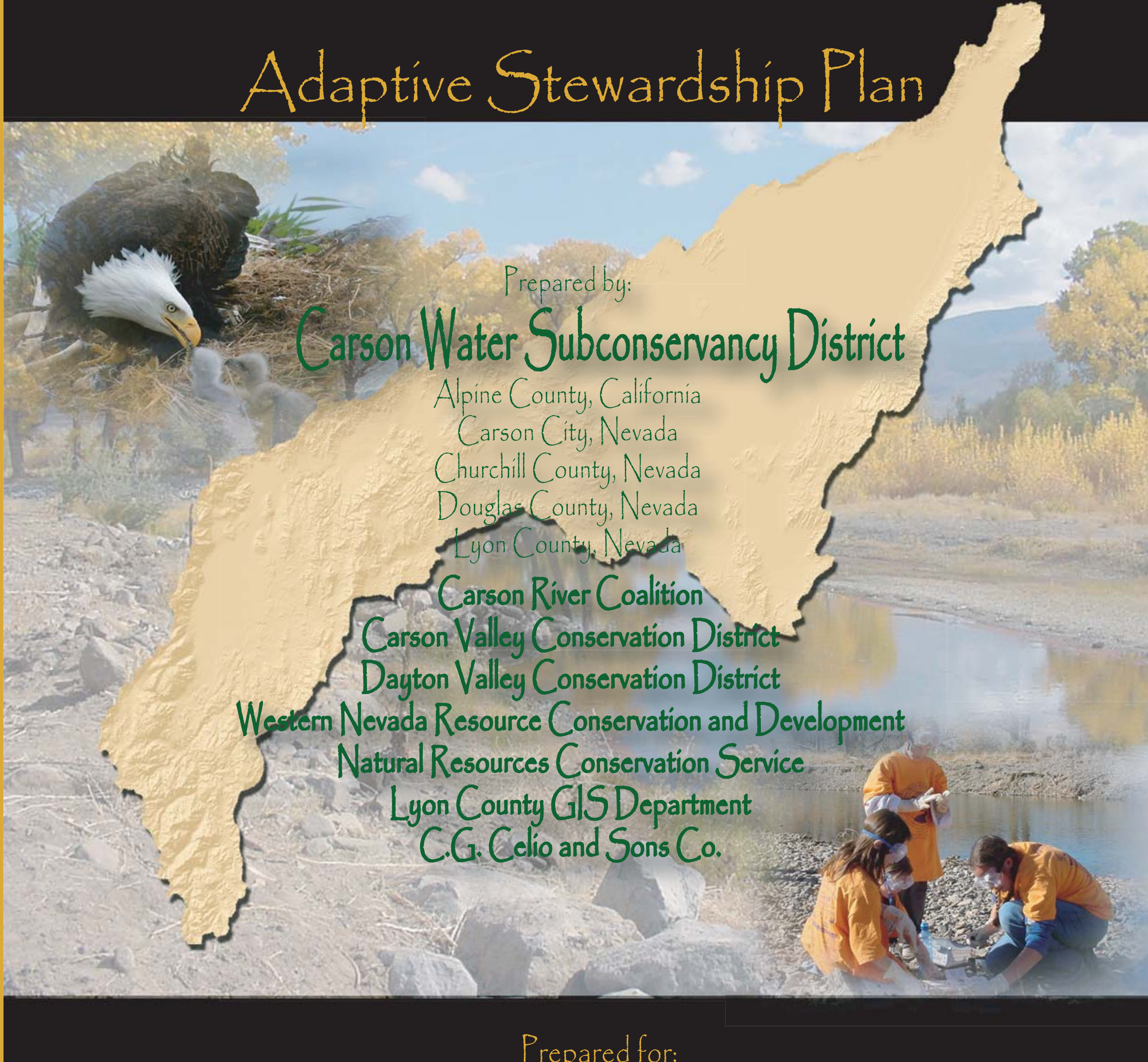
CARSON RIVER WATERSHED
"Our Lifeline in the Desert"

Adaptive Stewardship Plan



Prepared by:

Carson Water Subconservancy District

Alpine County, California
Carson City, Nevada
Churchill County, Nevada
Douglas County, Nevada
Lyon County, Nevada

Carson River Coalition
Carson Valley Conservation District
Dayton Valley Conservation District
Western Nevada Resource Conservation and Development
Natural Resources Conservation Service
Lyon County GIS Department
C.G. Celio and Sons Co.

Prepared for:

U.S. Environmental Protection Agency
Nevada Division of Environmental Protection - Water Quality Planning

June 2006

DRAFT

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In Cooperation with:
Carson River Coalition

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Review and comments have been provided by the following:

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Diana Furness	CWSD, Chapters 1 - 3
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Carson City Parks and Recreation Department
Carson City Planning Department
Carson City Weed Management Group
Carson Valley Conservation District
Carson Water Subconservancy District
Clear Creek Watershed Council
Churchill County GIS Department
Churchill County Mosquito and Weed Abatement
Churchill County Planning Department
Dayton Valley Conservation District
Douglas County GIS Department
Douglas County Planning Department
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Lahontan Valley Environmental Alliance
Lyon County GIS Department
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River Wranglers
The Nature Conservancy
Washoe Tribe of Nevada and California
Western NV Resource Conservation & Development
University of Nevada Cooperative Extension
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U.S. Environmental Protection Agency
U.S. Forest Service
U.S. Geological Survey

For questions or comments regarding this plan contact Genie Azad, Carson Water Subconservancy District, at 775-887-9005 or genie@cwsd.org.

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Carson River Watershed Adaptive Stewardship Plan

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EXECUTIVE SUMMARY

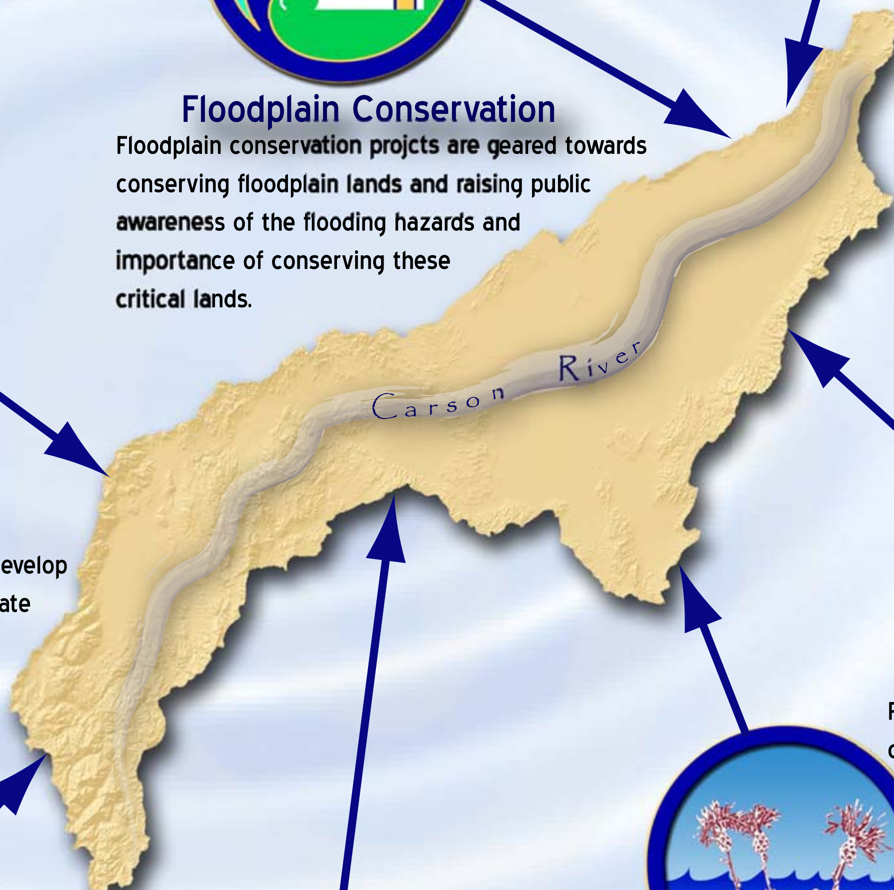
The Carson River Watershed is our lifeline in the high Sierra desert. The watershed encompasses approximately 3,965 square miles in California and Nevada with habitats ranging from lush, high mountain meadows, forests and aspen groves to dry, salt desert shrub lands. The Carson River begins as two separate tributaries, the East and West Forks, high in the Sierra Nevada in California. These forks join to form the mainstem Carson River near Genoa, Nevada before continuing its 184-mile journey to its terminus in the Carson Sink. Snowmelt from high mountain ranges passes over forests, agricultural lands and urban areas on its way to the river. As the water passes over land it picks up evidence from our everyday lives and reflects it back to us through the quality of the water and the health of the watershed.

Integrated watershed management takes into account everything that happens in a watershed. In this regard soil, vegetation, animals, and humans are all integral parts. The history of a watershed is also a critical part. The Carson River Watershed was changed forever during the Comstock Mining era in the late 1800's. This was a period for great discoveries and challenges as man searched for ways to reap the treasures from the region's natural resources. It was also a time in which great damage was done to the watershed. The entire Carson River system is still recovering from the impacts incurred from wood drives that scoured the riverbanks and discharges of huge amounts of mercury to the river from the ore refining process. Channelization and levee construction on more than 70 miles of the river during the 1960's has resulted in channel instability and an increase in sediment loading to the river. Today, our expanding populations and urbanization of agricultural areas is changing the face of our watershed. If not properly planned for the expansion will further impact the ability of the watershed and its river system to properly function and provide us with clean water and a healthy environment.

Organizations, agencies, tribal governments and private citizens from the headwaters to the terminus work on a regular basis to maintain and restore the watershed and will continue to do so through programs, such as the Clean Water Act 319 Program. Without these types of programs the work cannot be done and degradation will continue. It is recognized that the Carson River may never be returned to its native condition. But the river and its floodplain can be restored or enhanced to a condition where it can function properly so values, such as a floodwater attenuation and public safety, habitat for aquatic and terrestrial species, safe drinking water supplies and recreational opportunities are available. Improvements are being seen, but it will take many years and millions dollars before substantial measurable progress is observed.

The main purposes of this stewardship plan are to: a) provide an overview of the watershed and its challenges; b) identify potential sources of nonpoint source pollution; c) discuss short and long term strategies and actions to address these potential sources; d) provide a tracking mechanism for projects and programs; e) identify future project and program opportunities; and, f) address the nine criteria elements of the Clean Water Act Section 319 Program (provided on page 2).

Carson River Watershed Project Categories



Floodplain Conservation

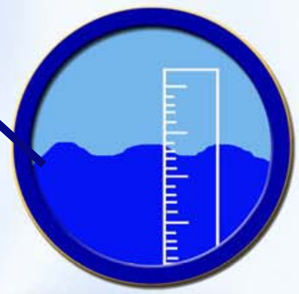
Floodplain conservation projcts are geared towards conserving floodplain lands and raising public awareness of the flooding hazards and importance of conserving these critical lands.

Recreation Use and Management

Recreational use and management projects are aimed at protecting the natrual resources while providing adventurous recreational experiences.

Water Quantity

By working together we can develop regional solutions and investigate opportunities for meeting municipal, environmental, and agriculture demands.



Outreach and Education

Projects are aimed at inviting community members to explore and conserve the watershed through community programs and hands-on experiences.

River Rehabilitation/ Stabilization

River rehabilition projects are aimed at creating or enhancing riparian habitat, mitigating severe erosion, restoring some geomorphic form and function, and ultimately improving water quality.

Noxious Weed Abatement

Noxious weed abatement projects are geared towards mapping, monitoring and treating the weeds, plus public outreach and education.

Water Quality Monitoring and Assessment

These projects will help to evaluate the health of the river and the appropriateness of the water quality standards.

ES.1 Project Categories

As illustrated in Figure ES-1, this stewardship plan will focus on seven major project categories. One of the goals of this plan is to present a comprehensive list of projects that fall within these categories to illustrate how watershed projects and programs are moving in a purposeful and solution-based direction. The seven major project categories are:

Monitoring and Assessment – Numerous projects have been, and will be, implemented to attempt to characterize the chemical, physical, and biological conditions of the river system. This characterization will help to evaluate the health of the river and the appropriateness of the water quality standards.

River Rehabilitation/Stabilization – Virtually every reach of the Carson River has been impacted by human activity. Excessive sediment deposition has had an overwhelming effect on many reaches, and incised banks of up to 6 feet are not uncommon. Fluvial geomorphic assessments conducted in recent years describe the general stability of the Carson River as poor with extensive habitat degradation of the riparian corridor. The degraded condition has led to a loss of biological integrity and exceedance of the water quality standards for total phosphorus, total suspended solids, and turbidity. River rehabilitation projects are aimed at creating or enhancing riparian habitat, mitigating severe erosion, restoring some geomorphic form and function, and ultimately improving water quality.

Floodplain Conservation – Floodplain lands are being converted to developed property at an unprecedented rate throughout the watershed. Once these lands are impacted by development, the river loses the ability to re-establish its natural functions. Floodplains are critical for floodwater attenuation, groundwater recharge, nonpoint source pollution buffering, and providing habitat for wildlife. Floodplain conservation projects are geared towards conserving floodplain lands and raising public awareness of the flooding hazards and importance of conserving these critical lands.

Water Quantity – Population growth and potential water use change in the watershed over the next 50 years will most likely create demands for water resources that will exceed local groundwater supplies. By working together we can develop regional solutions and investigate opportunities for water purveyors, counties, and others to work together to protect and enhance the water supply of the Carson Basin.

Outreach and Education – Public awareness and participation by community members in watershed projects and programs is considered critical for successful efforts. Many people do not know that they live in a watershed, or even what a watershed is. We have implemented numerous programs aimed at raising watershed and nonpoint source pollution awareness. These programs have won several federal, state and local awards. River workdays, conferences and workshops, tours, newsletters, and websites are key components of our outreach and education strategy.

Noxious Weed Abatement – Invasive plant species, such as Tall Whitetop, are increasingly affecting lands within the watershed, particularly in areas along the Carson River and its tributaries. Increases in development, land use changes, off road vehicle use, and future flooding events may significantly increase weed infestations, if left unchecked. Noxious weed abatement projects are geared towards mapping, monitoring, and spraying the weeds, plus raising public awareness about what landowners can do to help.

Recreation Use and Management - The Carson River is becoming more popular as a recreation area as public access to the river increases. With an increase of river recreation there is the potential for an increase of impacts, if not properly planned for and managed. Recreational use and management projects are aimed at protecting the natural resources while providing adventurous recreational experiences.

ES.2 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 and floodplain conservation projects, and help to identify critical areas for implementation of these and other nonpoint source pollution management measures. These maps can be found in Appendix F.

Projects identified on the maps have corresponding project summary sheets that are located in Appendix G. All future river rehabilitation and floodplain conservation projects will include the development of a project summary sheet. These sheets provide historical documentation about the projects and serve as a tracking mechanism.

ES.3 Future Management Measures and Estimated Costs

Management measures and estimated costs should be considered as flexible due to the unpredictability of funding and the political environmental.

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

Activity	Estimated Cost
Environmental Ed. Coordinator	$35,000 (annually)
Carson River Report	$3,500 (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:
TBD – To Be Determined
* Table 9.4-2 provides the breakdown for this estimated cost
* $11,700 of the estimated costs has been secured through a grant from NDWR

ES.4 Implementation Monitoring Timeline

In order to evaluate the effectiveness of management measures over time the following monitoring time schedule was developed.

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

ES.5 Conclusion

This Stewardship Plan culminates the work by many entities and hundreds of individuals over many years. We recognize that a planning document, such as this, is only valuable if the diverse groups of agencies and organizations working within the watershed aggressively seek new and innovative ways to develop and fund projects that will collectively improve the watershed on a regional level. Because the watershed is a living system that is constantly evolving, restoring and managing it requires responsiveness and flexibility. New funding mechanisms, natural and man-made disasters, economic or regulatory changes, plus science and technology developments are just a few of the factors that can affect recommendations and identified projects.

This stewardship plan is a living document, which loses its value unless it is updated on an ongoing and regular basis. It is intended to be a guide and resource for organizations working within the watershed, and an education tool for those who are interested in finding out more about the area in which they live. We actively seek input, comments, and other feedback that can be used to improve the plan and its recommendations and proposed activities.

1.0: Introduction

For years, the Carson River Watershed (watershed) has been manipulated and changed to meet human needs. Human impacts include channelization, removal of riparian vegetation, floodplain development, bridge and road construction, gravel mining, irrigation diversions, levee construction and beaver introduction. Mining and logging in the late 1800's denuded the watershed and contaminated the river with mercury. In more recent years, the 1997 and 2006 New Years' floods ripped out unstable/damaged riverbanks and increased the spread of the aggressive perennial non-native noxious weed Tall Whitetop (*Lepidium latifolium*). In addition, Nevada is a rapidly growing state and the most arid state in the nation. Populations within some of the watershed communities are expected to increase significantly within the next 20 years. The watershed is experiencing an expansion of urban "sprawl" over the landscape, reducing agricultural lands and increasing the pressure on the riverine system. The importance of proper planning and management for the watershed's natural resources cannot be overstated.

High view of the East Fork Carson River as it leaves the high Sierra in Alpine County, California and winds it way into Carson Valley, Nevada.
Photo: G. Azad, 2003

The watershed has been identified as a Category I Watershed by the Nevada Division of Environmental Protection (NDEP) Non-Point Source (NPS) Management Program and by the California Unified Watershed Assessment. Three fluvial geomorphic assessments have been conducted in recent years and describe the general stability of the Carson River as poor with extensive habitat degradation of the riparian corridor. In addition, eighteen reaches of the Carson River are listed on the Nevada 303(d) Impaired Waters List. The West Fork of the Carson River and Indian Creek in Alpine County are listed on the California 303(d) List.

The main purposes of this stewardship plan is to: a) provide an overview of the watershed and its challenges; b) identify potential sources of nonpoint source pollution; c) discuss short and long term strategies and actions to address these potential sources; d) provide a tracking mechanism for projects and programs; e) identify future project and program opportunities; f) address the nine criteria elements of the Clean Water Act Section 319 Program

This stewardship plan is intended to be a "living document" that will be updated and revised on a not to exceed three-year basis, or as needed. Existing management plans prepared for the Upper, Middle and Lower Carson River have been incorporated into this management plan in order to provide a more comprehensive, holistic approach to watershed management.

1.1 319 Elements of a Watershed-Based Plan

To ensure that projects that are conducted on the Carson River and are funded with Section 319 funds progress towards improvement of water quality, the following required elements will be addressed in this plan:

a. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in watershed plan. ***(Section 5.11)***

b. An estimate of the load reductions expected for the management measures described under paragraph (c) below. ***(Section 6.2.5.2.1)***

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) above and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan. ***(Section 8.1.1)***

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. ***(Section 9.4)***

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. ***(Section 8.4)***

f. A schedule for implementing the NPS management measures identified in this plan that is reasonably expeditious. ***(Section 9.1)***

g. A description of interim, measurable milestones for determining whether NPS management measures or other control actions are being implemented. ***(Section 8.1.1)***

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. ***(Section 6.2.5.2.1)***

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) above. ***(Section 9.1)***

1.2 Abbreviations

afy	Acre-feet per year
AWG	Alpine Watershed Group
amsl	above mean sea level
BAQP	Bureau of Air Quality Planning
BCA	Bureau of Corrective Actions
BMP	Best Management Practice
BOD	Biological Oxygen Demand
BOR	Bureau of Reclamation
CA	California
CAF&G	California Department of Fish and Game
CCWC	Clear Creek Watershed Council
CDWR	California Department of Water Resources
CERCLA	Comprehensive Response Compensation and Liability Act
CO	Carbon Monoxide
CWA	Clean Water Act
CWMA	Cooperative Weed Management Area
CRC	Carson River Coalition
CRMP	Coordinated Resource Management Plan
CVCD	Carson Valley Conservation District
CWSD	Carson Water Subconservancy District
cfs	Cubic feet per second
DO	Dissolved oxygen
DVCD	Dayton Valley Conservation District
FEMA	Federal Emergency Management Act
FIRM	Flood Insurance Rate Map
GRTS	Grants Reporting and Tracking System
H_2S	Hydrogen sulfide
HUC	Hydrologic Code Units
HTNF	Humboldt Toyiable National Forest
IBI	Index of Biological Integrity
IWPP	Integrated Watershed Planning Process
LCD	Lahontan Conservation District
LCT	Lahontan Cutthroat Trout
LUST	Leaking Underground Storage Tank
LVEA	Lahontan Valley Environmental Alliance
MCL	Maximum Contamination Level
mg/kg	milligram per kilogram
M & I	Municipal and Industrial
MS4	Municipal Storm Sewer System Permit
NAC	Nevada Administrative Code
NDEP	Nevada Division of Environmental Protection
NDOT	Nevada Department of Transport
NDOW	Nevada Department of Wildlife
NDSL	Nevada Division of State Lands
NO_2	Nitrogen dioxide
NO_3	Nitrate
NPDES	National Pollutant Discharge Elimination System
NPL	National Priority List
NPS	Non-Point Source
NRCS	Natural Resource Conservation Service
NRS	Nevada Revised Statute
NTU	Nephelometric Turbidity Unit

NV	Nevada
O_3	Ozone
OHP	California Office of Historical Preservation
Pb	Lead
PCT	Paiute Cutthroat Trout
PM	Particulate Matter
PO_4	Phosphates
RAM	Removal Action Memorandum
RIB	Rapid Infiltration Basin
RMHQ	Requirements to Maintain Existing or Higher Quality
SAR	Sodium Absorption Ratio
SHPO	Nevada State Historic Preservation Office
SLAMS	State of local air monitoring station
SO_2	Sulfur dioxide
SPM	Special purpose air monitoring station
STPUD	South Tahoe Public Utility District
SWMP	Stormwater Management Plan
SWPPP	Stormwater Pollution Prevention Plan
TCID	Truckee Carson Irrigation District
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
TWT	Tall Whitetop
UNCE	University of Nevada Cooperative Extension
UNR	University of Nevada Reno
USDA	United States Department of Agriculture
USEPA	United Stated Environmental Protection Agency
USFS	United States Forest Service
USFWS	United Stated Fish and Wildlife Service
USGS	United States Geological Survey
WEPD	Washoe Tribe Environmental Protection Department
WNRC&D	Western Nevada Resource Conservation and Development
WT	Washoe Tribe of Nevada and California
WWTF	Waste Water Treatment Facility

2.0 Integrated Watershed Management

A watershed can be defined as an area of land that drains water, sediment, and dissolved materials to a common outlet at some point along a stream channel (Dunne and Leopold 1978). All of the land that the water passes over on its way to this common outlet is part of the watershed. Therefore, a watershed-based management approach must take into account everything that occurs within the watershed. In this regard, soil, vegetation, animals and humans are all integral parts. The primary goal of integrated watershed management is to consider local as well as regional issues and is rooted in an ecosystem approach to watershed management that uses the watershed as a water quality planning unit. This results in a better understanding of problems related to water quality and quantity, aquatic ecosystems, and makes it possible to identify sustainable solutions. Watershed-based management also makes it easier to define action priorities by considering the cumulative impacts on aquatic ecosystems.

Adoption and implementation of a watershed plan requires actions by a variety of partners, including individual counties and municipalities, federal, state and local agencies, and citizen organizations.

2.1 Coordinated Resource Management

From 1992 to 1994, the United States Department of Agriculture (USDA)-Natural Resource Conservation Service (NRCS) and Western Nevada Resource Conservation and Development (WNRC&D) began working with local landowners, conservation districts, and NDEP to develop Coordinated Resource Management Projects (CRMP) for the upper, middle and lower Carson River. The upper Carson River CRMP was formed in 1994. The group received 319(h) Clean Water Act (CWA) funding to begin the planning process. A watershed plan coordinator was retained, a steering committee was formed and a coordinated effort was launched. The committee developed a goal for a watershed management plan and a vision statement. By 1996 the "Upper Carson River Watershed Management Plan" was released. Recommendations from this plan are still being implemented and have been incorporated into this document. The ***Carson Valley Conservation District (CVCD)*** is the responsible entity for the implementation of the upper watershed management plan.

The middle Carson River CRMP was founded in 1994 by landowners along the middle Carson River whose concerns focused on the need to address streambank erosion rates, loss of land, vegetation maintenance, water quality and permitting. In 1996, the group received their first funding from the Carson-Truckee Conservation District and other federal and state agencies which allowed this locally led effort to set the framework for accomplishing work on the ground. On March 16, 1999, the Middle Carson River CRMP became the ***Dayton Valley Conservation District (DVCD)***.

