	?	High
Causeway at Mc Carran Blvd.	?	?	High
Replace bridges at Pembroke Drive and Longley Lane	High	Medium	Medium
Floodwalls, Levees			
Floodwalls	High	Medium	Medium
Setback floodwalls	High	Medium	Medium
Levees	High	Medium	Medium
Setback levees	High	Medium	Medium
Modify Other Infrastructure			
Remove / relocate diversion structures	Medium	Medium	High
Relocate N. Truckee Drain outlet	High	Medium	High
Reduce width of Riverside Drive	?	Low	High
Install road closure bladders	High	Medium	High
Floodplain Management Measures			
Flood-proofing	High	Low	High
Floodplain regulation and administration	Medium	High	High
Stormwater regulation and administration	Medium	High	High
Education	Medium	Medium	High

TABLE 4-9

REJECTED FLOOD DAMAGE REDUCTION MEASURES (LOW EFFECTIVENESS OR LOW ACCEPTABILITY)

Measure	Effectiveness	Efficiency	Acceptability
Storage / Detention			
New upstream reservoirs	?	Low	Low
Increasing flood control storage at upstream reservoirs	Low	Low	?
Tahoe re-operation (precautionary release)	Low	High	Low
Huffaker Hills detention facility	Low	Low	Low
Delayed release of Truckee River peak	Low	Medium	Medium
Increase Channel Flow Capacity			
Downtown Reno bypass channel	Low	Low	Low
Channelization between Keystone and Virginia Streets.	Low	?	?
Channelization under downtown Reno bridges	Low	?	Low
Channelization – Glendale Park area	Low	?	Low
Channel widening (excavation to channel bottom)	Medium	Medium	Low
Channel deepening at Vista reefs	High	Medium	Low
Reduce Constrictions At Bridges			
Replacement of Arlington Ave bridge	Low	Low	Medium
Wells Ave lower bridge removal	Low	Low	Medium
Causeway at Rock Blvd.	?	?	Low
Culverts around existing downtown Reno bridges	Low	Medium	Low
Culverts around new bridges (Sierra, Virginia, Lake, Center Streets.)	?	Medium	Low
Floodwalls, Levees			
Movable barrier floodwall system	?	Low	Low
Modular floodwalls	?	Medium	Low
Tilt-up floodwalls	?	Medium	Low

TABLES 4-10

FLOOD DAMAGE REDUCTION MEASURES RETAINED FOR POTENTIAL FUTURE RECONSIDERATION (NEITHER REJECTED NOR SELECTED)

Measure	Effectiveness	Efficiency	Acceptability
Storage / Detention			
Upstream detention with weirs	Low	?	?
Upstream, off-channel detention	?	Low	?
Bella Vista Ranch storage	?	?	?
Reduce Constrictions At Bridges			
In-kind replacement of Virginia St. bridge	High	Low	Medium
Floodwalls; Levees			
Modify Existing Floodwalls	?	?	?

4.4.2.3. Screening of Environmental Restoration Measures

Restoration measures were assessed on the basis of their acceptability. The majority of restoration measures were rated as having high community acceptability. The exceptions were the Bella Vista Ranch restoration element, the replacement of rip-rap with biotech bank stabilization, and channel modifications for Lahontan cutthroat trout habitat. These three elements were assigned a rating of medium. Their lower level of community acceptability is evidenced by their failure to be carried forward into the Coalition Concept Plan. These elements have been set aside for potential future reconsideration.

One measure, Fisherman's Park – West, became incorporated into the Hwy 395 to Greg St. restoration measure. It is no longer carried forward as a distinct measure, but is incorporated into the Hwy 395 to Greg St. measure.

Two measures, proposed for the Silva Ranch Road and Dorokstar Park areas, are beyond the project's immediate geographic area. These measures have been set aside for possible future reconsideration, in case a need should arise for mitigation measures above and beyond the restoration measures proposed for the immediate project area.

Screening results for environmental restoration measures are summarized in Tables 4-11, 4-12, and 4-13.

TABLE 4-11

SUMMARY OF RESULTS OF APPLYING SCREENING CRITERIA

Environmental Restoration Measures	Acceptability	Other
Hwy 395 to Greg Street	High	
Greg Street to South McCarran Boulevard	High	
South McCarran Boulevard to Steamboat Creek	High	
Steamboat creek: Pembroke Drive to Kimlick Lane	High	
Silva Ranch Road near Verdi		Beyond project area
Dorotskar Park area		Beyond project area
Fisherman's Park - West		Incorporated into other measure
Floodplain restoration, University Farms area	High	
Floodplain restoration, Edison area	High	
Bella Vista Ranch restoration	Medium	
Bank stabilization – "biotech" methods	High	
Replacement of rip-rap with biotech bank stabilization	Medium	
Channel modifications for Lahontan cutthroat trout habitat	Medium	
Education on floodplains as natural systems	High	

TABLE 4-12

SELECTED ENVIRONMENTAL RESTORATION MEASURES (CARRIED FORWARD INTO ALTERNATIVES)

Environmental Restoration Measures Carried Forward Into Alternatives
Hwy 395 to Greg Street
Greg Street to South McCarran Boulevard
South McCarran Boulevard to Steamboat Creek
Steamboat creek: Pembroke Drive to Kimlick Lane
Floodplain restoration, University Farms area
Floodplain restoration, Edison area
Bank stabilization – "biotech" methods
Education on floodplains as natural systems

TABLES 4-13

ENVIRONMENTAL RESTORATION MEASURES RETAINED FOR POTENTIAL FUTURE RECONSIDERATION

Environmental Restoration Measures Retained for Potential Future Reconsideration
Silva Ranch Road near Verdi
Dorotskar Park area
Bella Vista Ranch restoration
Replacement of rip-rap with biotech bank stabilization
Channel modifications for Lahontan cutthroat trout habitat

4.4.2.4. Screening Of River Parkway Measures

Measures principally contributing to the River Parkway planning objective were rated on their acceptability, using the Community Coalition as a barometer of the degree of importance the community attaches to the measure/element. Measures which the community appear to attach priority to were rated high. Potential plan elements appearing to be of lesser importance were rated medium. Measures rated as having high acceptability have been carried forward into the alternatives. Measures with a medium rating have been retained for potential future reconsideration. Screening results for river parkway measures are summarized in Tables 4-14, 4-15 and 4-16.

TABLE 4-14

SUMMARY OF RESULTS OF APPLYING SCREENING CRITERIA

River Parkway Measures	Acceptability
Create new parkland	High
New bicycle trails	High
Channel modifications for kayak course	Medium
Relocate sewer pipeline crossings	High
Removal of rubble	Medium

TABLE 4-15

SELECTED RIVER PARKWAY MEASURES (CARRIED FORWARD INTO ALTERNATIVES)

River Parkway Measures Carried Forward Into Alternatives
Create new parkland
New bicycle trails
Relocate sewer pipeline crossings

TABLES 4-16

RIVER PARKWAY MEASURES RETAINED FOR POTENTIAL FUTURE RECONSIDERATION

River Parkway Measures Retained for Potential Future Reconsideration
Channel modifications for kayak course
Removal of rubble

4.4.3. Potential Combinations of Measures

4.4.3.1. 1988 WRDA Authorized Plan

The Corps completed a feasibility report in 1985 that identified a project that was designed to safely pass a flow of 18,500 cfs through Reno. The project was subsequently authorized by Congress under the Water Resources Development Act (WRDA) of 1988. The 1988 WRDA authorized project is one potential bundling of measures which could be considered for advancement to the status of an alternative project plan for further analysis.

Due to revised hydrologic analysis, it has been subsequently estimated that this project would reduce the chance of flooding in the project area to about 1 in 75 in any given year. The

flood control features of the plan included approximately 5 miles of floodwalls, 7 miles of levees, and the replacement of six bridges along the Truckee River. Some channel excavation would be required and a 900-acre detention basin and levees would be constructed to mitigate potential increases in downstream flooding due to upstream flood control measures. Mitigation of adverse effects of the flood control features on fish and wildlife resources would be accomplished through planting of riparian vegetation on 31 acres along the Truckee River and Steamboat Slough. The total estimated first cost of the project, updated to 1999 prices, is $105.7 million and estimated first Federal cost is $55.5 million. Project benefits include $13.7 million for flood control and $3.4 million for recreation. Plate 4-9 shows a general layout of the authorized project plan.

The WRDA 1988 authorized plan offers potential to contribute to flood damage reduction in the study area, but it would not provide protection against the 100-year event with current hydrologic information. Thus it would not lead to the elimination of the requirement for flood insurance in the project area. In addition, some of the authorized project features (portions of levees in the Truckee Meadows area and portions of its detention basin) are designed to be sited where land development and the construction of real estate improvements have subsequently occurred. Throughout the project area, the authorized plan made use of levees positioned close to the river's edge, which would restrict visual and physical access to the river, and probably result in higher water surface elevations than a plan designed with setback levees. The authorized project also included some channelization measures which have been eliminated through the current screening process. Consequently the 1988 authorized project, as designed, will not be put forward as an alternative for further detailed analysis. Nevertheless, this leaves open the possibility of grouping measures into an alternative that has similarities to the 1988 WRDA authorized project.

4.4.3.2. Community Coalition Concept Plan

The Truckee River Flood Management Community Coalition, through numerous working meetings over a half year or more, has been discussing various potential elements to a project that would contribute to flood damage reduction, environmental restoration, and river parkway objectives. Elements which appear to have a high level of community acceptance have been bundled by the Coalition into an "Emerging Draft Concept Plan" which is the current forerunner to a future Coalition Concept Plan. The Coalition's draft Concept Plan is a second potential combination of measures / elements which could be advanced as an alternative for further study. Since support from the local community is essential for the successful culmination of efforts to address the flood hazard in the Reno-Sparks-Truckee Meadows area, the USACE will seriously consider as an alternative any reasonable plan that the Coalition can bring forward in sufficient detail to allow it to be assessed against other alternative projects. Consequently, the Coalition's working draft of its Concept Plan is being advanced to the level of an alternative for further assessment of its relative merits and costs. The section in this report discussing Alternative 5 explains which of the measures which were selected for advancement into the alternatives are contained in the Coalition's draft Concept Plan.

In order to compare the Coalition's alternative plan with a reasonable array of other alternatives, promising measures were grouped together to form a downtown Reno flood

damage reduction component, four different combinations of flood damage reduction measures for the Truckee Meadows area, and an environmental restoration component.

4.4.3.3. Downtown Reno Flood Damage Reduction Component

A recent prior study, *Designs and Cost Estimates for Flood Damage Reduction, Downtown Reno Reach Truckee Meadows, Washoe County, Nevada (May 2000)* focused on measures and alternatives for reducing flood damages in the downtown Reno portion of the current project study area. The least cost alternative from that report is a potential combination of measures which offers excellent potential to contribute to the project's flood damage reduction objective. A pragmatic desire to avoid a situation in which the costs of examined alternatives might exceed estimated project benefits led to a decision to incorporate the set of measures represented by that prior alternative into project alternatives for the entire study area. The discussion of which selected measures have been combined for the purpose of flood protection in the downtown Reno portion of the study area is discussed later in this chapter, in the "Overview of Alternatives" subsection and in the detailed description of Alternative 1.

Incorporation of the prior least cost set of measures from that study does not rule out the future possibility of modifying the set of measures focused on flood protection for downtown Reno. In particular, there has been discussion regarding the possibility of setting floodwalls back from the river's edge in conjunction with road closure structures and increased flood-proofing. The alternatives presented in this report can be modified in future additional studies.

4.4.3.4. Flood Damage Reduction Measure Combinations for Truckee Meadows Area

Several measures which conceptually have good prospects (medium to high expected effectiveness) for providing flood protection in the Truckee Meadows area, downstream of Hwy. 395, were selected, then grouped together in four different combinations, to complement the downtown Reno flood damage reduction component. These four combinations differentiate Alternatives 1-4.

4.4.3.5. Environmental Restoration Component

The approach to designing environmental restoration measures to complement the flood damage reduction measures was to combine various restoration actions into a unique measure suited to the conditions at a particular site. Restoration actions are defined by the vegetation zones that would be present at the site and include enhancing existing riparian habitat, creating new riparian habitat, creating new riparian transition habitat, and creating new wetland habitat. The appropriate matching of these actions to the conditions at a given site guided the development of potential measures. These measures were in turn grouped into an environmental restoration component that could be combined with a set of flood damage reductions to form a more complete alternative. More details on how restoration measures were effectively matched to site specific proposed flood protection measures are provided in the overview of alternatives section, later in this chapter.

4.4.3.6. Potential to Combine River Parkway Measures

Alternatives 1-4 are expected in the future to include recreationally oriented measures that would contribute to the river parkway planning objective. However, at the current level of project planning, details of such measures were not incorporated in this report in order to focus on the relative costs and differences between principal flood damage reduction options. Measures which contribute to the river parkway objective are included in Alternative 5, and could be added to one or more other alternatives in the future.

4.5. ALTERNATIVE PROJECT PLANS

4.5.1. Overview of Alternatives

There are five alternative projects assessed in this report. Alternatives 1-4 have similarities that are described next. Alternative 5 is the Truckee River Flood Management Community Coalition's most recent working draft version of its Concept Plan.

4.5.1.1. Alternatives 1-4

Alternatives 1-4 all have four common elements: (1) a component which provides protection for the downtown Reno portion of the study area (Booth St. to US Hwy. 395); (2) an environmental restoration component; (3) physical barriers made up of levees, several of which are set back considerably from the river's edge, and floodwalls; and (4) replacement of two bridges in the Truckee Meadows portion of the study area (Pembroke Dr. and Longley Lane bridges). Floodwalls were used in reaches where land or structure constraints existed and to minimize the required right-of-way easements. Levees were used in reaches where open space/undeveloped land was available to accommodate the wider footprint.

