3.8 HYDROLOGY AND FLOODING

This section summarizes existing hydrologic conditions in the study area, presents the regulatory guidance for hydrologic resources, and evaluates potential adverse environmental effects of project implementation on hydrology.

The examination of hydrology is based primarily on (1) previous hydrologic and hydraulic analyses prepared for the project, including *Upper Truckee River and Marsh Restoration Project: Processes and Functions of the Upper Truckee Marsh* (Conservancy and DGS 2003) and *Upper Truckee River and Marsh Restoration Project Alternatives Evaluation Report* (Conservancy and DGS 2005); and (2) the preliminary engineering schematic conceptual design prepared for the alternatives. Additional important information is referenced from other relevant published and unpublished academic studies and reports and other documents issued by federal, state, and local agencies. For a discussion of geomorphology and water quality issues, please refer to Section 3.9, "Geomorphology and Water Quality." Cumulative hydrology and flooding impacts are addressed in Section 3.18, "Cumulative Impacts." Consistency with TRPA goals and policies is presented in Section 3.10, "Land Use."

3.8.1 AFFECTED ENVIRONMENT

REGULATORY SETTING

Federal

The following federal laws and regulations related to hydrology and flooding are relevant to the proposed alternatives and described in detail in Chapter 5, "Compliance, Consultation, and Coordination":

- Clean Water Act
- Floodplain regulations
- Truckee River Operating Agreement
- Executive Order 11988

State

The following state law related to hydrology and flooding is relevant to the proposed alternatives and described in detail in Chapter 5, "Compliance, Consultation, and Coordination":

- Porter-Cologne Water Quality Control Act

TRPA

1987 Regional Plan

Goals and Policies

The Goals and Policies document of the 1987 Regional Plan presents the overall approach to meeting the environmental thresholds. A key component is the Land Use Element, which identifies fundamental philosophies directing land use and development in the Tahoe Basin. It addresses topics such as suitable development locations and maintenance of the region's environmental, social, physical, and economic well-being.

Code of Ordinances

Proposed project construction activities are regulated by Section 60.4, "Best Management Practice Requirements," of the TRPA Code of Ordinances (TRPA Code), specifically in relation to best management practices (BMPs), especially temporary, permanent, and standard BMPs. In accordance with the *Handbook of Best Management Practices*, and as required in Section 33.5, "Grading and Construction Schedules," of the TRPA Code, temporary BMPs shall be implemented on construction sites and maintained throughout the construction period (TRPA 2003:25-1). Permanent BMPs must be applied within the parcel or all project area boundaries, unless the project is exempt. TRPA states that a project that involves Stream Environment Zone (SEZ) restoration may be exempt from the aforementioned requirements. SEZ is defined by TRPA as the major and minor streams, intermittent streams, drainage ways, meadows and marshes, primary and secondary riparian vegetation, and other water influence zones areas within the Lake Tahoe Region that provide natural treatment and conveyance of surface runoff (TRPA 2004:28).

Standard BMP requirements that are applicable to the project deal mainly with drainage conveyance. Drainage conveyances through a parcel shall be designed for at least a 10-year, 24-hour storm. Drainage conveyances through an SEZ shall be designed for a 50-year storm, at a minimum.

Chapter 35, "Natural Hazard Standards," of the TRPA Code also addresses floodplain management. TRPA defines a floodplain as that portion of a river valley, adjacent to the channel, that is built of sediments deposited during the present geological/climatic regime. Hydrologic statistics are used to estimate the magnitude of peak streamflow expected on a 100-year recurrence interval, and the area that could be inundated from that event is defined as the 100-year floodplain. TRPA reviews all additional development in 100-year floodplains and regulates any necessary public uses located in the floodplains. The 100-year floodplain is determined by the limits delineated by the Flood Insurance Rate Maps (FIRMs) issued by the Federal Emergency Management Agency (FEMA). TRPA prohibits development, grading, and filling of lands within the 100-year floodplain, with certain exceptions, including specific public outdoor recreation facilities and water quality control facilities. TRPA may permit erosion control, habitat restoration, wetland rehabilitation, SEZ restoration, and similar projects within a 100-year floodplain. To receive a permit from TRPA, the proponent of a restoration project within the floodplain must show that the project is necessary for environmental protection, must demonstrate that there is no reasonable alternative to reduce the extent of encroachment, and must fully mitigate all impacts (TRPA 1980:28-3).

TRPA's development restrictions and exemption findings for 100-year floodplains do not apply to the shorezone of Lake Tahoe, except where the study area is determined to be within the 100-year floodplain of a tributary stream, which is where this study area lies. Therefore, the restrictions and exemptions for shorezone protection in Chapter 81, "Permissible Uses and Accessory Structures in the Shorezone and Lakezone," of the TRPA Code apply in addition to those for floodplain protection mentioned above. (See Section 3.9, "Geomorphology and Water Quality," for further discussion.)

Plan Area Statements

TRPA's plan area statements (PASs) outline land use classifications, special policies, planning considerations, permissible uses, and maximum allowances for the Tahoe Basin. The PASs in which the study area is located are PAS 099 (Al Tahoe), PAS 100 (Truckee Marsh), PAS 102 (Tahoe Keys), PAS 103 (Sierra Tract Commercial), PAS 104 (Highland Woods), and PAS 111 (Tahoe Island). The criteria and permissible uses for each PAS covering the study area are described in Section 3.10, "Land Use," of this DEIR/DEIS/DEIS. Considerations include commercial and residential uses that infringe on the SEZ and restrictive highway crossings over the Upper Truckee River and Trout Creek that alter the natural functioning capacity of the SEZ. The relevant special policies outlined in this PAS are:

(1) Stream zones should be restored where U.S. Highway 50 (U.S. 50) crosses the Upper Truckee River and Trout Creek.

(2) SEZs should be restored in the vicinity of the crossings of Trout Creek at U.S. 50 and at Black Bart Road.

(3) New roadway alignments through SEZs are to be discouraged.

El Dorado County

Land under the jurisdiction of El Dorado County is located upstream of the portion of the Upper Truckee River located within the study area, so the El Dorado County Code's provisions on grading (Chapter 15.14) do not directly apply to the project. However, the project's compliance with TRPA and City of South Lake Tahoe (CSLT) grading requirements and water quality and flooding obligations required by the Clean Water Act will also provide consistency with El Dorado County requirements.

City of South Lake Tahoe

The study area is located entirely within CSLT's jurisdictional limits. Chapter 8, "Building Regulations," of the CSLT Ordinance requires that projects prepare a grading plan for review and grading-permit approval by the CSLT building official. The grading plan must include the present contours of the land and the proposed final grade and location of improvements. The purpose of the review is for CSLT to safeguard adjoining properties and public streets and ways from damage by unnatural flows of surface waters, and to prevent construction of homes and other buildings in areas likely to become flooded. CSLT is the floodplain administrator for FEMA in the project area, responsible for implementing the federal policies and regulations for floodplain management.

ENVIRONMENTAL SETTING

Hydrology

The study area's hydrology is the result of numerous physical environmental parameters. Among the important parameters are watershed characteristics and climatic conditions affecting the Upper Truckee River and Trout Creek, streamflow magnitudes and regimes, runoff from adjoining urban drainage areas, direct precipitation in the study area, Lake Tahoe surface-water elevations, and groundwater elevations and gradients.

Surface Water

Watersheds

The study area is situated at the downstream end of the Upper Truckee River and Trout Creek watersheds (Exhibit 3.8-1), the two largest watersheds that drain to Lake Tahoe. The watershed areas of the river and creek are 56.5 and 41.2 square miles, respectively; these areas comprise 18 percent and 13 percent of the total area tributary to Lake Tahoe (Rowe and Allander 2000:7–8). The general characteristics of these two watershed areas provide a background for understanding specific hydrologic events and patterns observed in the study area.

The watersheds of the Upper Truckee River and Trout Creek share several important characteristics related to surface-water and groundwater hydrology. The geology of both basins is dominated by granitic rock with glacial deposits and lacustrine sediment, and by similar distributions of soil types and land cover (Jeton 1999). In addition, they both encompass the largest urban centers in the Tahoe Basin. The land uses, transportation systems, and water use (e.g., groundwater pumping, urban stormwater) of these urban centers substantially affect the amount and patterns of runoff relative to undisturbed watersheds (Jeton 1999).

The differences in shape, orientation, and proportion of watershed land near lake level affect the runoff patterns of the Upper Truckee River and Trout Creek basins. The Upper Truckee River basin is elongated from north to south, characterized by a total valley distance of about 21 miles from the southern headwaters to Lake Tahoe. The highest headwater areas in the basin generally face north and west. The elevation of the Upper Truckee River watershed ranges from about 6,225 feet at the lake to about 10,000 feet at the crest. About 20 percent of the area within the Upper Truckee River watershed is below 6,500 feet (generally associated with a broad U-shaped valley). The Trout Creek basin is fan-shaped, with a total valley distance of about 15 miles from the headwaters to Lake Tahoe. Its broad headwater area faces northwest. The elevation of the Trout Creek watershed ranges from about 6,225 feet at the lake to about 10,800 feet; only about 10 percent of the Trout Creek watershed lies below

6,500 feet (USACE 2002:Exhibits 2-5 and 2-6). Differences in basin shape, headwater orientation, and elevation distributions produce variations in storm patterns, snowpack accumulations, snowmelt processes, and the time required for runoff to pass through the basin to the lake (Conservancy and DGS 2003:2-3).

Streams

Annual and seasonal flows in both the Upper Truckee River and Trout Creek vary substantially, as is typical of unregulated snowmelt rivers in the Sierra Nevada. The difference in flow volumes and peak magnitudes generally reflects differences in basin size (Conservancy and DGS 2003: 2-6 to 2-11), with some variations as a result of snow accumulation, snowmelt patterns, and differences in base flow.

Most precipitation in the Tahoe Basin falls between October and May, in the form of snow at higher elevations and snow and rain at lake level (Roberts and Reuter 2007:3-6 through 3-7). The seasonal snowmelt process creates annual streamflow peaks in May or June. The snowpack at lower elevations can melt completely and generate runoff in the urban areas and valley floors near the lake before the snow at the headwaters melts. The minimum streamflows on both streams occur during the summer and fall.

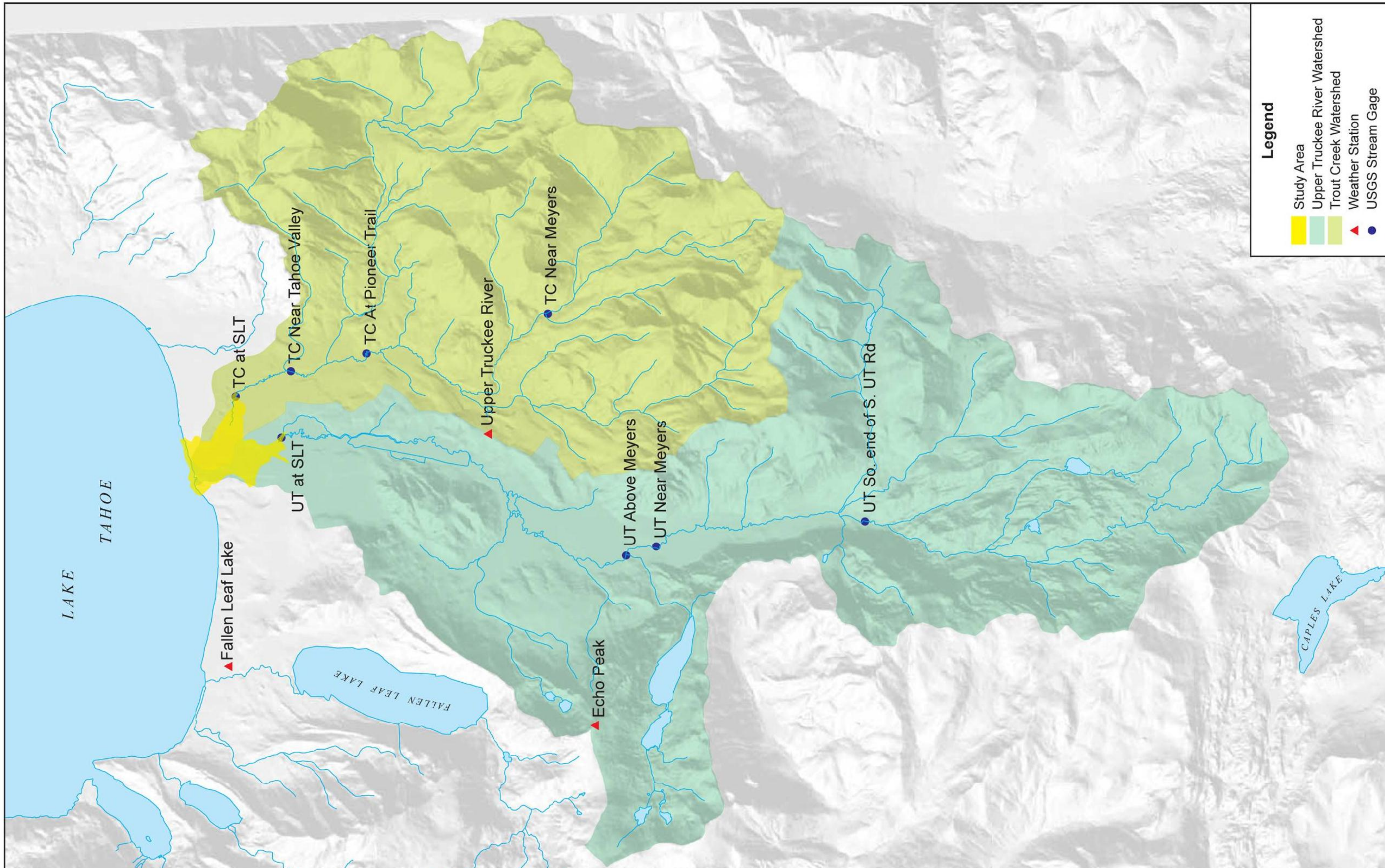
Climate-driven cycles can produce extreme highs and lows during a single year and from one year to the next. Precipitation timing and amounts and the mix of snow and rain can vary substantially from year to year (Coats and Goldman 2001:406, Rowe et al. 2002:13), producing year-to-year variability in streamflow. Future climate change may alter the spatial distribution and total amount of precipitation as well as the relative proportion of snow versus rain, and alter flood and drought extremes.

Streamflow observations made at several locations in the Upper Truckee River and Trout Creek watersheds characterize the hydrology of streamflows entering the study area from both watersheds (Table 3.8-1 and Exhibit 3.8-1).

Table 3.8-1
U.S. Geological Survey Streamflow Gauge Stations within the Upper Truckee River and Trout Creek Watersheds

Gauge Station Name	USGS Station ID	Period of Record (Water Years)	Contributing Drainage Area (Sq. Mi.)	Basin Area Gauged (%)
Upper Truckee River at South Lake Tahoe	10336610	1972–1974 1977–1978 1980–current	54.0	97.2
Upper Truckee River at U.S. 50 above Meyers	103366092	1990–current	39.2	68.8
Upper Truckee River near Meyers	10336600	1961–1986	33.2	58.6
Upper Truckee River at South Upper Truckee Road	10336580	1991–2006	14.1	25.0
Trout Creek at South Lake Tahoe	10336790	1972–1974 1988–1992	40.4	90.1
Trout Creek near Tahoe Valley	10336780	1961–current	36.7	89.1
Trout Creek at Pioneer Trail	10336775	1990–current	23.0	55.8
Trout Creek near Meyers	10336770	1990–current	7.4	17.7

Notes: ID = identification number; sq. mi. = square miles; U.S. 50 = U.S. Highway 50; USGS = U.S. Geological Survey
Sources: Rowe and Allander 2000, USACE 2002, USGS 2008



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Source: Conservancy and DGS 2003

Exhibit 3.8-1 **Upper Truckee River and Trout Creek Watersheds**

The mean daily streamflows on the Upper Truckee River and Trout Creek for water years 1972–2007 were analyzed to provide comparable years for both streams. The monthly statistics demonstrate generally similar seasonal patterns on both streams, but different magnitudes, particularly for the median and higher flows (Exhibits 3.8-2 and 3.8-3). Median flows during snowmelt season are around 200 cubic feet per second (cfs) on the Upper Truckee River, but only 50 cfs on Trout Creek. The maximum flows on the Upper Truckee River are much larger than those on Trout Creek, as might be expected based on drainage area (Conservancy and DGS 2003:2-12). However, Trout Creek has similar or slightly higher fall base flows. A later snowmelt peak, higher headwater elevations, and a larger percentage of drainage area above 8,000 feet in the Trout Creek watershed may increase the supply for base flow (Conservancy and DGS 2003:2-12). Summer/fall evaporative losses may also be reduced in the shorter, steeper, narrower valleys and channels along Trout Creek.

Local Runoff

The study area's surface-water hydrology also includes direct on-site precipitation, snowpack and snowmelt processes, and runoff from adjacent urbanized lands that drain to the meadow, streams, or both (Exhibit 3.8-4). The adjacent urban drainage areas are Al Tahoe, Highland Woods, County Cross Roads Village, Tahoe Island, and Sky Meadows. Although these local runoff sources are small compared to the upstream watersheds, the water they produce supplements that represented by the U.S. Geological Survey (USGS) gauge records. In some locations (e.g., Al Tahoe neighborhood), the urban storm drainage system may convey water from a larger-than-natural topographic watershed. In other locations (e.g., Tahoe Island neighborhood), the urban storm drainage system may reroute water to new discharge points, resulting in a smaller-than-natural local watershed. Much of the urban drainage from these areas is gravity fed via CSLT's system of curbs and gutters and is directed into the study area via simple outfalls, or in some cases, via flow across road surfaces. Drainage through Sky Meadows is in a vegetated swale/ditch.

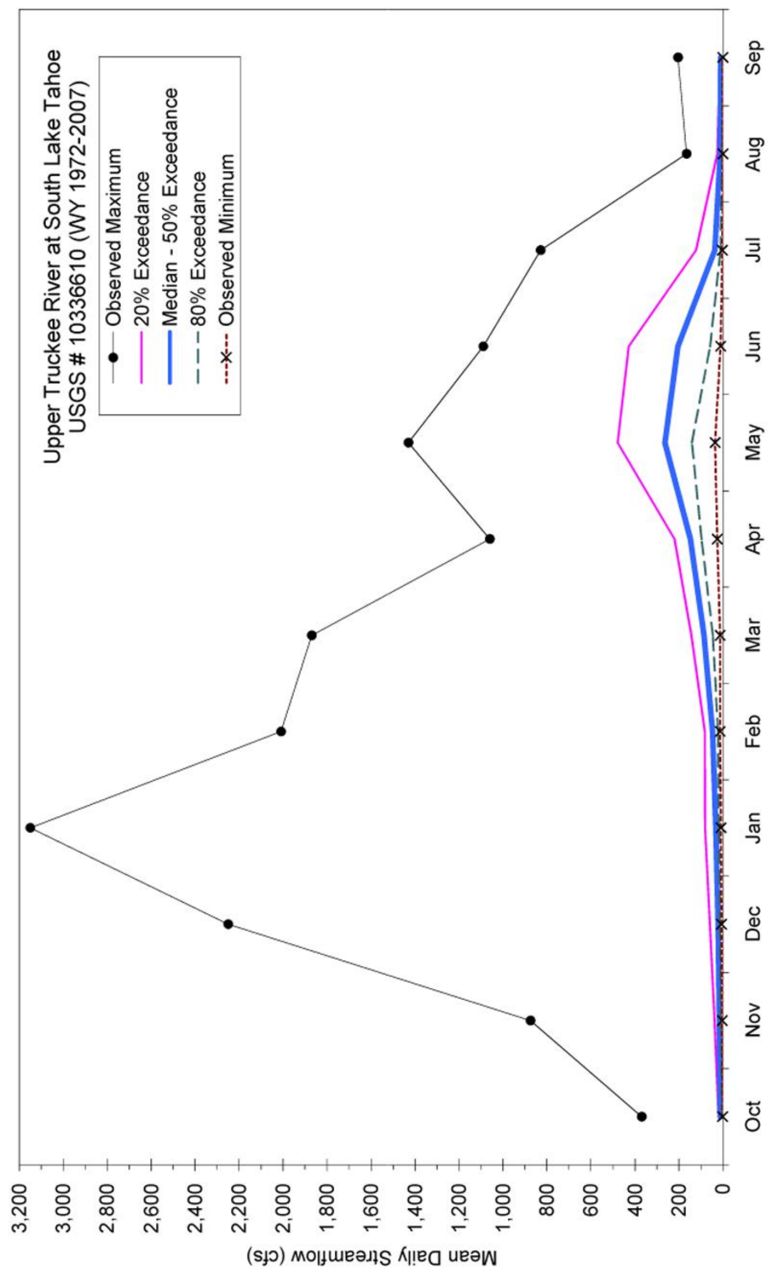
The hydrology of these small urbanized watersheds has not been measured, but it can be estimated for the purpose of sizing storm drainage features, water quality treatment improvements, or both. Hydrographs showing the levels of discharge from these drainage areas would likely reflect the urban land uses and low elevation, and thus would rise to peak sooner than the hydrographs for the overall watershed. Although they are relatively small, these areas could have larger peaks and volumes than they did in their historic, undeveloped state, except where drainage and water quality mitigation measures have been fully implemented.

At the request of the Lake Tahoe Storm Water Quality Improvement Committee, the U.S. Army Corps of Engineers (USACE) is developing a new drainage design criteria manual to improve estimates of runoff volumes, peak discharges, and hydrograph shapes (USACE 2007). The methodology approved by CSLT or the committee (or both) at the time of project review would be applied to quantify runoff as a basis for the project's modifications to storm drainage features, mitigation measures, or both. Tentative estimates of urban drainage hydrology are provided below in Section 3.8.2, "Environmental Consequences," to compare alternatives, using recommendations by USACE (2007).

Lake Tahoe

Lake Tahoe interacts with both the surface-water and groundwater hydrology of the study area. The lake directly connects with the Upper Truckee River at the river's mouth, and water flows across Barton Beach during flood events. Direct surface-water and groundwater connections also exist at the Tahoe Keys Marina and the Sailing Lagoon at a wide range of lake levels.

The natural rim of Lake Tahoe's outlet to the Truckee River at Tahoe City is 6,221.9 feet National Geodetic Vertical Datum (NGVD), or 6,223.0 feet on the U.S. Bureau of Reclamation's (Reclamation's) lake datum (Reclamation et al. 2008:3-41). Although some uncertainty exists about the elevation of the natural rim before dam construction began in 1870, the working assumption is that 6,221.9 feet NGVD represents the natural rim.



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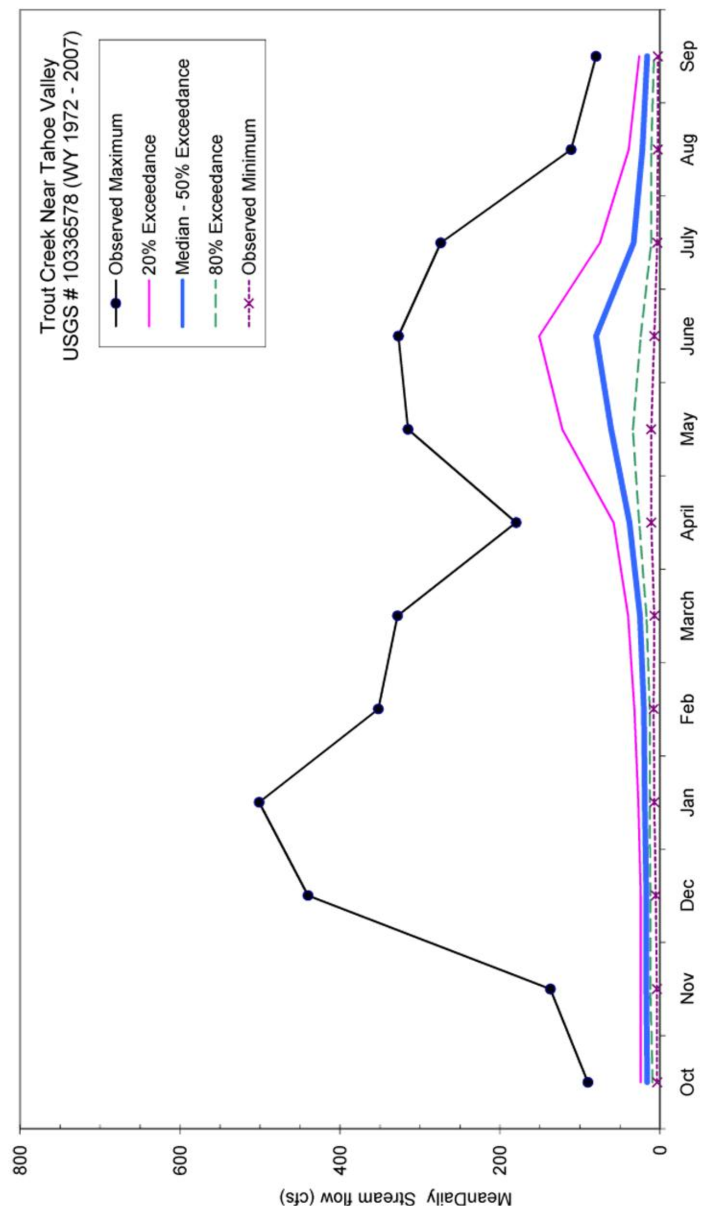
Source: USGS 2008, analyzed by Valley & Mountain Consulting in 2008

Exhibit 3.8-2 **Monthly Streamflows for the Upper Truckee River at South Lake Tahoe (Water Years 1972–2007)**



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Source: Valley & Mountain Consulting 2008

Exhibit 3.8-3 **Monthly Streamflow for Trout Creek near Tahoe Valley (Water Years 1972–2007)**

Topographic Drainage Areas

Neighborhood	sq miles
Al Tahoe West	0.04
Al Tahoe South	0.21
Highland Woods, Johnson Acres and Sierra Tract	0.27
Country Cross Roads Village and Sierra Tract	0.12
Tahoe Sierra No. 2	0.06
Tamarack and Sky Meadows	0.72
Tahoe Island Park	1.61

Urban Runoff Areas

Neighborhood	sq miles
Al Tahoe	0.38
Country Cross Roads Village and Highland Woods	0.19
Tamarack and Sky Meadows	0.09
Tahoe Island Park	0.12
Tahoe Keys	0.01

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Source: Conservancy and DGS 2003

Exhibit 3.8-4 **Local Urban Drainage Areas Surrounding the Upper Truckee Marsh**

Before the outlet was altered, this would have been the maximum lake level for hundreds to thousands of years. However, the maximum level of the lake has been even higher than 6,221.9 feet NGVD on major geologic time scales (i.e., 10,000 to more than 100,000 years ago) because volcanic flow or glacial ice dams, or both, impounded the lake at its outlet. See Section 3.6, "Geology and Soils, Mineral Resources, and Land Capability and Coverage," for more information. The lake would have begun spilling whenever lake water levels exceeded this elevation.

Dam construction and modification in the last 130 years raised the outlet's elevation, and thus the maximum possible lake level. The modern dam was constructed in 1913 and was seismically retrofitted and enlarged in 1988 (Roberts and Reuter 2007:3-2). The dam controls the top 6.1 feet of storage at Lake Tahoe as a federal reservoir (Reclamation et al. 2008:3-3). Since issuance of the 1944 Orr Ditch Decree, dam operations have provided for downstream water supply, but also have limited the maximum lake level to 6,228.0 feet NGVD (6,229.1 feet Reclamation lake datum). Lake Tahoe can temporarily rise above the legal limit under extreme precipitation and runoff conditions, such as the rapid surcharge of 0.3 foot that occurred on January 4, 1997, in response to regional flooding. The outlet dam does not control minimum lake elevations, which fall below the natural rim in response to drier climatic conditions.

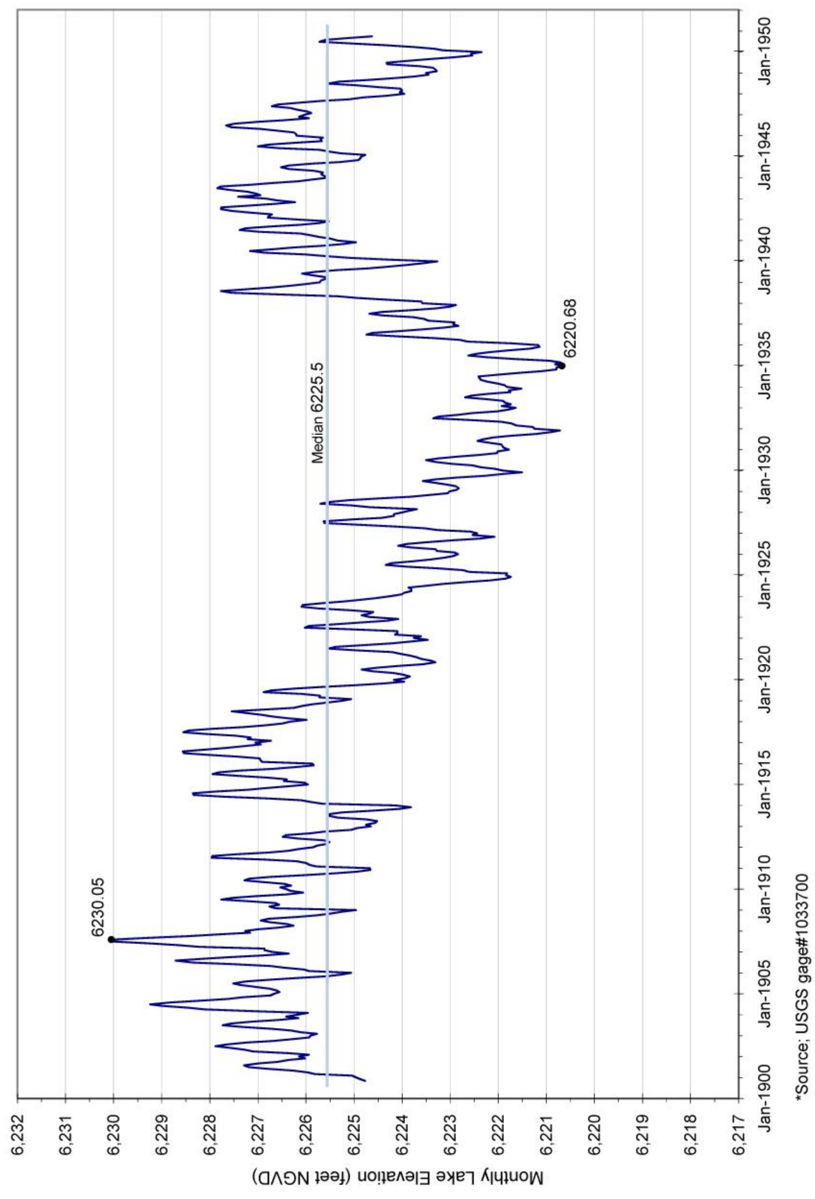
The elevation of Lake Tahoe has gone through cycles of relatively high and low stands (several years above or below median) for periods of several years (Exhibits 3.8-5 and 3.8-6). Relatively high stands occurred from 1900 to 1920, in the early 1940s, in the 1950s, from the late 1960s to the mid-1970s, in the early 1980s, and in the late 1990s. Occasional short-duration (one- to two-year) low-lake stands occurred in the late 1940s, in the early 1960s, and in the late 1970s. Prominent low stands (several years below 6,223.0 feet NGVD) occurred from the mid-1920s to the late 1930s and from the late 1980s to the mid-1990s. The recent drought did not last for as many years, but reached similar minimum elevations. Conditions since 2002 include a few years of low lake levels, followed by a high year in 2006. The trend for the next couple of years is not predictable based solely on the historic pattern.

In addition to the general year-to-year pattern, seasonal changes in Lake Tahoe's elevation are noticeable in the long-term monthly record. The seasonal changes in a given year are usually on the order of one–two feet, but sometimes Lake Tahoe falls or rises several feet within a few months (Exhibits 3.8-5 and 3.8-6).

Statistical analysis of the daily lake levels for water years 1972–2007 (the same period analyzed for stream records) describes the monthly pattern under modern watershed conditions and dam operations (Exhibit 3.8-7). The typical lake levels (minimum through 20 percent exceedance) are highest in spring and early summer (May–July) as a result of seasonal snowmelt runoff entering Lake Tahoe (Exhibit 3.8-7). However, maximum lake levels have occurred in January from major rain-on-snow floods, despite lower median and minimum values in the fall and winter months. The level of Lake Tahoe declines during the summer months as runoff input decreases and evaporative loss increases. The lowest lake levels are in October and November.

Marina/Sailing Lagoon

The Tahoe Keys Marina is an artificial surface-water body located immediately west of the study area. Owned by the Tahoe Keys Property Owners Association, the marina is generally parallel to the lower 3,000 feet of the Upper Truckee River. The Tahoe Keys Marina has been directly connected to Lake Tahoe since its construction in the late 1950s. In 1959, a navigation channel was dredged up to the mouth of the Upper Truckee River and one of its natural distributary arms, known today as the "Sailing Lagoon." (See the historic aerial maps in Appendix A of Conservancy and DGS 2003.) From 1959 to 1969, the marina was connected to Lake Tahoe via the river and the Sailing Lagoon served as a portion of the dredged navigation channel. In 1969, however, the marina's navigation channel was changed. The East Channel was excavated through Cove East Beach at its present location, connecting the marina to the lake directly. Fill was placed across the Upper Truckee River's former distributary arm to cut off the Sailing Lagoon from the river. Since 1969, the Sailing Lagoon and Tahoe Keys Marina have been connected to Lake Tahoe via the marina's East Channel.



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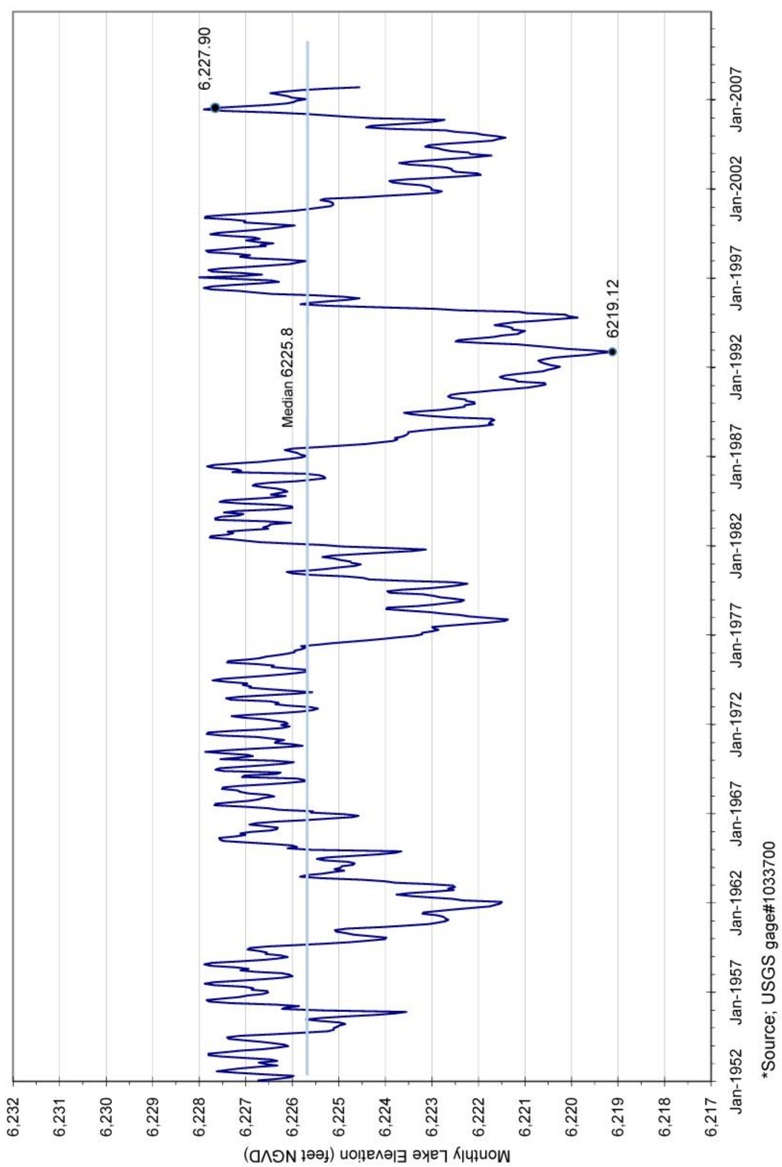
Source: Conservancy and DGS 2003

Exhibit 3.8-5 **Lake Tahoe Elevations, 1900–1950**



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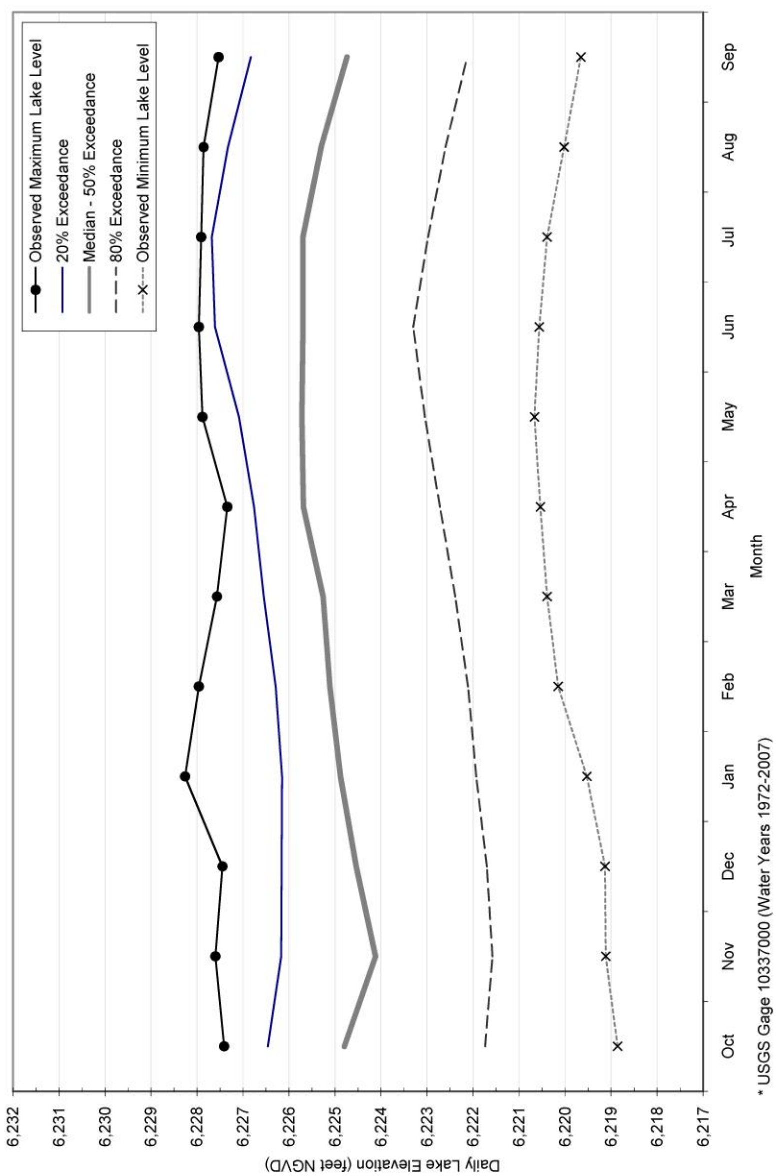
Source: Conservancy and DGS 2003

Exhibit 3.8-6 **Lake Tahoe Elevations, 1951–2007**



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Source: Valley & Mountain Consulting 2008

Exhibit 3.8-7 **Seasonal Pattern of Daily Lake Levels, 1972–2007**

The marina and East Channel are dredged to about 6,216.2 feet NGVD every few years—most recently in 2004 (TKPOA 2005)—to maintain navigation depths (Conservancy and DGS 2003:3-9, 3-10). The Sailing Lagoon has not been officially maintained as a primary navigation component since the State of California acquired it as part of the Cove East Parcel in the early 1980s.

Surface-water levels in the Tahoe Keys Marina and Sailing Lagoon likely were equivalent to the lake elevations described above (Exhibits 3.8-5, 3.8-6, and 3.8-7) for the period since 1959, once the open-water connections were established or enlarged (or both) by dredging. Surface-water elevations in the Sailing Lagoon before the 1959 dredging of the river mouth and lagoon arm likely reflected combined controls from the river, high lake levels, and groundwater. There are no direct records of these conditions, but it is likely that they were similar to the modern relationships of the Trout Creek distributaries, lagoon areas within the Upper Truckee Marsh, and Lake Tahoe.

Analysis of the standing-water areas in historical aerial photographs of the study area from 1930 to 2002 indicates that although lake level is an important control on “lagoon” areas, other factors also affect natural lagoon areas. Among these factors are groundwater levels, streamflows and overbanking, beach ridge height, and mouth depths (Conservancy and DGS 2003:3-22, 3-23). The results suggest that natural lagoons were not directly connected to the lake, except during flood events, or perhaps for a whole season in some years of very high lake levels.

Groundwater

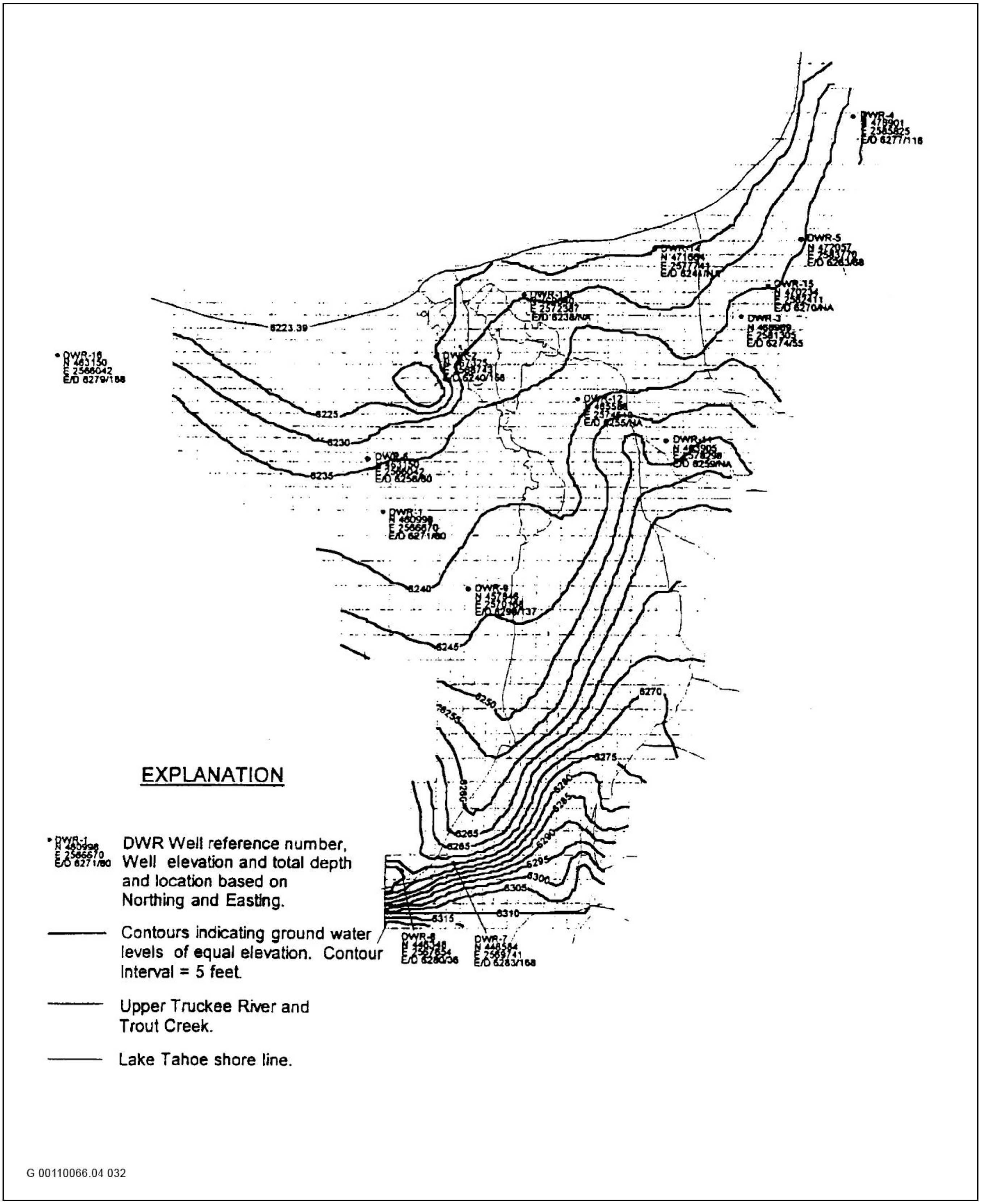
Groundwater Basins

The study area is within the South Lake Tahoe groundwater basin, the area’s primary source of domestic and public water supplies. Various monitoring programs and studies have focused on concerns about groundwater withdrawals, wastewater disposal, and the water quality implications of interaction between groundwater and surface water (Rowe and Allander 2000, USACE 2003). The most recent groundwater evaluation for the total maximum daily load program (USACE 2003:4-1) places the study area within Subregion 3, Al Tahoe and Upper Truckee Marsh, of the South Lake Tahoe/Stateline region.

Groundwater Conditions in the Trout Creek and Upper Truckee River Watersheds

As reported by USACE (2003:1-2), studies have documented that the water surface of groundwater in aquifers in the Trout Creek and Upper Truckee River watersheds generally slopes toward the lake (i.e., with net flow toward the lake). The watershed-scale groundwater flow paths include discharge through springs, small lakes, and seepage to stream channels, along with direct discharge to the lake across the lakeshore (Thodal 1997:24). Groundwater elevations in the watersheds generally parallel the topography, with higher elevations in the headwaters and along ridgelines and lower elevations in the valleys and along the lake (Rowe and Allander 2000:36).

Observations from 1964 provide an estimate of the groundwater patterns that existed in the Upper Truckee River and Trout Creek watersheds before substantial pumping began (STPUD 1999). These data indicate that the natural groundwater slopes were steep in the upper reaches of the watersheds, but flattened out several miles upstream of the lake (Exhibit 3.8-8). At the Upper Truckee Marsh, groundwater was higher than the lake level and sloped toward the lake in both the Upper Truckee River and Trout Creek portions of the marsh (Exhibit 3.8-8). However, the estimated 1964 groundwater slope (gradient) was very low in the marsh—less than 10 feet per mile (0.001 to 0.002 foot vertically per foot horizontally)—even though the lake was low (STPUD 1999). Still, a shallow hydraulic slope under relatively undeveloped conditions is not unexpected. Such a slope could reflect the low-gradient valley floor and the relatively low hydraulic conductivity (i.e., ability of a porous material to transmit groundwater) of the lake bed and glacial outwash sediments that underlie the valley.



Source: AGRA Earth and Environmental, Inc. 1999

Exhibit 3.8-8 **Observed Groundwater Elevations for the Upper Truckee River and Trout Creek Watersheds circa 1964**

Regardless of the natural conditions, groundwater levels and patterns in the vicinity of the study area have changed substantially since the 1960s. These changes have occurred largely because of varied pumping and the construction of the Tahoe Keys (Loeb 1987, Thodal 1997:11–13). Depression of groundwater levels has occurred, especially in the Trout Creek portions of the study area. Also, the distance to the lake's open surface water was effectively reduced by the construction of the keys channels, which altered the groundwater slopes (and thus the rates of flow loss) to the lake on the west margin of the study area.

Local Groundwater Conditions

Groundwater monitoring data for the study area are limited to various short-term wells installed and observed by the Conservancy during different time periods related to specific project studies and construction of the Lower West Side (LWS) Restoration Area (Exhibit 3.8-9). Other short-term records exist from nearby research projects (e.g., on Pope Marsh), and long-term groundwater information is available at nearby production and monitoring wells (Exhibit 3.8-9).

Long-term data (1962–2007) from four California Department of Water Resources monitoring wells show the relationships between local groundwater and lake levels (Exhibit 3.8-10). The groundwater levels are dynamic, with seasonal shifts of a few feet (three–four feet) and year-to-year ranges of several feet. As might be expected, the groundwater elevation roughly parallels lake level (USACE 2003:B-4). The same rising-and-falling cycles over years occur in response to variations in watershed runoff and changes in pumping demand, both driven by climatic conditions. Groundwater levels can rise and have risen during periods of relatively constant high lake levels (e.g., 1966–1968 and 1995–1998) (Exhibit 3.8-10). Maximum groundwater levels are limited primarily by local topography and aquifer properties, not by the elevation of the lake-rim outlet. Groundwater discharge from the watershed, although slower than surface runoff, generally flows toward the lake. If precipitation levels are high for several years, groundwater may continue to rise after surface runoff has diminished (Conservancy 2003:2-27).

The wells upslope and west of the study area (the Tallac Village and Tahoe Valley School wells) have historic groundwater levels consistently higher than lake levels; since the late 1980s, however, they have shown some net decline (fewer feet of difference from lake levels) (Exhibit 3.8-10). East of the Upper Truckee Marsh, groundwater levels at one well (Al Tahoe West) have consistently been lower than lake levels, and another well's groundwater levels switched in the mid 1980s from generally similar to lake levels to consistently lower (Exhibit 3.8-10). These conditions reflect pumping effects that locally decrease groundwater levels (i.e., drawdown) and create slopes toward the production wells east of the study area (USACE 2003:B-5). Because of the naturally low groundwater gradient and sustained pumping, net groundwater flow to the lake from the study area is lower than net flow from neighboring subregions along the south shore (Exhibit 3.8-11).

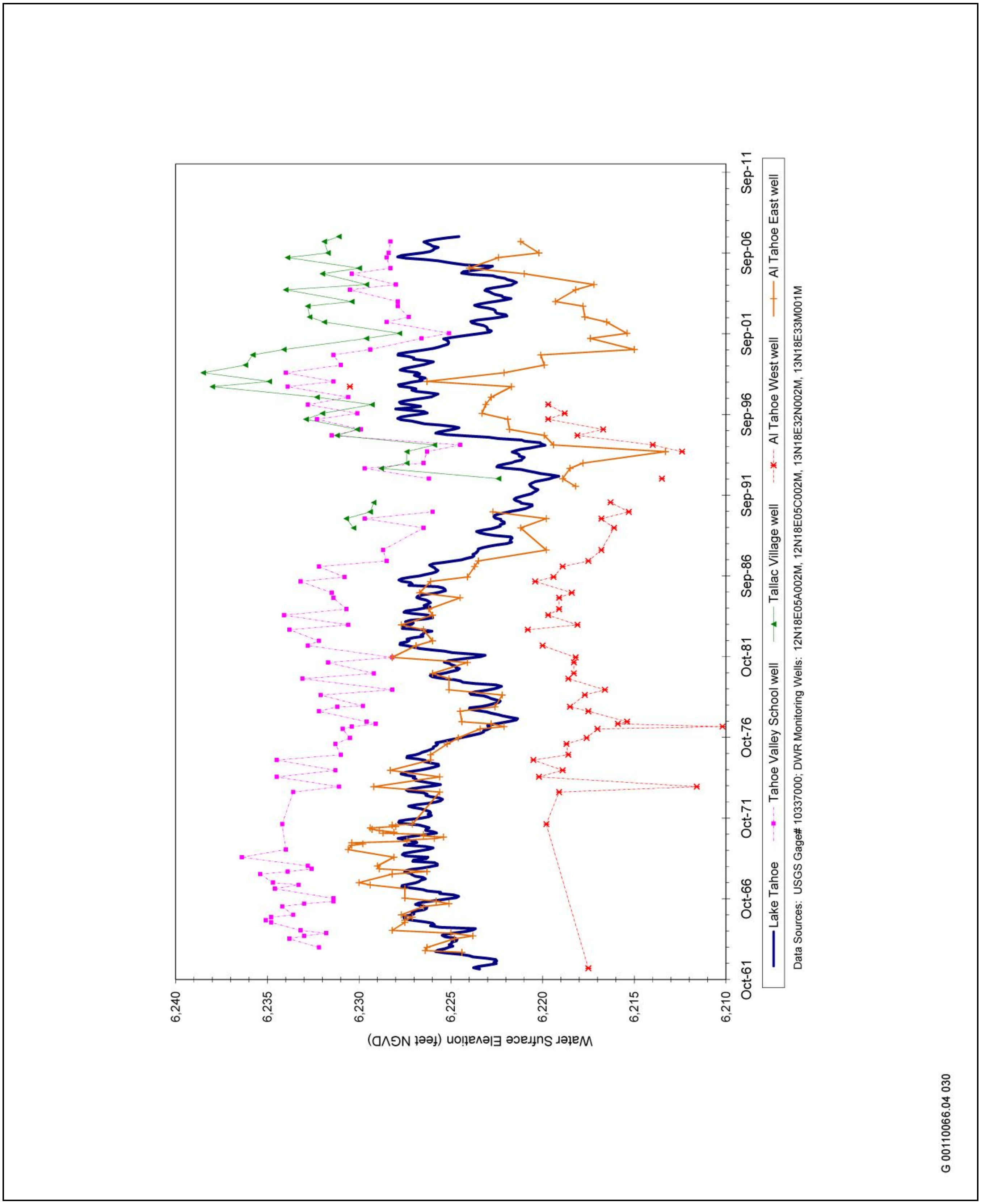
Groundwater Conditions in the Study Area

The most important control on groundwater conditions within the Upper Truckee Marsh is Lake Tahoe, including its artificially connected sections within the Tahoe Keys canal system. The lake is the major groundwater discharge boundary; groundwater within the sediments of the marsh flows toward the lake margin, including the Tahoe Keys. Therefore, groundwater levels (and gradients) within the unconfined aquifer under the marsh respond to fluctuations in lake level. Notably, construction of the Tahoe Keys effectively moved the lake's hydraulic margin, creating a human-made discharge boundary within the marsh (at the western margin of the study area). The distance to the discharge boundary from the interior of the marsh was shortened by construction of the Tahoe Keys canals, increasing localized groundwater gradients from the marsh toward the Keys.