The lower Carson River CRMP was established in 1987 with the ***Lahontan Conservation District (LCD)*** taking the lead. The first projects undertaken on the Lower Carson River were funded by the State Engineer's Clearance, Surveying, and Monumenting of Navigable Rivers Program, WNRC&D, and the Carson-Truckee Water Conservancy District.

2.1.1 Local Stakeholder Groups

Currently there are three locally organized stakeholder, or watershed, groups that were formed to address issues specific to their area of the watershed.

Alpine Watershed Group

The Alpine Watershed Group (AWG) has served Alpine County as a forum for resolving disputes, forming collaborations, and disseminating information between agencies and community members for over five years. AWG is comprised of a diversity of stakeholders with a variety of interests collaborating to address resource management issues throughout the headwaters of Alpine County. The mission of AWG is to preserve and enhance the natural system functions of Alpine County's watershed for future generations. The group works by inspiring participation to collaborate, educate, and proactively implement projects that benefit and steward the county's watersheds.

Clear Creek Watershed Council

In 2001, a group of landowners, concerned citizens, politicians, and natural resource managing agencies that share a common interest and responsibility to address the issues regarding the quality and health of the Clear Creek Watershed came together and formed the Clear Creek Watershed Council (CCWC). The mission of the Council is to protect, conserve, and restore the unique and valuable resource of Clear Creek and it's watershed through collaboration, education, planning, and project implementation. The Council meets every other month to discuss issues that impact the watershed. The group sponsors a clean-up/work day each year and encourages broad public participation in this event.

Lahontan Valley Environmental Alliance

The Lahontan Valley Environmental Alliance (LVEA) and is committed to reaching and maintaining an effective environmental balance through the preservation and protection of the valley's limited water resources. LVEA was created by an interlocal agreement with member organizations including Churchill County, City of Fallon, City of Fernley, Truckee-Carson Irrigation District, and the Lahontan and Stillwater Conservation Districts. Working groups are established as on a needed basis to address specific issues.

2.2 Western Nevada Resource Conservation and Development

Western Nevada Resource Conservation and Development (WNRC&D), located in Carson City, Nevada, is a United States Department of Agriculture (USDA) program that helps local groups plan and implement activities necessary to achieve the development, improvement, conservation, and wise use of the natural and human resources of the area. Member-sponsors include Carson City, Churchill, Douglas, Lyon, Storey, and Washoe Counties; Walker River Irrigation District; Carson Water Subconservancy District; eight conservation districts; Washoe Tribe of Nevada and California (WT), Pyramid Lake Paiute Tribe, Yerington Paiute Tribe, Fallon Paiute-Shoshone Tribe, and the Walker River Paiute Tribe. Current project measures include river restoration utilizing bioengineering techniques, commercial composting, open space protection, carbon seqestration, streambank stabilization, grazing management, monitoring, education/outreach, and floodplain retention. WNRC&D coordinates the Carson River Workdays that have involved over 10,000 community members and over 100 organizations since 1995.

2.3 Carson Water Subconservancy District

The Carson Water Subconservancy District (CWSD) was formed in 1959 to contract with local ranchers and farmers to guarantee pay back to the Bureau of Reclamation for the construction of Watasheamu Dam and Reservoir. In the early 1980's, the Federal Department of the Interior withdrew all support for the continuation of the dam project. In 1985, the Nevada Legislature appointed a special subcommittee to review the need for flood control storage and water supply in the Carson River above Lahontan Reservoir. The subcommittee asked the CWSD to complete a comprehensive water resource plan including the potential for a dam at a new site.

In 1989, the Nevada Legislature passed legislation that recreated the CWSD pursuant to Chapter 541 of the Nevada Revised Statutes (NRS). The legislature gave CWSD the responsibility for management and development of the water resources of the Carson River above Lahontan Dam to alleviate reductions or loss of water supply, to assume responsibility for conservation and supply of water, and protect against threats to the health, safety and welfare of the people of the Carson River Basin. The CWSD was directed by the legislature to accomplish this legislative directive with the cooperation of the involved counties. A nine-member board of directors was established consisting of five members from Douglas County of which two members must represent the agricultural interests of the region, two members from Carson City, and two members from Lyon County.

In 1999, the Nevada Legislature amended the legislation to allow Churchill County to become a member of the CWSD, expanding the board from nine to eleven members, and including the watershed below Lahontan Reservoir. A Joint Powers Agreement between CWSD and Alpine County, California was made and entered into pursuant to the Joint Exercise of Powers Act (California Government Code § 6500 et seq.) and the Interlocal Cooperation Act (Nevada Revised Statutes § 277.080-277.180) in 2001. With the addition of Alpine County the CWSD Board of Directors was expanded to 13 members representing all regions of the watershed. In 2005, the Governor of Nevada appointed the CWSD as the designated 208 Water Quality Planning entity for the Carson River basin.

The CWSD strives to ensure that watershed issues are addressed in a comprehensive and holistic matter. CWSD Board of Directors meetings are held on a monthly basis and are open to the public. Meeting agendas are posted at numerous locations throughout the watershed. Minutes and agendas, plus special events and activities by the CWSD and other watershed organizations are posted on the CWSD website. Steering and technical advisory committees for projects and programs are developed through the CWSD to ensure appropriate stakeholder involvement in decision-making and project implementation.

In 1998, a Carson River Conference was held in Carson City. Stakeholders from throughout the watershed discussed the need for better watershed management. The CWSD was asked to serve as the lead agency for implementing and coordinating an integrated watershed planning effort. The Carson River Coalition (CRC) was formed to serve as the steering committee for this effort.

2.4 Carson River Coalition

The Carson River Coalition (CRC) is a large stakeholder group with representatives from all areas of the watershed from the headwaters to the terminus. Members represent local, state and federal agencies, non-profit groups, environmental groups and interested citizens. The main purpose of the CRC is to form relationships so that problems, threats and issues are addressed on a regional level in a spirit of communication and cooperation. The group is a critical element of the integrated watershed planning process. The CWSD provides coordination and facilitation for the CRC through the watershed coordinator position.

CRC meetings are held on a regular basis and are open to the public. These meetings provide a format for the exchange of information regarding projects and programs so that stakeholders are provided the opportunity to view the bigger picture and how their particular project can benefit the whole.

Working groups within the CRC have been established to address specific problems and projects. Meetings are held on a monthly basis. These groups include the following:

Water Resource Development, Supply, Conservation and Reuse
Interaction/Cooperation with Local, State, Tribal and Federal Agencies
Education and Outreach
Water Quality
Natural Resource Conservation
River Corridor and Floodplain Management (formerly the Land Use Planning and Management group)

A vision statement and set of guiding principles has been developed by the CRC and were adopted by all five counties within the watershed along with approximately 20 other agencies and organizations. These principles, as provided in Table 2.6-1, outline the broad goals for the watershed and provide the framework for this stewardship plan. These guiding principles can also be considered “Rules to Live By” and provide a roadmap for long-term stewardship for the watershed.

2.5 Vision Statement

To achieve healthy sustainable watersheds within the entire Carson River Basin; to achieve improved watershed conditions, so all lands and waterways safely receive, store, and release clean water for the good of all peoples, environments, and natural resources of the Carson River Basin; to achieve this vision by 2010, through community led and agency supported implementation of local and basin wide plans and projects.

2.6 Guiding Principles

Table 2.6-1: Carson River Watershed Guiding Principles

Main Theme	Guiding Principle	Why is Principle Included?	How Might it be Implemented?
Property rights, overall quality of life	**1. Manage the water resources for economic sustainability, quality of life, and protection of private and public property rights.**	Program will respect basic property rights.	Water projects & programs implemented within the confines of the Alpine Decree
Work with the river's natural processes not against them.	**2. Acknowledge and respect the watershed's natural processes in land use decisions.**	Must look at solutions over the long term, not on a short-term basis.	Encourage preservation of open space in floodplain, possibly through easement dedication or acquistion.
Water Quality	**3. Maintain or improve the quality of the water to support a variety of beneficial uses.**	Water Quality protection is critical to all uses on the river.	Implement erosion control programs to reduce sediment and chemical load to the river.
Alpine County portions of the watershed	**4. Protect the headwaters region as the system's principal water source.**	The lands in Alpine County that drain into the river supply over 80% of the total water.	In conjunction with Alpine County, work with federal agencies to ensure that land use plans protect land's water holding/snow storage capability.
Inclusion of all stakeholders in plan	**5. Recognize and respect that interests of all stakeholders upstream and downstream by fostering collaborative and mutually respectful relationships.**	With implementation of watershed planning, we must consider concerns of all stakeholders.	Work to include all stakeholders in the process; hold open forum meetings; ask for input
Floodplain Protection	**6. Maintain the riverine and alluvial fan floodplains of the Carson River Watershed to accommodate flood events.**	Floodplains are critical to the river's normal functions, including flood protection and recharge.	Work with local planners to reduce development burden within the river and alluvial fan floodplains.
Integrated land management	**7. Protect and manage uplands, mountain ranges, wetlands, and riparian areas to enhance the quality of surface flow, groundwater recharge, and wildlife habitat.**	Lands surrounding the river perform important functions for the long-term health of the watershed.	Work with major landholders (federal agencies) and resource agencies to promote the quality of natural areas.
Water Conservation	**8. Promote conservation of water from all sectors of the community's water users for the benefit of municipal, industrial, agricultural, domestic, recreational, and natural resources.**	We need to be aware of how water can be conserved.	Develop water conservation programs that raise awareness about water consumption.
Open Space Preservation; growth management	**9. Encourage management of growth that considers water quality and quantity; open space preservation, and maintenance of agriculture in floodplains.**	Growth and development have the single largest impact on the watershed. Must be planned for carefully.	Bring local planners into process.
Recreation access opportunities	**10. Protect and support opportunities for public recreational access to natural areas throughout the watershed, including the river corridor, where appropriate.**	People need opportunities to enjoy the resources within the watershed.	Work with local agencies and landowners to develop recreational access through voluntary programs.
Education and public information	**11. Promote understanding and awareness of watershed resources and issues through cooperative education efforts throughout the watershed.**	The more people understand, the more they have the ability to appreciate and act responsibility.	Promote existing educational programs & develop new ones to reach all portions of the watershed.

2.7 Cooperating Entities

Numerous stakeholders provide continued sponsorship, funding, technical assistance and volunteer time for stewardship of the watershed and were instrumental in the development of the guiding principles upon which this management plan is based and will be maintained. Appendix A provides information on entities with interest in the Carson River Watershed.

There are individuals and organizations that participated in the establishment of the CRC in 1998 and remain active to this date in the CRC and associated working groups. ***Special thanks and recognition*** are extended to the following in alphabetical order:

John Cobourn, University of Nevada Cooperative Extension (UNCE)
Linda Conlin, River Wranglers
Jacques Etchegoyhen, Terra Firma Associates LLC
Dan Jacquet, U.S. Bureau of Land Management (BLM)
Edwin James, CWSD
Dan Kaffer, Western Nevada RC&D, NRCS
Steve Lewis, UNCE
Bob Milz, CWSD, Lyon County Commissioner, WNRC&D
Icyl Mulligan, NDEP
Randy Pahl, NDEP
Brian Peters, Alpine County Planning
Kevin Piper, University of Reno
Paul Pugsley, CVCD
Mary Kay Riedl, NDEP
JoAnne Skelly, UNCE
Jeanmarie Stone, NDEP
Sherman Swanson, University of Nevada Reno (UNR)
John Warpeha, Washoe Tribe of Nevada and California
Robin Williamson, CWSD, Carson City Board of Supervisors
Stephanie Wilson, U.S. Environmental Protection Agency (USEPA)

3.0 Overview of the Carson River Watershed

The watershed is the land in Nevada and California that captures, stores and releases rain and snowmelt to the Carson River. The watershed covers an approximate area of 3,965 square miles and includes portions of six counties and two states (Figure 3.0-1). These are Alpine County, California and Douglas, Lyon, Storey, Carson City and Churchill Counties in Nevada (Figure 3.0). A small unpopulated portion of Pershing County is also located within the watershed, however this area does not have any direct tributaries to the Carson River and is therefore, not typically included for planning purposes.

Approximately 606 square miles of the watershed is located in Alpine County, California. This portion of the upper watershed is delineated into four sub-watersheds as follows (MACTEC 2004):

1. Wolf Creek
2. East Fork Carson River
3. Markleeville Creek
4. West Fork Carson River

West Fork Carson River in Hope Valley
Alpine County, California.
Photo: G. Azad

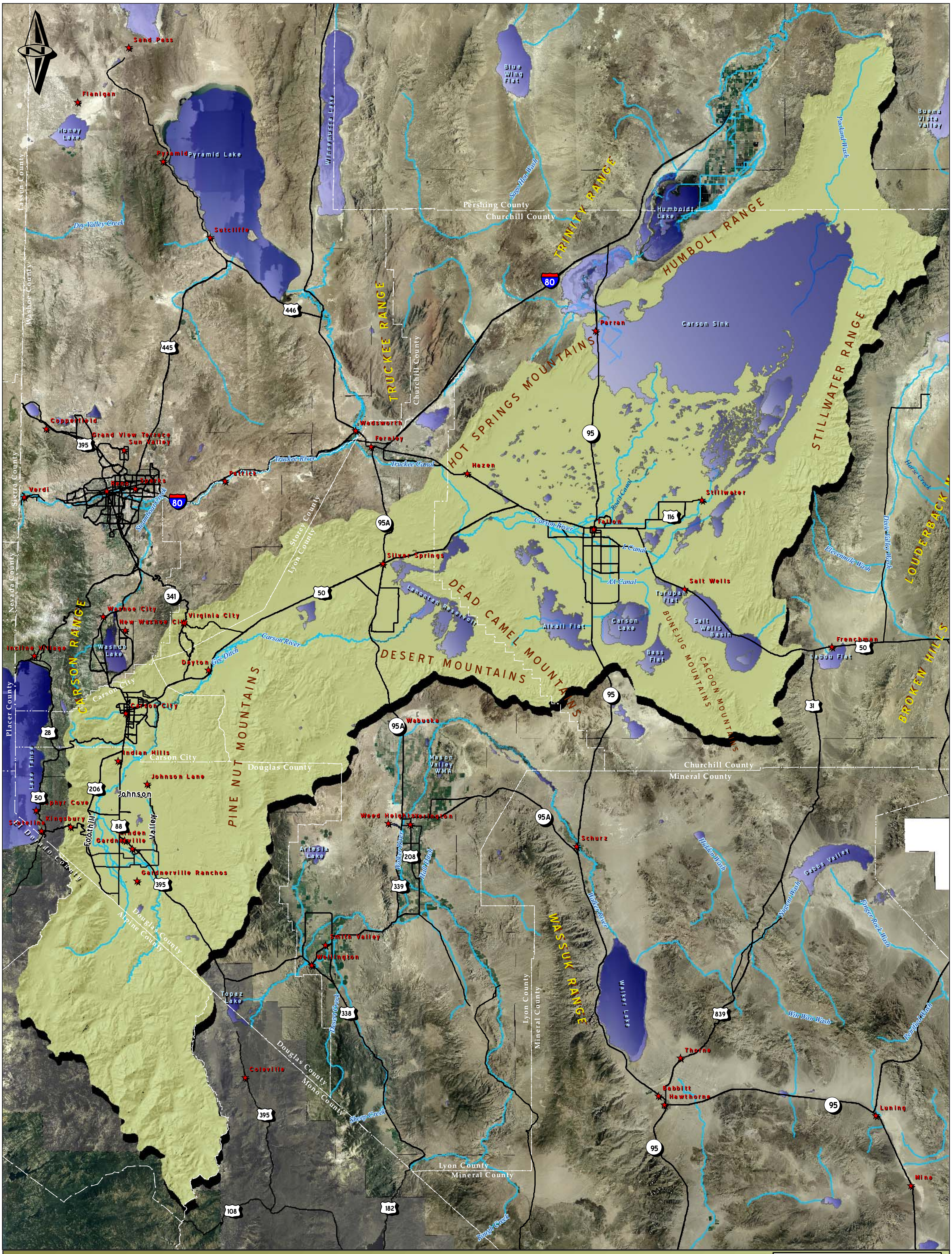
Major valleys within these sub-watersheds include the following: Charity Valley, Pleasant Valley, Hope Valley, Diamond Valley, Wolf Creek Meadow, and Faith Valley.

Approximately 3,359 square miles of the watershed is located in Nevada. There are five hydrographic areas in the Nevada portion of the watershed as shown in Table 3.0-1.

Table 3.0-1: Hydrographic Areas in the Carson River Watershed

Nevada Hydrographic Area [Nearest Cities]	**COUNTY (IES)**	**Surface Area (ACRES)**	**Surface Area (SQ. MI.)**
Carson Valley [Minden, Gardnerville, Genoa]	Carson City Douglas	268,160	419
Eagle Valley [Carson City]	Carson City Douglas	44,160	69
Dayton Valley [Dayton, Virginia City]	Carson City Douglas, Lyon, Storey	236,160	369
Churchill Valley [Fallon]	Douglas, Lyon, Pershing, Storey	307,200	480
Carson Desert [Fallon, Stillwater]	Churchill, Lyon, Pershing	1,294,080	2,022
Carson River Basin (in Nevada)		**2,149,760**	**3,359**
Carson River Basin (in California)	**Alpine, CA**	**387,840**	**606**
Total Carson River Basin		**2,537,600**	**3,965**

Sources: Horton 1997, MACTEC 2004



Carson River Watershed

Figure 3.0-1

3.1 Carson River System

The Carson River, the main perennial stream in the watershed, rises in the Sierra Nevada and is fed by waters from melting snow and springs. The river makes a journey of approximately 184 miles from its headwaters on the East Fork to the end point in the Carson Sink. Like other rivers located within the Great Basin Watershed region the waters of the Carson River do not reach an ocean. Instead the Carson River flows northeast from the Sierra Nevada out onto the floor of the Great Basin, where the water evaporates from farmlands and wetlands.

The Carson River begins as two separate tributaries, the East and West Forks Carson River, in Alpine County, California. The East Fork originates south of Ebbetts Pass, California in part of the Carson-Iceberg Wilderness (Wolf Creek and Silver King area) at an elevation of 11,460 feet. The West Fork begins near Lost Lakes at about 9,000 feet in elevation.

Tributaries to the East and West Forks of the Carson River in California include the following:

View from Carson-Iceberg Wilderness Area, headwaters for the East Fork Carson River.
Photo: P. Druschke

East Fork Drainage

- Bryant Creek
- Indian Creek
- Mountaineer Creek
- Leviathan Creek
- Markleeville Creek
- Pleasant Valley Creek
- Hot Springs Creek
- Murray Canyon Creek
- Silver Creek
- Wolf Creek
- Silver King Creek and Tributaries
- Poison Flat Creek

West Fork Drainage

- Horsethief Canyon Creek
- Willow Creek
- Red Lake Creek
- Forestdale Creek

Spillway at Lower Lost Lakes, headwaters for the West Fork Carson River.
Photo: G. Azad

The East and West Forks flow separately into Nevada. Approximately three miles north of the California-Nevada State line the West Fork Carson River becomes the Brockliss Slough.

The Brockliss Slough then becomes the principal watercourse on the west side of Carson Valley. From this point the West Fork Carson

River is referred to as the West Fork Ditch. The West Fork Ditch carries waters from the Brockliss, Rocky Slough, Home Slough and other ditches that originate from the East Fork and flow to the west. The main stem of the Carson River begins at the confluence of the West and East Forks about a mile southeast of Genoa, Nevada. It continues another 11 miles where it reaches the New Empire Bridge at Deer Run Road, which marks the end of the upper Carson River. The middle Carson River then continues through Lyon County to the Lahontan Dam in Churchill County. The lower Carson River is described as the area downstream of Lahontan Dam. Most of this area is below 4,000 feet in elevation. The Carson River enters the area through Lahontan Reservoir and then is distributed throughout Lahontan Valley through a series of irrigation channels.

Nevada defines the Carson River as three separate hydrologic code units (HUC) as follows:

HUC#	Catalog Name
16050201	Upper Carson
16050202	Middle Carson
16050203	Lower Carson

The only tributary to the Carson River in Nevada is Clear Creek, which joins the main Carson River just south of Carson City. Springs and snowfall feed it and impacts to it have been historically logging, agricultural, grazing and roadways. As Carson City has grown, the agricultural and grazing pressures on Clear Creek have diminished and its present impacts are from nearby industrial growth and land development. The Clear Creek watershed encompasses approximately 50% residential, 20% commercial, 20% undeveloped woodland and 10% undeveloped lowlands. Water rights to Clear Creek are governed by the Clear Creek Decree, which was initiated in the late part of the 19th century.

3.1.1 Reservoirs and Lakes

Entrance to BLM Campground at Indian Creek Reservoir.
Photo: S. Hill

Numerous small alpine reservoirs and lakes are located within the upper watershed in Alpine County (Table 3.1.1-1). These reservoirs were originally constructed to serve agricultural needs, or were originally small lakes whose capacity was increased by dam construction. Two upper watershed reservoirs, Indian Creek and Harvey Place Reservoirs, were constructed specifically for storage of treated wastewater from the Lake Tahoe Basin. Indian Creek Reservoir is now a very popular fishing and camping area.

The BLM campground at Indian Creek Reservoir is one of the busiest BLM campgrounds in the area.

Table 3.1.1-1: Reservoirs and Lakes in Alpine County

Name	Elevation	Capacity (acre-feet)	Source
EAST FORK DRAINAGE			
Upper Kinney Lake	8,536	328	Silver Creek
Lower Kinney Lake	8,442	920	Silver Creek
Kinney Reservoir	8,333	900	Silver Creek
Wet Meadows	8,030	450	Pleasant Valley Creek
Summit Lake	8,022	31	Pleasant Valley Creek
Raymond Lake	8,980	50	Pleasant Valley Creek
Tamarack Lake	7,890	404	Pleasant Valley Creek
Upper Sunset	7,858	68	Pleasant Valley Creek
Lower Sunset	7,823	860	Pleasant Valley Creek
Heenan Lake	7,084	2,948	Heenan Lake Creek
Indian Creek Reservoir	5,604	3,100	Indian Creek
WEST FORK DRAINAGE			
Upper or East Lost Lake	8,598	92	Headwater of West Fork
Lower or West Lost Lake	8,546	127	Headwater of West Fork
Crater Lake	8,522	320	Crater Lake Creek
Scotts Lake	8,001	736	Scott Creek
Red Lake	7,867	1,103	Red Lake Creek
Total Capacity		**2,378**	

Source: Glancy and Katzer (1975)

The ***Lahontan Dam*** forms the only large reservoir on the entire Carson River, a facility of the ***Newlands Irrigation Project***, which was completed by the Bureau of Reclamation (BOR) in 1914. The dam forms Lahontan Reservoir, which is 23 miles long and covers 100,000 acres. Truckee River water is diverted from Derby Dam near Fernley, Nevada and enters Lahontan Reservoir and the Newlands Irrigation Project through the Truckee Canal. Derby Dam and the Truckee Canal have been in operation since 1905 (LCD 1999). Water from the Newlands Project is used to irrigate more than 60,000 agricultural acres. In 1926 the Truckee-Carson Irrigation District (TCID) contracted with BOR to assume responsibility of the project. There are approximately 380 miles of canals and 34 miles of drains within the Newlands Project. Most of these, if not all, were constructed prior to the 1930's. Easements for the canals and drains are drawn by BOR and can be identified and reviewed by interested parties at the TCID office.

Left: Lahontan Reservoir & Dam with Truckee Canal in forefront. (Photo: G. Azad)
Right: Derby Dam on the Truckee River (Photo: P. Rissler)

3.2 Geology

The watershed is characterized by partly filled alluvial valleys ranging in elevation from 3,000 to 7,000 feet above mean sea level (amsl) (B&C 2005). Mountains ranging in elevation from 6,000 to 11,000 amsl surround the valleys. The ranges include: Sierra Nevada, Pine Nut Mountains, Carson Range, Virginia Range, Dead Camel Mountains, Desert Mountains, Hot Springs Mountains, East Humboldt Range, Desert Mountains, and Stillwater Range

The upper part of the watershed in Alpine County, California was shaped by Pleistocene glaciation (CVCD 1996). An ancient fault line in the Sierra Nevada Mountains was expanded and filled by glaciers and glacial melt, forming Lake Tahoe and the Carson Range 1,800,000 – 500,000 years ago (Horton 1997). Only a few glacial moraines exist and none are very extensive. Moraines (accumulation of boulders or stones, deposited by a glacier) are located near Grover Hot Springs and Silver Mountain City.