As previously discussed, it is anticipated that the floodplain management measures will be pursued by the local sponsors to minimize the risk of flood damage to future development or redevelopment in the floodplain and to minimize the potential for future development to contribute to increased discharge in the Truckee River and its tributaries. These expectation are based upon the fact that the federal government would require local sponsors, as part of a Project Cooperation Agreement, to make commitments oriented toward preventing unwise future development in the floodplain and ensuring the compatibility of future development with the flood protection provided by the project.

Thus, floodplain management measures would be unlikely to be part of the federally sponsored project itself, but are expected to be implemented by the local sponsors. For this reason, floodplain management measures are not explicitly designated as part of Alternatives 1-4, but they are for Alternative 5, which the Community Coalition took the lead in developing. The benefits of floodplain management measures, especially locally driven floodplain regulation, are that they would protect the federal and local investment in the project and could help reduce damages from flood events greater in magnitude than the events for which the levees and floodwalls are designed.

4.5.1.1.1. Downtown Reno Flood Damage Reduction Component

Alternatives 1-4 all include the following measures designed to provide flood damage reduction benefits for the developed area bordering the Booth St. – Hwy. 395 (downtown Reno) reach of the Truckee River:

- Replacement of Sierra, Virginia, and Lake Street Bridges, and
- Floodwalls.

For reference, this combination of measures is the same as those put forward in the Downtown Reno Feasibility Report as Alternative 3, the least cost plan for the downtown Reno area.

4.5.1.1.2. Truckee Meadows Area Flood Damage Reduction

The four alternatives differ in significant ways in how they would provide flood protection for existing development along the Truckee River downstream of Hwy. 395, and in the areas directly affected by flooding of Steamboat Creek and Boynton Slough. These areas are collectively referred to as the "Truckee Meadows Reach", to distinguish it from the Booth St. – Hwy 395 area on the Truckee River (Downtown Reno reach.), as shown in Plate 4-2. Alternatives 1-4 differ with regard to whether or not they include the detention basin and channel benching both upstream and downstream of the confluence of Steamboat Creek and Truckee River ("upstream" and "downstream" channel benching). The heights of the floodwalls and levees may also differ between the alternatives.

4.5.1.1.3. Environmental Restoration Component

A conceptual habitat restoration component has been developed for the Truckee River between Interstate 395 and its confluence with Steamboat Creek and for Steamboat Creek downstream from Pembroke Lane. This component has been developed in conjunction with flood damage reduction plans for the project reach. Restoration actions include enhancing existing riparian habitat, creating riparian habitat, creating riparian transition habitat, and creating wetland habitat. In reaches of the river with limited space available, restoration actions focus on enhancing existing riparian habitat by planting native trees and shrubs among existing vegetation to create a continuous riparian corridor. Where proposed flood control features are setback from the river, creation of riparian habitat to create a wide, continuous riparian corridor is proposed. The width of the riparian corridor is increased in areas with available space by creating a riparian transition zone adjacent to riparian habitat. In addition, in alternative plans where channel benching is proposed, additional restoration is included on the benched banks. Creation of a wetland habitat is proposed along Steamboat Creek that includes a riparian area, wetlands, and deep water areas.

4.5.1.1.4. River Parkway

Alternatives 1-4 will likely include recreationally oriented measures that would contribute to the river parkway planning objective. However, at the current level of project planning, details of such measures were not incorporated in this report.

4.5.1.1.5. Summary of Alternatives 1-4

Table 4-17 summarizes all major components of Alternatives 1-4. Although not currently defined, Alternatives 1-4 will likely incorporate River Parkway measures during future refinement of the alternatives.

TABLE 4-17

MEASURES INCORPORATED INTO ALTERNATIVES 1-4

Primary Objective	Measure	Alternative			
		1	2	3	4
Flood Damage Reduction – Downtown Reno Reach	Sierra Street Bridge Replacement	X	X	X	X
	Virginia Street Bridge Replacement	X	X	X	X
	Lake Street Bridge Replacement	X	X	X	X
	Floodwalls	X	X	X	X
Flood Damage Reduction – Truckee Meadows Reach	Replace Longley Lane Bridge	X	X	X	X
	Replace Pembroke Drive Bridge	X	X	X	X
	Floodwalls	X	X	X	X
	Levees/Setback Levees	X	X	X	X
	Channel Benching Upstream of Steamboat Confluence		X		X
	Channel Benching Downstream of Steamboat Confluence		X		X
	University Farms Detention Basin			X	X
	Dedication of Floodplain to Natural Storage	X	X		
Environmental Restoration	Interstate 395 to Greg Street	X	X	X	X
	Greg Street to South Mc Carran Boulevard	X	X	X	X
	South Mc Carran Boulevard to Steamboat Creek	X	X	X	X
	Steamboat Creek: Pembroke Drive to Kimlick Lane	X	X	X	X

4.5.1.2. Alternative 5 (Working Draft Coalition Concept Plan)

Alternative 5 is the most recent draft version of the Coalition's evolving Concept Plan. It combines a large number of flood damage reduction elements, environmental restoration elements, and river parkway elements. It also includes floodplain management measures that the community would like to pursue with the local sponsors.

To facilitate comparison of Alternative 5 with Alternatives 1-4, Table 4-18 indicates which types of components discussed in Alternatives 1-4 are also present in Alternative 5. Alternative 5 is presented here in its own table because few if any of its elements are identical to those contained in Alts 1-4. It contains some of the same *types* of components, but the details of the components themselves (the measures or sets of measures) are not the same.

TABLE 4-18

COMPONENTS OF ALTERNATIVE 5 SIMILAR IN TYPE TO THOSE IN ALTS. 1-4.

Portion of Study Area	Component	Alternative				
		1	2	3	4	5
Overall	Environmental Restoration	X	X	X	X	X
	River Parkway					X
Flood Damage Reduction - Downtown Reno Reach	Floodwalls	X	X	X	X	X
	Bridge Replacement	X	X	X	X	X
Flood Damage Reduction - Truckee Meadows Reach	Levees/Setback Levees	X	X	X	X	X
	Floodwalls	X	X	X	X	X
	Bridge Replacement	X	X	X	X	X
	Upstream Benching		X		X	
	Downstream Benching		X		X	X
	Detention Basin			X	X	
	Dedication of Floodplain to Natural Storage	X	X			X

Alternative 5 also has a group of elements which are oriented at creating an envisioned Truckee River parkway and a group of elements oriented at floodplain management. At the level of specific measures, Alternative 5 includes elements not present in any of the other four alternatives at this time.

4.5.2. No-Action Alternative

Under this alternative, no future action would be taken by the Federal Government to increase flood protection in the study area. The existing flood control facilities, in both the downtown Reno and Truckee Meadows reaches, would continue to operate as described in the without project future condition. This alternative provides a baseline from which to evaluate the effects of all other alternatives.

4.5.2.1. Features

The No-Action Alternative does not include construction and/or mitigation efforts, other than existing or currently planned programs to enhance flood protection through the downtown Reno reach and the Truckee Meadows reach of the Truckee River, as described in the without project (No-Action) future conditions.

4.5.2.2. Accomplishments

The No-Action Alternative would neither reduce water surface elevations during a flood event, nor increase the channel carrying capacity of the Truckee River or Steamboat Slough. The Truckee River channel would be unable to carry the 100-year design flow of 20,700 cubic feet per second (cfs). Table 4-19 illustrates the water surface elevations for the No-Action Alternative at selected locations along the Truckee River and Steamboat Slough.

TABLE 4-19

WATER SURFACE ELEVATIONS FOR THE NO-ACTION ALTERNATIVE IN THE TRUCKEE MEADOWS REACH

Location	Flow (cfs)
Truckee River before confluence with Steamboat Creek	
Truckee River after Steamboat Creek confluence	17,800
Water Surface Elevations at Above Modeled Flows	**STAGE (NAVD 88 –Feet)**
Truckee River (Upstream of Steamboat Creek Confluence)	
Mouth of Steamboat	4394.2
South Mc Carran Boulevard	4401.9
Rock Boulevard	4417.2
Greg Street	4426.9
Steamboat Creek	
Pembroke Drive	4396.5
Mira Loma Drive	4396.5
Note: Alternatives were modeled at different flows (cfs), thus direct comparison of water surface elevations for modeled alternatives is not applicable.	

4.5.2.3. Effects

The No-Action Alternative would result in continued susceptibility to flood related damages.

4.5.2.4. Operations and Maintenance Requirements

No O&M would be required above and beyond current practices. However, the potential exists for the existing O&M costs to increase due to the aging of infrastructure.

4.5.2.5. Costs

No implementation or construction costs are associated with this alternative.

4.5.2.6. Uncertainty

This alternative would not assist in meeting the objectives of this Alternatives Report.

4.5.2.7. Advantages and Disadvantages

Under the No-Action Alternative, there would be no imposed constraints on future implementation of any other alternative. There would be no cost increases for O&M of the existing facilities. The primary disadvantage of this alternative would be (1) the safe channel carrying capacity would not be increased, (2) no additional storage would be created to capture peak flood flows, and (3) no additional flood protection would result from the No-Action Alternative.

4.5.3. Alternative 1 – Bridge Replacements, Floodwalls, Levees/Setback Levees and Dedication of Floodplain to Natural Storage

4.5.3.1. Features

4.5.3.1.1. Downtown Reno Reach

Alternative 1 would increase flood protection in the downtown Reno reach of the Truckee River by incorporating the following measures, as shown in Plate 4-10:

- Sierra Street Bridge Replacement,
- Virginia Street Bridge Replacement,
- Lake Street Bridge Replacement, and
- Floodwalls.

Bridge Replacement
This alternative would replace three bridges located in the Downtown Reno reach. The Sierra Street and Lake Street Bridges would be replaced with bridges of similar width as the existing structures. The existing Virginia Street Bridge has a deck width of approximately 80 feet wide, providing four lanes of traffic, two lanes of parallel parking and a pedestrian sidewalk in each direction. The Virginia Street Bridge would be replaced with a new bridge with a deck width of approximately 66 feet, providing for four lanes of traffic and a pedestrian sidewalk in each direction.

Floodwalls
Alternative 1 would include both the replacement of existing floodwalls and the construction of new floodwalls. Most of the floodwalls requiring replacement are located within the channel, primarily between Arlington Avenue downstream to Lake Street. Most of the newly constructed floodwalls would be located on the existing banks, primarily upstream of Arlington Avenue on the north (left) bank and downstream of Lake Street. The floodwall lengths included in Alternative 1 are summarized in Table 4-20.

TABLE 4-20

LOCATION OF FLOODWALLS IN THE DOWNTOWN RENO REACH FOR ALTERNATIVE 1

Stream	Bank Location	Description(Upstream to Downstream)	Included in Alt. 1	Increase in Floodwall Height Relative to Existing Conditions	
				Maximum (feet)	Average (feet)
Downtown Reno Reach					
Truckee River	North (left)	Booth Street to Brick Park	X	8.2	3.1
	North (left)	Sierra Street to East 2nd Street	X	2.4	1.1
	North (left)	Kuenzli Street to 450 feet downstream	X	1.4	0.8
	South (right)	1,550 feet upstream (west) of Arlington Avenue to Sierra Street	X	7.2	5.1
	South (right)	Virginia Street to 250 feet downstream of Lake Street	X	3.2	1.1

4.5.3.1.2. Truckee Meadows Reach

Alternative 1 provides flood protection for existing development in the Truckee Meadows reach by incorporating the following measures, as shown in Plate 4-11:

- Pembroke Bridge replacement;
- Longley Lane Bridge replacement;
- Floodwalls;
- Levees/Setback Levees; and
- Dedication of floodplain to natural storage.

Bridge Replacement
Alternative 1 would replace two bridges in the Truckee Meadows reach, one located across Steamboat Slough and one located across Boyton Slough. The Pembroke Bridge located on Steamboat Slough and Longley Lane Bridge located on Boyton Slough, would be replaced with structures with greater cross-sectional flow area.

Floodwalls
Along the Truckee River in the Truckee Meadows reach, floodwalls would be used most extensively on the north side of the river, whereas levees would be used on the south side. Along Boynton Slough, floodwalls would be used on both sides. For Steamboat Creek, a combination of floodwalls and levees would be used on either side of the stream.

In the Truckee Meadows area, floodwalls would be used in 11 segments, six off of the Truckee River, three off of Boynton Slough, and two off of Steamboat Creek, as shown in Table 4-21.

TABLE 4-21

LOCATION OF FLOODWALLS IN THE TRUCKEE MEADOWS REACH FOR ALTERNATIVE 1

Reach	Bank Location	Description (Upstream to Downstream)	Included in Alt. 1	Length (ft)	Min. Height (ft)	Max. Height (ft)	Ave. Height (ft)
Truckee Meadows Reach							
Truckee River	South (right)	Highway 395 to Glendale Avenue	X	2,250	8	12	9.6
	North (left)	Glendale Avenue to Greg Street	X	2,808	4	14	10.8
	North (left)	Greg Street to South Rock Boulevard	X	1,882	4	10	6.3
	North (left)	South Rock Boulevard to South Mc Carran Boulevard	X	6,050	4	12	7.3
	North (left)	South Mc Carran Boulevard to North Truckee Drain outlet	X	12,450	4	14	7.6
	North (left)	North Truckee Drain outlet to 1st railroad bridge downstream of Vista	X	4,226	6	18	11.6
Boynton Slough	North (left)	Longley Lane to South Mc Carran Boulevard	X	1,853	4	10	5.5
	North (left)	South Mc Carran Boulevard to South Rock Boulevard	X	5,549	6	14	8.2
	South (right)	South Mc Carran Boulevard to northeast end of Fairwood Drive	X	6,216	6	14	8.5
Steamboat Creek	West (left)	Mira Loma Drive to northeast end of Fairwood Drive (Setback)	X	3,644	6	12	10.0
	East (right)	Along Hidden Valley Drive northeast to Pembroke Drive	X	5,640	8	14	9.8

Levees and Setback Levees

In the Truckee Meadows Area, three levee segments would be used along the Truckee River on its south (right) side; one levee segment would connect Truckee River levees with Boynton Slough floodwalls; and three levee segments would be situated along or off of Steamboat Creek, as shown in Table 4-22. No levees would run along Boynton Slough; however, a levee would run along South Mc Carran Boulevard from the Truckee River to the Boyton Slough floodwalls.

