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Donner Basin Watershed Assessment

Final Report

Prepared for:

Truckee River Watershed Council
CELEBRATING 20 YEARS

Prepared by:
cbec, inc., eco engineering
H.T. Harvey & Associates
Susan Lindstrom, Ph.D. - Archaeologist

January 2016
Project Number: 15-1011

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GLOSSARY OF ACRONYMS

Acronym	Meaning
CDFW	California Department of Fish and Wildlife
LiDAR	Light Detection and Ranging
LRWQCB	Lahontan Regional Water Quality Control Board
NCDC	National Climatic Data Center
NRCS	Natural Resources Conservation Service
OHV	Off Highway Vehicles
SNOTEL	Snow Telemetry
SSURGO	Soil Survey Geographic Database
SWAMP	Surface Water Ambient Monitoring Program
SWE	Snow Water Equivalent
SWRCB	State Water Resources Control Board
TDPUD	Truckee Donner Public Utility District
TMDL	Total Maximum Daily Load
TMWA	Truckee Meadows Water Authority
TRWC	Truckee River Watershed Council
USACE	United States Army Corps of Engineers
USFS	United States Forest Service
USGS	United States Geological Survey

EXECUTIVE SUMMARY

This report documents the Donner Basin Watershed Assessment, a multidisciplinary effort conducted by the Truckee River Watershed Council (TRWC) to evaluate the Donner Basin's attributes, disturbances, existing conditions, and restoration opportunities. To perform this work, TRWC contracted with a team led by cbec inc., eco engineering, and assisted by H.T. Harvey & Associates (ecological consultants) and Susan Lindstrom (consulting archaeologist). This effort builds upon assessments recently completed for TRWC of two sub-watersheds of the overall Donner Basin: the Johnson Canyon watershed (a tributary to Donner Lake) and Coldstream Canyon (a tributary to Donner Creek). Given the coverage of these previous studies, this assessment generally excluded Coldstream Canyon and upper Johnson Canyon from detailed analysis and field efforts.

The report is divided into four sections: (1) Watershed Attributes, (2) Disturbance Assessment, (3) Existing Conditions and Reference State Comparison, and (4) Opportunities Assessment. The watershed attributes section describes the historic and current land uses, hydrology, geology, physical processes, water quality and ecology of the Donner Basin. The second section discusses the disturbances to the physical and ecological health of the watershed. In order to assess the watershed's alteration from its pre-disturbance condition, a reference state is defined for the watershed and compared with the existing conditions. Finally, the opportunities assessment identifies and prioritizes restoration projects, management actions and future studies that will improve or maintain the basin's health. To conduct this effort, desk-based analysis was complemented with field-based assessments of upland areas, the stream network, and Donner Lake.

The Donner Basin is a 29.5 square mile sub-watershed of the Truckee River watershed located just east of the Sierra Nevada crest. The basin features Donner Lake, a natural, freshwater lake roughly three miles in length and fed mostly by three tributaries (Summit, Gregory and Lakeview Creeks) at its western end. Today, the lake is managed as a water supply reservoir for municipal, industrial, irrigation and hydropower uses. At its outlet, the lake feeds Donner Creek which is joined by the basin's largest tributary, Cold Creek, roughly one mile downstream. In turn, Donner Creek flows into the Truckee River another 1.5 miles downstream. The basin encompasses a significant portion of the Town of Truckee, from its eastern extent to the western end of Donner Lake.

Over the past 150 years, the Donner Basin has been extensively affected by human uses. Located along a major transportation corridor through the Sierra Nevada, the Donner Basin experienced numerous impacts associated with the construction of the Central Pacific Railroad, roads, highways and Interstate 80. In many locations, historic logging practices still contribute to increased hillslope erosion and impact sediment dynamics. The use of Donner Lake as a water supply reservoir also affects the health of both the lake and Donner Creek. More recently, residential and commercial development have further impacted the hydrology, physical processes, water quality and habitat within the basin's aquatic and upland environments.

Impacts to the basin's hydrology and increased upland erosion rates result in greater delivery of stormwater and fine sediment to receiving streams and Donner Lake. In a watershed prone to naturally high sediment yields due to its easily erodible soils and glacial history, these historic and current disturbances are magnified. Donner Creek is considered one of the largest contributors of suspended sediment to the Truckee River, which is Clean Water Act 303(d) listed for sedimentation. The basin's water quality is also affected by the discharge of untreated stormwater runoff from numerous sources and contamination from polychlorinated biphenyls (PCBs), chlordane and arsenic (for which Donner Lake is also 303(d) listed). The management of Donner Lake as a water supply reservoir drives lake levels, affects shoreline and aquatic communities, and influences downstream geomorphic processes and habitat conditions. Donner Lake and Donner Creek have also been colonized by Asian Clam and, due to high levels of recreation activity, the basin is at risk for additional aquatic invasive species introductions. Channel realignment, stream corridor narrowing and land development within floodplains have also severely impacted the basin. These disturbances have impaired physical processes and greatly reduced the quality and abundance of aquatic and riparian habitat along Donner Creek and the residential reaches of Donner Lake's tributaries.

While returning the watershed to its pre-disturbance condition is highly infeasible, significant opportunities exist for restoration, management and protection of the basin's physical and ecological health. Both Donner Lake and the basin's stream network would benefit highly from projects in upland areas aimed at reducing erosion and treating urban stormwater runoff. Unpaved roads that exhibit ongoing erosion problems can be improved (or decommissioned) and eroding hillslopes along the railroad grade can be stabilized to reduce downstream fine sediment delivery. Stormwater management practices can be implemented along the Interstate 80 corridor and in residential and commercial areas to dissipate energy, reduce peak flows and erosion, and capture pollutants

Donner Lake would also benefit from a number management actions and future studies. It is critical that watercraft inspections for aquatic invasive species be continued. These efforts should be complemented with public education programs to prevent introductions of new aquatic invasive species. Conducting additional water quality monitoring is suggested to further characterize PCB, chlordane, arsenic and mercury contamination, identify pollutant sources, and inform future remediation strategies.

Within the stream channel network, the most meaningful restoration opportunities are located along Donner Creek. As is the case in many urbanized settings, space is limited for large-scale restoration efforts. However, three sites were identified for floodplain and channel restoration along Donner Creek between the Cold Creek and Truckee River confluences that would significantly improve physical processes, habitat conditions and water quality. Large wood can also be installed in the stream channel to provide in-stream habitat complexity where space is otherwise limited. Donner Creek's downstream reach within Donner Memorial State Park also exhibits the highest functioning stream habitat observed along the creek and should be managed and protected to maintain healthy conditions. Additionally, two bank stabilization opportunities along the downstream-most 0.6 miles of Donner Creek would significantly reduce fine sediment loading to Donner Creek and the Truckee River. Finally, recommendations for resource management and future scientific research are provided to enhance and build upon current management programs and research efforts. In all cases, restoration, management, and enhancement of the Donner Basin will require ongoing coordination and cooperation with land managers that include but are not limited to California Department of Parks and Recreation, U.S. Forest

Service, Truckee Donner Land Trust, Town of Truckee, CALTRANS, and a large array of private land owners in the basin.

1 INTRODUCTION

1.1 BACKGROUND

The Donner Basin is located just east of the Sierra Nevada crest and encompasses part of the Town of Truckee from Donner Lake's western end to the watershed's eastern limits. The basin is an important component of the Middle Truckee River watershed and is home to significant natural resources, a vibrant population and economic center, and a major transportation corridor through the Sierra Nevada. The centerpiece of the watershed is Donner Lake, a freshwater lake that captures runoff from the western portion of the basin and feeds Donner Creek at its dam-regulated outlet. In addition to providing aquatic habitat, Donner Lake serves as a significant water supply reservoir for northern Nevada and a recreational hub for residents and visitors.

Over the past 150 years, the Donner Basin has experienced a number of physical and ecological impacts associated with western emigration, natural resource exploitation, and land development. The creation of major transportation arteries through the Donner Basin along with timber harvesting, reservoir management, fishing, and community development have negatively impacted the health of the watershed. Today, the watershed's hydrology, geomorphic processes, water quality and biological resources have been affected by anthropogenic disturbances. Despite this, much of the watershed's area is managed as permanent open space and there are extensive restoration and management opportunities to improve the health of the system.

As part of its Coordinated Watershed Management Strategy, the Truckee River Watershed Council (TRWC) initiated an assessment of the Donner Basin to evaluate the watershed's natural attributes, disturbances, existing conditions and opportunities for restoration. To perform this work, TRWC has contracted with a multidisciplinary team led by cbec inc., eco engineering, and assisted by H.T. Harvey & Associates (ecological consultants) and Susan Lindstrom (consulting archaeologist). This effort builds upon assessments recently completed for TRWC of two sub-watersheds of the overall Donner Basin: the Johnson Canyon watershed (a tributary to Donner Lake) and Coldstream Canyon (a tributary to Donner Creek) (River Run Consulting, 2007; IERS, 2010).

The development of this assessment included a stakeholder engagement process. Land managers, government agencies, local businesses, and other community groups with vested interest in the Donner Basin were invited to participate in a stakeholder group. This group convened four times over the 11-month period during which the assessment was conducted. Feedback and recommendations from this group were incorporated into the assessment process and the report.

1.2 ASSESSMENT OBJECTIVES

The key objectives of the Donner Basin watershed assessment include the following:

1. Describe the watershed's attributes including natural history, land cover, hydrology, geology, geomorphology, water quality, and biological resources
2. Develop a robust inventory of watershed disturbances
3. Assess the existing conditions of the watershed, particularly with regard to physical processes and ecological health
4. Identify restoration and management opportunities and develop a portfolio of prioritized project concepts that TRWC can pursue when opportunities arise for feasibility assessment, design and permitting.

1.3 STUDY AREA

The Donner Basin is a 29.5 square mile watershed located a short distance east of the Sierra Nevada crest and centered around Donner Lake (Figure 1 and Figure 2). The upper watershed includes several major tributaries (Gregory, Summit, Billy Mack and Lakeview Creeks) which drain into the western end of Donner Lake. Billy Mack Creek flows into Summit Creek while the others flow directly into Donner Lake. Donner Creek flows out of the dam-controlled, eastern end of Donner Lake and is joined by the basin's largest tributary, Cold Creek, roughly one mile downstream. Donner Creek then passes alongside Interstate-80 as well as commercial and residential areas before flowing into the Truckee River. The names of the valleys or canyons differ from the stream name for Gregory Creek, which flows through Johnson Canyon (also known as Negro Canyon) and Cold Creek, which drains Coldstream Canyon (Figure 3). The Coldstream Canyon sub-basin was the site of an earlier watershed assessment completed for TRWC in 2007. A watershed assessment was also performed for Gregory Creek of Johnson Canyon in 2010 for TRWC. Both of these efforts evaluated impacts to these tributaries and identified restoration opportunities, some of which have already been implemented. The assessment documented in this report builds upon these previous efforts and focuses primarily on the portion of Donner Basin that excludes Coldstream Canyon. However, some analyses performed for this assessment include Coldstream Canyon given its connectivity with the Donner Basin. Field efforts were also not conducted in the upper portion of Johnson Canyon where previous work had been done.

2 WATERSHED ATTRIBUTES

2.1 LAND USE HISTORY

As part of the Washoe people's territory and later as a major Sierra Nevada transportation corridor and a population center, the Donner Basin has a long history of human use. The following sections summarize the history of the basin and its various land uses. A much more detailed reporting of the basin's history is provided Appendix A[1], along with maps, photos and a timeline. Additional discussion of land development and impacts to the streams and lake within Donner Basin is provided in Sections 4, 5 and 8 as relevant to the basin's hydrology and geomorphology.

Ethnography

Prior to the arrival of the first west-bound overland emigrant explorers, the Donner Summit areas was used by the Washoe and Southern Maidu (or Hill Nisenan) peoples. The Hill Nisenan peoples likely only occupied the areas around the Donner Basin during hunting, fishing and plant collecting efforts, after which they would return to their permanent villages along the western slope of the Sierras. The Washoe people had more established camps and communities in the Donner Basin area, and made extensive use of Donner Creek for fishing. Communal fishing practices included temporarily damming the creek to harvest fish from the stream. The Washoe also hunted large game and gathered edible plants and medicinal roots in the surrounding landscape.

Transportation

<u>Emigrant Travel</u>

Beginning in the 1840s, west-bound emigrant travelers began utilizing the Overland Emigrant Trail which traverses the north side of Donner Lake on its way to Donner Pass. Although the route had already been used and successfully traveled by several parties, the history of emigrant travel through the Donner Basin centers on the failed journey of the Donner Party, which became trapped at Donner Lake during the winter of 1846 to 1847. Much of the group perished over the winter. Due to the steep slopes leading up to Donner Pass, alternative routes through Coldstream Canyon became more popular as passage routes over the Sierra Nevada crest.

<u>Road Development</u>

Preliminary road development began with the construction of the Dutch Flat and Donner Lake Wagon Road which opened over Donner Pass in 1864. This road was originally established to provide supplies for the first proposed transcontinental railroad alignment. Way-side inns were constructed alongside the road to accommodate travelers and spurred early development within the Donner Basin. The road eventually became part of the Lincoln Highway in the 1910s, although it was not paved until the 1920s.

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[1] Appendix A provides a detailed review of the land use history and cultural resources of the Donner Basin in the form of a workbook. As a standard archaeological protocol, the workbook is developed as a standalone report, and consequently provides discussion of the physiography, geology, climate, ecology and other elements of the Donner Basin that is intended only to provide context for the cultural component of the assessment. Where redundant sections exist, the reader should refer to the text in the main body of the report.

Over the following years, the highway was renamed the Victory Highway and then U.S. Route 40, which was ultimately rerouted. In 1963 portions of the two-lane U.S. 40 were incorporated into the new interstate highway system and became the four-lane Interstate 80, completed in 1964 over Euer Saddle which is located to the north of Donner Pass.

Transcontinental Railroad

The route of the first transcontinental railroad passes through the Donner Basin to the south side of Donner Lake. Construction of the railroad began in the Donner Basin area in 1864 and was completed over Donner Pass by 1869. The construction effort involved the creation of seven tunnels within the two-mile section of rail east of Donner Summit. Maintenance and improvements have occurred since the railroads construction and it continues to operate today. In addition to the direct impacts of railroad construction on the landscape, the railroad also stimulated a market for a number of economic activities that included logging, commercial fishing, the ice industry and recreation.

Logging

Timber harvesting began in the Donner Basin in 1864 with the construction of a sawmill at the edge of Donner Lake. Demand for timber was fueled by the railroad and by 1881 timber around Donner Lake had largely been cut out. After this date, logging operations around Donner Lake were limited to mostly small-scale enterprises. Timber stands were reentered between the 1940s and 1970s as part of modern-era logging.

Water Reclamation

Starting in the 1860s, the outlet of Donner Lake was artificially dammed to support the logging industry. Several decades later, subsequent dams were constructed at the outlet to generate a water-supply reservoir for downstream users. The construction of these dams involved dredging a canal at the eastern end of Donner Lake. Plans were also developed to build a sequence of four dams in the Donner Basin that would also capture flows from Cold Creek, they were never pursued to fruition. The present-day dam was constructed in 1929 by the Donner Lake Company and was built from concrete. The dam is located approximately 1,600 ft east of the lake's original outlet and raised water levels roughly 12 above the natural lake level of 5,924 ft.

Partial water rights were transferred from the Donner Lake Company to Sierra Pacific Power Company (SPPC) and Truckee Carson Irrigation District (TCID) between 1924 and 1943. Under these agreements, the maximum elevation to which water could be stored was fixed at 5,935.8 feet, this elevation being the maximum to which the lake could be raised without flooding the resort owned by the Donner Lake Company at the west end of the lake. The lake could not be drawn down prior to September 1st of any year below the elevation of 5,932 feet, thus assuring a high enough level to permit the recreational use of the lake (Senate Journal 1945:684).

Ice Production

Upon the completion of the railroad, the ice harvesting industry in the Sierra Nevada grew rapidly to provide ice to Californians and people across the country. Ice operations were established along the perimeter of Donner Lake and on tributaries. As much as 35,000 tons of ice were harvested in a single year at Donner Lake (Meschery 1978:48). Artificial ice ponds were also established near the downstream end of the lake, and a dam on Donner Creek was constructed to divert water from Donner Creek into the ponds in the 1890s.

Fisheries

Donner Lake and Donner Creek originally supported a strong fishery for the Washoe people. Commercial fishing began around the time of the completion of the railroad in the 1860s. By 1870 the dam at the Donner Lake outlet was obstructing fish runs. A trout-breeding farm was also established in 1871 using three natural and three artificial ponds to raise fish for commercial production. In 1878 the State fish commissioners ordered stockings of non-native species (eastern trout, salmon and whitefish). In 1901 fish ladders were added to the Donner Lake Dam and sport fishing began rising in popularity (Richards 2006).

Grazing

In 1872, Joe Marzen Sr. began grazing cattle herds in fenced areas in a meadow area below Donner Lake, which became known as Marzen's Meadow. In addition to beef cattle, Marzen raised hogs, chickens and sheep and also grew alfalfa. In 1901 Marzen leased portions of his land to a dairy farmer to graze his cows. Grazing continued on Marzen Meadow until 1905. Transitory grazing of sheep also occurred throughout portions of the Donner Basin, particularly those that had been recently logged.

Community Development and Tourism

Small resorts and hotels were established around Donner Lake in the 1860s as the railroad rendered Truckee and Donner Lake accessible. Residential subdivisions began as early as the 1910s, with many lots built out by the mid 1950s to 1960s. By the 1920s the Truckee/Donner Pass region began to develop into a recreation-based economy. The first known ski lift in America was reportedly built in Truckee in 1913. The development of Truckee’s Hilltop ski hill and ski jump during the 1910s-1930s and the 1960 Winter Olympics at nearby Squaw Valley secured Truckee's position as a center point for year-round recreation.

Public Utilities

The development of public utilities in the Donner Basin area began with the installation of a telegraph line over Donner Summit between 1865 and 1866. Two power transmission lines were built over Donner Summit, the first in the 1923 and the second in 1937. A gas pipeline was installed in 1956 that passes through the basin. In 1997, the pipeline developed a leak in Summit Canyon and contaminated Summit Creek. Additionally, a major fiber optic cable runs through the basin and local water and sanitary sewer networks are present in the watershed.

2.2 CURRENT LAND USE

Present day land use within the Donner Basin consists of a mixture of public open space, residential, commercial, municipal and transportation uses (Figure 4 and Figure 5). Much of the western portion of the watershed, particularly areas located along the steeper hill slopes of the basin, is managed as open space by California State Parks, the US Forest Service and the Truckee Donner Land Trust (Figure 5). Donner Memorial State Park also includes land along the eastern and southern extents of Donner Lake. Low to moderate density residential development exists around much of the lake's perimeter, while residential and commercial development are most dense in the Town of Truckee located in the eastern portion of the basin.

The Donner Basin is also a major transportation corridor through the Sierra Nevada. Interstate 80 runs alongside the northern edge of Donner Creek and Donner Lake for much of their length, passing over Euer Saddle to the north of Donner Pass. The Central Pacific Railroad passes through the southern side of the Donner Basin as it makes its way up to Donner Pass. A network of paved roads and highways also exists in the watershed, located predominantly in the residential and commercial areas around the lake and to its east.

Donner Lake serves both as a water supply reservoir and a recreation destination for local residents and visitors. The Truckee Meadows Water Authority operates a dam on the lake's outlet which controls water levels for the upper 11.8 feet of the lake (discussed in greater detail in Section 4). Recreation activities on the lake include boating, swimming, fishing and beach and shoreline use. These activities unfortunately generate boat wake and shoreline erosion problems in some areas. Residents have even observed jet ski users traveling up the downstream end of Summit Creek. Mega-events (large, multi-component sporting events and races) can also draw hundreds of residents and visitors to the lake's shores and exacerbate shoreline erosion issues. In the upland areas, recreational activities in the watershed include hiking, equestrian use, mountain biking, Off Highway Vehicle (OHV) use, camping, and rock climbing.

2.3 HYDROLOGY

Located just east of the Sierra Nevada crest, the Donner Basin experiences a high-elevation Mediterranean climate characterized by wet winters and dry summers punctuated with occasional thunderstorms. Orographic effects result in significant snowfall, particularly in the western portion of the watershed, that typically accumulates over the winter months and melts by early summer. Runoff from spring snowmelt typically generates significant stream flows between March and June, while rain-on-snow events produce the most significant flood events in the area. Streams flows are typically lowest in the late summer. The warmest time of year is typically July when mean temperatures are just above 60° F while January is often the coldest month with mean temperatures near 28° F. Analysis of long-term stream flow records, lake levels, reservoir management, precipitation and temperature was performed to characterize and quantify the Donner Basin hydrologic regime and to identify any long-term trends.

2.3.1 Basin Hydrology Overview

The Donner Basin is comprised largely of two distinct watersheds, one to the north drained by Donner Creek and the other to the south drained by Cold Creek (Figure 1). The headwaters of the Donner Basin originate near Donner Summit, fed by three tributaries (Gregory Creek, Summit Creek and Lakeview

Creek) that flow into the western end of Donner Lake. The lake is approximately 2.7 miles in length and has a maximum depth of 328 feet. At its eastern end, the dam-controlled lake feeds Donner Creek, which flows east through Donner Memorial State Park and commercial areas to its confluence with Cold Creek. Downstream of the confluence, Donner Creek continues through a more developed corridor bordered by Interstate 80, residential areas and commercial properties before flowing into the Truckee River. At its confluence with the Truckee River, the Donner Basin is 29.5 square miles. Just upstream of the Cold Creek confluence, the Donner Creek watershed is approximately 15.1 sq miles, an area that is mostly regulated by the dam on Donner Lake. At its confluence with Donner Creek, the Coldstream Canyon drainage area is 12.6 sq miles and is unregulated. The elevations in Donner Basin range from 5,832 feet at the mouth of Donner Creek at the Truckee River to over 8,946 feet at the headwaters of the Donner Basin.

Similar to most streams along the eastern side of the Sierra Nevada crest, the Donner Basin experiences the majority of its precipitation during the winter and spring months. A significant portion of the annual precipitation typically falls in the form of snow, often accumulating substantially over the winter and resulting in significant stream flows during the spring snowmelt period between March and June. The largest flood events for the basin are typically rain-on-snow events. While Donner Creek experiences the low summer flows typical of most streams in the region, the dam on Donner Lake and associated reservoir management alter downstream flows, particularly in the fall. Lake level draw down and delivery of stored water to downstream users result in artificially increased flows between September and November. Water storage in the reservoir also mutes peak spring snowmelt flows coming out of Donner Lake.

The Donner Basin benefits from a robust set of hydrology and climate records collected at several gauge stations within the watershed and in nearby areas. The data sets analyzed in this assessment are summarized below in Table 1 and their locations are depicted in Figure 6. These data records were evaluated to characterize the Donner Basin hydrologic regime.

Hydrologic analyses have also been performed in recent years by a number of groups. As part of a sediment monitoring effort for the Middle Truckee River performed for TRWC, Balance Hydrologics has characterized the hydrology of Donner Basin by leveraging stream flow along Donner Creek as measured at the two USGS gauges above and by establishing an additional streamflow gauging station on Cold Creek for water years 2011 to 2014 (Balance, 2011-2014). Earlier efforts also estimated flood magnitudes and recurrence for Cold Creek by flow reconstruction using the two USGS gauges on Donner Creek that bound the Cold Creek confluence (River Run Consulting et. al, 2007). The above studies and the Negro Canyon Watershed Assessment also evaluated precipitation and snowfall data to characterize the climate and runoff patterns of the Donner Basin (Integrated Environmental Restoration Services, 2010).

Table 1. Hydrologic data sets

Station / Gauge Name	Data Collector	Date Range	Parameters
USGS 10338100 Summit Creek above Donner Lake, CA	USGS	February 1997 to September 1998	Stream flow
USGS 10338500 Donner Creek at Donner Lake near Truckee, CA	USGS	January 1929 to May 2015	Stream flow
USGS 10338700 Donner Creek at Highway 89 near Truckee, CA	USGS	March 1993 to May 2015	Stream flow, Temperature
USGS 10338400 Donner Lake Truckee, CA	USGS	January 1989 to May 2015	Reservoir Water Surface Elevation observations at midnight
NRCS SNOTEL 834 - Bald Mountain	NRCS SNOTEL	June 1980 to May 2015	Precipitation, Snow Water Equivalent
NRCS SNOTEL 428 - Soda Springs (Central Sierra Snow Lab)	NRCS SNOTEL	July 1983 to May 2015	Precipitation, Snow Water Equivalent
NCDC COOP (Donner Memorial State Park)	NCDC	1961 to 2010	30-year normals for Precipitation and Temperature

2.3.2 Donner Lake Management

Donner Lake is a fresh water lake capturing runoff and snowmelt from 14.3 square miles of Donner Basin. The majority of the flow entering the lake comes from three tributaries (Summit Creek, Gregory Creek and Lakeview Canyon) as well as runoff from smaller sub-basins. Starting in the late 1860's, the naturally-occurring lake was dammed by various entities with different objectives (refer to Section 2 for more details). The present-day dam controlling the lake was built in 1927 and is owned and operated by the Truckee Meadows Water Authority (TMWA) primarily for water supply. The location of the dam is approximately 1,200 feet east of the main body of the lake along the outlet channel that drains into Donner Creek. This dam augments the lake's natural storage by increasing water surface elevations of the lake by approximately 11.8 feet, generating an additional 9,500 acre-feet of storage capacity. TMWA and the Truckee-Carson Irrigation District (TCID) each hold water rights to 50% of the available reservoir storage. Uses of the Donner Lake water by TMWA include municipal, industrial and hydropower, while TCID's primary use is irrigation along with incidental hydropower generation (pers. comm. Bill Hauck, TMWA).

While its primary management objective for Donner Lake is water supply, TMWA must also meet flood control requirements (per California's Department of Water Resources Division of Safety of Dams). Figure 8 shows a plot of lake levels from 1989 to 2014. Between November 15 and April 15, TMWA is required to leave the two outside gates of its dam open, which typically lowers water surface elevations to a level between 5,928 and 5,929 feet during the winter months. Outside of these flood control requirements, TMWA generally seeks to maximize storage within Donner Lake. Starting in the spring, typically after April 15, TMWA begins storing additional water in the reservoir as the spring snowmelt and precipitation contribute greater flows to Donner Lake. Exceptions to the April 15 start time are sometimes made during critically dry years (e.g., in 2014 TMWA started filling the reservoir in early March) or years with exceptional snow pack (gates can be closed later). Storage usually reaches a maximum near the cessation of the spring snowmelt period, with lake levels typically peaking between late May and early July (Figure 9). Per operating rules, the maximum permissible storage elevation for the lake is 5,935.8 ft though the height of the dam is 5,938.5 ft.

Since 1988, TMWA has also followed an informal agreement with the California Department of Fish and Wildlife (CDFW) to maintain base flows in Donner Creek for ecological purposes. If flows in Donner Creek measured at the USGS gauge at Highway 89 are below 5 cfs, TMWA is expected to provide at least 3 cfs of that total flow via releases from Donner Lake. If flows at Highway 89 are greater than 5 cfs, TMWA is expected to provide at least 2 cfs of the total flow measured at Highway 89. TMWA maintains these ecological flows at all times except when lake levels are extremely low and there are dire water supply concerns downstream (pers. comm. Bill Hauck, TMWA). Furthermore, TMWA generally maintains high lake levels through the end of the summer partly for the benefit of local residents and recreational purposes. From the time of peak storage (usually late-May to early July) to the end of the summer (typically end of August or early September), lake levels are typically affected only by release of ecological flows, incoming runoff from precipitation and evaporation. In early fall, typically between September and November, lake levels are drawn down fairly quickly for downstream water supply (a combination of agricultural, municipal, industrial and hydropower) purposes and in preparation for meeting flood control requirements.

The maximum stage recorded for Donner Lake between 1989 and present today was 5938.60 ft and occurred on January 2, 1997 when the dam overtopped during a rain-on-snow event. The mean of annual maximum lake levels recorded is 5,935.94 ft and the mean of annual minimum lake levels recorded is 5,928.00 ft. The lowest lake level recorded is 5,927.20 ft, which occurred in January 1991 during the 1987-1993 drought.

2.3.3 Flow Record Analysis

The flow records from the USGS gauges along Donner Creek at the Donner Lake outlet (USGS 10338500) and at Highway 89 (USGS 10338700) were analyzed to characterize the existing flow regime. At the lake outlet, Donner Creek has a contributing drainage area of 14.3 sq miles while flows at the Highway 89 gauge reflect an overall drainage area of 29.1 square miles (which includes the Coldstream Canyon watershed). While flow data at the lake outlet is available starting in 1929, the flow data at Highway 89 is only available starting in 1993. The USGS also temporarily operated a gauge located upstream of

Donner Lake (USGS 10338100) on Summit Creek (drainage area of 4.96 square miles), but it has very limited data (1997 – 1998).

In addition to demonstrating the wet winter and spring snowmelt periods and dry summer conditions characteristic of most high-elevation Sierra Nevada streams, Donner Creek's flow time series also show the influence of Donner Lake and its associated reservoir management (Figure 10). Flows measured at the Highway 89 gauge reflect a combination of the lake outflows, discharge from Cold Creek and local runoff between the lake outlet and Highway 89. Lake outflows dominate discharge in Donner Creek between September and November during the period of a lake draw down and downstream water supply deliveries. Discharge typically peaks in May each year due to snowmelt, with monthly average flows at Highway 89 just above 200 cfs. Because Cold Creek has an unregulated watershed, it typically contributes a greater proportion of the snowmelt runoff between April and June.

The peak discharge recorded at the USGS gauges at the lake outlet and near Highway 89 are 863 cfs and 2,500 cfs, respectively. Both of these flows were recorded during the January 2, 1997 rain-on-snow event (USGS, 1998). The decline in Snow Water Equivalent (SWE) recorded at Central Sierra Snow Lab (Soda Springs) SNOTEL gauge coinciding with an increase in accumulated precipitation confirms that the stream flows are a result of rainfall associated with snowmelt (rain-on-snow event).

Flood Frequency Analysis

A flood frequency analysis was performed to quantify the magnitude and recurrence interval of peak stream flows along Donner Creek. The analysis was conducted using the U.S. Army Corps of Engineers' (USACE) Statistical Software Package (HEC-SSP) and the annual peak flows recorded at the Donner Creek gauges at the lake outlet and at Highway 89. The results are illustrated in Figure 11 and summarized in Table 2.

Based on the flood frequencies, the January 2, 1997 flood event with peak flow of 863 cfs at the lake outlet corresponds to a 77-year recurrence interval, which agrees with the recurrence interval determined by USGS (USGS, 1998). The peak flow of 2,500 cfs recorded at the Highway 89 gauge on the same day corresponds to a 50-year recurrence interval.

Table 2 also indicates that the 2-year and larger flood flows at Highway 89 are approximately three times that of flood flows at the lake outlet even though the contributing watershed area only doubles between the lake outlet and Highway 89. This disproportionate increase is due largely to the unregulated nature of Coldstream Canyon, which experiences a greater flood response to precipitation and runoff. Coldstream Canyon (12.7 square miles) forms approximately 40 percent of the total drainage area at Highway 89 and receives most of its annual precipitation as snow during the winter months of November through March. The Cold Creek high flows tend to be dominated by spring snowmelt and occasional rain-on-snow events (BHI, 2014) that result in a much greater flood response at the Highway 89 gauge.

Table 2. Flood frequency for Donner Creek at lake outlet and at Highway 89

Percent Chance Exceedence	Recurrence Interval	Donner Creek at Lake Outlet (USGS 10338500) Computed Flow (cfs)[1]	Donner Creek at Hwy 89 USGS 10338700 Computed Flow (cfs)[2]
0.2	500-year	1,234	3,720
0.5	200-year	1,051	3,240
1	100-year	920	2,874
2	50-year	795	2,505
5	20-year	637	2,011
10	10-year	522	1,633
20	5-year	409	1,246
50	2-year	255	703
99	1-year	66	96
Notes: [1] Based on the period of record, i.e. water years 1931 to 2014 [2] Based on the period of record, i.e. water years 1994 - 2014			

Flow Duration and Low Flow Estimates

The flow duration curve is a plot of discharge versus the percent of time that a particular flow in a stream is equaled or exceeded. This type of curve characterizes the frequency with which a basin experiences flows of various magnitudes. Figure 12 shows the flow duration curves for the following gauges and periods:

- Daily flows at USGS gauge at the lake outlet for water years 1929 – 1988 (period of record prior to CDFW agreement)
- Daily flows at USGS gauge at the lake outlet for water years 1994 – 2014 (period that coincides with the period of record at Donner Creek gauge at Highway 89)
- Daily flows at USGS gauge at Highway 89 for water years 1994 – 2014 (complete period of record)

The flow exceedance data is also summarized in Table 3. Flows with 95-percent exceedance probability are typically characterized as low flow conditions in a stream. Based on the flow duration curves for the 1994 to 2014 period, low flows for the USGS gauge at the lake outlet and at Highway 89 are 2.0 cfs and 4.3 cfs, respectively.

As discussed above, the Donner Lake operations have been modified following a handshake agreement in 1998 with CDFW to maintain base flows in Donner Creek for ecological purposes. Concurrent with this agreement, the flow record demonstrates an increase in low flow discharges after 1988. Comparison of the flow exceedance probabilities at the lake outlet for the two time periods (i.e. water years 1929 – 1988 and 1994 -2014), as shown in Figure 12 and summarized in Table 3, indicates the following:

- there was zero outflow from the lake roughly 18% of the time prior to the CDFW agreement

- low flows that lie in lower 20 percentile of flow distribution have increased reflecting the change in lake operations
- no pronounced shift in the medium to high range flows that lie in the upper 50 percentile of flow distribution

Table 3. Flow exceedance for Donner Creek at Lake Outlet and at Highway 89

Percent of Time Flow Exceeded	USGS 10338500 (1929-1988)[1] Flow (cfs)	USGS 10338500 (1994-2014)[2] Flow (cfs)	USGS 10338700 (1994 - 2014) Flow (cfs)
99	0.0	1.3	3.4
95	0.0	2.0	4.3
90	0.0	2.5	5.2
80	0.8	3.5	9
50	12	17	37
25	44	50	91
15	72	78	140
10	97	99	191
5	144	128	273
2	204	189	405
1	254	236	509
0.1	482	540	1019

Notes:
[1] Based on record for water years 1929 – 1988
[2] Based on period that coincides with period of record at Donner Creek gauge at Hwy 89 (USGS 10338700)

Low flows were also characterized using annual minimum mean flows computed over several consecutive minimum flow days (also referred to as N-day low flows) during an annual period. Annual minimum mean flow is a low-flow statistic representing the lowest mean discharge over a given number of consecutive days (N-days) during an annual period. For example, a 7-day annual minimum mean flow in any given year is the average of 7 consecutive lowest daily flow values. Computation of annual low flows is based on the climactic year (starting April 1 and ending March 31). Appendix B lists the computed annual low flows for 3-, 7-, 10-, 15-, 30- and 60- consecutive days for Donner Creek gauges at lake outlet and at Highway 89 for each year during the 1994 to 2014 period and the frequencies within specific flow ranges. Table 4 summarizes the range of annual low flows for 3, 7, 10, 15, 30 and 60 consecutive days.

As shown in Table 4, the magnitude of 7-day annual minimum mean flow varies between 0.8 cfs and 4.4 cfs at the lake outlet with a 21-year average around 2.0 cfs. For Donner Creek at Highway 89, it varies between 2.5 cfs and 8.5 cfs at Highway 89 with a 21-year average around 4.5 cfs. Although most annual 7-day low flows occur during the summer months of June through August, or extend into fall (September and October), the annual 7-day low flow can sometimes occur in the winter during prolonged periods of freeze for high altitude streams. It can be noted that flows with 95-percent exceedence probability are similar to the mean 7-day low flows, which is typical of streams in temperate climates. Inspection of the limited Summit Creek flow record shows that flows declined substantially during the late summer and early fall with some periods of zero flow occurring for both summers on record.

Table 4. Ranges of annual low flows for Donner Creek at Lake Outlet

Flow Range	1-day	3-day	7-day	15-day	30-day	60-day
Donner Creek at Lake Outlet USGS 10338500 (1994 – 2014)						
Average (cfs)	1.3	1.5	2.0	2.3	2.9	4.1
Minimum (cfs)	0.0	0.4	0.8	1.3	1.8	2.0
Maximum (cfs)	4.3	4.4	4.4	4.5	8.1	21.3
Donner Creek at Hwy 89 USGS 10338700 (1994 – 2014)						
Average (cfs)	4.0	4.2	4.5	4.8	5.7	8.1
Minimum (cfs)	2.0	2.3	2.5	2.5	2.8	3.9
Maximum (cfs)	8.4	8.4	8.5	9.0	15.5	22.4

2.3.4 Climate and Precipitation Analysis

Annual Precipitation

Similar to many watersheds along the eastern crest of the Sierra Nevada, the Donner Basin is subject to significant precipitation differences across its watershed due to orographic effects. Based on regional-scale precipitation mapping efforts, annual precipitation at the watershed's western crest is approximately 65 inches while total precipitation at the eastern, lower-elevation end of the watershed is 35 inches per year (Figure 13). This general trend is reflected in precipitation data from two Natural Resources Conservation Service (NRCS) Snow Telemetry (SNOTEL) network stations. The Central Sierra Snow Lab (CSS Lab) station is located west of Donner Basin near Soda Springs at an elevation of 6,855 feet while the Truckee #2 station is located east of Donner Basin at Bald Mountain (Figure 6) at an elevation of 6,509 ft. For the period of record (1983 to present at the CSS Lab station; 1980 to present for the Truckee #2 station), mean annual precipitation was 65.9 inches at CSS Lab and 34.1 inches at Truckee #2 station (Figure 14). These records also demonstrate the significant inter-annual variability in precipitation that is characteristic of the region.

Snow Water Equivalent

As discussed above, Donner basin receives precipitation both in the form of rain and snow. Snow water equivalent (SWE) is a measure of the amount of water that is available within the accumulated snow pack. Similar to the annual precipitation data, long-term SWE data was obtained from the two SNOTEL network stations: CSS Lab and Truckee #2. Figure 15 shows the peak SWE recorded at the two SNOTEL sites for each water year from 1984 to 2014, the common period of record for both stations.

Similar to the patterns in precipitation for the region, snowfall and snowpack accumulation are significantly affected by orographic effects. They are also strongly correlated with elevation. While the peak SWE recorded at CSS Lab ranged between 11.7 inches (2014) to 72.3 inches (2011) with a 31-year average of 37.4 inches, the peak SWE recorded during the same period at Truckee#2 ranged between 3.4 inches (2014) to 38.7 inches (2011) with a 31-year average of 17.5 inches (see Figure 6 for station locations).

In addition to the significant inter-annual variability of peak SWE, there is a high level of variation in the timing of snowfall and snowpack accumulation within the area on a year-to-year basis. Figure 16 shows daily SWEs for a sampling of water years (2001, 2010, 2011 and 2014), reflecting a range in precipitation amounts and the seasonal variability of snowpack. These water years were chosen to represent the full range of hydrologic conditions measured in terms of annual SWE recorded at CSS Lab. Long-term averages computed at the beginning of each month between January and June are also shown in the figure. The figure shows that the snow pack typically peaks during the months of March and April and snow-melt runoff occurs from as early as March and runs as late as July depending on the magnitude and timing of precipitation and temperatures within the basin.

Water year 2010 recorded an annual precipitation of 67.3 inches, which is similar to the annual mean, and was assumed to represent a normal water year. Water year 2010 exhibited snow pack similar to the long-term averages. Water year 2011 recorded an annual precipitation of 99 inches, which is 50 percent above mean, and indicates wetter than normal conditions. Water year 2011 exhibited a snow pack much higher than the long-term averages, resulting in snow-melt runoff that extended though the end of June. Water year 2001 recorded an annual precipitation of 41.9 inches, which is 36 percent below mean, and was assumed to represent a dry water year. Water year 2014 recorded an annual precipitation is 40.6 inches, which is 38 percent below mean, and was assumed to represent critical dry year. Both of these water years exhibited snowpack much below long-term averages, resulting in earlier than normal spring peak snowmelt runoff.

Climate Normals

Climate normals are 30-year averages of climatologic variables such as temperature and precipitation. 30-year monthly normals for Donner Basin were evaluated based on precipitation and temperature data from National Climatic Data Center (NCDC) Cooperative Observer Program (COOP) station at Donner Memorial State Park.

Figure 17 shows 30-year monthly precipitation normals for 1961-1990, 1971-2000 and 1981-2010 periods. The figure generally does not demonstrate a visible temporal trend in monthly precipitation over the period of record. However, it can be noted that the summer months (June, July and August) have become slightly drier.

Figure 18 shows 30-year monthly temperature normals for 1961-1990, 1971-2000 and 1981-2010 periods. Table 5 summarizes annual and seasonal means of temperatures normals.