Cenozoic (the most recent era of geologic time) faults are predominant in the upper watershed area (CVCD 1996) and metamorphic rocks are widely distributed. Fossil evidence indicates that metamorphic rocks are predominately Late Triassic and Early Jurassic (230 to 187 million years old) in age. Siltstone, shale, sandstone, and greywacke are common and contain volcanic materials. Limestone and gypsum are also common. The economic minerals most commonly found in the metamorphic rock are tungsten, gold and silver.

The Sierra Nevada is composed mainly of intrusive granitic rocks that likely form the bedrock beneath Carson and Eagle Valleys (USGS 2004). Granitic rock outcrops are most abundant in the Carson Range. In the Pine Nuts, granitic rocks are continuous with those of the Carson Range. Flow breccia and lava flows are also common as are dikes and small volcanic intrusions throughout the upper watershed. Sedimentary rocks of Tertiary age occur interbedded with volcanic rocks. Vertebrate, invertebrate, and plant fossils found in the strata indicate that most of them are Miocene and Pliocene in age (23.7 to 1.9 million years old).

Older alluvium, mainly gravel, is present throughout the watershed. The materials include sediments deposited during a broad span of late Tertiary and Quaternary time. Some of this older alluvium was deposited by an ancestral Carson River as floodplain deposits. The river gravels are more than 50 feet thick and contain well-rounded cobbles up to six inches in diameter.

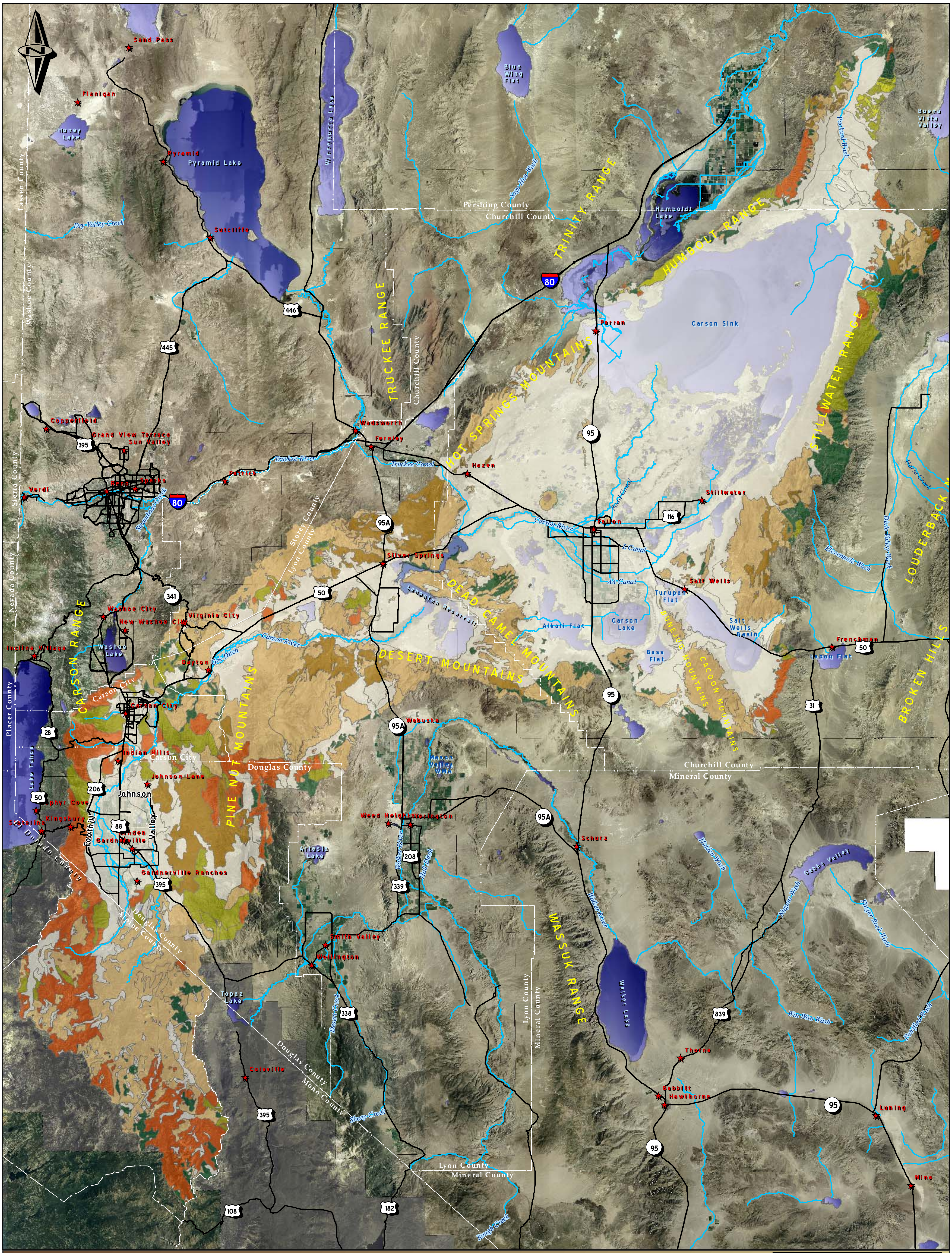
The geology of the lower watershed is described as the following (LCD 1999):

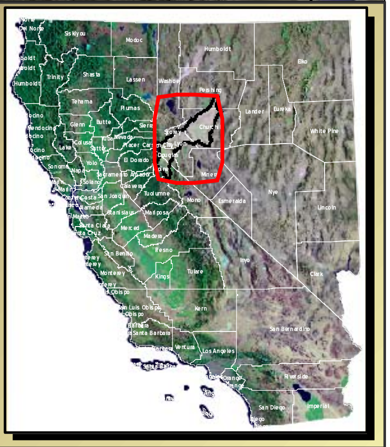
> *"The lowlands of the lower Carson River Watershed in Churchill County were periodically inundated by fluctuating deepwater lake during the Pleistocene. The valley consists of great thicknesses of lake-laid materials interwedged with river alluvium and material deposited by the wind. The lowlands away from the floodplain of the Carson River consist of irregularly shaped sandhills, sand plains, and clay flats. In addition to the flood plains and sand dunes prominent landforms on the lowlands are wave-built terraces, bars, embankments, and other shoreline deposits. Landforms shaped by the Pleistocene lakes are in evidence everywhere. Throughout the area, below the high water level of the*

Pleistocene lakes, a material identified as tufa can be found. Tufa is composed of calcium carbonate, and is found in many different forms, originates in the Sierra Nevada, was washed from solid derived from mixed rock sources, but it has a strong granitic influence. Local alluvium washed from soils in the uplands bordering the area is derived mostly from volcanic rocks."

A relatively large number of thermal springs are present within the watershed. Hot spring terrace deposits are present in several locations indicating the sites of old extinct mineral springs (CVCD 1996).

A map of the generalized geology of the Carson River Basin upstream from Lahontan Reservoir is provided in Figure 3.2-1.





Generalized Geology of the Carson River Watershed

Figure 3.2-1

3.3 Climate

The climate of the upper watershed is characterized by long, very cold winters and short, moderate to warm summers. The climate of the middle and lower watersheds are described as semi-arid to arid. Due to the rain shadow effect of the mountains, precipitation is higher in the western part of the watershed.

Areas in the Sierra Nevada above 9,000 feet typically receive more than 40 inches of precipitation per year, usually as snowfall. The average annual precipitation at elevations of 4,500 to 9,000 feet is about eight to twenty inches. In lower elevations of less than 4,500 feet the average annual precipitation is four to eight inches.

Temperatures vary depending on elevation and season. In the Alpine County portion of the watershed the average annual temperature ranges from 45ºF in valley regions to 33ºF in the mountain ranges. Average winter temperature in the upper watershed is 33ºF with an average minimum temperature of 19ºF. Summer temperatures in the upper watershed are on average 66ºF with an average maximum of 87ºF. (CVCD 1996)

Compiled climate data (B&C 2005) show an annual average maximum temperature for Minden, Carson City, Lahontan Valley and Fallon areas ranging from 68.2ºF at the Lahontan weather station to 66.3ºF at the Carson City station. The average minimum temperature ranges from 41.4ºF at the Lahonton station to 31.4ºF at the Minden station.

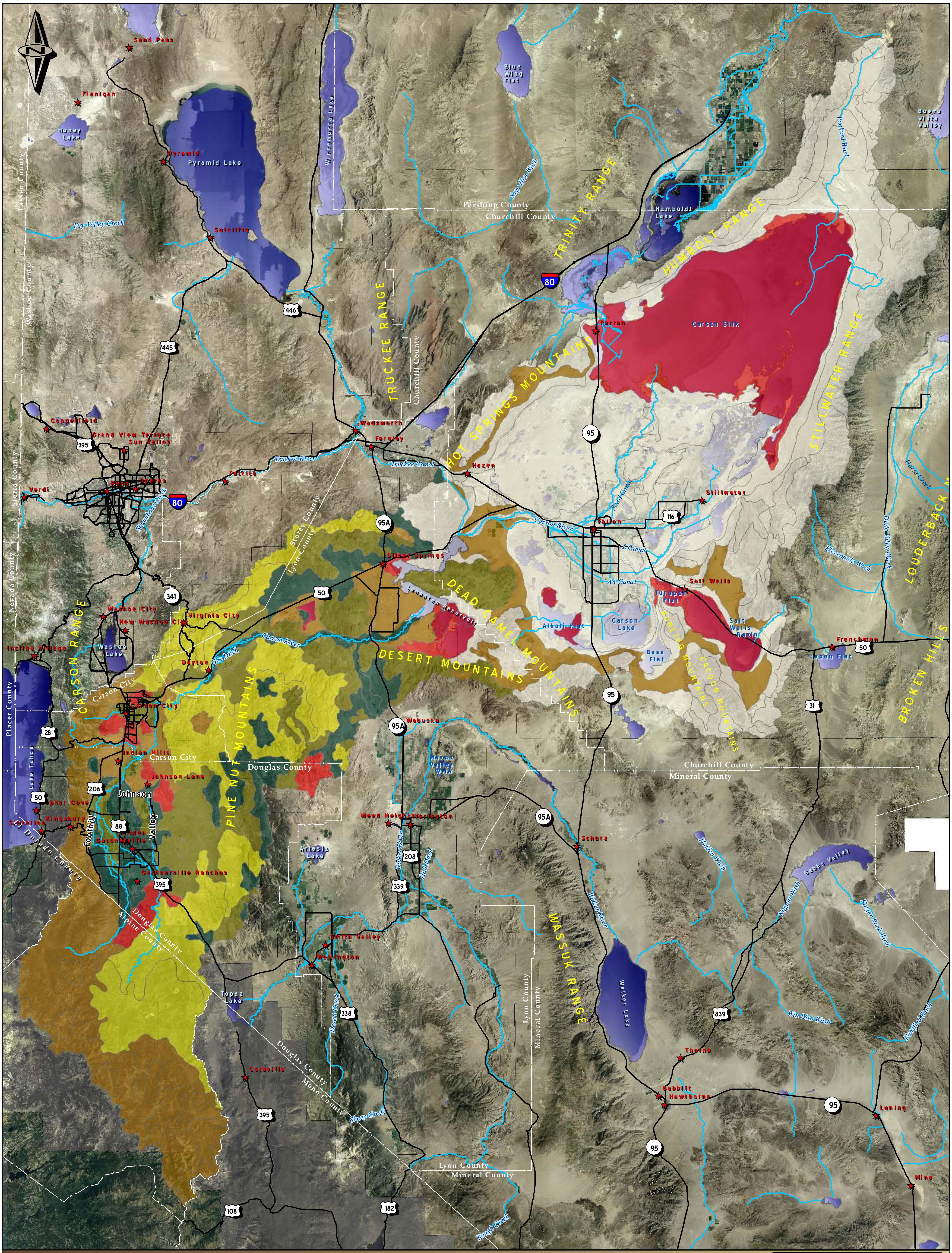
3.4 Soils

Soils in the upper watershed consist of four major soil categories based on landscape locations, according to the USDA-NRCS Soil Surveys.

1. Areas dominated by soils on floodplains and low stream terraces.
2. Areas dominated by well-drained soils on alluvial fans and terraces.
3. Areas dominated by well drained soils on foothills and high terraces
4. Areas dominated by well drained soils on mountains and uplands

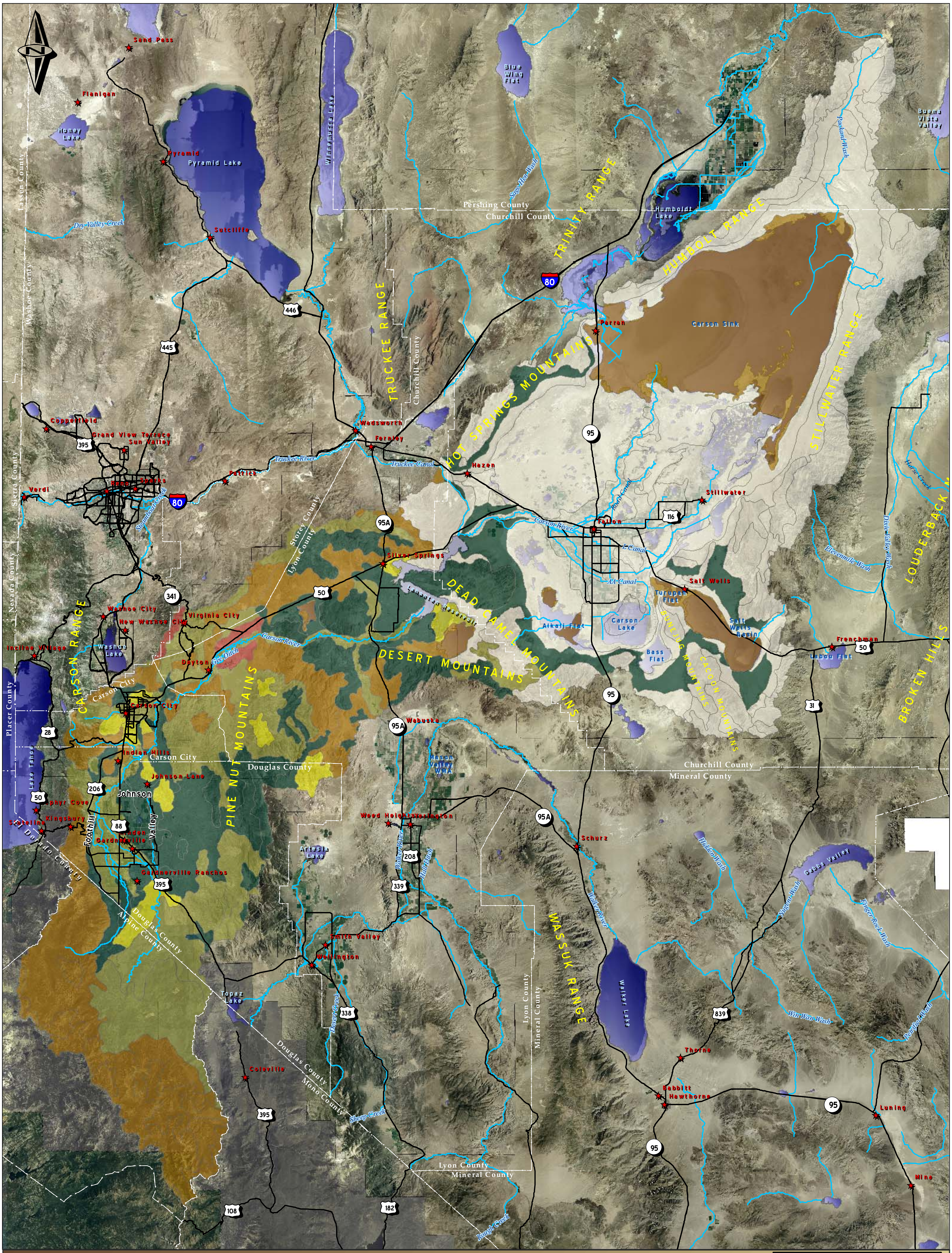
Most of the soils in the lower watershed (approximately 47%) are included in a group called "Nearly Level Soils on Flood Plains and Low Lake Terraces." This soil is characterized as excessively drained to poorly drained and have a coarse-textured to fine-textured surface layer. They are formed in alluvium weathered from mixed basic rocks and are found on flood plains, low stream terraces, and low lake terraces, and in basins.

Figures 3.4-1 and 3.4-2 show soils of the Carson River Basin upstream from Lahontan Reservoir with (a) clay content and (b) erodibility (USGS 2004).



Soils of the Carson River Basin with Clay Content

Figure 3.4-1



Soil Erodibility factor for Universal Soil Loss Equation

Soil Erodibility

- 0
- 0 to 0.20
- 0.21 to 0.25
- 0.26 to 0.30
- 0.31 to 0.35
- 0.36 to 0.42

Soils of the Carson River Basin with Erodibility

Figure 3.4-2

3.5 Habitat and Vegetation

Habitats range from dry, salt desert scrublands to lush mountain meadows, forests and aspen groves. In the high mountain areas habitats such as quaking aspen groves, meadows of grass and flowering plants, big sagebrush, antelope bitterbrush, needle grass and bluegrass species are found. The forest habitats support vegetation types such as ponderosa, Jeffery, lodge pole, and sugar pine, incense cedar, and white and red fir. Streamside species include black cottonwood, aspen, alder, and willows. Pinyon/juniper woodlands are found in foothill areas and in mountainous areas in shallow, rocky soils.

Habitats in the lower watershed are composed of those species that survive very dry, salty soils. These species include black greasewood, shadscale, fourwing saltbush, and squirreltail. In areas east of Dayton, Nevada salt marshes can be found. These marshes sustain cattails, bulrush, numerous sedges and saltgrass.

Existing vegetation from the California/Nevada Stateline to Lahontan Reservoir was most recently documented in the Draft Middle Carson River Geomorphic and Biological Assessment (Otis Bay 2005). This study states that the vegetation community distribution and species composition from Stateline to Lahontan Reservoir has changed significantly from historic conditions due to the conversion of native riparian forest and shrublands, wet meadow and emergent marsh wetland vegetation, and floodplain terraces to agricultural lands, urban and industrial developments.

3.5.1 Wetlands

The watershed contains a system of important natural and man induced wetlands. Wetlands are areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year. Obligate and facultative wetland plants can be present in a wetland area. Wetland plant communities are highly valued by tribal communities for their medicinal and ceremonial benefits as well as for the protection of water resources. Wetlands in Nevada are disappearing as a result of the challenges such as growing human population and water rights issues.

Numerous natural hot spring wetlands are found throughout the watershed including Walleys Hot Springs near the town of Genoa. These smaller wetland areas provide groundwater recharge, natural flood protection and control, sediment trapping and water pollution filtering, plus habitat for many aquatic and terrestrial species and plant communities. Historically, a series of oxbow wetlands, which are critical for wildlife such as waterfowl and amphibians, were found along the river but have disappeared in recent history. Palustrine emergent wetlands (which includes floodplains) and riparian cottonwood forests used to be extensive in the Carson Valley. These wetlands have been associated with agricultural water conveyance systems for over a century in the Carson Valley. Agricultural lands have been shown to have hydric soil and support wetland and wetland-oriented vegetation.

One of the most well-known wetland areas is the Stillwater National Wildlife Refuge, located at the terminus of the Carson River in the Lahontan Valley. Stillwater has been designated by the Western Hemispheric Shorebird Reserve Network as a site of international importance due to the hundreds of thousands of shorebirds that pass through the area during migration.

The refuge is also listed by the American Bird Conservancy as a globally important bird area. More than 280 species have been sighted. More than a quarter million waterfowl, and over 20,000 other water birds, including the American White Pelican, are attracted to the refuge area each year. Stillwater is a part of the U.S. Fish and Wildlife Service (USFWS) America's National Wildlife Refuge System.

The Nevada Natural Heritage program is in the process of developing a priority conservation plan for Nevada's wetlands. Workshops were held in 2006 to gather technical information on priority wetland areas. The areas will be systematically scored and ranked with a general conservation approach identified. The results will be part of the Nevada Wetlands Priority Conservation Plan.

3.6 Fish and Wildlife

The diversity of environments within the watershed provides habitats for numerous fish and wildlife species. The land use and land cover of the habitat mostly determines species type and population numbers. The Upper Carson River is best known for its trout, including rainbow, brook and browns. Many species, such as the mule deer and coyote, are wide spread while other species such as the mountain lion, pronghorn and peregrine falcon, are declining in numbers. The U.S. Forest Service (USFS) and the Nevada Department of Wildlife (NDOW) work cooperatively to introduce and augment fish and wildlife species. Some of the common species found in the watershed are shown in Table 3.6-1

Table 3.6-1: Common Fish and Wildlife Species

Fish
Golden, Rainbow, Brown, and Brook trout

Rodents
Yellow-bellied Marmot
Kangaroo Rat
Deer Mouse
Meadow Vole
Flying and Antelope Squirrel
Beaver

Lagomorphs
Pika (small rabbit)
Cottontail Rabbit
Black-tailed Jackrabbit

Avian Species
Redtail, Roughleg, Cooper's, Ferruginous, Northern Harrier, and Sharpshinned Hawk
Saw-whet, Borrowing, Great Horned & Spotted Owl
Bald and Golden Eagle
Goshawk
American Kestrel
Merlin
Peregrine and Prairie Falcon

Big Game Species
Desert Bighorn Sheep
Mule Deer
Pronghorn Antelope

Predators
Mountain Lion
Bobcat
Red and Kit Fox
Badger
Mink
Black bear
Coyote

Reptiles
Western Diamondback Rattlesnake
King Gartersnake
Gopher Snake
Rubber Boa Snake
Horned, Sagebrush and Fence Lizard

Source: CRC 2003

3.6.1 Special Status Wildlife Species

During a 2004 bird survey seven species were found that are considered by Partners-in-Flight and/or NDOW as conservation concerns (Otis Bay 2004), these include American White Pelican, Bank Swallow, Blue Grosbeak, MacGillivray's Warble, Western Bluebird, White-faced Ibis, and White-throated Swift:

Carson-Iceberg wilderness is a diverse and wide-ranging expanse that may contain habitat for many at-risk species. Species that may reside in the region include spotted owl, pine marten, pacific fisher, leopard frog, and yellow-legged frog. Northern leopard frogs were confirmed during a 2004 survey (Otis Bay 2004) on private property in Genoa and on the River Fork Ranch. There are also unconfirmed reports of relic populations in the Stillwater area.

The Nevada Natural Heritage Program provides information on plants and animals that are considered at-risk, and that are on the Nevada Plant and Animal Watch List. This information can be found at http://heritage.nv.gov/index.htm.

3.6.1.1 Sage Grouse

The sage grouse (*Centrocercus urophasianus)* is a native of the watershed with its natural habitat in the sagebrush steppe. Sage grouse is considered a species of concern, but has not been selected for federal listing. "The Greater Sage-Grouse Conservation Plan for Nevada and Eastern California," dated June 30, 2004 was developed by NDOW. The goal of the plan is to protect and conserve the sage grouse populations. Management recommendations include restoring degraded habitat and reducing habitat fragmentation. The plan can be found at http://www.ndow.org/wild/conservation/sg/plan/SGPlan063004.pdf.

3.6.2 Beaver: Native or Introduced?

The origin and true nature of beaver on the Carson River is an ongoing debate that will not be put to rest until proof positive of pre-European beaver remains or old dams are identified.

The Washoe Indian Tribal language did not have a name for beaver, and no beaver remains have been found in archeological excavations on the watershed. The journals of John C. Freemont, numerous trappers, and pioneer families indicate no beaver were present when Europeans came to the watershed. By examination of all historic and Washoe Tribal language records, beaver were apparently not a native species to the watershed. This same conclusion seems to be accepted for the Truckee and Walker River Watersheds.

The watershed of the neighboring Humboldt and American Rivers had native beaver populations. The Ogden Trapping Party removed 5,000 beaver in two years from the Humboldt River Drainage in the 1850's (Currans 2006). The Humboldt and Carson Watersheds both drain into a common area know as the Carson Sink on very high-prolonged runoff years. Why these somewhat gregarious rodents would not be present on the Carson is a mystery.

Records do show that in the 1920's – 1950's, the USFS and the NDOW introduced beaver to the Carson River. The animals were live trapped from Idaho and California and released to stop erosion, build ponds for livestock water on the Carson River and tributaries. Without predators or a market for beaver fur, the beaver populations continue to expand (Currans 2006).