TABLE 4-22

LOCATION OF LEVEES IN THE TRUCKEE MEADOWS REACH FOR ALTERNATIVE 1

Location	Bank Loc.	Description (If Stream Length, Upstream to Downstream)	Included in Alt. 1	Length (ft)	Min. Height (ft)	Max. Height (ft)	Ave. Height (ft)
Truckee Meadows Reach							
Truckee River	South (right)	Glendale Avenue to Greg Street	X	2,995	0	8	5.4
	South (right)	Greg Street to South Rock Boulevard (setback)	X	3,240	1	7	3.1
	South (right)	South Rock Boulevard to South Mc Carran Boulevard (setback to Mill Street)	X	5,460	2	9	4.3
Detention Basin Levees	West	From Truckee River to Pembroke Drive (parallel to South Mc Carran Boulevard)	X	8,503	2	8	5
	North	From South Mc Carran Boulevard east along the Truckee River right bank for 7,500 feet		7,500	3	13	6.3
	South-East	From Pembroke Drive to confluence with Truckee River (setback from Steamboat Creek)		8,719	5	10	7.4
Steamboat Creek	West (left)	From Pembroke Drive to Boynton Slough Floodwalls	X	663	1	6	4.5
	West (left)	Mira Loma Drive to Rio Poco Road (setback considerably)	X	7,520	1	10	6.1
	East (right)	Along Mira Loma Drive for 809 feet to Rosehill Court	X	809	3	8	5.5
	East (right)	From Pembroke Drive along Steamboat Creek for 3,850 feet	X	3,850	1	10	6.1

Dedication of Floodplain to Natural Storage
Alternative 1 would include the dedication of floodplain for natural storage in the University Farms area. This storage would be located along the Truckee River from Mc Carran Blvd. to the Steamboat Creek confluence between south bank of Truckee River to Boyton Slough. This element would be carried out in conjunction with a proposed restoration element, described separately. Implementation at a minimum would require reaching agreement with University of Nevada, Reno regarding disposition of a portion of the University Farms area, and would likely involve acquisition of floodplain lands.

4.5.3.1.3. Environmental Restoration Component

Alternative 1 would enhance riparian and wetland habitat values along the Truckee River and Steamboat Creek by incorporating the following environmental restoration measures, as shown in Plate 4-12:

- Interstate 395 to Greg Street;
- Greg Street to South Mc Carran Boulevard;
- South Mc Carran Boulevard to Steamboat Creek; and
- Steamboat Creek: Pembroke Drive to Kimlick Lane.

4.5.3.2. Accomplishments

This alternative would reduce flood damages in both the downtown Reno and Truckee Meadows reaches. Table 4-23 compares the difference in water surface elevations between the No-Action Alternative and Alternative 1 for the downtown Reno reach.

TABLE 4-23

REDUCTION IN WATER SURFACE ELEVATIONS BETWEEN NO-ACTION AND ALTERNATIVE 1 FOR THE DOWNTOWN RENO REACH

Location	Difference in Water Surface Elevation for 20,700 cfs Flow (feet)
Booth Street to Keystone Avenue	0
Keystone Avenue to Arlington Avenue	0
Arlington Avenue to Sierra Street	1.61
Sierra Street to Virginia Street	1.54
Virginia Street to Center Street	0.46
Center Street to Lake Street	0.55
Lake Street to East 2nd Street	0
Kuenzli Street to Wells Avenue	0.36

Table 4-24 provides the water surface elevations for the No-Action Alternative and Alternative 1 at selected locations in the Truckee Meadows area.

TABLE 4-24

WATER SURFACE ELEVATIONS FOR ALTERNATIVE 1 IN THE TRUCKEE MEADOWS REACH

Location	Alt. 1
Modeled Flows	**Flow (cfs)**
Truckee River before confluence with Steamboat Creek	20,700
Truckee River after Steamboat Creek confluence	21,741
Water Surface Elevations at Above Modeled Flows	**Stage (NAVD 88 -feet)**
Truckee River(Upstream of Steamboat Creek Confluence)	
Mouth of Steamboat	4396.0
South Mc Carran Boulevard	4408.2
Rock Boulevard	4418.4
Greg Street	4427.8
Steamboat Creek	
Pembroke Drive	4397.8
Mira Loma Drive	4398.0
Truckee River (Downstream of Steamboat Creek Confluence)	
Downstream of Steamboat Creek confluence	4389.7
Note: Alternatives were modeled at different flows (cfs), thus direct comparison of water surface elevations for modeled alternatives is not applicable.	

The restoration component of this alternative would:

- Enhance 22.3 acres of existing habitat,
- Create 139.9 acres of new habitat, and
- Create 33.7 acres of wetlands.

Implementation of the restoration component would create a wide, nearly continuous corridor of riparian vegetation along the south bank of the Truckee River. Riparian enhancement on the north side of the river would also serve to increase habitat connectivity. The wetland complexes along Steamboat Creek would restore some of the wetland habitat values historically supported in the Truckee Meadows area.

4.5.3.3. Effects

This alternative increases the channel carrying capacity through the downtown Reno reach to the specified level of protection. This alternative provides similar effects for the downtown Reno reach as Alternative 2, Alternative 3, and Alternative 4, as they incorporate the same measures.

For the Truckee Meadows reach, this alternative is anticipated to require the largest floodwalls and levees relative to other alternatives. These higher floodwalls would reduce river visibility and access. These higher floodwalls may also negatively impact residual land values of the property adjacent to the river

The following land use effects were evaluated for Alternative 1. The net vegetated habitat impacts that may occur as a result of implementing Alternative 1 is 1,395 acres of habitat loss that includes willows, Fremont cottonwoods, elms, box elders, ornamental plantings, agricultural areas, and undefined areas. Of this acreage, 91 percent is non-riparian habitat (i.e., agricultural areas, ornamental plantings, and undefined areas). This net habitat loss takes into consideration land use for right-of-ways, flowage easements, permanent easements, and temporary construction easements with flowage easements accounting for 95 percent of these uses. These same land uses will affect 129 acres of vegetated habitat to provide areas for environmental restoration; 92 percent of the affected acreage is non-riparian habitat. Actual loss of existing riparian habitat is 2.24 acres. However, 196 acres of habitat will be created or enhanced as part of environmental restoration efforts. Environmental restoration will include the creation of riparian transition areas, new riparian areas, wetlands, and deep-water areas; and the enhancement of existing riparian areas. A Habitat Evaluation Procedure (HEP) analysis is currently in progress that will determine the net gain or loss in beneficial habitat as a result of this alternative. The environmental restoration goal for the project is to have a net gain in habitat. A HEP analysis allows for the rating of the quality and quantity of habitat in order to quantify the impacts of changes made to land and water development projects. Thus, although greater than 1,500 acres of gross vegetated habitat may be impacted by this alternative, it is anticipated that the 196 acres restored will be of greater value to the environment than the original acreage impacted.

Wildlife, including federal endangered and threatened species will be temporarily affected by the implementation of Alternative 1. Species present may experience temporary disturbance and/or displacement due to construction noise and activity for the duration of the project (approximately 3 years). This disturbance will not be sustained in any one particular locale for extended lengths of time because of the large study area (approximately 8,900 acres) that the project covers. Additionally, any displaced species will be expected to return once construction is completed in that area. The quantity and variety of species is also expected to increase once the restored areas become established.

Potential beneficial and adverse effects are associated with the implementation of Alternative 1 on fisheries. Adverse effects may result from construction actions causing pollution, increased sedimentation, increases in short-term turbidity, vegetation removal, fish stranding, short-term increases in water temperature, and a reduction in habitat complexity. Impacts to the federally-listed threatened Lahontan cutthroat trout and endangered cui-ui may occur during the spring and early summer if water quality impacts within the construction area are sustained in reaches downstream in the area of Derby Dam where these species are known to spawn. Beneficial effects will result from the environmental restoration activities; riparian plantings will result in increased shade cover thus lowering water temperatures, also an increase in leaf and insect drop will provide increased habitat complexity and food availability.

As part of Alternative 1, construction of levees and floodwalls along the Truckee River corridor will limit access to many of the parks and other recreational facilities as well as the river itself. Recreational impacts will only be temporarily restricted during construction, and will resume to normal access following completion of construction. Beneficial impacts to recreation may occur if additional parks and river access points are added as part of the environmental restoration effort.

Changes to the river channel would result in geomorphologic changes until the river is able to establish equilibrium. In attempting to reach this equilibrium, the river would adjust its hydraulic properties, including channel width and depth, velocity, roughness, slope, sinuosity, etc. If the river is incapable of changing its boundaries, channel armoring and periodic dredging will be required. Since Alternative 1 should not alter the flow of the river, the equilibrium of the channel should not be impacted

Effects of Alternative 1 on aesthetics, agriculture and prime and unique farmlands, air quality, cultural resources, socioeconomic, water quality, and water supply will be discussed in detail in the EIS being prepared for this project. The EIS will also include additional discussion of the environmental effects of fisheries, land use, recreation, species of special concern, vegetation, and wildlife.

4.5.3.4. Operation and Maintenance Requirements

The local sponsor would be responsible for the operation, maintenance, replacement, and rehabilitation of the project features. For the downtown Reno reach, the operation and maintenance for the replaced bridges and floodwalls would not be expected to change relative to existing condition.

For the Truckee Meadows reach, the primary operation and maintenance requirements of the proposed project would consist of floodwall and levee maintenance. These requirements include (1) regularly inspecting and maintaining floodwalls and (2) regularly inspecting and maintaining levees regularly and keeping them free of growth that could reduce reliability.

During floods, the levees and floodwalls would be patrolled continuously to locate possible boils or unusual wetness that signals a problem in the structure. As with all proposed measures, appropriate advance measures would be taken to ensure the availability of adequate labor and materials to meet all contingencies. Immediate steps would need to be taken to control any condition that would endanger the levee and to repair the damaged section. Should bladders or other temporary closure structures be utilized where roadways create gaps in the floodwall line, they would require personnel to activate them during a flood and would need to be inspected routinely for serviceability.

The habitat areas created by this alternative will require maintenance to preserve and maintain the plantings. This maintenance will be required for at-least three years following completion of construction. At the end of the three-year term, the areas will be turned over to the local sponsor if the vegetation has become established, and no additional maintenance requirements are expected.

4.5.3.5. Costs

The estimated first cost of constructing the facilities proposed in this alternative for a flow of 20,700 cfs is approximately $186.5 million. The average annual cost is $ 14.5 million. A summary of the costs for Alternative 1 is provided in Table 4-25. Appendix A – Cost Estimates provides detailed cost estimate information.

TABLE 4-25

COST ESTIMATE FOR ALTERNATIVE 1

Account Number	Item	Item Description	Item Cost ($1,000)	NED Cost ($1,000)	NER Cost ($1,000)
First Cost					
01	Lands and Damages	Land Preparation and Acquisition	$64,661	$64,661	
02	Relocations	Bridge Relocations	$11,629	$11,629	
		Utility Relocation	$ 970	$ 970	
06	Fish and Wildlife Facilities	Environmental Restoration	$16,236		$16,236
09	Channels and Canals	Channel Widening	$ 0	$ 0	
11	Levees and Floodwalls	Levees	$7,144	$7,144	
		Traditional Vertical Floodwalls	$30,671	$30,671	
14	Recreation Facilities		$ 0	$ 0	
15	Flood Control and Diversion Structures	Relief Wells	$2,680	$2,680	
		Ogee Inlet Structure	$ 0	$ 0	
Subtotal Construction Cost			$133,991	$117,755	$16,236
18	Cultural Resources Preservation	1% of Subtotal Construction Cost	$1,340	$1,178	$ 162
Contingency		15% of Subtotal Construction Cost	$20,099	$17,663	$2,435
Total Construction Cost			$155,430	$136,596	$18,833
30	Planning, Engineering, and Design	12% of Total Construction Cost	$18,652	$16,392	$2,260
31	Construction Management	8% of Total Construction Cost	$12,434	$10,928	$1,507
Total Project First Cost			$186,516	$163,916	$22,600
Annual Cost					
Interest and Amortization		7 3/8% over 50 years	$14,159	$12,443	$1,716
Operation and Maintenance			$ 350	$ 350	$ 0
Annualized Replacement Costs			$ 0	$ 0	$ 0
Total Project Annual Cost			**$14,509**	**$12,793**	**$1,716**

4.5.3.6. Uncertainty

The uncertainty related to this alternative is low relative to the other plans considered. The uncertainty associated with the Downtown Reno reach is the same for all five plans considered. There is minimal uncertainty associated with the floodwalls and bridge replacements for this reach.

Relative to the other plans, the uncertainty is low for the Truckee Meadows reach. Minimal uncertainty is associated with the floodwalls, levees and bridge replacements in this reach.

