5.11.12 Recreational Use

The upper watershed in Alpine County is heavily used for recreational purposes, such as camping, hiking, rafting, canoeing, fishing, snowmobiles, off-road vehicles, horseback riding, bicycling, and cross-country skiing. The East Fork of the Carson River is designated as a "Wild and Scenic River" by the State of California and is very popular with rafters and backcountry campers. Designated camping areas are found throughout the upper watershed and many opportunities for dispersed recreation exist as well. There has been an increase in the amount of dispersed camping in the upper watershed during recent years. Concerns with dispersed camping include trampling of stream banks and riparian vegetation, wildfires from unattended campfires, unavailability of restrooms, litter and over-fishing. There have also been concerns regarding the use of snowmobiles and other off-road vehicles in meadow areas, such as Hope Valley.

5.11.13 Silviculture

According to B&C (2005), nearly all silviculture NPS pollution is associated with woodcutting that takes place predominately on USFS and BLM lands. Most of these activities occur in the Alpine County portion of the watershed. Improper silviculture practices can lead to erosion of land leading to high levels of turbidity and increased sediment loads to surface water bodies.

5.11.14 Fire

The Sierra Front (includes western uplands areas of the watershed) is a fire-prone area due to the dry and windy conditions. According to the Sierra Forest Plan Amendment (USFS 2000), the increased accumulation of forest fuels over the past century has contributed to a trend of increasing fire severity. According to MACTEC (2004), "Changes in forest structure will likely result in high intensity forest fires; burned areas will contribute significant amounts of sediments to the Carson River." It may take decades for the watershed, riparian areas, and aquatic ecosystems to recover from a severe fire. Impacts from high severity wildfires include increase in runoff and sedimentation due to reduced soil cover by vegetation; reduced infiltration capacity of soil; and an increase in peak streamflows that can result in accelerated stream bank erosion.

The most recent major wildfire, the "Water Fall Fire, occurred in July of 2004. Over 8,700 acres were burned along the western edge of Carson City. Much of the fire area is located on alluvial fans that are prone to flash floods. Re-vegetation is critical in these areas to prevent adverse impacts to homes, creeks and ultimately the Carson River. Restoration efforts are currently underway.

5.12 Noxious Weeds

Invasive plant species are increasingly affecting lands within the watershed, particularly in areas along the Carson River and its tributaries. Invasive weeds are highly competitive and difficult to control. They take over agriculture lands, displace native species, decrease wildlife habitat, reduce recreational values and uses, consume water resources, and cost millions of dollars for treatment and lost land productivity.

Chapter 555 of the NRS addresses the control of insects, pests and noxious weeds, defining "noxious weed" as any species of plant that is, or is likely to be, detrimental or destructive and difficult to control or eradicate. Property owners are responsible for controlling noxious weeds

on their properties. According to NRS 555.150 "……every person owning, controlling or occupying lands in this state…shall cut, destroy or eradicate all weeds declared and designated as noxious as provided in NRS 555.130, before such weeds propagate and spread, and whenever required by the state quarantine officer." The full text of Chapter 555 can be found at http://www.leg.state.nv.us/NRS/NRS-555.html.

Noxious weeds are typically plants that have come from other areas and are able to outcompete native species and crops. Nevada law requires that owners and/or occupiers of land in Nevada control all weeds designated as noxious by the NDOA. The designated Nevada Noxious Weeds are shown in Table 5.12-1.

Table 5.12-1: Designated Nevada Noxious Weeds (Source: UNCE 2004a)

Common Name	Scientific Name
African rue	*Peganum harmala*
Austrian fieldcress	*Rorippa austriaca*
Austrian peaweed	*Sphaerophysa salsula/Swainsona salsula*
Black henbane	*Hyoscyamus niger*
Camelthorn	*Alhagi pseudalhagi*
Common crupina	*Crupina vulgaris*
Dyer's woad	*Isatis tinctoria*
Eurasian water-milfoil	*Myiophyllum spicatum*
Giant Salvinia	*Salvinia molesta*
Goats rue	*Galega officinalis*
Green fountain grass	*Pennisetum setaceum*
Hemlock: Poison Water	*Conium maculatum* *Cicuta maculata*
Horse-nettle: Carolina White	*Solanum carolinense* *Solanum elaeagnifolium*
Houndstongue	*Cynoglossum officinale*
Hydrilla	*Hydrilla verticillata*
Klamath weed	*Hypericum perforatum*
Knapweed: Diffuse Russian Spotted Squarrose	*Centaurea diffusa* *Acroptilon repens* *Centaurea maculosa* *Centaurea virgata Lam. Var. squarrose*
Leafy spurge	*Euphorbia esula*
Mayweed chamomile	*Anthemis cotula*
Mediterranean sage	*Salvia aethiopis*
Medusahead	*Taeniatherum caput-medusae*
Perennial pepperweed	*Lepidium latifolium*
Puncturevine	*Tribulus terrestris*
Purple loosestrife	*Lythrum salicaria, L. virgatum & cultivars*
Rush skeletonweed	*Chondrilla juncea*
Saltcedar (tamarisk)	*Tamarix ramosissima, T. parviflora*
Sorghum species, perennial, including, but not limited to: (a) Johnson grass; (b) Sorghum alum; (c) Perennial sweet sudan	
Sulfur cinquefoil	*Potentilla recta*
Syian bean caper	*Zygophyllum fabagp*
Thistle: Canada Musk Scotch Sow Iberian star Purple star Yellow star	 *Cirsium arvense* *Carduus nutans* *Onopordum acanthium* *Sonchus arvensis* *Centaurea iberica* *Centaurea calcitrapa* *Centaurea solstitalis*

Common Name	Scientific Name
Malta star	*Centaurea melitensis*
Toadflax, Dalmatian	*Linaria dalmatica*
Toadflax, yellow	*Linaria vulgaris*
Whitetop or hoary cress	*Cardaria draba*

The noxious weeds that are most well known in the watershed are Tall Whitetop (*Lepidum latifolium*) (TWT) and hoary crest. After the flood event of 1997, distributions of TWT increased dramatically on lands directly impacted by the floodwaters. A watershed wide effort to stop the spread of TWT has been implemented and will be ongoing. Tamarisk, knapweed, and Canada and bull thistle are prevalent weeds identified in the watershed.

Noxious weeds are distributed in the watershed by a variety of means, thereby creating challenges to the groups that are working hard to control the infestations. For example, in 2002, an effort to control Diffuse Knapweed (*Centaurea diffusa*) was initiated by the Alpine/Upper Carson River Watershed Weed Management Group after thirty-nine (39) infestations were documented on roads in Alpine County in 2001. The infestations were detected along roads that had utilized gravel materials from a commercial supplier, located within a large diffuse knapweed infestation in Gardnerville, NV (AWMG 2004).

Noxious Weed Management is a priority concern for the watershed. Increases in development, land use changes, on and off road vehicle use, and future flooding events may significantly increase weed infestations, if left unchecked. Public education will continue to be critical in the battle against noxious weeds.

6.0 Clean Water Act Responsibilities

This section will address criteria elements (b), (g) and (h) of the CWA Section 319 as described below.

b. An estimate of the load reductions expected for the management measures described under paragraph (c).
h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised, or, if a NPS TMDL has been established, whether the NPS TMDL needs to be revised.

6.1 Introduction

The Clean Water Act (CWA) is the cornerstone of surface water quality protection in the United States. The broad goal of the CWA is to "restore and maintain the chemical, physical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water." This is accomplished by use of regulatory and non-regulatory tools. In 1987 the CWA was amended by Congress to focus greater national efforts on the control of NPS pollution. Section 319 was added to the CWA to specifically address NPS causes. This section requires States to assess NPS causes and implement management programs to control these causes. The CWA does not address issues regarding groundwater or water quantity.

Major CWA programs include the following:

1. Water quality standards
2. Antidegradation policy
3. Waterbody monitoring and assessment
4. Reports on condition of the nation's waters
5. Total maximum daily loads (TMDLs)
6. NPDES permit program for point sources
7. Section 319 program for nonpoint sources
8. Section 404 program regulating filling of wetlands and other waters
9. Section 401 state water quality certification
10. State revolving loan fund

The following sections provide information specific to the watershed regarding water quality standards and TMDLs.

6.2 State Mandates

6.2.1 Water Quality Management 208 Plan

If an area is identified as having substantial water quality controls problems it can be designated as a CWA Section 208 planning area. The Carson River Basin has been identified as a designated area and in 2003 the CWSD was appointed by the Governor of Nevada to serve as the 208 planning entity for the watershed.

Section 208 of the CWA requires the preparation of an area wide water quality management plan for designated areas, with emphasis on wastewater. The first 208 Plan was developed in 1982 and had not undergone revision since that time. In 2005 the plan was updated by the CWSD through a collaborative effort with NDEP-Bureau of Water Quality Planning, USEPA and Brown & Caldwell. The updated version incorporates current information on point and NPS pollution as related to population growth and increases in the use of surface and groundwater resources; existing and projected wastewater loads from wastewater treatment facilities (WWTFs); stormwater management issues associated with urban runoff and highway construction and other construction projects, and potential NPS pollution sources. The plan incorporates a 20-year planning period for population projections and related changes in both point and NPS discharges to the Carson River and to groundwater. Significant changes affecting surface and groundwater quality since the 1982 edition was published include the following (B&C 2005):

- Effluent discharges to the Carson River from WWTFs ceased in 1987 with treated effluent currently being used for irrigation purposes.
- BMPs have been implemented for ranch and farm operations and urbanized areas with a large emphasis on managing phosphorus.
- Dairy operations in the upper watershed have decreased from 14 operations to 2.

The updated Plan will allow State and local governments to manage water resources in the watershed by (B&C 2005):

1. Integrating information concerning existing water quality conditions in the watershed;
2. Projecting wastewater loads (point sources) from WWTFs;
3. Managing run-off volume and quality from urban stormwater control systems; and
4. Evaluating effects from NPS pollution including agriculture, construction, mining, and silviculture.

The 2005 Plan recommends that additional feasibility studies be conducted to evaluate the environmental and economic effects of potential direct or indirect discharges of treated effluent to the Carson River. Recommendations include: a) Water quality and flow monitoring data be collected during time-limited discharges of treated effluent to the river to provide background information for evaluating higher levels of treatment and the effects of longer term discharges; and, b) appropriate wasteload allocations should be established prior to permitting any discharge to the river.

6.2.2 Stormwater Programs

The CWA amendments of 1987 established the National Pollutant Discharge Elimination System (NPDES) stormwater program. The act called for implementation in two phases; Phase I addressed the most significant sources of pollution in stormwater runoff. Phase II addresses other sources to protect water quality. The Phase II regulations were published in the Federal Register on December 8, 1999 and are summarized below:

- Municipalities located in urban areas as defined by the Census Bureau are required to obtain NPDES permit coverage for discharges from their municipal separate storm sewer systems (MS4s). Municipalities located outside urbanized areas may need to comply within 180 days notice or as determined by the NPDES Permitting Authority.
- Beginning on March 10, 2003, construction sites that disturb one acre or more are required to have coverage under the NPDES general permit for stormwater discharges from construction site activities.
- Municipalities under 100,000 population will no longer be exempt from the construction site stormwater requirements and the industrial stormwater requirements effective March 10, 2003.
- Definition of industrial stormwater has been revised to expand the "no exposure" exemption to all industrial categories except construction.

The NPDES permitting system requires entities that are regulated under the Stormwater Program to obtain coverage under a NPDES permit and implement a stormwater pollution prevention plan (SWPPP) or a stormwater management plan (SWMP). Both types of plans require the identification and implementation of best management practices (BMPs). Currently, four municipal storm sewer system (MS4) permits have been issued in the watershed. The permitted entities are the Carson City MS4, the Douglas County MS4, the Indian Hills MS4 and a statewide stormwater permit issued to the Nevada Department of Transportation (NDOT). SWMPs were developed and submitted to NDEP in September 2003 for all of the entities and are awaiting review and approval.

Existing stormwater point source locations within the watershed include the following (B&C 2005):

1. Carson City: All storm drains are routed to an outfall at Kings Canyon Creek and eventually reaches the Carson River.
2. Douglas County: There are two locations. One outfall is the sand/oil/water separator on Vista Grande Boulevard; and the second is the NDOT culvert on U.S. Highway 395 that receives discharges from a privately maintained stormwater system. The NDOT culvert discharges to a dirt channel that connects to Clear Creek.
3. Indian Hills General Improvement District discharges to an NDPT drainage along Highway 395.
4. NDOT has numerous outfalls located along its highway system throughout the watershed.

In the future there may be additional outfall locations in Carson City and throughout the NDOT system as new roads are constructed.

6.2.3 Water Quality Standards

The CWA requires that each State set water quality standards for waterbodies throughout their state. The standards are used in many ways including:

1) Assessing the health of water bodies
2) Setting limitations for surface water discharge permits
3) Setting of goals for NPS pollution control projects

The standards define water quality goals by designating beneficial uses of the water and setting numeric water quality criteria necessary to protect the beneficial uses. Federal regulations (40 CFR 131.10(g)) recognize beneficial uses as either existing or designated (Pahl 2004).

- *Existing uses* are those uses actually attained in the waterbody on or after November 28, 1975, whether or not they are included in the water quality standards.
- *Designated uses* are those uses specified in water quality standards for each waterbody or segment whether or not they are being attained.

Understanding the difference between the two types of uses is important. An existing use cannot be removed or modified from a state's water quality standards, while a designated use may be changed based upon the findings of a use attainability analysis (Pahl 2004).

When the beneficial uses have been determined for a waterbody, numeric water quality criteria are then set to protect these uses. The criteria are typically based on either: a) EPA water quality criteria, b) site-specific criteria derived from national criteria modified to reflect site-specific conditions or, c) site-specific criteria developed solely for unique waters.

Water quality standards are the foundation upon which TMDLs are built so it is important to recognize that any deficiencies in the standards will translate into inappropriate and ineffective TMDLs.

6.2.3.1 California Surface Waters

The Lahontan Water Board is the responsible entity for water quality standards in the California portion of the watershed. The "Water Quality Control Plan for the Lahontan Region," also known as the "Basin Plan", sets forth these standards. The standards include designated beneficial uses of water, the narrative and numerical objectives that must be maintained or attained to protect the beneficial uses, and the state Nondegradation Policy (California State Water Resources Control Board Resolution 68-16). The USEPA has also promulgated numerical standards for toxic "priority pollutants" in the "National Toxics Rule" and "California Toxics Rule" that apply to surface waters of the upper watershed in California. For more information on these rules please visit the following website: http://www.waterboards.ca.gov/iswp/index.html.

The Basin Plan divides water quality objectives into three categories:

1. Objectives which apply to all surface waters

2. Objectives for certain water bodies
3. Objectives for fisheries management activities using the fish toxicant rotenone

Objectives which apply to all surface waters

Narrative and numerical water quality objectives apply to all surface waters within the Lahontan region for the following parameters:

Ammonia	Pesticides
Bacteria, Coliform	pH
Biostimulatory Substances	Radioactivity
Chemical Constituentes	Sediment
Chlorine, Total Residual	Settleable Materials
Color	Suspended Materials
Dissolved Oxygen (DO)	Taste and Odor
Floating Materials	Temperature
Oil and Grease	Toxicity
Nondegradation of Aquatic Communities and Populations	Turbidity

For more information and equations for the objectives please refer to the Basin Plan which is available at http://www.swrcb.ca.gov/rwqcb6/BPlan/BPlan_Index.htm. Amendments to the plan and information on the TMDL program can also be found on this website.

Objectives for certain water bodies

Some narrative and numerical water quality objectives are site specific and supersede the objectives that apply to all surface waters. There are specific objectives for the West Fork and for the Indian Creek watershed. The following objectives apply to both waterbodies (CRWQCB 1994):

1. Algal growth potential: The mean of monthly mean of algal growth potential shall not be altered to the extent that such alterations are discernible at the 10% significance level.
2. Biostimulatory Substance: The concentrations of biostimulatory substances shall not be altered in an amount that could produce an increase in aquatic biomass to the extent that such increases in aquatic biomass are discernible at the 10 percent significance level.
3. Color: The color shall not exceed the 13 Platinum Cobalt Unit mean of monthly means (approximately equal to the State of Nevada standard of 13 Platinum Cobalt Unit sample mean).
4. Dissolved Oxygen (DO): The DO concentration shall not be depressed by more than 10 percent, below 80 percent saturation or below 7.0 mg/L at any time, whichever is more restrictive.
5. pH: Changes in normal ambient pH levels shall not exceed 0.5 unit.
6. Species Composition: Species composition of the aquatic biota shall not be altered to the extent that such alternations are discernible at the 10% significance level.
7. Taste and Odor: The taste and odor shall not be altered.

In addition to the above objectives the West Fork has an objective for turbidity that is as follows:

Turbidity: The turbidity shall not be raised above a mean monthly means value of 2 NTU. (This objective is approximately equal to the State of Nevada standard of 2 NTU annual mean).

Tables 6.2.3.1-1 provides additional water quality objectives specific to the upper watershed as stated in the Basin Plan.

Table 6.2.3.1-1: Water Quality Objectives Specific to the Upper Carson Basin (California)

Surface Waters	Objective (mg/L except as noted)[4]								
	TDS	CI	SO_4	Total P	B	%Na*	Total N	TKN	No_3-N
West Fork at Woodfords[1]	55	1.0	2.0	0.02	0.02	20	0.15	0.13	0.02
West Fork at Stateline[1]	70	2.5	2.0	0.03	0.02	20	0.25	0.22	0.03
Indian Creek Reservoir[1]	305	24	-	0.04	-	-	4.0	-	-
East Fork[2]	80 100	4.0 6.0	4.0 8.0	0.02 0.03	0.12 0.25	25 30	0.20 0.30	-	-
Bryant Creek Basin[2,3]	140 200	15 25	35 50	0.02 0.03	0.20 0.50	- 50	0.20 0.30	-	-

Source: CRWQCB 1994, as amended through 2006, Table 3-14

Notes:

[1] Values shown are mean of monthly mean for the period of record

[2] Annual average value/90th percentile value

[3] In addition, numerical water quality objectives listed in Table 5.3.2.1-2 shall apply specifically to surface waters of the Bryant Creek Basin

[4] Objectives are as mg/L and are defined as follows:

B	Boron	NO_3-N	Nitrogen as Nitrate
Cl	Chloride	TKN	Nitrate, Total Kjeldahl
N	Nitrogen, Total	P	Phosphorus, Total
% Na	Sodium, Percent*		

* $\%Na = \frac{(Na \times 100)}{Na+Ca+Mg+K}$ Na, Ca, Mg and K expressed as milliequivalents/liter

Percent Sodium Standard Proposed Revision

The Water Board is in the process of revising the water quality standard for "percent sodium". The percent sodium objective would be replaced with new objectives expressed as "Sodium Adsorption Ratio" (SAR). SAR is more widely used as a criterion for irrigation water than percent sodium and is calculated differently. The proposed plan revision and equation for calculating SAR can be found on the Water Board's website.

Objectives for fisheries management activities using the fish toxicant rotenone

The third category for water quality objectives pertains to fisheries management activities using the fish toxicant rotenone. Because the application of rotenone solutions and the detoxification agent, potassium permanganate, can cause water quality objective exceedences (both inside and outside of the project area) specific objectives have been developed for the following parameters: color, pesticides, species composition and toxicity. Specific information on these objectives can be found in Chapter Three of the Basin Plan.

Beneficial Use Designations for California

Water quality standards are established to protect the beneficial uses established for the water body. Beneficial uses of surface waters for the California portion of the watershed can be found in Table 2-1 of the Basin Plan.

6.2.3.2 Nevada Surface Waters

The Nevada State Environmental Commission has established water quality standards for the Carson River as provided in Nevada Administrative Code (NAC) 445A. Table 6.2.3.2-1 shows the progression of the standards from 1967 to 2002.

Table 6.2.3.2-1: Chronology of Main Water Quality Standards Revisions for "Designated Waters" in the Carson Basin

Date	Action
1967	Water pollution control regulations were adopted for the East Fork Carson, West Fork Carson, main Carson rivers and Bryant Creek including numeric criteria for numerous parameters (pH, temperature, dissolved oxygen, biological oxygen demand, chlorides, phosphorus, nitrates, total dissolved solids).
1972-75	Numeric criteria for color, turbidity, and fecal coliform were added.
1978-80	Beneficial uses were added. Also, significant changes in the numeric criteria occurred. Nitrite criteria added.
1984	Beneficial uses were reworded (fish species of concern were identified). Tables were reformatted to current form. Antidegradation RMHQs were added. Significant changes in the numeric criteria occurred. Ammonia criteria added.
1994	Some RMHQs were revised. pH criteria were revised.
2002	*E. coli* numeric criteria were added and ammonia numeric criteria were revised.