Table 5. Means of 30-year temperature normals

Season / Period	NCDC 1961-1990 Monthly Normals	NCDC 1971-2000 Monthly Normals	NCDC 1981-2010 Monthly Normals
Mean Max. Temperature (F)			
Annual	58.7	57.5	59.9
Summer (June – August)	77.8	76.5	79.4
Winter (December to February)	41.5	40.5	41.8
Spring / snow-melt (March – July)	63.2	61.6	65.0
Mean Temperature (F)			
Annual	42.6	42.4	44.0
Summer (June – August)	58.5	58.0	59.9
Winter (December to February)	27.9	27.9	29.0
Spring / snow-melt (March – July)	46.9	46.4	48.4
Mean Min. Temperature (F)			
Annual	26.5	27.3	28.0
Summer (June – August)	39.0	39.5	40.4
Winter (December to February)	14.3	15.4	16.2
Spring / snow-melt (March – July)	30.5	31.2	31.9

The following conclusions can be drawn from Figure 18 and Table 5:

- No visible temporal trend in the temperatures can be observed for mean high temperature and mean temperatures. However, the most recent 30-year period is warmer than the prior two 30-year periods for the two parameters.
- Mean minimum temperatures have increased over the last 3 sets of 30-year normals, as evidenced across annual time scales as well as seasonal (winter lows, summer lows, spring/snow-melt lows). This trend indicates a potential for earlier than normal loss of spring snow-pack.

Projections for Future Climate Change

Climate change projections for the Sierra Nevada vary widely on the basis of future emissions scenarios and other factors, but consistent among most projections is an increase in temperatures, an increase in the proportion of precipitation that falls as rain, a decline in average snow pack accumulation, and an earlier melting of accumulated snowpack (Belmecheri 2015, California Energy Commission 2015, Dettinger et al. 2004, Luers et al. 2006, Maurer 2007, Stewart et al. 2004). Changes to snowpack levels and stream flow conditions will likely be significant, and are arguably already occurring. Water year 2015 is considered to have a 500-year record low snow pack (Belmecheri 2015). Reductions in snow pack by the end of the century could be as high as 70-90% (California Energy Commission 2015, Luers et al. 2006). As snowpack formation declines, runoff volumes during the winter months will increase. Warmer temperatures will also likely result in earlier snowmelt and earlier peaks in spring stream flows in the Donner Basin. This in turn will likely influence how Donner Lake is managed as a reservoir as earlier gate closures may be necessary to fill the reservoir's typical impoundment capacity. Climate change, and resulting changes in human behavior and resource management, will likely have significant impacts on the both physical processes and ecological conditions in the Donner Basin.

2.4 GEOMORPHIC ASSESSMENT

A combination of desk-based and field-based assessments were performed to investigate physical processes occurring at both the basin and the reach-scales. The following sections discuss the physical context of the watershed, study methods and findings from the geomorphic portion of the study.

2.4.1 Geology and Glaciation

A combination of granitic, andesitic and other volcanic rocks, and glacial drift constitute the majority of the geologic formations present within the Donner Basin (Figure 19). The higher elevation, western slopes of the basin are dominated by granite and granodiorite, which are intrusive volcanic rocks that resist erosion. Examples of these materials include the large outcrops near the Donner Summit area that are visible from the lake. Also present within the western part of the basin are a series of three north-south trending faults. These faults may be responsible for abrupt changes in slope in some areas along the western slopes of the basin. A significant portion of the study area is made up of volcanic flow deposits with varying silica content, ranging from basaltic to andesitic rocks. These types of flow deposits are of intermediate to high erodibility. These formations are present along the higher-elevation sections of the northern and southern slopes of the Donner Lake, Gregory Creek and Lakeview Canyon valleys. Andesitic materials also make up many of the higher elevation portions of the Coldstream Canyon watershed. Many of these areas feature steep gradients due to glacial erosion and are visibly eroding today.

Other types of volcanic rocks present in the area, particularly Johnson Canyon, include tuffs, breccias and undifferentiated volcaniclastics. These types of rocks can be formed by any volcanic-related sediment deposit such as volcanic mudflow, pyroclastic flow and fall, and ash fall. They tend to contain a high percentage of fine-grained matrix which makes them highly erodible.

Four glaciations occurred in the Tahoe Basin region during the Late Pleistocene[2] (Blackwelder 1931, Birkeland 1964). The most extensive of these was likely the Donner Lake glaciation which occurred between 600,000 and 400,000 years before present (YBP) (Birkeland 1964). More recently, the Tahoe and Tioga glaciations occurred between 120,000 and 60,000 YBP and 30,000 and 10,000 YBP, respectively. Of these, the Tahoe is considered to be more extensive within the Donner Basin as its deposits occur further up valley slopes in the eastern part of the watershed. More recent glaciation during the Holocene (within the last 10,000 years) is considered to have been limited to smaller glaciers in cirques (bowl-shaped depressions separated by sharp ridges) along the Sierra Nevada crest.

Glacial erosion and deposition that occurred during the Late Pleistocene played a significant role in determining the modern-day landscape, geology, erosion patterns and stream characteristics of the Donner Basin. Where glaciers carved through the relatively soft volcanic rocks in the watershed (e.g., the bounding crest of the Coldstream Canyon watershed) there exist steep-sided bowls, or cirques, separated by sharp ridges (River Run Consulting 2007). These areas are naturally prone to high rates of erosion and sediment production. Many of the discontinuities in slope present within the Donner Basin occur at breaks in glacial activity or where different sized glaciers interacted. Terminal moraines are also present at the eastern end of Donner Lake, formed during the retreat of glaciers (Figure 20).

Glacial till deposits, which consist of poorly sorted materials ranging from clay to boulder-sized particles that were eroded and moved by glaciers, are also extensive in the Donner Basin. Both glacial till and outwash deposits make up the majority of the eastern part of the watershed's geologic units as well as significant fractions of the Gregory Creek, Billy Mack Creek, Lakeview Canyon and Summit Canyon valleys. These materials usually contain a large proportion of easily eroded fine-grained materials. The Coldstream Canyon Watershed Assessment (2007) provides a more exhaustive discussion of the basin's geology, glacial processes and their influence on today's landscape and erosion patterns in both the Coldstream Canyon watershed and the larger Donner Basin.

2.4.2 Soils

The soils present in the Donner Basin are derived from a combination of underlying geology and subsequent glacial and fluvial activity (Figure 21). The area of interest largely consists of the Waca and Meiss soil units. The Waca unit is derived from andesitic tuff[3], is well drained and has low susceptibility to erosion. The Meiss unit is a cobbly loam derived from andesite. It is a shallow unit (approximately 13 inches thick), is somewhat excessively drained and has intermediate susceptibility to erosion. The Waca and Meiss units are intermixed in some areas with other minor components sometimes present. The Tallac unit is also moderately present in the area, mainly at lower elevations. Tallac is a very gravelly sandy loam originating from glacial deposits such as outwash, till or moraines, with moderate erosional susceptibility. They are poorly drained with a variety of parent materials such as colluvium, alluvium or glacial sediments. The units most susceptible to erosion are the Gefo-Aquolls-Celio complex (GEC), the

[2] The Pleistocene Epoch refers to a time period ranging from roughly 2.6 million to 11,700 years before present.
[3] Tuff refers to a rock type composed of fine volcanic ash and debris fragments that, once ejected from a vent and deposited, are compressed into a solid rock.

Martis-Euer variant complex (MEB) and the Euer-Martis variant complex (EUB). However, these units are predominant over a relatively small area and are generally present at low elevations with low slope.

2.4.3 Watershed and Stream Channel Overview

Terrain in the western portion of Donner Basin is characterized by steep hill slopes and stream gradients (Figure 22 and Figure 23). The major tributaries (Summit Creek, Billy Mack Creek, Gregory Creek and Lakeview Canyon) that drain into the western end of Donner Lake consist of mostly high-energy stream reaches with bedrock cascade and step-pool channel types. Channels are typically confined by valley walls, feature fairly low sinuosity and have numerous bedrock controls. As the channels approach Donner Lake, and in some of the stream's higher elevation valley bottoms, the stream gradients are more gentle and sediment deposition can occur on the floodplain and along the channel bed. Discontinuities in slope are likely driven predominantly by past glacial activity, underlying geology, and faults. With the exception of some of the lower gradient sections of high-elevation valleys, these streams predominately function as high sediment transport channels. Today, these channels show both direct impacts (e.g., culverts, crossings, etc.) and indirect effects (altered sediment dynamics and channel form) in response to historic logging practices and the construction of Interstate 80 and the railroad. The most visible impacts to these western tributaries appears to be their channelization and the extensive application of bank protection in the residential areas surrounding Donner Lake.

As the receiving water body of Summit Creek, Gregory Creek, Lakeview Canyon and other minor drainages, Donner Lake functions as a natural sediment trap, capturing most of the transported bed load and suspended load sediments, passing relatively low turbidity stream flows to Donner Creek. The lake is bounded by several terminal moraines at its eastern end. Reservoir management also causes backwater effects along the western tributaries, enhances shoreline erosion in areas (by drowning out vegetation, which directs boat wake and wind/wave action to exposed shores), and typically reduces peak flows in Donner Creek during spring snow melt periods.

Below the lake, Donner Creek passes through a low gradient, wide valley bottom shaped largely by glacial processes. Stream gradients between the lake outlet and the confluence with Truckee River range from 0.01% to 4.7%. From its start at lake's outlet, Donner Creek runs through a low energy channel with evidence of historic dredging as it winds through two terminal moraines at the eastern end of the lake. Continuing east, the downstream half of the Donner Memorial State Park is characterized by numerous beaver dams that enhance floodplain connectivity, and a wet meadow complex. From the Cold Stream Rd culvert to the Highway 89 bridge, Donner Creek has been straightened (mostly due to the construction of the interstate), largely disconnected from its floodplain and heavily armored with boulder rip rap. Downstream of Highway 89 the valley bottom narrows considerably and the laterally confined channel passes through the railroad culvert and the West River Street bridge before its confluence with the Truckee River. Variability in the stream corridor width and stream gradient drives patterns of sediment deposition in some areas and transport in others (discussed in greater detail in Sections 5.8 and 5.9).

2.4.4 Historical Channel Assessment

Time-series historical channel assessment provides invaluable information regarding the long-term development impacts to and dynamic behavior of streams and their contributing watersheds. The Donner Basin benefits greatly from US Forest Service (USFS) historical aerial imagery flown for the area starting in 1939. Aerial images providing coverage of much of the Donner Basin were obtained from the USFS office in Truckee, CA for the years 1939, 1952, 1966 and 1983. The following sections describe the historical condition of Donner Lake and Donner Creek and the major physical impacts to the stream channel as visible in the aerial time series.

Tributaries at West End of Donner Lake
As shown in Figure 24, Summit Creek emptied into Donner Lake as a distributary system with multiple channels flowing through what appears to be well connected floodplain wetland system on the lake's western shore. By 1952, Summit Creek was channelized, likely to facilitate drainage and permit residential development and road construction. Minor changes to channel alignment and character may have occurred between 1952 and 1966 but the images are not clear. However, between 1962 and the present there has been little physical change to the channel alignment, although the area has become increasingly developed. The channel alignments for the upper portions of Summit and Billy Mack Creeks as well as most of the length of Gregory Creek and Lakeview Canyon are not readily discernible in the historic aerials due to their small size.

Donner Creek Below Donner Lake
By 1939 the modern Donner Lake dam had already been constructed and the channel downstream through the large bends into the meadow had been dredged and may also have been channelized. Between 1939 and present, the dredged channel does not appear to change, although field evidence of dredge spoils and conversations with the reservoir operator indicate that this section of the channel has been dredged multiple times, most recently in 1988 (Figure 25 and Figure 27). Downstream of the dredged reach, the channel meanders through a large wet meadow. Historically, the wet meadow reach appears to have extended to the confluence with Cold Creek. Downstream of the confluence, the channel historically transitioned to a meandering, wider active channel with large depositional bar features (Figure 26). While the valley floodplain does not appear as wide in this reach as in the wet meadow, the channel still had extensive floodplains. This low gradient, meandering channel form continued until the Highway 89 crossing. Between Highway 89 and Truckee River, the stream is more laterally constrained and the channel sinuosity decreases. By 1939, Highway 89 and the railroad had already been constructed and culverts had been established over Donner Creek (Figure 26).

In 1964, construction of Interstate 80 was completed, greatly affecting the alignment and morphology of Donner Creek. To make room for the highway, much of Donner Creek was relocated to a narrow, linear corridor mostly to the south of its former alignment. Within this corridor (roughly from the present-day Cold Creek Rd crossing to Highway 89), Donner Creek was straightened and channelized as it runs parallel to Interstate 80 (Figure 25 to 27). Throughout this reach of Donner Creek the banks were also extensively armored with large boulder riprap. The wet meadow that extended until the confluence with Cold Creek was greatly reduced in area by 1966, ending at the Cold Creek Road crossing. Between

Highway 89 and the Truckee River confluence, the channel planform has undergone little change from 1939 to present, likely due to the laterally constrained nature of the valley bottom (Figure 24 and Figure 25). After widening of Highway 89 by 1966, it can be seen that the stream started to impinge on the highway on its right bank, which has persisted to present (Figure 26).

2.4.5 Fluvial Audit

A field-based geomorphic assessment was conducted during the spring and summer of 2015 utilizing a combination of fluvial audit (higher resolution) and reconnaissance level (lower resolution) approaches. This methodology characterizes geomorphically relevant features which inform a detailed understanding of physical form and processes within a stream network. It also inventories human impacts and river engineering measures (e.g., bank protection, grade control structures, levees, etc.) to facilitate a more nuanced understanding of the degree of impairment to physical processes and channel health. The survey is conducted on foot and utilizes a field tablet computer equipped with GIS mapping software to record observations, photos and locations using GPS. Reaches that were surveyed include the following and are also indicated in Figure 28:

- Donner Creek from the Truckee River to Donner Lake
- Gregory Creek from Donner Lake to its tributary confluence roughly 800 ft upstream of Interstate 80
- Summit Creek from Donner Lake to a distance approximately 2,000 upstream of its confluence with Billy Mack Creek
- Billy Mack Creek from its confluence with Summit Creek for a distance of approximately 3,200 ft upstream
- Lakeview Canyon from Donner Lake to the confluence of its tributaries approximately a half-mile upstream from the lake

The following is a summary of the various feature categories of interest that were observed in the study reaches and how they were characterized as part of this assessment. The fluvial audit methodology characterized all of these features as present in a high degree of detail while the reconnaissance level approach utilizes a less detailed inventory of bank erosion and sediment bar features but maintains the same level of detail for the other characteristics. The data is also presented in a mapped format in Figure 29 through 35.

Reach Type Characterization

This qualitative classification is based largely on bedforms and the stream gradient or slope. The reach type was typically characterized over a section of channel at least 10 channel widths in length, rather than at a specific point or individual morphological unit. Observed reach types ranged from slow glide sections on Summit Creek in the backwatered areas near Donner Lake to bedrock cascade reaches along many of the western tributaries. Reach types are highly correlated with stream gradient as presented in Figure 23 and also offer insights into a channel's capacity to transport or store sediment. In some areas, the reach type classification was complicated by glacial lag deposits (e.g., large boulders unlikely to be moved by modern-day fluvial processes) within the stream channel which affected channel bedforms, local hydraulics and sediment deposition. Additionally, high lake levels driven by the dam caused backwater effects that drowned out the lower reaches of the western tributaries. Reach type classifications for these channel segments may differ when lake levels drop.

Hydraulic Control Structures

Hydraulic control structures are manmade structures that artificially control channel bed elevations or grade. Structures observed in the Donner Basin include a wide range of bridges, weirs, culverts and fords (Figure 36 and Figure 37). In addition to controlling channel grade, many of these features also strongly influence local hydraulics and constrain the lateral migration of the stream channel. Some of the characteristics noted include the length and width of the feature, the elevation of the structure's invert relative to the channel bed, the materials used to armor the bed and banks (if any are present), and a visual assessment of the degree to which the structure interacts with high flows. These observations inform the degree of physical impact each structure has on the stream channel and healthy geomorphic processes. In turn, the observations are leveraged as part of the engineering and land use pressure index described in Section 9.2.2.

Bank Erosion

The length, height and severity of erosion was recorded for observed bank erosion sites along the survey reaches. Erosion severity was classified as high, moderate-high, moderate or minor. The most significant bank erosion sites were along Donner Creek, and included high severity sites downstream of Highway 89 and the railroad culvert (Figure 38). These sites serve as local sediment sources to the stream network. Given the degree of hydromodification[4] in the watershed (which usually results in channel incision and bank erosion), there appeared to be relatively few active bank erosion sites, which is likely a result of widespread application of bank armoring. Bank erosion is mapped in Figure 29 through 35.

Bank Protection

Bank protection observed in the Donner Basin consists of hard engineering measures, which refer to the use of concrete or rock protection installed along stream banks (see Figure 39 for examples). These materials resist lateral migration and erosion of a stream channel, and consequently inhibit natural geomorphic processes. The bank protection measures observed were classified as either large scale or small scale. Large scale bank protection involves armoring the majority of the stream bank such that stream flows have little interaction with the native bank material below. Small scale bank protection refers to less extensive bank armoring such that the native bank material and vegetation still partially interact with the stream, particularly during higher flows. As can be seen in the mapping provided in Figure 29 through 35, bank protection has been extensively applied to stream channels flowing through residential and urbanized parts of the watershed.

[4] Hydromodification refers to changes in hydrology due to human influences such as urbanization, forest practices or land use changes that alter the proportion of precipitation that becomes surface runoff rather than infiltrating into the ground. Hydromodification is also typically associated with increases in stream flows due to the above land use changes as well as modifications to stream channel form.

Depositional Sedimentary Features
Sediment is stored within a stream channel in depositional bar features (e.g., point bars, lateral bars) as well as distributed along the channel bed. When depositional features were observed, the feature type, sediment material (e.g., sand or gravel) and maturity of the vegetation cover, if present, were recorded. Almost all of the bar features observed were bare or had small amounts of young riparian vegetation, suggesting they had been recently activated during high flow events. However, several larger bar features with mature vegetation were also observed, suggesting that they had not been altered significantly in recent years (see Figure 40). Downstream of Donner Lake, the perimeter of depositional bar features was digitized to support the development of a sediment storage index, while upstream of Donner Lake only the longitudinal extents of the bar features were mapped.

Beaver Dams
A number of beaver dams were observed along Donner Creek within Donner Memorial State Park as well as at the downstream end of the channelized reach running alongside Interstate-80 (Figure 41 and Figure 54). When observed, the location and approximate head drop of the beaver dams were noted. Beaver dams along Donner Creek raise the water table locally, promoting wetland and riparian vegetation, and generally improve habitat diversity. They also encourage greater channel-floodplain connectivity.

Large Wood
Occurrences of large wood were mapped. Where large wood is present and interacting with the low flow channel, it often generates habitat complexity and cover for aquatic species. Loading of large wood and the size of large logs have likely declined due to timber harvesting and development in the watershed.

Tributary Confluences
The location of tributary confluences were noted along with their relative contribution to in-channel sediment supply. Large depositional sedimentary bars located at and downstream of the Cold Creek and Donner Creek confluence suggest that Cold Creek delivers significant volumes of sediment to Donner Creek. After a summer thunderstorm in July 2015, the fine sediment loading patterns of Donner Creek and Cold Creek were also starkly contrasted by the difference in turbidity levels of the two streams (Figure 42 for confluence sediment plume).

2.4.6 Watershed Reconnaissance

In addition to performing channel-based geomorphic surveys, general watershed reconnaissance was conducted to assess impacts of residential, commercial, transportation and logging land uses on physical processes and basin hydrology. Given the concerns regarding fine sediment loading in the Donner Basin, particular emphasis was placed on evaluating impacts of past and current land use on fine sediment production of upland areas. Due to the size of the watershed, limited access to many backcountry areas and scale of this assessment, the reconnaissance was focused on two categories (summarized below) whereby select field sites were targeted rather than the entire basin.

Residential, Commercial and Transportation Stormwater Infrastructure

Stormwater infrastructure mapping provided by the Town of Truckee was used to identify and prioritize field sites. In the field, visual assessments of stormwater infrastructure were conducted to evaluate the potential for fine sediment delivery to receiving stream channels in the Donner Basin. Characteristics evaluated include the materials lining the bed of the stormwater conveyance feature (e.g., concrete, rocks/gravel or bare soil), the presence of roadside or adjacent hillslope erosion feeding sediment directly into the conveyance feature, and any indications of sediment accumulation or failure of the feature. In some locations, grading for road cuts on steeper slopes has left behind destabilized hillslopes and ongoing erosion issues (Figure 43). While some stormwater ditches appeared to be accumulating (and likely passing on) fine sediment, there were relatively few drainage conveyances themselves appeared to causing significant fine sediment loading compared to other sediment sources in the basin.

Several drainage features downhill of Interstate 80 stormwater culverts in Billy Mack Canyon were also investigated given concerns about road sand accumulating in the stream channel. These drainage features show significant incision and down-cutting in some areas, and appear to liberate significant volumes of sediment with grain sizes ranging from silts to gravels (Figure 44). These features are discussed in more detail in the Watershed Disturbance Assessment (Section 9).

Backcountry Logging and Railroad Sites

cbec staff accompanied California State Park personnel to visit select logging areas and logging roads within Coldstream Canyon, Lakeview Canyon, Summit Canyon and Billy Mack Canyon. As one of the largest land managers in the Donner Basin, State Park's personnel were able to focus field sites to particularly problematic areas and provide valuable insights on logging impacts. Additional follow-up site reconnaissance was subsequently undertaken by cbec team staff. Where logging roads were constructed in areas with steep slopes and easily erodible soils, many sites appear to be actively contributing large volumes of sediment during runoff events. The accumulation of fine sediment behind a downed log at the base of a logging road in the Summit Canyon headwaters provides an indication of the magnitude of hillslope erosion occurring in some areas (Figure 45). These field visits underscored the importance of developing a more spatially-robust understanding of the backcountry logging road network that is still present today and its influence on erosion hazard for the Donner Basin.

Several hillslope destabilization areas associated with grading for the railroad were also visited. One site in the headwaters of Summit Canyon is particularly problematic, with natural revegetation appearing incapable of re-stabilizing the badly eroding slope downhill of a retired railroad grade (Figure 46). In many places where railroad grading coincided with erodible soils, hillslopes have yet to fully re-stabilize and are likely continuing to liberate large volumes of sediment.

General Observations

The watershed reconnaissance revealed that backcountry erosion sites associated mostly with logging roads as well as the railroad and Interstate 80 likely release substantial volumes of fine sediment to the Donner Basin stream network. The degree of sediment loading from residential and commercial infrastructure appears to be smaller in magnitude than the backcountry impacts, although grading associated with roads and land development also likely increases fine sediment production above natural baselines. A spatial analysis of erosion hazard is informed by these observations and is presented in the following section.

2.4.7 Erosion Hazard Analysis

To develop a spatially robust understanding of fine sediment erosion potential and the impact of backcountry roads and logging impacts, an erosion hazard analysis was performed. The resulting index, herein after referred to as erosion hazard, was derived as the sum of four factors: fine soil erodibility, cover, slope and road density. The following paragraphs summarize the input factors and the development of the erosion hazard index.

Fine Soil Erodibility

The fine soil erodibility factor was developed from NRCS SSURGO soil data (2015) (Figure 47). Fine soil erodibility within SSURGO database is defined as K_f with values ranging from zero to one, where one is the most easily erodible. On occasion, composite K_f values were calculated (see Appendix C for more details). K_f values were then ranked and binned into five categories ranging from 0 to 4, with 4 representing the highest erosion potential.

Cover

The cover factor was created using the Department of the Interior Landfire (2012) vegetation type dataset (Figure 47). The cover factor provides an indication of the ability of vegetation to protect against erosion whether through intercepting rainfall, by root network, or by vegetation density. Higher cover factors represent less protection against erosion with barren earth being the highest possible value. Vegetation types were assigned values ranging from 0 to 4 depending on vegetation type and density (Appendix C). Minor reclassifications were also made to barren cover types where the exposed surfaces were granite outcrops. A more extensive summary of the cover factors and classifications in provided in the Appendix C.

Slope

The slope factor was derived from the earlier hillslope analysis (Section 5.3) that leveraged a DEM generated from 1-meter resolution 2014 USFS LiDAR. Slopes were binned and given values from 0 to 4, with higher (steeper) values of slope representing greater erosion potential (Figure 47). Additional discussion of the slope factor is similarly provided in Appendix C.

Erosion Potential

An intermediate erosion potential was calculated by summing the first three factors (fine soil erodibility, cover and slope) to provide an indication of baseline erosion risk that does not reflect logging road impacts (Figure 48). Potential values range from 0 to 12. Erosion potential was used to represent the potential of the landscape to contribute fine sediment in the absence human disturbance in backcountry areas, although it is likely that historic logging practices altered vegetation community composition and the resulting cover mapping.

Backcountry Road Density

Backcountry roads were digitized using a combination of aerial imagery and a hillshade generated from the 1 meter resolution DEM derived from 2014 USFS LiDAR. To create more meaningful impact assessment and prioritize action areas, the watershed was divided into micro-watersheds. The micro-watersheds were delineated using a combination of hydrologic boundaries (streams and ridgelines) and major infrastructure (e.g., Interstate 80). Road lengths were calculated for each road segment and summed within each micro-watershed. The total road length was divided by the area of the micro-watershed to obtain the road density, expressed as miles per square mile (Figure 48, right panel). In this analysis, road density described the potential for erosion due to soil compaction and increasing drainage density (i.e., roadside ditches and culverts), but it was also intended to serve as a proxy for the effects of forestry associated with backcountry roads, such as removal of vegetation and soil compaction from skidding.

Calculating Erosion Hazard Index

Road densities were then binned and given a road density factor value from 0 to 4, with higher values representing greater erosion potential (Appendix C). The final erosion hazard index was generated by adding the logging road density factors to the earlier three-factor erosion potential, resulting in a cumulative index that can be used to identify problematic areas and prioritize actions (Figure 49).

Discussion of Findings

In the Donner Creek watershed, the erosion hazard was highest on the hillslopes along the north side of Donner Lake, above I-80, but it was also medium to high within Lakeview Canyon. Along the north side of Donner Lake, especially in the Johnson Canyon drainage and just to the east of Johnson Canyon, more erosive soils coincide with steep slopes and sparse vegetation or shrubs and grass, creating a high potential for erosion (e.g., micro-catchments 6, 7, 8, 10 and 11). This area also had some of the highest density of backcountry roads. Within Lakeview Canyon, the erosion potential was low, except on the northern side of Schallenberger Ridge (e.g., micro-catchments 27, 29, and 31), however the road density in this area was moderate to high. Erosion hazard was low in the upper extent of the Donner Creek Watershed with generally lower slopes, more erosion resistant soils with large areas of rock outcrop, and low road density (eg., micro-catchments 1-4, 14-16, 20 and 21). Along the south side of Donner Lake, there are some patches of medium erosion hazard (e.g., micro-catchment 22), which were driven more by erosion potential than by road density, as road density in these areas was moderately low.

In the Cold Creek Watershed, the erosion hazard seems to be driven more by road density on the hillslopes south of Cold Creek and by both erosion potential and road density along hillslopes north of Cold Creek. The erosion hazard was generally highest on hillslopes along the east side of the South Fork of Cool Creek (e.g., micro-catchments 52, 55, 56 and 63). In this area, the soil had moderately low soil erodibility, open-canopy forest cover, and limited areas of steep slopes, but the road density was very high. The lower portion of the Cold Creek watershed, below Emigrant Canyon, also had high erosion hazard. In this area, hillslopes on the south side of Cold Creek had mostly low to medium erosion potential due to lower slopes with dense cover, but road density was high.

On the north side of Cold Creek, along the south slope of Schallenberger Ridge, erosion potential was high due to lower density tree coverage with more erosive soils overlaying steep slopes. Road density was also medium to highest along the south slope of Schallenberger Ridge, particularly on the eastern edge (e.g., micro-catchments 35-38). Erosion hazard was medium to high between Emigrant Canyon and the North Fork of Cold Creek (microcatchments 43, 44 and 46), due mostly to road density, except in micro-watershed number 47, which had steep slopes as well as some of the highest soil erodibility. In most of the highest elevation western extent of the Cold Creek watershed, the erosion potential was low. The upper extent of the watershed has some of the highest erosion potential, but the relative lack of roads resulted in a low erosion potential.

2.4.8 Specific Stream Power Analysis

A specific stream power analysis was performed for Donner Creek from the lake outlet to the Truckee River and for the lower section of Cold Creek to quantitatively characterize the 'geomorphic energy regime' (i.e., the sediment transport capacity or the stream's ability to do “work”) of the system (Figure 50). Specific stream power was calculated using the estimated 2-year flood event discharges. Specific stream power[5] is defined as:

$$\omega = \frac{\rho g Q S}{w} \ (Watts/m^2)$$

Where:

ρ = density of water (kg/m^2)
g = gravity term (m/s^2)
Q = flow rate (m^3/s)
S = channel slope (m/m)
w = bankfull width (m)

The reaches of Donner Creek and Cold Creek were broken into 300 ft segments for the analysis with discharge, slope, and width defined for each segment. The width term was the bankfull width measured using the hillshade from the 1 meter resolution LIDAR DEM and aerial imagery. At least one width was measured for each segment and, where necessary, multiple width measurements were made. The stream gradient calculated as part of Section 5.3 was used for slope.

Bankfull discharge within Donner Creek was estimated using the 2-year peak flow values calculated from flood frequency analysis of the USGS discharge gauges below Donner Lake and at Highway 89 (Section 4.3.1). Bankfull discharge in Cold Creek was estimated just upstream of the confluence with Donner Creek using the USGS StreamStats tool (U.S Geological Survey, 2012), as Cold Creek did not have a gauge with sufficiently long record for a meaningful flood frequency analysis. Flow for Donner Creek between the Cold Creek confluence and the Highway 89 USGS gauge was roughly interpolated using significant stormwater outlets as contribution points.

[5] Specific stream power is presented in $Watts/m^2$ to facilitate meaningful comparison with relevant literature.

Specific stream power values for the analyzed reaches of Donner and Cold Creeks ranged from 0.58 to 428 Watts/m^2. Nanson and Croke (1992) define a genetic classification system for floodplains, using specific stream power as the key variable, broadly breaking the floodplains and their channels into low, medium, and high energy systems with further subcategories. The specific stream power values calculated ranged from low energy to high energy floodplain systems.

Within Donner Creek, specific stream power was low to medium energy from the lake outlet to where it opens into the meadow. Within the meadow (reach 7), the specific stream power was the lowest. Specific stream power increased downstream of the meadow to the confluence with Cold Creek (reach 6), where the stream becomes channelized. Specific stream power was mostly medium throughout Cold Creek until just upstream of the confluence. Within the majority of this reach, Cold Creek flows through a fairly straight channel within a gravel extraction zone located on its historic alluvial fan. At the confluence, stream power decreased, which correlates with the large depositional bars in this area.

Specific stream power just below the confluence (reach 5) was low as Donner Creek enters a fairly wide corridor (relative to other reaches downstream). Further below the confluence, where the stream has been straightened and channelized (reach 4), specific stream power ranged from low to medium. This may be due to the valley gradient naturally being low in this area as there appears to be a meadow in historic aerial images (Figure 26). Even though the stream has been straightened to accommodate the freeway, the gradient is still fairly low through this reach due to the gentle valley slope. From the 90 degree bend in the channel, the stream power increases. In this segment, the stream is laterally confined by bank protection structures along the bends (reach 3).

Below Highway 89, the stream gradient steepens and the stream becomes naturally valley confined (reaches 1 and 2). Specific stream power values are generally higher within this reach, ranging from medium to high. Some of the highest stream power values observed in this analysis are between Highway 89 and the Truckee River. The highest specific stream power values appear to occur at the highway and railroad crossings. The high specific stream power just downstream of the railroad culvert correlates to an area where a high degree of channel incision was noted in the fluvial audit, with severely eroded banks.

2.4.9 Sediment Storage Index

To assess depositional zones within Donner Creek between Donner Lake and the Truckee River, a sediment storage index was calculated for distinct geomorphic reaches as shown in Figure 51. The sediment storage index is a useful indicator of where sediment is being stored, but is biased towards coarse sediment found on depositional bar features, and, as such, may not characterize fine sediment storage. It was observed during field surveys that the sequence of beaver dams within the downstream end Donner Memorial State Park were facilitating fine sediment storage within the channel and the floodplain. The index was not developed for the tributaries at the western end of Donner Lake due to their smaller channel size (which limits the use of LiDAR and aerial imagery in feature mapping), higher stream gradient, and the less detailed reconnaissance-level field geomorphic assessment conducted in many portions of these reaches.

Depositional bar features were recorded during field surveys along with descriptions of bar dimensions and whether vegetation was present. The depositional bar feature coordinates and 2014 aerial imagery were used to digitize the extents of depositional features. The total area of deposition was then summed for each geomorphic reach. The total sediment storage area was then divided by reach length to give an index of sediment storage (units of ft^2/ft).

Sediment storage was lowest in the reaches 6-9 from the lake outlet until the confluence with Cold Creek and in the straightened, channelized reach (reach 4) where Donner Creek runs parallel to Interstate 80 (0-0.4 ft^2/ft). Sediment storage below the lake outlet to the confluence is low due to the trapping efficiency of Donner Lake and the limited supply available from stream banks below the lake outlet. In reach 5, downstream of the Cold Creek confluence, sediment storage is highest (19.5 ft^2/ft), with several large depositional bars spanning nearly the entire length of the reach. This reach has a wide, shallow active channel with access to its floodplain along both banks, which allows the channel to store large volumes of sediment coming from Cold Creek. In reach 4, the straightened, channelized section of Donner Creek running parallel to Interstate 80, sediment storage is again low (0.4 ft^2/ft) as the channel is narrow with steep banks on both sides. Very coarse boulder armoring placed during construction of Interstate 80 on both banks throughout the reach further enhances channel constriction. This reach is transport efficient, and as such, has only a few small gravel bar features. In reach 3, where the channel enters two sharp bends, sediment storage is somewhat greater, but still low (4.7 ft^2/ft). In this reach, the channel is less constrained as the banks are less steep and lower, although the channel is still disconnected from its floodplain. The wider channel as well as the flow resistance from the bends serves to slow flow, allowing some deposition.

In reach 2, below the Highway 89 crossing, sediment storage is high again (18.7 ft^2/ft). In the upstream portion of this reach the stream is constrained by Highway 89 along the right bank, but has access to its floodplain on the left bank. In the lower half of this reach the channel is connected to the floodplain on both sides. Two large bar features here extend from the bank all the way to the toe of the valley wall. This unconfined reach allows the channel to store sediment. In reach 1, from the railroad crossing to the confluence with the Truckee River, sediment storage is moderate (10.5 ft^2/ft). This reach is highly incised just below the culvert and just above the confluence. Between the incised regions, the channel widens and connects to its floodplain on river right through the mobile home park. Sediment storage in this reach is almost entirely due to one large medial bar feature where the channel widens and a side channel is present.

2.4.10 Suspended Sediment

Suspended sediment monitoring has been conducted for several years within the Donner Basin as part of a larger sediment monitoring effort for the Middle Truckee River. Due to excessive sediment loading, the California State Water Resources Control Board (SWRCB) has listed the Middle Truckee River as impaired for sediment and the Lahontan Regional Water Quality Control Board (LRWQCB) has established a Total Maximum Daily Load (TMDL) for suspended sediment within the Truckee River. Balance Hydrologics (Balance) performed sediment monitoring in the Donner Basin at three locations for water years 2011 through 2014 (Balance 2012, 2013 and 2014). These locations included the following:

1. Cold Creek at Teichert Bridge
2. Donner Creek at Highway 89 (co-located with USGS streamflow gaging station 10338700)
3. Donner Creek at West River Street (just upstream of the confluence with the Truckee River; site added WY 2012).

On Cold Creek at Teichert Bridge, Balance established a monitoring station to continuously measure streamflow and turbidity as well as perform discrete suspended sediment sampling during the 4-year period. These data were leveraged to develop a relationship between turbidity and suspended sediment, which in turn was used to provide continuous estimates of sediment loading in the creek. At the two stations on Donner Creek (which were not equipped with turbidity meters), Balance performed suspended-sediment sampling over a range of streamflows and leveraged a streamflow-based rating curve method to approximate suspended sediment loads in Donner Creek.

These monitoring efforts demonstrate that the overall Donner Basin is a significant contributor of suspended sediment to the Truckee River and that sediment loading increases in the lower portions of the watershed. Analysis performed by Balance indicates that annual sediment yields from the Cold Creek watershed were 5 tons per square mile when normalized for drainage area. While sediment monitoring was not conducted at the outlet of Donner Lake, the size of the lake and field observations after a summer thunderstorm in July 2015 suggest that the lake captures most sediment from incoming tributaries. Additional field observations, particularly during more sustained winter flows, may help validate this assumption. On Donner Creek at Highway 89, sediment yields were estimated at 12 tons per square mile, while just half a mile downstream at West River Street, sediment yields were estimated at 19 tons per square mile. These increases suggest that there is substantial fine sediment loading in the urbanized portion of the lower watershed. Balance also notes (Balance, 2014) that sediment loading to the Donner Basin from upland sources differs based on the type of hydrologic event (e.g., rain-on-snow vs. snowmelt vs. summer thunderstorm).

Hydrologic and water quality modeling of stormwater outfalls draining to Donner Creek has also been conducted in recent years by CDM Smith and Balance Hydrologics for the County of Placer and Town of Truckee (2014). This work, which combines modeling with field data from stormwater sampling, indicates that outfalls along Highway 89 and W. River Street are among the largest contributors of the annual total suspended sediment load to Donner Creek that is derived from stormwater runoff from the Town of Truckee. The modeling results indicate that the average annual total suspended sediment load for all stormwater outfalls in the Town of Truckee between years 1983 and 2013 was 24 tons. However, given that the increase in annual suspended sediment load between Highway 89 and W. River Street ranged between 104 and 321 tons according to monitoring by Balance between WY 2012 and 2014 (Balance, 2014), it is likely that other sources contribute significant volumes of suspended sediment to Donner Creek between Highway 89 and W. River Street.

During the fluvial audit field surveys conducted as part of this watershed assessment, two instances of high-severity erosion were noted between Highway 89 and W. River Street. One of these is alongside Highway 89 on the right bank and the other is a combination of bank erosion and hillslope failure along the right bank immediately downstream of the railroad culvert. It is conceivable that a large fraction of the increases in suspended sediment between Highway 89 and W. River Street are derived from these two bank erosion sites. However, additional assessment would be necessary to evaluate bank retreat rates and validate this possibility. Watershed reconnaissance in the developed areas contributing to this last half mile reach of Donner Creek did not identify any upland sites with exceptional erosion potential.

2.5 WATER QUALITY ASSESSMENT

Donner Lake was originally listed as an impaired water body under the Clean Water Act 303(d) due to exceeding standards set for fish tissue concentrations of 'priority organics,' a category listed due to violations for polychlorinated biphenyls (PCBs) and chlordane. In 2002, tissue standards were updated and only PCBs were exceeding the limits. As of 2012, Donner Lake is exceeding standards for PCBs, chlordane and arsenic in fish tissues (Table 6), but not in the water column itself. Chlordane and arsenic were added as pollutants of concern in 2012 while PCBs remained from prior assessment cycles. The following sections focus on PCBs, chlordane and arsenic, with some attention given to mercury due to the issuance in 2011 of a health advisory regarding elevated levels of mercury in fish tissue[6] (Lim et al., 2011). The Middle Truckee River is also listed as impaired for excessive sediment and recent monitoring shows that the Donner Basin is a significant contributor of sediment to the Truckee River (BHI, 2014).

Donner Lake was originally listed as an impaired water body due to violations of 'priority organics', but the specific compounds being referred to by this classification were PCBs and chlordane (addressed above). The group 'priority organics' includes a wide variety of compounds with different properties, transport mechanisms and health effects. We do not address any other 'priority organics' in this assessment.

Table 6. Donner Lake impairment for constituents of concern

Constituent	Fish Contaminant Goals (ppb)[1]	Concentration (ppb)
PCBs	2.6	12 – 56[2]
Chlordane	3.9	6.75 – 13.38[3]
Arsenic	3.4	0.06 – 0.10[3]

[1]adapted from fish contaminant goals (FCGs) derived in Klasing and Brodberg (2008); FCGs calculated assuming average body weight of 70 kg, consumption rate of 32 g/day, exposure of 30 years over a 70-year lifetime; risk set to one in a million (Klasing and Brodberg, 2008; SWRCB, 2012)
[2](SWRCB, 2010)
[3](SWAMP, 2010)

This assessment attempts to distill the complex nature of how these constituents enter the environment, how they move through the environment, where they end up and what the consequences are of their presence. The presence of arsenic, chlordane, PCBs, mercury and excess sediment within the Donner Basin have impacts on the ecological health of Donner Lake, Donner Creek and its tributaries, and the Truckee River as well as the human population relying on these water bodies for recreation and

[6] As of the writing of this report, these mercury findings have not been replicated in the publicly available literature.

water supply. The potential sources of these constituents are numerous and include historical human impacts in the Donner Basin, present-day land use, natural occurrence in the environment and atmospheric transport from other areas. Assessing the chemical properties and potential sources of each constituent is critical to understanding how they are initially mobilized, their environmental transformation, their transport, and how long they might persist in the environment.