4.5.3.7. Advantages and Disadvantages

The primary economical and environmental advantage of this alternative is reduced flood-related damages and increased fish & wildlife habitat. Other specific advantages include:

- Low uncertainty relative to other alternatives;
- Lowest annual cost;
- Lowest operation and maintenance requirements; and
- Minimized in-channel construction and/or excavation.

The primary disadvantages of Alternative 1 include:

- May reduce access and visibility of river due to floodwall and levee heights.

4.5.4. Alternative 2 – Bridge Replacements, Floodwalls, Levees/Setback Levees, Channel Benching, and Dedication of Floodplain to Natural Storage

4.5.4.1. Features

4.5.4.1.1. Downtown Reno Reach

Alternative 2 would increase flood protection in the downtown Reno reach of the Truckee River by incorporating the following measures, as shown in Plate 4-10:

- Sierra Street Bridge replacement;
- Virginia Street Bridge replacement ;
- Lake Street Bridge replacement; and
- Floodwalls.

These are the same combination of measures presented for the downtown Reno reach in Alternative 1.

4.5.4.1.2. Truckee Meadows Reach

Alternative 2 provides flood protection for existing development in the Truckee Meadows reach by incorporating the following measures, as shown in Plate 4-13:

- Pembroke Bridge Replacement;
- Longley Lane Bridge Replacement;
- Floodwalls;
- Levees/Setback Levees;
- Channel Benching Upstream of Steamboat Creek Confluence;
- Channel Benching Downstream of Steamboat Creek Confluence; and
- Dedication of Floodplain to Natural Storage.

As with Alternative 1, Alternative 2 would include setback levees, floodwalls, and bridge replacements. Unlike the prior alternative, Alternative 2 would include benching of the Truckee River channel both upstream and downstream of the confluence with Steamboat Creek.

Bridge Replacement
Alternative 2 incorporates the same bridge replacements as Alternative 1, (Longley Lane on Boyton Slough and Pembroke Drive on Steamboat Creek).

Floodwalls
Alternative 2 incorporates the same floodwall reaches for the Truckee Meadows area as Alternative 1, as shown in Table 4-26. The floodwall heights shown in Table 4-26 are similar to those shown for all Alternatives. Upon completion of detailed hydraulic modeling, smaller floodwall heights would be expected relative to Alternative 1.

TABLE 4-26

LOCATION OF FLOODWALLS IN THE TRUCKEE MEADOWS REACH FOR ALTERNATIVE 2

Reach	Bank Location	Description (Upstream to Downstream)	Included in Alt. 2	Length (ft)	Min. Height (ft)	Max. Height (ft)	Ave. Height (ft)
Truckee Meadows Reach							
Truckee River	South (right)	Highway 395 to Glendale Avenue	X	2,250	8	12	9.6
	North (left)	Glendale Avenue to Greg Street	X	2,808	4	14	10.8
	North (left)	Greg Street to South Rock Boulevard	X	1,882	4	10	6.3
	North (left)	South Rock Boulevard to South Mc Carran Boulevard	X	6,050	4	12	7.3
	North (left)	South Mc Carran Boulevard to North Truckee Drain outlet	X	12,450	4	14	7.6
	North (left)	North Truckee Drain outlet to 1st railroad bridge downstream of Vista	X	4,226	6	18	11.6
Boynton Slough	North (left)	Longley Lane to South Mc Carran Boulevard	X	1,853	4	10	5.5
	North (left)	South Mc Carran Boulevard to South Rock Boulevard	X	5,549	6	14	8.2
	South (right)	South Mc Carran Boulevard to northeast end of Fairwood Drive	X	6,216	6	14	8.5
Steamboat Creek	West (left)	Mira Loma Drive to northeast end of Fairwood Drive (Setback)	X	3,644	6	12	10.0
	East (right)	Along Hidden Valley Drive northeast to Pembroke Drive	X	5,640	8	14	9.8

Levees and Setback Levees
Alternative 2 incorporates the same levee reaches as Alternative 1 for the Truckee Meadows area, as shown in Table 4-27. The levee heights and widths shown in Table 4-27 are similar to those shown for all Alternatives. Upon completion of detailed hydraulic modeling, smaller levee heights and base widths would be expected relative to Alternative 1.

TABLE 4-27

LOCATION OF LEVEES IN THE TRUCKEE MEADOWS REACH FOR ALTERNATIVE 2

Location	Bank Loc.	Description (If Stream Length, Upstream to Downstream)	Included in Alt. 2	Length (ft)	Min. Height (ft)	Max. Height (ft)	Ave. Height (ft)
Truckee Meadows Reach							
Truckee River	South (right)	Glendale Avenue to Greg Street	X	2,995	0	8	5.4
	South (right)	Greg Street to South Rock Boulevard (setback)	X	3,240	1	7	3.1
	South (right)	South Rock Boulevard to South Mc Carran Boulevard (setback to Mill Street)	X	5,460	2	9	4.3
Detention Basin Levees	West	From Truckee River to Pembroke Drive (parallel to South Mc Carran Boulevard)	X	8,503	2	8	5
	North	From South Mc Carran Boulevard east along the Truckee River right bank for 7,500 feet		7,500	3	13	6.3
	South-East	From Pembroke Drive to confluence with Truckee River (setback from Steamboat Creek)		8,719	5	10	7.4
Steamboat Creek	West (left)	From Pembroke Drive to Boynton Slough Floodwalls	X	663	1	6	4.5
	West (left)	Mira Loma Drive to Rio Poco Road (setback considerably)	X	7,520	1	10	6.1
	East (right)	Along Mira Loma Drive for 809 feet to Rosehill Court	X	809	3	8	5.5
	East (right)	From Pembroke Drive along Steamboat Creek for 3,850 feet	X	3,850	1	10	6.1

Channel Benching Upstream of Steamboat Creek Confluence
Alternative 2 would also include benching of the Truckee River south bank, from the confluence of Steamboat Creek upstream as far as South Mc Carran Boulevard. The ground would be excavated down to a level corresponding to the water surface elevation (WSE) associated with the maximum discharge which, on average, would be exceeded once within a two year period (i.e. the WSE associated with the flow which has a 50% probability of being

exceeded in any given year). Since this level is significantly above that which occurs throughout most of the year, excavation to the two year WSE would create a bench or terrace of land above the channel bed, which would become inundated during high flow events. . Excavation would extend vertically down to the two-year WSE under existing conditions and horizontally 200 ft from the channel centerline.

Channel Benching Downstream of Steamboat Creek Confluence
Along the Truckee River, from near the confluence with Steamboat Creek downstream to the first railroad bridge beyond Vista, portions of both the north and south banks would be excavated. Excavation would extend vertically down to the two-year WSE under existing conditions. The stretch of river to be benched by this measure commences on the north bank at approximately the point where the N. Truckee Drain meets the Truckee River and would extend to the first railroad bridge beyond Vista. On the south bank, the benching would occur near where the Storey Co. boundary forms a "pocket" with the Truckee River, roughly coinciding with the stretch of river where the most downstream south-bank levee segment would be situated. The area to be benched would not be of uniform width. In the area of greatest widening (on the north bank opposite the Reno-Sparks wastewater treatment plant), it would extend up to 200 ft from the river centerline. In stretches of least widening (at the upstream end near N. Truckee Drain outlet on the north bank), the area to be benched would be closer to 50 ft from the centerline.

Dedication of Floodplain to Natural Storage
Alternative 2 would include the dedication of floodplain for natural storage in the University Farms area, as described in Alternative 1.

4.5.4.1.3. Environmental Restoration Components

Alternative 2 would enhance riparian and wetland habitat values along the Truckee River and Steamboat Creek by incorporating the following environmental restoration measures, as shown in Plate 4-12:

- Interstate 395 to Greg Street;
- Greg Street to South Mc Carran Boulevard;
- South Mc Carran Boulevard to Steamboat Creek; and
- Steamboat Creek: Pembroke Drive to Kimlick Lane.

Implementation of the restoration component would create a wide, nearly continuous corridor of riparian vegetation along the south bank of the Truckee River. Riparian enhancement on the north side of the river would also serve to increase habitat connectivity. The wetland complexes along Steamboat Creek would restore some of the wetland habitat values historically supported in the Truckee Meadows area. The restoration component for this alternative takes advantage of the channel widening from Mc Carran Boulevard to Steamboat Creek by developing habitat areas within the widening limits.

4.5.4.2. Accomplishments

This alternative would reduce flood damages in both the downtown Reno and Truckee Meadows reaches. The combination of measures selected for the downstream Truckee Meadows reach is not expected to influence water surface elevations in the downtown Reno

reach. Alternative 2 incorporates the same combination of measures for the downtown Reno reach as Alternative 1, thus similar reductions in water surface elevations would be expected, and are shown in Table 4-23.

Table 4-28 provides the water surface elevations for the No-Action Alternative and Alternative 2 at selected locations in the Truckee Meadows area.

TABLE 4-28

WATER SURFACE ELEVATIONS FOR ALTERNATIVE 2 IN THE TRUCKEE MEADOWS REACH

Location	Alt. 2
Modeled Flows	**Flow (cfs)**
Truckee River before confluence with Steamboat Creek	20,840
Truckee River after Steamboat Creek confluence	22,430
Water Surface Elevations at Above Modeled Flows	**Stage (NAVD 88 - feet)**
Truckee River(Upstream of Steamboat Creek Confluence)	
Mouth of Steamboat	4395.1
South Mc Carran Boulevard	4407.8
Rock Boulevard	4418.2
Greg Street	4427.8
Steamboat Creek	
Pembroke Drive	4397.8
Mira Loma Drive	4397.9
Truckee River (Downstream of Steamboat Creek Confluence)	
Downstream of Steamboat Creek confluence	4390.8
Note: Alternatives were modeled at different flows (cfs), thus direct comparison of water surface elevations for modeled alternatives is not applicable.	

The restoration component of this alternative would:

- Enhance 46.4 acres of existing habitat,
- Create 115.8 acres of new habitat, and
- Create 33.7 acres of wetlands.

Implementation of the restoration component would create a wide, nearly continuous corridor of riparian vegetation along the south bank of the Truckee River. Riparian enhancement on the north side of the river would also serve to increase habitat connectivity. The wetland complexes along Steamboat Creek would restore some of the wetland habitat values historically supported in the Truckee Meadows area. The restoration component for this alternative takes advantage of the channel widening from Mc Carran Boulevard to Steamboat Creek by developing habitat areas within the widening limits.

4.5.4.3. Effects

This alternative increases the channel carrying capacity through the downtown Reno reach to 20,700 cfs. This alternative provides similar effects for the downtown Reno reach as Alternative 1, Alternative 3, and Alternative 4, as they incorporate the same measures.

For the Truckee Meadows reach, this alternative requires the smaller floodwalls and levees relative to Alternative 1 in some areas. In comparison to Alternative 1, this alternative would require smaller floodwalls/levees upstream of South Mc Carran Boulevard and similar sized floodwalls and levees downstream of South Mc Carran Boulevard.

The environmental effects of Alternative 2 are the same as those for Alternative 1 with a few notable exceptions. The channel widening that is a part of Alternative 2 will increase the vegetated habitat affected by the environmental restoration activities by 39 acres, of which 24 acres are riparian habitat. Whereas in Alternative 1 these 24 acres would be enhanced, in Alternative 2 these 24 acres would be created. Channel widening may affect the geomorphology of the river resulting in downstream impacts; the specific geomorphologic impacts are in the process of being determined through on-going modeling efforts and analysis.

4.5.4.4. Operation and Maintenance Requirements

The local sponsor would be responsible for the operation, maintenance, replacement, and rehabilitation of these project features. As with Alternative 1, the operation and maintenance for the replaced bridges and floodwalls in the downtown Reno reach would not be expected to change relative to existing conditions.

For the Truckee Meadows reach, the primary operation and maintenance requirements of the proposed project would consist of floodwall and levee maintenance. These requirements would be similar to Alternative 1, including (1) regularly inspecting and maintaining floodwalls, and (2) regularly inspecting and maintaining levees and keeping them free of growth that could reduce reliability. In addition, maintenance of the upstream and downstream channel benching would be required. This would entail maintenance of excavated bench and established vegetation. Removal of debris and/or sediment would also be required on an as needed basis to maintain safe flow carrying capacities.

During floods, the levees and floodwalls would be patrolled continuously to locate possible boils or unusual wetness that signals a problem in the structure. As with all proposed measures, appropriate advance measures would be required to ensure the availability of adequate labor and materials to meet all contingencies.

The habitat areas created by this alternative will require maintenance to preserve and maintain the plantings. This maintenance will be required for at least three years following completion of construction. At the end of the three-year term, the areas will be turned over to the local sponsor if the vegetation has become established, and no additional maintenance requirements are expected.

4.5.4.5. Costs

The estimated first cost of constructing the facilities proposed in this alternative for a flow of 20,700 cfs is approximately $194.0 million. The average annual cost is $ 15.1 million. A summary of the costs for Alternative 2 is provided in Table 4-29. Appendix A- Cost Estimates provides detailed cost estimate information.

