Staff Report

TOTAL MAXIMUM DAILY LOAD FOR SEDIMENT

MIDDLE TRUCKEE RIVER WATERSHED
PLACER, NEVADA AND SIERRA COUNTIES
Includes Gray and Bronco Creeks

MAY 2008

California Regional Water Quality Control Board, Lahontan Region
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EXECUTIVE SUMMARY

The middle Truckee River Watershed Total Maximum Daily Load (TMDL) is a plan to attain sediment-related water quality objectives, focusing on narrative objectives set to protect in-stream aquatic life beneficial uses. The beneficial uses of concern are those related to the protection of early life stage aquatic organisms (COLD and SPWN).

This TMDL addresses the segment of the Truckee River from the outflow of Lake Tahoe at Tahoe City to the California/Nevada state line. This reach flows through the eastern parts of Placer, Nevada and Sierra counties, and is commonly referred to as the middle Truckee River. The TMDL also addresses Gray and Bronco creeks, which are adjacent drainages located in the eastern portion of the Truckee River basin, near the California-Nevada state line. The watersheds are rugged, mostly undeveloped areas, with few controllable sediment sources. No data are available to support that Gray or Bronco creeks were listed due to beneficial use impairment in the creeks; rather, the listings were based on reports of sediment discharges from the creeks to the Truckee River during thunderstorm events. Therefore, this TMDL establishes watershed-wide sediment load reductions that are protective of beneficial uses in the Truckee River, and sets load allocations for Gray and Bronco creeks to address their 303(d) listings.

Problem Statement

At higher stream flows, suspended sediment concentrations in the Truckee River are above those recommended for aquatic life protection, particularly at the Farad gauging station at the downstream end of the TMDL project area. Continuous turbidity monitoring conducted in 2002 and 2003 indicates that flow events resulting from thunderstorms, snow melt and dam releases produce turbidity spikes that exceed the water quality objective. Studies of aquatic insect populations in the river indicate that as deposited sediment volumes increase, the diversity and structure of these communities shift toward more sediment-tolerant species. Lastly, the watershed's population has increased significantly over the last decade and major development and population growth is planned over the next 10 years in formerly undeveloped areas. Increased sedimentation to stream channels is linked to urbanization associated with high growth and population density, accompanied by development in erosion-sensitive landscapes.

Desired Conditions

Desired conditions in the Truckee River are expressed by a numeric target for in-stream suspended sediment that is protective of aquatic life, with an emphasis on early life-stage salmonids (e.g., rainbow, cutthroat and brown trout). Based on a review of scientific literature and analysis of 30 years of suspended sediment data in the river, suspended sediment concentrations in the Truckee River should be less than or equal to 25 milligrams per liter, as an annual 90th percentile value.

Desired conditions are also expressed by implementation actions needed to control sediment discharges and improve in-stream conditions in the Truckee River. Specific implementation actions were identified based on the source assessment, which showed that control of storm water runoff from urban areas, dirt roads, graded ski runs, and legacy sites (past land or in-stream disturbances that have ongoing impacts) is needed to minimize sediment discharges from these sources.

Source Assessment

The annual suspended sediment load estimated for the Truckee River at the Farad gauging station is approximately 50,300 tons, based on an above average water year (1996-1997). This is a broad estimate which will vary significantly depending on the characteristics and magnitude of runoff for any given water year. The primary sources are dirt roads, urban storm water runoff, legacy erosion sites, and in some subwatersheds, graded ski runs. Continuous turbidity monitoring in the river during 2002 and 2003 shows that sediment loading "pulses" attributed to thunderstorms, snowmelt periods and dam releases may account for up to half the total sediment loading.

Loading Capacity

The suspended sediment loading capacity is derived from a mathematical comparison of long-term suspended sediment concentrations in the river and those recommended in literature to provide high quality early life stage aquatic habitat. It is estimated that a 20 percent reduction in overall sediment loading is needed to achieve desired in-stream conditions; therefore, the loading capacity is 40,300 tons per year, based on water year 1996-1997.

TMDL and Allocations

The TMDL is the sum of wasteload allocations for point sources [National Pollutant Discharge Elimination System (NPDES)-regulated sources], load allocations for nonpoint sources, and a margin of safety. The allowable sediment load (i.e., the loading capacity) is allocated to the existing urban and non-urban sources and future development in the watershed. The allocations reflect conservative assumptions about the efficiencies of sediment and erosion control practices that will reduce sediment loading to the river, resulting in TMDL attainment over time. TMDL attainment will be evaluated through the TMDL targets that express desired conditions in the watershed, rather than sediment mass reductions. This is appropriate since sediment mass reductions are not a practical indication of beneficial use protection due to the inherent natural variability of sediment delivery and the uncertainties associated with accurately measuring sediment loads and reductions.

Margin of Safety, Seasonal Variation and Critical Conditions

The Truckee River TMDL includes an implicit margin of safety. Conservative assumptions that comprise the implicit margin of safety were incorporated into data interpretations and analysis throughout the TMDL, including the use of a high water year to base loading estimates, and conservative assumptions regarding the ability to reduce sediment loading through management practices.

Seasonal variations are accounted for by expression of the SSC target as an annual 90th percentile value, allowing for fluctuations in SSC over the target limit, while providing a high level of protection for sensitive aquatic life stages.

Implementation and Monitoring Plan

Implementation of the TMDL is based on continuation and improvement of existing erosion control and monitoring programs, newly issued NPDES municipal storm water permits, and cooperative agreements with other state and federal agencies.

Existing Waste Discharge Requirements (WDRs) contain requirements to control sediment discharges from construction projects, highway operations and maintenance, and facilities with long-term operations such as ski resorts or industrial areas. Newly issued NPDES municipal permits for the Town of Truckee's and Placer County's jurisdictions in the watershed contain similar requirements. Water quality improvement projects undertaken by entities such as the USFS-Tahoe National Forest, the Tahoe Donner Land Trust, and the Truckee River Watershed Council will complement the Water Board's regulatory activities to meet the TMDL.

Tracking of implementation indicators and compliance with sediment and erosion control requirements in permits will help Water Board staff and the public assess progress toward meeting the TMDL. Monthly monitoring of suspended sediment concentrations in the Truckee River will track the in-stream response to improving upland conditions.

1. INTRODUCTION

The Lahontan Regional Water Quality Control Board (Water Board) is the California state agency responsible for water quality protection east of the Sierra Nevada crest. It is one of nine Water Boards in California, each generally separated by hydrological boundaries. Each Water Board consists of nine governor-appointed members who serve four-year terms. The Water Board, under its federally designated authority, administers the Clean Water Act (CWA) within the Lahontan Region.

In accordance with the CWA, the Water Board has adopted the *Water Quality Control Plan for the Lahontan Region* (Basin Plan) that specifies water quality standards for waters in the Lahontan Region and implementation measures to enforce those standards. Section 305(b) of the CWA mandates biennial assessment of the nation's water resources to identify and list waters not meeting their water quality standards. These waters are listed in accordance with CWA Section 303(d) and the list is commonly referred to as the 303(d) list. The CWA requires states to establish a priority ranking for impaired waters and to develop and implement Total Maximum Daily Loads (TMDLs) to address the impairments.

A TMDL is a written, quantitative assessment of water quality problems and contributing pollutant sources. It identifies one or more numeric targets for restoring beneficial uses based on applicable water quality standards, specifies the maximum pollutant load that can be discharged and still meet water quality standards, allocates pollutant loads among sources in the watershed and provides a basis for taking actions needed to meet the numeric target(s) and water quality standards.

This TMDL covers the segment of the Truckee River between the outlet of Lake Tahoe and the California/Nevada state line, which is also known as the middle Truckee River. The segment above Lake Tahoe is commonly referred to as the upper Truckee River and the segment below the California/Nevada state line is referred to as the lower Truckee River. Unless otherwise noted, references to the Truckee River in this document address the middle segment of the Truckee River as defined above.

In 1991, the Water Board adopted Resolution No. 6-91-937 (Lahontan RWQCB, 1991), approving revisions to the Regional Water Quality Assessment database, including the recommended addition of the Truckee River and two of its tributaries, Gray and Bronco creeks, to the 303(d) list because of excessive sedimentation. The resolution was subsequently approved by both the State Water Resources Control Board and the US Environmental Protection Agency.

The Truckee River was listed based on information from the California Department of Fish and Game (Messersmith, 1990) that identified substrate and fish habitat loss in the river due to siltation. No data are available that show that Gray or Bronco creeks were listed due to beneficial use impairment in the creeks; rather, the listings were based on reports of sediment discharges from the creeks to the Truckee River during thunderstorm events. Therefore, this TMDL establishes watershed-wide sediment load reductions that are protective of beneficial uses in the Truckee River, and sets load allocations for Gray and Bronco creeks to address their 303(d) listings.

The Water Board proposes to amend its Basin Plan to incorporate a TMDL and implementation plan to address sedimentation problems adversely affecting water quality in the Truckee River watershed. This TMDL staff report describes the scientific and technical basis for confirming sediment impacts, developing numeric targets, determining sediment sources, and establishing watershed loading capacity.

2. BACKGROUND

This section presents:

- Descriptions of the Truckee River watershed, including Gray and Bronco creek subwatersheds
- Designated beneficial uses and applicable sediment-related water quality objectives for the Truckee River hydrologic unit

2.1 DESCRIPTION OF THE WATERSHED

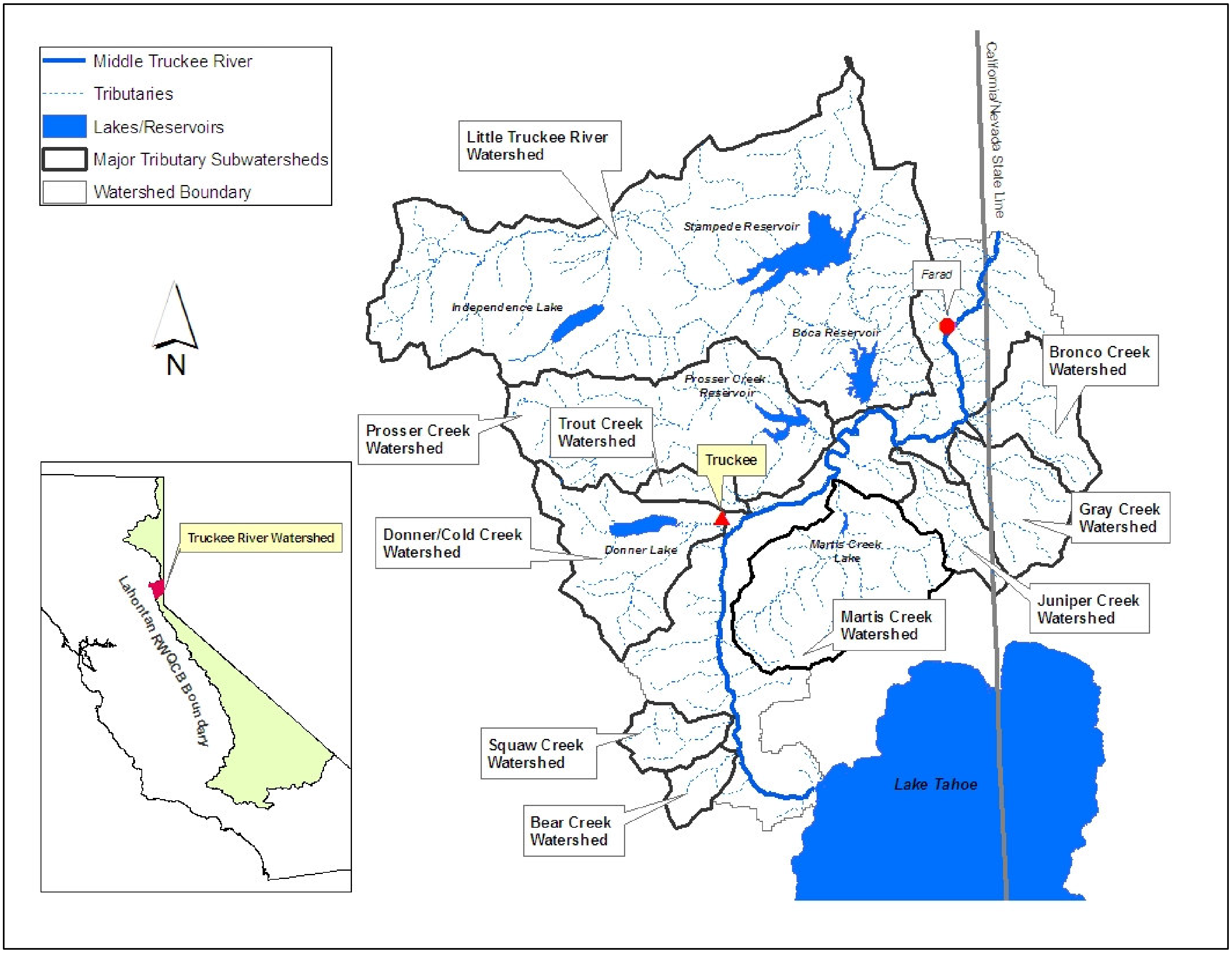
2.1.1 Location and General Characteristics

The entire Truckee River watershed covers approximately 2,720 square miles (Desert Research Institute [DRI], 2001) and includes the Lake Tahoe, Truckee River, and Pyramid Lake systems in California and Nevada. The river has its headwaters in California's Sierra Nevada Mountains, where it flows into the southern end of Lake Tahoe. This reach, from the headwaters to South Lake Tahoe, is known as the upper Truckee River. At the northern end of Lake Tahoe, a small concrete dam controls the lake's outflow into the Truckee River at Tahoe City, where it flows generally north and east toward its terminus in Pyramid Lake, Nevada.

This TMDL assessment focuses on the Truckee River from the outflow of Lake Tahoe at Tahoe City to the California/Nevada state line (Hydrologic Unit 636.00 and Hydrologic Area 635.20). This reach flows through the eastern parts of Placer, Nevada and Sierra counties. The project area is commonly referred to as the middle Truckee River watershed, and contains 428 square miles of mountainous topography, with a significant portion of the area above 6,000 feet in elevation (DRI, 2001). Figure 2.1 shows the watershed's location in eastern California.

Major tributaries to the Truckee River in California include Bear, Squaw, Donner/Cold, Trout, Martis, Prosser, Juniper, Gray and Bronco creeks, and the Little Truckee River. The subwatersheds containing these tributaries comprise approximately 80 percent of the project area. The other 20 percent of the project area is comprised of intervening zones, where surface runoff enters the Truckee River without first discharging through a stream channel, and minor tributary subwatersheds such as Deep, Pole, Cabin and Silver creeks. Dam-regulated impoundments include Lake Tahoe, Donner, Independence, and Webber Lakes, and Boca, Stampede, Prosser Creek, and Martis Creek Reservoirs.

Figure 2-1. Location of the Truckee River Watershed and Major Subwatersheds.



Elevations in the area range from about 5,050 feet at the California/Nevada State line to 10,778 feet at the summit of Mount Rose, Nevada. The river's elevation drops from 6,225 feet at the outlet at Tahoe City to 5,050 feet at the California/Nevada state line, a distance of 39 miles. Tributary streams to the Truckee River are characterized by steep gradients in narrow, steep-walled canyons, except where the region was glaciated; in these areas, stream channels are broad and flat (Convay et al., 1996, in Truckee River Watershed Council [TRWC], 2002).

Gray and Bronco Creek Watersheds

Gray and Bronco creek watersheds are adjacent drainages located in the eastern portion of the Truckee River TMDL project area, near the California/Nevada state line (Figure 2-1). They discharge into the Truckee River upstream of the US Geological Survey's (USGS) gauging station at Farad in Nevada County. Both creeks have their headwaters in the Mount Rose wilderness area of Nevada, and the majority of their drainage areas are in Nevada. Gray Creek's watershed area is approximately 18 square miles, with the lower 3.8 square miles located in California. The Truckee-Donner Land Trust, California Department of Fish and Game and private individuals are the primary landowners in the California portion of Gray Creek (Northwest Hydraulic Consultants [NHC], 2006). Bronco Creek's drainage area is approximately 16 square miles, with less than one square mile in California. The majority of the Bronco Creek watershed is located on Humboldt-Toiyabe National Forest land. A small parcel near the Truckee River-Bronco Creek confluence is privately owned.

The watersheds are characterized by large areas of erodible volcanic rocks that yield high rates of sediment production; both have steep slopes and relatively narrow, alluvial valleys. Small tributaries in the lower portions of the drainages have extremely high gradients, and intense rain events may be capable of generating substantial runoff and erosion of the steep slopes. Aerial photographs indicate large areas of exposed bedrock and there appears to be little stabilizing vegetation throughout the watersheds (DRI, 2001). The Martis fire in 2001 resulted in a further loss of vegetation in both areas.

The watersheds are rugged, mostly undeveloped areas. Sheep grazing occurred historically in the watersheds, but is not a current land use. Land uses that contribute to excessive sediment within the watersheds are primarily construction and maintenance of roads and trails associated with logging, fire suppression and recreation. Many of the roads are no longer maintained and are now impassable due to erosion, logs and other debris, or damage to bridges (NHC, 2006). The US Geological Survey's (USGS's) *National Land Cover Dataset* shows shrub and brush rangeland and evergreen forestland as the primary cover types. Available data generally indicate that the most important erosion sources in the watersheds are naturally erosive soils on steep, poorly vegetated slopes, although relict roads may exacerbate sediment delivery to stream channels (NHC, 2006; DRI, 2001; US Fish and Wildlife Service [FWS] et al., 2002).

2.1.2 Development and Land Use

Historical Development

The Truckee area began attracting settlers in the 1860s, primarily related to logging activity and railroad construction. In 1868, the Central Pacific Railroad connected the Town of Truckee and Reno, Nevada, via the Truckee River canyon. Numerous other railroads prospered around this time in the area, promoting the logging industry, pulp and paper mills, and other early forms of commercial enterprises. This began a period of extensive pollution, as sawdust and other logging and milling debris were discharged directly in the river. Silt loading from timber harvesting clear-cuts and overgrazed areas significantly degraded the river's water quality and impacted native wildlife (Nevada Division of Water Planning [NDWP], 1997). Mining (both upland and in-stream) and road construction further exacerbated the degradation. Additional discussion on the impacts of these activities is included in Section 3.3.1.

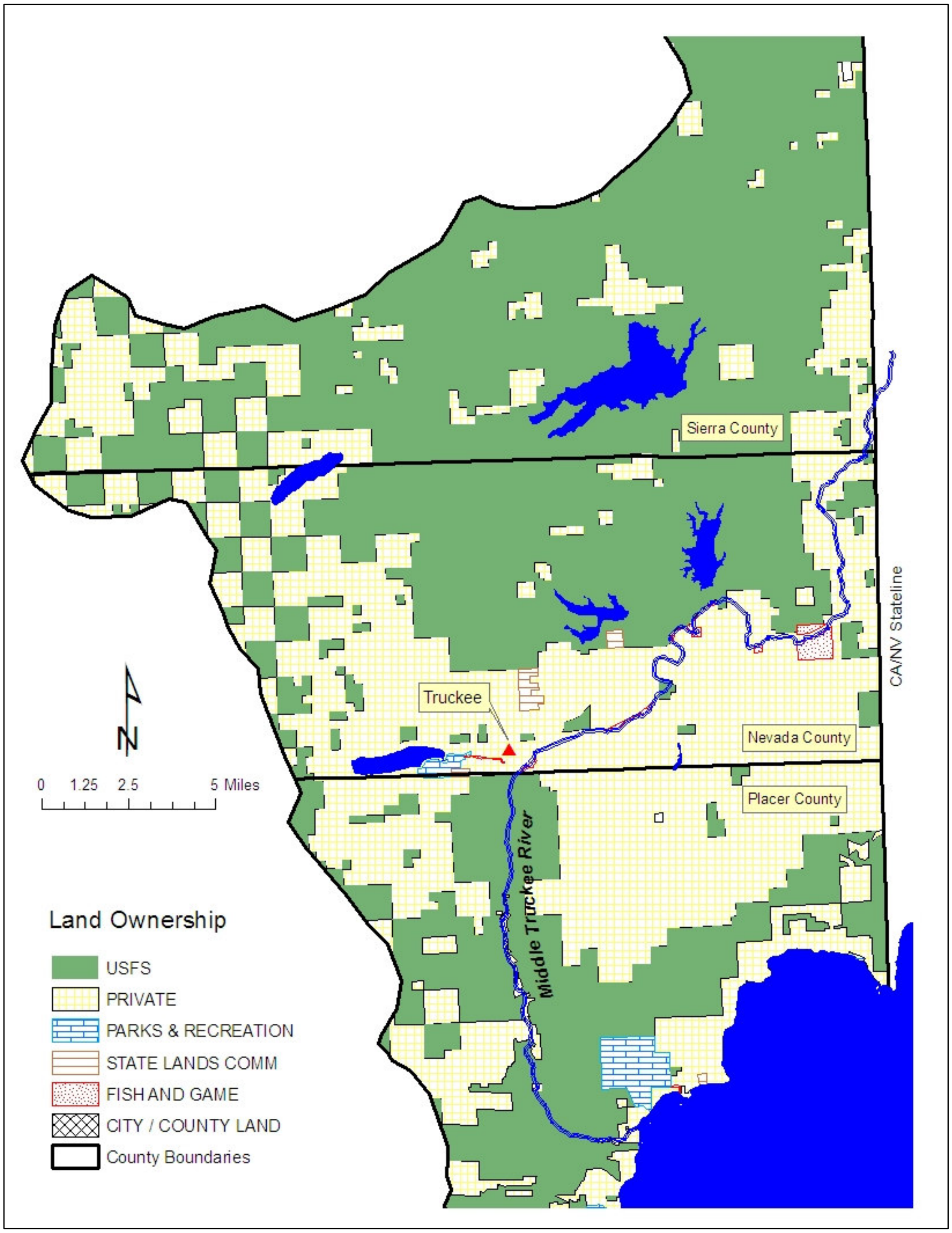
Improved transportation routes brought more people to the area. The Lincoln Highway, completed around 1913, crossed the Sierra Nevada roughly following the Truckee River canyon on its way from New York City to San Francisco. In 1927, it was replaced by US 40, which, in turn, was replaced by today's Interstate 80 in the mid-1960s. This greatly reduced travel time from Sacramento and the San Francisco Bay area, and allowed for year-round travel. The eight-mile stretch of Highway 89 between Squaw Valley and Truckee was extensively graded and widened in preparation for the 1960 Winter Olympics (California Department of Water Resources [DWR], 1991).

With the ease of travel, people began looking at the Truckee/Tahoe area as a prime location for a first or second home. Large, outlying recreational subdivisions, such as Tahoe Donner and Northstar, became the trend starting in the early 1970s (TRWC, 2004). According to population statistics from the Department of Finance, the population in Truckee in 1970 was 1,392 (virtually the same as the 1890 population estimate of 1,350). By 1980, the population had climbed 70 percent to 2,389, and then increased almost six-fold to 13,864 by 2000 (Herbst and Kane, 2006).

Current Development

The watershed is home to approximately 20,000 year-round residents (Town of Truckee, 2006; US Census, 2000). Urban areas include the Town of Truckee, Tahoe City and the communities around the three major ski resorts of Squaw Valley, Alpine Meadows and Northstar-at-Tahoe. All of these areas are experiencing high growth and development related to primary and second home building and resort-related tourism (described in Section 3.3.2). State Highway 89 and US Interstate Highway 80 are the major transportation corridors, and generally run parallel to the Truckee River throughout the project area. Much of the watershed is within the Tahoe and Toiyabe National Forests, and approximately 54 percent of the land within the project area is owned by the US Forest Service (USFS). Figure 2-2 shows the general land ownership patterns in the watershed.

Figure 2-2. Land Ownership in the Truckee River Watershed.



The Town of Truckee is the only incorporated area in the watershed. Housing areas within the Town include the Donner Lake and Gateway areas, and residential subdivisions including Tahoe Donner, Glenshire, Devonshire, the Prosser Lake neighborhoods, Olympic Heights, and Sierra Meadows. According to the US Census bureau, the 2000 population of the greater Truckee area (ZIP code 96161) was about 16,000.

The Martis Valley is adjacent to the Town of Truckee, occupying approximately 44,800 acres in the southeast portion of the watershed. Land use patterns consist of urban and commercial areas, forestlands, public and private recreational areas and facilities, as well as areas designated for airport use (Pacific Municipal Consultants, 2002). The area includes rapidly growing residential, recreational and resort developments such as the Lahontan golf community and Northstar-at-Tahoe Ski Area. The valley occupies portions of Placer and Nevada Counties.

Squaw Valley (also known as Olympic Valley) is an unincorporated community located in Placer County northwest of Tahoe City, with a population of 926 (US Census, 2000). It is the home of the Squaw Valley Ski Resort, which hosted the 1960 Winter Olympics.

The northern portion of the watershed lies in eastern Sierra County. Sierra County has a total population of 3,300, although none of Sierra County's urbanized areas falls within the Truckee River watershed. Sierra County's economy revolves largely around timber harvest and recreation (TRWC, 2002).

Recreation

Mountainous streams, reservoirs, natural lakes, and outstanding scenery characterize the study area. The area provides for year-round recreational opportunities, including fishing, hiking, horseback riding, biking, swimming, kayaking, skiing, golfing, and off-highway vehicle use. Recreation and tourism are key attributes of the economy of the mountain communities. Developed ski resorts in the project area include Alpine Meadows (Bear Creek watershed), Squaw Valley (Squaw Creek watershed), Tahoe-Donner (Prosser Creek watershed), and Northstar-at-Tahoe (Martis Creek watershed).

Developed recreational facilities occur along the Truckee River and provide camping and picnicking at Granite Flat, Goose Meadow, and Silver Creek Campgrounds, and Deer Flat Picnic Area. Dispersed recreation consists of horseback riding, backpacking, hiking and mountain biking. Nationally known trail systems such as the Pacific Crest and Western States trails traverse the project area. Rafting, whitewater kayaking, swimming and fishing are popular uses on the Truckee River. Visitor days for the Tahoe National Forest in 2005 totaled 1,609,300 (USFS, 2005).

Timber Harvest

Timber harvest occurs on lands owned by USFS-Tahoe National Forest, commercial timber operators, and smaller private landholders. Timber operations range from larger-scale harvesting of commercial sawlogs (for example, in the Little Truckee River watershed), to smaller-scale fuels reduction and forest management projects. Salvage logging typically occurs following forest fires. Due to the high population growth rate in certain areas of the watershed, increasing numbers of timber parcels are being converted to residential or urban land uses (D. Cushman, pers. comm., 5/2/07).

Mining

Current mining activity in the project area is primarily for industrial minerals, particularly construction materials such as sand and gravel. A search of the USGS Mineral Resources dataset (http://mrdata.usgs.gov/website/MRData-US/viewer.htm) shows several "producing" sand and gravel or pumice pits in the project area, including the Martis Valley, Truckee, and Hirschdale pits.

2.1.3 Climate

The climate is characterized by cold, wet winters and short, mild summers. From 1948 to 2000, the average annual temperature recorded at the Truckee Ranger Station was 43.2°F. Highs averaged 78.3°F during summer and 40.9°F during winter months. Lows averaged 58.9°F during the summer and 28.4°F during the winter. Precipitation measured at the Truckee Ranger Station averaged 32.5 inches annually, ranging from 16 inches to 54.6 inches for the period of record. Precipitation occurs predominantly as snowfall during winter months, generally increasing with elevation. Snow packs in the Sierra Nevada have been observed year-round, and snowfall has occurred as late as July. Snowfall averages 208.2 inches, but has been recorded as high as 401.4 inches at the Ranger Station (Western Regional Climate Center, 2007).

2.1.4 Geology

The western boundary of the watershed is formed by the Sierra Nevada crest and consists mainly of granitic base rocks capped, in places, by basaltic lava flows. The watershed's southern boundary contains volcanic deposits that have formed a natural dam across the fault-formed northern end of Lake Tahoe (TRWC, 2004).

Volcanic rocks such as basalt, tuff and scoria are found in the area just south of the Town of Truckee and the Hirschdale area. Sedimentary rocks in the region consist of relatively unconsolidated rock units associated with glacial outwash, fluvial (river/stream-related) and minor lacustrine (lake-related) deposits. Erodible glacial deposits are common in the larger sub-basins along the western boundary of the Truckee River watershed (DRI, 2001). In the higher elevations, glacial moraines are preserved along valley margins, near the mouths of Bear, Squaw, Pole, Deep, Cold, Donner, and Prosser creeks, and near cirque basins.