The primary recharge of groundwater in the marsh occurs as the result of down-valley flow of groundwater, with some contributions from the local slopes at the margin of the study area. The Upper Truckee River is not the primary control on groundwater conditions. Recent investigations have suggested that the lower portions of the river are not predominantly "gaining" or "losing" reaches (with groundwater flowing into the channel or flowing

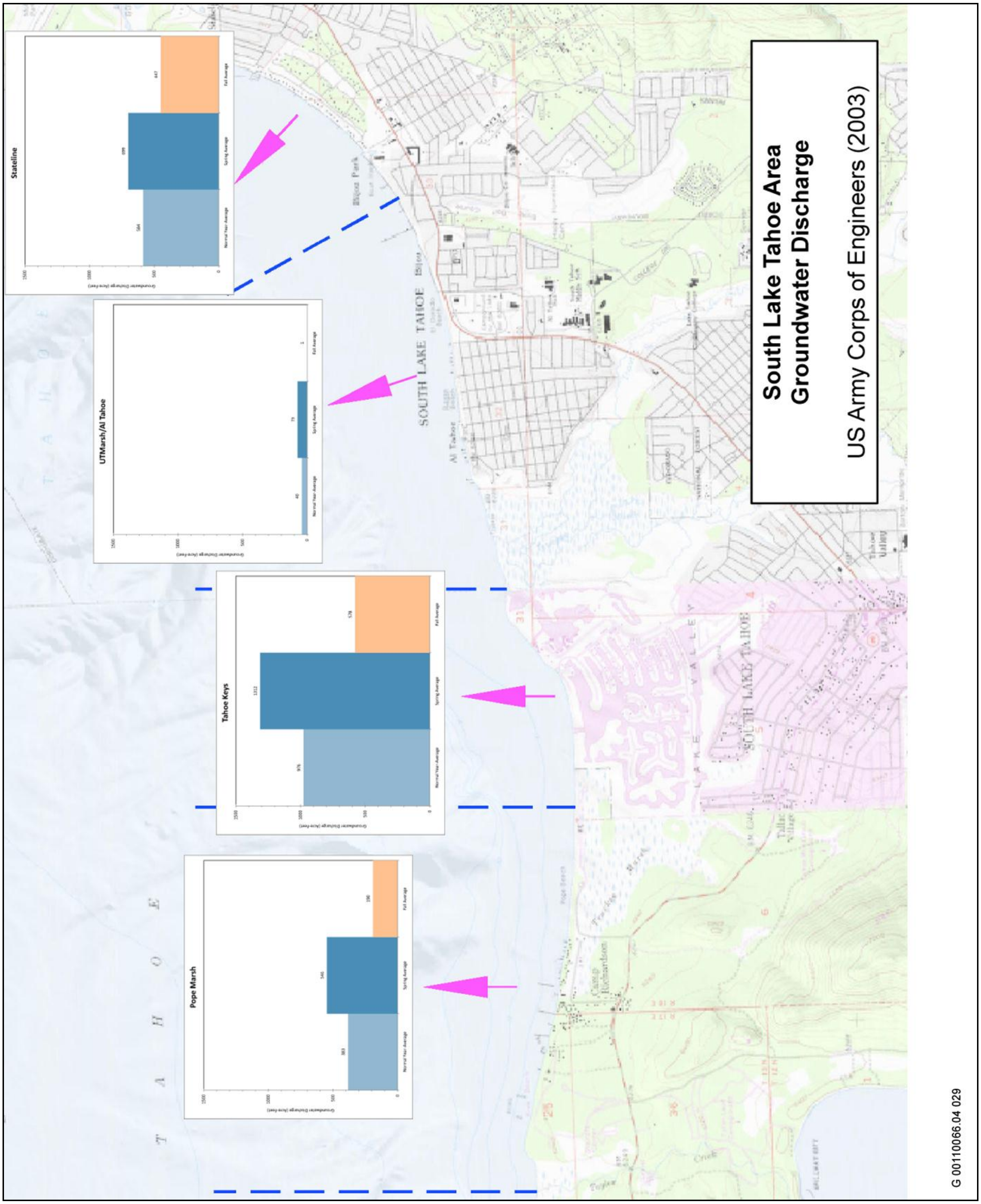
Source: Conservancy and DGS 2003

Exhibit 3.8-9 **Groundwater Data Sources in the Vicinity of the Study Area**



Source: Conservancy and DGS 2003

Exhibit 3.8-10 Long-Term Groundwater and Lake Elevations in the Vicinity of the Study Area



Source: USACE 2003

Exhibit 3.8-11 **Net Groundwater Discharge to Lake Tahoe along the South Shore under Average Annual and Seasonal Conditions**

out of the river to the aquifer, respectively); the reach downstream of U.S. 50 is characterized as steady relative to groundwater losses or gains (Rowe and Allander 2000:Plate 1). A more detailed investigation of conditions along Trout Creek for the period 1996 to 2001 (Allander 2003:40) indicates that groundwater flow into or away from the channel in the lower reach is variable depending on surface flow and lake level.

However, the river does temporarily and locally affect groundwater during particular seasonal conditions. During periods when surface water in the channel remains above the elevation of the groundwater level in the surrounding areas, water from the river may recharge the local aquifer (creating a "losing" river situation). During periods of sustained low-flow conditions in the stream, groundwater may discharge to the river if the surrounding groundwater levels are above the elevation of the low-flow channel (creating a "gaining" river situation).

The study area's existing groundwater levels and flow patterns have been modified by direct disturbance to the channel, and the channel's natural geomorphic response to disturbance through incision and widening. The incision of the channel has progressively lowered the transient discharge boundary that may occur during low-flow conditions. Therefore, that control on groundwater levels has been lowered relative to natural conditions, at least in the corridor adjacent to the incised channel. The effect of lowering the groundwater surface is to reduce the amount of groundwater storage space within the shallow aquifer beneath the marsh. The degraded channel condition has also increased the seasonal fluctuation of groundwater levels throughout the natural floodplain by reducing the amount of overbanking relative to more natural conditions. The reduced frequency of overbanking and smaller area of inundation reduces the amount of recharge to shallow groundwater from water infiltrating the marsh surface during and after overbanking events. All of these effects tend to reduce the availability of groundwater for marsh and floodplain habitat.

Observations of groundwater conditions in the study area are available for recent years, the same years for which vertical aerial photographs are available over a range of lake levels. These lake levels vary from extreme low (1992) to legal maximum (1999) elevations, including median lake level under high-volume runoff (1995). With these data, groundwater contours and approximate hydraulic slopes could be calculated for the study area (Conservancy 2003:2-27 to 2-36).

The 1992 data set demonstrates that at times of low lake levels (6,220 feet NGVD) and low streamflow input, groundwater along the incised Upper Truckee River was at or below the channel bed. There was a steep groundwater slope northwest or west toward the Tahoe Keys channels, steeper than the groundwater gradient north to Lake Tahoe. Groundwater in the middle marsh remained relatively high: about five feet above the lake level (Conservancy and DGS 2003: Exhibit 2-23).

The 1995 data set demonstrates that for a period with Lake Tahoe at median lake level (6,225.8 feet NGVD) and under high streamflow, groundwater levels onsite actually peaked before either the lake rise or streamflow. This indicates that the groundwater onsite was recharged from groundwater flowing from up-valley areas and/or on-site snowpack/snowmelt. The groundwater slope was still to the northwest or west toward the Tahoe Keys channels, but not as steep as during low lake levels. Small reversals of groundwater flow may have occurred west of the existing Upper Truckee River channel when the lake level rose quickly. Under these conditions, net groundwater flow would temporarily be from the Tahoe Keys Marina and channels toward the river. Groundwater in the middle marsh remained about three–four feet above the lake (Conservancy and DGS 2003:Exhibits 2-24 and 2-25).

The 1999 data set demonstrates that when Lake Tahoe was at high lake level (6,228.9 feet NGVD) and moderate streamflow occurred, groundwater levels onsite peaked before the spring runoff, perhaps because of on-site snowpack/snowmelt. The groundwater slope was extremely gentle, and groundwater was higher than the lake, as much as a couple of feet higher in spring. Groundwater in the middle marsh remained two–three feet above the lake level (Conservancy and DGS 2003:Exhibit 2-26).

The relatively high groundwater levels in the middle marsh over the range of lake levels and river flows indicate that, as expected, the groundwater supply from the upper watersheds is primarily discharging to the study area along the ridge between the Upper Truckee River and Trout Creek. The available data also suggest how important the Tahoe Keys Marina channels are in controlling groundwater levels and slopes along the west side of the study area. These excavated, open-water surfaces are connected to the lake. Therefore, they support high on-site groundwater when lake levels are high but draw it down locally when lake levels are low. The pronounced response of groundwater levels to changes in lake levels suggest that zones of high hydraulic conductivity (possibly more coarse sediments) discharge groundwater along the western study area boundary.

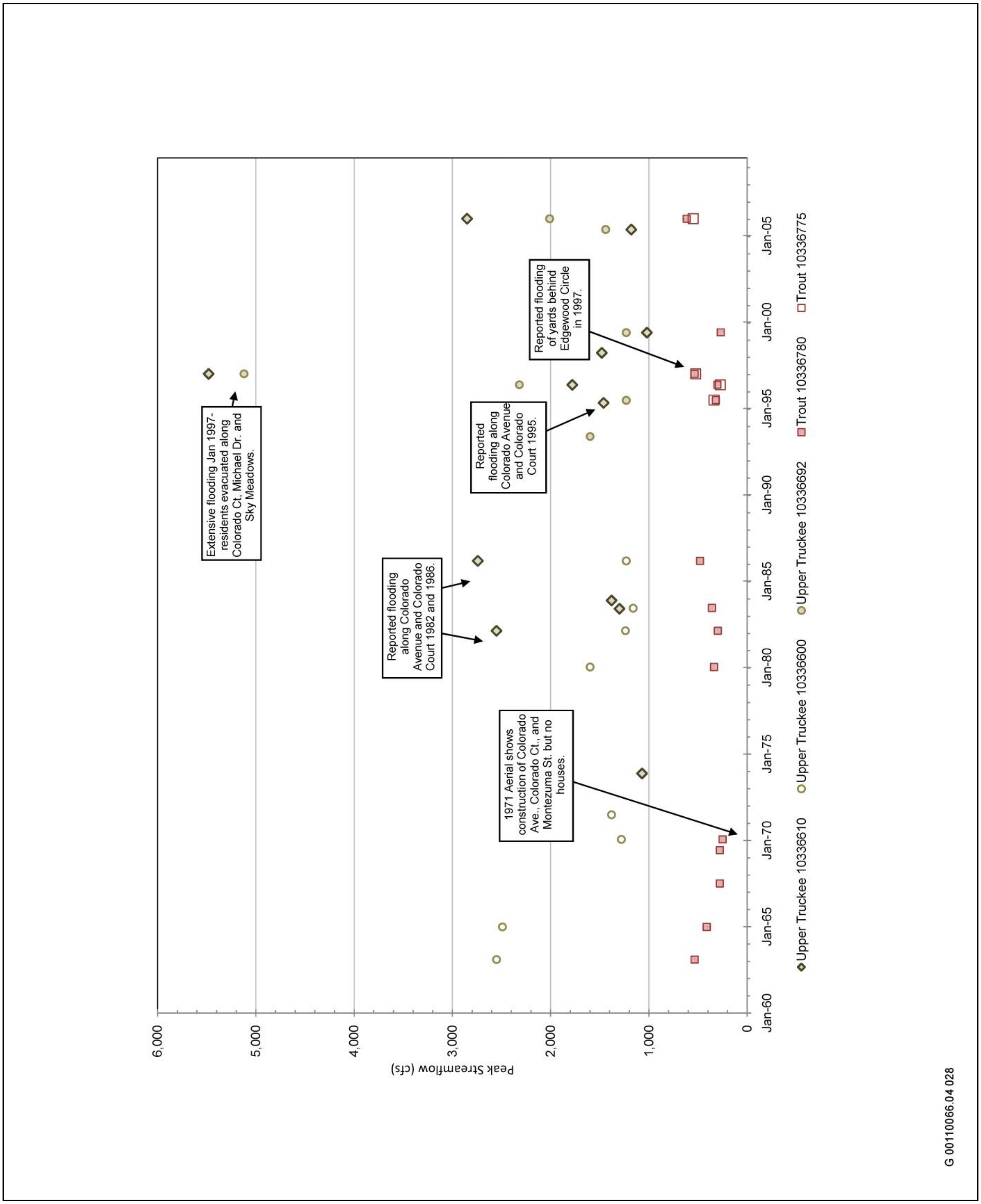
Additional information about groundwater conditions and processes in the study area is available for water years 1995–1997. During this period, monitoring programs were conducted on both the Upper Truckee Marsh (Conservancy 2003) and Pope Marsh (Green 1998). The Pope Marsh data demonstrate that upslope groundwater and local surface water (including snowmelt) are the dominant sources of water to "fill" the marsh, but lake level is an important control on the rate at which water drains out of the marsh (Green 1998). The Upper Truckee Marsh data have similarities with the Pope Marsh data, including local groundwater depressions for the monitoring wells closest to the Tahoe Keys (Conservancy and DGS 2003:Exhibits 2-21 and 2-22). Groundwater was encountered in four of seven geotechnical boring locations in the study area in April 1995, at depths below ground surface ranging from 3.75 feet to 10.0 feet (Marvin E. Davis and Associates 2005).

Flooding

Flooding is an important aspect of the hydrology of all river systems. It has a substantial influence on riparian vegetation, bank stability, water quality, wildlife habitat, and channel morphology. When flood magnitudes are large, property damage and safety risks can occur, particularly in developed areas. Although the Upper Truckee Marsh study area is undeveloped, it is surrounded by developed land uses, so flooding that may span the valley, or flooding along the margins of the study area, may result in flood hazards to urban structures and local residents.

Water begins to overtop channel banks (i.e., overbanking) when streamflow exceeds channel capacity, which is about 1,000–1,500 cfs for the Upper Truckee River and about 150–200 cfs for Trout Creek, depending on the specific locations within the study area. Over the 45-year period of record on these streams, several peak-flow events have exceeded these magnitudes (Exhibit 3.8-12). Before the mid-1970s, there were few structures at risk along the margins of the study area. During the following decades, however, flooding was reported in the Tahoe Island subdivision (at Colorado Avenue, Colorado Court, Montezuma Street, and Michael Drive) and the Sky Meadows subdivision, particularly for flows on the Upper Truckee River exceeding 1,400 cfs. As discussed below, some of this historical flooding of residential neighborhoods resulted from internal problems with the urban drainage system, and not simply from river flows crossing the floodplain. Along Trout Creek, only the most extreme flows have affected any residential areas, with effects mostly limited to backyard flooding along Edgewood Circle. The smaller overbank peak flows (less than approximately 1,400 cfs on the Upper Truckee River and less than approximately 500 cfs on Trout Creek) occur every several years but have not been associated with flood hazards.

Extreme peak flows associated with damaging floods on the Upper Truckee River and Trout Creek are mostly, but not entirely, associated with winter rain-on-snow conditions. These conditions occur during large winter rainstorms when antecedent snowpack conditions add to the total runoff. Floods of moderate magnitude may result from spring snowmelt events or rainstorms, or less intense rain-on-snow events. Flow from spring snowmelt tends to be less extreme, because the snowpack melts gradually over the watershed's various elevation zones, moderating the peak flow arriving at a downstream location like the study area. Summer thunderstorms in the Tahoe Basin are common and can be intense, but they are typically brief and cover only small portions of the watersheds. They rarely produce substantial flooding or flood hazards in the vicinity of the study area (USACE 1999).



Source: Valley & Mountain Consulting 2008

Exhibit 3.8-12 **Peak Streamflow Events on the Upper Truckee River and Trout Creek (Water Years 1962–2007)**

The flood of January 1–2, 1997, was triggered by rainfall that followed prior snowstorms (i.e., fell on top of the existing snowpack). Heavy rain and melting snow resulted in high flows throughout the Tahoe Basin (Conservancy and DGS 2005). This event was the largest flood of record at 21 of 31 USGS stream monitoring sites in the Tahoe Basin (Crompton, Hess, and Williams 2002). For other sites in the basin, the largest historic flood resulted from rainstorms during the spring or early-summer snowmelt (e.g., April and May 1973, May and June 1995) (Crompton, Hess, and Williams 2002).

Flood Frequencies

Statistical analysis of either recorded or estimated flows, or both, is typically used to characterize various flood events. Several hydrologic studies have developed flood statistics for the Upper Truckee River and Trout Creek using available data and standard methods for the specific purpose of each study (Table 3.8-2). These studies produced estimates of the statistical frequency (expressed as either a probability of occurrence in any year or as a return interval in years) and associated peak flow magnitudes (streamflow in cfs). High-magnitude flooding events with the potential to inundate adjacent residential neighborhoods have long return intervals (e.g., 10-year, 25-year, 100-year), statistically meaning that the probability of occurrence is lower (i.e., they occur less frequently).

Table 3.8-2
Flood Frequency Analyses and 100-Year Flood Estimates for the Upper Truckee River and Trout Creek

Study	Year of Study	Period of Record Used	Estimated 100-Year Peak Flow (cfs)	
			Upper Truckee River	Trout Creek
USACE	1983	1972–1983[a]	10,600	5,400
CEDR	1991	1961–1990[b]	8,000	[c]
GLOBAL—snowmelt	1996	1972–1995[a]	1,780	[c]
GLOBAL—rain	1996	1972–1995[a]	5,610	[c]
USACE—snowmelt	1999	1972–1998[a]	2,020	[c]
USACE—rain	1999	1972–1998[a]	10,500	[c]
USGS	2001	1901–2001[d]	4,700	855
ENTRIX	2001	1972–2001[a]	6,480	900
ENTRIX—extended record:				
January 1997, peak 5,480 cfs (USGS)	2001	1961–2001[b]	6,660	900
January 1997, peak 8,200 cfs (USACE)	2001	1961–2001[b]	7,650	900

Notes: cfs = cubic feet per second; CEDR = Center for Environmental Design Research; ENTRIX = ENTRIX, Inc.; USACE = U.S. Army Corps of Engineers; USGS = U.S. Geological Survey; GLOBAL = Global Environmental.
[a] Raw observed data only
[b] Extended using Meyers record
[c] Not analyzed by cited source study
[d] Extended using regional data
Source: Conservancy and DGS 2003

The estimated magnitudes of the 100-year flood peaks (i.e., those with a one percent chance of occurring in a given year) on the Upper Truckee River and Trout Creek (Table 3.8-2) have changed over the years of study as more data have become available and various methods have been applied. The January 1997 flood added important information to the data set, but damage to the Upper Truckee River gauge and flow blockage at the U.S. 50 crossing during the flood required that the peak flow be estimated (5,480 cfs by USGS and 8,200 cfs by

USACE). Based on independent analysis, ENTRIX validated the USACE estimate of 8,200 cfs as the most probable flow for the 1997 extreme event (Conservancy and DGS 2003:8-15) and entered that value into the statistical analysis. Therefore, the resulting flood hazard analysis for this project estimated a 100-year flood peak of 7,650 cfs for the Upper Truckee River and 900 cfs for Trout Creek.

Using the same statistical data and analysis, peak-flow magnitudes for both streams in the study area have been estimated over a wide range of expected return intervals (Table 3.8-3). Because these streams are unregulated (i.e., no substantial dams or other flow-control structures exist upstream), the flow magnitudes and frequencies are not managed, but occur as a function of climate and weather conditions, land use and vegetation cover, and channel and floodplain characteristics. These flows represent the anticipated streamflow to the study area over the life of the project if watershed hydrology is assumed to be similar to the hydrology of the last 35 years.

Table 3.8-3
Estimates of 1.5-Year to 200-Year Peak Streamflows on the Upper Truckee River and Trout Creek

Return Interval (years)	Estimated Peak Flow (cfs)	
	Upper Truckee River	Trout Creek
1.5	530	100
2	760	140
5	1,660	270
10	2,550	380
25	4,130	560
50	5,690	720
100	7,650	900
200	10,100	1,100

Notes: cfs = cubic feet per second
Source: ENTRIX, cited in Conservancy and DGS 2003

Historical flooding in adjacent residential areas has resulted from a combination of the flow magnitudes, the location and elevation of homes, and street drainage systems, as well as the channel capacity and floodplain topography. The interaction of these factors has caused urban flooding west of the Upper Truckee River (i.e., in the Tahoe Island subdivision at Colorado Avenue, Colorado Court, Montezuma Street, and Michael Drive and the Sky Meadows subdivision) at flows around or slightly less than the 5-year event, and in urban-fringe flooding east of Trout Creek (i.e., Al Tahoe subdivision) at flows between the 10-year and 25-year events.

The following discussion of floodplain management and flood hazards focuses on larger-magnitude, lower-frequency events of concern from a regulatory perspective (e.g., a 100-year event), but also includes evaluation of smaller events known to have created flood nuisance or hazards in the vicinity (e.g., 5- to 10-year events). Further discussion of the overbanking associated with small-magnitude, high-frequency events considered important to active floodplain processes (e.g., 2-year events) is included in Section 3.9, “Geomorphology and Water Quality.”

Historical data suggest that, unlike spring snowmelt events, which tend to have staggered peak flows on the Upper Truckee River and Trout Creek, major winter rainfall flood events produce peak flows on both streams on the same day. Therefore, the flood hazard analysis for the study area combines the 100-year peaks of the Upper Truckee River and Trout Creek channels (i.e., 8,550 cfs). The two flows would converge in the main floodplain (marsh) as influenced by:

- the lake's water-surface elevation before the flood,
- the configuration of the Upper Truckee River and Trout Creek outlet(s) through the beach ridge, and
- the amount of water stored in the entire floodplain (including the lagoon area south of Barton Beach) before the flood.

Flooding and Floodplain Storage

Most of the study area is composed of the shared floodplain of the Upper Truckee River and Trout Creek, which has the potential to store a large amount of runoff during flood events. The floodplain is about one mile long and about 0.5 mile wide, with about 14 acre-feet of storage volume at the legal maximum lake elevation of 6,229.0 feet (Conservancy and DGS 2005:6-1). It is bounded on the south and east by urbanized uplands, and on the west by a combination of urbanized upland, urbanized floodplain, and the Tahoe Keys Marina. The northern boundary of the floodplain is along the Barton Beach ridge, stretching from uplands west of the mouth of the Upper Truckee River (in the former Cove East Beach dunes) to uplands east of East Barton Beach. The only perennial (low-flow) outlet to the lake is the existing mouth of the Upper Truckee River, which was deepened by dredging in the late 1950s to late 1960s. The Trout Creek system's lagoon includes a separate mouth that was not dredged and is not active as a low-flow channel to Lake Tahoe. As shown in historic aerial photography (Conservancy and DGS 2003), Trout Creek has historically breached the Barton Beach ridge during large flood events; this breach typically stays open to discharge directly to the lake during high flows and high lake levels. Extreme flood events may overtop additional parts of the barrier beach, via the combined effects of high streamflow and floodplain (lagoon) water levels, and storm wave action on both the lake and the lagoon.

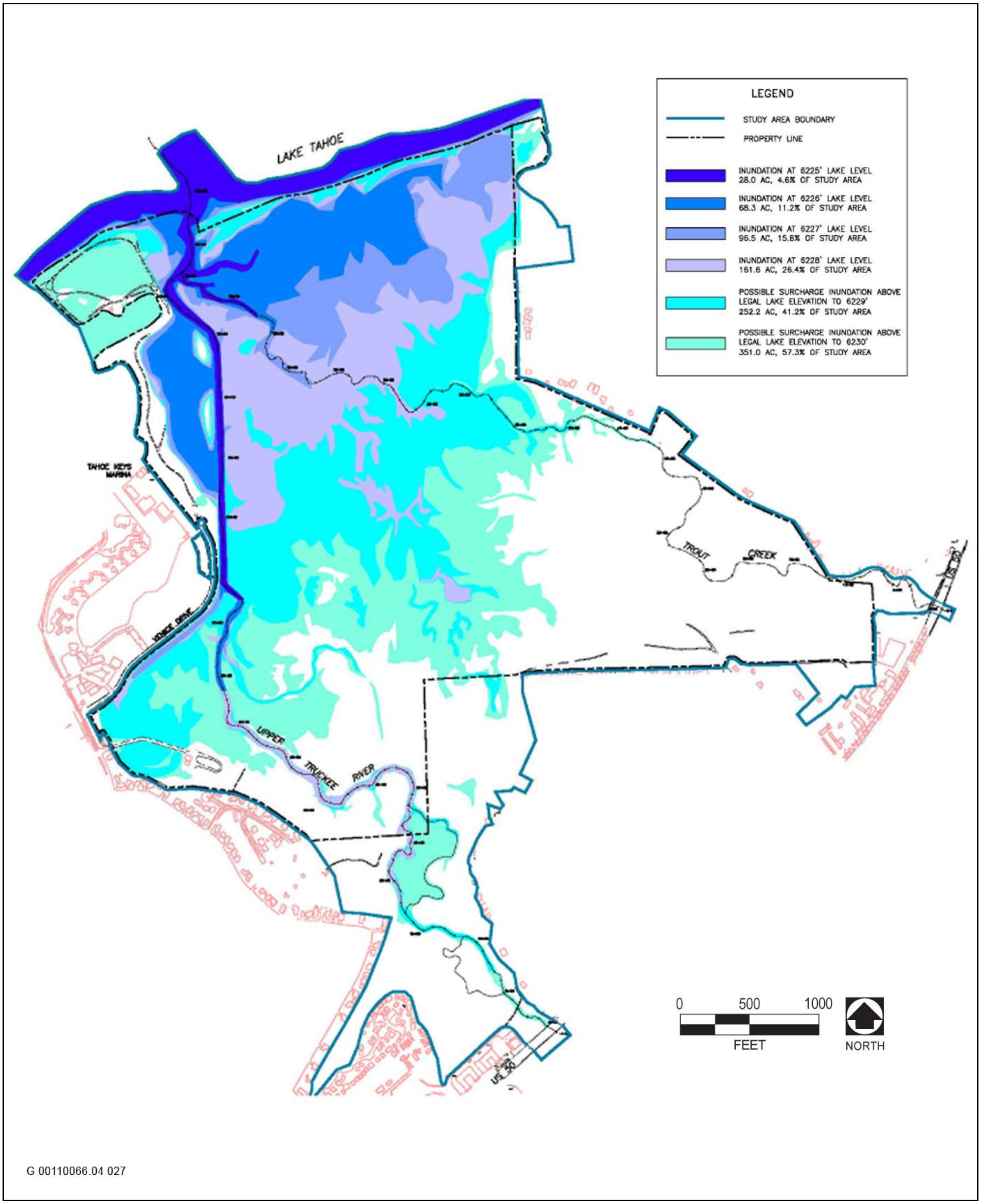
Lake Level Effects

Several aspects of hydrology in the study area are directly affected by lake level, and flood hydrology is no exception. As Lake Tahoe rises above its median level, floodplain storage is reduced because the mouth of the Upper Truckee River (and other low portions of the Barton Beach ridge) allows lake water to fill in the low-elevation areas of the marsh (Exhibit 3.8-13). About 1,000 feet of lower Trout Creek and as much as 5,000 feet of the Upper Truckee River would have reduced channel capacity under lake backwater conditions (Conservancy and DGS 2003:8-9). The area of lake backwater is a small percentage of the total floodplain storage when the lake is near median elevation (i.e., 6,225–6,226 feet). However, during high lake levels (i.e., 6,228–6,229 feet), 25 percent or more of floodplain storage could be taken up by lake backwater. The increase in area affected by backwater effects reflects the low surface gradient of the marsh.

Because of the Upper Truckee River's channel-lake connection through the straightened reach, high lake levels can also interfere with urban drainage during floods. The backwater can submerge the Colorado Avenue outlet by about two feet, possibly affecting sump performance.

Bridge Effects

The bridge at U.S. 50 also limits the maximum streamflow of both the Upper Truckee River and Trout Creek as they enter the study area. Bridge replacements and repairs by the California Department of Transportation over the years (as recently as 1996–1997) used the original bridge-capacity designs from the early 1900s, to avoid litigation in case bridge modifications would have altered upstream or downstream discharge. The effects of constriction by the bridge during high flows would be reflected in the historic gauge records and flood-frequency analysis for the Upper Truckee River (Tables 3.8-2 and 3.8-3) because the gauge is downstream of the bridge.



Source: Conservancy and DGS 2003

Exhibit 3.8-13 Potential Backwater Inundation of the Upper Truckee Marsh under High Lake Levels

Drainage Effects

Topography and urban drainage systems in the developed areas that surround the study area can also affect flooding on the margins of the study area. Flooding problems have occurred primarily on the west side of the study area in the Tahoe Island and Sky Meadows areas. In these areas, urban development occurred within the topographic floodplain, but before implementation of federal regulations that prohibit development or require specific flood protections in the 100-year floodplain. The installed street drainage infrastructure includes a sump pump system that discharges water into the Upper Truckee River. The system has been modified and updated over the years. Occasionally the system has failed, resulting in localized street flooding (Gibson, pers. comm., 2002; Rodgers, pers. comm., 1999; Conservancy and DGS 2003:8-7). Such problems can occur during intense thunderstorms, or when winter snow and ice impede drainage even if the river is not flooding. However, serious flooding in these neighborhoods is most often associated with major rain-on-snow events that also cause generalized flooding on the main floodplain.

FEMA Floodplain

The regulatory floodplain identified by FEMA is land temporarily inundated by water overflowing from an adjacent or nearby river or stream during the identified “base flood,” in this case the 100-year flood.

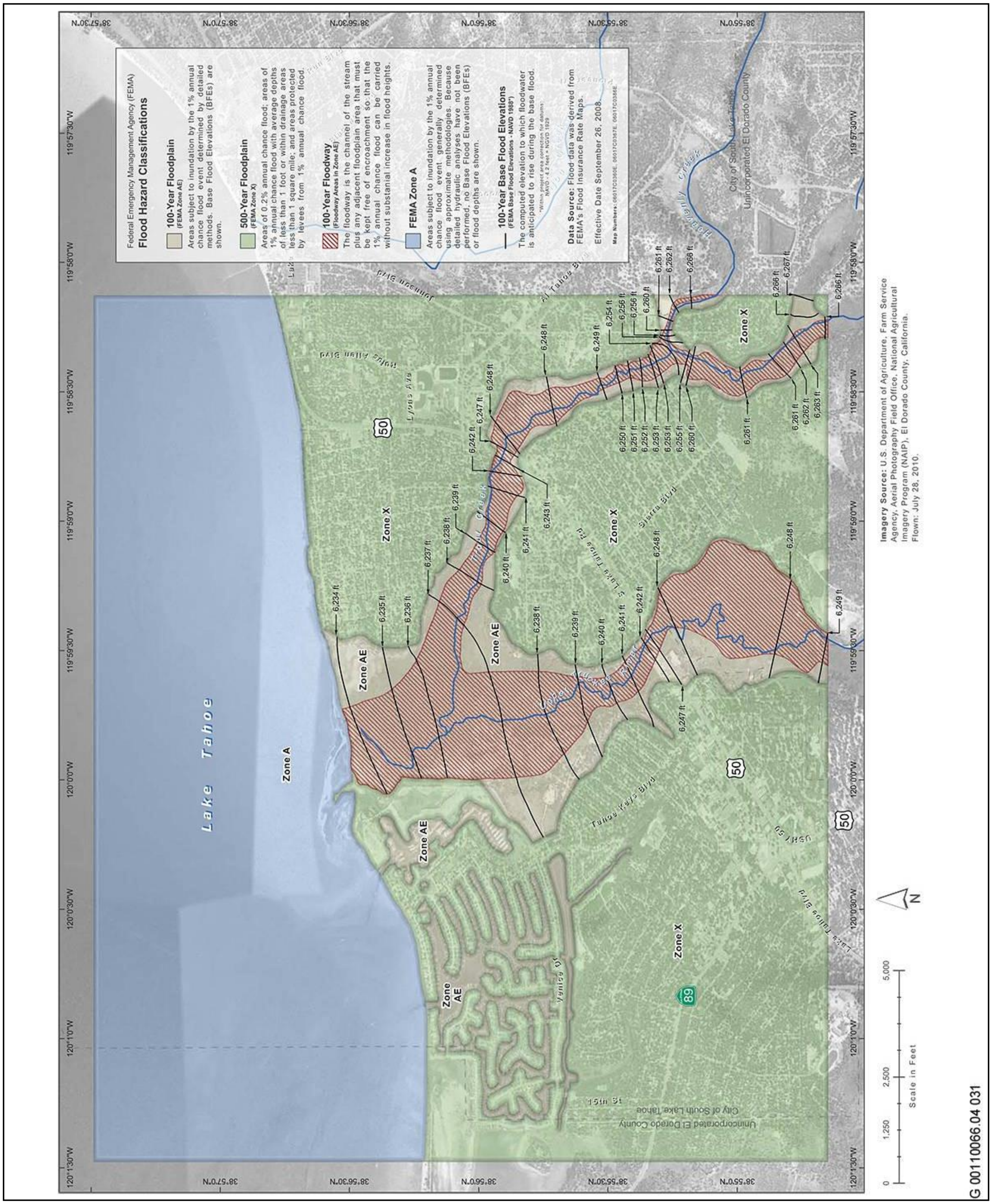
The regulatory floodplain consists of the floodway and margins of the floodplain, which are called the flood fringe. The floodway is where the water is likely to be deepest and fastest, and is considered the zone of highest flood hazard. As specifically defined by FEMA (44 Code of Federal Regulations [CFR] 59.1[d]), a floodway is the channel of a river or other watercourse, and the adjacent land areas, that must be reserved to convey and discharge floodwaters. This area within the floodplain should be kept free of all obstructions to allow floodwaters to flow freely downstream. Therefore, development in or modification of a floodway is usually prohibited. The flood fringe is a zone of floodwater storage where water moves slowly or is ponded during flooding. Development within the flood fringe is permitted by FEMA as long as the resulting water-surface profile of the 100-year flood is not increased by more than one foot at any location.

Floodplain Boundaries and Water Elevations

The boundaries of the 100-year floodplain and estimated water-surface elevations and floodway boundaries in the study area (Exhibit 3.8-14) are from FEMA’s 2008 Flood Insurance Rate Maps (FEMA 2008a, 2008b, 2008c). This regulatory floodplain is used by FEMA and CSLT in implementing floodplain development regulations. The mapping reflects revisions to the 1978 FIRM following land use changes in and around the study area, including improvements to the U.S. 50 bridges at the Upper Truckee River and Trout Creek crossings, additional urban development, record peak flood events, and restoration of the LWS Restoration Area. Additionally, a Letter of Map Revision (LOMR) was prepared in 2009 on the basis of updated topographic information for the Tahoe Keys and Lake Tallac area (FEMA 2009). The LOMR revised flood zone mapping in the northwest corner of the study area but did not revise the base flood elevations.

Nearly all of the study area is in the 100-year floodplain, except the uplands adjacent to the Highland Woods subdivision, between Cove East Beach and the Sailing Lagoon, and along the margins of the Tahoe Keys Marina (Exhibit 3.8-14). The Upper Truckee River and Trout Creek channels, adjacent areas, and the shared floodplain in the central meadow are the designated floodway. The FEMA base flood elevations in the Upper Truckee River marsh range from approximately 6,243 feet NGVD (6,247 feet NAVD [North American Vertical Datum], used by FEMA) at the U.S. 50 crossing, to approximately 6,230 feet NGVD (6,234 feet NAVD) near the mouth of the river.

Some residential areas adjacent to the study area (a couple of streets in Tahoe Island and some lots in Sky Meadows) are within the floodplain fringe west of the Upper Truckee River. A few lots in Al Tahoe (along El Dorado Avenue, Edgewood Circle, and Lilly Avenue) are along the edge of the regulatory floodplain east of Trout Creek (Exhibit 3.8-14).



Source: Conservancy and DGS 2003

Exhibit 3.8-14 **FEMA Floodplain Overlain on Aerial Map**

Flood Profiles for the Upper Truckee River

Hydraulic modeling has been performed for the study area to estimate flood boundaries and elevations, using the USACE Hydraulic Engineering Center's River Analysis System (HEC-RAS) model (Version 3.1.2) in combination with geographic information system (GIS) applications (ArcView and HEC-GeoRAS) (Conservancy 2003, Conservancy and DGS 2005).This modeling routed the large and assumed concurrent peak-flow hydrographs for both the Upper Truckee River and Trout Creek through the study area, and included the effects of changing floodplain storage on resulting water surface elevations. The worst-case analysis assumed a high lake level (6,229 feet). The modeled flood hydrographs spanned the 5-year to 100-year events, and thus covered the range of flows that are likely to be associated with flood hazards.

The flood model was calibrated using field markings in Sky Meadows and Colorado Court from the January 1997 event (Conservancy and DGS 2005:6-10, 6-11). Photographs, homeowners' recollections, and remaining flood debris/damage marks were used to field-survey water levels from the 1997 event. (The survey occurred in 2000.) Simulated water surface elevations were generated by model runs that used the range of estimated peak flow for the 1997 event. Comparison of the field-surveyed water surface data to the simulated elevations supported calibration of the model (Table 3.8-4).

Table 3.8-4
Surveyed and Simulated Water Surface Elevations for the January 1997 Flood

Location	Surveyed Elevation Range (feet)	Simulated Elevation Range (feet)*		
		At 5,560 cfs	At 6,560 cfs	At 7,500 cfs
Sky Meadows	6,236.80 to 6,237.02	6,236.44	6,236.78	6,237.08
Colorado Court	6,232.00 to 6,232.04	6,231.95	6,232.16	6,232.35

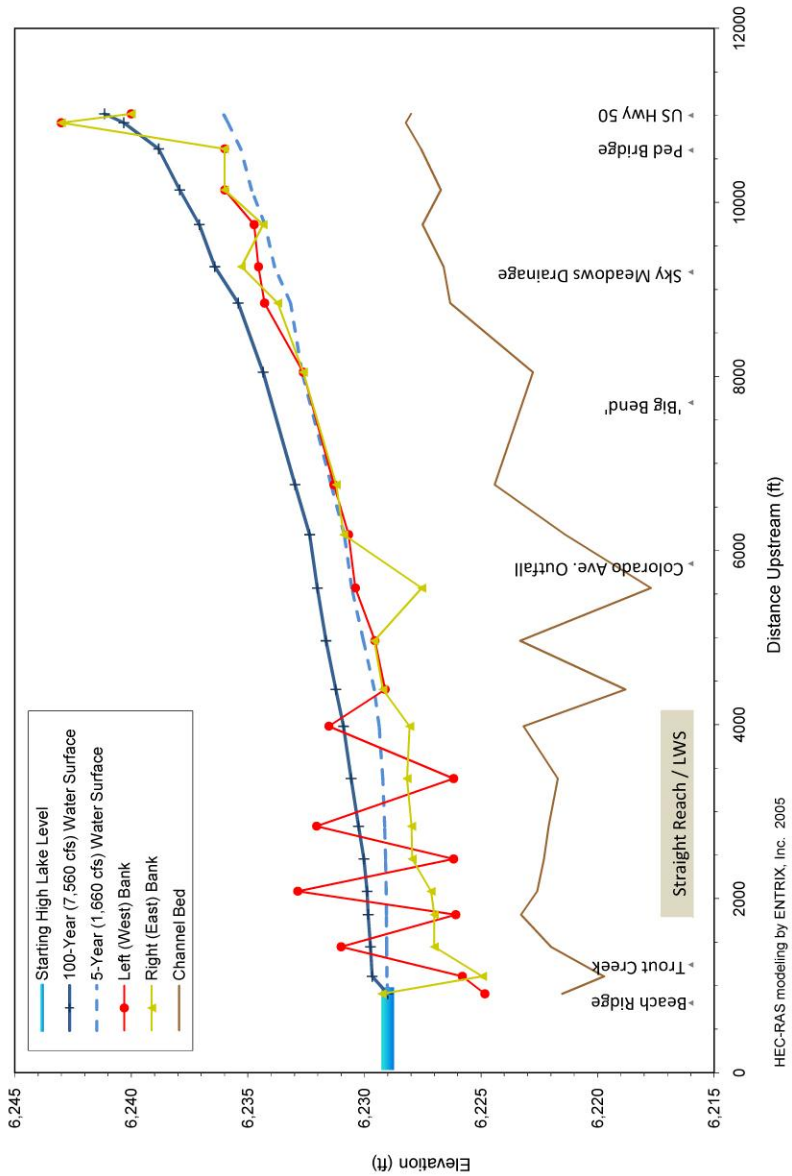
Notes: cfs = cubic feet per second
* Modeled three different peak flows for the range of estimated 1997 peak flows downstream of the U.S. Highway 50 bridge.
Source: Conservancy and DGS 2005

The calibrated results of the hydraulic modeling include profiles of the existing channel bed, banks, and floodwater surfaces of the Upper Truckee River (Exhibit 3.8-15). As discussed above, the channel's capacity is large enough to contain the 5-year event in the upstream portion of the study area between U.S. 50 and the "big bend." The 5-year floodwater surface is about equal to the bank heights from the "big bend" to just upstream of the Colorado Avenue outfall. Downstream of this area, the 5-year water surface is higher than the east bank and higher than the west bank in some short reaches, including the restored LWS wetland. As expected, the 100-year water surface elevation exceeds the bank heights throughout the project reach, with the exception of the reserved fill "islands" along the restored LWS wetlands.

Seismically Generated Waves

Seismic shaking during earthquakes can cause waves to form within open bodies of water. The two major types of seismically generated waves are tsunamis and seiches.

Tsunamis are waves generated by the displacement of a large volume of water and thus occur only in large water bodies such as oceans, bays, or large lakes. Displacements of water can be caused by several phenomena (including subaqueous landsliding or explosions), but the most common are submarine displacements of the earth's crust that result from earthquakes.



G 00110066.04 025

Source: Conservancy and DGS 2003; Valley & Mountain Consulting 2008

Exhibit 3.8-15 **Simulated Flood Profiles for the Upper Truckee River for the 5-Year and 100-Year Events**

A seiche is a wave that oscillates in a lake, bay, or gulf for a few minutes to a few hours as a result of seismic or atmospheric disturbances. Small seiches are almost always present on larger lakes; the frequency of the oscillation is determined by the size of the body, its depth and contours, and the water temperature. Larger seiches can be caused by nearby or distant earthquakes and occur when the wave signature of the seismic waves is resonant with the natural period (controlled by basin geometry) of the lake.

Recent investigations of the tectonic and seismic conditions within the Lake Tahoe region indicate the potential for moderate to large earthquakes that may generate strong to very strong seismic shaking in the study area. (See Section 3.6, "Geology and Soils, Mineral Resources, and Land Capability and Coverage.") The West Tahoe and North Tahoe–Incline Village Faults are considered active and capable of generating magnitude (M) 7 or greater earthquakes (Schweickert et al. 2004). Another important seismic source in the vicinity of the study area is the Genoa Fault. This fault, which forms the eastern boundary of the Carson Range, is considered capable of generating large earthquakes (M 7.2 to 7.5). The probability of an M 7 earthquake occurring within the next 50 years in the South Lake Tahoe area has been estimated by the Nevada Earthquake Safety Council to be between 10 and 12 percent (NESC 2007).

Occurrence of such seismic events may result in the formation of tsunamis within Lake Tahoe. The amplitudes (i.e., wave heights) of these seismically induced waves are expected to be on the order of 3–10 meters (10–30 feet). Additionally, the earthquakes may generate large seiches within the lake for hours after the events (Ichinose et al. 2000).

3.8.2 ENVIRONMENTAL CONSEQUENCES

SIGNIFICANCE CRITERIA

For this analysis, significance criteria are based on the checklist presented in Appendix G of the State CEQA Guidelines; the TRPA Initial Environmental Checklist; factual or scientific information and data; and regulatory standards of federal, state, and local agencies. Below are outlined the significance criteria for CEQA, NEPA, and TRPA. Each agency assigns significance to its criteria in different ways. For this document an impact is considered to be a physical change in the environment and is considered significant under TRPA and CEQA and adverse under NEPA, if the conditions described below would occur.

CEQA Criteria

Under CEQA, an alternative was determined to result in a significant effect related to hydrology if it would:

- substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of preexisting nearby wells would drop to a level that would not support existing land uses or planned uses for which permits have been granted) (CEQA 1);
- substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner that would result in substantial erosion or siltation on- or off-site (CEQA 2);
- substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site (CEQA 3);
- create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff (CEQA 4);

- place housing within a 100-year flood hazard area as mapped on a federal flood hazard boundary or FIRM or other flood hazard delineation map (CEQA 5);
- place within a 100-year flood hazard area structures that would impede or redirect flood flows (CEQA 6);
- expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam (CEQA 7); or
- expose people or structures to a significant risk of inundation by seiche, tsunami, or mudflow (CEQA 8).

NEPA Criteria

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by or result from the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. The factors that are taken into account under NEPA to determine the significance of an action in terms of the context and the intensity of its effects are encompassed by the CEQA criteria used for this analysis. NEPA requires documentation and discussion of any beneficial effects of a project in addition to its negative impacts. Where appropriate, these beneficial effects are discussed and called out specifically for the purposes of NEPA in the following impact analysis.

TRPA Criteria

Based on TRPA's Initial Environmental Checklist, an alternative would result in a significant impact for hydrology and flooding if it would result in any of the following:

- changes in currents, or the course or direction of water movements (TRPA 1);
- changes in absorption rates, drainage patterns, or the rate and amount of surface water runoff so that a 20-year, 1-hour storm runoff (approximately one inch per hour) cannot be contained on the site (TRPA 2);
- alterations to the course or flow of 100-year floodwaters (TRPA 3);
- change in the amount of surface water in any water body (TRPA 4);
- alteration of the direction or rate of flow of groundwater (TRPA 5);
- change in the quantity of groundwater, either through direct additions or withdrawals, or through interception of an aquifer by cuts or excavations (TRPA 6);
- substantial reduction in the amount of water otherwise available for public water supplies (TRPA 7); or
- exposure of people or property to water-related hazards such as flooding and/or wave action from 100-year storm occurrence or seiches (TRPA 8).

METHODS AND ASSUMPTIONS

The impact analysis examines the effects of each alternative in the short term and long term for each issue and topic listed above. Temporary effects are those that could occur over hours, days, or weeks during the active construction phase. Because the river system is expected to experience adjustments after construction, the analysis of temporary effects also looks at the potential for interim effects during construction or the first three–five years after construction (assuming that streamflows are at least average), or until the first moderately large flood event (approximately ten-year peak flow).

A combination of quantitative and qualitative methods was used in the impact analysis. The analysis was performed by a team of hydrologists/geomorphologists experienced in river restoration generally and the Tahoe Basin environment specifically. Information about the study area and vicinity and the analysts' professional experience on similar projects has been incorporated into the analysis of the river system's history, existing conditions, likely future conditions, and conditions expected under each action alternative. Groundwater dewatering impacts are described in Section 3.9, "Geomorphology and Water Quality."

The results of hydraulic modeling of the study area and the initial alternatives, completed by ENTRIX (2006), are incorporated into this impact analysis. These results provide information about water surface elevations, boundaries of the inundation area, flow depths, and average velocity, allowing a comparison between existing conditions and a restored-channel alternative.

The effects of climate change on future hydrology have been incorporated into the evaluation of the No-Project/No-Action Alternative (Alternative 5). However, even the most geographically and temporally focused available forecasts of climate change effects on hydrologic parameters (Tetra Tech 2007) are relatively variable and substantially uncertain. Therefore, the possible influences of various climate change scenarios, not just the core/central scenario, are considered in this analysis. Because of the degree of uncertainty and because the influences vary by scenario, the statements are expressed only in qualitative terms.

EFFECTS NOT DISCUSSED FURTHER IN THIS EIR/EIS/EIS

Placing Housing within a 100-Year Flood Hazard Area (CEQA 5)—The proposed alternatives would not place any new housing or buildings within the existing FEMA flood hazard area; therefore, no impact related to placing housing within a 100-year flood hazard area would occur. Other possible changes related to flooding hazards to existing housing are fully discussed below.

Failure of a Levee or Dam (CEQA 7, in part)—The study area is not within an identified dam-failure inundation zone or near any constructed levees; therefore, no flood hazard related to failure of a levee or dam would occur. Other possible changes related to flooding are fully discussed below.

Landslide or Mudflow Risks (CEQA 8, in part)—The study area is located within an area of relatively gentle topography within the alluvial valley of the Upper Truckee River. The potential for landslides or mudflows within this setting is low. Slope failures are restricted to small rotational slides or slumps along the river banks resulting from erosion processes.

Short-Term Dewatering of Surface Water Features (TRPA 4, in part)—Major construction activities would require temporary dewatering or bypassing of work areas along the Upper Truckee River, the Sailing Lagoon, and other surface water within the study area. Although these activities may result in temporary changes to the amount of water in the surface water features of the study area, they would not result in any long-term changes to surface water. Hydrologic effects would be less than significant. Temporary dewatering and water diversion effects on aquatic biological resources are discussed in Section 3.5, "Fisheries."

IMPACT ANALYSIS AND MITIGATION MEASURES

Alternative 1: Channel Aggradation and Narrowing (Maximum Recreation Infrastructure)

IMPACT 3.8-1 (Alt. 1)	**Increased Runoff Volumes and Peak Flows. (CEQA 3, 4; TRPA 1, 2)** *Implementing Alternative 1 would require construction of impervious surfaces at several discrete and dispersed locations within the study area for trails, viewpoints, observation areas, boardwalks, and kiosks. As described in Environmental Commitment 11, permanent stormwater detention features or infiltration systems and other BMPs would be incorporated into the final design to accommodate all 20-year, 1-hour storm runoff without erosion. This impact would be* ***less than significant****.*

New facilities constructed at several discrete and dispersed locations under Alternative 1—a parking lot, new trails, kiosks, viewpoints and observation areas, a boardwalk, and a pedestrian bridge—would include impervious or partially pervious surfaces. Constructing these features would incrementally and locally change runoff flow volumes and direction. However, implementing Alternative 1 would also involve conversion of existing impervious areas, including the Tahoe Keys Property Owners Association (TKPOA) Corporation Yard and its access road.

Changes in land coverage are analyzed in Impact 3.6-3 (Alt. 1) in Section 3.6, "Geology and Soils, Mineral Resources, and Land Capability and Coverage." As stated in Impact 3.6-3 (Alt. 1), the proposed coverage is less than the allowable coverage in the study area. For areas outside the litigation parcels coverage relocation would be completed at a 1:1 ratio, as allowed for this type of project by the TRPA Code. The hydrologic changes resulting from construction of impervious coverage would be minimized.

Construction under Alternative 1 would modify the type of impervious surfaces on portions of the site from soft coverage (compacted soil) to hard coverage (e.g., asphalt, boardwalks). However, if permanent BMPs were installed for the proposed facilities, the 20-year, 1-hour storm runoff from these locations could still be contained. Compliance with stormwater regulations would require BMPs, but Alternative 1 does not specify the design or location of BMPs for the proposed facilities. Therefore, runoff volumes and peak flows could change incrementally on portions of the site.

However, implementing Environmental Commitment (EC) 11, "Incorporate Effective Permanent Stormwater Best Management Practices," described in Table 2-6 in Chapter 2, would ensure that the final project design would include stormwater detention features or infiltration systems for runoff from areas of proposed impervious surfaces (i.e., pavement, buildings, laid stone, bridge deck). These detention or infiltration facilities would be sized to accommodate all 20-year, 1-hour storm runoff from each developed portion of the site. In addition, the final design of partially impervious surfaces (i.e., trails, boardwalks) would incorporate materials and methods to minimize changes to existing infiltration capacity. The detention or infiltration facilities and the partially impervious surfaces would include features to convey runoff safely to discharge points without erosion, and they would be maintained over the life of the project. These measures would reduce the effect of the incremental increase in runoff that may result from constructing impervious surfaces. This impact would be **less than significant**.

IMPACT 3.8-2 (Alt. 1)	**Effects on Channels from Reconfiguration of Stream Channels and Lagoon Surface Water Features. (NEPA)** *Implementing Alternative 1 would move portions of the Upper Truckee River channel, reconnect the Sailing Lagoon with the river, and reconstruct the East Barton Lagoon, which would reconfigure the study area's drainage patterns. The change to drainage patterns would reestablish the site's naturally occurring surface water features and hydrologic/hydraulic processes. This impact would be **beneficial**.*

Implementing Alternative 1 would involve directly modifying surface water features in the study area to counteract and/or compensate for past actions and the degraded existing condition. These modifications would include reconfiguring two lagoons to restore natural hydrologic function in both lagoon areas. In addition, constructing new channel features would increase floodplain connectivity and improve floodplain processes. Relocating the low-flow channel would affect internal drainage patterns on this portion of the site, but would not substantially affect off-site drainage patterns or the quantity of water in surface water features.

The relocation of the river's low-flow channel sections that would occur under Alternative 1 is within the range of historic locations on-site, and the changes to drainage patterns would not affect off-site drainage or the amount of water in any surface water body. Reconnecting the Sailing Lagoon to the river and reconstructing the East Barton Lagoon would reestablish surface water features and drainage patterns in the study area that occurred historically and would not adversely affect off-site drainage or the amount of water in any off-site water bodies. Therefore, this impact would be **beneficial**.

IMPACT 3.8-3 (Alt. 1) **Modified 100-Year Flood Flow Directions or Floodplain Boundaries. (CEQA 7; TRPA 3, 8)** *Implementing Alternative 1 would decrease the channel capacity, raise the streambed elevation, lower the streambank heights and lengthen the channel, but would also enlarge floodplain storage because fill would be excavated in some areas of the FEMA regulatory floodway or floodplain. As a net result, the boundaries and depth of flooding in the 100-year flood hazard area would not increase in the study area. However, constructing the bridge and boardwalk across the river and marsh could locally obstruct flood flow and increase flood levels and flood hazards. The final design of the bridge and boardwalk would be determined through iterative modeling and review by multiple agencies to ensure that the extent or elevation of the 100-year special flood hazard area as designated by FEMA would not be adversely modified. This impact would be* ***less than significant****.*

Implementing Alternative 1 would decrease the low-flow channel capacity, directly raise the streambed elevation, lower streambank heights, and increase the length of the Upper Truckee River channel in the study area to beneficially increase the frequency and extent of overbanking onto the floodplain under low to moderate flood events (i.e., 2-year and 5-year events). Proposed changes include constructing grade control structures to promote bed aggradation, constructing geomorphically sized channels, and enlarging floodplain storage by removing fill (approximately 23,000 cubic yards).

A hydraulic analysis of the study area was conducted to estimate potential changes in floodwater surface elevations, flows, and floodplain boundaries for the 100-year flood under Alternatives 1, 2, 3, and 4 (Conservancy and DGS 2005). The results of the modeling indicate that the water surface elevation for the 100-year event under Alternative 1 would be the same as or lower than the existing 100-year water surface (labeled as 'original' in the graphic). Based on existing topography at the floodplain margins, increased flood storage created by Alternative 1 would generally reduce the width of the flood area of the 100-year flood fringe. The proposed restoration efforts described above would not raise floodwater surfaces for the 100-year flood event within the study area, nor would they increase flood hazards in the surrounding area.

However, the proposed bridge upstream of the mouth of the Upper Truckee River (River Station [RS] 10+00) and the raised boardwalk across the marsh were not evaluated in the hydraulic modeling. Bridge footings and abutments and boardwalk supports could potentially obstruct flow, causing incremental increases in flood elevation. The designated floodway in the study area includes broad areas of the lower marsh, as well as the channels of the Upper Truckee River and Trout Creek (Exhibit 3.8-14). The elements of the final design of the proposed bridge and boardwalk would ensure that these structures would not obstruct flood flows, to the degree that any effective increase in the elevation of the 100-year event would occur in the study area. The final design would be supported by a hydraulic analysis that would evaluate the potential for substantial changes to flooding hazards and littoral processes. Design elements (e.g., deck height, locations of bridge or boardwalk supports, and cross-sectional areas of those supports) would be adjusted to ensure that flow capacity through the structures would be sufficient to pass the 100-year event without increasing the effective flood elevation. The final design would be submitted to CSLT for review and approval. Therefore, this impact would be **less than significant**.

IMPACT 3.8-4 (Alt. 1) **Increased Overbank Flooding for Small Streamflow Events. (NEPA)** *Implementing Alternative 1 would decrease the channel capacity, raise the streambed elevation, and lower the streambank heights to enlarge the area of overbank flooding for small (760-cfs) streamflow events within the study area by about 11 acres. This effect would reestablish natural connections between the low-flow channel and the floodplain/marsh surface. This impact would be* ***beneficial****.*

The design of Alternative 1 provides for increased overbank flows during relatively frequent, small flood events (i.e., the 2-year event). Implementing Alternative 1 would decrease the Upper Truckee River's channel capacity, raise the bed elevation, lower bank heights, and increase the length of the channel, thus enlarging the portion of the study area inundated under the existing 2-year return interval flow (e.g., 760 cfs). The existing area of inundation during a 2-year event is about 64 acres (see Table 3.8-5); the channel and floodplain modifications proposed by Alternative 1 would increase this area to about 74 acres. The increase in inundation is proposed to improve the connectivity of the floodplain and marsh surface to the river channel. More frequent and expanded inundation would benefit riparian and marsh wildlife habitat and vegetation. The expanded inundation area would not include any existing or proposed structures.