Source: Pahl 2004
Note:
RMHQ – Requirements to Maintain Existing or Higher Quality

Currently two types of waters are addressed by the Nevada standards:

1) Designated waters – These waters are typically larger streams with each water having its own set of beneficial uses and numeric water quality criteria.
2) Class waters – These waters are grouped into 4 classes from A to D, with Class A being the highest quality. Beneficial uses and numeric water quality criteria are specific to each class.

The relationship between flows and water quality is important when assessing the health of the river system. The Nevada Administrative Code (NAC) recognizes that standards may be exceeded during extreme flow events, such as drought and flood, and that these exceedences should not be considered a violation of the standards. NAC 445A121(8) states, "The specified standards are not considered violated when the natural conditions of the receiving water are outside the established limits, including periods of extreme high or low flow…..".

A summary of the Nevada standards (including beneficial uses and numeric criteria) as stated in the NAC for the main Carson basin water is provided in Appendix C. There are also standards for toxic material and water quality criteria for total ammonia that applies to all surface waters in Nevada. This information can be found on the NDEP website at http://ndep.nv.gov/nca/445a-118.pdf.

6.2.4 303(d) Impaired Waters List

Section 303(d) of the CWA requires States to develop a list of waterbodies that need additional work beyond existing controls to achieve or maintain the water quality standards. These waterbodies are the target waterbodies for watershed-based solutions such as TMDLs.

Appendix D provides the NDEP 2004 303(d) list and the Lahontan Water Board's 2002 303(d) list.

6.2.5 TMDL Development and Load Reduction Objectives

TMDLs are an assessment of the maximum amount of pollutant a waterbody can receive without violating water quality standards. The CWA, Section 303(d) establishes the TMDL process that consists of three steps:

1. Identify waters not meeting standards and prepare 303(d) list
2. Establish priority waters/watersheds
3. Develop TMDLs – States must develop TMDLs for 303(d) listed waterbodies.

The USEPA approves TMDLs and once approved they are implemented through existing NPDES permits for point source discharges and, depending upon the state, through voluntary or regulatory NPS control programs. The TMDLs discussed in this document do not apply to sovereign nations. The Tribe's are responsible for developing water quality standards and TMDLs within the boundaries of their land.

6.2.5.1 Lahontan Regional Water Quality Control Board

The Lahontan Water Board is the responsible entity for TMDL development and implementation for the California portion of the watershed. In California, TMDLs and TMDL implementation programs are adopted as basin plan amendments. In 2005 the State Water Board adopted a policy that allows alternative regulatory programs to substitute for TMDLS under specific circumstances.

In addition the State Water Board accepted the California Rangeland Water Quality Management Plan in July 1995. This plan describes a program for voluntary compliance with the CWA, Coastal Zone Management Act, and Porter-Cologne Act.

The California NPS Pollution Control Program is the most up to date NPS program. The purpose of the program is to improve California's ability to effectively manage NPS pollution and to conform to the requirements of the CWA and the Federal Coastal Zone Act Reauthorization Amendments of 1990. The program received final approval in July of 2000 and was updated in 2004. The entire plan including updates can be found at the following website: http://www.waterboards.ca.gov/nps/protecting.html.

To date there is only one TMDL that has been developed for the California portion of the watershed. All other California 303(d) listed waterbodies have a low priority for TMDL development. TMDL development for listed waterbodies that are associated with the Leviathan Mine Superfund Site, such as Aspen Creek, Bryant Creek, and Leviathan Creek, will be coordinated with ongoing Regional Board and CERCLA remediation activities at the mine site. Monitor Creek TMDLs will be coordinated with CERCLA remediation.

6.2.5.1.1 Existing California TMDLs

Indian Creek Reservoir
Amendments to the Basin Plan concerning TMDL and implementation plan for Indian Creek Reservoir (ICR) were adopted in July 2002 and received final approval from the USEPA in July 2003. The purpose of the TMDL is to ensure the attainment of all water quality standards specific for the reservoir, including beneficial uses for aquatic life and recreation.

Monitoring at the reservoir (which had been used for wastewater disposal until 1989) showed decreases in the concentrations of most wastewater related constituents including total phosphorus (TP) levels. However, concentrations of TP remained at levels which scientific literature indicates will maintain euthrophic conditions. Euthrophic symptoms include blooms of blue-green algae, low transparency, and depletion of dissolved oxygen in the hypolimnion. TP was selected as the quantitative focus for the TMDL due to frequent violations of the water quality objectives and because of TP as a factor in reservoir eutrophication. The primary numeric target is an annual mean concentration in the water column of 0.02 mg/L TP (CRWQCB 2002). This target represents the threshold between mesotrophic and eutrophic conditions. The Lahontan Water Board suggests that this target can be attained by significantly reducing TP loading from the sediment. Suggested methods include increased flushing, removal of phosphorus-rich sediment, or chemical treatment to prevent phosphorus release to the water column.

Implementation of the TMDL is the responsibility of STPUD for control of internal loading. The BLM, Alpine County, STPUD, and other landowners and land managers in the watershed are responsible for control of external sources. The implementation program will involve an adaptive management approach and will be done in coordination with the Regional Board watershed management planning and NPS control efforts. An interim TP target of 0.04 mg/L is projected for attainment by 2013. If monitoring demonstrates that the beneficial uses are supported at higher phosphorus concentrations, the TMDL may be revised. Long-term targets are expected to be attained by 2024.

6.2.5.2 Nevada Division of Environmental Protection

NDEP Bureau of Water Quality is responsible for the development of TMDLs in the Nevada portion of the watershed. In Nevada, TMDLs are implemented through NPDES permits for point sources and through the voluntary 319 NPS Program.

TMDLs are typically developed using existing information and studies. When adequate information is not available TMDLs may be developed through a phased approach. With this approach the limited existing information can be used to set estimated load reductions, begin to implement needed controls and restoration actions, monitor waterbody responses to theses actions, and plan for future TMDL review and revision when improved data and prediction tools are available. NDEP uses a phased approach that has utilized load duration curves as a method to better characterize the pollutant problems over the entire flow regime. The goal is to more adequately reflect water quality across flow conditions rather than at a single flow event such as average daily flow.

The watershed has some outdated TMDLs that were documented in the 1982 version of the 208 Plan. These TMDLs are for biological oxygen demand (BOD), NO^3, PO^4, and TDS. Since 1982 all of the wastewater treatment plan discharges have been removed from the Carson River. As a result, the Carson River is no longer impaired for DO, BOD, nitrates, orthophosphates and TDS. However, the river still appears on Nevada's 303(d) List for phosphorus.

The 2002 Nevada 303(d) List identifies TP, TSS, Turbidity, Temperature, Total Iron and Total Mercury, fecal coliform, e. coli, and dissolved zinc as the main parameters of concern for the Carson River. A TMDL for TP has been developed and is discussed below. NDEP is in the process of developing TMDLs for total suspended solids and turbidity from Stateline to Lahontan Reservoir. TMDLs for temperature, Total Iron and Total Mercury and other pollutants have been assigned a low priority with no plans to develop these TMDLs in the near future. Currently, the Cities of Reno/Sparks and the Truckee Meadows Water Reclamation Facility are pursuing a possible revision to the Truckee River Total Nitrogen (TN), TP and TDS TMDLs. Also, the City of Carson City is examining the feasibility of a Carson River discharge from their wastewater treatment facility. Both of these efforts may drive the need to develop TMDLs for Lahontan Reservoir in the future. Loading from both the Truckee Canal and the Carson River will be evaluated as part of a possible future TMDL for the Lahontan Reservoir.

6.2.5.2.1 Existing Nevada TMDLs

Bryant Creek

Bryant Creek was added to the Nevada 1998 303(d) list due to concerns related to copper (dissolved), iron (total) and nickel (total). In 2002 the listing was expanded to include arsenic (total), turbidity, total suspended solids (TSS), and temperature. A TMDL was approved by EPA in November of 2003 that addresses arsenic (total), iron (total), nickel (total), TSS and turbidity. The TMDL also provides justification for delisting copper and temperature. Future needs that have been identified for Bryant Creek include the following (NDEP 2003):

Creek impacted by acid mine drainage (orange color) joins other stream on its way to Bryant Creek and eventually the East Fork Carson River
Photo: G. Azad

- A detailed source assessment including quantity, location, timing may be necessary for some of the identified pollutants of concern. An initial step could include monitoring at the stateline to begin differentiating between loading with Nevada and within California.
- An evaluation of the appropriateness of "municipal or domestic supply" as a beneficial use may be appropriate
- Some of the water quality standards need to be reviewed and possibly revised to appropriate levels.
- The addition of nickel analysis for Monitoring Site BCU is needed to characterize nickel levels in Bryant Creek.

- As additional data are collected, update the linear regression relationship between total suspended solids and turbidity.

Carson River

The Carson River is impaired for TP, TSS and Turbidity downstream of the West Fork at Paynesville and the East Fork at Riverview. The TP standard has been set for a concentration of 0.1 mg/L in order to support the most restrictive beneficial uses, propagation of aquatic life and recreation involving contact with water. The TMDL is based upon the total number of standard exceedences instead of annual averages in order to assess the seasonal differences in concentration and loading.

The TSS and turbidity standards set in the NAC reflect the "desired goal" recommended by EPA in the water quality criteria books to protect propagation of aquatic life. The turbidity standards were used to calculate surrogate TSS values from the regression equations relating Turbidity to TSS (NDEP 2006). The surrogate values were used as the water quality targets for Turbidity.

Tables 6.2.5.2.1-1a and b show the TMDL sites with corresponding reaches and the USGS gaging stations.

Table 6.2.5.2.1-1a: Total Phosphorus TMDL Sites, Corresponding Reaches and USGS Gaging Stations

TMDL Site	Corresponding Reach upstream of TMDL Site and the NAC segments within TMDL Reaches	USGS Gaging Station
East Fork at Riverview	No impairment – Duration Curve developed to illustrate decline in water quality at downstream sites	Near Gardnerville #10309000
West Fork at Paynesville, CA	No impairment – Duration Curve developed to illustrate decline in water quality at downstream sites	Woodfords #10310000
Carson River at Mexican Gage	Mexican Gage to Stateline on both East and West Forks 445A.147, 445A.149 through 445A.154	Near Carson City #10311000
Carson River at New Empire Bridge	New Empire to Mexican Gage 445A.155	Deer Run Road #10311400
Carson River at Weeks Bridge	Weeks to New Empire 445A156, 445A157	Near Ft. Churchill #10312000

Source: NDEP 2005

Table 6.2.5.2.1-1b: TSS/Turbidity TMDL Sites, Corresponding Reaches and USGS Gaging Stations

"TMDL" Site	Impaired for TSS or Turbidity?	Corresponding Reach upstream of TMDL Site and the Nevada Administrative Code (NAC) segments *within* TMDL Reaches	USGS Gaging Station
1 West Fork at Paynesville, Ca.	No	Duration Curves developed to illustrate change in water quality at downstream sites	Near Gardnerville # 10309000
2 East Fork at Riverview - at Washoe Bridge, downstream of power dam & upstream of mobile home park	Turbidity only	East Fork at Riverview to the Stateline 445A.150 TSS Duration Curve developed to illustrate change in water quality at downstream sites	Woodfords # 10310000
3 Carson River at Mexican Gage	TSS & Turbidity	*Mexican Gage to the West Fork at Muller & on the East Fork to Muller for TSS* 445A.152, 445A.153, 445A.154 *Mexican Gage to the Stateline on the West Fork and to the East Fork at Riverview for Turbidity* 445A.151, 445A.152, 445A.153, 445A.154	Near Carson City # 10311000

"TMDL" Site	Impaired for TSS or Turbidity?	Corresponding Reach upstream of TMDL Site and the Nevada Administrative Code (NAC) segments *within* TMDL Reaches	USGS Gaging Station
4 Carson River at New Empire Bridge	Turbidity only	*From New Empire to Mexican Gage* 445A.155 TSS Duration Curve developed for to illustrate change in water quality at downstream site	Deer Run Road # 10311400
5 Carson River at Weeks Bridge	TSS & Turbidity	*Weeks to New Empire for TSS* 445A.156, 445A.157 *Weeks to Dayton for Turbidity* 445A.157	Near Fort Churchill # 10312000

Sites which meet the water quality targets do not require a TMDL. However, load duration curves were developed for these sites to illustrate the changes in water quality occurring between TMDL monitoring stations.

Total Maximum Daily Loads Reduction Estimates (*element b*)

TMDLs and load reduction estimates for TP (NDEP 2005) were determined through Duration Curve Analysis (NDEP 2003) and approved by EPA in November 2005. Draft TMDLs and load reductions for Total Suspended Solids and Turbidity were completed in June 2006. A final draft was submitted to EPA by January 2007.

A duration curve plot illustrates the percentage of time during which the value of a given parameter (e.g. – flow, loading) is equaled or exceeded (Figure 6.2.5.2.1-1). The target load duration curves or TMDLs are represented by the following equation:

$$TMDL\ (lbs/day) = Water\ Quality\ Target \times Flow \times 5.39 \qquad (Eq.\ 1)$$

Where:

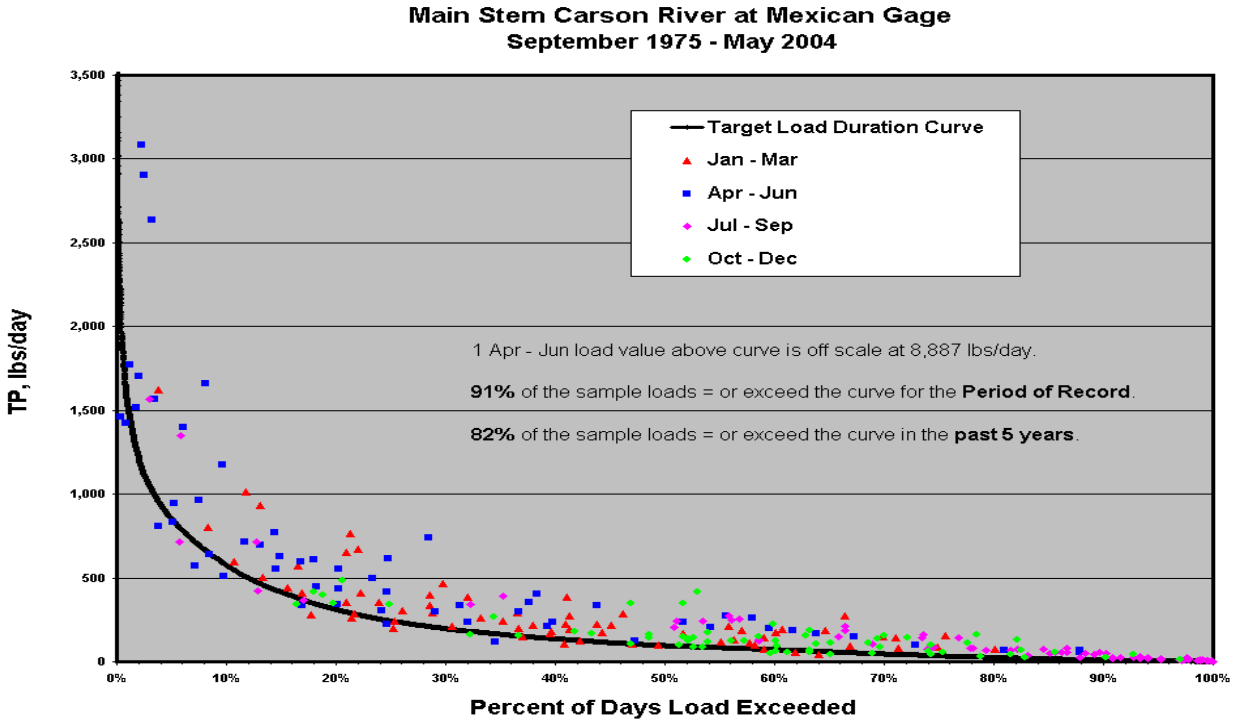
TP water quality target = 0.1 mg/L

TSS/Turbidity water quality targets -

- 25 mg/L at West Fork Paynesville for TSS & TSS as a surrogate for Turbidity
- 37 mg/L for EF Riverview, Mexican Gage & New Empire for TSS as a surrogate for Turbidity
- 80 mg/L at EF Riverview, Mexican Gage & New Empire for TSS
- 80 mg/L at Weeks Bridge for TSS & TSS as a surrogate for Turbidity

Flow = period of record stream flow at the appropriate USGS Gage, cfs
5.39 = conversion factor

Figure 6.2.5.2.1-1



Total Phosphorus

Full compliance with each TMDL occurs when 90% of the observed loads fall below the allowable loads as defined by the Target Duration Curve. *Reductions necessary to achieve the TMDL are determined by computing the difference between the total observed sample loads and the corresponding target loads from the curve for selected duration intervals.* The intervals represent the percent of days the load is exceeded under different hydrologic conditions. This method is described for median observed and allowable loads in a white paper written by Tetra Tech (2004). Cleland (2003) also discusses using the duration curve to identify load exceedances under specific conditions. Table 6.2.5.2.1-2 provides the calculation at the Mexican Gage control point in Carson City and the data is illustrated in Figure 6.2.5.2.1-2. The reduction tables for the remaining sites are provided in Tables 6.2.5.2.1-5 through 6.2.5.2.1-8. The East Fork at Riverview and West Fork at Paynesville are included in the analysis for comparison to the three impaired sites. Median Load reductions are also provided in Appendix E.

Summarizing the load exceedances by the duration intervals again demonstrates that the load increases between the upstream sites and the downstream sites in Carson City (Figure 6.2.5.2.1-3). Table 6.2.5.2.1-3 shows the influence of spring runoff on loadings within each interval at four of the "TMDL" sites. For example, 75% of the Mexican Gage samples (15 out of 20 samples) that fall on or above the duration curve within 0-10% exceedance were collected in April, May or June. Flows occurring during this time period are dominated by snowmelt. Thirty-seven percent of the Mexican Gage samples falling on or above the duration curve within the 10-40% interval were collected in April, May or June. Spring snowmelt is not a factor influencing exceedance of the duration curve at the West Fork Paynesville site.

Approximately 50% of the measured TP loads at Riverview, Mexican Gage and New Empire are concentrated within the 0 to 10% duration interval, which is typically associated with streambank erosion processes. Sixty percent of the observed TP load is generated under high flow conditions at Weeks Bridge. Management of nonpoint source loads produced by extreme flows or flood events, represented by points located on the steepest part of the curve, may not be feasible.