Beavers can cut down and eat thousands of trees a year. (Photo: G. Azad)

Beaver are large rodents attaining weights of over 70 pounds. A single pair of beaver will have 6-12 young (kits) per litter. In drought years, two litters per year are not uncommon. Beaver are herbivores, living on a diet of trees and shrubs. Thousands of Fremont and Black Cottonwood trees up to 4' in diameter are cut down and eaten each year by beaver. Beaver also east Quaking Aspen, willows, and other softwoods growing along the Carson River and tributaries.

Beaver build dams on waterways and irrigation systems that can interfere with agriculturalist receiving water. The beaver burrow into the riverbanks and build subterranean lodges. These lodges and tunnels create weak spots in riverbanks that often pipe water in high flows, causing bank collapse and erosion.

Beaver can have a very positive effect on watershed. Their dams trap sediment, which improves water quality, creates wetlands, wildlife habitat, and encourages groundwater recharge. Abandoned dams often break, sending sediment and organic matter downstream into already nutrient rich waters. The need to keep populations from destroying riparian forests and river restoration project vegetation is an ongoing problem.

3.6.4 Fish Populations

Carson River fisheries have been reported as extremely abundant, according to newspaper articles and other historical documents, until the late 1800's. A rapid decline of the abundance and diversity of fish species began during the Comstock Mining Era. Impacts from the mills and the massive log drive greatly impacted the water quality and habitat conditions. Native species experienced additional pressures that resulted in declining numbers from the introduction of exotic species that were able to out-compete the native species. In more recent history, channel modifications, bank erosion, and decrease in riparian vegetation are among factors that continue to challenge native and non-native species. The unavailability of proper habitat in many reaches makes successful propagation and population maintenance extremely difficult. According to both the NDOW and the California Department of Fish and Game (CAF&G) fewer trout are present in the Carson River than other large rivers in the region. Poor environmental conditions are suspected to be the major contributing factor. In addition to high suspended sediment, water temperatures can reach into the high 70's and low 80's (°F) in the main stem, lowering the dissolved oxygen, and creating conditions that are lethal to trout. Currently, the predominate management strategy employed by NDOW and CAF&G is to maintain a put and take fishery.

The NDOW and the CAF&G have conducted population surveys for fish species during the period of 1983 to 2002. Species that have been identified in the Carson River include the following:

Native to the Lahontan Basin:

Lahontan cutthroat trout (*Oncorhynchus clarki henshawi)*
Paiute cutthroat trout (*Oncorhynchus clarki seleniris)*
Mountain whitefish (*Prosopium williamsoni)*
Paiute sculpin (*Cottus beldingi)*
Mountain sucker (*Catostomus platyrhynchus)*
Tahoe sucker (*Catostoomus tahoensis)*
Lahontan redside shiner (*Richardsonius egregious)*
Speckled dace (*Rhinichthys osculus)*

Non-Native Introduced Species

Rainbow trout (*Oncorhynchus mykiss)*
Golden trout (*Oncorhynchus aguabonita)*
Brown trout ((*Salmo trutta)*
Brook trout (*Salvelinus fontinalis)*
White bass (*Morone chrysops)*
Largemouth bass (*Micropterus salmoides)*
Smallmouth bass (*Micropterus dolomieui*)
Channel catfish (*Ictalurus punctatus*)
Black bullhead (*Ictalurus melas*)

Other Non-Indigenous Fish:

Mosquito fish (*Gambusia affinis*)
Green sunfish (*Leponis cyanellus*)
Carp (*Cyprinus carpio)*

3.6.2.1 Lahontan Cutthroat Trout

Lahontan Cutthroat Trout (LCT) is a subspecies of the wide-ranging cutthroat trout species (*O. clarki)* that includes at least 14 recognized forms in the western United States (USFWS 2005) and has the most extensive range of any inland trout species of western North America. Basins where cutthroat trout are found typically contain remnants of more extensive bodies of water that were present during the wetter period of the late Pleistocene epoch (Smith 1978), such as the ancient Lake Lahontan. USFWS (2005) describes these fish as unusually tolerant of both high temperatures (>27 C) and large daily fluctuations (up to 20 C). They are also tolerant of high alkalinity (>3,000 mg/l) and dissolved solids (>10,000 mg/l). However, they are seem to be intolerant of competition or predation by non-native salmonids, and rarely exist with them.

LCT was listed by the USFWS as endangered in 1970 and was reclassified as threatened in 1975 to facilitate management and to allow regulated angling. There is no designated critical habitat and the species has been introduced into habitats outside its native range, primarily for recreation fishing purposes (USFWS 1995). According to the USFWS Recovery Plan (1995) historic distributions of LCT in the Carson River basin included most of the drainage downstream from Carson Falls on the East Fork and Faith Valley on the West Fork. Gerstung (1986) estimated that at least 300 miles of cold water stream habitat was used by LCT but currently no self-sustaining LCT populations occupy the historic range.

As late as 1911, LCT was numerous in both forks and tributaries in California (CAF&G 2004a). By 1930 they were virtually gone from native habitats and displaced by introduced salmonids. USFWS (1995) states major impacts to LCT habitat and abundance include: 1) reduction and alteration of stream discharge; 2) alteration of stream channels and morphology; 3) degradation of water quality; 4) reduction of lake levels and concentrated chemical components in natural lakes; and 5) introductions of non-native fish species.

Small LCT populations have been established by transplants into fishless headwater tributaries above natural barriers in the upper East Fork drainage. According to Dennis Lee (2003) of CAF&G LCT does reproduce in these protected areas when they are the only species present. Genetically pure populations are found in the East Fork drainage above Carson Falls, Murray Canyon Creek, Golden Canyon Creek and Poison Flat Creek. A hybridized population of the Carson River strain exists in Heenan Creek and downstream of Heenan Lake. The fishery at Heenan Lake is currently managed for LCT and has long served as the source of LCT eggs used in CAF&G hatchery programs. Trophy size LCT can be caught here. Fish from the lake are known to migrate downstream into Monitor Creek and have been found in a flowing reach near the stream's confluence with the East Fork. Leviathan Creek contains a nonviable population consisting of only a few hybridized LCT. A small reproducing population occupies Raymond Meadows Creek; however the harsh environment limits fish abundance. LCT were captured in two West Fork drainage streams (Red Lake Creek and the West Fork near the confluence of Forestdale Creek); however they were assumed to be migrants from upstream reservoirs and not part of a self-sustaining population (CA F&G 2004b).

Isolated populations, such as those found within the Carson Basin, are at greater risk of extinction than metapopulations. Metapopulation refers to interconnected and interactive subpopulations that tend to be less vulnerable to extinction from catastrophic events. According to the USFWS (1995), there is no potential for a metapopulation within the Carson River basin. USFWS (1995) states that currently there are six self-sustaining populations with about 9.5 stream miles of occupied habitat on the Carson River. The following table shows locations where LCT currently exists according to USFWS Recovery Plan. Note that all locations contain introduced or reintroduced populations.

Table 3.6.2-1 – Current or Recently Existing Populations of Lahontan Cutthroat Trout

Location of Populations	Land Management Agency	Reach Length (in miles)	Notes
East Fork Carson River, CA	U.S. Forest Service	5 *	1, 2
Murray Canyon Creek,CA	U. S. Forest Service	2	1, 2
Raymond Meadows Creek, CA	U.S. Forest Service	0.5	1, 2
Poison Flat Creek, CA	U. S Forest Service	1.0	1, 2
Golden Canyon Creek, CA			1
Heenan Lake, CA			1, 3
Heenan Creek, CA			1, 4
Bull Lake, CA			1, 5

Source: USFWS 1995

***** Report does not provide specific location of LCT on East Fork; however, according to CAF&G (2004) LCT have been found on the East Fork near confluence of Monitor Creek.

Note:

1. Introduced or reintroduced populations.
2. Population determined best suited for recovery.
3. Artificially maintained population of Independence Lake strain.
4. Supports a limited, naturally maintained population of Carson River strain LCT which may be slightly introgressed with rainbow trout.
5. Supports a naturally maintained population of Carson River strain LCT that may be slightly introgressed with rainbow and Paiute cutthroat trout.

The USFWS recovery plan lists the following sites as potential locations for LCT introduction within the watershed: Horsethief Creek, CA, Willow Creek, CA, Charity Valley, CA, Forestdale Creek, CA, Mountaineer Creek, CA, Jeff Davis Creek, CA, and Charity Valley Creek, CA. The USFWS in cooperation with the WT is currently evaluating Clear Creek for the reintroduction of LCT.

3.6.2.2 Paiute Cutthroat Trout

The Paiute Cutthroat Trout (PCT) was listed as endangered on October 13, 1970, and was reclassified to threatened on July 16, 1975. The PCT are believed to be native only to the Silver King Creek drainage upstream from an impassable barrier above Snodgrass Creek but downstream from Llewellyn Falls where they occupied about 9 miles of habitat (CA F&G 2004a). According to CA F&G (2004a) they also may been native to Corral Valley Creek and Coyote Valley Creek. In 1912 a small transplant was made by sheepherders which resulted in the establishment of a population above Llewellyn Falls. The fish were then able to establish populations in tributaries Bull Canyon and Four Mile Canyon creeks. In 1947 PCT were also transplanted into Fly Valley Creek upstream from a natural barrier.

Hybridization with nonnative species is considered a primary threat to the PCT. In 1949 an inadvertent transplant(s) resulted in the hybridization with introduced rainbow trout in all locations occupied by PCT with the exception of Fly Valley Creek and the headwaters of Four Mile Canyon Creek (CA F&G 2004a). Coyote Valley, Silver King, Bull Canyon, and lower Four Mile Canyon were treated to eradicate the hybridized populations during the 1960's and 1970's and again from 1988 to 1992. These reaches were restocked with pure PCT from Fly Valley and upper Four Mile creeks. According to CA F&G (2004a), the populations have recovered to historic levels. The PCT populations downstream from Llewellyn Falls was extirpated by 1930 after years of stocking with hatchery produced rainbow trout fingerlings. Pure strains of Lahontan and Paiute cutthroat trout survived during the last century in the East Fork drainage due largely to transplants above Carson and Llewellyn Falls. No such major headwater barriers that can protect native fish are known to exist in the West Fork drainage.

The PCT require cool, well oxygenated waters, undercut or overhanging banks and abundant riparian vegetation. To spawn successfully they require access to flowing waters with clean gravel substrate. Paiute trout are piscivorus upon young fish, and when compared to other trout species, their populations are composed of a greater proportion of older, larger fish.

Currently, 11.8 stream miles are now occupied by pure strains of Paiute cutthroat trout (CA F&G 2004a): Corral Valley Creek (2.3 miles), Coyote Valley Creek (3.1. miles), Silver King Creek (2.7 miles), Four Mile Canyon Creek (1.8 miles), Fly Valley Creek (1.1 mile), Bull Canyon Creek (0.6 mile), and an unnamed tributary (0.2 mile).

A Recovery Plan was approved by USFWS on January 25, 1985, and revised in January 2005 (USFWS 2005). The first two criteria in the revision for accomplishing the goal of delisting the species are when: 1) all non-native salmonids are removed in Silver King Creek and its tributaries downstream of Llewellyn Falls to fish barriers in Silver King Canyon; and 2) a viable population occupies all historic habitat in Silver King Creek and its tributaries downstream of Llewellyn Falls to fish barriers in Silver King Canyon.

Currently, USFWS is planning to expand the population downstream to a series of inaccessible barriers in Silver King Canyon that would isolate the PCT from other trout species and greatly reduce the likelihood of an illegal introduction. Rotenone treatments would be used to eliminate hybridized trout in 6 miles of mainstem Silver King Creek, 5 miles of associated tributary streams, and Tamarack Lake. Two years of chemical treatments would occur. This plan has met with a lot of resistance from environmental groups and community members.

3.7 Cultural

The watershed is extremely rich in cultural history and numerous archaeological sites have been investigated. Many of the archaeological site locations are not disclosed in order to protect the site and its artifacts. These sites and their resources are non-renewable and hold valuable information regarding our past history. Many prehistoric archeological sites have been lost forever without ever being inventoried and protected during the westward immigrant expansion period, and into the historic era before there were laws to protect heritage resources from unregulated development.

In 1940 S. M. and Georgia Wheeler, archaeologists hired by the Nevada Parks Commission to investigate Nevada caves, excavated a mummy from a dry cave outside of Fallon known as “Spirit Cave”. Several years later the bones and skull were measured and entered into a world database of skull measurements. The most likely relative of what is known today as “Spirit Cave Man” is an ancestral, indigenous tribe from northern Japan. The radio carbon dates from “Spirit Cave Man” and a similar mummified body found on the eastern shore of Pyramid Lake, Nevada, date to 9600 and 9800 years before present.

In 1980’s, archeologists discovered Indian burial sites in the Stillwater Marsh area. These findings are believed to be one of Nevada’s most significant archaeologist sites. The site contains more human remains than found at other sites, in addition to remains of huts, middens, assorted artifacts, and numerous animal bones (CDWR 1991). Many of the bones represent species that are no longer present in the area, such as mink and otter.

Projectile points (spear points) of the Clovis style, which are believed to be associated with the native peoples who traversed the Bering Straits some 10-12,000 years ago, have also been collected on the mountains that designate the boundaries of the Carson River watershed. While evidence of human occupation in the Carson watershed is somewhat limited before 5,000 years ago, abundant projectile points (atl atl darts, arrowheads) and other assorted material suggest relatively steady and intensive human presence from 5000 years ago in to the historic period.

For more information on areas of cultural significance in the watershed or to have a cultural survey conducted, please contact the Nevada State Historic Office (SHPO) or the California Office of Historic Preservation (OPH). SHPO offers programs, such as the Nevada Centennial Ranch and Farm Program that honor ranching and farming families who have been working in Nevada for over 100 years.

3.8 Tribal Overview

The watershed is home to two Native American tribes, the Washoe Tribe of Nevada and California (WT) in the upper reaches of the river system down to Dayton and Paiute-Shoshone Tribe in the lower reaches of the river system from Dayton to the Carson Sink.

3.8.1 Washoe Tribe of Nevada and California

The history of the WT extends over 10,000 years in the Lake Tahoe Basin and adjacent east and west slopes and valleys of the Sierra Nevada Range. The WT's original territory encompassed an area that stretched from Honey Lake in the north, to Sonora Pass in the south, to Mono Lake and the eastern slopes of the Pinenut Range to the east, and west to the upper foothills of the Sierra Nevada. The Washoe people, who called themselves "Wa She Shu", lived as hunter gatherers with seasonal habitation patterns between Lake Tahoe and winter encampments in the lower elevations during the cold winter months which also corresponds to the game movement, as well as annual migration of spring, fall and winter home sites.

In the spring, summer and fall the WT inhabited the Lake Tahoe Basin (Dow wa) and utilized the natural resources there. At Lake Tahoe the WT would trap/catch a variety of fish, including Lahontan Cutthroat Trout (LCT) weighing up to 60 pounds, from the 63 creeks that feed Lake Tahoe. The estuaries around the lake were rich in waterfowl, bulbs and herbs, which along with the trout, was smoke dried for transport and winter storage. In the fall, the majority of the Washoe people left their summer camps in the Lake Tahoe Basin and returned to their winter home sites in the lower elevations along the eastern slopes of the Sierra Nevada's in Washoe, Eagle, and Carson Valleys. Some members of the WT also wintered in Martis Valley. During the fall, in preparation for the winter months, the WT returned to their Pinyon pine groves in the Pinenut Mountains to harvest tons of Pinion nuts, a highly nutritious food source that supplemented their diet along with other fresh and dried foods during the long winter months

The Washoe people utilized all resources in the watershed system including large and small game, waterfowl and plentiful aquatic resources. The vegetation was used for medicinal and utilitarian uses. Some of the riparian vegetation was used for baskets and the Washoe have produced some of the finest skilled basket makers. Some of the basket weavers are very well known with their products selling for as much as 600,000 dollars a basket. The Washoe also made rabbit skin blankets which could contain over 60 skins per blanket.

The WT is federally recognized pursuant to the Indian Reorganization Act of June 18, 1934. There are four Washoe communities within the watershed, the Stewart, Carson, and Dresslerville in Nevada, and the Woodfords community in California. The WT has jurisdiction over their allotments in both Nevada and California, with additional Tribal Trust parcels located in Alpine, Douglas, Sierra, Placer, Washoe, Lyon, and Carson City Counties. At the WT's population peak, there were about 5,000 tribal members; today there are about 1, 500.

The WT has a long commitment to the restoration of Tribal lands and the aboriginal homelands. The Washoe Environmental Protection Department (WEPD) was established in the Tribal government structure in 1998. Several laws and plans to protect the environment of Tribal lands have been established, including:

1. Planning Development law (1995)
2. Water Code (1999)
3. Environmental Protection Code
4. Land Use Management Plan (1995)
5. Nonpoint Source Assessment and Management Program (2000)
6. Sampling and Analysis Plan for the Water Quality Monitoring Program (2000).
7. Development of Water Quality Standards since 1999.
8. Unified Watershed Assessment (2001)
9. Preliminary Water Quality Data Report (305b) (1997, 2002, 2005).
10. Developed a Community Outreach Program.
11. Noxious Weed Management Plan (2001)
12. Emergency Operations Plan (2004)
13. State Level Multi Hazard Mitigation Plan (2005)
14. Carson River Geographic Response Plan (2006)
15. Wellhead Protection Program (1997) Revised (2006)
16. Integrated Solid Waste Management Plan (2005)
17. Wetlands Inventory and Assessment mapping.
18. Grazing Management Plan
19. Carson River Geographic Response Plan (2006)
20. Annual Fire Operations Plan (BIA)

The WEPD has many comprehensive programs including, water resources, noxious weeds, emergency response, compliance assurance, lead, radon, wildlife, fisheries, forestry, solid waste/recycling, underground storage tanks, environmental planning, and environmental education.

WEPD with the support of the Tribal Council has initiated many specific environmental restoration and protection projects (streambank restoration, well instrumentation, chemical and biological monitoring of surface water) to protect groundwater and surface water quality. An emphasis has been placed on protection of the Carson River and Clear Creek Watersheds where the Tribe has joined forces with federal, state, and local governments on water quality, air quality, and bank stabilization projects. Additionally, the WEPD has worked with Tribal elders and the children on the restoration and recording of the knowledge base of traditional and customary stewardship and practices. The WEPD works with federal, state, local, and private parties to ensure the protection of traditional Washoe natural resources, including gathering areas and native vegetation.

Development and the revision process for the WT's Water Quality Standards have been underway since 1999 with hopes of final approval by the Washoe Tribal Council and EPA in the near future. Treatment as a State (TAS) status for program authorization under §303 and

§401 Water Quality Program will be submitted to EPA in 2007. Utilizing CWA §106 funding the Tribe developed an approved NPS Assessment Report and Management Program Plan and became eligible for funding under CWA §319h Nonpoint Source Pollution Control Program (NPS) in 2000. Since 2000 the WT has implemented several successful projects on the riverbanks along the Carson River and Clear Creek. These projects will address temperature and turbidity issues in the long term, as identified in the water quality monitoring program, by stabilizing and re-vegetating the riverbanks. The WEPD completed a Unified Watershed Assessment (UWA), which listed the Middle Carson as a Category One, and Priority One Watershed.

WEPD, through the NPS projects, has thus far implemented Phases I - III of a multiple phased project at Stewart Ranch, Phases 1 – 11 at Stewart Community, Clear Creek, and Carson Community Waterfall Fire, Carson River and Clear Creek Watersheds. Washoe NPS projects have resulted in over 5,000 feet of riverbank stabilization, six alternative water sources for domestic cattle, development of a grazing plan, monitoring components, education and outreach events, installation of three miles of fencing river corridor, bioengineering training, water quality monitoring, wellhead protection, ranching BMP measures, and wildland fire mitigation erosion control projects. The WEPD received the 2004 Environmental Award for Outstanding Achievement from EPA IX for NPS efforts on the Carson River.

The primary goal of the WT's NPS Program is to identify, control, and abate the impacts of NPS pollution on the quality of the WT's surface and ground water resources. This goal will provide for the beneficial use of the surface and groundwater resources. Water quality, riparian and watershed condition must be managed to provide the opportunity for the WT to exercise beneficial and traditional uses.

The WT has full jurisdiction over their land and water resources and reports directly to the USEPA. In addition the Tribe has jurisdiction of fish and wildlife resources on Tribal trust and allotment lands.

3.8.2 Fallon Paiute Shoshone Tribe

The Fallon Paiute Shoshone Tribe, also known as the Toi Ticutta (cattail eaters), reservation is located in the Lahontan Basin, in the shadow of the sacred Fox Peak Mountain. The original territory of the Toi Ticutta included the areas surrounding current day Fallon, Nevada, and 50 miles along the Carson River. The reservation began in 1890 when the federal government made 50 allotments of 160 acres each to individual Paiute and Shoshone Indians under the General Allotment Act of 1887 (CDWR 1991). The reservation was eventually expanded to a total of 8,120 acres to support a tribal membership of about 850. In 1978, Congressional legislation was passed that called for the United States government to compensate the Tribe for federal non-performance on the early land exchange contracts by acquiring more land for the reservation and providing a complete irrigation system (CDWR 1991). Provisions of this legislation were not carried out due to issues with endangered species at Pyramid Lake and the limitations on irrigated lands within the Newlands Project by the OCAP. The Fallon Paiute Shoshone Tribal Settlement Act was intended to compensate the Tribe for the government's failure to carry out its obligations, including the 1978 legislation. The Tribe was awarded $43 million by Congress as settlement. The Tribe developed and submitted a plan to allocate the funds into six different programs: economic development; tribe government; per capita payments to tribal members; rehabilitation of irrigation; on-reservation water rights and land acquisitions; and off-reservation land and water right acquisitions.

The Fallon-Paiute Shoshone Tribe's Environmental Department initiated and completed environmental programs that addressed: tribal capacity development; tribal air program development; solid waste and recycling; arsenic reduction in drinking water; reducing nonpoint source water pollution; water quality sampling and analysis; consumptive plant analysis; open dump closure planning; Geographical Information Systems (GIS) and Global Positioning Systems (GPS), radon detection, lead awareness, mosquito abatement, noxious weed inventory and control, wetlands protection, wildlife assessment, mining issues, mold assessments, hazardous materials awareness and response, emergency planning and preparedness, and community education.

The Fallon Paiute Shoshone Tribe has full jurisdiction over their land and water resources and reports directly to USEPA.

3.9 Land Ownership

A significant amount of land within the watershed is under public ownership. In Alpine County, CA over 84% is public land, managed predominately by the USFS. In the Nevada approximately 54% of lands are managed by the BLM, 32% private; 4% State Wildlife Reserve; 3% Department of Defense; 2% water bodies; 2% USFWS Wildlife Refuge; 1% USFS lands; and, 1% Native American.

Appendix B provides land ownership maps for Alpine, Douglas, Carson City, Central Lyon and Churchill County.

3.10 Land Use

The State of Nevada has become highly urbanized, meaning that most people live within a few metropolitan areas. The Nevada State Demographer's Office projects that statewide the annual growth rate will average 2.6 percent from 2002 to 2010, equivalent to adding another city the size of Carson City each year.

Significant land use changes are projected to occur within the watershed over the next 20 years. Former open-range and agricultural lands are being converted to both low density and relatively high-density housing developments.

The watershed still contains large amounts of rural areas due to a strong agricultural base. However, urban sprawl is becoming more evident in some areas. Urban sprawl is described as a development cycle that starts with subdivisions built outside urban boundaries and ends with a blanket of residential and commercial buildings. This approach often results in a piecemeal approach, without the consideration of systematically conserving open space for important ecological functions and socioeconomic values. Critical areas, such as floodplains, wetlands, and forest patches that serve as migration corridors for wildlife, may be negatively impacted. Sprawl is an inefficient consumption of resources and raises the costs of municipal and utility services. In addition, sprawl places greater demands on state and local agencies to mitigate issues, such as air and water quality deterioration; wildfire threats at the urban/wildland interface; fragmentation of wildlife habitat; threats to vulnerable plant and animal species; over-development of floodplains; loss of wetlands and riparian resources; and loss of public land access.

Significant land use changes are projected to occur within the watershed over the next 20 years. According to CWSD (2005):

> *"Former open-range and agricultural lands have been converted to both low-density (i.e., one unit per acre or more) and relatively high-density (i.e., four or more units per acre) housing developments, commercial areas and industrial areas. To date, these land use changes have been particularly important in the Gardnerville Ranchos, Gardnerville, Minden, East Valley, and Indian Hills of Douglas County, Carson City, the Mound House and Dayton areas of Lyon County and the Fallon area of Churchill County. It is anticipated that similar land use changes will continue over the next 20 years around and within the more developed and urbanized portions of the Basin. Such growth will be accompanied by a more centralized population, and associated growth of water supply and wastewater treatment systems".*

1965 – Ranchland in Lyon County
Photo: Nevada State Historical Society

2006 - Residential Development
Photo: L. Crane

The States of Nevada and California have delegated responsibility for land use planning to counties and cities. The master plan for each of the counties contains a component stating the goals and objectives for land use planning and outlines some of the challenges and issues that the Counties face. Appendix B provides a series of maps that show the land use status for each county.