The chemical contaminants (i.e., PCBs, chlordane, arsenic and mercury) are of concern due to human exposure via consumption of fish caught in Donner Lake. All of these contaminants have the potential to bioaccumulate in organisms, meaning that relatively limited concentrations present in the environment can concentrate to toxic levels in animal tissues because of their chemical properties. They are also quite persistent in the environment which leads to continued contamination even in the case of chemicals that are currently out of use (i.e., chlordane and most applications of PCBs). Certain forms of each of these compounds readily sorb (stick to the surface or partition in) to particles such that they are stored and transported with those sediment particles. PCBs, chlordane and mercury are also commonly transported in the atmosphere and subsequently deposited in soils and water bodies. This information can inform future monitoring activities, preventative measures and remediation techniques (or whether remediation efforts are even feasible, necessary or wise).

Historical and current anthropogenic activities in Donner Basin contribute to the delivery of pollutants to Donner Creek and Cold Creek. In the Donner Creek subwatershed, residential and commercial development along with roads (paved and unpaved) including Interstate 80 contribute to soil erosion and stormwater runoff that transport sediment and pollutants to Donner Lake and Donner Creek (2nd Nature, 2008). In the Cold Creek subwatershed, historical gravel mining, logging and railroad construction likely contribute to soil erosion and stormwater runoff that transport sediment and pollutants to Cold Creek (2nd Nature, 2008). Atmospheric deposition (both current and past) could also contribute to the loading of PCBs and chlordane in the lake (Daly and Wania, 2005). Wind borne delivery may also be responsible for loading of particulate matter and nutrients from within the watershed to Donner Lake. It is important to note that almost all residences within the Donner Basin are connected to a sanitary sewer system that transports wastewater out of the basin for treatment, making this an unlikely source of any of the contaminants. Potential sources for pollutants in Donner Basin are summarized in Table 7.

This section summarizes the chemical properties, potential sources and health hazards of PCBs, chlordane and arsenic with a less thorough examination of mercury (due to its presence yet non-involvement on the 303(d) listing).

Table 7. Donner Basin potential pollution sources

Potential Pollutants	Sources
PCBs	Erosion of contaminated sediments/soils, improper waste oil disposal, road/railroad runoff, power transformers, atmospheric deposition
Chlordane	Erosion of contaminated soils, improperly disposed pesticides, road/railroad runoff, atmospheric deposition
Arsenic	Erosion of natural mineral deposits, pesticides, wood combustion, coal combustion, waste incineration, mining and smelting (unlikely here)
Mercury	Erosion of natural deposits, fossil fuel emissions, atmospheric deposition
Sediment	Natural hillslope erosion, logging roads, construction areas, inadequate stormwater drainage infrastructure, in-channel bed mobilization and bank erosion

2.5.1 Polychlorinated Biphenyls (PCBs)

The category of compounds named PCBs refers to a mixture of various polychlorinated biphenyl chemicals that are very similar in structure and effect. PCBs were produced primarily from the 1930s to 1977, when they were banned for most uses by the Toxic Substances Control Act (OEHHA, 2010). These compounds were used for a wide variety of applications, including uses as coolants in electrical transformers, hydraulic fluids, plasticizers, flame retardants, dyes, etc. The production and use of PCBs is very limited now, but they continue to occur in the environment due to introduction through spills, improper disposal, runoff of soils contaminated with PCBs and atmospheric deposition. PCBs are persistent in the environment, bioaccumulate in aquatic organisms, and are contaminants of concern because they are considered both an ecological hazard and a human health hazard (Daly and Wania, 2005; Geosyntec, 2013; Klasing and Brodberg, 2008). Since 2008, contamination of fish tissues by PCBs has resulted in the second highest number of fish consumption advisories in the US (after mercury). One such advisory was issued regarding fish caught for consumption from Donner Lake, suggesting limitations on the number and frequency of fish the public should consume based on age and gender, due to elevated concentrations of PCBs and mercury (Lim et. al, 2011).

Chemical Properties

PCBs are mixtures of various chlorinated biphenyl compounds, known as congeners, that contain different numbers of chlorine atoms. These compounds are persistent in the environment, and persistence increases as the amount of chlorine atoms on the congener increases. PCBs are very stable, leading to their extensive use in industry and their continued presence in various environmental compartments (Geosyntec, 2013; Klasing and Brodberg, 2008). They are semi-volatile, meaning that they can both enter the gas phase and fall back out, making them susceptible to long-range atmospheric transport and deposition (Daly and Wania, 2005). It may be possible to track the source of specific PCB contamination by determining the congener signature, which refers to the fraction of the mixture composed of each individual congener. Such comparisons have suggested that PCBs found in fish tissues from animals in Lake Tahoe are likely derived from atmospheric deposition as opposed to direct contamination (Datta et al., 1998). In lake environments, PCBs are likely to be sorbed to bed sediments and suspended solids, and are then ingested by fish. These compounds are lipophilic, meaning that they tend to accumulate in fatty tissue, leading to the bioaccumulation of PCBs in fatty tissues of organisms (including humans) (Geosyntec, 2013; Klasing and Brodberg, 2008).

Potential Sources

PCBs have been found in fish tissues in remote ecosystems, suggesting their capacity for long-range atmospheric transport, and have been found in air, snow pack, sediments and fish tissues as close to Donner Lake as Lake Tahoe (Daly and Wania, 2005; Klasing and Brodberg, 2008). Datta et. al (1998) even suggest that, based on in-depth analysis of the PCB signature in Lake Tahoe and comparison with lakes that are only influenced by atmospheric deposition, the primary source of PCBs to Lake Tahoe may be atmospheric deposition. Like many lakes in the northern Sierra Nevada, Donner Lake is likely also susceptible to atmospheric deposition of PCBs. Although many lakes may not have documented PCB contamination, this may be more a result of concentrations not yet exceeding limits of detection or reporting thresholds. Donner Lake's position near a lower elevation pass may also contribute to greater levels of deposition.

Because PCBs are still manufactured in the US (though in a very limited capacity), direct spills or leaks from the nearby roadways and railroad corridor are possible. Improper disposal of PCB-containing wastes and subsequent runoff into water bodies is another frequent source of contamination in industrial areas, but is possible in this watershed on a smaller scale. Erosion of previously contaminated sediments is possible as PCBs are persistent and may remain in sediments from earlier uses. Power transformers are one of the few currently approved uses of PCBs, so these could contribute to the PCB load in the lake and surrounding water bodies as well. Because PCBs are so persistent, some of the contamination could have originated a long time ago but still remains in lake sediments and biota.

Health Concerns

PCBs are known human health hazards, causing neurological, reproductive and developmental effects. They are also carcinogens and can be passed through breast milk and through the placenta (Klasing and Brodberg, 2008).

2.5.2 Chlordane

Chlordane, similar to PCBs, refers to a mixture of chemicals that is no longer in production, yet still occurs in the environment. Chlordane was used extensively as a pesticide on agricultural cropland, roadsides, lawns and soils from 1948 to 1988. The only approved use from 1983 through 1988 was subsurface application for termite control, after which time the manufacture and use of chlordane was banned (USDHHS, 1994). Introduction of chlordane to the environment from new sources is not expected, but runoff of historically contaminated soils and past atmospheric deposition are possible pathways leading to chlordane contamination. Similar to PCBs, chlordane is persistent, bioaccumulates, and is harmful to both aquatic organisms and humans (Klasing and Brodberg, 2008; EPA, 2000).

Chemical Properties

Chlordane is a mixture of many structurally similar organic, chlorinated compounds. It is very persistent and has been shown to remain in some soils for over 20 years (USDHHS, 1994). Due to its persistence and it moderate volatility (or ability to enter the gas phase from the liquid phase), it is susceptible to long-range atmospheric transport. Despite being semi-volatile, it is not likely to volatilize in an aquatic system with sediments or suspended solids present as it is more likely to be sorbed to the solids (which means partitioned into the organic phase of the sediments, in this case). Chlordane is also lipophilic, resulting in bioaccumulation in organisms and biomagnification in food webs (Klasing and Brodberg, 2008; USDHHS, 1994).

Potential Sources

In Donner Basin, chlordane was most likely used for termite control in residential development, and potentially as an insecticide along major roadways and railroad line. It is also possible that there are improperly disposed chlordane-containing pesticides in the watershed. Erosion of contaminated sediments and subsequent runoff into Donner Lake could have contributed to the chlordane load in the bed sediments. Due to its environmental persistence, the legacy chlordane is still present in the lake, and potentially in soils being transported into the lake, despite the lack of continued use. Long-range atmospheric transport could also bring chlordane from remote locations, such as the Central Valley, into Donner Basin (Datta et al., 1998; Ohyama, 1994; Daly, 2005).

Health Concerns

The most frequent pathway of human exposure to elevated chlordane levels is through consumption of contaminated fish, which is directly relevant to Donner Lake. Chlordane is toxic to humans, with the potential to cause neurotoxicity and liver damage, and has been shown to cause cancer in animal studies (Klasing and Broberg, 2008).

2.5.3 Arsenic

Arsenic is a naturally occurring element that is often present is rock formations and is introduced into water bodies due to weathering of these arsenic-containing minerals. Arsenic can also be introduced to aquatic systems through anthropogenic sources such as pesticides, the burning of fossil fuels and mining wastes. It has been detected in groundwater in many locations in California due to the native geology of the state (SWRCB, 2010). The toxic forms of arsenic are usually associated with minerals in the sediments of lake environments but their mobilization is dependent upon the water quality characteristics of the lake itself (Neff, 1997; Smedley and Kinniburgh, 2002; Oremland and Stolz, 2003). Similar to PCBs and chlordane, arsenic bioaccumulates in aquatic biota and is harmful to human health.

Chemical Properties

Arsenic has many organic and inorganic forms and undergoes various transformations in the environment, making it difficult to classify in complex environments. Arsenic primarily exists in aquatic systems in its inorganic forms, arsenate and arsenite. Arsenate is found in oxidizing environments and is more likely to be sorbed to or incorporated into minerals, while arsenite is found in reducing environments and is more mobile and toxic. Thus arsenic can be present in both the water column and the sediments of an aqueous system, with the distribution depending on factors including pH, alkalinity, salinity, biological activity and sediment composition (e.g., presences of clays with metal oxides) (Neff, 1997; Smedley and Kinniburgh, 2002). It can also be transported to aqueous systems either in the water or bound to sediments. Arsenic has been shown to bioaccumulate in fish, but there has been no evidence of biomagnification (ATSDR, 2007).

Potential Sources

Erosion of natural arsenic-containing minerals is a common contributor of arsenic to groundwater and is likely to be a source to Donner Lake. Other possible sources in this watershed include pesticide application, treated wood combustion, coal combustion and waste incineration with subsequent runoff of contaminated soils or atmospheric transport and deposition. Metal mining and smelting are well-known sources of arsenic, but these activities do not currently take place in this watershed and it is unknown if they were conducted historically.

Health Concerns

Diet is the most common route of exposure to arsenic for the majority of people exposed, and consumption of seafood contaminated with arsenic is a predominant source. Consumption of arsenic can cause circulatory problems, skin damage and increased risk of cancer in humans (ATSDR, 2007).

2.5.4 Mercury

Mercury is a naturally occurring metal that is found in rock formations, sediments, water and air around the world. It is also used in many products including batteries, paints, laboratory equipment, mercury-vapor lamps, dental products and is present a low levels in fossil fuels. The use of mercury in batteries and latex paints was among the highest uses and was banned in 1991 (Geosyntec, 2013). Like chlordane and PCBs, mercury is also susceptible to atmospheric transport and deposition, which results in remote ecosystems experiencing mercury contamination (Morel, 1998). Mercury is a common contaminant in fish tissues and consumption of fish is the primary route of human exposure to elevated mercury levels (Klasing and Brodberg, 2008).

Chemical Properties

Mercury is a metal that can be present in its elemental form, inorganic form or organic form. It is persistent in the environment and the form of mercury present in an aqueous system is dependent on the water quality conditions, including pH, alkalinity, temperature, suspended sediment load, and geomorphology. In anaerobic environments (those without oxygen), such as in bed sediments, mercury is transformed into methylmercury, the organic form which is highly toxic to humans. This is then bioaccumulated by fish and biomagnified as higher trophic levels accumulate the fraction of methylmercury from the organisms they consume (Klasing and Brodberg, 2008; Lim et. al, 2011; Geosyntec, 2013).

Potential Sources

In Donner Basin, erosion from residential and commercial construction could cause mercury-contaminated soils to be transported into the lake. Runoff from the road and railroad corridor and combustion of fossil fuels could also be contributing to the mercury load in the lake. Of particular consideration is the potential for long-range atmospheric transport of mercury from point sources in industrial areas, and subsequent deposition in and around Donner Lake. The amount of mercury in the atmosphere due to anthropogenic activities now comprises approximately two-thirds of the mercury in the atmosphere while naturally occurring mercury only makes up about one-third of the total (Morel, 1998). Deposition can contribute mercury directly to lake surface or to nearby sediments which are then transported into the lake. Atmospheric mercury is a significant source to remote water bodies around the world, but even urban watersheds like that of the San Francisco Bay consider the most important source of mercury to the water to be atmospheric deposition (Geosyntec, 2013; Morel, 1998).

Health Concerns

The primary target of toxicity for mercury exposure is the nervous system, thus it is toxic to all humans and especially to young children. It can cross both the placenta and the blood-brain barrier, directly affecting the brain and fetuses (Lim et. al, 2011; Klasing and Brodberg, 2008).

2.5.5 Sediment

Since 1992, the Middle Truckee River has been designated as impaired for excessive sediment on the Clean Water Act (CWA) 303(d) list by the SWRCB (Balance Hydrologics, 2014). As discussed in the preceding geomorphic section, monitoring efforts during water years 2011 to 2014 demonstrated that the Donner Basin is a significant source of suspended sediment loading to the Truckee River (Balance Hydrologics, 2014). Suspended sediment present in Donner Creek and its tributaries is generated by both upland and in-channel sources. The high suspended sediment loads in Donner Creek are indicative of alterations to basin-scale geomorphic processes as well as channel impacts, and have negative impacts on aquatic biota and downstream water bodies.

Physical and Chemical Properties

The sediment transported in stream channels can be subdivided into broad categories based on the physical mechanisms responsible for a particle's movement. Suspended sediment refers to sediment particles that are entrained in the water column and typically consist of fine particles the size of sand. Larger and more dense sediment particles are typically transported along the bed (called bed load) and move by rolling, hopping (saltation) or sliding. The smaller a sediment particle is in size, the greater its surface area is relative to its mass. This characteristic causes fine sediment particles to be particularly important for several reasons. The first is that fine sediment particles take far longer to settle out of suspension than larger sediment particles, often increasing their likelihood of being transported downstream and causing greater turbidity (or reduced water clarity). Another characteristic of fine sediment is its increased capacity to sorb and transport other water quality constituents of concern (depending on the sediment particle's composition) relative to its mass or size (e.g., a teaspoon worth of a very fine silt has a much greater collective surface area than a stone filling the same teaspoon).

Potential Sources

Sources of fine sediment in the Donner Basin are numerous and include both natural and anthropogenic causes. Erosion of hill slopes through rainfall and overland flow results in downstream transport of fine sediment to Donner Creek and its tributaries. This process is intensified by naturally-occurring processes (e.g., fire, natural hillslope failures, etc.) as well as anthropogenic disturbance (e.g., logging, unpaved road development, construction, etc.). Erosion of both natural and manmade drainage features also serves as a sediment source for the Donner Basin. Application of sand to roads and highways within the watershed also results in sediment loading. Additionally, the downstream transport of sediment stored within depositional bar features and sediment mobilized by bank erosion can release sediment into stream flow in Donner Creek and its tributaries.

Environmental Health Concerns

Excessive loading of fine sediment to stream, river and lake ecosystems results in a broad array of negative impacts to aquatic biota. Recent work performed along the Middle Truckee River demonstrates that increased deposition of fine sediment and sands on the river bed resulted in reduced biodiversity, population density and organism size in benthic macroinvertebrates (Herbst et. al, 2013). Declines in benthic macroinvertebrate populations in turn can undermine the health of aquatic food webs. Additionally, the presence and transport of large volumes of fine sediment can also provide a transport mechanism for a large array of toxic chemical and compounds that sorb to sediment (including many of those discussed above).

2.6 BIOLOGICAL RESOURCES

2.6.1 Plant Communities and Stream Environment Zones

Plant communities and stream environments in the Donner Basin watershed are described below. Plant communities in the Donner watershed were identified using the National Land Cover Dataset (NLCD) (Homer et al., 2012). Descriptions of plant communities in the watershed were developed based on professional experience with similar habitat types in the northern Sierra Nevada. Field surveys of the watershed for the purpose of describing plant communities were not included in the scope of the watershed assessment; therefore, no original data were collected to map these plant communities.

Plant communities were named according to Holland (1986) and Sawyer and Keeler-Wolfe (1995) rather than current vegetation community nomenclature (Sawyer et al. 2009). The Holland and Sawyer and Keeler-Wolfe classification systems were used because they do not require collection of fine-scale vegetation community and plant association data and because they are of appropriate detail to describe and analyze plant communities and the ecosystem functions and services provided by these communities within the context of a watershed assessment.

Stream environment zones were mapped in conjunction with plant communities to aid in assessing the current ecological condition and functions potentially provided by streams and meadows in the watershed. Maps of stream environment zones were prepared using aerial imagery and existing stream data.

Plant Communities

In Donner Basin, two land cover types and five plant communities were mapped in the NLCD. In some cases, the NLCD classification approximated the more detailed Holland and Sawyer and Keeler-Wolfe classifications (see below); however, in most cases, the NLCD classification encompassed multiple Holland and Sawyer and Keeler-Wolfe classes, some of which were not found in Donner Basin. The distribution of land cover types and plant communities in the basin is shown by Figure 52, and the primary characteristics of each land cover type or plant community are described below.

<u>Barren Land</u>

Barren land is characterized by bare rock, gravel, sand, silt, clay, or other earthen material with less than 15% vegetation cover. Vegetation, if present, is widely spaced and scrubby. Generally, these are areas of bedrock, talus, slides, volcanic material, glacial debris, and other accumulations of earthen material. In Donner Basin, exposed granitic bedrock and talus slopes occur primarily throughout the western and northwestern portions of the watershed. This land cover type also corresponds to the rock/barren habitat described below under “Stream Environment Zones.”

<u>Developed</u>

Developed areas are characterized by a high percentage (30% or greater) of constructed materials (e.g., asphalt, concrete, buildings) and include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes. In Donner Basin, developed areas include roadways, residential areas, and developed recreational areas (i.e., cabins, campgrounds) concentrated around Donner Lake and Donner Creek, both upstream and downstream of the lake.

<u>Emergent Herbaceous Wetland</u>

Emergent herbaceous wetlands are plant communities with seasonally to permanently saturated soils where at least 80% of the vegetation is dominated by perennial herbaceous vegetation. Emergent wetlands were historically more abundant in Donner Basin before the development of the Interstate 80 corridor; today, this important plant community occurs along undeveloped reaches of Donner Creek, Lakeview Canyon, Billy Mack Canyon, and Johnson Canyon, and along the southeast shores of Donner Lake. The greatest abundance of emergent herbaceous wetlands in Donner Basin is located in upper Billy Mack Canyon in association with small alpine lakes. This community type also corresponds to the montane meadow plant community described below under “Stream Environment Zones.”

<u>Evergreen Forest</u>

Evergreen forest is the most abundant land cover type in Donner Basin. Evergreen forests are plant communities with at least 25% tree cover and are dominated by trees generally greater than 20 feet tall.

Common evergreen tree species that are known or likely to occur in Donner Basin include lodgepole pine (*Pinus contorta ssp. murrayana*), red fir (*Abies magnifica*), white fir (*Abies concolor*), and Jeffrey pine (*Pinus jeffreyi*). At higher elevations, western white pine (*Pinus monticola*) also occurs intermixed with lodgepole pine and red fir.

Depending on topography, aspect, and tree canopy cover, the understory community of evergreen forests may be dominated by a variety of shrubs or herbaceous species; these plant communities are described separately below, under “Shrub/Scrub” and “Herbaceous.” Although not specifically mapped in NLCD dataset, this community type also includes scattered, small groves of quaking aspen (*Populus tremuloides*). Quaking aspen is relatively rare within Donner Basin, but small groves or stands of aspen occur along streams, seeps, and other wet areas that favor this species.

The evergreen forest plant community type includes mixed coniferous forest, which is described below under “Stream Environment Zones.”

<u>Herbaceous</u>

Herbaceous communities are characterized by less than 25% tree and shrub cover and a variety of perennial and annual grasses and forbs. Characteristic species in herbaceous communities are described under “Montane Meadow” in “Stream Environment Zones”; however, this community type as mapped in the NLCD also includes various rocky and dry upland areas, such as slopes and ridgelines, that may include species such as mule’s ear (*Wyethia sp*.), penstemon (*Penstemon spp*.), phacelia (*Phacelia spp*.), coyote mint (*Monardella spp*.), and buckwheat (*Eriogonum spp*.).

<u>Open Water</u>

Open water corresponds to lakes, ponds, and other aquatic habitats with less than 25% vegetation cover. Most open water habitat in Donner Basin is at Donner Lake, although dozens of small alpine lakes also represent this land cover type in the western and northwestern portions of the watershed. In addition, several artificial ponds located along lower Donner Creek, west and east of Cold Stream Road, are characterized as open water. This land cover type corresponds to the lacustrine habitat described below under “Stream Environment Zones.”

<u>Shrub/Scrub</u>

Shrub and scrub communities, as mapped in the NLCD, include both riparian and upland shrub and scrub plant communities with at least 20% canopy cover and dominated by woody plants less than 15 feet tall. In addition to shrubs, it includes early succession forests and trees stunted by environmental conditions. Common plants in upland shrublands include species in the following genera: Ceanothus, Arctostaphylos, Ribes, Cercocarpus, Prunus, Chrysolepis, Chrysothamnus, and Symphoricarpos, among others. In Donner Basin, this plant community is abundant north of Interstate 80, along Donner Ridge and in Johnson Canyon. Common species in riparian scrub and shrub communities are described in the next section, under “Montane Riparian Scrub.”

Stream Environment Zones

Three distinct plant communities and two habitats were mapped in the stream environments in Donner Basin. Each of these communities or habitats is briefly described below. Figure 52 shows the locations of these communities and habitats in the study area.

<u>Montane Riparian Scrub</u>

This community comprises low- to moderate-stature willow, primarily Lemmon's willow (*Salix lemmonii*) and arroyo willow (*Salix lasiolepis*). Montane riparian scrub occurs along Donner Creek and the various perennial and ephemeral stream courses flowing into Donner Lake, including Billie Mack Canyon, Johnson Canyon, and Lakeview Canyon. Willow cover can be dense, such as at the confluence of Donner Creek and the Truckee River, or open and sparse. Montane riparian scrub frequently intermixes with montane meadow and mixed coniferous forest communities, described below.

<u>Montane Meadow</u>

Montane meadows are located on lower landforms along the active stream channels of lower Donner Creek, in upper Billy Mack Canyon, and in Lakeview Canyon, where shallow summer groundwater is present. This community encompasses both mesic and wet environments dominated by perennial graminoids (i.e., grasses, sedges, and rushes) and forbs, with little bare ground. Shrubs and trees are not commonly found in this plant community. Characteristic species in mesic settings include Kentucky bluegrass (*Poa pratensis*), meadow barley (*Hordeum brachyatherum* ssp. *brachyatherum*), slender wheatgrass (*Elymus trachycaulus*), California oatgrass (*Danthonia californica*), Baltic rush (*Juncus balticus*), yarrow (*Achillea millefolium*), Parish's yampah (*Perideridia parishii*), mat muhly (*Muhlenbergia richardsonis*), lupine (*Lupinus* spp.), longstem clover (*Trifolium longipes*), California corn lily (*Veratrum californicum* var. *californicum*), and potentilla (*Potentilla* sp.), among other species. In wetter settings, such as stream courses and oxbows, the margins of lakes, and areas with shallow summer groundwater, many of these same species may be present but less commonly encountered. Dominant species in wetter settings are typically sedges, principally Nebraska sedge (*Carex nebraskensis*), inflated sedge (*Carex vesicaria*), beaked sedge (*Carex utriculata*), and short-beaked sedge (*Carex simulata*), and rushes, such as *Juncus nevadensis*, wood-rush (*Luzula comosa*), and bulrush (*Scirpus* spp.). Areas with persistent, shallow summer groundwater found at the margins of stream channels also may support a variety of perennial forbs such as western columbine (*Aquilegia formosa*), big leaf lupine (*Lupinus latifolius*), larkspur (*Delphinium* spp.), and California tiger lily (*Lilium pardalinum*).

<u>Mixed Coniferous Forest</u>

Mixed coniferous forests are found at the dry margins of perennial and intermittent streams, where the meadow and scrub communities transition into upland habitat. Lodgepole pine and white fir trees are found in this open-canopy plant community; individual trees range in size from small, pole-sized or sapling trees to large, mature trees. The understory is typically sparse and open and characterized by many of the species listed under "Montane Meadow." In Donner Basin, small stands of quaking aspen are included in this plant community type but are relatively sparse. Several dead and downed trees were observed at the margins of the montane meadow community located along the lower Donner Creek stream channel upstream of the Cold Stream Road crossing; these indicate that the plant community in the area may be in a successional stage from mixed coniferous forest to montane meadow.

<u>Lacustrine</u>
Although not typically considered a plant community, lacustrine habitat was mapped at Donner Lake and along perennial streams in Donner Basin. This is typically a deep to shallow, open water habitat. Floating aquatic plants such as pondweed (*Potamogeton* spp.) may be present in some areas, and shallow areas (e.g., areas less than 3 feet deep) at lake and pond margins can support various emergent aquatic plant species such as sedges, rushes, and bulrushes that are tolerant of prolonged, shallow inundation. Although not mapped in Figure 52, these marshy habitats are commonly found at the outlet of Donner Lake and the margins of the small alpine lakes in upper Billie Mack Canyon.

<u>Rock/Barren</u>
Like the lacustrine habitat, rock/barren habitats generally are not considered to be plant communities and are defined by a lack of significant plant cover. Rock/barren habitats are found along the perennial stream in upper Billie Mack Canyon and along various intermittent streams in Donner Basin, where granitic bedrock is exposed. Scattered, sparse annual forbs and occasional willows or lodgepole pines may occur in rock/barren habitats that are otherwise devoid of vegetation.

2.6.2 General Wildlife

This section provides an overview of general wildlife use in Donner Basin. The species discussed below were included based on (1) wildlife occurrence data obtained from the State of California Department of Parks and Recreation (State Parks) and Tahoe National Forest, which track the occurrence of species considered to be sensitive or of special importance to the region; (2) a review of prior watershed investigations; (3) recent focused bird surveys conducted in Donner Basin and surrounding watersheds (i.e., Coldstream Canyon); and (4) professional knowledge and prior experience regarding the wildlife that may be expected to be found in the region. Field surveys in Donner Basin for the purpose of documenting general wildlife use were not conducted as part of this assessment.

Mammals

Donner Basin comprises a mosaic of connected habitat types that provide foraging opportunities and sources of water for many mammal species. Upland forest and scrub habitats surrounding Donner Lake provide a suite of functional habitat values for mammals, including foraging, denning, and reproduction habitat, and cover. The following common species of mammals are either known to occur or are expected to occur in Donner Basin: American black bear (*Ursus americanus*), North American beaver (*Castor canadensis*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), long-tailed weasel (*Mustela frenata*), mountain lion (*Puma concolor*), Columbian black-tailed deer (*Odocoileus hemionus columbianus*), mule deer (*Odocoileus hemionus*), common porcupine (*Erethizon dorsatum*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), western spotted skunk (*Spilogale gracilis*), ground squirrels (*Spermophilus spp.*), chipmunks (*Neotamias* spp.), voles (*Arborimus* spp.), and yellow-bellied marmot (*Marmota flaviventris*).

North American beaver is known to be present in Donner Basin; the greatest concentration of beaver signs and activity occurs in Donner Creek, upstream of the Cold Stream Road crossing. Beaver activity in the watershed has increased over the past 15 years, and substantial dams and beaver-created ponds now occur within the creek. There is debate regarding the status of this beaver in the Sierra Nevada and whether the species is native to the region or intentionally introduced. Lindström (2012) conducted extensive archival and oral history research and could not determine whether historical beaver accounts by the Washoe Tribe and early non-Washoe settlers referred to the native Sierra Nevada mountain beaver (*Aplodontia rufa californica*), which is a relatively small fossorial animal that does not construct large dams, or to the North American beaver. Based on her research, Lindström (2012) concludes that beavers were not an important Native American game species and that there was not a historical fur trade in the area, despite extensive exploration of the Sierra Nevada by fur traders in the 1800s. She therefore postulates that North American beavers were likely not native to the Truckee/Donner area. Other studies have offered conflicting evidence, some supporting the long-held notion that North American beavers in the Upper Truckee River watershed were nonnative and intentionally introduced by the California Department of Fish and Game (CDFG) in the 1940s (Beier and Barrett 1989) and others maintaining that the North American beaver was native to the Sierra Nevada (Lanman et al. 2012, James and Lanman 2012) and locally extirpated in the 1800s. The status and distribution of the Sierra Nevada mountain beaver in the region is described in more detail below, under “Special-status Species.”

Habitat in Donner Basin supports deer migration and summer residence. Mule deer in the watershed belong to the Loyalton-Truckee Deer Herd unit (Kahre and Fowler. 1982). In general, this herd can be found during summer in the eastern Sierra Nevada from Lassen County south to Lake Tahoe, and during winter either south of the Truckee River along the Carson Range, or north of the Truckee River near Cold Springs, Nevada. The Donner Basin is located along the western edge of the herd’s summer range and represents important migratory and foraging habitat for the herd. Habitat is located primarily in upper Billie Mack Canyon, although deer will migrate through the watershed toward Martis Valley and the west shore of Lake Tahoe. The critical summer and winter ranges, fawning areas, transitional areas, and migratory corridors of the Loyalton-Truckee Deer Herd have been disrupted by fire, development, and barriers such as roads and highways. The herd has experienced historical declines as a result of residential development and reductions in early seral-stage habitat in Nevada and eastern Lassen County, and is currently stable or declining (California Department of Fish and Wildlife [CDFW] 2015).

Amphibians

Amphibians are most likely to occur near the various lakes, streams, meadows, and ponds in Donner Basin and surrounding watersheds. Common species expected to use these habitats for foraging and reproduction include Sierran chorus frog (*Pseudacris sierrae*), Sierra Nevada yellow-legged frog (*Rana sierrae*), and western toad (*Bufo boreas*); however, the presence of introduced, predatory fish such as rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), and eastern brook trout (*Salvelinus fontinalis*) in Donner Lake and its tributaries may reduce habitat suitability for these species. Small alpine lakes and ponds, as well as isolated stream pools (i.e., deep pools not connected by flowing surface water to the rest of the stream), may provide suitable amphibian habitats because they lack predatory fish.

Birds

Despite their relatively sparse distribution and sensitivity to disturbance, montane meadows in the Sierra Nevada play a crucial role in the life history and ecology of many Sierra Nevada bird species (Grinnell and Miller 1944, Orr and Moffitt 1971, Stewart 1977, Gregory et al. 1991, Gaines 1992, Morton 1992, Cicero 1997, Lynn et al. 1998, Bombay et al. 2003a, Cain and Morrison 2003, Heath and Ballard 2003, Borgmann 2010). The juxtaposition of water, herbaceous vegetation, and riparian shrubs create needed habitats for both the aquatic and terrestrial life stages of many insect species on which meadow birds prey (Erman 1984, Gray 1993, Erman 1996, Hatfield and LeBuhn 2007). In addition, Sierra Nevada meadows provide dense herbaceous cover for avian nesting, predator avoidance, and thermal cover as well as bountiful seed crops for granivorous birds in late summer and fall.

Although much of Donner Basin is owned and managed by the USFS and California State Parks, few formal bird surveys have been conducted in the watershed. Most recent survey efforts have focused on breeding populations of federally or State-listed species, such as the California-listed endangered willow flycatcher (*Empidonax traillii*). The documentation of other species is opportunistic in nature. Nonetheless, the bird community in the watershed has been documented during various survey efforts, and several uncommon species have been recorded. Common and migratory bird species that occur in Donner Basin include: Clark's grebe (*Aechmophorus clarkii*), great blue heron (*Ardea herodias*), great egret (*Ardea alba*), turkey vulture (*Cathartes aura*), Canada goose (*Branta canadensis*), mallard (*Anas platyrhynchos*), common merganser (*Mergus merganser*), Cooper's hawk (*Accipiter cooperii*), red-tailed hawk (*Buteo jamaicensis*), American coot (*Fulica americana*), killdeer (*Charadrius vociferus*), band-tailed pigeon (*Patagioenas fasciata*), mourning dove (*Zenaida macroura*), great horned owl (*Bubo virginianus*), common nighthawk (*Chordeiles minor*), Anna's hummingbird (*Calypte anna*), white-headed woodpecker (*Picoides albolarvatus*), northern flicker (*Colaptes auratus*), Steller's jay (*Cyanocitta stelleri*), Clark's nutcracker (*Nucifraga columbiana*), black-billed magpie (*Pica hudsonia*), common raven (*Corvus corax*), mountain chickadee (*Poecile gambeli*), pygmy nuthatch (*Sitta pygmaea*), brown creeper (*Certhia americana*), American dipper (*Cinclus mexicanus*), western bluebird (*Sialia mexicana*), American robin (*Turdus migratorius*), savannah sparrow (*Passerculus sandwichensis*), dark-eyed junco (*Junco hyemalis*), brown-headed cowbird (*Molothrus ater*), pine grosbeak (*Pinicola enucleator*), and evening grosbeak (*Coccothraustes vespertinus*).

The osprey (*Pandion haliaetus*) is a California Department of Forestry and Fire Protection sensitive species and is on CDFW's watch list; however, this species is not listed as a State or federal endangered or threatened species and is not a forest service sensitive species in the Tahoe National Forest. Osprey nests are protected under the Migratory Bird Treaty Act and the California Fish and Game Code. Ospreys typically nest within 1 mile of a large water body where fish and suitable foraging and nesting habitat (i.e., large trees or snags) are present. Nesting pairs of ospreys are known to occur in Donner Basin on the south shore of Donner Lake (CNDDB 2015). Donner Lake and undeveloped portions of the lakeshore provide high-quality spring/summer breeding habitat for the osprey. Smaller lakes in the Donner Basin watershed, such as Summit Lake, Flora Lake, and Azalea Lake in upper Billie Mack Canyon, may also provide foraging and nesting habitat for this species.

Fish

Moyle et al. (1996) identified four zoogeographic regions (drainages) in the Sierra Nevada, each defined by distinctive native fish communities that share few species in common. The Lahontan drainage, consisting of the Susan, Truckee, Carson, and Walker River drainages, is characterized by 10 native fish species, which are distributed widely throughout the drainage from the lowlands to elevations above 6,600 feet. Despite their widespread distribution in the surrounding region, it is probable, although not certain, that these fish are absent from the smaller alpine lakes located upstream of Donner Lake, because natural barriers to fish movement are situated between the upper reaches of Donner Basin and the lower reaches of the Truckee River system. Fish absence is typical in high-elevation eastern Sierra Nevada watersheds (La Rivers 1994, Moyle et al. 1996), and, before Euro-American settlement, nearly all Sierra Nevada lakes and streams were fishless above 6,000 feet (Knapp 1996). Common native fish species, such as Paiute sculpin (*Cottus beldingi*), speckled dace (*Rhinichthys osculus*), and mountain whitefish (*Prosopium williamsoni*), likely occur in Donner Lake and the lower, accessible stream reaches of the watershed.

Nonnative fish were introduced to historically fishless high-elevation lakes through private and government-sponsored programs beginning in the mid-1800s and continuing far into the 1900s (Knapp et al. 2001). Fish introduced to Donner Lake may have initially consisted of native species such as “trout and minnows” (Lindstrom 2012). Subsequent introductions included nonnative fish species, largely game fish, such as rainbow trout, eastern brook trout, brown trout, lake trout (*Salvelinus namaycush*), brown bullhead catfish (*Ameiurus nebulosus*), and common carp (*Cyprinus carpio*) (Lindström 2012); however, historical records do not always identify the fish species introduced. Nonnative species, particularly rainbow, brook, and lake trout, now represent the primary target species for anglers in Donner Lake and Donner Basin. Rainbow trout populations continue to be supplemented in the Truckee River by continued stocking by the Nevada Department of Wildlife with triploid (sterile) rainbow trout.

2.6.3 Special-Status Species

Special-status species include species listed as threatened or endangered under the California or federal Endangered Species Acts (CESA and ESA), as California species of special concern, as California fully protected species, or as Tahoe National Forest sensitive species. For plants, special-status species also include species assigned a California Rare Plant Rank by the California Native Plant Society (CNPS) (2015).

To identify special-status species potentially occurring in Donner Basin, the California Natural Diversity Database (CNDDB), a database of species observations maintained by CDFW, was queried to find records of all observations reported within 5 miles of Donner Lake (CDFW 2015). The CNDDB contains only records of species observations that are voluntarily submitted to CDFW; thus, a lack of recorded observations may indicate only a lack of survey effort and not necessarily a lack of special-status species occurrences. To supplement the CNDDB data, records of special-status species occurrences were obtained from the Tahoe National Forest, State Parks biologists, and CNPS’s online inventory of rare plants (CNPS 2015), which was queried for the Norden 7.5-minute U.S. Geological Survey (USGS) topographic quadrangle and the surrounding eight 7.5-minute quadrangles (Soda Springs, Webber Peak, Independence Lake, Hobart Mills, Truckee, Tahoe City, Granite Chief and Royal Gorge). Finally, based on professional experience and opinion, some special-status species were considered in this assessment to potentially occur in the basin, even if they were not otherwise documented as occurring in the areas by the above-referenced sources.

The distribution, ecology, life history, and potential for occurrence in Donner Basin for each of the identified species are summarized below. Each species' potential to occur was assessed based on queries of existing records and professional experience and opinion, and was rated as follows:

- Known to occur: the species has been documented to occur in Donner Basin
- Likely to occur: the species is known to occur within 5 miles of Donner Lake, and habitats in Donner Basin are suitable for the species
- May occur: the species is not known to occur within 5 miles of Donner Lake, but it does occur regionally, or habitats found in the watershed are marginally suitable for the species
- Unlikely to occur: the species is only rarely found regionally, it is restricted to particular habitat types (e.g., particular soil types or plant communities), or the habitats in Donner Basin are unsuitable for the species

All special-status species either known or likely to occur in Donner Basin are described in more detail below; a description of other species of potential management concern or species with some uncertainty regarding their presence in the watershed (e.g., Sierra Nevada red fox) are also included.

Plants

<u>Donner Pass buckwheat (*Eriogonum umbellatum* var. *torreyanum*)</u>

Donner Pass buckwheat (also known as Torrey's buckwheat) is a named variety of the ubiquitous sulphur buckwheat (*Eriogonum umbellatum*). It is a perennial shrub in the buckwheat family (Polygonaceae) that forms large, low mats roughly 4 to 12 inches high and up to 6 feet across (Urie 2000). Donner Pass buckwheat is found growing from roughly 7,200 to 8,200 feet in alpine and subalpine areas of patchy vegetation within conifer forests and scrub, on the east side of the Sierra Nevada crest near Donner Pass. Preferred soils are typically shallow and derived from andesitic rock. This species is usually found in areas of moderate slope, although it can be found in flatter areas with spare shrub and tree cover or, occasionally, on steep rocky slopes (Kan 1993, cited in Urie 2000). This species is known to occur in Donner Basin (CNDDB 2015), and additional populations are located within 5 miles of Donner Lake, near Donner Pass. The entire known distribution ranges from Webber Mountain in the north to Silver Peak (just north of Squaw Valley) in the south, and consists of 16 known populations (Urie 2000). Donner Pass buckwheat is on CRPR List 1B.2, indicating that it is rare, threatened, or endangered throughout its range and fairly endangered in California (CNPS 2015).

<u>Sub-alpine fireweed (*Epilobium howellii*)</u>

Subalpine fireweed (also known as Yuba Pass willowherb) is a wispy, perennial herb in the evening primrose family (Onagraceae), growing 3–8 inches high and spreading by short stolons. It is most commonly found growing in wet and boggy areas in the Sierra Nevada from roughly 6,600 to nearly 9,000 feet in elevation (Baldwin et al. 2012). Originally collected in 1975 along Yuba Pass (Taylor 2000), it has since been found in numerous locations throughout the Sierra Nevada (CNPS 2015) and is now known to occur in at least 23 different 7.5-minute USGS topographic quadrangles, ranging from Webber Peak in the north to areas in the Sierra National Forest east of Fresno (CNPS 2015) in the south. Sub-alpine fireweed is on CRPR List 4.3, the lowest rarity ranking, indicating that it is uncommon in California and not very endangered.