TABLE 4-29

COST ESTIMATE FOR ALTERNATIVE 2

Account Number	Item	Item Description	Item Cost ($1,000)	NED Cost ($1,000)	NER Cost ($1,000)
First Cost					
01	Lands and Damages	Land Preparation and Acquisition	$64,639	$64,639	
02	Relocations	Bridge Relocations	$11,629	$11,629	
		Utility Relocation	$ 970	$ 970	
06	Fish and Wildlife Facilities	Environmental Restoration	$11,077		$11,077
09	Channels and Canals	Channel Widening	$10,589	$10,589	
11	Levees and Floodwalls	Levees	$7,144	$7,144	
		Traditional Vertical Floodwalls	$30,671	$30,671	
14	Recreation Facilities		$ 0	$ 0	
15	Flood Control and Diversion Structures	Relief Wells	$2,680	$2,680	
		Ogee Inlet Structure	$ 0	$ 0	
Subtotal Construction Cost			$139,399	$128,322	$11,077
18	Cultural Resources Preservation	1% of Subtotal Construction Cost	$1,394	$1,283	$ 111
Contingency		15% of Subtotal Construction Cost	$20,910	$19,248	$1,662
Total Construction Cost			$161,703	$148,853	$12,850
30	Planning, Engineering, and Design	12% of Total Construction Cost	$19,404	$17,862	$1,542
31	Construction Management	8% of Total Construction Cost	$12,936	$11,908	$1,028
Total Project First Cost			$194,043	$178,623	$15,420
Annual Cost					
Interest and Amortization		7 3/8% over 50 years	$14,730	$13,560	$1,171
Operation and Maintenance			$ 350	$ 350	$ 0
Annualized Replacement Costs			$ 0	$ 0	$ 0
Total Project Annual Cost			**$15,080**	**$13,910**	**$1,171**

4.5.4.6. Uncertainty

The uncertainty related to this alternative is medium relative to the other plans considered. The uncertainty associated with the Downtown Reno reach is the same for all five plans considered. There is minimal uncertainty associated with the floodwalls and bridge replacements for the downtown Reno reach.

Some uncertainty is associated with the proposed elements of the Truckee Meadows reach. Minimal uncertainty is associated with the floodwalls, levees/setback levees and bridge replacements in this reach. However, some uncertainty is associated with the hydraulic effects and constructability of the benched areas. In addition, the long-term benefits of the benched areas are uncertain, as are the short-term construction impacts. This alternative channel benching, thus this alternative has a greater uncertainty than Alternative 1.

4.5.4.7. Advantages and Disadvantages

The primary economical and environmental advantage of this alternative is reduced flood-related damages and increased fish & wildlife habitat. Other specific advantages include:

- Reduced floodwall heights relative to Alternative 1.

The primary disadvantages of Alternative 2 include:

- Large extent of in-channel construction and excavation (equal to Alternative 4); and
- Greater uncertainty associated with channel benching relative to Alternative 1.

4.5.5. Alternative 3 – Bridge Replacement, Floodwalls, Levees/Setback Levees, and University Farms Detention Basin

4.5.5.1. Features

4.5.5.1.1. Downtown Reno Reach

Alternative 3 would increase flood protection in the downtown Reno reach of the Truckee River by incorporating the following measures, as shown in Plate 4-10:

- Sierra Street Bridge replacement;
- Virginia Street Bridge replacement ;
- Lake Street Bridge replacement; and
- Floodwalls.

These are the same combination of measures presented for the downtown Reno reach in Alternative 1.

4.5.5.1.2. Truckee Meadows Reach

Alternative 3 provides flood protection for existing development in the Truckee Meadows reach by incorporating the following measures, as shown in Plate 4-14:

- Pembroke Bridge replacement;

- Longley Lane Bridge replacement;
- Floodwalls;
- Levees/setback levees; and
- University Farms Detention Basin.

As with the prior alternatives, Alternative 3 would include levees/setback levees, floodwalls, and bridge replacement. Additionally Alternative 3 includes a detention facility in the University Farms area. No channel benching would be included in Alternative 3.

Bridge Replacement
Alternative 3 incorporates the same bridge replacements as Alternatives 1, 2, & 4, Longley Lane on Boyton Slough and Pembroke Drive on Steamboat Creek.

Floodwalls
Alternative 3 incorporates the same floodwall reaches as Alternative 1 & 2, as shown in Table 4-30. The floodwall heights shown in Table 4-30 are similar to those shown for all Alternatives. Upon completion of detailed hydraulic modeling, the smaller floodwall heights would be expected relative to Alternative 1.

TABLE 4-30

LOCATION OF FLOODWALLS IN THE TRUCKEE MEADOWS REACH FOR ALTERNATIVE 3

Reach	Bank Location	Description (Upstream to Downstream)	Included in Alt. 3	Length (ft)	Min. Height (ft)	Max. Height (ft)	Ave. Height (ft)
Truckee Meadows Reach							
Truckee River	South (right)	Highway 395 to Glendale Avenue	X	2,250	8	12	9.6
	North (left)	Glendale Avenue to Greg Street	X	2,808	4	14	10.8
	North (left)	Greg Street to South Rock Boulevard	X	1,882	4	10	6.3
	North (left)	South Rock Boulevard to South Mc Carran Boulevard	X	6,050	4	12	7.3
	North (left)	South Mc Carran Boulevard to North Truckee Drain outlet	X	12,450	4	14	7.6
	North (left)	North Truckee Drain outlet to 1st railroad bridge downstream of Vista	X	4,226	6	18	11.6
Boynton Slough	North (left)	Longley Lane to South Mc Carran Boulevard	X	1,853	4	10	5.5
	North (left)	South Mc Carran Boulevard to South Rock Boulevard	X	5,549	6	14	8.2
	South (right)	South Mc Carran Boulevard to northeast end of Fairwood Drive	X	6,216	6	14	8.5
Steamboat Creek	West (left)	Mira Loma Drive to northeast end of Fairwood Drive (Setback)	X	3,644	6	12	10.0
	East (right)	Along Hidden Valley Drive northeast to Pembroke Drive	X	5,640	8	14	9.8

Levees and Setback Levees

The levees identified in Alternatives 1 and Alternative 2 would also be included in Alternative 3, although their heights and base widths may differ. In addition, two new levee segments, which would serve as a perimeter wall of the detention basin, would be included in Alternative 3, as shown in Table 4-31. The levee heights and widths shown in Table 4-31 are similar to those shown for Alternatives 1-4. Upon completion of detailed hydraulic modeling, smaller levee heights and base widths would be expected relative to Alternative 1 due to the increased storage created by the detention basin.

TABLE 4-31

LOCATION OF LEVEES IN THE TRUCKEE MEADOWS REACH FOR ALTERNATIVE 3

Location	Bank Loc.	Description (If Stream Length, Upstream to Downstream)	Included in Alt. 3	Length (ft)	Min. Height (ft)	Max. Height (ft)	Ave. Height (ft)
Truckee Meadows Reach							
Truckee River	South (right)	Glendale Avenue to Greg Street	X	2,995	0	8	5.4
	South (right)	Greg Street to South Rock Boulevard (setback)	X	3,240	1	7	3.1
	South (right)	South Rock Boulevard to South Mc Carran Boulevard (setback to Mill Street)	X	5,460	2	9	4.3
Detention Basin Levees	West	From Truckee River to Pembroke Drive (parallel to South Mc Carran Boulevard)	X	8,503	2	8	5
	North	From South Mc Carran Boulevard east along the Truckee River right bank for 7,500 feet	X	7,500	3	13	6.3
	South-East	From Pembroke Drive to confluence with Truckee River (setback from Steamboat Creek)	X	8,719	5	10	7.4
Steamboat Creek	West (left)	From Pembroke Drive to Boynton Slough Floodwalls	X	663	1	6	4.5
	West (left)	Mira Loma Drive to Rio Poco Road (setback considerably)	X	7,520	1	10	6.1
	East (right)	Along Mira Loma Drive for 809 feet to Rosehill Court	X	809	3	8	5.5
	East (right)	From Pembroke Drive along Steamboat Creek for 3,850 feet	X	3,850	1	10	6.1

University Farms Detention Basin

A detention basin, roughly triangular in shape, is formed by three of Alternative 3's levee segments. At the upstream point of the triangle, the two levees that come together would be separated slightly to provide an inlet for flood flows from the Truckee River. The detention basin would be designed to capture peak Truckee River flood flows. As the river's discharge just upstream of the detention basin inlet is rising to its peak, flows would be diverted into the detention basin, thus decreasing the magnitude of the peak flow passing beyond the inlet and resulting in less backwater accumulating upstream of the Truckee River's constriction at the Vista Reefs.

4.5.5.1.3. Environmental Restoration Components

Alternative 3 would enhance riparian and wetland habitat values along the Truckee River and Steamboat Creek by incorporating the following environmental restoration measures, as shown in Plate 4-12:

- Interstate 395 to Greg Street;
- Greg Street to South Mc Carran Boulevard;
- South Mc Carran Boulevard to Steamboat Creek; and
- Steamboat Creek: Pembroke Drive to Kimlick Lane.

Implementation of the restoration component would create a wide, nearly continuous corridor of riparian vegetation along the south bank of the Truckee River. Riparian enhancement on the north side of the river would also serve to increase habitat connectivity. The wetland complexes along Steamboat Creek would restore some of the wetland habitat values historically supported in the Truckee Meadows area.

4.5.5.2. Accomplishments

This alternative would reduce flood damages in both the downtown Reno and Truckee Meadows reaches. The combination of measures selected for the downstream Truckee Meadows reach is not expected to influence water surface elevations in the downtown Reno reach. Alternative 3 incorporates the same combination of measures for the downtown Reno reach as Alternative 1, thus similar reductions in water surface elevations would be expected, and are shown in Table 4-23.

Although not fully modeled, the University Farms detention basin is assumed to lower water surface elevations in the Truckee Meadows reach.

The restoration component of this alternative would:

- Enhance 22.3 acres of existing habitat;
- Create 139.9 acres of new habitat; and
- Create 33.7 acres of wetlands.

4.5.5.3. Effects

This alternative increases the channel carrying capacity through the downtown Reno reach to 20,700 cfs. This alternative provides similar effects for the downtown Reno reach as Alternative 1, Alternative 2, and Alternative 4, as they incorporate the same measures.

For the Truckee Meadows reach, this alternative is anticipated to require the smaller floodwalls and levees relative to Alternative 1 in some areas. The effects of the detention basin have not been fully modeled; however, previous modeling efforts have shown a reduction in water surface elevations. Lower water surface elevations would correlate to lower floodwall and levee heights in the Truckee Meadows reach. The detention basin will be designed to counteract these hydraulic effects. It has been scaled to accommodate the

volumetric difference between the no-project and with-project hydrographs over the duration of the flood event, for the 100 yr design flood. Consequently, this alternative would be expected to have less downstream hydraulic impacts than Alternatives 1 and 2.

The environmental effects of Alternative 3 are the same as those for Alternative 1 with one notable exception. There are potential benefits as well as adverse effects associated with the use of the detention basin. Fish may enter the detention basin during flood events. Short-term beneficial effects may be realized if increased feeding opportunities are more favorable water temperatures are present in the detention basin. However, these benefits may not prove beneficial if fish are stranded in shallow pools when the floodwaters recede. Fish stranding is considered an adverse effect. Effects can be reduced to levels less than significant if detention basin control structures are designed to reduce fish entrapment into the basin.

4.5.5.4. Operation and Maintenance Requirements

The local sponsor would be responsible for the operation, maintenance, replacement, and rehabilitation of these project features. As described in Alternative 1, the operation and maintenance for the replaced bridges and floodwalls in the downtown Reno reach would not be expected to change relative to existing conditions.

For the Truckee Meadows reach, the primary operation and maintenance requirements of the proposed project would consist of floodwall and levee maintenance. These requirements would be similar to Alternative 1, including (1) inspecting and maintaining floodwalls regularly, and (2) inspecting and maintaining levees regularly and keeping them free of growth that could reduce reliability. However, this alternative requires longer lengths of levee for operation of the detention basin. In addition, operation and maintenance of the inlet and outlet structures of the detention basin would be required.

During floods, the levees and floodwalls would be patrolled continuously to locate possible boils or unusual wetness that signals a problem in the structure. As with all proposed measures, appropriate advance measures would be required to ensure the availability of adequate labor and materials to meet all contingencies.

The habitat areas created by this alternative will require maintenance to preserve and maintain the plantings. This maintenance will be required for three years following completion of construction. At the end of the three-year term, if the plantings have become established, the areas will be turned over to the local sponsor, and no additional maintenance requirements are expected.

4.5.5.5. Costs

The estimated first cost of constructing the facilities proposed in this alternative for a flow of 20,700 cfs is approximately $200.5 million. The average annual cost is $ 15.6 million. A summary of the costs for Alternative 3 is provided in Table 4-32. Appendix A – Cost Estimates provides detailed cost estimate information.

TABLE 4-32

COST ESTIMATE FOR ALTERNATIVE 3

Account Number	Item	Item Description	Item Cost ($1,000)	NED Cost ($1,000)	NER Cost ($1,000)
First Cost					
01	Lands and Damages	Land Preparation and Acquisition	$64,724	$64,724	
02	Relocations	Bridge Relocations	$11,629	$11,629	
		Utility Relocation	$ 970	$ 970	
06	Fish and Wildlife Facilities	Environmental Restoration	$16,236		$16,236
09	Channels and Canals	Channel Widening	$ 0	$ 0	
11	Levees and Floodwalls	Levees	$13,340	$13,340	
		Traditional Vertical Floodwalls	$30,671	$30,671	
14	Recreation Facilities		$ 0	$ 0	
15	Flood Control and Diversion Structures	Relief Wells	$2,680	$2,680	
		Ogee Inlet Structure	$3,761	$3,761	
Subtotal Construction Cost			$144,011	$127,775	$16,236
18	Cultural Resources Preservation	1% of Subtotal Construction Cost	$1,440	$1,278	$ 162
Contingency		15% of Subtotal Construction Cost	$21,602	$19,166	$2,435
Total Construction Cost			$167,053	$148,219	$18,833
30	Planning, Engineering, and Design	12% of Total Construction Cost	$20,046	$17,786	$2,260
31	Construction Management	8% of Total Construction Cost	$13,364	$11,858	$1,507
Total Project First Cost			$200,463	$177,863	$22,600
Annual Cost					
Interest and Amortization		7 3/8% over 50 years	$15,218	$13,502	$1,716
Operation and Maintenance			$ 350	$ 350	$ 0
Annualized Replacement Costs			$ 0	$ 0	$ 0
Total Project Annual Cost			**$15,568**	**$13,852**	**$1,716**

4.5.5.6. Uncertainty

The uncertainty related to this alternative is medium relative to the other plans considered. The uncertainty associated with the Downtown Reno reach is the same for all five plans considered. There is minimal uncertainty associated with the floodwalls and bridge replacements for the downtown Reno reach.