3.10.1 Pastures, Rangelands and Farms

Farming and ranching began with the earliest settlers to the watershed in the 1850's and continues to play an important role today. Carson Valley in Douglas County and the Newlands Project in Churchill County are the largest agricultural areas. Most of the acreage is devoted to pasture, alfalfa and cattle production. Irrigation structures have been developed consisting of direct diversion of surface water through extensive systems of privately owned ditches. All of the surface water rights on the Carson River are allotted and most are for agricultural use.

Approximately 223,755 acres are currently zoned or designated as agricultural lands in the Nevada portion of the watershed (B&C 2005). This figure includes: Douglas County 38,551-zoned acres, Carson City 2,213 acres, Churchill County 182,991 acres (B&C 2005). In Alpine County there are 8,000 acres of private agricultural lands located mostly in Diamond Valley (CVCD 1996). Irrigated lands in Alpine County were estimated in 1997 to be 2,925 acres (USGS 2004). The remainder of the land is used primarily for sheep and cattle grazing.

Agricultural land acreage is decreasing throughout the watershed. For example, in 1982 Churchill County had an estimated total of 420,353 agricultural acres as compared to the 1997 estimate of 182,991 acres. This is a 229% decrease over a fifteen-year period in Churchill County alone. Agricultural lands along the Carson River in Lyon County are rapidly being converted to residential housing developments.

4.0 History of the Carson River Watershed

As recently as 12,500 years ago the upper watershed was covered in snowpack and glaciers and much of the lower watershed was covered by the pre-historic Lake Lahontan (Horton 1997). At its peak, approximately 65,000 years ago, the Lake covered an estimated 8,655 square miles in northwestern Nevada. Surface elevation of the ancient ice age lake attained a maximum of approximately 4,380 feet amsl and reached a maximum depth of at least 86 feet where Pyramid Lake is today. Lake Lahontan covered the area now know as Stillwater National Wildlife Refuge and the Carson Lake and Pasture to a depth of 500 to 700 feet. It would have also covered the City of Fallon by almost 420 feet. Lake Lahontan reached its final descension phase approximately 9,500 – 7,000 years ago. During this period the region became extremely arid and a 1,000-year drought ensued (Horton 1997). It is believed that the region became uninhabitable during this period. In more recent pre-history period various tribes of Paiute, Shoshone, and Washoe Indians inhabited the watershed.

In addition to geological changes, many colorful figures and discoveries have shaped the history of the watershed. The most notable historical persons include Kit Carson, John "Snowshoe" Thompson, John C. Fremont, Henry T. Comstock and Francis G. Newlands. These early explorers, prospectors, and adventurers would have found the watershed much different than today. For instance, the Lahontan Valley may have been covered by water up to 40 square miles (Horton 1997). Early visitors to the area described the Carson Sink as "half shallow lake, half tule swamp which extends for 20 miles along the valley bottom and furnishes enough salt grass, sedges, and tules to winter many thousands head of stock, and a breeding ground for great numbers of water and shore birds" (Horton 1997).

The entire Carson River system is still recovering from the impacts incurred during the Comstock Mining Era.

The watershed was changed forever during the Comstock Mining era in the 1860's to 1880's. This was a period for great discoveries and challenges as man searched for ways to reap the treasures from the region's natural resources. It was also a time in which great damage was done to the watershed. The entire Carson River system is still recovering from the impacts incurred during this mining era from wood drives that scoured the riverbanks, and discharges of huge amounts of mercury to the river from the ore refining process.

The construction of the Lahontan Dam and the development of the Newlands Irrigation Project provided opportunities for farming and ranching in the once arid desert of the lower watershed, changing forever the history and hydrology of the lower watershed.

The history of the watershed is well documented in the "Carson River Atlas". Museums and historical societies containing historical documents, photographs, and books on the history of the watershed are located in Markleeville, Minden, Carson City, Dayton and Fallon. Historical maps and aerial photographs are also available from the University of Nevada (UNR), Bureau of Mines. The Nevada Historical Society, located on the campus of UNR, has a large collection of historical photographs from all regions of the watershed. In addition, the CWSD library has numerous historical documents and maps available for review and check out.

The following subsections highlight some of the historical occurrences that have significantly shaped the watershed and affected the quality of the natural resources.

4.1 Mines and Mills

Mines and mills have played a significant role in the history of the watershed from the headwaters to the terminus. The earliest mining camp in Alpine County, named Kongsberg, was established in 1863 on Silver Creek (later changed to Silver Mountain). The mining town of Monitor also came into existence in 1863 and by 1864 had a population of 2,500. Today the entire population of Alpine County is under 1,200. The Monitor/Mogul Mining District was the county's greatest producer of gold and silver, along with lead, zinc, copper, and mercury. By 1885, much of the readily available ore deposits were depleted and the mining towns became vacated (MACTEC 2004). Of the over 227 mines that were in operation in Alpine County during the Comstock era only the Zaca Mine on Colorado Hill remains active.

4.1.1 Colorado Hill Historic Mining District

Mines included in this district are the Zaca, Curtz, Deadman, Lincoln, and Loope Canyon mines. Also, included are the Alpine mines, Zaca tailings, Lovestedt tailings, Morning Star mines, and Orion mine.

On November 5, 2003, a "Removal Action Memorandum (RAM) and "Record of Decision" was issued for the Colorado Hill District (Executive's Officers Report – LRWQCB 11/26/04-01/15/04). The RAM is a Comprehensive Response Compensation and Liability Act (CERCLA) document that establishes the intended action plan for site cleanup.

4.1.1.1 Zaca Mine Complex

The Zaca Mine Complex is part of the Colorado Hill District and is a historic underground mining operation that began operations in 1857. It is located about six miles southeast of Markleeville, California and is within the Humboldt-Toiyabe National Forest. There are approximately two miles of near-horizontal underground tunnels at the site which includes the following units in ascending elevation order: Lower Advance; Lower Colorado; Upper Advance; Upper Colorado; and the Upper Workings. Some of the tunnels are allowing groundwater to reach the surface by creating induced horizontal and vertical permeability (USFS 2003). Discharges from the Lower Advance adit are very acidic and contain elevated levels of metals. Discharges from the site negatively impact Monitor Creek, which is a tributary to the East Fork of the Carson River.

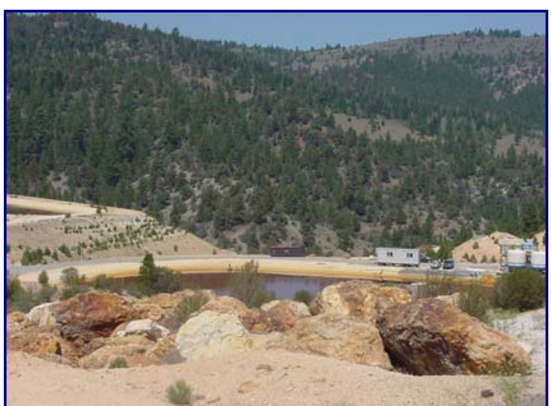
A planned action included in the RAM is the construction of an infiltration gallery to infiltrate acid-mine drainage from the Lower Advance portal to eliminate the current direct discharge to Monitor Creek. Monitoring wells will be installed for pre- and post-project monitoring. Mine tailings piles adjacent to Monitor Creek will be excavated back from the creek, and the streambank will be stabilized with rock slope protection. The tailings piles will be regraded, capped with a soil cap, and vegetated. In addition, monitoring programs include: 1) monitoring groundwater between Zaca mine and Monitor Creek, and 2) bioassessment of macroinvertibrates in Monitor Creek. Two years of baseline bio-assessment data will be compared with data obtained after the remediation has been completed to determine whether water quality has improved. Groundwater monitoring wells will be installed up gradient and down gradient of the Zaca mine to obtain baseline groundwater monitoring data.

An Engineering Evaluation/Cost Analysis was conducted in 2003 for a non-time critical removal action for the mine complex (MSE 2003). The removal action objectives are to (1) improve water quality in Monitor Creek by reducing discharge of acid mine drainage to surface water; (2) provide for the viability of native plant and animal species; (3) protect and restore aquatic, riparian and meadow systems; and (4) restore degraded ecosystems and processes.

4.1.2 Leviathan Mine

The most famous of the Alpine County mines is the Leviathan Mine that mined sulfur ore, used in processing silver ore from the Comstock mines near Virginai City, from 1863 to 1872. This underground sulfur mine was operated sporadically from 1915 to 1939. The Anaconda Mining Company conducted open pit sulfur mining from 1952 until 1962, when all mining operations permanently ceased. The site is a federal Superfund site. Under the direction of the U.S. Environmental Protection Agency (USEPA), certain releases of acid mine drainage are currently being treated on a seasonal basis. A Remedial Investigation (RI) is continuing, and a Feasibility Study (FS) should begin in 2007.

During its active years Leviathan Mine contributed about 22 million tons of overburden containing large amounts of sulfide minerals to the surrounding area. The mine pit and waste piles cover about 250 acres near Monitor Pass about six miles east of Markleeville, CA. Downstream creeks (Aspen, Leviathan and Bryant Creeks) have been severely degraded. Sulfuric acid, formed by the combination of sulfur, water and oxygen in the mine waste rock, dissolves minerals and metals present in the rocks, such as arsenic, copper, nickel, zinc. These contaminants continue to be released into the creeks that are tributaries to the East Fork of the Carson River. These creeks are within the traditional territory and use are of the WT, including land held in trust for Tribal members.



Remediation Efforts at Leviathan Mine.
Photo: G. Azad

In 2000, at the urging of the WT and others the Leviathan Mine was designated a federal Superfund Site. Atlantic Richfield Company and the State of California Lahontan Regional Water Quality Control Board (Lahontan Water Board) have been identified by USEPA as parties responsible for cleanup. Altantic Richfield, owned by British Petroleum, is the successor to the operator of the open pit mine, and the State of California purchased the site in 1984. A number of interim remedial actions to control the releases have been put in place by the responsible parties over the years. The Lahontan Water Board is operating under an Administrative Abatement Order from USEPA, and Atlantic Richfield is operating under an USEPA Unilateral Administrative Order. Because of the location of the site high in the Sierra Nevada, interim remedial actions to date have been operating only in the summer months. Only when the releases are totally contained, year-round, will it be possible for injured natural resources to recover, and that recovery may take many years. It is possible that some resources may never recover.

As the next step in the phases RI/FS for Leviathan Mine, USEPA will issue a scope of work for additional technical investigations and for the study of remedial action alternatives, which will leas to the selection of the final remedy for cleaning up the contamination. Through technical studies, the RI is intended to definitively identify the source and extent of the contamination and the effects those contaminants might have on human health and the environment. As part of the RI, human health and ecological rish assessments will be performed. In an FS, alternatives for cleanup are developed, screened, and put through a detailed evaluation in order to help USEPA select the final remedial action for the site. USEPA currently estimates that the remaining RI sampling will be done in 2008 and 2009, the data will be analyzed and the RI/FS report will be written in 2010, and USEPA will choose the final remedy in 2011.

4.1.3 Comstock Mining Era

In an area originally referred to as the "Region of Washoe" came the most significant event in the history of the watershed. In 1859, Hosea and Ethan Allen Grosh discovered a silver and gold rich ore body in Gold Canyon. This discovery began a 20-year period of intensive ore processing. Prospectors from all over swamped the area in search of gold and silver; among them was a Canadian named Henry T. Comstock. Comstock took over the possessions of the Grosh's, who both died under tragic circumstances before their claims were filed. Comstock, nicknamed Old Pancake, was also successful in becoming partners with Peter O'Riley and Patrick McLaughlin who had made a lode strike of high grade ore on an outcropping along Six Mile Canyon. Emmanuel Penrod also became a partner with Comstock. Old Pancake named himself Superintendent of the Mines in the area and took over running things. The ore deposits became known as the "Comstock Lode". Comstock, Penrod, O'Riley, and McLaughlin all sold out before the full value of the lode was realized and ended up living in poverty and dying under tragic circumstances. The mining of the lode continued until the bottom of the high grade ore lode was reached in 1877 and ore production dramatically decreased.

The Comstock Lode is one of the richest silver strikes in North American history and is credited with the building of San Francisco, with helping to end the Civil War, and with making many individuals extremely wealthy. But the Comstock Lode era also marked the beginning of an era of environmental degradation unparalleled in the history of the State of Nevada.

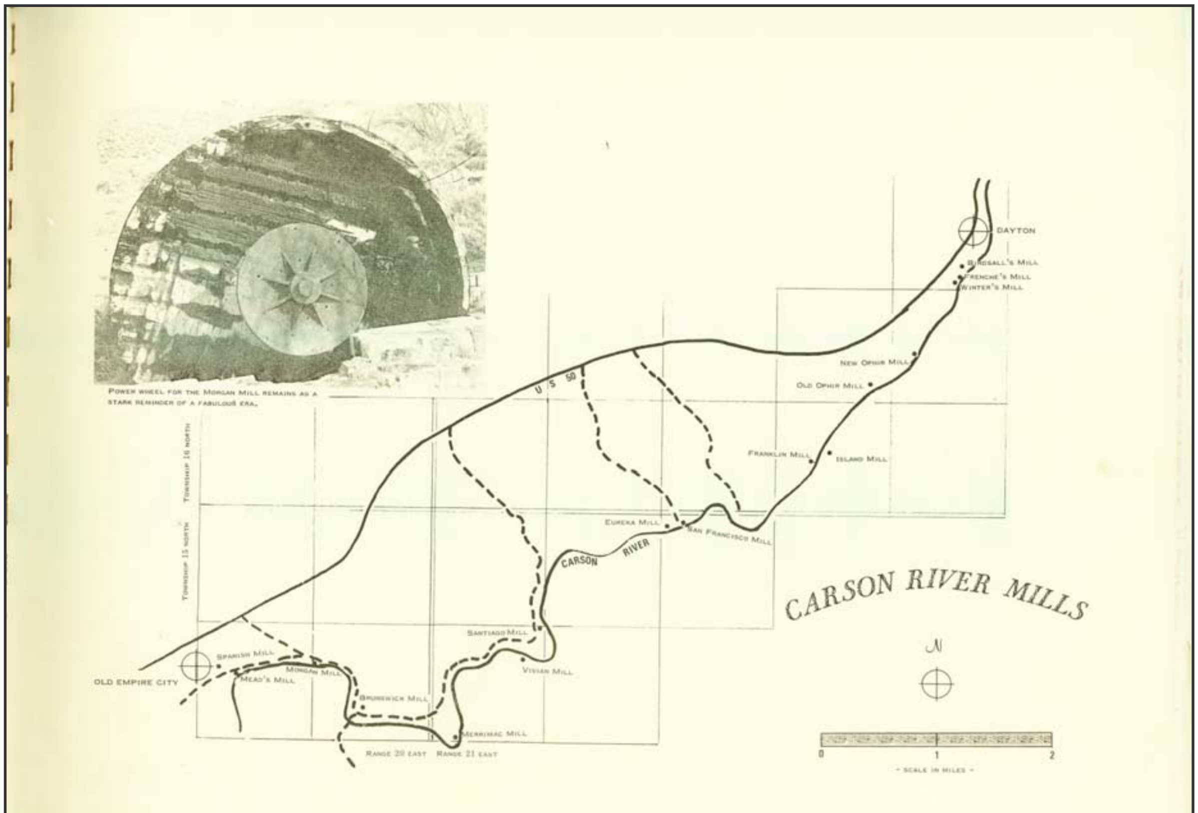


Figure 4.1.3-1 Carson River Mills Map

Mills sprang up throughout the region and along the Carson River to process the ore. It is estimated that 186 mills were in operation during the Comstock era (NDEP BCA 2006). Of these at least 16 were located on the Carson River from Old Empire City to Dayton. Gold and silver were extracted from the ores using the mercury amalgamation process, (NBMG 1992), referred to as the "Washoe Process". This process results in significant losses of mercury and precious metals to the surrounding environment. It is estimated that about 14 million pounds of mercury, three million ounces of gold, and 192 million ounces of silver (NBMG 1992) were lost to the Carson River drainage system. These deposits reside in mill tailings and the channel sediments and flood plain deposits of the Carson River, largely along the 70-mile stretch between Carson City and Fallon (NBMG 1992).

In 1901, the first cyanide leaching operation began in Six Mile Canyon. This process enabled more extraction of gold and silver from lower-grade material than was possible with the amalgamation methods (NDEP BAC). A large tonnage of the low-grade ore was mined between 1920 and 1950. Mining operations have been extremely limited since approximately 1950.

4.1.3.1 Logging

With the establishment of the Comstock mines came the need for vast amounts of lumber for the mines and mills. In Alpine County, 13 sawmills were operating in 1861, and by the mid-1860's, over 45 sawmills were operating. Eight of the mills were located on the East Fork of the Carson River, and five were located along the West Fork. The remaining mills were located along smaller streams within the upper watershed. Most of the lumber was cut in the winter and then floated down the Carson River to Empire during spring run-off. From Empire the lumber was taken to Virginia City by rail. In 1861, it was reported that 5 million feet of saw logs and 6,000 cords of firewood were floated down the Carson River (MACTEC 2004). In 1865, over six million feet of saw logs were delivered to Empire during a 21-day drive. It is reported that stacks of logs lined the river for miles waiting for the appropriate streamflow. In 1866, 14 million feet of lumber was floated downstream. By the 1880's, the logging declined as mining reserves were being depleted. As a result of the logging during this era, most of the forests in the upper watershed are secondary growth.

Wood drive on the East Fork of the Carson. Holding the wood at Young's Crossing, waiting for a head of water that would permit floating it through Carson Valley. ***(Courtesy of Nevada State Museum)***

4.1.3.2 Carson River Mercury Site

In the 1970's the USGS discovered elevated levels of mercury in river sediments and unfiltered surface water samples from the Carson River downstream from the Comstock era ore milling sites (NDEP BCA 2006). Subsequent studies have delineated the extent of contamination. Based on the information from these studies of the widespread presence of mercury, the Carson River Mercury Site was added to the National Priorities List (NPL) in August 1990 based on (NDEP BCA 2006). This site includes mercury-contaminated soils at former mill sites; mercury contamination in waterways adjacent to the mill sites; and mercury contamination in sediments, fish, and wildlife over more than a 50-mile length of the Carson River, beginning near Carson City and extending downstream to the Lahontan Valley

(USEPA 2004). The USEPA began investigation work in 1992 to determine cleanup actions of the contaminated sediments. In that same year an ecological assessment of the mercury-related impacts to Lahontan Reservoir and upstream portions of the Carson River was conducted. The report entitled "Ecological Risk Assessment Carson River Mercury Site Upstream of Lahontan Dam" was released in May of 1998. In 1995, the USEPA issued a Record of Decision for the site that established a mercury action level for surface soil of 80 mg/kg. This standard was established by USEPA using a risk assessment methodology for ingestion and is a conservative threshold level for long-term exposure of a child up to six years old.

Clean up actions have been conducted in six areas in the town of Dayton and one area in Silver City. The cleanup included the excavation of contaminated soils to a depth of two feet, offsite disposal of the soil and replacement of the contaminated soil with clean fill (NDEP BCA 2006). This clean up action dealt only with the highly contaminated soils that were identified around existing residences at the time of the investigation.

4.2 Newlands Irrigation Project

After the Comstock Lode collapsed Nevada's economic situation took a downturn. Nevada Senator Francis G. Newlands believed that the key to recovery was in agricultural development, and he began advocating irrigation projects for the area. In 1902, the U.S. Reclamation Service (now the U.S. BOR) was formed to construct projects that would bring water to the arid west. The Newlands Project, named after Senator Newlands, was the first project built by the U.S. Reclamation Service. Construction of the project began in 1903 and was completed in 1914.

The project is divided into two portions: the Truckee Division, near Fernley in the Truckee River Watershed, and the Carson Division, near Fallon in the Lahontan Valley within the Carson River Watershed. Since the flow of the Carson River was not enough to irrigate the entire project, the Truckee Canal was designed to divert a substantial amount of Truckee River water to augment the Carson River flow. The Lahontan Dam is the largest structure in the Newlands Project. It is an earthen dam measuring about 120 feet high and 1,300 feet wide and forms the Lahontan Reservoir. The reservoir is 23 miles long, covers 100,000 acres, has 70 miles of shorelines, and has the capacity to hold 314,000 acre-feet of water. Water is released from the Lahontan Dam into a series of canals and laterals that are operated by the TCID. Water from the Newlands Project is used to irrigate more than 60,000 agricultural acres.

"Turn This Water Into Gold – The Story of the Newlands Project" provides a detailed history of the Newlands Project. The BOR also provides the history of the Newlands Project on their website at http://www.usbr.gov/dataweb/html/newlands1.html#Newlands.

4.3 Historic River Projects

4.3.1 Channelization

During the 1960's the BOR channelized approximately 70 miles of the Carson River. The most heavily channelized portions are on the East Fork through Carson Valley. The channelized areas are easily seen on the corridor maps 3, 4, and 8 located in Appendix F. The strategy for these projects included reducing channel sinuosity, confining areas of multiple channels to a single channel, addition of rip rap to the channel banks and diversions, channel relocation, and the expansion of the new channel's cross-sectional area (Inter-Fluve 1996).

This channelization of the river resulted in channel instability and an increase in sediment loading. Interfluve (1997) describes the process as the following:

> *"The most common response to channelization is increased erosion of the channel bed, generally in an upstream direction (headcutting), resulting in incision. From this point, there is an infinite number of combinations of channel responses which act to move toward balance among variables. Erosion will generally exceed deposition until the channel reaches a balance between the sediment supply (from bed and bank erosion as well as upstream sources) and the stream's ability to move sediment. Channel instability associated with channelization also affects upstream and downstream reaches. Downstream reaches are generally affected by excess sediment supply resulting from bed and bank erosion in and below the channelized reach. Upstream reaches are generally affected by headcutting processes migrating upstream from the channelized reach."*

4.3.2 Levees

Levees were also constructed as part of the BOR projects. Approximately 70 miles of the river have or have had levees along the banks. In addition, there are spoil piles or berms in many areas due to the depositing of the excavated materials on the riverbanks. Interfluve (1997) describes the effect of the levee as the following:

> *"The fundamental effect of levees is to increase channel depth, thereby containing greater than the historic bankfull flows. With an increase in depth comes an increase in the velocity and erosional forces of a river. Consequently, the primary effect of levees are extreme channel depths during floods. In some areas of the Carson River, the combination of channel incision, related to channelization, and levee construction has resulted in channel depths up to 20 feet where previous natural channel depths may have been less than 5 feet."*

Section 5.0 Existing Conditions

This section discusses the existing conditions in the watershed with regard to issues such as surface water quantity and quality, physical channel/reach characteristics and potential sources of NPS pollution.

5.1 Air Quality

The State of Nevada has established air quality standards based on the national standards for criteria pollutants. The six principal criteria pollutants are carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO^2), ozone (O^3), particulate matter (with an aerodynamic size less than or equal to 10 microns (PM^{10}), and with an aerodynamic size less than or equal to 2.5 microns ($PM^{2.5}$), and sulfur dioxide (SO^2). In addition, Nevada has established an air quality standard for the non-criteria pollutant hydrogen sulfide (H^2S).

The Nevada Revised Statute (NRS) 445B.100 establishes public policy regarding air quality in Nevada. This statue states:

> *"It is the public policy of the State of Nevada to achieve and maintain levels of air quality which will protect human health and safety, prevent injury to plant and animal life, prevent damage to property, and preserve visibility and scenic, esthetic and historic values of the state".*

NDEP Bureau of Air Quality Planning (BAQP) has been monitoring air quality in the basin since the 1960's (Bryant 2005). Stations are moved to different locations when necessary. Currently there are three air quality monitoring stations as described in Table 5.1-1.