Table 6.2.5.2.1-2: Estimated Load Reductions for Mexican Gage

Duration Interval	Hydrologic Condition	# Samples = to or exceeding curve within Interval	Total Observed Sample Load, lbs/day	Total Allowable Load Allocation, lbs/day	Estimated Reduction to meet Target, lbs/day	Estimated Reduction *, %
0 - 10%	Extreme high flows or flood	20	49,169	22,013	27,156	55
10 - 40%	Wet conditions	65	27,832	17,800	10,032	36
40 - 60%	Mid range flows	56	10,516	5304	5211	50
60 - 90%	Dry conditions	70	7201	2666	4536	63
90 - 100%	Low flows	31	511	163	348	68

* (Estimated Reduction in lbs/day / Total Observed Sample Load in lbs/day) x 100 Total

Table 6.2.5.2.1-3: Percent of April - June Sample Loads Equal to or Exceeding Curve Within Each Duration Interval

"TMDL" Site	Extreme high flows 0 - 10%	Wet Conditions 10 - 40%	Mid-range flows 40 - 60%	Dry conditions 60 - 90%	Low Flows 90 - 100%
West Fork at Paynesville	0	0	0	0	0
East Fork at Riverview	90	14	0	33	0
Mexican Gage	75	37	13	11	0
New Empire Bridge	67	40	13	12	0
Weeks Bridge	82	34	10	17	0

Figure 6.2.5.2.1-2

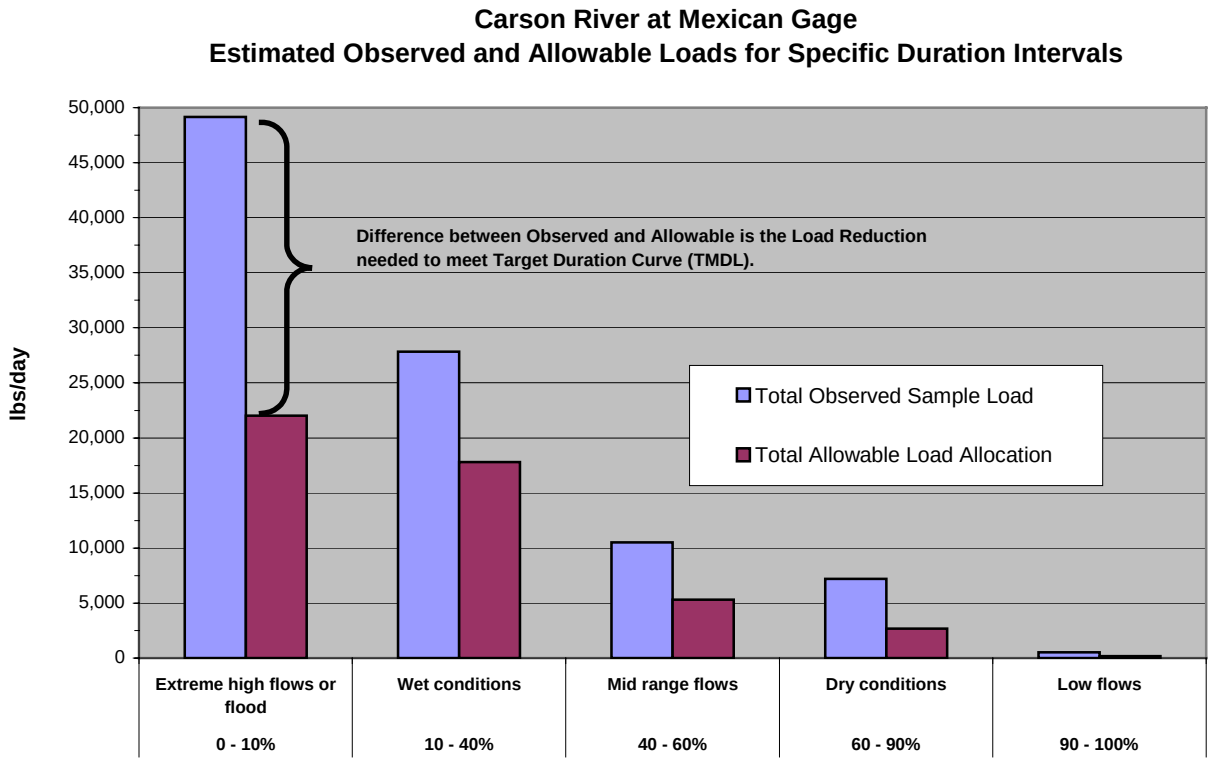
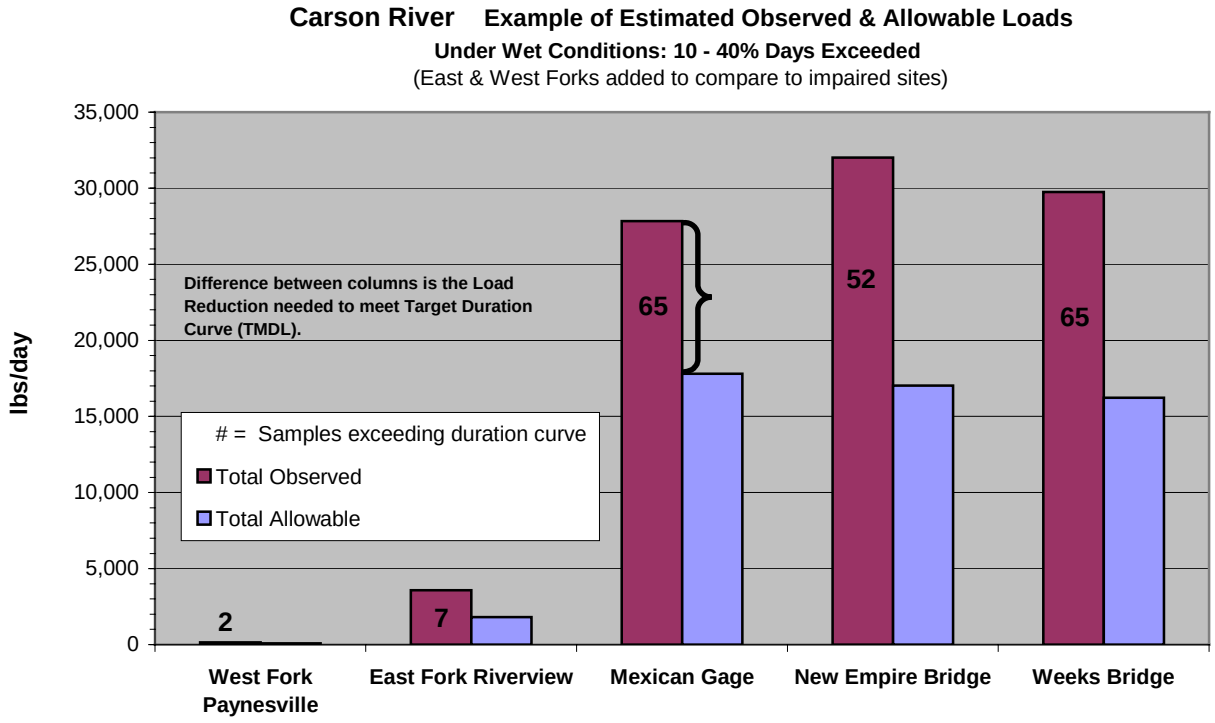


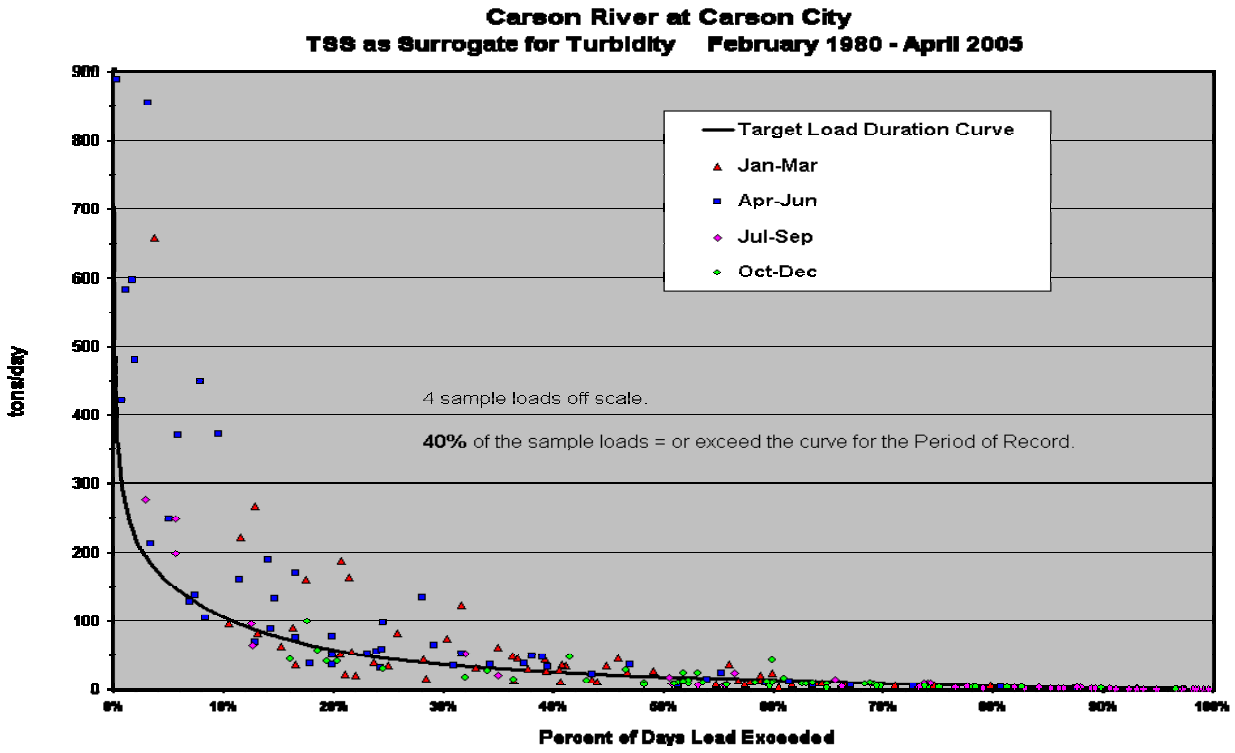
Figure 6.2.5.2.1-3



TSS and Turbidity

As with the Total Phosphorus TMDLs, full compliance occurs when 90% of the observed loads fall below the allowable loads as defined by the Target Duration Curve. *Reductions necessary to achieve the TMDL are determined by computing the difference between the median observed sample loads and the corresponding median target loads from the curve for selected duration intervals.* The intervals represent the percent of days the load is exceeded under different hydrologic conditions (Figure 6.2.5.2.1-4). This method is described for median observed and allowable loads in a white paper written by Tetra Tech (2004). Cleland (2003) also discusses using the duration curve to identify load exceedances under specific conditions. Table 6.2.5.2.1-5 provides an example of the calculations at the Mexican Gage control point in Carson City and the data is illustrated in Figure 6.2.5.2.1-5. The remaining reduction tables are provided in Appendix E. The data demonstrates that most of the sample loads exceeding the targets are concentrated within the 0 to 10% duration interval, which is typically associated with streambank erosion processes. Management of nonpoint source loads produced by extreme flows or flood events, represented by points located on the steepest part of the curve, may not be feasible.

Figure 6.2.5.2.1-4



Tables 6.2.5.2.1-4, -5 and -6 show the influence of spring runoff on loadings within each interval at the "TMDL" sites. The data shows that at each site, > 50% of the loads falling on or above the duration curve within 0-10% exceedance interval were collected in April, May or June. Flows occurring during this time period are dominated by snowmelt. Twenty-eight to fifty percent of loads falling on or above the duration curve within the 10-40% interval were collected in April, May or June.

Table 6.2.5.2.1-4 Estimated Median Load Reductions for Mexican Gage (TSS as surrogate for Turbidity)
Applies to Reaches 445A.151, 445A.152, 445A.153 (including Brockliss Slough as tributary), 445A.154

Duration Interval	Hydrologic Condition	# Samples = to or exceeding curve within Interval	Median Observed Sample Load, tons/day	Median Allowable Load Allocation, tons/day	Estimated Reduction to meet Target, tons/day	Estimated Reduction*, %
0 - 10%	**Extreme high flows or flood**	**20**	464	191	273	**59**
10 - 40%	**Wet conditions**	**40**	68.4	44.2	24.2	**35**
40 - 60%	**Mid range flows**	**19**	28.2	18	10.2	**36**
60 - 90%	**Dry conditions**	**9**	8.6	6.9	1.7	**20**
90 -100%	**Low flows**	**4**	1.1	0.9	0.2	**18**

* **(Estimated Reduction in tons/day / Median Observed Sample Load in tons/day) x 100**

Figure 6.2.5.2.1-5

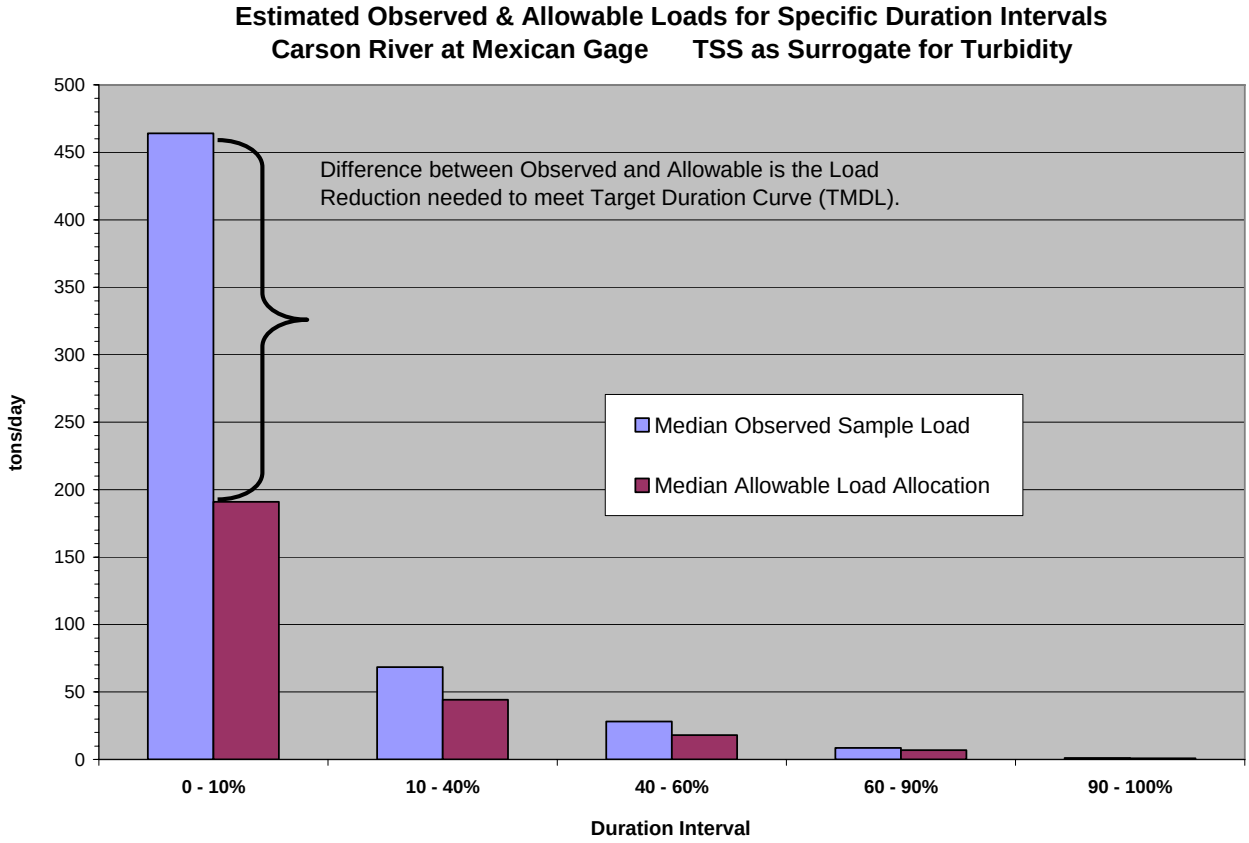


Table 6.2.5.2.1-5 % of April - June Sample Loads Equal to or Exceeding curve within each duration interval TSS

"TMDL" Site	Extreme high flows 0 - 10%	Wet Conditions 10 - 40%	Mid Range Flows 40 - 60%	Dry Conditions 60 - 90%	Low Flows 90 - 100%
West Fork at Paynesville	**58**	**0**	**0**	**0**	**0**
East Fork at Riverview	**78**	**0**	**0**	**50**	**0**
Mexican Gage	**79**	**29**	**0**	**0**	**0**
New Empire Bridge	**71**	**43**	**0**	**0**	**0**
Weeks Bridge	**83**	**57**	**0**	**0**	**0**

*TSS as surrogate for Turbidity ** Percentage based on 1 sample.

Table 6.2.5.2.1-6 % of April - June Sample Loads Equal to or Exceeding curve within each duration interval TSS as Surrogate for Turbidity

"TMDL" Site	Extreme high flows 0 - 10%	Wet Conditions 10 - 40%	Mid Range Flows 40 - 60%	Dry Conditions 60 - 90%	Low Flows 90 - 100%
West Fork at Paynesville	**100***	**0**	**0**	**0**	**0**
East Fork at Riverview	**86**	**28**	**0**	**50**	**0**
Mexican Gage	**75**	**50**	**10**	**0**	**0**
New Empire Bridge	**69**	**43**	**31**	**0**	**0**
Weeks Bridge	**64**	**50**	**0**	**0**	**0**

*Percentage based on 1 sample.

Criteria established to determine if load reductions have been achieved (*element h*)

Criteria established to determine if load reductions have been achieved over time were derived from analysis of the duration curves. As stated under Element b (estimated Load reductions), *full compliance* with the TP TMDL occurs when 90% of the observed loads fall below the allowable loads as defined by the Target Load Duration Curves. Currently, the Carson River is sampled twice per year. Starting in 2011, monthly sampling will be instituted for a two or three year time period. It is hoped that the data collected during this more intense monitoring phase will indicate a reduction in TP when compared to the Target Load Duration Curves and the estimated load reductions for Mexican Gage, New Empire Bridge and Weeks Bridge. USEPA approved the load reductions established by the TP TMDL in November 2005.

From the Duration Curve analysis the reduction required to meet the water quality standard and thus the TMDL are known. These reductions *do not* reflect a specific level of biological improvement. It is unknown if the estimated load reductions or improvement in water quality will translate into an improvement in biological integrity. If the TP concentration in the Carson River decreases over time, will it benefit aquatic life? If high nutrient levels are causing algae blooms and excessively low dissolved oxygen concentrations as the algae decays, an increase in aquatic life populations may be observed as phosphorus levels decline. However, other factors *or combination* of factors may actually be limiting improvement in aquatic life (e.g. - light, water availability). Lower TP concentration may be indicative of some improvement in the physical condition of the river, particularly if large-scale restoration projects have been implemented along miles of river. Projects designed to lay back and revegetate eroding, incised banks will potentially capture phosphorus adsorbed to sediment and promote nutrient uptake. Improving the physical condition may enhance riparian habitat for aquatic life, leading to increased populations of macroinvertebrates or fish.

Again, it is unknown how much biological improvement might occur if the river corridor is actively rehabilitated or is protected through efforts to limit floodplain development. It is also unknown how many miles of river need to be restored, which will lead to such improvements, or how long improvements may take once protection or restoration is implemented. The connection or correlation between load reduction, physical condition, water quality and biology will only be determined over the long term as NDEP's bioassessment data is evaluated and Indices of Biotic Integrity (IBIs) are developed and compared to changes in the other parameters. Completion of the IBIs are expected by December 2007. If large-scale restoration has been implemented and load reductions achieved, it may be possible to develop a relationship between miles of river revegetated and the degree of water quality or biological improvement observed.

Load Reduction Estimates based on the Region 5 Model

Load reductions expected from the implementation of streambank stabilization projects can be grossly estimated for TP, TN and sediment from the Region 5 (R5) Pollutant Control spreadsheet model (Michigan DEQ 1999). USEPA provides access to this model through the Grants Reporting and Tracking System (GRTS) database. States are required to document the results of nonpoint source pollutant control projects funded by the Section 319(h) Grant Program in GRTS. The R5 model calculates the load reduction based on project length, bank height, soil textural class, a lateral recession rate and concentrations of TN and TP in the soil. A BMP Efficiency of 1 (100% pollutant removal) is also assumed for sediment reduction. EPA recognizes the limitations of modeling and States are given the option in GRTS to explain any possible shortcomings affecting the accuracy of the estimated load reductions.

Load reductions for a *general* one mile stretch of the Carson River are listed in Table 6.2.5.2.1-4. All soil textures were evaluated and a range of bank heights were selected to illustrate how these parameters affect the calculation. Soil texture for the Upper Carson Reaches (Douglas County and Carson City) were found to range from sands to fine sandy loam by reviewing the typical pedon descriptions for the general soil map units found on low terraces and floodplains (USDA 1979). An average sandy loam soil texture for the Middle Carson reach was determined based on field surveys completed by an NRCS soil scientist for the DVCD. However, soils and bank

heights can vary dramatically along the length of each reach. Reductions for the one-mile stretch can be used to determine reductions for *specific* reaches or project lengths.