Some uncertainty is associated with the proposed elements of the Truckee Meadows reach. Minimal uncertainty is associated with the floodwalls, levees and bridge replacements in this

reach. However, some uncertainty is associated with the hydraulic effects of the detention basin.

4.5.5.7. Advantages and Disadvantages

The primary economical and environmental advantage of this alternative is reduced flood-related damages and increased fish & wildlife habitat. Other specific advantages include:

- Minimized in-channel construction and/or excavation.

The primary disadvantages of Alternative 1 include:

- Uncertainty associated with hydraulic effects of University Farms detention basin.

4.5.6. Alternative 4 – Bridge Replacements, Floodwalls, Levees/Setback Levees, Channel Benching and University Farms Detention Basin

4.5.6.1. Features

4.5.6.1.1. Downtown Reno Reach

Alternative 4 would increase flood protection in the downtown Reno reach of the Truckee River by incorporating the following measures, as shown in Plate 4-10:

- Sierra Street Bridge replacement;
- Virginia Street Bridge replacement ;
- Lake Street Bridge replacement; and
- Floodwalls.

These are the same combination of measures presented for the downtown Reno reach in Alternative 1.

4.5.6.1.2. Truckee Meadows Reach

Alternative 4 provides flood protection for existing development in the Truckee Meadows reach by incorporating the following measures, as shown in Plate 4-15:

- Pembroke Bridge replacement;
- Longley Lane Bridge replacement;
- Floodwalls;
- Levees/setback levees;
- Channel benching upstream of Steamboat Creek confluence;
- Channel benching downstream of Steamboat Creek confluence; and
- University Farms Detention Basin.

Bridge Replacement
Alternative 4 incorporates the same bridge replacements as Alternatives 1, 2, & 3, Longley Lane on Boyton Slough and Pembroke Drive on Steamboat Creek.

Floodwalls
Alternative 4 incorporates the same floodwall reaches as Alternatives 1-3, as shown in Table 4-33. The floodwall heights shown in Table 4-33 are similar to those shown for Alternatives 1-3.

Upon completion of detailed hydraulic modeling, smaller floodwall heights would be expected relative to Alternatives 1-3.

TABLE 4-33

LOCATION OF FLOODWALLS IN THE TRUCKEE MEADOWS REACH FOR ALTERNATIVE 4

Reach	Bank Location	Description (Upstream to Downstream)	Included in Alt. 4	Length (ft)	Min. Height (ft)	Max. Height (ft)	Ave. Height (ft)
Truckee Meadows Reach							
Truckee River	South (right)	Highway 395 to Glendale Avenue	X	2,250	8	12	9.6
	North (left)	Glendale Avenue to Greg Street	X	2,808	4	14	10.8
	North (left)	Greg Street to South Rock Boulevard	X	1,882	4	10	6.3
	North (left)	South Rock Boulevard to South Mc Carran Boulevard	X	6,050	4	12	7.3
	North (left)	South Mc Carran Boulevard to North Truckee Drain outlet	X	12,450	4	14	7.6
	North (left)	North Truckee Drain outlet to 1st railroad bridge downstream of Vista	X	4,226	6	18	11.6
Boynton Slough	North (left)	Longley Lane to South Mc Carran Boulevard	X	1,853	4	10	5.5
	North (left)	South Mc Carran Boulevard to South Rock Boulevard	X	5,549	6	14	8.2
	South (right)	South Mc Carran Boulevard to northeast end of Fairwood Drive	X	6,216	6	14	8.5
Steamboat Creek	West (left)	Mira Loma Drive to northeast end of Fairwood Drive (Setback)	X	3,644	6	12	10.0
	East (right)	Along Hidden Valley Drive northeast to Pembroke Drive	X	5,640	8	14	9.8

Levees and Setback Levees
All of the floodwall and levee segments described in Alternative 1 would be present in Alternative 4 and would have the same alignments and lengths. Alternative 4 would also include the additional levees described in Alternative 3, which form the boundary walls of

the Detention Basin, as shown in Table 4-34. The levee heights and widths shown in Table 4-34 are similar to those shown for all Alternatives. Upon completion of detailed hydraulic modeling, the smaller levee heights and base widths would be expected relative to Alternatives 1-3.

TABLE 4-34

LOCATION OF LEVEES IN THE TRUCKEE MEADOWS REACH FOR ALTERNATIVE 4

Location	Bank Loc.	Description (If Stream Length, Upstream to Downstream)	Included in Alt. 4	Length (ft)	Min. Height (ft)	Max. Height (ft)	Ave. Height (ft)
Truckee Meadows Reach							
Truckee River	South (right)	Glendale Avenue to Greg Street	X	2,995	0	8	5.4
	South (right)	Greg Street to South Rock Boulevard (setback)	X	3,240	1	7	3.1
	South (right)	South Rock Boulevard to South Mc Carran Boulevard (setback to Mill Street)	X	5,460	2	9	4.3
Detention Basin Levees	West	From Truckee River to Pembroke Drive (parallel to South Mc Carran Boulevard)	X	8,503	2	8	5
	North	From South Mc Carran Boulevard east along the Truckee River right bank for 7,500 feet	X	7,500	3	13	6.3
	South-East	From Pembroke Drive to confluence with Truckee River (setback from Steamboat Creek)	X	8,719	5	10	7.4
Steamboat Creek	West (left)	From Pembroke Drive to Boynton Slough Floodwalls	X	663	1	6	4.5
	West (left)	Mira Loma Drive to Rio Poco Road (setback considerably)	X	7,520	1	10	6.1
	East (right)	Along Mira Loma Drive for 809 feet to Rosehill Court	X	809	3	8	5.5
	East (right)	From Pembroke Drive along Steamboat Creek for 3,850 feet	X	3,850	1	10	6.1

Channel Benching Upstream of Steamboat Creek Confluence
Alternative 4 would also include benching of the Truckee River south bank, from the confluence of Steamboat Creek upstream as far as South Mc Carran Boulevard, as described for Alternative 2.

Channel Benching Downstream of Steamboat Creek Confluence
Alternative 4 would include benching on both the north and south banks of the Truckee River between the confluence with Steamboat Creek and the 1st railroad bridge, as described in Alternative 2.

University Farms Detention Basin
Alternative 4 would incorporate a University Farms detention basin, as described in Alternative 3.

4.5.6.1.3. Environmental Restoration Components

Alternative 4 would enhance riparian and wetland habitat values along the Truckee River and Steamboat Creek by incorporating the following environmental restoration measures, as shown in Plate 4-12:

- Interstate 395 to Greg Street;
- Greg Street to South Mc Carran Boulevard;
- South Mc Carran Boulevard to Steamboat Creek; and
- Steamboat Creek: Pembroke Drive to Kimlick Lane.

Implementation of the restoration component would create a wide, nearly continuous corridor of riparian vegetation along the south bank of the Truckee River. Riparian enhancement on the north side of the river would also serve to increase habitat connectivity. The wetland complexes along Steamboat Creek would restore some of the wetland habitat values historically supported in the Truckee Meadows area. The restoration component for this alternative takes advantage of the channel widening from Mc Carran Boulevard to Steamboat Creek by developing habitat areas within the widening limits.

4.5.6.2. Accomplishments

This alternative would reduce flood damages in both the downtown Reno and Truckee Meadows reaches. The combination of measures selected for the downstream Truckee Meadows reach is not expected to influence water surface elevations in the downtown Reno reach. Alternative 4 incorporates the same combination of measures for the downtown Reno reach as Alternatives 1-3, thus similar reductions in water surface elevations would be expected, and are shown in Table 4-23.

Although not fully modeled, the detention basin is assumed to lower water surface elevations in the Truckee Meadows reach. The detention basin, in combination with the upstream channel benching, is expected to require the lowest floodwall and levee heights in comparison to Alternatives 1-3.

The restoration component of this alternative would enhance:

- Enhance 46.4 acres of existing habitat,
- Create 115.8 acres of new habitat, and
- Create 33.7 acres of wetlands.

Implementation of the restoration component would create a wide, nearly continuous corridor of riparian vegetation along the south bank of the Truckee River. Riparian enhancement on the north side of the river would also serve to increase habitat connectivity. The wetland complexes along Steamboat Creek would restore some of the wetland habitat values historically supported in the Truckee Meadows area. The restoration component for this alternative takes advantage of the channel widening from Mc Carran Boulevard to Steamboat Creek by developing habitat areas within the widening limits.

4.5.6.3. Effects

This alternative increases the channel carrying capacity through the downtown Reno reach to the specified level of protection. This alternative provides similar effects for the downtown Reno reach as Alternative 1, Alternative 2, and Alternative 3, as they incorporate the same measures.

For the Truckee Meadows reach, this alternative is anticipated to require the smaller floodwalls and levees relative to Alternatives 1, 2, & 3. The effects of the detention basin have not been fully modeled, however previous modeling efforts have shown a reduction in water surface elevations.

In addition, hydraulic modeling runs have demonstrated reduced water surface elevations upstream of South Mc Carran Boulevard with the upstream channel benching feature. Lower water surface elevations would relate to lower floodwall and levee heights in the Truckee Meadows reach.

The environmental effects of Alternative 4 are the same as those for Alternative 1 with the additional effects discussed under Alternatives 2 and 3.

4.5.6.4. Operation and Maintenance Requirements

The local sponsor would be responsible for the operation, maintenance, replacement, and rehabilitation of these project features. As with Alternative 1, the operation and maintenance for the replaced bridges and floodwalls in the downtown Reno reach would not be expected to change relative to existing conditions.

For the Truckee Meadows reach, the primary operation and maintenance requirements of the proposed project would consist of floodwall and levee maintenance. These requirements would include (1) inspecting and maintaining floodwalls regularly, and (2) inspecting and maintaining levees regularly and keeping them free of growth that could reduce reliability. However, this alternative requires longer lengths of levee for operation of the detention basin in comparison to Alternatives 1 and 2. In addition, operation and maintenance of the inlet and outlet structures of the detention basin would be required.

During floods, the levees and floodwalls would be patrolled continuously to locate possible boils or unusual wetness that signals a problem in the structure. As with all proposed measures, appropriate advance measures would be required to ensure the availability of adequate labor and materials to meet all contingencies.

The habitat areas created by this alternative will require maintenance to preserve and maintain the plantings. This maintenance will be required for three years following completion of construction. At the end of the three-year term, the areas will be turned over to the local sponsor, if the plantings have become established, and no additional maintenance requirements are expected.

4.5.6.5. Costs

The estimated first cost of constructing the facilities proposed in this alternative for a flow of 20,700 cfs is approximately $208.0 million. The average annual cost is $ 16.1 million. A summary of the costs for Alternative 4 is provided in Table 4-35. Appendix A – Cost Estimates provides detailed cost estimate information.

TABLE 4-35

COST ESTIMATE FOR ALTERNATIVE 4

Account Number	Item	Item Description	Item Cost ($1,000)	NED Cost ($1,000)	NER Cost ($1,000)
First Cost					
01	Lands and Damages	Land Preparation and Acquisition	$64,723	$64,723	
02	Relocations	Bridge Relocations	$11,629	$11,629	
		Utility Relocation	$ 970	$ 970	
06	Fish and Wildlife Facilities	Environmental Restoration	$11,077		$11,077
09	Channels and Canals	Channel Widening	$10,589	$10,589	
11	Levees and Floodwalls	Levees	$13,340	$13,340	
		Traditional Vertical Floodwalls	$30,671	$30,671	
14	Recreation Facilities		$ 0	$ 0	
15	Flood Control and Diversion Structures	Relief Wells	$2,680	$2,680	
		Ogee Inlet Structure	$3,761	$3,761	
Subtotal Construction Cost			$149,440	$138,363	$11,077
18	Cultural Resources Preservation	1% of Subtotal Construction Cost	$1,494	$1,384	$ 111
Contingency		15% of Subtotal Construction Cost	$22,416	$20,754	$1,662
Total Construction Cost			$173,350	$160,501	$12,850
30	Planning, Engineering, and Design	12% of Total Construction Cost	$20,802	$19,260	$1,542
31	Construction Management	8% of Total Construction Cost	$13,868	$12,840	$1,028
Total Project First Cost			$208,020	$192,601	$15,420
Annual Cost					
Interest and Amortization		7 3/8% over 50 years	$15,792	$14,621	$1,171
Operation and Maintenance			$ 350	$ 350	$ 0
Annualized Replacement Costs			$ 0	$ 0	$ 0
Total Project Annual Cost			**$16,142**	**$14,971**	**$1,171**

4.5.6.6. Uncertainty

The uncertainty related to this alternative is high relative to the other plans considered. The uncertainty associated with the Downtown Reno reach is the same for Alternatives 1-4. There is minimal uncertainty associated with the floodwalls and bridge replacements for the downtown Reno reach.

Some uncertainty is associated with the proposed elements of the Truckee Meadows reach. Minimal uncertainty is associated with the floodwalls, levees and bridge replacements in this

reach. However, some uncertainty is associated with the hydraulic effects of the detention basin, as described with Alternative 3. Additional uncertainty is also associated with upstream and downstream channel benching, as described for Alternative 2.