Table 3.8-5
Comparison of Floodplain Area Inundated during 2-year Flow Event

Existing Conditions	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
64 acres	74 acres	126 acres	156 acres	82 acres	64 acres

Source: Conservancy and DGS 2005

In the long term, the watershed's response to climate change could reduce typical streamflows and the magnitude of the peak streamflow expected frequently (i.e., every couple of years). Implementing Alternative 1 would improve overbanking at specific streamflow magnitudes, but watershed hydrology shifts caused by climate change might reduce the frequency with which those flows would occur. The uncertain but possible hydrologic effects of climate change could partially offset the benefits of Alternative 1. Still, Alternative 1 would reestablish natural hydrologic/hydraulic processes and result in an improvement relative to existing conditions. Therefore, this impact would be **beneficial**.

IMPACT 3.8-5 (Alt. 1) **Modified Groundwater Levels and Flow Patterns. (NEPA)** *Implementing Alternative 1 would modify the size, shape, and location of the Upper Truckee River and change the surface connections and subsurface conditions around the channels and lagoons, which could change groundwater levels and flow patterns. This effect would partially counteract the historic effects on groundwater levels and flow patterns on the west side of the study area caused by dredging of the Tahoe Keys waterways. This impact would be* ***beneficial****.*

Implementing Alternative 1 would involve directly raising channel bed elevations and backfilling existing incised channels, which would allow for higher groundwater levels and better groundwater continuity across the study area. In addition, the stream channels would be modified to increase overbank flows across the floodplain, which would enhance opportunities for groundwater recharge within the study area. These actions would not directly counteract the historic effects on groundwater levels and flow patterns on the west side of the study area caused by dredging of the Tahoe Keys waterways, which would remain in place. However, the actions would restore groundwater storage opportunities and flow patterns previously altered by dredging and straightening of the Upper Truckee River channel and by the river's geomorphic adjustments to watershed disturbances (i.e., incision and widening).

Alternative 1 would keep the active Upper Truckee River channel close to the existing alignment, near the previously dredged waterways of the Tahoe Keys. Implementing this alternative would not effectively change the groundwater loss that occurs toward those artificial channels during low lake stands under existing conditions. This would result in an improvement relative to existing conditions. Therefore, this impact would be **beneficial**.

IMPACT 3.8-6 (Alt. 1) **Exposure to Seismically Generated Wave Hazards. (CEQA 8, TRPA 8)** *Alternative 1 proposes recreation improvements within the study area that could be damaged by seismically generated waves that could develop in Lake Tahoe. The most important hazard would be presented by a tsunami caused by a large local earthquake, rather than by seiche waves of varied sources. The potential for exposure of people or structures to the effects of a tsunami would be low. This impact would be* ***less than significant****.*

Alternative 1 proposes the development of recreational facilities within and at the margins of the Upper Truckee Marsh. The area is adjacent and graded to Lake Tahoe. The topography throughout the study area is relatively flat to gently sloping. The results of recent evaluations of seismic hazards indicate that faults within or near the Tahoe

Basin are capable of generating large earthquakes (NESC 2007). The occurrence of such earthquakes could result in the development of tsunamis with amplitudes of 10–30 feet (Ichinose 2000). A tsunami could also be generated in Lake Tahoe if a large landslide were to occur within or adjacent to the lake.

No accurate estimates are available to indicate the probability of a tsunami or the tsunami runup height at the study area. However, if a tsunami of this magnitude were to occur, it would likely overtop the barrier beach berm along the northern margin of the site and inundate much of the study area. The improvements most vulnerable to damage by a tsunami are the boardwalk proposed for the northern margin, the foot bridge over the river channel, the restored Sailing Lagoon, and the dune restoration area at Cove East Beach. Most other improvements would be inundated and may be damaged by only the largest of the estimated range of tsunamis. Visitors at the study area could be injured during inundation by a tsunami.

A variety of conditions, including nearby and distant earthquakes, could result in the development of seiches in Lake Tahoe. The amplitude (size) of possible seiches would vary, but no condition would be expected to generate seiches of the size of estimated tsunamis, as described above. Alternative 1 does not propose the construction of structures for human occupation, limiting the duration of potential human exposure to tsunami risks.

Project components would be constructed in an area that already supports urban development and recreational facilities, including residential housing and a marina, and users of the public-access facilities are expected to be people who already reside or recreate in the Tahoe Basin. Therefore, constructing the proposed improvements would not expose additional people to tsunami hazards. Furthermore, there is no way of knowing whether a tsunami with enough force to damage project improvements or to present a safety hazard to recreational users would ever be generated during the lifetime of the project facilities. The potential damage to the improvements (i.e., flooding and erosion) could be repaired. Because of the low probability of a tsunami occurring in Lake Tahoe, the relatively low human use of the study area, and the reparability of expected damage, this impact would be **less than significant**.

Alternative 2: New Channel—West Meadow (Minimum Recreation Infrastructure)

IMPACT 3.8-1 (Alt. 2)

Increased Runoff Volumes and Peak Flows. (CEQA 3, 4; TRPA 1, 2) *Implementing Alternative 2 would require construction of impervious surfaces at several discrete and dispersed locations within the study area for trails, fishing access areas, and viewpoints. As described in Environmental Commitment 11, permanent stormwater detention features or infiltration systems and other BMPs would be incorporated into the final design to accommodate all 20-year, 1-hour storm runoff without erosion. This impact would be* ***less than significant****.*

This impact would be similar to Impact 3.8-1 (Alt. 1) but of smaller extent and magnitude, as described below. Implementing Alternative 2 would require construction of impervious surfaces at several discrete and dispersed locations within the study area for new trails, fishing access areas, and viewpoints. However, construction of these surfaces would be offset by the restoration of existing trails and removal of impervious cover and compacted fill within the TKPOA Corporation Yard.

Changes in land coverage are analyzed in Impact 3.6-3 (Alt. 2) in Section 3.6, “Geology and Soils, Mineral Resources, and Land Capability and Coverage.” As stated in Impact 3.6-3 (Alt. 2), the proposed coverage is less than the allowable coverage in the study area. For areas outside the litigation parcels coverage relocation would be completed at a 1:1 ratio and therefore would comply with the TRPA Code.

The features of Alternative 2 would increase the volume of runoff generated within portions of the study area and would locally redirect or increase peak flows. These runoff changes would occur in only small portions of the study area, and it is unlikely that increased flow volumes and peaks would be released off-site (e.g., into the storm drainage system and ultimately into Lake Tahoe).

As described for Alternative 1, EC 11 (Table 2-6) would be implemented. This environmental commitment would involve installing permanent BMPs, stormwater detention features, or infiltration systems that would convey runoff safely to discharge points and would be maintained over the life of the project. These measures would reduce the effect of the incremental increase in runoff that may result from constructing impervious surfaces as part of Alternative 2. This impact would be **less than significant**.

IMPACT 3.8-2 (Alt. 2) **Effects on Channels from Reconfiguration of Stream Channels and Lagoon Surface Water Features. (NEPA)** *Implementing Alternative 2 would move portions of the Upper Truckee River channel, reconnect the Sailing Lagoon with the river, and reconstruct the East Barton Lagoon, which would reconfigure the study area's drainage patterns. The change to drainage patterns would reestablish the site's naturally occurring surface water features and hydrologic/hydraulic processes. This impact would be* ***beneficial****.*

Implementing Alternative 2 would involve directly modifying surface water features in the study area to counteract and/or compensate for past actions and the degraded existing condition. Alternative 2 would also make the same changes to the surface water lagoons as Alternative 1 (see Impact 3.8-2 [Alt. 1]).

In addition, new channel features would be constructed and some of the existing floodplain areas would be modified to conditions similar to those that existed historically in portions of the site. These measures would improve the degraded surface water functions and values by restoring floodplain processes to large areas of the existing terrace surface.

Alternative 2 would also involve constructing about 8,420 feet of sinuous single-thread channel to replace the degraded existing channel (between RS 21+00 and RS 96+00) and the straightened reach adjacent to the LWS Wetlands Restoration Project area. This would move the low-flow channel up to 500 feet to the west of its existing location between RS 21+00 and 39+00, and up to 500 feet to the east between RS 39 +00 and 96+00. However, these relocations would still be within the range of location(s) of the positions of historically active low-flow channel(s). Relocating the low-flow channel would affect internal drainage patterns on this portion of the site, but would not affect off-site drainage patterns or the quantity of water in surface water features.

Also, Alternative 2 would involve reconfiguring the previously dredged mouth of the Upper Truckee River by constructing approximately 400 feet of new channel downstream of RS 96+00 and a new, smaller, higher elevation mouth. This would move the low-flow channel and river mouth as much as 200 feet west of its existing location, although it would still be within the range of location(s) of the historically active low-flow channel(s) and mouth. Relocating the low-flow channel would affect internal drainage patterns on this portion of the site, but would not affect off-site drainage patterns or the quantity of water in surface water features.

Relocating the river mouth under this alternative would modify the drainage patterns along the beach ridge and lake shoreline because it would move the river's discharge point to the new location. At times when the lake level is between the median elevation (6,226 feet NGVD) and existing river-mouth elevation (6,222 feet NGVD), the relocated, higher-elevation river mouth would discharge less water from the river to Lake Tahoe. The amount of river water discharged to the lake would not change when the lake level is below the existing river mouth or above the median elevation. The modified river mouth would retain proportionally more surface water within the lagoon and marsh system during moderately low lake level conditions (median to low) than under the existing dredged-mouth condition. Although these drainage patterns differ from the existing condition, they are within the range of historic conditions and would be typical of a river mouth within a naturally functioning barrier beach system. The proposed reduction of the capacity and elevation of the river mouth and improved water quality (i.e., reduction of transport of fine sediment to the littoral zone) would generally improve littoral processes by returning the river-lake conditions to a more natural configuration.

Alternative 2 would reestablish the same connection between the Sailing Lagoon and the Upper Truckee River near the river mouth as Alternative 1. Alternative 2 would also result in reconstruction of a back-beach lagoon behind East Barton Beach as described for Alternative 1.

Relocation of the river's low-flow channel sections as described above would present conditions falling within the range of historic conditions on-site. The changes to drainage patterns would not affect off-site drainage or the amount of water in any surface water body. Reconnecting the Sailing Lagoon to the river and reconstructing the East Barton Lagoon would reestablish surface water features and drainage patterns in the study area that occurred historically and would not adversely affect off-site drainage or the amount of water in any off-site water bodies. Therefore, this impact would be **beneficial**.

IMPACT 3.8-3 (Alt. 2)	**Modified 100-Year Flood Flow Directions or Floodplain Boundaries. (CEQA 7; TRPA 3, 8)** *Implementing Alternative 2 would decrease the channel capacity, raise the streambed elevation, lower the streambank heights, and modify flow routes, but would enlarge floodplain storage because fill would be excavated in some areas within the FEMA regulatory floodway or floodplain. As a net result, the extent or elevation of the 100-year special flood hazard area as designated by FEMA would not be adversely modified. This impact would be **less than significant**.*

Implementing Alternative 2 would decrease the low-flow channel capacity, directly raise the streambed elevation, lower streambank elevations and increase the length of the Upper Truckee River channel in the study area. Proposed actions that would decrease existing floodplain storage would include filling abandoned channels and reducing the mouth of the river. These losses in floodplain storage would be offset by other actions proposed by Alternative 2, including creating areas of lowered floodplain along some of the new channels and removing fill at the LWS Restoration Area and the TKPOA Corporation Yard and behind East Barton Beach. This alternative would also reconnect the Sailing Lagoon to Upper Truckee River flows.

A hydraulic analysis of the study area was conducted to estimate potential changes in floodwater surface elevations, flows, and floodplain boundaries for the 100-year flood under Alternative 2 (Conservancy and DGS 2005). The results of the modeling indicate that the water surface elevation for the 100-year event (7,650 cfs) under Alternative 2 would generally be the same as or lower than the existing 100-year water surface within the study area, nor would the flood boundary enlarge or flood hazards increase in the surrounding area. Therefore, this impact would be **less than significant**.

IMPACT 3.8-4 (Alt. 2)	**Increased Overbank Flooding for Small Streamflow Events. (NEPA)** *Implementing Alternative 2 would decrease the channel capacity, raise the streambed elevation, and lower the streambank heights to enlarge the area of overbank flooding for small (760-cfs) streamflow events within the study area by 61 acres. This effect would reestablish natural connections between the low-flow channel and the floodplain/marsh surface. This impact would be **beneficial**.*

Implementing Alternative 2 would decrease the Upper Truckee River's channel capacity, raise the bed elevation, lower the streambank heights, and increase the length of the channel, thus enlarging the portion of the study area inundated under the existing 2-year return interval flow (e.g., 760 cfs) (Table 3.8-5). However, the watershed's response to climate change could reduce typical streamflows and the magnitude of the peak streamflow expected frequently (i.e., every couple of years). Implementing Alternative 2 would improve overbanking at specific streamflow magnitudes, but watershed hydrology shifts caused by climate change might reduce the frequency with which those flows would occur. The uncertain but possible hydrologic effects of climate change could partially offset the benefits of Alternative 2. Still, the channel modifications would improve connections between the low-flow channel and the floodplain and marsh surface, reestablishing natural hydrologic/hydraulic processes, which would result in a substantial improvement relative to existing conditions. Therefore, this impact would be **beneficial**.

IMPACT 3.8-5 (Alt. 2) **Modified Groundwater Levels and Flow Patterns. (NEPA)** *Implementing Alternative 2 would modify the size, shape, and location of the Upper Truckee River and change the surface connections and subsurface conditions around the channels and lagoons, which could change groundwater levels and flow patterns. This effect would partially counteract the historic effects on groundwater levels and flow patterns on the west side of the study area caused by dredging of the Tahoe Keys waterways. This impact would be* ***beneficial***.

Implementing Alternative 2 would involve directly raising channel bed elevations and backfilling existing incised channels. These actions would be similar to but more extensive than actions that would occur under Alternative 1. Also like Alternative 1, this alternative would additionally involve modifying the stream channels to increase overbank flows across the floodplain, but the modification would be more extensive than under Alternative 1. These actions would not directly counteract the effects on groundwater levels and flow patterns on the west side of the study area caused by dredging of the Tahoe Keys waterways, which would remain in place. However, the actions would restore groundwater storage opportunities and flow patterns previously altered by dredging and straightening of the Upper Truckee River channel and by the river's geomorphic adjustments to watershed disturbances (i.e., incision and widening).

Alternative 2 would keep the active Upper Truckee River channel close to the existing alignment, near the previously dredged waterways of the Tahoe Keys. Implementing this alternative would not worsen the groundwater loss that occurs toward those artificial channels during low lake stands under existing conditions. This would result in an improvement relative to existing conditions. This impact would be **beneficial**.

IMPACT 3.8-6 (Alt. 2) **Exposure to Seismically Generated Wave Hazards. (CEQA 8, TRPA 8)** *Alternative 2 proposes improvements within the study area that could be damaged by seismically generated waves that could develop in Lake Tahoe. The most important hazard would be presented by a tsunami caused by a large local earthquake, rather than by seiche waves of varied sources. The potential for exposure of people or structures to the effects of a tsunami would be low. This impact would be* ***less than significant***.

Alternative 2 proposes the development of recreational facilities within and at the margins of the Upper Truckee Marsh. The area is adjacent and graded to Lake Tahoe and is exposed to inundation when large waves develop on the lake, as described above in Impact 3.8-6 (Alt. 1). The proposed improvements most vulnerable to damage by a tsunami are the reclaimed Sailing Lagoon and the dune restoration area (and facilities) at Cove East Beach. Because of the low probability of a tsunami occurring in Lake Tahoe, the relatively low human use of the study area (i.e., no proposed structures for human occupation), and the reparability of expected damage, this impact would be **less than significant**.

Alternative 3: Middle Marsh Corridor (Moderate Recreation Infrastructure)

IMPACT 3.8-1 (Alt. 3) **Increased Runoff Volumes and Peak Flows. (CEQA 3, 4; TRPA 1, 2)** *Implementing Alternative 3 would require construction of impervious surfaces at several discrete and dispersed locations within the study area for trails, viewpoints, observation areas, fishing access areas, boardwalks, and a kiosk and would incrementally modify the drainage pattern. As described in Environmental Commitment 11, permanent stormwater detention features or infiltration systems and other BMPs would be incorporated into the final design to accommodate all 20-year, 1-hour storm runoff without erosion. This impact would be* ***less than significant***.

This impact would be similar to Impact 3.8-1 (Alt. 1), but of smaller extent and magnitude. Under Alternative 3, new foot and bike trails, six viewpoints, one observation area, a fishing access area, and a kiosk would create new impervious areas. However, Alternative 3 would also include activities and features that would decrease the volume of runoff or peak flows generated within portions of the study area, including restoration of existing trails and the TKPOA Corporation Yard and its access road.

Changes in land coverage are analyzed in Impact 3.6-3 (Alt. 3) in Section 3.6, "Geology and Soils, Mineral Resources, and Land Capability and Coverage." As stated in Impact 3.6-3 (Alt. 3), the proposed coverage is less than the allowable coverage in the study area. For areas outside the litigation parcels coverage relocation would be completed at a 1:1 ratio and therefore would comply with the TRPA Code.

The features of Alternative 3 could increase the volume of runoff generated within portions of the study area and could locally redirect or increase peak flows. These runoff changes would occur only in portions of the study area, but increased flow volumes and peaks could be released off-site (e.g., into the storm drainage system and ultimately into Lake Tahoe).

As described for Alternative 1, EC 11 (Table 2-6) would be implemented. This environmental commitment would involve installing permanent BMPs, stormwater detention features, or infiltration systems that would convey runoff safely to discharge points and would be maintained over the life of the project. These measures would reduce the effect of the incremental increase in runoff that may result from constructing impervious surfaces as part of Alternative 3. This impact would be **less than significant**.

IMPACT 3.8-2 (Alt. 3) **Effects on Channels from Reconfiguration of Stream Channels and Lagoon Surface Water Features. (CEQA 2; TRPA 1, 4)** *Implementing Alternative 3 would move portions of the Upper Truckee River channel and reconnect the Sailing Lagoon with the river, which would reconfigure the study area's drainage patterns to have both the river and Trout Creek flows in the middle of the marsh. The change to drainage patterns would reestablish the site's naturally occurring surface water features and hydrologic/hydraulic processes, and the project design would incorporate measures to protect the lower reach of Trout Creek from local erosive effects of increased flow. However, adjustments to the river mouth locations and duration of active flow through the beach may change the size of the Trout Creek lagoon and/or beach opening. Still, the changes would be within the range of natural conditions. This impact would be* ***less than significant****.*

Implementing Alternative 3 would involve directly modifying surface water features in the study area to counteract and/or compensate for past actions and the degraded existing condition. Alternative 3 would connect the main channel with the network of small remnant channel sections in the center of the study area through two direct measures.

First, the approximately 1,910-foot-long eastside channel of the Upper Truckee River channel between RS 17+00 and RS 29+00 would be reestablished as the low-flow channel to create a longer, more sinuous channel. This would move the low-flow channel as much as 200 feet to the east of its existing location, although the low-flow channel would still be within the range of location(s) of the historically active low-flow channel(s). Second, a single-thread pilot channel would be constructed, extending from RS 29+00 about 1,500 feet into the middle of the study area. This would move the low-flow channel as much as 400 feet to the east of its existing location, although the pilot channel would still be within the range of location(s) of the historically active low-flow channel(s).

Alternative 3 would also involve replacing the degraded existing channel and the straightened reach adjacent to the LWS Wetlands Restoration Project area between RS 28+00 and RS 96+00 with the reoccupied channel(s) in the middle of the study area. However, the design and construction would not dictate the location of the river's low-flow channel(s) through the middle of the marsh, because several existing topographic lows and channel fragments might be reoccupied by the river over time. Natural processes would determine the eventual location of the channel(s) downstream of the pilot channel. This could move the low-flow channel as much as 1,700 feet to the east of its existing location between RS 39 +00 and RS 96+00.

Also, Alternative 3 would involve modifying the previously dredged mouth of the Upper Truckee River by constructing a hardened grade control at RS 99+00 with a minimum elevation of 6,222.0 feet NGVD and installing biotechnical measures (e.g., willow stakings) to narrow the channel and to encourage sediment deposition. This would not relocate the existing river mouth, but would reinforce its existing vertical and lateral position. The proposed changes to the river mouth under Alternative 3 would not be expected to change drainage patterns. Alternative 3 (as with Alternatives 1 and 2) would also reestablish the same hydrologic connection between the Sailing Lagoon and the Upper Truckee River near the river mouth.

The relocations of the river's low-flow channel sections described above are within the range of historic locations on-site, but constitute a major change relative to conditions that have existed for more than 90 years. Reconnecting the Sailing Lagoon to the river would reestablish surface water features and drainage patterns within the study area that occurred historically and would not adversely affect off-site drainage or the amount of water in any off-site water bodies. The changes to the drainage pattern in the middle of the marsh, though confined to locations within the study area, would increase the amount of water in the downstream reaches of Trout Creek and its lagoon. They also could potentially affect the location or frequency of discharge from Trout Creek to the lake through the barrier beach. These effects could modify the hydraulics of the Trout Creek lagoon and flow directions along the local shore, and could indirectly affect beach erosion or beach habitat.

Redirecting the low-flow channel(s) to the middle of the study area under Alternative 3 would increase flows in the downstream reach of Trout Creek. The relative increase in flows would be largest for low and moderate events, but increases would occur even during large events. For some flow events, more surface water could be conveyed to the Trout Creek lagoon and more flow could be directed at the Trout Creek portion of the barrier beach than under existing conditions. Although this condition would still be within the range of conditions that may have existed naturally, it would be a major change relative to conditions that have existed for at least 90 years. This would alter the amount of surface water within portions of the study area, although it would not alter the amount of water discharged from the study area to Lake Tahoe. It could alter the hydraulic forces on the portion of the beach ridge along the Trout Creek lagoon during moderate flood events.

Alternative 4 would involve constructing channel stabilization on Trout Creek (RS 66+00 to RS 95+00) and a lateral grade control structure at the existing confluence of Trout Creek and the Upper Truckee River (RS 96+00) in anticipation of possible increased flows. The design would be vertically stable up to the 100-year peak flows, assuming combined peaks of Trout Creek and the Upper Truckee River, and the bank stabilization would be designed to be stable up to the 25-year peak flows.

Therefore, although permanent changes to drainage patterns and surface water features could occur, the long-term reconfigurations after implementation of Alternative 3 would be within the range of previously occurring natural patterns. This impact would be **less than significant**.

IMPACT 3.8-3 (Alt. 3)	**Modified 100-Year Flood Flow Directions or Floodplain Boundaries. (CEQA 7; TRPA 3, 8)** *Implementing Alternative 3 would decrease the channel capacity, raise the streambed elevation, lower the streambank heights, and modify flow routes (adding and reconnecting channel length), but would enlarge floodplain storage because fill would be excavated in some areas within the FEMA regulatory floodway or floodplain. As a net result, the extent or elevation of the 100-flood hazard area as designated by FEMA would not be adversely modified. This impact would be* ***less than significant****.*

Implementing Alternative 3 would decrease the low-flow channel capacity, directly raise the streambed elevation, and increase the length of the Upper Truckee River channel in the study area through both active and passive restoration. Under the alternative, about 3,300 feet of new, geomorphically sized channel would be constructed and 1,500 feet of existing secondary channel would be reshaped, creating new floodplain storage. Also, additional storage would be added by creating lowered floodplains along segments of the new and existing low-flow channel and removing fill at the LWS Restoration Area and the TKPOA Corporation Yard. However, backfilling abandoned channels would decrease storage.

A hydraulic analysis of the study area was conducted to estimate potential changes in floodwater surface elevations, flows, and floodplain boundaries for the 100-year flood under Alternative 3 Conservancy and DGS 2005. The results of the modeling indicate that the water surface elevation for the 100-year event (7,650 cfs) under Alternative 3 would be the same as or lower than the existing 100-year water surface at most cross sections. These changes would not be associated with any expansion of the 100-year flood hazard zone and would not cause inundation of any existing structures during the 100-year event. Therefore, this impact would be **less than significant**.

IMPACT 3.8-4 (Alt. 3) **Increased Overbank Flooding for Small Streamflow Events. (NEPA)** *Implementing Alternative 3 would decrease the channel capacity, raise the streambed elevation, and lower the streambank heights to enlarge the area of overbank flooding for small (760-cfs) streamflow events within the study area by 91 acres. This effect would reestablish natural connections between the low-flow channel and the floodplain/marsh surface. This impact would be* ***beneficial****.*

Implementing Alternative 3 would decrease the Upper Truckee River's channel capacity, increase the length of the channel, and enlarge the portion of the study area inundated under the existing 2-year return interval flow (e.g., 760 cfs) (Table 3.8-5). However, the watershed's response to climate change could reduce typical streamflows and the magnitude of the peak streamflow expected frequently (i.e., every couple of years). Implementing Alternative 3 would improve overbanking at specific streamflow magnitudes, but watershed hydrology shifts caused by climate change might reduce the frequency with which those flows would occur. The uncertain but possible hydrologic effects of climate change could partially offset the benefits of Alternative 3. Still, the channel modifications would improve connections between the low-flow channel and the floodplain and marsh surface, reestablishing natural hydrologic/hydraulic processes, which would result in a substantial improvement relative to existing conditions. Therefore, this impact would be **beneficial**.

IMPACT 3.8-5 (Alt. 3) **Modified Groundwater Levels and Flow Patterns. (NEPA)** *Implementing Alternative 3 would modify the size, shape, and location of the Upper Truckee River and change the surface connections and subsurface conditions around the channels and lagoons which could change groundwater levels and flow patterns. This effect would partially counteract the historic effects on groundwater levels and flow patterns on the west side of the study area caused by dredging of the Tahoe Keys waterways. This impact would be* ***beneficial.***

Like Alternative 1, Alternative 3 would involve directly raising channel bed elevations and backfilling existing incised channels, but these actions would be more extensive than under Alternative 1. Also like Alternative 1, this alternative would additionally involve modifying the stream channels to increase overbank flows across the floodplain, but the modification would be more extensive than under Alternative 1. These actions would not directly counteract the effects on groundwater levels and flow patterns on the west side of the study area caused by dredging of the Tahoe Keys waterways, which would remain in place. However, the actions would restore groundwater storage opportunities and flow patterns previously altered by dredging and straightening of the Upper Truckee River channel and by the river's geomorphic adjustments to watershed disturbances (i.e., incision and widening).

Alternative 3 would move the active Upper Truckee River channel to the east from its existing alignment, farther from the previously dredged waterways of the Tahoe Keys. Construction of the keys channels essentially moved the natural discharge boundary (i.e., the lake margin) closer to the location of the present Upper Truckee River channel. Under this alternative, the channel would be moved away from the discharge boundary. Relocating the channel would increase the separation of the river from the discharge boundary. Theoretically, the increased separation would lengthen the groundwater flow paths (and reduce the groundwater gradients) between the river and the Tahoe Keys when the river acts as a recharge boundary (i.e., during periods when the surface flow elevation in the river is higher than the groundwater table). Under this condition, more of the water recharging from the river would be retained in the marsh area (or retained longer). Although difficult to quantify, this effect is expected to promote or prolong seasonal high-groundwater conditions in the marsh. Therefore, expected changes to groundwater conditions under Alternative 3 would result in an improvement relative to existing conditions. This impact would be **beneficial**.

IMPACT 3.8-6 (Alt. 3) **Exposure to Seismically Generated Wave Hazards. (CEQA 8, TRPA 8)** *Alternative 3 proposes improvements within the study area that could be damaged by seismically generated waves that could develop in Lake Tahoe. The most important hazard would be presented by a tsunami caused by a large local earthquake, rather than by seiche waves of varied sources. The potential for exposure of people or structures to the effects of a tsunami would be low. This impact would be **less than significant**.*

Alternative 3 proposes the development of recreational facilities within and at the margins of the Upper Truckee Marsh. The area is adjacent and graded to Lake Tahoe and is exposed to inundation when large waves develop on the lake, as described above in Impact 3.8-6 (Alt. 1). The proposed improvements most vulnerable to damage by a tsunami are the reclaimed Sailing Lagoon and the dune restoration area (and facilities) at Cove East Beach. Because of the low probability of a tsunami occurring in Lake Tahoe, the relatively low human use of the study area (i.e., no proposed structures for human occupation), and the reparability of expected damage to any proposed structures, this impact would be **less than significant**.

Alternative 4: Inset Floodplain (Moderate Recreation Infrastructure)

IMPACT 3.8-1 (Alt. 4) **Increased Runoff Volumes and Peak Flows. (CEQA 3, 4; TRPA 1, 2)** *Implementing Alternative 4 would require construction of impervious surfaces within the study area for trails, viewpoints, observation areas, fishing access areas, boardwalks, and a kiosk. As described in Environmental Commitment 11, permanent stormwater detention features or infiltration systems and other BMPs would be incorporated into the final design to accommodate all 20-year, 1-hour storm runoff without erosion. This impact would be **less than significant**.*

This impact would be similar to Impact 3.8-1 (Alt. 1), but of smaller extent and magnitude. Construction of new trails, viewpoints, observation areas, and a kiosk would require placement of new impervious or partially pervious surfaces within the study area. The affected areas are generally small relative to the size of the overall study area.

Changes in land coverage are analyzed in Impact 3.6-3 (Alt. 4) in Section 3.6, "Geology and Soils, Mineral Resources, and Land Capability and Coverage." As stated in Impact 3.6-3 (Alt. 4), the proposed coverage is less than the allowable coverage in the study area. For areas outside the litigation parcels coverage relocation would be completed at a 1:1 ratio and therefore would comply with the TRPA Code.

The features of Alternative 4 would increase the volume of runoff generated within portions of the study area and would locally redirect or increase peak flows. These runoff changes would occur only in portions of the study area, but increased flow volumes and peaks could be released off-site (e.g., into the storm drainage system and ultimately into Lake Tahoe).

Alternative 4 would also involve restoring about 123,000 square feet of existing informal trails lying on compacted soils. The soils would be decompacted and native vegetation would be reestablished. This would increase infiltration and would reduce runoff volumes and peak flows generated along the informal trails.

As described for Alternative 1, EC 11 (Table 2-6) would be implemented. This environmental commitment would involve installing permanent BMPs, stormwater detention features, or infiltration systems that would convey runoff, and maintaining them over the life of the project. These measures would reduce the effect of the incremental increase in runoff that may result from constructing impervious surfaces as part of Alternative 4. This impact would be **less than significant**.

IMPACT 3.8-2 (Alt. 4) **Effects on Channels from Reconfiguration of Stream Channels and Lagoon Surface Water Features. (NEPA)** *Implementing Alternative 4 would reconfigure the low-flow channel along portions of the Upper Truckee River channel, which would modify drainage patterns within the study area. This effect on drainage patterns would reestablish naturally occurring surface water features and hydrologic/hydraulic processes on the portion of the site located along the Upper Truckee River corridor. Therefore, this impact would be* ***beneficial****.*

Implementing Alternative 4 would involve directly modifying surface water features in the study area to counteract and/or compensate for past actions and the degraded existing condition. Alternative 4 would modify the existing channel's shape and size and create an active floodplain below the existing terrace along the Upper Truckee River. Implementing this alternative would cause only minor changes to internal drainage patterns and is not expected to generate changes in either off-site drainage patterns or the quantity of water in any surface water feature.

The reconfigured Upper Truckee River low-flow channel and overbanking floodplain would be within the range of historic locations on-site. The reconfiguration would improve channel stability and reestablish natural hydrologic/hydraulic processes (i.e., overbanking) on a portion of the site without causing indirect adverse effects. Therefore, this impact would be **beneficial**.

IMPACT 3.8-3 (Alt. 4) **Modified 100-Year Flood Flow Directions or Floodplain Boundaries. (CEQA 7; TRPA 3, 8)** *Implementing Alternative 4 would not modify the river channel elevation, but would make minor changes to the size and capacity of the low-flow channel and would increase floodplain storage because an inset floodplain would be excavated and fill would be removed in some areas within the FEMA regulatory floodway or floodplain. As a net result, the extent or elevation of the 100-year special flood hazard area as designated by FEMA would not be adversely modified. This impact would be* ***less than significant****.*

Implementing Alternative 4 would directly reestablish a narrow but functional floodplain along the single-thread, degraded existing channel (RS 0+00 to RS 67+00) inset into the surrounding terrace. Local cut and fill would be used to improve sinuosity and bed diversity in the straightened reach (RS 67+00 to RS 93+00).These proposed changes have been designed to beneficially increase the frequency and extent of overbanking onto the floodplain under low to moderate flood events (i.e., the 2-year and 5-year events).

Implementing this alternative would not raise the streambed elevation or increase the channel length of the Upper Truckee River, but it would decrease the capacity of the river's active channel in the study area. A hydraulic analysis of the study area was conducted to estimate potential changes in floodwater surface elevations, flows, and floodplain boundaries for the 100-year flood under Alternative 4 (Conservancy and DGS 2005). The results of the modeling indicate that the water surface elevation for the 100-year event (7,650 cfs) under Alternative 4 would be the same as or lower than the existing 100-year water surface at all cross sections. The results reflect the increased floodplain storage formed by creation of inset floodplains and other excavation proposed by the alternative. These changes would not produce any expansion of the 100-year flood hazard zone and would not cause any existing structures to be inundated during the 100-year event. Therefore, this impact would be **less than significant**.

IMPACT 3.8-4 (Alt. 4) **Increased Overbank Flooding for Small Streamflow Events. (NEPA)** *Implementing Alternative 4 would decrease the channel capacity and lower the streambank heights to enlarge the area of overbank flooding for small (760-cfs) streamflow events within the study area by about 17 acres. This effect would reestablish natural connections between the low-flow channel and an active floodplain surface. Therefore, this impact would be* ***beneficial****.*

Implementing Alternative 4 would decrease the Upper Truckee River's channel capacity and enlarge the portion of the study area inundated under the existing 2-year return interval flow (e.g., 760 cfs) (Table 3.8-5). However, the watershed's response to climate change could reduce typical streamflows and reduce the magnitude of the peak streamflow expected frequently (i.e., every couple of years). Implementing Alternative 4 would improve overbanking at specific streamflow magnitudes, but watershed hydrology shifts caused by climate change might reduce the frequency with which those flows would occur. The uncertain but possible hydrologic effects of climate change could partially offset the benefits of Alternative 4. Still, the channel modifications would reestablish natural hydrologic/hydraulic processes along the existing Upper Truckee River alignment, which would still result in an improvement relative to existing conditions. Therefore, this impact would be **beneficial**.

IMPACT 3.8-5 (Alt. 4) **Modified Groundwater Levels and Flow Patterns. (CEQA 1; TRPA 5, 6)** *Implementing Alternative 4 would not modify the size, shape, and location of the Upper Truckee River or change the surface connections and subsurface conditions around the channels and lagoons. However, this alternative would involve excavating an inset floodplain, which would result in minor and localized changes to groundwater levels and flow patterns. This impact would be* ***less than significant****.*

Alternative 4 would not involve raising the streambed elevation but would involve excavating a widened inset floodplain throughout the study area. The length and elevation of the boundary between the groundwater level in the unconfined aquifer and the surface water would not increase or decrease substantially. Therefore, a substantial change to the channel's function as a seasonal groundwater discharge or recharge boundary would be unlikely.

Although Alternative 4 would not lower groundwater levels beneath the stream, it would not raise the streambed and groundwater, nor would it improve groundwater connectivity across the site (as under Alternatives 1, 2, and 3). The enlarged inset floodplain could move groundwater flow paths and the locations where groundwater might discharge to surface water.

Removing marsh sediments to create the inset floodplain would also reduce the available groundwater storage in the marsh, but only during periods of high groundwater levels. During such periods, the intersection of the groundwater table with the active floodplain would move outward from the channel and groundwater may discharge onto the surface of the inset floodplain, rather than directly into the channel. This condition would be transitory; the groundwater boundary would eventually fluctuate as groundwater levels and streamflow elevations change. Minor amounts of groundwater on the inset floodplain's surface may evaporate. This effect would be similar to the result of channel widening in response to past disturbance that may occur both under existing conditions and under future conditions with the No-Project/No-Action Alternative. Construction of Alternative 4 would mimic a possible future geomorphic state with an active floodplain inset within a widened stream corridor. This would result in groundwater levels and flow paths that are similar to those expected under the No-Project/No-Action Alternative, which could be worse than the existing condition.

Alternative 4 could result in future modifications of groundwater levels and patterns of flow in the study area, but the potential changes would be similar to those that would occur under existing conditions and the No-Project/No-Action Alternative. Therefore, this impact would be **less than significant**.

IMPACT 3.8-6 (Alt. 4) **Exposure to Seismically Generated Wave Hazards. (CEQA 8, TRPA 8)** *Alternative 4 proposes improvements within the study area that could be damaged by seismically generated waves that could develop in Lake Tahoe. The most important hazard would be presented by a tsunami caused by a large local earthquake, rather than by seiche waves of varied sources. The potential for exposure of people or structures to the effects of a tsunami would be low. This impact would be* ***less than significant****.*

Alternative 4 proposes the development of recreational facilities at the margins of the Upper Truckee Marsh. The area is adjacent and graded to Lake Tahoe and is exposed to inundation when large waves develop on the lake, as described above in Impact 3.8-6 (Alt. 1). The proposed improvements potentially vulnerable to damage by the largest of estimated tsunamis are trails, viewing areas, and the self-service visitors center restoration (and facilities) at Cove East Beach. Because of the low probability of a tsunami occurring in Lake Tahoe, the relatively low human use of the study area (i.e., no proposed structures for human occupation), and the reparability of expected damage to any proposed structures, this impact would be **less than significant**.

Alternative 5: No-Project/No-Action

No-Project/No-Action Future Effects of Climate Change

Analysis of the potential impacts of the No-Project/No-Action Alternative considers the potential environmental effects that may occur within the study area should none of the action alternatives (Alternative 1, 2, 3, or 4) be implemented. The analysis assumes that no purposeful (i.e., built) changes to the channel of the Upper Truckee River or Trout Creek or to other hydrologic resources would occur in the study area. Although no human-made changes would be expected, the effects of global climate change may substantially affect the hydrology of the area. Recent research has documented expected substantial changes in California's climate, including changes within the northern Sierra Nevada and the Tahoe Basin (Moser et al. 2009). Climate change could affect hydrology and flood conditions in the study area.

The project is intended to function as a relatively self-sustaining system that is subject to the unregulated streamflows of the Upper Truckee River and Trout Creek. The designs of the project alternatives have been guided by historic data sets and by current field conditions that reflect historic geomorphic adjustments to natural factors and human disturbance. However, the project's life span is long (more than 25 years), which increases the likelihood that the effects of global climate change could alter hydrologic conditions over the life of the project. Therefore, public review of and agency decisions about the project alternatives would benefit from an analysis of whether (and to what extent) climate change is expected to affect the project's performance, benefits, or adverse impacts. No formal federal, state, or TRPA policies currently require or specify an approach to such an analysis, but climate change effects need to be considered.

Current long-term planning efforts for the Tahoe Basin are considering the potential effects of climate change either via sensitivity analyses or in approaches to adaptive management, or both. Furthermore, the increase in reported climate change effects by various media and widening application of climate change considerations in resource management decisions indicate that laypersons, regulators, and managers alike will seek information about the effects of climate change on the project's outcome.

Data resources regarding the causes and consequences of global climate change are abundant; these resources range widely in their geographic scope and applicability to the analysis of the project. This analysis focuses on the anticipated consequences of climate change on physical environmental conditions in the next 50 years in the western United States, and more specifically, in the mountainous areas of California. In the last decade or so, a few studies have looked at potential climate change effects on surface-water and groundwater hydrology, water resource issues, or forest response for the Sierra Nevada or the Lake Tahoe region, or both (Jeton et al. 1996; Knowles and Cayan 2007). These evaluations provide information about possible changes in water inputs to the project's study area (e.g., earlier seasonal snowmelt, increased winter precipitation from snow to rain, and increased streamflow).

Effects of climate change documented by these recent studies include increasing average water temperatures in Lake Tahoe and increased thermal stability and resistance to mixing within the lake (Coats et al. 2006; TERC 2009). Some studies have focused on the response of Lake Tahoe to climate change (e.g., Coats et al. 2006), but have not commented directly on expected changes in tributary rivers. However, regional studies for the Sierra Nevada suggest that under expected climate change, higher snowlines will probably increase the frequency and magnitude of flooding and floods (as larger portions of mountain watersheds may be exposed to rainfall rather than snow) (Dettinger et al. 2009).

The most useful data specific to the Lake Tahoe region are those compiled and generated by Tetra Tech (2007). Using regional (within California) projections of climate change (Dettinger 2004; Cayan et al. 2006), Tetra Tech (2007) explored the effects of climate change on the overall hydrologic response of the watershed in relation to the total maximum daily load watershed model of pollutant loadings to Lake Tahoe. The studies used somewhat different modeling, downscaling, and meta-analysis approaches, but for the Tahoe Basin, they had close agreement on modeled, representative changes. Further, Dettinger (2004) provided predictions for time intervals of interest (ca. 2050).

The central estimate for temperature and precipitation changes from the Cayan et al. (2006) paper and the Dettinger (2004) paper formed the basis of Tetra Tech's Central Projection model scenario: warming of 2 degrees Celsius (°C) and a ten percent decrease in total precipitation by midcentury. Additional modeling scenarios were formulated by Tetra Tech (2007), using temperature increases of one standard deviation on either side of that central estimate (1°C and 3°C increases above current temperatures) and precipitation changes of one standard deviation above and below the central estimate (-25 percent and +15 percent of today's total precipitation, as well as a no change from today's precipitation).

Tetra Tech simulated baseline (existing) and the various climate change scenarios for a 15-year model evaluation period (1990 through 2004) by applying the percent changes in temperature and precipitation uniformly to the historic weather data sets. Simulations with the spatially discrete and temporally detailed Tetra Tech model (with 184 subwatersheds, 20 land uses, and hourly time steps for the 15-year period) provide information about the range of conditions that could occur throughout Lake Tahoe watersheds in terms of total precipitation, air temperature and snowpack, and water yield from snow, as well as total outflow to streams (surface runoff and base flow). An analysis of annualized daily snowpack from the model results is also provided by Tetra Tech (2007), which indicates the range of likely changes in snowpack depth, snow accumulation/melt season, and timing shifts.

The following analysis of the potential impacts of the No-Project/No-Action Alternative considers the potential for the hydrologic conditions in the study area to adjust in response to possible climatic changes.

IMPACT 3.8-1 (Alt. 5)	**Increased Runoff Volumes and Peak Flows. (CEQA 3, 4; TRPA 1, 2)** *Implementing Alternative 5 would not increase impervious surfaces within the study area. Therefore,* ***no impact*** *would occur.*

Existing adverse conditions related to runoff volumes and peak-flow magnitudes could worsen under the No-Project/No-Action Alternative. Alternative 5 would not directly modify runoff volumes or peak flows generated on the site. In the absence of other future actions, runoff characteristics under the No-Project/No-Action Alternative, in the absence of other future actions, would largely be controlled by climate change influences on hydrology and the associated vegetation responses and interactions. The effects of climate change would modify runoff volumes and peak flow, but there is uncertainty about the change in precipitation that, in combination with various temperature projections, could produce a range of runoff responses. The climate change analysis conducted by Tetra Tech (2007) indicates that mean runoff flows would increase in fall and winter but would decrease in spring and summer. In most climate change scenarios, mean flows and total annual runoff are similar to or less than existing flows and runoff; however, peak flows, from rainstorms and rain-on-snow events, could be similar to or worse than existing peak flows. Implementing the No-Project/No-Action Alternative would not modify the historical increase of impervious surfaces, degraded soil and vegetation cover properties, and their runoff generation and peak-flow conditions.

The above features of Alternative 5 would not measurably change the volume of runoff generated within the study area, nor would they redirect or increase peak flows. Flow volumes and peaks released off-site (e.g., to the storm drainage system and the lake) would not be expected to increase. Therefore, no adverse impacts on runoff volumes and peak flows in the study area would result and no off-site effects would occur. **No impact** would occur.

IMPACT 3.8-2 (Alt. 5) **Effects on Channels from Reconfiguration of Stream Channels and Lagoon Surface Water Features. (CEQA 2; TRPA 1, 4)** *Implementing Alternative 5 would not directly modify the low-flow channel or lagoon areas in the study area. Therefore,* ***no impact*** *would occur.*

Under the No-Project/No-Action Alternative, the Upper Truckee River and Trout Creek channels in the study area would undergo changes as they continue to respond to past disturbances. The progressive geomorphic adjustment along the Upper Truckee River would likely be primarily in the form of streambank erosion and widening. The trend of streambed erosion in the lower reach of Trout Creek also is expected to progress. Channel instability would decrease over time and sediment yields from channel erosion would decrease. Stabilized sediment deposits or inset floodplains would be expected to form along the widened stream corridor of the Upper Truckee River, at least upstream of Lake Tahoe's backwater effect. However, these natural geomorphic adjustments would not reconnect the incised channels to the historic floodplain, maintain or increase overbank flows onto the floodplain, raise or maintain groundwater levels, or otherwise restore the degraded ecosystem functions of the stream channels.

Future channel processes and conditions under the No-Project/No-Action Alternative are generally expected to follow a predictable trend based on geomorphic channel-evolution models. However, such processes and conditions could be altered by the effects of climate change, which would likely exacerbate some of the existing degraded condition and function of the surface water features. Increased rainfall as a proportion of total precipitation, increased runoff during winter, decreased snow-water equivalent, and decreased spring/summer runoff are all likely to limit the rate of natural recovery within the incised channel systems, further reduce overbank flows, and lower groundwater levels that can support floodplain wetlands.

No proposed actions or natural processes occurring under Alternative 5 would provide "recovery" from the past direct disturbances within the study area, such as dredging and filling of surface water bodies. For example, the fill that separates the Sailing Lagoon from the Upper Truckee River would likely remain and the historical maintenance of the navigation channels would continue. Surface water in the Tahoe Keys Marina and Tahoe Keys channels would continue to circulate with the water in the Sailing Lagoon, and both would remain directly connected to Lake Tahoe via the East Channel. The physical features would be similar to existing features, but their hydrology would be altered by climate change, potentially exacerbating existing flow and water quality problems in the constructed channels.

Uncertainty exists about whether total precipitation is more likely to decrease or to increase as a result of climate change; however, the net effect of changes in precipitation and average temperature, with continued year-to-year and decadal variation (e.g., flood and drought cycles), may reduce total runoff to Lake Tahoe. Should this reduction occur, the proportion of time when the lake is below historic median elevations may increase. Correspondingly, lower water levels in the Sailing Lagoon and connected Tahoe Keys navigation channels would result, thus worsening circulation, temperature, and related water quality problems in those water bodies.

Implementing Alternative 5 would not directly change the location or size of the channels, lagoons, or other topographic features that would affect drainage within the study area. Therefore, **no impact** would occur.

IMPACT 3.8-3 (Alt. 5) **Modified 100-Year Flood Flow Directions or Floodplain Boundaries. (CEQA 7; TRPA 3, 8)** *Implementing Alternative 5 would not directly modify the existing channel, floodplain, fill materials, the lagoon configuration, or the river mouth. No direct or indirect modifications to the 100-year flow directions or floodplain boundaries would be expected, and the existing flood hazards would remain. This impact would be* ***less than significant****.*

Several past actions along the Upper Truckee River corridor have modified the 100-year floodplain boundaries, storage capacity, and/or flow directions: placement of fill for road crossings and other transportation facilities (e.g., U.S. 50 road fills, City of South Lake Tahoe Airport); placement of fill and/or structures for residential, commercial, or other uses (e.g., Tahoe Island area, Elks Club, Grocery Outlet, Carrows); and/or removal of floodplain area by levee protection for residential, commercial, or other uses (e.g., Tahoe Keys). Most of these actions occurred several decades ago, before floodplain management regulations took effect. However, the result of historic actions has been to degrade both the storage capacity of the 100-year floodplain and the flow routes in the study area and upstream along the Upper Truckee River relative to natural conditions. Floodplain capacity and flow routes in specific reaches affect those in adjacent reaches, and for the 100-year event these effects have influences in both upstream and downstream directions.

Under the No-Project/No-Action Alternative, the topography and physical characteristics of the existing floodplain and channel in the study area would not be modified directly. Continued geomorphic adjustments to past disturbance might enlarge the incised channel along various reaches of the Upper Truckee River, but not increase total floodplain capacity for the 100-year flood. Therefore, the degraded existing capacity of the 100-year floodplain and flow routes would remain.

Implementing Alternative 5 would not directly modify the existing channel, floodplain, or fill materials, or the configuration of the Sailing Lagoon. The alternative would not raise the streambed elevation, increase the channel length, or decrease the channel capacity of the Upper Truckee River channel within the study area. Unlike the other alternatives, under Alternative 5 the floodplain would not be enlarged by direct removal of fill, excavation of inset floodplain features, or reconnection of lagoons in the study area to the active floodplain. Alternative 5 would not modify the river mouth’s location, elevation, or capacity.

Therefore, the 100-year flow directions and floodplain boundaries would not be directly modified under Alternative 5. The 100-year water surface profile would remain as simulated for existing conditions (Exhibit 3.8-15). Land uses along the margins of the study area would remain subject to existing flood hazards. In response to global climate change, future watershed hydrology may increase the 100-year return interval peak streamflow to a magnitude greater than the existing value (7,650 cfs) that has been calculated from the recorded conditions over the last several decades. This impact would be **less than significant**.

IMPACT 3.8-4 (Alt. 5) **Increased Overbank Flooding for Small Streamflow Events. (CEQA 3, TRPA 1)** *Implementing Alternative 5 would not change channel capacity, streambed elevation and streambank heights, or the area of overbank flooding for small to moderate streamflow events within the study area. The existing degraded conditions would persist. This impact would be* ***less than significant****.*

Past actions enlarged the capacity of stream channels in the study area and upstream on the Upper Truckee River and Trout Creek. The existing stream channels are now oversized both because direct actions have occurred (e.g., straightening, dredging, or adding levees) and because the channels have responded indirectly to watershed hydrology and/or the direct disturbances (e.g., through streambed and streambank erosion).

The enlarged channel capacities reduce opportunities for normal overbank flows (flows onto the floodplain) during frequent, small-magnitude streamflow events. Under natural conditions, overbank flows are typically expected on functioning streams every couple of years, lasting for a few days up to a couple of weeks. However, under existing conditions in the study area and along long sections of the Upper Truckee River and Trout Creek (except where previous restoration projects have been implemented), the channels are so large that flows only reach the top of bank every five–ten years. Given the channels’ present conditions and capacities, overbank flooding does not happen in the study area during frequent, small streamflow events (i.e., streamflows of 760 cfs recurring every two years). Limited overbanking in particular reaches can reduce floodplain connectivity in adjacent downstream reaches, but does not have substantial effects in the upstream direction.

This degraded condition negatively affects channel stability. The reduced stability, in turn, increases sediment pollutant sources (i.e., sediment produced by erosion). It also negatively limits overbank processes and groundwater support for sediment and nutrient storage that would occur on a functioning active floodplain.

Under the No-Project/No-Action Alternative, the Upper Truckee River and Trout Creek channels in the study area would undergo continued progressive geomorphic adjustments in response to past disturbances. The primary adjustments would be streambank erosion and widening along the river and streambed erosion in the creek's lower reach. These changes would further enlarge the channels, thus worsening the existing degraded condition relative to overbanking.

Future channel processes and conditions are generally expected to follow a predictable trend based on geomorphic channel-evolution models. Under the No-Project/No-Action Alternative, the potential for frequent overbanking at a given streamflow magnitude (e.g., 760 cfs, the existing 2-year return interval flow) would be similar to the existing potential. However, channel processes and conditions could be altered by the effects of climate change. Precipitation changes, reductions in the percentage of precipitation falling as snow, and temperature increases caused by climate change would likely reduce mean streamflows, average annual runoff, and the magnitude of peak streamflow expected frequently (every two–five years). Therefore, climate change could exacerbate the existing degraded condition by further reducing the frequency with which the existing design overbank flow (760 cfs) would occur in the study area.

In addition, the watershed's response to climate change could reduce typical streamflows and the frequency with which the proposed design overbank flow (760 cfs) would occur in the study area. Therefore, under the No-Project/No-Action Alternative, the opportunity for frequent overbanking in the study area and along upstream reaches could be further degraded beyond the existing condition.

However, implementing Alternative 5 would not result in any actions that would change existing conditions relative to the potential for or frequency of overbanking events. Therefore, this impact would be **less than significant**.

IMPACT 3.8-5 (Alt. 5) **Modified Groundwater Levels and Flow Patterns. (CEQA 1; TRPA 5, 6)** *Implementing Alternative 5 would not modify the size, shape, and location of the Upper Truckee River or change the surface connections and subsurface conditions around the channels and lagoons. The existing degraded condition would persist. This impact would be* ***less than significant****.*

Groundwater levels and flow patterns upstream along the Upper Truckee River and Trout Creek have been altered historically by watershed-scale hydrologic changes, stream channel incision, and extraction of groundwater for water supply. These actions generally lowered groundwater levels as stream channels progressively incised. In areas of groundwater pumping, the actions modified groundwater flow rates, even reversing flows in areas with excessive extraction.

Groundwater conditions in the study area also have been affected by dredging of the Tahoe Keys waterways and the most downstream reach of the Upper Truckee River. Dredging and construction of the waterways at Tahoe Keys essentially moved the surface water/groundwater contact zone inland from the natural shoreline. As a result, groundwater rises along the west margin of the study area when the lake level is high, but is depleted rapidly when the lake level is low. This response may also indicate that the excavated channels have intercepted zones of relatively high hydraulic conductivity (e.g., Upper Truckee River channel deposits).

Along the incised stream channels throughout the watershed or dredged waterways near Lake Tahoe, groundwater flow paths may be interrupted when the surface water levels are low, and more groundwater is released to the surface water body than under natural conditions. The resulting lowered groundwater levels would reduce the total volume of groundwater storage and the rate and volume of groundwater discharge to the channel. Groundwater discharge helps to moderate variations in surface water flow, particularly during periods of reduced streamflow.

These conditions also would impair ecosystem values because lowered groundwater levels would reduce the amount of groundwater available near the surface to support high soil moisture in meadows and marshes.

Under the No-Project/No-Action Alternative, the Upper Truckee River and Trout Creek channels in the study area would continue to change as they respond to past disturbances. These natural geomorphic adjustments would not reverse or improve the degraded groundwater conditions, however. Groundwater levels could decline further in locations where future channel incision or channel widening is likely to occur as part of natural geomorphic evolution.

The effects of climate change would likely exacerbate some of the existing degraded condition and function of the groundwater levels and patterns. Increased seasonality of runoff, reduced snowpack, and possibly decreased total runoff would likely reduce groundwater recharge within the Upper Truckee River and Trout Creek watersheds. This reduction would cause groundwater volumes and flows to decrease throughout the Upper Truckee River and Trout Creek systems. If decreases in total runoff to Lake Tahoe were to increase the proportion of time that the lake is below historic median elevations, then surface water levels in the lake, the Sailing Lagoon, and the connected Tahoe Keys navigation channels would also be lowered. This could increase the rate of groundwater flow and total groundwater discharge along the north and west margins of the study area, further reducing groundwater support for the meadow and marsh.

Under the No-Project/No-Action Alternative, groundwater levels or flows in the study area would remain degraded relative to natural conditions. The geomorphic response to past actions would continue and locally worsen existing groundwater conditions as channels continue to incise and/or widen. Climate change may exacerbate existing degraded conditions. Therefore, under Alternative 5, the degraded existing groundwater levels and flow patterns would persist and possibly worsen as geomorphic response continues. This impact would be **less than significant**.