Table 5.1-1: Air Quality Monitoring Stations in Carson Basin

Location	Site Reference	Pollutants Monitored	Type of Site
Carson City	Long Street	Ozone, CO, $PM^{2.5}$	SLAMS
Fallon	280 Russell	Ozone (continuous sample type)	SPM
Gardnerville Ranchos	Aspen Park	PM2.5	SPM

Source: NDEP BAQP 2005
Note:
CO – Carbon Monoxide
PM – Particulate Matter
SLAMS – State or Local Air Monitoring Stations
SPM – Special Purpose Monitoring Stations

The watershed currently does not exceed any air quality standards. In the past, there have been two documented exceedences. The first exceedence was recorded in Carson City on January 10, 1997 for the 24 hour standard for PM^{10}. USEPA classified the exceedence as an exceptional event related to slit deposited from the 1997 flood. The second exceedence was documented on July 14, 2004 for exceedence of the 24 hour standard for PM2.5. NDEP

BAQP has made a request to USEPA that this exceedence be classified as an exceptional event due to the Waterfall Fire. This request is currently pending (Bryant 2005).

The potential for air quality problems is greater during the colder months when an inversion layer can form over the valleys. This layer consists of a body of warm air over a body of cold air. Since the air does not circulate between the two layers, pollutants can accumulate to higher concentrations. Potential sources of air pollution in the watershed are auto emissions, fuel burning (including wood burning stoves), and dust emissions from construction and agricultural sites.

5.2 Water Quantity

The Carson River and its tributaries are interstate streams and are fully appropriated. The watershed also receives water from the Truckee River via the Truckee Canal. This water is utilized in the Newlands Irrigation Project, the largest water user on both rivers. Water is also imported to Eagle Valley and Virginia City via the Marlette-Hobart Water System from the Lake Tahoe basin. The majority of surface water used in the watershed is for agricultural and livestock use. Domestic, municipal, and industrial/commercial uses rely mainly on groundwater resources.

Flows in the Carson River and its tributaries vary significantly from year to year depending upon the amount of precipitation and snowpack accumulation. For example, in the drought year of 1977, approximately 42,360 acre-feet per year (afy) flowed past the Carson City gaging station; this same station recorded 826,770 afy during the high water year in 1993; during the Flood of 1997 an estimated 27,500 cfs (1 cfs = 723.92 afy) was measured for a short duration at this station (B&C 2000). Surface water flows in the upper watershed are diverted for irrigation purposes from April through October, from November through March the flows are allowed to go to the Lahontan Reservoir. Peak flows generally occur April through June with the peak agricultural demand occurring in July and August.

The population and water demand of the watershed is expected to increase significantly as shown in the following table. Balancing the needs of all users will continue to be a difficult task.

Low to No Flow Conditions on Carson River
Photo: R. Pahl - August, 2004

Table 5.2-2: Population and Water Demand Estimates for the Carson River Basin 2000-2025

Year	Douglas County (Carson Valley) Population (persons)	Douglas County (Carson Valley) Water Demand (acre-feet)	Carson City Population (persons)	Carson City Water Demand (acre-feet)	Lyon County (Carson River Corridor) Population (persons)	Lyon County (Carson River Corridor) Water Demand (acre-feet)	Churchill County Population (persons)	Churchill County Water Demand (acre-feet)	Total Population (persons)	Total Water Demand (acre-feet)
2000	33,875	10,163	52,455	11,016	14,195	3,123	23,980	6,475	124,505	30,777
2005	35,905	10,772	56,145	11,790	22,710	4,996	26,875	7,256	141,635	34,814
2010	38,450	11,535	58,840	12,356	28,700	6,314	29,490	7,962	155,480	38,167
2015	41,525	12,458	61,650	12,947	33,280	7,322	32,055	8,655	168,510	41,382
2020	44,640	13,392	64,120	13,465	37,860	8,329	34,565	9,333	181,185	44,519
2025	47,540	14,262	65,955	13,851	42,440	9,337	37,055	10,005	192,990	47,455

Notes: population estimates rounded to nearest 5 persons; 2000 population of Mound House, Dayton, Stagecoach and Silver Springs compiled from a variety of sources, including utility hook-ups; population growth in the Dayton area is based on current development plans, not State Demographer projections; population growth in Carson City and Churchill County may be greater than projected by the State Demographer; per capita water consumption in Douglas, Lyon and Churchill Counties may decrease over time as a result of land use changes and the implementation of conservation measures
Source: B&C 2005

5.2.1 Upstream Storage

The quest for upstream storage on the Carson River has been investigated several times over the last hundred years. The BOR actually evaluated several sites in the upper watershed before the Lahontan Dam was constructed for the Newlands Project.

In the 1950s, the Department of the Interior submitted a report to Congress called the Washoe Project, which recommended constructing the Watasheamu Dam on the East Fork in Alpine County. The purpose of the Watasheamu Dam was to store water for agricultural use, power generation, and flood control. The largest economic component of the project was the enhancement of agriculture. Power generation and flood control combined accounted for only about 40 percent of the overall benefit of the project. The CWSD was created in 1959 to manage this project. In 1983, BOR re-evaluated the Watasheamu Dam project and concluded that the benefits no longer out-weighed the costs, and the Federal Government withdrew its support for the project.

In the late 1980s the Nevada State Legislature began evaluating alternative dam sites on the East Fork of the Carson River and restructured the CWSD to help with the evaluation. All the alternatives turned out to be too expensive. Additionally, in 1989 the State of California declared the East Fork of the Carson River located in California as “Wild and Scenic,” thus prohibiting any dam construction on the East Fork in California.

Originally, in the 1960s, the Federal Government thought it could divert additional water from the Truckee River into Lahontan Reservoir to make up for any water stored in the upper watershed. At that time the Federal Government was not concerned with the effect that additional diversions from the Truckee River would have on water levels in Pyramid Lake. Today, however, the Federal Governmental is going to great lengths to minimize the amount of water diverted out of the Truckee River to Lahontan Reservoir. Any water stored upstream of Lahontan Reservoir must either be transferred from an existing water right, or be temporary storage of "Lahontan Water" that is released later in the season. This water cannot be used for any upstream purpose because the water rights belong to those located below Lahontan Reservoir.

As growth continues in the watershed, so will the need to store surface water for late summer use. Storage projects will most likely consist of small off-stream reservoirs or storage in the groundwater aquifers.

5.2.2 Water Rights

Water rights are administered by the State Water Resources Control Board in California, and by the State Engineer in Nevada. California recognizes riparian or appropriative surface water rights. Nevada has a statewide system for the administration of surface water rights that is based on appropriative doctrine.

5.2.2.1 Riparian Doctrine

The Riparian Doctrine seeks equitable distribution and right of use regardless of the date of water right or place of use (Kennedy-Jenks 1998). It provides for the use of a watercourse that will benefit all users of the watercourse to an equal extent. The dominate provision is that a user will not degrade the quality or quantity of the stream flow except for that loss due to beneficial uses.

5.2.2.2 Appropriative Doctrine

The Appropriative Doctrine is the most common administrative method of water right delivery in the western United States. It allows an assignment of a water right priority based upon the date of first use of that water right. The priority date dictates whether a right will be served when the water supply will not allow for delivery to all water righted lands. This doctrine is initiated only when there is not enough water to serve all vested water rights.

5.3 River Bed and Banks Ownership

According to the Nevada Division of State Lands (NDSL), upon statehood Nevada received title to all sovereign lands, which are submerged beneath navigable bodies of water. According to ***State v. Bunkowski*** (1972), the Attorney General of Nevada, on January 6, 1970, and the Nevada Legislative Counsel, on January 13, 1970, issued opinions that the Carson River is a navigable stream due to the river being used to float logs during the Comstock Era. Therefore, the State of Nevada owns the bed and banks of the river generally up to the ordinary and permanent high water mark. Ownership by the State does not generally extent to wetlands, tributaries, ditches or flood overflows.

Does this ownership extend to the West Fork/Brockliss Slough and the irrigation sloughs? CVCD was apprised by NDSL that the streambeds of the irrigation sloughs in Carson Valley are considered to be the property of the State of Nevada. Differences of opinion on this lie in the fact that the sloughs are not, and have not ever, been navigable. Currently, a review of this claim by the NDSL is being conducted. If the NDSL does determine that it is appropriate to claim the streambeds of the sloughs, an identification of those sloughs will be requested.

5.4 Water Resources Legal Agreements

Conflicts between the agricultural community and the Comstock or processing and milling interests during the late 1850's and early 1860's resulted in several legal disputes over the uses of Carson River water. One such case "***Union Mill & Min.Co. vs. Dangberg***, set the precedence for the recognition of the riparian doctrine on the California reaches of the Upper Carson River. As the population and agricultural development continued to boom in Carson Valley, pressure to stretch water resources through the dry summer months led to the ***Anderson-Bassman Decree*** in 1905. This decree established the practice of weekly rotation between the California and Nevada water users. In 1921, the ***Price Decree*** adjudicated the distribution of waters during the weeks that Nevada received demands under the Anderson-Bassman Decree. Both of these decrees are incorporated into the ***Alpine Decree***.

In 1913, the Federal Government recognizing that the highly seasonal flows of the Carson River would not sustain the Newland Project without additional water from the Truckee River, filed to quiet title of Truckee River water rights, resulting in the ***Orr Ditch Decree.*** This decree, which was finalized in 1944, ensured that the Newlands Project would receive delivery of its decreed stored water upstream in Lake Tahoe and later, Project water stored in Donner Lake (Kennedy-Jenks 1998).

5.4.1 Alpine Decree

The Alpine Decree (Decree) was a quiet title action filed in 1925 by the Federal Government (Kennedy-Jenks 1998). From 1925 – 1950, fruitless litigation occurred and by 1950 most the interest in the litigation began to wane. In 1951, the Court appointed a Special Master. This action resulted in the development of a Special Master's Report known as "The Mueller Findings of Fact" or the ***"Mueller Report"***. This report served as the basis for much of the Decree litigation and tabulation. The final adjudication of the Decree was entered in 1980. The Alpine Decree is still the chief regulatory control for Carson River operations. The federal district court-appointed Water Master administers the decree.

CVCD (1996) describes the Decree as the following:

> "*The decree established the respective Carson River surface water rights of the parties to the lawsuit, both in California and Nevada. It also established the right to reservoir storage in high alpine reservoirs (located in Alpine County), and confirmed the historical practice of operating the river on rotation, so that irrigators with junior priorities could be served as long as possible. These reservoirs were permitted to fill out of priority order, in regard to historical practice. The decree also recognized riparian rights in California (as distinguished from the quantified appropriated rights*".

The Decree divides the Carson River and its tributaries into eight segments to account for the physical impossibility of delivering water in strict compliance to the Appropriative Doctrine. The designated segments are as follows (US 1980):

Segment 1: The headwaters of the East Fork to the California/Nevada state line.

Water Master exercises little supervision in this segment, except to regulate the release of water from the upper reservoirs.

Segment 2: The East Fork from the California/Nevada state line to the confluence of the East and West Forks in Carson Valley.

When flow rate at the Gardnerville gage reduces to 200 cubic feet per second (cfs), 1/3 of the flow is directed into the Allerman Canal and 2/3 stays in the river. Most diversions are based upon a two-week irrigation interval.

Segment 3: The headwaters of the West Fork to the gage at Woodfords, California.

Water Master exercises little supervision in this segment, except to regulate the release of water from the mountain reservoirs for downstream use.

Segment 4: The West Fork from the gage at Woodfords to the California/Nevada state line.

Beginning the first Monday in June and continuing to the end of the irrigation season the available water supply is rotated on a weekly basis between segments 4 and 5. During non-irrigation season, diversions are made by the Snowshoe Thompson No. 2 Ditch via Indian Creek to store water in the Mud Lake Reservoir.

Segment 5: The West Fork (and Brockliss Slough) between the California/Nevada state line and the confluence of the East and West Forks.

During designated week in irrigation season, the water is allocated according to priorities. Junior appropriators who do not get direct flows during this time are allowed to use return flows from Segment 4.

Some rights that appear to be served with West Fork water are actually served with East Fork water that drains into the West Fork channel after irrigation use.

Water taken out of the East Fork through Rocky Slough and into Edna Ditch and other small ditches is used to irrigate lands between the East and West Forks.

Segment 6: The main stream of the Carson River from the confluence of the East Fork, West Fork, and Brockliss Slough to the gage at Carson City.

Diversions occur by pumping from the river and the amount of water reaching each pump is sufficient to satisfy priority. Water Master does not regulate this segment unless a controversy arises.

Segment 7: The main stream of the Carson from the Carson City gage to Lahontan Reservoir.

Due to the intermittent nature of the river's flow this segment is further subdivided for administration (and regulation) into autonomous subsegments:

a) Mexican Ditch, Dayton and the reach between Rose Ditch and Cardelli Ditch, inclusive:
b) Gee Ditch;
c) Koch Ditch;
d) Houghman and Howard Ditches;
e) Buckland Ditch.

Segment 8: The area below the Lahontan Dam.

Water management strategies cannot impact decreed surface water rights and/or the natural flows into Lahontan Reservoir. The Decree allows for the conversion of agricultural rights to Municipal & Industrial (M&I) use at a rate of 2.5 acre-feet per acre.

According to the Decree (US 1980), in the Newlands Project the water duties are 3.5 acre-feet per acre delivered to the land for the bottomlands and 4.5 acre-feet delivered to the land for the bench land. For lands above the Newlands Project the water duties are 4.5 acre-feet per acre diverted to the canal for the bottomlands, 6.0 acre-feet per acre diverted to the canal for the alluvial fan lands and 9.0 acre-feet per acre diverted to the canal for the bench lands. The net consumptive use of surface water for irrigation in the Newlands Project is 2.99 acre-feet per acre and 2.5 acre-feet per acre for lands above the project.

The partial decree can be found at www.newlands.org/alpine.htm. The decree in its entirety is available from the CWSD or can be found on www.cwsd.org.

5.4.2 Regulation of the Carson River

During summer months when there is an inadequate amount of water to supply all water rights, the river goes on regulation and the Federal Water Master enforces delivery based on priority. The more senior priority will receive water before a more junior priority within the same river segment. This inner-segment rotation assures a more efficient and beneficial use of the water resources.

Two unconventional features of this regulation have been incorporated in the Decree, the ***Allerman Split*** and the ***California/Nevada Rotation***. The Allerman Split is defined as (US 1980):

> *"When the flow rate at the Gardnerville gauge reduces to 200 cubic feet per second, 1/3 of the river flow is directed into the Allerman Canal and 2/3 of the flow stays in the river. The point of measurement for the 1/3-2/3 split is at a weir located 100 feet downstream of the intersection of Highway 395 and the Allerman Canal. Water users on the Heybourne Tract served by the Allerman Canal, the Upper New Virginia, Company and Cottonwood ditches hire a ditch rider to assist, under the direction of the Water Master, in the distribution of water."*

The Anderson-Bassman Decree defines the rotation of water along the West Fork near the Stateline. This rotation, the California/Nevada Rotation, is defined as (US 1980):

> *"Beginning the first Monday in June and continuing to the end of the irrigation season the available water supply is rotated on a weekly basis between Segment 4 and Segment 5. This custom applies to all water users on these two segments."*

5.5 Flow Regime

Flows in the Carson River vary from year to year. Major factors influencing the flow regime are annual and monthly precipitation rates and temperatures, accumulated snowpack and runoff characteristics in the headwaters and tributaries. The 208 Water Quality Management Plan (B&C 2005) describes the general flow regime of the Carson River as the following:

> *"The East and West Forks of the Carson River flow from their headwaters in California in a northerly direction into the Carson Valley hydrographic area. Within the Carson Valley, both forks flow through an intricate and complex irrigation and diversion system. In the northern portion of the valley, the forks join to form the Carson River. The river continues north through the Riverview sub-basin of the Dayton Valley hydrographic area before turning northeast and passing through Brunswick Canyon. As the river emerges from Brunswick Canyon, it enters Dayton Valley where it turns east and flows into Churchill Valley to the Lahontan Reservoir. The reservoir also receives a portion of Truckee River flows released from Derby Dam through the Truckee Canal. The water stored in Lahontan Reservoir is used in the downstream agricultural area of the Carson Desert hydrographic area as part of the Newlands Irrigation Project. The eastern margin of the reservoir coincides with the hydrographic boundary. Within the Carson Desert hydrographic area, the river either flows south to Carson Lake or east through numerous canals to the Carson Sink and the Stillwater wetlands".*

Note: The above quote refers to Brunswick Canyon. The correct name is Carson Canyon.

A schematic flow diagram for the Nevada portion of the watershed is shown in Figure 5.5-1. The diagram was prepared by the U.S. Geological Survey (USGS) and shows the major tributaries to the river, gaging stations, irrigation conveyance features, storage facilities, areas of municipal and irrigation use and terminal areas.

Carson River flows are monitored by a number of USGS gaging stations that generally define the flows between hydrographic basins and political boundaries. The station locations are provided on the river corridor maps in Appendix F. Stations with relatively long and continuous periods of records are summarized in Table 5.5-1. The average annual flow data for the period of record for these same gages are summarized in Table 5.5-2.

Table 5.5-1: Carson River USGS Gaging Stations

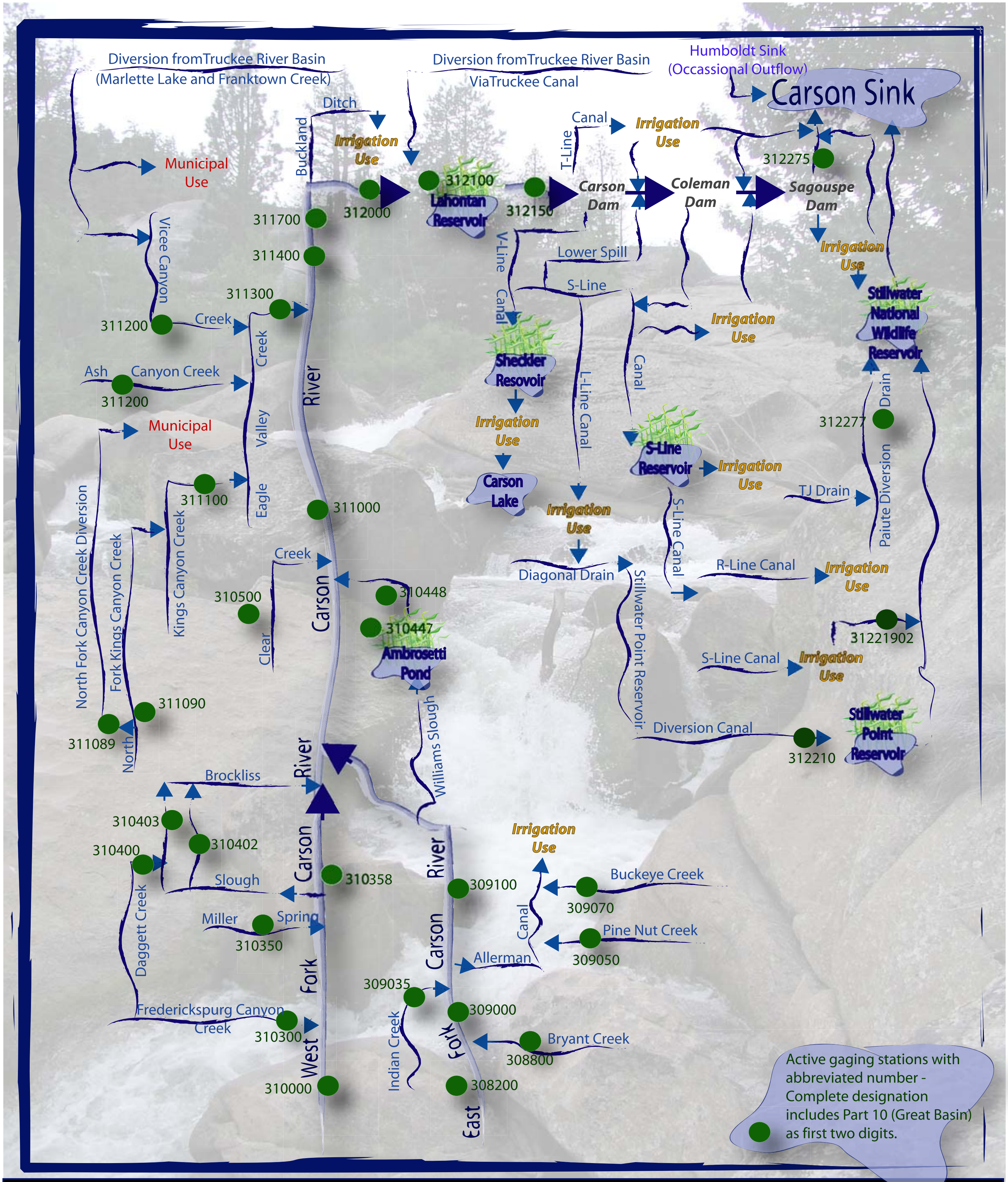
USGS GAGING STATION ID NUMBER	Gaging Station Name and Location	Period of Record
10309000	East Fork Carson River near Gardnerville, NV	1940 - Present
10310000	West Fork Carson River near Woodfords, CA	1938 - Present
10311000	Carson River near Carson City, NV	1939 – Present
10312000	Carson River near Fort Churchill, NV	1911 – Present
10312150	Carson River below Lahontan Reservoir	1966 - Present

Source: B&C 2005

Table 5.5-2: Carson River Flow Data

USGS Gaging Station ID Number	Gage Name/Location	Flow for Water Year 2003 (cfs)	Average Annual Flow (cfs)
10309000	East Fork Carson River near Gardnerville, NV	225,446	265,139
10310000	West Fork Carson River near Woodfords, CA	64,762	75,264
10311000	Carson River near Carson City, NV	218,07	295,109
10312000	Carson River near Fort Churchill, NV	198,710	271,343
10312150	Carson River below Lahontan Reservoir	262,616	363,668

Source: B&C 2005

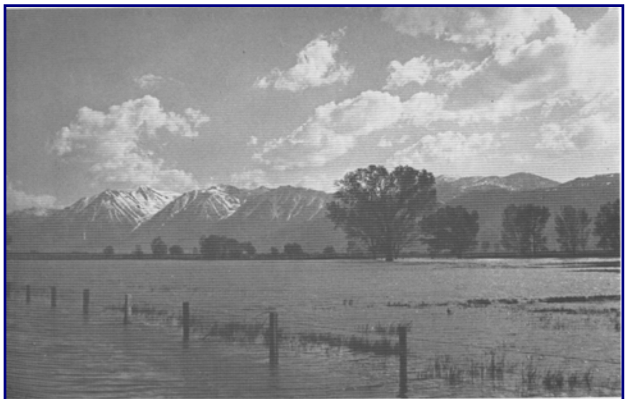


Carson River - Schematic Flow Diagram

Figure 5.5-1

5.6 Droughts and Floods

History shows repeated incidents of flooding with at least 17 major river flooding events since 1852. Most flooding events in the watershed are the result of heavy rain on accumulated snow pack that causes rapid melting. Since the upper watershed is not regulated to provide flood control, large flows can occur downstream. The Carson River is typically not adequate to contain a flood flow exceeding a ten-year event (CVCD 1996). The Carson Valley provides the floodplain areas for the waters to disperse when the river's capacities are exceeded. During a major flood event the valley floor is inundated and overland flows can exceed depths of three feet.

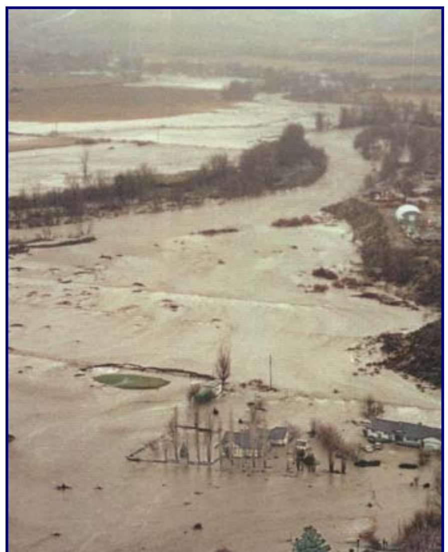


The flood of 1937, looking south from the Cradlebaugh Bridge. *(Courtesy of Juanita Schubert)*

The area above the river floodplain is also subject to flooding from steeper drainage areas. This is referred to as alluvial fan flooding. In the upper watershed these smaller, higher, drainages include the Sierra, Genoa and Schoolhouse (CVCD 1996). On the east side of the watershed the Buckeye and Pinenut Creek's drain the Pine Nut Mountain Range along with other intermittent creeks. These creeks are prone to flash floods.

The Johnson Lane area of Carson Valley is especially prone to flash flooding due to its location below two washes originating from a large drainage area in the Pinenut Range. This area, along with areas in Genoa and Carson City, can be subject to flash floods generated by intense thunderstorms.