Long-term lateral erosion rates have not been quantified for the Carson River, which is deeply incised in many segments, therefore the default value of 0.5 ft/year (very severe) provided in the model was utilized and held constant for each reach. The actual erosion rate may be much higher. Aerial photo comparisons conducted by Otis Bay Ecological Consultants (2004) indicate that the Truckee River increased in width by approximately 80 feet in 40 years (average 2 ft/yr). Using a Lateral Recession Rate of 2 ft/yr increases the load reductions by a factor of four. However, it must be understood that one flood event can cause the observed erosion. Modeling results reported by Carroll et al. (2004) indicate that the flood of 1997 produced 87% of the erosion occurring on the Carson River during the period 1991 to 1997 between Carson City and Fort Churchill. Miller et al. (1999) determined the average increase in channel widths was 30 m (98 ft) in 7 years (14 ft/yr). Using such a high rate in the R5 model, biased by one flood event, might greatly overestimate the load reductions achievable by implementing bank stabilization or restoration

TP concentrations in the bank soil were also held constant. The average phosphorus soil concentration utilized in the model was obtained from an investigation conducted in the watershed by the USGS (2004). The Carson River is currently not impaired for any of the nitrogen species; therefore load reductions for nitrogen will not be evaluated at this time.

The model produces a wide range of load reductions, which is assumed to be the amount of pollutants being *kept out* of the river by repairing or stabilizing the streambank. The values have *no* relationship to the *existing* loads in the river. Though it might be reasonable to assume that the reduction estimates are representative of what has been discharged into the river in the past *due to erosion*. The R5 model does not account for reductions due to mechanisms such as denitrification, plant/algae uptake, sediment adsorption or settling processes. Thus the load reductions could be underestimating actual improvements in water quality that could occur. As inferred previously, there is also uncertainty in selecting a realistic Lateral Recession Rate for input into the model. At this time, it is unknown if the amounts presented in Table 6.2.5.2.1-4 are realistic reductions to expect from streambank stabilization or restoration projects implemented on the Carson River.

Table 6.2.5.2.1-7: Carson River-R5 Model Input Parameters & Run Results for a General One Mile Stretch

Reach Length: 5280 ft
Lateral Erosion Rate: 0.5 ft/yr
P soil concentration: 0.0006 lb/lb soil
Range of Bank Heights: 4 to 12 feet

Soil Texture	Sediment Reduction, ton/yr	Sediment Reduction, lb/day	TP Reduction, lb/yr	TP Reduction, lb/day
Sands, loamy sands	581-1742	3183-9545	592-1777	1.62-4.86
Sandy loam	554-1663	3036-9112	566-1696	1.55-4.65
Fine sandy loam	528-1584	2893-8679	539-1616	1.48-4.43
Loams, sandy clay loams, sandy clay	475-1426	2603-7814	485-1454	1.33-3.98
Silt loam	528-1584	2893-8679	539-1616	1.48-4.43
Silty clay loam, silty clay	422-1267	2312-6942	507-1521	1.39-4.17
Clay loam	396-1188	2170-6510	546-1639	1.50-4.49
Clay	370-1109	2027-6077	510-1530	1.40-4.19
Organic	116-348	636-1907	209-627	0.57-1.72

Pound per day reductions for TP determined by Duration Curve Analysis of the total observed and allowable sample loads are in general much greater than the values calculated using the R5 Model. Load reductions determined by the difference between *median* observed and allowable loads under extreme high flow or flood conditions (Appendix E) are also greater than the values calculated using the R5 model. If it is assumed the 54 miles between Stateline and Mexican Gage has been stabilized, the R5 model predicts reductions of 88-262 lb/day of TP for sand or loamy sand banks (maximum erosion potential) ranging from 4 to 12 feet in height. Based on the duration curve analysis under extreme high flow or flood conditions, a reduction of 27,156 lb/day (Table 6.2.5.2.1-2) is required to meet the target load duration curve developed for Mexican Gage. The Median reduction is 595 lb/day. The R5 model results suggest streambank restoration or stabilization may not be enough to achieve the highest TP load reductions identified by the TMDL. In addition, cost of large-scale restoration or stabilization will be prohibitive. The DVCD, after nine years of design experience, has determined that projects constructed with a mixture of rock and bioengineering is approximately $150/foot. One mile of bank on one side of the river would cost approximately $792,273 to rehabilitate.

Criteria for determining whether the Watershed Plan or TMDL needs to be revised (*element h*)

Lack of landowner participation in restoration projects, loss of agricultural land to development, rapid urbanization of the floodplain and loss of funding opportunities may limit the efforts to improve water quality and the overall health of the river system. If reach restoration/corridor protection milestones are not achieved by 2015 because of the issues stated above, NPS control strategies identified in the Stewardship Plan may be redirected or refocused towards stormwater and urban runoff.

If load reductions have not occurred by 2015 because minimal implementation of NPS management measures was achieved, no changes to the TMDL or load reduction criteria will be made. If load reductions have not occurred and the restoration/corridor protection milestones *have been* achieved, the TMDL and load reduction criteria will be re-evaluated.

Future needs that have been identified for further refinement of the TMDLs include (NDEP 2005, 2006):

- Evaluate how nitrogen may be contributing to water quality impairment
- Evaluate water quality data collected by the Conservation Districts, USGS, and DRI
- Assess physical condition and relate characteristics such as percentage of riparian vegetation or percentage of incised banks within a reach to the degree of water quality impairment or lack of biological integrity
- Determine if updates to the nitrogen or phosphorus standards are warranted

7.0 Monitoring and Assessment

Numerous studies and projects have been implemented over the years to attempt to characterize the chemical, physical and biological conditions of the river system. This characterization will help to evaluate the health of the aquatic life and the health of the water quality standards. The following are summaries for routine or on-going programs and select projects.

7.1 Carson River Watershed "Report Card" Project

NDEP is currently in the process of developing a Carson River Watershed Assessment or "Report Card" from Stateline to Lahontan Reservoir. By drawing upon numerous studies and monitoring efforts, the Report Card will provide a comprehensive characterization of the past and current health of the Carson River and its aquatic life from a CWA perspective. Chemical, physical, and biological parameters will be considered. One goal of the project is to evaluate the appropriateness of the 303(d) listings for the Carson River. The project will actually be a series of reports that will cover topics such as the following:

- History and background
- Beneficial use needs and criteria evaluation
- Existing conditions
- Use impairment
- Recommendations for future actions

Upon completion of the report card project NDEP will determine if the water quality standards for nitrogen and phosphorus need to be modified to improve the support of the beneficial uses.

7.2 Water Quality Monitoring Programs

Numerous programs have been implemented over the years to develop a long-term data set for water quality. In addition, programs have been conducted to investigate specific issues. The following subsections provide summaries for some of the programs. Tables 7.1.8-1 and –2 provide information on these and other programs.

7.2.1 California Surface Water Ambient Monitoring Program

The California Surface Water Ambient Monitoring Program (SWAMP) is a California statewide monitoring effort to assess the conditions of the state's surface waters. The State Water Board first established the program in 2000. For the purposes of the SWAMP program "ambient" refers to any activity in which information about the status of the physical, chemical, and/or biological characteristics of the environment is collected to answer specific questions about the status and trends in water quality and/or beneficial uses of the water. The primary objectives for surface monitoring in the Lahontan Region are (to the extent that funding is available):

- To determine whether ambient water quality at selected sites is in compliance with the chemical and physical water quality objectives contained in the Basin Plan and the "California Toxics Rule".
- To determine whether water flowing from California into the State of Nevada meets Nevada's water quality objectives.
- To determine indices of biological integrity (IBIs) for streams and rivers in the eastern Sierra based on instream benthic macroinvertebrates and periphyton assemblages.

Numerous SWAMP documents are available on the Water Board's website at http://www.waterboards.ca.gov/lahontan/swamp.html.

7.2.2 South Tahoe Public Utility District Monitoring

STPUD conducts routine water quality monitoring on a monthly basis within the West Fork and Indian Creek watersheds.

7.2.3 Upper Carson River Watershed Water Quality Monitoring Program

Alpine County in conjunction with the CWSD, STPUD, DRI, and the AWG received funding from the State Board to conduct a water quality monitoring program in the upper watershed. The project area includes the upper East and West Forks watersheds plus Indian Creek. Sampling was conducted between April 2004 and January 2006. Sampling site locations include eight sites within the West Fork drainage, and 12 sites within the East Fork drainage (including two sites on Markleeville Creek, three on Millberry Creek, and two on Indian Creek). Red and Summit Lakes are also sampled at least once a year as part of the program.

The goals of the program are to:

- Identify and quantify the various sources of contaminants, where possible.
- Provide public officials the necessary information to design proper remedial measurements, including the establishment of TMDLs.
- Provide data that could be utilitized by Alpine County, and other agencies, for future projects aimed at improving water quality and biological resources in the Watershed.

A draft final report has been developed for the program presenting data results and recommendations for future monitoring efforts. The projected completion for this project is June 30, 2007.

7.2.4 Volunteer Citizen Water Quality Monitoring Program

In 2004, the SNA, CWSD and AWG began a volunteer monitoring program for the upper watershed with funding from the Water Board. Eight sites located on the East and West Forks of the Carson River plus Markleeville, Hot Springs and Silver Creeks are sampled on a quarterly basis for temperature, dissolved oxygen, pH, conductivity and turbidity. Photo monitoring of the sampling sites is also conducted. Bioassessment and bacteria sampling were recently added to the program. The intended use of the collected data is for general watershed assessment purposes and for pollution prevention and screening. The data is available to the public for

purposes of watershed education and to regulatory and resource management agencies to supplement existing data collection efforts.

7.2.5 NDEP Routine Water Quality Monitoring Program

Historically, NDEP sampled 18 sites on the Carson River from 3 to 12 times per year. In April 2005 the program was redesigned to conduct sampling on eight sites two times a year. Under the new design "base" and "full" sampling schemes have been established for the Carson system. A subset of the historic sites has been selected as the "base" sites, while the "full" sites generally consist of all the historic sites. In general, the "base" sites will be sampled two times per year (switching between spring-fall, or summer-winter combinations) with each season being represented during a two year period. The purpose for the base sampling is to continue adding to the long-term database of the sites, and to use the data to identify possible indicators of water quality changes. The base sites are:

- East Fork Carson River above Bryant Creek
- Bryant Creek
- East Fork Carson River at Muller Lane
- West Fork Carson River at Stateline
- Carson River at Genoa Lakes Golf Course
- Carson River at Mexican Gage
- Carson River at Weeks
- Carson River below Lahontan Reservoir

Full sampling will begin again around 2011 and will be used to develop more detailed data as needed for reviewing or revising the water quality standards. Additional monitoring may occur as part of special studies for the 303(d) lists or TMDL development. Full sampling will generally occur for about 2 to 3 years and will periodically be rotated to different sets of waters as needed to support other BWQP programs. Full sampling sites locations are shown in Figure 7.2.5-1.

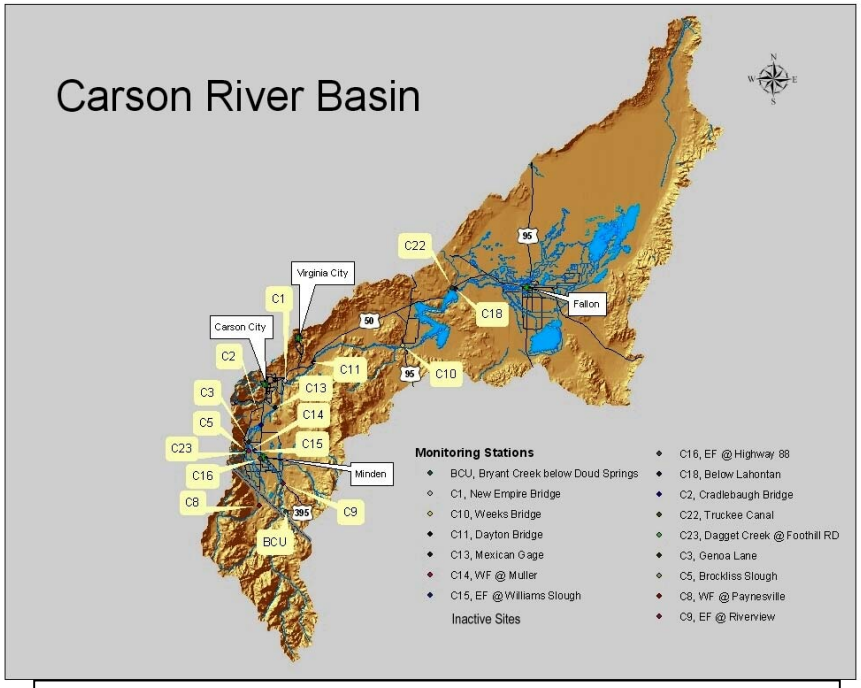


Figure 7.2.5-1: Full Sampling Site Locations for Carson River Basin

7.2.6 Conservation District Supplemental Water Quality Monitoring

CVCD and DVCD conduct additional monitoring to supplement NDEP's program. Sampling sites and schedules for the CDs are shown in Table 7.2.6-1.

Table 7.2.6-1: Conservation District Supplemental Sampling

Site	Carson Valley Conservation District	Dayton Valley Conservation District
East Fork at Riverview	Collect March-October, alternating months with NDEP	-
Mexican Gage	Collect March-October, alternating months with NDEP	-
New Empire Bridge	Collect March-October, alternating months with NDEP	-
Weeks Bridge	-	Weekly over a 6 to 8 week period during high & low flow

Source: NDEP 2005

7.2.7 Clear Creek Baseline Water Quality Monitoring Project

Initiated by the CCWC and funded by NDEP with the assistance of the Carson City Stormwater Engineering and the Washoe Tribe, this study will provide baseline water quality data for the Clear Creek Watershed. Samples will be collected from five sites on a seasonal basis for two years and will be analyzed for TSS, complete nutrient suite, streptoccocal fecal coliform and toal coliform. Sampling for this program began in June of 2006. Data from samples will be compiled and housed at NDEP.

7.2.8 Washoe Tribe Monitoring

The WEPD conducts water quality, biological and macroinvertebrate monitoring on areas of the river system within Tribal boundaries. Samples are collected and analyzed on a quarterly basis.

7.2.9 Summary of Water Quality Characterization Projects/Studies

Tables 7.2.8 –1 and 7.2.8-2 provide additional information on recent projects and studies that have been completed or are underway. Historical project information and a list of USGS studies is available in Appendix I.

Table 7.2.8-1: Characterization of Carson River Water Quality Completed Projects/Studies

Completed Projects and Studies				
Title	**Location**	**Dates**	**Lead Organization/ Partners**	**Description**
Carson River Special Dissolved Oxygen and Temperature Monitoring Project - 2005	EF, WF, BS	2006	NDEP	Determine early morning dissolved oxygen levels and afternoon temperatures at various locations
Identification of Nitrate and Dissolved-Solids Sources in Ground Water by GIS Analyses	Douglas County	2005	USGS; Douglas County; CWSD	Data from a 16-year period were used to investigate groundwater quality and its relation to nearby land uses in the Carson Valley area of Douglas County.
Sources of Phosphorus to the Carson River in Carson Valley, Nevada and California, water years 2001-2002	Carson Valley	2004	USGS; NDEP; CWSD	Purpose of study is to identify reaches of greatest increase of phosphorus and suspended-sediment concentrations and loading; and to identify the most important sources of phosphorus.
Carson River Special Dissolved Oxygen and Temperature Monitoring Project - 2001	EF, BS, CR	2002	NDEP	Determine early morning dissolved oxygen levels and afternoon temperatures at various locations
Mercury and Suspended Sediment, Carson River Basin, Nevada – Loads To and From Lahontan Reservoir in Flood Year 1997 and Deposition in Reservoir Prior to 1983	Middle and lower CR	January 1998	USGS	Report investigates how episodic floods play a major hydrologic role in erosion, transport, and deposition of fluvial sediments and associated mercury in the Carson River.
Characterization of Algae and Dissolved Oxygen Dynamics in the Carson River	CR from Genoa Lane to Riverview Park	2006	NDEP, DRI	Through monitoring, modeling and analysis, characterize algae and dissolved oxygen occurring in the Carson River.

Notes:
BS – Brockliss Slough
CR – Main Stem Carson River
CWSD – Carson Water Subconservancy District
DRI – Desert Research Institute
EF – East Fork
NDEP – Nevada Division of Environmental Protection
USGS – U.S. Geological Survey
WF- West Fork

Table 7.2.8-2: Characterization of Carson River Water Quality Projects/Studies Underway

Project and Studies Underway				
Title	**Location**	**Dates (Estimated Completion)**	**Lead Organization Partners**	**Description**
Upper Carson River Water Quality Monitoring Program	EF, WF	March 2007	Alpine County, CWSD, STPUD, DRI	Goal of project is to provide baseline water quality data. Final report will be available in 2007.
Characterization of Turbidity and TSS Levels in Upper Carson River	EF (Riverview), CR (Genoa Lakes & Deer Run Road)	July 2006	NDEP, DRI	To conduct continuous monitoring for turbidity and TSS to determine duration and extent of standard violation.
Carson River Relative Bed Stability Investigation	Stateline to Lahontan	2006	NDEP, EPA	Determine substrate stability at various locations throughout the system
California SWAMP Monitoring	Upper watershed in Alpine County	Ongoing	State Water Board	Routine water quality monitoring.
NDEP Water Quality Monitoring	Stateline to Lahontan Reservoir	Ongoing	NDEP	Routine water quality monitoring.
STPUD Routing Monitoring	WF, Indian Creek	Ongoing	STPUD	Routine water quality monitoring
Conservation District Supplemental Monitoring	EF, WF, CR	Ongoing	NDEP, CVCD, DVCD	Sampling supplements routine monitoring by NDEP.
AWG Citizen Monitoring Program	EF, WF	Ongoing	AWG	Basic field parameters, bacteria, photo monitoring
Clear Creek Water Quality Monitoring Program	Clear Creek	Ongoing	CCWS, NDEP	Program will provide baseline water quality data for the Clear Creek Watershed
Airborne Thermal Infrared Remote Sensing Survey	Stateline to Deer Run Road	SOW in process	DRI, NDEP; CWSD	Goal is to better understand the thermal characteristics of the river system.

Notes:
AWG – Alpine Watershed Group
CCWS – Clear Creek Watershed Council
CR – Main Stem Carson River
CWSD – Carson Water Subconservancy District
DRI – Desert Research Institute
EF – East Fork
EPA – U.S. Environmental Protection Agency
NDEP – Nevada Division of Environmental Protection
SOW – Scope of Work
STPUD – South Tahoe Public Utility District
USGS – U.S. Geological Survey
WF- West Fork

7.3 Physical Condition Assessments

7.3.1 1996 Fluvial Geomorphic Assessment of the Carson River with Implications for River Management

A fluvial geomorphic investigation of 110 river miles was conducted through funding coordinated by WNRC&D and documented in this 1996 report. Detailed site assessments were performed at over 65 locations on the Carson River and looked at overall channel stability by reach, planform issues, capacity, sediment supply, and vegetative conditions. Hydrologic, hydraulic and channel type analyses were also investigated. Recommendations are provided on system-wide and by reach basis. More detail on the assessment findings can be found in Section 5.10 of this plan. Table 5.10-2 provides a summary of the recommendations by reach.

This report was originally submitted in December 1996, prior to the New Year's Flood of January 1997. The conclusions and recommendations made in the report were based on observations that were made before the flood, which significantly altered the physical state in many of the reaches. However, the long-term management recommendations presented in the report are still considered to be appropriate and relevant on a watershed scale.

7.3.2 Dayton Valley Conservation District Five-Year Monitoring Program

In 2000, the DVCD embarked upon the development of a program to provide a means for monitoring the effectiveness of erosion control and water quality improvement projects conducted in the middle Carson River. The primary objectives of implemented projects has been to stabilize the channel banks while minimizing the potential loss of adjacent lands and do so by utilizing ecologically sensitive materials. The stabilization designs have utilized natural vegetative and riparian stabilization means (willow bundles, rock groins, brush mattresses, etc.) as opposed to mechanical means. Previously each of these projects has been evaluated as separate, individual sites rather than collectively as a group or in a regional context. Once the subject improvements were constructed there was not a method to determine which of the alternate approaches has been most appropriate or an ability to measure the project's success or failures. This program provides methods for determining how more comprehensive design data might best be obtained and what could practically be done to measure the effectiveness of the improvements thereby monitoring the investment made at each site.

The program includes an aerial topographical survey, channel cross-section and baseline data, and hydraulic modeling. Data obtained will be analyzed and synthesized into a final report documenting pertinent findings and recommendations. This information will provide specific recommendations for design/construction of future projects. Methods from this program may serve as a template for future monitoring programs that are implemented in the watershed.

7.3.3 Clear Creek Erosion Assessment

In response to concerns regarding excessive erosion and sedimentation within the Clear Creek Watershed, the Nevada Department of Transportation (NDOT) retained the consulting firm PBS&J to complete an erosion assessment for the Clear Creek watershed.