IMPACT 3.8-6 (Alt. 5) **Exposure to Seismically Generated Wave Hazards. (CEQA 8, TRPA 8)** *Implementing Alternative 5 would not result in construction of any improvements within the study area that could be damaged by seismically generated waves that could develop in Lake Tahoe. The effects of large waves would not change risks to people or structures relative to existing conditions. Therefore, this impact would be **less than significant**.*

The flat to gently northward-sloping topography of the study area presents the hazard of inundation during the development of large waves on Lake Tahoe. Potential tsunamis or large seiches (see Impact 3.8-6 [Alt. 1]) may inundate much of the study area. No new improvements would be constructed under the No-Project/No-Action Alternative. Therefore, the risk of damage to improvements posed by inundation by large waves would not change relative to existing conditions. However, the study area currently includes informal trail networks used by the public for recreation, as well as minor improvements that include fencing. Possible damage or injury from tsunamis would be continuing hazards. This impact would be **less than significant**.

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3.9 GEOMORPHOLOGY AND WATER QUALITY

This section presents the regulatory setting for geomorphology and water quality, describes the existing conditions in the study area related to geomorphology and water quality, and evaluates potentially adverse environmental impacts related to erosion, sedimentation, and deposition associated with project implementation.

The analysis of geomorphology and water quality is based on information obtained through review of academic research and available information published by federal, state, and local agencies, primarily the *Final Report: Upper Truckee River Upper Reach Environmental Assessment* (SH&G 2004a), the *Amendment Report: Upper Truckee River Upper Reach Reclamation Project* (SH&G 2004b), and the *Riparian Ecosystem Restoration Feasibility Report* associated with the Upper Truckee River Restoration Project (River Run Consulting 2006). The examination of geomorphology is also based on the preliminary engineering schematic designs prepared for the alternatives. For a discussion of other water resource issues, refer to Section 3.8, “Hydrology and Flooding.” Cumulative geomorphology and water quality impacts are addressed in Section 3.18, “Cumulative Impacts.”

3.9.1 AFFECTED ENVIRONMENT

REGULATORY SETTING

Federal

The following federal laws and regulations related to geomorphology and water quality are relevant to the proposed alternatives and described in detail in Chapter 5, “Compliance, Consultation, and Coordination”:

- Clean Water Act (CWA)
  - Section 401
  - Section 402
  - Section 404

- Safe Drinking Water Act

State

The Porter-Cologne Water Quality Control Act (California Water Code Section 13000 et seq.) requires establishment of water quality objectives and standards to protect water quality for beneficial uses. This act is implemented by the State Water Resources Control Board (SWRCB) and nine regional water quality control boards (RWQCBs), which are responsible for preserving California’s water quality. The SWRCB protects water quality by setting statewide policy, coordinating and supporting RWQCB efforts, and reviewing petitions that contest RWQCB actions. The RWQCBs issue waste discharge permits, take enforcement action against violators, and monitor water quality for the protection of waters in their specified regions. The SWRCB and the RWQCBs jointly administer federal and state laws related to water quality in coordination with the U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE).

The study area is under the jurisdiction of the Lahontan RWQCB. The Lahontan RWQCB administers CWA Section 401 water quality certifications in conjunction with USACE’s CWA Section 404 permit. In addition, the Lahontan RWQCB regulates discharge of stormwater from construction projects (as well as municipal and industrial stormwater) under the CWA Section 402 National Pollutant Discharge Elimination System (NPDES) permit program. Because the project would disturb more than one acre of land, the Conservancy would need to obtain and comply with the Lahontan RWQCB’s NPDES General Permit Number CAG616002 for discharge of stormwater runoff associated with construction activity. The SWRCB adopted a new statewide NPDES Construction General Permit Order 2009-0009-DWQ on September 2, 2009, that became effective July 1, 2010 (SWRCB 2010). This General Permit imposes more minimum best management practices (BMPs) and establishes three levels of risk-based requirements based on both sediment risk and receiving water risk. All dischargers are subject to narrative effluent limitations. Risk Level 2 dischargers are subject to technology-based numeric action levels (NALs) for pH and turbidity. Risk Level 3 dischargers are subject to NALs and numeric effluent limitations (NELs). Certain sites must develop and implement a storm water pollution prevention plan (SWPPP) and rain event action plan and all projects must perform effluent monitoring and reporting, along with receiving water monitoring and reporting for some Risk level 3 sites. Key personnel (e.g., SWPPP preparers, inspectors) must have certifications to ensure that they are qualified to design and evaluate project specifications that will meet the requirements. For projects commencing on or after July 1, 2010, the applicant must electronically submit several permit registration documents before commencement of construction activities: the notice of intent, risk assessment, postconstruction calculations, a site map, the SWPPP, a signed certification statement by the legally responsible person, and the first annual fee. The Lahontan RWQCB is responsible for enforcing the new statewide General Permit in its region and is updating its regional General Permit for construction stormwater discharges within the Lake Tahoe Hydrologic Unit (HU) to be as least as stringent as the statewide permit (Amorfini, pers. comm., 2010).

The *Water Quality Control Plan for the Lahontan Region* (Basin Plan), adopted March 31, 1995, and as amended, identifies the beneficial uses, water quality objectives, numerical standards, and waste discharge prohibitions for surface water and groundwater in the California portion of the Tahoe Basin (Lahontan RWQCB 1995:1-1). Table 3.9-1 summarizes the applicable environmental issues related to this project that are covered under the Basin Plan. BMPs are defined as "[m]ethods, measures or practices selected by an agency to meet its non-point source control needs. BMPs include, but are not limited to, structural and nonstructural controls and operation and maintenance procedures. BMPs can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters" (Lahontan RWQCB 1995:5.3-1). Stream Environment Zones (SEZs) are wetland and riparian areas designated by TRPA and the Lahontan RWQCB through specific criteria using designated water, soil, and vegetation indicators (Lahontan RWQCB 1995:5.7-2). The Basin Plan incorporates water quality thresholds, programs, and regulations as developed and implemented by TRPA along with federal and state regulations. The project would be required to meet the provisions of the Basin Plan for the protection and enhancement of Lake Tahoe.

The Basin Plan lists water quality objectives for all surface waters of the region, including the Lake Tahoe HU, in addition to specific water quality objectives for certain water bodies in the Lake Tahoe HU (i.e., the entire watershed tributary to and containing Lake Tahoe), including the Upper Truckee River. The regionwide and water body–specific objectives pertaining to the Upper Truckee River, groundwater, and stormwater are summarized in Table 3.9-2. To achieve those objectives, the Basin Plan prohibits discharges and threatened discharges in 100-year floodplains. These prohibitions are described in Chapter 5 of the Basin Plan and those relevant to project implementation are summarized below in Table 3.9-3.

Tahoe Regional Planning Agency

Goals and Policies

The TRPA Regional Plan's Goals and Policies document presents specific goals and policies for achieving and maintaining adopted environmental thresholds. These goals and policies are implemented through the TRPA Code of Ordinances (TRPA Code), described below (TRPA 1986:I-1). A key component of the Goals and Policies document is the Land Use Element, which identifies the fundamental philosophies directing land use and development in the Tahoe Basin. The Land Use Element consists of seven subelements, including the Water Quality Sub Element. This subelement identifies two goals and 18 policies designed to support attainment of the water quality thresholds:

Table 3.9-1
Summary of Basin Plan Water Quality Control Measures Relevant to the Project

Water Quality Control Measure	Description
Water quality standards	State standards, including designated beneficial uses and water quality objectives, implemented by the SWRCB and RWQCBs. Regional “environmental threshold” standards implemented by TRPA.
Waste discharge prohibitions	State prohibitions against discharge of sewage, industrial waste, solid wastes, earthen materials, and so on, including prohibitions related to new subdivisions, land capability, SEZs, development not offset by remedial measures, and new piers in significant fish spawning habitat, implemented by the Lahontan RWQCB. TRPA implements similar land-use restrictions.
Best management practices	Use of mandatory BMPs for all new development. Implementation through state and TRPA permits and enforcement programs. Retrofit of BMPs required by the Lahontan RWQCB for existing development. BMPs also required for resource management uses, such as timber harvest and livestock grazing. The Basin Plan endorses the TRPA *BMP Handbook*.
Controls for SEZs and similar resources	Development and disturbance strictly limited in SEZs and setback areas, 100-year floodplains, and shorezone areas. Limited implementation through Lahontan RWQCB discharge prohibitions, TRPA land-use restrictions, and CWA Section 401 and 404 programs. Some exceptions for public projects and coverage relocation; specific exemption findings required. Restoration requirement of 1.5:1 for permitted SEZ disturbance, unless meets specific criteria, such as if the relocation is from one portion of a SEZ to another portion, there is a net environmental benefit to the SEZ. Shorezone projects must meet TRPA development standards. TRPA 208 Plan includes SEZ restoration program, which is expected to restore 25% of disturbed/developed SEZs. Control measures for other problems also serve to protect groundwater.
Water rights and water use	Limits on diversions for consumptive use from all sources in the Tahoe Basin by act of Congress. Waste discharge requirements for sewer districts include conditions to prevent use beyond limits. TRPA plans include minimum fireflow requirements, as well as requirements for use of native/adapted plants in landscaping. Recommendations or SWRCB action on water rights policy update and water meter use.
Outdoor recreation	Controls for water quality impacts of outdoor recreation (dispersed recreation, campgrounds and day-use areas, ski areas, golf courses, and boating and shorezone recreation) through Lahontan RWQCB and TRPA permits and USFS programs on national forest lands. Impact examples: erosion, SEZ disturbance, fertilizer use, dredging and underwater construction, wastewater disposal, and fuel spills.
Miscellaneous water quality problems	Control measures for problems related to fertilizer use, pesticide use, and wet and dry atmospheric deposition. Fertilizer and pesticide controls through Lahontan RWQCB and TRPA permits; atmospheric deposition control through TRPA traffic/air pollution controls and other 208 Plan commitments.

Notes: 208 Plan = regional water quality control plan required under Section 208 of the Clean Water Act; Basin Plan = *Water Quality Control Plan for the Lahontan Region*; BMP = best management practice; CWA = Clean Water Act; Lahontan RWQCB = Lahontan Regional Water Quality Control Board; SEZ = Stream Environment Zone; SWRCB = State Water Resources Control Board; TRPA = Tahoe Regional Planning Agency; USFS = U.S. Forest Service
Source: Lahontan RWQCB 1995:5-11 to 5-13

Table 3.9-2
Water Quality Objectives for the Upper Truckee River

Water Quality Constituent	Lahontan Region Water Quality Objective	
	Numeric Standard (mg/L unless noted) [1]	Narrative Limits or Explanation of Numeric Tests
Upper Truckee River		
Ammonia	calculation	pH and temperature dependent values
Bacteria, Coliform	20/100 mL 40/100 mL	Log mean during any 30-day period Limited to no more than 10% of samples in any 30-day period.
Biostimulatory Substances	-	Concentrations must not promote aquatic growth to the extent of nuisance or adversely affect beneficial uses
Chemical Constituents	-	All MCLs and SMCLs of the CCR, for each designated beneficial use.
Chloride	4	
Chlorine (Total Residual)	0.003/0.002	Max/median based on daily measurements in any 6 month period.
Color		Water shall be free of coloration that causes nuisance or adversely affects beneficial uses.
Dissolved Oxygen	80% of saturation	Not to be depressed by more than 10%, nor shall the minimum DO saturation concentration be less than 80%; Specific limits apply to aquatic resource beneficial uses.
Floating Materials		Shall not cause nuisance or adversely affect beneficial uses.
Iron, Total	0.03	
Nitrogen, Total	0.19	
Nondegradation of Aquatic Communities and Populations		Wetlands shall be free of substances attributable to wastewater or other discharges that produce adverse response in organisms.
Oil and Grease		Shall not result in a visible film or coating on the surface of the water or on objects in the water that cause nuisance, or adversely affect beneficial uses.
Pesticides		Not to exceed lowest detectable levels.
pH	6.5-8.5	Not to be outside the stated limits: Waters designated as COLD beneficial use shall have less than 0.5 pH unit change.
Radioactivity		Shall not be present at concentrations deleterious to organisms, or result in accumulation of radionuclides.
Phosphorus, Total	0.015	
Settleable Materials		Shall not result in deposition of material that causes nuisance or adversely affects beneficial uses.
Sulfate	1	
Suspended Materials		Shall not cause nuisance or adversely affect beneficial uses.
Suspended Sediment	60	90th percentile value
Taste and Odor		Shall not impart undesirable tastes or odors to fish or other edible products, cause nuisance, or adversely affect beneficial uses.
Temperature		Natural receiving water temperatures shall not be altered
Total Dissolved Solids	55	

Table 3.9-2
Water Quality Objectives for the Upper Truckee River

Water Quality Constituent	Lahontan Region Water Quality Objective: Numeric Standard (mg/L unless noted) [1]	Lahontan Region Water Quality Objective: Narrative Limits or Explanation of Numeric Tests
Toxicity		Remain free of substances in concentrations that are toxic or detrimental to organisms (based on indicator organisms).
Turbidity	<10% over natural NTU	Shall not cause nuisance or adversely affect beneficial uses.
Groundwater		
Fecal Coliform	1.1/100 MPN	mL/7-day period median in groundwater designated as MUN
Chemical Constituents		Incorporates MCLs and SMCLs of the CCR for beneficial uses.
Radioactivity		For municipal groundwater, incorporates standards of the CCR.
Taste and Odor		Shall not contain in concentrations that interfere with beneficial use. For municipal groundwater, incorporates standards of the CCR.
Stormwater Runoff		
Total Nitrogen as N	0.5; 5.0	For discharges to collection systems, Lake Tahoe or any of its tributaries; For discharges to land treatment systems.
Total Phosphorus as P	0.1; 1.0	For discharges to collection systems, Lake Tahoe or any of its tributaries; For discharges to land treatment systems.
Total Iron	0.5; 4.0	For discharges to collection systems, Lake Tahoe or any of its tributaries; For discharges to land treatment systems.
Turbidity	20 NTU; 200 NTU	For discharges to collection systems, Lake Tahoe or any of its tributaries; For discharges to land treatment systems.
Grease and Oil	2; 40	For discharges to collection systems, Lake Tahoe or any of its tributaries; For discharges to land treatment systems.

Notes: CCR = California Code of Regulations; DO = dissolved oxygen; MCL = maximum contaminant level; mL = milliliter; MPN = Most Probable Number; NTU = nephelometric turbidity units; SMCL = secondary maximum contaminant level

* Where there is a direct and immediate connection between ground and surface waters, discharges to groundwater shall meet the guidelines for surface discharges.

Source: [1] Lahontan RWQCB 1995:Chapter 5

Table 3.9-3
Discharge Prohibitions, Lake Tahoe Hydrologic Unit

General Prohibitions

- Discharges that violate water quality objectives or impair beneficial uses
- Discharges that cause further degradation of water where objectives are already being violated
- Discharges to surface waters of the Lake Tahoe Hydrologic Unit

Prohibitions Related to Development

- Discharges or threatened discharges below the high-water rim of Lake Tahoe or in the 100-year floodplains of tributaries
- Discharges attributable to new development in Stream Environment Zones
- Discharges attributable to new development not in accordance with offset requirements

Source: Lahontan RWQCB 1995:5.8-12

- **GOAL 1:** Reduce loads of sediment and algal nutrients to Lake Tahoe; meet sediment and nutrient objectives for tributary streams, surface runoff, and subsurface runoff, and restore 80 percent of the disturbed lands.

  - **Policy 1:** Discharge of municipal or industrial wastewater to Lake Tahoe, its tributaries, or the groundwaters of the Tahoe Region is prohibited, except for existing development operating under approved alternative plans for wastewater disposal, and catastrophic wildfire protection to prevent the imminent destruction of the STPUD (South Tahoe Public Utility District) Luther Pass Pump Station.

  - **Policy 2:** All persons who own land and all public agencies that manage public lands in the Lake Tahoe Region shall put best management practices (BMP) in place; maintain their BMPs; protect vegetation on their land from unnecessary damage; and restore the disturbed soils on their land.

  - **Policy 3:** Application of BMPs to projects shall be required as a condition of approval for all projects.

  - **Policy 4:** Restore at least 80 percent of the disturbed lands within the region.

  - **Policy 5:** Units of local government, state transportation departments, and other implementing agencies shall restore 25 percent of the SEZ lands that have been disturbed, developed, or subdivided in accordance with the Capital Improvements Program (Part II).

  - **Policy 6:** The use of fertilizer within the Tahoe region shall be restricted to uses, areas, and practices identified in *The Handbook of Best Management Practices*. Fertilizers shall not be used in or near stream and drainage channels, or in stream environment zones, including setbacks, and in shorezone areas. Fertilizer use for maintenance of preexisting landscaping shall be minimized in stream environment zones and adjusted or prohibited if found, through evaluation of continuing monitoring results, to be in violation of applicable water quality discharge and receiving water standards.

  - **Policy 7:** Off road vehicle use is prohibited in the Lake Tahoe region except on specified roads, trails, or designated area where the impacts can be mitigated.

  - **Policy 8:** Transportation and air quality measures aimed at reducing airborne emissions of oxides of nitrogen in the Tahoe basin shall be carried out.

- **GOAL 2:** Reduce or eliminate the addition of other pollutants that affect, or potentially affect, water quality in the Tahoe Basin.

  - **Policy 1:** All persons engaging in public snow disposal operations in the Tahoe region shall dispose of snow in accordance with site criteria and management standards in *The Handbook of Best Management Practices*.

  - **Policy 2:** Discharges of sewage to Lake Tahoe, its tributaries, or the groundwaters of the Lake Tahoe region are prohibited. Sewage collection, conveyance and treatment districts shall have approved spill contingency, prevention, and detection plans.

  - **Policy 3:** All institutional users of road salt in the Lake Tahoe region shall keep records showing the time, rate, and location of salt application. Storage of road salt shall be in accordance with *The Handbook of Best Management Practices*.

  - **Policy 4:** Underground storage tanks for sewage, fuel, or other potentially harmful substances shall meet standards set forth in TRPA ordinances, and shall be installed, maintained, and monitored in accordance with *The Handbook of Best Management Practices*.

- **Policy 5:** No person shall discharge solid wastes in the Lake Tahoe region by depositing them on or in the land, except as provided by TRPA ordinance.

- **Policy 6:** TRPA shall cooperate with other agencies with jurisdiction in the Lake Tahoe region in the preparation, evaluation, and implementation of toxic and hazardous spill control plans.

- **Policy 7:** The BMPs will be amended to include special construction techniques, discharge standards, and development criteria applicable to projects in the shorezone.

- **Policy 8:** Liquid or solid wastes from recreational vehicles and boats shall be discharged at approved pump-out facilities. Pump-out facilities will be provided by public utility districts, marinas, campgrounds, and other relevant facilities in accordance with standards set forth in *The Handbook of Best Management Practices*.

- **Policy 9:** Evaluate the feasibility and effectiveness of ponding facilities along stream corridors as a strategy for removing instream loads of sediment and nutrients.

- **Policy 10:** Reduce the impacts of motorized watercraft on water quality.

Before the TRPA Code was established, TRPA prepared Volume 1 of the regional water quality management plan required under Section 208 of the CWA (208 Plan), along with other environmental values and standards, to identify important issues relating to water quality in the Tahoe Region (TRPA 1981:1-4). The Lahontan RWQCB subsequently incorporated appropriate provisions of the 208 Plan into the Basin Plan. The 208 Plan has the same two major water quality goals as the TRPA Regional Plan. The first goal, with eight policies to support its implementation, is to reduce loading of sediment and nutrients to Lake Tahoe and meet sediment and nutrient objectives for tributary streams, surface runoff, and subsurface runoff. The second goal, with ten policies to support its implementation, is to reduce or eliminate the addition of other pollutants that affect water quality in the Tahoe Basin.

Code of Ordinances

The TRPA Code is a compilation of all the ordinances needed to implement the Goals and Policies. The following portions of the TRPA Code are most relevant to the geomorphology and water quality aspects of the project:

- Basic standards and prohibitions for all discharges to surface waters and groundwater are specified in TRPA Code Section 60.1, “Water Quality Control.” Table 3.9-4 describes the discharge limits to surface runoff and to groundwater discharges in the Tahoe Basin.

- Measures to avoid or reduce potential short- and long-term erosion and sedimentation impacts on the quality of surface water, groundwater, or both are required by TRPA Code Section 33.3, “Grading Standards”; Section 33.6, “Vegetation Protection during Construction”; and Section 61.4, “Revegetation.”

- Measures to prevent contamination of sources of drinking water and protect the public health relating to drinking water are required by TRPA Code Section 60.3, “Source Water Protection.” This measure may apply to the project since a few domestic wells are located immediately north of the study area and the confluence of the Upper Truckee River and Angora Creek. The public well south of the study area close to U.S. Highway 50 (U.S. 50) in Meyers is believed to be located far enough from the study area to avoid any potential impact.

- A section of the TRPA Code in Chapter 30, “Land Coverage,” that indirectly relates to water quality, given the ability of SEZ to buffer waterways and provide infiltration and uptake opportunities, also relates to the project. Land coverage standards, limitations, and prohibitions of additional land coverage in TRPA Code Chapter 30 would apply.

Table 3.9-4 TRPA Limits on Discharges for Water Quality Control	
Constituent	**Maximum Concentration**
Surface runoff: Pollutant concentration in surface runoff shall not exceed the following reading at the 90th percentile:	
Dissolved inorganic nitrogen as N	0.5 mg/L
Dissolved phosphorus as P	0.1 mg/L
Dissolved iron as Fe	0.5 mg/L
Grease and oil	2.0 mg/L
Suspended sediment	250 mg/L
Discharge to groundwaters: Waters infiltrated into soils shall not exceed the following maximum constituent levels:	
Total nitrogen as N	5 mg/L
Total phosphate as P	1 mg/L
Iron as Fe	4 mg/L
Turbidity	200 NTU
Grease and oil	40 mg/L
Notes: mg/L= milligrams per liter; NTU = nephelometric turbidity unit Source: TRPA 1980:81-1, 81-2	

Plan Area Statements

Each plan area statement (PAS) outlines land use classifications, special policies, planning considerations, permissible uses, and maximum allowances for a portion of the Lake Tahoe Basin. The study area is located within three PASs: PAS 099 (Al Tahoe), PAS 100 (Truckee Marsh), and PAS 102 (Tahoe Keys).

Runoff control and SEZ restoration are allowed permissible uses under resource management in PAS 009 and 102, but must be considered under a special use provision in PAS 100.

PAS 099 special considerations include a statement that projects need to address the drainage problems in the Al Tahoe Area, including the problem of stagnant water at Los Angeles and Freel Peak Streets. The study area receives water from the Al Tahoe Area, and could be affected by drainage projects in that area, but due to its location the project would only receive runoff and would not directly modify drainage within the Al Tahoe Area.

As considerations for project planning, PAS 100 identifies the commercial and residential uses infringing upon the SEZ (consisting of the Upper Truckee River and Trout Creek corridors, and adjacent marshlands) and the U.S. 50 crossings’ restriction on natural function of the SEZ. PAS 100 also designates special planning considerations and policies regarding water quality that relate to the study area:

- Stream zones should be restored where U.S. 50 crosses the Upper Truckee River and Trout Creek.
- SEZ should be restored in the vicinity of the crossings of Trout Creek at U.S. 50 and at Black Bart Road.
- New roadway alignments through SEZ are to be discouraged.
- Banks along both Trout Creek and the Upper Truckee River should be stabilized.

PAS 100 includes a special planning consideration and two special policies regarding geomorphology. The special planning consideration is the localized problem of bank slumping and erosion along the Upper Truckee River. The two special policies are:

- Banks along both the Upper Truckee River and Trout Creek should be stabilized.
- Instream habitat should be improved through artificial creation of deep pools and the removal of obstructions.

City of South Lake Tahoe

The study area is located entirely within the jurisdiction of the City of South Lake Tahoe (CSLT). CSLT ordinances in Chapter 8, "Building Regulations," require projects to prepare a grading plan for review and approval of a grading permit by the city building official. The grading plan must include the present contours of the land, the proposed final grade and location of improvements. CSLT review is intended to safeguard adjoining properties and public streets and ways from damage by unnatural flows of surface waters.

ENVIRONMENTAL SETTING

This section presents both the geomorphology and water quality of the environmental setting, because the geomorphologic characteristics and related processes in the study area, including erosion and sedimentation, influence physical and biological aspects of the water quality conditions. However, some aspects of water quality in the study area and in surrounding surface and groundwater bodies are independent of geomorphic characteristics of the study area. Therefore, aspects of geomorphology and water quality that would not be affected by the project are also discussed to provide perspective on the environmental conditions of the study area.

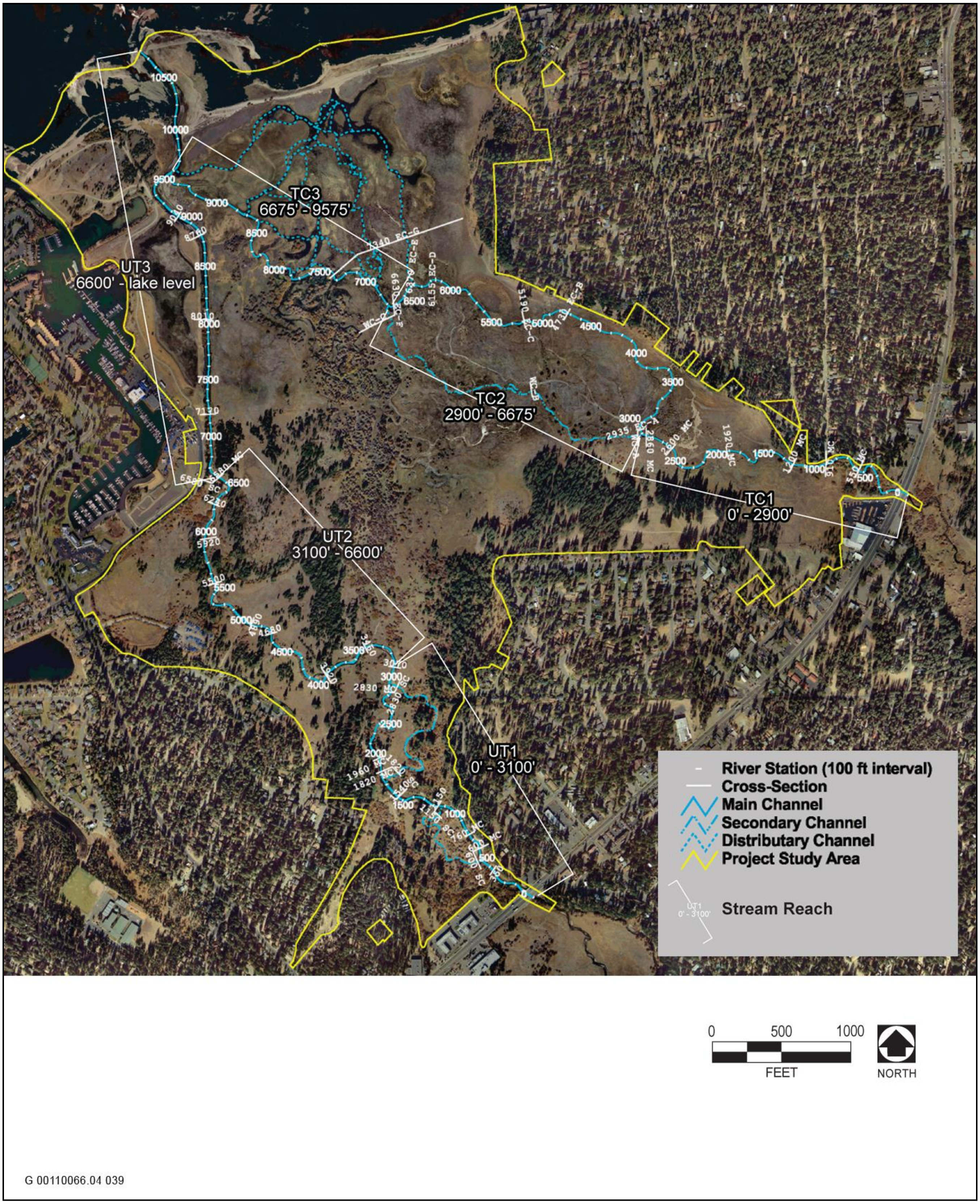
Geomorphology

Geomorphology is generally defined as the study of the processes that shape the surface of the earth and analysis of the formation of landscapes. Environmental factors that influence geomorphic processes include climate and weather, hydrologic conditions, local and regional geology, geologic history, and tectonics. The project study area is located within the Sierra Nevada Geomorphic Province and, more specifically, the southern end of the Lake Tahoe Basin. The basin has formed as the result of block faulting (i.e., tectonic movement) and damming of the outlet of Lake Tahoe (Saucedo 2005:2). The Upper Truckee River occupies a valley developed on and underlain by igneous and volcanic bedrock. Glacial deposits within the Upper Truckee River watershed reflect multiple occupations of the valley by Quaternary glaciers. The presence of lake sediments record past high stands of Lake Tahoe that inundated the valley.

River and hillslope processes have been the dominant recent geomorphic factors, resulting in creation of the active floodplain of the Upper Truckee River and deposition of fluvial and alluvial sediments. The project study area includes the reaches of the river closest to its mouth at Lake Tahoe and its confluence with Trout Creek, a major tributary. The deposition of sediment at this distal end of stream forms the Upper Truckee Marsh. The geomorphology of the area is also influenced by lake processes, which contribute to the creation of a beach and beach berm complex at the northern end of the study area.

River Reaches

Three geomorphically distinct reaches have been identified along the Upper Truckee River and Trout Creek within the study area (Conservancy 2003:4-1) that are generally associated with the "valley," "meadow," and "marsh" portions of each stream (Exhibit 3.9-1). Reach 1 is the area within a relatively narrow valley immediately north (downstream) of the U.S. 50 bridge on each stream. Reach 2 is the transition zone from the narrow valley to the broad floodplain, including the main meadow shared by both streams. Reach 3 is the marsh reach, which has numerous distributaries and a lagoon along Trout Creek, but is a single straight channel along the Upper Truckee River.



Source: Data compiled by Cardno ENTRIX in 2010

Exhibit 3.9-1 Stream Reaches on the Upper Truckee River and Trout Creek within the Study Area

Prior to modern urban development, the Upper Truckee River and Trout Creek were affected by nearly 100 years of watershed-scale changes in land use, hydrology, and sediment loads, and on-site uses (e.g., Comstock-era logging and log transport, early 1900s irrigation dams and ditches, and grazing). In the 1950s and 1960s, the Upper Truckee River channel was directly modified within the study area for urban development: distributaries were cut off and filled, the main channel was straightened and deepened, and the mouth and lagoon were periodically dredged. The following reach descriptions are of existing conditions, rather than an estimate of the undisturbed (i.e., pre-Comstock) conditions:

- Reach 1 of the Upper Truckee River is about 3,100 feet in length and includes an active, main (or primary) channel, as well as secondary channels that carry flow only during large flow events.
- Reach 2 of the Upper Truckee River is a 3,500-foot single-thread,[1] slightly meandering channel.
- Reach 3 of the Upper Truckee River is a relatively straight, deep, and wide channel. The single-thread reach extends about 3,900 linear feet to the river mouth.
- Reach 1 of Trout Creek is a 2,900-foot single-thread, meandering channel.
- Reach 2 of Trout Creek is about 3,775 feet in length and includes two meandering channels: a main (low-flow) and secondary channel.
- Reach 3 of Trout Creek is about 2,900 feet in length and includes several distributary channels that branch off the main channel to flow north through the marsh/lagoon (Exhibit 3.9-1). The lagoon of Trout Creek meets the Upper Truckee River about 240 feet upstream of the beach ridge, while the main channel of Trout Creek enters the Upper Truckee River another 90 feet upstream.

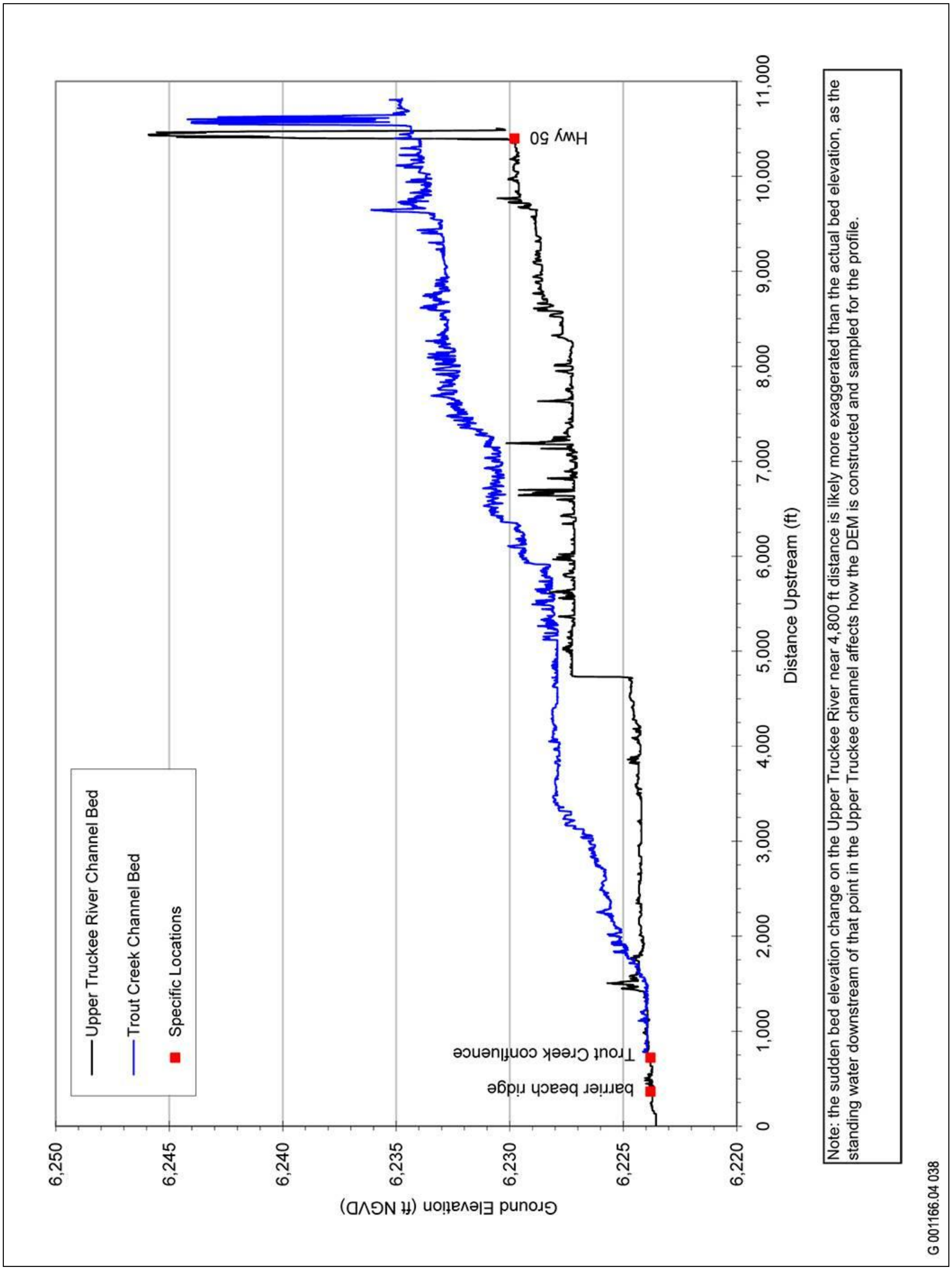
The Upper Truckee River channel position has been largely unchanged since the late 1950s. However, in Reach 1, the low-flow channel has switched position between branches (possibly in response to flood and drought events, log debris jams, and beaver dams). The Trout Creek channel position has also been relatively static since the late 1950s. In the 1980s, bed and bank stabilization was installed on Trout Creek to protect public sewer lines, reinforcing the location of the east branch of the stream.

River Profiles

Both the Upper Truckee River and Trout Creek have very low-profile gradients (i.e., channel bed steepness) within the study area. The average streambed slope of Trout Creek is 0.00106 (0.106 percent) and that on the Upper Truckee River is 0.00155 (0.155 percent). The profile steepness varies by reach on each stream. Trout Creek has a higher bed elevation (relative to the river) and a fairly consistent bed slope of 0.00085 (0.085 percent) in Reach 1. The slope steepens slightly to 0.00099 (0.099 percent) in the floodplain and meadow of Reach 2. The steepest slope on Trout Creek (0.00138 or 0.138 percent) is found within a short transition zone of Reach 3 that extends down from the meadow to the lagoon and lake. The Upper Truckee River bed in Reach 1 is lower and has a steeper slope of 0.0041 (0.41 percent) than Reach 1 on Trout Creek. The Upper Truckee River transitions to an even lower floodplain and meadow slope of 0.00089 (0.089 percent) in Reach 2. Past channelization and dredging have lowered the channel bed elevation throughout much of Reach 3 of the Upper Truckee River, resulting in an extremely low bed slope (0.00017 or 0.017 percent) (Exhibit 3.9-2).

The different bed elevations and profile shapes on the two streams (Exhibit 3.9-2) reflect differences in floodplain processes and lake interactions. The Trout Creek channel bed is higher (i.e., nearer to the floodplain/meadow ground surface), remaining above the median lake level (approximately 6,226 feet National Geodetic Vertical Datum [NGVD]) through most of the site, except along the 1,800 feet of channel closest to the lake. In contrast, the Upper Truckee River channel bed elevation is lower than the median lake level for nearly 5,000 feet upstream

[1] The term “single-thread” indicates that one primary active channel of the river is present (as opposed to multiple channels).



Source: DEM 2001

Exhibit 3.9-2 Streambed Profiles of the Upper Truckee River and Trout Creek through the Study Area

of the lake. Therefore, the Upper Truckee River channel is more affected by backwater from the lake. Whenever the lake rises, more of the Upper Truckee River channel onsite would be inundated by lake waters than would Trout Creek.

Channel Capacity

Historical alterations of the river and watershed and related channel response have resulted in increased cross-sectional area of the channel of the Upper Truckee River. Because of this increased cross-sectional area throughout the study area, the frequency and area of inundation by overbank flows (i.e., floodplain connectivity) has been reduced. A flow of at least 1,000 cubic feet per second (cfs) is required before the Upper Truckee River overtops its banks throughout most of the study area, and at least 1,212 cfs is required in some of the larger single-thread channel sections (Conservancy 2003:4-19). This magnitude of streamflow is close to the estimated 5-year recurrence interval[2] peak flow (see Section 3.8, Table 3.8-3). The capacity of the channel of the Upper Truckee River exceeds 2,000 cfs in portions of Reach 1. In these portions of Reach 1, flows close to the 10-year event magnitude may be contained in the channel. Because the oversized channel contains such large flows, erosive forces on the banks are greater than would be expected for this very-low-gradient reach. In turn, the exaggerated erosive forces create adverse erosion and water quality conditions, which are described in greater detail below.

Along Reach 1 of Trout Creek, the estimated channel capacity ranges from about 150 to 200 cfs (Conservancy 2003:4-22), which is roughly between the 2- and 5-year estimated recurrence peak flows (see Section 3.8, Table 3.8-3). Channel capacity on Trout Creek decreases in Reaches 2 and 3 in the multiple thread and distributary channel areas. Therefore, flows overtop the channel banks more frequently and erosive forces are lessened.

Streambank Erosion

Studies of sediment sources for Lake Tahoe included an estimation of contribution of streambank erosion to fine sediment loads (i.e., sediment that is less than 0.063 millimeter [mm] in diameter) delivered to the lake by individual tributary streams (Simon et al. 2003:ES-1; Simon 2006:618). The Upper Truckee River was identified as the stream with the highest fine sediment loads contributed by bank erosion. Although these studies did not make quantitative estimates of bank erosion for each reach of the river, the average annual erosion rate for fine sediment from streambanks for the Upper Truckee River is 639 tons per year and approximately 63 percent of the total fine sediment from its entire watershed (Simon 2006:635). The relatively large percentage of the total fine sediment loads attributed to streambank erosion indicates the important effect of this process on water quality.

The total maximum daily load (TMDL) analysis of Lake Tahoe sediment load reduction opportunities (California Water Boards and NDEP 2008:211-215) also produced quantitative estimates of erosion of fine sediment from streambanks of the Upper Truckee River, including estimates covering the study area reaches (Table 3.9-5). Although the study area reaches are nearly 12 percent of the total length of the river studied in this TMDL analysis, the study area reaches account for only 4.7 to 6.3 percent of the fine sediment eroded from streambanks. This indicates that the study area reaches have proportionally less streambank erosion than other upstream reaches of the river. This is not unexpected, because the upstream reaches have steeper channel slopes, greater percentages of banks actively failing, and in some locations, a greater proportion of fines in the banks than the study area reaches. These data are consistent with the relative pattern of bank failure observed by reach within the study area. The greatest bank erosion is within the study area in Reach 1, likely because there the channel is eroding against the side slope of the valley. Although the absolute values of estimates from the TMDL analysis of

[2] The magnitude, or amount, of streamflow is generally described as discharge at a point (i.e., the volume of flow per unit of time). Discharge is variable over time in response to changes in precipitation and water runoff. Expected flow event (or flood) is defined by the probability that a certain rate of flow is possible in any one year. For example, the "100-year flood" is the rate of flow with a 1 percent chance (1 in 100) occurring any one year; a 5-year flood has a 20 percent chance (1 in 5) of occurring.

load reduction opportunities should not be considered precise, these estimates provide useful data for comparisons of the impacts of project alternatives on bank erosion.

Table 3.9-5
Estimated Stream Channel Bank Erosion on the Upper Truckee River within the Study Area for Above-Average Streamflow Year and Event

River Station (feet)[1]	Length (feet)	Percent Bank Failing (% of length)	Estimated Existing Bank Erosion of Fine Sediment (cubic yards)	
			Assuming Upper Truckee River Average % Fines[2] Bank Composition	Assuming Reach-Specific % Fines[2] Bank Composition
Entire Upper Truckee River Watershed				
Upper Truckee River Total	81,693	20.2	4,174	4,320
Upper Truckee River within the Study Area				
Mouth to 53+48 (Study Reach 3 and portions of Reach 2)	5,348	13.8	12.7	3.1
53+48 to 64+30 (most of Study Reach 2)	1,082	5.2	4.8	3.9
64+30 to 96+78 (Study Reach 1)	3,248	26.6	243.3	197.8
Site Subtotal	9,678	-	260.8	204.8
Site as Percent of Upper Truckee River	11.85%	-	8.2%	6.2%

1 River stationing is that from the total maximum daily load studies, to reflect their data set.
2 Fine sediment is less than 0.063 millimeter in diameter.
Source: California Water Boards and NDEP 2007

Overbanking

In natural alluvial stream systems, the form and capacity of the active channel are generally developed such that high frequency flows (e.g., typical seasonal variations in discharge) are contained within the banks. Less frequent, larger flows result in overtopping of the banks and inundation of portions or all of the floodplain. Normal overbanking is considered to occur when the channel overtops during a 2-year recurrence streamflow event. In other words, a naturally or normally functioning stream would be expected to typically overbank, on average, approximately during one event (for a period of several days to a couple of weeks) every couple of years. The relatively large channel capacity of the majority of the Upper Truckee River within the study area severely limits the opportunity for flows to reach or overtop the banks during the typical snowmelt season (Table 3.9-3). Therefore, streamflow (and the sediments and nutrients conveyed by the flow) is rarely able to spread out on the floodplain. To illustrate the reduction in overbanking, 35 years of recorded streamflow data were statistically analyzed and indicate that channel reaches with a capacity of 1,000 cfs would only overtop an average of just three–five days yearly, and reaches with a capacity of 2,000 cfs would not overtop (Table 3.9-6). The enlarged river channel reduces the potential for sediment deposition on the floodplain and, therefore, results in increased transport of fine sediment through the study area and to the lake (Stubblefield et al. 2006:287-302). In spatial terms, the lengths of existing Upper Truckee River streambank in the study area that would be overtopped during a 2-year streamflow event (760 cfs), for median and low lake levels, are estimated to be 2,129 feet and 1,520 feet, respectively (Conservancy and DGS 2005:Appendix A). This indicates that less than 10 percent of the channel length within the study area would support normal overbanking processes.

Table 3.9-6 Average Percent and Number of Days during Typical Snowmelt Months that the Upper Truckee River Mean Daily Streamflow Exceeded Channel Capacity (Water Years 1972–2007)*								
Estimated Channel Capacity (cfs)	Month							
	April		May		June		July	
	Percent of Days	Number of Days	Percent of Days	Number of Days	Percent of Days	Number of Days	Percent of Days	Number of Days
1,000	0.001	<1	0.010	**3**	0.004	<1	0	0
2,000	0	0	0	0	0	0	0	0

Note: cfs = cubic feet per second

* Based on analysis of U.S. Geological Survey Upper Truckee River Gauge #10336610 mean-daily flows by month for water years 1972–2007.

Source: Data compiled by Valley & Mountain Consulting in 2008

In contrast to the river, Trout Creek has a relatively less incised channel and greater floodplain connectivity (Stubblefield et al. 2006:287–302). The channel capacity for Trout Creek ranges from about 150 to 200 cfs in Reach 1, decreasing somewhat in Reaches 2 and 3. The channel would be overtopped between the calculated 2- and 5-year recurrence peak flows in Reach 1, and more often in Reaches 2 and 3 (Conservancy 2003:4-22). The channel capacity of Trout Creek allows more flows to reach or overtop the banks during the snowmelt season than does the channel capacity of the Upper Truckee River (Table 3.9-7). Under the existing channel conditions, streamflow (and the sediments and nutrients conveyed by it) spreads out on the floodplain for over a week (about 10–11 days per year on average) over the entire season.

Table 3.9-7 Average Percent and Number of Days during Typical Snowmelt Months* that Trout Creek Mean Daily Streamflow Exceeded Channel Capacity (Water Years 1972–2007)								
Estimated Channel Capacity	Month							
	April		May		June		July	
	Percent of Days	Number of Days	Percent of Days	Number of Days	Percent of Days	Number of Days	Percent of Days	Number of Days
150 cfs	0.001	<1	0.104	**3**	0.206	**6**	0.045	**1**
200 cfs	0	0	0.042	**1**	0.079	**2**	0.021	<1

Note: cfs = cubic feet per second

*Based on analysis of U.S. Geological Survey Trout Creek mean daily flows by month for water years 1972–2007.

Source: Data compiled by Valley & Mountain Consulting in 2008

Floodplain

Most of the study area is a floodplain that is shared by the Upper Truckee River and Trout Creek under maximum streamflows and lake levels. In major floods, the waters from both streams mix in the middle of the marsh. For smaller streamflows and lower lake levels, the area of floodplain wetted by each stream becomes distinct and the area of mixing is limited to the mouth reaches or the lagoon and mouth reaches. The area and duration of floodplain inundation is affected by many variables on each stream, and in turn influence the location and amount of floodplain sedimentation.

To describe existing conditions and allow comparison with the conditions resulting from the proposed alternatives along the Upper Truckee River, modeling (HEC-RAS) of potential inundation area was performed. This modeling used topographic cross sections and water surface profiles along with digital elevation surface analysis (using GEO-RAS). The modeling assumed a 2-year recurrence streamflow (760 cfs) and a median starting lake level. The inundation area is less if lake level is lower, and is greater if lake level is higher.

For existing topographic and geomorphic conditions, the modeled floodplain inundation area is 65 acres, covering a narrow and discontinuous area (Exhibit 3.9-3). In the upstream half of the site (approximately River Station [RS] 0+00 to RS 40+00), inundation is restricted to the area alongside channels. In the center of the site (approximately RS 40+00 to RS 70+00), some overflow from the channel onto the floodplain occurs, along with backwater up into side channels or ditches, or both. In the downstream portion of the site (approximately RS 70+00 to RS 92+00), overflow is relatively broad on both sides of the channel, particularly in the recently restored Lower West Side Restoration Area wetlands.

Although the Upper Truckee River has reduced frequency and extent of overbank flows under existing conditions, some overbank flow and floodplain sedimentation does occur. Stubblefield and others (2006:287–302) measured how differences in the frequency and extent of overbank flows in various parts of the Upper Truckee River and Trout Creek floodplain affected suspended sediment and total phosphorus loads during the 2003 snowmelt season. Measurements indicated that as water depths and floodplain connectivity increased, sediment retention on the floodplain also increased. Greatest sediment and nutrient retention were measured for water flowing through the lagoons and beaver dam backwater areas of the marsh (more or less Reach 3) on Trout Creek.

Soil cores taken from the marsh indicate that net sedimentation has been occurring on both the Trout Creek and Upper Truckee River portions of the study area (Winter 2003:64). Since the 1950s, the average vertical accretion rates have been 0.25 inch per year on the Trout Creek floodplain and 0.35 inch per year on the Upper Truckee River floodplain. These modern net sedimentation rates are significantly greater than rates averaged over the last ~1,650 years (0.032 inch per year) or over the last ~4,620 years (0.028 inch per year [Winter 2003:65]). The mass sedimentation rates on the study area are greater than at Pope Marsh (Kim 1999:25, Winter 2003:78), where net biological accumulation/decomposition of groundwater-supported peat (Green 1998) may play a stronger role in vertical accretion of the marsh surface than deposition of mineral material.

River Mouth(s)

Analysis of historic maps and aerial photographs from 1861 through 2002 was performed to study the location(s) and dimensions of the Upper Truckee River and Trout Creek as they enter Lake Tahoe (Conservancy 2003:3-11). These data indicate that the position of the mouth of the Upper Truckee River has laterally migrated about 1,000 feet over about 150 years. The migrated location has ranged from 750 feet west (in 1860s and 1914) to 275 feet east of the present location of the mouth. The oldest maps suggest that Trout Creek and the Upper Truckee River had a single outlet to the lake, similar to present conditions. However, some historical photographs (from 1940 and 1965) show a separate Trout Creek outlet through the beach ridge to the lake. A separate Trout Creek mouth has been observed recently during and following large flood events (e.g., in 1997 and 2005). The location of a separate Trout Creek mouth has been consistent, although the frequency and duration of a direct discharge from Trout Creek to the lake at this location is not known.

The historical aerial photograph analysis also documented that the Upper Truckee River mouth has ranged from around 50 feet wide to over 250 feet wide since 1940 (Conservancy 2003:3-11), with no clear trend over time. The river mouth widths in the photographs would be expected to vary in relation to lake level and streamflow, with a wider river mouth generally associated with larger flows and higher lake levels. However, the river mouth width at any given time (or photograph) could also reflect preceding conditions (such as a drought or flood), vegetation density at the mouth, and alteration by dredging and straightening.

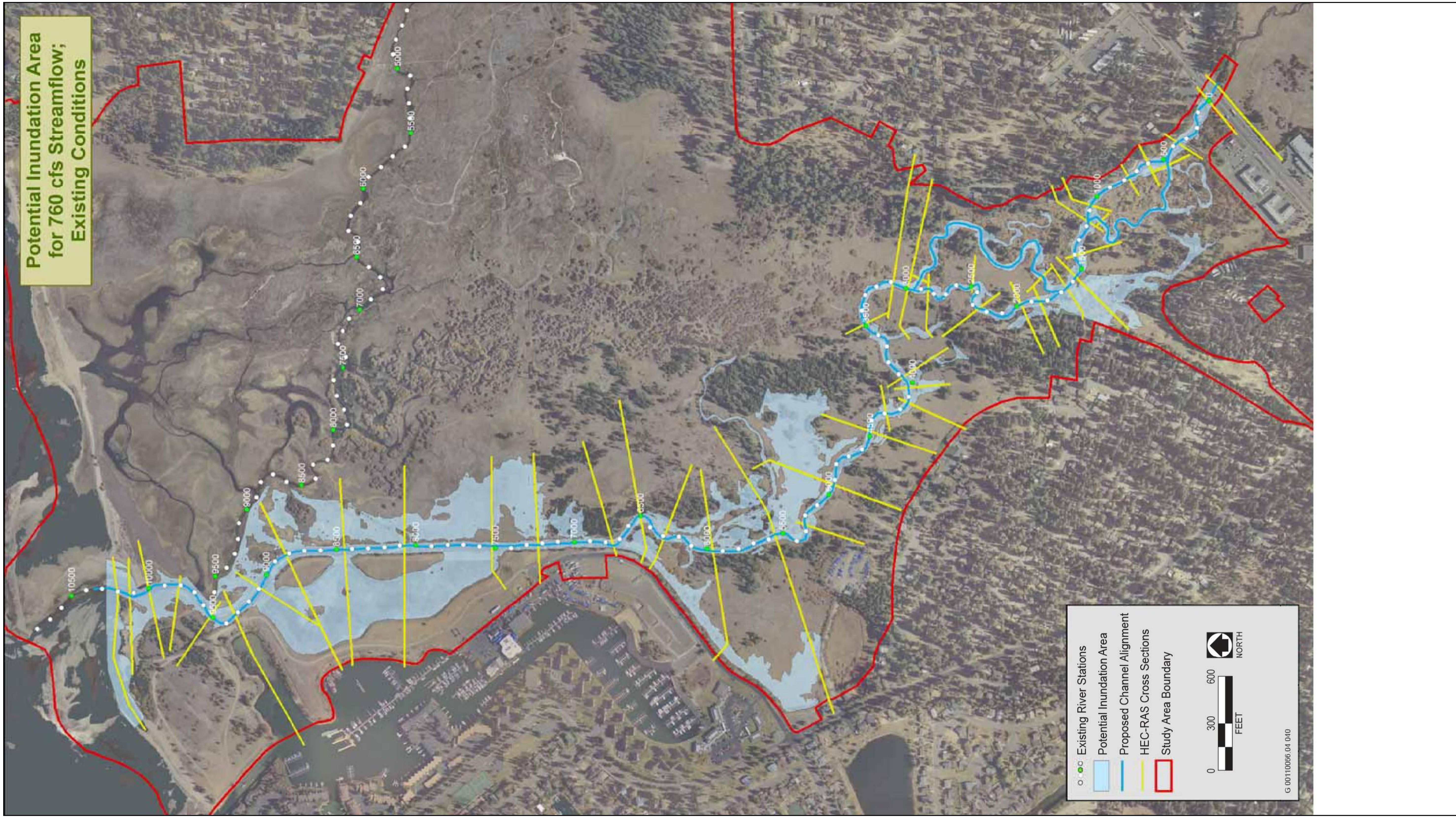


Exhibit 3.9-3 **Approximate Overbank Inundation Area from the Upper Truckee River at 760 Cubic Feet per Second Streamflow, under Median Lake Level**

Lagoons

The dynamic interaction of river and lake processes at the mouth of the Upper Truckee River results in a range of geomorphic features, including the formation of a beach, beach berm, and lagoon environments. Natural influences on these processes include variable river flows and sediment transport and changing wave conditions, lake currents, and lake levels. Under undisturbed conditions, transport of sediment along the beach probably caused the mouth of the river to close during low streamflow conditions and formation of a lagoon behind (landward of) the beach berm. The existing conditions of the Upper Truckee River mouth, beach, and lagoon system have been modified from predisturbance conditions by a combination of watershed-scale changes in land use, hydrology and sediment supply for the beach, the raising and regulation of the Lake Tahoe outlet, site-specific land and water use (e.g., Comstock-era log rafting and transport), and the navigation channel(s) construction and maintenance since the 1950s (Conservancy 2003:3-23). The direct alterations have included dredging to deepen and widen the mouth of the Upper Truckee River, excavation and dredging to create the former boat launch area (i.e., the Sailing Lagoon), and later, the placement of fill to disconnect the Sailing Lagoon and present marina from the river.