Starved daisy (*Erigeron miser*)

Starved daisy is a perennial, spreading herb in the sunflower family (Asteraceae) that grows up to 10 inches high. It is found on granitic, rocky slopes and crevices in the Sierra Nevada from roughly 6,000 to 9,000 feet in elevation (Baldwin et al. 2012). There are herbarium records for this species from seven counties: Mono, Butte, Nevada, Placer, Lassen, El Dorado, and Sierra (CCH 2012), and the CNDDB (2015) lists 23 observations of the species occurring in the central Sierra Nevada north to the Cascades. Starved daisy is known to grow in Donner Basin. Starved daisy is on CRPR List 1B.3, indicating that it is rare, threatened, or endangered throughout its range but not very endangered in California (CNPS 2015).

Mammals

California wolverine (*Gulo gulo leteus*)

The California wolverine was listed by the State in 1971 as threatened and is a California fully protected species. Additionally, it is a candidate for listing under the federal ESA and is a U.S. Forest Service sensitive species. It is a scarce resident of the North Coast and Sierra Nevada. In the northern Sierra Nevada, it inhabits mixed conifer, red fir, and lodgepole habitats and probably uses subalpine conifer, alpine dwarf-shrub, wet meadow, and montane chaparral habitats with an elevational range of 4,300 to 7,300 feet (Johnson 1990). The wolverine feeds primarily on small mammals and carrion (Grinnell et al. 1937, Ingles 1965, Hornocker and Hash 1981, Krott 1982), but other prey includes marmots, ground squirrels, gophers, mice, other vertebrates, deer carcasses, berries, and insects. The wolverine hunts in relatively open areas, but uses dense cover for resting and reproduction. Daily movements recorded in Montana indicated that this species can range between 3.1 and 81 miles (Hornocker and Hash 1981). A single individual of this species is known to occur in the region based on a series of photos taken in the Tahoe National Forest between March 16 and 19, 2008, by a remote sensor camera (Moriarty et. al. 2009), and additional unpublished sightings, also recorded by remote sensor camera, occurred in or near the Donner Basin watershed in December and February 2009, in January 2010, and November 2015 (Associated Press).

Pacific fisher (*Martes pennanti*)

The Pacific fisher is a California species of special concern and a USFS sensitive species. Fishers occur in habitats that are dominated by conifers and contain variable amounts of hardwood forest (Buskirk and Powell 1994). They select old-growth and late-seral conifer forests that provide closed canopies and a complex forest floor structure (Buskirk and Powell 1994). Fishers are associated with riparian habitats and often occur close to (i.e., within 1,500 feet of) open water (Buskirk and Powell 1994, Self and Kerns 2001). They also have been reported to use brushy or open-forest areas (Self and Kerns 2001). Such high-brush-groundcover, open-forest condition is relatively common in some portions of lower-elevation California forests, particularly in areas that receive high rainfall. Fishers occur at elevations of 4,000 to 8,000 feet in the Sierra Nevada (Freel and Stewart 1991, U.S. Department of the Interior 2006). They are opportunistic foragers and feed on a variety of food items including small mammals, birds and their eggs, ungulate carrion, insects, fruits, nuts, and vegetation (Powell 1981). The Pacific fisher is likely to occur in Donner Basin.

Sierra marten (*Martes americana sierrae*)

The Sierra marten is a USFS sensitive species. It is a subspecies of American marten with an elevational range of 3,400 to 10,400 feet (Freel and Stewart 1991), and is found throughout much of its historical range, from Trinity and Siskiyou Counties east to Mount Shasta, south through the Cascades and Sierra Nevada to Tulare County (Grinnell et al. 1937, Kucera et al. 1996, Zielinski et al. 2001). Mesocarnivore surveys conducted in the forests of the Sierra Nevada from 1996 to 2002 reported Sierra martens in Amador, Calaveras, El Dorado, Fresno, Lassen, Madera, Mariposa, Placer, Plumas, Shasta, Sierra, Tehama, Tulare, and Tuolumne Counties (Zielinksi et al. 2005). In the Sierra Nevada, martens prefer old-growth fir forests and high-elevation riparian lodgepole pine associations (Spencer et al. 1983). American martens are considered to be uncommon and are known to occur in very low densities (Buskirk and Ruggiero 1994). They are omnivores that eat a variety of different foods, including small mammals, vegetation (fruits, berries, nuts, fungi, lichens, grass, conifer needles, leaves, twigs, and bark), birds, fish, insects, and carrion (Martin 1994). This species is likely to occur in Donner Basin.

Sierra Nevada mountain beaver (*Aplodontia rufa californica*)

The Sierra Nevada mountain beaver is one of six subspecies of mountain beaver occurring in California (Hall 1981) and is designated a California species of special concern. It is uncommon throughout its range and appears to have a scattered distribution in montane riparian habitats in the Sierra Nevada. This species frequents open habitats and habitats with intermediate-canopy cover in riparian-deciduous vegetation with a dense understory near water. These beavers feed on plants, specifically lupines, willows, grasses, thimbleberry (Polite 1990), conifers, and deciduous trees (Voth 1968). Mountain beavers breed from December through March, producing one litter of two or three young per year. They burrow in deep, friable soils in dense thickets near streams. Moles (*Scapanus* spp.), pygmy shrews (*Sorex hoyi*), snowshoe hares (*Lepus americanus*), brush rabbits (*Sylvilagus bachmani*), deer mice (*Peromyscus maniculatus*), American minks (*Mustela vison*), long-tailed weasels (*Mustela frenata*), and Western spotted skunks (*Spilogale gracilis*) use mountain beaver burrows (Maser et al. 1981). Predators include bobcat (*Lynx rufus*), long-tailed weasels, American minks, coyotes (*Canis latrans*) and great-horned owls (Polite 1990). Based on historical research and oral history accounts, Lindström (2012) determined that mountain beaver may have occurred in the Truckee River watershed. This subspecies is known to occur in the Tahoe Basin in Washoe and Douglas Counties and in Coldstream Canyon (Richardson pers. comm.2015). There is suitable habitat in the watershed and several documented populations occur within 5 miles of the watershed boundary (CNDDB 2015); therefore, this species is likely to occur in Donner Basin.

Sierra Nevada red fox (*Vulpes vulpes necator*)

The Sierra Nevada red fox was State-listed as threatened in 1980. It is one of several recognized North American subspecies of *Vulpes vulpes* (Hall 1981). CDFW uses location and elevation to preliminarily distinguish this subspecies from other subspecies of red fox, because it has no distinctive visible characteristics (Lewis et al. 1993, Perrine et al. 2007). Genetic analysis is required to conclusively determine the subspecies to which an observed red fox belongs. The Sierra Nevada red fox occurs at elevations from 4,500 to 11,500 feet, but is most commonly found above 7,000 feet (Aubry 1997) in the Cascades and Sierra Nevada. The fox inhabits various habitats in alpine and subalpine zones; its preferred habitats are red fir and lodgepole pine forests. These foxes hunt in forest openings, meadows, and barren, rocky areas (CDFW 1991). They mate in February, gestation is just over 50 days, and pups are born in late March to early April (Aubry 1997). Available data indicate that true Sierra Nevada red foxes are found in California in limited areas around Lassen National Park and an area around Sonora Pass and the northern part of Yosemite National Park (USFWS 2015). The CNDDB contains historic red fox observations within 5 miles of the watershed boundary (CNDDB 2015), but these observations have not been verified using genetic analysis. Because the authenticity of these observations cannot be verified and the best available scientific information does not support inclusion of the Donner Basin in the current range for this species (USFWS 2015), this species is unlikely to occur in the Donner Basin.)

Sierra Nevada snowshoe hare (*Lepus americanus tahoensis*)

Both subspecies of snowshoe hare that are found in California are California species of special concern (Williams 1986). In California, the Sierra Nevada snowshoe hare is found primarily in montane riparian habitats with thickets of alders and willows and in stands of young conifers interspersed with chaparral (Hoefler and Duke 1990). The early seral stages of mixed conifer, subalpine conifer, red fir, Jeffrey pine, lodgepole pine, and aspen are likely habitats, especially along edges and near meadows (Orr 1940, Ingles 1965). In the summer, this hare’s diet consists of grasses, forbs, sedges, and low shrubs (Hoefler and Duke 1990). The needles and bark of conifers and the leaves and green twigs of willows and alders are eaten in the winter (Wolff 1980). Bobcats, long-tailed weasels, red foxes, coyotes, and great horned owls are the main predators of snowshoe hares. Snowshoe hares are considered likely to occur in Donner Basin based on records of occurrence from within 5 miles of the basin boundary (CNDDB 2015).

Pallid bat (*Antrozous pallidus*)

The pallid bat is a California species of special concern and a USFS sensitive species. It occurs throughout California with the exception of the northwest corner of the state and the high Sierra Nevada (Hall 1981, Harris 1990). This bat is colonial, with colonies ranging in size from a few individuals to more than a hundred, but usually consisting of at least 20 individuals (Wilson and Ruff 1999, Sherwin and Rambaldini 2005). Pallid bats are most commonly found in oak savannas and in open, dry habitats with rocky areas, trees, buildings, or bridge structures, which are used for roosting (Harris 1990, Ferguson and Azerrad 2004). Typically, pallid bats use separate day and night roosts (Hermanson and O’Shea 1983). In general, day roosts are more enclosed, protected spaces than are night roosts, which often occur in open buildings, porches, garages, highway bridges, and mines. Roosts generally have unobstructed entrances/exits and are high above the ground, warm, and inaccessible to terrestrial predators (Sherwin and Rambaldini 2005). Pallid bats do not migrate long distances between summer and winter sites (Johnston et al. 2006). After mating during late fall and winter, females and males share a common wintering roost, usually along a canyon bottom where temperatures are relatively stable and cool. Females leave the common winter roost in early spring to form maternity colonies, often on ridge tops or other warmer locales (Johnston et al. 2006). Maternity colonies in California may be active from May to October (Gannon 2003). Pallid bats forage on a variety of insects, including beetles, centipedes, cicadas, crickets, grasshoppers, moths, and others, both gleaned from surfaces and taken aerially (Johnston and Fenton 2001). Their roosts are highly susceptible to human disturbance, and urban development has been cited as the most significant factor contributing to their regional decline (Miner and Stokes 2005). This species is likely to occur in the Donner Basin watershed.

<u>Townsend's big-eared bat (*Corynorhinus townsendii*)</u>

Townsend's big-eared bat a California species of special concern and a USFS sensitive species. The bat is associated with a variety of habitat types, including coniferous forests, deserts, native prairies, riparian communities, active agricultural areas, and coastal habitats (Sherwin and Piaggio 2005). The distribution of the species is strongly correlated with the availability of roosting habitat and the absence of human disturbance at roost sites (Pierson and Rainey 1998a, Sherwin and Piaggio 2005). Like the pallid bat, the Townsend's big-eared bat is a colonial species. Pierson and Rainey (1998a) identified 39 active Townsend's big-eared bat maternity colonies and 55 maternity roost sites scattered throughout California. Females aggregate in the spring at maternity colonies to begin their breeding season, and the colonies may be active from March to September in California (Pierson and Rainey 1998a). Females typically give birth to one pup, and both females and their young show high fidelity to their group and their specific roost site (Pearson et al. 1952). The Townsend's big-eared bat is easily disturbed while roosting in buildings; females are known to abandon their young when disturbed (Humphrey and Kunz 1976). They forage primarily on small moths, and feed both aerially and by gleaning insects from foliage (Harris 2000). This species is likely to occur in Donner Basin.

Amphibians and Reptiles

<u>Sierra Nevada yellow-legged frog (*Rana sierra*)</u>

The Sierra Nevada yellow-legged frog was State-listed as threatened in February 2012 and federally listed as threatened in 2014, and is a U.S. Forest Service sensitive species. This species occurs in the Sierra Nevada from Plumas County to Fresno County, and is associated with streams, lakes, and ponds in montane riparian, lodgepole pine, subalpine conifer, and wet meadow habitats. This aquatic species is always encountered within a few feet of water. Reproduction does not take place until lakes and streams are free of ice. Tadpoles may require up to two overwintering periods to complete their aquatic development (Cory 1962). During winter, adults hibernate beneath ice-covered streams, lakes, and ponds. These frogs feed primarily on aquatic and terrestrial invertebrates and favor terrestrial insects. Adults and tadpoles are commonly preyed upon by garter snakes and introduced trout, such as brook trout (Cory 1963, Zweifel 1968). This species is likely to occur in the lakes, ponds, and streams in upper Donner Basin, where suitable habitats lack predatory fish. However, lakes and stream reaches with significant trout populations, such as Donner Lake and Donner Creek below the dam, are not likely to provide suitable habitat for this species.

Birds

American white pelican (*Pelecanus erythrorhynchos*)

The American white pelican is a California species of special concern. It breeds on protected islands and peninsulas at lakes and marshes in northeastern California as far south as Lake Tahoe (Shuford 2005, Shuford 2008a). These birds use ground nests or floating masses of vegetation and often nest colonially with other species from March through July. They also travel long distances to forage during the breeding season, and some nonbreeding individuals spend the entire summer at good foraging sites (Knopf and Kennedy 1980, Shuford 2005). American white pelicans are occasionally seen foraging at Donner Lake and Lake Tahoe.

Bald eagle (*Haliaeetus leucocephalus*)

The bald eagle was federally listed as endangered in 1967 and State-listed as endangered in 1971. The U.S. Fish and Wildlife Service (USFWS) removed the bald eagle from its list of threatened and endangered species in 2007, but it remains a State-listed endangered and fully protected species. It is also a USFS sensitive species. California's breeding population of bald eagles is resident year-round in areas with a relatively mild climate; breeding sites are distributed across all national forests in the Sierra Nevada. Between mid-October and December, migratory individuals from areas north and northeast of the state arrive in California as well. Wintering populations remain in California through March or early April. Nesting territories are normally associated with lakes, reservoirs, rivers, or large streams (Lehman 1979). Bald eagle nests are usually located in uneven-aged (multistoried) stands of trees with old-growth components (Anthony et al. 1982). Most nests in California are located in predominantly coniferous stands. Factors such as relative tree height, diameter, species, position relative to topography, distance from water, and distance from disturbance also appear to influence nest site selection (Lehman et al. 1980, Anthony and Isaacs 1981). Trees selected for nesting are characteristically among the largest in the stand or at least codominant with the overstory. Nest trees usually provide an unobstructed view of the associated water body and often are prominently located on the landscape. Live, mature trees with deformed tops occasionally are selected for nesting. Bald eagles often construct several nests within a territory and alternate between them from year to year. Up to five alternative nests may be constructed in a single territory (USFWS 1986). The most common food sources for bald eagles are fish, waterfowl, jackrabbits, and various types of carrion (USFWS 1986). Because fish and waterfowl are abundant in Donner Lake and the surrounding watershed, these areas provide high-quality habitat for bald eagles. This species is known to occur in the Donner Basin watershed; bald eagles have been documented to nest on the south shore of Donner Lake on a relatively continual basis (D. Shaw pers. comm.).

Northern goshawk (*Accipiter gentilis*)

The northern goshawk is a California species of special concern and a USFS sensitive species. This species nests and forages primarily in mature montane coniferous forests with large-diameter trees and relatively closed canopies. It sometimes nests and forages in mature aspen stands and will frequently forage along meadow edges or in aspen/willow shrub communities (Keane 2008). Primary prey are songbirds, squirrels, and other small mammals. USFS records show that this species nests in multiple forested locations in the Donner Basin watershed. The Tahoe National Forest currently manages three protected activity centers (PACs) for northern goshawk in the watershed and south of Donner Lake.

Extensive suitable habitat also occurs on the south side of Donner Lake; however, recent data on nesting activity is lacking for this area.

Yellow rail (*Coturnicops noveboracensis*)

The yellow rail is a California species of special concern. It breeds in sedge marshes and wet meadows with shallow, standing water or moist soil in coastal California, northeastern California, and the eastern Sierra Nevada (Sterling 2008). Very little is known about this species, especially in montane meadow and marsh settings in the Sierra Nevada, but these birds were historically found in similar settings in Bridgeport Valley, and recently have been found in the vicinity of Mount Shasta in Siskiyou County and in Modoc County. Occupied sites are generally bordered by coniferous forest and are seasonally flooded from 1 to 12 inches in depth. The yellow rail has not been reported to occur in the Donner Basin, but without targeted surveys for this secretive species, absence cannot be assumed, especially given the presence of other breeding rail species. Therefore, this species may occur in Donner Basin.

Black tern (*Chlidonias niger*)

The black tern is a California species of special concern. This species is a semicolonial bird historically found in freshwater marshes of central and northeastern California and eastern Sierra Nevada valleys. The species currently is found in greatest abundance in northeastern California, with a smaller population in select Central Valley locations. In the Sierra Nevada, the southernmost locations documented in the literature are in the Sierra Valley and in Kyburz Flat. Semicolonial nests are built on floating masses of vegetation that are typically anchored to (or lodged in) emergent vegetation or beds of submerged aquatic plants. Most breeding sites are dominated by low emergent vegetation (usually less than 3.3 feet tall), most often spikerush (*Eleocharis* ssp.). Sometimes yellow pond lily (*Nuphar lutea*), smartweed (*Polygonum* ssp.), or bullrush is used in nesting (Orr and Moffitt 1971, Shuford 2008b). Nests are typically located over water 10 to 36 inches deep, and are sometimes found in abandoned grebe nests, on floating logs, on plant debris, or on small earthen hummocks (Orr and Moffitt 1971, Shuford 2008b). This species is primarily insectivorous in California, but in some locales fish may play an important role in the species' diet. Black tern is likely to occur in Donner Basin.

California spotted owl (*Strix occidentalis occidental*)

The California spotted owl is a California species of special concern. It is a subspecies of the spotted owl (*Strix occidentalis*) that occurs only in California. This owl is found on the western side of the Sierra Nevada and very locally on the eastern slope, from Shasta County south through the Sierra Nevada to Kern County, as well as in the Coastal Ranges from Monterey County south to Baja California (Verner et al. 1992, Gutierrez et al. 1995). California spotted owls occur in a wide variety of habitats; however, individuals at high elevations in the Sierra Nevada prefer habitats dominated by conifers (Gutierrez et al. 1995). This subspecies is strongly associated with forests that have a complex, multilayered structure, dense canopies, and large-diameter trees (Verner et al. 1992, Gutierrez et al. 1995, USFWS 2006, U.S. Forest Service 2008). In the Sierra Nevada, approximately 80% of known sites are found in mixed-fir conifer forests (U.S. Forest Service, 2001). The species is sensitive to disturbance and requires several hundred acres of mature forest for breeding (Beedy and Granholm 1985). Large trees (greater than 35.4 inches in diameter at breast height) are essential for nesting and roosting habitat, whereas foraging habitat is more variable and includes both intermediate and old-growth forests (Gutierrez et al. 1995).

California spotted owls do not construct their own nests, but use existing nest structures or cavities in the hollows of trees. The breeding season for California spotted owls extends from mid-February to mid-October (U.S. Forest Service, 2008). This species is known occur in Donner Basin. The Tahoe National Forest currently manages three PACs for spotted owls in the Coldstream Canyon subwatershed to the south of Donner Lake.

Great gray owl (*Strix nebulosa*)

The great gray owl is a State-listed endangered species and a USFS sensitive species. The Sierra Nevada population is the southernmost population in North America. Great gray owls in the Sierra Nevada primarily use meadows for foraging, and nest locations are almost all within 600 feet of a meadow edge. Evidence in the Yosemite region suggests that great grey owls need meadows at least 25 acres in size to support persistent occupancy and reproduction (Winter 1986) but meadows as small as 10 acres can support infrequent breeding. The highly restricted range of the Sierra Nevada great gray owl population and its apparent genetic differentiation from great gray owls elsewhere (Hull et al. 2010) indicate an isolated and at-risk population (Beck and Winter 2000). Most known breeding locations are located at elevations between 2,500 and 8,000 feet (CNDDB 2015). This species is likely to occur in Donner Basin.

Long-eared owl (*Asio otus*)

The long-eared owl is a California species of special concern that breeds in coniferous and broad-leaved woodlands bordering marshes, meadows, and riparian areas. Although the species is distributed across much of the state, its stronghold in California is thought to be in northeastern California and the Sierra Nevada and Cascades (Hunting 2008). The USFS database includes one observation of the long-eared owl near Bonta Creek north of the watershed (A. Kula pers. comm.). This species is likely to occur in Donner Basin.

Black-backed woodpecker (*Picoides arcticus*)

The black-backed woodpecker became a candidate for listing under CESA on January 6, 2012. This bird is an uncommon, year-round resident with an elevation range of 6,000–9,500 feet (Grinnell and Miller 1944). It is predominantly found in montane coniferous forests, especially fir and lodgepole pine forests (Grinnell and Miller 1944). The black-backed woodpecker is associated with and attracted to forest stands with wood-boring insect infestations, including burns and windfall areas, where the bird flakes away bark or drills into trunks of conifers to obtain larval and adult insects, mostly wood-boring beetles. Although most individuals are probably year-round residents of the same locations, some downslope movement may occur in winter (Gaines 1977), and these birds may follow insect infestations of dead trees. They prefer relatively large trees for foraging and nesting, and canopy cover may range from sparse to dense (Short 1974). In California, this species excavates nesting cavities in the trunks of living conifers or snags (Raphael and White 1984). This species is likely to occur in Donner Basin, but there are no confirmed records of it breeding in the basin.

Willow flycatcher (*Empidonax traillii*)

Two subspecies of willow flycatcher regularly occur in the northern Sierra Nevada. *E. t. adastus* and *E. t. brewsterii* are found along the east and west slopes (respectively) of the Sierra Nevada and southern Cascades (Unitt et al. 2003). Analyses of DNA and song recordings from willow flycatchers breeding in the northern Sierra Nevada failed to successfully differentiate between the *E.t. adastus* and *E. t. brewsterii* subspecies; as such, these birds are considered to be intergrades between the two subspecies (Paxton 2000, Sedgwick 2001). Both subspecies are State-listed as endangered and are USFS sensitive species.

Anecdotal and demographic studies indicate a dramatic decline in the Sierra Nevada willow flycatcher population since the 1920s, when this species was considered locally common in riparian areas (Ray 1903, Orr and Moffitt 1971, Gaines 1992). These regional declines, as well as local extirpations from most southern Sierra Nevada locations, have been well documented since 1980 (Harris et al. 1987, Bombay et al. 2003a, Siegel et al. 2008, Mathewson 2010). Ten years of willow flycatcher population monitoring during the 1990s and 2000s indicated 17% annual declines in the area immediately south of Lake Tahoe, 6% annual declines in the northern Sierra Nevada, and 1% declines along the Cascades/Sierra Nevada interface (Mathewson et al. in press). With few exceptions, sites in the region that consistently support more than three territories annually are restricted to the northern Sierra Nevada and southern Cascades (Mathewson et al. in press). A few clusters of meadows that are still occasionally occupied by willow flycatchers persist in areas south of Lake Tahoe, primarily in Alpine County on the east side of the Sierra Nevada (Mathewson 2010). Additional, more isolated breeding sites are located near Mono Lake and in the East Carson and Walker River watersheds (McCreedy and Heath 2004). Sites that supported multiple territories along the west slope in the vicinity of the Sierra and Stanislaus National Forests and Yosemite National Park during the 1980s and early 1990s have remained unoccupied for many years, and they are presumed to have been extirpated (Green et al. 2003, Siegel et al. 2008).

In the Sierra Nevada, willow flycatchers breed almost exclusively in willow-dominated, wet montane meadows. These birds occupy sites with extensive stands of shrubby willows, mixed with alders and other deciduous shrubs at least 6 feet in height. With few exceptions, the species is associated with two types of meadow settings: riparian meadows, where water fills backwater oxbows or beaver ponds, and discharge slope meadows, where water sheets across the surface in spring-fed areas (Bombay et al. 2003a, 2003b; Green et al. 2003; Mathewson 2010). In fact, many of the largest meadows occupied by willow flycatchers contain both of these hydrologic characteristics. Most meadows occupied by willow flycatchers have at least some surface water that persists throughout the summer and a vegetation community that thrives in saturated or flooded conditions. Large floodplain meadow systems, such as those found at Perazzo Meadows in Sierra County and in Warner Creek in Lassen County, currently support the greatest densities of willow flycatchers (Humple and Burnett 2004, Mathewson 2010). Willow flycatchers are known to occur in the Donner Basin watershed and along the Truckee River to the east of the watershed boundary (CNDDB 2015).

<u>Vaux's swift (*Chaetura vauxi*)</u>

The Vaux's swift is a California species of special concern. It is primarily known to occur in the coastal redwood forests, but is documented as breeding in small numbers in northeastern California and on the west slope of the Sierra Nevada. The species nests in hollow trees or snags or in old chimneys, which it also uses for night roosts (Hunter 2008). Vaux's swifts forage over many habitats, but especially open water and wetlands, up to 3 miles from their nest sites (Hunter 2008). They also are found in these habitats during migration. Vaux's swifts are likely to occur in Donner Basin.

Yellow warbler (*Dendroica petechia*)

The yellow warbler is a California species of special concern that breeds in riparian woodlands and shrublands across much of California, excepting the Central Valley, deserts, and the higher elevations of the west slope of the Sierra Nevada. The species is found in some of its greatest numbers in willow-dominated wet meadows of northeastern California and the east slope of the Sierra Nevada (Heath 2008). Suitable habitat in the Donner Basin is found along Donner Creek near the confluence with the Truckee River and in upper Billie Mack Canyon. This species is known to occur in Donner Basin.

Yellow-headed blackbird (*Xanthocephalus xanthocephalus*)

The yellow-headed blackbird is a California species of special concern. It is locally common in marshes found in large mountain valleys of northeastern California and the eastern Sierra Nevada (Jaramillo 2008). This species nests in tall, emergent vegetation over relatively deep water. Typically, nests are found in cattails (*Typha* spp.), bullrush, or spikerush. Yellow-headed blackbirds are likely to occur in Donner Basin.

Fish

Lahontan cutthroat trout (*Oncorhynchus clarkii henshawi*)

The Lahontan cutthroat trout is federally listed as threatened. This fish occurs in inland lakes and rivers of the Lahontan Basin, including the greater Truckee River watershed from Lake Tahoe downstream to Pyramid Lake (USFWS 2003). This trout generally occurs in cool, flowing water with available cover and adequate spawning gravels and in large lakes or reservoirs, where males reach sexual maturity in 2 to 3 years and females reach sexual maturity in 3 to 4 years. Lahontan cutthroat trout are stream spawners, generally spawning from February to July depending on streamflow, elevation, and water temperature. Self-sustaining populations of this species occur in approximately 11% of its historical stream habitats and less than 1% of historical lake habitats (USFWS 2005).

Although Donner Lake once supported a viable population of lacustrine Lahontan cutthroat trout, historical introductions of nonnative trout species and pressures from overfishing and development have reduced or eliminated this species from the Donner Basin watershed (USFWS 2005). Recent recovery efforts in nearby watersheds, such as Independence Lake and the Little Truckee River, as well as the reintroduction of the Pilot Peak strain of cutthroat trout to Pyramid Lake, have increased the likelihood that this species may migrate to Donner Creek and Donner Lake from the Truckee River. However, the continued presence of nonnative species, and physical barriers to fish passage, such as the dam at the Donner Lake outlet, severely reduce the quality of spawning and rearing habitat in the Donner Basin watershed. Future recovery efforts in the basin should consider the utility of existing fish passage barriers to fisheries management and the presence of nonnative salmonid species.

2.6.4 Invasive Species

Invasive species are species of plants, vertebrates, and invertebrates that may adversely affect aquatic and terrestrial ecosystems, as well as species of terrestrial plants considered to be capable of producing adverse economic or ecological effects (i.e., weeds). Invasive species typically affect ecosystems by outcompeting native species for food and resources (e.g., space, light) or by otherwise altering ecosystem processes such as nutrient cycling, primary or secondary productivity, and wildfire frequency and intensity, among many others (Bossard et al. 2000, U.S. Army Corps of Engineers [USACE] 2009). Invasive species that are known to occur or that could occur in the Donner Basin are briefly described below.

Asian clam (*Corbicula fluminea*) is a small (less than 1.5 inches wide) freshwater aquatic mollusk that poses significant ecologic and economic threats to water bodies and communities in the Sierra Nevada (USACE 2009). Once established, this invasive species can rapidly reproduce and spread, often reaching densities of greater than 500 individuals per square foot. Asian clam was first introduced to the West Coast of the United States in 1938 and today has spread to more than 40 states, where it has invaded lakes, reservoirs, rivers, and small streams. The clam typically occurs in sandy substrates in quiet and sunlit waters. Asian clams can alter the ecology and physical characteristics of the environment by filtering out important food sources for native invertebrates, depositing massive amounts of dead shells, and increasing local concentrations of calcium. These impacts reduce the abundance and diversity of native aquatic insects, such as stoneflies and mayflies, which provide an important food source for fish and amphibians. In the Donner Basin watershed, Asian clams have been documented at the Donner Lake outlet and in Donner Creek downstream to the State Park property boundary (Figure 53). Live Asian clams and accumulated dead shells were observed in Donner Creek as far downstream as the Cold Stream Road crossing during surveys conducted for this watershed assessment in June and August 2015, although no focused surveys for invasive species have been conducted for the purpose of this watershed assessment. Based on these observations, it is likely that this invasive species was first introduced in Donner Lake near the creek outlet, has spread downstream to the observed extent, and will continue to spread downstream in the future.

New Zealand mudsnail (*Potamopyrgus antipodarum*) is also a freshwater mollusk that poses significant ecologic and economic threats to streams and rivers in California and Nevada. These mudsnails are readily transported on boots, equipment, rafts, and other watercraft and can survive out of water for several days. As recently as 2012, New Zealand mudsnail was detected in the Truckee River by the Nevada Department of Fish and Game. The distribution of this invasive species in the Truckee River appears to extend from Mayberry Crossing, near Verdi, to downstream of Reno at least as far as Lockwood. Although the snail has not been detected in or in close proximity to the Donner Basin watershed, the presence of this species in the Truckee River presents a significant threat to the watershed, as private vehicles transporting contaminated equipment or rafts could travel from an infested site to the Donner Basin in less than 30 minutes.

Signal crayfish (*Pacifastacus leniusculus*) is a freshwater crustacean that can have significant ecologic effects on streams and rivers in the western United States. This species was intentionally introduced to lakes, rivers, and reservoirs of the Sierra Nevada to increase fish production and was most likely introduced to Donner Lake during the late 1800's and early 1900's. Today, crayfish are present throughout accessible portions of the system and are abundant in both Donner Lake and Donner Creek. This species has the potential to affect the flow of energy and nutrients in the watershed, which can have positive and negative impacts on both algal production and benthic invertebrate production and diversity (Caldwell and Chandra 2015). At high densities, crayfish can potentially over-graze periphyton, reducing food for benthic invertebrates. Additionally, crayfish excretion may be a significant source of nitrogen to Donner Lake (Caldwell and Chandra 2015). Although the overall role of introduced crayfish in benthic primary production is still not well understood, the presence of this species in the watershed may have a significant impact on both water quality and ecologic factors, such as lake clarity and productivity.

Eurasian watermilfoil (*Myriophyllum spicatum*) and **curly-leaf pondweed (*Potamogeton crispus*)** are two aquatic invasive plants that pose significant ecologic and economic threats to aquatic habitats of Nevada and California. Each of these plant species are able to colonize and spread rapidly, alter the food web and ecology of invaded habitats, degrade water quality, and impede recreation. Eurasian watermilfoil is known to occur in the Truckee River east of Donner Lake. Curly-leaf pond weed is known to occur to the south of the watershed, on the southern shores of Lake Tahoe (LTBWCG 2011). Although these species have not been observed to occur in Donner Basin, they may occur there or may invade the watershed in the future, based on the close proximity of known infestations and the potential for these species to spread via vehicle traffic, human recreational activities, and other means of dispersal and colonization.

Other invasive plants, or species commonly called "weeds", also occur in the Donner Basin. The Truckee River Watershed Council maintains a Weed Warriors program that has identified priority weeds for the Truckee River Watershed, including the Donner Basin. A list of weeds with local significance for the Truckee River Watershed is available online at the council's Weed Warriors website (TRWC 2015). The Weed Warriors program also coordinates reporting of priority weed infestations in the watershed and provides resources for the treatment of observed infestations.). Small infestations (i.e., 10s of plants) of several priority weeds were incidentally observed during reconnaissance fieldwork completed for the watershed assessment. These species were primarily observed along Donner Creek, downstream from Donner Lake, and include: bull thistle (*Cirsium vulgare*), perennial pepperweed (*Lepidium latifolium*), white sweet clover (*Melilotus alba*), cheatgrass (*Bromus tectorum*), common mullein (*Verbascum thapsus*), and Klammathweed (*Hypericum perforatum*). Infestations of other priority weeds likely occur in other locations in the Donner Basin, especially in developed areas, along roadways, and in other areas of previous ground disturbance (e.g., abandoned logging roads and logging skids and landings).

3 DISTURBANCE ASSESSMENT

3.1 HYDROLOGIC IMPACTS ASSESSMENT

3.1.1 Land Use Impacts to Runoff Regime

The land use history within Donner Basin, particularly logging, road construction and land development have significantly altered the hydrologic regime of the watershed (often now referred to as hydromodification). The construction of logging roads, clearing of forests, and forest soil compaction and loss have reduced natural infiltration of rain and snowmelt and increased the fraction of precipitation that acts as surface runoff. Despite the natural forest regeneration that has occurred throughout much of the watershed, these historic impacts still have a strong effect on surface runoff patterns. The construction of impervious surfaces including roads, parking lots, and residential and commercial buildings has further decreased the natural infiltration capacity of the basin. When coupled with the construction of stormwater infrastructure such as ditches, culverts, curbs and gutters, these increases in stormwater runoff have significantly altered the manner in which water moves through the Donner Basin.

As surface runoff volume increases and is subsequently concentrated, it's capacity to erode hillslopes, gullies and stream channel beds increases. While Donner Lake likely dampens the increased stormwater flows carried by western tributaries, the contributing watershed to Donner Creek below the lake has greater proportions of developed land and impervious surfaces. Much of the runoff from Interstate 80, roads and highways, and residential and commercial developments flows into Donner Creek without stormwater treatment or attenuation, significantly increasing the peak flows within the stream channel. Residential developments on the northern side of Donner Lake have also been impacted by the concentration of stormwater runoff from I-80, which has led to local infrastructure damage and flooding in some areas.

Hydrologic Impact Mapping

To develop a more spatially robust understanding of land use change impacts to the watershed's hydrologic regime, a GIS-based hydrologic impacts assessment was conducted. Land cover mapping from 2012 was reclassified by anticipated level of impact to surface runoff patterns in the watershed. The unpaved backcountry road network previously digitized using the DEM generated from 2014 USFS 1M LiDAR was also integrated into the analysis to account for runoff pattern changes still persisting from historic logging impacts and the logging roads themselves. While typical logging roads generally have a width far less than the 30 meter raster cell size utilized in this analysis, 30 meter raster cells intersected by the logging road network were reclassified from lower impact scores to an impact value of 2 to account for both the logging roads themselves and surrounding soil compaction and loss. The original land cover classifications and hydrologic impact scores are summarized below in Table 8. The reclassified land cover map by hydrologic impact score is depicted in the left panel of Figure 56.

Table 8. Summary of land cover reclassification to assess hydrologic impacts

Land Cover Classification	Hydrologic Impact Score
Non-Developed (this includes hardwood, conifer, grassland, shrubland, sparsely vegetated, riparian, and barren land cover classes)	0
Developed - Vegetated (this includes the above land cover types that been subjected to some form of management as well as other types of managed open spaces)	1
Backcountry Roads	2
Developed - Low Intensity	2
Developed - Medium Intensity	3
Developed - High Intensity	4
Developed - Roads	4

To assess hydrologic impacts at the scale of the micro-watersheds delineated as part of the erosion hazard analysis (see Section 5.7), zonal statistics were used to calculate the mean hydrologic impact score for each micro-watershed. The results for each micro-watershed are presented in Figure 56 and provide a simplified assessment of land use change impacts. Areas with extensive urbanization, along with those containing the Interstate-80 corridor, generally received the highest impact scores. Areas with high density of logging roads were also scored as moderately impacted.

It is important to note that the results generated by this analysis are intended as a first-order level of assessment of hydrologic impacts. A more detailed analysis of land cover change and hydrologic modeling would be necessary to more precisely assess the impacts to the watershed's hydrologic regime.

3.1.2 Reservoir Management Impacts

The use of Donner Lake as a reservoir for downstream water supply has altered the timing and magnitude of flows out of the lake. Prior to the construction of the dam for water storage purposes, much of the spring snow melt flows from the western tributaries and hillslope runoff would have passed through the lake unimpeded. Depending on the timing of spring gate closures, a significant portion of the spring snow melt flows (when a winter snow pack has accumulated) are now captured and held back through the summer. While the largest flows moving through the basin were likely driven by rain-on-snow events, the capture of spring snowmelt flows (which often persist longer) by the dam results in reduced capacity for sediment transport and geomorphic work in Donner Creek, particularly above Cold Creek.

Comparing the total annual runoff with the typical management volume of a reservoir can provide useful insights into the relative impacts of a reservoir on a stream or river's capacity for geomorphic work. In the case of the Donner Lake, the average annual discharge from the lake into Donner Creek between water years 1994 and 2014 was approximately 25,500 acre-feet, while the typical annual storage volume used was approximately 6,500 acre-feet. The management volume to annual runoff ratio is roughly 0.25, which indicates that the lake does have a significant impact on the stream's capacity for sediment transport and geomorphic work, but that generally the stream has retained the majority of its flood flows.

Historically, late summer through fall would have been the driest period of the year within Donner Basin. However, flow releases out of Donner Lake between September and November artificially augment flows in Donner Creek between the lake and the Truckee River. The maintenance of minimum flows in Donner Creek, as per an informal agreement between CDFW and TMWA (described in the Section 4.2), may also prevent occasional periods of zero flow and the resulting disconnection of the Truckee River from Donner Lake that may have otherwise occurred during drought conditions.

The management of Donner Lake as a reservoir also results in a larger annual variation in water surface levels than likely occurred prior to the construction of a dam at the lake outlet. The greater oscillations in lake levels influence the vegetation communities that can persist at the margins of the lake, and also exacerbates potential for lake shoreline erosion.

3.2 IMPACTS TO PHYSICAL PROCESSES AND CONDITIONS

3.2.1 Changes to Basin-Scale Sediment Regime

Many areas of the Donner Basin naturally yield high volumes of sediment due to the combination of easily erodible soils, steep hill slope gradients, past glacial activity (which has created many of the sharp ridges present in the backcountry areas (e.g., Coldstream Canyon) and left glacial deposits and outwash), limited vegetation cover in places, and high levels of precipitation, particularly near the Sierra Nevada crest. Land use and development within the watershed have further increased sediment delivery from upland areas to the stream network. As presented in the erosion hazard analysis in Section 5.7, logging impacts are extensive throughout the watershed and continue to cause increased sediment yields today. The development of logging roads and skid trails and the harvesting of timber exposed forest soils and concentrated overland runoff, dramatically increasing soil loss. The construction of the railroad and Interstate 80 also concentrated runoff and destabilized hillslopes where grading occurred, particularly in steeper areas located on volcanic soils. Road and highway construction and grading for other land development have caused similar impacts throughout the basin. As a result, greater volumes of sediment, particularly fine-grained materials, are delivered to the basin's stream network.

In sub-watersheds such as that of Billy Mack Creek, it appears that the loading of fine-grained materials (silts to coarse sand) has increased due to a combination of stormwater concentration by Interstate 80 and resulting gully formation downhill of the Interstate's stormwater culverts, and the application of road sand applied to the Interstate for which a significant fraction likely washes into the stream during precipitation events. Given the extent of erosion that has occurred downstream of many of these culverts and the grain size distribution of these soils (see Figure 44), it is difficult to determine the proportion of small-grained sediment along Billy Mack Creek's that is coming from road sand application.

3.2.2 Impacts to Stream Channels and Sediment Dynamics

Donner Basin's stream network has been significantly impacted by changes to upland sediment delivery, hydromodification and physical impacts of the stream channel through engineering and land use pressures. Changes to upland conditions and the increased delivery of sediment to Donner Creek is visible in the earliest aerial imagery of 1939. The large depositional bar features present in Figure 40 and Figure 51 likely developed in response to increases in sediment supply from Coldstream Canyon, and are evidence of altered sediment dynamics along Donner Creek. The construction of the railroad culvert within Coldstream Canyon has also likely had a destabilizing effect on Cold Creek's stream corridor, disconnecting the stream from its floodplain in areas, increasing bank erosion and mobilizing sediment that may be carried down to Donner Creek. These impacts in turn would have negatively affected the health of the wet-meadow complex present within the Donner Creek floodplain. Also present in the 1939 aerial imagery is evidence of alternate or abandoned channels, particularly in the area upstream of Highway 89 (Figure 55). Another land use that likely drove stream impacts was livestock grazing that occurred prior to this aerial photo. In order to maximize the use of the meadow, it is conceivable that any secondary channels were intentionally disconnected and that the stream was managed as a single-thread channel. Given that this area was used for livestock grazing prior to this aerial photo, it is not unlikely that Donner Creek was managed to be kept as a single-thread channel.