Flooding events can contribute to NPS pollution by carrying large amounts of sediment and trace elements that are attached to sediment particles to downstream areas. According to USGS (1998) during the flood of 1997 about 200,000 tons of sediment and 3,000 pounds of total mercury flowed past the Carson River streamflow gage near Fort Churchill.



Flood of 1997 – Genoa, Nevada
Photo: Reno Gazette-Journal

A drought is considered to be a period of two or more consecutive years in which stream flow is much less than average; major droughts are those periods greater than ten years. The most severe droughts of this century occurred throughout the State of Nevada from 1928 to about 1937; 1959 to 1962; and from 1987 to 1994. It is common for droughts to end with a flooding event.

As evidenced in Table 5.6-1, the watershed experiences drought and flood conditions on a regular basis.

Table 5.6-1: Major Floods and Droughts Impacting the Carson River Watershed

Event	Date	Areas Affected	Recurrence Interval (years)	Remarks
Flood	18???			
Flood	March 1907	Sierra Nevada drainages	Unknown	May rank with 1950 and 1955 floods in Carson Valley
Drought	1928-37	Most of State of Nevada especially Humboldt River and Sierra Nevada drainages	>25	
Flood	November-December 1950	Sierra Nevada drainages	50	Not as severe as December 1955 flood in Carson River Basin
Drought	1953-55	Most of State of Nevada	About 10	December 1955 flooding ended drought in Sierra Nevada
Flood	December 1955	Sierra Nevada Drainage	40-100	Most severe flood upper Carson River Basin downstream to Carson City
Drought	1959-62	Most of State	10-20	Lasted 3-4 years depending upon location
Flood	February 1963	Sierra Nevada drainages	50	Severe in Carson and Truckee River basins
Flood	December 1964	Sierra Nevada drainages	20	
Drought	1976-77	Statewide except in south	About 10	Most severe along Sierra Nevada drainages
Floods	March-June 1983	Statewide except in south	<10-50	Greatest snowmelt floods known except in Humboldt River Basin where they were exceeded in 1984
Floods	February 1986	Sierra Nevada drainages	10-50	Greatest discharge in main rivers since 1963
Drought	1987-1994	Statewide, especially in Sierra Nevada drainages	Unknown	Worst period of drought on record
Flood	May-June 1995	Carson and Walker River drainages	Unknown	Concentrated in the Carson River below Lahontan Reservoir and in the Walker river downstream of the state line
Flood*	January 1997	Sierra Nevada Drainages	50-100	
Flood	January 2006		10-25	

Sources: Horton 1997; *USGS Fact Sheet FS-077-07

Development in floodplain areas and on alluvial fans, construction of elevated roadways across the floodplains, and channelization of the river have altered the natural flooding routes of the Carson River. As the watershed continues to urbanize, flooding events are expected to cause greater damage and flood areas that were not previously prone to flooding. Although Lahontan Dam can provide for some storage of floodwaters, it was not designed to provide flood control.

Flood zones for each county are provided in Appendix H. These zones are based on the Federal Emergency Management Agency (FEMA) flood insurance rate maps (FIRMs). FIRMs are prepared for the purpose of insurance rating, land use regulations and for lenders in determining where the flood insurance must be purchased. It should be noted that the FIRMs are outdated and all were prepared prior to the Flood of 1997.

Historic flood information for the watershed can be on the "Flood Chronology of the Carson River Basin, California and Nevada Web Site at http://nevada.usgs.gov/crfld/.

5.7 Groundwater Resources

Groundwater is the most important M&I water supply resource for the watershed. Surface water resources have been fully appropriated, so any future development will depend on groundwater resources. Perennial or safe yields (the amount of water in a hydrologic basin which can be withdrawn each year without depleting the resource) are designated by the Nevada State Engineer and the California State Water Resources Control Board. Perennial yields for the watershed are provided in Table 5.7-1:

Table 5.7-1: Groundwater Perennial Yields for Carson River Basin

Basin Name	Area Sq. Miles	Perennial Yield (AFY)
Carson Valley	419	49,000
Eagle Valley	69	7,000
Dayton Valley	369	9,445
Churchill Valley	480	1,600
Carson Desert	2,022	2,500

Source: B & C 2000

California does not have a statewide system for administration of groundwater rights, except for groundwater that is actually stream underflow or that flows in known and definite underground channels. Groundwater in California is not regulated, except in situations where individual basins have undergone special adjudications or where a local groundwater management district has been created. Nevada has a statewide system for the administration of groundwater water rights that is based on the appropriative doctrine. All groundwater basins in Nevada are over-appropriated. Currently a groundwater management plan is being developed for Alpine County, California and will address groundwater issues in the upper watershed.

The regional groundwater flow system in the watershed above Lahontan Dam is generally in a downstream direction toward the reservoir and is mainly controlled by the surface-water altitude (Glancy and Katzer 1975). The groundwater systems of the larger valleys are complex due to several aquifers existing at varying depths that may act semi-independently of each other. Recharge of these aquifers is provided by precipitation in mountainous areas, with water seepage from streams on the alluvial slopes and by underflow from consolidated rocks. However, only about three percent of the water actually finds its way to the groundwater reservoirs (Glancy and Katzer 1975).

The groundwater basins within the watershed, as described by Glancy and Katzer (1975) and Welch et. al (1997), are the following:

5.7.2 Carson Valley Groundwater Basin

The Carson Valley groundwater basin contains two discontinuous confined alluvial aquifers and a shallow water-table aquifer (Welch, et al 1997). Groundwater movement is towards the Carson River from both sides of the valley and then generally northward through sediments beneath the river. The system is connected to the river throughout most of the valley with water moving between the river and aquifer in either direction, depending mostly on the stage of the river (Welch, et al 1997). This basin is probably the most important groundwater basin in the watershed as the system results from valley-fill deposits that form a major storage of high-quality groundwater.

5.7.2 Eagle Valley Groundwater Basin

The Eagle Valley basin contains a shallow water-table aquifer and one or more deeper alluvial aquifers (Welch, et al). Groundwater movement in the basin is complex but is generally toward the Carson River. Recharge comes from runoff, underflow along the west side of the valley, and infiltration of streamflow and irrigation waters. Water quality within this basin has been described as generally good and satisfactory for irrigation, domestic, and most common uses, with the exception of poor water quality in the New Empire area of northeast Carson City (Glancy and Katzer 1975).

5.7.3 Dayton Valley Groundwater Basin

The Dayton Valley hydrologic area includes several basins extending from Eagle Valley to Churchill Valley. The basins include the Carson Plains, a valley east of the town of Dayton, and a narrow strip of river floodplain and uplands of the Pine Nut Mountains south of Stagecoach Valley. In the Carson Plains the groundwater generally moves east through the valley and average depth to water is about 60 ft (Welch et. al 1997). Recharge comes from precipitation in the Virginia Range and Pine Nut Mountains. Shallow aquifers near the Carson River receive recharge by diversions from the river. During high flow the river can also be a source of recharge. In Stagecoach Valley, water levels indicate that shallow groundwater moves eastward and southward through basin-fill deposits. Recharge comes from precipitation in the Virginia Range and by inflow from the Carson River flood plain in the east part of the Carson Plains (Welch et. al 1997).

Water quality within this system varies and has several acute water quality problems. Groundwater in the Pinion Hills area, just east of the Carson River near Carson City, is of very poor quality due to the influence of hot mineralized water that is associated with a deeply circulating groundwater system. Water of poor quality due to high concentrations of calcium, sulfate and dissolved solids is found in the Mound House area. Water from shallow wells used for domestic purposes in the Town of Dayton shows high levels of dissolved solids (400 to at least 500 mg/L) and sulfate (150 to at least 250 mg/L), and is hard (200 to 300 mg/L) (Glancy and Katzer 1975).

5.7.4 Churchill Valley Groundwater Basin

Groundwater levels in the Churchill Valley range from 20-50 feet or less below land surface near the shores of Lahontan Reservoir and the Carson River floodplain to more than 200 feet near the margins of the valley (Glancy and Katzer 1975). Recharge comes from precipitation in the surrounding mountains and infiltration from the Carson River and Lahontan Reservoir (Welch et. al 1997). Groundwater quality to the wells in Silver Springs is hard but generally of good chemical quality.

5.7.5 Carson Desert Groundwater Basin

The Carson Desert is the most complex in the Carson River basin (Welch et. al 1997). It contains shallow, intermediate, and deep alluvial aquifers and a basalt aquifer underlying the southern area. This basin has an abundance of water but it is of poor to very poor quality for most uses. This is mainly due to the fact that this basin is the final discharge area for the Carson River hydrologic system and as such becomes the final receiving area for soluble chemicals transported by the water (Glancy and Katzer 1975). Groundwater movement in the shallow and intermediate aquifers is generally northeastward and eastward toward the Carson Sink (Welch et. al 1997). Flow direction in the basalt aquifer is uncertain due to nearly horizontal gradients. Recharge is supplied mostly by seepage from irrigation canals, the Carson River, flood irrigation, and precipitation in surrounding mountains. Glancy and Katzer (1975) grouped the Carson Desert groundwater into five categories:

1. Large quantities of moderately saline to very saline water that fills most of the valley-fill deposits from relatively shallow to great depths.
2. Unknown quantity of moderately dilute water occurring within a basalt aquifer of apparently local area extent generally about 500 feet below land surface in the Fallon area.
3. Unknown quantities of dilute to moderately dilute water found within, or associated with, recent fluvial sediments generally near present Carson River channels, from shallow to unknown maximum depths.
4. Dilute to moderately dilute water occurring within shallow valley-fill deposits, probably resulting from infiltration or irrigation water beneath or near lands of the Newlands Reclamation Project.
5. Unknown amounts of water of variable chemical quality lie within consolidated rocks.

Domestic water demands for the City of Fallon and the Naval Air Station are met from the basalt aquifer and individual domestic wells. The basalt aquifer water is soft with arsenic concentrations slightly exceeding drinking water standards (Glancy and Katzer 1975). The shallow groundwater that is tapped by individual domestic wells has an uncertain future due to the risk of contamination from septic tanks discharges within, or very close, to the water supply zone (Glancy and Katzer 1975).

5.8 Groundwater Quality Issues of Concern

Groundwater quality in Nevada is regulated by NDEP and is monitored by Federal and State agencies. The USGS has been conducting groundwater monitoring under the National Water-Quality Assessment program since 1991. The program divides the watershed into two different studies, one addressing the Carson and Eagle Valleys and the other for the Dayton, Stagecoach and Churchill Valleys. Some of the main issues of concern for groundwater quality are the following:

5.8.1 Leaking Underground Storage Tanks

Groundwater and soil contamination is occurring from numerous Leaking Underground Storage Tanks (LUSTs). According to NDEP-Bureau of Corrective Actions, the following number of sites were added to the list of LUSTs for the watershed (B&C 2005):

Douglas County (Gardnerville, Minden and Genoa) – 79 sites
Carson City – 208 sites
Lyon County (Dayton, Moundhouse and Silver Springs) – 32 sites
Fallon – 95 sites

The main contaminants from these sites are benzene, toluene, ethylbenzene and xylenes resulting for underground storage tanks containing petroleum products, such as gasoline, diesel, heating oil, kerosene, and jet fuel.

5.8.2 Large Groundwater Contamination Sites

Large groundwater contamination sites are referred to as "plumes". Plumes that have been identified in the watershed (B&C 2005) include:

1. Bentley Plume in Douglas County – pollutants of concern including 1,1,1-Trichloroethane (1,1,1-TCA), trichloroethene (TCE), 1,1-Dichloroethylene (1,1-DCE), and 1,2-Dichloropropane (1,2-DCP).
2. Mallory Plume in Carson City – pollutants of concern include 1,1-DCE, 1,1-Dicloroethane (1,1-DCA) and 1,1,1-TCA.

5.8.3 Septic Tanks

Septic tank usage has been identified as having a large impact on the groundwater quality in the watershed. Rosen (2003) found that the highest nitrate concentrations in groundwater occurred near or directly under areas that have high concentrations of septic tanks. The study found that there is an increasing trend in nitrate and TDS in areas that use septic disposal systems. The study also found that in some locations in Carson Valley there are consistent increases in nitrate concentrations in more that 50 percent of the long-term monitoring wells; and that the highest nitrate concentrations are near the Carson River.

5.9 Reclaimed Water

Discharges of reclaimed water to the Carson River ceased in 1987. The 2005 revised Water Quality Management Plan (208 Plan) for the Carson River may allow discharges to the river in the future under higher levels of treatment. However, it is uncertain if water quality standards will be met even with tertiary treatment. Currently, reclaimed water from Waste Water Treatment Facilities (WWTF) is either discharged to effluent management areas such as rapid infiltration basins (RIB) and leach fields, or the reclaimed water is held until it can be reused as surface irrigation on community and private lands.

The effluent management areas in Carson Valley are Bently Agrowdynamics, Park Cattle Company, and the Buckeye Creek Reservoir. Effluent is stored from November through April, and then discharged to the Bently Agrowdynamics and Park Cattle Company land application sites during the irrigation season. Carson City stores treated effluent during the winter months in golf course water features, the Prison Farm and at the Brunswick Canyon Reservoir. The Brunswick Canyon Reservoir can store up to 3,288 acre-feet of treated effluent. Approximately 2,000 acre-feet are lost annually from the reservoir via evaporation and seepage into the bedrock aquifer. Springs and seeps of the effluent occur around the reservoir and some of the seepage enters the Carson River. Carson City is currently in the process of examining options for the reservoir and the seepage.

The 2005 Water Quality Management Plan for the Carson River contains information on the effluent management areas and specific details on the sources and amounts of reclaimed water being utilized.

5.9.1 South Tahoe Public Utility District Waste Disposal

In 1968, the State of California passed the Porter-Cologne Act, which required that all wastewater be exported out of the Tahoe Basin. Indian Creek Reservoir was constructed in 1969-70 on an ephemeral tributary of Indian Creek, a tributary to the East Fork to store the tertiary wastewater effluent. The largest exporter comes from the southern end of Lake Tahoe, where South Tahoe Public Utility District (STPUD) conveys treated effluent in a pipeline over Luther Pass into Alpine County (CDWR 1991). The water is then delivered to selected agricultural operations for use as a supplemental irrigation supply. Indian Creek Reservoir became euthrophic during the 1970’s and was placed on California’s Section 303(d) list in the 1980’s (LRWQCB Board 2002). STPUD discontinued wastewater disposal to the reservoir in 1989 and acquired water rights to maintain a minimum reservoir level to support recreation uses.

STPUD constructed Harvey Place Reservoir in 1989 for use in storing the Tahoe Basin wastewater. Harvey Place has a capacity of 3,800 acre-feet, including 800 acre-feet of flood storage with an additional 250 acre-feet of dead storage (B&C 2005). Reuse facilities are located on various ranches in Diamond Valley, Wade Valley, Carson Valley and Fredricksburg for crop irrigation. The operation of both reservoirs are controlled by agreements between STPUD and Alpine County, and the use of the effluent for irrigation is limited to specific areas.

5.10 Physical Channel/Reach Characteristics

The extent of the Carson River, including the East and West Forks, encompass a wide range of conditions and differ markedly in fluvial geomorphology, climatic regimes, geology, seismic activity and ecology. Streams in the upper watershed can be classified generally as coarse-bed composed primarily of gravel and cobbles and bedrock controlled areas (e.g. canyons). From Genoa to McTarnahan Bridge the streambed consists primarily of sand. Below Dayton the middle Carson River continues with mostly sand streambed with some localized braiding since about 1980. Although there are several bedrock controlled areas, much of the Carson River and its tributaries may be considered to have sufficient alluvial material and erodable boundaries to be self-forming active alluvial channels. The drainage areas range from 65.4 mi^2 on the East Fork, 356 mi^2 on the West Fork to 1302 mi^2 on the mainstem at Fort Churchill and the stream gage elevations range from 5,754 ft at the West Fork Gage to 4,180 ft at Fort Churchill. Overall due to historic mining, channel straightening, engineering structures, anthropogenic factors and climatic changes the channel has been in many reaches unstable (either aggrading or incising in the main channel) and has adjusted its planform and vertical behavior numerous times on the mainstem in order to meet changes in hydrology and sediment load. As an example Figure 5.10-1 shows how the river has moved from 1903 to 2003 in the area from Genoa, Nevada to Cradlebaugh.

The East Fork of the Carson River drains forested alpine mountains up to 12,000 ft with annual precipitations of more than 800 inches, lower juniper dominated mountain ranges up to 8,700 ft, alluvial valleys occupied by agricultural and housing developments and continues through increasing urban centers such as Minden, Carson City and Dayton. Floods range in degrees of variability from year to year, encompassing over several orders of magnitude at the Carson City gage on the mainstem. The maximum recorded event is 30,500 cfs at the Carson City gage with 65 years of data.

Diversion structures exist throughout the entire river system with the exception of the wilderness areas in Alpine County. The structures withdraw water from the river and in some reaches, during the fall season, as much as 100 percent of the flow is diverted and the riverbed becomes dry. Downstream users become dependent upon upstream return flows. Effects on the river system from the diversion structures can include the reduction of velocity and the creation of backwater areas adjacent to the structures. This can cause aggradation upstream of the structure as the potential for sediment transport is reduced. This local aggradation can also raise streambed elevation, forcing the stream to migrate laterally or become braided. In both cases, greater pressure is put on streambanks and bank erosion is the common response.

In 1996 a fluvial geomorphic study of 110 miles of the Carson River Watershed was sponsored by Western Nevada Resource Conservation & Development, Inc with the support of a large consortium of stakeholders. The fluvial geomorphic report looks anthropogenic manipulations, regional geomorphology, and overall channel stability as characterized by vertical and planform changes, channel capacity, sediment supply and vegetation. Overall the study found that the East Fork and mainstem of the Carson River were in a state of transition and were unstable. Instability ranged from over 10 miles on the East Fork to approximately 40 miles on the mainstem of the Carson River (Inter-Fluve 1996). Identified in the study was the need to account for sediment pulses due to flooding, in which in the Sierra's are noted for large floods.

As part of the Inter-Fluve study (1996) recommendations were made to continue to replicate photo points that had been surveyed in order to assess lateral and vertical changes and periodic assessment of aerial photos. Sediment transport investigations were also considered as a vital component in order to assess relative stability and to promote effective management and designs. Although a hydraulic model was conducted, and qualitative data was collected regarding sediment transport dynamics, there currently exists no watershed or reach based quantitative assessment of sediment storage, routing, incipient motion determinations or indication of sources of potential instability regarding fluxes in sedimentation.

Since 1996 there have been two larger floods (1997 and 2006) punctuated by annual normal to below normal peak flows. During the 2006 flood photo documentation and initial observations suggest that at least 2-3 feet of fine materials were deposited instream and overbank. Instream deposits of sediment effected channel capacity, and when combined with historic channel manipulations and erodable boundaries, there were bank migrations that exceeded 5 feet/day and > 150 feet over the course of 4 months. The effect of sediment deposition has had an overwhelming effect in this section, as the river has moved from a mostly single thread channel prior to 1980 to a braided highly dynamic system currently.

Two other fluvial geomorphic assessments have been conducted on the river system. In 2004 an assessment was completed for the upper watershed in California. During the study, thirty-two reaches were assessed as part of a preliminary survey. Reach characteristics for Wolf Creek, Upper East Fork, Upper West Fork, and Markleeville Creek were documented in MACTEC 2004. Based on the data collected during the preliminary assessment, a list of impaired and reference areas were developed. More in-depth geomorphic analysis was conducted on these reaches. Also, in 2004 an assessment of the system from the Stateline to the Lahontan Reservoir was conducted. Results from the 2004 study are in draft form and in the process of revision.

Historic Movement of the Carson River from 1906-2003

Figure 5.10-1

River Movements

- 1906 Carson River from Genoa Lane to Cradlebaugh
- 1938 Carson River in Carson Valley
- 2003 Carson River in Carson Valley

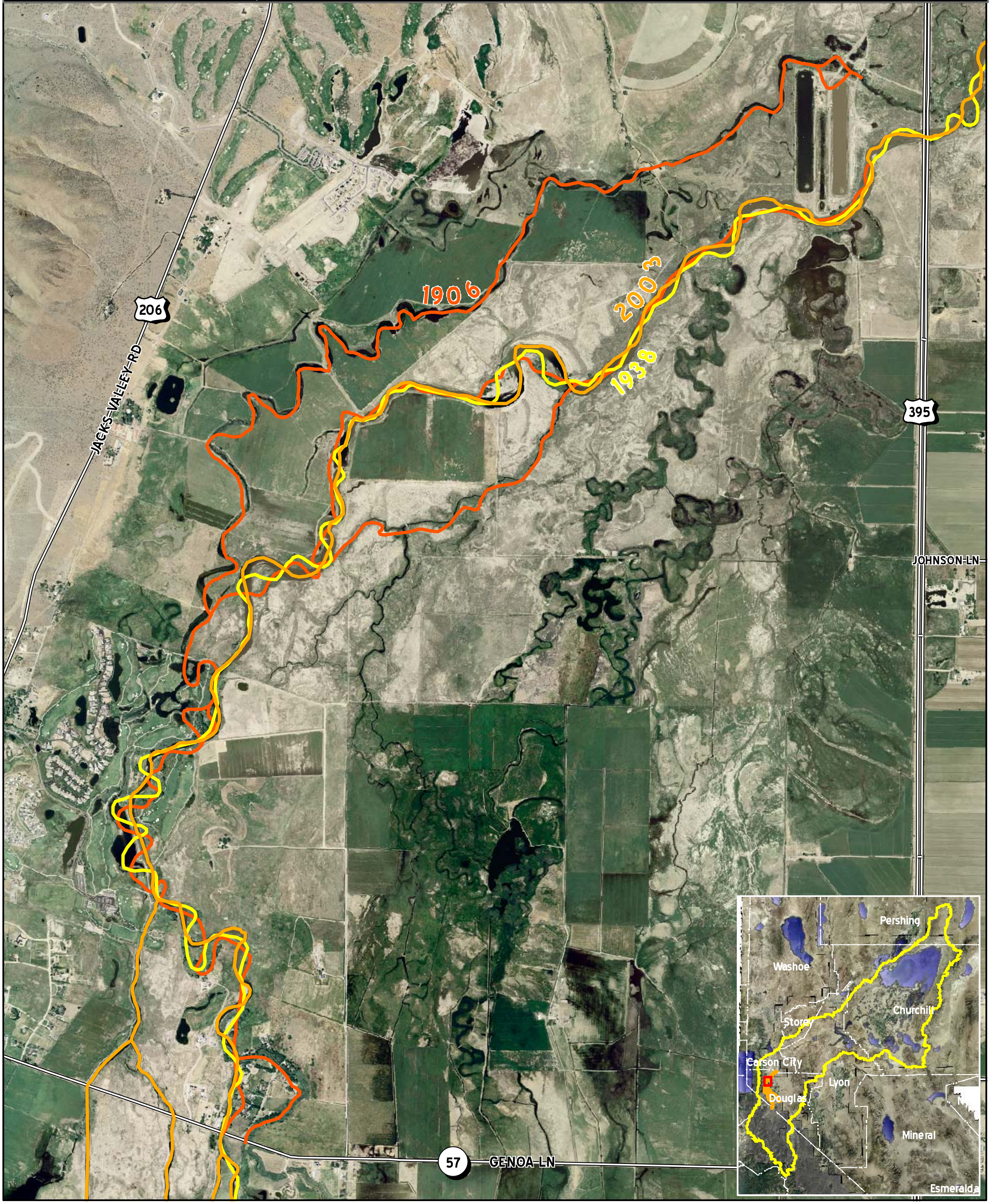


Table 5.10-1 provides a summary of the more in-depth geomorphic analysis that was conducted as part of the 2004 Upper Carson River Watershed Stream Corridor Condition Assessment. Table 5.10-2 provides a summary of the reach characteristics and recovery priory reaches as described in the report by Inter-Fluve (1996). Stability ratings shown in Table 5-10.2 are generally defined as the following:

<u>Very Stable</u>

- Presence of erosion resistant bed and banks
- Excellent riparian vegetation
- Contact with floodplain area
- Absence of levees
- Low land use pressure
- Has bedrock control

<u>Stable</u>

- Minimal human manipulation of the channel or banks
- Good riparian vegetation
- May have some indication of incision but the extent is not greatly affecting overall stability

<u>Moderately unstable</u>

- Evidence of channel incision
- Some eroding banks
- Evidence of mid-channel bars
- Instability on outside bends

<u>Unstable</u>

- Lack of sufficient stabilizing riparian vegetation
- Some likelihood of further channel widening
- High percentage of vertical, steep and/or failing banks