Weathering and erosion characteristics of the rock units differ considerably. Massive granitic outcrops at high elevations tend to be more resistant to weathering and erosion. In contrast, highly fractured granitic units near major fault zones weather and erode to a fine to coarse-grained sand. Volcanic rock units are more heterogeneous in texture and composition, and tend to weather and erode into mostly fine-grained sediments. Glacial deposits and other young surficial units have a variety of weathering characteristics depending on texture and age of the deposit (DRI, 2001). According to the California Watershed Assessment, 54 percent of the Truckee River watershed is classified as "moderate" to "very high" erosion potential based on slope (TRWC, 2002).

2.1.5 Soils

Soils found within the study area have been mapped and classified by the Soil Conservation Service (now the Natural Resources Conservation Service). The soils in the Truckee River Basin include nearly level soils of valley floors to very steep soils of high elevation mountainsides. The soils are generally excessively drained to moderately well drained.

Soils at higher elevations (above 6,500 feet) are typically formed from weathered volcanic, metasedimentary and granitic rocks and include glacial and alluvial deposits, which, if disturbed, can release fine sediments into streams. Soils at middle elevations (4,800 to 6,500 feet) are formed primarily from weathered volcanic, rhyolitic and granitic rock and alluvial deposits that can be relatively stable, depending on slope, vegetation cover and other variables (DRI, 2001).

2.1.6 Vegetation

Vegetation varies significantly throughout the study area. Mountain summits and peaks are generally barren, whereas high alpine meadows are composed of grasses and wildflowers. Headwater areas are distinguished by three different vegetative zones: 1) mountain hemlock, western white pine and California red fir in the highest elevations; 2) white fir, jeffery pine, ponderosa pine, sugar pine, and incense cedar in the mid-elevation ranges; and 3) pinyon pine, ponderosa pine, and western juniper in the lower elevations. Sagebrush, bitterbrush, rabbitbrush, and various grasses make up the lower elevations in the headwater areas. Riparian vegetation, primarily cottonwood, quaking aspen, dogwood, willow, sedges and grasses, grows along the Truckee River, some of its tributaries and along the margins of wetland areas (USFS, 2001 in TRWC, 2002).

2.1.7 Fisheries

Both native and non-native fish species are found in the Truckee River and its tributaries. Common native fish of the Truckee River include Paiute sculpin, Lahontan redside shiner, Tahoe sucker, speckled dace and mountain sucker. Recent information shows that mountain whitefish is also common; however, population levels can vary dramatically over time depending on river conditions. Two native species, the cui-ui and Lahontan cutthroat trout (LCT), are federally listed as endangered and threatened, respectively. The mountain sucker is a California Species of Concern (US Department of the Interior [USDOI] et al., 2008).

LCT (*Oncorhynchus clarki henshawi*) is an inland subspecies of cutthroat trout endemic to the Lahontan basin of northern Nevada, eastern California and southern Oregon. LCT occupied about 360 miles of suitable stream habitat and 284,000 acres of lake habitat within the Truckee River basin prior to the 1860s. The largest populations of LCT occurred in Pyramid Lake and Lake Tahoe (USDOI et al., 2008).

LCT was listed by US Fish and Wildlife Service (FWS) as endangered in 1970 and later reclassified as threatened in 1975 to facilitate management and allow regulated angling. A recovery plan was issued in 1995. LCT has been introduced into habitats outside its native range, consistent with the recovery plan. Within the Truckee River basin, there are currently seven small headwater tributaries with a total of eight miles that support self-sustaining river populations. These populations are found in Independence Creek, Pole Creek, Upper Truckee River, Bronco Creek, Hill Creek, and West Fork Gray Creek. There are two lake populations in Pyramid and Independence Lakes. Only Independence Lake has a naturally reproducing population. Pyramid Lake has a hatchery-maintained population (USDOI et al., 2008).

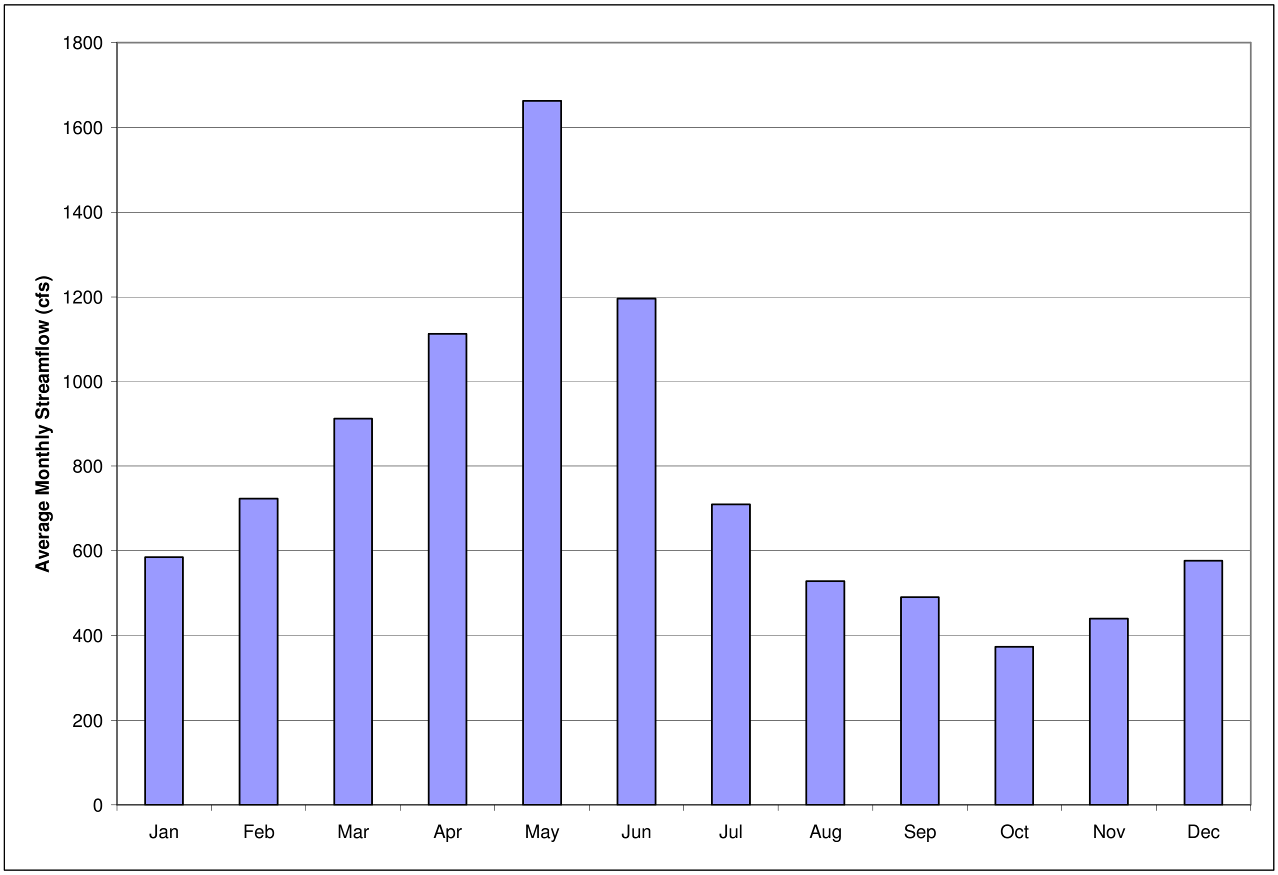
Rainbow and brown trout are the most common non-native fish species in the Truckee River and in many upstream tributaries (USDOI et al., 2008). The Truckee River from the confluence with Trout Creek to the confluence with Gray Creek has been designated a "Wild Trout Water" by the California Department of Fish and Game.

2.1.8 Hydrology

Flow Characteristics

Generally, streamflow is low in late summer, gradually increases through autumn and winter, and peaks during the spring snowmelt. Peak discharges are usually in May or June. Intense rain and rain-on-snow events can also produce occasional high-magnitude, short-duration peaks at various times throughout the year, and peaks associated with thunderstorms are more common between July and September. Figure 2-3 shows average monthly streamflows recorded at the USGS gauging station at Farad (No. 10346000) from 1975 to 2006. Farad is located at the downstream end of the project area, and is shown on Figure 2-1. It is important to note that effects of dams located within the basin will be reflected in the hydrograph record.

Figure 2-3. Average Monthly Streamflows, Truckee River at Farad, 1975 to 2006.



Annual mean discharge at the Farad gauging station ranges from 176 cubic feet per second (cfs) in 1931 to 2,567 cfs in 1983. The highest discharge at Farad for the period of record (1900 to present) is 17,500 cfs on November 21, 1950. From 1909 to 2000, the average annual discharge is 776 cfs (USDOI et al., 2008, Table 3.1).

Reservoirs and Dams

Approximately 30 percent of the surface water supply upstream of Farad is regulated by Lake Tahoe and 40 percent by other federal and non-federal reservoirs located in California. In general, the reservoirs store water in the spring and release it in the summer and early fall, primarily to meet demands in Nevada. Reservoir storage, along with natural runoff, determines the water supply available to Nevada (USDOI et al., 2008).

The existing Lake Tahoe Dam, located at Tahoe City, was constructed in 1913. The dam is owned by the US Bureau of Reclamation and operated under agreement by the Truckee-Carson Irrigation District for the Newlands Project in Churchill County (NDWP, 1997).

From the Lake Tahoe Dam, the Truckee River flows north for about 15 miles to the town of Truckee, where it is joined by Donner Creek. A dam on Donner Lake, constructed in 1929, regulates Donner Creek. Truckee Meadows Water Authority and Truckee-Carson Irrigation District jointly own storage rights in Donner Lake.

About 1.5 miles downstream from Truckee, the river is joined by Martis Creek, which is dammed at Martis Creek Reservoir, located approximately 2 miles upstream of the confluence with the Truckee River. The reservoir has a capacity of 20,400 acre-feet, and is owned and operated by the US Army Corps of Engineers for temporary storage of flood flows. Completed in 1971, it was the last of the dams constructed in the watershed.

Three miles further downstream, the river is joined by Prosser Creek. Prosser Creek is regulated by Prosser Creek Reservoir owned by the US Bureau of Reclamation, located about 1.5 miles upstream of the confluence with the Truckee River and has a capacity of 29,800 acre-feet. The dam was constructed in 1961.

Three miles downstream from Prosser Creek, the river is joined by its largest tributary, the Little Truckee River. The Little Truckee River is regulated by a dam on Webber Lake (privately owned) and by Stampede and Boca Reservoirs (federally owned). A dam at Independence Lake, which is owned by Sierra Pacific Power Company, regulates Independence Creek, which is tributary to the Little Truckee River.

Water Rights

Truckee River flows are regulated by a number of complex agreements, decrees, and river operating requirements extending as far back as the turn of the last century. These are monitored and enforced by a Federal Watermaster in Reno, Nevada. Some of the key historic events related to water rights include: the 1908 Floriston rates; the 1915 Truckee River General Electric Decree; the 1935 Truckee River Agreement; and the 1944 Orr Ditch Decree. Details on these agreements and decrees are available in the *Truckee River Chronology* (NDWP, 1997), the *Truckee River Operating Agreement Final Environmental Impact Report* (USDOI et al., 2007) and the Truckee River Watershed Council's *Coordinated Watershed Management Strategy* (2004).

The most recent agreement to allow more efficient operation of Truckee River reservoirs is known as the Truckee River Operating Agreement, or TROA. TROA's objectives are to enhance conditions for threatened Lahontan cutthroat trout and endangered cui-iu, increase municipal and industrial drought protection for Reno-Sparks, improve Truckee River water quality and enhance streamflows and recreational opportunities in the Truckee River basin. An Environmental Impact Report/Statement (EIS/EIR) for TROA was finalized in September 2007. The EIR/EIS concluded that implementation of TROA will have no significant effect on stream channel erosion or sediment transport capacity (USDOI et al., 2007).

2.2 BENEFICIAL USES OF THE TRUCKEE RIVER, GRAY AND BRONCO CREEKS

Water quality standards include designated beneficial uses of water and narrative and numerical water quality objectives established to protect those uses. Chapter 2 of the Basin Plan contains definitions of the beneficial uses assigned to waters in the Lahontan Region. The beneficial uses of the Truckee River are:

- Municipal and Domestic Supply (MUN)
- Agricultural Supply (AGR)
- Industrial Service Supply (IND)
- Groundwater Recharge (GWR)
- Freshwater Replenishment (FRSH)
- Hydropower Generation (POW)
- Water Contact Recreation (REC-1)
- Non-Contact Water Recreation (REC-2)
- Commercial and Sportfishing (COMM)
- Cold Freshwater Habitat (COLD)
- Wildlife Habitat (WILD)
- Rare and Endangered Species Habitat (RARE)
- Migration of Aquatic Organisms (MIGR)
- Spawning, Reproduction and Development (SPWN)

The designated beneficial uses for Gray and Bronco creeks are MUN, AGR, GWR, REC-1, REC-2, COMM, COLD, COLD, WILD, RARE, SPWN.

2.3 APPLICABLE WATER QUALITY OBJECTIVES

Sediment-related water quality objectives established in the Basin Plan are listed in Table 2-1. These objectives apply to all waters in the TMDL project area. The majority of sediment-related water quality objectives are expressed in narrative form, based on the protection of beneficial uses.

Table 2-1. Sediment-Related Water Quality Objectives Contained in the Lahontan Basin Plan.

Objective	Description
Sediment	The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect the water for beneficial uses.
Suspended Materials	Waters shall not contain suspended materials in concentrations that cause nuisance or that adversely affect the water for beneficial uses. For natural high quality waters, the concentration of total suspended materials shall not be discernible at the 10 percent significant level.
Settleable Materials	Waters shall not contain substances in concentrations that result in deposition of material that causes nuisance or that adversely affects the water for beneficial uses. For natural high quality waters, the concentration of settleable materials shall not be raised by more than 0.l milliliter per liter.
Turbidity	Truckee River Hydrologic Unit: The turbidity shall not be raised above 3 Nephelometric Turbidity Units (NTUs), mean of monthly means (This objective is approximately equal to the State of Nevada standard of 5 NTU sample mean). Lahontan Region-wide: Waters shall be free of changes in turbidity that cause nuisance or adversely affect the water for beneficial uses. Increases in turbidity shall not exceed natural levels by more than 10 percent.
Nondegradation	Whenever the existing quality of water is better than the quality of water established in the Basin Plan as objectives (both narrative and numerical), such existing quality shall be maintained unless appropriate findings are made under the State Water Board's Resolution 68-16, "Statement of Policy with Respect to Maintaining High Quality of Waters in California."

3. PROBLEM STATEMENT

Information from a variety of sources suggests that the Truckee River is at or above its limit to assimilate sediment and still protect aquatic life beneficial uses. Herbst and Kane (2006) studied aquatic insect populations in the river and concluded that as deposited sediment volumes increase, the diversity and structure of these communities shift toward more sediment-tolerant species. During higher stream flows, suspended sediment concentrations at the downstream end of the project area show levels above those recommended for aquatic life protection, specifically the COLD and SPWN beneficial uses.

Factors contributing to excessive sediment delivery to the Truckee River include legacy land use impacts and more recent development in naturally erosion-sensitive areas. In the last decade, increases in residential and seasonal population growth and recreational visitation have created a demand for resort development, recreation opportunities, primary and vacation home construction, and transportation needs. Because the Truckee River watershed contains a large percentage of areas classified as moderate to very high erosion potential (TRWC, 2002), these activities have the potential to contribute excessive sediment loading to the Truckee River.

This section presents:

- A discussion on the effects of excessive sediment on beneficial uses
- The basis for including the Truckee River, Gray and Bronco creeks on the Clean Water Act Section 303(d) list of impaired waters
- Data and information to assess water quality in the Truckee River and Gray and Bronco creeks

3.1 Excessive Sedimentation Effects

Fluvial environments are conveyance systems for water and sediment produced in a watershed. Sediment is an important, naturally occurring component of healthy streams and rivers that benefits many elements of the biologic community. However, an excessive amount of sediment in streams can have adverse effects on the in-stream biologic communities and recreational and municipal uses.

Waters (1995) provides a comprehensive literature review of the impacts of suspended and deposited sediment on in-stream beneficial uses. These impacts include coating of "biologically active surfaces" of plants and animals (e.g., fish gills), abrasion and suffocation of attached algae, reduction of light for photosynthesis, and modification of animal behavior and benthic invertebrate habitat.

Suspended sediment may have sub-lethal effects on fish, including reduced feeding and growth, respiratory impairment, and physiological stress leading to reduced tolerance to disease and toxicants. Deposited sediment can have significant impacts on the reproductive success of salmonid fish by filling interstitial spaces in spawning gravels, reducing water and oxygen flow to fish embryos and fry, smothering of embryos and fry, and entrapment of emerging fry (Waters, 1995). High rates of sediment transport can initiate scour and fill of the bed, removing embryos or burying them deeply. Volcanic rocks produce greater percentages of soils containing silt and fine sand than granitic rocks, and these materials are likely to penetrate deeper into a gravel bed, thus increasing the negative effects on fish spawning success (Lisle and Eads, 1991).

Changes to channel form and velocity distribution (e.g., pools and riffles) resulting from increased sediment deposition can limit the migration and movement of aquatic organisms. Excessive sedimentation, turbidity, and undesirable substrate material can adversely impact swimming, wading, fishing and aesthetic enjoyment of streams. Excessive sediment loading can also foul water treatment and supply facilities, which increases operational costs and affects service.

3.2 303(d) Listing Basis for Truckee River, Gray and Bronco Creeks

3.2.1 Truckee River

In the 1992 statewide Water Quality Assessment, the Truckee River was reclassified from "intermediate" to "impaired," and placed on the 303(d) list for sedimentation, among other concerns. Data supporting the listing included a 1990 California Department of Fish and Game (DFG) memo that listed siltation, substrate loss and loss of fish habitat as problems in the river (Messersmith, 1990). Additionally, complaints related to sediment discharges have been lodged with the Water Board, and there have been sediment-related violations of permit conditions and waste discharge prohibitions.

3.2.2 Gray and Bronco Creeks

An article in the Reno-Gazette Journal (Timko, S., in LRWQCB, 1991) noted that Sierra Pacific Power's Reno-Sparks water treatment plant was shut down due to sediment-laden water discharged into the Truckee River from Gray and Bronco creeks. This led to both creeks being reclassified from "unknown" to "impaired" during the 1992 Water Quality Assessment process. The Reno-Sparks treatment plant was shut down again on July 14, 1992 and July 18, 1995 due to thunderstorm runoff of "extensive quantities of mud" from the Gray Creek watershed (NDWP, 1997). Water Board staff does not have data that indicate the listings were based on beneficial use impairment in Gray or Bronco creeks; rather, the listings were based on the creeks' sediment discharges that affected water quality in the Truckee River.

3.3 Truckee River Beneficial Use Assessment

3.3.1 Historical Conditions

The Truckee River Watershed has a long history of land use practices that have affected watershed functions and water quality, including:

- logging
- lumber mills
- grazing
- water diversions
- mining
- urbanization

Elimination of the Lahontan cutthroat trout fishery is one of the critical impacts resulting from historical watershed activities. The destruction of the fishery was featured in newspapers of the late 1800s and early 1900s and is recounted in an article presented by the Truckee-Donner Historical Society, Inc. (Richards, 2004). Key points from the article are paraphrased below.

> Prior to the discovery of the Truckee River in 1844 by John C. Fremont, the Paiute and Washoe people relied on the trout as a traditional food supply. During the Comstock era, commercial fishermen quickly started harvesting the trout in large numbers to supply food for the expanding mining communities of Carson and Virginia Cities. With the advent of the railroads and Truckee River ice industry, the trout were also shipped in large quantities to supply urban markets throughout the west. The over-fishing rapidly began to degrade the fishery.
>
> Dam construction, sawdust dumping and livestock grazing further stressed the trout habitat. Dams were constructed as early as 1861 to divert water for agricultural irrigation, lumber milling and ice production. Most of the dams lacked provisions for fish passage, which effectively eliminated trout runs above the California state line by the late 1800s.
>
> Sawdust dumping from lumber mills was also common, which smothered spawning beds and contributed to algae growth. It was reported that, by 1874, a large sawdust delta had formed at the inlet of Pyramid Lake that prevented fish passage and at one point caused the Truckee River to change course such that it flowed into Winnemucca Lake. Additionally, extensive livestock grazing and logging contributed large quantities of sediment to the river that covered spawning beds and created silt bars behind the many dams located on the river.

The forests around Lake Tahoe and the Truckee River were logged beginning in the mid-1800s for Ponderosa, Jeffrey and Sugar pine. According to a 1902 report by the USGS on the condition of forests in the northern Sierra Nevada, by 1902 nearly 59 percent of the forestland in the Truckee basin had been "logged clean or culled" (TRWC, 2004).

The watershed had sawmills on almost every major tributary and in many smaller tributaries as well. Those areas without mills likely contained skid trails, flumes and/or roads for transporting felled timber to nearby mills (TRWC, 2004). Dams and diversions were built to help float sawlogs to the mill, to lessen the impacts of flood events, to store water for downstream use, and in a few cases, to generate electricity.

In the early 1900s, the Floriston Pulp and Paper Company mill was constructed along the river between Boca and Verdi, which dumped excess pulp and acid into the river. Hydroelectric power plants were also constructed at various locations along the river causing further impacts, and an oil spill from the Truckee yards of the Southern Pacific Railroad spread oil down to Reno. By about 1940, the Pyramid Lake subspecies of the Lahontan cutthroat trout became extinct in the Truckee River.

Mining occurred in the watershed using various techniques, including placer, underground, surface and in-stream mining. Products included sand and gravel, pumice, molybdenum, uranium, and gold. Based on data from the State of California, at least 11 of the watershed's sub-basins have experienced some mining activity, with the heaviest concentration found along the mainstem of the Truckee River (TRWC, 2004).

In 1958, a gravel-washing plant was operated on Cold Creek, one-half mile upstream from its confluence with Donner Creek. It was estimated that twenty to twenty-five tons of fine sediment per day of operation were discharged to the creek (1958 was the only year of operation). According to a California DFG report, the effects of the silt load on the substrate of Cold Creek and the Truckee River were striking: the greater portion was covered with silt, and most of the rubble and gravel in riffle areas were cemented together to form a hard bedrock-like substrate. Eddy areas behind boulders contained thick mud deposits (Cordone and Pennoyer, 1960 in Herbst and Kane, 2006).

By the 1950s, many of the activities that contributed to the river degradation had diminished. Clearcut areas were regenerating, the Floriston paper mill had closed, many of the old dams had been washed away, and most of the sawdust had been washed into Pyramid Lake (Richards, 2004). However, these activities have left a legacy of degraded conditions affecting water quality in the Truckee River.

3.3.2 Current Conditions

The Truckee River watershed has experienced significant growth and development over the past 10 to 15 years. The watershed includes portions of Sierra, Nevada and Placer Counties, as well as the Town of Truckee, which was incorporated in 1993. There is also significant development planned over the next ten years in the Town of Truckee and Placer County. There has been considerable controversy and legal challenges over planned residential development in the unincorporated area in the Martis Valley, many related to environmental impacts. A summary of the growth and development issues in the watershed, and their significance to water quality, is presented below.

1. <u>High population growth rate and tourism</u>: According to the U.S. Census Bureau, the growth rate from 1990 to 2000 in the Placer County portion of the Lahontan Region was over 40 percent. Significant future development pressure also exists in the Martis Valley area. According to the Martis Valley Community Plan Update Draft

Environmental Impact Report (EIR) (Pacific Municipal Consultants, 2002) and analysis from the Town of Truckee Planning Commission (Hall, 2004), almost 1,000 new single-family residential units, 2,200 cluster-type residential units, and 345,000 square feet of commercial/office space is either in construction, approved, or proposed within Placer County. The current Martis Valley General Plan would allow for over 11,000 residential dwelling units and over 1.6 million square feet of commercial/office space at build-out.

The US Census Bureau indicates that the growth rate in the Town of Truckee from 1990 to 2000 was over 50 percent. Significant future development pressure also exists within the town. According to the Martis Valley Community Plan Update Draft EIR and analysis from the Town of Truckee Planning Commission, over 1,300 new single-family residential units, 1,600 cluster-type residential units, and 2.2 million square feet of commercial/office/resort facility space are either in construction, approved, or proposed within the Town of Truckee. The current Town of Truckee General Plan would allow for over 18,000 residential dwelling units and over 5.6 million square feet of commercial floor space at build-out.

The area is also experiencing significant non-resident population increases and associated transportation activities due to tourism. For example, the estimated number of visitors in the area during each ski season is over 1.6 million, based on estimates for Squaw Valley USA, Alpine Meadows, and Northstar-at-Tahoe (SRRI, 2004).

2. Major highways: Major highways run parallel, and in close proximity, to the entire 39-mile reach of the Truckee River covered by this TMDL. These include state Highway 89 from the outlet of Lake Tahoe to the Town of Truckee and Interstate 80 from the Town of Truckee to the California/Nevada state line. According to traffic data collected by the California Department of Transportation for 2006 (Caltrans, 2006), the estimated annual average daily traffic on Interstate 80 through the Truckee corridor ranges from 29,000 to 31,500 vehicles. It is estimated that the annual average daily traffic on Highway 89 at the junction of Interstate 80 is 20,600 vehicles. In the Martis Creek watershed, State Highway 267 parallels portions of the middle fork of Martis Creek, and crosses the west fork of the creek. These highways run through high elevation areas, which receive significant amounts of snowfall and require extensive snow and ice management activities, including the application of traction sand.

3. Disturbance of erosion-sensitive lands: The Truckee River watershed includes high elevation lands with steep slopes and erosion-prone soils that are highly sensitive to land disturbance. According to the California Watershed Assessment (www.ice.ucdavis.edu/newcara), 54 percent of the Truckee River watershed has "moderate" to "very high" erosion potential based on slope, soil type, ground cover

and precipitation. There is significant development (either existing or planned) that is adjacent to the numerous small tributary creeks and the Truckee River. These developments have the potential to discharge sediment-laden storm water as well as other pollutants to the waterways. Several complaints have been filed with the Water Board regarding land disturbing activities and high turbidity in surface waters. Additionally, elevated turbidity levels in the Truckee River during high flow events have affected operations at the Truckee Meadows Water Authority, which treats water from the Truckee River for municipal supply in the Reno/Sparks area. Newspaper reports stated that high-turbidity discharges from Gray and Bronco creeks were observed during these flow events.

4. Legacy impacts: There are numerous land disturbances and stream channel modifications remaining from historical activities conducted in the watershed. Legacy sites include poorly designed stream crossings, unstable stream channels and banks resulting from land disturbance, and destabilized upland soils caused by past land use practices. Recent watershed assessments (e.g., NHC, 2006; River Run Consulting, 2007) have been conducted for tributaries to the Truckee River, including Gray Creek and Cold Creek, in Coldstream Canyon. These assessments indicate that legacy land uses continue to have an impact on water quality today.

3.3.3 Data to Assess Current Conditions

Data used to assess current conditions includes:

- Turbidity grab sampling: US Geological Survey (USGS), Desert Research Institute (DRI), Lahontan Water Board (1969-2002)
- Continuous turbidity monitoring: California Department of Water Resources (2002-2003)
- Suspended sediment concentration (SSC) data: USGS, DRI, Lahontan Water Board (1975-2006)
- Bioassessment using benthic macroinvertebrates: Dr. D. Herbst and J. Kane of Sierra Nevada Aquatic Research Laboratory (2006)

Turbidity

Grab Samples

The USGS and other agencies collected turbidity measurements over an approximately 30-year period (1969-2002). These data may be found in the USEPA's Legacy STORET database[1]. Grab samples were generally collected monthly at Farad (USGS gauge 10346000), approximately 3.5 miles upstream of the California/Nevada state line, near the downstream end of the project area. As such, these data represent cumulative conditions in the river, and are useful to assess compliance with the numeric turbidity

[1] EPA's repository for water quality data - http://www.epa.gov/storet/

water quality objective (WQO) set in the Basin Plan for the Truckee River hydrologic unit. The WQO is 3 nephelometric turbidity units (NTUs), expressed as a mean of monthly means[2] (MOMM). These data indicate that the WQO for turbidity is met at the Farad sampling station. A summary of the data is shown in Table 3-1.