An indicator of changes in lagoon area is the total area of standing water observed on historical aerial photographs. The relationship of water area in the study area to lake level generally displays an expected increase with higher lake levels (Exhibit 3.9-4). Generally, the area of standing water increases as lake level increases. This general correlation seems fairly strong for the data in the extreme range of lake levels (e.g., lake levels 6,220–6,222 feet and 6,228–6,229 feet NGVD). However, there is considerable variation in the data points representing a relatively narrow lake elevation range (e.g., 6,225–6,228 feet NGVD), suggesting that factors aside from lake level are important controls. Several other factors may also produce the observed pattern: river mouth and back beach topography; groundwater levels; surface water flow (via stream channels or overbank flooding); evaporative losses; and temporary dams and diversions by beaver or humans (Conservancy 2003:3-26).

Lagoon-area changes over time may reflect human impacts on the lagoon system (Conservancy 2003:3-23). For example, at relatively high lake levels (6,226–6,228 feet NGVD), the older photographs display smaller areas of standing water than more recent images. Also, the area of standing water at median lake levels (approximately 6,226 feet NGVD) has decreased since the 1970s. These patterns may reflect changes resulting from dredging of the river mouth, channel incision, beach erosion or excavation, or some combination of these processes, along with historical groundwater pumping and sedimentation (i.e., filling) of the lagoon environment. At high lake levels, lake water can more readily enter the site through the current incised and dredged channel. At low lake levels, surface runoff may more readily exit the site through the incised and dredged channel and by percolation to groundwater in the lagoon area.

A comparison of the water surface area of the Sailing Lagoon to the lake level illustrates differences between this artificially modified water body and the rest of the marsh (Exhibit 3.9-5). These data show that its constructed shape (i.e., steep sided, deep, and surrounded by higher ground) maintains a surface area of water consistently between 3 and 4 acres whether lake level is high and near legal maximum (e.g., 1999) or low and down to the natural rim (e.g., 2002). The only case when the Sailing Lagoon is smaller than 3 acres is when lake level is below the natural rim (e.g., 1992). The other extreme is the 1965 photo, when the Sailing Lagoon had a very large connected water area because the river mouth was dredged to allow navigation up the river mouth into the Sailing Lagoon.

The Tahoe Keys Marina (TKM) occupies about 8 acres of land and 13.5 acres of water immediately west of the study area (TRPA 2002b:1-1). The TKM water body has an open surface water connection to Lake Tahoe through the East Channel and an open-water connection to the Sailing Lagoon within the study area. The water in the TKM interacts with water in the channels of the Tahoe Keys via a circulation system, shared with the Tahoe Keys Property Owners Association (TKPOA), that operates under a NPDES permit (Lahontan RWQCB 2004:1). Therefore, under the present configuration and operations, the surface water of the marina and keys channels may interact with that in the Sailing Lagoon.

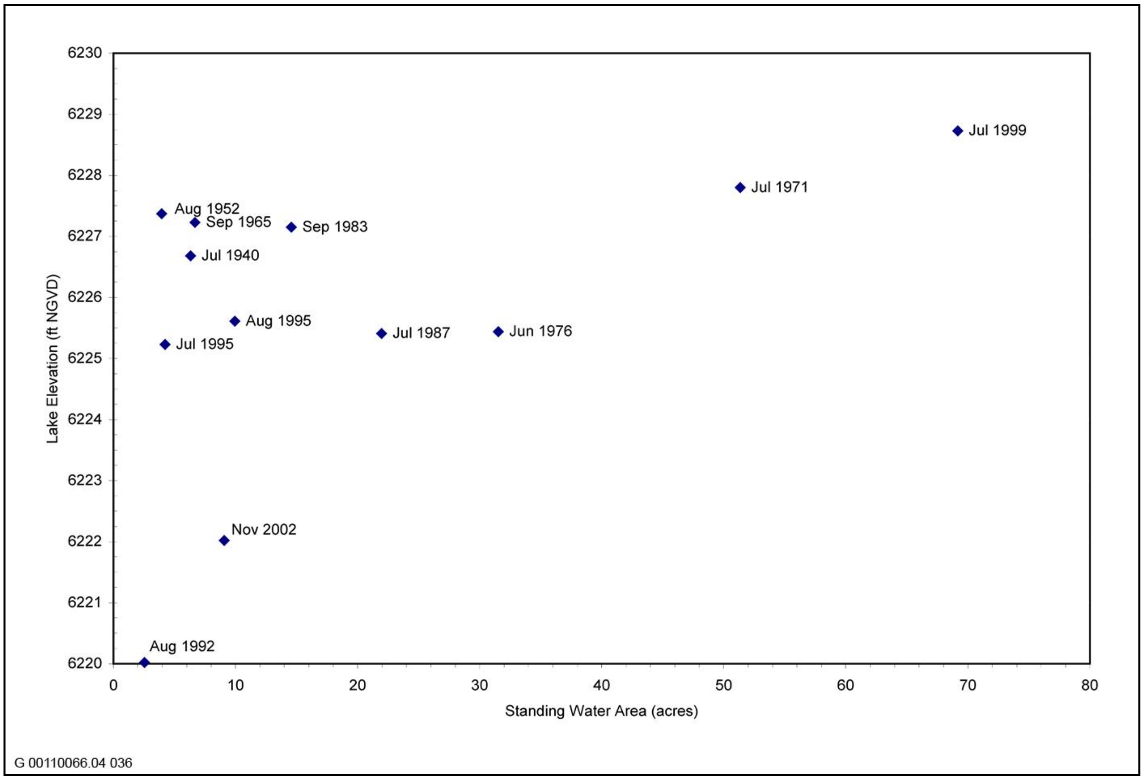


Exhibit 3.9-4 **Relationship of Standing Water Area on Study Area to Lake Elevation (1940–2002)**

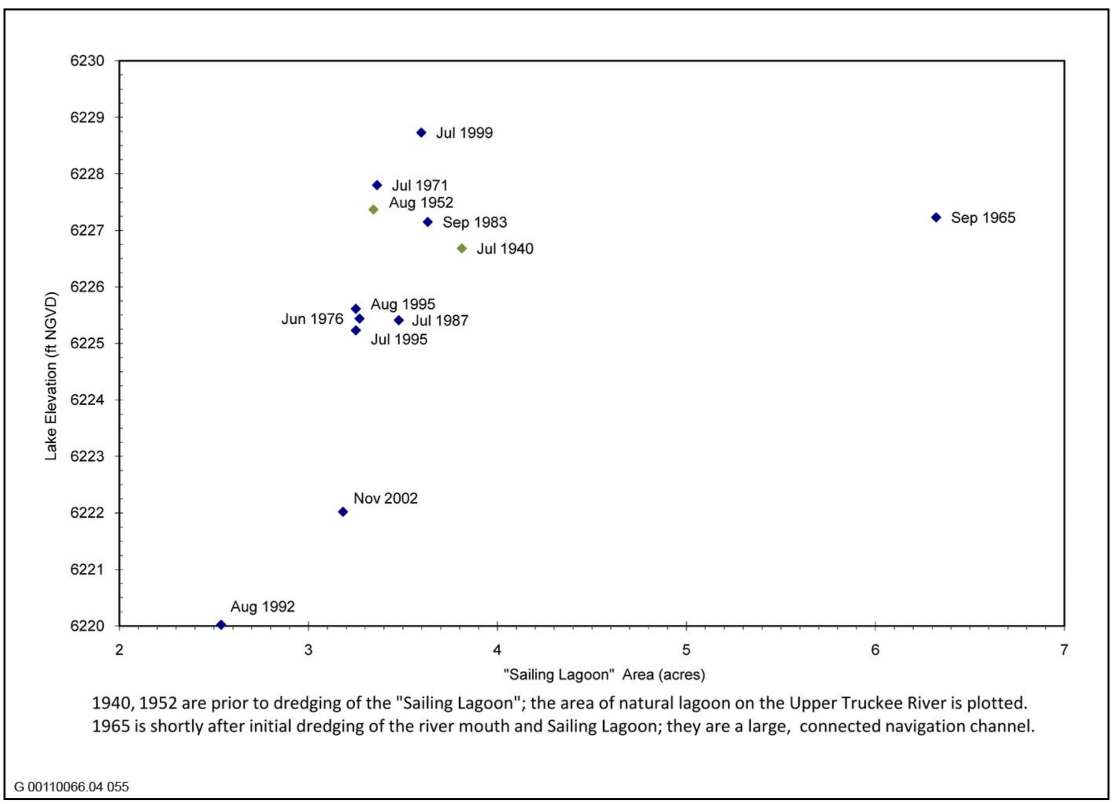


Exhibit 3.9-5 **Relationship of Sailing Lagoon Water Area to Lake Elevation (1940–2002)**

Because the TKM is an artificial water body and its operation requires a navigation channel out into the lake, dredging at the East Channel entrance to the TKM and out into the lake has occurred in the past and is expected to continue. The maintenance dredging of TKM occurs under permits from USACE (CWA 404), the Lahontan RWQCB (CWA 401), the California State Lands Commission, the California Department of Fish and Game (CDFG) (lakebed alteration agreement), and TRPA.

Tahoe Keys Marina and Tahoe Keys Channels

The TKM maintenance dredging has used a couple of different methods (i.e., suction dredger and clamshell bucket). Lahontan RWQCB (2005) Regional Board Order No. R6T-2005-0015 NPDES CAG616003 includes the following discussion of maintenance dredging that indicates beach replenishment is not prohibited, but would require permitting as a "complex" maintenance dredging project:

> …A simple maintenance dredging project must meet all of the following criteria: (1) no temporary on-site storage of spoils, (2) no on-site dewatering of dredged spoils, (3) no use of a flocculent for settling spoils, (4) no discharge of decant water to surface waters, and (5) no beach replenishment.
>
> …If the dredging project includes fill below high-water or beach replenishment, the Discharger must also submit a complete application for Section 401 Water Quality Certification in accordance with Title 23, Section 3856 of the California Code of Regulations.
>
> …Bypass dredging which involves beach replenishment by redeposition of dredged sediments may be allowed on a case-by-case basis only if the Discharger can show through pre-project substrate sampling that the dredged material is cleaner than the material that exists in the proposed replenishment area.

Dewatering and settling of the dredged slurry and off-site disposal has been the environmentally preferred option accepted by the Lahontan RWQCB and TRPA (TRPA 2002a). This is consistent with general BMPs requiring that all dredged sediments be removed from the lake and disposed above its high-water rim (TRPA 2002b:3-7). Sediments excavated during dredging at TKM have been removed from the area (i.e., hauled offsite), and therefore have not been transported to or deposited in the lake or shorezone (TRPA 2002b:4-9). Bypass dredging (which would redeposit sediment in another local area) has not been conducted. TKM has noted the potential beneficial impacts of bypass dredging to leave coarse material in the littoral zone of the lake (TRPA 2002b:4-4), but is uncertain whether this technique would be used for future dredging.

Beaches

The shoreline is a dynamic environment where wave action and lake-level fluctuations are dominant forces, interacting primarily with sediment supply to control the size, elevation, and position of the beach. The study area has two distinct beach areas, one on either side of the Upper Truckee River mouth (Exhibit 3.9-1). The beach west of the river, known as Cove East Beach, is about 800 feet long and lies between the TKM East Channel and the river. The beach east of the river, known as Barton Beach, is about 2,600 feet long and extends eastward from the river to the Al Tahoe residential neighborhood.

In terms of waves and currents, the study area and its adjoining shallow lake areas within one–two miles east and west likely behave as a littoral circulation cell (Orme 1971:10, Osborne et al. 1985:29). A distinct littoral cell has also been identified between the mouth of the Upper Truckee River and the Ski Run Marina (Foxx, Nielsen, and Associates 1989:8). The circulation pattern limits the possible sources of sediment for the study area beaches to other beaches and the shallow nearshore of the lake within the cell.

Generally, beach sediment has four possible sources: local cliffs, offshore bars, the nearshore, and riverbed load (Orme 1971:4-5). Under present conditions in the study area, the erosion of the beaches themselves has been determined to be a larger source than the riverbed load (Osborne et al. 1985:9-10). These materials are delivered to or removed from the beach by onshore/offshore wave transport and alongshore drift in lake currents (Selby 1985:359–360). Long-term beach sediment loss occurs when sediment is transported to deep offshore sinks (or if dredging and upland disposal removes sediment from the river or shorezone).

Understanding changes in the study area’s beach and shoreline conditions over the geologic time scale (10,000–100,000 years or more) is not critical for assessing changes resulting from the project. However, beach and shoreline changes over shorter time scales, such as hundreds to thousands of years, provide important context for evaluating the potential impacts of the project.

Over the last few thousand years, there have been substantial changes in the shoreline boundary near the study area. During the mid-Holocene (about 5,000 years ago), lake level was several feet lower than at present and the shoreline was about 0.25 mile farther north (Conservancy 2003:3-1). Over the next couple of thousand years, runoff and lake levels increased, and the barrier beaches and backshore marshes may have been initiated (Adams and Minor 2001:3).

Over the past couple hundred years, there have been substantial changes in sediment supply and hydrology that also modified lake levels and shoreline conditions (Stine 1994; Heyvaert 1998, 2001; Conservancy 2003). These include natural climate-driven shifts, the results of watershed-scale land use and vegetation changes, direct management of the lake outlet at Tahoe City, and local dredging (Orme 1971:13).

Dramatic increases in sediment delivery to the lake occurred during the Comstock logging era, followed by watershed recovery that reduced lake sedimentation rates between 1900 and 1970 (Heyvaert 1998:134) (Table 3.9-8). Similarly, increased deposition in Pope Marsh between the 1880s and 1910s has been documented (Kim 1999:34).

Table 3.9-8
Historic Watershed Condition and Lake Sedimentation Rates

Time Period	Watershed Condition Land Use [1]	Lake Core Mass Sedimentation Rate ($g/cm^2/yr$) [2]
Predisturbance “pre-1850”	Predisturbance	0.006 (± 0.003)
Comstock Era 1860–1890	Extensive logging and construction of logging roads; log runs down Upper Truckee River	0.043 (± 0.011)
1900–1970	Forest Second Growth; rapid urbanization in 1960s	0.009 (± 0.004)
Modern 1970–1990	Continued forest regrowth and urbanization	0.027 (± 0.006)

Note: $g/cm^2/yr$ = gram per square centimeter per year
1 Source: Lindström 1996, 2000
2 Source: Heyvaert 1998

Historical maps are consistent with the lake and Pope Marsh indicators. The study area shoreline advanced from 1861 to 1914 (i.e., moved northward into the lake), from about 50 feet in some areas to as much as 200–300 feet in other locations (Conservancy 2003:3-16). These data support hypotheses that greater watershed sediment production and delivery to the lake during the late 1800s would have been accompanied or followed by shoreline advance into the lake as sediment was mobilized, transported, and reworked over the following decade(s) (i.e., 1890s to 1910s).

For the first half of the 1900s, nearshore sediment would not have been replenished from the watershed at the same high rate as during the Comstock Era, which is a factor favoring shoreline erosion. Between 1914 and 1940, historical maps and aerial photos show net shoreline erosion at the study area (Conservancy 2003:3-12): the Barton

Beach shoreline east of the 1940 Trout Creek mouth experienced retreat of 20–60 feet in some areas and as much as 50–190 feet in others; and the west side of the study area experienced retreat of as much as 300 feet, to about the same position as in 1861. The 1940 shoreline between the mouths of Trout Creek and the Upper Truckee River did not shift. These data indicate that shoreline erosion and retreat at the study area began prior to the Tahoe Keys development, probably due to watershed sediment load changes and management of the lake outlet.

Considerable and continued shoreline retreat since 1939 has also been quantified (Adams and Minor 2002, 2001; Conservancy 2003). The continued erosion may still reflect watershed sediment trends and lake level management, but as exacerbated by local dredging. The following observations have been made from aerial photo analysis of erosion at the study area since 1940 (Conservancy 2003: Chapter 3):

- Between 1940 and 1995, the portion of the study area west of the Upper Truckee River mouth experienced net shoreline retreat on the order of 90–120 feet, with 50–100 feet of retreat near the river mouth. Barton Beach had net retreat ranging from 70 to 135 feet just east of the river, but less than 10 feet east of the Trout Creek mouth (Exhibit 3.9-6).

- Between 1940 and 1965, some local shoreline advance occurred on portions of the Barton Beach, but net erosion followed from 1965 to 1983 (Exhibit 3.9-7).

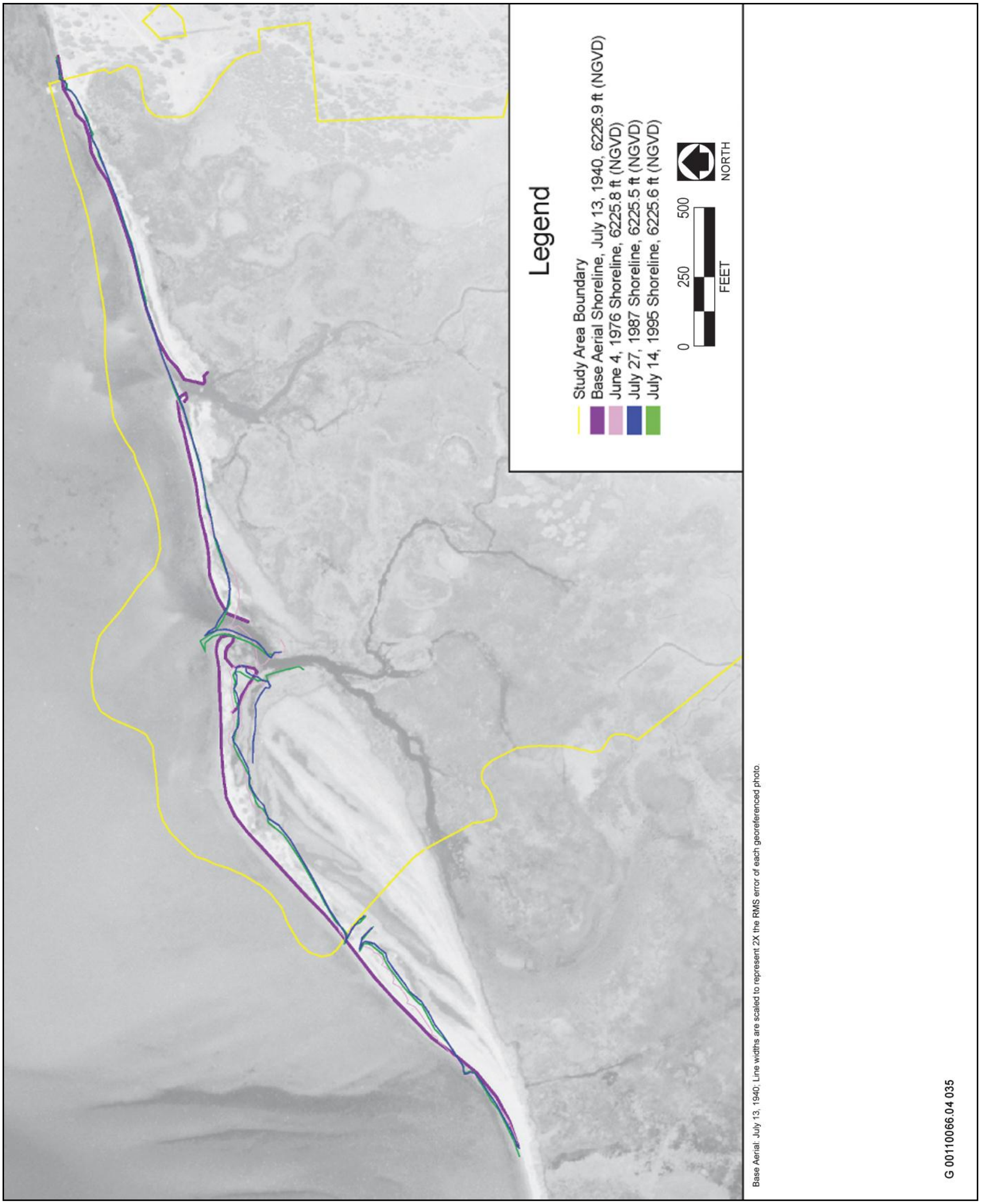
- Between 1971 and 1999, net shoreline retreat east of the Upper Truckee River mouth ranged from 35 to 50 feet and as much as 50–70 feet near the sand spit. However, some areas of sand deposition occurred over this same period east of the river mouth (Exhibit 3.9-8).

Several local studies of beach and shoreline conditions conducted shortly after development of the Tahoe Keys identified substantial net erosion (ranging from three to over 50 linear feet of retreat) for storm events in March and June 1970 (Orme 1971, Budlong 1971). Comparison of lake bed surveys from 1922 and 1970 documented a trend of net nearshore erosion and sediment loss of over 300,000 cubic yards (averaging greater than 6,000 cubic yards per year) in the vicinity of the study area. While this loss was largely attributed to development impacts on the channel and sediment delivery to the lake, more recent studies (Conservancy 2003:3-21) suggest that some sediment loss may have begun prior to development.

Beach particle composition and shape data also indicate net shoreline erosion. The study area beach sediment is primarily granitic sand of granule and small pebble diameters, with magnetite in the sand-size class (Orme 1971:5). Osborne and others (1985) determined that the beach sediment morphology was enriched with irregularly shaped and angular grains, indicating backshore erosion is now an important sediment supply to the beach.

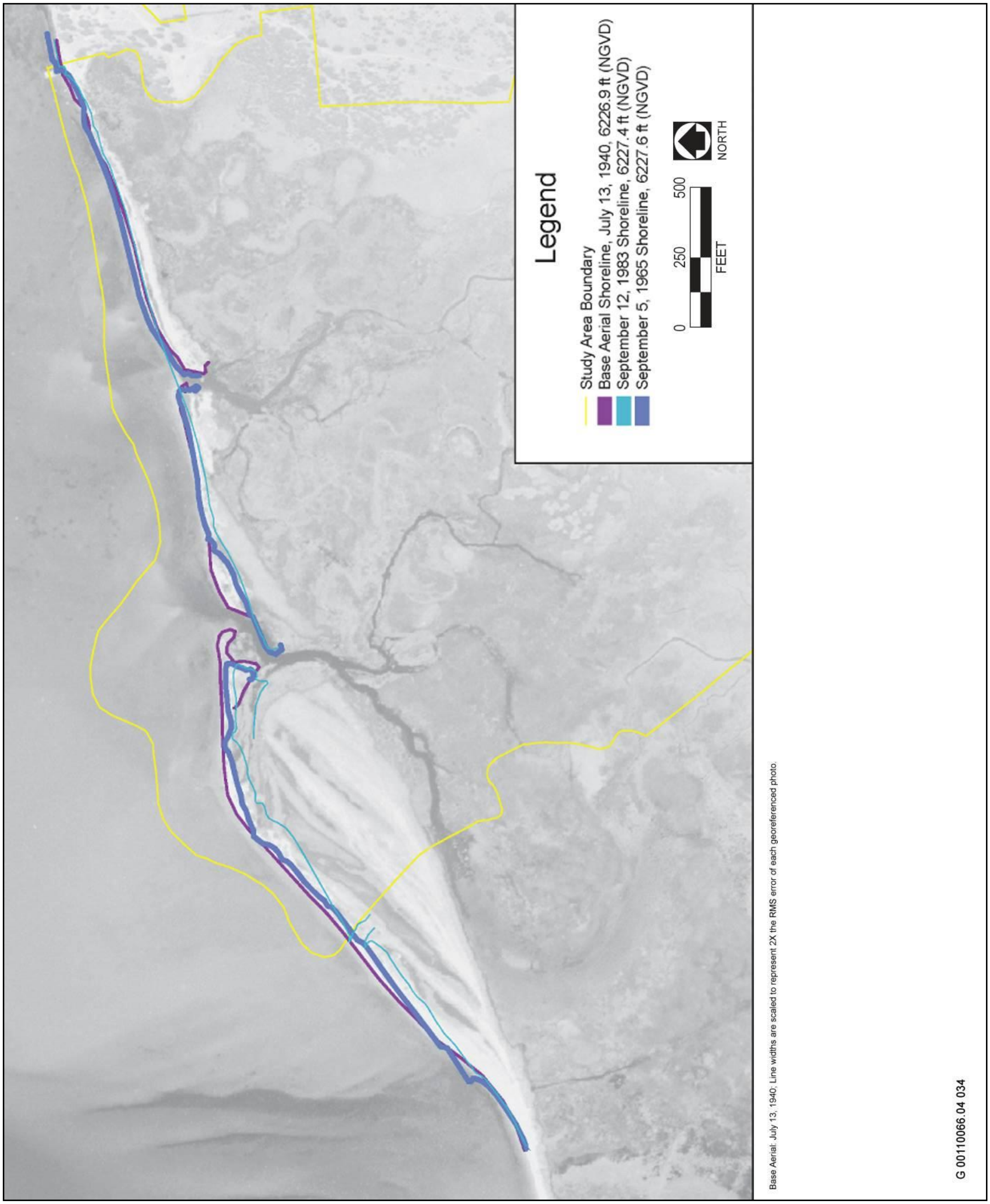
An additional indicator of net beach erosion at the study area is the change in relationship of exposed, unvegetated beach to lake elevation over the last 60 years (Exhibit 3.9-9). While generally showing the expected increase of beach exposed at lower lake levels, the variations over time reflect net shoreline erosion, and flood and drought cycles, as well as the Tahoe Keys development (Conservancy 2003:3-21). For example, historical aerial photographs in 1940, 1952, 1965, and 1983 are all for lake elevations within about one foot of each other, yet the two older, predevelopment examples have considerably more beach area.

The construction and maintenance of navigation channels, jetties, and small groins that cross through the beach and/or extend from the beach into the nearshore have altered shorezone processes and affected beach conditions west of the study area (Orme 1971:14-15). Historic grazing (discontinued after 2000) could have affected vegetation and reduced dune stability, and was identified as a possible impact on shoreline erosion along Barton Beach. Excavation, grading/leveling, and vegetation removal occurred at the former dune field west of the mouth of the Upper Truckee River in 1969 (Budlong 1971:80).



Source: CardnoENTRIX 2008

Exhibit 3.9-6 Shoreline Erosion, 1940–1995, Documented by Georeferenced Aerial Photographs for Lake Levels near Median

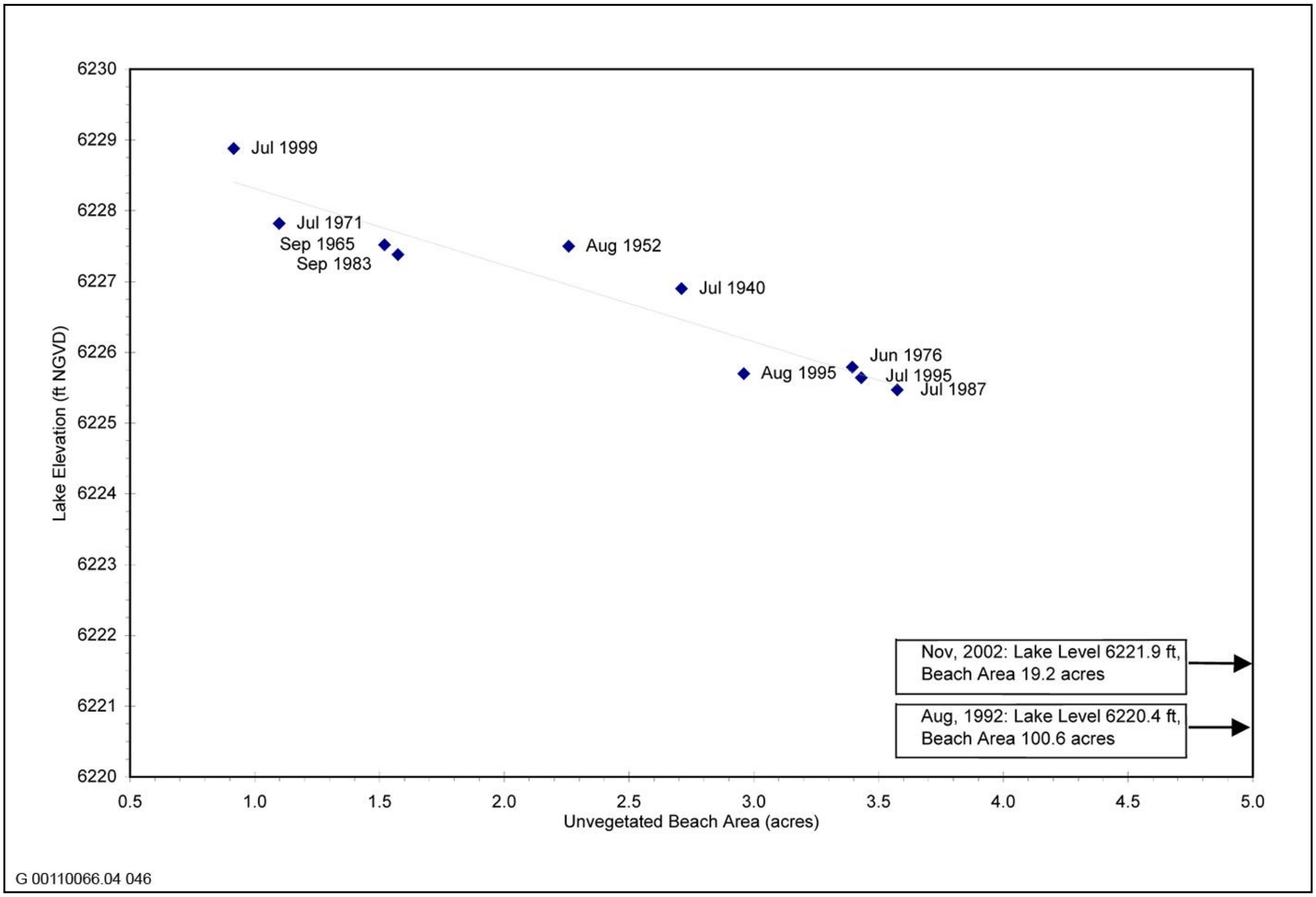


Source: CardnoENTRIX 2008

Exhibit 3.9-7 Shoreline Erosion, 1940–1983, Documented by Georeferenced Aerial Photographs for Lake Levels above Median

Source:CardnoENTRIX2008

Exhibit 3.9-8 Shoreline Erosion, 1971–1999, Documented by Georeferenced Aerial Photographs for Lake Levels near Maximum



Source: CardnoENTRIX 2008

Exhibit 3.9-9 Relationship of Study Area Unvegetated Beach Area to Lake Elevation (1940–2002)

Additionally, the sediment supply to local beaches has been adversely affected by maintenance dredging of the Tahoe Keys navigation channels during the past 50 years. The long-term average annual dredging volume is about 800 cubic yards per year (Conservancy 2003:3-11). Replacement of sand to the beach or nearshore system via bypass dredging or replenishment programs (i.e., artificial deposition) has not occurred. However, artificial beach nourishment has been used on a limited scale at the west end of the study area after storm events (Budlong 1971:92). Unfortunately, these recent site-specific impacts exacerbate the background trends of beach erosion and the reduced sand delivery by the rivers.

The volume of coarse sand supplied to the nearshore by either the Upper Truckee River or Trout Creek is meager in relation to the shoreline length of the study area. Osborne and others (1985) determined coarse sand supply to the beaches using a long-term average annual load rate of total coarse sediment (i.e., sediment greater than 0.0024 inch [0.062 mm]) of 2,800 and 1,400 tons per year for the Upper Truckee River and Trout Creek, respectively (Kroll 1976). Coarse sand supply from the Upper Truckee River was estimated to be 356 tons per year (293 cubic yards per year), and that from Trout Creek was slightly greater, 377 tons per year (310 cubic yards per year) (Osborne et al. 1985:9). For an active beach width of 25 feet, and assuming just one cubic foot covering each square foot of beach area, the Upper Truckee has sufficient annual supply for a beach 316 feet long, and Trout Creek can support a beach 335 feet long. This is much shorter than the shoreline of the study area and is a much smaller total area (0.4 acre) than half the existing area at median lake level (Exhibit 3.9-5). Assuming only one foot of depth is much shallower than the typical USACE beach nourishment rate of one cubic yards per square foot. Making a more normal or typical thickness assumption indicates that river sand supply would only support an even smaller beach area. Therefore, the average annual river sand supply is small, and clearly inadequate to compensate for the long-term net beach erosion and continued dredging.

Water Quality

Water quality refers to a combination of characteristics (parameters) that can be quantitatively or qualitatively described for a given water body. The parameters include pollutants, such as nutrients, suspended sediment, bacteria, toxic elements or chemicals, and attributes important to biological resources such as pH, dissolved oxygen, and temperature. There are several potential pathways for nutrients, fine sediment, and other pollutants to enter waters of the study area. Several potential sources, sinks, and transformations of these constituents may occur in the study area. Sources to the study area include streamflow, urban stormwater runoff, lake water, groundwater flow, and direct atmospheric deposition. Watershed and site-scale monitoring of water quality has been performed at varied times for various purposes, but site-specific data is limited. Most available water quality information is for historical conditions of the surrounding water bodies such as Lake Tahoe, the TKM and TKPOA channels, and the two main streams that flow through the study area. The information below is organized by surface and groundwater categories, and is focused on topics that describe the existing water quality in the study area or water quality parameters that may be altered by the project.

Surface Water

Lake Tahoe

Both the federal and California governments have designated Lake Tahoe an “Outstanding National Resource Water” (Lahontan RWQCB 1995:5-1). In addition to aesthetic enjoyment, the exceptional quality of water in the Tahoe Basin supports a number of beneficial uses related to human and environmental health, including drinking water supply, water-based recreation, wildlife habitat, and aquatic life and habitat. Stringent water quality goals and watershed regulations, along with mitigation and restoration measures have been implemented, particularly since the 1980s. However, Lake Tahoe has been losing its famed clarity at a rate of nearly nine inches per year since the late 1960s and has failed to meet transparency and clarity standards (Lahontan RWQCB and NDEP 2007a:25). The lake is considered “impaired” with respect to the aesthetic-recreation beneficial use under Section 303(d) of the Federal CWA. Development of a TMDL identified the pollutant sources, quantified the amounts of pollutants the lake can accept and achieve the clarity goals, determined options for reducing pollutants, estimated load allocations, and developed implementation and monitoring plans (Lahontan RWQCB and NDEP 2007a:13-15). The Lahontan RWQCB approved Basin Plan amendments to establish the Lake Tahoe TMDL and an implementation plan for associated changes to urban stormwater regulations on November 16, 2010 (Resolution No. R6T-2010-0058). EPA approved the Lake Tahoe TMDL on August 16, 2011.

TMDL research has established that Lake Tahoe is impaired by excess nutrient (nitrogen and phosphorus) and fine sediment inputs. Nitrogen and phosphorus stimulate algae growth, which in turn absorbs light and reduces light penetration through the water (Reuter and Miller 2000). Fine sediments decrease clarity by scattering light as the particles slowly settle through the water (Swift et al. 2000, Lahontan RWQCB and NDEP 2007b:261). Fine mineral particles (i.e., particles less than 20 micrometer [µm] in diameter) have been shown to strongly affect clarity and may be responsible for 60 percent or more of the transparency loss (because of their impact on light scattering) (TRPA 2007:3-2, 3-3).

Pelagic Lake Clarity

Water clarity is measured using Secchi dish depth readings (of transparency) at established index locations on Lake Tahoe. Year-to-year variability in transparency occurs, inversely related to precipitation and runoff amounts (Jassby et al. 2003:1456). However, the overall trend has been a decrease in average annual Secchi depth from the 1967–1971 historic average of 97.4 feet (i.e., the California Standard numeric target) to 67.6 feet in 2006 (TRPA 2007a:3-11). Lake clarity varies by season, ranging from its lowest levels in May through June, to a secondary low in December, and an annual high in February (TRPA 2002a:3-30). The seasonal pattern generally reflects the seasonal variation in suspended sediment loading from stream runoff, and the impacts of lake mixing. Substantial vertical mixing can occur during summer (CWB and NDEP 2007:3-20) as a result of sustained summer wind events. The December clarity minimum is attributed to consistent annual deep mixing. The winter average Secchi depth in 2006 was 78.4 feet, less than the TRPA standard of 109.6 feet (TRPA 2007:3-30).

Nearshore Lake Clarity

Lake clarity is measured in the deep (pelagic) waters, but the area where clarity is most obvious to the casual observer is in the littoral zone or "nearshore" (Lahontan RWQCB and NDEP 2007a:10*). There are varied working definitions of the nearshore in specific studies (Orme 1971, Taylor 2002, Taylor et al. 2004) and in regulations (e.g., Basin Plan vs. TRPA Code). Despite these variations, all of the definitions refer to portions of the lake with water depths too shallow for Secchi depth measurements to be informative.

The optical water quality concern in the shallow nearshore zone is murkiness, as indicated by turbidity and periphyton (i.e., attached filamentous algae). Turbidity is expressed in nephelometric turbidity units (NTU), which are based on an empirical relationship to light transmission in standard concentrations of formazin (a white powder) in water (Taylor 2002).

The study area is adjacent to the largest nearshore environment on the margins of Lake Tahoe. This area is characterized by a shallow shelf that extends a few thousand feet out from the beach ridge (Orme 1971:4). The nearshore lake waters adjacent to the study area consistently have the highest turbidity around the lake, and have been occasionally greater than the TRPA WQ-1 threshold (Taylor 2002:20). Recent studies have recorded high turbidity at both the mouth of the Upper Truckee River and the Tahoe Keys channel entrance. These studies include data by Taylor (2002) of all locations less than 24.6 feet deep or within 656 feet of shore, and by Taylor et al. (2004) of all locations up to 3.28 feet deep and extending offshore 328 feet or until the water is at least 98.4 feet deep.

At times when turbidity of the middle of the lake is very low (less than 0.06 NTU), the nearshore adjacent to the study area had turbidity levels up to an order of magnitude greater than any other sampling location (Taylor 2002:11). The south shore (including the study area) was one of the three high turbidity areas with large extent (more than 1.9 miles in extent and greater than 0.2 NTU) reported by Taylor (2002) from lakewide concurrent sampling. Elevated turbidity (up to a maximum of 20 NTU after a storm events) off the Upper Truckee River mouth was noted in 23 out of 23 surveys, and affects an area commonly extending 0.5 mile to the east, 0.3 mile to the west, and 0.74 mile offshore (Taylor et al. 2004:48*). Turbidity in this area and in the adjacent West Al Tahoe area was identified as "extremely elevated" relative to the middle of the lake.

The highest nearshore turbidity levels coincided with snowmelt and runoff periods characterized by the highest ratios of mineral to algal particle content. Generally, lower turbidity is recorded in winter, but localized plumes of increased turbidity linked to storm event inputs can occur. During spring peak runoff, water temperatures and turbidity levels rise, and during the summer there is a widespread increase in turbidity.

During calm conditions, increased turbidity was due to organic particles, but during storm events, up to half the particles were mineral composition (Shanafield et al. 2007:53). In all locations and times that nearshore turbidity was moderately elevated (greater than 0.35 NTU), the particles were predominantly mineral material, except within the Keys channels (Taylor et al. 2004:48).

Tahoe Keys Marina and Channels

Organic debris or living organisms that are considered noxious, invasive, or exotic to the biologic systems may also be present in the water or sediment of the Sailing Lagoon, whether or not they directly affect water or sediment quality. See the Sections 3.4 and 3.5 (Biological Resources: Vegetation and Wildlife, and Fisheries, respectively) for further details on this related topic.

Tahoe Keys Water Quality

The water quality in the Tahoe Keys Marina and other Tahoe Keys channels has been studied as part of various scientific and permit-compliance programs over many years, but the locations, parameters, and time frames of each study have differed. The following discussion is organized by study, with the most recent information presented first.

Studies have documented high levels of turbidity in the channels of the Tahoe Keys. In 2001 and 2002, the two navigation channels and the immediately adjoining nearshore in the lake have had turbidity levels that are an order of magnitude greater than any other sampling location (Taylor 2002). Channels in the Tahoe Keys had very high turbidity (greater than 0.5 NTU), with plumes of particularly high turbidity (values in excess of 2.0 NTU) (Taylor 2002:11). In 2003, channels in the Tahoe Keys had "moderately elevated" average turbidity greater than 0.4 NTU and a maximum turbidity greater than 1.5 NTU (Taylor et al. 2004:49).

The contribution of the Tahoe Keys channels and their configuration on lake turbidity is not well understood. Surface water in the Marina and Tahoe Keys channels can only enter the lake through the east and west navigation channels. Their outflow is highly time-dependent and seasonally variable. The relative contribution to nearshore turbidity from the Tahoe Keys versus outflow of the Upper Truckee River has not been determined (Taylor et al. 2004:50). However, observations during periods when lake currents were moving the Upper Truckee River outflow away from Tahoe Keys indicate the lake was only moderately affected by outflow from the Tahoe Keys and boat traffic resuspension (Taylor et al. 2004:51). Also, organic materials were always the dominant source of turbidity inside Tahoe Keys, but inorganic materials dominate as the source of turbidity in the lake (Taylor et al. 2004, Shanafield et al. 2007).

The Tahoe Keys channels and marina are served by the TKPOA circulation system, which operates under a NPDES permit (R6T 20004-0024; Board Order CA0103021-WDID No. 6A090090000 (Lahontan RWQCB 2004). The system included the TKPOA water treatment plant, which operated periodically between 1975 and 1998 (TRPA 2002b:3-6). A chemical release from the treatment system resulted in toxic levels of aluminum in August 1998, and the plant has not operated for treatment since that time. Only the circulation system portion of the plant is currently permitted and operational. The system circulates untreated water between May and October, exchanging water between the Tahoe Keys lagoons (110 acres), Tallac Lagoon (45 acres), and the TKM (32 acres, including the Sailing Lagoon). There are 13 outfalls, including one in the TKM (Lahontan RWQCB 2004:2-5). The permits have required water quality sampling at a point at the East Channel inside the marina (Point M, which is near the Sailing Lagoon) and at a point in Lake Tahoe at the East Channel outside the marina (Point MLT) since 1998. Monitoring (typically between July and October in most years) indicates that marina turbidity exceeded the 1.0-NTU limit in 1998 and 2005. Total phosphorus generally was below 0.1 milligram per liter (mg/L), except in July 2007. Total nitrogen was generally below 0.15 mg/L except in October 2005 and July 2007. Testing showed detections for various hydrocarbons between 1998 and 2000, but nondetection in more recent monitoring.

During the period 1993 to 1997, water quality at the TKM was investigated to evaluate the potential impacts of motorized watercraft, with sampling around the Fourth of July and Labor Day holidays (Lahontan RWQCB 2005, and prior permit files). Marina water samples consistently exceeded the 1.0-NTU turbidity level between 1993 and 1997. Total nitrogen exceeded 0.15 mg/L for all samples between 1993 and 1997 except in July 1997. Total phosphorus exceeded 0.01 mg/L in all samples between 1993 and 1997, except July 1995; July, August, and September 1996; and June 1997. Hydrocarbon and other contaminant detections have occasionally occurred, but nondetectible results were common by 2004. Routine sampling of the marina water was discontinued and is not required under the present permit (GA 09S0122415).

There has been monitoring of stormwater runoff from the commercial/industrial portions of the TKM facilities, and reporting of any spills or incidents. The present TKM SWPPP requires stormwater/nonstormwater observations and sampling in the marina parking, storage, and maintenance areas (Tyler, pers. comm., 2008). Review of SWPPP monitoring reports indicates that no stormwater releases were sampled because no release events were reported during daylight hours and/or no events exceeded the installed BMP capacities. Only one spill was reported between 2002 and 2007. The spill was on April 10, 2007, and consisted of three–five gallons of hydraulic oil that was contained and cleaned up.

Water and sediment in the marina have also been sampled in association with permitted maintenance dredging, most recently in 2002 (WDID 6A098805007). The 2002 dredging included excavation in the East Channel and the approach channel in the lake. During dredging, dewatering fluids were discharged to a portion of the study area south of East Venice Drive (Conservancy Parcel Assessor's Parcel Number 22-210-37). Water discharged to the Upper Truckee meadow was required to have less than 20 NTU turbidity and nutrient levels less than 0.1 mg/L total phosphorus (TP) and less than 0.5 total nitrogen (TN). Water sampled on September 23, 2002, had turbidity of 17.6 NTU in the river and 2.0 NTU in the TKM channel, while the lake turbidity was 0.31 NTU. TN exceeded 0.15 mg/L in the TKM channel (0.2 mg/L) and in the river (0.26 mg/L), while the lake had TN of 0.14 mg/L. Total phosphorus exceeded 0.1 mg/L in the river (0.019 mg/L) and the lake (0.014 mg/L), and was highest in the TKM channel (0.024 mg/L). No volatile organic compounds (VOCs) or polycyclic aromatic hydrocarbons (PAHs) were detected in the river or the TKM channel water, but 0.03 part per billion (ppb) naphthalene (a PAH) was detected in the lake.

Tahoe Keys Sediment and Organics

In addition to water samples, sediment from the TKM channel and the lake nearshore were also tested in September 2002 and the results were reported as part of the dredging permit monitoring data. The sediment samples had much greater concentrations of TN and total phosphorus than water samples, reflecting the propensity of these materials to attach to sediment particles. The TKM channel sediment concentrations of nutrients (57 mg/L TN and 150 mg/L TP) were much less than the concentrations in lake sediments (560 mg/L TN and 310 mg/L TP). One of the TKM channel sediment samples contained 30 ppb acetone (a VOC), while no VOCs were detected in the lake sediments. Both the lake and the TKM channel sediments had some detectable PAHs, but the TKM channel had more species present (about ten) and for the PAH species detected in both locations, the concentrations were greater in the channel than in the lake.

In addition to these recent studies, sediment and interstitial water of the channel versus lake sediments were also analyzed by the University of California, Davis Tahoe Research Group in 1995 (TRPA 2002b). The 1995 study found nutrient levels in sediment interstitial water to be much greater in the marina (lagoon) than in the lake or in beach sediment (which was sampled at Valhalla Beach), and the nutrients were in more biologically available forms. However, the 1995 study found the marina and east channel sediments to be "unpolluted" with respect to either heavy metals or oil and grease. In addition to the presence of PAHs, it is possible that aluminum (Al)-contaminated sediments occur in the TKM as residual from apparently heavy application of aluminum sulfate during initial dredging of the keys.

Tributary Streams

There are 63 perennial streams tributary to Lake Tahoe and 54 intervening areas (without stream channels) that contribute runoff to Lake Tahoe (Tetra Tech 2007:3). The streams in the study area are the largest (Upper Truckee River) and third largest (Trout Creek) tributaries to the lake. Stream water quality sampling on major Lake Tahoe tributaries has been conducted since 1980, including sampling stations on the Upper Truckee River and Trout Creek near U.S. 50. Data collected at these stations indicate the water quality of streamflow entering the study area.

Average annual nutrient and suspended sediment sampling results for the two streams for water years (WYs) 1980 to 2005 and their relation to TRPA threshold standards are shown in Exhibits 3.9-10 to 3.9-13.

Nutrient concentrations in the Upper Truckee River and Trout Creek often exceed Basin Plan objectives and TRPA threshold criteria. Average annual total phosphorus concentrations in both the Upper Truckee River and Trout Creek exceeded the Basin Plan objective of 0.015 mg/L in all years and exceeded the TRPA threshold criteria of 0.03 mg/L in about two-thirds of the years (Exhibit 3.9-10). Average annual TN concentrations exceeded the Basin Plan objective of 0.19 mg/L in 59 percent of the years on Trout Creek and in 76 percent of the years on the Upper Truckee River (Exhibit 3.9-11). The TRPA total nitrogen standard of 0.22 mg/L was exceeded in 53 percent of the years on Trout Creek and in 41 percent of the years on the Upper Truckee River (Exhibit 3.9-11). The total iron concentrations in both the Upper Truckee River and Trout Creek have only been sampled since WY 1989, but consistently exceeded the Basin Plan objective and TRPA standard of 0.03 mg/L (Exhibit 3.9-12), perhaps because of high natural background levels. The average annual total suspended sediment concentrations on Trout Creek did not exceed the TRPA standard of 60 mg/L, and only one year on the Upper Truckee River exceeded the standard (Exhibit 3.9-13).

An evaluation of median suspended sediment concentrations of the 10 largest tributaries to Lake Tahoe from 1993 to 1998 indicated that the Upper Truckee River and Trout Creek at U.S. 50 ranked sixth and fifth, respectively (Rowe et al. 2002:94). During this period, the minimum concentration of suspended sediment in the Upper Truckee was 1 mg/L, the maximum was 458 mg/L, and the median was 16 mg/L. During this same time, the minimum concentration of suspended sediment in Trout Creek was 2 mg/L, the maximum was 335 mg/L, and the median was 14 mg/L.

Although average suspended sediment concentrations in the Upper Truckee River and Trout Creek do not usually exceed water quality standards, these streams contribute much greater suspended sediment loads than any other tributary to Lake Tahoe because of their large flow volumes. Suspended sediment loading becomes more substantial with the evidence that a substantial portion of phosphorus enters Lake Tahoe as particulate phosphorus adsorbed to the sediment (Reuter and Miller 2000).

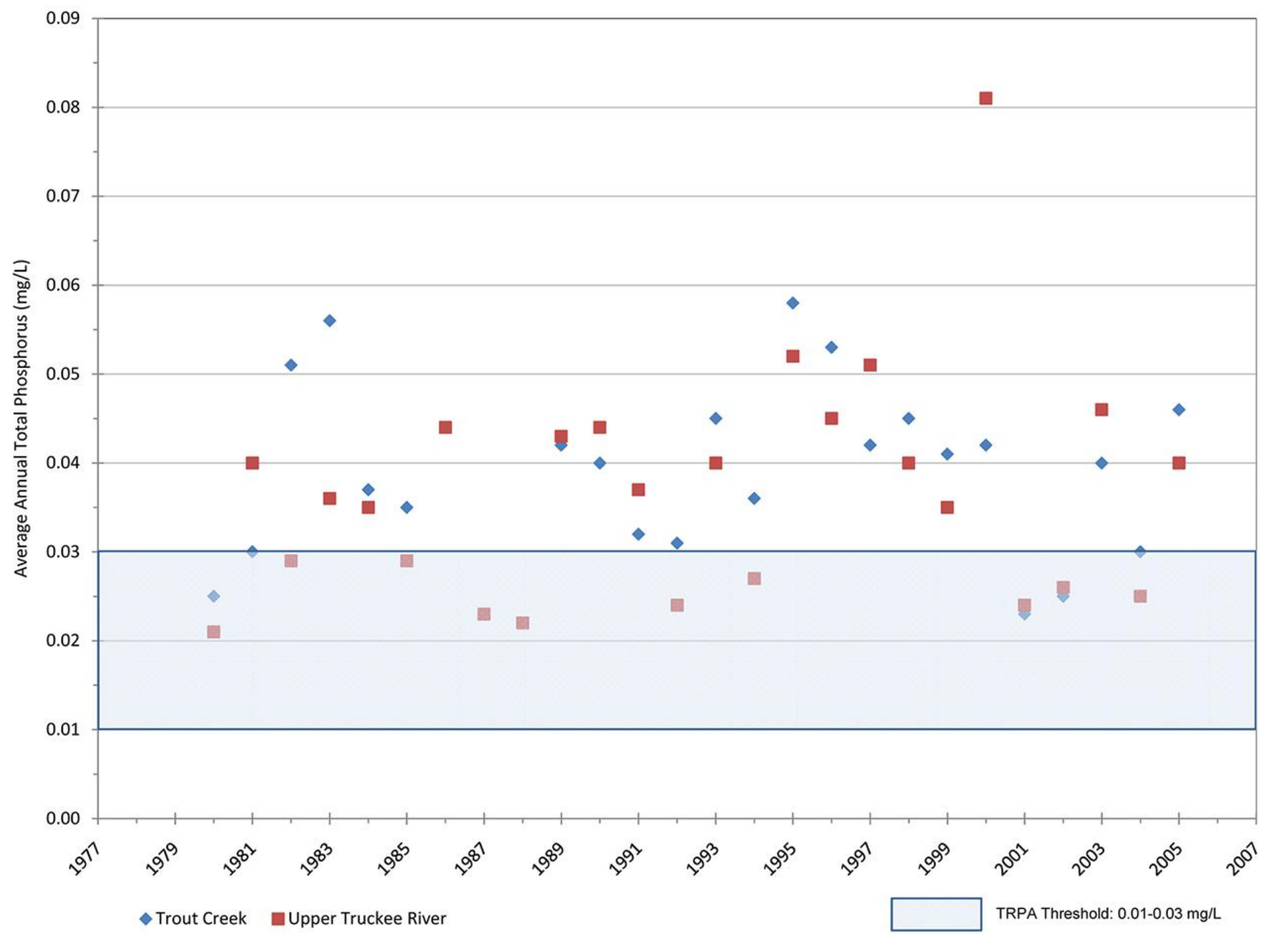
Monthly suspended sediment loads on the Upper Truckee River demonstrate, as expected, year-to-year variations that generally track precipitation and overall streamflow volume variations (Rowe et al. 2002:114). Annual suspended sediment loads on the Upper Truckee River and Trout Creek for all years of record since 1960 (using the sediment rating curves from Simon et al. 2003 and Simon 2006) also display a wide range of values. The lower estimated sediment loads are generally under 1,000 Tons/year (T/year) during drought years on the Upper Truckee River and about a third of the years on Trout Creek. The high end of the range, about 8,000 T/year or more, occurred during wet years: WY 1983 on both streams and during WY 1997 on the Upper Truckee River. Various estimates of average suspended-sediment loads for the Upper Truckee River and Trout Creek have been calculated by different studies for different data periods (Table 3.9-9), all within the same order of magnitude.

Table 3.9-9
Published Average Suspended Sediment Loads (metric tons per year) for Upper Truckee River and Trout Creek from Measured Data

Water Years	Reuter and Miller 2000 (Total Annual Average)	Kroll 1976 (Average Annual Load)	Simon and others 2003 (Average Annual Load)	Simon and others 2003 (Median Annual)
	1989–1996	1972–1974	1972–2002	1972–2002
Trout Creek	798	1,540	1,790	1,190
Upper Truckee River	3,305	3,900	2,850	2,200

Source: Simon et al. 2003

Because of the importance of fine suspended sediment to lake clarity, estimates of fine sediment loads have also been made. Simon (2006) calculated fine (less than 0.063 mm) sediment loads (metric tons per year [MT/yr]) from mean daily flow data using the sediment-rating relations developed in Simon et al. (2003). He also estimated the number (flux in n/year where n = number of particles) and proportion of fine particles (fine particles defined as less than 0.02 mm distinguished from fine sediment defined as less than 0.063 mm) using relations between the sediment mass and particle numbers established by Rabidoux (2005).



Data as reported in TRPA 2002 and 2007.