4.5.6.7. Advantages and Disadvantages

The primary advantages of Alternative 4 include:

- Lowest water surface elevations; and
- Best access and visibility of river due to low floodwall and levee heights.

The primary disadvantages of Alternative 4 include:

- Highest annual cost;
- Largest operation and maintenance requirements; and
- High uncertainty relative to other alternatives.

4.5.7. Alternative 5 – Community Coalition Concept Plan

Alternative 5 is the Community Coalition's most recent working draft version of its Emerging Concept Plan. The form in which it is presented here has not been endorsed by the Coalition. It has been interpreted from the Coalition's most recent map-format version of its "Emerging Draft Concept Plan" (October 30, 2000), in conjunction with a list of potential Plan Elements dated September 10, 2000 (which was an amended version of the list of potential elements distributed at the Coalition's September 9, 2000 meeting). Since the Coalition's Concept Plan development phase is still underway, this is a preliminary representation of the ideas that have been generated to date. The Coalition's Concept Plan is evolving and will most likely change. Thus, the alternative presented here is a snapshot in time of an evolving proposed plan.

Measures which have been identified by the Coalition only as "potential" or "alternative" elements have not been included in the definition of Alternative 5. Alternative 5, the Coalition's "Emerging Draft Concept Plan" is shown in Plate 4-16.

4.5.7.1. Features

The majority of the elements of this Alternative are as described in the "Descriptions of Measures" section of this report. Where needed, additional details about an element of the alternative are presented.

4.5.7.1.1. Downtown Reno Reach

Alternative 5 contains the following elements for the portion of the study area between Booth St. and Hwy. 395:

- Floodwalls;
- Levees;

- Replacement of Sierra St. and Lake St. bridges;
- Improvement of Virginia St. bridge;
- Remove Arlington Ave. diversion structure;
- Reduce width of Riverside Drive;
- Install road closure bladders;
- Flood-proofing;
- Create new parkland;
- Relocate sewer pipeline crossings; and
- Bank stabilization – "biotech" methods.

Floodwalls
Alternative 5 includes floodwalls which would be built into new development in Reno Redevelopment area, Arlington - 2nd Street,along both sides of Truckee River

Levees
Alternative 5 includes:

- Levees from Booth St. along Riverside Dr. to Arlington Ave; and
- Levees in a sawtooth alignment, north along extension of Evans Ave up to Second St., east nearly to river, north to railroad tracks, east to river.

Road Closure Bladders
To close gaps between flood barriers where roads cross the line of defense, bladders are proposed at the following locations:

- Booth St., north and south sides of river;
- Arlington Avenue, north side;
- Sierra St., both sides of river;
- Virginia St., both sides; and
- Lake Street, both sides.

Floodproofing
Two structures would be flood proofed on the north side of the Truckee River, between Arlington Ave. and Virginia Street. In addition, structures at Barbara Bennet Park would be flood proofed, including the private residence in that location. Relocation of the private residence is a potential modification to this element.

Create New Parkland
New parkway would be added from Second St. – Hwy 395, south bank of Truckee River, including a strip along existing bicycle trail and a triangular area between Kuenzli Street and the river, near Manuel Street. The incorporation of restoration efforts has been proposed for

south bank of river. Although a few other areas are identified on Plate 4-16 as proposed park sites in this reach, they are not part of the current alternative.

Bank Stabilization – "Biotech" Methods
This element involves the use of vegetation and/or landscape shaping to stabilize river banks to prevent or arrest mass wasting (i.e. slumping, landsliding) or erosion. The term "biotech" is used to distinguish the intended techniques from those that rely upon armoring with rip-rap, gabions, rock, concrete blocks, etc. This element is located on the south bank of the Truckee River between Booth Street and Keystone Ave.

4.5.7.1.2. Truckee Meadows Reach

Alternative 5 contains the following elements for the Truckee Meadows portion of the study area:

- Floodwalls;
- Setback floodwalls;
- Levees;
- Setback levees;
- Benching downstream of Steamboat confluence;
- Causeways at Rock and Mc Carran Boulevards;
- Remove / relocate diversion structures;
- Relocate N. Truckee Drain outlet;
- Install road closure bladders;
- Dedication of floodplain to natural storage;
- Floodplain restoration, University Farms area;
- Floodplain restoration, Edison area;
- Create new parkland; and
- New bicycle trails.

Floodwalls
This alternative would include floodwalls in the following locations:

- Floodwalls on river side of Glendale Park area industrial buildings, 5-10 ft high; and
- Floodwalls will located in tight areas, river side of industrial buildings, north bank, Mc Carran-Vista, 5-8 ft high.

Setback Floodwalls
This alternative would include floodwalls that are setback from the channel in the following locations:

- Floodwalls set back behind Fisherman's Park area, Hwy. 395 – Glendale Ave., north side of Truckee River;
- Floodwalls set back behind Rock Park, river side of Rock Blvd., north bank of Truckee River, approximately 5 ft high;
- Floodwalls, Rock Blvd. – Mc Carran Blvd., set back behind Glendale Park; and
- Floodwalls set back behind Cottonwood Park, East of Mc Carran Blvd, north bank of Truckee River.

Levees
This alternative would include levees in the following locations:

- Hwy. 395 – Glendale Ave., south bank Truckee River, 1-3 ft high through Indian Colony lands; and
- Glendale Ave. – Rock Blvd., passing river side of Sierra Pacific treatment ponds.

Setback Levees
This alternative would include floodwalls that are setback from the channel in the following locations:

- Levees set back nearly to Mill Street from south bank of Truckee River, running from Greg St. – Mc Carran Blvd., 3 – 8 ft high;
- Levees from Mc Carran to Pembroke Drive, through Univ. Farms area, approximately 8 ft high; and
- Levees set back from north bank of Truckee River to Greg Street, running from Sparks Blvd. past Larkin Circle to new alignment of North Truckee Drain.

Benching Downstream of Steamboat Confluence
On the Truckee River, from the Steamboat Creek confluence to a point of Vista, portions of both the north and south banks would be excavated in order to increase the high flow channel capacity. With this element to the Coalition Plan, the excavation would extend downward to the five year water surface elevation, horizontally up to 300 ft from the channel centerline, and downstream as far as the second railroad bridge beyond Vista.

Remove / Relocate Diversion Structures
This element involves relocation of the Glendale Ditch intake to a point further upstream, and relocation of the Pioneer Ditch intake.

Install Road Closure Bladders
In the Truckee Meadows area, bladder closures are intended for Mc Carran Blvd. on both sides of the Truckee River.

Dedication of Floodplain to Natural Storage
This involves the permanent dedication of the following areas within the floodplain to uses that would not interfere with flood flows:

- Greg Street to Mc Carran Boulevard between south bank of Truckee River to approximately Mill Street. This element would be carried out in conjunction with proposed restoration and river parkway elements, described separately. Implementation

would require acquisition and relocation of Edison Industrial Park and Sage Winds substance abuse rehabilitation center as well as acquisition of vacant floodplain lands.

- Mc Carran Blvd. to Steamboat Creek confluence between south bank of Truckee River to Boyton Slough, as described in Alternative 1.
- Franklin Way to Larkin Circle, north bank of Truckee River to E. Greg Street and Larkin Circle. This element would be carried out in conjunction with river parkway elements, described separately. Implementation would require acquisition and relocation of a rib specialty restaurant. The Pick & Pull auto salvage yard lands would also need to be acquired, as well as vacant floodplain lands.
- Bella Vista Ranch located below Rio Poco Road. Restoration efforts have been suggested for this site but not detailed. Implementation would require acquisition of the land.

Create New Parkland
This element involves the acquisition of the following areas and dedicating their use to public park. Where there are existing residences or businesses, relocation assistance would also be needed. This element overlaps with the natural floodplain storage element, and includes the following areas:

- Greg St. – Mc Carran Blvd., a portion of the land between the south bank of the Truckee River and Mill Street; and
- Greg St. & Sparks Blvd. area, at and near the current location of the Pick & Pull auto salvage yard.

4.5.7.1.3. Study Area - Wide Elements

The following elements are part of the Coalition's Concept Plan, but are not site specific:

- Floodplain regulation and administration;
- Stormwater regulation and administration; and
- Education.

4.5.7.2. Accomplishments

Since this alternative as currently formulated provides for no structural flood protection for the Boynton Slough and Steamboat Creek flood plains, it is doubtful that this alternative would be as effective as the other alternatives in reducing flood damages in these areas.

However, this alternative has better defined river parkway elements than the other alternatives. At this stage of project formulation it would appear to be more effective at meeting the river parkway objective.

Alternative 5 provides for considerable environmental restoration efforts. However, insufficient design and analysis has been conducted to allow for a meaningful comparison between the environmental restoration effectiveness of this alternative relative to the others.

4.5.7.3. Effects

Since Alternative 5 is still under development, the specific flood damage reduction, ecosystem restoration, and recreation effects have not been established.

4.5.7.4. Operation and Maintenance Requirements

The local sponsor would be responsible for the operation, maintenance, replacement, and rehabilitation of these project features. The operation and maintenance for the replaced bridges and floodwalls in the downtown Reno reach would not be expected to change relative to existing conditions. The creation of new park area would require additional operation and maintenance.

For the Truckee Meadows reach, the primary operation and maintenance requirements of the proposed project would consist of floodwall and levee maintenance. These requirements would include (1) inspecting and maintaining floodwalls regularly, and (2) inspecting and maintaining levees regularly and keeping them free of growth that could reduce reliability.

During floods, the levees and floodwalls would be patrolled continuously to locate possible boils or unusual wetness that signals a problem in the structure. As with all proposed measures, appropriate advance measures would be required to ensure the availability of adequate labor and materials to meet all contingencies.

The habitat areas created by this alternative will require maintenance to preserve and maintain the plantings. This maintenance will be required for three years following completion of construction. At the end of the three-year term, the areas will be turned over to the local sponsor, and no additional maintenance requirements are expected.

4.5.7.5. Costs

The cost associated with the design, construction, and operation of the facilities proposed in this alternative have not been developed at this time. Cost types for Alternative 5 are provided in Table 4-36.

TABLE 4-36

COST ESTIMATE FOR ALTERNATIVE 5

Account Number	Item	Item Description	Item Cost ($1,000)	NED Cost ($1,000)	NER Cost ($1,000)
First Cost					
01	Lands and Damages	Land Preparation and Acquisition	$ 0	$ 0	
02	Relocations	Bridge Relocations	$ 0	$ 0	
		Utility Relocation	$ 0	$ 0	
06	Fish and Wildlife Facilities	Environmental Restoration	$ 0		$ 0
09	Channels and Canals	Channel Widening	$ 0	$ 0	
11	Levees and Floodwalls	Levees	$ 0	$ 0	
		Traditional Vertical Floodwalls	$ 0	$ 0	
14	Recreation Facilities		$ 0	$ 0	
15	Flood Control and Diversion Structures	Relief Wells	$ 0	$ 0	
		Ogee Inlet Structure	$ 0	$ 0	
Subtotal Construction Cost			$ 0	$ 0	$ 0
18	Cultural Resources Preservation	1% of Subtotal Construction Cost	$ 0	$ 0	$ 0
Contingency		15% of Subtotal Construction Cost	$ 0	$ 0	$ 0
Total Construction Cost			$ 0	$ 0	$ 0
30	Planning, Engineering, and Design	12% of Total Construction Cost	$ 0	$ 0	$ 0
31	Construction Management	8% of Total Construction Cost	$ 0	$ 0	$ 0
Total Project First Cost			$ 0	$ 0	$ 0
Annual Cost					
Interest and Amortization		7 3/8% over 50 years	$ 0	$ 0	$ 0
Operation and Maintenance			$ 0	$ 0	$ 0
Annualized Replacement Costs			$ 0	$ 0	$ 0
Total Project Annual Cost			**$ 0**	**$ 0**	**$ 0**

4.5.7.6. Uncertainty

Since this alternative is still in the process of being developed by the Coalition, the level of uncertainty associated with this alternative is relatively high. The lack of structural flood protection for the Boynton Slough and Steamboat Creek areas results in additional uncertainty regarding the alternative's expected effectiveness at reducing flood damages there.

4.5.7.7. Advantages and Disadvantages

The principal advantages of this alternative are that they provide better defined recreational (river parkway) elements than the other alternatives. Since this alternative is being developed through a consensus process under the auspices of the Community Coalition, the plan that emerges can also be expected to have a high level of acceptability to the community.

The principal disadvantage of this alternative is that, as currently defined, it is unlikely to be as effective at flood damage reduction than the other alternatives.

4.5.8. Summary of Alternative Plans

4.5.8.1. Features

All measures currently incorporated into the five alternative plans are identified in Table 4-37. All five alternatives incorporate flood damage reduction measures for both the Downtown Reno reach and the Truckee Meadows reach. In addition, all five alternatives also include ecosystem restoration measures. Alternative 5, the Community Coalition Plan, incorporates river parkway measures. No river parkway measures are incorporated in Alternatives 1-4 at this time, however such measure will likely be incorporated in these plans upon further plan refinement.