Table 3-1. Summary of Grab Sample Turbidity Data for the Truckee River at Farad, 1969-2002.

Statistic	Result
Number of Samples	370
MOMM	**2.5 NTU**
Median	1.8 NTU
Minimum	0 NTU
Maximum	50 NTU

Continuous Turbidity Monitoring

Additional turbidity measurements were collected by the California Department of Water Resources (DWR) at four locations on the Truckee River subsequent to the USGS dataset summarized above. The DWR monitoring program used in-stream, continuous monitoring instruments to collect turbidity, pH, temperature, and electrical conductivity measurements every 15 minutes at each station. The system provides the frequency of measurement to allow detailed analysis, but can be affected by instrument malfunctions and requires careful data cleanup to account for instrument drift and fouling (Lewis, 2002).

Turbidity measurements collected from May 2002 through August 2003 (DWR, 2007) at the Farad monitoring station were analyzed and compared to the numeric turbidity WQO. Analyzed separately, or combined with the dataset previously described, the data indicate that the MOMM WQO of 3 NTU is not met. A summary is presented in Table 3-2.

Table 3-2. Summary of Continuous Turbidity Monitoring Data for the Truckee River at Farad, May 2002 to August 2003.

Statistic	Result
Number of samples	44,705
Number of months	16
MOMM (combined DWR/USGS dataset) -	**4.2**
MOMM *(DWR dataset only)*	42.5 NTU
Minimum	0.0 NTU
Maximum	1,767.5 NTU
Average	44.5 NTU
Median	3.4 NTU

[2] Arithmetic mean of 30-day averages (arithmetic means)

Although these data indicate the turbidity standard is not met, Water Board staff took into account two potential data limitations while considering the DWR dataset. First, examination of the data showed wide variability within short time frames under consistent flow conditions, which suggest the potential for instrument fouling and/or data cleanup issues. Additionally, the data are not normally distributed as indicated by the disparity in the average (44.5 NTU) and median (3.4 NTU) turbidity values. This suggests that data outliers skew the analysis of compliance for this dataset with the MOMM WQO, which is based on an arithmetic average. For non-normally distributed datasets, a median or geometric mean may be more appropriate to assess the central tendency (Helsel and Gilroy, 2005). While it is important to acknowledge these limitations, we conclude that the DWR dataset is useful information to consider, because it provides the best available data to depict short-term sediment events loading that would be missed by the grab sampling data alone.

Regardless of the direct comparison of the data to the turbidity WQO, the continuous turbidity measurements illustrate relationships between turbidity and high flow or storm events. The occurrence of thunderstorms, snowmelt events, and dam releases were related to increases in turbidity measurements (DRI, 2004). These relationships are helpful in evaluating the types of conditions or land uses that contribute to increased turbidity and sediment loading (see Source Assessment, Section 5). The data also reveal that intense, episodic events are important to sediment transport in the river.

Suspended Sediment

Water column samples have been collected and analyzed for suspended sediment from the Truckee River and many of the major tributaries in the watershed. These data are available from the USGS's surface water data website (http://nwis.waterdata.usgs.gov/nwis) and DRI (2001, 2004). Samples were analyzed for total suspended sediment (TSS), suspended sediment concentration (SSC), or both. Although the analytical methods differ, both methods are assumed to produce equal results for purposes of this TMDL. In the Truckee River, DRI (2001) tested this assumption by comparing 26 integrated and grab samples collected in 2000. These samples were analyzed using both the SSC and TSS analytical methods. No significant difference between the analysis methods was detected ($y=0.9979x$; $R^2=0.9431$). Therefore, sediment concentrations are referred to as SSC hereafter in this document.

Suspended Sediment Grab Samples

A summary of the "period of record" SSC results from grab sampling events is presented in Table 3-3. Because there are no numeric WQOs established in the Basin Plan for SSC for the Truckee River Hydrologic Unit, data were compared to two screening benchmarks: 1) 60 milligrams per liter (mg/L) set as a water quality objective for Lake Tahoe tributary streams; and 2) 25 mg/L derived from literature reviews related to protection of aquatic life. The Lake Tahoe tributary stream objective is evaluated as a 90th percentile, to recognize that natural variation in sediment transport may result in short-term episodes of SSC above this objective. For this discussion, the 90th percentile evaluation will be applied to both benchmarks. The 90th percentile value means that ninety percent of data evaluated (or a subset of the data, e.g., annual, seasonal, or flow-based) are less than or equal to this value. Bolded values in the two far right columns in Table 3-3 indicate where SSC values exceed the 90th percentile for each benchmark (that is, where the percentage of SSC values over the benchmark is *greater* than 10 percent).

The comparison of the period of record dataset to the benchmarks is useful for broad-scale screening purposes; however, this analysis is limited because it yields only one data point per sampling site to assess. Examining the data on an annual basis is more useful to determine frequencies and trends of SSC exceedances; this analysis is presented in Section 4 and Table 4-2. In order to evaluate whether SSCs exceed benchmarks across the range of flows observed, or only during certain flow regimes, flow and loading duration curves (described in the next section) were examined. This type of analysis is useful to identify and focus on hydrologic conditions of concern (Stiles and Cleland, 2003). However, the period of record data presented in Table 3-3 indicates that Gray, Squaw, and Donner creeks exceed the screening benchmarks more frequently than other tributaries in the watershed.

Table 3-3. Summary of Flow and SSC Period of Record Data for the Truckee River and Major Tributaries.

Site	Flow Date Range	# of Flow Data Points	Min CFS	Max CFS	SSC Date Range	# of SSC Data Points	SSC Min (mg/L)	SSC Max (mg/L)	% SSC values > 60 mg/L	% SSC values > 25 mg/L
Truckee River										
Tahoe City	1/1/75 - 9/30/04	10,940	0.01	2,630	12/26/00 - 9/17/04	39	0.5	7.8	0	0
Near Truckee	6/24/02 - 8/14/03	423	8	664	6/24/02 - 8/14/03	23	0.4	63.4	1	1
Farad[a]	1/1/75 - 9/30/04	11,276	37	12,400	1/7/75 - 9/13/05	434	0.07	869.0	3.5	8
Tributaries										
Bear Creek	1/16/96 - 10/24/00	27	0.96	160	1/16/96 - 10/24/00	27	0.1	33.6	0	**11**
Squaw Creek	1/3/96 - 7/7/00	32	0.15	661	1/3/96 - 7/7/00	32	0.2	111.5	**22**	**31**
Donner	3/24/93 - 9/30/04	4,245	2.3	2,380	12/11/95 - 10/24/00	36	1.0	91.0	5.5	**19**
Trout Creek	10/29/73 - 10/24/00	31	0.52	59	10/29/73 - 10/24/00	31	1.0	235.8	6.5	**13**
Martis Creek	1/1/75 - 9/30/004	9,984	0.2	626	5/28/75 - 10/24/00	86	1.0	16.0	0	0
Prosser Creek	1/1/75 - 9/30/04	10,887	0.02	1,790	12/11/95 - 10/24/00	21	2.7	29.7	0	5
Little Truckee River	1/1/75 - 9/30/04	10,742	0.02	2,530	1/3/96- 10/24/00	19	1.2	6.0	0	0
Juniper Creek	3/8/00 - 10/24/00	17	0.72	35	3/8/00 - 10/24/00	17	1.3	80.3	6	**12**
Gray Creek	1/4/96 - 8/31/04	1,102	6.7	236	1/4/96 - 8/31/04	64	1.0	7,780.0	**33**	**48**
Bronco Creek	4/23/93 - 1/24/00	2,014	2.80	152	3/8/00 - 10/24/00	19	1.3	15.7	0	0

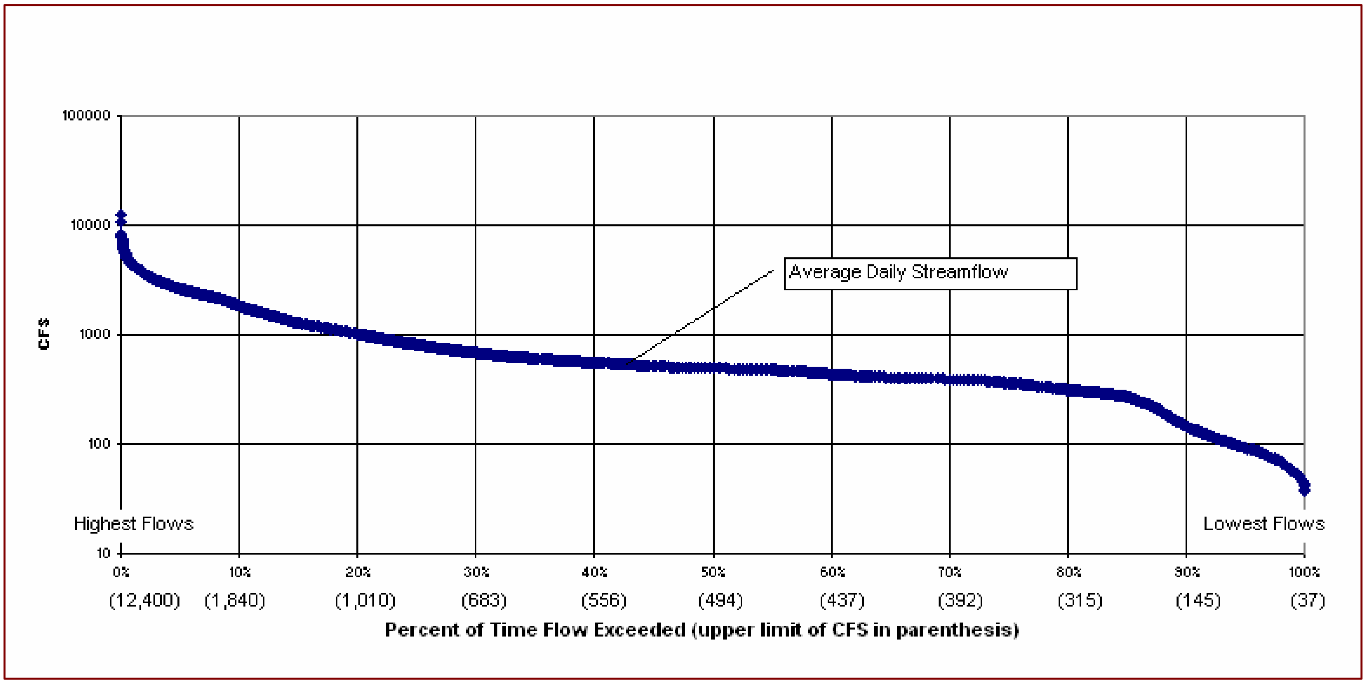
a. Multiple samples collected on the same day were averaged to derive a single value for consistency in analysis.

Flow and Load Duration Curves

Duration curves are plots that combine streamflow frequency information with water quality data to characterize water quality across the full range of flows in a system. Flow duration curves use daily average streamflow data, which are sorted from the highest historic recorded value to the lowest. Using this convention, flow duration intervals are expressed as an exceedance frequency on the x-axis of the plot. Figure 3-

1 shows the flow duration curve for the Truckee River at Farad, based on USGS average daily streamflow data from 1975 to 2006. On the left edge of the x-axis, zero percent corresponds to the highest stream discharge in the dataset (i.e., extreme flood conditions that have a zero exceedance frequency) and on the right edge, 100 percent corresponds to the lowest observed value (i.e., extreme low flows, or drought conditions, that are always exceeded). Fifty percent corresponds to the median observed streamflow value. For example, Figure 3-1 shows the median flow at Farad is 494 cubic feet per second (cfs). The stream discharge values (in cfs) are represented on the y-axis, on a logarithmic scale.

Figure 3-1. Flow Duration Curve for the Truckee River at Farad, 1975-2006.

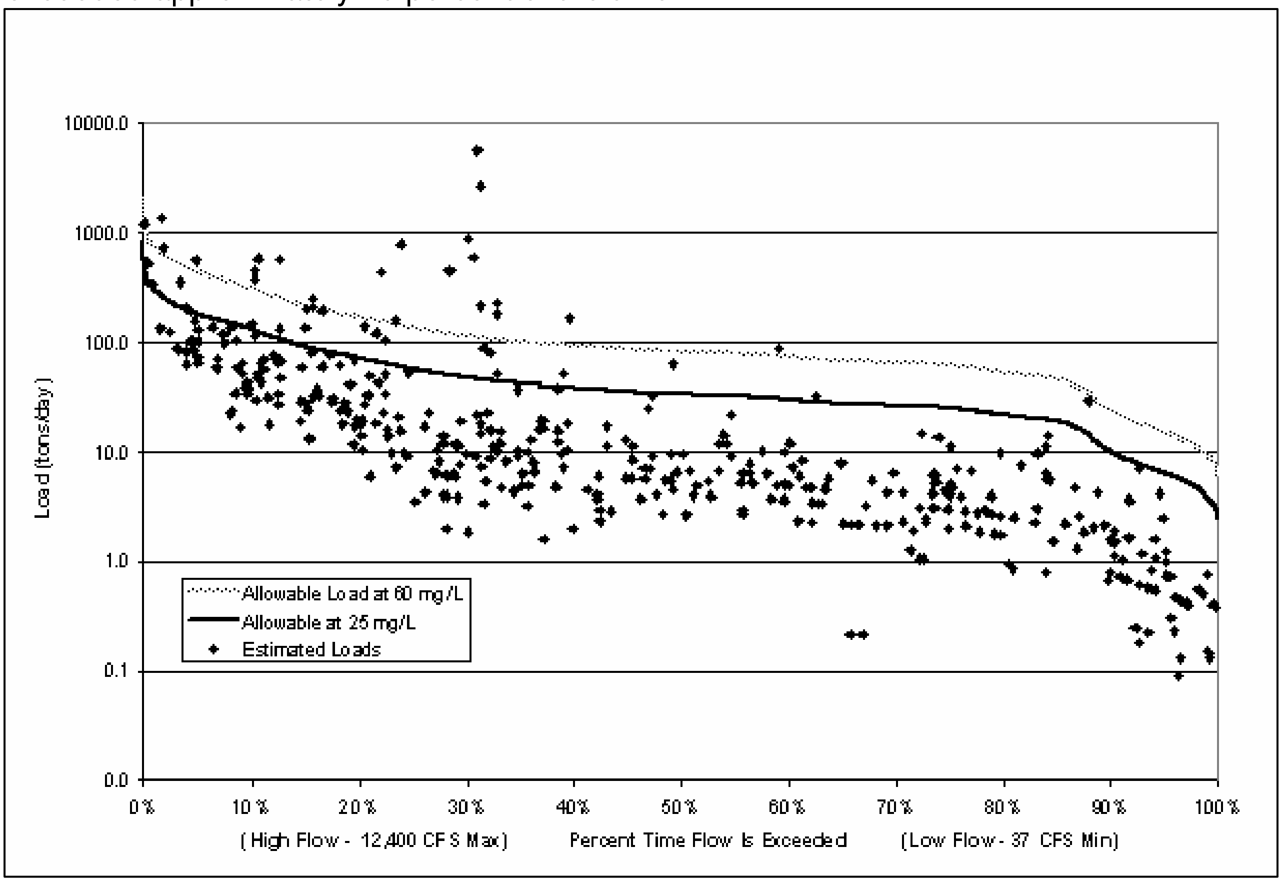


Flow duration curves serve as the foundation for pollutant load duration curves (in this case, sediment loads). A sediment load duration curve is developed by multiplying each average daily streamflow value by a numeric water quality target for sediment, and a conversion factor. This yields a curve showing the allowable loads at the water quality target over all flows observed. Measured SSCs are then converted to sediment loads by multiplying SSC grab sample data (in mg/L) by the average streamflow on the day the SSC sample was collected (in cfs) and a conversion factor of 0.0027 (to convert units of cfs x mg/L into units of tons/day). This allows SSC data to be graphed against the load duration curve for comparison.

For the Truckee River, numeric SSC benchmarks of 25 and 60 mg/L were plotted by using the procedure described above. Recall that the screening benchmarks are statistically expressed as 90^{th} percentile values; therefore, up to 10 percent of the data could fall above the curve and be within the benchmark limits. Duration curves are also useful for examination of hydrologic condition groups; for example, if loads plot above the curve in certain flow ranges, this identifies critical conditions that should be focused on.

Available SSC data were converted into daily loads and compared to the curve. Figure 3-2 is the load duration curve for the Truckee River at Farad, based on SSC and flow data collected from 1975 to 2006. Load duration curves for the sites shown in Table 3-3 are presented in Appendix B.

Figure 3-2. Load Duration Curve for the Truckee River at Farad. Note that sediment loads (diamonds) fall above the curved lines most frequently at flows that are exceeded approximately 40 percent of the time.



The load duration curve developed for the Truckee River at Farad indicates that sediment loads fall above the benchmarks more frequently when flow rates are in the upper 40 percent of those observed (those that are exceeded 0 to 40 percent of the time). About 15 percent of the samples taken during these flows are greater than 25 mg/L, five percent above the benchmark.

Although there are less SSC data available for upstream sampling points on the Truckee River (Near Truckee and Tahoe City), the data show that benchmarks are exceeded at higher flows much more frequently at Farad than at the upstream locations. This indicates a cumulative increase in sediment loading at this most downstream sampling point, and suggests that the range of flows in which benchmarks are exceeded at Farad should be reduced.

Deposited Sediment and Bioassessment

Overview

The Lahontan Water Board commissioned a study of the Truckee River with Dr. David B. Herbst and Jeffrey M. Kane of the University of California's Sierra Nevada Aquatic Research Laboratory (Herbst and Kane, 2006). The purpose of the study was to assess whether aquatic life beneficial uses of the Truckee River were impaired by excessive sediment, using sedimentation measurements coupled with bioassessment. Bioassessment is the study of benthic macroinvertebrate (BMI) communities, and measures aquatic life health and diversity.

The researchers determined that standard bioassessment techniques, which were developed for smaller, wadeable streams (e.g., the targeted riffle method), are not ideal for assessing the Truckee River. Instead, they measured fine sediment volumes deposited in channel margins at sampling sites positioned directly up- and downstream of tributaries entering the Truckee River, and correlated the measurements with bioassessment results at each of the sites. Channel margins in the Truckee River were sampled at confluences with Bear, Squaw, Martis, Juniper, Gray, and Bronco creeks.

The study plan was developed on the hypothesis that if there was excessive sedimentation it would be most evident in the channel margins of the Truckee River because flow velocities are typically lower in this portion of the channel. It was anticipated if the sediment supply from a given tributary was excessive (more than the Truckee River's carrying capacity), then a channel margin sampling point downstream of the tributary' s confluence would show more fine sediment deposition than an upstream margin. It was also hypothesized that sedimentation would be greater downstream of tributary sites with higher modeled load estimates. Modeled estimates of sediment loading for calendar years 1996 and 1997 were previously developed for each of the tributaries by DRI (2001).

Although researchers did not consider standard bioassessment sampling as the best evaluation method for the Truckee River, these types of samples were also collected to add information on aquatic life conditions. Targeted riffle sampling consisted of collecting BMI samples from riffle habitat in the main channel of the Truckee River, downstream of tributary confluence locations.

A suite of BMI community metrics were calculated for both the channel margin samples and the main channel targeted riffle samples. Selected metrics were compared among sites, to sediment volumes measured in channel margins, and to modeled loading estimates. Additionally, targeted riffle invertebrate samples were compared to a 10-metric Index of Biological Integrity (IBI) score.

Discussion

In general, study results were mixed. BMI communities showed expected responses to increasing levels of sediment. That is, where more deposited sediment was measured in channel margins, biologic metrics indicated less integrity of biologic health. To illustrate this, researchers selected a sediment volume limit of 100 milliliters (ml) from channel margins to examine differences in BMI metrics above and below that level. Approximately half of the BMI samples showed loss of integrity corresponding to sediment volumes of 100 ml or greater. Overall, this relationship demonstrates that sedimentation adversely affects invertebrate communities, but due to the lack of conformity to anticipated sediment loading patterns, it is unclear whether the measured sediment volumes can be termed excessive.

For example, half of the downstream sample sites showed greater volumes of sediment compared with upstream sample sites; however, statistically significant inferences regarding these differences were not possible. Differences in mean volumes between sites were not statistically significant. No relationship was found between estimated tributary loading and channel margin sediment volumes. Because sedimentation measurements were not consistent with hypothesized up- and downstream relationships or loading estimates, indications of excessive deposited sediment were not conclusive.

Results of the Truckee River main channel targeted riffle samples were evaluated with respect to an IBI benchmark score (representing macroinvertebrate community health). The score was based on bioassessment work previously conducted at numerous wadeable reference streams and other test sites in Eastern Sierra watersheds, where researchers found that an IBI score of 62 or less is indicative of impaired conditions. In the Truckee River, three of the eight targeted riffle sites had IBI scores of 62 or less. A summary of the IBI scores is presented in Table 3-4. Note that the BMI samples were collected from the Truckee River, but the results are reported relative to the nearest upstream tributary.

Table 3-4. IBI Scores for the Truckee River, Reported Relative to the Nearest Tributary.

Upstream Tributary	IBI Score[a]
Bronco Creek	80
Trout Creek	77
Gray Creek	76
Squaw Creek	67
Canyon 24	67
Juniper Creek	62
Martis Creek	60
Bear Creek	55

a. Higher scores indicate better biologic community structure and diversity.

There was no clear relationship between channel margin sedimentation and IBI scores in the main channel of the river. Half of the sites show a reasonably consistent relationship and half of the sites do not. This is likely due to higher stream-flow velocities in the main channel that would carry suspended sediment downstream until velocities would be low enough for sediment to settle out.

In summary, channel margin BMI communities showed expected responses to increasing sedimentation, but there were no consistent patterns of sediment deposition to determine if measured sediment represented levels above the Truckee's carrying capacity (i.e., excessive sedimentation). Sediment volume measurements were not necessarily greater at downstream locations compared with upstream locations, or longitudinally through the study area. Results did show that increasing levels of sediment adversely affect BMI communities in channel margins, and that three of eight main channel BMI samples scored at or below a provisional IBI of 62.

3.3.4 Conclusions

Review of monitoring information in combination with current and legacy land use issues indicate that the Truckee River is at the maximum range of its sediment carrying capacity, and at certain streamflow regimes, may exceed it. The following points provide the basis for TMDL development:

1. The grab sampling record for SSC indicate that levels exceed aquatic life protection benchmarks at higher flows at the downstream sampling point on the Truckee River, and less frequently at upstream locations.
2. The grab sampling record for turbidity indicates the river meets the water quality objective, although continuous turbidity monitoring indicates that flow events resulting from thunderstorms, snow melt, and dam releases produce short-term spikes that exceed the WQO. These loading events have more influence on stream channel functions and aquatic life impacts compared with base flow conditions.
3. Fine sediment deposition in the channel margins adversely affects benthic invertebrate communities. Although the pattern of sediment deposition and its relationship to potential sources are not well understood, deposited sediment at volumes greater than 100 ml corresponded with a loss of integrity in BMI metrics in approximately half of the channel margin samples.
4. Benthic communities measured in the main channel of the Truckee River show less than optimal conditions in three out of eight sites sampled.
5. Watershed disturbances associated with historic activities such as logging, lumber milling, grazing, mining, and road building have left legacy impacts that continue to contribute to upland erosion and adversely impact stream functions.
6. The population has increased significantly over the last decade and major development and population growth is planned over the next 10 years in formerly undeveloped areas. Increased sedimentation to stream channels is linked to urbanization associated with high growth and population density, accompanied by development in erosion-sensitive landscapes.

7. Major highways run in close proximity to the river throughout the project area. Snow management activities, as well as storm water runoff, contribute additional sediment to the river.

3.4 BRONCO CREEK BENEFICIAL USE ASSESSMENT

3.4.1 2002 Stream Survey

Staff of the Humboldt-Toiyabe National Forest and the US Fish and Wildlife Service surveyed stream conditions in Bronco Creek during summer 2002 (USFWS et al., 2002). The purpose of the survey was to identify and evaluate fish passage barriers and measure the physical components of the watershed to initiate Lahontan cutthroat trout (LCT) recovery in the Truckee River basin. Data included substrate composition, physical habitat characteristics (pool-riffle, width-depth, entrenchment ratios, sinuosity) and an inventory of fish passage barriers, road crossings, culverts, and woody debris.

Two of the surveyed reaches (Reaches 1 and 10) were located in the California portion of the watershed. Reach 1 began at the confluence of Bronco Creek and the Truckee River, extending approximately 3 miles into Nevada and ending at a tributary confluence at 6,864 feet. Of interest for this discussion is the first 1.2 miles of this reach within California. Reach 10 was located on a tributary to Bronco Creek in California. This reach began at an elevation of 5,870 feet, and was approximately 0.23 miles long.

Reach 1

Habitat types consisted of mostly step pools and high velocity riffles. All of Reach 1 was burned by the 2001 Martis wildfire, and unstable banks with little ground vegetation were noted; however, alder, aspen and willow regeneration was apparent throughout the reach. Average median (D-50) substrate particle size throughout the 3-mile reach was 48.6 millimeters (mm), with an average percentage of fine substrate sediment (< 2 mm) of 13 percent. As these data represent average values recorded over the 3-mile reach, it is unknown how well they represent the lower 1.2 miles of the California segment of interest.

Herbst (2002) developed numeric targets for D-50 particle size and percent fines and sand based on data collected from low gradient streams in the Truckee River basin. Although the average channel gradient throughout Reach 1 is reported at 10.7 percent (higher gradient than those surveyed by Herbst), the Bronco Creek substrate composition data collected in Reach 1 falls well within the targets of D-50 > 40 mm, and percent fines and sand (< 3mm) of 25 percent or less of the substrate composition.

Two road crossings and one railroad crossing were recorded at the mouth of Reach 1. No specific erosion problems related to these features were noted. No logging, road erosion, grazing or other land use impacts were identified.

Reach 10

All of Reach 10 was burned in the 2001 Martis fire. No road crossings, culverts or other land use impacts were recorded. Unstable banks, entrenched conditions and down cutting were noted, along with a steep channel gradient of 18.1 percent. Average D-50 particle size was 25.6, with an average of 17 percent of fine substrate sediment throughout the reach.

3.4.2 DRI Sediment Source Assessment (2001)

DRI modeled sediment loading to the Truckee River from ten major tributary subwatersheds, including Bronco Creek. Of the ten subwatersheds, Bronco Creek's sediment contribution is the fourth lowest.

DRI also assessed sediment loads using suspended sediment rating curves developed for the ten major subwatersheds in the Truckee River basin, including Bronco Creek. When normalized by subwatershed area, Bronco Creek's sediment load is the third lowest of the ten.

3.4.3 SSC Data

Grab Samples

DRI collected 19 SSC grab samples at the mouth of Bronco Creek from March to October 2000. The majority of samples were collected during the higher end of the flow range recorded from 1993 to 2000, so they represent likely sediment transport conditions. Table 3-5 summarizes the dataset.