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Exhibit 3.9-10 **Average Annual Total Phosphorus Concentrations (mg/L) in the Upper Truckee River and Trout Creek (Water Years 1980–2005)**

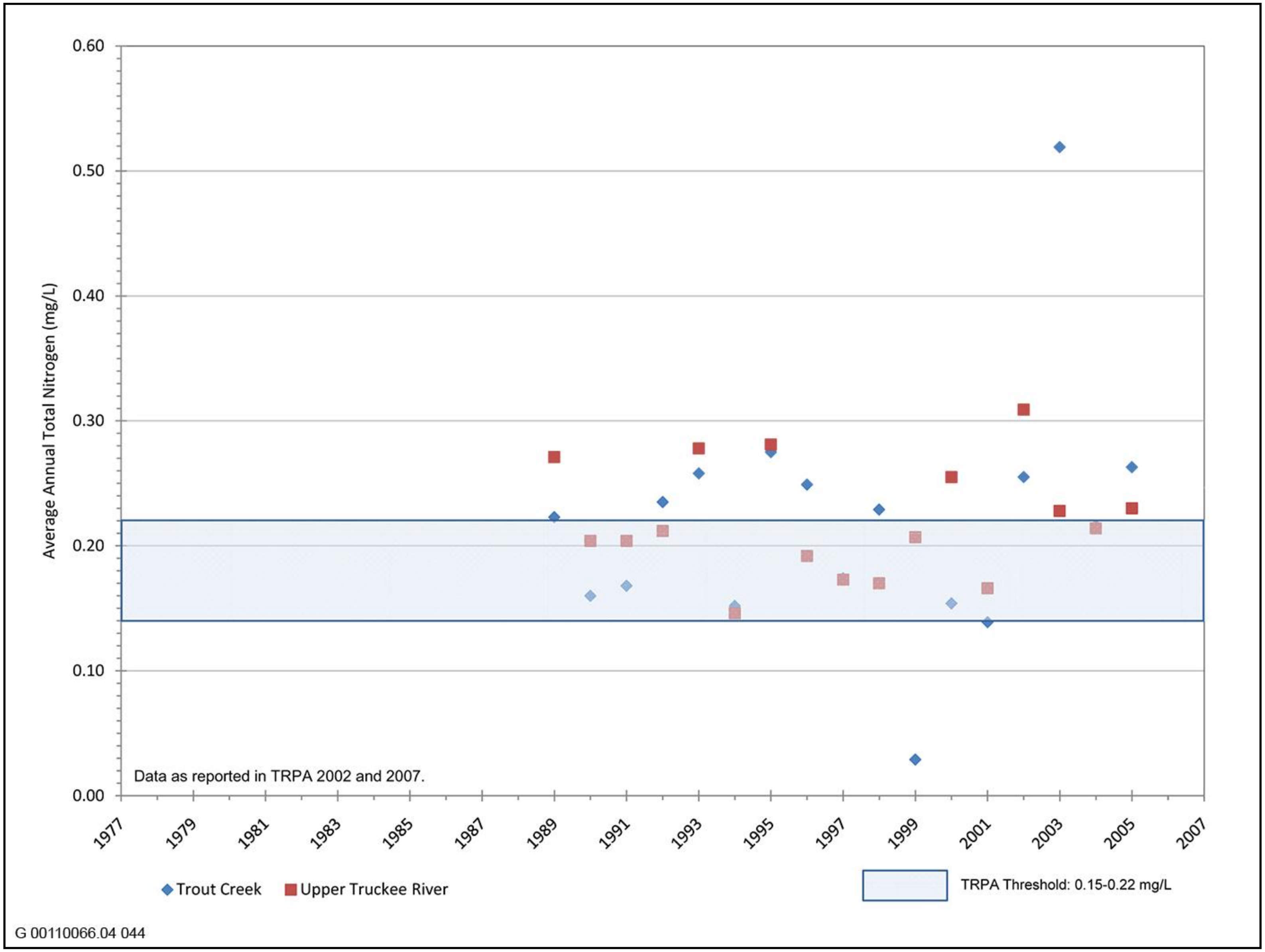


Exhibit 3.9-11 **Average Annual Total Nitrogen Concentrations (mg/L) in the Upper Truckee River and Trout Creek (Water Years 1980–2005)**

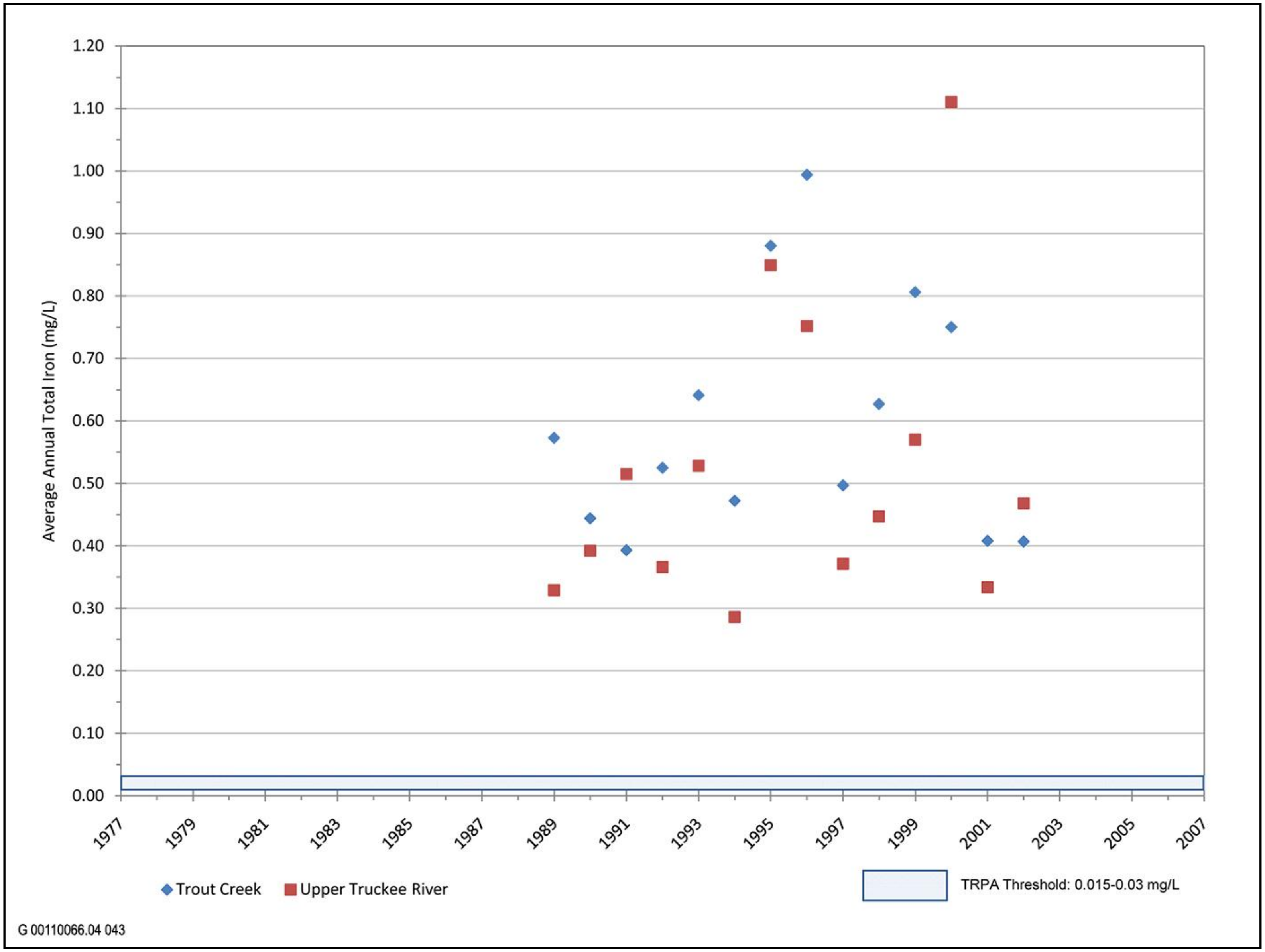


Exhibit 3.9-12 Average Annual Total Iron Concentrations (mg/L) in the Upper Truckee River and Trout Creek (Water Years 1989–2005)

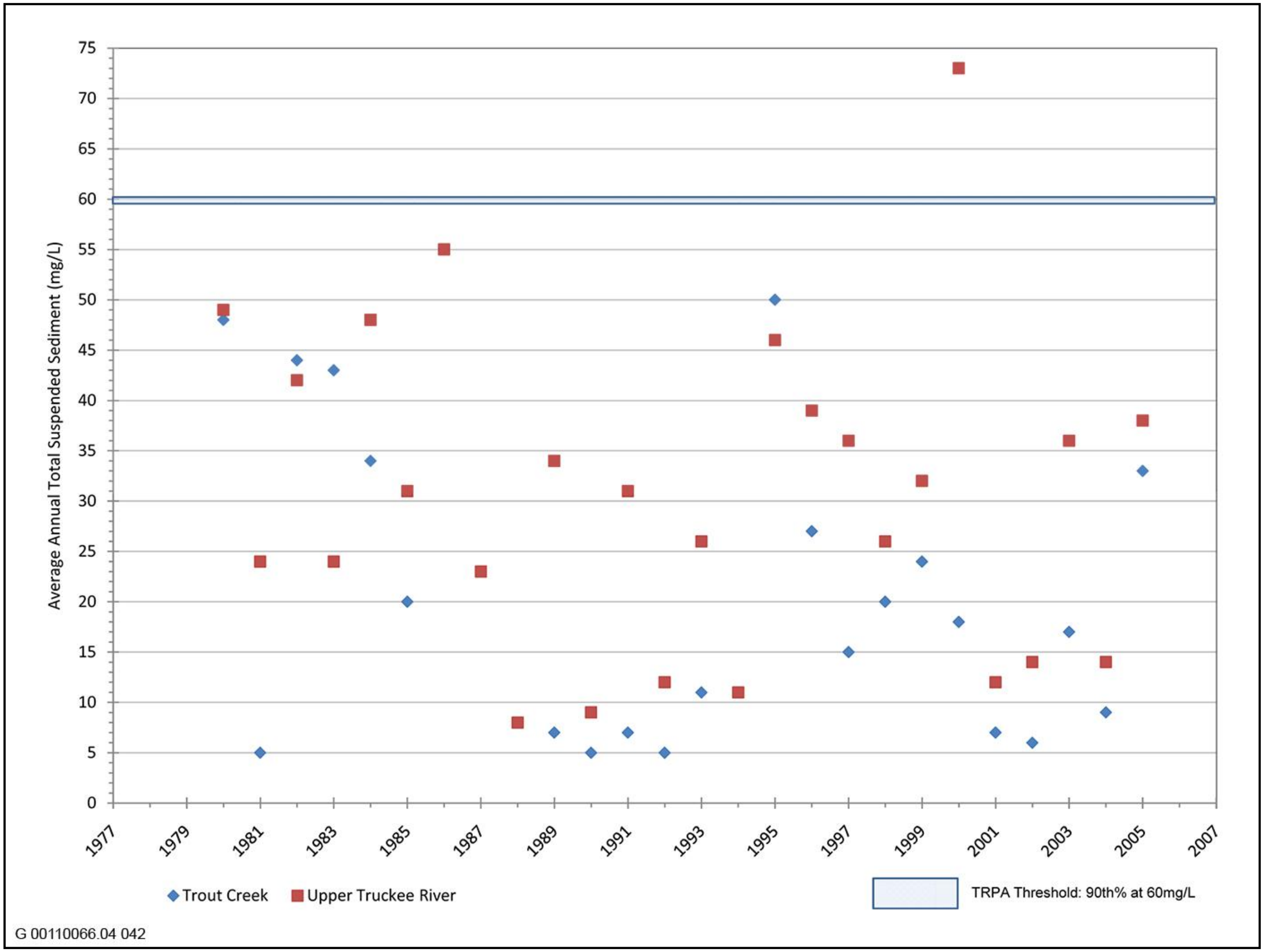


Exhibit 3.9-13 **Average Annual Total Suspended Sediment Concentrations (mg/L) in the Upper Truckee River and Trout Creek (Water Years 1980–2005)**

The calculated annual load of fine (less than 0.063 mm) sediment for the Upper Truckee River is 1,010 MT/yr and 462 MT/yr for Trout Creek (or 19.4 and 8.9 percent of the total annual suspended load for the streams, respectively) (Simon 2006:24). The Upper Truckee River fine sediment load and fine particle flux are the highest of all tributaries in the Tahoe Basin, and Trout Creek ranks third and fourth for sediment load and fine particle flux, respectively (Simon 2006:24). While the suspended sediment yields (per unit watershed area) estimated for the Upper Truckee River (6.0 tons per year per square mile) and Trout Creek (4.8 tons per year per square mile) are "moderate" relative to other watersheds at Lake Tahoe, the sheer size of these two watersheds increases their loading to the lake (Simon et al. 2003:ES-1). Rowe et al. (2004) found that the seasonal pattern of sediment loading generally follows runoff variability. The highest seasonal median loads for the Upper Truckee River occur during snowmelt months of April, May, and June, as for suspended sediment. The largest median monthly loads for all measured constituents occurred in May. The lowest seasonal loads occurred in summer (July, August, and September) with the lowest monthly loads usually in August, September, or October (Rowe et al. 2002:115).

Statistical analysis has been conducted to look at trends over time in suspended sediment and other constituents (Rowe et al. 2002, Simon et al. 2003). Simon et al. (2003) identified a possible decreasing trend in annual total and fine-grained sediment loads on the Upper Truckee River while Trout Creek had no trend. The trend for the Upper Truckee River may indicate long-term watershed recovery from past disturbances (Simon et al. 2003:7-4).

Shifts in the suspended sediment rating curves also highlight changes over the period of record. Sediment loads on the Upper Truckee River first increased during the period 1983 to 1992 and then decreased from 1993 to 2002 to values lower than recorded for 1972 to 1982 (Simon et al. 2003:3-31). Short-term analysis of suspended sediment data from before and after the 1997 flood event showed a statistically significant decrease in the rating curve after the flood event (Simon et al. 2003:3-14). The decrease resulted from flushing of readily available sediment from the channel system by the major flood event.

Floodplain Deposition

Soil cores within the Upper Truckee Marsh have been analyzed and age dated to identify sedimentation processes and rates over the past few thousand years (Winter 2003:64-65). The age of the sediments at the base of the dated cores ranged from 1,650 ± 50 to 4,620 ± 40 years before present (BP). Average mass sedimentation rates during the last 50 years (0.6 gram per square centimeter per year [$g/cm^2/yr$]) are an order of magnitude greater than for the rest of the period recorded by these cores (0.05 $g/cm^2/yr$) (Winter 2003:86). These data indicate that the modern marsh surface is accumulating and retaining sediment, despite channel deepening and widening that has reduced floodplain connectivity, especially on the Upper Truckee River. However, even these relatively high sediment retention rates represent a very small percentage of the modern sediment load being transported by the streams and surface runoff. Winter (2003) estimated that less than five percent of the average annual suspended sediment transported to the Upper Truckee Marsh is retained. Most suspended sediment continues to be delivered to the lake.

While most of the sediment retained on the floodplain represented deposition of suspended sediment, sedimentation of bedload (i.e., coarser sediments) occurred in one area along the west branch of Trout Creek near the middle of the marsh (Winter 2003:79). The other location with modern bedload sedimentation was not on the floodplain, but at the mouth of the Upper Truckee River (which may receive bedload from both streams) (Winter 2003:79). This indicates that bedload is able to be conveyed through the study area to the lake, although some net retention of bedload occurs in the middle marsh and at the river mouth.

Observations at the study area during the 2003 snowmelt season documented modern patterns and amounts of suspended sediment and total phosphorus retention within the Upper Truckee Marsh (Stubblefield et al. 2006). Using sediment budgets constructed from turbidity, suspended sediment correlations, and discharge data at seven sampling stations within the study area, Stubblefield et al. (2006) describe and compare water quality impacts of Trout Creek versus Upper Truckee River, and floodplain versus marsh portions of the study area. The Trout Creek system retained 68–90 percent of the suspended sediment and 61–85 percent of the total phosphorus (Stubblefield et al. 2006:296). The Upper Truckee River system retained only 26 percent of the suspended sediment and 24 percent of the total phosphorus (Stubblefield et al. 2006:296). Streambank erosion was observed along the Upper Truckee River within the study area during 2003, so streambanks were a net source of sediment during part of the study period (although moderate sediment retention occurred overall, as stated above). The greatest retention was in the marsh reaches in areas of distributary channels and/or ponding (Stubblefield et al. 2006:297). Ponding increased the spreading of water across the floodplain. As water depths and floodplain connection increased later in the runoff season, sediment retention on the floodplain increased. Sedimentation in the marsh reach of Trout Creek retained all particle sizes measured (1–1,000 µm), even fine particles less than 10 µm (Stubblefield et al. 2006:298). The 2003 mass sedimentation rate (approximately 0.029 g/cm^2/year) observed by Stubblefield et al. (2006) was only about five percent of the rate measured for soil cores over the past 50 years (approximately 0.6 g/cm^2/year) (Winter 2003:86). However, the rate is similar to the modern period average (0.027 g/cm^2/year) measured in lake cores (Heyvaert 1998; see Table 3.9-8 above). Notably, WY 2003 did not include large or sustained periods of overbank flow. The variations in the rate suggest that floodplain sedimentation from large flood events is probably important in the overall net accumulation under existing conditions.

Lake and River Interaction

Limited information is available regarding the mixing of lake and river water in the adjacent nearshore or within the study area. The mixing pattern and depth of river inflow and lake water is affected by temperature, density, and streamflow (Perez-Losada and Schladow 2004). Additionally, the depth at which river water enters the main lake body can potentially have a substantial influence on lake clarity (CWB and NDEP 2007:3-21). Taylor et al. (2004) documented seasonal differences in the extent of mixing of river and lake waters and the size of high-turbidity plumes in the lake. During winter (January 2003), the river inflow was colder than the surface of the lake, and formed a plume of cold, turbid water that plunged to depth because it was denser than the lake surface water. During spring (June 2003), the river inflow was warmer than the surface of the lake, and formed a broad plume of warm, turbid water that did not mix readily because it floated on top of the relatively colder and denser lake water. The river inflow and lake water interactions in the nearshore are controlled primarily by factors not affected by conditions in the study area.

However, the study area's geomorphic and topographic conditions do affect mixing of river and lake water within the study area. The riverbed and portions of the marsh and lagoon are several feet below median lake elevation and the gradient of the river channel is very low. Therefore, water from the lake may penetrate for nearly 1 mile upstream (Exhibit 3.9-2) during periods of elevated lake levels. The enlarged, straightened channel of the Upper Truckee River becomes an arm of the lake with low velocities that favor deposition on the channel bed when the lake is high (Stubblefield et al. 2006:298). However, the material deposited on the channel bed is not stabilized by vegetation compared to deposition on a floodplain (Stubblefield et al. 2006:298). When lake level is lower, the river mobilizes materials deposited on the channel bed, and delivers these materials to the lake. The extensive lake backwater does raise water surface elevations in the channel and slightly "improves" the potential for overbanking onto the floodplain.

The effect of elevated sediment (and associated nutrient) loading is particularly adverse within the littoral zone of Lake Tahoe. Generally defined by TRPA as extending to a depth in the lake of 100 feet, the relatively shallow conditions of the littoral zone allow for the penetration of sunlight for productive aquatic plant growth. Increased turbidity and algal growth promoted by sediment and nutrient loading inhibits light penetration and the growth of aquatic plants that provide a food source and habitat for fish and other organisms.

Urban Runoff

The east, south, and west sides of the study area adjoin areas of urban development. Stormwater runoff is directed from these local neighborhoods to several outfalls that enter the study area along its meadow and forest margins. In a few locations, stormwater outfalls discharge directly to the stream channels.

Constituents of concern in urban runoff include sediment, nutrients, petroleum products, pesticides, heavy metals, organic matter, and coliform bacteria. Toxic "priority pollutants" in urban runoff include lead, zinc, copper, arsenic, chromium, cadmium, nickel, cyanide, and asbestos (Lahontan RWQCB 1995). Deicing chemicals used in these areas and "sanding" operations used on highways in the winter are also a major concern for water quality in the Lake Tahoe/Truckee region.

Between 1986 and 1989, the Lahontan RWQCB sampled urban runoff on six sites in South Lake Tahoe for total nitrogen, total phosphorus, total iron, and turbidity (TRPA 2002a). Samples collected exceeded state standards for all constituents on several occasions, with the highest concentrations occurring in late spring through late summer. TRPA monitored untreated urban runoff discharge at 10 culvert outlets to Lake Tahoe from 1991 to 1995. Approximately 80 percent of the samples exceeded TRPA and state water quality standards.

Runoff from uplands with urban land uses has been identified as producing the largest fine sediment particle load to Lake Tahoe (348 x 10^{18} particles/yr), the highest total phosphorus load (18 MT/yr), and the second largest TN load (63 MT/yr) of the major source categories in the Lake Tahoe TMDL (CWB and NDEP 2007:4-165). Stormwater runoff from urban areas has substantial pollutant concentrations (Hevyaert et al. 2006) and higher volumes and peak flows than undeveloped areas. Monitoring around Lake Tahoe during 2003–2004 was used to determine event mean concentrations for runoff from several urban land uses (Gunter 2005, Heyvaert et al. 2006) as input to recent TMDL modeling. Some of the land use categories developed for the TMDL are representative of land use in and immediately surrounding the study area (Table 3.9-10). These event mean concentrations provide an indication of the existing water quality of untreated urban runoff that enters the study area. No on-site monitoring data are available.

Table 3.9-10
Derived Event Mean Concentrations (mg/L) of Sediment and Key Nutrients Associated with Selected Land Use Types

Land Use Type	Constituent[1] as mg/L				
	TN	DN	TP	DP	TSS
Residential Single Family Pervious	1.752	0.144	0.468	0.144	56
Residential Multifamily Pervious	2.844	0.42	0.588	0.144	150
Commercial/Institutional/Communications/Utilities (CICU) Pervious	2.472	0.293	0.702	0.078	296
Vegetated Turf	4.876	0.487	1.5	0.263	12
Residential Single Family Impervious	1.752	0.144	0.468	0.144	56
Residential Multiple Family Impervious	2.844	0.420	0.588	0.144	150
CICU Impervious	2.472	0.294	0.702	0.078	296
Roads Primary	3.924	0.72	1.98	0.096	952
Roads Secondary	2.844	0.42	0.588	0.144	150

Notes:
[1] DN = dissolved nitrogen, DP = dissolved phosphorus, mg/L = milligrams per liter, TN = total nitrogen, TP = total phosphorus, TSS = total suspended solids
Source CWB and NDEP 2007

Other On-site Water Quality Data

The Lahontan RWQCB collected water quality data from 12 sampling sites on the Upper Truckee River and Trout Creek (2000 to 2002), including up to six sites within the site (Conservancy 2003:12-17). The primary purpose was to determine fecal coliform concentrations in areas heavily utilized by domestic animals (primarily cattle) and wild animals. In general, fecal coliform was greatest during mid-summer (July and August), with no apparent trend with downstream position (Conservancy 2003:12-19). In 2000, fecal coliform concentrations varied widely by location and by month. For example, September average values for all sites ranged from 4.6 Most Probable Number (MPN)/100 milliliters (mL) to 767 MPN/100 mL. From June to August, the average values at one site ranged from 12.3 MPN/100 mL to 692 MPN/100 mL. During the 2001 and 2002 sampling periods, maximum fecal coliform concentrations were much less (13–95 MPN/100 mL, respectively) than during the 2000 sampling period (36–950 MPN/100 mL), possibly due to reduced grazing activity since 2000.

The Lahontan RWQCB also collected baseline nitrogen and phosphorus data in August and October 2000. Total phosphorus concentrations ranged from 0.019 to 0.042 mg/L, and consistently exceeded the water quality objective of 0.015 mg/L (Conservancy 2003:12-22). Total nitrogen analysis was not performed, but concentrations of nitrate-nitrite (as nitrogen) ranged from 0.02.6 to 0.044 mg/L (Conservancy 2003:12-22).

As part of Winter's (2003) marsh research project, five stations located in the study area (four on the Upper Truckee River and one on Trout Creek) were sampled in spring and summer 2001 for pH, conductivity, total Kjeldahl nitrogen (TKN), ammonia (as N), nitrate (as N), soluble phosphorus, TP, and carbon. Results from the analysis suggest that low nutrient levels occur during spring (Conservancy 2003:12-18).

Groundwater

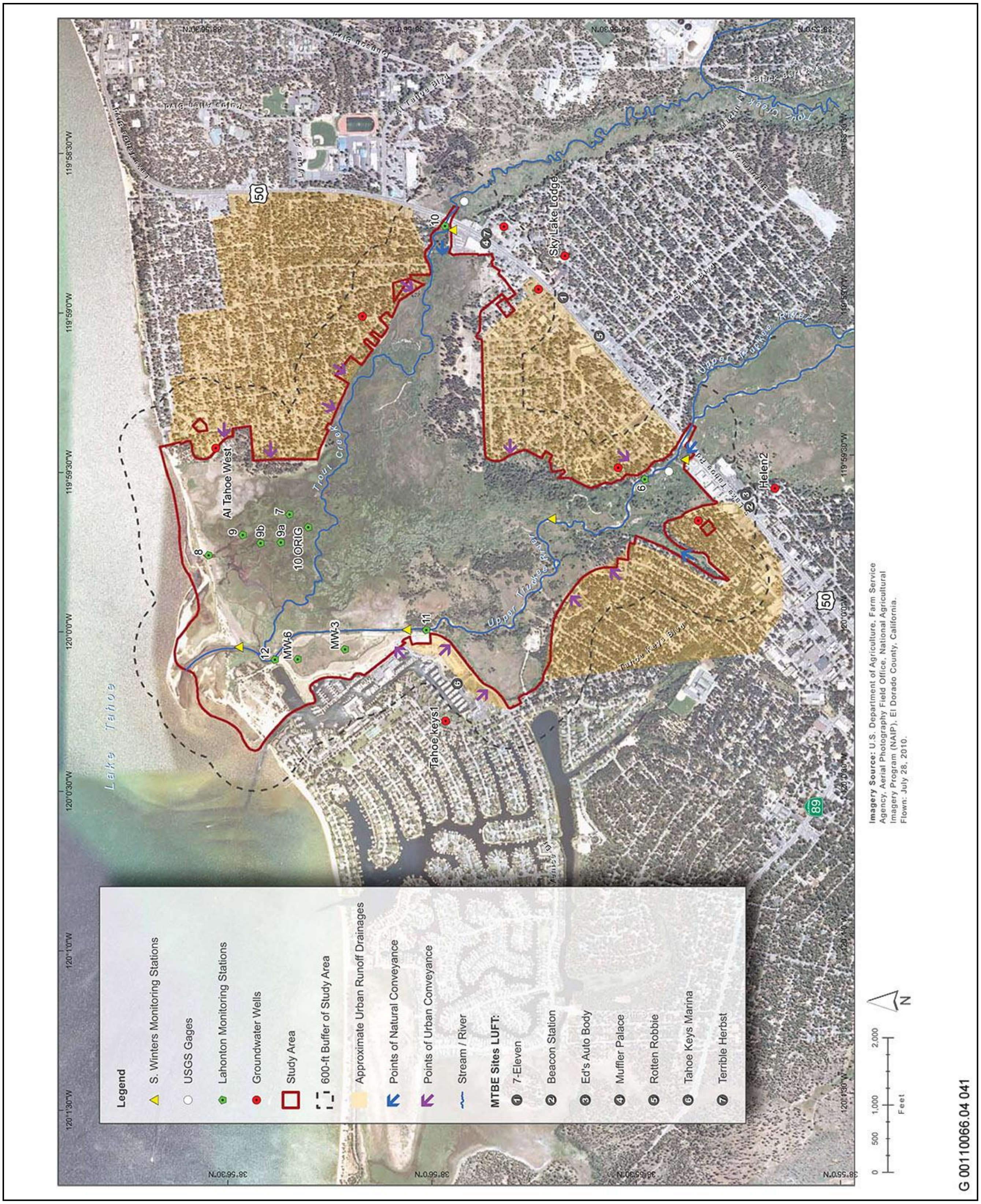
Groundwater, and the constituents contained therein, can enter the study area via underground flow from adjacent areas. Groundwater inputs include percolation from surface water, groundwater discharge to Upper Truckee River and Trout Creek stream channel beds and banks. There are also groundwater interactions with Lake Tahoe. Generally, groundwater flows from the study area toward the lake. However, a narrow zone of the study area near the lake may have net subsurface flow from the lake for short periods of time of elevated lake levels.

Groundwater Nutrients

Groundwater has been identified as a relatively large source of the TN load (50 MT/yr) to the lake and a relatively minor source of total phosphorus load (7 MT/yr) to the lake, but is assumed not to be a source of fine sediment particles (CWB and NDEP 2007:4-165). Groundwater loading to the lake from groundwater Subregion 3 on the south shore (which includes the study area) was estimated to be just 0.04 percent of the total dissolved N load and 0.6 percent of the total dissolved P load (USACE 2003:4-42). The study area is within a zone of limited groundwater discharge to the lake due to the low groundwater gradients and the impacts of groundwater pumping.

Groundwater quality data have not been collected in the study area, but Loeb (1987), Rowe and Allander (2000), and the U.S. Geological Survey have sampled groundwater quality at four wells (Al Tahoe West, Sky Lake Lodge, Helen 2, and Tahoe Keys 1 wells) surrounding the study area (Exhibit 3.9-14). These wells may have groundwater quality similar to the study area because they are close to the site and up gradient. The groundwater data collected in these studies are discussed further in the *Upper Truckee River and Marsh Restoration Project Processes and Functions of the Upper Truckee Marsh* report (Conservancy 2003:Chapter 2).

Groundwater studies in the Upper Truckee River and Trout Creek watersheds have noted generally increasing nutrient concentrations down valley in the direction of regional groundwater flow (Rowe and Allander 2000:36). Some seasonal effects have also been observed, such as lower groundwater phosphorus concentrations in the fall than in the summer (Rowe and Allander 2000:36). Studies of the potential impact of stormwater infiltration basins on groundwater quality found that, while typical urban stormwater poses little risk of migrating hydrophobic hydrocarbons, a nitrate plume into shallow groundwater may occur during spring snowmelt at some of their sampling sites (2nd Nature 2006a:19).



Source: CardnoENTRIX 2011

Exhibit 3.9-14 **Surface Water and Groundwater Inflows to the Study Area and Water Quality Monitoring Locations**

Groundwater Contaminants

Several sites that had methyl tertiary butyl ether (MTBE) groundwater contamination from leaking underground fuel tanks occur within a half mile of the study area (Exhibit 3.9-14). It is unknown whether MTBE is present within the study area, and none of the surrounding contaminated sites are close to the proposed ground disturbance areas.

3.9.2 ENVIRONMENTAL CONSEQUENCES

SIGNIFICANCE CRITERIA

For this analysis, significance criteria are based on the checklist presented in Appendix G of the State CEQA Guidelines; the TRPA Initial Environmental Checklist; factual information; scientific data; and regulatory standards of federal, state, and local agencies. In development of mitigation measures for significant impacts of the project, effects on environmental thresholds of the Tahoe Regional Planning Compact were considered. The project's effects on thresholds are further described in Section 4.5, "Consequences for Environmental Threshold Carrying Capacities."

CEQA Criteria

Under CEQA, an alternative was determined to result in a significant effect related to geomorphology or water quality if it would:

- violate any water quality standards (CEQA 1),
- create or contribute to runoff water that would include substantial additional sources of polluted water (CEQA 2), or
- otherwise substantially degrade surface water or groundwater quality (CEQA 3).

NEPA Criteria

An environmental document prepared to comply with NEPA must consider the context and intensity of the environmental effects that would be caused by or result from the proposed action. Under NEPA, the significance of an effect is used solely to determine whether an EIS must be prepared. The factors that are taken into account under NEPA to determine the significance of an action in terms of the context and the intensity of its effects are encompassed by the CEQA criteria used for this analysis. NEPA requires documentation and discussion of any beneficial effects of a project in addition to its negative impacts. Where appropriate, these beneficial effects are discussed and called out specifically for the purposes of NEPA in the following impact analysis.

TRPA Criteria

Based on TRPA's Initial Environmental Checklist, an alternative would result in a significant impact on geomorphology and water quality if it would:

- result in continuation of or increase in wind or water erosion of soils (TRPA 1);
- create changes in deposition or erosion of beach sand, or changes in siltation, deposition, or erosion, including natural littoral processes, that may modify the channel of a river or stream or the bed of a lake (TRPA 2);
- result in discharge into surface waters or in any alteration of surface water quality, including temperature, dissolved oxygen, or turbidity (TRPA 3);

- result in the potential discharge of contaminants to the groundwater or any alteration of groundwater quality (TRPA 4); or

- result in an effect on drinking water sources located within 600 feet of the project (TRPA 5).

METHODS AND ASSUMPTIONS

The impact analysis has been completed using a combination of quantitative and qualitative methods performed by a hydrologist/geomorphologist and civil engineer experienced in river restoration in general and the Tahoe Basin environment specifically. Information for the project site and vicinity and professional experience on similar projects have been referenced and incorporated into the analysis of the river system history, existing conditions, likely future conditions, and conditions expected under each action alternative.

Climate change effects on future geomorphology and water quality are incorporated in the No Project/No Action Alternatives evaluation. However, even the most geographically and temporally focused available forecasts of climate change effects on hydrologic parameters (Tetra Tech 2007) have relatively large variability and substantial uncertainty. Due to this variability and uncertainty, a range of climate change scenarios, not just end members or a midline scenario, are considered. Depending on the scenario, the statements are expressed in only qualitative terms.

The impact analysis examines the effects of each alternative over the short term and long term for each of the criteria listed above. Short-term effects are defined as those that would be temporary and could occur over hours, days, or weeks during the active construction phase. In addition, the river system is expected to undergo changes following construction as vegetation matures and the river reoccupies and adjusts to the restoration project, so the short-term analysis also looks at interim effects that might occur during the first few years following construction, assuming that streamflows are at least average, and also considers conditions if a large flood event (approximately 25-year peak flow) occurs within five years after construction.

Wherever federal, state, or local water quality standards applicable for the region must be attained and maintained pursuant to Article V(d) of the TRPA Compact (TRPA 2004), the strictest standards are used as the significance criteria for this project; therefore, the project effects must meet or exceed such water quality standards to earn a less-than-significant conclusion, recognizing that any violation of a water quality standard is considered a water quality impact without taking in account the extent and duration of that impact. Based on informal agency consultations during alternatives development and analysis, the Lahontan RWQCB's numeric and narrative water quality standards are the most stringent factors for significance determinations. Violation of any of the numeric water quality limits or narrative standards in the objectives of the Basin Plan (see Table 3.9-2 for examples), or actions inconsistent with the "nondegradation" objective, would result in a significant impact for this analysis. While it is possible that other water quality parameters could be affected by a project alternative, the "turbidity standard" (i.e., <10 percent above natural background) appears to be the most sensitive measure that is likely to be affected by potential construction in and along the river channel. The applicable limit is related to the Lahontan RWQCB's narrative turbidity standard for receiving waters in the Basin Plan, which states that "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" (Lahontan RWQCB 1995:5.1-9).

Natural turbidity levels range widely by season with flow magnitudes and the availability of sediment to be entrained. Over the past several years, most turbidity sampling on the Upper Truckee River has been conducted via grab samples as part of volunteer monitoring or research programs, along with some sampling during construction activities. For example, a citizen's volunteer water quality monitoring event called Snapshot Day, held in May each year, typically includes sites on the Upper Truckee River: in Christmas Valley; one in the downstream end of the Middle Reach (Mosher property); and a couple of sites near the river's mouth. May 2002 samples had turbidity readings ranging from 0.12 NTU to 1.61 NTU (in the Mosher Reach). May 2003 samples had turbidity readings ranging from 0.3 NTU to 0.98 NTU (near the mouth). May 2005 samples had turbidity readings ranging from 2.43 NTU (near the mouth, but above Trout Creek) to 3.47 NTU (Christmas Valley) (TRPA 2002c). Additional grab samples were collected at two sites on the Upper Truckee River and two sites on Angora Creek on four dates in 2008 (January, March, the May 10th snapshot day, and in July), but none were over 4.5 NTU (Sierra Nevada Alliance 2008).

During the summer of 2008, Upper Truckee River and Angora Creek were sampled at multiple stations on the same dates as part of a Tahoe-Baikal Institute program. The Upper Truckee River samples ranged from less than 1 NTU at Meyers and by the Elks Club to less than 1.5 NTU at U.S. 50/Lake Tahoe Boulevard. The Angora Creek samples ranged from less than 0.5 NTU at the headwaters (by Angora Lakes) to just over 1 NTU at View Circle and nearly 3 NTU near the confluence with the Upper Truckee River (Tahoe-Baikal Institute 2008). Restoration project–specific water quality compliance monitoring for the Upper Truckee River Reaches 3 and 4 during construction included numerous grab samples between July 21 and September 4, 2008, along with continuous monitoring from September 5 to October 7, 2008 (Taylor, pers. comm. 2010); none of the grab samples were over 4 NTU. Median values during continuous monitoring remained between 1 and 3 NTU both upstream and downstream of the construction site for the restoration project, although a few brief spikes exceeded 10 and even 100 NTU for 10- to 20-minute periods. The brief turbidity spikes were associated with miscellaneous background disturbance (by recreation users and animals) upstream of the construction, as well as potential construction-related effects at least on one date (Taylor, pers. comm., 2010; Conservancy 2008).

The only continuous turbidity monitoring that spans multiple seasons and locations on the Upper Truckee River was conducted by CSLT (2nd Nature 2006b). This monitoring included three sites along the Upper Truckee River beginning in April 2002 (for a partial water year) and throughout WYs 2003, 2004, and 2005. The background turbidity levels (between storm events) were generally under 15 NTU and often less than 10 NTU. Short duration peaks exceeded 100 NTU (and a few exceeded 500 NTU) in all years, but the season when peak values occurred was not consistent, ranging from the onset of fall rains to snowmelt season and brief summer storms.

Background turbidity levels on the Upper Truckee River are typically extremely low (i.e., less than 10 NTU), especially during summer construction season; therefore, very small changes from the natural state (an increase of <1 NTU) could result in a violation of the Basin Plan standard. Water with turbidity less than 10 NTU, and especially less than 5 NTU, generally appears clear to the naked eye. Thus, a potential violation in this range can be determined only with sensitive instrumentation that is appropriately deployed, calibrated, and maintained (USGS 2005: TBY-47). Additionally, the Basin Plan provides no narrative or numeric distinction regarding the season or duration of a turbidity increase to be considered detrimental, so an increase more than 10 percent over natural, of any duration, could be considered a violation of the standard as written in the Basin Plan.

Potential violations of the narrative turbidity standard at the low end of the NTU range, while considered a significant impact for CEQA/NEPA/TRPA analysis (as stated above), would not necessarily correspond to an adverse effect on Lahontan RWQCB–defined beneficial uses. For example, an effect on aesthetic values under the Non-Contact Recreation Use designation in the Basin Plan (Lahontan RWQCB 1995:2-2) is considered by the Lahontan RWQCB to be the first (i.e., most sensitive) indicator of an effect on beneficial uses (Kemper, pers. comm., 2010). If persistent visible turbidity from the project site were to occur—particularly during the summer recreation period when flows are low, recreation use is high, and background conditions would exhibit low turbidity (i.e., good background clarity)—this visible turbidity would potentially impair noncontact recreation beneficial uses. However, the turbidity values that would correlate with this impairment of aesthetics-related beneficial use might not occur unless turbidity was increased beyond natural seasonal background by several orders of magnitude (i.e., well beyond the <10 percent increase limit in the turbidity standard of the Basin Plan). Summer turbidity levels would also likely need to exceed the minimum aesthetic criterion to have adverse effects on other beneficial uses, including those supporting aquatic organisms. The project alternatives would have to elevate turbidity considerably above ten percent over background to impair beneficial uses; however, the stringent ten-percent-above-background turbidity standard is used as a significance threshold for this EIR/EIS/EIS because of the CEQA checklist question regarding violation of "any water quality standard."

EFFECTS NOT DISCUSSED FURTHER IN THIS EIR/EIS/EIS

Effects on Drinking Water Sources (CEQA 1, 3; TRPA 4, 5)—There are five groundwater supply wells within 600 feet of the study area boundary (Exhibit 3.9-14). These wells are sources of public and private drinking water. All of the wells are outside of construction/disturbance areas proposed by any of the alternatives and are located upgradient from affected areas. Therefore, there would be no substantial potential for disturbance of or contaminant releases to the wells. The effect of each project alternative (i.e., promotion of increased inundation of the floodplain) would be to generally increase recharge to the uppermost water-bearing zones; the project alternatives would not adversely affect groundwater supplies. Although the specific rates and quantities of increased recharge are not known and the effects would be generally low compared to other regional recharge effects, the potential for increased infiltration to groundwater supplies would be beneficial.

IMPACT ANALYSIS AND MITIGATION MEASURES

Alternative 1: Channel Aggradation and Narrowing (Maximum Recreation Infrastructure)

IMPACT 3.9-1 (Alt. 1)

Short-Term Risk of Surface Water and Groundwater Degradation during Construction. (CEQA 1, 2, 3; TRPA 1, 2, 3, 4, 5) *Implementing Alternative 1 would involve substantial construction activities along or in the channel of the Upper Truckee River, sections of Trout Creek, along the Tahoe Keys Marina (Sailing Lagoon), and near the shoreline of Lake Tahoe. Although temporary BMPs would be implemented, short-term risks of water quality degradation could occur in each summer construction season or over the intervening winters. Grading would result in ground disturbance within sensitive lands and increase the potential for erosion and sediment transport. Accidental releases of hazardous materials or other pollutants could affect surface or subsurface waters. Implementing Alternative 1 could result in short-term turbidity exceeding the Basin Plan's stringent turbidity standard (10 percent above background levels). Although the Conservancy would implement Environmental Commitments 5 and 6 to protect water quality, this impact would be* ***significant****.*

Construction activities under Alternative 1 would include large-scale grading operations and construction of permanent facilities (a bridge, boardwalk, streambed and bank structures, and two self-service kiosks). Implementing Alternative 1 would require four years of seasonal construction (between May 1 and October 15), with winter closedowns except for BMP maintenance and monitoring. Construction would disturb areas in uplands, as well as in the active floodplain of the Upper Truckee River and Trout Creek and the main channel of the Upper Truckee River.

The extent of "in-channel" (i.e., area of channel that normally carries flows year-round) work would vary by year. Installing the new bridge and constructing grade controls, bank protection measures, and transitional connections between channel segments would require work in the active channel. Reconnection of meanders and construction of new meanders, portions of the floodplain reconstruction, and filling of abandoned river segments would be conducted "off-channel" (outside of the active channel). Nearly all of the disturbance areas, access routes, and staging areas would be within the 100-year floodplain. Using motorized construction equipment would require the use of fuels, lubricants, and other hazardous materials. If accidentally released (particularly during in-channel construction activities), these materials could potentially discharge to water bodies; pollutants released to the surface could migrate to groundwater.

As discussed in Chapter 5, "Compliance, Consultation, and Coordination" and in Environmental Commitment (EC) 6, "Obtain and Comply with Federal, State, Regional, and Local Permits" (Table 2-6), the project would acquire permits and approvals from several entities (e.g., El Dorado County, TRPA, the Lahontan RWQCB, USACE, and the CDFG). Those permits and approvals would impose conditions and requirements to minimize the risks of construction-related water quality degradation by sediment or other pollutants. The general types of permit documents and their components are known; however, the specific measures, performance standards, and enforcement elements would not be established until after selection of the project alternative and completion of the project design. For purposes of this analysis, any violation of any duration and magnitude would be potentially significant within the strict thresholds necessary for CEQA compliance.

Exact erosion control measures (i.e., BMPs) and their performance standards have not yet been specified. However, general BMPs would include the use of construction fencing, silt fences, straw bales, temporary settling basins, vegetation protection, hydroseeding, and straw mulch to assure protection of water quality. To the extent feasible, these water quality protection measures would be designed to be redundant so that if one means of protection were to fail, a backup would be in place.

Construction activities that would occur within the existing streambed or streambanks (i.e., in-channel activities) would require temporary dewatering of surface water in the river channel. Dewatering also could be required if groundwater were to collect in active excavation areas. Conceptual approaches to dewatering have been identified for various elements of the Alternative 1 in-channel work, but specific measures have not yet been determined. The options for managing dewatered effluent would depend on seasonal conditions (including groundwater levels. lake levels, and storm/flow events). The most likely options for reusing the effluent would be either to irrigate the floodplain or to pump the effluent to containment areas on the floodplain. Direct discharges of effluent to the river or to Lake Tahoe would not be allowed unless water quality standards were met. If volumes were relatively low, the effluent would be pumped and used for irrigation. If volumes or rates of effluent generated were relatively high, temporary containment areas would be created. The effluent would be pumped into the containment areas and allowed to infiltrate and evaporate. The level of water in the containment areas would be monitored to minimize the potential for overtopping. If necessary, advanced filtration would be used to treat effluent to a standard that could be discharged back to surface water. The temporary containment areas could be removed at the end of each construction season.

Newly constructed channel segments would be protected from flows; these areas would be isolated by water-filled berms, earthen berms, and/or by other approved methods. Flow would not be diverted into the new channel for at least two years as the planted vegetation became sufficiently established (i.e., during channel “seasoning”). All disturbed areas to be reclaimed to natural habitat would be revegetated and irrigated appropriately. Although these precautions would reduce the potential for erosion before stabilization, the possibility of inundation during the stabilization period exists. The strict turbidity standard presented in Section 5.2 of the Basin Plan (i.e., turbidity that is ten percent above background levels) could be exceeded if these areas were inundated.

Based on the conceptual information regarding proposed construction management for Alternative 1, water quality standards may be violated, at least for short periods during each summer’s activities and/or over each intervening winter and snowmelt season. The violations would be likely to occur because of the large scale of grading and construction activities that would occur adjacent to the Upper Truckee River channel and floodplain, and especially because of the close proximity of construction to the river mouth and Lake Tahoe. Efforts would be made to work as quickly as possible to move from initial disturbance through final revegetation throughout the study area, but disturbed areas likely would be exposed to winter conditions between summer construction seasons. Winterization protection would be needed throughout the construction zone, and possible overwinter use of staging, storage, or access areas has not yet been determined.

All temporary stormwater controls and/or overwinter flood flow protections would be designed and sized to meet typical regulatory requirements (e.g., 20-year rainstorm for stormwater, 50-year peak streamflow). They could be overwhelmed by a larger storm event if it were to occur during the construction period. However, the probability that an event of greater magnitude would occur during either the summer low-flow seasons or the intervening winters is low and such a larger event is not reasonably foreseeable.

In addition, the Basin Plan’s strict turbidity standards would likely be exceeded during the initial stages of use of the new channel. Flushing flows would be released to clean the new channel before activation; however, these flushing flows would not be likely to create a condition in which the turbidity of the water would be less than 10 percent above background levels. Shortly after activation, turbidity levels are expected to return to upstream background conditions. Despite efforts to minimize risks, these effects would likely result in a violation of the Basin Plan's turbidity standard.

However, the Conservancy would implement EC 5, "Prepare and Implement Effective Construction Site Management Plans to Minimize Risks of Water Quality Degradation and Impacts to Vegetation." The measures in EC 5 would prevent surface-water and/or groundwater degradation that could be of sufficient magnitude and duration to impair the Upper Truckee River's beneficial uses, including visible turbidity that could impair aesthetic values or affect other beneficial uses. This commitment would avoid environmental damage to the river and its beneficial uses. Impairment of beneficial uses would likely require considerably higher turbidity levels, orders of magnitude above the river's very low background levels. However, as mentioned previously, in accordance with CEQA thresholds, the significance conclusion for this environmental document is based on the potential to violate the Basin Plan's turbidity standard. Therefore, this impact would be **significant**.

All feasible measures to avoid, minimize, or mitigate this impact have already been incorporated into the design of Alternative 1. However, these measures would not be sufficient to fully mitigate the potential for at least short-term violations of the Basin Plan's stringent water quality standard for turbidity. Because the potential to exceed this stringent standard would remain, Impact 3.9-1 (Alt. 1) would be **significant and unavoidable**.

IMPACT 3.9-2 (Alt. 1)	**Short-Term, Project-Related Risk of Surface Water Degradation Following Construction. (CEQA 1, 2, 3; TRPA 1, 2, 3, 4, 5)** *The biotechnical streambank treatments and other revegetated areas, such as the backfilled channel segments, of Alternative 1 could be vulnerable during a flood flow within the first few years following construction. Furthermore, some of the proposed treatments would prompt aggradation and could result in channel adjustment following construction. Therefore, implementing Alternative 1 could result in short-term exceedance of the Basin Plan's stringent turbidity standard (ten percent above background levels) after the construction phase. This impact would be* ***significant****.*

Construction activities under Alternative 1 would include construction of grade control structures to foster channel aggradation between RS 29+00 and RS 63+00. This alternative would rely on natural geomorphic processes to redistribute sediment and allow vegetation stabilization within that subreach following construction. These adjustments, while intended to achieve net deposition (aggradation), may include localized erosion and redistribution of channel sediment that induces turbidity.

Under Alternative 1, the new, geomorphically sized channel constructed between RS 63+00 and RS 93+00 and the small areas of inset floodplain in the upstream portion of the study area would be relatively susceptible to erosion (compared to the well-established, undisturbed vegetated surfaces) if a large flood were to occur within the first few years after construction. The risk of sediment mobilization may increase slightly if a major flood event were to occur before the vegetation could mature.

A possible risk of water quality degradation within the first few (approximately five) years after construction could arise from two potential mechanisms:

- expected natural channel adjustments in accordance with the project design and/or
- a large flood event (e.g., 25-year recurrence or greater) occurring in the first few years after construction.

A natural channel adjustment effect could occur where engineered designs were implemented. In particular, such adjustments would be expected as normal postconstruction channel dynamics for sites where the selected restoration design would not impose the final channel size, shape, or bed and bank materials directly during construction. At least a few (approximately three-five) years of expected channel adjustments would likely be needed for flows to approach or exceed the geomorphic design flow and reach equilibrium.

The potential magnitude and duration of water quality degradation would vary by the type and degree of channel adjustment, but the effects could violate the strict water quality standards outlined in Section 5.2 of the Basin Plan (i.e., the stringent turbidity standard of 10 percent above background levels). Channel adjustments, in the form of streambed material sorting and/or net streambed or streambank erosion, could produce turbidity effects. The effects would be greatest at each specific site of adjustment in the study area and would dissipate after the end of each erosion event, but turbidity might be detectable and could extend to Lake Tahoe, at least for short periods. Most possible channel adjustments would normally be expected to occur during periods of high streamflow when the background turbidity levels are also high, which would reduce any project-specific contribution to turbidity.

Under Alternative 1, unexpectedly large flows could damage the active channel and/or backfilled channels, causing instability that could continue beyond the initial flood event or propagate over time to affect additional locations. This effect could also occur under existing conditions, and a flood flow of this same magnitude under existing conditions or the No Project/No Action Alternative would also produce streambed and streambank erosion that could mobilize some areas of the existing floodplain. However, implementing Alternative 1 would modify the specific locations, areal extent, and soil/vegetation conditions that would be exposed to the flows in the channel or across the reactivated floodplain. Localized increases in erosion and sedimentation could occur, potentially resulting in violations of narrative or numeric water quality standards, at least briefly.

Design and revegetation specifications would be implemented for all reactivated channels and floodplain areas with remnant channels to minimize the risk that accumulated fine sediments and/or organic materials would be mobilized during a large flood in the first few years after construction. Despite these efforts to minimize risks, the effects of a flood event could cause a violation of the Basin Plan's stringent turbidity standard (ten percent above background levels). For purposes of this analysis, any violation of any duration and magnitude would be significant, in strict compliance with the impact thresholds under CEQA. Therefore, this impact would be **significant**.

Mitigation Measure 3.9-2 (Alt. 1): Adaptively Manage Potential Flood Disturbance in the Interim Period after Construction.

The Conservancy will develop and implement an adaptive management plan focused on the short-term water quality degradation that could result within the first five years after construction. The plan will identify specific data collection and monitoring protocols, describe decision-making processes and authorities, and list thresholds for corrective actions. The performance criteria for the corrective actions will focus on preventing initial flood damage or turbidity effects from becoming persistent, recurring, or chronic, whether the corrective action is needed at the initial damage site or at other locations that could be affected by channel response to the initial damage.

Significance after Mitigation: With implementation of Mitigation Measure 3.9-2 (Alt. 1) as described above, the short-term risk of surface-water or groundwater degradation following construction would be minimized, because potential flood damage in the interim period after construction would be adaptively managed. However, the potential for at least short-term violations of the Basin Plan's stringent water quality standard for turbidity cannot be feasibly eliminated. Because of the potential to exceed this stringent standard, Impact 3.9-2 (Alt. 1) would be **significant and unavoidable**.

IMPACT 3.9-3 (Alt. 1)	**Upper Truckee River Channel Erosion within the Study Area. (NEPA)** *Implementing Alternative 1 would involve making direct changes to the channel of the Upper Truckee River. The changes would offset past geomorphic responses to historic disturbances by reconstructing more appropriately sized channel sections with better connectivity to the existing floodplain and constructing features to promote channel aggradation and prevent streambank erosion. This would result in a substantial long-term benefit by improving channel stability and reducing erosion of the channel bed and banks. This impact would be* ***beneficial****.*

Alternative 1 would result in the development of about 3,900 feet of "geomorphically sized" channel (i.e., channel designed to accommodate existing hydrologic/hydraulic conditions and efficiently convey expected flows and sediment) (Exhibit 2-1). Under current conditions, approximately 500 feet of the existing channel is considered geomorphically stable (Conservancy and DGS 2005:Table 5-1). The improvement in channel stability is expected to reduce the potential for lateral migration of the channel. Additionally, bank stabilization proposed on the right (east) bank of the river downstream of the U.S. 50 bridge would minimize the potential for continued erosion in this area.

Vertical stability of the channel would be provided under Alternative 1 by the installation of seven vertical grade controls in the channel between RS 14+00 and RS 64+00. These structures would serve as relative “hard points” across the channel, minimizing the potential for downcutting (incision) and possibly promoting localized deposition (aggradation). The alternative also proposes a bioengineered grade control structure near the river mouth (RS 95+00) to minimize the potential for incision of the design channel resulting from the response of the river to possible substantial and prolonged lowered lake levels.

Compilation of the TMDL streambank-erosion results (California Water Boards and NDEP 2008) for specific subreaches of the Upper Truckee River allows a quantitative estimate of the effect of the proposed alternatives on stream channel erosion (Table 3.9-11). Using the range of treatment tiers analyzed for the TMDL, the estimated reduction in fine sediment loads from streambank erosion in the study area under Alternative 1 would be nearly 60 percent (reduced to 221 cubic yards from 538 cubic yards under existing conditions and the No-Project/No-Action Alternative). The study area is a small portion of the entire 15-mile-long river, and the proposed action alternatives alone would reduce the entire Upper Truckee River’s fine sediment load from streambanks by about 7 percent relative to existing conditions. While small, this would be a considerable and measurable benefit relative to the degraded existing condition or the No-Project/No-Action Alternative.

Table 3.9-11
Estimated Stream Channel Bank Erosion on the Upper Truckee River under Alternative 1

River Reach	Distance Upstream of Lake (feet)	Bank Erosion of Fine Sediment (cubic yards)[1]	
		Alternative 1	Alternative 5 (No-Project/No-Action)
Upper Truckee Marsh study area	0–9,646	221	538
TOTAL	**79,364**	**4,002**	**4,320**

Note:
[1] Fine sediment is less than 0.063 millimeter in diameter
Source: California Water Boards and NDEP 2007 (compiled for these subreaches in Appendix I).

Alternative 1 proposes changes to the channel and overbank morphology that may alter the hydraulics of the Upper Truckee River channel downstream of the U.S. 50 bridge. The alternative’s design includes bank stabilization on the right (east) bank adjacent to and downstream of the bridge. Alternative 1 would involve lowering the terrace to expand the floodplain area on the west side of the river downstream of the existing pedestrian bridge (RS 05+00 to RS 11+00). Alternative 1 would improve direction of a portion of high flows into the secondary channel. The project has evaluated the impacts of these channel modifications on water surface elevations up- and downstream of the modified areas for the 5-year through 100-year flood events (and DGS 2005:Exhibits 4.7-1 and 4.7-5). The analysis indicates that the water surface elevations would remain unchanged relative to the existing conditions downstream of (and at) the existing bridges. Therefore, no change in the hydraulic conditions at the bridge is expected as a result of implementation of the alternative.