The meandering, highly sinuous planform of Donner Creek is maintained through the 1952 aerial imagery, although a bridge spanning the creek between the Cold Creek confluence and Highway 89 was removed during the period between the photos (Figure 26). However, by 1966 the construction of Interstate 80 had taken place and Donner Creek was extensively realigned and straightened from just upstream of the present day location of Cold Stream Rd to a short distance downstream of the Highway 89 bridge. It appears that the southern hillslope bounding the valley bottom floodplain meadow was graded back to make room for the interstate and new stream channel in some locations. The realigned channel configuration has persisted through present day and is kept in place through the extensive application of bank armoring along the stream channel corridor. Today, much of Donner Creek between Cold Stream Rd and Highway 89 is largely disconnected from its floodplain and features little diversity in physical form and aquatic habitat. Several bridge culverts (most notably the railroad culvert downstream of Highway 89) and weirs also restrain lateral migration and vertical adjustments of the channel (indicated in Figure 36 and Figure 37).

At the western end of Donner Lake, Gregory Creek, Summit Creek, Billy Mack Creek and Lakeview Canyon have also experienced varying degrees of physical impacts. The 1939 aerial imagery suggests a distributary stream network and highly active floodplain of Summit Creek, which by 1952 had been replaced with a single channel. By 1966, the channel appears to have been further straightened and channelized as additional residential developments were constructed at the west end of the lake. The alignment of Gregory Creek and Lakeview Canyon and associated impacts are difficult to discern in these aerials. However, field observations made as part of this assessment show that stream reaches passing through the residential areas at the western end of the lake are heavily armored with bank protection. The channels also appear somewhat incised and entrenched in areas, and what was likely their former floodplains are now extensively developed as private residences. Additional impacts include the backwatering of significant portions of these reaches due to high lake levels, which reach greater water surface elevations than were likely present before the mid 1800s.

Engineering and Land Use Pressure Index

To better assess the cumulative impact of various channel modifications and engineering efforts within the Donner Basin to healthy physical processes of the stream network, an engineering and land use pressure index was developed. Engineering features and impacts both in the stream channel and along the channel margins were classified into 12 categories. These impacts include both historic activities (e.g., historic channel realignment and dredging) and present-day impacts (presence of bridges, weirs, culverts, etc.). Present-day features of interest were mapped during the fluvial audit and field reconnaissance described in Section 5.5 and are depicted in Figures 29 through 35. The pressure index was only developed for stream reaches that were surveyed during field work conducted as part of this watershed assessment. Weightings were developed based on expert judgment and are indicative of the severity of the impact assigned to each feature as indicated below in Table 9.

Table 9. Summary of engineering and land use pressure feature classes and weightings

Impact Category	Sub-Category	Weighting / Score[1]
Bank Protection	Large Scale	2.0 * length of feature (in feet)
	Small Scale	1.0 * length of feature (in feet)
Hydraulic Control Structures	Weir	Between 20 and 1500 depending on estimated severity of impact
	Dam	Between 250 and 2000 depending on severity of impact
	Open Bridge	Between 20 and 1500 depending on estimated severity of impact
	Culvert	Between 20 and 1500 depending on estimated severity of impact
	Ford	Between 20 and 750 depending on estimated severity of impact
	Bed Armoring	2.0 * length of feature (in feet)
Relict Structures	Historic Bridge Piers	Between 20 and 750 depending on estimated severity of impact
Levees or Berms		0.5 * length of feature (in feet) when close to channel; 0.25 * length of feature when set back more than 100% of channel width
Historic Channel Realignment or Straightening		0.5 * length of feature (in feet)
Historic Dredging or Re-Profiling		0.5 * length of feature (in feet)

[1] Hydraulic control structures and relict structures are assigned scores within the range of values presented in the table by assessing the cumulative impacts of the feature on physical processes in the channel. Assignment of scores is detailed in Appendix D.

The impact scores for grade control structures account for both their local effects (e.g., lateral and vertical restraint of the stream channel and flows, potential for influencing local hydraulics and sediment transport, etc.) as well as their upstream and downstream impacts due to their influence on longer-scale reach hydraulics and sediment dynamics. Linear features such as bank protection and channel realignment were multiplied by their length to generate a score. As an example, the railroad culvert located on Donner Creek downstream of Highway 89 features a partially armored bed that controls channel grade and stone walls that restrain lateral migration of the channel. While no hydraulic analyses have been conducted to assess the culvert's size, the fact that it was constructed in the early 1900s suggests that it is likely undersized for today's peak flows given the degree of hydromodification that has occurred over the last century. In turn, the culvert may backwater a significant distance upstream during high flows and may also artificially encourage sediment deposition upstream. On its downstream end, it also appears to be responsible for significant bank erosion and hill slope destabilization along the right bank. The manner by which these various elements of the structure's impacts on physical processes and hydraulics are quantified and integrated is provided in Appendix D (along with all other mapped impacts to the Donner Basin).

The large range in potential values for the hydraulic control structures and relict structures is due to the significant variability in the impact they can have on a fluvial system. This range in impacts is due both to the characteristics of the structure or impact (e.g., the height of a weir) and the environmental setting in which the impact is found (e.g., a low gradient, meandering river or a high-energy mountain stream in a steep catchment). For example, a cemented rock weir that extends less than 0.25 feet from the stream bed that is located in a steep gradient, bedrock-dominated channel will have relatively minor impact on the stream and will score on the low end of the impact range. Conversely, a 2-foot tall concrete weir constructed in a low gradient channel that generates a backwater effect for over a half mile of stream length will receive a high score.

A total engineering and land use pressure score was calculated for each geomorphic sub-reach and then divided by the reach length to generate a cumulative impact index for the reach. Each reach's impact index is intended to signify the degree of impairment to physical processes and channel conditions within the reach and they are depicted in Figure 57 and Figure 58.

The engineering and land use pressure index varies significantly throughout the watershed, reflecting the wide range in the degree of impacts to physical processes and channel conditions on a reach-by-reach basis. At the upstream end of the Donner Memorial State Park, the presence of the dam, a weir and an access road bridge as well as historic dredging have significantly impacted the stream channel (reaches 8 and 9). Further downstream in the park, the stream exhibits only relatively minor impacts and has healthy physical functions (reach 7). However, from Cold Stream Rd through Highway 89, Donner Creek is heavily impacted by the extensive application of bank protection, channel straightening, weirs, a perched culvert at Cold Stream Rd and Highway 89 bridge (reaches 3-6). The railroad culvert downstream of Highway 89 was considered one of the most significant impacts to the stream channel (reach 2). The culvert appears responsible for the significant bank erosion and hillslope failure at the downstream end of the culvert, which is likely contributing significant volumes of fine sediment to the channel during high flow events.

The tributaries to the western end of Donner Lake are most heavily impacted in the residential areas near the lake (reaches 10, 16, 17 and 32-34). This is due largely to the heavy degree of bank armoring in these lower reaches. Further upstream, the presence of several cemented boulder weirs on Summit Creek just below the confluence with Billy Mack Creek (see Figure 34 for weir locations and reach 19 in Figure 58 for impacts assessment) disrupts sediment transport and process connectivity and influences local reach hydraulics. The Interstate 80 culverts on Gregory Creek also disrupt physical processes and channel conditions (reach 13). Potential rehabilitation opportunities are presented and evaluated in the opportunities and constraints analysis in Section 5 below.

3.3 WATER QUALITY IMPACTS ASSESSMENT

The Donner Basin experiences water quality impacts due to a large array of historic disturbances, current and historic land uses, natural sources and atmospheric transport from out-of-basin locations.
As discussed in detail in Section 2.5, the presence of PCBs, chlordane, arsenic, mercury and elevated levels of fine sediment are of particular concern. Of these contaminants, the first four pose a risk to human health via the consumption of fish caught in Donner Lake and the first three have resulted in Clean Water Act 303(d) listing of Donner Lake. These pollutants' capacity for bioaccumulation also suggests that they may cause toxicity in fish and other aquatic biota. However, water quality data on these constituents is sparse and we strongly recommend additional water quality monitoring to better characterize their concentration, distribution, sources and long term trends (as discussed in Section 5.3.1). It is also probable that other pollutants, such as hydrocarbons and excess nutrients, are present in some of the basin's water bodies and we recommend that future water quality monitoring of surface water be expanded to a broader array of potential contaminants.

Of the known water quality impacts to the Donner Basin, we believe the most harmful is the increased loading of fine sediment due to human-induced soil erosion in upland areas. As discussed in more detail in Section 2.5.5, excessive fine sediment can degrade stream and river bed habitat, causing declines in benthic macroinvertebrate populations and thereby affecting aquatic food webs. Fine sediment also serves as a transport mechanism for other pollutants. The combination of elevated suspended sediment concentrations within Cold Creek and Donner Creek (Balance, 2014) and the observations of fine sediment accumulation along some reaches of Donner Lake tributaries suggest that fine sediment loading has impacted the majority of the basin's water bodies.

3.4 ECOLOGICAL IMPACTS ASSESSMENT

In general, the ecology of the Donner Basin is highly functional when assessed on a regional scale, as demonstrated by the abundance and diversity of terrestrial and aquatic plants and wildlife described in Section 7. However, as is the case throughout much of the region, the ecologic conditions in the Donner Basin today are the product of both natural processes and many decades of human influence, at varying levels of intensity. The most significant ecologic impacts that have historically occurred in the watershed are lumber harvests, which deforested lower-elevation areas of the Donner Basin, and transportation developments, which significantly altered natural habitats along the canyon walls north and south of Donner Lake and filled much of the historic Donner Creek stream course. In addition, residential and commercial developments in the City of Truckee and surrounding Donner Lake have resulted in a significant reduction in the distribution of wetland and meadow habitats in these area. Continued human presence, development, and transportation maintenance activity continue to reduce the functional values of plant and wildlife habitats where these impacts are present. Therefore, the watershed is subject to a large range of ecologic impacts, from very high in and around developed areas by Truckee and Donner Lake and along transportation corridors, to very low in high-elevation and relatively inaccessible portions of the basin.

The relative quality of aquatic biological resources was assessed based on the presence of quality lacustrine, riparian, and meadow habitats. This assessment used field observations, aerial photograph interpretation, and professional judgment to assign a qualitative habitat value to stream reaches within lower Donner Creek, Johnson Canyon, Billy Mack Canyon, Summit Creek, and Lakeview Canyon (Figure 59). The relative quality of aquatic habitat in the Donner Basin is a reflection of inherent differences in the natural landscape, such as slope, soils types, and vegetative cover, as well as human impacts that have modified the existing landscape. Figure 59 displays the relative habitat quality scores for each subwatershed and stream reach in the Donner Basin. These scores represent the relative quality of habitat within the watershed and are not intended to represent a regional comparison.

The relative quality of terrestrial and upland biologic resources was assessed at a subwatershed scale based on the plant assemblages and presence of multiple stages of forest and scrub habitat succession. Terrestrial habitats of relatively high quality are present in the western- and southern-most portions of the watershed. These include the headwaters and canyon walls of Billy Mack Canyon, Summit Creek, and Lakeview Canyon. In addition, the upland habitats surrounding several alpine lakes in the western and northwestern portions of the watershed support a relatively undisturbed mixed coniferous forest with late seral stages of forest, mature trees and shrubs, and substantial recruitment of young trees. Terrestrial habitats of relatively poor quality in the watershed are developed areas and rocky or barren land covers. Granitic outcroppings and barren land cover are dispersed throughout the watershed; however, these are a natural component of the landscape and are typically not an indicator of ecologic impacts. Developed areas that have resulted in significant impacts to the natural ecology of Donner Basin are located primarily along the I-80 corridor, around the City of Truckee, along Donner Creek below the Cold Creek Road crossing, and on the north, west, and southwest shores of Donner Lake. Although residential landscaping within developed areas of the Donner Basin provide some habitat value to wildlife species, residential landscaping is generally of lower functional value to plants and wildlife than the natural habitats that historically occurred in these areas.

3.5 IMPACTS TO DONNER LAKE

Given the significance of Donner Lake within the overall function and health of the Donner Basin as well as its numerous human beneficial uses, impacts to the lake are summarized here in a standalone section. Donner Lake has been negatively affected in numerous manners over the past 150 years due to the extensive historic impacts and existing land uses within the basin. Historic disturbances such as logging, the railroad construction, and the development of roads and highways continue to exacerbate upland erosion and the delivery of fine sediment to Donner Lake. Stormwater runoff from roads and commercial and residential development also delivers a wide array of potential pollutants to the lake. Reservoir management affects the aquatic biota, shoreline conditions and fish passage. Recreation and motorized watercraft on the lake also impact shorelines, increase the risk of aquatic invasive species introductions and deliver unspent fuel to the lake. These impacts, which are discussed in more detail in previous sections, are briefly discussed in the following paragraphs with specific regard to how they affect Donner Lake.

Water Quality

The presence of PCBs, chlordane, arsenic and mercury within the tissue of Donner Lake fish indicates that the lake has likely been affected by a combination of historic and present-day contamination. While the presence of these compounds in fish tissue is of concern for human health via fish consumption, it is unknown whether concentrations are significant enough to affect humans via other recreational activities (such as direct exposure to surface waters). Also of significant concern is the delivery of large volumes of fine sediment due to increased upland soil erosion rates. In addition to providing a transport mechanism for numerous contaminants, fine sediment (including pulverized traction sand and other dust emissions) may contribute to decreased lake clarity. Other pollutants, such as hydrocarbons and elevated nutrient loading, may be present but additional water quality monitoring is necessary to characterize lake contamination.

Aquatic Species

The historic stocking of Donner Lake with non-native sport fish significantly altered the species composition of the lake. The presence of the Donner Lake Dam at least partially obstructs fish passage into Donner Lake from Donner Creek, particularly when lake levels are high. Reservoir management, specifically rapid down of water levels, may also affect near-shore benthic macroinvertebrate communities. Two aquatic invasive species, Asian clam and signal crayfish, are also present in Donner Lake and have the capacity to affect the water quality, food web dynamics, and composition of native plants and animals in the lake. Additional aquatic invasive species that occur in the region further threaten the ecology of the lake through the risk of future invasion and impacts.

Shoreline Conditions

In addition to eliminating wetland vegetation along the historic margins of the lake, reservoir operations cause significant inter-annual variability in lake levels such that shoreline vegetation struggles to persist below the current high pool water levels. When coupled with boat wake and natural wave action, this lack of vegetation exacerbates shoreline erosion in many areas. Additionally, heavy recreational use in some portions of the lake further affects shoreline vegetation and causes erosion in some areas (e.g., along footpaths to public docks).

4 EXISTING CONDITIONS AND REFERENCE STATE COMPARISON

The reference state of a system generally refers to its pre-disturbance or natural conditions. This pre-disturbance state can be compared with present conditions to evaluate human impacts to the system and the degree to which natural processes have recovered. In most cases, the reference state is no longer a realistic nor desired condition for the system, but can provide useful insights on healthy physical processes and ecological conditions. For the purposes of this assessment, the reference state described here refers to the condition of the environment prior to western exploration and settlement in the 1800s and subsequent development and land use change. As discussed extensively in the land use history workbook (see Appendix A), the Donner Basin was used and altered by native peoples for several millennia prior to the first emigrant travel through the area. However, the scale of these impacts are not considered to be anywhere near the magnitude of those occurring since the mid 1800s.

Furthermore, it should be noted that the physical processes and biological communities present within the Donner Basin have varied dramatically over geologic time scales due to natural climatic variability. The reference state described in this assessment refers to the conditions of this current warmer, drier interglacial period. Glacial periods would have covered the Donner Basin with snow, ice and glaciers and resulted in dramatic physical processes dominated by glacial erosion and deposition that are markedly different than those at play in today's landscape.

Hydrology

Pre-disturbance hydrologic conditions were characterized by natural land cover and runoff patterns and an unmanaged Donner Lake. Prior to logging and land development within the watershed, forest soils would have more effectively captured rainfall and snowmelt, maintaining higher levels of infiltration than occurs today. A smaller fraction of precipitation would have become direct surface runoff, and the surface runoff would concentrate as it followed the natural contours and topography of the landscape.

Prior to disturbance, it is likely that existing terminal moraines from past glacial activity served as natural dams along the eastern side of Donner Lake. Water surface levels of Donner Lake would have likely varied naturally with changes in annual precipitation, air temperatures and weather patterns, as well as the periodic accumulation of natural materials at the outlet of the lake. In particular, large wood jams may have periodically enhanced lake levels. While the lake likely dampened the magnitude of peak flows passing from the upper watershed to Donner Creek, today's peak flows, particularly during spring snow melt events when the dam gates are closed, are more significantly regulated. During late summer and the fall, it is likely that Donner Creek may have occasionally experienced periods of little to no flow (intermittent creek conditions) while today minimum flows are typically maintained year round (perennial creek conditions) and between September and November natural flows are artificially augmented by significant water releases from Donner Lake.

Physical Processes and Channel Form

At the basin-scale, sediment dynamics of the watershed's reference state condition were driven by natural processes. Upland sediment production would have been supported largely by hillslope erosion of highly erodible soils. Particularly in areas of steeper slope and less vegetative cover, highly erodible soils would have supplied relatively large quantities of fine-grained materials to the basin's stream network. Episodic landslides and other hillslope failures, particularly in steeper areas within the Coldstream Watershed, would occasionally deliver significant volumes of sediment to the stream network (a natural process that continues today). Land use practices over the past two centuries have likely enhanced sediment yields from most upland areas of the watershed. Similar to today, Donner Lake would have functioned as a sediment trap, capturing practically all sediment from the upper part of Donner Basin while water was passed on to Donner Creek downstream of the lake. The majority of sediment in Donner Creek would have been supplied by Cold Creek as well as any bank and terrace erosion within the Donner Creek stream corridor itself and minor upland erosion inputs.

Channel form would have been driven in large part by the interactions of fluvial processes with historic glacial landforms such as moraine features, glacial outwash and lag deposits. Aerial photography from 1939 suggests that Summit Creek functioned as a distributary system with multiple channels once the creek reached the low gradient depositional areas near the western end of the lake. However, with their steeper hillslopes continuing almost up to the margins of Donner Lake, Gregory Creek and Lakeview Canyon may have maintained a single stream channel up to their confluence with the lake. All three of these western tributaries were likely better connected with their floodplains in these lower elevation portions of the basin where they now run through mostly residential development. Upstream of the residential areas, these streams likely maintained channel form characteristic of undisturbed high-gradient Sierra streams driven by the combination of steep gradient, sediment input from hillslope erosion and the interaction of fluvial processes with glacial lag deposits.

Below Donner Lake and upstream of Cold Creek, Donner Creek was most likely a fine-sediment dominated stream with a well connected floodplain. After its headwaters at the lake, Donner Creek's gradient and floodplain interaction would have been mostly driven by the streams interaction with the terminal moraines present to the east of the lake. As it flows through the eastern portion of Donner Memorial State Park, present-day Donner Creek serves as the strongest example of a healthy reference state condition for Donner Creek between the lake and the Truckee River. Sequences of beaver dams result in backwatered areas, multiple channel threads, significant wetland vegetation and enhanced floodplain connectivity (Figure 54). This type of channel condition is increasingly recognized within the river restoration community as a pre-disturbance channel type as well as a potential restoration objective (Cluer and Thorne, 2013).

Downstream of the confluence with Cold Creek, Donner Creek likely had a meandering channel form and a well-connected wet-meadow floodplain. Similar to other minimally-disturbed Sierra wet-meadow stream channel complexes present today, Donner Creek likely had a U-shaped stream channel capable of transporting the majority of its coarse sediment load without developing large in-channel depositional features (e.g., point bars) that are observed today. The dense root growth and high root strength of the meadow vegetation likely had a greater capacity to resist erosion than today's unarmored stream banks in the lower portions of Donner Creek. Channel form and lateral migration would also have been driven by the presence of beaver dams and the accumulation of large wood, which would have facilitated avulsions and multiple channel threads. Evidence of historic channel alignments and threads are present in the 1939 aerial imagery (Figure 55), although the channel had likely been heavily influenced by this point due to anthropogenic stream channel adjustments and changes to upland sediment supply.

Where the width of the valley bottom narrows further downstream (i.e., downstream of the present-day Highway 89 bridge), the channel would have been more laterally confined and would have interacted more frequently with adjacent hillslopes. Due to the naturally constrained valley bottom between Highway 89 and the Truckee River, the historic floodplain width was significantly smaller than it was in the reaches immediately upstream, and would have likely featured less wet meadow habitat. Sediment transport rates through this reach would have also been higher due to the steeper valley slope.

Biological Resources

The reference state for aquatic biological resources includes a diverse assemblage of wet montane meadow, montane riparian forest and riparian scrub (including willows, alders, and quaking aspen), open water, and lacustrine habitats. Prior to widespread development of the Basin, these habitats likely would have been more commonly found in association with the Truckee River and its tributaries, the western and eastern ends of Donner Lake, and in narrower bands along smaller lakes and streams above Donner Lake. Due to the development of the Interstate 80 corridor, Truckee, and Donner Lake much of the Donner Basin no longer supports these habitats or these habitats have been reduced in extent.

The reference state for upland biological resources is characterized by a mosaic of mixed coniferous forest and shrub habitats with outcroppings of barren rock. Mixed coniferous forest should include species diversity as well as all stages of forest succession, from old-growth trees to saplings and seedlings, including dead or senescent trees that provide sources of cavities, downed wood, and otherwise contribute to forest complexity and wildlife habitat quality. This reference state for uplands in the Donner Basin can be observed in the western, high elevation, portions of the watershed where deforestation, development, and infrastructure impacts have not occurred to the extent that they have in the eastern and low-lying portions of the watershed.

5 OPPORTUNITIES ASSESSMENT

5.1 IDENTIFIED PROJECTS AND MANAGEMENT ACTIONS

Given the history of disturbances to the Donner Basin and its current land uses, returning the watershed to its pre-disturbance condition is considered infeasible. As such, the projects and actions identified in this report seek to mitigate hydrologic impacts, rehabilitate physical processes, improve water quality and enhance habitat such that the basin can provide greater ecological function within current land use constraints. In some areas where healthy physical and ecological conditions are already present, management recommendations are made regarding natural resource protection. All opportunities identified in this assessment are intended to benefit or maintain one or more of the following components of the physical and ecological health of the watershed:

- Geomorphic / physical processes
- Hydrology
- Water Quality
- Fine Sediment Reduction[7]
- Habitat

The identified opportunities are summarized below in Table 10 which separate opportunities into the following categories: (1) in-channel and stream corridor projects, (2) upland erosion reduction projects, (3) stormwater treatment projects, (4) trash cleanup efforts, and (5) management actions. In each table, information is provided on the location, existing conditions, proposed project, anticipated benefits and potential constraints. When applicable, opportunity locations are provided in basin maps (Figure 60 and Figure 61) with numbering that corresponds to the tables.

The tables also include qualitative scoring of the anticipated benefit level for each of the five categories above. The final column in the tables provides a prioritization of the opportunities on the basis of the above beneficial criteria alone. In developing the prioritization rankings, specific emphasis was placed on an opportunity's anticipated improvements to habitat and water quality conditions. However, given that the health of the Donner Basin's aquatic and riparian habitat depends significantly on physical processes and hydrology, these beneficial criteria were also strongly considered in the prioritization of opportunities. It should also be noted that while information on potential constraints is provided in the table, opportunity prioritization did not consider constraints such as cost, existing land use[8], infrastructure impediments, permitting considerations and other factors.

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[7] While fine sediment loading is a component of both physical processes and water quality, it was given a separate benefit category due to the high levels of fine sediment loading within Donner Creek and the Middle Truckee River.

[8] Large scale removal of infrastructure and impediments to restoration (e.g., realigning Interstate-80, removing Donner Lake Dam, large-scale residence and commercial building setbacks from stream corridors) were not included in the project concepts developed. Additionally, existing land use constraints on a parcel by parcel basis were not considered in the prioritization of project concepts.

The identified projects, protection opportunities and management actions are intended as preliminary concepts only. Additional analysis will be required to further assess opportunity feasibility, project scope, constraints, compatibility with future land use or management, costs, designs, permitting and other project elements. Furthermore, there may exist additional opportunities in the basin that were not identified during this assessment due to limitations in field coverage and available resources.

Previous watershed assessments of Coldstream Canyon and Johnson Canyon identified project opportunities for these sub-watersheds of the Donner Basin (River Run Consulting, 2007; IERS, 2010). Given these earlier efforts, this assessment generally did not seek to identify additional projects within these sub-watersheds. Readers interested in project opportunities in these two areas are encouraged to review the relevant sections of the Coldstream Canyon and Johnson Canyon assessment reports.

Table 10. Identified restoration project and management opportunities for Donner Basin

ID	Project Name	Stream / Watershed	Location	Existing Conditions	Project Description	Benefits	Potential Constraints	Benefits [1] Physical Processes	Hydrology	Water Quality	Fine Sediment Reduction	Habitat	Cost [2]	Timeline (yrs)	Priority
In-Channel and Stream Corridor Projects															
1	Relict Bridge Pier Removal	Donner Creek	Between West River Street and Donner Creek confluence with the Truckee River	Three concrete piers and footings are currently located within the active channel and artificially influence hydraulics and physical processes along the reach.	The relict bridge piers and footings will be removed from the stream channel. Depending on site access and equipment used, it may be necessary to move some boulders and clear riparian vegetation. Bed stabilization may be required where pier footings were located.	The removal of the historic piers and footings will eliminate artificial hydraulic impacts.	Permitting will be required to remove the old piers and footings from the channel.	M	N	N	N	L	$$	1 to 2	Low
2	Bank Armoring Retrofit at Mobile Home Park	Donner Creek	Right bank adjacent to mobile home park	The southern bank of Donner Creek is armored with large boulder rip rap for much of the stream length that borders the mobile home park. Consequently, the stream bank offers poor riparian habitat quality and impairs natural physical processes.	The rip rap will be replaced with more ecologically supportive materials. Log toe armoring could be used (essentially one long large wood structure along the toe of the bank), with coir or some erosion control fabric above. Some of the existing rock may be needed to anchor the new bank protection materials.	The project will enhance riparian habitat and allow for the reestablishment of riparian vegetation. Depending on the design, the large wood incorporated into the new bank protection could provide cover for fish and other aquatic species in the stream channel.	Permitting will likely be required to replace the bank armoring materials. Depending on the proposed design, the perceived increase in bank erosion risk may also need to be addressed through education efforts and / or a more detailed geomorphology and hydraulics study.	M	N	N	N	M	$$	1 to 2	Low
3	Mobile Home Park Floodplain Restoration	Donner Creek	Lower elevation areas of the mobile home park along the right bank of Donner Creek upstream of W. River Street	A mobile home park is located along the right bank of Donner Creek upstream of the W. River Street crossing. The section of the home park closest to the stream is at a low elevation relative to the stream and at risk of flooding (potentially a 5- to 10-year recurrence interval). The site topography suggests this area was a historic floodplain. This project will provide significant value, as today the lower section of Donner Creek has very limited floodplain access which negatively impacts physical processes, habitat, water quality and hydrology.	The low elevation areas within the mobile home park will be converted to a more natural floodplain condition. Select homes and paved surfaces could be removed, the floodplain elevation lowered through grading and then replanted with riparian vegetation to provide a more natural and frequently activated floodplain. Project concept assumes support of all land owners, land managers, and stakeholders.	The project will significantly enhance physical processes and habitat, and could increase the riparian food subsidy to the Truckee River. Floodplain lowering could also relieve flood pressure on other parts of the mobile home park community. Increased floodplain access will promote infiltration and may also provide temporary storage of floodwaters in pocket depressions.	This project will require purchasing land (or easements) and relocating trailers in the lowest elevation zones of the mobile home park.	H	M	M	M	H	$$$ to $$$$$	3 to 7	High
4	Bank Armoring Retrofit at Railroad Rip Rap Site	Donner Creek	Left bank of Donner Creek 400 ft downstream of RR culvert outlet	Large boulder rip rap currently lines the left bank of Donner Creek at the base of the hillslope that supports the railroad line. Above the rip rap, the upper bank appears to be somewhat unstable and likely erodes during exceptionally high flow events (i.e. 10-year or greater recurrence interval).	The rip rap could be replaced with more ecologically supportive materials to improve habitat conditions and reduce the stream's interaction with an armored bank. A combination of large wood structures, riparian plantings, and erosion control fabric could be installed that extend further up the bank and hillslope. Some of the existing boulders could be used to further secure the project design.	The project will enhance riparian habitat and cover for aquatic species. It will also reduce fine sediment loading that may occur during large flood events.	The perceived increase in risk of hillslope erosion due to a bank armoring retrofit may be a constraint.	M	N	L	L	M	$$$	2	Low

[1] Benefits: H = High; M = Moderate; L = Low; N = None   [2] Cost: $ < $10K; $$ = $10K to $100K; $$$ = $100K to $500K; $$$$ = $500K to $1M; $$$$$ > $1M

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5	Bank Stabilization Downstream of Railroad Culvert	Donner Creek	Right bank immediately downstream of RR culvert	Just downstream of the railroad culvert outlet, the right bank of Donner Creek and hillslope above currently exhibit severe erosion. The erosion appears to be driven by the orientation of the railroad culvert outlet which directs relatively high velocity flows at the fairly soft, non-cohesive soils of the bank. Field observations indicate that this bank erosion site is likely one of the two locations responsible for significant fine sediment loading in the downstream 0.5 miles of Donner Creek.	The right bank and hillslope will be reprofiled by pulling the top of the hillslope further back from the channel and stabilized through a combination of large wood, rock, erosion control fabric, hydroseeding, and plantings. The site will incorporate large log toe protection, essentially one long large wood structure along the base of the bank. Additional longitudinal peak stone toe protection may be needed to provide additional toe anchorage, due to the site hydraulics. A combination of plantings and the placement of coir, jute or other erosion control fabric further up the hillslope will help stabilize the site.	The project will stabilize the existing bank and hillslope erosion, thus reducing one of the largest fine sediment sources to the lower 0.5 miles of Donner Creek during high flow events. The project will also provide some improvements to riparian habitat and, depending on design, could improve in-stream habitat.	Reprofiling the bank will require the setback of a private residence and other infrastructure. Further analysis is needed to determine if extending the toe of the bank into the channel is infeasible. If reprofiling the bank is not an option, the site design will need to incorporate a fairly steep bank and hillslope.	M	N	M/H	H	M	$$$ to $$$$	2 to 5	Med / High
6	Railroad Culvert Replacement with Open Span Bridge	Donner Creek	Railroad culvert adjacent to Hwy 89	The existing railroad culvert likely acts as a hydraulic constriction, causing backwater effects upstream during high flow events and jetting flows from its downstream end toward the right bank of Donner Creek. This constriction influences sediment dynamics both upstream and downstream of the site. The 200 foot long culvert exhibits poor habitat conditions with an armored bed and walls.	The existing culvert could be replaced with an open span bridge. Secondary options include widening the culvert or replacing the bed armoring.	Replacing the culvert with an open span bridge will reduce or eliminate the flow constriction and associated backwater effects. It will also daylight the stream channel and create a more natural stream bed and corridor through this area.	The existing railroad line and the stability of the underlying hillslope are constraints. Project costs will also likely be substantial due to the geotechnical requirements associated with replacing the culvert with an open span bridge.	H	N	N	N	M	$$$$	3 to 10	Med
7	Bank Stabilization and Channel Enhancement Along Highway 89	Donner Creek	Donner Creek right bank 350 ft downstream of Highway 89 bridge	The right bank of Donner Creek currently exhibits severe bank erosion that, if unaddressed, will likely affect the stability of Highway 89 relatively soon. The left bank currently offers limited area for riparian habitat and little riparian canopy for the channel (and these habitat features are currently lacking in this reach). Field observations indicate that this bank erosion site is likely one of the two locations responsible for significant fine sediment loading in the downstream 0.5 miles of Donner Creek.	To address the bank erosion concerns and improve habitat conditions, the right bank will be reprofiled such that the toe of the bank extended further into the current stream channel alignment. Concurrently, the left bank will be set back, reprofiled and replanted to enhance aquatic and riparian habitat and reduce erosion pressure on the right bank. Depending on bank stability objectives, the right bank may be further stabilized with plantings and an erosion control fabric, and/or longitudinal peak stone toe protection.	This project will reduce the fine sediment loading from the existing bank erosion site on the right bank. By stabilizing the right bank and adjusting the stream channel further to the east, the project will reduce the erosion risk to Highway 89. The project will enhance riparian habitat along the stream corridor and improve instream habitat diversity.	The proximity of the project to Highway 89 may become a constraint if stakeholders do not have buy-in.	M	N	M/H	H	H	$$$	2 to 5	High
8	Bank Armoring Retrofit Downstream of Highway 89	Donner Creek	Donner Creek stream banks immediately downstream of Highway 89	Both banks of Donner Creek are heavily armored with boulder rip rap in this area, offering little riparian habitat and inhibiting physical processes. The armoring also likely contributes to degraded in-channel habitat conditions.	The rip rap along both banks could be replaced with engineered wood structures, riparian plantings and other ecologically supportive materials. Boulders may be necessary to anchor the large wood structures.	The project will enhance riparian habitat and improve cover for aquatic species. It will also lessen the stream's interaction with artificial bank armoring.	Due to the hydraulic constriction at the Highway 89 bridge during high flows and the sharp channel bend just downstream of the road, the bank armoring retrofit will need to be designed to withstand high shear stresses and erosion potential.	L	N	N	N	M	$$	2 to 3	Low / Med
9	Concrete Weir Removal Near Highway 89 - Site 1	Donner Creek	Immediately upstream of Hwy 89 and stream gage	A low elevation concrete weir currently spans the stream channel, affecting local hydraulics and inhibiting adjustments to the stream bed elevation.	Remove the concrete weir from the stream channel. Bed stabilization to replace the existing concrete wier may be required using fish passage friendly rock or other materials.	The removal of an artificial grade control will enhance physical processes and provide minor habitat benefits resulting from more natural local morphology and bedforms.	The weir may currently maintain a small downstream pool used for the existing gaging station.	M	N	N	N	L	$$ to $$$	1 to 2	Low / Med

[1] Benefits: H = High; M = Moderate; L = Low; N = None   [2] Cost: $ < $10K; $$ = $10K to $100K; $$$ = $100K to $500K; $$$$ = $500K to $1M; $$$$$ > $1M

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ID	Project Name	Stream / Watershed	Location	Existing Conditions	Project Description	Benefits	Potential Constraints	Benefits [1]					Cost [2]	Timeline (yrs)	Priority
								Physical Processes	Hydrology	Water Quality	Fine Sediment Reduction	Habitat			
10	Bank Enhancement and Channel Realignment	Donner Creek	The right bank of Donner Creek immediately upstream of Highway 89 near fast food restaurant	Donner Creek's outside (right) bank is heavily armored with gabian baskets for a length of roughly 350 feet as the stream approaches the Highway 89 bridge. The right bank offers poor riparian habitat and in-channel habitat is also highly degraded. Space exists to reprofile the bank and realign the channel to the northeast.	The stream channel will be realgined to the northeast. The right bank will be reprofiled by extending the toe further into the channel. Reprofiled right bank could involve installing large wood structures along the toe, covering rip rap / gabian baskets with soil and coir matting (or other "natural" fabrics) and then planting riparian vegetation. Inset floodplain terrace could be enhanced on the left bank to promote more frequent inundation.	The project will enhance riparian habitat and improve cover for aquatic species. It will also lessen the stream's interaction with artificial bank armoring, including rip rap and gabion baskets.	Perceived increase in flood risk to the gas station may be a constraint. There may also be perceived risk of bank erosion along the outside bank due to the bank amendments and reprofiling efforts. A sewer line also passes through the project site.	M	N	N	N	M	$$$	2 to 4	Med
11	Channel Realignment and Floodplain Restoration at Gas Station	Donner Creek	Gas station on Highway 89 adjacent to Donner Creek	Just upstream of Highway 89, Donner Creek flows between a gas station and a heavily armored bank. The gas station appears to be located in a natural floodplain area that inundates frequently despite a low-elevation berm separating it from the stream. The interaction of floodwaters with the gas station poses both human health and water quality risks. Between Cold Creek and the Truckee River, Donner Creek has very limited floodplain access, and this site appears to be one of most naturally flood-prone areas along this reach.	Donner Creek could be reconnected to a sizeable floodplain area by relocating the gas station and eliminating the berm along the left bank. The stream channel could also be adjusted further to the northeast to soften the meander bend and reduce interaction with the heavily armored right bank. Soil remediation may be necessary if fuel leakage has contaminated soils over time. The creation of an overflow channel, topographic enhancement and vegetation planting will greatly improve habitat and physical processes. The channel bed elevation could also be raised slightly to promote increased floodplain connectivity.	The relocation of the gas station, removal of the berm and restoration of the floodplain presents a signfiicant opportunity for improving physical processes and habitat conditions along the lower portion of Donner Creek. The removal of the gas station will also improve water quality by encouraging sediment deposition and eliminating the interaction of stream water with fuel tanks.	The feasibility and cost of relocating the gas station are likely constraints. The need for soil remediation at the site will also need to be considered. A sewer line runs along the edge of the project site.	H	L	M	M	H	$$$$$	2 to 5	High
12	Concrete Weir Removal Near Highway 89 - Site 2	Donner Creek	Upstream of Hwy 89 near McDonalds	A low elevation concrete weir currently spans the stream channel, affecting local hydraulics and inhibiting adjustments to the stream bed elevation.	Remove the concrete weir from the stream channel.	The removal of an artificial grade control will enhance physical processes and provide minor habitat benefits resulting from more natural local morphology and bedforms.	The weir may serve as a protective topping for an underlying sewer line.	M	N	N	N	L	SS	1 to 2	Low / Med
13	Concrete Weir Removal Near Highway 89 - Site 3	Donner Creek	Upstream of Hwy 89 and McDonalds	A low elevation concrete weir currently spans the stream channel, affecting local hydraulics and inhibiting adjustments to the stream bed elevation.	Remove the concrete weir from the stream channel.	The removal of an artificial grade control will enhance physical processes and provide minor habitat benefits resulting from more natural local morphology and bedforms.	The weir may serve as a protective topping for an underlying sewer line.	M	N	N	N	L	SS	1 to 2	Low / Med
14	Channel Realignment and Floodplain Enhancement at 90-Degree Bend	Donner Creek	Downstream end of I-80 reach, and immediately west of Highway 89 gas station	At the end of a long channelized section of stream running adjacent to I-80, Donner Creek experiences an artificially sharp right bend. This unnatural river feature directs unnecessarily high forces toward the outside of the bend, requiring extensive boulder rip rap for bank protection. In addition, floodplain interaction is reduced along both sides of the channel. Topographic data also suggests a relatively large floodplain area exists along the interior of the bend and southwest of the channel.	A combination of channel realignment and floodplain grading will soften the meander bend and promote greater floodplain connectivity. The land to the southwest could be lowered through grading and/or the stream bed could be elevated (or beaver dams enhanced) to encourage more frequent inundation. Removal or covering of rip rap on the left-bank could also enhance riparian habitat and reduce the stream's interaction with artificial armoring. The project could be integrated with floodplain restoration project at the gas station site immediately downstream.	The project will enhance natural physical processes through greater floodplain connectivity and a more natural channel morphology. The project could improve riparian habitat and create additional floodplain wetland habitat. The floodplain may also help improve water quality and capture some amount of fine sediment during higher flow events.	A sewer line along the right bank of Donner Creek will need to be relocated if that stream channel is realigned. The project will also require agreement with the land owner.	H	L/M	M	M	H	$$$ to $$$$$	2 to 5	High

[1] Benefits: H = High; M = Moderate; L = Low; N = None

[2] Cost: $ < $10K; $$ = $10K to $100K; $$$ = $100K to $500K; $$$$ = $500K to $1M; $$$$$ > $1M