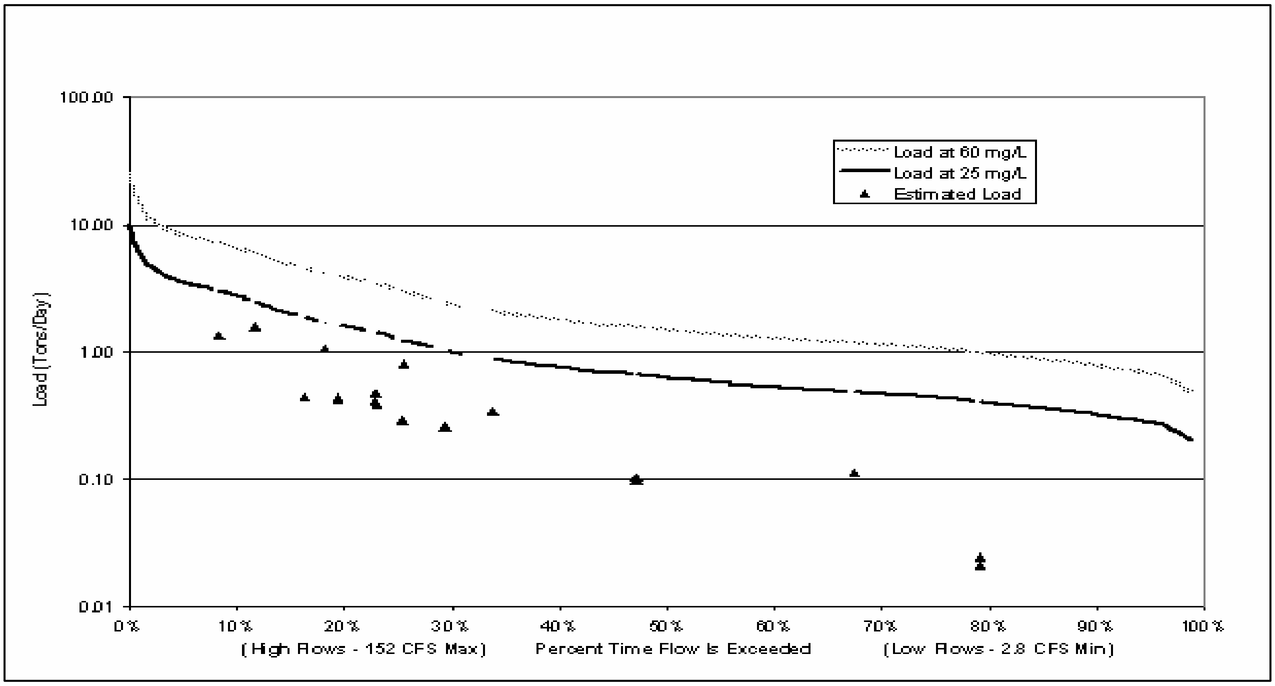
Table 3-5. Summary Statistics of SSC Data from Bronco Creek, 1993-2000.

Statistic	Result
Number of Samples	19
Average SSC	7.6 mg/L
Median SSC	6.6 mg/L
90^{th} Percentile SSC	15.6 mg/L
Maximum SSC	15.7 mg/L

Load Duration Curve

Water Board staff developed a flow and sediment loading duration curve to characterize the sediment transport regime in Bronco Creek, using the procedures and suspended sediment benchmarks of 25 and 60 mg/L as described in Section 3.3.3. SSCs were converted into suspended sediment loads (in tons/day), and plotted against the range of flows recorded by the USGS at the mouth of Bronco Creek from 1973 to 2000. None of the SSC values collected in Bronco Creek exceed the benchmarks, even at the higher flow ranges (Figure 3-3). Although these data do not represent SSCs during extreme flow events, they do show that under most conditions, Bronco Creek's sediment load is within a protective range for aquatic life.

Figure 3-3. Load Duration Curve for Bronco Creek. Allowable loads at 25 and 60 mg/L SSC are shown as curved lines, and measured loads are triangles. Note that none of the measured loads exceed the allowable loads.



3.4.4 Conclusions

Bronco Creek is a naturally erosive watershed that is extremely sensitive to disturbance. The drainage area is underlain by large areas of unstable volcanic rocks conducive to high rates of sediment production. Aerial photography analysis indicates large areas of exposed bedrock and little stabilizing vegetation (DRI, 2001). Stream surveys in the California portion of the watershed do not indicate significant problem areas due to land use impacts; rather, steep stream gradients and erosive geology appear to be the primary sources of erosion.

The watershed has been subject to historic logging, but current commercial logging activity, at least in the California portion of the watershed, is not ongoing (D. Cushman, pers. comm., 2007). Dirt roads are also present in the subwatershed, primarily located on USFS lands. Current land uses do not appear to be causing sedimentation to stream channels in the watershed, although the impact of the 2001 Martis fire on vegetation was noted in the 2002 stream surveys.

Generally, sediment levels do not suggest impairment to beneficial uses. Limited SSC data show that levels are well below benchmarks for sensitive aquatic life protection. Substrate particle size data do not show an accumulation of fine sediments on the streambed that may negatively affect benthic invertebrate health. Watershed modeling (DRI, 2001) shows that Bronco Creek's sediment contribution to the Truckee River is the third or fourth lowest out of the ten major subwatersheds. Although information does not indicate Bronco Creek is impaired, some controllable sources associated with dirt roads are present, and are addressed through load allocations to those sources based on protecting beneficial uses in the Truckee River (see Section 7).

3.5 GRAY CREEK BENEFICIAL USE ASSESSMENT

3.5.1 2006 Watershed Assessment

Northwest Hydraulic Consultants (NHC) completed a comprehensive assessment of the Gray Creek watershed in 2006 using 319(h) funds granted to the Truckee River Watershed Council. NHC determined that much of the sediment production in the watershed is due to mass wasting of hill slopes. Mass wasting refers to the downslope movement of soil and rock material due to gravity.

NHC delineated four subwatersheds: the West, Middle and North Forks, and the Mainstem of Gray Creek. The average basin slope is very steep at 54 percent, with the middle and north forks exhibiting steeper topography than the west fork. The area includes highly erodible volcanic soils classified as "high erosion hazard" and moderate to rapid runoff rates.

The watershed was extensively burned during the Martis fire of 2001. Erosion control treatments were not recommended following the fire since potential treatments were considered hazardous to implement and unlikely to be effective due to the steep topography. Similar to Bronco's watershed, there appears to be little stabilizing vegetation in the watershed (DRI, 2001).

NHC identified erosion sites and zones in each subwatershed, described as individual, smaller sediment sources and larger source areas, respectively. NHC notes that all erosion zones identified in the watershed are natural and appear unaffected by land uses. The Middle Fork, which is nearly unaffected by human activities, showed the highest percentage of erosion zones: 33 percent of the subwatershed was identified as an erosion zone, with mass wasting the predominant erosional process.

All human-induced (anthropogenic) erosion sites were attributed to road-related features. Roads and tracks accounted for 24 percent of erosion sites. The north, west, and mainstem subwatersheds had the highest numbers of erosion sites related to roads; the Middle Fork had none.

The NHC report concludes it is not feasible to reduce overall sediment loading to the Truckee River from mass wasting, but that localized impacts from dirt roads in the West Fork could be addressed and would improve habitat conditions for aquatic life. They also note that stream bank erosion control may be feasible in the lowest reach of Gray Creek, near the mouth of the watershed in California.

3.5.2 DRI Sediment Source Assessment (2001)

DRI modeled sediment loading to the Truckee River from ten major tributary subwatersheds, including Gray Creek. Of the ten subwatersheds, Gray Creek's sediment contribution was the fourth highest.

DRI also assessed sediment loads using suspended sediment rating curves for the ten major subwatersheds in the Truckee River basin, including Gray Creek. When normalized by subwatershed area, Gray Creek's sediment load is the second highest of ten.

3.5.3 SSC Data

Grab Samples

DRI and the USGS collected SSC grab samples at the mouth of Gray Creek near Floriston periodically from 2000 to 2004. The data were collected over of a range of streamflows. The DRI samples were collected during 2000, one year before the 2001 Martis fire. Following the fire, the USGS collected data between November 2001 and August 2004. NHC prepared suspended sediment rating curves from the two datasets, and found that SSCs have typically been four to five times greater since the 2001 fire. NHC speculates that the change in transport rates likely results from erosion associated with the fire, but may also reflect changes in the watershed from a large flood that occurred in 2003. Table 3-6 summarizes the entire dataset.

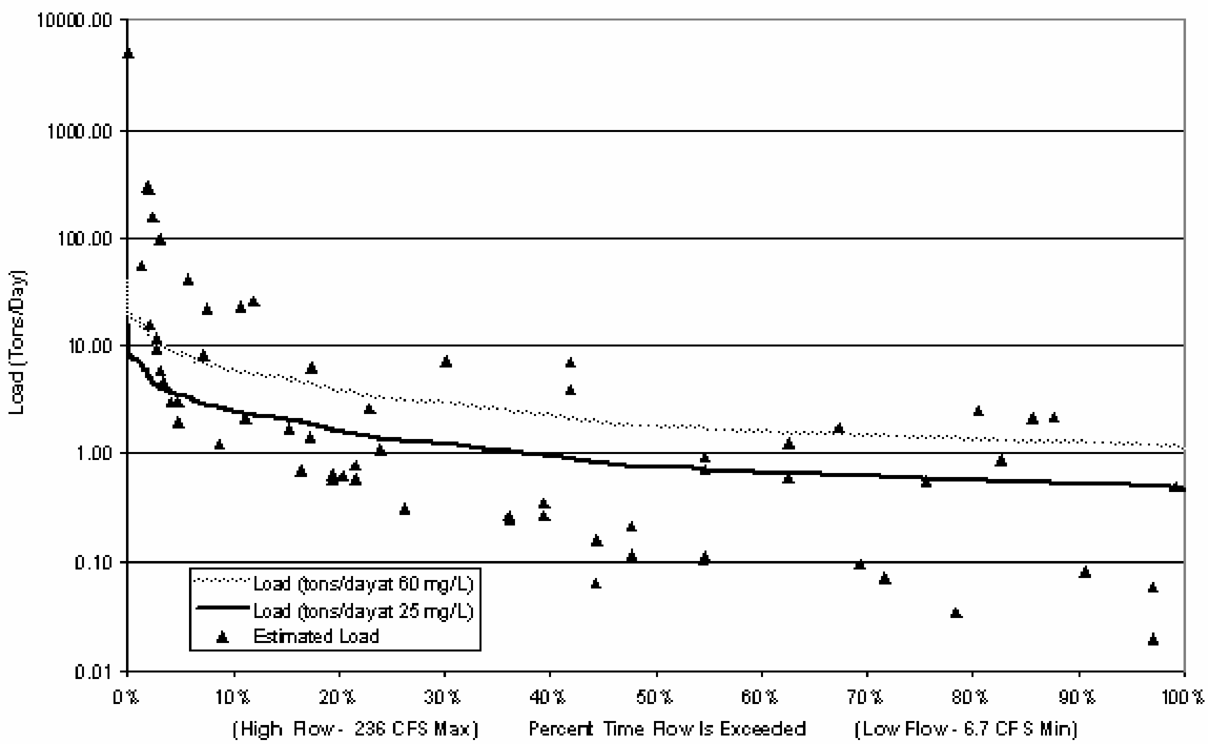
Table 3-6. Summary Statistics of SSC Data from Gray Creek, 1996 to 2004.

Statistic	Result
Number of Samples	64
Average SSC	235 mg/L
Median SSC	24 mg/L
90th Percentile SSC	274 mg/L
Maximum SSC	7,780 mg/L (5/28/2003)

Load Duration Curve

Water Board staff developed a flow and sediment loading duration curve to characterize the sediment transport regime in Gray Creek, using the same methodology and aquatic life benchmarks described in Section 3.3.3. Measured SSC values regularly exceed the benchmarks throughout the range of observed flows, even during lower flow periods (Figure 3-4).

Figure 3-4. Load Duration Curve for Gray Creek. Allowable loads at 25 and 60 mg/L SSC are shown as curved lines, and measured loads are triangles. Note that exceedances of the allowable loads occur across a wide range of flows.



3.5.4 Conclusions

Similar to Bronco Creek, Gray Creek is a naturally erosive watershed that is extremely sensitive to disturbance. The watershed is very steep and almost entirely covered by highly erodible soils derived from volcanic rocks and glacial moraine material. The 2001 Martis fire has apparently exacerbated erosion.

The 2006 Watershed Assessment Report by NHC indicates that landslides, both as individual features and in erosion zones, are the dominant erosion mechanism, followed by roads and trails, gully and bank erosion. A few landslides result from anthropogenic disturbance, such as drainage diversions on roads, but most occur naturally. Anthropogenic impacts include grazing, logging and road construction, but logging and grazing are now less significant than roads. Roads are the most important anthropogenic source of sediment and many are concentrated in the California portion of the West Fork subwatershed.

SSC data show that levels are often above benchmarks for sensitive aquatic life protection, at all flow ranges. Watershed modeling (DRI, 2001) shows that Gray Creek's sediment contribution to the Truckee River is the second highest of the ten major subwatersheds, when normalized by area. Although available evidence indicates that high levels of sediment discharging from the watershed are primarily from natural sources, there are conditions that should be mitigated, specifically dirt roads and possibly limited riparian zones in the lower reaches of the creek. Sediment reductions from these types of projects would benefit aquatic habitat in Gray Creek, although significant reductions to the overall sediment load in the Truckee River may not be feasible. Load reductions from controllable sources are addressed in the Load Allocation section of this report.

4. TARGETS

CWA Section 303(d)(1)(C) states that TMDLs "… shall be established at a level necessary to implement the applicable water quality standards." Water quality standards include the designated beneficial uses of waters and the water quality objectives established to protect beneficial uses. Because the applicable water quality objectives for this TMDL are narrative, rather than numeric, a variety of indicators and associated target values were developed to interpret narrative sediment-related water quality objectives and ensure protection of aquatic life beneficial uses, particularly cold freshwater habitat.

This section describes the selected indicators and target values, provides background information and rationales for each target, and where feasible, compares existing conditions to target values. Two types of indicators are proposed: water column and implementation indicators. The water column indicator relates to the protection of early life stages of coldwater fish species inhabiting the Truckee River. The implementation indicators are meant to help Water Board staff and stakeholders track progress on sediment control activities needed to improve in-stream conditions in the Truckee River. Table 4-1 summarizes the indicators and target values for this TMDL.

Table 4-1. Summary of Indicators and Targets for the Truckee River TMDL.

Indicator	Target Value	Notes
Water Column: Suspended sediment concentration	Annual 90th percentile value of less than or equal to 25 milligrams per liter (mg/L) suspended sediment. Measured at Farad (USGS gauge 10346000) Data from other monitoring sites along the mainstem Truckee River will be evaluated as needed to assess SSC variations and potential source areas from upstream tributaries.	Target represents protection of aquatic life beneficial uses (COLD and SPWN), based on literature review.
Implementation Measure: Road sand application best management practices (BMPs), and recovery tracking	Road sand is applied using BMPs and recovered to the maximum extent practicable (MEP).	Road traction sand is needed for public safety; therefore amounts used cannot be specified by TMDL. However, application BMPs and increased road sand recovery can lessen sediment impacts to watercourses.
Implementation Measure: Ski area BMP implementation and maintenance	Ski areas identify and prioritize areas within their facilities where BMP implementation and maintenance is needed to control erosion and sedimentation to stream channels.	Candidate sites to be identified and prioritized in annual worklists submitted to fulfill WDR permit requirements.
Implementation Measure: Dirt roads maintained or decommissioned	Identified dirt roads with inadequate erosion control structures are rehabilitated and maintained, or decommissioned. Focus on dirt roads with high potential for sediment delivery to surface waters (e.g., within 200 feet of watercourse).	Candidate roads to be identified and prioritized through watershed assessments or Water Board inspections.
Implementation Measure: Legacy sites restoration/BMP implementation	Identified legacy sites are restored or storm water BMPs are implemented to prevent erosion and sedimentation to surface waters.	Candidate sites to be identified and prioritized through watershed assessments, or Water Board inspections. Storm water NPDES/WDR holders should identify and prioritize legacy sites in annual worklists.

4.1 WATER COLUMN INDICATOR: SUSPENDED SEDIMENT CONCENTRATION

Suspended sediment concentration is chosen as an indicator because it directly measures sediment conditions and impacts to beneficial uses in the Truckee River.

4.1.1 Review of Suspended Sediment Criteria and Guidance

To select a suspended sediment target to protect aquatic life in the Truckee River, numerous studies, water quality objectives and goals for suspended sediment were reviewed. In general, the majority of the literature focused on criteria to protect aquatic life beneficial uses such as COLD and SPWN, and many were specific to suspended sediment's effects on salmonids (e.g., trout), which occur in the Truckee River. Primary sources of information included:

- The European Inland Fisheries Advisory Commission (EIFAC, 1964)
- The National Academy of Sciences (1973)
- USEPA guidance (Mills et al., 1985; Berry et al., 2003)
- Newcombe and Macdonald; Newcombe (1991;1997)
- North Coast Regional Quality Control Water Board (2001)
- Idaho Department of Environmental Quality (2003)

Additionally, other sediment TMDLs and various state water quality standards were reviewed. Appendix C contains the literature review on suspended sediment targets.

Based on the literature review, recommended SSCs to protect aquatic life range from 10 to 1,800 mg/L, most commonly ranging between 25 to 80 mg/L. Different statistical approaches and evaluation periods are utilized, including averages and geometric means applied over a variety of time steps (daily, monthly, seasonally, yearly), 90th and 98th percentiles, single value and daily maxima. The higher end of this range was derived from the impacts of suspended sediments on adult fish, whereas the low-end concentrations are derived for the protection of juveniles, larvae, and eggs (Miller, 1998).

4.1.2 Target

To protect early life stage aquatic organism beneficial uses, suspended sediment concentrations in the Truckee River should be less than or equal to 25 mg/L, expressed as an annual 90th percentile value. This value is selected for several reasons:

- It represents the lower-end (most protective) range of suggested or existing sediment values to protect early aquatic life stages, providing a high level of protection for most sensitive SPWN beneficial use (Spawning, Reproduction and Development)
- The literature review does not indicate that a more stringent target is warranted to protect this sensitive beneficial use
- The annual target is consistent with and comparable to the level of protection for beneficial uses as the annual TSS water quality standard promulgated by the state of Nevada for the Truckee River at Farad
- The annual evaluation is consistent with the frequency of data collection for SSC at Farad, which is typically once per month. Evaluating the target more frequently

(e.g., monthly or quarterly) would not allow enough data points to be collected for analysis. Evaluating the target less frequently (e.g., biennially or period of record) would hamper detection of trends, and would make associating trends in water quality with upslope improvements difficult.

The suspended sediment target will be assessed based on data collected at the USGS gauging station at Farad (No. 10346000). This location is chosen for the following reasons:

- It is located at the downstream end of the project area, and therefore reflects cumulative sediment transport conditions in the river
- The SSC target is most frequently exceeded at Farad compared to other locations; therefore, it is consistent with USEPA (1999) guidance that targets should be located where impacts occur
- It is the site where the most comprehensive dataset on streamflow and SSC has been collected
- An existing SSC and streamflow sampling regime is ongoing at this location (DRI's Truckee River Long-term Monitoring, funded by Nevada Department of Environmental Protection [NDEP]); therefore, data to asses the target over time will occur

NDEP also collects suspended sediment data at four other locations along the mainstem Truckee River (at Tahoe City, and at Donner, Martis, and Juniper creeks). These data can be evaluated to determine potential sources areas if SSCs exceed the target at Farad.

The 90th percentile value of SSC was chosen because it allows for seasonal or short-term variability while still fully supporting aquatic life beneficial uses under USEPA policy (USEPA, 1997; 2002). Water Board staff recognizes that sediment conditions, even in the absence of development, are highly variable. Random, high-intensity events (e.g., summer thunderstorms) may create conditions in which sediment concentrations exceed protective levels, even in pristine streams (Benda and Dunne, 1997 in Idaho DEQ, 2003).

4.1.3 Comparison of Existing and Target Conditions at Farad

Description of Datasets

USGS Streamflow and SCC Data

Average daily streamflow for the Farad gauging station (No. 10346000) from January 1975 to January 2006 were downloaded from the USGS surface water data website (http://nwis.waterdata.usgs.gov/nwis). This date range was selected to correspond to the period of time that SSC data were available. The USGS collected SSC samples at Farad generally monthly from January 1975 to October 1977, and from April 1993 to March 1995, for a total of 60 samples.

Desert Research Institute (DRI) SSC Data

Long-term Truckee River Monitoring

DRI collects grab samples at Farad (and occasionally, Floriston, located about 2 miles upstream) as part of its Truckee River Monitoring Program. The results are reported to the Nevada Department of Environmental Protection, which funds the program. The DRI SSC dataset begins in February 1979, and samples are collected generally monthly, except in 2000, when samples were collected up to 5 times per month during the summer.

DRI (2004) Suspended Sediment Analysis of the Truckee River

In 2002 and 2003, data were collected from continuous turbidity meters operated by the California Department of Water Resources at four locations along the Truckee (including Farad), as well as grab samples of SSC collected monthly during the project, and weekly during snowmelt. Additionally, SSC was collected at Farad during thunderstorm events, often numerous samples in one day. DRI (2004) analyzed the data to assess sediment loading during specific flow events. Due to the specific objectives of the study, and the frequency of sampling (hourly rather than daily at times), integrating these data with the historic set presents some challenges in data interpretation. Water Board staff's treatment of duplicate day sampling data is discussed below.

Lahontan Water Board SSC Data

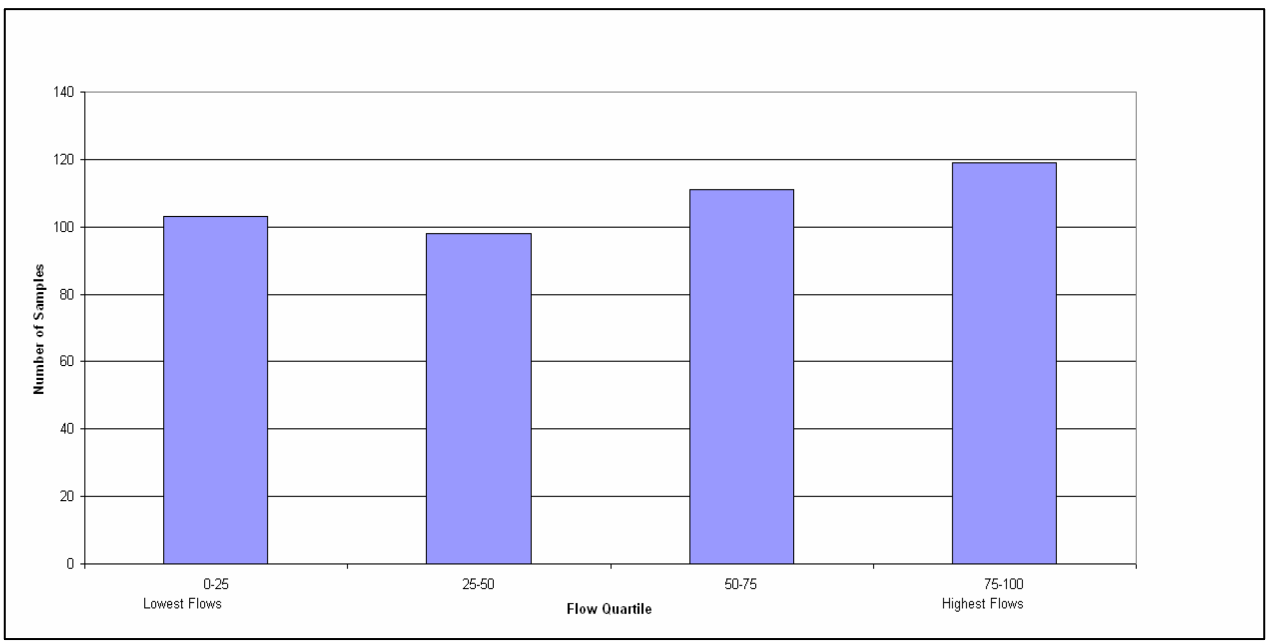
Starting in December 1995 and continuing through September 1997, staff of the Lahontan Water Board collected SSC samples in the Truckee River at numerous locations (including Farad and Floriston) to characterize sediment conditions in the Truckee River in preparation of TMDL development. Samples were collected generally monthly.

Treatment of Duplicate Data

Most of the SSC data at Farad were collected at fixed time intervals and were not targeted towards specific precipitation or flow events, with a few exceptions. The primary exception is the dataset generated from the DRI 2002-2003 study, due to the study objectives. This dataset also contained numerous duplicate days of sampling (i.e., where several SSC measurements were made in one day). Also, several duplicate days of SSC sampling occurred in the Lahontan Water Board dataset, often because samples were collected on the same day at two nearby locations (Farad and Floriston). In order to facilitate computation of daily loads, and to make the dataset internally consistent with the majority of data historically collected, Water Board staff averaged any SSC data collected on the same day into one data point for that day.

The resulting SSC and streamflow dataset covers a period from January 1975 to January 2006. A total of 434 SSC values, with corresponding average daily streamflow data from the USGS, were used to assess SSCs at Farad. SSCs were collected over the full range of average daily streamflows recorded at Farad (Figure 4-1). This observation is important for meaningful assessment of the 90th percentile value, as a dataset biased toward high (or low) flow sampling would not be appropriate to compare to the proposed target.

Figure 4-1. Number of SSC samples (vertical axis) collected in each flow quartile (horizontal axis). Quartiles are based on average daily flows measured in the Truckee River at Farad from 1975 to 2006.



Data Analysis

Annual 90th Percentile SSC Values

Table 4-2 shows the 90th percentile SSCs for water years 1976 through 2005, along with the number of samples collected per water year. Of the 27 water years presented, 6 years (22 percent) showed annual 90th percentile values greater than 25 mg/L (values shown in bold font in Table 4-2).

Table 4-2. Annual 90th Percentile SSC Values for the Truckee River at Farad, Water Years 1976 to 2005.

Water Year	90th Percentile SSC (mg/L)	Number of samples
75-76	10	12
76-77	11	12
80-81	14	11
81-82	20	9
82-83	**34**	11
83-84	18	12
84-85	9	12
85-86	**64**	12
86-87	11	12
87-88	8	12
88-89	6	12
89-90	7	12
90-91	13	12
91-92	22	12
92-93	**42**	18
93-94	9	24
94-95	14	17
95-96	**45**	27
96-97	22	19
97-98	11	11
98-99	13	12
99-00	9	20
00-01	7	12
01-02	**56**	25
02-03	**51**	36
03-04	7	12
04-05	6	12

4.2 IMPLEMENTATION INDICATOR: ROAD SAND APPLICATION BMPs AND RECOVERY TRACKING

Road sanding best management practices (BMPs) is chosen as an indicator because it is a direct measure of progress in implementation of management practices to limit sedimentation to streams. Recovery of applied sand limits the amount that can be transported to waterways.

4.2.1 Discussion

Application of road traction sand is a management practice designed to improve vehicle traction on snow- and ice-covered roads. When traffic grinds the sand into smaller particles it can become suspended in runoff, transported off-site and deposited into waterways, potentially impacting aquatic life habitat.

4.2.2 Target

The amount of traction sand used each winter varies according to snowfall and weather conditions, and its application is necessary for public safety during winter driving months. Therefore, it is not possible to assign a target value or limit for this indicator. However, by using BMPs to ensure maximum effectiveness of traction sand, and considering alternatives to sanding, amounts can be reduced. BMPs include establishing and adhering to traction sand durability and fine particle specifications, modifying application rates based on road characteristics, storm intensity, duration and ambient temperatures. Responsible entities shall measure and report the quantity and type of material applied, and the amount recovered each season. The goal of the road sand indicator is to encourage practices to reduce road sand usage, improve traction sand durability, consider alternatives, and maximize the amount of sand recovered (by sweeping or vactoring) before it moves into waterways.

4.2.3 Comparison of Existing and Target Conditions

Sand is applied to the more heavily used-roads in the Truckee River watershed, such as Interstate 80, Highway 89 north and south, Highway 267, and areas such as Northstar-at-Tahoe, Squaw Valley, Alpine Meadows, and the Town of Truckee.

4.3 IMPLEMENTATION INDICATOR: SKI AREA BMP IMPLEMENTATION AND MAINTENANCE

Ski area BMPs should be installed and maintained to reduce sediment discharges in the Bear, Squaw, Prosser and Martis creek subwatersheds.

4.3.1 Discussion

Land use activities related to ski areas, such as graded ski runs and roads can disrupt drainage and infiltration patterns, increase the rate of runoff and erosion to stream channels.

4.3.2 Target

WDRs for the Truckee River watershed's four ski areas contain requirements to identify sources of erosion, implement programs that minimize the disturbance of natural vegetation, and use BMPs such as water bars, drop inlets, and other sediment control measures to prevent sedimentation to surface waters. Facility inspections are required to discover potential erosion and surface runoff problems so corrective actions can be immediately undertaken, and any needed BMP maintenance can be assessed. Annual work lists with problems noted and corrective actions needed are also required. Target conditions are compliance with these sediment and erosion control provisions contained in WDRs.

4.3.3 Existing and Target Conditions

For the 2007 inspection season, there were no permit violations related to ski area erosion control BMPs recorded. In 2006, a permit violation for failure to install effective source control BMPs related, in part, to the ski facilities, was recorded for Northstar-at-Tahoe (S. Ferguson, pers. comm., 4/17/2008).