The purpose of the project was to locate and identify erosion and sedimentation areas, determine the causes, and develop mitigation alternatives and construction cost estimated to eliminate the erosion and sedimentation areas (PBS&J 2003). Also, an evaluation of the Clear Creek stream corridor for environmental and general geomorphic conditions was conducted. Watershed information was used to conduct hydrologic, hydraulic, erosion and sedimentation, and environmental analyses. NDOT provided funding for the project and the Clear Creek Watershed Council served as the steering committee. The assessment was completed in January 2003.

7.3.4 Upper Carson River Watershed Stream Corridor Condition Assessment

In September 2002, the Sierra Nevada Alliance (SNA), on behalf of the AWG, entered into an agreement with the Water Board to prepare a Stream Corridor Assessment for the Upper Carson River Watershed in Alpine County, California. MACTEC Engineering and Consulting, Swanson Hydrology and Geomorphology, River Run Consulting, and C.G. Celio & Sons were selected to conduct the assessment.

The purpose of the project was to obtain watershed information so that future planning, restoration, and improvement in resource management can occur in a reasoned manner. The assessment area includes approximately 66 miles of channel within the West Fork, East Fork, Wolf Creek, and Markleeville/Hot Springs Creek watersheds. A preliminary survey resulted in the identification of 32 reaches. Of these reaches, nine reaches were selected for more detailed characterization (see Table 5.10-1). Also, four bridges were selected for limited hydraulic analysis. Historical conditions are well documented in the report. A comprehensive collection of historical photographs and current day photographs are provided on CD. This report can be viewed at http://www.ndep.nv.gov/bwqp/upper_carson04.htm

7.3.5 HSI/LiDAR River Corridor Assessment and Survey

In June 2004, airborne hyperspectral data and LiDAR data were collected over a project area comprising 220,779 acres in the Lyon, Carson City, Douglas and Alpine counties. Hyperspectral imagery (HSI) provides the capability to differentiate, locate and quantify various vegetation types (including noxious weeds) and to baseline their spatial extent (i.e. percent of horizontal cover). The LiDAR data results in high resolution digital elevation models (DEM) for orthorectification of the imagery, as well as mapping of vegetation height and slope analysis.

The objectives for this project are:

- Assess the extent of wetland and riparian vegetation in the Carson River Corridor from Stateline to above Lahontan Reservoir

- Evaluate baseline channel morphology data for long term monitoring and restoration project design
  - Subsequent HSI/LiDAR surveys will be compared to the original dataset
  - Detect any significant changes in erosion/deposition caused by land use practices, urbanization, flood or restoration activities along the entire length of river corridor within the study area

If funding allows the river system will be flown again in 5 years to begin to look at long-term trends and changes. Data from this survey was used to create the river corridor maps provided in Appendix F.

7.3.6 *Draft* Middle Carson River Geomorphic and Biological Assessment and Recommendations for Ecosystem Preservation and Recovery

Otis Bay, Inc. was retained by BLM to conduct an assessment of the Carson River corridor from the California-Nevada Stateline to Lahontan Reservoir, which this report refers to as the middle Carson River. Findings are documented in the 2004 draft report.

The purpose of this study is to provide land management recommendations that are intended to preserve, enhance and sustain the middle Carson River ecological system. Objectives for the study include the following (Otis Bay 2004):

1. Assess the physical environment of the middle Carson River through review of geology, analyzing hydrology records, assess river geomorphology, model river segments using HEC-RAS to determine the channel hydraulic properties; calculate sediment transport rates for each river segment (this element has not been completed to date).
2. Assess the flora and fauna of the corridor by: mapping all major riparian vegetation community types; compiling information on terrestrial and aquatic fauna; and, supplement literature sources with field studies.
3. Develop recommendations for future conservation strategies.

Currently there is not an anticipated date for a final report.

7.4 Biological Monitoring Programs

Several programs are currently being conducted to look at the benthic macroinvertebrate (BMI) populations in the river system. BMI's are the aquatic insects and other invertebrates that are central to functioning aquatic ecosystems. They consume organic matter and algae, and provide food to higher trophic levels such as fish and riparian birds. BMI's are sensitive to chemical pollution and physical habitat disturbance and as such serve as useful indicators for assessment of rivers biological health. Indexes of biological integrity or IBI's are based on the abundance and type of BMI's found in a water body and can be used as a tool for assessing river health. IBI's may be used in the future for 1) assessing attainment of water quality standards and listing of impaired waters; 2) Identifying causes and sources of impairments to support control strategy development including TMDLs; and 3) Evaluating changes in water quality in response to ongoing

management actions to gauge level of success and guide strategy revisions. Both California and Nevada are planning to develop IBI's for the Carson River.

In 1995, the Water Board began a stream bioassessment program in order to monitor the success of remediation efforts at Leviathan Mine. In 1999 these efforts were expanded into a region-wide program as part of the SWAMP program. Numerous creeks within the West and East Fork drainages have been sampled during 1999 to 2002. NDEP has been sampling for BMI from Stateline to Lahontan Reservoir since 2000. NDOW has been collecting BMI samples from the lower East Fork since 1994. The AWG added bioassessment to their Citizen Monitoring Program in the summer of 2006.

8.0 Management Measures

This section will address the following 319 criteria elements:

c. A description of the non-point source (NPS) management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.
e. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.
g. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented.

Major efforts within the watershed can be categorized into six groups for the purposes of developing management measures. These categories include: River Rehabilitation/Stabilization; Floodplain Conservation; Water Quantity; Outreach and Education; Noxious Weed Abatement; and Recreational Use Management.

In addition to the projects listed in this plan, numerous other studies and projects have been conducted in the watershed dating back to the early 1900's. The CWSD library has copies of many of these resources. The library can be searched via the CWSD website at www.cwsd.org/resources. A copy of the library list has also been included in Appendix I. The USGS has conducted many studies on the Carson and a list of their reports can also be found in Appendix I.

8.1 River Rehabilitation/Stabilization

River Rehabilitation projects are in support of the following guiding principles:

- Maintain or improve the quality of water to support a variety of beneficial uses.
- Protect and manage uplands, mountain ranges, wetlands, and riparian areas to enhance the quality of surface flow, groundwater recharge, and wildlife habitat.

River rehabilitation projects are aimed at creating or enhancing riparian habitat, mitigating severe erosion, restoring some geomorphic form and function where feasible and ultimately improving water quality. The primary objectives of the projects include the following:

- Use NRCS approved bio-engineering techniques, that utilize natural vegetation (i.e., willow bundles, root wads, brush mattresses) in combination with hard engineering structures (e.g. rock streambarbs, toe rock);
- Reduce accelerating rates of streambank erosion;
- Re-establish connection to the floodplain where feasible;

Bio-Engineering Workshop Participants put into practice methods learned during workshop.

- Re-establish riparian vegetation and increase habitat for aquatic invertebrates, native fisheries, migratory and neo-tropical birds;
- Use an interdisciplinary team of professionals;
- Encourage and incorporate landowner and other stakeholder involvement;
- Work towards long-term improvements in water quality that include lower water temperatures, decreased turbidity and lower concentrations of nutrients and total suspended sediment.

8.1.1 Project Tracking and Measurable Milestones

Using LiDAR data collected in 2004, river corridor maps depicting the river system from Alpine County to Lahontan Reservoir were developed. These maps provide a tracking mechanism for river rehabilitation/stabilization projects and help to identify critical areas for implementation of NPS management measures **(*element c*)**. These maps can be found in Appendix F.

Projects identified on the maps have corresponding project summary sheets that are located in Appendix G. These sheets provide more detail on each project. Current project summary sheets also include interim, measurable milestones for determining whether NPS management measures or other controls are being implemented **(*element g*)**. All current and future river rehabilitation projects will include the development of a project summary sheet. These sheets provide historical documentation about the river rehabilitation projects and serve as a tracking mechanism.

8.1.2 Completed River Rehabilitation Projects

Table 8.1.2-1 provides a summary of river rehabilitation projects that have been completed since 1995. More detail on each project can be found on the project summary sheets located in Appendix G. These projects are also highlighted on the river corridor maps found in Appendix F. Some areas within Alpine County and all of the watershed below Lahontan Reservoir are not depicted on the maps as these areas were not flown as part of the LiDAR project.

Table 8.1.2-1: Completed River Rehabilitation Projects from 1995

Map I.D. Code*	Sub-Reach**	Project Title	Project Type***	Project Manager/ & Partners****	Year Completed
N/A	MC	Grover Hot Springs Meadow Stabilization Project	Rehabilitation/ Stabilization	AWG & CA State Parks	9/2006
WT-5	E-1	Heitman Diversion	Flood Protection	Washoe Tribe EP, FEMA	9/2006
WT-3	E-2	Tribal Levee	Flood Protection	Washoe Tribe EP; NRCS, WNRC&D	1997
WT-4	E-2	Washoe Tribe Streambank Protection	Flood Protection	Washoe Tribe EP; NRCS, WNRC&D	1997
WT-6	E-2	Wheeler Buckeye Diversion	Flood Protection	Washoe Tribe EP; FEMA	9/2006
WT-9	E-2	New Years Flood Fence Repair	Habitat Enhancement & Floodplain Conservation	Washoe Tribe EP, FEMA	2006
CV-1	E-2	Hatchery Streambank	Rehabilitation/ Stabilization	Douglas County; NRCS, CWSD, USFWS, WNRC&D, State of NV	1997
CV-2	E-2	Riverview Trail Park Streambank	Flood Protection	Douglas County; NRCS, CWSD, Riverview Trailer Park; WNRC&D, State of NV	1997
CV-3	E-2	Settelmeyer Streambank	Rehabilitation/ Stabilization	Douglas County; NRCS, CWSD, Settelmeyer Ranch, WNRC&D, State of NV	1997
CV-5	E-2	5th Green Levee Original Project - Maintenance on Project	Flood Protection	Douglas County; NRCS, CWSD, Carson Valley Golf Course, State of NV	1997 2006
CV-7	E-2	Rocky/Virginia Levee	Flood Protection	Douglas County; NRCS, Carson Valley Golf Course, State of NV	1997
CV-28	E-2	Rocky/Virginia Levee	Flood Protection	CVCD; FEMA, landowner, CWSD, NDWR	3/2006
CV-8	E-3	Riverview Bridge Levee	Flood Protection	Douglas County; NRCS, CWSD, Carson Valley Golf Course, State of NV	1997
CV-9	E-3	Glenwood Drive Streambank	Rehabilitation/ Stabilization	Douglas County; NRCS	1995
CV-10	E-3	Rivertree Ranch Levee	Flood Protection	Douglas County, NRCS, CWSD,. Rivertree Ranch, State of NV	1997
CV-29	E-3	Cottonwood Diversion	Flood Protection	CVCD; FEMA, landowner, CWSD, NDWR	3/2006
CV-32	E-3	Stodieck Grade Control	Flood Protection	CVCD; FEMA, landowner, CWSD, NDWR	9/2006
CV-33	E-3	Topping #2 Diversion	Flood Protection	CVCD; FEMA, landowner, CWSD, NDWR	9/2006
CV-35	MS	Martin Slough Ponds	Habitat Enhancement	City of Gardnerville, NDEP	2000
CV-11	E-4	Lutheran Bridge to Highway 88	Rehabilitation/ Stabilization	Douglas County; NRCS, East Fork Ranch, Stodieck Ranch, Mack Ranch, FEMA, CWSD, WNRC&D, State of NV	1998
CV-12	E-4	Mack Ranch Levee	Flood Protection	Mack Ranch	Prior to 1995
CV-31	E-4	Madison Mack V-Weir Channel Repair	Flood Protection	CVCD; FEMA, Mack Ranch, CWSD, NDWR	9/2006

Map I.D. Code*	Sub-Reach**	Project Title	Project Type***	Project Manager/ & Partners****	Year Completed
CV-13	E-5	Highway 88 to Muller Lane	Rehabilitation/ Stabilization	Douglas County; NRCS, Park Cattle Company, CWSD, WNRC&D, State of NV	1998
CV-19	B-1	Thunderbird Ranch Levee	Flood Protection	Thunderbird Ranch, NRCS	1996
CV-20	B-1	Jones-West Streambank	Flood Protection	Thunderbird Ranch; CVCD, NDWR, CWSD	2006
CV-21	B-3	Sarman Ranch - Involved 2 river work days	Rehabilitation/ Stabilization	Sarman Ranch; NRCS, CVCD, CWSD, WNRC&D, State of NV	2002-2004
CV-24	W-2	River Fork Ranch Workday	Habitat Enhancement	CVCD; TNC, WNRC&D, CWSD	2003
CV-16	C-1	Lippencott	Flood Protection	Lippencott	NA
WT-1	C-1	Mallard Bend #1	Rehabilitation	Washoe Tribe EP; EPA	2004
WT-2	C-1	Mallard Bend #2	Rehabilitation	Washoe Tribe EP; EPA	2003
WT-8	C-1	River Corridor Fencing	Floodplain Protection	Washoe Tribe, EPA, NV Dept. of Forestry, Washoe Development Group	2001
WT-7	C-1	Washoe Tribe Work Day #1	Habitat Enhancement	Washoe Tribe EP, community members, WNRC&D	2002
CV17	C-2	Prison Ranch Revetment	Habitat Enhancement	Prison; NRCS, CVCD, WNRC&D, CWSD	2004
CV18	C-2	Prison Ranch Willow bundles	Habitat Enhancement	Prison; NRCS, CVCD, WNRC&D, CWSD	2003
CV-30	C-3	Mexican Ranch	Flood Protection	CVCD; FEMA, Carson City, Mexican Dam Users, BLM, NDWR, CWSD	4/2006
CC-1	C-3	Mexican Dam Road	Flood Protection	DVCD; Carson City, CWSD, NRCS	1999
CC-2	C-3	Ambrose Nature Area	Rehabilitation	CVCD; NRCS Engineering, CWSD, NDEP, NDF, WNRC&D	2002
CC-3	C-3	Empire Ranch Golf Course	Rehabilitation	Empire Ranch Golf Course	1999
DV-008	C-4	Ricci Ranch/Tracey Property	Habitat Enhancement	DVCD; WNRC&D, NDEP, State of NV	11/1999
DV-101	C-4	JohnD Winters Ranch	Flood Protection	DVCD; NRCS, Lyon County, landowner, WNRC&D, State of NV	12/1997
DV-102	C-4	Ricci Diversion Grade Control	Habitat Enhancement	DVCD; NRCS, Lyon County, landowner, State of NV	3/1997
DV-103	C-4	Tracey Property	Habitat Enhancement & Flood Protection	DVCD; NRCS, Lyon County, WNRC&D, landowner, State of NV	2/1997
DV-104	C-5	Anderson Property	Habitat Enhancement & Flood Protection	DVCD; NRCS, Lyon County, landowner, WNRC&D, State of NV	2/1998
DV-105	C-5	Ricci Ranch	Habitat Enhancement	DVCD; NRCS, Lyon County, landowner, State of NV	2/1998
DV-112	C-5	Ricci Division Debris	Flood Protection	DVCD; CWSD, FEMA, landowner	4/2006
DV-106	C-6	Sbragia Property	Habitat Enhancement	DVCD; NRCS, Lyon County, landowner, WNRC&D, State of NV	2/1998
DV-107	C-6	Baroni Ditch	Habitat Enhancement	DVCD; NRCS, Lyon County, landowner, CWSD,	1/1998

Map I.D. Code*	Sub-Reach**	Project Title	Project Type***	Project Manager/ & Partners****	Year Completed
				State of NV	
DV-108	C-6	Cardelli Ditch	Habitat Enhancement	DVCD; NRCS, Lyon County, landowner, WNRC&D, CWSD, State of NV	2/1998
DV-109	C-6	Holley Ranch/Quilici Diversion	Rehabilitation/ Stabilization	DVCD; NRCS, Lyon County, landowner, WNRC&D, CWSD, State of NV	3/1998
DV-201	C-6	Army Corps Channel Restoration Project	Habitat Enhancement	DVCD; NRCS, WNRC&D, CWSD	1/1997
DV-001	C-7	Quilici Ranch/Rolling A Big Ranch	Rehabilitation/ Stabilization	DVCD; NDEP, CWSD, NRCS, landowner, State of NV	4/1997
DV-002	C-7	Empey Property	Rehabilitation/ Stabilization	DVCD; NRCS, Lyon County, landowner, CWSD, State of NV	4/1998
DV-003	C-7	Quilici Ranch	Habitat Enhancement	DVCD; WNRC&D, NRCS, CWSD, State of NV	4/1999
DV-009	C-7	Quilici Ranch/Rolling A Ranch	Rehabilitation/Stab.	DVCD; NDEP, CWSD, WNRC&D	
DV-004	C-7	Minor Ranch	Habitat Enhancement	DVCD; CWSD, WNRC&D, State of NV	4/1999
DV-010	C-7	Eitel/Hughes/Walker Properties	Rehabilitation/Stab.	DVCD; NDEP, WNRC&D, CWSD, State of NV	12/2001
DV-111	C-7	Empey Property/Minor Diversion	Rehabilitation/Stab.	DVCD NRCS, State of NV, CWSD	4/1998
DV-012	C-8	Borda and Minor Ranches	Rehabilitation/Stab.	DVCD; WNRC&D, CWSD, State of NV	2001-02
DV-006	C-8	Glancy Property	Rehabilitation/Stab.	DVCD; NDEP, WNRC&D, NRCS, CWSD	11/1998
DV-113	C-9	Hodges Transportation Levy Repair #1	Flood Protection	DVCD; CWSD, FEMA, landowner, State of NV	6/2006
DV-114	C-9	Hodges Transportation Levy Repair #2	Flood Protection	DVCD; CWSD, FEMA, landowner, State of NV	
DV-007	C-8	Fort Churchill Historic State Park	Rehabilitation	DVCD; NDEP, NV State Parks, WNRC&D	12/1998
NA	LV	Sediment Removal Project	Habitat Enhancement	LCD	1996-98
NA	LV	Rechel-Casey Property	Rehabilitation/Stab.	LCD, WNRC&D, CWSD	2002
NA	LV	Venturracci Property	Rehabilitation/Stab.	LCD, WNRC&D, CWSD	2002
NA	LV	Christensen Property	Rehabilitation/Stab.	LCD, WNRC&D, NDF, CWSD	2002
NA	LV	Debris Removal	N/A	LCD; NDF, CWSD, WNRC&D, State of NV	2006

Notes:

* This code corresponds to the river corridor maps located in Appendix F and project summary sheet located in Appendix G.

**With the exception of MC & LV, this code corresponds to the sub-reaches listed in table 5.10-2 derived from Interfluve (1996)

***Project Types – Project type categories are defined as the following:

Rehabilitation/Stabilization – combination of hard and soft treatments designed to collect sediment, establish thalweg, and connect stream processes and forms.

Flood Protection – Projects designed to deal with high and overbank flows, encourage some plant recruitment and protect property. Most of these projects are emergency repair projects due to a flooding event.

Habitat Enhancement – Projects typically do not involve rockwork and include bank shaping and vegetation.

Floodplain Conservation – These projects are typically conservation easements or land acquistions. The goal is to conserve floodplain lands and retain their natural function.