<u>Extremely unstable</u>

- Extreme likelihood of further channel widening
- Significant possibility of continued and more severe aggradation
- Very high percentage of vertical, steep and/or failing banks
- Extreme erodability and instability of existing channel work
- Absence of stabilizing riparian vegetation

Table 5.10-1: Summary of Reach Characteristics for Selected Reaches in Upper Watershed, Alpine County, CA

Reach Name	Channel Stability Rating*	General Characteristics	Restoration Objectives
West Fork-Lower Hope Valley	Moderate	Meadow; streambanks generally stable; some channel incision but appears to be recovering	Increase bank stability; monitor
West Fork-Upper Hope Valley	Moderate to low	Meadow; erosion of streambanks on outside bends; aggradation common throughout reach	Increase bank stability, increase floodplain surfaces
West Fork-Lower Faith Valley	Moderate to low	More entrenched than downstream reaches; large bar deposits; many outside bends eroding; good riparian vegetation; beavers active in reach.	Lengthen channel, grade stabilization
West Fork-Middle & Upper Faith Valley	Moderate to low	Contains a large stable beaver dam; channel stability higher above dam; bank erosion and bar formation below dam; good riparian vegetation	Bank and grade stabilization
East Fork-EF Carson River Gorge	Not provided	Reference reach for East Fork; canyon area; well-developed pool-riffle sequence	Not applicable
East Fork- upstream of EF Carson River Gorge reach	Not provided	Road and levee area; directly influence by Highway 89; canyon area just downstream of EF-6; little to no pool-riffle development	Remove in-channel levees and protect road toe; replace road out of floodplain
Markleeville Creek-upstream of Markleeville	Not provided	Ranges from depositional areas with flat valley to narrow, steep areas; primary impact is large water diversion and lack of woody debris in channel	Maintain in-stream flows; add woody material
Markleeville Creek-Grover Hot Springs	Not provided	Dry meadow area adjacent to Hot Springs; incised channel; new overflow and floodplain have formed in some areas	Revegetate, introduce woody material
Red Lake Creek (West Fork drainage)	Moderate to high	Reference reach for West Fork meadow channels; few eroding banks	Not applicable

Source: MACTEC 2004

Bank Stability:
Low: Significant bank erosion occurring
Moderate: Streambanks are generally stable, but some banks are eroding
High: Very few eroding banks and streambank are generally stable

Table 5.10-2: Summary of Reach Characteristics from Stateline to Lahontan Reservoir

NAC Reach and/or Sub-Reach[3]		Interfluve Reach and/or Sub-Reaches *within* NAC Reach	Interfluve Stability [1] Listed by sub-reach if applicable	Total Length, *miles*	Total Length, *feet*	Restoration Priority	*Approximate* Length of reach/sub-reach targeted for high priority restoration, *feet*	Comments
445A.150 EF Stateline to Hwy 395 (Riverview)		E1 EF Stateline to Washoe Bridge	Stable	10.48	55,334.4	low	**0**	Most of reach difficult to access - in canyon
445A.151 EF 395 to Muller Lane	EF Hwy 395 to HWY 88	E2 Washoe Bridge to Country Club Dr. E3 Country Club Dr. to Lutheran Bridge E4 Lutheran Bridge to Hwy 88	S1 Stable S2 mod.unstable S1, S2 moderately unstable S1 mod. unstable S2 stable	8.53	45,038.4	S1, S2 low S1, S2 high S1, S2 low	**0** **5300** **0**	Erosion after flood - Stabilization project scheduled for 2006 just downstream of Country Club Drive. Site located on bank opposite the Golf Course. Some bank work done after flood between Lutheran and 88.
	EF Hwy 88 to Muller Lane	E5 Hwy 88 to Muller Lane	S1 extremely unstable S2 unstable.	2	10,560	S1 low S2 high	**7800**	Approximately 1/3 of the reach repaired after 1997 Flood. Last 2/3 mile needs restoration/revegetation - landowner is interested.
445A.152 Carson River at Genoa Lane to the EF at Muller Lane and to the WF at Stateline	WF at Stateline to Muller Lane	W1 Waterloo Lane to Muller Lane	Stable	11.23	59,294.4	low	**0**	Interfluve was unable to access property from the WF at Stateline to Waterloo Lane.
	East & West Fork Muller Lane to Genoa Lane	W2 West Fork Muller Lane to Genoa E6 East Fork Muller Lane to Genoa	Both moderately unstable	4.59	24,235.2	WF - low EF - high	**0** **13,800**	Total Mileage is length of EF + WF reach. Work on West Fork channel proposed by The Nature Conservancy. Landowners have expressed interest in restoration on the EF stretch.
445A.153 Carson River at Genoa Lane to Cradlebaugh Bridge		C1 Genoa Lane to Cradlebaugh Bridge	Willow Bend - stable Remainder of reach - moderately unstable	5.88	31,046.4	high	**31,046.4**	Erosion has been occurring along Willow Bend section - stabilization project scheduled for 2006. Overall, reach is highly incised with minimal residential development. Potential for corridor protection high.
445A.154 Carson River at Cradlebaugh Bridge to Mexican Ditch Gage		C2 Cradlebaugh to Old McTarnahan Bridge	S1 moderately unstable S2 stable S3 unstable.	6.34	33,475.2	S1, S2 low S3 high	**0** **10,000**	1st two sub reaches now in easement (Kirman Field) and will be managed by The Nature Conservancy using minimal grazing, fencing and passive restoration. A more detailed description under Implementation.
445A.155 Carson River at Mexican Ditch Gage to New Empire		C3 Old McTarnahan to Deer Run Road	S1 moderately unstable - section between USGS Gage & Dam not rated. S2 very stable S3 stable	7.82	41,289.6	S1 low S2,S3 low	**0** **0**	Eroding, vertical bank occurred after flood through Ambrose Nature Area across from Empire Golf Course in Carson City was repaired in 2002 using bioengineering methods. City working with Landowners along river in S2 & S3 to preserve ag land in open space. No active bank restoration proposed.
445A.156 Carson River at New Empire to Dayton Bridge		C4 Deer Run Road to Ricci Diversion C5 Ricci Diversion to Dayton Bridge	very stable 1st part of reach not rated S1 stable S2 moderately unstable	16.82	88,809.6	low S1 low S2 high	**0** **3800**	Most of C4 in Carson Canyon. Trash clean-up & trail enhancement - future Q1 project. New development has sparked increased discussion regarding floodplain encroachment & mercury contamination downstream of canyon. DVCD has completed several restoration/stabilization projects since 1997.
445A.157 Carson River at Dayton Bridge to Weeks Bridge		C6 Dayton Bridge to Quilici/Minor Property C7 Quilici/Minor Property to Chavez Diversion C8 Chavez Diversion to Break-a-heart (just upstream Houghman Howard Diversion) C9 Houghman Howard Diversion to Buckland Station *Bridge* (Weeks Bridge)	S1 stable S2 mod. unstable S3, S4 unstable S5 mod. unstable S6 extremely unstable S1 mod. unstable S2 unstable S3 stable S1, S2 unstable very small section at end of reach - stable S1 unstable, very end of reach - moderately unstable S2 unstable	25.5	134,640	S1 low S2-S6 high S1,S2 high S3 low S1,S2 low S1,S2 high	**0** **17,600** **8760** **0** **0** **35,390**	A bioengineering project was completed in 1998 within the unstable section (Glancy Property) of the Quilici-Minor Property to Chavez Diversion Reach. The Glancy Property is also the downstream end of a series of 10 projects in Dayton Valley that were monitored over a 5 year period by the DVCD for changes in vegetation, cross section and water quality. Discussion of this long-term project is listed in Section 7.0. Buckland *Diversion* to Weeks is considered high priority because the reach includes the Fort Churchill State Park.

Source: Interfluve 1996

5.11 Potential Causes of Non-Point Source Pollution

This section addresses **element "a"** of the required elements of a watershed-based plan funded by the 319(h) program:

a. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in watershed plan.

Unlike pollution from distinct, identifiable point sources, non-point source (NPS) pollution comes from diffuse sources. NPS is defined in The State of Nevada's Nonpoint Source Management Program (NDEP 1999) as "pollution that is contained in stormwater or snowmelt runoff as it moves over land surfaces. The pollution can directly impact surface bodies of water or percolate through the soil and reach the groundwater." Characteristically, NPS pollution responds to hydrological conditions, is not easily measured or controlled directly (and therefore is difficult to regulate), and focuses on land use and related management practices. Major water quality impacts to the Carson River watershed are currently attributed to NPS pollution**.**

Nonpoint Source Pollution responses to hydrological conditions, is not easily measured or controlled directly, and is therefore difficult to regulate.

Under the federal Clean Water Act (CWA), states are required to develop NPS Pollution Management Programs. California's NPS Pollution Control Program (SWRCB 2000) describes NPS pollution as the leading cause of water quality impairments in California and the nation. This plan provides strategies and implementation plans that include the development of regional watershed management initiatives and total maximum daily loads (TMDLs). Potential NPS pollution sources that are identified in California's plan include mining, livestock, grazing, recreational use, and highway and urban run-off. The State of Nevada's Nonpoint Source Management Program identifies three major areas of concern--urbanization, agricultural issues, and hydrologic modifications (NDEP 1999). General land use activities that can contribute to NPS pollution are summarized in Table 5.11.1.

Table 5.11-1 Contributing Land Use Activities to Nonpoint Source Pollution

Land Use	Activities	Pollution Problems
Urban Development	Automobile maintenance, lawn and garden care, painting, pet waste, stormwater	Oil, gas, antifreeze, nitrate, heavy metals, phosphate, pesticides, paints, bacteria
Mining	Mineral excavation/extraction, gravel	Sediment, heavy metals, acid drainage, nitrate, phosphate
Forestry/Silviculture	Timber harvesting, road construction, fire control, weed control	Sediment, pesticides
Land Disposal	Septic systems, treated effluent	Bacteria, nitrate, phosphate
Agriculture	Flood irrigation, tillage, cultivation of alfalfa and pasture grass, pest control, fertilization, animal waste management	Sediment, nitrogen, phosphorus, pesticides, bacteria
Construction	Land clearing and grading	Sediment

The 208 Plan reports that current and future NPS pollution concerns in the watershed are mostly related to rapid urbanization of agricultural lands and subsequent loss of landscape features that prevent degradation of water quality in wetlands, floodplains, and riparian areas (B&C 2005). Potential causes of NPS pollution that are of specific concern to the Carson River Watershed are addressed in more detail in the following subsections.

5.11.1 Construction & Urban Development

The watershed is experiencing unprecedented growth. Agricultural lands in the Carson, Eagle and Dayton Valleys are being taken out of production and converted to residential and commercial development. Construction activities associated with this urban development, including roadway projects, are potential causes of NPS pollution.

5.11.2 Urban Run-Off

Urbanization is encroaching upon the riparian corridor, filling in critical floodplain and wetlands, creating more impervious surfaces and subsequently increasing the volume of runoff. Stormwater and urban run-off reaching the Carson River may contain a variety of pollutants:

- Excess sediment from new construction and already-developed areas;
- Oil, grease, toxic chemicals and heavy metals from automobiles;
- Pesticides and nutrients from fertilizers used in turf management and gardening;
- Pathogens from failing septic systems or pet waste; and
- Road salts.

Storm sewer systems may transport contaminated runoff directly into water bodies without any type of treatment. Increased pollutant loads can result in harm to fish and wildlife, kill off native vegetation, foul drinking water supplies, and create unsanitary conditions in recreation areas. Runoff also absorbs heat from concrete and other impervious surfaces, discharging the warmer water to streams, rivers and lakes. This increase in temperature is detrimental to aquatic life.

5.11.3 Hydrologic Modifications

"Virtually every mile of the Carson River system has been affected by human activities…."

The Carson River has highly erodable riverbanks and a history of channel instability. Anthropogenic activities that alter hydrology, such as channelization, dredging, flow regulation, and stream bank modifications have adversely impacted the watershed. These activities can result in increased erosion and sediment loading, growth of invasive weeds and loss of wildlife habitat. Historic impacts, such as the massive wood drives that occurred during the Comstock Mining Era, would have scoured the riverbanks of vegetation. Flood attenuation and pollutant filtering benefits of floodplains and wetland areas are lost when these features are removed for urban development. Interfluve (1996) states: "*Virtually every mile of the Carson River system has been affected by human activities, which range from the direct effects of land use activities and irrigation withdrawals. Furthermore, those few areas which* *have not been directly affected are indirectly affected by upstream or downstream instability and imbalances".*

5.11.4 Channelization and Levees

The East Fork through Carson Valley is the most heavily channelized portion of the Carson River.

The most significant channelization and levee projects were conducted along approximately 70 miles of the Carson River by the Bureau of Reclamation (BOR) from 1962 to 1965 (Interfluve 1996). Approximately one million cubic yards of gravel was moved into the channel and 36,000 cubic yards was used to construct the levees along 3 miles of banks. The project involved channel relocation and the reduction of channel sinuosity. Multiple channels were confined to a single, wider channel and riprap was added to the channel banks and diversions (Interfluve 1996). The most heavily channelized portion of the Carson River occurs on the East Fork through Carson Valley. According to Interfluve (1996) the most common response to river channelization is increased erosion of the channel bed that results in incision. Interfluve (1996) also states:

The most common response to river channelization is increased erosion of the channel bed that results in incision.

> *"In addition to incision in reaches confined by levees, upstream and downstream effects of levee construction may include downstream sediment excesses, resulting from bed and bank erosion, and upstream incision due to headcut migration. Furthermore, levees reduce the frequency of floodplain inundation, thereby, limiting floodplain energy dispersal and sediment storage and the potential for productive riparian zones".*

5.11.5 Roads and Bridges

Roads and bridges alter and concentrate flow paths that can increase sediment supply to the channel. Undersized bridge culverts can clog during peak and flood events, resulting in the washout of the road or gully formation when the flow path is changed. Sediment supplied from roads can be grouped into two classes (MACTEC 2004):

- Large-scale failures that occur during large storm events and deliver high volumes of sediment
- Chronic production of finer sediment that occurs during brief, low intensity storm events at lower rates over longer periods.

5.11.6 Agriculture

Agriculture has played a significant role in the history of the watershed and will continue to be an important component. Although development pressures are changing the rural face of the watershed, much of the land use adjacent to the river is still agricultural. Table 5.11.6-1 shows generalized potential NPS pollution impacts that can result from agricultural operations.

Table 5.11.6-1: Potential Impacts to Surface and Groundwater from Agricultural Activities

Agricultural activity	Potential Impacts	
	Surface water	Groundwater
Tillage/ploughing	Sediment/turbidity: sediments carry phosphorus and pesticides adsorbed to sediment particles; siltation of river beds and loss of habitat, spawning ground, etc.	
Fertilizing	Runoff of nutrients, especially phosphorus, excess algae growth leading to deoxygenation of water and potential fish kills.	Leaching of nitrate to groundwater, excessive levels are a threat to public health.
Manure spreading	Carried out as a fertilizer activity; spreading on frozen ground results in high levels of contamination of receiving waters by pathogens, metals, phosphorus and nitrogen leading to eutrophication and potential contamination.	Contamination of groundwater, especially by nitrogen
Pesticides	Runoff of pesticides can lead to contamination of surface water and biota; dysfunction of ecological systems in surface waters by loss of top predators due to growth inhibition and reproductive failure; public health impacts from eating contaminated fish. Pesticides are carried as dust by wind over very long distances and contaminate aquatic systems 1000s of miles away (e.g. tropical/subtropical pesticides found in Arctic mammals).	Some pesticides may leach into groundwater causing human health problems from contaminated wells.
Feedlots/animal corrals	Contamination of surface water with many pathogens (bacteria, viruses, etc.) leading to chronic public health problems. Also contamination by metals contained in urine and feces.	Potential leaching of nitrogen, metals, etc. to groundwater.
Irrigation	Runoff of salts leading to salinization of surface waters; runoff of fertilizers and pesticides to surface waters with ecological damage, bioaccumulation in edible fish species, etc. High levels of trace elements, such as selenium, can occur with serious ecological damage and potential human health impacts.	Enrichment of groundwater with salts, nutrients (especially nitrate).

Source: Ongley, Edwin 1996

Although farming and ranching can contribute to NPS pollution, agricultural land has aesthetic value and provides food, open space, wildlife habitat, groundwater recharge, and protection of critical floodplain areas. All of the county master plans contain a goal to preserve agriculture. Although best management practices (BMPs) are utilized on many of the ranches and farms to decrease NPS pollution problems still exist. Some of the specific issues of concern related to agricultural lands in the Carson River watershed are described in the following subsections.

5.11.6.1 Phosphorus

Elevated levels of total phosphorus and orthophosphate are a concern in Carson Valley. According to a study conducted by the USGS (2004), the estimated annual total phosphorus (TP) loads measured from 2001 to 2002 ranged from 1.33 tons at the West Fork Carson River at Woodfords to 43.41 tons near Carson City. Average annual loads entering Carson Valley were estimated at 21.9 tons, and loads leaving the valley were estimated at 37.8. This represents an annual gain in TP load across the valley of 15.9 tons during the study time period. Loading appears to correlate with stream flow. TP loads are greatest during spring run-off and lowest during the summer. USGS (2004) states that the amount of phosphorus in runoff from agricultural land is largely dependent upon the time, amount, and intensity of rainfall. The amount of fertilizers applied to fields is also critical in determining the amount of phosphorus in field runoff. Surface return flows were found to contain greater concentrations of TP and orthophosphate than in irrigation waters. The study also found that the composition of the phosphorus changed during summer months from particulate phosphorus entering Carson Valley to dissolved orthophosphate leaving Carson Valley. The reason for this has not yet been determined but may be the result of direct discharges of dissolved phosphorus into the river through return flow, livestock manure, or organic matter decay.

A Total Maximum Daily Load (TMDL) for TP was developed by NDEP and has been approved by USEPA. The TMDL is discussed in detail in Section 6.0.

5.11.6.2 Grazing and Loss of Riparian Vegetation

Grazing impacts riparian vegetation through trampling and browsing. The loss of vegetation on streambanks due to grazing tends to result in higher rates of bank erosion and increased sediment supply (MACTEC 2004).

Animal grazing near the Carson River and its tributaries may be an important source of phosphorus to surface waters in addition to increased sediment and erosion (USGS 2004). Animal waste is rich in phosphorus and can make its way to surface waters by direct contact or by runoff. According to USGS (2004), the season plays an important role in nutrient loading from animal waste. Winter months tend to generate more nutrient movement because of the combination of rainfall and snowmelt.

5.11.6.3 Dairies

There are currently only two dairies in operation in the upper watershed (B&C 2005). The Churia Dairy is located in Gardnerville, Nevada (Appendix F, Map #3) and has approximately 150 head of cattle; and the Prison Dairy, located in Carson City, Nevada, (Appendix F, Map #6) has approximately 243 head of cattle. The Churia Dairy is considering either building a pond to contain dairy effluent or selling the herd (B&C 2005). Runoff from concentrated animal feeding operations can increase nutrient and bacteria concentrations in surface waters. In the Newlands Project there are approximately 27 dairies currently in operation.

5.11.6.4 Diversions and Irrigation

The primary use of Carson River water is for agricultural purposes and, as a result, diversion structures exist throughout the river system. In Alpine County, the irrigation diversions are limited to the West Fork in the Diamond Valley area (MACTEC 2004). All of the diversion structures withdraw water from the river and, depending upon the season, as much as 100% of the flow can be diverted, removing flow needed for healthy riparian vegetation growth and aquatic life. The majority of the diversion structures are permanent, but there are also some “push-up” structures that are used. According to Interfluve (1996) “without exception, the permanent diversion structures observed along the Carson River showed aggradation upstream of the structure and incision below the structure.”

5.11.8 Effluent Reuse

Direct, point source discharges from wastewater treatment facilities (WWTFs) to the Carson River ceased in 1987 (B&C 2005). The 2005 revision of the Carson Basin Water Quality 208 Plan does allow for discharges to the river, but the discharge must meet water quality standards and beneficial use criteria. This would require treating the water to a higher level of treatment that the WWTFs currently do.

Currently, effluent from WWTFs is reused as surface irrigation on community and private lands, such as golf courses, ranches, farms, school, parks and residential developments. The use of effluent as irrigation water has the potential to pollute the Carson River if improper irrigation management practices are used.

5.11.9 Septic Tanks

The results of a study conducted by USGS (Rosen 2003) indicate that nitrate and total dissolved solids concentrations are increasing in over 50 percent of the groundwater monitoring wells in Carson Valley that were sampled over a 16-year period. The report states the likely cause of the increases is related to the increase in septic-tank usage over the past 40 years. The concentrations were mostly below the USEPA MCL for nitrate (10 mg/L) and the Nevada State secondary MCL for TDS (500 mg/L), but an upward trend is evident. Some of the highest concentrations were found in areas near the Carson River. For more detailed information on the nitrate study please refer to Shipley & Rosen (2005).

5.11.10 Mass Wasting and Natural Sediment Transport

Geology plays an important role in the processes of erosion and sedimentation. The upper watershed contains volcanic and granite rocks, both of which are very erosive. Along the East Fork in Alpine County, the slopes are steep and channels are deeply incised volcanic material (MACTEC 2004). The upper reaches of the West Fork also exhibit a similar terrain, but granite rock is more common. According to MACTEC (2004) the East Fork has significantly higher natural sediment transport than the West Fork. Throughout the upper watershed storm events can supply large amounts of sediment to the main channels from the tributaries. Channel erosion of the main channels during these events may also be high, resulting in additional sediment loading.

Throughout the upper watershed storm events can supply large amounts of sediment to the main channels from the tributaries.

Mass wasting processes, such as debris flows and landslides, contributes to the sediment load in the Carson River. Debris flows can move masses of water, fine sediment, larger sediment clasts and woody debris quickly. Evidence of debris flows is found throughout the East Fork drainage, particularly in the Wolf Creek drainage (MACTEC 2004). The upper West Fork drainage may also experience debris flows in areas associated with volcanic geology. Large landslides are common throughout the East Fork drainage and can contribute large amounts of sediment and cause changes in channel slope. There is an active landslide that dates back to the 1960's just downstream of the Wolf Creek confluence with the East Fork. During high magnitude storm events the landslide is undercut, causing instability and subsequent material movement. The most recent occurrence was during the flood of 1997.

5.11.11 Mining

NPS pollution from mining related activities is the result of historic operations and is described below.

5.11.11.1 Colorado Hill Historic Mining Area

The Colorado Hill Historic Mining Area, located on land managed by the Humboldt-Toiyabe National Forest (HTNF), contains numerous abandoned mines, including the Zaca Mine Complex. Remediation activities being addressed include acidic, metals laden water discharging from abandoned mine portals and mine waste piles impacting Monitor Creek, a tributary to the East Fork. Impacts to the creek include elevated levels of beryllium, aluminum, cadmium, copper, iron, manganese, pH, sulfate, TDS and zinc. Currently, HTNF and the USFS are working together to address these issues.

5.11.11.2 Leviathan Mine

As stated in Section 3.0, during its active years the Leviathan Mine contributed about 22 million tons of over burden containing large amounts of sulfide minerals to the surrounding areas. The site was designated a federal Superfund site in 2000. Clean-up efforts began in 1985, after the State of California purchased the property. Several pollution abatement projects have been installed at the site to capture and treat the acidic waters generated by the mine site. Water chemistry, aquatic insect and fish life are showing improvements in Bryant and Leviathan Creeks during the treatment season (USEPA 2004).

The USEPA is working toward the implementation of a year round treatment system. This system will reduce environmental damages and risk to humans from the untreated acid and dissolved metals flowing into the small creeks. The year round treatment will also help to further evaluate the risks once the acid and metals no longer can enter the creeks. USEPA plans to measure the remaining metals left in the creek beds and soils to establish what other cleanup measures will be necessary for long term protection.

5.11.11.3 Carson River Mercury Site

As stated in Section 3.0 during the Comstock Mining era an estimated 14 million pounds of mercury was deposited in the channel sediments and floodplain deposits of the Carson River, largely along the 70-mile stretch between Carson City and Fallon. The area was declared a Superfund site in 1995.

Currently, the area within and around the site is experiencing significant growth pressures. Numerous housing developments are being built and more are being proposed. The NDEP BCA requires that developers must demonstrate that the top two feet of soil is below the EPA action level of 80 mg/kg (Jackson 2005). If the soil samples are not below this threshold, the developer must either: 1) remove the contaminated soil and landfill; or, 2) depending upon the grading, bring in two feet of clean soil. NDEP BCA (per com. Jackson 2005) states that due to development pressures at the site, the requirements for residential development are currently being reviewed and will be updated.