4.4 IMPLEMENTATION INDICATOR: DIRT ROAD IMPROVEMENT OR DECOMMISSIONING

A dirt road-related indicator is chosen to provide a measure of progress on improving upslope conditions.

4.4.1 Discussion

Dirt roads can be a major source of erosion and sedimentation. Compacted road surfaces disrupt natural drainage and sediment storage patterns, increase the rate of runoff, and increase sediment delivery to streams. Roads built on steep or unstable slopes may trigger landslides that deposit excess sediment in stream channels. Lack of inspection and maintenance of drainage structures and road surfaces can also result in erosion and sedimentation in stream channels (Weaver and Hagans, 1994).

4.4.2 Target

Identified dirt roads with inadequate erosion control structures should be rehabilitated and maintained, or decommissioned. Focus should be on those roads that are identified as likely sediment contributors to waterways; for example, those within 200 feet of a watercourse ((Washington Forest Practices Board, 1997), on steep or erodible soils, and roads with signs of erosion problems (e.g., gullies, eroding roadside ditches and cut/fill slopes). This identification should occur on a project-level basis as individual watersheds are assessed for restoration potential, or as identified by Water Board inspections.

4.4.3 Existing and Target Conditions

Geographic Information System (GIS) analysis of dirt roads indicates that there are approximately 450 miles of dirt roads within 200 feet of a waterway in the Truckee River watershed. Approximately 200 miles of these roads are located in areas that were identified in DRI (2001) as susceptible to erosion in its 2001 assessment of the Truckee River watershed (see DRI, 2001 for details on the Truckee River GIS database and assessment). The condition of these roads has not been fully inventoried, so no comparisons between existing and target conditions can be made. However, in Gray Creek, a 2006 Watershed Assessment (NHC, 2006) concluded that the primary sediment problem that could be mitigated was road-related erosion. NHC identified ten road-related erosion sites in the California portion of the Gray Creek watershed. Three of these sites are within 200 feet of a watercourse, increasing the potential for sediment delivery.

4.5 IMPLEMENTATION INDICATOR: LEGACY SITES RESTORED AND BMPs IMPLEMENTED

4.5.1 Discussion

Legacy sites are areas with impacts from historical activities or prior land management and development, such as inadequately constructed bridges, or other stream crossings, improper road construction and maintenance, railroad construction, forestry, mining, recreation uses, or livestock grazing. Legacy sites also include urbanized areas developed without adequate storm water controls to contain or treat runoff.

4.5.2 Target

Identified legacy sites should be restored to prevent sediment delivery to surface waters. Candidate sites shall be identified through watershed assessments, Water Board or permittee inspections and annual worklists. Sites should be prioritized based on threat to water quality and implementation feasibility.

4.5.3 Comparison of Existing and Target Conditions

Data on the location and condition of existing watershed-wide legacy sites are not available. Comparisons of existing and target conditions should be assessed as specific restoration projects are proposed, or as sites are identified through WDR/NPDES annual worklists developed by permit holders.

Recent watershed assessments in the Donner/Cold Creek and Gray Creek watersheds (NHC, 2006; River Run Consulting, 2007) indicate that water quality impacts due to legacy land uses are apparent. Relict dirt roads, grazing impacts and railroad infrastructure were identified as primary human-caused erosion contributors.

5. SOURCE ASSESSMENT

This section presents a watershed-wide evaluation of sediment loading to the Truckee River based on SSC and turbidity data, GIS analyses and subwatershed assessments. It is important to note that sediment loading fluctuates greatly from year to year depending on the amount of precipitation and runoff. Estimates based on high- or low-flow water years, or using different sampling or calculation methods, vary by an order of magnitude or more. Therefore, these estimates are useful to understand the *relative* magnitude of sediment sources, rather than absolute loading values.

Sediment loading estimates were developed for tributary subwatersheds, intervening zones and unmeasured inputs, and sediment loading events. Then, land use characteristics in each subwatershed were evaluated to determine the relative extent of land use types that are considered controllable sources contributing to the overall sediment load.

5.1 DISCUSSION OF TERMS

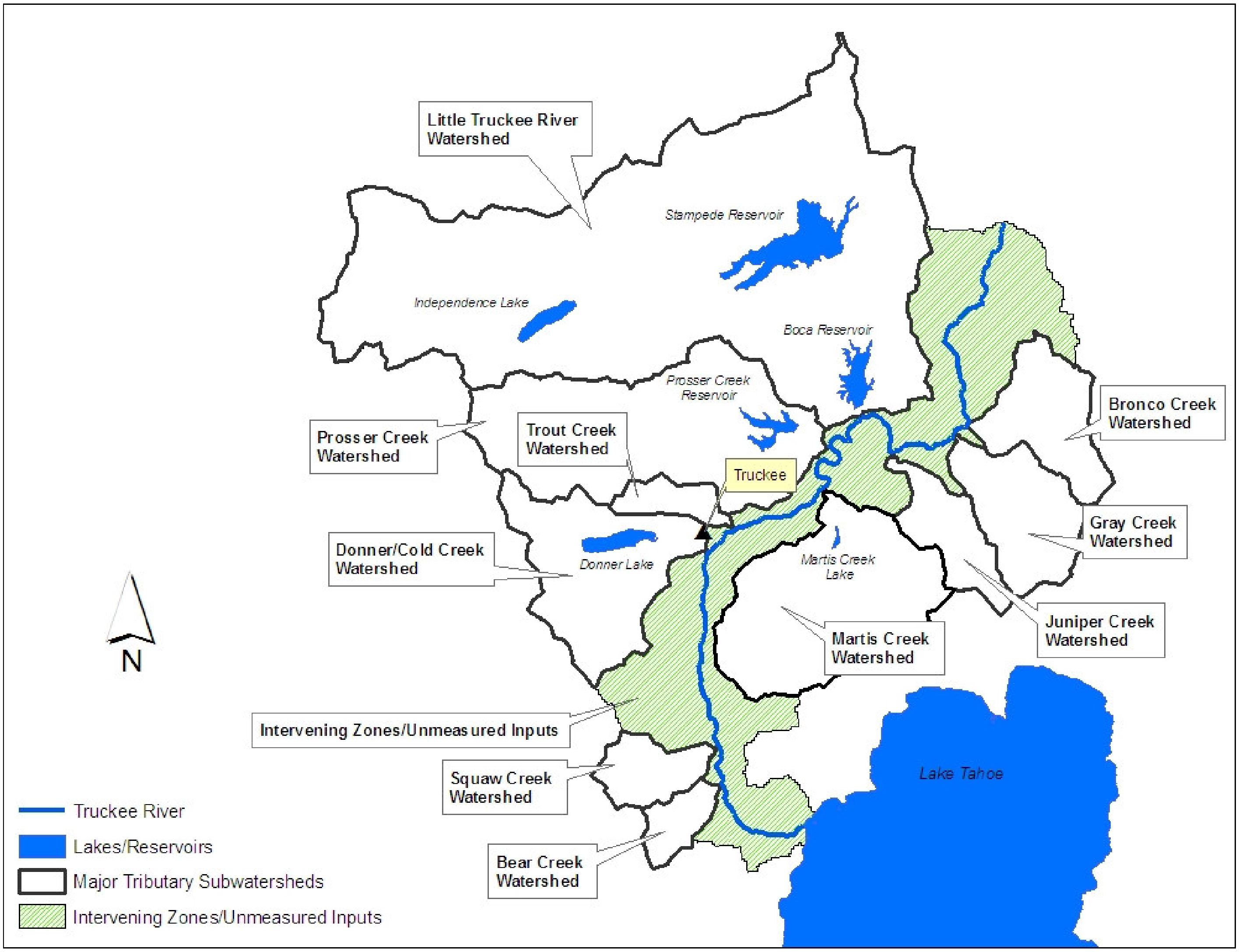
Several terms introduced in this section require some discussion for clarity. "Controllable" sediment sources are defined as those that are associated primarily with human activity and will typically respond to mitigation, restoration or improved management activities. "Uncontrollable" sediment sources mean those sources associated with naturally-occurring erosion and sediment delivery, mostly from undisturbed areas; although it is recognized that control of naturally-occurring erosion is certainly possible.

In evaluating sediment loading for specific areas of the watershed, we use the terms "tributary subwatersheds" and "intervening zones and unmeasured inputs." "Tributary subwatersheds" are the ten major subwatersheds evaluated by DRI (2001) in its sediment source assessment. They are (in order from up- to down-stream along the Truckee River): Bear, Squaw, Donner/Cold, Trout, Prosser, Martis and Juniper creeks, Little Truckee River, and Gray and Bronco creeks. These subwatersheds comprise approximately 80 percent of the total project area, and sediment loading estimates were available for these areas in the DRI (2001) report.

"Intervening zones and unmeasured inputs" comprise the rest of the project area, and do not have data from which to directly estimate loads. "Intervening zones" are those areas where surface runoff discharges directly to the Truckee River without first entering a tributary stream channel. Unmeasured inputs include the subwatersheds of Deep, Silver, Cabin and Pole creeks in the southwest portion of the watershed, other minor tributaries to the Truckee River besides the ten major subwatersheds, and in-stream erosion in the Truckee River. Intervening zones and unmeasured input areas are evaluated together as one area in this source assessment, and for convenience, will be referred to simply as "intervening zones". Figure 5-1 shows the locations of the tributary subwatersheds and the intervening zones.

The term "legacy site" is defined as impacts from past land uses or development activities that remain as significant and ongoing sediment sources, and may be associated with in-stream, upland or urban areas. Examples of identified legacy sites include stream channel alterations (channelized sections, railroad culverts, eroding streambanks) in the Squaw, Trout, and Cold creeks watersheds; grazing, logging, and recreational impacts in the Martis, Little Truckee, and Cold Creeks watersheds; and industrial land use impacts along the Truckee River urban corridor. Past residential or commercial development without adequate storm water controls to treat or infiltrate storm water may also exist. Some legacy sites have been identified from watershed assessments and stakeholder knowledge of the watershed. Based on the extent of historical land uses in the watershed, additional legacy sites may also be present, but have not yet been identified and evaluated. We note that legacy sites do not include dirt roads, since dirt roads are evaluated as a separate land use category.

Figure 5-1. Tributary Subwatersheds and Intervening Zones in the Truckee River Watershed.



5.2 TRIBUTARY SUBWATERSHED AND INTERVENING ZONE LOADING ESTIMATES

5.2.1 Data and Methods

Water Board staff calculated suspended sediment loads for the Truckee River at Farad, and the ten major tributary subwatersheds using the following information:

1. Flow and SSC regression equations developed by DRI (2001)
2. USGS streamflow data from gauged streams

3. Synthesized flow records developed for un-gauged streams
4. Squaw Creek streamflow gauging data (West-Yost, 2005)

In DRI (2001), regression equations were developed to estimate sediment loading to the Truckee River from ten major tributaries that comprise approximately 80 percent of the total watershed land area. These equations express the mathematical relationship between limited SSC data and more readily available streamflow data. The regression equations can then be used to estimate suspended sediment loads from daily flow records available from the USGS. See Appendix A for a summary of the equations used in the evaluation.

Water Board staff applied the DRI (2001) regression equations for tributary subwatersheds and the Truckee River at Farad to streamflow data for 1996-1997 and 2003-2004, and included newly available flow data for Squaw Creek (West-Yost, 2005). Sediment loading estimates are based on water years (October 1 through September 30) rather than calendar years as presented in DRI 2001.

Intervening zones did not have co-collected SSC and streamflow data from which to directly estimate loads; therefore, loading from these areas is calculated as the difference between the suspended sediment load at Farad minus the sum of the loading from the ten major tributary subwatersheds.

To illustrate the impact of precipitation and runoff on sediment loading, estimates are presented for a below average water year (2003-2004) and an above average water year (1996-1997).

5.2.2 Below Average Water Year Suspended Sediment Loads

Table 5-1 summarizes suspended sediment load estimates for water year 2003-2004. Streamflow that year was approximately 70 percent of average. Peak streamflows at Farad, according to the USGS National Water Information System, was 1,600 cfs. The suspended sediment load at Farad is estimated at about 2,900 tons. Tributary subwatersheds are estimated to contribute about 2,000 tons, or about 70 percent of the total suspended sediment load measured at Farad.

Table 5-1. Suspended Sediment Load Estimates for the Truckee River at Farad and Major Tributary Subwatersheds - Below Average Water Year.

Site	Suspended Sediment Load 2003-2004 (tons)	Average Annual SSC 2003-2004 (mg/L)	Annual Flow 2003-2004 (acre-feet)
Truckee River			
Farad	**2,892**	**5.8**	**369,870**
Major Tributary Subwatersheds			
Little Truckee River	666	3.8	130,290
Donner (incl. Cold Creek)	380	7.1	39,546
Prosser Creek	371	5.6	48,664
Squaw Creek [a]	185	8.9	15,231
Gray Creek	181	11.0	12,400
Martis Creek	110	7.4	10,912
Bear Creek [b]	66	4.9	9,844
Juniper Creek [b]	21	5.2	2,939
Trout Creek [b]	21	5.2	3,002
Bronco Creek [c]	20	3.0	4,453
Sum of Tributary Subwatershed Load/Flow	**2,021**		**277,281**
Intervening Zones and Unmeasured Inputs [d]	871	not available	not available
Percent of Farad Load/Flow From Tributaries	70%		75.0%

a. Loads from flow estimates based on West-Yost (2005).
b. Loads from synthesized flow estimate - calculated using flow correlations by DRI (2001). See Appendix A.
c. Loads from synthesized flow estimate - See Appendix A.
d. Calculated as total load at Farad minus cumulative load from ten major tributaries.

The data generally indicate that the dam-controlled tributaries[3] (Little Truckee River - Boca Reservoir, Donner Creek - Donner Lake, and Prosser Creek - Prosser Creek Reservoir) are the largest sediment contributors under low flow conditions. In general, the load rankings are consistent with the flow rankings, where the high streamflow producers are also the highest sediment load producers.

Donner Creek shows the highest average annual SSC of the dam-controlled tributaries, but it is also influenced by flows coming from Cold Creek. Cold Creek, a tributary to

[3] Martis Creek Reservoir provides flood control storage, but is configured with a bottom release that is not generally regulated; therefore, it does not affect flows to the extent that other dams do in the system.

Donner Creek, does not have any impoundments on its reach, and enters Donner Creek below the Donner Lake dam. The data suggest that Cold Creek is a significant loading source for the Donner Creek/Cold Creek watershed.

The data indicate that the highest loads from creeks without impoundments are attributable to Gray and Squaw creeks. These creeks also show the highest average annual SSC of any of the tributaries shown in Table 5-1.

5.2.3 Above Average Water Year Suspended Sediment Loads

Table 5-2 presents tributary loading estimates for water year 1996-1997, when precipitation was 140 percent of the annual mean. Streamflow was 260 percent of the annual average, and included a large rain-on-snow event where peak flows reached the fourth highest recorded rate of 14,900 cubic feet per second (cfs).

The suspended sediment load estimated at Farad is about 26,300 tons, an order of magnitude larger than the estimate for below average water year. Tributary subwatersheds contribute 10,300 tons, or about 40 percent of the total suspended sediment load measured at Farad.

Table 5-2. Suspended Sediment Load Estimates for the Truckee River at Farad and Major Tributary Subwatersheds - Above Average Water Year.

Site	Suspended Sediment Load 1996-1997 (tons)	Average Annual SSC 1996-1997 (mg/L)	Annual Flow 1996-1997 (acre-feet)
Truckee River			
Farad	**26,318**	**15.5**	**1,249,343**
Major Tributary Subwatersheds			
Squaw Creek (a)	2,971	55.3	39,547
Donner (incl. Cold Creek)	2,253	19.6	84,679
Gray Creek	1,453	46.0	23,247
Prosser Creek	1,276	8.9	105,788
Little Truckee River	1,026	3.2	236,884
Martis Creek	490	10.0	36,116
Bear Creek [a]	432	13.5	23,556
Bronco Creek	210	12.0	12,844
Juniper Creek [a]	173	15.0	8,477
Trout Creek [a]	61	7.7	5,809
Sum of Tributary Load/Flow	**10,345**		**576,947**
Intervening Zones and Unmeasured Inputs [b]	15,973	not measured	not measured
Percent of Farad Load/Flow From Tributaries	39%		46%

a. Synthesized flow estimate - calculated using flow correlations by DRI (2001). See Appendix A.
b. Calculated as total load at Farad minus cumulative load from ten major tributaries.

Under high flow conditions Squaw and Donner creeks are the two highest sediment contributors, followed by Gray Creek, Prosser Creek, and the Little Truckee River. The relative loading and SSC for Martis Creek does not appear to change significantly from low to high flow conditions, suggesting that the dam may buffer sediment loading to the Truckee River. High flow conditions have a greater effect on SSC in tributaries without dams compared to dam regulated creeks. In above average water years, tributaries without dams appear to contribute more to loading than the tributaries with dams. This suggests that loading is most significant under high flow conditions and that tributaries without dams have the most influence on loading patterns.

5.3 SEDIMENT LOADING EVENTS

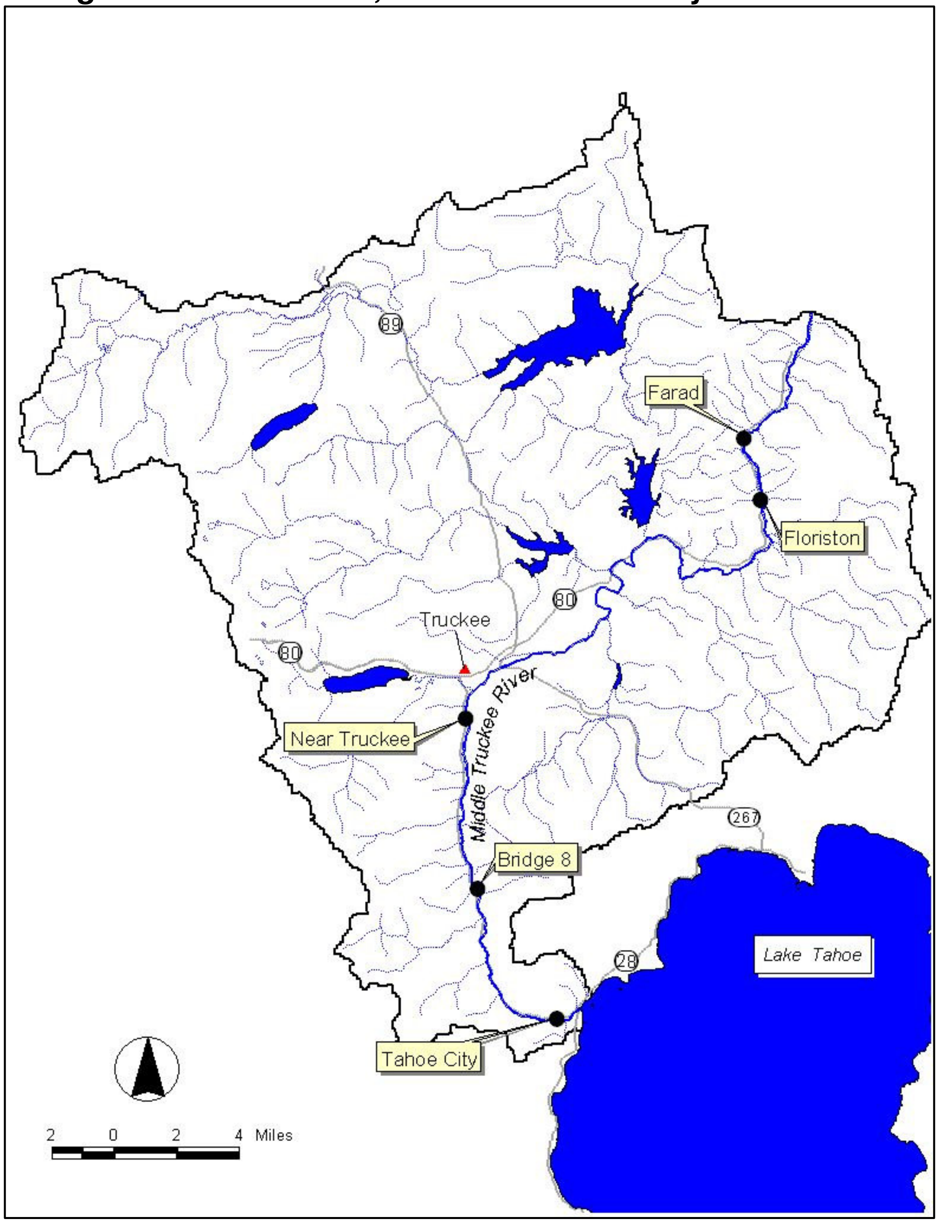
To assess runoff or flow events that affect suspended sediment loads in the Truckee River, Water Board staff evaluated data collected by DRI (2004) and load duration curves, which are described in Section 3.

5.3.1 DRI Turbidity/SSC Study (2002-2003)

DRI conducted a study to assess the magnitude, duration and frequency of specific sediment loading events by developing a sediment surrogate that could be measured continuously in the Truckee River. A continuously measured surrogate (in this case, turbidity) combined with less-frequently monitored SSC data to develop an SSC-turbidity relationship, can produce a more robust dataset than SSC grab sampling methods alone.

Turbidity data and other parameters were collected every 15 minutes at up to four locations the Truckee River using an automated multi-parameter monitoring device. The four continuous monitoring sites, Tahoe City, Bridge 8, Near Truckee, and Farad, are shown on Figure 5-2, along with the Floriston site where grab SSC samples only were collected. Except for Bridge 8, the four continuous monitoring sites were co-located with USGS discharge gauging sites such that flow rates could be matched with the other measured surrogate parameters.

Figure 5-2. Continuous Turbidity Monitoring Locations Along the Truckee River, 2003-2003 DRI Study.



Data were collected over a fourteen-month period from June 2002 through July 2003; however, due to instrument malfunctions, the turbidity record was incomplete by two to four months at each location; therefore, annual loads could not be estimated, according to the researchers. Additionally, instrument fouling and limited monitoring under higher turbidity flow events appeared to produce some unreliable results under these conditions.

DRI developed a multiple linear regression equation for predicting SSC from turbidity, flow, water temperature, and specific conductivity. DRI used this regression equation to estimate sediment load due to "events" in the Truckee River watershed. Events were determined by the researchers, and defined as sediment pulses measured during snowmelt periods, thunderstorms and dam releases. The length of the sediment pulse (as determined through elevated turbidity levels) is referred to as the "event duration." Event "intensities" (in tons/hour) were evaluated by dividing the event load by the event duration. The following conditions were noted in the study report (DRI, 2004).

Snowmelt

Sediment loading attributed to snowmelt occurs as a diurnal cycle that follows the daily melting of snow. Sediment loading may vary an order of magnitude with that daily cycle. For example, the sediment load at the near Truckee site varied between 38 tons/hour and 952 tons/hour during a diurnal cycle on June 7, 2003. The duration of snowmelt events ranged between 18 hours and 3.5 days, with the most frequently occurring durations between 25 to 38 hours.

Thunderstorms

A thunderstorm event on July 23, 2003 produced sediment loading of 3.5 tons/hour at Farad, with a duration of 20 hours. At the Bridge 8 site, the duration of the July 23 thunderstorm event was 15 hours, producing 2 tons/hour. Thunderstorm events generally last less than one day, and contribute less than 28 tons per event.

Dam Releases

Peak loadings just below the dam at Lake Tahoe occurred in July 2002 and 2003 (343 and 264 tons, respectively) and were likely related to increased dam releases at that time of year. Dam release events typically lasted between 5 to 39 days, and contributed sediment loads ranging from 0.09 tons/hour to 0.5 tons/hour.

Data Interpretation and Limitations

Water Board staff recognize that some of these events may already be accounted for by the data used to develop the regression equations (DRI, 2001) presented in the previous section. Due to the nature of the DRI (2004) study, we cannot determine how much overlap occurs between the two datasets. Both datasets have certain advantages and limitations. The DRI 2001 regressions cover a full range of flow conditions over a 30-year time period, but the grab sampling method had the potential to miss important short-term loading events. The DRI 2004 data were able to discern short-term loading events, but only covers a 14-month period, appears to over-predict loading at high turbidity levels, and had problems with instrumentation maintenance/failure. Further, as noted previously, missing data at all locations precludes using the only DRI 2004 data to estimate an annual watershed load.

Considering these factors, and to ensure that all sediment loading is accounted for, we conclude that the results from DRI (2004) should be fully considered in conjunction with the DRI (2001) data, because it provides the best available data to depict short-term sediment events loading that would be missed by the grab sampling data alone.

Summary

Each site had a different number of loading events during the course of the study: Tahoe City had 16 events; Bridge 8 had 94 events; Near Truckee had 33 events; and Farad had 74. Analysis of the data shows that the events most commonly produced loads in the range of 64 to 256 tons per event and typically lasted between 25 and 38 hours.

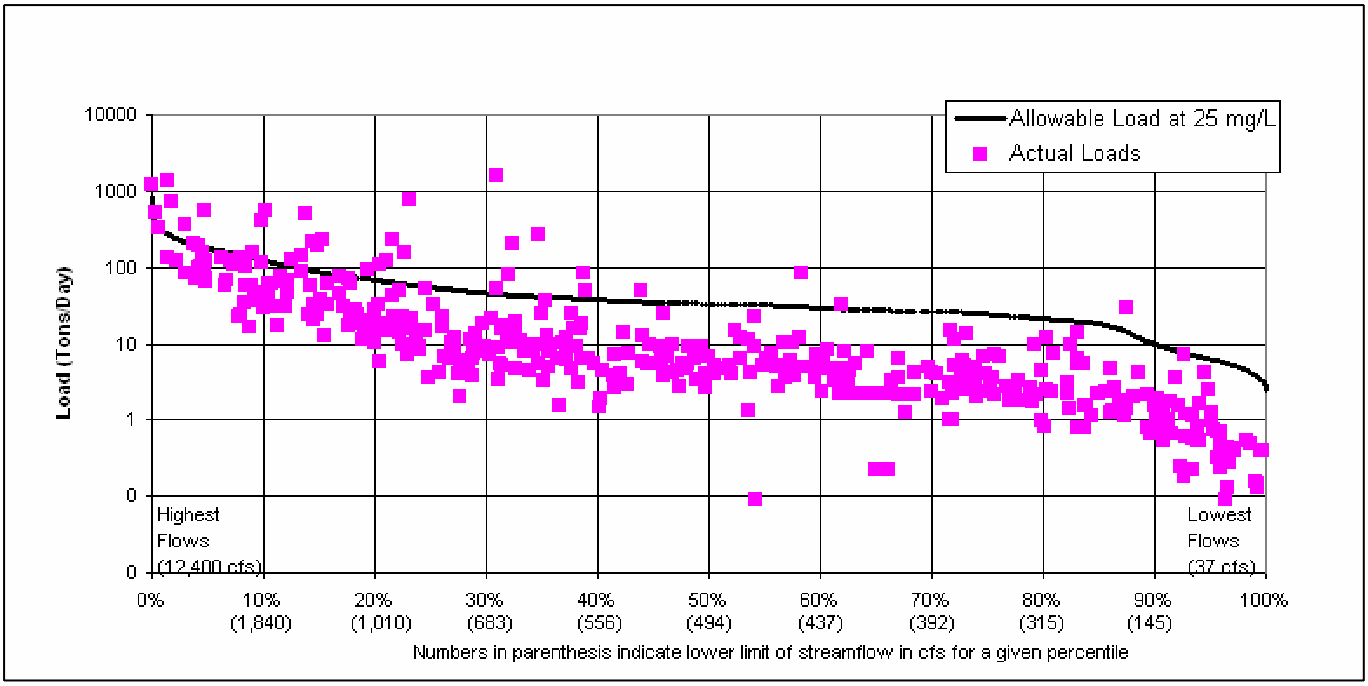
Therefore, the DRI 2004 data conservatively suggests that specific sediment loading events may contribute as much as 24,000 additional tons of sediment per year, using the highest estimates for loading per event (256 tons) and number of events (94, at Bridge 8). Because the DRI (2004) study took place during a lower-than-average water year (2002-2003), likely corresponding to lower sediment transport conditions, this conservative assumption is appropriate. This estimate for event-based loading was assigned to urban and non-urban categories using the ratio of non-urban to urban sources in the subwatersheds and intervening zones, as shown in Table 5-6.