TABLE 4-37

MEASURES INCORPORATED IN ALTERNATIVES 1-5

Primary Objective	Measure	Alternative				
		1	2	3	4	5
Flood Damage Reduction – Downtown Reno Reach	Replacement of Sierra Street Bridge	X	X	X	X	X
	Replacement of Virginia Street Bridge	X	X	X	X	
	Improvement of Virginia Street Bridge					X
	Replacement of Lake Street Bridge	X	X	X	X	X
	Floodwalls	X	X	X	X	X
	Levees					X
	Remove Arlington Avenue Diversion Structure					X
	Reduce width of Riverside Drive					X
	Install Road Closure Bladders [1]					X
	Flood-Proofing [1]					X
Flood Damage Reduction – Truckee Meadows Reach	Replacement of Pembroke Drive Bridge	X	X	X	X	
	Replacement of Longley Lane Bridge	X	X	X	X	
	Floodwalls	X	X	X	X	X
	Setback Floodwalls					X
	Levees/Setback Levees	X	X	X	X	X
	Channel Benching Upstream of Steamboat Creek Confluence		X		X	
	Channel Benching Downstream of Steamboat Creek Confluence		X		X	X
	Remove/Relocate Diversion Structures					X
	Install Road Closure Bladders [1]					X
	Causeway at Mc Carran Boulevard					X
	Relocate North Truckee Drain Outlet					X
	University Farms Detention Facility			X	X	
	Dedication of floodplain to Natural Storage	X	X			X
Flood Damage Reduction – Study Area	Floodplain Regulation and Administration					X
	Stormwater Regulation and Administration					X
	Education					X
Ecosystem Restoration	Interstate 395 to Greg Street	X	X	X	X	
	Greg Street to South Mc Carran Boulevard	X	X	X	X	
	South Mc Carran Boulevard to Steamboat Creek	X	X	X	X	
	Steamboat Creek: Pembroke Drive to Kimlick Lane	X	X	X	X	
	Floodplain Restoration, University Farms Area					X
	Floodplain Restoration, Edison Area					X
	Bank Stabilization – "Biotech" Methods					X
River Parkway	Create New Parkland [1]					X
	Relocate Sewer Pipeline Crossings					X
	New Bicycle Trails [1]					X

[1] Although not currently included, these measures will likely be incorporated into Alternative Plans 1-4 in the future.

4.5.8.2. Accomplishments

4.5.8.2.1. Flood Damage Reduction

Alternatives 1-4 all rely upon the same set of measures for the downtown Reno portion of the study area. Consequently they would all increase the flow capacity of that reach of the Truckee River and would all provide the same level of flood damage reduction for the downtown area. In addition, they would all reduce water surface elevations in the downtown Reno reach of the Truckee River by the same amount, relative to the no-action alternative. The water surface elevation reductions were shown previously in Table 4-23, based upon prior hydraulic modeling. Alternative 5 has not been modeled, so no estimates are available for how it would perform relative to the other alternatives.

Alternatives 1-4 would all provide the same level of flood damage reduction for the Truckee Meadows portion of the study area. The alternatives would be expected to vary to some degree with regard to the water surface elevations which would result on account of their implementation, relative to the no-action alternative. However, hydraulic modeling of the alternatives in the Truckee Meadows reach of the Truckee River has not been completed. No quantitative statements can be made about the alternatives' relative accomplishments in this regard.

4.5.8.2.2. Ecosystem Restoration

Alternatives 1-5 would all create a nearly continuous corridor of riparian habitat along the south bank of the Truckee River from Greg St. to the confluence of Steamboat Creek. For Alternatives 1-4, the corridor would extend nearly to Hwy. 395.

Alternatives 1 – 4 all would restore the same total amount of area. They differ, however, with regard to how much of the riparian habitat area would be enhanced versus created. Alternatives 2 and 4, which include channel benching, result in a greater amount of enhanced riparian habitat than Alternatives 1 and 3, which do not include benching. This is because the excavation associated with benching destroys existing habitat before it is restored. Where this occurs, the resulting habitat has been considered enhanced rather than newly created. Consequently there is more enhanced riparian habitat under the alternatives that include benching, and more created habitat under the alternatives, which do not involve benching.

Alternative 5 provides for restoration on 165 acres of land in the University Farms area between Cleanwater Way and the south bank of the Truckee River, including wetland creation. It also provides for restoration and park creation on roughly 175 acres in the Edison area between Mill St and the south bank of the Truckee, between Rock and McCarran Blvds., including creation of a river meander. It is not known how much of the University Farms area restoration would be for wetlands per se versus other types of vegetation zones. Nor is it known how much of the Edison area acreage would be for park versus restoration and for different classes of restoration. Table 4-38 lists the amount of area restored under the different alternatives.

TABLE 4-38

ACREAGE RESTORED BY ALTERNATIVES

Restored Area Type	Alternative				
	1	2	3	4	5
Riparian habitat enhanced	22.3	46.4	22.3	46.4	?
Riparian habitat created	139.9	115.8	139.9	115.8	?
Wetlands created	33.7	33.7	33.7	33.7	?
Total restoration area	195.9	195.9	195.9	195.9	?

Since Alternatives 2 and 4 include both upstream and downstream channel benching, they would be expected to sustain more vegetation that requires a shallow depth to the water table than Alternatives 1 and 3, which contain no benching. Alternative 5, with downstream benching only, would be expected to sustain an intermediate amount of vegetation that requires a shallow depth to the water table.

4.5.8.2.3. River Parkway

Alternative 5 provides for the establishment of new parks and bicycle trails, plus the removal of sewer pipe crossings, which detract from the river's visual appeal. Although as currently formulated for feasibility level assessment Alternatives 1-4 do not contain details regarding recreational measures, it is anticipated that they would include recreational measures as plans are refined in the future.

4.5.8.3. Effects

4.5.8.3.1. Floodwall and Levee Heights

Since Alternatives 1-4 rely upon the same set of measures for downtown Reno, their required floodwall heights would be equal for that portion of the study area.

Ultimately, required floodwall and levee heights for each alternative in the Truckee Meadows portion of the study area would depend upon each alternative's associated water surface elevations as determined by hydraulic modeling. Since this modeling has not yet been completed, no quantitative information is available about the alternatives' relative structure heights in the Meadows area. However, since Alternative 1 does not include channel benching or the detention basin, one would expect it to have the highest floodwall and levee height requirements. Since Alternative 4 includes upstream channel benching, downstream channel benching, and the detention basin, one would expect it to require the smallest floodwalls and levees. Alternatives 2, 3, and 5 include either channel benching or the detention basin, but not both, so they would be expected to require structure heights that are intermediate to Alternatives 1 and 5.

4.5.8.3.2. Downstream Hydraulic Impacts

Although hydraulic modeling has not been completed, floodwalls and levees are expected to potentially result in an increase in downstream Truckee River discharge during a flood event. The detention basin measure in Alternatives 3 is designed to capture the volumetric difference between the no-project and with-project hydrographs over the duration of the 100

yr design flood event. Consequently, Alternatives 3 and 4, which both include the detention basin, would be expected to have less downstream hydraulic impacts than Alternatives 1 and 2.

4.5.8.3.3. Environmental Effects

The environmental impacts of levee and floodwall construction would be similar for all alternatives. However, since Alternatives 3 and 4 include detention basin levees in the Truckee Meadows portion of the study area, levee associated impacts would be greater for those alternatives. There might also be some potential impacts to fish trapped in the detention basin during flooding events. Alternatives 2, 4, and 5 include channel benching. Those alternatives would generate impacts which alternatives 1 and 3 would not.

4.5.8.4. Operation and Maintenance Requirements

Alternatives 3 and 4 would have greater operations and maintenance requirements for levees since they include detention basin levee segments not included in the other alternatives. Alternatives 2 and 4 would have channel benching maintenance requirements not encountered in Alternatives 1 and 3.

4.5.8.5. Costs

A summary of the first costs and annualized costs for each alternative are presented in Table 4-39. Appendix A – Cost Estimates provides detailed cost estimate information for Alternatives 1-4.

TABLE 4-39

SUMMARY OF FIRST AND ANNUAL COSTS FOR ALTERNATIVES 1-5

Type	Alternative Cost ($ 1000)				
	1	2	3	4	5
First Costs					
Total Construction Cost	$155,430	$161,703	$167,054	$173,351	?
Total Project First Cost	$186,517	$194,044	$200,465	$208,021	?
Annual Costs					
Interest and Amortization [1]	$14,159	$14,731	$15,218	$15,792	?
Total Project Annual Cost	$14,509	$15,081	$15,568	$16,142	?
[1] 7 3/8 % over 50 years					

4.5.8.6. Uncertainty

An equal level of uncertainty is associated with the downtown Reno reach of Alternatives 1-4, since they contain the same, well defined set of flood damage reduction measures for that reach.

For the Truckee Meadows portion of the study area, there is a minimal and roughly equal level of uncertainty associated with the floodwalls, levees/setback levees and bridge

replacements of Alternatives 1-4. There is greater uncertainty regarding the expected effectiveness of Alternative 5, which does not include flood barriers in the Boynton Slough and Steamboat Creek areas.

For Alternatives 2, 4, and 5 there is additional uncertainty associated with the hydraulic effects of the benched areas along with complications of in-channel construction activities. The geomorphologic effects and long-term benefits of the benched areas are uncertain as are the short-term construction impacts. Alternatives 3 and 4 also have uncertainty regarding the hydraulic effects of the detention basin.

4.5.8.7. Advantages and Disadvantages

The alternatives were assigned relative qualitative ratings for required structure heights, downstream hydraulic effects, environmental effects, uncertainty, and cost, which are shown in Table 4-40.

TABLE 4-40

COMPARISON OF SELECTED ASPECTS OF ALTERNATIVES

Aspect	Alternative				
	1	2	3	4	5
Required Structure Heights	High	Medium	Medium	Low	Medium
Downstream Hydraulic Effects	High	High	Low	Low	High
Environmental Effects	Low	Medium	High	High	Medium
Uncertainty	Low	Medium	Medium	High	High
Cost	Low	Medium	Medium	High	?

The alternatives were also compared on the criteria of effectiveness, efficiency, completeness, and acceptability, as shown in Table 4-41. Effectiveness ratings follow from the discussion above regarding accomplishments. Efficiency ratings follow from the cost information. Acceptability reflects anticipated receptivity of the Reno-Sparks-Truckee Meadows community to the alternatives. It is anticipated that the Coalition Plan (Alternative 5), once completed, would be highly acceptable; Alternative 1, with the highest expected structure heights and no downstream hydraulic mitigation, would be least acceptable; and the other alternatives would have an intermediate level of acceptability. With regard to completeness, Alternatives 1 and 2 were assigned low ratings because they lack downstream hydraulic mitigation and do not yet include detailed recreation measures. Alternatives 3 and 4 were assigned medium ratings because they do contain hydraulic mitigation but do not yet provide details regarding recreational features. Alternative 5 already provides for recreation measures but lacks hydraulic mitigation.

TABLE 4-41

RELATIVE EFFICIENCY, EFFECTIVENESS, COMPLETENESS, AND ACCEPTIBILITY OF ALTERNATIVES

Criterion	Alternative				
	1	2	3	4	5
Efficiency	High	Medium	Medium	Low	?
Effectiveness - Restoration	High	High	High	High	High
Effectiveness - Flood Damage Reduction	High	High	High	High	?
Effectiveness - River Parkway	?	?	?	?	High
Completeness	Low	Low	Medium	Medium	Medium
Acceptability	Low	Medium	Medium	Medium	High

APPENDIX A

COST ESTIMATES

Estimated project costs were developed for the four alternatives for the Truckee Meadows Flood Damage Reduction and Environmental Restoration Project. These alternatives are:

- Alternative 1 – Bridge replacement, levees and setback levees, floodwalls, and dedication of flood plain to natural storage.
- Alternative 2 – Bridge replacement, levees and setback levees, floodwalls, dedication of flood plain to natural storage, and channel benching.
- Alternative 3 – Bridge replacement, levees and setback levees, floodwalls, and detention basin.
- Alternative 4 – Bridge replacement, levees and setback levees, floodwalls, channel benching, and detention basin.

Costs have not yet been developed for Alternative 5 – the Coalition Plan. The estimates are based on the facilities described in Chapter 4. Cost estimates reflect 1999 construction costs.

Construction quantities and cost estimates were developed for each measure described in Chapter 4. Calculations of levee and floodwall quantities and associated costs are based on a 100-year water surface elevation. The height of all levee and floodwall reaches is identical for each alternative. The bridge replacement estimates were determined from 1996 bid tabulations for Center Street Bridge. A direct relationship between surface area and quantity was assumed.

The following tables present more detailed backup data for the project costs summarized in Chapter 4. Table A-1 shows the unit costs that were used in floodwall and levee calculations. The quantities for all levee reaches are shown in Table A-2. The levee costs, based on these quantities, are provided in Table A-3. The quantities and costs required for the channel benching are included in Table A-4. Upstream (SW-BB) and downstream channel benching (SW-AA and NW-A) are included in Alternative 2 and 4. Table A-5 shows the number of relief wells needed and the associated cost. Tables A-6 through A-16 show the quantity and cost for each floodwall in the Truckee Meadows area. Tables A-17 and A-18 provide the quantity and cost calculations for the floodwalls in the Downtown Reno reach. All floodwall quantities and costs are identical for each alternative.

The bridge cost estimates for the Truckee Meadows reach are included in Table A-19; bridge replacement costs in the Downtown Reno reach are calculated in Table A-20. The real estate cost estimates are provided in Table A-21. The environmental restoration costs are described and calculated in Table A-22. The cost for environmental restoration in Alternatives 1 and 3 (without channel benching) is the same, and Alternatives 2 and 4 (with channel benching) have identical restoration costs as well. These costs, which include enhancing and creating habitat, creating wetlands, and excavation, are included in the Fish and Wildlife Facilities (06) account. The utility costs are described in Table A-23. Finally, Table A-24 itemizes the

total project cost for each of the four alternatives. The costs of all features are allocated to the appropriate Corps of Engineers account and feature code.