Alternative 1 includes features that would improve future protection of the bridge. The alternative would stabilize the high eroding right streambank downstream of the bridge (including through protection of slope vegetation and the slope toe). The stabilization would minimize future enlargement of eroded areas and protect the bridge from future erosion at the hazard. Potential hydraulic impacts related to the proposed pedestrian bridge at RM 10+00 are addressed in Impact 3.8-3 (Alt. 1) in Section 3.8, “Hydrology and Flooding.”

This impact addresses long-term benefits associated with a net reduction of erosion. However, all stream restoration projects, particularly those that incorporate geomorphic process–based adjustments as part of the design elements, may experience localized channel erosion during an interim period following construction. The potential adverse water quality impacts of such adjustments (including unexpected changes or responses to flood disturbance) were described as a significant short-term impact above in Impact 3.9-2 (Alt. 1). The mitigation for that impact, Mitigation Measure 3.9-2 (Alt. 1), requires implementation of an adaptive management plan that commits to actions that would prevent short-term water quality problems from becoming chronic, thus ensuring that the long-term improvements to Upper Truckee River conditions expected under Impact 3.9-3 (Alt. 1) can be realized. This impact would be **beneficial**.

IMPACT 3.9-4 (Alt. 1)	**Trout Creek Channel Erosion within the Study Area. (NEPA)** *Implementing Alternative 1 would not involve directly modifying the channel of Trout Creek. However, Trout Creek would be expected to adjust to the proposed changes to the elevation and size of the Upper Truckee River channel in the vicinity of the mouth of the creek. The anticipated response of Trout Creek would likely be deposition in the lowest reach, reducing the potential for continued incision that previously was prompted by historical dredging and lowering of the Upper Truckee River channel bed. This effect would be* ***beneficial****.*

Under Alternative 1, the channel of the Upper Truckee River through the marsh (Reach 3) would be modified by abandoning the existing straightened segment and constructing a new meandering channel (Exhibit 2-1). The new channel would be narrower and its bed would be raised compared to the existing channel. These modifications would include the confluence of the river with Trout Creek. The effect of raising the elevation of the Upper Truckee River channel and mouth would likely initiate deposition at the confluence and within the lower reach of the Trout Creek. The change would also reduce the potential for further incision (vertical erosion) of the creek. Overall, modifying the Upper Truckee River channel would either have a neutral effect or reduce the potential for erosion within Trout Creek.

No quantitative estimate of streambank erosion loads or load reduction potential along Trout Creek was made in studies for the TMDL (California Water Boards and NDEP 2008). However, based on geomorphic principles and qualitative analysis, Alternative 1 would not substantially change the amount of flow (and sediment) carried by Trout Creek's main channel and distributaries under normal or flood conditions. Although the modifications at the mouth may promote some localized deposition, the low-gradient environment of the lower reach of the creek would not be expected to be subject to substantial changes in lateral or vertical erosion. The effect on lower Trout Creek would be slightly beneficial relative to existing conditions, because of the potential for reduced erosion.

As described above for the Upper Truckee River in Impact 3.9-3 (Alt. 1), implementing mitigation to prevent adverse short-term water quality impacts from becoming chronic (Mitigation Measure 3.9-2 [Alt. 1]) would ensure that the long-term improvements to Trout Creek conditions expected under Impact 3.9-4 (Alt. 1) can be realized. This effect would be **beneficial**.

IMPACT 3.9-5 (Alt. 1)	**Erosion of Backfilled and/or Remnant Channel Segments on the Floodplain. (CEQA 1, 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 1 would involve backfilling portions of the existing Upper Truckee River to function as part of the active floodplain, and would increase the frequency with which existing remnant channel segments on the floodplain would be inundated. Following the project design details and specifications would prevent "recapture" of the backfilled channel or an increase in erosive force on remnant channel segments that could mobilize accumulated sediment and organic matter. This impact would be* ***less than significant****.*

Alternative 1 would abandon and backfill existing Upper Truckee River channel segments between RSs 17+00 and 29+00 and between RSs 63+00 and 93+00 (about 4,200 feet). The abandoned channels would be filled with floodplain sediments generated by construction of new channel segments, existing stockpiled sediments, and imported sediments (if necessary). Lateral grade controls would be installed upstream and downstream of the proposed intersections of backfilled abandoned channels with the newly constructed channel segments. The lateral controls would be designed to resist erosion of the backfilled channels up to the 100-year flood event.

Alternative 1 may also incrementally increase the exposure of existing remnant (i.e., naturally abandoned) channel segments on the floodplain to flood flows. The remnant channels are discontinuous, curved depressions on the marsh surface that are partially filled with fine sediment and accumulated organic material. Alternative 1 would increase the area inundated during low-magnitude, high-frequency flow events (i.e., 2-year and 5-year flows), but would not substantially alter inundation in the area during high-magnitude events (i.e., 25-year flows or greater). The increased inundation from small floods might raise the potential for flow to enter remnant channel segments and possibly erode them more often, but these areas would be subject to erosion from larger floods under existing conditions. Additionally, the portion of the study area that would experience increased overbank inundation under Alternative 1 does not include well-defined remnant channels. Therefore, the potential risk of reoccupation and erosion of remnant channels under Alternative 1 would be small.

Following the project's proposed specifications for backfill areas would prevent uneven placement of backfill, differential compaction, or varied success of revegetation, which induce erosion of either the backfill or adjacent natural soil/sediment. Potential erosion along the backfilled abandoned channel segments would be reduced. This impact would be **less than significant**.

IMPACT 3.9-6 (Alt. 1) **Retention of Fine Sediment and Nutrients within the Study Area. (NEPA)** *Implementing Alternative 1 would directly reduce the Upper Truckee River's channel capacity and raise the streambed elevation in the lowest reach of the study area, make modifications that would reduce channel capacity and streambank height in other subreaches, and restore lagoon features along the river and behind East Barton Beach. These modifications would increase the frequency of overbanking, enlarge the area of functional active floodplain, and offset past geomorphic adjustments to historic disturbances. Overtopping of the banks during small to moderate flood peaks would result in a substantial improvement in fine sediment and nutrient retention on the floodplain (i.e., marsh surface). This effect would be* ***beneficial****.*

Alternative 1 proposes modifying the Upper Truckee River to generally raise the elevation of and narrow the low-flow channel (decreasing the channel capacity) and increase the frequency of overbanking events. With implementation of Alternative 1, the length of channel experiencing overbanking during the 2-year recurrence flow (at median lake levels) would increase from approximately 2,129 feet under existing conditions to about 12,145 feet (about 54 percent of new channel length, inclusive of both banks) (Table 3.9-12). The expected area of inundation during such an event would increase from about 65 acres to 74 acres under Alternative 1.

Table 3.9-12
Floodplain Connectivity and Floodplain Process Indicators under Alternative 1

Upper Truckee Marsh Alternative	Length of Channel with Overbanking at 760 cfs[1] (feet)	Percent of Channel with Overbanking at 760 cfs[1] (%)	Area of Floodplain Inundated at 760 cfs[1] (acres)
Alternative 1	12,145	54	74
Alternative 5 (No Project/No Action)	2,129	10	65

Note: cfs = cubic feet per second
[1] Based on hydraulic modeling (HEC-RAS), assuming median lake level.
Source: Conservancy and DGS 2005

The increased frequency and increased area of inundation during relatively frequent flow events would promote the deposition of fine-grained sediment on portions of the floodplain that are not inundated as frequently under existing conditions. During an overtopping event, streamflow would spread over a wider area, resulting in decreased flow velocity and depth. These hydraulic conditions would favor the retention of sediment particles transported by the storm flows. The retention of sediment and associated nutrients, including phosphorous and nitrogen, on the floodplain would enhance nutrient delivery to marsh soils and vegetation. Additionally, infiltration of water in inundated areas would increase soil moisture and would recharge (and temporarily raise) shallow groundwater. The increased nutrient delivery and increased available water in the shallow subsurface would improve conditions for riparian and marsh vegetation. The magnitude of these benefits would vary depending on the timing and duration of inundation.

Alternative 1 would involve removing fill and grading the west streambank of the Upper Truckee River to reconnect the existing Sailing Lagoon to the river, while isolating it from the dredged marina. Restoration of the surface water connection with the river would increase the opportunity for overbank flows to convey sediment and nutrients into the lagoon. Increased sediment retention and nutrient cycling in the lagoon relative to the existing condition is an additional benefit beyond active floodplain inundation.

Alternative 1 would also include removal of sediment behind (landward of) East Barton Beach to recreate lagoon and wet meadow conditions. These modifications would also increase the areas along the floodplain margin to capture sediment and nutrients.

The combined effects of creating more stable channel segments, promoting more frequent overtopping events and sediment deposition on the floodplain, implementing bank protection, and creating/improving functioning lagoon and wetland environments under Alternative 1 would help to reduce transport of fine sediment to Lake Tahoe. The proposed reduction of the river mouth's capacity and retention of sediment would return long-term littoral processes at the river-lake interface to a more natural regime. This impact would be **beneficial**.

IMPACT 3.9-7 (Alt. 1)	**Decreased Delivery of Coarse Sediment to Cove East and Barton Beaches. (TRPA 2)** *Implementing Alternative 1 could result in a net decrease in the transport of coarse sediment by the Upper Truckee River to beach areas adjacent to its mouth. The reduction in coarse-sediment delivery could hinder beach replenishment in the short term and worsen the ongoing trend of net beach erosion. In the long term, the amount of coarse sediment transported through the study area would be similar to the amount transported under existing conditions. Also, climate change effects could either exacerbate or counteract present trends. In the long term, the potential effects could range from worse than the existing degraded condition to a possible improvement. Any determination regarding* ***long-term effects of climate change on coarse-sediment transport and delivery downstream would be too speculative for a meaningful conclusion****. In the short term, however, implementing Alternative 1 would directly modify transport of coarse sediment and foster deposition within various portions of the study area, which may temporarily decrease delivery of coarse sediment to the adjacent beaches. This short-term impact would be* ***potentially significant.***

Under Alternative 1, the Upper Truckee River would be modified to develop a more stable channel and to improve the natural interaction of the river with its floodplain and marsh environments. A goal of Alternative 1 is to design and construct a channel that would minimize channel instability (particularly incision) and efficiently convey flows and related sediment load. The design would include raising the channel bed and installing vertical grade control structures. The structures would encourage localized deposition of bedload (coarse-grained sediments). Therefore, some sediment would be expected to remain in temporary storage within the active channel of the river. Given the design geometry of the proposed channel, each of the eight grade control structures has the potential to result in the deposition of approximately 300 cubic yards of coarse sediment each for a total of 2,400 cubic yards (3,600 tons).

Estimates of the total annual sediment transport in the Upper Truckee River range from 439 tons per year (USGS 2002) to 17,040 tons per year (DSC 1969). Bedload transport is approximately ten percent of the Upper Truckee River's total sediment load (Swanson 1996), or 44–1,704 tons per year. Assuming all deposition promoted by the proposed placement of grade controls necessary to achieve the streambed aggradation needed for Alternative 1 would occur over a relatively short period (one–five years), the retention would represent a substantial reduction in the annual bedload transport of the Upper Truckee River near the mouth. The net short-term effect would be the loss of bedload (coarse-grained) sediment transported via the mouth of the river and available to local beaches.

Additionally, the modified channel would be designed to promote development of bars, which could also temporarily store sediment. This effect would be transitory because sediment forming the bars would migrate downstream (and eventually to the mouth). Therefore, over time, the amounts of coarse sediment transported through the study area would be similar to that input from upstream. The long-term effects on sediment transport and input of coarse sediment to the littoral zone would be to restore a more natural regime.

Alternative 1 would involve connecting the river to the Sailing Lagoon (at high flows) and modifying the marsh landward of East Barton Beach, providing increased potential for deposition and storage of coarse sediment transported by the river and/or Trout Creek. If not controlled, the overflow of river flows into the Sailing Lagoon could result in a permanent low-flow connection of the river to the lagoon. In the event that the area ("highlands") between the lagoon and design channel (approximate elevation 6,227 feet) were overtopped during a flood flow when the water level in the lagoon was relatively low (e.g., a low lake level on the order of elevation 6,220 feet), a channel could develop through incision of the highlands. If a permanent connecting channel between the river and lagoon were created at relatively low flows, it could increase deposition and permanent storage of coarse sediment in the lagoon. Final project design would include a flow control feature to manage water flowing into the Sailing Lagoon during bank overtopping events when the lagoon's starting water surface would be low. The control feature (e.g., a rock-lined channel or weir structure) would be designed to control the location and minimum elevation of overflow into the lagoon. It would prevent the development of a permanent, uncontrolled erosion channel connecting the river to the lagoon at low flows.

However, as under the No-Project/No-Action Alternative, potentially offsetting factors may result from climate change in the long term. The net effect on river dynamics and beach erosion is highly uncertain. Even after thorough investigation, any determination regarding climate change effects on coarse-sediment transport and delivery downstream would be speculative.

Regardless of uncertainty about long-term effects of climate change, Alternative 1 has the potential to decrease the delivery of coarse sediment to Lake Tahoe relative to existing conditions in the short term. The reduction in sediment delivery could incrementally decrease replenishment of sand to the beaches at the south margin of the lake. The decrease in replenishment could modify littoral processes and promote continued or increased erosion of the beaches and reduced supply of sediment to dunes. This short-term impact would be **potentially significant**.

Mitigation Measure 3.9-7 (Alt. 1): Monitor and Adaptively Manage Delivery of Coarse Sediment to Cove East and Barton Beaches.

During the period of channel adjustments following construction, and until the streambed profile attains a relatively continuous slope within the study area, the Conservancy will monitor the supply of coarse sediment entering the study area, deposition within the treated reaches, and beach-face erosion at least once a year. Specifically, the Conservancy will make observations of net deposition or scour during low-water conditions. If substantial coarse-sediment deposition is occurring within large portions of the study area or beach-face erosion has worsened, and coarse-sediment input from upstream has not decreased, the Conservancy will respond with site-specific adaptive management. The Conservancy will develop and implement an adaptive management plan that will review and evaluate monitoring data and project conditions and recommend follow-up actions. Such actions could include continued or revised monitoring, corrective actions or interventions, and documentation.

Significance after Mitigation: With implementation of Mitigation Measure 3.9-7 (Alt. 1) as described above, the potential adverse geomorphic consequences of short-term interruption of coarse-sediment delivery would be **less than significant** because the coarse sediment would be supplemented if necessary to prevent additional beach erosion.

IMPACT 3.9-8 (Alt. 1) **Stormwater Drainage and Treatment. (CEQA 1, 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 1 would involve constructing permanent recreational features. The development of these features could potentially result in the release of pollutants and degradation of water quality. As described in Environmental Commitments 5, 6, and 11, effective permanent BMPs to protect water quality would be included in the final design of all recreation features. This impact would be* ***less than significant****.*

Alternative 1 would include several recreational features, including two kiosks, observation areas, trails at the margins of the marsh, and a boardwalk across the northern end of the marsh. The facilities generally would be restricted to the margins of the SEZ to minimize the extent of encroachment in this sensitive area. Developing these features would require disturbance of floodplain areas within an SEZ, presenting potential erosion hazards. Recreational facilities with impervious cover (e.g., the surfaces of bicycle paths) could also increase or concentrate runoff and increase erosion potential.

The design of recreational features has not been finalized. Developing these features may increase the potential for the transport of sediment or other pollutants to the Upper Truckee River and Lake Tahoe, which would be a potentially significant effect. However, the Conservancy would implement ECs 5 and 6 (Table 2-6). Implementing these environmental commitments would require implementation of effective construction site management plans and compliance with federal and state permits and thus would minimize short-term construction-related impacts. The final project design and implementation would include permanent stormwater detention features or infiltration systems for runoff from areas of proposed impervious surfaces (see Impact 3.8-1 [Alt. 1] in Section 3.8, "Hydrology and Flooding," for further discussion). The Conservancy would also implement EC 11, "Incorporate Effective Permanent Stormwater Best Management Practices," to provide effective permanent BMPs for all recreation features. With implementation of ECs 5, 6, and 11, this impact would be **less than significant**.

Alternative 2: New Channel—West Meadow (Minimum Recreation Infrastructure)

IMPACT 3.9-1 (Alt. 2) **Short-Term Risk of Surface Water and Groundwater Degradation During Construction. (CEQA 1, 2, 3; TRPA 1, 2, 3, 4, 5)** *Implementing Alternative 2 would involve substantial construction activities along or in the channel of the Upper Truckee River, sections of Trout Creek, along the Tahoe Keys Marina, and near the shoreline of Lake Tahoe. Although temporary BMPs would be implemented, short-term risks of water quality degradation could occur in each summer construction season or over the intervening winters. Grading would result in ground disturbance within sensitive lands and increase the potential for erosion and sediment transport. Accidental releases of hazardous materials or other pollutants could affect surface or subsurface waters. Implementing Alternative 2 could result in short-term turbidity potentially impairing noncontact recreation beneficial uses (aesthetics). Although the Conservancy would implement Environmental Commitments 5 and 6, this impact would be* ***significant****.*

Construction activities under Alternative 2 would include large-scale grading operations and construction of permanent facilities during multiple construction seasons. These activities pose a similar range and magnitude of possible impacts, under the same permit conditions, and within the same conceptual level of BMPs and design certainty as discussed for Impact 3.9-1 (Alt. 1). Despite efforts to minimize risks, the effects could result in a the turbidity standard described in Section 5.2 of the Basin Plan. For purposes of this analysis, any violation of any duration and magnitude would be potentially significant.

The Conservancy would implement ECs 5 and 6 (Table 2-6). These measures would prevent surface-water and/or groundwater degradation that could be of sufficient magnitude and duration to impair the Upper Truckee River's beneficial uses, including visible turbidity that could impair aesthetic values or affect other beneficial uses. Impairment of beneficial uses would likely require considerably higher turbidity levels, orders of magnitude above the river's very low background levels. However, as mentioned previously for Impact 3.9-1 (Alt. 1), the significance conclusion for this environmental document is based on the potential to violate the Basin Plan's turbidity standard. Therefore, this impact would be **significant**.

All feasible measures to avoid, minimize, or mitigate this impact have already been incorporated into the design of Alternative 2. However, these measures would not be sufficient to fully mitigate the potential for at least short-term violations of the Basin Plan's stringent water quality standard for turbidity. Because the potential to exceed this stringent standard would remain, this impact would be **significant and unavoidable**.

IMPACT 3.9-2 (Alt. 2)

Short-Term, Project-Related Risk of Surface Water Degradation Following Construction. (CEQA 1, 2, 3; TRPA 1, 2, 3, 4, 5) *Implementing Alternative 2 would require completion of in-channel construction activities. The biotechnical streambank treatments and other revegetated areas, such as the backfilled channel segments and inset floodplains, could be vulnerable during a flood flow within the first few years following construction. Therefore, implementing Alternative 2 could result in short-term exceedance of the Basin Plan's stringent turbidity standard (ten percent above background levels) after the construction phase. This impact would be* ***significant****.*

Possible risks from natural channel adjustment effects (described further under Impact 3.9-2 [Alt. 1]) would be minimal under Alternative 2. The final channel size, shape, and bed and bank materials would be installed during construction and would be allowed to season and establish before the release of live stream flows, and natural channel adjustments would not be needed to meet final design grade or functions.

Under Alternative 2, the new, geomorphically sized channel constructed between RS 20+00 and the mouth of the Upper Truckee River and the small areas of inset floodplain in the upstream portion of the study area would be relatively susceptible to erosion (compared to the well-established, undisturbed vegetated surfaces) if a large flood were to occur within the first few years after construction. A slightly increased risk of sediment mobilization may occur if a major flood event were to occur before the vegetation could mature.

Design and revegetation specifications would be implemented for all reactivated channels and floodplain areas with remnant channels to minimize the risk that accumulated fine sediments and/or organic materials would be mobilized during a large flood in the first few years after construction. Despite these efforts to minimize risks, the effects could cause a violation of Section 5.2 of the Basin Plan (i.e., the stringent turbidity standard of ten percent above background levels). This impact would be **significant**.

Mitigation Measure 3.9-2 (Alt. 2): Adaptively Manage Potential Flood Disturbance in the Interim Period after Construction.

This mitigation measure is identical to Mitigation Measure 3.9-2 (Alt. 1).

Significance after Mitigation: With implementation of Mitigation Measure 3.9-2 (Alt. 2) as described above, the short-term risk of surface-water or groundwater degradation following construction would be minimized, because potential flood damage in the interim period after construction would be adaptively managed. However, the potential for at least short-term violations of the Basin Plan's stringent water quality standard for turbidity cannot be feasibly eliminated. Because of the potential to exceed this stringent standard, Impact 3.9-2 (Alt. 2) would be **significant and unavoidable**.

IMPACT 3.9-3 (Alt. 2)

Upper Truckee River Channel Erosion within the Study Area. (NEPA) *Implementing Alternative 2 would involve making direct changes to the channel of the Upper Truckee River. The changes would offset past geomorphic responses to historic disturbances by reconstructing more appropriately sized channel sections with better connectivity to the existing floodplain and constructing features to prevent streambank erosion. This would result in a substantial long-term benefit by improving channel stability and reducing erosion of the channel bed and banks. This impact would be* ***beneficial.***

Alternative 2 would involve constructing a new, more geomorphically stable channel for the Upper Truckee River between RS 20+00 and RS 10+700 (Exhibit 2-2). The proposed channel has been designed to improve channel stability and to promote more natural interaction of the river with its floodplain and relocate the mouth of the river. The new channel would increase the length of channel that is "geomorphically sized" from approximately 500 feet under existing conditions to 6,150 feet. The proposed improvements in channel morphology would promote a more stable channel, reducing the potential for lateral and vertical erosion. The alternative also proposes the construction of bank stabilization and new floodplain areas downstream of the U.S. 50 bridge (RS 0+00 to RS 20+00) to reduce existing bank erosion. These improvements are specifically proposed to minimize the potential for future erosion and sediment transport from the study area (and to Lake Tahoe).

In addition to these features, Alternative 2 proposes installation of a vertical grade control just downstream of the confluence of the river with Trout Creek. This structure would reduce the potential for upstream migration of a knickpoint in the Upper Truckee River that might develop in the future in response to sustained periods of low lake levels.

Compilation of the TMDL streambank-erosion results (California Water Boards and NDEP 2008) for specific subreaches of the Upper Truckee River allows a quantitative estimate of the effect of the proposed alternatives on stream channel erosion (Table 3.9-13). Using the range of treatment tiers analyzed for the TMDL, the estimated reduction in fine sediment loads from streambank erosion in the study area under Alternative 2 would be nearly 60 percent (reduced to 221 cubic yards from 538 cubic yards under existing conditions and the No-Project/No-Action Alternative). The study area is a small portion of the entire 15-mile-long river, and the proposed action alternatives alone would reduce the entire Upper Truckee River's fine sediment load from streambanks by about 1 percent relative to existing conditions. While small, this would be a considerable and measurable benefit relative to the degraded existing condition or the No-Project/No-Action Alternative.

Table 3.9-13
Estimated Stream Channel Bank Erosion on the Upper Truckee River under Alternative 2

River Reach	Distance Upstream of Lake (feet)	Bank Erosion of Fine Sediment (cubic yards) [1]	
		Alternative 2	Alternative 5 (No-Project/No-Action)
Upper Truckee Marsh study area	0–9,646	221	538
TOTAL	**79,364**	**4,002**	**4,320**

Note:
[1] Fine sediment is less than 0.063 millimeter in diameter
Source: California Water Boards and NDEP 2007 (compiled for these subreaches in Appendix I).

Alternative 2 proposes the same changes as Alternative 1 to the channel and overbank morphology, which may alter the hydraulics of the Upper Truckee River channel downstream of the U.S. 50 bridge, and the same bank stabilization. These features would generally improve channel stability downstream of the bridge and may help prevent future adverse effects on bridge stability.

This impact addresses long-term benefits associated with a net reduction of erosion. However, all stream restoration projects, particularly those that incorporate geomorphic process–based adjustments as part of the design elements, may experience localized channel erosion during an interim period following construction. The potential adverse water quality impacts of such adjustments (including unexpected changes or responses to flood disturbance) were described as a significant short-term impact above in Impact 3.9-2 (Alt. 2). The mitigation for that impact, Mitigation Measure 3.9-2 (Alt. 2), requires implementation of an adaptive management plan that commits to actions that would prevent short-term water quality problems from becoming chronic, thus ensuring that the long-term improvements to Upper Truckee River conditions expected under Impact 3.9-3 (Alt. 2) can be realized. This impact would be **beneficial**.

IMPACT 3.9-4 (Alt. 2) **Trout Creek Channel Erosion within the Study Area. (NEPA)** *Implementing Alternative 2 would not involve directly modifying the channel of Trout Creek. However, Trout Creek would be expected to adjust to the proposed changes to the elevation and size of the Upper Truckee River channel in the vicinity of the mouth of the creek. The anticipated response of Trout Creek would likely be deposition in the lowest reach, reducing the potential for continued incision that previously was prompted by historical dredging and lowering of the Upper Truckee River Channel bed. This impact would be* ***beneficial****.*

Under Alternative 2, the channel of the Upper Truckee River through the marsh (Reach 3) would be modified by abandoning the existing straightened segment and constructing a new meandering channel (Exhibit 2-2). The new river channel would be narrower and its bed would be raised compared to the existing channel. Although the effect of raising the river's elevation may be to initiate deposition at the confluence and within the lower reach of the creek, the change would also reduce the potential for continued incision (vertical erosion) of the river. Raising the bed of the river would also reduce the potential for future incision of the creek channel. Overall, modifying the Upper Truckee River channel would either have a neutral effect or reduce the potential for erosion within Trout Creek.

No quantitative estimate of streambank erosion loads or load reduction potential along Trout Creek was made in studies for the TMDL (California Water Boards and NDEP 2008). However, based on geomorphic principles and qualitative analysis, Alternative 1 would not substantially change the amount of flow (and sediment) carried by Trout Creek's main channel and distributaries under normal or flood conditions. Although the modifications at the mouth may promote some localized deposition, the low-gradient environment of the lower reach of the creek would not be expected to be subject to substantial changes in lateral or vertical erosion. The effect on lower Trout Creek would be slightly beneficial relative to existing conditions.

As described above for the Upper Truckee River (Impact 3.9-3 [Alt. 2]), implementing mitigation to prevent adverse short-term water quality impacts from becoming chronic conditions (Mitigation Measure 3.9-2 [Alt. 2]) would ensure that the long-term improvements to Trout Creek conditions expected under Impact 3.9-4 (Alt. 2) can be realized. This impact would be **beneficial**.

IMPACT 3.9-5 (Alt. 2) **Erosion of Backfilled and/or Remnant Channel Segments on the Floodplain. (CEQA 1, 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 2 would involve backfilling portions of the existing Upper Truckee River to function as part of the active floodplain, and would increase the frequency with which existing remnant channel segments on the floodplain would be inundated. Following the project design details and specifications would prevent "recapture" of the backfilled channel or an increase in erosive force on remnant channel segments that could mobilize accumulated sediment and organic matter. This impact would be* ***less than significant.***

Alternative 2 may incrementally increase the exposure of existing remnant (i.e., naturally abandoned) channel segments on the floodplain to flood flows. The remnant channels are discontinuous, curved depressions on the marsh surface that are partially filled with fine sediment and accumulated organic material. Alternative 2 would increase the area inundated during low-magnitude, high-frequency flow events (i.e., two-year and five-year flows), but would not substantially alter inundation in the area during high magnitude events (i.e., 25-year flows or greater). The increased inundation from small floods might raise the potential for flow to enter remnant channel segments and possibly erode them more often, but these areas would be subject to erosion from larger floods under existing conditions. The portion of the study area that would experience increased overbank inundation under Alternative 2 includes an abandoned ditch east of the river and the upstream portion of a remnant channel. Flow in the ditch would be expected to return to the river, but the remnant channel would not discharge to the river or Trout Creek except under major flood flows. Potential erosion of the ditch caused by improved overbanking under Alternative 2 could increase transport of sediment and nutrients to the river and lake during small to moderate events rather than just under large, less frequent events. The change would relate to long-term timing and not to the total magnitude; therefore, this would not be a substantial effect.

Alternative 2 also would abandon existing channel segments between RS 20+00 and RS 107+00 (about 8,700 feet). The abandoned channels would be filled with floodplain sediments generated by construction of new channel segments, existing stockpiled sediments, and imported sediments (if necessary). Lateral grade controls would be installed upstream and downstream of the proposed intersections of backfilled abandoned channels with the newly constructed channel segments. The lateral controls would be designed to resist erosion of the backfilled channel in that vicinity at forces up to the 100-year flood event.

Following the project's proposed specifications for backfill areas would prevent uneven placement of backfill, differential compaction, or varied success of revegetation, which induce erosion of either the backfill or adjacent natural soil/sediment. Potential erosion along the backfilled abandoned channel segments would be avoided. This impact would be **less than significant**.

IMPACT 3.9-6 (Alt. 2) **Retention of Fine Sediment and Nutrients within the Study Area. (NEPA)** *Implementing Alternative 2 would directly reduce the Upper Truckee River's channel capacity and raise the streambed elevation throughout much of the study area, make modifications that would reduce streambank height in other subreaches, and restore lagoon features along the river and behind East Barton Beach. These modifications would increase the frequency of overbanking, enlarge the area of functional active floodplain, and offset past geomorphic adjustments to historic disturbances. Overtopping of the banks during small to moderate flood peaks would result in a substantial improvement in fine sediment and nutrient retention on the floodplain (i.e., marsh surface). This effect would be* ***beneficial****.*

Alternative 2 proposes a channel design that would reduce the Upper Truckee River's channel capacity and/or bank heights relative to the floodplain surface to reestablish overbanking and expand the area of active floodplain that receives flow during small events (e.g., the 2- to 5-year-magnitude storms). With implementation of Alternative 2, the length of channel experiencing overbanking during the two-year flow (at median lake levels) would increase from approximately 2,129 feet under existing conditions to about 16,345 feet (about 79 percent of the new channel) (Table 3.9-14). The expected area of inundation during such an event would increase from about 65 to 126 acres under Alternative 2.

Table 3.9-14
Floodplain Connectivity and Floodplain Process Indicators under Alternative 2

Upper Truckee Marsh Alternative	Length of Channel with Overbanking at 760 cfs[1] (feet)	Percent of Channel with Overbanking at 760 cfs[1] (%)	Area of Floodplain Inundated at 760 cfs[1] (acres)
Alternative 2	16,345	79	126
Alternative 5 (No Project/No Action)	2,129	10	65

Note: cfs = cubic feet per second
[1] Based on hydraulic modeling (HEC-RAS), assuming median lake level.
Source: Conservancy and DGS 2005

The increased frequency and area of inundation during relatively frequent flow events would promote the retention of fine-grained sediment on portions of the floodplain that are not inundated as frequently under existing conditions. During an overtopping event, streamflow would spread over a wider area, resulting in decreased flow velocity and depth. These hydraulic conditions would favor the retention of sediment particles transported by the storm flows. The retention of sediment and associated nutrients, including phosphorous and nitrogen, on the floodplain would enhance nutrient delivery to marsh soils and vegetation. Additionally, infiltration of water in inundated areas would increase soil moisture and would recharge (and temporarily raise) shallow groundwater. The increased nutrient delivery and increased available water in the shallow subsurface would improve conditions for riparian and marsh vegetation. The magnitude of these benefits would vary depending on the timing and duration of inundation.

Alternative 2 would involve removing fill and grading the west streambank of the Upper Truckee River to reconnect the existing Sailing Lagoon to the river, while isolating it from the dredged marina. Restoration of the surface water connection with the river would increase the opportunity for overbank flows to convey sediment and nutrients into the lagoon. Increased sediment retention and nutrient cycling relative to the existing condition is an additional benefit beyond active floodplain inundation.

Alternative 2 would also include removal of fill behind (landward of) East Barton Beach to recreate lagoon and wet meadow conditions. These modifications would also increase the areas along the floodplain margin to capture sediment and nutrients.

The combined effects of creating more stable channel segments, promoting more frequent overtopping events and sediment retention on the floodplain, implementing bank protection, and creating/improving functioning lagoon and wetland environments under Alternative 2 would help to reduce transport of fine sediment to Lake Tahoe. The proposed reduction of the river mouth’s capacity and raising of its elevation and the retention of sediment would return long-term littoral processes at the river-lake interface to a more natural regime. This effect would be **beneficial**.

IMPACT 3.9-7 (Alt. 2)	**Decreased Delivery of Coarse Sediment to Cove East and Barton Beaches. (TRPA 2)** *Implementing Alternative 2 could result in a net decrease in the transport of coarse sediment by the Upper Truckee River to beach areas adjacent to its mouth. The reduction in coarse-sediment delivery could hinder beach replenishment and worsen the ongoing trend of net beach erosion. In the long term, climate change effects could either exacerbate or counteract present trends; potential effects could range from worse than the existing degraded condition to a possible improvement. Any determination regarding long-term effects of climate change on coarse-sediment transport and delivery downstream would be too speculative for a meaningful conclusion. In the short term, however, implementing Alternative 2 would directly modify transport of coarse sediment and foster deposition within various portions of the study area, which may temporarily decrease delivery of coarse sediment to the adjacent beaches. This short-term impact would be* ***less than significant.***

Under Alternative 2, the Upper Truckee River would be modified to develop a more stable channel and to improve the natural interaction of the river with its floodplain and marsh environments. A goal of the design of Alternative 2 is to design and construct a channel that would minimize channel instability (particularly incision) and efficiently convey flows and related sediment load. The design would include raising the channel bed and installing two vertical grade control structures. The structures would reduce the potential for erosion and transport (i.e., remobilization) of marsh/floodplain sediments, including some coarse sediment. A continuous low-flow channel would be created and would not require aggradation to reach its design elevation.

Alternative 2 would involve connecting the river to the Sailing Lagoon (at high flows) and modifying the marsh landward of East Barton Beach providing increased potential for deposition and storage of coarse sediment transported by the river. If not controlled, the overflow of river flows into the Sailing Lagoon could result in a permanent connection of the river to the lagoon (see discussion in Impact 3.9-5 [Alt. 1]) and the potential for transporting coarse sediment into the lagoon during more frequent flows. Final project design would include a flow control feature to manage water flowing into the Sailing Lagoon during bank overtopping events when the lagoon’s starting water surface would be low. The control feature (e.g., a rock-lined channel or weir structure) would be designed to control the location and minimum elevation of overflow into the lagoon. It would prevent the development of a permanent, uncontrolled erosion channel connecting the river to the lagoon at low flows.

However, as under the No-Project/No-Action Alternative, potentially offsetting factors may result from climate change in the long term. The net effect on downstream river dynamics and beach erosion is highly uncertain. Even after thorough investigation, any determination regarding climate change effects on coarse-sediment transport and delivery downstream would be speculative.

Regardless of uncertainty about long-term effects of climate change, Alternative 2 has the potential to temporarily decrease the delivery of coarse sediment to Lake Tahoe relative to existing conditions. However, the design elements of Alternative 2 include a low-flow channel that would be complete at the time of construction, and none of the features would require aggradation to meet the finished grade or function. Therefore, any temporary reduction in sediment delivery would be expected to be minor. Sediment transport and coarse sediment input to the littoral zone would continue.

This short-term impact would be **less than significant**.

IMPACT 3.9-8 (Alt. 2)	**Stormwater Drainage and Treatment. (CEQA 1, 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 2 would involve incorporating site-specific measures along the margins of the study area to provide additional stormwater pretreatment and/or flow routing improvements to enhance water quality treatment before discharge to the SEZ or directly to the Upper Truckee River and Trout Creek in the study area. Implementing these measures would improve conditions and help to reduce the amount of urban pollutants discharged to surface waters. However, this alternative would also involve constructing permanent recreational facilities. The development of these facilities could potentially result in degradation of water quality. As described in Environmental Commitments 5, 6, and 11, effective permanent BMPs to protect water quality would be included in the final design of all recreation features. This impact would be* ***less than significant.***

Implementing Alternative 2 would involve incorporating site-specific measures along the margins of the study area to provide additional stormwater treatment and/or flow routing improvements to enhance water quality treatment before discharge within the SEZ or directly to the surface water in the Upper Truckee River and Trout Creek. This would be beneficial relative to the no-project future. Alternative 2 would provide treatment areas for urban stormwater runoff flowing into the study area from developed areas to the west. Specifically, the alternative would include two “stormwater treatment areas” near the western margin of the site: one area at the existing storm drain outfall from Colorado Court, the second in the area east of East Venice Drive. The alternative designates areas to be available for the treatment of stormwater, but does not specify the method or type of treatment. The areas appear sufficiently large to accommodate a range of typical and effective urban runoff treatment options: vegetated swales, infiltration trenches or basins, wet ponds or extended detention basins, or some combination of options. These areas provide for stormwater quality treatment before discharge within the SEZ and/or directly to the surface water in the Upper Truckee River. The opportunity to provide treatment of runoff would be an improvement relative to existing conditions.

Alternative 2 proposes limited permanent public access, recreation, and habitat protection elements: a pedestrian trail extending from East Venice Drive to the Sailing Lagoon (with a new fishing platform) and Cove East Beach (with a viewpoint), and viewpoint areas along the eastern margin of the study area. The facilities generally would be restricted to the margins of the SEZ to minimize the extent of encroachment in this sensitive area. Developing these features would require disturbance of floodplain areas within an SEZ, presenting potential erosion hazards. Recreational facilities with impervious cover (e.g., pavements and other structures) could also increase or concentrate runoff and increase erosion potential.

The design of these features has not been finalized. However, without proper mitigation of their effects, these features may increase the potential for the transport of sediment or other pollutants to surface water bodies, which would be a potentially significant effect. However, the Conservancy would implement ECs 5 and 6 (Table 2-6). Implementing these environmental commitments would require implementation of effective construction site management plans and compliance with federal and state permits and thus would minimize short-term construction-related impacts. The final project design and implementation would include permanent stormwater detention features or infiltration systems for runoff from areas of proposed impervious surfaces (see Impact 3.8-1 [Alt. 2] in Section 3.8, “Hydrology and Flooding,” for further discussion). The Conservancy would also implement EC 11 to provide effective permanent BMPs for all recreation features. With implementation of ECs 5, 6, and 11, this impact would be **less than significant**.

Alternative 3: Middle Marsh Corridor (Moderate Recreation Infrastructure)

IMPACT 3.9-1 (Alt. 3)	**Short-Term Risk of Surface Water and Groundwater Degradation During Construction. (CEQA 1, 2, 3; TRPA 1, 2, 3, 4, 5)** *Implementing Alternative 3 would involve substantial construction activities along or in the channel of the Upper Truckee River, along the Tahoe Keys Marina, and near the shoreline of Lake Tahoe. Although temporary BMPs would be implemented, short-term risks of water quality degradation could occur in each summer construction season or over the intervening winters. Grading would result in ground disturbance within sensitive lands and increase the potential for erosion and sediment transport. Accidental releases of hazardous materials or other pollutants could affect surface or subsurface waters. Implementing Alternative 3 could result in short-term turbidity exceeding the Basin Plan's stringent turbidity standard (10 percent above background levels). Although the Conservancy would implement Environmental Commitments 5 and 6, this impact would be* ***significant****.*

Construction activities under Alternative 3 would include large-scale grading operations and construction of permanent facilities during multiple construction seasons. These activities pose a similar range and magnitude of possible impacts, under the same permit conditions, and within the same conceptual level of BMPs and design certainty as discussed for Impact 3.9-7 (Alt. 1). The Conservancy would implement ECs 5 and 6 (Table 2-6) to minimize the likelihood and potential magnitude of short-term water quality degradation that could persist. These protective measures would be expected to avoid adverse effects on beneficial uses. However, this impact would be **significant**.

All feasible measures to avoid, minimize, or mitigate this impact have already been incorporated into the design of Alternative 3. However, these measures would not be sufficient to fully mitigate the potential for at least short-term violations of the Basin Plan's stringent water quality standard for turbidity. Because the potential to exceed this stringent standard would remain, Impact 3.9-1 (Alt. 3) would be **significant and unavoidable**.

IMPACT 3.9-2 (Alt. 3)	**Short-Term, Project-Related Risk of Surface Water Degradation Following Construction. (CEQA 1, 2, 3; TRPA 1, 2, 3, 4, 5)** *Implementing Alternative 3 would require completion of in-channel construction activities. The biotechnical streambank treatments and other revegetated areas, such as the backfilled channel segments, could expose areas of existing remnant channels to vulnerability during a flood flow within the first few years following construction. Additionally, Alternative 3 expects natural geomorphic erosion processes to reestablish one or more Upper Truckee River low-flow or overflow channels within the main marsh after construction of the pilot channel. Therefore, implementing Alternative 3 could result in short-term exceedance of the Basin Plan's stringent turbidity standard (ten percent above background levels) after the construction phase. This impact would be* ***significant****.*

Possible risks from natural channel adjustment effects (described further under Impact 3.9-2 [Alt. 1]) could be substantial under Alternative 3.The final location, size, and shape of newly formed channels and the bed and bank materials downstream of the pilot channel would not be controlled by design or construction; rather they would be established by natural geomorphic processes. Although the processes would be natural, the potential magnitude and severity of short-term channel dynamics would be greater under Alternative 3 than under the other action alternatives.

The existing main marsh has numerous remnant channel features of irregular width and depth, many of which have accumulated fine sediment and organics. It is not possible to accurately predict which or how many remnant channel segments would be activated by natural geomorphic processes after construction. However, historic aerial photos and existing topography suggest at least one moderately prominent abandoned channel that intersects the existing Trout Creek between RS 70+00 and RS 80+00 (on Trout Creek). Formation of one or more new Upper

Truckee River channels within the central portion of the marsh could erode existing sediment and organic material. A rough estimate (based on existing topographic data) suggests that 34,815 cubic yards of material could be mobilized if a single channel were to form with a length of about 4,700 feet and a cross-section area similar to the "geomorphically sized" design channel (about 200 square feet).

Disturbed and revegetated areas present under Alternative 3, such as inset floodplains, the pilot channel, and Sailing Lagoon margins, would be similar to those in Alternatives 1 and 2. These areas would be relatively susceptible to erosion (compared to the well-established, undisturbed vegetated surfaces) if a large flood were to occur within the first few years after construction. Design and revegetation specifications would be implemented for all reactivated channels and floodplain areas with remnant channels to minimize the risk that accumulated fine sediments and/or organic materials would be mobilized during a large flood in the first few years after construction. Although some of the material may be removed in advance or redeposited on the surrounding floodplain, some material could be transported to Lake Tahoe. Given the strict turbidity standard included in Section 5.2 of the Basin Plan (ten percent above background levels), this standard could be violated even if the channel adjustments were to occur during large streamflow events with high background turbidity. This impact would be **significant**.

Mitigation Measure 3.9-2 (Alt. 3): Adaptively Manage Potential Flood Disturbance in the Interim Period after Construction.

This mitigation measure is identical to Mitigation Measure 3.9-2 (Alt. 1).

Significance after Mitigation: With implementation of Mitigation Measure 3.9-2 (Alt. 3) as described above, the short-term risk of surface-water or groundwater degradation following construction would be minimized, because potential flood damage in the interim period after construction would be adaptively managed. However, the potential for at least short-term violations of the Basin Plan's stringent water quality standard for turbidity cannot be feasibly eliminated. Because of the potential to exceed this stringent standard, Impact 3.9-2 (Alt. 3) would be **significant and unavoidable**.

IMPACT 3.9-3 (Alt. 3)	**Upper Truckee River Channel Erosion within the Study Area. (NEPA)** *Implementing Alternative 3 would involve making direct changes to the channel of the Upper Truckee River and redirect its flow to the center of the marsh via a constructed "pilot" channel. The flow would not be directed or controlled downstream of the pilot channel, and natural geomorphic processes would be allowed to form one or more new river channels over time. The changes would offset past geomorphic response to historic disturbances by allowing the river to reestablish channels on the existing floodplain surface. The long-term effects would be beneficial relative to the existing degraded channel condition. This impact would be* ***beneficial****.*

Under Alternative 3, the low-flow channel of the Upper Truckee River would be relocated eastward to promote the development of a main channel and/or distributary channels in the central portion of the Upper Truckee Marsh (Exhibit 2-3). A new channel would be built (beginning at RS 17+00) to redirect flow to the east of the existing channel. The constructed "pilot" channel would be approximately 3,300 feet long and would be designed similarly to the "geomorphically sized" channels proposed in Alternatives 1 and 2. The banks and bed of the channel would be stabilized with vegetation and a sand and gravel fill. At its northern end, the pilot channel would terminate in a flared energy-dissipation structure. From this point, the flow would be uncontrolled and allowed to seek a preferred drainage path. The flow would likely form one or more meandering channels, possibly reoccupying existing remnant channel segments. The newly formed channels would be expected to connect with the existing lower reach of Trout Creek and flow out of the marsh through the existing mouth of the combined Upper Truckee River and Trout Creek channel. Vertical grade control structures and bank stabilization would be built into the lower reaches of the system.

Like Alternatives 1 and 2, Alternative 3 would provide bank protection for actively eroding banks downstream of the U.S. 50 bridge and reconnect the Sailing Lagoon to the Upper Truckee River floodplain during high-flow events.

Alternative 3 would include installation of a vertical grade control upstream of the mouth of the Upper Truckee River near the beach ridge (RS 99+00). The grade control would reconstruct the streambed elevation and conditions to be similar to those that likely existed before historic dredging. The vertical grade control would reduce the potential for downcutting of the Upper Truckee River channel (and Trout Creek) during any future periods of sustained low lake levels.

Compilation of the TMDL streambank-erosion results (California Water Boards and NDEP 2008) for specific subreaches of the Upper Truckee River allows a quantitative estimate of the effect of the proposed alternatives on stream channel erosion (Table 3.9-15). Using the range of treatment tiers analyzed for the TMDL, the estimated reduction in fine sediment loads from streambank erosion in the study area under Alternative 3 would be nearly 59 percent (reduced to 221 cubic yards from 538 cubic yards under existing conditions and the No-Project/No-Action Alternative). The study area is a small portion of the entire 15-mile-long river, and the proposed action alternatives alone would reduce the entire Upper Truckee River's fine sediment load from streambanks by about 1 percent relative to existing conditions. While small, this would be a considerable and measurable benefit relative to the degraded existing condition or the No-Project/No-Action Alternative.

Table 3.9-15
Estimated Stream Channel Bank Erosion on the Upper Truckee River under Alternative 3

River Reach	Distance Upstream of Lake (feet)	Bank Erosion of Fine Sediment (cubic yards)[1]	
		Alternative 3	Alternative 5 (No-Project/No-Action)
Upper Truckee Marsh study area	0–9,646	221	538
TOTAL	**79,364**	**4,002**	**4,320**

Note:
[1] Fine sediment is less than 0.063 millimeter in diameter.
Source: California Water Boards and NDEP 2007 (compiled for these subreaches in Appendix I)

Potential Upper Truckee River channel erosion during the interim period after construction is discussed above under Impact 3.9-2 (Alt. 3).

Alternative 3 proposes the same changes as Alternatives 1 and 2 to the channel and overbank morphology, which may alter the hydraulics of the Upper Truckee River channel downstream of the U.S. 50 bridge, and the same bank stabilization. In addition, under this alternative, two arched corrugated-metal pipes would be installed under U.S. 50 (west of the bridge, through the roadfill) to allow a portion of flood flows to bypass the bridge and flow onto a inset floodplain downstream during high-flow conditions. The bypass flow would reduce hydraulic pressure on the bridge for flow levels above 6,233 feet NGVD at the bridge. These improvements would generally improve channel stability downstream of the bridge and would not result in adverse effects on bridge stability.

This impact addresses long-term benefits associated with a net reduction of erosion. However, all stream restoration projects, particularly those that incorporate geomorphic process–based adjustments as part of the design elements, may experience localized channel erosion during an interim period following construction. The potential adverse water quality impacts of such adjustments (including unexpected changes or responses to flood disturbance) were described as a significant short-term impact above in Impact 3.9-2 (Alt. 3). The mitigation for that impact, Mitigation Measure 3.9-2 (Alt. 3), requires implementation of an adaptive management plan that commits to actions that would prevent short-term water quality problems from becoming chronic, thus ensuring that the long-term improvements to Upper Truckee River conditions expected under Impact 3.9-3 (Alt. 3) can be realized. This impact would be **beneficial**.

IMPACT 3.9-4 (Alt. 3)	**Trout Creek Channel Erosion within the Study Area. (CEQA 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 3 would involve modifying the hydrology and geomorphic processes in the lower reach of Trout Creek. Additional streamflow and sediment would be conveyed to lower Trout Creek from the channel(s) of the Upper Truckee River downstream of the constructed pilot channel. The future confluence of the Upper Truckee River and Trout Creek would not be constructed but would form through natural geomorphic response to the construction of the pilot channel, and it would likely be located upstream of the existing confluence. The changes in flow, sediment loads, and confluence location could worsen ongoing streambed incision in the lower reach of Trout Creek or extend channel instability upstream, or both. However, stabilization of the streambed and streambank along the lower 2,600 feet of Trout Creek would be provided to prevent this potential response. This impact would be* ***less than significant.***

No quantitative estimate of streambank erosion loads or load reduction potential along Trout Creek was made in studies for the TMDL (California Water Boards and NDEP 2008). However, based on geomorphic principles and qualitative analysis, Alternative 3 would be expected to have the following varied effects on erosion of the Trout Creek channel within the study area.

Alternative 3 could create unstable conditions within the Trout Creek channel that could result in adverse erosion of the creek's bed or banks. Directing the flow of the Upper Truckee River into the center of the marsh would convey the flows into the existing Trout Creek channel. This would likely destabilize the segment of Trout Creek downstream of the newly formed confluence with the river (a possible location would be near RS 78+00 on Trout Creek). The increase in flows conveyed by this creek segment would result in erosion of the bed and/or banks.

The assumed intersection of the new Upper Truckee River channel and Trout Creek would move the confluence approximately 1,700 feet upstream (along Trout Creek) from the present location. The effect would be to shorten the overall length of Trout Creek. Assuming that the bed at the confluence would be controlled by the river channel, the gradient of Trout Creek would be expected to steepen, possibly resulting in lateral or vertical erosion in Trout Creek. Such erosion would also increase the amount of sediment transported through the combined Upper Truckee River/Trout Creek system.

In anticipation of some of these changes, the final project design for Alternative 3 would involve stabilizing the Upper Truckee River's streambed elevation downstream of the existing confluence of the river and Trout Creek. In addition, vertical grade controls and streambank stabilization measures would be designed based on the combined peak flows of the creek and river. These grade controls and stabilization measures would be incorporated along about 2,600 feet of lower Trout Creek (RS 66+00 to RS 95+00). The vertical grade controls would be adequate to maintain the channel's existing average slope and elevation and remain stable under 100-year peak flows. The streambank stabilization measures would be designed to remain stable under 25-year peak flows.

As described above for the Upper Truckee River (Impact 3.9-3 [Alt. 3]), implementing mitigation to prevent adverse short-term water quality impacts from becoming chronic (Mitigation Measure 3.9-2 [Alt. 3]) would protect Trout Creek from project-related erosion in the long term. This net impact would be **less than significant**.

IMPACT 3.9-5 (Alt. 3)	**Erosion of Backfilled and/or Remnant Channel Segments on the Floodplain. (CEQA 1, 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 3 would involve backfilling portions of the existing Upper Truckee River to function as part of the active floodplain. A full range of river flows would be redirected into areas of remnant channel segments on the floodplain. Following the project design details and specifications would prevent "recapture" of the backfilled channel or an increase in erosive force on remnant channel segments that could mobilize accumulated sediment and organic matter. This impact would be* ***less than significant.***

Alternative 3 would increase the exposure of existing remnant (i.e., naturally abandoned) channel segments on the floodplain to flood flows. The remnant channels are discontinuous, curved depressions on the marsh surface that are partially filled with fine sediment and accumulated organic material. Alternative 3 would increase the area inundated during low-magnitude, high-frequency flow events (i.e., two- and five-year flows). Because the main flows of the Upper Truckee River would be directed to the central marsh, some characteristics of inundation could also change during larger magnitude events (i.e., 25-year flows or greater).

Several partial remnant channels and at least one well-expressed remnant channel could potentially concentrate overbank flows and initiate erosion of sediment and/or organic material. In the long term, increased inundation might raise the potential for flows to enter remnant channel segments and possibly erode them more often; however, these areas would be subject to erosion from larger floods under existing conditions. Potential erosion of the remnant channel(s) by Alternative 3 could increase transport of sediment and nutrients to Trout Creek and Lake Tahoe under small to moderate flood events, rather than just under large, less-frequent events. The change would relate to long-term timing and not to the total magnitude; therefore, this would not be a substantial effect. (Potential short-term erosion impacts of remnant channel segments within the middle of the marsh during the interim period as the Upper Truckee River develops one or more channel[s] downstream of the pilot channel were discussed separately in Impact 3.9-2 [Alt. 3].)

Alternative 3 also would abandon existing channel segments between RS 17+00 and RS 93+00 (about 7,600 feet). The abandoned channels would be filled with floodplain sediments generated by construction of new channel segments, existing stockpiled sediments, and imported sediments (if necessary). Lateral grade controls would be installed upstream and downstream of intersections of the backfilled abandoned channels and the newly constructed channel segments. The lateral controls would be designed to resist erosion of the backfilled channel in that vicinity at forces up to the 100-year flood event.

Following the project's proposed specifications for backfill areas would prevent uneven placement of backfill, differential compaction, or varied success of revegetation, which induce erosion of either the backfill or adjacent natural soil/sediment. Potential erosion along the backfilled abandoned channel segments would be avoided. This impact would be **less than significant**.

IMPACT 3.9-6 (Alt. 3) **Retention of Fine Sediment and Nutrients within the Study Area. (NEPA)** *Implementing Alternative 3 would redirect the Upper Truckee River to the central portion of the Upper Truckee Marsh, thus allowing the flow to spread in existing remnant channels and floodplain surfaces; make modifications to reduce streambank height in upstream subreaches; and restore connection to the Sailing Lagoon during high flows. These modifications would increase the frequency of overbanking, enlarge the area of functional active floodplain, and offset past geomorphic adjustments to historic disturbances. Overtopping of the banks during small to moderate flood peaks would result in a substantial improvement in fine sediment and nutrient retention on the floodplain (i.e., marsh surface). This impact would be* ***beneficial****.*

A major component of Alternative 3 is to redirect flow from the existing Upper Truckee River channel eastward to the central portion of the marsh via a constructed "pilot" channel. The flow would then be allowed to flow uncontrolled over the marsh surface. This condition is intended to mimic natural, uncontrolled conditions within the distal end of marsh/delta environments. The effect would be to spread flows over a large area, decreasing flow velocities and promoting the retention of sediments transported by the river. One or more channels would be expected to develop within the marsh over time, but the location of the channel(s) cannot be accurately predicted. The channel system could be dynamic and channel locations would be expected to change. Depending on variations in flow and sediment load, a particular channel may fill and new channels may form by erosion. Given the marsh's low-gradient conditions, development of relatively deep and permanent channels is unlikely and channel banks would be overtopped frequently (relative to existing conditions). The conditions would promote increased retention of sediment and associated nutrients.