5.3.2 Suspended Sediment Load Duration Curves

Farad Load Duration Curve

The load duration curve for the Truckee River at Farad indicates that since 1975, loads exceeding target levels are associated with wet to high flow conditions (Figure 5-3).

Figure 5-3. Load Duration Curve, Truckee River at Farad. Note that measured loads (squares) most often exceed the numeric target (dark curved line) once flows are in the wet to high flow hydrologic condition class (flows exceeded 40 percent of the time, or above about 556 cfs).



Subwatershed Load Duration Curves

The following general observations regarding sources can be made from the subwatershed load duration curves and monitoring data. Individual subwatershed duration curves are available in Appendix B.

1. Highest SSC in Squaw Creek occurred during spring snowmelt in above average flow years (May 1996) and during fall rain events coupled with high flows (December 1996).
2. Highest SSC in Donner Creek occurred during high-flow, spring snowmelt (May 1996) and during high flows coupled with rain on snow events (February 1996 and December 1996).
3. Highest SSC in Trout Creek occurred during probable rain events, once under moderate flow conditions (November 1973) and once under higher flow conditions (July 1974).
4. Highest SSC in Juniper Creek occurred under spring snowmelt conditions (May 2000).
5. Elevated SSC (greater than 25 to 60 mg/L) in Gray Creek is observed frequently under the full range of flow conditions found in the creek. Elevated SSC appears to be triggered by high flow, spring snowmelt conditions, fall rain, and summer thunderstorms.

5.4 EFFECTS OF LAND CHARACTERISTICS

The effects of land use characteristics on suspended sediment loading to the Truckee River were evaluated based on GIS information, watershed assessments, and staff knowledge. Two main categories were considered: urban and non-urban land use types. All loading from the urban category is considered controllable (as defined in the beginning of this Source Assessment). Within the non-urban land use type, controllable sediment sources were identified as dirt roads, graded ski runs and legacy sites (also defined previously). Evaluations of the contributions of these land use categories within each tributary subwatershed and the intervening zones, are presented below.

5.4.1 Urban Areas

Staff used information developed for the Lake Tahoe Basin Sediment and Nutrients TMDL Technical Report to estimate loading from urbanized land uses. Storm water runoff in the Lake Tahoe Basin was sampled and analyzed over a 2-year period to determine event-mean concentrations (EMCs) of various pollutants associated with different land uses (LRWQCB, 2007). Staff compared suspended sediment EMCs associated with urbanized (which includes effects from winter traction sand use on paved roads) and non-urbanized land uses[4], which showed that the average EMCs for urbanized land uses are approximately 1.2 times higher than for non-urbanized land uses.

Staff estimated the suspended sediment loading from urban areas by multiplying the total suspended sediment load (in tons/year, based on the 1996-1997 water year estimates) by the percent of urbanized area and the EMC scaling factor of 1.2. Urbanized areas in each subwatershed were determined through GIS analysis using the USGS's *National Land Cover Dataset*, and the *Land Cover* theme provided in DRI's 2001 Truckee River GIS database. Loading estimates for each subwatershed for the 1996-1997 water years are shown in Table 5-3.

[4] Urban land uses - residential, commercial/industrial, recreational, and paved roads.
Non-urban land uses - undisturbed and disturbed forested areas.

Table 5-3. Estimated Suspended Sediment Loading From Urban Areas by Subwatershed, 1996-1997 Water Year.

Subwatershed	Total Watershed Load (tons)	Percent Urbanized Area in Subwatershed	EMC Scaling factor	Sediment Loading (Tons)
Intervening zones/unmeasured inputs	15,973	10%	1.2	1,832
Squaw	2,971	12%	1.2	430
Donner/Cold	2,253	6%	1.2	168
Prosser	1,276	7%	1.2	108
Bear	432	11%	1.2	56
Trout	61	63%	1.2	46
Martis	490	3%	1.2	20
Little Truckee	1,026	0%	1.2	0
Gray	1,453	0%	1.2	0
Bronco	210	0%	1.2	0
Juniper	173	0%	1.2	0

5.4.2 Non-Urban Areas

The suspended sediment load attributed to non-urban areas in tributary subwatersheds and intervening zones was calculated by subtracting the load calculated for urban land uses from each area's estimated total load. Non-urban areas include both controllable sources (areas impacted by human activities) and uncontrollable sources (e.g., undisturbed forest lands).

Staff defined dirt roads, graded ski runs and legacy sites as the primary controllable sources. Several other potential source categories were contemplated, but determined to be *de minimus* for purposes of this broad scale evaluation. For example, potential loading from fuels reduction and other forest management activities were not included because studies show that regular forest management activities, in compliance with permit or waiver requirements, result in lower long-term average sediment delivery rates than would occur as a result of less frequent but higher intensity wildfires (LRWQCB, 2007).

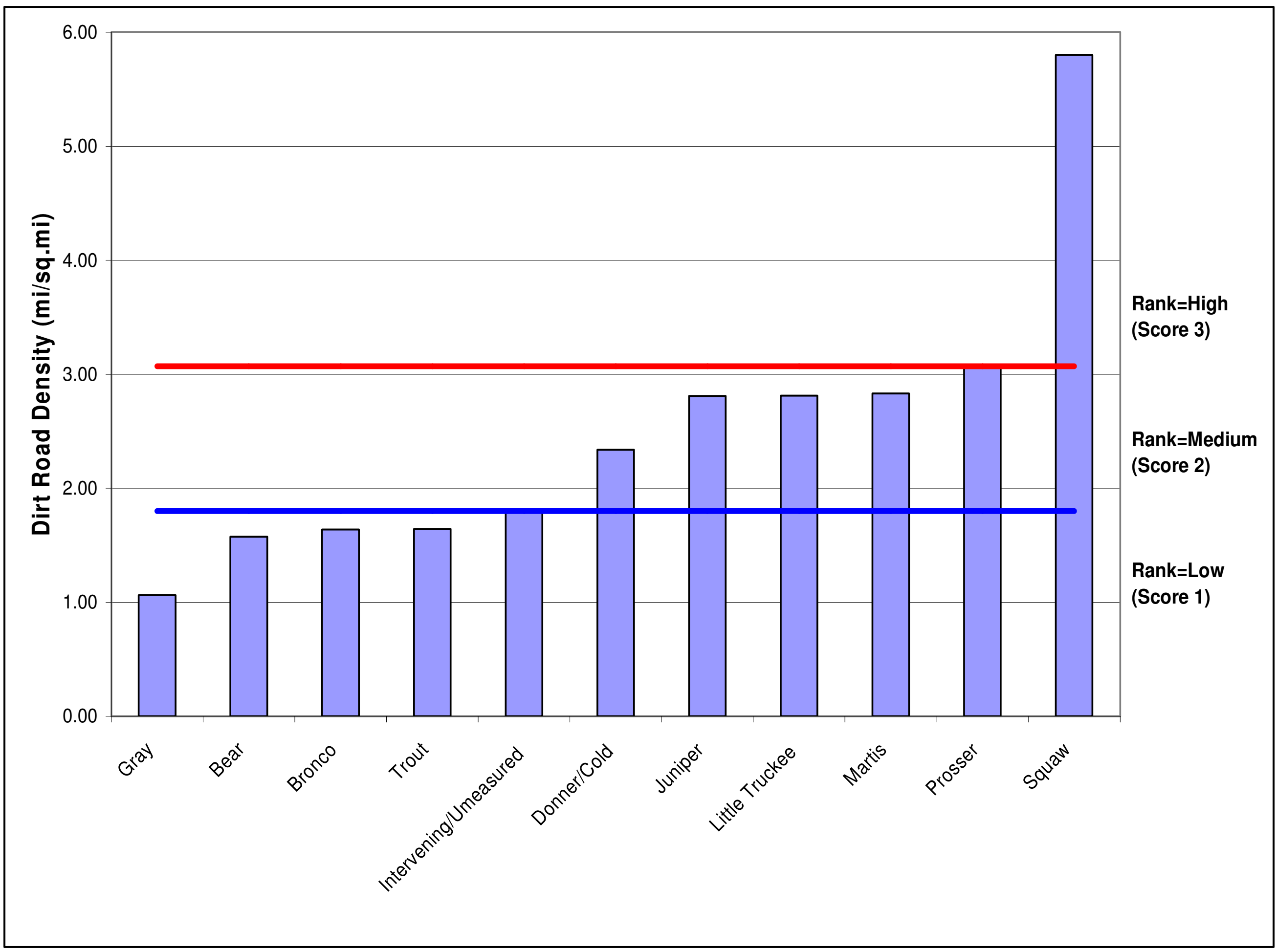
Because of the broad scale of this assessment, Water Board staff note that the estimates presented here may not account for best management practices that are already in place. We also note that site-specific information on the sediment delivery potential of any source area must be evaluated to determine the need for BMPs or restoration activities. We do not intend to imply that all controllable non-urban sediment sources in the watershed must be addressed, but rather, they should be prioritized based on threat to water quality. For example, a watershed may have a high density of dirt roads, but some may be located on low gradient slopes away from stream channels or other water bodies. These roads would likely have low potential to deliver sediment to water bodies, and should not be high priorities for mitigation.

Major controllable sources in each subwatershed and intervening zones were assessed by assigning a score from zero to three to identify the relative extent or importance of each source. The scores were then added up to assign a rating to each subwatershed corresponding to the relative amount of controllable sources (low, medium or high). A description of the scoring system for each land use type is presented below, and a summary of the results is shown in Table 5-5.

Dirt Roads

Relative loading was assigned a rank from one to three based on GIS analysis of dirt road miles per square mile of each subwatershed area. Observable breaks in the range of dirt road densities were used to group subwatersheds into the identified rankings. A score of one (low) represents the least miles of dirt roads per square mile and three (high) represents the most miles of dirt roads per square mile. The evaluation of dirt road densities is illustrated in Figure 5-4 below.

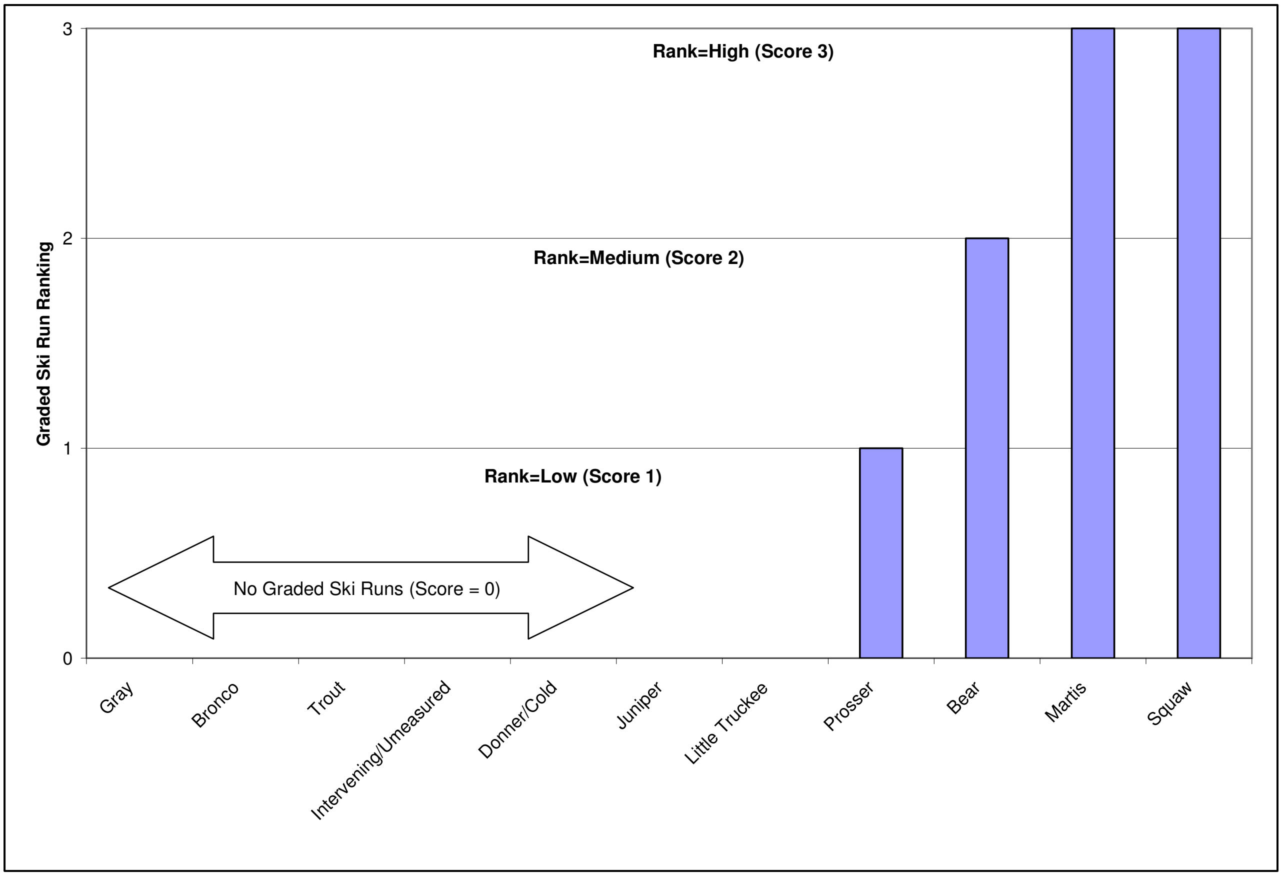
Figure 5-4. Dirt Road Densities and Corresponding Rankings by Subwatersheds.



Graded Ski Runs

Each subwatershed was assigned a score of zero to three based on the presence or absence of ski areas, and staff knowledge regarding size of each ski area. Squaw Creek (Squaw Valley) and Martis Creek (Northstar-at-Tahoe) subwatersheds were assigned a score of three (high), Bear Creek (Alpine Meadows) subwatershed was assigned a score of two (medium), and Prosser Creek subwatershed (Tahoe-Donner) assigned a score of one (low). All other subwatersheds did not have graded ski runs, and were scored as zero. The evaluation of graded ski runs is illustrated in Figure 5-5 below.

Figure 5-5. Graded Ski Run Rankings by Subwatersheds.



Legacy Sites

The relative importance of loading from legacy sites was assigned a score of one (low) to three (high) based on subwatershed assessments (Donner/Cold Creeks and Gray Creek), the Town of Truckee's Downtown River Revitalization Strategy and Railyard Master Plan, Truckee River Watershed Council's list of potential restoration projects, and staff knowledge. The evaluation of legacy sites is summarized below in Table 5-4.

Note that dirt roads are not considered in the legacy sites category because they're evaluated in their own source category.

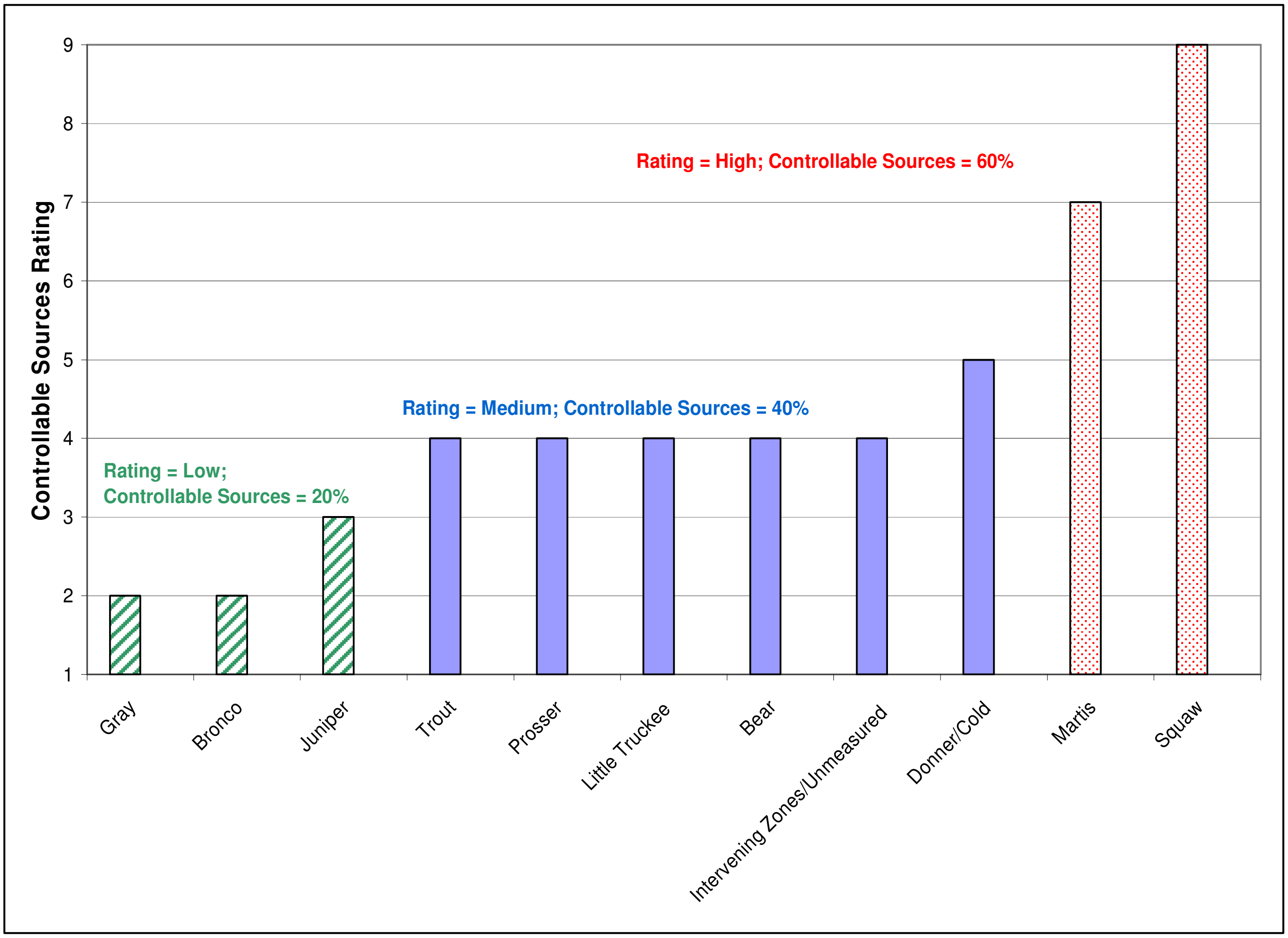
Table 5-4. Ranking of Legacy Sites by Subwatersheds.

Subwatershed	Legacy Sites Ranking	Comments
Bear Creek	1	Significant legacy sites have not been identified to date.
Prosser Creek	1	Significant legacy sites have not been identified to date.
Juniper Creek	1	Significant legacy sites have not been identified to date.
Gray Creek	1	Watershed was adversely affected by wildfire and historical land uses, but control options are very limited due to the steep terrain and naturally erosive characteristics of the watershed.
Bronco Creek	1	Although the watershed was affected by the 2001 Martis Fire, stream surveys did not identify significant erosion sites from human disturbance.
Martis Creek	2	The Martis Creek watershed has been affected by past grazing and recreational use. Work to restore trails and streambanks, and efforts to conserve open space are ongoing.
Little Truckee River	2	Impacts from past land uses are present in Davies Creek and Merril Creek watersheds, and Perazzo Meadows. Grant-funded restoration projects are planned. Loading to the Truckee River may be buffered by Stampede and Boca Reservoirs.
Squaw Creek	3	Squaw Creek has been realigned to accommodate a parking lot. Just below the confluence of the north and south forks, the stream channel is formed by a man-made trapezoidal channel. The creek alterations have been identified significantly impairing the natural functions of the stream channel.
Donner/Cold Creeks	3	Although the dam at Donner Lake buffers loading to the Truckee River, legacy impacts remain from urbanization and development. Adverse effects from roadway discharges have been identified in the watershed. Coldstream Canyon has a long history of human disturbance including logging, railroad construction, gravel mining, stream realignment, and urbanization. The watershed is still impacted by the past disturbances and has been identified as a significant source of sediment loading to the Truckee River.
Trout Creek	3	Development in the Trout Creek watershed, as well as construction of surface road and highway crossings, has left impacts in the watershed. Restoration projects have been scoped and funding is needed for implementation.
Intervening Zones	3	Significant adverse impacts from historical development and past land uses have been identified. Scoping to mitigate impacts is ongoing under the Railyard Master Plan Improvements, Downtown Specific Plan, and Downtown River Revitalization Strategy.

Controllable Non-Urban Sources Rankings

Scores from each controllable non-urban source category were summed, and each subwatershed received a single score ranging from two to nine. Apparent breaks in the overall scores were examined to assign each subwatershed area a rating of low, medium or high to indicate the relative extent and magnitude of controllable sources. This rating is then equated to a "percent controllable sources" estimate, described below. The evaluation of the controllable non-urban sources is illustrated in Figure 5-6 below.

Figure 5-6. Controllable Non-Urban Sources Ratings, by Subwatersheds.



Watersheds with a score of six or above were ranked as "high" controllable sources, corresponding to a 60 percent controllable load rating. This number is based on the Squaw Creek TMDL, where 60 percent of the total load was considered controllable (the Squaw Creek watershed ranked "high" in this assessment, and the sources of sediment in Squaw are similar to those evaluated in the Truckee TMDL). Watersheds with a score of four or five were ranked as having "medium" controllable sources, and given a 40 percent controllable load rating. Watersheds with a score of three or less were ranked "low" controllable sources, and given a 20 percent controllable load rating, based on best professional judgment.

This analysis was used to help determine appropriate load reductions and allocations, which are described in detail in Section 7 (TMDL and Allocations).

5.5 SUMMARY

A summary of the key points from the source assessment is presented below.

1. Truckee River load estimates vary at least an order of magnitude. For above average (1996-1997) and below average (2003-2004) water years, suspended sediment loads are estimated at 26,318 and 2,892 tons, respectively.

2. Relative overall sediment loading contributions from each subwatershed for an above average (1996-1997) and below average (2003-2004) water year are shown in Table 5-5:

Table 5-5. Relative Suspended Sediment Contributions from Subwatersheds (Highest to Lowest), for an Above- and Below-Average Water Year.

Above Average Water Year	Below Average Water Year
Squaw Creek	Little Truckee River
Donner Creek	Donner Creek
Gray Creek	Prosser Creek
Prosser Creek	Squaw Creek
Little Truckee River	Gray Creek
Martis Creek	Martis Creek
Bear Creek	Bear Creek
Bronco Creek	Juniper Creek
Juniper Creek	Trout Creek
Trout Creek	Bronco Creek

3. Tributaries that are not dam-regulated tend to vary most in load contribution depending on flow and runoff events. Source control in these watersheds would have a greater effect on loading contribution to the Truckee River than in watersheds with dam-regulated creeks. Gray, Squaw and Donner/Cold creeks are important sediment sources that are not dam-regulated.

4. Thunderstorms and snowmelt periods produce significant spikes in suspended sediment loading and suggest that disturbed upland areas and are important source areas to be addressed.

5. Sediment loading is more significant under wet to high-flow conditions and suggests that storm water runoff from both impervious and upland areas, and in-stream erosion are significant sources.

6. Urbanized areas are a significant sediment source in the intervening zones, and to a lesser extent in the Squaw, Donner/Cold, and Prosser subwatersheds.

Using the loading estimates for the above average water year 1996-1997 (representing worst-case sediment transport conditions) and considering the observations listed above, existing sediment loading sources are represented by the following estimates shown in Table 5-6.

Table 5-6. Summary of Suspended Sediment Sources in the Truckee River Watershed.

Summary of Suspended Sediment Sources (Water Year 1996-1997[a] in Tons)			
Subwatershed	**Total Watershed Loading** ***From Table 5-2*** **(tons/year)**	**Urban Areas** ***From Table 5-3*** **(tons/year)**	**Non-Urban Areas[b] (tons/year)**
Squaw Creek	2,971	430	2,541
Donner/Cold Creeks	2,253	168	2,085
Gray Creek	1,453	0	1,453
Prosser Creek	1,276	108	1,168
Little Truckee River	1,026	0	1,026
Martis Creek	490	20	470
Bear Creek	432	56	376
Bronco Creek	210	0	210
Juniper Creek	173	0	173
Trout Creek	61	46	15
Subwatershed Totals	**10,345**	**828**	**9,517**
Intervening Zones/Unmeasured Inputs[c]	15,973	1832	14,141
Load Measured at Farad	26,318		
Event-Based Loading[d]	24,064	2,406	21,658
Total Suspended Sediment Load	**50,382**	**5,066**	**45,316**
Percent of Total		10%	90%

a. Except for the estimate for event-based loading, which relies on the DRI 2004 study, conducted from May 2002 to June 2003 (see table note "d", below).
b. Calculated as the difference between the sum of load estimates for each subwatershed's urban areas and each subwatershed's total load.
c. Calculated as the difference between the total suspended sediment load from subwatersheds and the total suspended sediment load measured at Farad (26,318 tons minus 10,345 tons).
d. Calculated by multiplying 256 (tons of sediment) by 94 (events). 256 tons is the upper limit of the most frequently occurring suspended sediment event load range. This range also corresponds to most frequent event load occurring at Farad, where the watershed sediment load is calculated. Ninety four represents the most conservative (worst-case) number of events recorded during the DRI 2002-2003 study (at Bridge 8). This conservative estimate is appropriate given that the study occurred over a lower than average water year.

6. LOADING CAPACITY AND LINKAGE ANALYSIS

Loading capacity is defined as the maximum amount of a pollutant that a water body can receive without violating water quality standards (called water quality objectives in California) [40 CFR 130.2 (f)]. Sediment load reductions needed to protect beneficial uses are estimated from mathematical comparisons of existing and target conditions as described by USEPA (1999), and then applied to the existing annual sediment load shown in Table 5-6 to estimate the loading capacity.

The linkage analysis describes the link between the loading capacity and the applicable water quality objectives, and provides the rationale for load reductions. The loading capacity and linkage analysis are presented below.

6.1 TRUCKEE RIVER LOADING CAPACITY

The loading capacity must be set to attain sediment-related water quality objectives and support the beneficial uses of the Truckee River. Because these objectives are narrative rather than numeric, they are expressed as a water quality indicator (suspended sediment concentrations) with an associated target value to protect coldwater aquatic life, particularly early life stages (COLD and SPWN, the most sensitive beneficial uses). The target also reflects the assumption that there is some amount of in-stream sediment loading above natural conditions under which beneficial uses will be supported and narrative water quality objectives met. This assumption is reasonable because of the inherent natural annual and seasonal variability of in-stream sediment levels.

Therefore, it is not necessary for the Truckee River watershed to reflect completely natural or pre-disturbance conditions in order to achieve water quality standards, and restoration of the river to "pristine" conditions is not required as long as beneficial uses are adequately supported.

As recommended by USEPA (1999), a rough estimate of needed reductions can be made by comparing the difference between existing and target conditions, and specifying that existing loads should be reduced by an equivalent percentage. Table 6-1 shows existing and target SSC conditions measured in the Truckee River at Farad.

Table 6-1. Comparison of Existing and Target SSCs in the Truckee River at Farad, 1975 to 2006.

SSC Target Evaluation	Target	Existing	Difference between Target & Existing
Annual water year 90th percentile value	Annual 90th percentile values should be less than or equal to 25 mg/L.	Out of 27 years, 6 years, or 22 percent, showed 90th percentile values greater than 25 mg/L (table 4-2)	22 percent

This comparison indicates load reductions of approximately 22 percent are needed to meet the SSC target; therefore, the loading capacity of the Truckee River is based on a 20 percent reduction (rounded from 22 percent) in overall suspended sediment loading.

The loading capacity is calculated as shown in Equation 6-1:

Equation 6-1:

> Loading capacity = (existing sediment load) – (existing load x load reduction percentage needed to achieve desired condition).