**** Please see page 3, Section 1.2 for Abbreviations

8.1.3 Current (In-Process) River Rehabilitation Projects

Map I.D. Code*	Sub-Reach **	Project Title	Project Type***	Project Manager & Partners****	Estimated Completion Date
NA	MC	Markleeville Guard Station Restoration – Phase I	Rehabilitation & Floodplain Conservation	Alpine County, Alpine Watershed Group, USFS, CDWR	July 2011
CV-34	MS	Martin Slough Water Quality Enhancement Project	Rehabilitation	Douglas County; Douglas County Water Conveyance Advisory Committee, Douglas County School District, landowners, NDEP, State Lands Q1 program	2006
CV-25	C-1	Willowbend Streambank Protection & Restoration	Rehabilitation/ Stabilization	CVCD; Douglas County, State Lands Q1, property owners, CWSD, WNRC&D, State of NV	Fall 2007
CV-26	E-3	Carson Valley Golf Course Streambank Protection & Restoration Project	Rehabilitation/ Stabilization	CVCD; State Lands Q1, NWDR, CWSD, Carson Valley Golf Course, Hussman Ranch, Carson Truckee Conservancy District, Rivertree Ranch, State of Nevada, NRCS	February 2007
CV-27	E-6	Lower East Fork	Rehabilitation/Stabilization	CVCD; Park Cattle Company, Mr & Mrs. Hutt, TNC, CWSD, NDWR, State Lands Q1, Carson Truckee Conservancy District	2008
DV-115	C-7	Middle Carson River Stream Rehabilitation	Rehabilitation	DVCD; Lyon County, State Lands Q1, CWSD, landowners, Carson-Truckee Water Conservancy District, NDWR	2008
WT-10	C-1	Stewart Ranch Bank Protection #3	Habitat Enhancement, Rehabilitation/Stabilization	Washoe Tribe of Nevada and California	Contingent upon funding availability
WT-11	C-1	Stewart Ranch Bank Protection #4	Habitat Enhancement, Rehabilitation/Stabilization	Washoe Tribe of Nevada and California	Contingent upon funding availability
WT-12	C-1	Stewart Ranch Bank Protection #5	Habitat Enhancement, Rehabilitation/Stabilization	Washoe Tribe of Nevada and California	Contingent upon funding availability
WT-13	C-1	Stewart Ranch Bank Protection #6	Habitat Enhancement, Rehabilitation/Stabilization	Washoe Tribe of Nevada and California	Contingent upon funding availability
NA	LV	Debris Removal	N/A	LCD, NRCS, NDF	ongoing

Notes:
* This code corresponds to the river corridor maps located in Appendix F and project summary sheets located in Appendix G.
**This code corresponds to the sub-reaches listed in table 5.10-2 derived from Interfluve (1996)
*** Project types:
Rehabilitation/Stabilization – combination of hard and soft treatments designed to collect sediment, establish thalweg, and connect stream processes and forms.
Flood Protection – Projects designed to deal with high and overbank flows, encourage some plant recruitment and protect property. Most of these projects are emergency repair projects due to a flooding event.
Habitat Enhancement – Projects typically do not involve rockwork and include bank shaping and vegetation.
Floodplain Conservation – These projects are typically conservation easements or land acquistions. The goal is to conserve floodplain lands and retain their natural function.
**** Please see page 3, Section 1.2 for Abbreviations

8.1.4 Recommendations for Future Management Measures

The following management measures are either in the early planning stages or have been identified in an assessment document. The actual implementation of the management measure is dependent upon funding and staff availability, political climate, and landowner cooperation.

Hot Springs Creek Streambank Stabilization Project

The AWG and the USFS are partnering to identify and implement potential streambank stabilization projects along Hot Springs Creek, a tributary to Markleeville Creek. This area is a large contributor of suspended sediment to Markleeville Creek during large runoff events. The objective of these projects will be to decrease erosion, improve water quality, and improve in-stream habitat. Estimated costs $20,000 per project. Monitoring of projects for 3-5 years ($15,000 to $20,000).

Stabilize Stream through Faith Valley

The assessment conducted in 2004 (MACTEC 2004) recommends that the reaches through Faith Valley would benefit from stabilization activities. These activities would include the stabilization of the beaver dam ($70,000 to $100,000), reactivation of meanders ($160,000 to $200,000), and project monitoring for 3-5 years ($30,000 to $50,000).

Restoration of Sub-Reach C-1

This sub-reach is highly incised and needs to be addressed from an erosion control perspective. The project design will be determined after the 2009 LiDAR reconnaissance flight. This would be a large-scale restoration project that would be highly dependent upon landowner interest, cooperation and funding availability. Costs for this type of project is estimated at $1.8 million.

Rolling A Restoration Project – Middle Carson River

This proposed project is part of a larger county-wide effort to improve conditions along the middle Carson River. The project will encompass over 220 acres within the Carson River corridor on the old Rolling A property through Dayton. The project proposes the creation of a public low-impact recreational trial, restoring areas that have been taken over by invasive species, and restoring form and function to a stretch of the Carson River that has been severely degraded. The project will include more than one mile of river restoration utilizing bioengineering techniques, 100+ acres of floodplain restoration and 18,181 linear feet of trail. Total estimated cost for this project is $2 million.

Lower Watershed Future River Rehabilitation Projects Description

LCD designs and implements projects within the lower watershed below Lahontan Reservoir. LCD supports the improvement of conditions within the lower watershed through clearing and snagging projects from Diversion to Sagouspi Dam. LCD's goal is to achieve improved river channel capacity, remove debris and other obstructions that may cause potential problems to property owners adjacent to the river and reduce the risk of flooding. To date, LCD's efforts have resulted in more than 25 miles of channel

restoration and reduced flood potential. The cost for these types of projects is subject to the extent of debris and obstructions in the river.

LiDAR

Light Detection and Ranging (LiDAR) was flown on the Carson River in 2004 from Alpine County to Lahontan Reservoir. The topographical data generated from the aerial reconnaissance provides for evaluating the channel morphology for long term monitoring and restoration project design, and allows for the assessment of the extent of wetland and riparian vegetation in the Carson River Corridor. It is recommended that the LiDAR be flown again in the future in order to show changes in stream morphology and vegetation. Total anticipated costs are $280,000 for the LiDAR flight and $120,000 for data analysis.

Carson River Workdays

WNRC&D began the Carson River Workday Program in 1995. Since 1995 over 80 workdays have been held between Markleeville and Fallon. These workdays provide the volunteer work force for many of the river related projects listed in Tables 8.1.2-1 and 8.1.3. Thousands of willows have been planted on the streambank as a result of the workdays, in addition to numerous tree protection activities, installation of duck and bat houses, and reseeding of bare streambank. CWSD provides $24,000 per year to WNRC&D for the workdays. In –kind match is provided by various entities including landowners.

Maintenance of Grade Controls

Several grade controls on the Carson River are in need of maintenance. The parties responsible for funding and conducting this maintenance has not yet been determined. Maintenance of these grade controls is important for water quality and safety. Maintenance costs have not yet been determined. During the summer or 2007 the DVCD and CWSD will survey all of the grade controls along the river through Carson and Dayton Valleys.

High Water Response

Future management measures will include emergency response to damages caused by high water and flood conditions. Costs for the emergency response projects vary depending upon the degree of flooding damage.

Sediment Transport Investigation

Sudden and abrupt changes in river behavior can signal localized or systemic instability as inputs of flow and sediment change. Correct estimation of pollutant loading, or total suspended solids, are, for example, dependent on understanding erosion and sedimentation processes over particular reaches and the entire watershed. Adequately determining current physical conditions and historic geomorphic changes including sources and sinks for sediment, erosion rates, sediment transport potentials, reach morphology and decreases or increases in streambank vegetation directly effect the ability to adequately characterize physical conditions that in turn influence chemical, biological and ecological conditions along the Carson River.

In a recent article by Wohl et al. (2005) the authors hypothesized that by focusing on processes that affect the whole ecology of the river, such as the transport of sediment from upland to lowland areas, scientist could begin to look at biological, physical and chemical conditions across the whole watershed. By identifying processes that are connective, as opposed to discrete conditions or states, there is an implicit understanding that conditions within a river are not fixed but are variable in time and space. This variability helps to shape past, present and future conditions along the river. Wohl et al. (2005) suggest that a methodology which has identified an "acceptable range of variability" might lead to greater success for restoration projects and allow for results which could be tested across different watersheds or reaches within the same watershed.

It is proposed that the model proposed by Wohl et al. (2005) be extended to the Carson River. The main goal is to determine the variability and uncertainty of sediment transport, erosion and changes to physical conditions on a watershed scale in order to effectively manage and design measures to improve physical, biological and chemical conditions on the Carson River. A determination of an acceptable range of variability will then be developed based on sediment conditions necessary to promote stability across reach and watershed scales. A variety of analytical, field based and numerical tools will be used to assess relative stability. The hypothesis that the Carson River currently is unable to effectively transmit sediment and that this condition negatively effects water quality, physical stability and ecology will be tested.

In order to adequately measure, characterize and model sediment conditions within the watershed a variety of qualitative and quantitative methods will be used. A five- step process is proposed in order to accomplish this.

1) If possible other watershed scale efforts to link physical instability, erosion and sedimentation to water quality conditions will be examined, such as the Chesapeake Bay Project.

2) The fluvial audit process developed by Sear et al. (2003) will be used to assess current and historic geomorphic conditions, catchment sediment dynamics and channel adjustments. The main goals of the audit will be to supplement the geomorphic study done in 1996, prior to the 1997 flood, which was the second largest flow on record. In particular, geomorphic adjustments and sediment sources, sinks and transfer zones will be identified. Although the 1996 study done by Inter-Fluve characterizes in-stream sediment dynamics, crucial storage and source zones are not identified. Prior documentation used in the 1996 study as well as high resolution LIDAR data will be incorporated with historic DEM's in GIS to look at geomorphic changes. Field and gauge data will be collected as needed.

3) The Sediment Impact Assessment (SIAM) model will be used in coordination with the current steady state hydraulic model (HEC-RAS) to determine sediment transport over full ranges of discharge. Sediment sources, including bank erosion, mass wasting, non-point erosion, gullying and mining impacts

will be accounted for. The model will help to determine annual sediment transport continuity, capacity and loads. The model allows for rapid assessment of alternative scenarios, calculations of sediment loads and management options.

4) If possible, model outputs from the SIAM model will be calibrated against field data collected during a five year monitoring study undertaken by the DVCD. The SIAM model will be tested first in the Dayton Valley area then extended upstream.

5) The SIAM model will be used in collaboration with supporting aerial photography data and the development of hydraulic models upstream of the Dayton area.

6) In 2000 the DVCD in partnership with the NDEP, EPA, CWSD, R.O. Anderson Engineering, WNRC&D and other partners undertook a five-year monitoring plan (2000-2005) to assess changes in physical, chemical, hydrologic, hydraulic and vegetation conditions in areas where restoration projects have been constructed (Final Report in process). One of the major goals was to quantify amounts of sediment deposition, sediment transport potential, localized erosion rates and changes in water quality as a result of engineered structures that altered hydrologic and hydraulic conditions. Data and model outputs derived from field analysis and numerical models will be used whenever possible to derive effective sediment strategies. Important findings from the study will be incorporated into management options.

Estimated costs to conduct this sediment transport investigation is $150,000 to $250,000.

8.2 Floodplain Conservation

Floodplain conservation is in the support of the following guiding principles:

- Acknowledge and respect the watershed's natural processes in land use decisions.
- Maintain the riverine and alluvial fan floodplains of the watershed to accommodate flood events.
- Encourage management of growth that considers water quality and quantity, open space preservations, and maintenance of agriculture in floodplains.

Flooding is a natural and regular event on the Carson River and with limited upstream storage and virtually no flood control, floodplain areas are critical for the safety of citizens and their property and for the natural function of the river system. Currently the Carson River floodplains are being converted to development at unprecedented rates.

Floodplains provide a wide range of benefits to both human and natural systems. These benefits can be grouped into three categories (Table 8.2-1): 1) *Water Resources* include those resources and functions of floodplains that are part of or provide a benefit to the hydrologic cycle; 2) *Biological Resources* are the floodplain resources and functions that

benefit plants and animals; and 3) *Societal Resources* are floodplain resources and functions that directly benefit human society.

Table 8.2-1: Floodplain Benefits to Water, Societal & Biological Resources

Water Resources	Societal Resources	Biological Resources
Natural Flood & Erosion Control	- Enhance agricultural lands	**Biological Productivity**
- Flood storage & conveyance	- Provide areas for open space	- Support high rate of plant growth
- Reduce flood velocities & peaks	- Provide aesthetic pleasure	- Maintain biodiversity
- Reduce sedimentation	- Provide opportunities for environmental learning experiences	- Integrity of ecosystem
Water Quality Maintenance	- Provide opportunities for recreational experiences	**Fish & Wildlife Habitat**
- Filter nutrients and impurities		- Provide breeding & feeding grounds
- Process organic waste		- Create and enhance waterfowl habitat
- Moderate temperature changes		- Protect habitats for sensitive species
Groundwater Recharge		
- Facilitate infiltration and aquifer recharge		
- Reduce low surface flows		

One of the best ways to protect the floodplain is for the lands to remain in agriculture. There have many efforts over the last couple of decades by numerous organizations to encourage ranchers to remain in ranching and to provide programs to help them. However, remaining in ranching and farming has become increasing difficult as the current landowners are approaching retirement age and many do not have heirs that would continue to work the land. In addition the pressure for the landowners to sell to developers has become irresistible to many. Many ranch owners are participating in a TDR Programs, entering into conservation easement or participating in other programs to conserve their properties, preserve the rural character of the area, and retain their current quality of life.

8.2.1 Completed Floodplain Conservation Projects

Main Message Survey

In 2003 the UNCE conducted a survey of the CRC to determine "What is the one, most important message the public needs to understand about out watershed?" The ideas were ranked and the one that received the higher rating than the rest is as follows:

"Protect the floodplain from future development. Once the floodplain and especially the river's meander belt corridor are impacted by development, the river loses the ability to reestablish its natural functions. Agricultural fields near the channel are critical for

floodwater attenuation, ground water recharge, NPS pollution buffering and providing habitat for wildlife."

2004 Stakeholder Conference

In October 2004 the CWSD and CRC organized a conference to address this issue and receive input from a variety of stakeholders on what needs to be done. The conference entitled ***"Conserving Our Lifeline in the Desert Through Community Development and Floodplain Management"*** investigated the following issues:

- Promotion of economic growth and development without sacrificing floodplain function
- Ensuring public safety upstream and downstream
- Protection of private property rights while conserving our natural resources
- Improvement of wildlife habitat and water quality by preserving the river corridor

Carson River Flooding History Database and Website

The USGS with funding from the NDWR has developed a database and website that provides historical information on the flooding history of the Carson River. The website includes historic photos of flooding events and historic maps. The website can be viewed at http://nevada.usgs.gov/crfld/.

Completed Floodplain Conservation Measures

Conservation easements and land acquistion are two of the best ways of protecting floodplain lands. An easement can provide landowners the means to protect the natural values of their land, tie the water to the land, provide funds to remain in agriculture, and still retain the benefits of private property ownership. Land acquistion secures the property and enables it to remain in floodplain.

Conserving the Floodplain through Conservation Easements
Kirman Field Conservation Easement
Photo: L. Crane

The following tables provide summaries of conservation management measures that have been completed or are in process. More detail project information on completed projects can be found on the project summary sheets located in Appendix G. Completed projects are also highlighted on the river corridor maps found in Appendix F.

Table 8.2.1-1: Completed Floodplain Conservation Easements & Land Acquistions

Map I.D. #*	Project Name	Project Location	Project Manager & Partners*	Type of Measure
FC-K	Kirman Field Conservation Easement	Carson Valley Sub-reach C-2	TNC; State Lands Q1, Donald Bentley, NDOW	Conservation Easement
FC-RFR	River Fork Ranch	Carson Valley Sub-reach C-1	TNC, Timken-Sturgis Foundation	Land Acquistion
FC-HR	Hussman Ranch	Carson Valley Sub-reach E-3	American Land Conservancy; BLM SNPLMA Program; Hussman Family	Conservation Easement
FC-BR	Byington Ranch	Carson Valley	Ranch Open Space of Nevada, Byington Family	Conservation Easement
FC-ANA	Ambrose Natural Area	Carson City Sub-reach C-3	Carson City	Land acquistion
FC-SSR	Silver Saddle Ranch	Carson City Sub-reach C-3	Carson City	Land acquistion
FC-RVP	Riverview Park	Carson City	Carson City	Land Acquistion

Note:
* This code corresponds to the project summary sheets located in Appendix G and the river corridor maps located in Appendix F.
EP – Environmental Protection
EPA - Environmental Protection Agency
NDF – Nevada Division of Forestry
NDOW – Nevada Division of Wildlife
SNPLMA – Southern Nevada Public Land Management Act
TNC – The Nature Conservancy

8.2.2 Current (In-Process) Floodplain Conservation Projects

Conservation measures (conservation easement or land acquistion) that have been approved for funding either through the State Land Question One program or the Southern Nevada Public Land Management Act (SNPLMA) program and are in –process are listed in Table 8.2.2-1.

Table 8.2.2-1: In-Process Floodplain Conservation Easement & Land Acquistions

Map I.D.#	Project Name	Project Location	Funding Program
FC AC P	Adams Canyon Property	Carson Valley near Genoa, Carson River	BLM SNPLMA Program
FC AD P	Flying J. Ranch Property	Carson Valley near Genoa, Carson River	BLM SNPLMA Program
FC R1 P	A.B. Ranch No. 1	Carson Valley near Genoa, Carson River	BLM SNPLMA Program
FC KN P	Knox Johnson Property	Carson Valley, West Fork	BLM SNPLMA Program
FC MR P	Mack Ranch Property	Carson Valley, East Fork	BLM SNPLMA Program
FC ST P	Stodieck Property	Carson Valley, East Fork	BLM SNPLMA Program,
FC WH P	White Property	Carson Valley	BLM SNPLMA Program
FC HE P	Henningsen Properties A,B	Carson Valley	BLM SNPLMA Program
FC SC P	Scossa Bros. Properties A, B	Carson Valley	BLM SNPLMA Program
FC JAR P	Jarrad Property	Carson City	State Lands Q1r
FC DES P	Desormier	Carson City	State Lands Q1

Map I.D.#	Project Name	Project Location	Funding Program
FC AND P	Anderson	Carson City	State Lands Q1
FC GIL P	Gilbert Property	Carson City	State Land Q1
NA	Churchill/Carson River Park System Phase I	Churchill County	State Lands Q1
NA	Soares Conservation Easement	Churchill County	State Lands Q1
NA	Biddinger Conservation Easement	Churchill County	State Lands Q1
NA	Bailey Conservation Easement	Churchill County	State Lands Q1
NA	Rambling River Ranches Conservation Easement Phase 2	Churchill County	State Lands Q1
NA	Wetlands Conservation Easement for Stillwater National Wildlife Refuge	Churchill County Stillwater Farms	BLM SNPLMA Program

Note:
BLM – Bureau of Land Management
SNPLMA – Southern Nevada Public Land Management Act
Q1 – Question One

Additional Floodplain Conservation Measures

CRC River Corridor Working Group

The CRC River Corridor Working Group was established to investigate options and ideas for conserving the floodplain and protecting the river corridor that were generated by the 2004 conference. The group meets on a monthly basis.

Agriculture's Value to the Community Workshop

This workshop, sponsored by the UNCE, CRC, and WNRC&D, was designed to explore the potential of rewarding agriculture producers for the value that their land brings to the community.

Regional Floodplain Management Plan

In December of 2005, CWSD received funding from the NDWR for the purposes of developing a Flood Mitigation/Management Plan for the watershed. The CRC River Corridor Working Group serves as the steering committee for the plan development. The plan is expected to be complete and approved by April 2009.

The goal of the regional plan is to reduce flood damages and provide protection for the river corridor through floodplain management. This major effort will require the cooperation of all the counties. Kick-off meetings with county managers and floodplain administrators from each county have been held.

Key components of the plan may include the following:

- Strategy for the development of a program that can lease floodplain lands for floodwater storage
- Strategy for working with FEMA to remap the watershed including future conditions mapping

- Identification of any necessary changes in legislation, development codes or ordinances to provide comprehensive flood control alternatives and implement floodplain protection measures
- Identification of funding opportunities for conducting unsteady state modeling of the river system. This modeling will provide information on cumulative impacts for development in the floodplain to downstream users.
- Identification of critical floodplain and river corridor areas
- Development of strategy for consistent data collection for all counties to provide reliable bench marks and elevation data
- Development of strategy to incorporate ideas from "No Adverse Impact" program into county operations
- Development of an outreach and education program for community members
- Look at alluvial fan flooding and options for protecting public and property

Estimated costs to develop the Floodplain Management Plan is $15,000 to $25,000 of which $11,700 has been obtained through a grant with the NDWR.

Markleeville Floodplain Restoration Project

Currently there is a USFS Guard Station, with fire station utilities and housing, occupying a portion of the floodplain on Markleeville Creek. Throughout history the station has experienced flooding by 25-year events. In the 1930's a floodwall was constructed which has consequently straightened and confined the stream channel. The USFS has agreed to move the Guard Station to a more appropriate location, at which time Alpine County will acquire the property. The County and the AWG plan to restore the reach to a more natural state and restore the floodplain. The project will take place in two phases.