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								Physical Processes	Hydrology	Water Quality	Fine Sediment Reduction	Habitat			
15	Large Wood and Habitat Enhancement	Donner Creek	Channelized reach of Donner Creek running parallel to I-80	As part of the construction of I-80 (completed in 1964), Donner Creek was realigned into a highly channelized stream running parallel to I-80 for a distance just over a half mile. This section of stream has highly homogeneous geomorphic form and offers limited habitat value.	The installation of large wood structures into the stream channel will significantly enhance physical processes and habitat diversity along this reach. Wood structures will be designed to extend as much as one third of the channel width to increase hydraulic sinosity and habitat heterogeneity. The wood structures will be spaced at distances of roughly 8 to 12 channel widths apart on alternating sides of the bank. The project could be implemented in phases to encourage an adaptive design process and evaluate realized benefits.	The project will significantly enhance geomorphic processes, encouraging localized bed scour and deposition. This in turn will improve the quality and diversity of in-stream habitat. The large wood may also help the stream to more effectively store sediment in its floodplain and trap finer grained material, further enhancing in-stream habitat diversity.	Flood risk to I-80 will need to be evaluated with hydraulic modeling. Regardless of modeling results, the perception of flood risk to I-80 may be a constraint.	M/H	L	L	L	H	$$$ to $$$$$	2 to 4	Med / High
16	Bank Protection Retrofit	Donner Creek	Channelized reach of Donner Creek running parallel to I-80	Large boulders have been placed as bank protection along much of the channelized section of Donner Creek running parallel to I-80. The boulders are most densely applied to the northern (left) bank and have degraded riparian habitat and inhibit physical processes.	The bank protection along both banks, but especially the northern bank, will be partly retrofitted with more ecologically supportive materials. Large wood structures will be used in place of the dense boulder armoring, along with riparian plantings and erosion control fabric. Boulders could still be used to anchor the the project sites and restrict lateral migration of the channel towards I-80.	The use of large wood and riparian plantings in place of large boulders, or in conjunction with the exiting large boulders, will provide a more natural form of bank protection that will encourage more natural physical processes within the channel (such as localized scour and deposition). It will also improve riparian and aquatic habitat conditions.	The perceived increase in risk of bank erosion and northern migration of Donner Creek towards I-80 is a likely constraint. There may also be concern that the increased roughness from the large wood and additional riparian vegetation may increase flood stages along the reach.	M	N	N	N	H	$$$ / $$$$$	2 to 6	Med
17	Bank Stabilization Along Southern Bank	Donner Creek	Eroding bank in a high deposition area roughly 500 feet downstream of Donner and Cold Creek confluence	The right bank and bounding hillslope of Donner Creek exhibits varying degrees of bank erosion for a length of approximately 350 feet and may contribute fine sediment during high flow events. The stream bank is set back from the base flow channel, and the overall stream corridor width is quite large in this area, suggesting less concentrated flood energy being directed at the bank. In some areas the bank erosion appears to be recovering.	The stream bank will be reprofiled by extending the toe of the bank further out towards the low flow channel. The bank could then be stabilized along the toe with large wood structures, planted with vegetation and further secured with erosion control fabric.	The project could reduce bank erosion and fine sediment contributions during high flow events. It could also improve riparian habitat conditions.	The project may require adding additional soil material to reprofile the stream bank, which could result in minor increases to local flood stages.	L	N	L	M	L	SSS	2 to 4	Low
18	Stream and Floodplain Restoration at Donner and Cold Creek Confluence	Donner and Cold Creeks	The area immediately southeast of the current Donner and Cold Creek confluence	Historically, Cold Creek's alluvial fan supported several secondary flood channels and significantt dynamic behavior as the channel neared its confluence with Donner Creek. However, today the stream runs through an artificially constrainted corridor as it approaches the confluence and Donner Creek has limited capacity for floodplain interaction to the southwest of the channel.	The floodplain area located southeast of the confluence will be lowered to widen the stream corridor, increase floodplain connectivity and enhance natural processes. Overflow channels will also be constructed or enhanced to provide secondary connections between Cold Creek and Donner Creek. The opportunity may exist to implement this project as part of the Town of Truckee's Coldstream Specific Plan (PC-1).	The project will substantially enhance floodplain connectivity and dynamic physical processes. Riparian, floodplain and secondary channel habitat could also be enhanced substantially with this project. Lowering the floodplain and broadening the stream corridor will also improve the stream's capacity to naturally create and maintain aquatic and riparian habitat and desposit sediment. The project may also reduce flood risk to adjacent land owners.	The property immediately southeast of the confluence appears to be public land, while parcels further south along Cold Creek appear to be privately owned. A sewer line also crosses below Cold Creek approximately 250 ft upstream of the confluence.	H	M	M	M	H	$$$ to $$$$$	2 to 5	High

[1] Benefits: H = High; M = Moderate; L = Low; N = None [2] Cost: $ < $10K; $$ = $10K to $100K; $$$ = $100K to $500K; $$$$ = $500K to $1M; $$$$$ > $1M

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								Physical Processes	Hydrology	Water Quality	Fine Sediment Reduction	Habitat			
19	Stream and Floodplain Restoration at Donner and Cold Creek Confluence	Donner Creek	The motel site immediately southwest of the current Donner and Cold Creek confluence	A vacant motel complex is currently located on the property immediately southwest of the confluence. It is likely that the elevation of the property was artificially increased with fill to support its development, further disconnecting the stream from this historic floodplain site. Today, Donner Creek runs through a heavily armored section of stream channel as it approaches the confluence, and the confluence's dynamic behavior is strongly inhibited.	The vacant structures and parking lot will be removed from the site and the floodplain lowered through grading. Donner Creek's alignment will be adjusted to the south to allow space for more dynamic behavior at its confluence with Cold Creek. The design will feature greater topographic complexity along the floodplain and the addition of large wood structures to further enhance physical processes and habitat quality. The opportunity may exist to implement this project as part of the Town of Truckee's Coldstream Specific Plan (PC-1).	The project will significantly enhance physical processes at the confluence, an area that was likely highly dynamic prior to disturbance. Donner Creek will be given a more natural stream morphology and the floodplain connectivity of the site will be greatly improved. In-channel and floodplain habitat will also be vastly enhanced, and water quality improvements and sediment deposition could also be realized. The project will also reduce flood risk to adjacent properties.	Current land use and future development plans for the site both pose constraints to the project.	H	M	M	M	H	$$$$ to $$$$$	2 to 5	High
20	Stream Corridor Widening and Inset Floodplain Creation	Donner Creek	Channel corridor just downstream of Cold Stream Rd	Between Cold Stream Rd and it's confluence with Cold Creek, Donner Creek's banks are armored with boulders and the stream appears to be fairly disconnected from it's floodplain. The active stream corridor is very narrow and supports only poor quality riparian and aquatic habitat.	The stream corridor will be widened by laying back the stream banks and creating inset floodplain benches on one or both sides of the channel. The banks could be given more gradual slopes and both the banks and inset floodplain benches could be planted with riparian vegetation.	The project will rehabiltate some degree of natural physical processes such as floodplain connectivity and sediment deposition. It will also enhance riparian and aquatic habitat. The broadened stream corridor and associated excavation will reduce flood risk to neighboring properties.	Land availability between Donner Pass Road and Deerfield Drive may be a constraint. Sewer lines and a pumping station are located to the south of the stream channel. An increase in the perceived erosion risk to Donner Pass Rd and Deerfield Dr. due to the widened stream corridor may also be constraints.	M	L	L	L	M	$$ to $$$$	2 to 3	Med
21	Fish Passage Barrier Alleviation at Cold Stream Rd	Donner Creek	Cold Creek Rd culvert and stream channel immediately downstream	At low flows, the Cold Stream Rd. culvert acts as a perched culvert and a fish passage barrier. It is also possible that the culvert may be slightly undersized and may act as a hydraulic constriction point during high flows.	To address the passage barrier, natural materials may be installed in the downstream channel to locally raise water surface elevations. Boulders, cobbles, and gravels may be placed to raise the bed, and then topped with a log structure (or series of log structures) to drown out the perched lip of the culvert at low flows. Increases in water surface elevations of 1.5 to 2 ft will likely be satisfactory. The project should be coordinated with non-native fish management and Lahontan Cutthroat Trout (LCT) recovery. This project concept should be integrated with the Town of Truckee's Capital Improvement Project C1607, the "Coldstream Road / Donner Creek Crossing Structure Replacement."	The project will alleviate a partial fish passage barrier and facilitate upstream migration of fish during low flows.	The stability and longevity of the rock and wood structures will be a constraint. The structure(s)' impact on local hydraulics and a potential reduction in flood flow capacity of the culvert are also constraints.	L	N	N	N	M	$$	1 to 3	Med
22	Cold Stream Rd Bridge Fish Passage Barrier Retrofit	Donner Creek	Cold Creek Rd culvert	At low flows, the Cold Stream Rd. culvert acts as a perched culvert and a fish passage barrier. It is also possible that the culvert may be slightly undersized and may act as a hydraulic constriction point during high flows.	The culvert could be replaced with an open span bridge or a larger, bottomless arch culvert to eliminate the passage barrier and reduce any huydraulic constriciton effects of the bridge. This project concept should be integrated with the Town of Truckee's Capital Improvement Project C1607, the "Coldstream Road / Donner Creek Crossing Structure Replacement" (design in FY 16/17; construction in FY 17/18).	The project will alleviate a partial fish passage barrier and the increased flow width will reduce impacts on reach hydraulics and limit backwater effects. However, the benefits of theis project to native and recreational fisheries are unclear.	The bridge replacement may require adjusting the elevation of the road approaches on either side (if the bridge deck elevation is altered).	M	N	N	N	M	$$$ to $$$$	2 to 3	Med

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23	Vehicle Bridge Update or Retrofit	Donner Creek	Vehicle bridge at upstream end of wet meadow reach in Donner Memorial State Park	The single land vehicle bridge spanning Donner Creek may serve as a hydraulic constriction, elevating upstream flood stages and influencing natural physical processes both upstream and downstream.	The bridge could be updated or replaced to have either a broader span and/or a higher deck to reduce the bridge impacts on local hydraulic and physical processes, particularly during higher stream flows. This work could be done as a standalone project for stream health, or as part of future bridge maintenance.	Larger bridge conveyance area will reduce hydraulic constriction effects of the bridge at peak flows	The bridge replacement may require adjusting the elevation of the road approaches on either side (if the bridge deck elevation is altered).	M	N	N	N	M	$$$ to $$$$	2 to 3	Med
24	Removal of Dredging Spoil Piles	Donner Creek	Right bank of Donner Creek downstream of vehicle bridge near gauging station	Spoil material from historic dredging of Donner Creek was left along the top of the stream banks. Today, the spoil pile serves as a partial levee, reducing the stream's potential for inundating its floodplain and influencing current bank erosion processes. Fairly mature trees now stand on some parts of the spoil pile.	The existing spoil pile could be removed, from the right stream bank, which will also necessitate the clearing of some trees from the stream bank. Partial removal of the spoil material could also be considered. Floodplain connectivity could be further enhanced by additional floodplain grading and/or by encouraging beaver to utilize this area.	The project will help create a wider riparian zone and could enhance floodplain connectivity. It may also reduce bank erosion risk and fine sediment loading in this area, both on the right bank and by reducing hydraulic forces on the taller left bank.	Agency and public resistance to clearing of trees and visual impacts of construction may be constraints. Encouraging beaver to use the area may impact the USGS gage and concern the dam operator. Enhanced floodplain connectivity may affect existing uses of near-stream space.	M	L	L	L	M	$$$	2 to 5	Med
25	Concrete Weir Removal	Donner Creek	Concrete weir downstream of gauging station and vehicle bridge	A low elevation concrete weir currently causes a backwater effect that extends upstream to the dam.	The concrete weir could be partially or entirely removed from the stream channel.	The weir's removal will reduce backwater effects and the associated impacts on physical processes and sediment dynamics.	The weir is likely used to support the USGS gaging station located immediately upstream.	M	N	N	N	L	$$	1 to 3	Med
26	Vehicle Bridge Update or Retrofit at Gaging Station	Donner Creek	Vehicle bridge upstream of gauging station in Donner Memorial State Park	The single land vehicle bridge spanning Donner Creek may serve as a hydraulic constriction, elevating upstream flood stages and influencing natural physical processes both upstream and downstream.	The bridge could be updated or replaced to have either a broader span and/or a higher deck to reduce the bridge impacts on local hydraulic and physical processes, particularly during higher stream flows. This work could be done as a standalone project for stream health, or as part of future bridge maintenance.	Larger bridge conveyance area will reduce hydraulic constriction effects of the bridge at peak flows		M	N	N	N	M	$$$	2 to 4	Med
27	Drainage Channel Stabilization	Donner Creek	Left bank of Donner Creek roughly 600 ft downstream of dam	A small drainage channel has experienced erosion and headcutting at its confluence with Donner Creek.	The drainage channel could be stabilized with large wood and/or rock structures to reduce additional erosion and headcutting risks.	The project will reduce erosion of drainage channel and associated loading of fine sediment to Donner Creek		L	N	L	M	L	$	0.5 to 1	Med
28	Donner Lake Dam Fish Passage Retrofit	Donner Creek	Donner Lake Dam	The current dam's construction offers limited opportunity for upstream fish passage, at least in its low flow operation configuration during summer months. It is possible that fish could more feasibly navigate the dam during winter months when the outer gates are opened.	The existing dam's construction could be retrofitted to enhance upstream fish passage. Potential project options include a more comprehensive fish ladder structure. The project should be coordinated with non-native fish management and LCT recovery	The project will enhance upstream fish passage through a greater range of flows and management conditions. However, the benefits to native fish species and roles of this fish ladder in the potential recovery of Lahontan cutthroat trout are unclear.	The reservoir and dam operations may constrain fish passage improvement designs and/or the feasibility of installing a fish ladder.	L	N	N	N	M	$$$ to $$$$$	3 to 5	Low / Med
29	Bank Protection Retrofit	Summit Creek	Lower portion of Summit Creek in residential neighborhoods	The banks of Summit Creek are heavily armored with boulder rip rap and other hard engineering measures (concrete blocks, wooden walls, etc.). The stream channel appears to have limited freedom for lateral migration. The stream banks also offer poor riparian habitat quality in most areas and there is limited cover for aquatic species.	The bank armoring along Summit Creek could be partially or fully retrofitted to feature large wood structures, riparian plantings and erosion control fabric made of natural materials. The banks could also be reprofiled and the rock armoring maintained but covered with a soil amendment, thus providing assurance to property owners but enabling healthier riparian and aqautic habitat areas.	The project will improve riparian and aquatic habitat quality, and reduce the stream's interaction with hardened banks.	Landowner consent to widen the stream corridor, reprofile the banks and remove concrete armoring are likely constraints.	M	N	N	N	M	$$ to $$$$	2 to 10	Med

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30	Summit Creek Bank Stabilization	Summit Creek	Left bank 200 ft upstream of Old Hwy Rd Bridge	The left bank of Summit Creek is currently exhibiting moderate to high severity erosion and likely contributes fine sediment to Summit Creek during high flows.	The left bank could be reprofiled such that the top of the bank is pushed further back from the stream. The toe of the bank could also be protected with large wood structures and riparian plantings and erosion control fabric could we used to further stabilize the bank in a more ecologically friendly manner.	The project will reduce fine sediment loading and improve riparian vegetation conditions at the site.	The landowner will need to agree to reprofiling the bank.	L	N	M	H	L	$$ to $$$	1 to 2	Med
31	Lower Rock Weir Removal	Summit Creek	The lower of three artificial weirs just downstream of Summit and Billy Mack confluence on the former Cadjew parcel	A collection of boulders appear to have been intentionally placed within the stream channel in the configuration of a weir that is covered in fairly dense riparian vegetation. The weir interrupts longitudinal connectivity of sediment processes and impacts local aquatic habitat.	The unimpacted boulders could be removed or redistributed in the channel. They could also be integreated into more natural step-pool features.	Improve physical process and improve longitudinal processes; remove eyesore; may help restore more natural habitat distribution along the reach	Perceived threats to channel stability and flood risk	H	N	N	N	M	$$	1 to 2	Med-High
32	Middle Rock and Concrete Weir Removal	Summit Creek	The middle of three artificial weirs just downstream of Summit and Billy Mack confluence on the former Cadjew parcel	A relatively tall weir constructed of large boulders patchily cemented together spans the full width of the channel. State Park staff expect that the weir was constructed by an earlier land owner for the purpose of creating a swimming hole. Today, it interrupts physical processes, causing unnatural sediment bars and scour patters, and disrupts the longitudinal connectivity of the stream corridor.	The boulders could be redistributed and/or removed from the project site, and the large depositional bar partly redistributed as well. The boulders and gravels could also be integrated into step-pool or other habitat features.	The project will help rehabilitate physical process and improve longitudinal connectivity of sediment transport. It will also remove an eyesore and may help restore a more natural habitat distribution along the reach.	Perceived threats to channel stability and flood risk	H	N	N	N	M	$$	1 to 2	Med-High
33	Upper Rock and Concrete Weir Removal	Summit Creek	The upper of three artificial weirs just downstream of Summit and Billy Mack confluence on the former Cadjew parcel	A relatively tall weir constructed of large boulders patchily cemented together spans the full width of the channel. State Park staff expect that the weir was constructed by an earlier land owner for the purpose of creating a swimming hole. Today, it interrupts physical processes, causing unnaturaly sediment bars and scour patters, and disrupts the longitudinal connectivity of the stream corridor.	The boulders could be redistributed and/or removed from the project site, and the large depositional bar partly redistributed as well. The boulders and gravels could also be integrated into step-pool or other habitat features.	The project will help rehabilitate physical process and improve longitudinal connectivity of sediment transport. It will also remove an eyesore and may help restore a more natural habitat distribution along the reach.	Perceived threats to channel stability and flood risk	H	N	N	N	M	$$	1 to 2	Med-High
34	Bank Protection Retrofit and Stream Corridor Widening	Gregory Creek	Lower portion of Gregory Creek in developed residential areas near Donner Lake	The banks and occasionally the bed of Gregory Creek are heavily armored with boulder rip rap and concrete, and the stream appears to have been channelized for much of its length. The stream banks also offer poor riparian habitat quality and there is limited cover for aquatic species.	Bed armoring could be replaced with native materials ranging in size from fine sands to boulders. Bank armoring could be replaced with more natural materials such as large wood, riparian plantings and erosion control fabric. The banks could also be laid back to widen the active stream corridor.	The project will reduce the stream's interaction with unnatural materials. Widening the corridor could rehabilitate some degree of natural physical processes. The project will also enhance riparian and aquatic habitat.	Landowner consent to widen the stream corridor, reprofile the banks and remove concrete armoring are likely constraints.	M	N	N	N	M-H	$$ to $$$$	2 to 6	Med

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35	Gregory Creek Meadow Habitat and Floodplain Enhancement	Gregory Creek	Large open space immediately downstream of Gregory Creek tributary confluence and immediately north of I-80.	A large open space currently exists that was likely a snow storage site or other staging area for Interstate 80. The site features a small concrete pad as well as a large gravel and dirt surface. A fairly narrow riparian buffer separates Gregory Creek from the open space.	The open space could be converted into a floodplain meadow and wetland complex. Site grading could be combined with increases to the stream bed elevation to encourage floodplain connectivity. A secondary channel could also be constructed through the open space. The floodplain could be designed to have wetland depressions to capture fine sediment coming from the upper watershed. Stormwater treatment wetlands could also be constructed to capture and treat I-80 runoff. This project concept expands on an opportunity identified in the Negro Canyon Assessment.	The project could significantly improve habitat conditions and provide additional meadow, wetland and floodplain environments. Physical processes and floodplain connectivity will also be enhanced. Depending on project design, the site could capture large volumes of suspended sediment and improve downstream water quality.	Elevation of existing open space relative to the stream may require significantt bed elevation increases and/or grading efforts to facilitate floodplain connectivity.	H	M	M	H	H	$$$ to $$$$	2 to 4	High
36	Bank Protection Retrofit and Stream Corridor Widening	Lakeview Canyon	Lower portion of Lakeview Canyon in developed residential areas near Donner Lake	The banks of Lakeview Canyon are armored with boulder rip rap and the stream appears to have been channelized in some places. Where the bank armoring is extensive, the channel offers poor riparian habitat quality and there is limited cover for aquatic species.	Bank armoring could be replaced with more natural materials such as large wood, riparian plantings and erosion control fabric. The banks could also be laid back to widen the active stream corridor in some places where it is artificially confined.	The project will reduce the stream's interaction with unnatural materials. Widening the corridor could rehabilitate natural physical processes. The project will also enhance riparian and intermittent aquatic habitat.	Landowner consent to widen the stream corridor and replace boulder armoring are likely constraints.	M	N	N	N	M	$$ to $$$$	2 to 6	Low/Med
37	Eroding Bank and Hillslope Stabilization	Lakeview Canyon	Right bank and slope roughly 1,500 ft upstream of S. Shore Dr	For a length of approximately 60 feet, the right bank and hillslope exhibit moderate to high severity erosion. Earlier bank erosion appears to have slightly undermined the stability of the hillslope above, leading to sediment loading to Lakeview Canyon.	The bank and hillslope could be stabilized with large wood, riparian plantings and erosion control fabric. A more robust option could also include reprofiling the bank such that the toe extends further out into the channel. Such a project will like require a slightly adjustment of the channel away from the right bank.	The project will reduce fine sediment loading to Gregory Creek and Donner Lake, benefitting water quality, aquatic habitat, and fisheries. The project will also increase riparian vegetation and habitat.	The steepness of the hillslope and the undercutting at some points of the underlying bank may make the work challenging. Heavy equipment access may also be difficult.	L	N	N	M	M	$$ / $$$	1 to 3	Low
38	Cold Creek Railroad Culvert Retrofit	Cold Creek	The railroad culvert on Cold Creek at the horseshoe bend in the railroad line	A single culvert that is passable by vehicle provides the only pathway for surface flows to pass through the railroad enbankment. The culvert's narrow width may cause hydraulic constriction effects and disrupt sediment dynamics along the reach. It also appears that the culvert has contributed to channel destabilization and loss of floodplain connectivity immediately downstream.	A project could involve adding as many secondary 1 to 2 meter diameter culverts on either side of the existing culvert as feasible. This will allow greater floodplain connectivity during high flows and will reduce the destabilizing impact of the culvert. Alternatively, the culvert could be replaced with an open span bridge that has dramatically less impact on physical processes.	The additional culverts or open span bridge will reduce the existing hydraulic constriction, reduce the impact of blockages due to upstream debris being trapped in existing culvert, improve floodplain connectivity and enhance physical processes.	The stability of the railroad enbankment may be a constraint.	H	M	L	M	H	$$$$	3 to 8	High

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39	Stream and Floodplain Large Wood Enhancement	Cold Creek	Cold Creek in meadow reaches below RR culvert	Today, the loading of large wood to Cold Creek is likely significantly less than it was historically, both in terms of the size and quantity of logs. In some areas it appears that the sediment dynamics and channel and floodplain conditions could be enhanced by the addition of large wood.	Large wood structures will be installed at select locations within the Cold Creek channel and on its floodplain following further field and desk-based analysis.	The large wood structures will enhance sediment dynamics, providing opportunities for local deposition and scour. In addition to creating more natural cover, the large wood will enable the creek to better create and maintain diverse aquatic and riparian habitat features. The large wood may also help the stream to more effectively store sediment in its floodplain and trap finer grained material, further enhancing in-stream habitat diversity.	Concerns about the downstream transport of large wood are a likely constraint. Site access in some areas may also be a constraint.	H	L	L	M	H	$$ to $$$	1 to 3	High
Upland Erosion Treatment Projects															
40	Unpaved Road Stabilization and Erosion Treatment	Entire Donner Basin (including Cold Creek)	Numerous Sites Throughout Donner Basin, Mostly Located in Backcountry Areas	Numerous unpaved roads, particularly in backcountry areas, exhibit significantt erosion problems today and contribute large volumes of fine sediment to the watershed. Many of these roads were created for logging purposes and are no longer actively used or maintained. However, due to steep slopes and unstable soils, many areas continue to suffer from unabated erosion issues.	Unpaved roads throughout the Donner Basin could be enhanced, decommissioned or otherwise improved to reduce or eliminate local erosion problems. Site identification should draw on the Erosion Hazard Analysis and the road prioritization based on slope and soil erodibility. Projects may consist of full hillslope recontouring, addressing drainage problems, reducing road width and a large array of other maintenance and stabilization actions. Scale of projects will depend on severity of erosion, funding and coordination with land managers.	The stabilization of eroding unpaved roads will reduce fine sediment yields to the watershed and help improve water quality. Projects may also serve to mitigate historic hydrology impacts assocated with logging and road construction. Upland forest and meadow habitat could also be improved directly, and may improve indirectly from reduced backcountry off-road vehicle traffic.	Further site prioritization will be necessary and will likely require additional field efforts. Coordination with land managers will be required, especially where roads provide access (e.g., to the railroad). The ability to revegetate steep hillslopes successfully may be challenging due to harsh climatic conditions.	M/H	M	H	H	M/H	$$ to $$$$$	0.5 to 10+	High
41	Donner Lake Road Hillslope Erosion Treatment	Johnson Canyon / Donner Lake	Donner Lake Rd	The road cut for Donner Lake Road has created a particularly steep hillslope on the uphill side of the road that has failed to stabilize in a number of locations. Ongoing hillslope erosion likely transports significantt volumes of fine sediment to downstream drainage channels and Donner Lake.	The eroding hillslope could be stablized using a combination of various materials including large wood or logs, soil amendments, natural fabrics (such as coir or jute) and and revegetation with native, drought-tolerant grasses and sedges.	The project will reduce fine sediment yields and mitigate some hydrology impacts from the road's construction.	Ability to revegetate successfully with harsh climatic conditions - may require need adaptive management techniques.	L	L	M	M	M	$$ to $$$	1 to 3	Med
42	Hillslope Erosion Treatment at I-80 Overpass	Johnson Canyon	Donner Lake Rd / I-80 Overpass	The enbankments of I-80 are particularly steep and appear to suffer from hillslope erosion (gulley and rill erosion). Ongoing erosion and a lack of vegetation likely result in fine sediment transport to downstream locations. Some minor erosion control measures have been installed but are unlikely to fully address the issue.	The eroding enbankment could be stablized using a combination of various materials including large wood or logs, soil amendments, natural fabrics (such as coir or jute) and revegetation with native, drought-tolerant grasses and sedges. The project will need to be coordinated with CALTRANS.	The project will reduce fine sediment yields and mitigate some hydrology impacts from the road's construction.	Ability to revegetate successfully with harsh climatic conditions - may require need adaptive management techniques.	L	L	M	M	M	$$ to $$$	1 to 3	Med
43	S. Shore Drive Hillslope Erosion Treatment	Donner Lake	S. Shore Dr	The road cut for S. Shore Drive created a particularly steep hillslope on the uphill side of the road that has failed to stabilize in a number of locations. Ongoing hillslope erosion likely transports significantt volumes of fine sediment to downstream drainage channels and Donner Lake.	The eroding hillslope could be stablized using a combination of various materials including large wood or logs, soil amendments, natural fabrics (such as coir or jute) and and revegetation with native, drought-tolerant grasses and sedges.	The project will reduce fine sediment yields and mitigate some hydrology impacts from the road's construction.	Ability to revegetate successfully with harsh climatic conditions - may require need adaptive management techniques.	L	L	M	M	M	$$ to $$$$	1 to 3	Med

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44	Hillslope Erosion Treatment along Interstate-80 Road Cut	Donner Basin	Various locations along I-80 corridor, particularly in steeper portions of the watershed.	The road cut for Interstate 80 has created a particularly steep hillslope on the uphill side of the road that has failed to stabilize in a number of locations. Ongoing hillslope erosion likely transports significantt volumes of fine sediment to downstream drainage channels and Donner Lake.	Eroding hillslopes could be stablized using a combination of various materials including large wood or logs, soil amendments, natural fabrics (such as coir or jute) and and revegetation with native, drought-tolerant grasses and sedges. Coordination with CALTRANS will be required.	The project will reduce fine sediment yields and mitigate some hydrology impacts from the interstate's construction.	Ability to revegetate successfully with harsh climatic conditions - may require need adaptive management techniques.	L	L	M	M	M	$$ to $$$$	1 to 3	Med
45	Railroad Grade Hillslope Erosion Stabilization	Entire Donner Basin (including Cold Creek)	Various locations along the railroad corridor	Grading for the railroad cut created steep, bare hillslopes in many areas along the railroad line. Particularly where these steep hillslope coincide with easily erodible soils, the grading cuts have failed to stabilize. Ongoing hillslope erosion likely transports significant volumes of fine sediment to Summit Creek, Lakeview Canyon and Donner Lake.	Eroding hillslopes should be stabilized using a combination of various materials including large wood or logs, soil amendments, natural fabrics (such as coir or jute) and revegetation with native, drought-tolerant grasses and sedges. In some cases, more intensive geotechnical stabilization efforts may be necessary.	The stabilization of eroding hillslopes will reduce fine sediment yields to the watershed and help improve water quality. Projects may also lessen historic hydrologic impacts associated with the railroad's construction. Upland forest and meadow habitat may also be improved.	Ability to revegetate successfully with harsh climatic conditions - may require need adaptive management techniques.	M	L	H	H	M	$$$ to $$$$$	1 to 10+	Med / High
46	Residential Stormwater Ditch Erosion Treatment	Donner Basin	Various	Some residential stormwater ditches currently exhibit erosion issues, which may contribute fine sediment to downstream water bodies.	Ditches could be stabilized by installing rocks or wood structures, or lining them with concrete or asphalt as necessary (though less desirable). In some cases, complete retrofitting of ditches could be done with Low Impact Development features that promote infiltration.	Reduce fine sediment yields	Limited space availability may constraint the options for more ecologically-friendly options that help slow flows and promote infiltration.	L	L	M	M	L	$$ to $$$$	0.5 to 3	Low / Med
47	Erosion Stabilization of Public Dock Footpaths	Donner Lake	Donner Pass Road	A number of footpaths connecting public docks to Donner Pass Road show ongoing erosion problems that likely contribute fine sediment to the lake	Trail stabilization and erosion control measures can be implemented along the public dock footpaths that include installing stepping stones, wooden boardwalks, water bars, soil amendments and surface treatments	Reduce fine sediment yields		L	N	L	L	L	$ to $$	< 1	Low
Stormwater Treatment Projects															
48	Stormwater Treatment Wetland Complex and Educational Site	Donner Creek	North of I-80 near high school and athletic fields	Stormwater from commercial areas, roads, the high school and athletic fields currently drains to a ditch along the north side of I-80 and into Donner Creek. This ditch offers minimal stormwater treatment and many pollutants flow directly into Donner Creek. At present, land alongside the ditch has minimal use, particularly to the north.	A stormwater treatment wetland complex will be constructed in the area of the existing ditch. Multiple wetlands or treatment cells will capture stormwater and improve water quality. The complex will create a living classroom for the neighboring high school's environmental education programs, featuring a board walk and signs. The site offers an unusual opportunity within a highly developed portion of the basin to intercept stormwater from a significant urban area before it enters Donner Creek.	The treatment wetland complex will improve water quality by capturing urban stormwater pollutants and fine sediment. Depending on the design of the wetland complex, the project will help reduce peak stormwater flows entering Donner Creek. The complex will also provide a wetland habitat area and improve the quality of riparian habitats.	The project will require the support of land managers and the repurposing of land as a stormwater treatment wetland complex. A sewer line passes through the project site.	M	H	H	H	M	$$$ to $$$$$	2 to 5	High

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ID	Project Name	Stream / Watershed	Location	Existing Conditions	Project Description	Benefits	Potential Constraints	Benefits [1]					Cost [2]	Timeline (yrs)	Priority
								Physical Processes	Hydrology	Water Quality	Fine Sediment Reduction	Habitat			
49	Stormwater Infiltration and Treatment Along I-80	Donner Creek	The southern edge of I-80 along the highly channelized section of Donner Creek between Cold Creek Rd and Highway 89	Much of the stormwater from the interstate's east-bound traffic currently drains directly off the edge of the pavement and into Donner Creek. This stormwater likely transports of a large array of pollutants as well as trash into Donner Creek, leading to water quality impairment and trash accumulation.	Stormwater from the interstate will be captured in a stormwater treatment feature constructed immediately between the southern edge of pavement and the top of the Donner Creek stream bank. Designs will involve a stormwater trench, percolation drain or grass swale. The feature will be divided into cells to further enhance treatment and infiltration. Soil amendments or replaceable media will also be used to enhance capture of stormwater pollutants.	Most significant will be the water quality improvements realized from capturing stormwater pollutants. The stormwater treatment feature will help reduce and attenuate some of the hydrology impacts by detaining a portion of the runoff from the interstate. The feature may also assist with reducing fine sediment loading from pulverized traction sand and minor hillslope erosion due to stormwater concentration.	Available space along the highway corridor between the edge of pavement and Donner Creek's stream bank is limited. Depending on the the project design and materials, regular maintenance may also be required.	N	M	H	M	N	$$$ to $$$$$	2	High
50	I-80 Stormwater Management and Erosion Reduction Projects	Summit Creek / Donner Basin	Along I-80 corridor, particularly in steeper portions of Donner Basin (i.e. those west of the eastern end of Donner Lake)	In many locations, the construction of the interstate resulted in the artificial concentration of runoff from uphill areas into stormwater drains and culverts passing under the highway. Combined with increased runoff volumes from the paved road surfaces, this concentrated stormwater causes hillslope erosion problems and gullying, and carries pollutants from the roadway to downstream channels and Donner Lake. Hillslope erosion and gullying are worst in areas with steep slopes and highly erodible soils.	To address the concentration of runoff and associated erosion problems, small-scale BMPs will be installed at the outlets of stormwater culverts. Where space is available, small settling basins or infiltration features could be developed. In other locations where little to no space is available, energy dissipation devices, slope drains, "hydro brakes" and other BMPs could be pursued.	Projects could reduce the concentration of stormwater on the downhill side of Interstate 80. In turn, this could reduce the hillslope erosion and gullying that currently occurs in some areas thereby reducing the fine sediment loading to tributaries and Donner Lake.	Space availability for BMPs along the interstate is very limited, especially in the steeper sections Donner Basin. Retrofitting many sites may also be cost-prohibitive.	M	H	M/H	M	L	$$$ to $$$$$	0.5 to 10+	High
51	Treatment of I-80 Stormwater by Gregory Creek	Gregory Creek	Snow storage yard / Land Trust property in Gregory Creek tributary confluence floodplain	Stormwater from I-80 and Donner Lake Rd may pass relatively unimpeded and untreated into Gregory Creek	Stormwater treatment BMPs will be installed to intercept runoff from I-80 or to treat peak flows diverted from Gregory Creek during high flow events	Improve water quality by capturing pollutants and traction sand in road runoff.	Coordination with landowners and CALTRANS.	L	H	M	M	L	$$ to $$$	1 to 4	Med / High
52	Residential Stormwater and Erosion Treatment	Donner Basin	Entire Basin	Residential development has altered the land surface and hydrology of many parts of Donner Basin, leading to stormwater and soil loss problems. Construction of residences, particularly in areas with steep slopes, required land grading and in many areas soils have not yet fully stabilized or revegetated. Due to impervious surfaces, changes in vegetation, soil compaction and other changes, the manner in which rainfall infiltrates and runs off has changed on many residential lots. Runoff derived from public infrastructure such as roads also causes stormwater and erosion problems on some residential properties. Many natural drainages passing through residential property also exhibit erosion due to road culverts and other development pressures.	Actions can be taken across the basin to address stormwater concerns in developed areas that include both private and public land. TRWC's River-Friendly Landscaping program, which provides funding for updating residential landscaping to reduce soil erosion, should be continued and expanded. Other actions including the installation of Low Impact Development (LID) measures can also address stormwater problems at the source. Specifically, stormwater flowpath disconnection, rainwater and snowmelt harvesting, vegetated swales, bioretention areas and infiltration trenches may be utilized to capture stormwater before it reaches downstream properties or water bodies. Natural drainages facing human-induced erosion issues can also be stabilized to address erosion concerns.	Installing LID measures and continuing efforts like the River-Friendly Landscaping program will help reduce the volume of stormwater generated by land development and lessen the resulting erosion problems it can cause. They can also reduce the likelihood of soil erosion to begin with, and, where it has already occurred, these efforts can help capture fine sediment before it reaches streams or Donner Lake.	Addressing residential stormwater issues requires the support of property owners. Resolving stormwater problems that are created by public infratstructure such as roads and highways also requires coordination with appropriate agencies. In some areas, physical space and existing land use may also be obstacles for addressing residential stormwater and erosion issues with landscaping and LID practices.	M	H	H	H	M	$$ to $$$$$	0.5 to 2	Med / High

[1] Benefits: H = High; M = Moderate; L = Low; N = None [2] Cost: $ < $10K; $$ = $10K to $100K; $$$ = $100K to $500K; $$$$ = $500K to $1M; $$$$$ > $1M

Table 10. Identified restoration project and management opportunities for Donner Basin

ID	Project Name	Stream / Watershed	Location	Existing Conditions	Project Description	Benefits	Potential Constraints	Benefits [1]					Cost [2]	Timeline (yrs)	Priority
								Physical Processes	Hydrology	Water Quality	Fine Sediment Reduction	Habitat			
Trash Clean Up															
53	Trash Cleanup At Abandoned Homeless Camp 1	Donner Creek	Along left bank of Cold Creek just upstream of Donner and Cold Creek confluence	Trash and debris have been left behind at makeshift camps	Remove trash and redistribute leaf litter, sticks and other natural materials	Eliminate potential trash source to Donner Creek during high flow events and remove visual eye sore for the stream corridor		N	N	L	N	L	$	<1	Low
54	Trash Cleanup At Abandoned Homeless Camp 2	Donner Creek	On gravel bars upstream of RR culvert on left bank	Trash and debris have been left behind at makeshift camps	Remove trash and redistribute leaf litter, sticks and other natural materials	Eliminate potential trash source to Donner Creek during high flow events and remove visual eye sore for the stream corridor		N	N	L	N	L	$	<1	Low
55	Trash Cleanup At Abandoned Homeless Camp 3	Donner Creek	Upstream of Hwy 89 crossing	Trash and debris have been left behind at makeshift camps	Remove trash and redistribute leaf litter, sticks and other natural materials	Eliminate potential trash source to Donner Creek during high flow events and remove visual eye sore for the stream corridor		N	N	L	N	L	$	<1	Low
Management Actions															
56	Reference Reach Protection in State Park	Donner Creek	Eastern extent of Donner Memorial State Park	The reach flowing through the eastern portion of the state park exhibits the highest degree of physical and ecological function present along Donner Creek. A broad and well-connected floodplain is further enhanced by numerous beaver dams which creates large wetland habitat areas, backwater channels and diverse in-channel habitat.	Maintaining the physical and ecological functions of this section of Donner Creek is strongly recommended. In particular, floodplain connectivity and the presence of beaver should be maintained and encouraged as possible. Future management within Donner Memorial State Park. Future trails and access road construction, wildlife management and vegetation management should be performed such that impacts to this reach are negligible.	The ongoing protection of this reach will maintain healthy physical processes and high-quality stream, floodplain and wetland habitat which are otherwise extremely limited along the Donner Creek corridor between Donner Lake and the Truckee River.		H	H	H	H	H	$ to $$	N/A	High
57	Two-Stroke Engine Phase-Out on Donner Lake	Donner Lake	Donner Lake	Carbureted and electronic-injection two-stroke engines are considered high-emission engines. Most of these engines were manufactured prior to 1999. A carbureted two-stroke engine could emit up to 25-30 percent of its fuel unburned into the water or atmosphere, which is significantly higher than four-stroke engines or other modern engine designs.	A ban on carbureted and electronic-injection two-stroke engines could be implemented on Donner Lake to reduce fuel contamination, similar to the program on Lake Tahoe. Since 2001, there has been a ban on the use of all two-stroke engines on Lake Tahoe that are not direct fuel injection (DFI) or that do not meet California and EPA emissions standards. The ban could be implemented at all boat launch sites on Donner Lake.	The ban will reduce the contamination of Donner Lake from unburned fuel coming from carborated and electric two-stroke engines and thereby improve water quality.	Boat owners that still own and operate two-stroke engines that will not meet the emissions standards may resist such a ban. Enforcing the ban will required coordination at all boat-launching sites. Light weight motorized watercraft can also be carried by hand to the lake shore at some locations.	N	N	M	N	L	$ to $$	1 to 3	Low / Med
58	Reservoir Operations Modifications to Provide More Natural Flow Regime in Donner Creek	Donner Lake	Donner Lake	The management of Donner Lake as a reservoir alters the timing and magnitude of flows that enter Donner Creek at the lake's outlet, which generally causes two categories of impacts. The first is that the peak magnitude of spring snowmelt flows in Donner Creek is often dampened, which reduces the stream's capacity for geomorphic work and instream habitat. The second impact is the altered timing and magnitude of base flows, which affects the composition and abundance of aquatic wildlife communities in Donner Creek.	The operations regime for Donner Lake could be modified to lessen the impact of reservoir management on physical processes and ecology of Donner Creek and Donner Lake. Active monitoring of rainfall and stream gages could be used to adjust reservoir managment such that peak flows can occur uninhibited during the largest event(s) of the spring season. Flow release schedules could also be modified to allow greater amounts of flow to pass through Donner Creek earlier in the season (e.g., late spring and early summer rather than the fall) and to allow occasional periods of low flow in Donner Creek during drier months in summer and fall to mimic pre-reservoir conditions.	Allowing peak flows to occur during the spring, especially those caused by the spring snow melt, will enhance Donner Creek's capacity for geomorphic work. This in turn will enable the stream to create and maintain habitat features. The changes to the flow release schedule could also provide a more natural flow regime in Donner Creek, which will generally better support native organisms that live in the creek. Low flow conditions in summer and fall will mimic natural conditions, encourage beaver activity, and discourage the movement of non-native fish species.	Water operations are constrained by water rights, supply needs, flood control, and the Truckee River Operating Agreement. Water released from Donner Lake likely helps to maintain favorable habitat conditions for recreational fisheries in the Truckee River downstream of the Donner Creek confluence.	H	H	L	L	H	$ to $$$$	1 to 10+	Med / High