Applying this equation to the current sediment load and the 20 percent load reduction, the loading capacity of the Truckee River is shown in Equation 6-2 (rounded to the nearest hundred tons):

Equation 6-2:

Truckee River Loading Capacity = **40,300 tons/year** = (50,382 tons/year) – (50,382 x 20%)

The quantitative relationship between the estimated sediment loading reductions and the corresponding percentage of improvement in SSCs is not known. Absent these data, Water Board staff assumes that a 1:1 relationship between sediment load reductions and decreasing suspended sediment concentrations provides a reasonable basis for establishing needed reductions. This assumption is based on guidance by USEPA (1999), and has been used in several USEPA-developed or approved TMDLs for sediment (Van Duzen River and Yager Creek [USEPA, 1999], South Fork Trinity River and Hayfork Creek [USEPA, 1998], San Lorenzo River [Central Coast Regional Water Board, 2002]).

Sediment loading reduction and loading capacity are estimated here only to give a relative sense of the watershed-wide improvements needed to protect water quality and beneficial uses. The success of the Truckee River Watershed TMDL will not be directly measured by sediment mass loading reductions, because that is not a practical indication of beneficial use protection due to the inherent natural variability of sediment delivery and the uncertainties associated with accurately measuring sediment reduction. The practical benchmarks to determine if desired conditions (and thus, the loading capacity) are achieved are the TMDL targets that measure sediment conditions in-stream, and watershed-wide sediment control actions.

6.2 LINKAGE ANALYSIS

The linkage analysis describes the relationship or link between the targets and the estimated loading such that the determination of sediment loading capacity is appropriate to support the beneficial uses for the waterbody. Linkage between sedimentation and beneficial use impairment was established by bioassessment studies (Herbst and Kane, 2006), literature reviews and best professional judgment.

The link to impairment of beneficial uses due to sedimentation was established based on the relationship between measured sediment volumes and biologic community structure and diversity from Herbst and Kane (2006). As sedimentation measures increased, the diversity and structure of biologic communities shifted toward more pollution-tolerant species.

The link between the level of impairment and sediment loading in the river was based on the difference between existing and target suspended sediment concentrations. The target SSC was developed from literature reviews, which focused on criteria to protect aquatic life beneficial uses from excess suspended sediment. Much of the literature was specific to suspended sediment's effects on salmonids, which occur in the Truckee River.

Best professional judgment was based on scientific literature supporting the link between urbanization and associated land disturbance to increased erosion and sediment delivery to streams channels (USEPA, 2006; Wemple et al., 1996; Weaver and Hagans, 2004; Ritter et al., 1995).

7. TMDL AND LOAD ALLOCATIONS

The TMDL is equal to the loading capacity and is allocated to pollutant sources as required. Allocations are defined as either load allocations (LAs) for non-point sources, or waste load allocations (WLAs) for point sources. A margin of safety must be included to account for uncertainty in the TMDL analysis, and may be addressed implicitly through conservative analytical assumptions, or explicitly by reserving a portion of the available loading. The margin of safety for this TMDL is provided for implicitly, as described in Section 8. The TMDL and allocations are presented in Table 7-2.

7.1 SUSPENDED SEDIMENT TMDL

The suspended sediment TMDL, or loading capacity, is 40,300 tons per year based on the loading estimates for an above average water year presented in Table 5-6 and applying the load reduction of 20 percent needed to meet the numeric SSC target. The TMDL expressed in units of tons per day is 110. It is recognized that loads will vary significantly on a yearly or daily basis; however, it is necessary to select a representative estimate in order to describe the required load reductions and allocate the load capacity. Because the load allocations presented here are broad estimates, they are not appropriate for use as discharge specifications in waste discharge requirement or permits. Water Board staff expect dischargers to follow an iterative approach to implementing storm water pollution controls, and will evaluate permit and waiver compliance, track implementation indicators described in Section 4, perform inspections and evaluate in-stream SSC monitoring to determine TMDL attainment.

7.2 ALLOCATIONS

Sediment loading allocations are based on the extent of controllable sources estimated in the Source Assessment, and Best Management Practices (BMP) efficiencies expected for the urban and non-urban source categories (except for Squaw Creek, as explained below). Factors such as location, design and maintenance practices can have substantial influence on BMP effectiveness. For example, a source control BMP that fully stabilizes a disturbed area may approach 100 percent effectiveness, whereas a poorly maintained treatment BMP may have zero effectiveness.

Reuter et al. (2001) reports median results for BMP effectiveness in reducing total suspended solids (TSS) concentrations ranging from 46 to 97 percent. This estimate is based on investigations of BMP effectiveness in the Lake Tahoe basin, a nearby watershed with similar land uses, topography and climate to the Truckee River watershed. Comparison to values reported in national erosion and sediment control literature for BMP effectiveness shows consistency between estimates, shown in Table 7-1.

Table 7-1. Literature Values Reported for Various Erosion and Sediment Control BMP Efficiencies

BMP Type	Sediment Source Category	Efficiency	Parameter	Reference
Maintain roadside vegetation	Dirt roads, urban areas	90% removal (average)	Sediment	*Stormwater Manager's Resource Center*, 2006. Pollution Prevention Fact Sheet
Sediment traps/basins	Urban areas, dirt roads, legacy sites, ski runs	60-90%	Sediment	*Stormwater Manager's Resource Center*, Erosion and Sediment Control Fact Sheet
Mulches	Ski runs, construction areas, legacy sites	65-97%	TSS, Sediment	*Stormwater Manager's Resource Center*, Erosion and Sediment Control Fact Sheet
Vegetative Stabilization	Ski runs, dirt roads, road cuts, construction areas	Up to 99%	Sediment	*Stormwater Manager's Resource Center*, Erosion and Sediment Control Fact Sheet

Based on this information, and considering both source control and treatment BMP use, a lower-end range of 50 to 55 percent BMP effectiveness was used to estimate feasible load reductions and assign allocations associated with existing urban areas (WLAs) and non-urban areas (LAs). The lower-end of the range is used to account for uncertainty regarding the extent of BMPs already in place, and the lack of site-specific information on the nature and control opportunities for the legacy sites sediment sources.

WLAs were assigned to the combined discharges associated with the current municipal National Pollutant Discharge Elimination System (NPDES) permit for Caltrans, and the newly issued municipal NPDES permits for Placer County and the Town of Truckee. The WLAs were assigned based on a 50 percent reduction (or 50 percent BMP efficiency) of the estimated loads from urbanized areas shown in Table 5-6, plus an estimate of loading from event-based loading.

The WLA to future development in the watershed is based on residential growth projections provided by the Town of Truckee (2006) and Placer County (2003). These projections indicate that urbanized areas have the potential to double in size (increase 100 percent) over the next 10 to 20 years; therefore, the WLA for future development could be equivalent to that given to existing development. However, staff estimates that greater control of sediment loading is feasible from new development; for example, by incorporating Low Impact Development (LID) principles. LID emphasizes maintenance of pre-development runoff patterns through storm water infiltration BMPs and minimization of new impervious surfaces. Potential sediment loading reductions due to LID are highly site-specific, and applicable estimates were not available from which to base additional reductions. Therefore, the WLA for future development was assigned at 85 percent of the existing WLA (a conservative 15 percent reduction over the current allocation, based on best professional judgment).

LAs for non-urban areas were assigned based on the percent of controllable load for each subwatershed, ranging from 20 to 60 percent, as discussed in the Source Assessment (Figure 5-5), and a conservative BMP efficiency of 55 percent. The BMP efficiency percentage for non-urban areas is higher than for urban areas because it is assumed there is more flexibility in control opportunities (non-urban areas have more open space to install BMPs than developed urban areas).

The controllable load percentage for event-based loading was rated as "medium", corresponding to a 40 percent controllable load. This rating was chosen because event-based loading is assumed to come from all sources (both controllable and uncontrollable, including in-stream erosion); therefore, the "medium" rating reflects some uncertainty in control opportunities. Using these assumptions, load reductions were calculated for subwatersheds, intervening zones/unmeasured inputs, and event-based loading by the following equation:

<u>Equation 7-1:</u>

> Load Reduction = Total estimated load X percent controllable load (20 to 60 percent) X BMP efficiency (55 percent)

The load reductions were then subtracted from the total load to calculate the LAs shown in Table 7-2.

For Squaw Creek, a watershed-wide load reduction of 25 percent was specified in the previously-approved sediment TMDL (LRWQCB, 2006); therefore, that reduction is applied to the load estimates for Squaw Creek presented in Table 5-6. The WLA presented here for Squaw Creek is equal to the allocations to urban areas and road sand in the Squaw Creek Sediment TMDL.

The TMDL for the Truckee River is the sum of the LAs and WLAs for subwatersheds, intervening zones/unmeasured inputs and event-based loading, plus the WLA for future development. The allocations are rounded to the nearest hundred tons only at the final summation. Therefore, the allocations for suspended sediment loading in the Truckee River are:

<u>Equation 7-2:</u>

> 40,300 tons/year ≈ 35,393 (LA) + 2,668 (WLA) + 2,268 (WLA - future urban)

Table 7-2. Allocations for the Truckee River Watershed Sediment TMDL.

	Allocations (Tons/Year)			
Subwatershed	**Urban Areas (Wasteload Allocation)[a]**	**Non-Urban Areas (Load Allocation)[b]**	**Total Allocated Load**	**Notes**
Squaw Creek	350	1,878	2228	Allocations are per Squaw TMDL: Total load = 25% reduction from total watershed load shown in Table 5-6; WLA = road sand/urban allocation from Squaw TMDL.
Donner/Cold Creeks	84	1,626	1710	Controllable non-urban load = 40%
Gray Creek	0	1,293	1293	Controllable non-urban load = 20%
Prosser Creek	54	911	965	Controllable non-urban load = 40%
Little Truckee River	0	800	800	Controllable non-urban load = 40%
Martis Creek	10	315	325	Controllable non-urban load = 60%
Bear Creek	28	293	321	Controllable non-urban load = 40%
Bronco Creek	0	187	187	Controllable non-urban load = 20%
Juniper Creek	0	154	154	Controllable non-urban load = 20%
Trout Creek	23	12	35	Controllable non-urban load = 40%
Total Suspended Sediment Loads Allocated to Subwatersheds	549	7,470	8,019	
Intervening Zones/ Unmeasured Inputs	916	11,030	11,946	Controllable non-urban load = 40%
Event Based Loading	1,203	16,893	18,096	10% to WLA based on existing wasteload/load ratio; Controllable non-urban load =40%
Future Development	2,268		2,268	85% of WLA to existing urban areas.
Totals	**4,936**	**35,393**	**40,329**	

Allocations Summary		
Total WLA	4,936	(549 + 916 + 1,203 + 2,268)
Total LA	35,393	(7,470 + 11,030 + 16,893)
Total Allocated Loads (WLA +LA) *Must not exceed TMDL*	**40,300**	(4,936 + 35,393**), rounded to nearest 100 tons**
TMDL (Loading Capacity)	**40,300**	(50,382 x 80%; 20% overall load reduction) **rounded to nearest 100 tons**

a. All WLAs based on 50% load reduction (BMP efficiency of 50%).
b. All LAs based on 55% BMP efficiency applied to percent controllable load.

8. MARGIN OF SAFETY, SEASONAL VARIATION AND CRITICAL CONDITIONS

Section 303(d) of the Clean Water Act and the regulations at 40 CFR 130.7 require that TMDLs be established at levels necessary to attain and maintain the applicable narrative and numeric water quality standards, and must include a margin of safety (MOS) that accounts for knowledge gaps or uncertainty in the TMDL analysis. The TMDL must also take into account seasonal variations and critical conditions that may affect temporal water quality variations. The Truckee River TMDL includes an implicit margin of safety, and the conservative assumptions that comprise the MOS are outlined in the following section.

8.1 UNCERTAINTIES AND CONSERVATIVE ASSUMPTIONS

It is difficult to accurately measure sediment loading and transport and the resulting effects as they occur throughout a watershed. There are substantial and poorly defined spatial and temporal lags between erosion, sediment delivery and the occurrence of sediment-related impacts on beneficial uses. For the most part, this TMDL analysis relied on data from field studies and GIS data that were developed specifically for the Truckee River watershed. Nonetheless, data interpretation, data limitations and the inherent variability of sediment-related processes can introduce varying degrees of uncertainty into the TMDL analysis.

To ensure that water quality and beneficial uses will be adequately protected regardless of these uncertainties, conservative assumptions and interpretations were often made. These assumptions comprise the implicit MOS for the Truckee River TMDL and are summarized in Table 8-1.

Table 8-1. Summary of Uncertainties, Conservative Assumptions and Adjustments.

Uncertainty in TMDL Analysis	Implications of Uncertainty	Conservative Assumption to Account for Uncertainty
Inherent seasonal and annual variability in sediment delivery and in-stream impacts of sediment common to all stream systems.	Sediment delivery estimates may be greater or less than predicted.	Loading estimates were developed based on worst-case scenarios to avoid underestimating loading as follows: • Estimates from the highest flow and loading conditions (1996-1997 water year) were used in the Source Assessment. • Conservative estimates of event-based loading were added to the total subwatershed inputs in the Source Assessment to account for the potential to underestimate loading derived only from monthly sampling data.
The available SSC data may not capture all exceedances of the target value.	Required load reductions may be underestimated.	Conservative estimates of event-based loading were added to the total subwatershed inputs in the Source Assessment to account for short-term spikes that may have been missed from monthly sampling data.
Amount of overlap in the datasets for event-based loading (DRI, 2004) and flow-SSC regression equations (DRI, 2001) used to calculate sediment loading at Farad.	Total loading may be overestimated if significant overlap exists.	The amount of overlap between the datasets cannot be estimated. The source assessment assumes no overlap to avoid underestimating sediment loading. This may result in some double-accounting of sediment sources, and is acknowledged in the TMDL. The conservative assumption of no overlap is appropriate given that the event-based study occurred during a below-average water year, when sediment transport is less than under higher flow conditions.
Literature estimates range widely for BMP efficiencies.	Load reductions achieved from BMPs may be greater or lower than estimated.	BMP efficiencies used to estimate load reductions and assign allocations are at the lower end of range reported in literature to avoid overestimating achievable load reductions.
Effect of BMPs already in place in many areas of the watershed.	Required load reductions may be partially met by BMPs already in place.	Existing BMPs are not factored into load reductions to avoid underestimating needed load reductions.

8.2 SEASONAL VARIATIONS AND CRITICAL CONDITIONS

All stream ecosystems, whether or not they have been disturbed by human activities, exhibit seasonal and annual variations in the rate of sediment delivery to the stream and in the impacts of sediment on stream organisms during different stages of their life cycles. Furthermore, there may be significant temporal lags and spatial disconnects between hillslope erosion events and the impacts of sediment on in-stream uses. Sediment impacts may be more important if they affect critical conditions of an organism's life cycle than if they occur at other times; e.g., sedimentation of spawning gravels can have particularly significant effects on early developmental stages of fish.

The TMDL accounts for critical conditions by establishing an SSC target that is based on protecting the more sensitive aquatic life stages (i.e., juveniles, larvae, and eggs). The SSC target compliance point is also located at the most downstream sampling location where the cumulative effects from upstream loading will be captured. The target also applies under all flow conditions, including higher flow periods which typically occur during spring spawning and incubation (rainbow trout), and rearing season (brown trout). Seasonal variations are accounted for by expression of the SSC target as an annual 90th percentile value, allowing for fluctuations in SSC over the target limit.

9. PUBLIC PARTICIPATION

Federal TMDL regulations require that the public be given the opportunity to review and comment on TMDLs. For TMDLs adopted as Basin Plan amendments in California, opportunities for public participation are provided through the procedures summarized in the USEPA Region IX *Guidance for Developing TMDLs in California* (2000), and through the California Environmental Quality Act (CEQA) review process.

The Lahontan Water Board maintains mailing lists for parties interested in receiving draft Basin Plan amendments and/or hearing notices, and a separate mailing list for its agenda announcements. The Basin Plan amendment and CEQA review processes include opportunities for written public comments and for testimony at a noticed public hearing. Written responses are required for written public comments received during the noticed public review period, and staff responds orally to late written comments and hearing testimony before Board action is taken.

The Lahontan Water Board's Basin Plan amendments (including draft TMDLs) are now made available on the Internet and publicized through press releases. Further opportunities for public participation are also provided in connection with review and approval of Water Board-adopted Basin Plan amendments by the State Board and the USEPA. Documentation of public participation, including copies of hearing notices, press releases, written public comments and written responses, and tapes or minutes of hearing testimony will be included in the administrative record of the Basin Plan amendments for USEPA review.

9.1 PUBLIC PARTICIPATION OPPORTUNITIES

In September 2002, the Truckee River Watershed Council (TRWC), the Lahontan Water Board and the Center for Collaborative Policy (CCP) convened a collaborative effort to develop the TMDL for the Truckee River. Due to questions on whether the river was actually impaired, active meetings as part of the collaborative effort ceased while the Water Board conducted an impairment assessment. During and following the collaborative process, numerous opportunities for stakeholder involvement were offered. Below is a summary of public participation in the TMDL process thus far.

May 1999: Truckee River Habitat Restoration Group (TRHRG) Watershed Planning Workshop

The TRHRG was the precursor to the Truckee River Watershed Council. This workshop identified planning needs in the watershed. In anticipation of the sediment TMDL for the Truckee River watershed, workshop participants, including Water Board staff, identified an opportunity for a collaborative approach between stakeholders and regulatory agencies to develop the TMDL.

April 11, 2000: Truckee River Sediment TMDL Collaborative Project Meeting

This meeting was held in Truckee, and hosted by the Water Board's Executive Officer. The purpose of the meeting was to explore the feasibility of developing a collaborative process for TMDL development in the Truckee River watershed. The agenda and discussions focused on key components of the collaborative process.

January through June 2002: TMDL Planning Meetings with TRWC

The CCP was chosen as the facilitator for the collaborative project. During the first half of 2002, staff of the CCP and the Lahontan Water Board met with executive members of the TRWC to discuss approaches for convening and organizing the collaborative TMDL effort.

September 2002: Public Awareness Forum, "Our Truckee River: Protecting Water Quality"

Ninety members from various agencies, organizations and the community attended this forum. A number of "information stations" were established to collect public input related to key elements of the TMDL. Participants were asked to identify questions, issues, tasks, resources or information within each element.

October and November 2002: Truckee River TMDL Stakeholder and Planning Committee Meetings

Numerous stakeholders attended these committee meetings. Presentations were made on different types of indicators that could be used to assess watershed health.
Staff of the Lahontan Water Board presented information on beneficial use impairment in the Truckee River related to the turbidity water quality objective. Issues and concerns regarding whether the data actually indicated beneficial use impairment surfaced.

December 2, 2002: Collaborative TMDL Project Planning Committee Meeting

Twenty-two members of the TMDL Planning Committee, including Water Board staff, met to discuss the need for a Beneficial Use Work Group to investigate whether beneficial uses were impaired by sediment in the Truckee River.

January 7, 2003: Beneficial Uses Work Group Meeting

This meeting brought stakeholders together to identify available information regarding sediment impacts in the Truckee River.

January 13, 2004: Stakeholder Meeting

Water Board staff made a presentation on the work completed on the collaborative TMDL project to date, the current status, and whether information existed to verify impairment due to sediment in the Truckee River. Staff concluded that there were no convincing impairment data and recommended suspending active collaborative project meetings while additional studies on beneficial use status were conducted. Staff presented information on a bioassessment study in the Truckee River (Herbst and Kane, 2006) that would be conducted to help inform the impairment issue.

March 2007: Release of the Herbst and Kane (2006) Bioassessment Study and update on Truckee River TMDL Status

Dr. Herbst's study and Water Board staff's summary of the data were posted on the Lahontan Water Board's Truckee River TMDL webpage. The TRWC was informed of the availability of the new information. The website also outlined the current approach to complete the Truckee River Sediment TMDL, and timelines for upcoming meetings and document reviews.

August 9, 2007: CEQA Scoping Meeting

CEQA Section 21083.9 requires scoping meetings for state, region, or area-wide significance. The purpose of a scoping meeting is to provide a forum for lead and jurisdictional agencies, and interested parties to comment on the scope and content of the environmental information to be analyzed during the CEQA process. At the meeting, Water Board staff presented summaries of the TMDL elements, the Herbst and Kane (2006) bioassessment study and discussed potential methods of implementing the TMDL.

December 12, 2007: Focused Stakeholder Implementation Meeting

Approximately fifteen stakeholders attended this outreach session led by Water Board staff, and held during the TRWC's regularly scheduled *Projects Assessment Committee* meeting in Truckee. The pre-peer review draft TMDL was made available via the TRWC's website before the meeting, and interested parties were encouraged to read the TMDL and bring questions for discussion with Water Board staff.

February 5 to March 21, 2008: Draft TMDL Public Review Comment Period

As required by CEQA, the draft TMDL was circulated for a 45-day review and comment period. Public agencies, Truckee River watershed stakeholders, and all parties whom expressed an interest in Basin Planning activities were notified of the document's availability. The document and review notices were also posted the Water Board's website. Ten comment letters were received, and written responses to all significant comments were provided and are available as part of the administrative record for the TMDL.

March 3, 2008: Public Review Draft TMDL Informational Meeting

During the 45-day public comment period for the draft TMDL, Water Board staff hosted an informational meeting to discuss development and implementation of the TMDL. The purpose of the meeting was to encourage interested parties to review and comment on the TMDL, and provide information to help them understand the technical aspects and data used to develop the TMDL. The meeting was held in Truckee, and was well-attended by a variety of stakeholder groups and individuals.

9.2 FUTURE PUBLIC PARTICIPATION

The Water Board webpage for this project will be updated as new information becomes available. Postings will include:

- Public review draft documents
- Notices of stakeholder meetings
- TMDL target monitoring data
- TMDL compliance and review information
- Project manager and contact information

10. IMPLEMENTATION AND MONITORING

10.1 REASONABLE ASSURANCE OF IMPLEMENTATION

USEPA's national policy is that all TMDLs are expected to provide reasonable assurances that they will be implemented in a manner that results in attainment of water quality standards. For nonpoint sources, reasonable assurance "means that nonpoint source controls are specific to the pollutant of concern, implemented according to an expeditious schedule, and supported by reliable delivery mechanisms and adequate funding" (USEPA, 1999). The sediment control actions outlined below are specific to the pollutant of concern, and are directly focused on the sources of that pollutant. Implementation is ongoing, and will be enhanced with additional permitting actions, focused application of the State Water Board's nonpoint source implementation and enforcement policy (SWRCB, 2004), and grant funding opportunities.

Additional assurance of implementation is provided because the sediment loading reductions are based on lower end values of efficiencies for BMPs used widely in the Lake Tahoe basin, a similar environment to the Truckee River watershed. Therefore, the load reductions are technically and economically feasible and achievable.

In California, Water Code section 13242 requires that a plan of implementation be incorporated into the Basin Plan when the Water Board adopts TMDLs. The implementation plan must include (1) a description of the nature of the actions necessary to achieve the water quality objectives, including recommendations for appropriate action by any entity, public or private, (2) a time schedule for the actions to be taken, and (3) a description of the monitoring and surveillance to be undertaken to determine compliance with the objectives. Therefore, Water Code requirements provide the regulatory reasonable assurance that the TMDL will be implemented in a manner that attains the water quality standards.

10.2 IMPLEMENTATION PROGRAM

The Water Board has regulatory authority to require implementation of this TMDL under both the CWA and the Water Code, including, but not limited to, adopting waste discharge requirements (WDRs), waivers of WDRs, and issuing storm water and construction permits to control sediment discharges. Enforcement actions may be used to address water quality problems when Basin Plan provisions, WDRs or waivers are violated. These include Notices of Violation, Cleanup and Abatement Orders, Cease and Desist Orders, and monetary penalties (administrative civil liabilities). Although the Water Board cannot specify the design, location, type, or particular manner of compliance (Water Code section 13360), it can require dischargers to implement sediment and erosion controls such as BMPs necessary to attain the water quality standards through its regulatory authority.

This section discusses the sediment control programs that the Water Board will rely on to achieve the sediment load reductions needed to protect beneficial uses in the Truckee River. Where appropriate, recommendations to focus or enhance the Water Board's application of these programs are included.

10.3 SEDIMENT CONTROL PROGRAMS

10.3.1 State and Regional Water Board Programs

Waste Discharge Requirements

Individual Waste Discharge Requirements

The Water Board has the authority to issue WDRs to control any waste discharges that have the potential to impact water quality. Individual WDRs are issued to several facilities with long-term operations in the watershed. Examples of such facilities are ski resorts including Squaw Valley (Squaw Creek watershed), Northstar-at-Tahoe (Martis Creek watershed), Tahoe-Donner Ski Area (Prosser Creek watershed) and Alpine Meadows (Bear Creek watershed).

The WDRs require dischargers to identify sources of erosion and sediment delivery, implement programs that minimize the disturbance of natural vegetation, and use BMPs such as revegetation, water bars, drop inlets and other sediment control measures to prevent waste earthen materials from entering surface waters. Annual worklists of erosion control facilities, inspection dates, problems noted, and corrective measures are required. Examples of specific requirements related to erosion and sedimentation control are listed below.

- Prior to any disturbance of existing soil conditions, install temporary erosion control facilities to prevent transport of eroded earthen materials
- Vehicle use shall be restricted to existing roads and disturbed areas
- All eroding slopes steeper than 2:1 (horizontal:vertical) shall be stabilized
- All disturbed areas shall be adequately re-stabilized or revegetated
- Surface flows from facilities shall be controlled so as not to cause erosion

General Waste Discharge Requirements for Small Construction Projects

In 2003, the Water Board developed General WDRs (Board Order R6T-2003-004) for small construction projects that involve at least 10,000 square-feet of land disturbance, but less than one acre. Proponents of these projects are required to obtain coverage under the General WDRs if they are located in the Truckee River Hydrologic Unit. The General WDRs contain requirements to submit a BMP plan to evaluate potential sources of sediment and other pollutants at the construction site, and put controls in place that will effectively prevent pollutant discharges to surface and ground waters. The General WDRs provide guidelines for erosion control (Attachment G of the WDRs) that are applicable to the Truckee River Hydrologic Unit. These guidelines are specified for both temporary construction and permanent BMPs:

- Retention of soil and sediment on the construction site
- Prevention of non-storm water discharges that would discharge pollutants off-site
- Permanent stabilization of disturbed soils
- Reduction of the effects of increased storm water runoff from impervious surfaces, using structural (roof) drip line infiltration trenches, vegetation, or other methods
- Land disturbance prohibitions between October 15 and May 1 of the following year (exemptions are available on a case-by-case or emergency basis).

National Pollutant Discharge Elimination System (NPDES) Permits

<u>Phase II NPDES Permit – Small Municipal Separate Storm Sewer Systems (MS4s)</u>

In late 2006, the Lahontan Water Board's Executive Officer designated Placer County (within the middle Truckee River watershed) and the Town of Truckee as regulated Small MS4s. As such, the dischargers are required to apply for coverage under the statewide general NPDES permit for storm water discharges from Small MS4s (NPDES General Permit No. CAS000004). As part of obtaining permit coverage, they are required to develop and implement a Storm Water Management Program (SWMP) to reduce the discharge of pollutants to the Maximum Extent Practicable (MEP) and meet applicable water quality objectives through an iterative implementation approach.

The SWMP must describe how pollutants in storm water will be controlled and address the following six program areas:

- Public Education
- Public Participation
- Illicit Discharge Detection and Elimination
- Construction Site Storm Water Runoff Control
- Post Construction Storm Water Control
- Pollution Prevention/Good Housekeeping for Municipal Operations

Recommended Focus Areas

The statewide General Permit includes a standard set of reporting requirements, and a provision for Water Boards to impose additional monitoring requirements. To address watershed-specific issues identified in this TMDL, the Water Board determined that additional monitoring and reporting requirements were necessary to demonstrate that implementation of the SWMP will protect water quality in the Truckee River Hydrologic Unit. Placer County and the Town of Truckee were directed to submit comprehensive storm water monitoring plans and implementation schedules. The SWMPs and monitoring plans should include an inventory of the storm water collection and conveyance systems, identification of significant source areas (including construction sites, dirt roads and legacy sites) and discharge points, tracking of road sand application and recovery. Monitoring locations should be developed with respect to the storm water system inventory such that it complements source identification and provides data to assess compliance with water quality standards. The SWMPs and monitoring plans are due July 1, 2008.