Funding for Phase I has been received from the California Department of Water Resources, Urban Stream Restoration Program. The objectives for Phase I are to initiate preliminary restoration efforts to stabilize and re-vegetate the river reach through Markleeville; establish baseline data; develop community and stakeholder support; and to develop design plans and specifications for the County to restore the creek and the adjacent floodplain through this reach. Phase II will consist of the implementation of the design plan. Estimated costs for Phase II of this project is $1.5 million.

Programs for Retaining Agriculture and Open Space

All of the counties in the watershed have components within their master plans aimed at preserving agriculture and open space. Mechanisms such as conservation easements are helping to provide the financial compensation to landowners so that they may remain in farming and ranching. TDR Programs are helping to steer development out of critical areas. Currently Douglas and Churchill Counties have TDR Programs. Open Space Programs, such as Carson City's, are very effective in acquiring sensitive lands and maintaining them for open space. BLM actively promotes open space opportunities through their land acquistion and exchange programs. Lyon County, which has been experiencing unprecedented growth, is now requiring that the floodplain lands are dedicated as open space when a ranch is sold to a developer.

The LVEA has established a Agriculture Preservation Working Group to investigate options and develop a plan for preserving agriculture in the Newlands Project. The working group developed the framework for the Churchill County TDR Program.

8.2.3 Recommendations for Future Management Measures

Living River Strategy

One of recommendations from the river corridor group is to strive to establish and maintain the Carson River as a living river system. A living river strategy would minimize the disruption and alteration of the river habitat, and maximize opportunities for environmental restoration and enhancement throughout the watershed. We recognize that through historic channelization projects and mining practices, diversion structures and levees, and development in the floodplain there are limited areas available for implementing this type of strategy. Potential areas for implementation include the Brockliss Slough and Genoa Lakes. A living river strategy can save millions of dollars by significantly reducing the need for flood control infrastructure and reducing the amount of funding needed to make flood repairs.

The benefits of a living river strategy include the following:

- Conveys variable flows and restores habitat in the floodplain
- Proper functioning sediment loading
- Provides natural aquatic and terrestrial habitat
- Maintains high water quality and supply
- Offers improved recreation opportunities
- Maintains its aesthetic qualities

A living river strategy would incorporate principles of geomorphology:

- Maintaining or restoring the connection of the river to the floodplain
- Allow the river to meander as much as possible
    - Maintaining a continuous fish and riparian corridor along the river
    - Allow the river to establish and maintain natural slope and width

Actual implementation of this type of strategy is dependent upon the cooperation of numerous entities and an enhanced understanding of what is meant by a “living river”. Key implementation approaches include the following:

- Education and Awareness Program geared to the general public, local governments and natural resource managers on the “living river” concept and the importance of this type of strategy for issues such as flooding, and floodplain conservation.
- Utilizing “soft” bio-engineering approaches in river rehabilitation design

- Design of river rehabilitation projects that encourage sediment capture and habitat enhancement
- Conserve and protect floodplain lands through conservation easements and land acquistions.

Un-Steady State Model for the Carson River

Typical flood plain management tools include the use of a steady state backwater calculation program to establish a water surface elevation at flood stage. The most widely used program is the HEC-RAS program developed by the Army Corps of Engineers. The steady state module in HEC-RAS utilizes information from each cross section in the model to calculate the conveyance, energy and ultimately the water surface elevation for the cross section.

This model is useful for verifying compliance with municipal floodplain regulations for most proposed developments. Most developments are only required to analyze for changes in water surface elevation that would impact the surrounding properties, and the steady state model is the "model of choice" for that purpose. However the steady state model does not take into account the significant volume of water that may be stored in existing floodplains as well as the resulting attenuation of the peak flows due to that storage.

Incrementally each new development could justify that "their" development makes an insignificant impact to the overall floodplain, certainly within the accuracy tolerance of the models; however the cumulative impact from the loss of floodplain storage could be significant especially in river systems like the Carson River where large areas of land flood and hold water during a significant storm event.

The unsteady module in HEC-RAS utilizes flood plain storage volume to make a more accurate estimate of flooding. Moreover, it is highly successful for shedding light on a growing problem faced by planners, that of loss of flood plain storage and the potential for increased flooding downstream. This impact has been studied by the Crops of Engineers along the Truckee River in Washoe County and was found that the Truckee Meadows holds significant potential for flood storage and loss of that storage can significantly increase the risk of flooding downstream. This fact was demonstrated effectively by development of an unsteady model of the Truckee River.

The estimated cost to develop the model is $650,000.

8.3 Water Quantity

Population growth and potential water use changes in the watershed over the next 50 years will most likely create demands for water resources that will exceed local groundwater supplies. Each county has developed a water resources plan or has included in their master plan a water resources component. There are eleven water purveyors in the watershed each with a designated area for supply and a plan specific to their area. CWSD is responsible for the development of regional solutions and investigates opportunities for the water purveyors, counties and others to work together to protect and enhance the water supply of the Carson Basin. Several projects are currently underway.

Water quantity programs are in the support of guiding principles:

- Manage the water's resources for economic sustainability, quality of life, and protection of private and public property rights.
- Protect the headwaters region as the system's principle water source.
- Promote conservation of water from all sectors of the community's water users for the benefit of municipal, industrial, agricultural, domestic, recreational, and natural resouces.
- Investigate opportunities and options for using reclaimed water to enhance river flow.

8.3.1 Completed Water Quantity Projects

2005 Carson River Symposium – Operation and Administration of Water Resources on the Carson River – How it all works!

CWSD organized and facilitated this symposium that provided information and discussion on the complex issue of how the water resources of the Carson River actually work. Presentations addressed issues such as the administration of water allocations, transfer of agricultural water to municipal uses, and the regional water system. Approximately 170 people from throughout the watershed attended. CWSD plans to hold similar symposiums on a bi-annual basis.

Carson Valley Arsenic Management Plan

In February 2003 Brown and Caldwell in conjunction with CWSD and representatives of Carson Valley water systems developed four alternatives for enabling Carson Valley communities to meet the 0.01-milligram per liter or 10 parts per billion arsenic maximum contaminant level for municipal drinking water supplies. The plan describes the projected demands through the 2030 planning period, provides descriptions of the four alternatives, estimated construction and operational and maintenance costs, and related assumptions and limitations.

Table 8.3.1-1: Other Water Supply Projects, Programs and Studies

Title	Date	Partners	Description
Silver Springs Groundwater Evaluation	July, 2004	CWSD, B&C	Evaluation conducted in response to a potential reduction in supply.
Water Resources Analysis for Carson River Watershed	June 2000	CWSD, B&C	Evaluates projected supplies and demands through the year 2050 for entire watershed.
Water Resource Analysis of the Upper Carson River Basin	August 1998	CWSD, USFWS, Kennedy/Jenks	Purpose of study is to identify available water resources from Fort Churchill to headwaters.

8.3.2 Current Water Quantity Projects

Regional Water System

For the last four years CWSD has been identifying pipelines that could connect or be upsized that would tie various water purveyors' systems together, thereby creating a regional water system. The goals of this system are:

- Enhance water supply reliability
- Enhance fire flow protection
- Help meet federal water quality objectives
- Benefit the environment
- Protect agriculture
- Provide lower overall costs to the communities

Although pipeline connections have been identified throughout the watershed, CWSD had not evaluated what and whose water would move through these inter-ties. With concerns from the lower and upper watershed that new growth in the watershed may take water out of their areas, CWSD is now evaluating the water resources throughout the entire watershed.

Workshops have been held in each county to determine current and future water needs, and what the common needs area. A regional water management plan may be developed that addresses the common needs water purveyors throughout the watershed.

Water Resources Technical Committee

A technical committee consisting of water purveyors, county staff and others, has been established by the CWSD to address issues involving water supply on a regional basis. The committee meets on a bi-monthly basis. No cost would be associated with this committee.

Newlands Water Rights Purchase Program – AB380

In June 1999, AB380 was passed by the Nevada State Legislature. An environmental assessment was completed and program began purchasing water rights in 2000. CWSD is the program administer. Partners include: U.S. Bureau of Reclamation; Pyramid Lake

Tribe, Carson Truckee Water Conservancy District, State of Nevada, Truckee Meadows Water Authority; City of Fallon; Churchill County; Truckee Carson Irrigation District.

The goal of the program is to purchase and retire challenged water rights that cannot be used or transferred, however, unchallenged water rights are also accepted. The program purchases Carson Division water rights for $2,200/acre and Truckee Division water rights for $3,800/acre. When unchallenged water rights are purchased, they can be "matched" with protested transfer applications or water rights challenged by petition. The unchallenged water rights are retired and the Pyramid Lake Tribe drops its legal challenge or protest. This "matching" program allows farmers to use water that was previously unavailable, and removes the "cloud" of litigation from many other properties. When 6,500 acres have been purchased and retired, the Pyramid Lake Tribe has agreed to drop the remaining litigation in the Newlands Project. The program was originally scheduled to last for five years, however a two year extension was received in 2003. The program ended on June 30, 2006 but processing of applications is expected to continue into 2007.

Marlette Hobart Water System Improvement Project

The Marlette Hobart Water System (MHWS) dates back to the 1870's when it was originally developed to transport timber to Spooner Summit and, later, to provide a more stable water supply to the mining communities in Virginia City. Water rights associated with the system are owned by the State of Nevada and water is sold to Carson City, Virginia City, Silver City, and Gold Hill. The MHWS is the only portable source of water for Virginia City, Silver City and Gold Hill.

In 2003, CWSD received funding from USEPA to evaluate and construct an alternative method to transport water out of Marlette Lake that is more environmentally friendly than the current operation. The proposed system improvements include 9,635 lineal feet of pipe replacement, installation of a natural gas service line and construction of a natural gas powered generator, replacement of the existing pump intake line and build a new pump station. Currently, a diesel pump is used which is very expensive, environmentally unfriendly, and if there were an accident, could contaminate Marlette Lake possibly extending to Lake Tahoe. A draft environmental assessment has been prepared and is undergoing the review process. Construction is expected to begin in summer of 2007.

Carson River Basin Planning Tool

A planning tool is in the process of being developed that can display the interactions between proposed development and hydrologic modification activities and the impacts that these activities could have on hydrologic conditions, water resource availability and water quality conditions. The tool could be used by a variety of agencies to help determine the viability of proposed plans and could also aid in educating stakeholders on the impacts of development and hydrologic modification activities on water resources availability and quality. A steering committee has been formed to direct the development of the tool.

Alpine County Groundwater Management Plan
Alpine County, California is currently working with B&C, CWSD, and the USGS to develop a management plan for their groundwater resources. The goal of the plan is to maintain efficient and effective groundwater management, quantity and quality, thereby providing a sustainable, high quality supply for agricultural, environmental, and municipal use into the future that remains protective of residents' health, welfare and safety. Objectives include the following:

- Minimize the long-term drawdown of groundwater levels;
- Protect groundwater quality;
- Prevent inelastic land surface subsidence from occurring as a result of groundwater pumping;
- Protect against undesirable conditions of surface water flows and quality that directly affect groundwater levels and quality;
- Protect against undesirable effect of groundwater pumping on surface water flows and quality.

The Plan is expected to be complete in 2007.

Groundwater Pumping Inventories
The Nevada Division of Water Resources (DWR) conducts inventories of the basin groundwater pumping on an annual basis. The purpose of the inventories is to investigate the groundwater resources allocated by the DWR and to estimate the amount of groundwater pumping that was conducted for that specific water year. The reports are available from the State Engineers office or from CWSD library.

Flow Regime Enhancement
In the past most of the Carson River water has been used for agricultural purposes, but today the demand for municipal, recreational, and environmental uses are increasing. With very limited upstream storage meeting these demands is becoming increasing difficult. Flows in the river are constantly changing and in late summer and fall reaches of the river are virtually dry. Increasing flows in the river has become a priority.

CWSD has been working with various State and Federal agencies to try to coordinate releases out of the various small upstream reservoirs to enhance flows in the late summer and fall. CWSD currently releases water from Lost Lakes after the irrigation season to provide additional in-stream flows to the West Fork and is looking at alternatives for diverting Mud Lake water that may also be used to enhance flows in the West Fork.

8.3.3 Recommendations for Future Management Measures

Carson Basin Reuse Management Plan
Investigate the development of a regional plan for the management of effluent that includes investigating opportunities for utilizing reclaimed water as a method for increasing river flows either through direct or indirect means. Estimated costs cannot be determined at this time.

Regional Water Conservation Program
At recent conferences and workshops it has been recommended that a regional water conservation program be investigated. This program could be developed through a regional approach and implemented on a local scale. Funding needs for this program cannot be determined at this time.

Conjunctive Use
As growth continues in the watershed communities may need to start using surface water to meet the new growth. However, due to the lack of upstream storage, communities, through conjunctive use programs, may need to utilize surface water when supplies are available, and when surface water supplies are low, groundwater resources may need to be used. Funding needs for this program cannot be determined at this time.

Investigation of Impacts of Climate Change to the Carson Basin
In the future it may become necessary to investigate potential impacts to the watershed from changes in the global climate condition. If climate change continues and temperatures continue to raise spring run-off could occur sooner. This could have an adverse affect on agriculture and the environment, plus on the planning process for organizations that utilize surface water. Funding needs for this program cannot be determined at this time.

8.4 Outreach and Education

Public awareness and participation by community members in watershed projects and programs is considered critical **(element e)**. Outreach and education projects are in support of guiding principle:

- Promote understanding and awareness of watershed resources and issues through cooperative education efforts throughout the watershed.

The CRC Education Working Group works to implement this principle. The group has developed the following vision and mission statements:

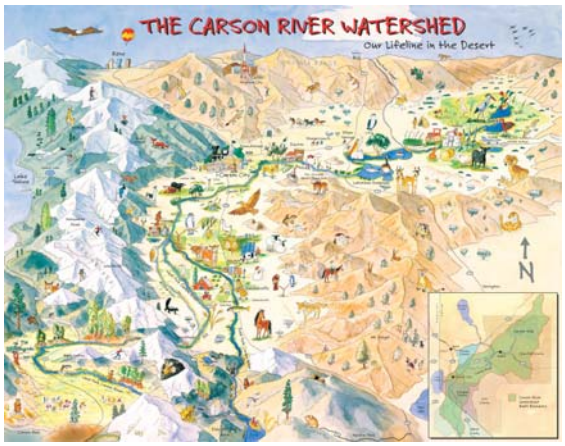
Vision Statement
The vision of the CRC Education Working Group is for all citizens within the Carson River watershed to have a deepened understanding of and commitment to the Carson River basin as their lifeline in the desert.

Mission Statement
The mission of the CRC Education Working Group is to educate, through active participation, the watershed communities, inviting everyone to explore and conserve our watershed through community programs and hands-on experience; advocating the protection of our lifeline in the desert.

Numerous outreach programs and activities have been successfully implemented and are ongoing by the CRC Education Working Group and many other entities. One of the main goals of watershed education is to enhance water quality by community participation in

workdays on the river, through understanding of water quality issues and actions that can be taken to prevent water quality degradation and to help create a sense of ownership so that water quality is protected and/or enhanced.

8.4.1 Completed Outreach and Education Projects



Carson River Watershed Map – Our Lifeline In the Desert

In 2003 the CRC Education Working Group (with representatives from CWSD, NDEP, UNCE and WNRC&D) finalized education tool that is an artistic rendering map of the watershed. This back of the map contains history, facts, and information about the watershed and is used to educate all watershed residents about the Carson River. The map is distributed to local schools and at environmentally focused events, is used during presentations and is available to groups that have an interest in promoting watershed awareness. The main purpose of the map is to inform watershed residents about the Carson River, the fact that they live in a watershed, what a watershed is and why it is important. This map along with the interactive website has won local, state and national awards for outstanding educational program. Funding for this project was provided by CWSD and NDEP, project management was provided by the CWSD.

Explore Your Watershed - Interactive Web Watershed Map

Expanding upon the Our Lifeline in the Desert Watershed Map an interactive website was developed by the local firm VisionASP. The website is hosted and maintained by the CWSD and allows the user to explore the watershed from the comfort of their classroom or home. Resources provided on the website include a method for local educators to share lesson plans, links to student activities and watershed resources, and detailed information on all features of the watershed map.

First Annual Carson River SnapShot Day

Modeled after the very successful Truckee River SnapShot Day, the first annual SnapShot on the Carson River was held in Fall of 2006. Monitoring teams led by water resource professional conducted field-tests for dissolved oxygen, conductivity, pH and temperature. Water samples were collected for laboratory analysis of nutrients, sediment and bacteria. Visual habitat assessment and photo monitoring was also conducted. A report will be developed in early 2007.

Native Waters/Project WET Educator's Symposium

In March 2007 Nevada and California Native American tribes and educators from northern Nevada participated in the symposium. Over 60 participants were introduced to lessons specifically adapted to conditions and water issues of western and arid regions. The WEPD and NDEP organized and hosted the symposium.

8.4.1 Current Outreach and Education Projects

Carson River Work Days
WNRC&D began the Carson River Work Days in 1995. The workdays have involved over 10,000 community members and 55,000 hours in clean up and restoration efforts. Over 100 organizations have sponsored the workdays and contribute time, money and materials. Over 40 projects have been completed on approximately 10 miles of riverbank through the workdays. The workdays program has won several national and state awards including the State of Nevada Water Quality Award in recognition of restoration efforts that resulted in the reduction of bank erosion; the State Wildlife Habitat Project of the Year Award from the NDOW; the Outstanding Community Service Program Award from former U.S. Senator Bryan; and, the National Volunteer Earth Team Award from the USDA NRCS. Annual costs for the workdays (not including match) is approximately $24,000.

Alpine Watershed Group Citizen Monitoring Program
In 2004 the AWG joined 772 other volunteer monitoring group in the United States in initiating a Citizen Monitoring Program. On a quarterly basis volunteers conduct field tests for temperature, dissolved oxygen, pH, conductivity, turbidity and bacteria in Alpine County. Habitat assessment and photo monitoring is also conducted. In 2005 the AWG added a bioassessment component to the program. Annual costs for the program are estimated at $1,000.00.

Watershed Tours
Annual river rafting and canoe trips are held when flow conditions are appropriate by a variety of organizations. Actually getting on the river and seeing first hand the beauty and the challenges is one of the best ways to gain support and buy-in from stakeholders and citizens. Tours for legislative groups and others are held when possible to showcase projects and to gain support for needed funding.

Washoe Tribe of Nevada and California Outreach and Education Programs
The WT conducts numerous outreach and education activities and events each year. One such event is “Washoe on the River”. This event serves to teach young and old about the critical resources of the watershed. The WT also hosts earth day events each year in addition to educational outreach in each Washoe Community. In 2007 the WT, in cooperation with Project WET and NDEP, organized and hosted “Native Waters”, a special symposium for Nevada and California Native American tribes, educators, and environmental specialists. For two days the participants were introduced to lessons specifically adapted to conditions and water issues of western and arid regions, focusing on Western Science and Cultural Knowledge.

BioEngineering Workshops
Bio-engineering workshops are held on a bi-annual basis by WNRC&D and the conservation districts. The workshops provide the opportunity for professionals and community members to learn about the latest design and techniques.

Environmental Education Coordinator

In August of 2005 WNRC&D, through a grant provided by the Smallwood Foundation, CWSD and NDEP combined funding sources to establish an environmental education coordinator position to work with local schools and to expand the River Wranglers program into the lower and upper watershed schools. Estimated cost for this program is $36,000 per year.

River Wranglers

The River Wranglers has developed and implemented a model environmental education program in the middle watershed. The program provides opportunities for high school student mentors to work with younger students. The number of students who were mentored as younger students and then return to serve as mentors demonstrates the success of this program. Workshops are provided for students and teachers with activities linked to state science curriculums. River workdays are held with high school students serving as facilitators for the activities. Student's benefit from hands-on experience in a wide variety of subjects including streambank stabilization and restoration, groundwater movement and contamination, fish and wildlife, wetlands, and noxious weeds. River Wrangler's mission is exploring, conserving, and celebrating our rivers through community programs, projects and hands-on experience.

Eagles and Agriculture

The Eagles and Agriculture event focuses on the influx of birds of prey who come to Carson Valley to feed on the rodents and nutrient-rich afterbirth during the winter calving season. The unique interaction between nature and agriculture attracts photographers, birders and nature-lovers of all kinds who come to observe eagles, hawks, falcons, owls and a variety of other bird species. WNRC&D began the annual event that has grown significantly over the past several years. Currently, the Douglas County Chamber of Commerce organizes the event. Special educational events such as workshops on photography and raptor behavior, tours of Carson Valley, and owl prowls are included in the program.