[1] Benefits: H = High; M = Moderate; L = Low; N = None

[2] Cost: $ < $10K; $$ = $10K to $100K; $$$ = $100K to $500K; $$$$ = $500K to $1M; $$$$$ > $1M

Table 10. Identified restoration project and management opportunities for Donner Basin

ID	Project Name	Stream / Watershed	Location	Existing Conditions	Project Description	Benefits	Potential Constraints	Benefits [1]: Physical Processes	Benefits [1]: Hydrology	Benefits [1]: Water Quality	Benefits [1]: Fine Sediment Reduction	Benefits [1]: Habitat	Cost [2]	Timeline (yrs)	Priority
59	Comprehensive Forest Management Plan	Donner Basin	Donner Basin forests	Forest habitat diversity is lacking in the lower elevation portions of the watershed, primarily due to historic logging and development. Current forest management practices focus on fuel and fire risk reduction may not promote regional habitat diversity. Opportunities may exist to integrate habitat management goals with fuel reduction goals to achieve a healthier and more diverse forest condition.	Forest management policy development and strategies should be coordinated with State Parks and Tahoe National Forest to promote greater habitat diversity through the implementation of fuel and fire risk reduction efforts.	Increases in habitat diversity in mixed coniferous forests in the watershed will promote forest health and benefit resident and migratory wildlife species.		L	L	L	L	H	$$	1 to 10+	Med
60	Watercraft Inspections for Aquatic Invasive Species	Donner Basin	Donner Lake	The introduction or transport of aquatic invasive species presents a significant threat to the ecology and recreational uses of lakes, streams, and wetlands in the watershed. Multiple aquatic invasive animals, like New Zealand mud snail, and plants, like Eurasian watermilfoil, occur in the surrounding regions. These species could be transported to the watershed by recreational water users, such as boaters, rafters, or anglers. Asian clam occur in Donner Lake and are likely to spread downstream through Donner Creek and into the Truckee River.	Support and adapt watercraft inpections and implement other measures to prevent the spread or introduction of aquatic invasive species. Provide adequate decontaminations to high-risk watercraft traveling to the atershed from infested or suspected infested locations.	Protect water quality and aquatic resources. Prevent future environmental degradation from aquatic invasive species.	Regional policies and local ordinances to implement and enforce the inspection and prevention program in the waterhsed requires colaboration across multiple local jurisdictions.	N	N	L	N	H	$ to $$	1+	Med / High
61	Public Education to Prevent Aquatic Invasive Species	Donner Basin	Public Access and Water Recreation Locations	The introduction or transport of aquatic invasive species presents a significant threat to the ecology and recreational uses of lakes, streams, and wetlands in the watershed. Multiple aquatic invasive animals, like New Zealand mud snail, occur in surrounding regions. This species could be transported to the watershed by recreational water users, such as boaters, rafters, or anglers. Asian clam also occur in Donner Lake and are likely to spread downstream through Donner Creek and into the Truckee River.	Continue and expand education and awerness efforts for the prevention of aquatic invasive plant tranport or introduction to the watershed. Focus on high-risk user groups and utilize signage at high use access and/or launching areas. Collaborate with regional education programs to better inform water users of the risks of tranporting aquatic invasive species before traveling to the watershed.	Protect water quality and aquatic resources. Prevent future environmental degradation from aquatic invasive species.	Effective aquatic invasive species prevention programs require regional collaboration across multuiple resource managers and local jurisdictions.	N	N	N	N	H	$ to $$	0.5+	Med
62	Public Education to Prevent Aquatic Invasive Plants	Donner Basin	Donner Basin	The introduction or transport of aquatic invasive species presents a significant threat to the ecology and recreational uses of lakes, streams, and wetlands in the watershed. Multiple aquatic invasive plants, like Eurasian watermilfoil, occur in surrounding regions. This species could be transported to the watershed by recreational water users, such as boaters and rafters.	Continue and expand education and awerness efforts for the prevention of aquatic invasive plant tranport or introduction to the watershed. Focus on high-risk user groups and utilize signage at high use access and/or launching areas. Collaborate with regional education programs to better inform water users of the risks of tranporting aquatic invasive species before traveling to the watershed.	Protect water quality and aquatic resources. Prevent future environmental degradation from aquatic invasive species.	Effective aquatic invasive species prevention programs require regional collaboration across multuiple resource managers and local jurisdictions.	N	N	M	N	H	$ to $$	0.5+	Med

[1] Benefits: H = High; M = Moderate; L = Low; N = None [2] Cost: $ < $10K; $$ = $10K to $100K; $$$ = $100K to $500K; $$$$ = $500K to $1M; $$$$$ > $1M

Table 10. Identified restoration project and management opportunities for Donner Basin

ID	Project Name	Stream / Watershed	Location	Existing Conditions	Project Description	Benefits	Potential Constraints	Benefits [1]					Cost [2]	Timeline (yrs)	Priority
								Physical Processes	Hydrology	Water Quality	Fine Sediment Reduction	Habitat			
63	Invasive Weed Inventory, Removal and Management	Donner Basin	Donner Basin upland / terrestrial areas	The introduction and colonization of invasive terrestrial weeds significantly impacts the ecology of the Donner Basin's upland and riparian habitats.	Build upon existing TRWC invasive weed inventories and management/removal efforts. Inform management with focused surveys for new infestations and best management practices for weed prevention. Utilize regional partners and local volunteer groups to increase awerness and participation in removal efforts. Educate local nurseries on noxious plant species in the watershed.	Improve and protect habitat quality. Maintain native plant diversity in the watershed, which in turn will benefit resident and migratory wildlife.		N	N	N	N	H	$ to $$	0.5+	Med
64	Wildlife Survey and Inventory Studies	Donner Basin	Upland forests and other habitat areas	Although annual or semi-annual monitoring has been conducted recently at known breeding sites and/or Protected Activity Areas, regional surveys or habitat assessments have not been condudted in greater than ten years.	Conduct focused surveys for goshawk, spotted owl, and forest carnivores in suitable habitat areas throughout the watershed. Conduct point count surveys for migratory birds in representative land cover types to determine relative abundance and local habitat associates.	Recent surveys and inventories will better inform wildlife and habitat management efforts in the watershed. This effort will also benefit other proposed restoration and managemrnt projects in the watershed, such as comprehensive forest management planning.		N	N	N	N	M	$ to $$$	0.5+	Med
65	"Care For Our Watershed" Program	Donner Basin	Donner Basin	Common water pollution sources associated with rural development, such as herbicides, pesticides, petroleum-based products, fertilizers, or pet fecies, may contribute to the water quality impacts in the watershed.	Educate local communities and park visitors about the health of Donner Lake and the existing risks to water quality. Encourage residents and visitors to clean up after their pets, and potentially provide resources (e.g., bags and trash cans) for this. Also encourage local communities to use fertilizers, herbicides and pesticides judiciously (or not at all) and avoid the use of chemicals / oils on their property (e.g., discourage people from changing oil for a vehicle at home). Existing programs such as the River-Friendly Landscaping program can also be integrated into these efforts.	Increased public awareness and education will help improve Donner lake water quality by reducing reduce the quantity of pollutants from recreation, gardens/yards, driveways, streets and other land uses.		N	N	L/M	N	N	$ to $$	0.5+	Low
66	Comprehensive Multi-Agency Recreation Management Plan	Donner Lake	Donner Lake and shoreline areas	Comprehensive coordination among various stakeholders and agencies with interests in Donner Lake and its shoreline is sometimes lacking, resulting in inconsistent management practices and occasional detriment to lake and shoreline habitat.	A comprehensive, multi-agency recreation plan should be developed for Donner Lake which includes the management of trails, docks and dock access, boat ramps, beaches and other shoreline areas.	More efficient allocation of resources, improved maintenance and protection of lake and shoreline habitat, and better management of public amenities and infrastructure around Donner Lake.		N	N	L/M	L	L/M	$ to $$	1+	Low

[1] Benefits: H = High; M = Moderate; L = Low; N = None [2] Cost: $ < $10K; $$ = $10K to $100K; $$$ = $100K to $500K; $$$$ = $500K to $1M; $$$$$ > $1M

5.1.1 Reservoir Operation and Flow Release Schedule Recommendations

The recommendations in this report regarding reservoir operations are intended as a starting point only and are focused exclusively on improving physical processes and ecological conditions within Donner Lake and Donner Creek. This assessment does not include an analysis of Donner Lake's role in water supply and flood protection needs as part of the larger network of tributaries and reservoirs within the Truckee River watershed. Furthermore, the recommendations provided here do not fully consider the constraints of flood protection, downstream water supply (both volume and timing), and recreational objectives (e.g., maintaining high lake levels through the summer). Modifications to the reservoir operations of Donner Lake that are intended to improve physical processes and ecology within Donner Lake and Donner Creek would need to be compatible with future uses and regulations. Coordination would be required with the dam operator (Truckee Meadow Water Authority), the Truckee River Operating Agreement (TROA) Administrator, the California Department of Water Resources Division of Safety of Dams, and other relevant agencies.

Existing Conditions

Reservoir operations of Donner Lake and flow releases into Donner Creek are subject to regulation (e.g., Truckee River Operating Agreement), flood protection requirements (e.g., winter water storage), various water supply interests and an informal agreement regarding minimum flows. The management of Donner Lake as a reservoir affects the lake in a number of ways. The maintenance of the dam at the Donner Lake outlet artificially increases water levels of the lake, while releases and storage cause significant inter-annual variability in water levels. This in turn affects shoreline conditions and ecology as well as the species that utilize the lake. The dam also restricts the movement of fish between Donner Lake and Donner Creek.

Donner Lake reservoir management also alters the timing and magnitude of flows that enter Donner Creek at the lake's outlet (see Section 3.1.2 for more detail), which generally causes two categories of impacts to Donner Creek. The first is that the peak magnitude of spring snowmelt flows in Donner Creek is often dampened, which reduces the stream's capacity for geomorphic work. The second impact is the altered timing and magnitude of base flows, which affects the composition and abundance of aquatic wildlife communities (Fausch et. al. 2006).

Recommendations

Studies of flow management on the Truckee River (especially of TROA) and reservoir operations of Donner Lake are strongly recommended. These efforts should include detailed analysis using RiverWare software to better understand what options exist for changing flow management within the Donner Basin.

Preliminary recommendations include adjusting the operations regime for Donner Lake to more closely mimic a natural flow regime and lessen the impact of reservoir management on physical processes and ecology of Donner Creek and Donner Lake. Active monitoring of rainfall and stream gages could be used to adjust reservoir management such that peak flows pass through Donner Lake uninhibited (or less inhibited) during the largest event(s) of the spring season.

To further support the strategy of reducing impacts to peak flows in Donner Creek during the spring and to compensate for un-captured spring flows, regulations could be adjusted to permit reservoir filling earlier in the season. Specifically, the typical April 15th gate closure date for Donner Lake dam could be modified, if storage is available, to allow for partial filling earlier in the season. Any changes to the timing of reservoir filling would need to be done in agreement with California's Division of the Safety of Dams and the dam operator, Truckee Meadow Water Authority.

Another possibility for reducing the impacts of reservoir releases on Donner Creek flows is releasing a portion of stored water from Donner Lake into Donner Creek earlier in the season (e.g., late spring and early summer rather than the fall as is currently the case). These changes could also potentially be made to provide base flows and cooler water temperatures to the Truckee River during the late summer. However, these modifications would require changes to the timing of downstream water supply deliveries and would affect summer-time lake levels.

Reservoir operations could also be adjusted to allow occasional periods of little to zero flow in Donner Creek during droughts to mimic pre-reservoir conditions. During these times, it is possible that riffle crests of Donner Creek may have dried out in some locations, creating isolated pools of water and restricting the movement of fish and other aquatic organisms along the channel length. Such a change to flow operations would need to be coordinated with current efforts to maintain minimum flows in the stream, which we expect are intended to maintain desirable conditions for sport fishing species within the Donner Creek fishery.

Benefits

Allowing larger peak flows to occur during the spring, especially those caused by the spring snow melt, will enhance Donner Creek's capacity for geomorphic work. This in turn will enable the stream to create and maintain a healthy diversity of habitat features. Potential modifications to the flow regime in Donner Creek could benefit native and recreational fisheries in the creek and the Truckee River. Larger releases during spring months would provide higher flows for upstream migration of native fish species, such as Lahontan cutthroat trout and mountain whitefish. Sustained flows during the summer months, when air temperatures are highest, provides a cold water supply to Donner Creek and Truckee River, which benefits native resident fish like sculpin and minnows.

Constraints

Adaptations to reservoir operations and flow releases to Donner Creek would need to be made through careful consideration of local and federal regulations, flood control practices, water rights, water supply management needs, and existing minimum flow agreements. Annual variations in precipitation and local hydrology would also need to be considered. Coordination would be required with a number of organizations and agencies.

5.2 PRIORITIZED PROJECTS

Following the opportunity identification and prioritization process, a subset of the highest-priority opportunities were selected for further development in project sheets. The project sheets provide more detailed information on existing conditions, project description, anticipated benefits, potential constraints and order of magnitude cost estimates. They also include photos, maps and concept sketches to further communicate the project components. The project sheets were developed for the following thirteen opportunities (not listed in any order of priority; corresponding project numbers from Table 10 and Figures 60 and 61 provided in parentheses after project name):

- Donner Lake Projects and Management Recommendations (47, 57, 58, 60, 61, 62 and 65)
- Mobile Home Park Floodplain Restoration (3)
- Bank Stabilization Downstream of Railroad Culvert (5)
- Bank Stabilization and Channel Enhancement Along Highway 89 (7)
- Donner Creek Channel Realignment and Floodplain Restoration (9 - 14)
- Large Wood and Habitat Enhancement (15)
- Stream and Floodplain Restoration at Donner and Cold Creek Confluence (18 and 19)
- Gregory Creek Meadow Habitat and Floodplain Enhancement (35 and 51)
- Unpaved Road Stabilization and Erosion Treatment (40)
- Railroad Grade Hillslope Erosion Stabilization (45)
- Stormwater Treatment Wetland Complex and Educational Site (48)
- Stormwater Infiltration and Treatment Along I-80 (49)
- I-80 Stormwater Management and Erosion Reduction Projects (50)

While implementing any of the above projects and management recommendations is considered highly beneficial, the success of in-channel habitat restoration projects in Donner Creek may be enhanced by the implementation of upland projects that significantly reduce sediment yields to Donner Creek. An ideal sequencing would begin with unpaved road and railroad grade erosion stabilization projects for areas that flow directly into Donner Creek (i.e. those below Donner Lake) while the in-channel habitat restoration projects (sites 3, 9-14, 18, and 19) would follow (or be constructed concurrently). Similarly, the project concept proposed for the open space along Gregory Creek (site 35) would likely have enhanced success following the implementation of upstream unpaved road erosion stabilization projects. Implementing the two bank stabilization projects along Donner Creek between Highway 89 and W. River St. in the near future is also recommended as unabated erosion will threaten public infrastructure and private residences, and less ecologically-sensitive solutions may be adopted by other parties. The sequencing of the other project sites is not considered to be as sensitive. However, we also recognize that the reality of coordinating project funding, stakeholder agreements and permitting may make it difficult to follow this sequencing without jeopardizing project opportunities, and we believe that project implementation in any sequencing would be highly beneficial to the basin's health.

It should also be noted that the project sheets are not intended to be an exhaustive list of the high-priority projects within the Donner Basin. There are many other opportunities that would significantly benefit the watershed. Of these, several may have lower cost-benefit ratios but will likely be smaller in overall impact. Overall, projects were selected with consideration of TRWC's mission and describe projects that would offer significant uplift of the basin's physical and ecological health.

Additionally, it is important to note that the projects presented in the following sheets are intended to be concept-level only. Further assessment will be required to evaluate constraints, project feasibility, design details, permitting and project scope. Cost estimates provided in the sheets indicate order of magnitude cost only. A range of costs is provided when there exists a significant range in project size, construction and land acquisition costs, and scale of implementation (e.g., for unpaved road erosion treatment, the full basin could be addressed or only a select number of sites could be treated).

Donner Basin
Donner Lake Projects and Management Recommendations

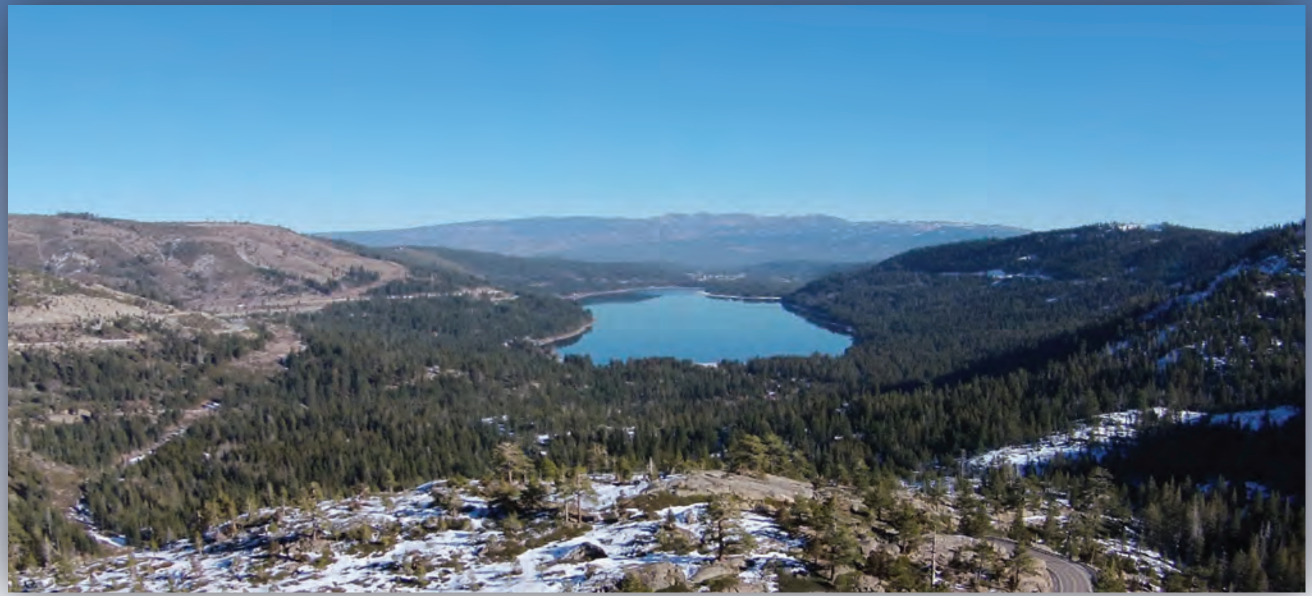
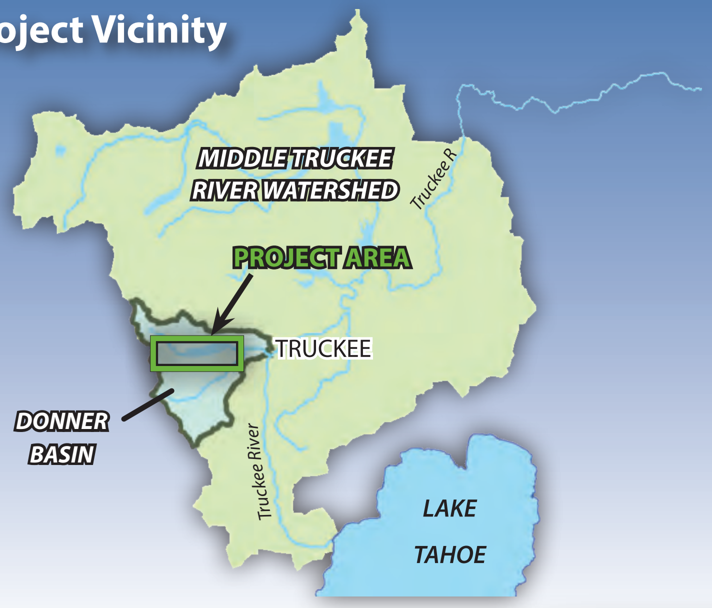


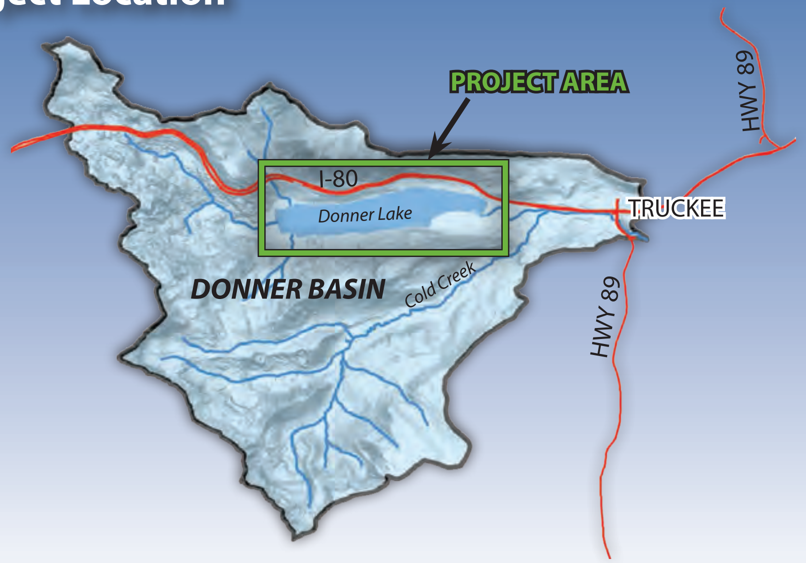
Photo by Chris Bowles, cbec

truckeeriverwc.org

Project Vicinity



Project Location



Overview

Donner Lake is a glacially-formed lake that today serves as a significant habitat area, water supply reservoir and recreation destination. The lake captures runoff and snowmelt from 14.3 square miles of Donner Basin, much of which enters the lake via Summit Creek, Gregory Creek and Lakeview Canyon. Starting in the 1860s, the outlet of Donner Lake was artificially dammed by the logging industry, and in 1929 the present-day dam was constructed for water supply and flood control. Today, the Truckee Meadows Water Authority operates the dam and controls water levels in the upper 11.8 feet of the lake for municipal, industrial, hydropower and irrigation uses. Biological habitat values of the lake include aquatic habitat for fish and invertebrates, wetland and riparian habitat for plants, resident wildlife, and migratory birds and foraging habitat for osprey, bald eagles, and other birds. The lake is also frequented by residents and visitors who enjoy boating, swimming, fishing and beach and shoreline use.

Current Challenges

Water Quality Degradation

Due to the many uses within the Donner Basin, there are a large number of potential pollutant sources to Donner Lake including roads and highways, the railroad, commercial and urban areas, water vessels, and residential properties. Some chemicals may also reach the basin via atmospheric transport and deposition. The concentration of arsenic, polychlorinated biphenyls (PCBs) and chlordane in Donner Lake exceeds standards set for fish tissue, which is of concern for human health. The high levels of fine sediment loading due to soil erosion in the watershed are also of concern.

Aquatic Invasive Species (AIS)

Aquatic invasive species significantly threaten the ecology, economy, and recreational uses of Donner Lake. Asian clam is present in Donner Lake and Donner Creek below the dam and the distribution and abundance of this harmful species are rapidly increasing. Asian clam can alter the food web, impact native and recreational fisheries, and degrade water quality through concentration of harmful bacteria and calcium. In addition, New Zealand mudsnail, an invasive snail, and Eurasian watermilfoil, an invasive plant, are known to occur in the Truckee River approximately 20 miles northeast and 2 miles southeast of Donner Lake, respectively. Each of these species has the ability to colonize new sites, grow and spread very rapidly, and out-compete native aquatic species.

Photo by Chris Bowles, cbec.

Photo by Jai Singh, cbec.

Current Challenges (cont.)

Introduced Species

Several non-native species have been intentionally introduced to Donner Lake to provide fishing opportunities and food sources for early immigrants. These species include Kokanee salmon, Mackinaw trout, rainbow trout, and signal crayfish. Today these species offer substantial fishing opportunities in Donner Lake and its tributaries; however, they also compete with and may preclude the recovery of native species, such as Lahontan cutthroat trout.

Shoreline Erosion

Erosion of the Donner Lake shoreline is problematic in some areas due a combination of heavy recreational use, boat wake, and the large range in water levels due to reservoir operation which limits the establishment of vegetation. A number of footpaths connecting public docks to Donner Pass Road show ongoing erosion problems that likely contribute fine sediment to the lake

Donner Lake Reservoir Management

The management of Donner Lake as a reservoir causes unnatural variations in lake levels, which affects aquatic species in the lake and exacerbates shoreline erosion. The dam also restricts fish passage. Furthermore, reservoir operations alter the timing and magnitude of flows entering Donner Creek, which generally causes two categories of impact to the stream. The first is that the peak magnitude of spring snowmelt flows in Donner Creek is often dampened, which reduces the stream's capacity for geomorphic work and consequently its ability to create and maintain habitat features. The second impact is the altered timing and magnitude of base flows, which affects the composition and abundance of aquatic wildlife communities.

cbec eco engineering, H.T. Harvey & Associates, Susan Lindstrom. 2016. Donner Basin Watershed Assessment. Prepared for Truckee River Watershed Council. January 2016.

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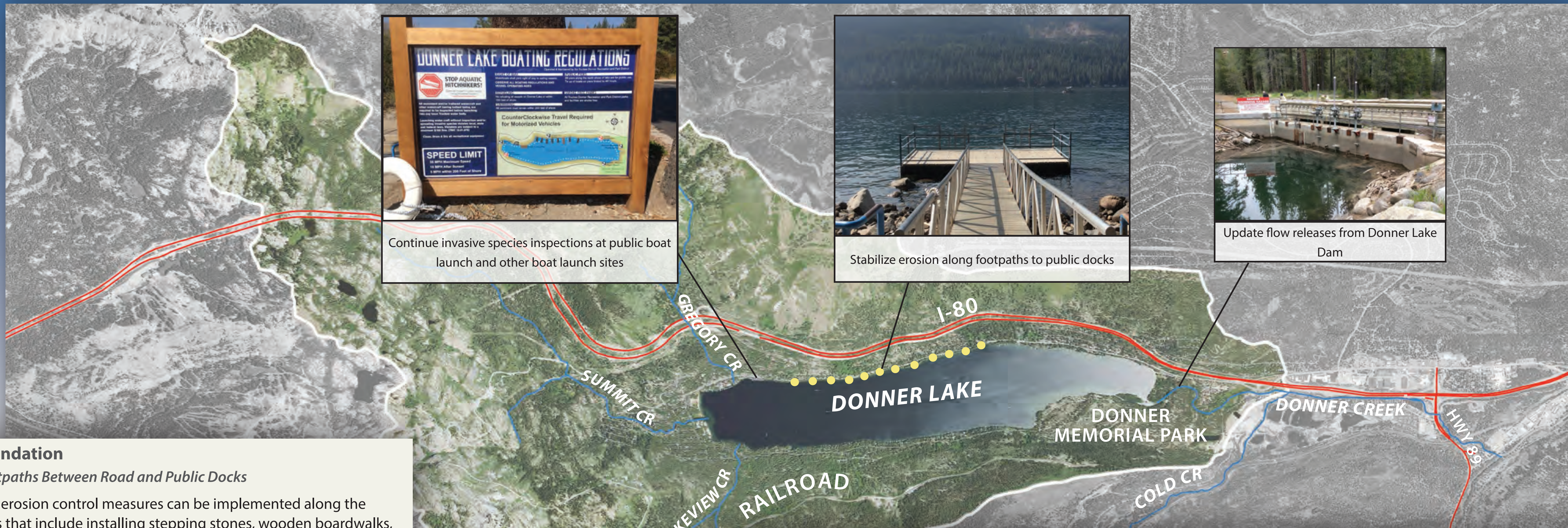
Donner Lake Project Overview



Continue invasive species inspections at public boat launch and other boat launch sites

Stabilize erosion along footpaths to public docks

Update flow releases from Donner Lake Dam

Project Recommendation

Stabilize Eroding Footpaths Between Road and Public Docks

Trail stabilization and erosion control measures can be implemented along the public dock footpaths that include installing stepping stones, wooden boardwalks, water bars, soil amendments surface treatments, designated access points, guiding features, and vegetation planting.

Management Recommendations

Implement a Multi-Agency Recreation Management Plan

A comprehensive, multi-agency recreation plan should be developed for Donner Lake which includes the management of trails, docks and dock access, boat ramps, beaches and other shoreline areas.

Continue Watercraft Inspections and Public Education Programs for Non-Native Species

Future conservation and recovery actions for native aquatic species must include the management of introduced species. To prevent the introduction of aquatic invasive species to Donner Lake and to minimize the spread of Asian clam within the lake, the current watercraft inspection program should be maintained and adapted to provide rigorous inspections for all motorized vessels entering the lake. In addition, significant risk of New Zealand mudsnail and aquatic invasive plant introductions through non-motorized boating, fishing, and other water use can be reduced through continued implementation of and adaptation to public education and outreach programs.

Implement Community Water Quality Protection Programs

To reduce contamination risks from pet feces, a "Clean Up After Your Pet" program should be implemented to encourage residents and visitors to clean up after their pets, and to provide helpful resources (e.g., bags and trash cans). To address pollution coming from fertilizer, pesticide and herbicide use, small scale fuel and oil leaks, and other roadside pollutants, a "Care For Our Watershed" program should be launched to educate local communities and visitors on the effects of water quality contamination and ways to reduce risks to Donner Lake.

Phase Out Use of 2-Stroke Engines on Donner Lake

Carbureted two-stroke engines often release nearly a quarter of their fuel into the air and water without it ever being burned. A ban on carbureted and electronic-injection two-stroke engines should be implemented on Donner Lake to reduce fuel contamination, similar to the program on Lake Tahoe.

Management Recommendations (cont.)

Update Reservoir Operations to Provide a More Natural Flow Regime in Donner Creek

Operations and flow release schedules could be modified to increase flows in Spring, when natural peak flows typically occur, and minimizing flows in Fall, when natural run-off from snow melt is typically exhausted. A natural flow regime in Donner Creek and downstream would support the recovery of native fish populations, such as Lahontan cutthroat trout, mountain whitefish, and sculpin. The timing of reservoir filling could also be modified to provide larger flows to Donner Creek during the spring snowmelt that enhance the stream's capacity for geomorphic work and its ability to create and maintain habitat.

Future Study Recommendations

Sediment Load Monitoring

Perform repeat bathymetric surveys of underwater deltas of the three major tributaries at the western end of the lake to estimate sediment loads.

Additional Water Quality Monitoring

Previous monitoring efforts have identified water quality concerns in Donner Lake but provide sparse information. To better understand the concentration, distribution and sources of chlordane, arsenic and PCBs, the following steps are suggested in order of priority:

1) Conduct additional fish tissue sampling
2) Monitor Donner Lake surface water
3) Perform Lake sediment sampling
4) Sample streambed sediment in tributaries
5) Collect precipitation and stormwater runoff samples
6) Conduct soil sampling at potential point source locations (e.g., spill sites along I-80, the railroad, gas pipeline, etc.)

AIS and Water Quality Synthesis from Existing UNR Data

Limnologists and aquatic biologists at the University of Nevada, Reno have conducted water quality sampling and, more recently, aquatic invasive species surveys in Donner Lake, Donner Creek, and tributaries to the lake (UNR 2014). A significant amount of this information has been reported only in unpublished literature (meaning it is generally harder to find or not available for review). A synthesis of existing unpublished information would both contribute to an understanding of the water quality and ecology of Donner Lake, and help to identify information gaps where further research or surveys are needed. Ecological information needed to inform future management decisions include fish population trends, water quality trends, and the effects of recent aquatic invasive species introductions.

Donner Basin
Mobile Home Park Floodplain Restoration

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Low floodplain area adjacent to creek. Photo by Jai Singh, cbec (2015).

Project Vicinity

Project Location

Location: Lower elevation areas of the mobile home park along the right bank of Donner Creek upstream of W. River Street.

Project Description

The low elevation areas within the mobile home park will be converted to a more natural floodplain condition. Select homes and paved surfaces could be removed, the floodplain elevation lowered through grading and then replanted with riparian vegetation to provide a more natural and frequently activated floodplain.

Problem

A mobile home park is located along the right bank of Donner Creek immediately upstream of the W. River Street crossing. The section of the home park closest to the stream is at a low elevation relative to the stream and at risk of flooding (potentially a 5- to 10-year recurrence interval). The site topography suggests this area was a historic floodplain. This project would provide significant value, as today the lower section of Donner Creek has very limited floodplain access which negatively impacts physical processes, habitat, water quality and hydrology.

Benefits

The project would significantly enhance physical processes and habitat, and could increase the riparian food subsidy to the Truckee River. Floodplain lowering could also relieve flood pressure on other parts of the mobile home park community.

Constraints

This project would require purchasing land (or easements) and relocating trailers in the lowest elevation zones of the mobile home park.

Cost Estimate: $500,000 to > $1M

Timeline: 3 to 7 years

Project concept assumes support of all land owners, land managers, and stakeholders.


Proximity of mobile homes to Donner Creek. Photo by Jai Singh, cbec (2015).


Photo by Jai Singh, cbec (2015).

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Project Benefits

Benefit	Comments
Geomorphic / Physical Processes	The project will restore a historic floodplain of Donner Creek, greatly enhancing physical processes and broadening the stream corridor's functional width. The removal of bank armoring on the right bank will also enhance the geomorphic condition of the stream.
Hydrology	The broadened stream corridor and more active floodplain will enhance infiltration of flood flows into the shallow groundwater table. Pocket depressions in floodplain areas may also provide temporary storage of flood waters.
Water Quality	The larger and more frequently inundated floodplain areas will provide opportunities for sediment deposition and the capture of pollutants.
Fine Sediment Reduction	Greater levels of fine sediment deposition will likely occur with the broader stream corridor and more active floodplain. The project may also reduce future fine sediment loading from stream bank erosion along the project reach.
Habitat	Reconnecting the floodplain with the active creek channel will enhance riparian and wetland habitats and could significantly improve the health and extent of the existing riparian vegetation. Re-establishing natural geomorphic processes and removing bank armoring could also improve aquatic habitat diversity within the creek and support the natural recruitment of wetland and riparian vegetation in the active floodplain.

cbec eco engineering, H.T. Harvey & Associates, Susan Lindstrom. 2016. Donner Basin Watershed Assessment. Prepared for Truckee River Watershed Council. January 2016.

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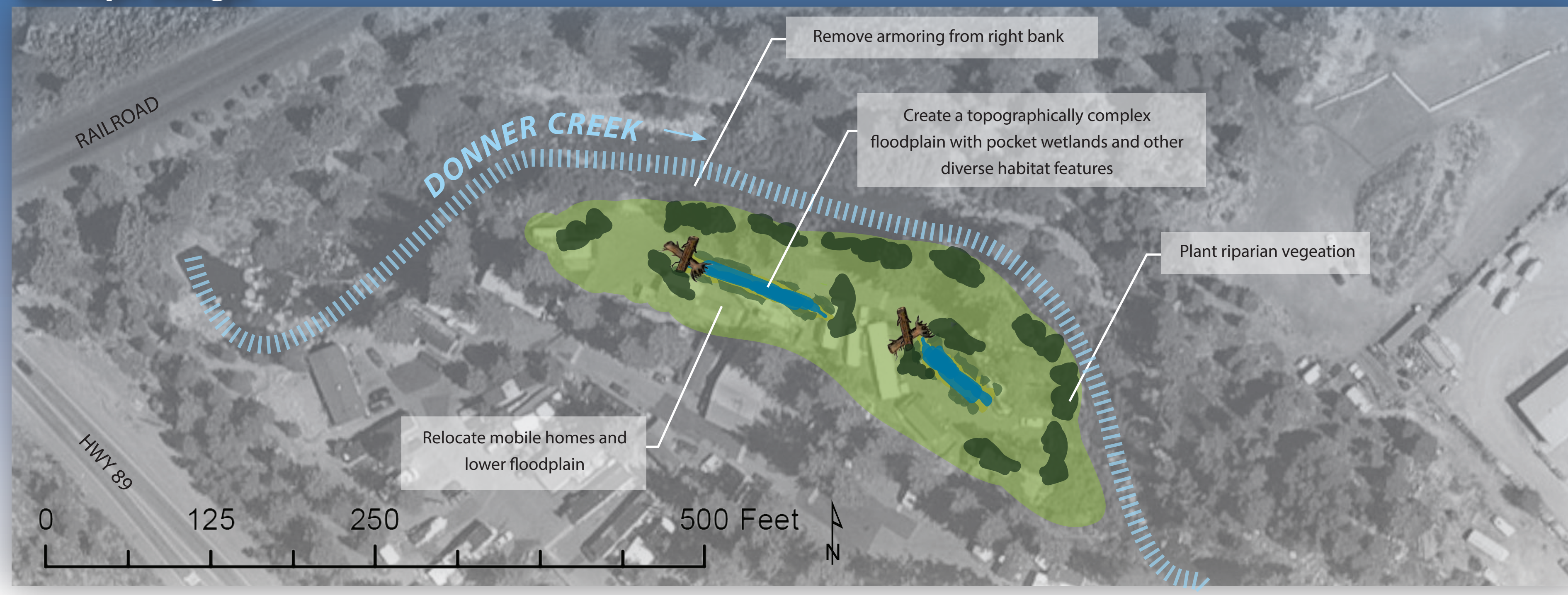
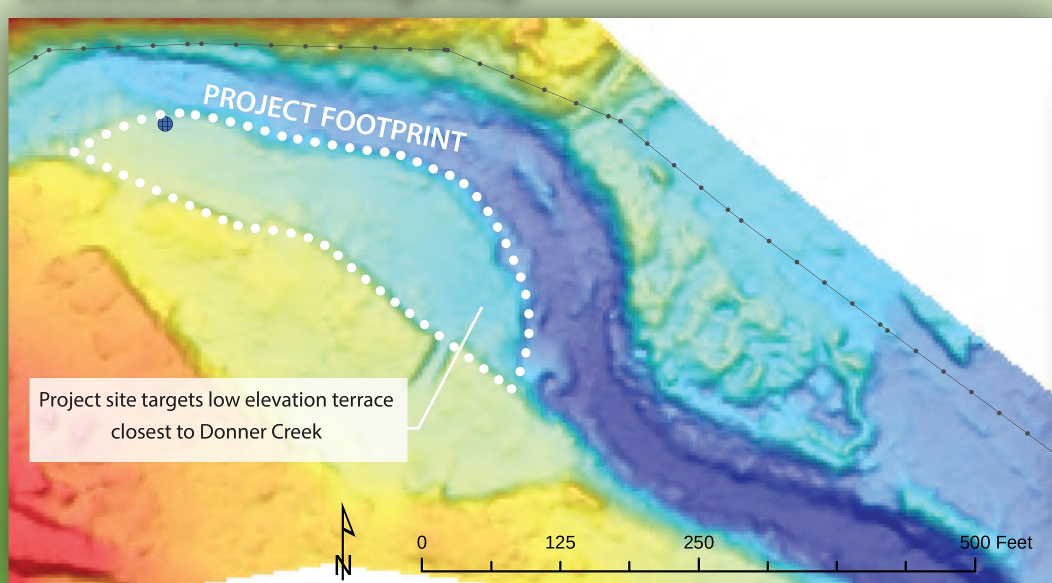
Concept Design



Elevation and Drainage Map



LEGEND
- SEWER LINES
- STORMWATER OUTLETS
- DITCHES
- CULVERTS

Elevation (ft)
5946
5964
5982

Elevation data from USFS 2014 LiDAR dataset

Project Footprint

Image from Google Earth

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Donner Basin
Bank Stabilization Downstream of Railroad Culvert

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View of the upstream portion of the eroding bank. Photo by Jai Singh, cbec (2015).

Project Vicinity

Project Location

Location: Right bank immediately downstream of railroad culvert.

Project Description

The right bank and hillslope will be reprofiled by pulling the top of the hillslope further back from the channel and stabilized through a combination of large wood, rock, erosion control fabric, hydroseeding with native, drought tolerant grasses and sedges and riparian plantings. The site will incorporate large log toe protection, essentially one long large wood structure along the base of the bank. Additional longitudinal peak stone toe protection may be needed to provide additional toe anchorage, due to the site hydraulics. A combination of plantings and the placement of coir, jute or other erosion control fabric further up the hillslope will help stabilize the site.

Problem

Just downstream of the railroad culvert outlet, the right bank of Donner Creek and hillslope above exhibit severe erosion. The erosion appears to be driven by the orientation of the railroad culvert outlet which directs high velocity flows at the soft, non-cohesive soils of the bank. Suspended sediment monitoring[1] between water years 2012 and 2014 shows that significant fine sediment loading occurs in the last 0.5 miles of Donner Creek between Highway 89 and W. River Street. Field observations indicate that this bank erosion site is likely one of the two locations responsible for a significant portion of these fine sediment contributions. Addressing this site is particularly important given that the Donner Basin is a significant contributor of fine sediment to the Truckee River and the Truckee River is currently listed as impaired for suspended sediment.