The dischargers will also be responsible for the adoption and enforcement of ordinances and policies to reduce and control pollutants in storm water runoff. This process is already underway in both the Town of Truckee and Placer County. For example, in 2007, the Town of Truckee approved an updated erosion prevention standard for one-and two-family residential construction and addition projects. The Town had recognized the need to improve the effectiveness of its previous erosion prevention measures, and began taking steps to develop the new ordinance before Phase II Municipal NPDES requirements were imposed. The goals of the updated standard are to implement a site-specific Erosion Prevention Plan and maintenance schedule to manage storm water and non-storm water discharges from construction sites at all times, by incorporating the following practices:

- Limit disturbed areas (areas that are cleared and/or graded) to only those areas necessary for construction
- Emphasize erosion prevention as the most important measure for keeping sediment on site during construction
- Utilize sediment control barriers as a supplement to erosion prevention
- Minimize exposure time of disturbed soil areas by phasing in construction activities
- Stabilize disturbed soils promptly. Either temporarily or permanently stabilize, landscape, revegetate and/or mulch disturbed soil areas as early/rapidly as possible
- Stabilize slopes as soon as possible

Specific requirements for grading, erosion prevention plans, and temporary and permanent erosion prevention methods are outlined in the Town's ordinance. Penalties for failing to implement an effective Erosion Prevention Plan are described.

In 2006, Placer County adopted its "Storm Water Quality Ordinance" to enhance and protect the waters of the state by reducing pollutants in storm water discharges to the maximum extent practicable and controlling non-storm water discharges to the storm drain system.

<u>Statewide NPDES Permit for the California Department of Transportation</u>

In the Truckee River watershed, the California Department of Transportation (Caltrans) operates and maintains State Routes 89 and 267 and Interstate 80. Caltrans' activities are regulated under a statewide NPDES storm water permit (Order No. 99-06-DWQ). The permit covers storm water discharges from all Caltrans properties, facilities, and activities, and consolidates the requirements for MS4s and the statewide construction general permit. Under the MS4 requirements, a Storm Water Management Program (SWMP) was developed and is implemented such that storm water discharges are controlled to the Maximum Extent Practicable (MEP) standard. Required elements of the SWMP are:

- Coordination with local agencies
- Fiscal analysis
- Vegetation control program
- Storm water system management
- Accidental spills
- Illicit connection/illegal discharge detection
- Characterization of discharges
- Maintenance facilities
- Training and public education
- Program evaluation and monitoring

The construction element of the permit requires Caltrans to comply with the requirements of the NPDES General Permit for Large Construction Projects (see below). Additionally, certain Lahontan Region-specific requirements in the Truckee River watershed include:

- A restriction on land disturbing activities between the wet season period of October 15 and May 1
- Design requirements for treatment or infiltration of storm water runoff generated by the 20-year, one hour design storm (3/4 inch precipitation)
- Early project design consultation with the Water Board for projects involving more than one acre or those requiring CWA 404 permits

Recommended Focus Areas

The following areas of the SWMP should be emphasized by the Water Board in regulating discharges from Caltrans facilities under its permit:

> <u>Review of Regional Workplans</u> - Regional workplans that describe all activities to be undertaken each year are required to be submitted for approval to the Water Board by April 1 of each year. The workplans must address the impact of discharges to surface waters, the monitoring program to be implemented, and the changes that should be made to the previous year's program. The process provides the opportunity for the Water Board to give input and direction on activities needed to protect water quality. Evaluation and mitigation of road sand impacts and erosion areas should be emphasized to meet the load reductions/allocations associated with urbanized areas.
>
> <u>Storm Water Drainage System Retrofitting</u> - Caltrans shall seek opportunities to retrofit storm water drainage systems for water quality improvement whenever a

section of right-of-way undergoes significant construction or reconstruction. Review of project proposals should include this element.

Highway Maintenance Activities - Caltrans must identify road segments that are prone to erosion and discharge of sediment and stabilize these slopes to the extent possible. Regional workplans should include activities to address these sources as feasible.

Annual Storm Drain Inlet Cleaning - Caltrans must remove all waste from inlets that pose a significant threat to water quality on at least an annual basis prior to the winter season each year. Completion of this activity should be verified.

Snow and Ice Control - Caltrans is required to record information on the use of abrasives and de-icing agents used in the watershed. The information includes the location and source of materials, types and chemistry of de-icing agents, the type and chemistry of abrasives, and the volume of abrasives and de-icing agents used on individual highway segments. By using traction materials that meet specifications for durability and percent fine particles, and by refining use based on area-specific needs, amount of traction sand can be reduced. Abrasive and de-icer information should be submitted by Caltrans and reviewed by Water Board staff to asses whether improvements are warranted. During the 2007 update of the Caltrans permit, Water Board staff submitted comments to the State Water Board to revise the permit to including reporting requirements for this information. The Department's permit is currently under negotiation and has not yet been re-issued by the State Water Board.

These recommended program enhancements will help Water Board staff implement the permit requirements more effectively to protect water quality and track improvements as they are made.

Statewide General NPDES Permit for Large Construction Projects

The State Water Board's General Permit for Discharges of Storm Water Associated with Construction Activities (99-08-DWQ) applies to dischargers whose projects disturb one or more acres of soil, or projects that disturb less than one acre but are part of a larger common plan of development that in total disturbs one or more acres. The Large Construction General Permit requires the development and implementation of a Storm Water Pollution Prevention Plan (SWPPP). The SWPPP should contain site maps which show the construction site perimeter, existing and proposed buildings, lots, roadways, storm water collection and discharge points, general topography before and after construction, and drainage patterns across the project. The SWPPP must list BMPs the discharger will use to protect storm water runoff and the placement of those BMPs. Additionally, the SWPPP must contain a visual monitoring program; a chemical monitoring program for "non-visible" pollutants to be implemented if there is a failure of BMPs; and a sediment monitoring plan if the site discharges directly to a water body listed on the 303(d) list for sediment (i.e., Truckee River, Squaw Creek, and Gray and Bronco Creeks)

The Large Construction General Permit requires all dischargers to:

- Develop and implement a SWPPP that specifies BMPs that will prevent all construction pollutants from contacting storm water, with the intent of keeping all products of erosion from moving off-site into receiving waters
- Eliminate or reduce non-storm water discharges to storm sewer systems and other waters of the nation
- Perform inspections of all BMPs

Statewide General NPDES Permit for Industrial Storm Water Discharges

The Industrial Storm Water General Permit (Order 97-03-DWQ- General Industrial Permit) is an NPDES permit that regulates discharges associated with ten broad categories of industrial activities. Examples of these types of facilities include sewage treatment plants, mining operations, disposal sites, recycling yards, and transportation facilities. The General Industrial Permit requires the implementation of management measures that will achieve the performance standard of BAT/BCT. The General Industrial Permit also requires the development of a SWPPP and a monitoring plan. Through the SWPPP, sources of pollutants are to be identified and the means to manage the sources to reduce storm water pollution are described. The General Industrial Permit requires that an annual report be submitted each July 1.

Active General Industrial permittees in the Truckee River watershed include the Tahoe Donner Maintenance Facility (Trout Creek watershed), Truckee Tahoe Airport District and Tahoe Truckee Sanitation District (Martis Creek watershed), Teichert Aggregates Truckee and Eastern Regional Landfill (Intervening Zones/Unmeasured Input areas), and Hobart Mills Material Processing Facility (Prosser Creek watershed).

Recommended Focus Areas

As resources allow, Water Board staff should identify facilities that are subject to Industrial Storm Water permit requirements, and require the facility operator to submit a Notice of Intent to obtain a storm water permit. Focus should be on those facilities whose storm water discharges are likely sediment contributors to surface waters of the Truckee River watershed.

Conditional Waiver of WDRs for Timber Harvest Activities in the Lahontan Region

All timber harvest and vegetation management activities conducted within the Lahontan Region that could affect the quality of the waters of the State must comply with Water Board's timber harvest waiver policy (Resolution No. R6T-2007-0008). Under the policy, land owners and federal or state land managers must apply for and receive either a conditional waiver or WDRs from the Water Board before conducting timber harvest or vegetation management activities.

All projects must comply with the general conditions specified in the policy along with six category-specific conditions, as applicable. General conditions include:

- Compliance with Basin Plan water quality objectives and prohibitions
- Requirements to conduct operations in accordance with approved plans, exemptions, or final environmental documents
- Prohibitions on creating pollution, contamination, or nuisance
- Prohibitions on the discharge of waste not regulated by the policy
- Monitoring in accordance with category-specific requirements
- Provisions to allow Water Board staff to inspect site operations and have access to self-monitoring information

Nonpoint Source Control Implementation and Enforcement

The State Water Board's Nonpoint Source (NPS) Implementation and Enforcement Policy (SWRCB, 2004) requires the Water Boards to regulate all NPS pollution. Regulation may be accomplished using Basin Plan prohibitions, WDRs, conditional waivers of WDRs, and other applicable authority. Examples of existing NPS implementation programs in the Truckee River watershed include the Water Board's Timber Harvest Waiver policy, Basin Plan prohibitions against waste discharges specific to the Truckee River Hydrologic Unit, and WDRs for nonpoint source pollution control.

Recommended Focus Areas

Based on the results of this TMDL's Source Assessment, nonpoint source regulation should focus on controlling sediment impacts from dirt roads, legacy land disturbances, or other erosion features identified in the watershed. Source areas may be identified from specific subwatershed assessments, programmatic assessments conducted by other public agencies (e.g., USFS), Water Board inspections, and public complaints. Once identified, the Water Board should take appropriate regulatory action in accordance with its authority under the Water Code and available resources, and assist with funding opportunities that may be available to address the problems. Currently, watershed assessments have identified dirt road sources and legacy sites in the west fork of Gray Creek and the Coldstream Canyon watershed. Additionally, the TRWC maintains a list of potential mitigation and restoration projects that should be evaluated for future funding or regulatory action, if appropriate.

Squaw Creek Watershed Total Maximum Daily Load for Sediment

In July 2007, the USEPA approved the Squaw Creek TMDL for Sediment. The TMDL analysis indicated that dirt roads, graded ski runs and in-stream erosion were the primary controllable sediment contributors to Squaw Creek. Runoff from urban/residential areas and road traction sand added to the sediment loading.

The overall sediment load reduction needed to protect beneficial uses in Squaw Creek was estimated at 25 percent, with load reductions to land use-based sediment source categories specified according to BMP control efficiencies (as was done for this TMDL). The load reductions contained in the approved Squaw Creek TMDL are consistent with those needed to protect water quality in the Truckee River, and therefore are carried over to this TMDL. No changes to the Squaw Creek TMDL requirements are currently foreseen.

The Squaw Creek TMDL implementation plan relies on compliance with the existing WDRs issued in the watershed, and recommends additional focus on certain key issues, including fine sediment control. It also contains requirements to address sediment discharges from urban/residential areas under the jurisdiction of Placer County that are not currently regulated. Water Board staff have designated Placer County as regulated Small MS4, and they are required to apply for coverage under the general NPDES permit for storm water dischargers.

Recommended Focus Areas

WDRs issued to existing dischargers in the watershed contain comprehensive requirements to control sediment discharges. These requirements specify that dischargers must identify erosion control problems, propose projects to address the problem, and maintain those projects, in accordance with the state's iterative approach for controlling storm water pollution. Because the TMDL analysis identified fine sediment as a particular concern, source control BMPs to control erosion on hillslopes and limit the delivery of fine sediment to Squaw Creek will be emphasized to fulfill permitting requirements. These regulatory tools, along with additional permitting actions for Placer County, should result in meeting the needed load reductions for Squaw Creek, and reducing Squaw Creek's sediment loading to the Truckee River.

Basin Plan Implementation Recommendations for Reservoir Operations

The authority to issue and modify water rights licenses rests with the State Water Board; however, the Regional Water Boards can bring water quality issues related to water diversions or dam operations to the State Board's attention, and request that solutions be considered (Lahontan Basin Plan, p. 4.9-3). The Water Board may take enforcement action when reservoir release practices result in resource damage, such as discharge of high levels of nutrient and sediments, deoxygenated water or insufficient downstream flows to sustain fish and aquatic habitat.

Recommended Focus Areas

The Lahontan Basin Plan recommends that operation and maintenance of reservoirs should minimize impacts on water quality and beneficial uses. The operation of reservoirs in the Truckee River system is subject to the requirements of TROA (see section 2.1.8). Through agency agreements, memorandums of understanding, or

WDRS, maintenance activities such as dredging, flushing, and repairs should include control measures to prevent increases in sediment loading, as well as BMPs to prevent downstream bank erosion and impacts to aquatic habitats.

10.3.2 Other Agency Programs and Agreements

USFS Management Agency Agreement

The State Water Board established a Management Agency Agreement (MAA) with the USFS in 1981. In general, the MAA establishes that the USFS is the responsible water quality management agency for national forest lands in California, establishes a procedure for Water Board involvement in the planning process for projects that have the potential to impact water quality, and requires the USFS to implement the practices and procedures set in the *Water Quality Management for National Forest System Lands in California* (USFS 2000). This guidance document describes the practices and procedures to identify, implement, maintain and monitor BMPs used for water quality protection on USFS lands. It also describes specific BMPs for categories of activities on USFS lands such as timber management, road building, mining, recreation, watershed management, range management and fire suppression and fuels management. A process for developing site-specific methods and techniques for applying BMPs is outlined. The State Water Board, Regional Water Boards and the USFS are evaluating possible changes to the MAA to address current state regulatory requirements.

Recommended Focus Areas

Water Board staff should work with USFS staff to develop a method to identify problem areas on USFS lands, and to track and report progress on TMDL targets for dirt road maintenance and legacy site restoration. Additionally, TMDL implementation requirements should be incorporated in any MAA revisions.

USFS Off-Highway Vehicle (OHV) Route Program

The Tahoe National Forest (TNF) has initiated a five-step process to inventory and catalog OHV routes across the national forest, including lands within the Truckee River watershed. The goal of the process is to develop a trail system that offers quality recreational opportunities while protecting sensitive areas, including areas that may affect water quality.

The five-step process is as follows:

- Map existing roads, OHV trails, and off-route use areas. Identify gaps and conduct field surveys. Share with the public and collect comments (completed in 2005)
- Collaborate with the public to develop site-specific proposals for changes to the system of USFS roads, trails, and off-road use areas (completed in 2006)

- Issue temporary Forest Orders prohibiting motor vehicle (and bicycle, if necessary) use on mapped roads, trails, and off-road use areas for temporary resource protection (completed in 2007)
- Complete analysis and prepare National Environmental Protection Act (NEPA) documents for the project. Include restrictions by season or vehicle type, with public input (in progress as of early 2008)
- Issue a motor vehicle use map showing roads, trails, and areas authorized for public motor use. Include seasons of use and designations by vehicle type as appropriate. Involve the public and install appropriate signing, publish visitor maps for distribution, and implement any mitigation (anticipated for Fall 2008) (from http://www.fs.fed.us/r5/tahoe/projects_plans/ohv_inv/index.shtml#overview)

It is initially estimated that there are approximately 900 miles of "non-system" roads or trails in the TNF as a whole (including west slope lands out of the TMDL project area) and that approximately 50 to 100 miles of these roads will be incorporated into its "system" network. Remaining non-system roads will be abandoned or decommissioned and no motorized access will be allowed (pers. comm., S. Eubanks, TNF Supervisor, May 21, 2007).

This program will be a key component to meeting the load reductions required from dirt roads, particularly where they occur on public lands.

10.3.3 Grant Funded Programs and Non-Profit Groups

Several grant funding mechanisms that are focused on water quality protection have been established by voter approval through the California proposition process or through other state and federal grant programs. Non-profit groups such as the Truckee River Watershed Council and the Truckee Donner Land Trust have applied for and received these funds, and have implemented many important watershed education, assessment, restoration and acquisition projects. A summary of the sediment-related control projects underway or planned is presented in Table 10-1. The projects implemented will help meet load reductions needed from urbanized areas, legacy sites, and stream channel erosion, and are anticipated to provide long-term benefits to the watershed.

Table 10-1. Summary of Active Grants and Associated Project Descriptions.

Fund Source	Project Description & Implementer	Comments
319h (Federal NPS)	BMP and Low Impact Development Workshops - TRWC	In-progress
Prop 13 - 2000 State Water Bond	Gray Creek land acquisition - TRWC/Truckee Donner Land Trust (TDLT)	Completed
Prop 13 - 2000 State Water Bond	Davies and Merril Creeks Watershed Restoration - TRWC	In-progress
Prop 40 - 2002 State Water Bond	Perazzo Meadows Restoration – TRWC, TDLT, USFS	In-progress
Prop 50 - Amended 2004 State Water Bond, Tahoe-Sierra Integrated Regional Water Management (IRWM)	Trout Creek Flood Control and Restoration - Town of Truckee, Sierra Watershed Education Partnership, TRWC Town of Truckee Storm Water Management Retrofits - Town of Truckee, TRWC Truckee River Watershed Voluntary BMP Retrofit - TRWC	In development
Prop 50 - Amended 2004 State Water Bond, Sierra Nevada Cascade Conservation Grants	Waddle Ranch Acquisition - Truckee Donner Land Trust (TDLT) Participate in the acquisition of 1400 acres in the Martis Valley, near Truckee. The property contains two miles of riparian corridor along Martis Creek, contiguous wildlife habitat and a forested upland lake.	In progress
Prop 50 - Amended 2004 State Water Bond, Sierra Nevada Cascade Conservation Grants	Upper Gregory Creek, Negro Canyon Acquisition - TDLT Acquire 280 acres of riparian corridor in Nevada County. Located in the Upper Gregory Creek canyon, this property drains directly into Donner Lake and the Truckee River, and is subject to severe erosion during winter storms.	In progress

Truckee River Watershed Council

In 1998, a local group of interested individuals, agency personnel, local business owners and others formed a Coordinated Resource Management & Planning group (CRMP). The group came together to develop and implement a locally initiated watershed assessment and resource management plan for the Middle Truckee River. To better reflect its long-term watershed management goals, the CRMP group changed its name to the Truckee River Watershed Council (TRWC) in 2001. The goals of the TRWC are:

- To evaluate and understand current and historical natural watershed conditions
- To initiate a collaborative effort to balance the competing and changing interests of current and future users of the watershed with long-term protection and enhancement of the watershed
- To protect and restore the watershed ecosystem to enhance the viability of human uses in harmony with all species which utilize the watershed
- To encourage the management of recreation use in the watershed which protects private property, natural resources, and sustains economic health
- To promote the education of all individuals, organizations, and agencies with the most current information on the function and the management of the watershed
- To gain flexibility in river operations to protect public, private property and natural resources from flood or high water levels

As shown in Table 10-1, the TRWC actively leads many important efforts to conserve and restore lands, provide education and outreach, and sponsor watershed awareness programs (Truckee River Day, Snapshot Day, Truckee River Aquatic Monitors). Using grant funds, they have developed contracts to conduct comprehensive watershed assessments in Gray and Donner/Cold Creeks. They have authored several informative reports that are compatible with their goal to evaluate and understand current and historical natural watershed conditions, including the *Middle Truckee River Baseline Assessment*, and the *Middle Truckee River Coordinated Management Plan*, both of which were used extensively in this TMDL document.

Recommended Focus Areas

Water Board staff should take advantage of the TRWC's local knowledge to identify additional assessment and restoration opportunities in the watershed. The Water Board should also continue to assist the TRWC in competing for grant funds to finance their efforts towards public outreach, education, watershed assessment, and restoration.

For example, the Donner/Cold Creek watershed was the subject of a watershed assessment prepared for the TRWC (River Run Consulting, 2007). The report focused on geomorphic function and process and their impacts on sediment production and transport and aquatic habitat. Opportunities for restoration were evaluated, and alternatives were developed for upland areas, and in-stream areas of the middle and lower portions of the watershed. Projects proposed to address sources of erosion and improve habitat in the watershed should be given high priority for grant funding, as Donner/Cold Creek is one of the three highest sediment producers during above average water years (Table 5-2).

Truckee Donner Land Trust

The Truckee Donner Land Trust (TDLT), founded in 1990, works with landowners, federal, state and local governments, and the public-at-large, to conserve and protect open space and sensitive lands. Its first acquisition included 160 acres in Coldstream Canyon next to Donner Lake. Since then, the land trust has worked to preserve numerous other areas. Between March 2006 and March 2007, the following activities have been completed.

- Entering an agreement to pay $23.5 million to preserve Waddle Ranch in Martis Valley
- Adding 300 acres to Donner Memorial State Park Expansion
- Working with the Placer County Board of Supervisors to preserve 1,500 acres in Martis Valley from residential development
- Acquiring $2 million in state funds to restore Perazzo Meadows
- Working to restore Cutthroat Trout populations in the Gray Creek canyon property they own/manage along the Truckee River Corridor
- Working with the Truckee Tahoe Airport District on a $2 million agreement that will assist the Land Trust in acquiring 1,500 acres in Martis Valley
- Purchasing a conservation easement on McIver Hill from Sierra College, site of the College's new Truckee/Tahoe campus. The easement allows for public access and a network of trails linking downtown to Highway 89

Activities conducted by the land trust provide long-term sediment reduction benefits by conserving areas that may otherwise be urbanized and by mitigating legacy land impacts. These efforts contribute to the overall load reductions required by the TMDL.

Recommended Focus Areas

Water Board staff should encourage projects to address controllable sediment sources in the Gray Creek watershed. Northwest Hydraulic Consultants (NHC) completed a comprehensive assessment of the Gray Creek watershed in 2006 using 319(h) funds granted to the Truckee River Watershed Council. NHC determined that much of the sediment production in the watershed is due to mass wasting of hill slopes; however, impacts from dirt roads in the West Fork could be addressed and would improve habitat conditions for aquatic life. The NHC report also noted that stream bank erosion control may be feasible in the lowest reach of Gray Creek, near the mouth of the watershed in California. The TDLT has acquired land in the area of Gray Creek where restoration may be feasible. Projects proposed to address these sources of erosion in the watershed should be given high priority for grant funding, as Gray Creek is one of the three highest sediment producers during above average water years (Table 5-2).

10.4 MONITORING PROGRAM

The primary measure of success of this TMDL is through the attainment of the targets specified in Section 4. Targets will be monitored through a variety of entities as specified in discharger-specific WDRs and NPDES permits, through collaboration with other responsible resource agencies, and from voluntary efforts. Results of the monitoring efforts will be tracked and reported to the public by the Water Board.

The target monitoring plan is summarized in Table 10-2.

Table 10-2. TMDL Target Monitoring Plan

Target	Monitoring and Reporting	Responsible Entities
Water Column: Suspended sediment concentration Annual 90th percentile value of less than or equal to 25 milligrams per liter (mg/L) suspended sediment.	SSC grab samples measured at least once per month at Farad (USGS gauge 10346000). Upstream SSC data can be assessed for potential variations and source areas if target exceedances are identified at Farad. SSC sampling is conducted on the Truckee River at Tahoe City, and at confluences with Donner, Martis and Juniper Creeks. Additionally, a municipal monitoring program is being developed that covers the jurisdictions of the Town of Truckee, Placer County, and Caltrans. Data generated by this program will be reported annually to further assist the evaluation of potential source areas or variations across the watershed.	SSC data are collected from the Truckee River locations by DRI, for NDEP's Water Quality Planning Branch and stored in the USEPA's STORET system. The Town of Truckee and Placer County are responsible for developing the municipal monitoring program, and Caltrans is required to coordinate with this effort. The program will be coordinated with NDEP's sampling on the Truckee River. The Water Board may require dischargers to contribute to the SSC monitoring on the Truckee River.
Implementation Measure: Road sand application and recovery managed to the maximum extent practicable (MEP).	Road sand use and recovery should be tracked and reported annually. Additionally, road sand characteristics such as durability, abrasion loss, sieve analysis, and phosphorous content should be reported annually.	Placer County, Town of Truckee, and Caltrans, as required under municipal storm water permits.
Implementation Measure: Ski area BMP implementation and maintenance to control erosion and sediment.	Ski runs and other related facilities are inspected at a minimum of once per year for erosion features once snow cover has dissipated. Annual reports are submitted describing inspection results, projects proposed to correct deficiencies, and effectiveness of erosion control projects previously implemented.	Squaw Valley Ski Corporation, Northstar-at-Tahoe, Alpine Meadows, Tahoe-Donner Ski Area.

Target	Monitoring and Reporting	Responsible Entities
Implementation Measure: Dirt roads maintained or decommissioned to control erosion to the extent feasible.	Monitoring should focus on dirt roads with high potential for sediment delivery to surface waters (e.g., within 200 feet of watercourse). Prioritized dirt roads should be monitored annually to evaluate erosion features and potential corrective actions. The number of miles of roads inspected, proposed corrective actions, and effectiveness of previous implementation measures should be reported annually.	Placer County, Town of Truckee, USFS, State Parks, and dischargers regulated by the Water Board. Water Board will respond to complaint-driven issues and oversee grant funded road assessments and improvement projects.
Implementation Measure: Legacy site restoration and BMP implementation.	Candidate sites should be identified and prioritized through watershed assessments and Water Board regulatory oversight. A list of legacy sites should be maintained and updated as sites are restored and new information is generated. Legacy site information should be reported annually under the municipal storm water programs.	Placer County, Town of Truckee, and Caltrans are required to evaluate and report annually. USFS should report progress on its OHV road management program. Other information should be collected from entities such as State Parks, TRWC, TDLT, etc. Water Board will respond to complaint driven issues and oversee grant funded road assessments and improvement projects.

10.5 SCHEDULE OF TMDL DATA REVIEW AND REVISION

The estimated time frame for meeting the numeric targets and achieving the TMDL is 20 years. This estimate takes into consideration time needed for dischargers to devise plans to address sediment sources and iteratively apply appropriate sediment controls. There will also be funding constraints that may affect the pace of certain implementation actions needed to address legacy sites. Further, there may be significant temporal disparities between upland erosion control actions and sediment delivery to the river.

Progress toward meeting the targets will be evaluated and reported by Water Board staff on an annual basis. In general, permitted facilities will be evaluated based on site inspections and required reporting in terms of effectiveness and completeness of control actions taken to reduce erosion in compliance with permit conditions. Progress toward mitigating other land uses, including dirt road impacts, legacy sites and urban areas, will be tracked and prioritized for corrective actions with consideration to available resources.

After 10 years (the halfway point estimated for TMDL attainment), staff shall examine all data trends to determine the need for revision of the TMDL, numeric targets, or implementation plan. Potential outcomes of the 10-year review could include recommendations to reassess sediment sources, revise targets, and adjust the implementation plan.

Examples of issues to consider during the evaluation of the TMDL will include:

- precipitation rates and types during the water years
- sampling or data collection problems
- overall compliance with permit conditions
- progress on legacy sites restoration
- completeness of dirt road management plans implemented and monitored
- status of road sand management activities
- other potential sources that could be affecting water quality conditions

Acronym and Abbreviation List

AnnAGNPS	Annual Agricultural Nonpoint Source Model
BAT	Best Available Technology
BCT	Best Conventional Technology
BMI	Benthic Macroinvertebrate
BMP	Best Management Practices
Caltrans	California Department of Transportation
CCP	Center for Collaborative Policy
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
D-50	Median Particle Diameter
DRI	Desert Research Institute
DWR	Department of Water Resources
EIFAC	European Inland Fisheries Advisory Committee
EIR/EIS	Environmental Impact Report/Environmental Impact Statement
EMC	Event-mean Concentration
GIS	Geographic Information System
IBI	Index of Biological Integrity
LA	Load Allocation
LCT	Lahontan Cutthroat Trout
LWRQCB	Lahontan Regional Water Quality Control Board
MEP	Maximum Extent Practicable
mg/L	Milligrams per liter
ml	milliliters
MOMM	Mean of Monthly Means
MOS	Margin of Safety
NDWP	Nevada Division of Water Planning
NHC	Northwest Hydraulic Consultants

NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NTU	Nephelometric Turbidity Units
OHV	Off Highway Vehicle
RWQCB	Regional Water Quality Control Board
SNARL	Sierra Nevada Aquatic Research Laboratory
SSC	Suspended Sediment Concentration
SWPPP	Storm water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TDLT	Truckee Donner Land Trust
TMDL	Total Maximum Daily Load
TNF	Tahoe National Forest
TROA	Truckee River Operating Agreement
TRWC	Truckee River Watershed Council
TSS	Total Suspended Solids
USDA	United States Department of Agriculture
USDOI	United States Department of the Interior
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WDR	Waste Discharge Requirements
WLA	Waste Load Allocation
WQO	Water Quality Objectives

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