Carson River Report

The Carson River Report is a monthly television show that is sponsored by the CWSD and has aired on public access since 2000. The program, which is hosted by the CWSD General Manager, explores different areas of the watershed, provides information on specific programs, issues and concerns, and provides the general public the opportunity to learn about where they live from the comfort of their own home. The show is now available on the CWSD website. The estimated cost for the program is $5,000 annually.

Project Water Education for Teachers (WET)

Project WET is an interdisciplinary water education program designed to supplement K-12 curriculum by integrating water education into any subject in the classroom. Project WET is a national nonprofit water education program. In 1991, the NDEP and the UNCE brought the program to Nevada. In June 2001, the NDEP, Bureau of Water Quality Planning became the coordinating entity for the program in Nevada. Workshops and "Make A Splash" festivals are held in all areas of the watershed. Costs for this

program are determined and coordinated through the Project WET coordinator for the State of Nevada.

CWSD Website

CWSD has developed and maintains a website that provides information on special events, meetings, water festivals and more. CWSD and CRC meeting agendas and notes, plus project and program information are available. Searches of the CWSD library can also be done on the website. Links are provided for other agency and organizations working in the watershed as well as links to current streamflow, weather conditions, and a list of ways that individuals can help combat NPS pollution. The Carson River Report and "The Flow" newsletter are available for viewing as well as the interactive "Explore Your Watershed" map. The website is found at www.cwsd.org. Annual for the website is approximately $1,000.00

"The Flow" Newsletter

Published quarterly by the CWSD, "The Flow" provides news of the plans, projects and people of the watershed. The newsletter is mailed to over 500 individuals and organization throughout the watershed and is available on the CWSD website. The estimated cost for the quarterly newsletter is $3,000 per year.

8.4.2 Recommendations for Future Management Measures

In addition to the ongoing programs listed in the previous section, the following projects are recommended by the CRC Education working group.

NPS Pollution and Floodplain Conservation Awareness Campaign

In order to raise awareness and instill a sense of stewardship by the general public the Education Working Group would like to begin the development of a broad outreach program regarding NPS pollution and floodplain conservation. This program could include the following components:

- Development of a map similar to the "Our Lifeline in the Desert" watershed map that focuses on the importance of floodplain areas and how each of us can help with the reduction of NPS Pollution.
- Billboards and signage with specific messages

The estimated cost for the campaign is $5,000.

SnapShot Day on the Carson River

The working group recommends the continuation of the "SnapShot Day" on the Carson River as an annual event. The event is geared to help raise general public awareness of NPS pollution sources and watershed issues. Estimated cost per year is $2,500.

Expansion of "Our Lifeline in the Desert" Watershed Map Program

The working group recommends expanding the watershed map program to include specific lesson plans for 4th and 7th grades. There is no cost associated with this activity.

Reprint of "Our Lifeline in the Desert" Watershed Map
Originally 10,000 copies of the watershed map were printed. Over 8,500 of these maps have been distributed at local schools and watershed events. There is still a large demand for the maps. Reprinting 10,000 copies of the map is estimated to cost $4,000.

8.5 Noxious Weed Abatement

Noxious weeds have become a major concern in the watershed. One of the biggest threats from noxious weeds is their tendency to increase soil erosion and stream sedimentation thereby reducing water quality. They also take over agricultural lands, displace native plants, decrease wildlife habitat, alter normal ecological processes, and reduce recreational values.

As a way to foster cooperation between organizations and programs Cooperative Weed Management Areas (CWMAs) have been established throughout Nevada. The Nevada Weed Management Association and the Nevada Department of Agriculture Noxious Weed Program provide resources and funding to the CWMAs in addition to other funding organizations such as the CWSD. Several CWMA's are currently operating in the watershed, including West Central Lyon County CWMA, Carson City Weed Coalition, Alpine/Upper Carson River Watershed Weed Management Group in addition to the Douglas County Weed Control District and the Churchill County Weed Abatement District. The Washoe Tribe also has a noxious weed abatement program. These groups have established mapping, monitoring and spraying programs for each region of the watershed. Funds are combined from a variety of sources to cover the costs and new challenges faced each spring as the weed infestations begin a new year.

Programs geared for supporting and/or managing noxious weed abatement are in support of the following guiding principle:

- Protect and manage uplands, mountain ranges, wetlands, and riparian areas to enhance the quality of surface flow, groundwater recharge, and wildlife habitat.

8.5.1 Completed Noxious Weed Abatement Projects

Fly Swapper Weed Education Program
The Churchill County Weed Abatement District and LCD developed an outreach program that involved the imprinting of 2,500 fly swappers with information on noxious weeds. The fly swappers were provided to community members free of charge.

Alpine/Upper Carson River WMA Education and Outreach Brochure
The Alpine/Upper Carson River WMA developed a brochure entitled "Don't Let Noxious Weeds Ruin the Carson River Watershed". The brochure provides information on weed identification, common practices to help control weeds, and how to get help. The brochure is provided to landowners and is handed out at public events.

Weed Mapping and Spraying
The WMAs and Washoe Tribe conduct mapping/inventory of weed infestations each season. The infestations are chemically treated or hand pulled. For example, the Carson City WMA has treated over 300 acres of noxious weeds since 2003.

8.5.2 Current Noxious Weed Abatement Projects

Goat Grazing Project

In July 2006, Carson City Open Space, in cooperation with UNCE, introduced goat grazing as an additional control method on Russian knapweed. The goats consume the flower which eliminates the seed and consume the leaves and some of the stem which reduces photosynthesis. The result is a stressed weed that can be chemically treated more effectively. The project is currently being monitored.

Goats battling noxious weeds in Carson City
Photo: A. Bollinger

Abatement and Mapping of Noxious Weeds Infestations

Numerous weed infestations have been treated throughout the watershed by the WMAs and the Washoe Tribe. The abatement process consists of removing weeds by manually pulling, mowing, burning, or by the application of a chemical spray. In 2005 major weed infestations were associated with Canada thistle, bull thistle, mullein, cheat grass, yellow starthistle, diffuse knapweed and tall whitetop. All areas of infestation are mapped and monitored by the WMAs on a seasonal basis. Infested sites are entered into a GPS system and documented on tracking maps. Annual costs for treatment and mapping of noxious weeds can exceed $150,000.

8.5.3 Recommendations for Future Management Measures

Development of Database to Track Weed Infestations

The Carson City WMA would like to develop a database that tracks the weed infestations, the treatments that the infested areas have received, the success rate of the treatments. The estimated costs for the database development is $4,000.

Community Outreach Programs

Development of outreach programs to provide education on noxious weed to the general public is critical to the ongoing battle to reduce the weed populations. The estimated cost for a watershed wide outreach and education program is $25,000.

Treatment and Monitoring

Continued treatment and monitoring of noxious weeds throughout the watershed is estimated to cost $150,000 per year.

8.6 Recreational Use and Management

The watershed is becoming more popular as a recreation area. With the increase of recreation on the river comes an increase of impacts to the river system if not properly planned for and managed. Negative impacts can include: loss of vegetation on stream banks from dispersed camping, trash, firewood collection, and off-road vehicle use. Negative impacts to the river system include the increase of erosion from bare stream banks, loss of wildlife habitat, and impacts to fish and other aquatic species.

Programs geared for supporting and/or managing recreational use are in support of the following guiding principle:

- Protect and support opportunities for public recreational access to natural areas throughout the watershed – including the river corridor – where appropriate.

8.6.1 Completed Recreational Use and Management Projects

Clear Creek/Kings Canyon Landscape Analysis and Strategy

The strategy developed by the USFS provides background information and site-specific decisions and recommendations for the National Forest System lands in Clear Creek, Kings Canyon, and Voltaire Canyon. The issues that are addressed in the strategy include: (1) Vegetation and Fuels, (2) Recreation, (3) Scenery Management, (4) Wildlife, (5) Watershed, (6) Roads Management, (7) Cultural Resources, and (8) Law Enforcement.

8.6.2 Current Recreational Use and Management Projects

East Carson River Landscape Strategy

The Strategy is a joint effort between the USFS and CWSD along with other stakeholder groups such as the Alpine Watershed Group, Washoe Tribe, and Alpine County to layout a plan of action for improving management of USFS lands along the East Fork of the Carson River. Increasing recreation and off-highway vehicle use is threatening watershed conditions along the river. The strategy is needed to improve recreation management, protect watershed and riparian values, and address the wild and scenic river issue. Recommendations will be presented in the strategy as well as site specific decisions that may require compliance with the National Environmental Policy Act (NEPA), priority management actions, and identification of special situations needing attention. Planning for the Strategy was initiated in March 2006 and is planned to be complete by October 2006. Public meetings and draft documents will be available. Costs for the development of the strategy was provided by the USFS.

Carson River Aquatic Trail

The goal of the Carson River Aquatic Trail project is to provide a local recreation area for local river enthusiasts and out of town visitors to the area. The trail will be approximately 13.7 miles from the Silver Saddle Ranch in Carson City to the Santa Maria Ranch in Lyon County. The project is being developed through Resource Concepts Inc. for Carson City Parks and Recreation and the Nevada Commission on Tourism. Partners include Lyon County, CWSD, State Lands, DVCD, and WNRC&D. The total estimated cost for the project is $500,000. The estimated completion time is dependent upon funding availability.

8.6.3 Recommendations for Future Management Measures

- Increase and More Effective Education and Enforcement
- Elimination of pit toilets to reduce sanitation problems
- Enhance signage along river, at vehicle points and at launch and take-out areas
- Monitor websites, guidebooks, and publications for accurate information. If information is incorrectly provided USFS will send notices about legal accesses and river use restrictions.
- Create effective vehicle closures in areas that have been used to cross the river.
- Inventory cultural site in known recreational areas and adjust management measures as necessary to protect archeological resources.
- Implement standard practice river use requirements that are already in place on many other rivers.

The cost for the implementation of these management measures has not been determined.

Driving across the river is a common occurrence on the East Fork in low flow conditions. Impacts include the increase of bank erosion from destabilization of streambank, plus damage to riparian and stream channel vegetation and fish and wildlife habitat.
Photo: G. Azad

9.0 Plan Implementation and Funding Needs

This section will address the following 319 criteria elements:

d. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan.
f. A schedule for implementing the NPS management measures identified in this plan that is reasonable expeditious.
i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h).

9.1 Timelines

The following timelines focus on activities through the year 2012 and provide targets for short and long-term programs. Project specific time schedules and milestones for river rehabilitation projects can be found in Appendix G - project summary sheets.

Table 9.1-1: Implementation Monitoring Timeline (element i)

Year	Action
2007	Assessment of Existing Physical Condition-"Report Card" complete
2007	Completion of Index of Biological Integrity Report
2008	Determine if nitrogen or phosphorus standards warrant modification
2009	First review and update of plan recommendations, projects and programs
2009	Conduct 2nd LiDAR aerial survey of river corridor if resources allow
2011	NDEP return to full sampling schedule
2012	Second review and update of plan recommendations, projects and programs
2012	Review of restoration/corridor protection milestones
2012	Evaluate exceedences of Duration Curves – Have concentrations and loadings decreased after 7 years of NPS mitigation projects and programs
2015	Review of load reductions and load reduction criteria for effectiveness
2015	Second review of restoration/corridor protection milestones

Note:
NPS – Nonpoint source pollution

Table 9.1-2 Completion Schedule for Current Projects (element f)*

Year	Project Title
2006	Martin Slough Water Quality Enhancement Project
2007	First Annual SnapShot Day Report
2007	Upper Carson Water Quality Monitoring Program Report
2007	AB 380 Program
2007	Carson River Planning Tool
2007	Alpine County Groundwater Management Plan
2007	Marlette Hobart Water System Improvement Project
2007	Willowbend Streambank Protection and Restoration Project

Year	Project Title
2007	Carson Valley Golf Course Streambank Protection & Restoration Project
2008	Lower East Fork Project
2008	Middle Carson River Stream Rehabilitation
2009	Regional Floodplain Management Plan
2009	Regional Water System Plan
2009	Un-Steady State Model of Carson River
2011	Markleeville Floodplain Restoration

*Schedule does not include projects that are ongoing or future projects.

It is important to recognize that the timelines should be considered to be flexible due to unpredictable political climate, economy, funding availability, and other factors.

9.2 Plan Implementation

The CWSD, DVCD, CVCD, WNRC&D, NDEP and other entities working in the watershed will continue to support, fund and carry out watershed projects and programs that are geared towards the ultimate goal of improving water quality and overall watershed conditions.

The CWSD/CRC watershed coordinator will continue to perform the following activities for plan implementation:

- Coordinate CRC and working groups activities, meetings and projects
- Provide regular updates to CWSD Board of Directors, CRC and others on watershed plan implementation and related projects and programs
- Increase awareness of issues and progress through presentations at conferences, community work groups, local access television and newspaper articles
- Organize and facilitate conferences and symposiums to present information and provide discussion on identified issues
- Pursue available funding for identified watershed plan activities, projects and staff positions
- Provide project administration, coordination and management
- Provide presentations to stakeholder group on plan development and updates
- Work with stakeholders to update plan according to timeline
- Provide easy access to the plan and project information via the CWSD website

CRC participants will continue to support the integrated watershed process by:

- Participating in CRC meetings, activities, and projects
- Provide their organization with updates and progress reports on CRC activities and plan implementation progress
- Provide specific expertise to discussions and projects
- Assist in obtaining funding (including in-kind match) for support of the CRC and its members projects and programs
- Help raise awareness of watershed challenges and the integrated watershed process through presentations at conferences, community workshops, etc.

9.3 Plan Updates

The proposed plan recommendations, management measures, maps and project summary sheets will be reviewed and updated on an as needed basis, not to exceed a three-year time frame. The plan and updates will be distributed via email to all counties, agencies and other stakeholder groups to increase awareness and expand and strengthen the core group of individuals committed to carrying out the stated goals and recommendations.

9.4 Funding Needs

General estimates of identified funding needs are provided in Table 9.4-1 and more specific funding needs for river restoration projects are provided in Table 9.4-2 ***(element d)***. These estimates do not include salaries for watershed coordinators or other paid positions.

Table 9.4-1: General Estimates of Future Funding Needs

Activity	Estimated Cost
Water Quality	
River Rehabilitation/Stabilization*	$8,430,000
Sediment Transport Investigation	$150,000 to $250,000
LiDAR – 2nd Flight	$500,000
Carson River Work Days	$24,000 (annually)
Maintenance of Grade Controls	TBD
High Water Response	TBD
Floodplain Conservation	
Conservation Easements and land acquistions	TBD
Regional Floodplain Management Plan	$ 15,000 to $ 25,000**
Unsteady State Modeling	$650,000
Water Quantity	
Regional Water System Plan	TBD
Marlette-Hobart Water System Improvement Project	$7,000,000
Carson Basin Reuse Management Plan	TBD
Regional Water Conservation Program	TBD
Education and Outreach	
NPS Pollution and Floodplain Conservation Awareness Campaign	$5,000
Reprint of watershed maps	$ 4,000
SnapShot Day Funds	$ 2,500
Environmental Ed. Coordinator	$35,000 (annually)
Watershed Website	$1,000 (annually)
Watershed Newsletter	$3,000 (annually)
Noxious Weed Abatement	
Development of Weed Infestation Database	$4,000
Community Outreach Programs	$25,000
Treatment and Monitoring	$150,000 (annually)
Recreational Use & Management	
Carson River Aquatic Trail	$500,000
USFS Landscape Strategy Implementation Measures	TBD

Note: * Table 9.4-2 provides the breakdown for this estimated cost
TBD – to be determined ** $11,700 of the estimated costs has been secured through a grant from NDWR

Based upon the restoration priorities stated in Table 5.10-2 the following costs estimates would apply for specific river reaches with high restoration priority ratings.

Table 9.4-2: Estimated Costs for River Rehabilitation/Stabilization Projects

Sub-Reach*	Project Title	Status	Estimated Cost
MC	Markleeville Floodplain Restoration Phase I	Current	$1,500,000
MC	Hot Springs Streambank Stabilization Project	Future	$20,000
WF	Stabilize Stream through Faith Valley	Future	$350,000
MS	Martin Slough Water Quality Enhancement Project	Current	TBD
C-1	Willowbend Streambank Protection & Restoration	Current	$360,000
C-1	Restoration of Sub –Reach C-1	Future	$1,800,000
C-8	Rolling A Restoration Project	Future	$2,000,000
E-3	Carson Valley Golf Course Streambank & Restoration	Current	$660,000
C-7	Middle Carson River Stream Rehabilitation	Current	$540,000
E-6	Lower East Fork	Current	$1,200,000
NA	Lower River Restoration Projects	Current & Future	TBD
	Total Estimated Costs		**$8,430,000**

*More detail can be found in Table 5.10-2
TBD - Estimated project costs are undetermined at this time

9.5 Funding Sources and Opportunities

Numerous opportunities exist for funding of projects and programs. Grant and matching requirements differ depending upon the focus of the grant program and the funding entity. Working cooperatively with other entities enables the funding to go further and the projects and programs to be more successful and long lasting. The project summary sheets, provided in Appendix G, provide information on the funding sources for specific projects. Some of the most utilized funding sources are listed below. Section 9.5.1 lists these and other potential funding sources.

Environmental Protection Agency

The USEPA is a significant source of funding for the watershed for projects involving river restoration, education and outreach and wetland protection. Current grants include the Marlette-Hobart Water System that is being administered by the CWSD.

Conservation and Resource Protection Grant Program – Question 1

Currently a significant source of funding for the watershed is the AB 9 or the Question 1 Program. Nevada voters passed Question 1 in 2004, authoring the State of Nevada to issue general obligation bonds in an amount not to exceed $200 million. The funds generated by the bond sales are being used to conserve valuable environmental assets as well as support recreational and cultural facilities through Nevada. The NDSL was charged with developing and implementing the program.

Of the total allocation, $10 million was allocated for the restoration of the Carson River Corridor. The $10 million is split equally between the four Nevada counties at $2.5 million each with a 50% matching requirement. All funds must be sold to projects by November 5, 2008, although some projects may continue to see reimbursement as late as 2011.

The CWSD provides oversight and approves projects allocated under the $10 million for the Carson River Corridor to ensure that projects are designed with a watershed approach and provides benefits on a regional basis.

Nevada Division of Environmental Protection – 319 Program
NDEP disperses the federal CWA 319 program funding. This is a crucial funding source for many of the project and programs that implemented in the watershed. Funded projects include river restoration, watershed coordinator positions, and outreach and education.

Nevada Division of Water Resources
NDWR provides funding for river rehabilitation and floodplain management projects through the channel clearance and the floodplain management programs.

Carson Water Subconservancy District
The CWSD provides funding for a variety of projects and programs including river rehabilitation, noxious weed abatement and education and outreach. Funds are allocated each year by the CWSD Board of Directors. CWSD funds can be used as match for federal and other sources of funding.

Carson-Truckee Conservancy District
The CTCD provides funding for a variety of projects and programs including river rehabilitation, noxious weed abatement and education and outreach.

Western Nevada RC&D
The WNRC&D provides funding river projects and education and outreach programs through grants obtained from non-profit organizations and private foundations.

Landowner Contribution
Without the support of landowners (including the Counties) and in-kind matches that they provide many of the river projects could not be conducted.

9.5.1 Potential Funding Sources

Funding for projects and programs are available from a wide variety of sources including federal, state and local agencies and private foundations and businesses. Contact information for these sources and other potential sources can be found in Appendix A.

Federal Funding Sources
U.S. Environmental Protection Agency
Federal Emergency Management Agency (FEMA)
Natural Resources Conservation Service
Farm Service Agency
U.S. Bureau of Reclamation
U.S. Army Corps of Engineers
U.S. Bureau of Land Management

Southern Nevada Public Land Management Act Program
U.S. Fish and Wildlife Service
U.S. Forest Service

State Funding Sources
California State Water Resources Control Board Lahontan Region
Nevada Division of State Lands - Question One Funds
Nevada Division of Environmental Protection
Bureau of Water Quality Planning
Bureau of Water Pollution Control
Nevada Division of Water Resources
Channel Clearance Fund
Floodplain Management Program
Nevada Division of Forestry
Nevada Division of Conservation Districts

Local Funding Sources
Carson-Truckee Conservancy District
Carson Water Subconservancy District
Western Nevada RC&D
Private Organizations and Non Profits

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