The net effect on water quality of the changes to channel length, channel capacity, bank elevations, and floodplain topography proposed under Alternative 3 cannot be modeled; however, key parameters that would control the potential for sediment retention have been determined (Table 3.9-16). Alternative 3 would reduce the river channel's capacity and/or bank heights relative to the floodplain surface to reestablish overbanking and expand the area of active floodplain that receives flow during relatively small events (e.g., the two- to five-year-magnitude storms). Overbanking during frequent small flood events would spread water across the active floodplain at shallow depths. Shallow inundation on the irregular microtopography and through dense vegetation on the floodplain would reduce velocities and encourage retention of suspended sediment. Indirect benefits to soil moisture and groundwater recharge would also provide positive feedback by supporting vegetation that helps trap sediment and take up nutrients. Hydraulic modeling has demonstrated that no increase in flow velocities and shear stress within the Upper Truckee River would result from Alternative 3 under the five-year event (1,660 cfs) (Conservancy and DGS 2005:4.1-5).

With implementation of Alternative 3, the length of channel experiencing overbanking during a two-year event would increase from about 2,129 feet under existing conditions to about 17,000 feet (Table 3.9-16). The expected area of inundation during such an event would increase from 65 to 156 acres under Alternative 3.

Table 3.9-16
Floodplain Connectivity and Floodplain Process Indicators under Alternative 3

Upper Truckee Marsh Alternative	Length of Channel with Overbanking at 760 cfs[1] (feet)	Percent of Channel with Overbanking at 760 cfs[1] (%)	Area of Floodplain Inundated at 760 cfs[1] (acres)
Alternative 3[2]	17,000	82	156
Alternative 5 (No Project/No Action)	2,129	10	65

Note: cfs = cubic feet per second
[1] Based on hydraulic modeling (HEC-RAS), assuming median lake level.
[2] Alternative 3 was not modeled due to complex multiple channel flow path possibilities, but its values were estimated from the other model results and evaluation of the digital elevation model (DEM) of the micro topography.
Source: Conservancy and DGS 2005

Alternative 3 would involve removing fill and grading the west streambank of the Upper Truckee River to reconnect the existing Sailing Lagoon to the river, while isolating it from the dredged marina. Restoration of the surface water connection with the river would increase the opportunity for overbank flows to convey sediment and nutrients into the lagoon. Increased sediment retention and nutrient cycling relative to the existing condition is an additional benefit beyond active floodplain inundation.

The combined long-term effects of increasing the number of stable channel segments, forming natural distributaries, promoting more frequent overtopping events and sediment deposition on the floodplain, implementing bank protection, and creating/improving functioning lagoon and wetland environments under Alternative 3 would help to reduce transport of fine sediment to Lake Tahoe. Improved retention of sediment would return long-term littoral processes at the river-lake interface to a more natural regime. That effect could include changing geographic patterns as the mouths of the Upper Truckee River and Trout Creek potentially experience shifts in magnitude and duration as discharge points to the littoral zone. This impact would be **beneficial**.

IMPACT 3.9-7 (Alt. 3) **Decreased Delivery of Coarse Sediment to Cove East and Barton Beaches.** (TRPA 2) *Implementing Alternative 3 could result in a net decrease in the transport of coarse sediment by the Upper Truckee River to beach areas adjacent to its mouth. The reduction in coarse-sediment delivery could hinder beach replenishment and worsen the ongoing trend of net beach erosion. In the long term, climate change effects could either exacerbate or counteract present trends; potential effects could range from worse than the existing degraded condition to a possible improvement. Any determination regarding long-term effects of climate change on coarse-sediment transport and delivery downstream would be too speculative for a meaningful conclusion. In the short term, however, implementing Alternative 3 would directly modify transport of coarse sediment and foster deposition within various portions of the study area, which may temporarily decrease delivery of coarse sediment to the adjacent beaches. This short-term impact would be* ***potentially significant****.*

Implementing Alternative 3 would increase the potential for deposition and retention of coarse sediment within the study area. It would enlarge the active floodplain and increase opportunities for deposition and net retention of coarse sediment; potentially reactivate multiple thread distributary channels and increase opportunities for net deposition; and reconnect and increase on-site lagoon areas that might receive river-overflow water and provide net coarse-sediment retention. Implementing this alternative may interrupt all delivery of coarse sediment to the mouth before establishment of one or more continuous low-flow channels. It also may reduce or interrupt coarse-sediment delivery during below-normal runoff (and low-lake-level) conditions if flow and sediment could not pass through potential small distributary channels and/or over the beach-ridge grade control.

Alternative 3 would involve connecting the Upper Truckee River to the Sailing Lagoon (at high flows), thus increasing the potential for deposition and storage of coarse sediment transported by the river. If not controlled, the overflow of river flows into the Sailing Lagoon could result in a permanent connection of the river to the lagoon (see discussion in Impact 3.9-5 [Alt. 1]) and the potential for transporting coarse sediment into the lagoon during more frequent flows. Final project design would include a flow control feature to manage water flowing into the Sailing Lagoon during bank overtopping events when the lagoon's starting water surface would be low. The control feature (e.g., a rock-lined channel or weir structure) would be designed to control the location and minimum elevation of overflow into the lagoon. It would prevent the development of a permanent, uncontrolled erosion channel connecting the river to the lagoon at low flows.

However, as under the No-Project/No-Action Alternative, potentially offsetting factors may result from climate change in the long term. The net effect on downstream river dynamics and beach erosion is highly uncertain. Even after thorough investigation, any determination regarding climate change effects on coarse-sediment transport and delivery downstream would be speculative.

Regardless of uncertainty about long-term effects of climate change, Alternative 3 has the potential to temporarily decrease the delivery of coarse sediment to Lake Tahoe relative to existing conditions. None of the design elements or expected natural processes of Alternative 3 would require aggradation to meet the finished grade or function. However, a temporary reduction in sediment delivery could occur because natural processes operating within the marsh downstream of the constructed pilot channel may not immediately form continuous low-flow channels to provide bedload-transport continuity all the way to the beach. The long-term effects on sediment transport and input of coarse sediment to the littoral zone would restore a more natural regime.

This short-term impact would be **potentially significant**.

Mitigation Measure 3.9-7 (Alt. 3): Monitor and Adaptively Manage Delivery of Coarse Sediment to Cove East and Barton Beaches.

This mitigation measure is identical to Mitigation Measure 3.9-7 (Alt. 1).

Significance after Mitigation: With implementation of Mitigation Measure 3.9-7 (Alt. 3) as described above, the potential adverse geomorphic effects and water quality consequences of short-term interruption of coarse-sediment delivery would be **less than significant** because the coarse sediment would be supplemented if necessary to prevent additional beach erosion.

IMPACT 3.9-8 (Alt. 3)	**Stormwater Drainage and Treatment. (CEQA 1, 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 3 would involve incorporating site-specific measures along the margins of the study area to provide additional stormwater pretreatment and/or flow routing improvements to enhance water quality treatment before discharge to the SEZ. Implementing these measures would improve conditions and help to reduce the amount of urban pollutants discharged to surface waters. However, this alternative would also involve constructing permanent recreational facilities. The development of these facilities could potentially result in degradation of water quality. As described in Environmental Commitments 5, 6, and 11, effective permanent BMPs to protect water quality would be included in the final design of all recreation features. This impact would be* ***less than significant.***

Like Alternative 2, Alternative 3 would provide treatment areas for urban stormwater runoff flowing into the study area from developed areas to the west. Specifically, this alternative would include two “stormwater treatment areas” near the western margin of the site: one area at the existing storm drain outfall from Colorado Court, the second in the area east of East Venice Drive. The alternative designates areas to be available for the treatment of stormwater, but does not specify the method or type of treatment. The areas appear sufficiently large to accommodate a range of typical and effective urban runoff treatment options: vegetated swales, infiltration trenches or basins, wet ponds or extended detention basins, or some combination of options. These areas provide for stormwater quality treatment before discharge within the SEZ and/or directly to the surface water in the Upper Truckee River. The opportunity to provide treatment of runoff would be an improvement relative to existing conditions.

Alternative 3 also proposes new, permanent recreational facilities within the study area, including a self-service kiosk on the west margin adjacent to East Venice Drive and a trail connecting these facilities to a fishing platform on the Sailing Lagoon. Additionally, the alternative proposes viewpoints and a trail along the eastern margin and a bike path and pedestrian trail north of Springwood Drive. The facilities generally would be restricted to the margins of the SEZ to minimize the extent of encroachment in this sensitive area. Developing these features would require disturbance of floodplain areas within an SEZ, presenting potential erosion hazards. Recreational facilities with impervious cover (e.g., roofs and other structures) could also increase or concentrate runoff and increase erosion potential.

The design of these features has not been finalized. However, without proper mitigation of the effects, these features may increase the potential for the transport of sediment or other pollutants to surface water bodies, which would be a potentially significant effect. However, the Conservancy would implement ECs 5 and 6 (Table 2-6). Implementing these environmental commitments would require implementation of effective construction site management plans and compliance with federal and state permits and thus would minimize short-term construction-related impacts. The final project design and implementation would include permanent stormwater detention features or infiltration systems for runoff from areas of proposed impervious surfaces (see Impact 3.8-1 [Alt. 3] in Section 3.8, “Hydrology and Flooding,” for further discussion). The Conservancy would also implement EC 11 to provide effective permanent BMPs for all recreation features. With implementation of ECs 5, 6, and 11, this impact would be **less than significant**.

Alternative 4: Inset Floodplain (Moderate Recreation Infrastructure)

IMPACT 3.9-1 (Alt. 4) **Short-Term Risk of Surface Water and Groundwater Degradation During Construction. (CEQA 1, 2, 3; TRPA 1, 2, 3, 4, 5)** *Implementing Alternative 4 would involve substantial construction activities along or in the channel of the Upper Truckee River and near the shoreline of Lake Tahoe. Although temporary BMPs would be implemented, short-term risks of water quality degradation could occur in each summer construction season or over the intervening winters. Grading would result in ground disturbance within sensitive lands and increase the potential for erosion and sediment transport. Accidental releases of hazardous materials or other pollutants could affect surface or subsurface waters. Implementing Alternative 4 could result in short-term turbidity, potentially impairing noncontact recreation beneficial uses (aesthetics). Although the Conservancy would implement Environmental Commitments 5 and 6, this impact would be* ***significant.***

Construction activities under Alternative 4 would include large-scale grading operations and construction of permanent facilities during multiple construction seasons. These activities pose a similar range and magnitude of possible impacts, under the same permit conditions, and within the same conceptual level of BMPs and design certainty as discussed for Impact 3.9-1 (Alt. 1). However, constructing an "inset" floodplain would require work immediately adjacent to the low-flow channel and would not allow the revegetated areas to be isolated from potential high flows. Final design materials, methods, and revegetation specifications would anticipate this challenge and use the most effective means to create surfaces that would be stable immediately upon installation.

The Conservancy would implement ECs 5 and 6 (Table 2-6). Because effective site management plans would be prepared and implemented, the likelihood and potential magnitude of short-term water quality degradation that could persist would be minimized. These protective measures would be expected to avoid adverse effects on beneficial uses. However, this impact would be **significant**.

All feasible measures to avoid, minimize, or mitigate this impact have already been incorporated into the design of Alternative 4. However, these measures would not be sufficient to fully mitigate the potential for at least short-term violations of the Basin Plan's stringent water quality standard for turbidity. Because the potential to exceed this stringent standard would remain, this impact would be **significant and unavoidable**.

IMPACT 3.9-2 (Alt. 4) **Short-Term, Project-Related Risk of Surface Water Degradation Following Construction. (CEQA 1, 2, 3; TRPA 1, 2, 3, 4, 5)** *Implementing Alternative 4 would require completion of in-channel construction activities. The biotechnical streambank treatments and other revegetated areas, such as the inset floodplain, could be vulnerable during a flood flow within the first few years following construction. Therefore, implementing Alternative 4 could result in potential short-term exceedance of the Basin Plan's stringent turbidity standard (10 percent above background levels) after the construction phase. This impact would be* ***significant.***

Possible risks from natural channel adjustment effects (described further under Impact 3.9-2 [Alt. 1]) would be reduced under Alternative 4 because the final channel size, shape, and bed and bank materials would be installed during construction, and natural channel adjustments would not be needed to meet final design conditions. However, constructing an "inset" floodplain would require work immediately adjacent to the low-flow channel and would not allow the revegetated areas to be isolated from potential high flows. Final design materials, methods, and revegetation specifications would anticipate this challenge and would use the most effective means to create surfaces that would be stable immediately upon installation. If construction were followed by relatively normal- to low-streamflow years, the risk of disturbance to the revegetated surfaces would be lower than if construction were followed by high-streamflow water years. However, water year conditions cannot be predicted with multiyear accuracy to help schedule construction, and because the Upper Truckee River is an unregulated river, it would not be possible to manage streamflows after construction.

The modified channel bank and low-flow streambed, constructed "inset" floodplain areas, and other disturbed but revegetated surfaces would therefore be highly susceptible to erosion if a large flood were to occur within the first few years after construction. A high risk of sediment mobilization would occur if a major flood event were to occur before the vegetation could mature. Despite efforts to minimize risks, the effects could cause a violation of Section 5.2 of the Basin Plan (i.e., the stringent turbidity standard of ten percent above background levels). This impact would be **significant**.

Mitigation Measure 3.9-2 (Alt. 4): Adaptively Manage Potential Flood Disturbance in the Interim Period after Construction.

This mitigation measure is identical to Mitigation Measure 3.9-2 (Alt. 1).

Significance after Mitigation: With implementation of Mitigation Measure 3.9-2 (Alt. 4) as described above, the short-term risk of surface-water or groundwater degradation following construction would be minimized, because potential flood damage in the interim period after construction would be adaptively managed. However, the potential for at least short-term violations of the stringent water quality standard for turbidity cannot be feasibly eliminated. Because of the potential to exceed this stringent standard, Impact 3.9-2 (Alt. 4) would be **significant and unavoidable**.

IMPACT 3.9-3 (Alt. 4)	**Upper Truckee River Channel Erosion within the Study Area. (NEPA)** *Implementing Alternative 4 would involve making direct changes to the channel of the Upper Truckee River to create an inset floodplain in the upper reach and increase channel sinuosity in the straightened reach. The changes would offset past geomorphic responses to historic disturbances by constructing features to provide overbank flow opportunities and reduce streambank erosion. This would result in a long-term benefit by decreasing flow depths and velocities in low to moderate flood events and reducing the potential for erosion of the channel bed and banks. This impact would be* ***beneficial****.*

Under Alternative 4, the length of "geomorphically sized" channel within the study area would increase from about 500 feet to 6,700 feet (Exhibit 2-4). The new channel morphology would be more stable while efficiently transporting sediment under typical flows. The modified channel would likely experience less erosion than the existing oversized channel. Alternative 4 also proposes the construction of inset floodplains along the existing river from RS 0+00 to RS 67+00. The existing terrace would be lowered (one-three feet) on either side of the existing channel for widths ranging from about 20 to 220 feet. The area of inset floodplain would be approximately 12 acres. In addition, the width and capacity of the existing low-flow channel would be reduced. Creating the lowered floodplain surface would increase the area of inundation, overbanking frequency, and the width of flow during the two-year event. This condition would reduce flow velocities and active channel bank heights, reducing the potential for erosion during small to moderate flow events.

The alternative also proposes to create a more sinuous channel through the existing straightened reach (RS 67+00 to RS 93+00). Localized alternating bank cuts and fills would be used selectively to form low-amplitude meanders. Increasing sinuosity would increase channel length and decrease channel slope relative to existing conditions. These changes would be expected to reduce flow velocities in low to moderate flow conditions.

Also proposed by Alternative 4 is the installation of bank protection/stabilization for areas of the right (east) bank downstream of the U.S. 50 bridge. This protection would address existing unstable banks and areas of the bank most prone to erosion and failure.

The combined effect of creating the inset floodplain and modifying the channel would be to reduce erosion potential throughout the proposed channel/floodplain area. This would be a beneficial effect of Alternative 4.

Compilation of the TMDL streambank-erosion results (California Water Boards and NDEP 2008) for specific subreaches of the Upper Truckee River allows a quantitative estimate of the effect of the proposed alternatives on stream channel erosion (Table 3.9-17). Using the range of treatment tiers analyzed for the TMDL, the estimated reduction in fine sediment loads from streambank erosion in the study area under Alternative 4 would be about

Table 3.9-17 Estimated Stream Channel Bank Erosion on the Upper Truckee River under Alternative 4			
River Reach	Distance Upstream of Lake (feet)	Bank Erosion of Fine Sediment (cubic yards)[1]	
		Upper Truckee Marsh Alternative 4	Alternative 5 (No-Project/No-Action)
Upper Truckee Marsh study area	0–9,646	228	538
TOTAL	**79,364**	**4,002**	**4,320**

Note:
[1] Fine sediment is less than 0.063 millimeter in diameter
Source: California Water Boards and NDEP 2007 (compiled for these subreaches in Appendix I).

58 percent (reduced to 228 cubic yards from 538 cubic yards under existing conditions and the No-Project/No-Action Alternative). The study area is a small portion of the entire 15-mile-long river, and the proposed action alternatives alone would reduce the entire Upper Truckee River's fine sediment load from streambanks by about 1 percent relative to existing conditions. While small, this would be a considerable and measurable benefit relative to the degraded existing condition or No-Project/No-Action Alternative.

This impact addresses long-term benefits associated with a net reduction of erosion. However, all stream restoration projects, particularly those that incorporate geomorphic process–based adjustments as part of the design elements, may experience localized channel erosion during an interim period following construction. The potential adverse water quality impacts of such adjustments (including unexpected changes or responses to flood disturbance) were described as a significant short-term impact above in Impact 3.9-3 (Alt. 4). The mitigation for that impact, Mitigation Measure 3.9-2 (Alt. 4), requires implementation of an adaptive management plan that commits to actions that would prevent short-term water quality problems from becoming chronic, thus ensuring that the long-term improvements to Upper Truckee River conditions expected under Impact 3.9-3 (Alt. 4) can be realized. This impact would be **beneficial**.

IMPACT 3.9-4 (Alt. 4) **Trout Creek Channel Erosion within the Study Area. (CEQA 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 4 would not involve directly modifying the channel of Trout Creek or modifying the Upper Truckee River at or downstream of its confluence with Trout Creek. Therefore, no significant hydraulic change would be proposed that would change the existing conditions relative erosion potential in Trout Creek.* ***No impact*** *would occur.*

No quantitative estimate of streambank erosion loads or load reduction potential along Trout Creek was made in studies for the TMDL (California Water Boards and NDEP 2008). However, based on geomorphic principles and qualitative analysis, Alternative 4 would be expected to have the following varied effects on erosion of the Trout Creek channel within the study area.

Alternative 4 would not raise and/or stabilize the existing streambed elevation of the degraded reach of the Upper Truckee River at the mouth of Trout Creek (Exhibit 2-4), and would not substantially change the amount of flow carried by the Trout Creek main channel and distributaries under normal or flood conditions. This would produce an effect on lower Trout Creek that is neutral relative to the existing, degraded conditions.

It is possible that persistent low lake levels (potentially caused by climate change) could initiate incision of the Upper Truckee River that could migrate upstream into Trout Creek (see Impact 3.9-3 [Alt. 4]).These potential future river responses would not represent a change relative to the existing conditions or No-Project/No-Action Alternative. Therefore, **no impact** would occur.

IMPACT 3.9-5 (Alt. 4) **Erosion of Backfilled and/or Remnant Channel Segments on the Floodplain. (CEQA 1, 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 4 would not involve abandoning and backfilling the existing Upper Truckee River, and would not increase the frequency with which existing remnant channel segments on the floodplain would be inundated. The risks of erosion and/or mobilization of organics and sediment within the floodplain topography would remain similar to existing risks.* ***No impact*** *would occur.*

Under Alternative 4, the entire existing Upper Truckee River channel alignment would be used as the active low-flow channel. This alternative would not involve backfilling abandoned portions to function as part of the active floodplain. Implementing Alternative 4 would not raise the streambed elevation or decrease the channel capacity; therefore, it would not substantially modify the frequency or magnitude of overbank flows (during low to moderate flows) that access the existing floodplain (terrace) surface across the study area. Therefore, implementing Alternative 4 would not increase the potential for erosion and sediment production related to increased flow in backfilled abandoned channels or remnant channels. **No impact** would occur.

IMPACT 3.9-6 (Alt. 4) **Retention of Fine Sediment and Nutrients within the Study Area. (NEPA)** *Implementing Alternative 4 would reduce the capacity of the Upper Truckee River channel. This alternative would involve constructing an inset floodplain along the river in the upstream portion of the study area and improving sinuosity in the downstream, straightened reach. These modifications would increase the frequency of overbanking, enlarge the area of functional active floodplain, and offset past geomorphic adjustments to historic disturbances. Overtopping of the banks during small to moderate flood peaks would result in an improvement in fine sediment and nutrient retention on the inset floodplain and some portions of the marsh surface. This impact would be* ***beneficial****.*

Under Alternative 4, the channel of the existing Upper Truckee River would be modified to create an inset floodplain in the reach of river from RS 0+00 to RS 67+00. Approximately 12 acres of inset floodplain would be created by lowering the existing terrace surface one-three feet. The alternative also proposes modifications to the channel between RS 67+00 and RS 93+00 that would decrease channel capacity. The proposed channel design would increase the frequency of overbanking, promoting the retention of sediment on the floodplain and a reduction in transport of fine sediment to Lake Tahoe.

Implementing Alternative 4 would increase the area of inundation during the 2-year event (assuming median lake level) from 65 to 82 acres and the length of overtopped bank from 2,129 feet to 17,633 feet. Overbanking would occur along approximately 85 percent of the length of new channel, compared to 10 percent under existing conditions (Table 3.9-18). The flows would spread out over newly created inset floodplain areas and expanded areas on the existing floodplain. As the flows spread out, the flow velocities would decrease, promoting the retention of some of the transported sediment (including fine sediment) and associated nutrients. Implementing this alternative would increase the potential for retention of fine sediment and decrease the potential for fine-sediment transport to Lake Tahoe. Neither changes to coarse-sediment discharges nor long-term changes to littoral processes would be expected to occur. This impact would be **beneficial**.

Table 3.9-18
Floodplain Connectivity and Floodplain Process Indicators under Alternative 4

Upper Truckee Marsh Alternative	Length of Channel with Overbanking at 760 cfs[1] (feet)	Percent of Channel with Overbanking at 760 cfs[1] (%)	Area of Floodplain Inundated at 760 cfs[1] (acres)
Alternative 4	17,633	85	82
Alternative 5 (No project/No Action)	2,129	10	65

Notes: cfs = cubic feet per second
[1] Based on hydraulic modeling (HEC-RAS), assuming median lake level.
Source: Conservancy and DGS 2005

IMPACT 3.9-7 (Alt. 4) **Decreased Delivery of Coarse Sediment to Cove East and Barton Beaches. (TRPA 2)** *Implementing Alternative 4 would not directly modify the streambed elevation or continuity of the Upper Truckee River's low-flow channel through the study area to Lake Tahoe, and therefore would be unlikely to modify the transport of coarse sediment to beach areas adjacent to the river's mouth. The ongoing trend of net beach erosion would continue. Any determination regarding long-term effects of climate change on coarse-sediment transport and delivery downstream would be* ***too speculative for a meaningful conclusion****. In the short term, however, implementing Alternative 4 would neither modify the streambed profile nor reconnect and increase the potential for sediment deposition in existing lagoon areas (Sailing Lagoon or East Barton Beach).* ***No impact*** *would occur in the short term****.***

In the long term, climate change effects could either exacerbate or counteract present trends in the study area. Potential long-term effects could range from worse than the existing degraded condition to a possible improvement. Any determination regarding climate change effects on coarse-sediment transport and delivery downstream would be **too speculative for a meaningful conclusion**. In the short term, however, implementing Alternative 4 would not modify transport and retention of coarse sediment within various portions of the study area, and coarse-sediment delivery to the adjacent beaches would remain similar to deliveries under existing conditions. The design elements of Alternative 4 include a low-flow channel that would be complete at the time of construction, at the existing grade, and none of the features would require aggradation to meet the finished grade or function. No changes to the input of coarse sediment to the littoral zone would be expected. **No impact** would occur.

IMPACT 3.9-8 (Alt. 4) **Stormwater Drainage and Treatment. (CEQA 1, 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 4 would involve constructing and operating permanent recreational features. Developing these features could potentially result in release of pollutants and degradation of water quality. As described in Environmental Commitments 5, 6, and 11, effective permanent BMPs to protect water quality would be included in the final design of all recreation features. This impact would be* ***less than significant.***

Alternative 4 proposes new, permanent recreational facilities within the study area, including a self-service kiosk on the west margin adjacent to East Venice Drive and a trail connecting these facilities to Cove East Beach. Also proposed are viewpoints and a trail along the eastern margin and a bike path north of Springwood Drive. The facilities generally would be restricted to the margins of the SEZ to minimize the extent of encroachment in this sensitive area. Developing these features would require disturbance of floodplain areas within an SEZ, presenting potential erosion hazards. Recreational facilities with impervious cover (e.g., pavements, roofs, and other structures) could also increase or concentrate runoff and increase erosion potential.

The design of these features has not been finalized. However, without proper mitigation of their effects, these features may increase the potential for the transport of sediment or other pollutants to surface water bodies, which would be a potentially significant effect. However, the Conservancy would implement ECs 5 and 6 (Table 2-6). Implementing these environmental commitments would require implementation of effective construction site management plans and compliance with federal and state permits and thus would minimize short-term construction-related impacts. The final project design and implementation would include permanent stormwater detention features or infiltration systems for runoff from areas of proposed impervious surfaces (see Impact 3.8-1 [Alt. 4] in Section 3.8, "Hydrology and Flooding," for further discussion). The Conservancy would also implement EC 11 to provide effective permanent BMPs for all recreation features. With implementation of ECs 5, 6, and 11, this impact would be **less than significant**.

Alternative 5: No-Project/No-Action

IMPACT 3.9-1 (Alt. 5) **Short-Term Risk of Surface Water and Groundwater Degradation During Construction. (CEQA 1, 2, 3; TRPA 1, 2, 3, 4, 5)** *Alternative 5 would not involve any planned or prolonged construction activities in the study area. Implementing this alternative would not result in short-term turbidity that could violate the Basin Plan's stringent turbidity standard (10 percent above background levels).* ***No impact*** *would occur.*

Under Alternative 5, the Conservancy would not conduct new or substantial construction or excavation activities within the study area. No construction would occur that could increase susceptibility to erosion and sedimentation or accidental release of other pollutants. Emergency or routine repairs to public utilities, infrastructure, or private property within the study area would be implemented, if needed, by other public and private entities. Such activities would be evaluated separately for compliance with existing laws and regulations. **No impact** would occur.

IMPACT 3.9-2 (Alt. 5) **Short-Term, Project-Related Risk of Surface Water Degradation Following Construction. (CEQA 1, 2, 3; TRPA 1, 2, 3, 4, 5)** *Alternative 5 would not require major or prolonged construction activities; it would not require a period of channel adjustments following construction to meet final design. Therefore, implementing this alternative would not make any changes to the existing condition that could increase the short-term risk of water quality degradation following construction.* ***No impact*** *would occur.*

Under Alternative 5, Conservancy would not conduct new or substantial construction or excavation activities within the study area, and no features would be installed that require geomorphic adjustments to meet final design. No disturbed areas would be created that would increase susceptibility to erosion and sedimentation during a flood after construction. Emergency or routine repairs to public utilities, infrastructure, or private property within the study area would be implemented, if needed, by other public and private entities. Such activities would be evaluated separately for compliance with existing laws and regulations. **No impact** would occur.

IMPACT 3.9-3 (Alt. 5) **Upper Truckee River Channel Erosion within the Study Area. (CEQA 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 5 would not involve making direct changes to the channel of the Upper Truckee River. However, natural geomorphic response to historic disturbances would continue, with channel instability that would erode the streambanks and streambed within the study area, releasing sediment and nutrients that would degrade the river and lake water quality relative to undisturbed natural conditions. Implementing Alternative 5 would allow the adverse conditions to persist, but this would not be a change from existing conditions. Therefore, this impact would be* ***less than significant****.*

Rates of stream channel erosion along the Upper Truckee River in the study area and along the upstream reaches have been accelerated relative to natural conditions by the geomorphic response to past direct human actions throughout the watershed and at particular locations on the river. These direct human actions typically decreased stream length and increased channel slope, width and depth, and/or bank heights. As a result, erosion occurred during or after the disturbance, generating total sediment and fine sediment loads that have exceeded natural conditions. Channel conditions in particular river reaches influenced erosion processes in other reaches, with erosion and sedimentation influences occurring both upstream and downstream of disturbances. At several sites along the Upper Truckee River, various types of streambank protection measures were installed to help limit erosion. However, the measures only addressed local sites and did not include streambed protection, so their effectiveness and life spans were limited.

The existing conditions continue to be degraded and erosion exceeds natural rates. Studies for the Lake Tahoe TMDL have documented the existing degraded condition of the Upper Truckee River from field observations (Simon et al. 2003). Calculations performed for these studies have demonstrated that the Upper Truckee River is the largest contributor of fine sediment from streambanks to the lake (Simon 2006, California Water Boards and NDEP 2007).

Substantial direct historical modifications were also made to channels in the study area. During the Comstock era, logging and log transport and installation of road crossings and piers affected local hydraulics and scour. In the early 1900s water infrastructure (including irrigation ditches) shortened and straightened channels and constructed ditches; and in the 1950s and 1960s, as part of urban development, some channel segments were cut off, new channels were dredged, and the lower reach of the Upper Truckee River was straightened and dredged. Recent restoration efforts within the study area at the Lower West Side Restoration Area wetlands lowered bank heights and partially offset past actions that increased erosion in the lower reach of the Upper Truckee River.

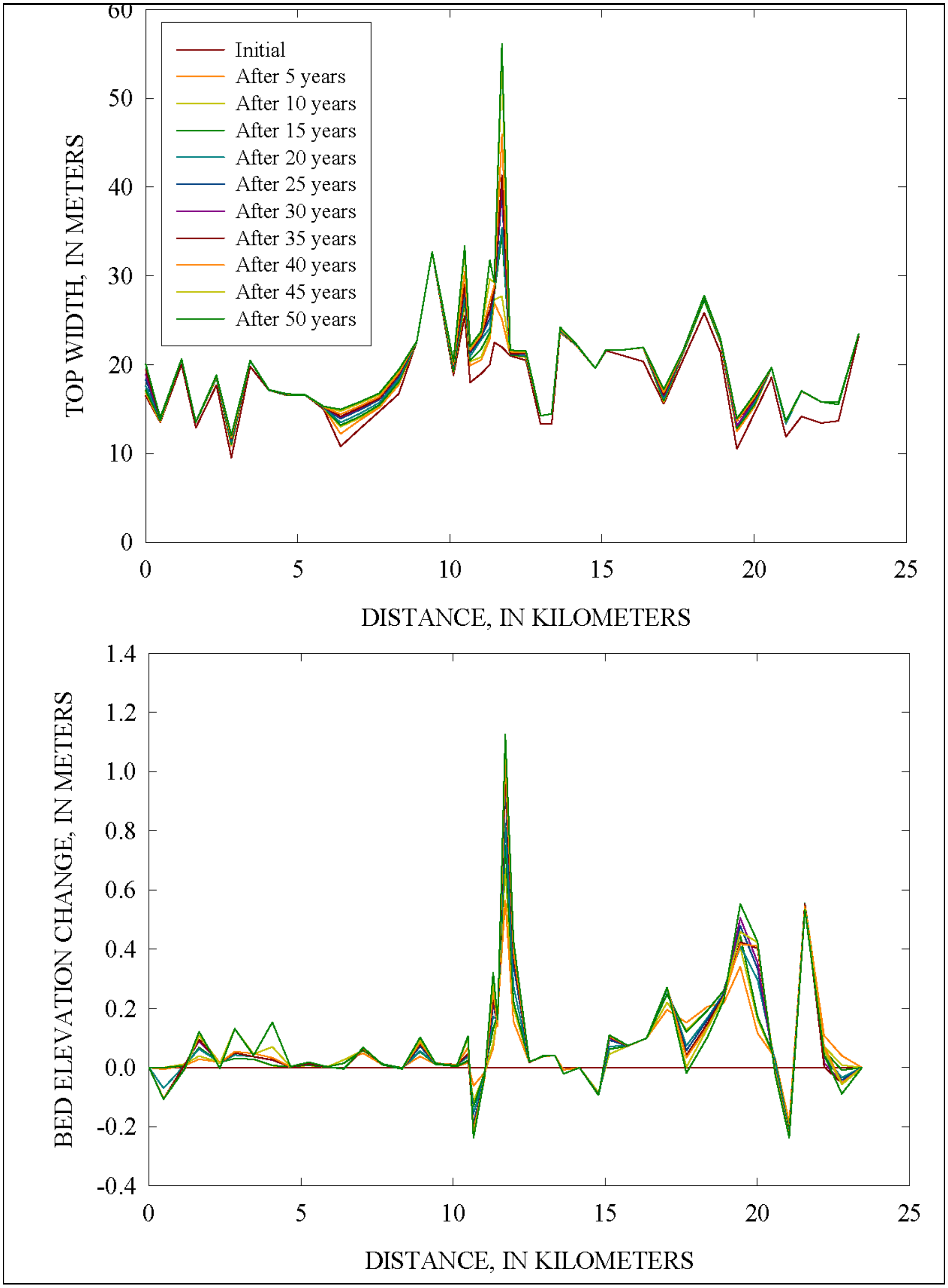
Under the No-Project/No-Action Alternative, the Upper Truckee River would continue to respond to past disturbances. The progressive geomorphic adjustment along the Upper Truckee River would occur primarily in the form of streambank erosion and widening, followed by streambed deposition in some upstream reaches. Simulations of future channel adjustments performed for the TMDL studies (Simon et al. 2003) estimate channel width and streambed elevation for the Upper Truckee River over a 50-year period (Exhibit 3.9-15). These data suggest that bank erosion and channel widening would progress rapidly over the next decade in some reaches (e.g., five kilometers upstream of the river’s mouth) and slowly for decades in other areas (e.g., seven kilometers upstream). The magnitude of channel widening may be substantial, with estimates ranging from several feet in most areas to more than 20 feet in some locations. The changes in streambed elevation would be smaller, with deposition expected to occur in much of the system, ranging up to one foot in most areas and a couple of feet thick in a few locations. The simulations indicate that net streambed erosion would occur in some locations, including portions of the study area (e.g., zero - one kilometers upstream).

Future channel erosion under the No-Project/No-Action Alternative, while generally expected to follow a predictable trend based on geomorphic channel evolution models described above, could be altered by climate change. Climate change may modify future hydrology and sediment loads from the watershed. However, the effects of climate change were not specifically represented in the TMDL modeling, which assumed future hydrology similar to the historic record. Increased rainfall as a proportion of total precipitation, increased runoff during winter, decreased snow water equivalent, and decreased spring/summer runoff are climate change conditions that could limit the rate of natural recovery within the incised channel system.

There could also be offsetting effects of climate change on stream channel erosion. For example, vegetation encroachment on channels resulting from lower average annual flows may help stabilize some existing streambanks. However, the potential for severe rain or rain-on-snow floods and associated erosion effects may remain the same or even increase.

Another adverse effect of climate change on channel erosion within the study area may occur if total runoff to Lake Tahoe were to decrease and the lake level were to stay below historic elevations more often or for sustained periods. This would lower the base elevation at the mouth of the Upper Truckee River and worsen streambed erosion (i.e., incision) locally, even relative to the TMDL simulation. If incision were to occur, the effect would be likely to migrate upstream in the river (and possibly Trout Creek), resulting in channel erosion and destabilization of channel banks.

Recent restoration efforts within the study area at the Lower West Side Restoration Area lowered bank heights and partially offset past actions that increased erosion in that reach of the Upper Truckee River. Ongoing restoration efforts upstream in the Middle Reach of the Upper Truckee River (Reaches 3 and 4) are adding channel length, reducing slope, and creating new channel segments with appropriate bank heights. Implementing these improvements is expected to result in a more functional channel with natural bank erosion rates. These efforts will partially offset the effects of past actions in the respective project reaches, but are not expected to correct the accelerated channel erosion throughout the system (e.g., not directly address conditions within the study area).



Source: Simon et al. 2003

Exhibit 3.9-15 **Simulated Changes in Bank Top Width and Bed Elevation of the Upper Truckee River over a 50-Year Period**

The TMDL analysis of load reduction opportunities (California Water Boards and NDEP 2008:211–215) produced quantitative estimates of erosion of fine sediment from streambanks of the Upper Truckee River under the existing condition and for a range of treatments to reduce streambank erosion. Compilation of the results for specific subreaches of the Upper Truckee River allows a quantitative estimate of the effect of the No-Project/No-Action Alternative on stream channel erosion within the study area (Table 3.9-19).

Table 3.9-19
Estimated Stream Channel Bank Erosion on the Upper Truckee River under Alternative 5

River Reach	Distance Upstream of Lake (feet)	Alternative 5 (No-Project/No-Action) Bank Erosion of Fine Sediment[1] (cubic yards)
Upper Truckee Marsh study area	0–9,646	538.13
TOTAL	79,364	4,319.74

Note:
[1] Fine sediment is less than 0.063 millimeter in diameter.
Source: California Water Boards and NDEP 2007.

Channel erosion along the Upper Truckee River would continue to exceed natural background conditions under Alternative 5. Although this is an adverse condition that would continue, it is not a change from existing conditions. This impact would be **less than significant**.

IMPACT 3.9-4 (Alt. 5) **Trout Creek Channel Erosion within the Study Area. (CEQA 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 5 would not involve directly modifying the channel of Trout Creek. However, Trout Creek would continue responding to historic disturbances with instability that would erode its streambanks and streambed within the study area and release sediment and nutrients that would degrade water quality in the creek and lake relative to undisturbed natural conditions. Implementing Alternative 5 would allow the adverse conditions to persist, but this would not be a change from existing conditions. Therefore, this impact would be* ***less than significant.***

The Trout Creek channel(s) in the study area and upstream reaches have experienced accelerated erosion in response to watershed-wide and site-specific past actions. The direct actions and the geomorphic responses to those actions have created increased rates of streambed and streambank erosion. Some past actions on the watershed scale, such as logging and transporting logs using stream channels and ditches or water supply diversions and ditches, had direct effects on channels within the study area and along upstream reaches. Some of the direct modifications made to the Upper Truckee River channel in the study area also affected Trout Creek, particularly the straightening and dredging near the mouth of the Upper Truckee River, which also lowered the base elevation at the mouth of Trout Creek. Many of these actions reduced stream length and increased channel slope, depths, and/or bank heights, resulting in direct or subsequent increases in channel erosion that generated total sediment and fine sediment loads at rates that exceed natural conditions.

Restoration efforts over the last decade upstream within the Trout Creek system have restored upstream channel segments on Trout Creek and its tributary, Cold Creek, to have more appropriate slopes, dimensions, and bank heights than their degraded historic condition. These efforts have partially offset the effects of past actions in their respective project reaches, but have not resulted in systemwide correction to the accelerated channel erosion.

Under the No-Project/No-Action Alternative, changes would occur along Trout Creek within the study area as it would continue to respond to past disturbances. The progressive geomorphic adjustment along Trout Creek and its distributary channels would occur primarily in the form of streambed erosion in the lower reach. Channel erosion would continue at an accelerated rate for a period of time, eventually stabilizing after a period of years to decades under likely trends based on geomorphic channel-evolution models. Quantitative modeling of future channel erosion on Trout Creek has not been performed for the TMDL; the expected trends, which are based on conceptual models, could be altered by the effects of climate change. Increased rainfall as a proportion of total precipitation, increased runoff during winter, decreased snow water equivalent, and decreased spring/summer runoff are all likely to limit the rate of natural recovery within the incised channel systems.

Offsetting indirect effects of climate change on stream channel erosion could occur. It is possible that vegetation encroachment within channels resulting from lower average annual flows may help stabilize some of the existing incised streambanks, but the potential for severe rain or rain-on-snow floods may stay the same or even increase. Another adverse potential effect of climate change on channel erosion within the study area may occur if total runoff to Lake Tahoe were to decrease and the lake level were to stay below historic median elevations more of the time or for longer durations. A lower lake level would lower the base elevation at the mouth of Trout Creek, potentially worsening ongoing and expected streambed erosion within that portion of the study area.

Under the No-Project/No-Action Alternative, continued or increased channel erosion is expected in Trout Creek as it continues to adjust to past disturbance. Channel erosion along the lower reach of Trout Creek would continue to exceed natural background conditions under Alternative 5. Although this is an adverse condition that would continue, it is not a change from existing conditions. This impact would be **less than significant**.

IMPACT 3.9-5 (Alt. 5)	**Erosion of Backfilled and/or Remnant Channel Segments on the Floodplain. (CEQA 1, 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 5 would not involve abandoning and backfilling the existing Upper Truckee River, and would not increase the frequency with which existing remnant channel segments on the floodplain would be inundated. The risks of erosion and/or mobilization of organics and sediment within the floodplain topography would remain similar to existing risks.* ***No impact*** *would occur.*

Alternative 5 would not involve modifying the location or capacity of the Upper Truckee River or modifying the frequency or magnitude of overbank flows that access the existing floodplain (terrace) surface across the study area. The potential for floodplain erosion to occur and mobilize organics and/or sediment that have accumulated within remnant channel features at various locations throughout the marsh would remain under Alternative 5. This would not be a change from existing conditions. **No impact** would occur.

IMPACT 3.9-6 (Alt. 5)	**Retention of Fine Sediment and Nutrients within the Study Area. (CEQA 1, 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 5 would not directly modify the channel capacity, elevation, frequency of overbanking, or area of functional active floodplain, although future natural geomorphic adjustments to historic disturbances would be expected to eventually form a small inset floodplain below the terrace banks. Implementing this alternative would allow the existing impaired fine sediment and nutrient retention conditions to persist. This impact would be* ***less than significant****.*

Relative to natural conditions, stream channel and floodplain connections, active floodplain areas, and overbanking processes that prompt deposition of fine sediment and retention of nutrients are degraded in the study area and along the upstream reaches of the Upper Truckee River. This degradation has resulted from past watershed-wide and site-specific direct actions and the stream's geomorphic response to those actions. The river channel is enlarged, banks are high, and fill has been placed in some floodplain areas. These conditions have reduced the frequency of overbank flow and the extent of active floodplain. These changes, in turn, have decreased the opportunity for and effectiveness of floodplain deposition of suspended sediment and/or the trapping and transformation of attached or dissolved nutrients.

The connectivity of the Upper Truckee River channel in the study area to its floodplain has been reduced by watershed-wide and site-specific past actions. Various direct actions and the geomorphic responses to those actions have enlarged the channel, increased bank heights, and placed fill within floodplain areas, and thus reduced the frequency of overbank flows and the extent of floodplain inundation. These effects have decreased the opportunity for and effectiveness of floodplain deposition of suspended sediment and/or the trapping and transformation of attached or dissolved nutrients.

Studies for the Lake Tahoe TMDL have documented the existing degraded condition of the Upper Truckee River, reported the magnitude of total and fine sediment loads, and calculated nutrient loads delivered to Lake Tahoe based on U.S. Geological Survey records (Simon et al. 2003, Simon 2006, California Water Boards and NDEP 2007). The loads reaching the lake reflect the net effect of numerous sources and sinks (or storage) throughout the watershed and along the stream corridor, not just the floodplain processes. The TMDL studies included estimates of several of the watershed's pollutant sources and opportunities to reduce loads from those sources (California Water Boards and NDEP 2007). However, little information is available to quantify the degree of impairment of floodplain processes as a sink for sediment and nutrients along the Upper Truckee River in the study area, relative to a natural or undisturbed condition.

Conceptual models that link channel and floodplain characteristics to sediment and nutrient sources and sinks and some limited field data have been the basis of discussions of the existing versus restored conditions to date (Conservancy and DGS 2003:Chapter 12; California Water Boards and NDEP 2008:Stream Cannel Erosion Load Reduction Analysis, Appendix A). A few studies have collected field data regarding overbank flows and information about floodplain sedimentation within the study area. Postconstruction monitoring at the restored Lower West Side project included visual observation and measured the accumulation of sediment on the restored floodplain wetlands. Analysis of soil cores collected in the study area documented modern net sedimentation in the Upper Truckee Marsh even under the degraded channel conditions, but at rates that only capture a small portion of the suspended sediment in the streamflow entering the study area (Winter 2003:90).

Observations at seven sampling sites in the study area during the 2003 snowmelt season identified patterns and amounts of suspended sediment and total phosphorus retention on the Upper Truckee River versus Trout Creek portions of the study area (Stubblefield et al. 2006). These field data indicate that the more functional floodplain along Trout Creek retained 68–90 percent of the suspended sediment and 61–85 percent of the total phosphorus, while areas along the degraded Upper Truckee River retained only 26 percent of the suspended sediment and 24 percent of the total phosphorus (Stubblefield et al. 2006). Conceptual models of floodplain processes and the limited local data both suggest that improved floodplain connectivity and floodplain conditions, as well as frequent overbank flows, would increase net sedimentation and nutrient retention as water quality treatment.

Recent restoration efforts within the study area at the Lower West Side Restoration Area excavated fill that had been placed on the natural floodplain, lowered bank heights, and specifically created a low area on the west side of the existing channel. The low area increased the opportunity for river water to overflow into the restoration site despite the enlarged existing channel and common lake backwater. These measures partially offset past actions by increasing the extent of floodplain connectivity and overbanking for a small section of the Upper Truckee River in the study area, restoring 12 acres of improved floodplain. However, this would not be expected to correct the decreased floodplain connectivity, area, and function that persist in other portions of the study area.

Under the No-Project/No-Action Alternative, changes would occur along the Upper Truckee River and Trout Creek channels within the study area as these streams would continue to respond to past disturbances. The progressive geomorphic adjustment along the Upper Truckee River and Trout Creek within the study area is expected to further enlarge the channels and worsen the existing degraded floodplain connectivity. No future direct or indirect reductions of floodplain area or storage capacity are expected under the No-Project/No-Action Alternative. The channel(s) and 65.0-acre inundation area for the 2-year event in the study area would not be directly modified. The active floodplain area (Table 3.9-20) and potential for frequent overbanking would be either similar to existing conditions or potentially worse in locations where the channel capacity would continue to enlarge. These factors would reduce the frequency, area, and duration of floodplain inundation. Small increases in active floodplain area could occur in some reaches where channel incision and widening had progressed to the point of creating an inset floodplain between terrace banks. However, net retention of sediment and nutrients would not necessarily be improved substantially because these inset surfaces would be more vulnerable to disturbance during high flows than would active floodplains on the surrounding terrace. Therefore, the opportunity for floodplain processes to provide water quality treatment in the study area and upstream would be further degraded under the No-Project/No-Action Alternative.

Table 3.9-20
Floodplain Connectivity and Floodplain Process Indicators under Alternative 5

Upper Truckee Marsh Alternative	Length of Channel with Overbanking at 760 cfs[1] (feet)	Percent of Channel with Overbanking at 760 cfs[1] (%)	Area of Floodplain Inundated at 760 cfs[1] (acres)
Alternative 5 (No Project/No Action)	2,129	10	65

Note:
[1] Based on hydraulic modeling (HEC-RAS), assuming median lake level.
Source: Conservancy and DGS 2005

Future overbanking and floodplain processes under the No-Project/No-Action Alternative could also worsen with the effects of climate change. Precipitation changes, reduced percentage of precipitation as snow, and temperature increases associated with climate change would likely reduce mean streamflows, average annual runoff, and the magnitude of peak streamflow expected frequently (i.e., every two-five years). Additionally, incision of the channels in response to lowered lake levels would be expected to exacerbate the increase in channel capacity and decrease connectivity. Therefore, climate change could exacerbate the existing degraded condition by further reducing the frequency at which the existing design overbank flow (i.e., 760 cfs for the study area) would occur.

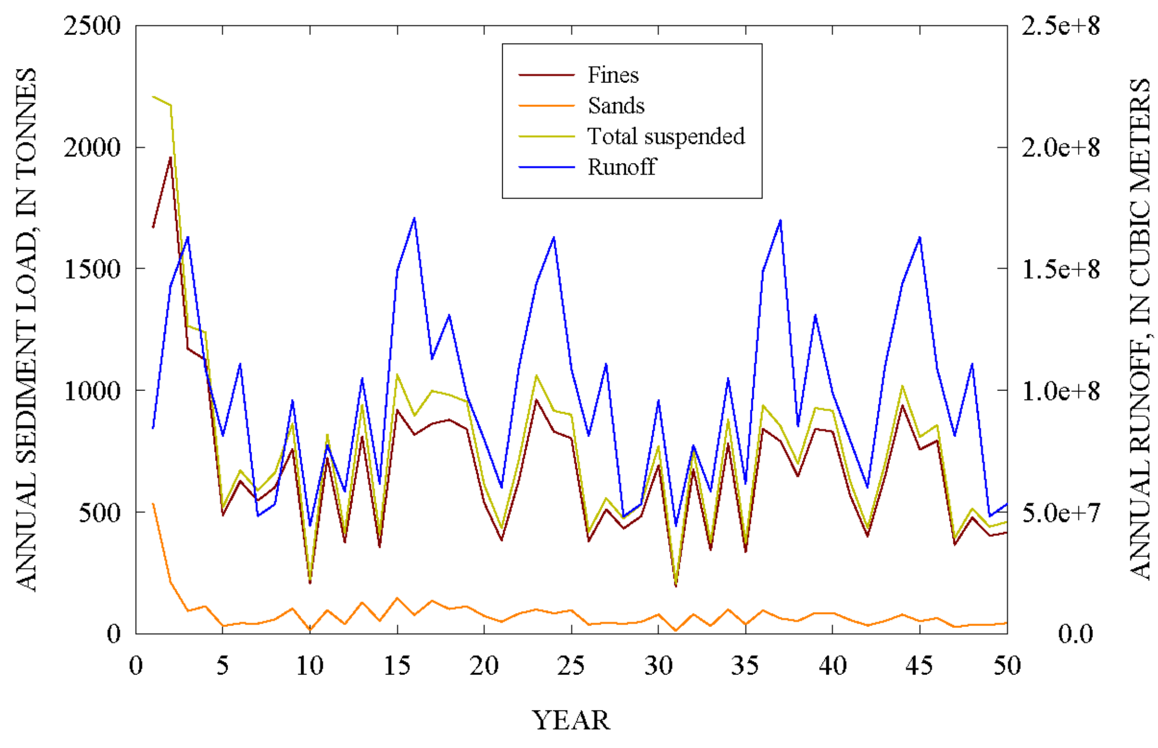
Therefore, the opportunity for floodplain processes to provide water quality treatment would be further degraded in the study area under the No-Project/No-Action Alternative. The adverse existing conditions would not change under Alternative 5. This impact would be **less than significant**.

IMPACT 3.9-7 (Alt. 5) **Decreased Delivery of Coarse Sediment to Cove East and Barton Beaches. (TRPA 2)** *Implementing Alternative 5 would not directly modify the streambed elevation or continuity of the Upper Truckee River's low-flow channel through the study area to Lake Tahoe, and therefore would not modify the transport of coarse sediment to beach areas adjacent to the river's mouth. The ongoing trend of net beach erosion would continue. In the long term, climate change effects could either exacerbate or counteract present trends. Potential long-term effects could range from worse than the existing degraded condition to a possible improvement. Any determination regarding long-term effects of climate change on coarse-sediment transport and delivery downstream would be* ***too speculative for a meaningful conclusion****. In the short term, however, implementing Alternative 5 would neither modify coarse-sediment transport and deposition within various portions of the study area nor affect delivery of coarse sediment to the adjacent beaches. The short-term impact would be* ***less than significant.***

Past direct actions throughout the watersheds, at the lake outlet, and in the study area, along with the geomorphic responses to those actions, have resulted in net erosion of Cove East and Barton Beaches since the early 1900s, producing a degraded condition relative to the predevelopment shoreline. At the watershed scale, past actions such as logging in the late 1800s and urban development in the mid 1900s temporarily increased delivery of sediment to the lake, including coarse sediment that supplied local beaches.

During the last few decades, coarse sediment carried by the Upper Truckee River and Trout Creek has been insufficient to maintain the historic length, width, or thickness of beach deposits. In addition, potential wave-energy effects on all Lake Tahoe beaches have increased since the late 1800s. U.S. Bureau of Reclamation management of lake levels holds water in storage and keeps the lake at a high elevation when possible. Site-specific actions since the 1950s, most importantly the initial and maintenance dredging of the Tahoe Keys navigation channels west of the Upper Truckee River, have directly reduced the supply of beach sediment to the study area. Dredging of navigation channels interrupts the movement of beach sand along the local shoreline and has directly resulted in net removal of all dredged sediment, including coarse sediment that would be supplied to beaches. These past actions have resulted in considerable and continued shoreline retreat in the study area. Historic beach erosion in the study area has especially affected active, largely unvegetated sand deposits, but it has also disturbed locations with dense herbaceous vegetation and mature conifers rooted in soils along the beach ridge.

Under the No-Project/No-Action Alternative, delivery of coarse sediment from upstream to the study area beaches would change as the watersheds and stream channels continued to respond to past disturbances, ongoing management, and to the influences of climate change. No quantitative projections have been made of the net effects of all these factors on future delivery of coarse sediment. Recent historic conditions, with relatively low yield of coarse sediment from the Upper Truckee River and Trout Creek watersheds, are expected to be followed by declining sand or coarser loads as channels continue to widen and the streambed stabilizes (with net deposition in certain reaches) (Exhibit 3.9-16). It is possible that flood processes from rainfall runoff could result in periodic increases in loads of coarse sediment, even if most years have reduced transport of coarse sediment compared to existing conditions. No further modifications to management of the lake outlet (Reclamation 2008) would be expected under the No-Project/No-Action Alternative. Relatively high lake elevations would continue to be maintained for water supply unless climate change–related decreases in runoff or other effects were to lower the lake level. Dredging of the navigation channel west of the study area would be expected to continue without sand replenishment.



Simulated annual runoff and loads of fines, sands, and total suspended sediments delivered to the lake for the 50-year period. Source: Simon and Others 2003

Exhibit 3.9-16 **Simulated Annual Runoff and Loads of Fines, Sands, and Total Sediments Delivered to Lake Tahoe for the 50-Year Period**

The net effect of the above factors on future beach erosion at the study area is highly uncertain and difficult to predict. There could be a continuing adverse trend of net deficit of coarse sediment. Continued or increasing beach erosion could advance landward into the soils and marsh sediments behind the beach ridge, potentially increasing environmental damage relative to the existing degraded condition. However, it is also possible that climate change could result in lowered lake levels that would reduce potential wave energy along the existing beach ridge. The net effect of these factors has not been quantified and is highly uncertain, but could range from worse than the existing degraded condition to a possible improvement in beach erosion.

Implementing Alternative 5 would not alter existing conditions. Depending on which climate change influences were to occur, they could either exacerbate or improve conditions with regard to coarse-sediment transport and delivery to the beaches. Therefore, this impact remains **too speculative for a meaningful significance conclusion**.

IMPACT 3.9-8 (Alt. 5) **Stormwater Drainage and Treatment. (CEQA 1, 2, 3; TRPA 1, 2, 3)** *Implementing Alternative 5 would not provide additional stormwater pretreatment and/or flow routing improvements to enhance water quality treatment before discharge to the SEZ or directly to the Upper Truckee River and Trout Creek in the study area. No new recreation facilities or features would be constructed. The existing conditions would be allowed to persist.* ***No impact*** *would occur.*

Under Alternative 5, no measures would be implemented along the margins of the study area to provide additional stormwater treatment and/or flow routing improvements to enhance water quality treatment before discharge within the SEZ and/or directly to the surface water in Trout Creek or the Upper Truckee River. New recreation features would not be constructed or operated under this alternative. Therefore, the existing condition of stormwater drainage or treatment would not change. **No impact** would occur.