Benefits

The project will stabilize the existing bank and hillslope erosion, thus reducing fine sediment loading to Donner Creek during high flow events. The project will also enhance riparian habitat and, depending on design, could improve in-stream habitat.

Constraints

Reprofiling the bank will require the setback of private residences and other infrastructure. Further analysis is needed to determine if extending the bank into the channel is feasible. If reprofiling the bank is not an option, the site design will need to incorporate a steep bank and hillslope.

Cost Estimate: $100,000 to > $1M

Timeline: 2 to 5 years

Project concept assumes support of all land owners, land managers, and stakeholders.

[1]Balance Hydrologics, Inc (Balance). 2014. Middle Truckee River Total Maximum Daily Load (TMDL) Suspended Sediment Monitoring Report, Water Year 2014, Nevada County, California. Prepared for Truckee River Watershed Council. Prepared by Balance Hydrologics, Inc. December 2014.

Railroad culvert just upstream of eroding bank. Photo by Jai Singh, cbec (2015).

View of the downstream portion of the eroding bank. Photo by Jai Singh, cbec (2015).

Project Benefits

Benefit	Comments
Geomorphic / Physical Processes	The project will reduce bank erosion and excessive fine sediment loading to the lower portion of Donner Creek, thus reducing impacts to fine sediment dynamics in the downstream-most portion of Donner Creek.
Water Quality	The project will improve water quality by reducing suspended sediment loads in the lower portion of Donner Creek as well as the Middle Truckee River.
Fine Sediment Reduction	The project will stabilize a severely eroding stream bank, thus largely eliminating one of the largest sources of fine sediment to the downstream-most half mile of Donner Creek.
Habitat	The project will enhance riparian habitat on the right bank and may improve in-stream habitat quality by providing cover for aquatic species. The project could also improve downstream in-stream habitat by reducing the amount of fine sediment along the stream bed.

cbec eco engineering, H.T. Harvey & Associates, Susan Lindstrom. 2016. Donner Basin Watershed Assessment. Prepared for Truckee River Watershed Council. January 2016.

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Project Location

Treatment Area

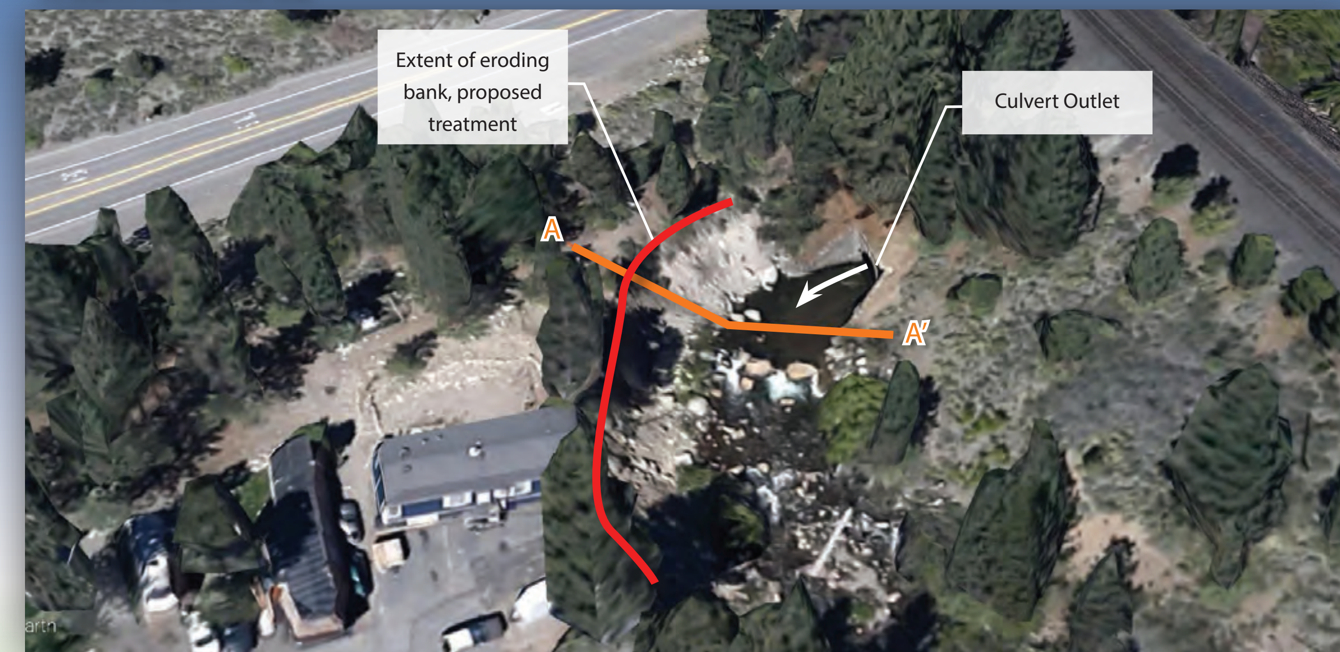
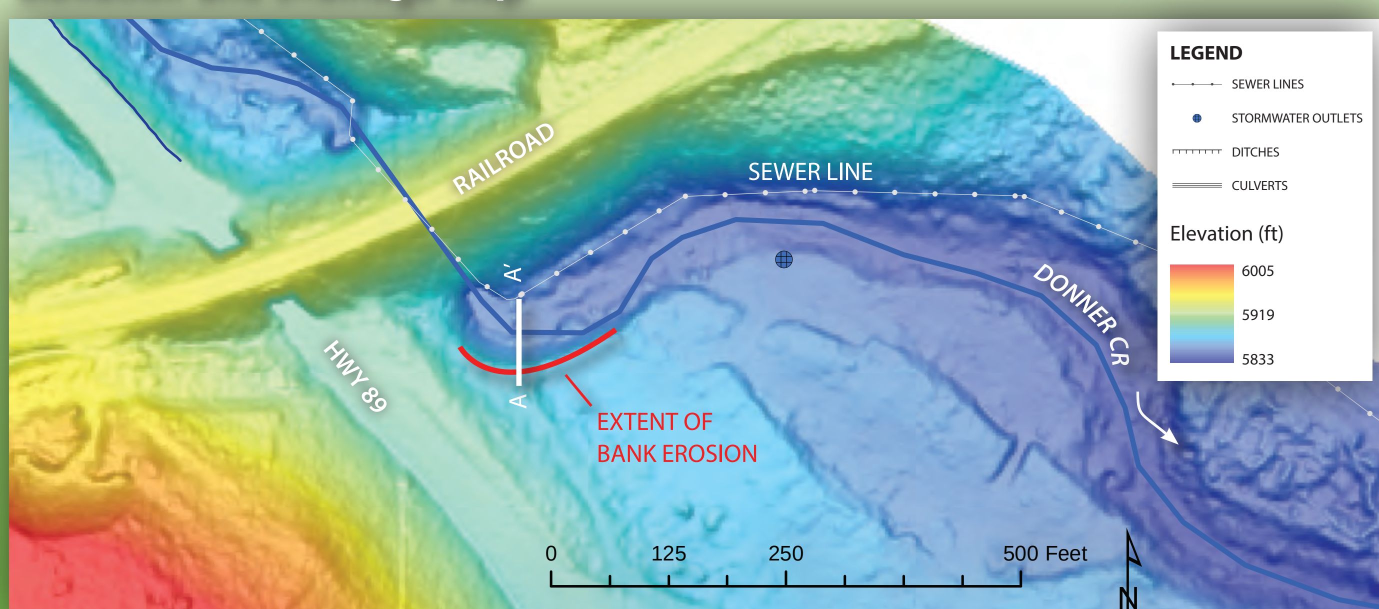


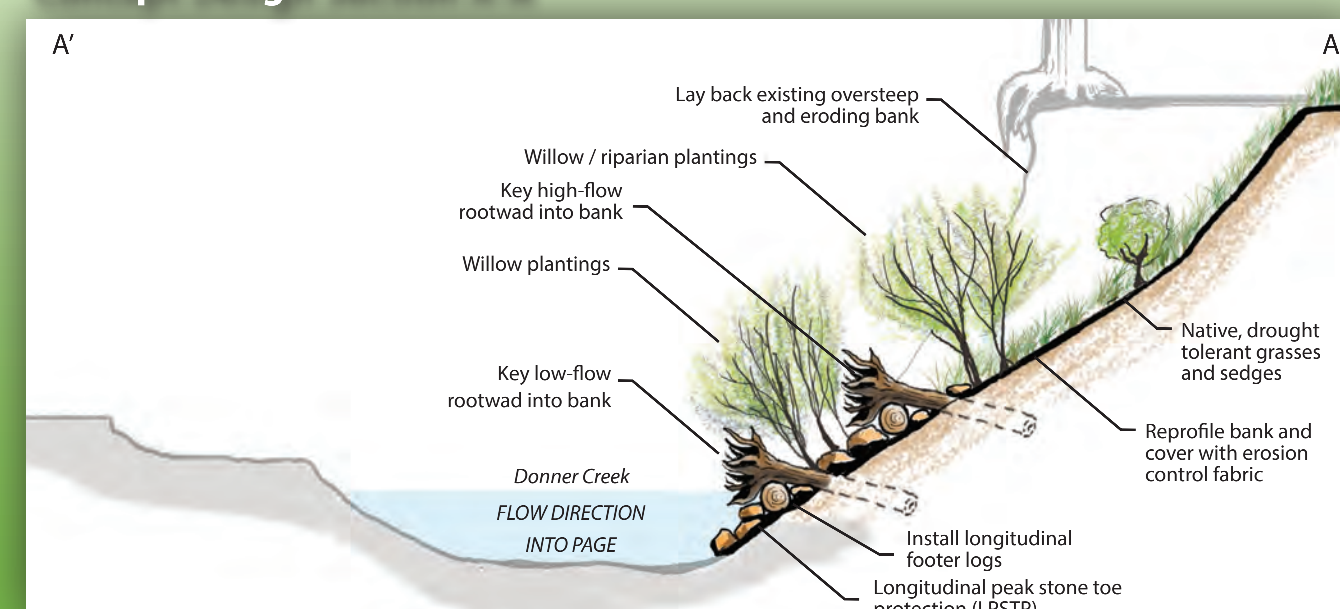
Image from Google Earth

Elevation and Drainage Map



Elevation data from USFS 2014 LiDAR dataset

Concept Design Section A-A'



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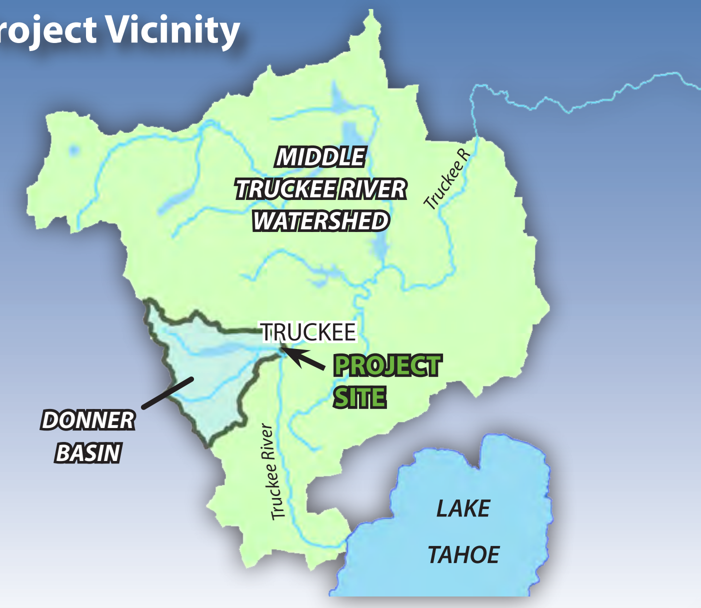
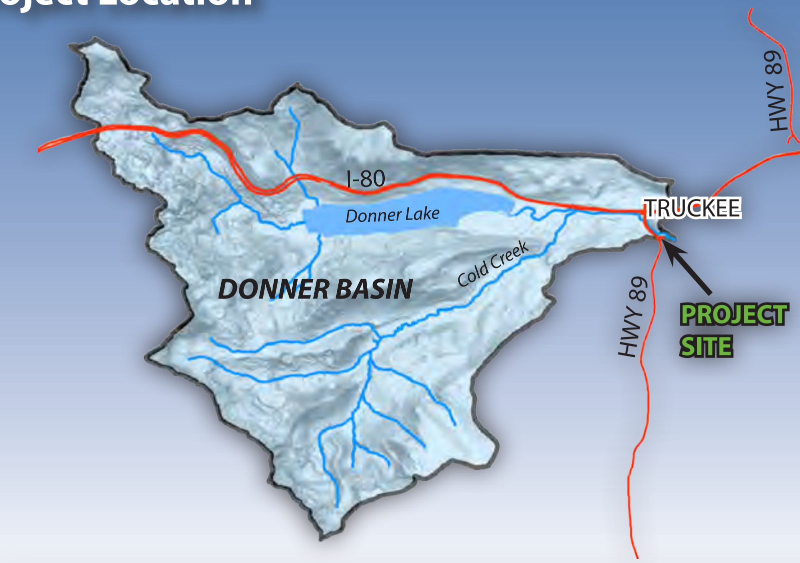
Donner Basin
Bank Stabilization and Channel Enhancement Along Highway 89

Eroding bank adjacent to Highway 89. Photo by Jai Singh, cbec (2015).

Project Vicinity



Project Location



Location: Donner Creek right bank 350 ft downstream of Highway 89 bridge

Project Description

To address the bank erosion concerns and improve habitat conditions, the right bank will be reprofiled such that the toe of the bank extended further into the current stream channel alignment. Concurrently, the left bank will be set back, reprofiled and replanted to enhance aquatic and riparian habitat and reduce erosion pressure on the right bank. Depending on bank stability objectives, the right bank may be further stabilized with plantings and an erosion control fabric, and/or longitudinal peak stone toe protection.

Problem

The right bank of Donner Creek currently exhibits severe bank erosion that, if unaddressed, will likely affect the stability of Highway 89 relatively soon. Both stream banks offer limited area for riparian habitat and little riparian canopy for the channel. Suspended sediment monitoring between water years 2012 and 2014[1] shows that significant fine sediment loading occurs in the last 0.5 miles of Donner Creek between Highway 89 and W. River Street. Field observations indicate that this bank erosion site is likely one of the two locations responsible for a significant portion of these fine sediment contributions. Addressing these sites is particularly important given that the Donner Basin is a significant contributor of fine sediment to the Truckee River and the Truckee River is currently listed as impaired for suspended sediment.

Benefits

This project would reduce the fine sediment loading from the existing bank erosion site on the right bank, benefitting water quality in both Donner Creek and the Truckee River. By stabilizing the right bank and adjusting the stream channel further to the east, the project would reduce the erosion risk to Highway 89. The project would enhance riparian habitat along the stream corridor, particularly along the left bank, and improve instream habitat quality and substrate diversity by reducing fine sediment loads and restoring natural physical processes.

Constraints

The proximity of the project to Highway 89 may become a constraint if stakeholders do not have buy-in.

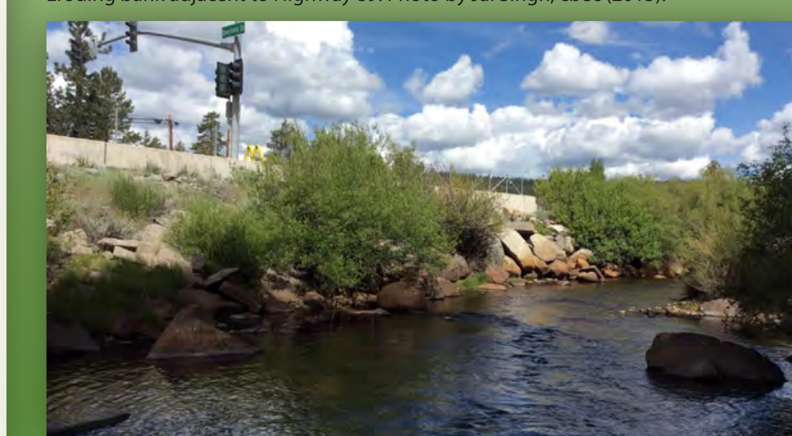
Cost Estimate: $100,000 to > $1M

Timeline: 2 to 5 years

Project concept assumes support of all land owners, land managers, and stakeholders.

[1]Balance Hydrologics, Inc (Balance). 2014. Middle Truckee River Total Maximum Daily Load (TMDL) Suspended Sediment Monitoring Report, Water Year 2014, Nevada County, California. Prepared for Truckee River Watershed Council. Prepared by Balance Hydrologics, Inc. December 2014.

Eroding bank adjacent to Highway 89. Photo by Jai Singh, cbec (2015).



Heavily armored bank immediately upstream of the project site. Photo by Jai Singh, cbec (2015).

Project Benefits

Benefit	Comments
Geomorphic / Physical Processes	The project will reduce bank erosion and excessive fine sediment loading to the lower portion of Donner Creek, thus lessening impacts to fine sediment dynamics in the downstream-most portion of Donner Creek. The project will also slightly widen the active low and moderate-flow channel, providing a broader riparian zone and more frequent interaction between flood flows and the riparian corridor.
Water Quality	The project will improve water quality by reducing suspended sediment loads in the lower portion of Donner Creek, as well as the Middle Truckee River.
Fine Sediment Reduction	The project will stabilize a severely eroding stream bank, thus largely eliminating one of the largest sources of fine sediment to the downstream-most half mile of Donner Creek.
Habitat	The project will significantly enhance the aquatic and riparian habitats through this reach of the creek. Increasing connectivity with the floodplain on the left bank would enhance riparian habitat diversity and increase the width and extent of the existing riparian corridor. Channel realignment and reprofiling to re-establish natural geomorphic processes could also improve aquatic habitat quality and substrate diversity within the creek by reducing fine sediment loads and restoring natural physical processes.

cbec eco engineering, H.T. Harvey & Associates, Susan Lindstrom. 2016. Donner Basin Watershed Assessment. Prepared for Truckee River Watershed Council. January 2016.

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Project Location

Treatment Area

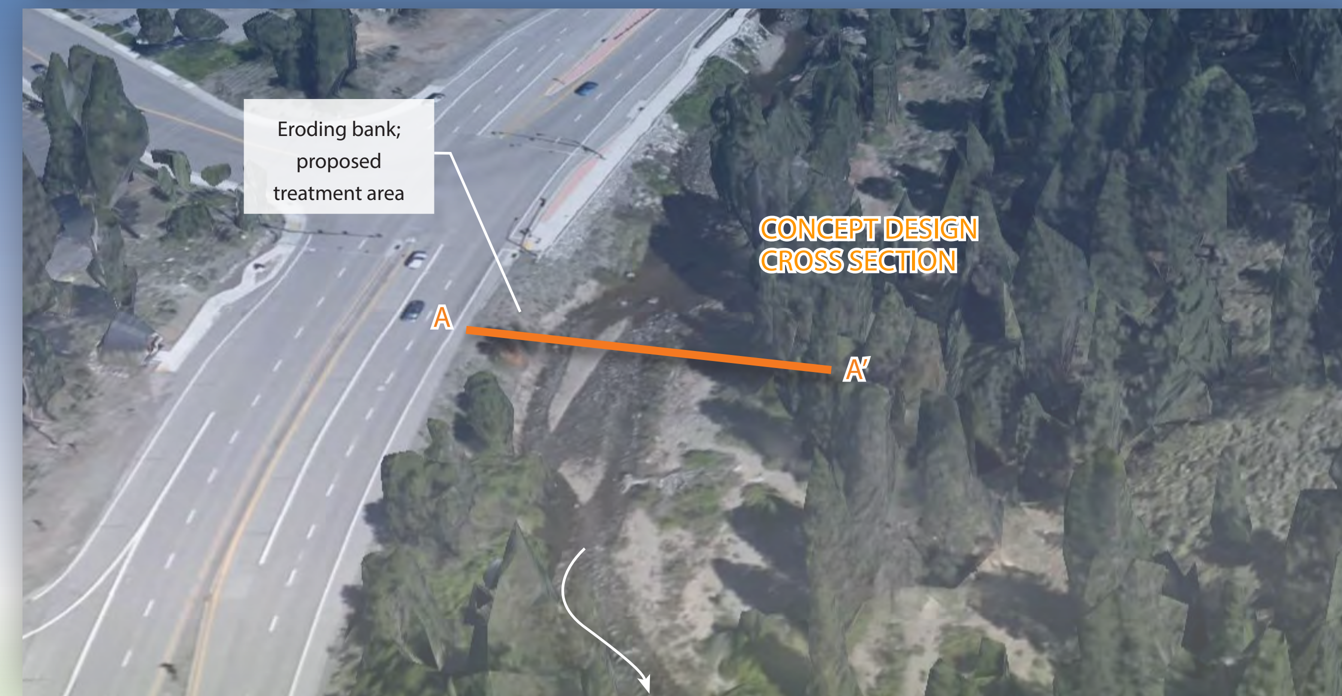
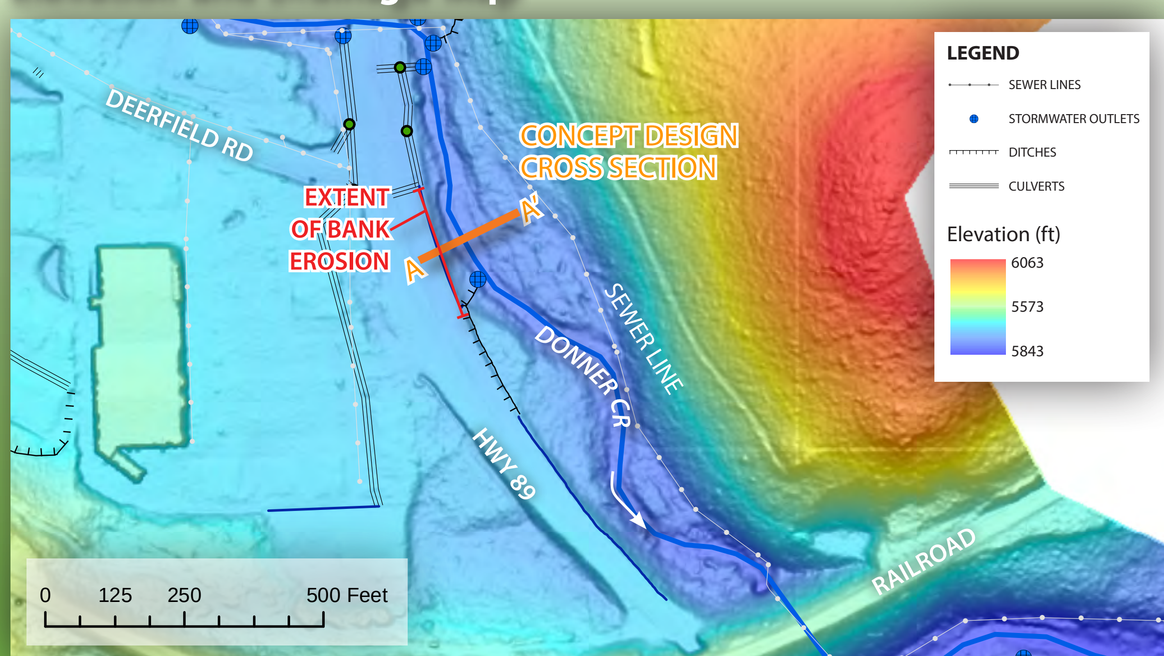


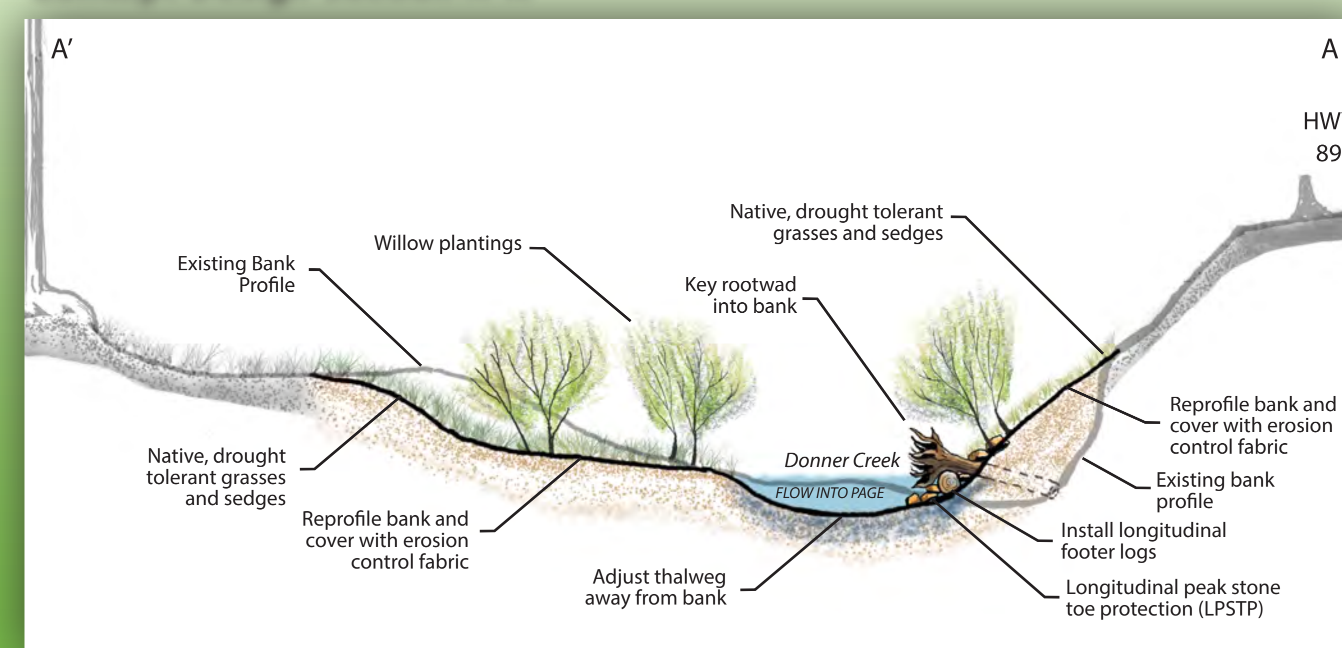
Image from Google Earth

Elevation and Drainage Map



Elevation data from USFS 2014 LiDAR dataset

Concept Design Section A-A'



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Donner Basin

Donner Creek Channel Realignment and Floodplain Restoration

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Aerial view of gas station and project area. Photo by Chris Bowles, cbec (2015).

Project Vicinity

Project Location

Location: Immediately upstream of Highway 89 at gas station and surrounding area to the west.

Project Description

Donner Creek will be reconnected to a sizeable floodplain area by relocating the gas station and eliminating the berm along the left bank. Further upstream, connectivity with the southwestern floodplain will also be enhanced by floodplain grading and local increases to the stream bed elevation. Both floodplains will be designed to support wetland vegetation and diverse habitat areas. The stream channel will be realigned to soften the two meander bends. The stream banks will be reprofiled and the rock armoring removed or covered with soils and planted.

Problem

Along the reach just upstream of Highway 89, Donner Creek has been realigned, heavily armored and disconnected from its floodplain. To the northwest of the stream, a gas station is located in a natural floodplain area that inundates frequently despite a low elevation berm. Extensive bank armoring has been applied to sections of both stream banks at the outside of sharp meander bends. The physical health and habitat quality of the stream are impaired, and the interaction of floodwaters with the gas station poses human health and water quality risks.

Benefits

The project would restore a large floodplain area and greatly enhance the physical and ecological health of the stream. The floodplains and realigned channels would support more robust wetland, riparian and aquatic habitat. The removal of the gas station and remediation of soils would significantly reduce risks water contamination risks.

Constraints

The feasibility and cost of relocating the gas station are likely constraints. The need for soil remediation at the site will also need to be considered. A sewer line along the right bank of Donner Creek would need to relocated if that stream channel is realigned.

Cost Estimate: $500,000 to > $1M

Timeline: 2 to 5 years

Project concept assumes support of all land owners, land managers, and stakeholders.

Donner Creek adjacent to gas station. Photo by Jai Singh, cbec (2015).

Flooding at the Highway 89 gas station in December 1997.
Photo by Tom Falconer, Tahoe Daily Tribune (1997).

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Project Benefits

Benefit	Comments
Geomorphic / Physical Processes	Increased connectivity with the two floodplain areas would rehabilitate natural physical processes. In turn, more natural deposition and scour of sediment will help create and maintain underrepresented habitat features. The stream will also benefit from softened meander bends and reduced interaction with armored banks.
Hydrology	The broadened stream corridor and more active floodplain would enhance infiltration of flood flows into the shallow groundwater table. Pocket depressions in floodplain areas may also provide temporary storage of flood waters.
Water Quality	Removing the gas station and underground fuel tasks from the floodplain and remediating soils will eliminate a significant contamination risk to Donner Creek. The new floodplain habitat areas may also capture other pollutants.
Fine Sediment Reduction	The broadened stream corridor and more frequently inundated floodplain will provide greater opportunities for fine sediment deposition during higher flows.
Habitat	The project will significantly enhance the aquatic and riparian habitats through this reach of the creek. Reestablishing connectivity with the historic floodplain would enhance riparian habitat diversity and significantly increase the width of the existing riparian corridor. Channel realignment and reprofiling to re-establish natural geomorphic processes will also improve aquatic habitat diversity within the creek.

cbec eco engineering, H.T. Harvey & Associates, Susan Lindstrom. 2016. Donner Basin Watershed Assessment. Prepared for Truckee River Watershed Council. January 2016.

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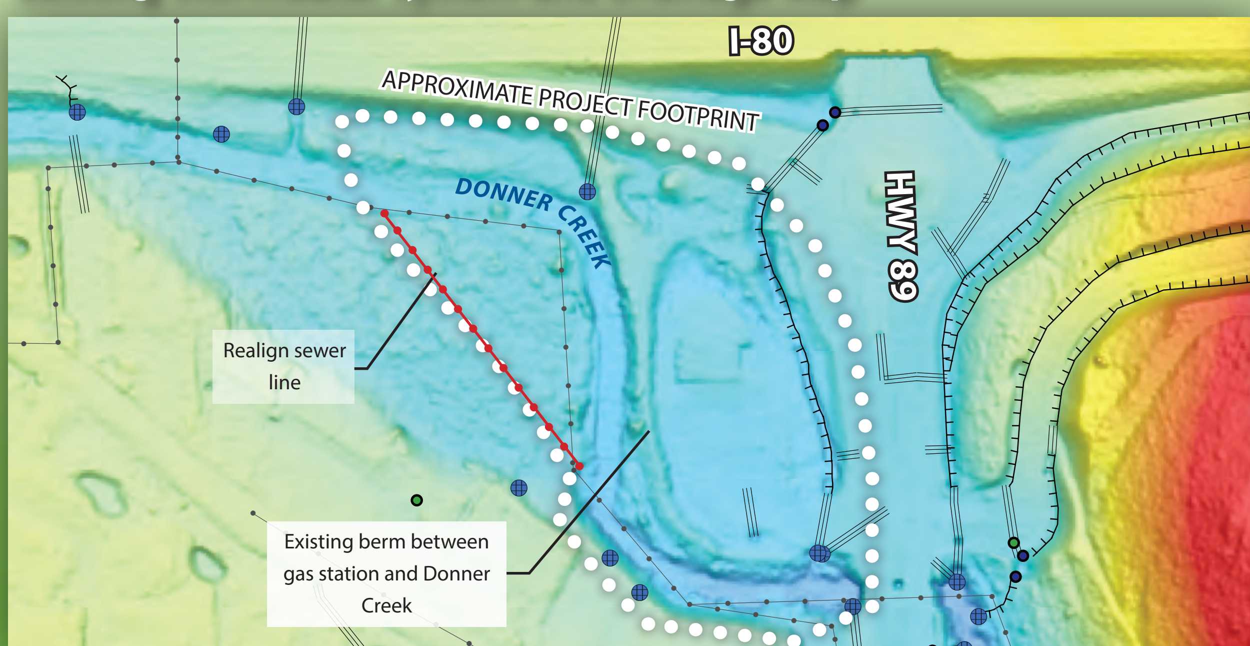
Concept Design

Existing Stormwater System and Drainage Map



Elevation data from USFS 2014 LiDAR dataset.

LEGEND

- SEWER LINES
- STORMWATER OUTLETS
- DITCHES
- CULVERTS

Elevation (ft)
5986
5920
5855

0 125 250 500 Feet

Project Footprint

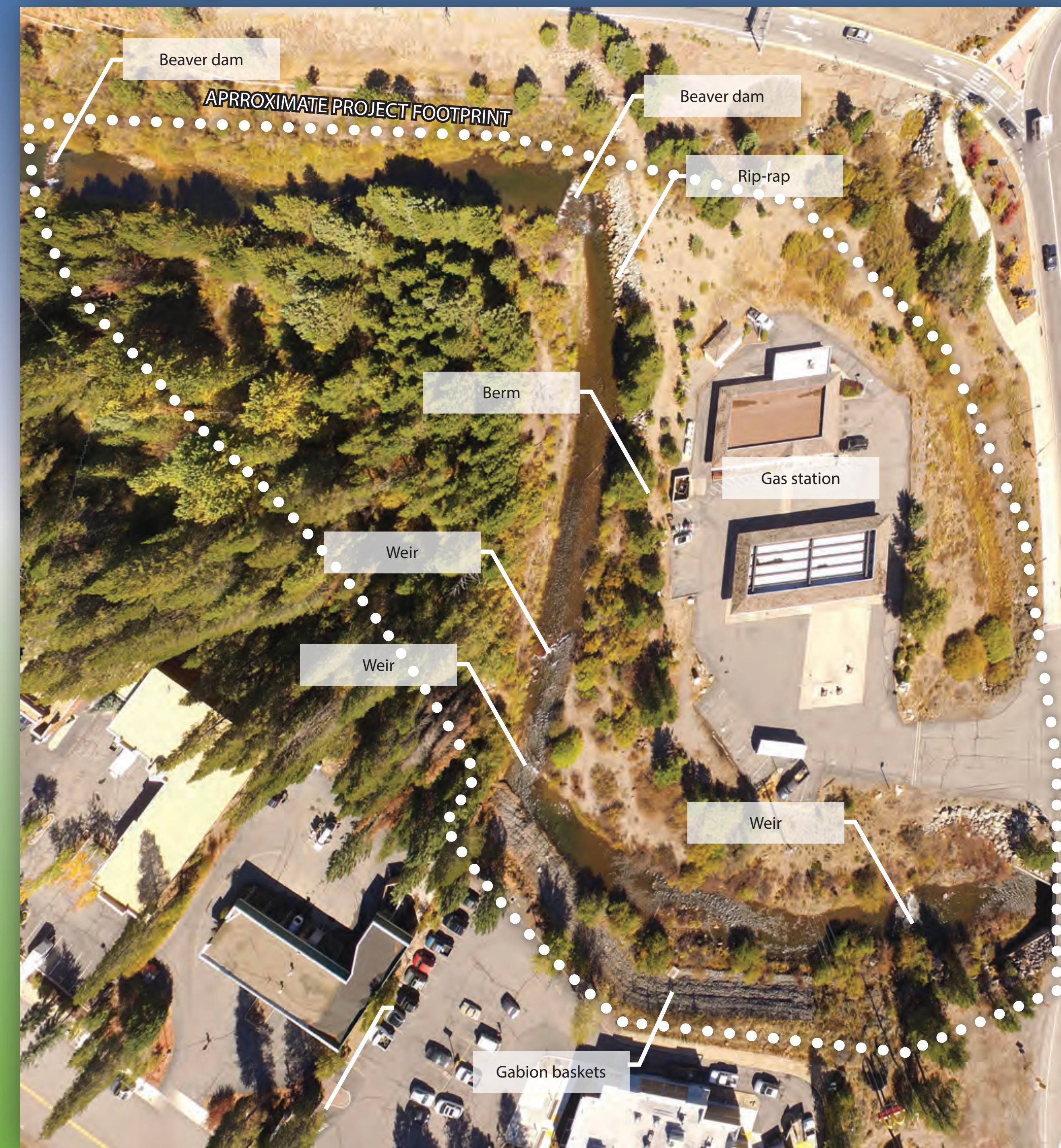


Photo by Chris Bowles, cbec (2015). Note: The image is composite of several images and some distortion is present.

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Donner Basin
Large Wood and Habitat Enhancement

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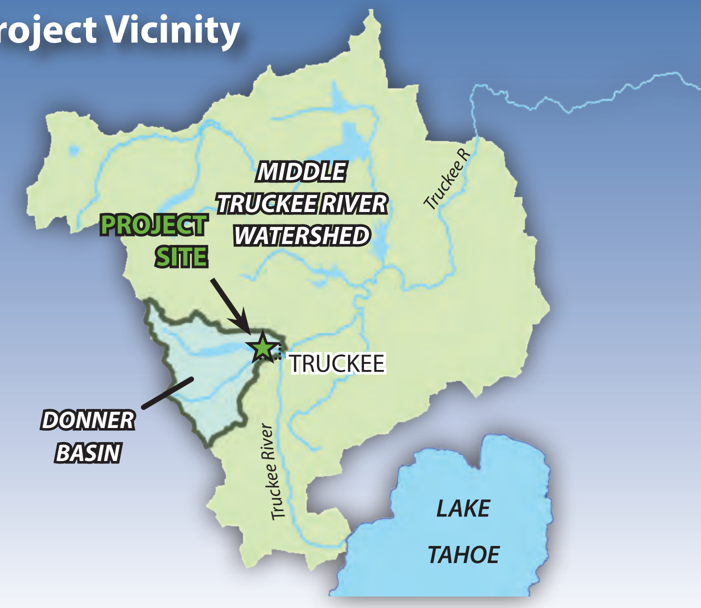
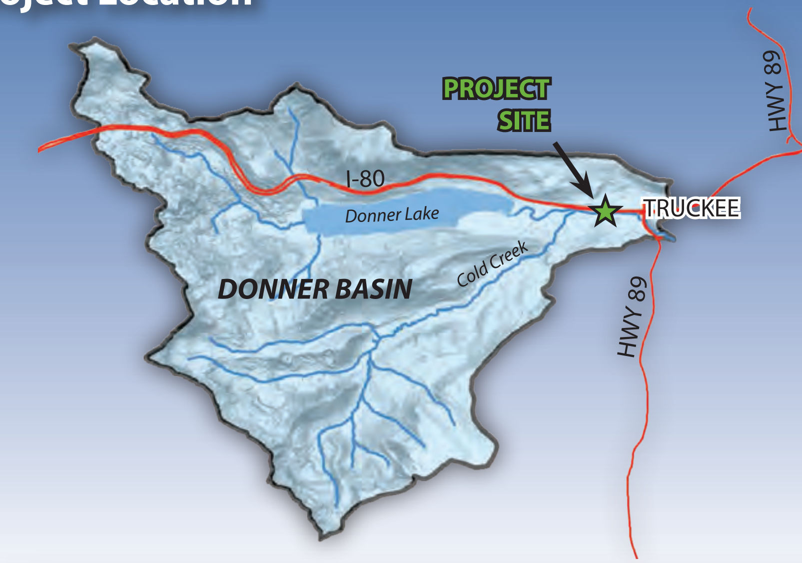
Aerial view of straightened project reach. Photo by Chris Bowles, cbec (2015).

Project Vicinity



Project Location



Location: Straightened reach of Donner Creek adjacent to I-80

Project Description

The installation of large wood structures into the stream channel will significantly enhance physical processes and habitat diversity along this reach. Wood structures will be designed to extend as much as one third of the channel width to increase hydraulic sinuosity and habitat heterogeneity. The wood structures will be spaced at distances of roughly 8 to 12 channel widths apart on alternating sides of the bank.

Problem

As part of the construction of I-80 (completed in 1964), Donner Creek was realigned into a highly channelized stream running parallel to I-80 for a distance just over a half mile. This section of stream has highly homogeneous geomorphic form and offers limited habitat value.

Benefits

The project would significantly enhance geomorphic processes, encouraging localized bed scour and deposition. This in turn would improve the quality and diversity of in-stream habitat. The project would be implemented in phases to encourage an adaptive design process and evaluate realized benefits. The large wood may also help the stream to more effectively store sediment in the channel and floodplain as well as trap finer grained material, further enhancing in-stream habitat diversity.

Constraints

Flood risk to I-80 would need to be evaluated with hydraulic modeling. Regardless of modeling results, the perception of flood risk to I-80 may be a constraint.

Cost Estimate: $100,000 to $1M

Timeline: 2 to 4 years

Project concept assumes support of all land owners, land managers, and stakeholders.

Looking upstream straightened reach of Donner Creek, with I-80 to right. Photo by Jai Singh, cbec (2015).

Looking upstream straightened reach of Donner Creek, with I-80 to the right. Photo by Jai Singh, cbec (2015).

Project Benefits

Benefit	Comments
Geomorphic / Physical Processes	The installation of large wood structures within the channelized section of Donner Creek will enhance physical processes in a highly simplified and degraded reach. The large wood will promote localized deposition of sediment in some areas while increased scour in others.
Hydrology	Depending on the design, the large wood structures may enhance the interaction of surface flows with the shallow groundwater table.
Water Quality	The increase complexity of the channel and the creation of deposition areas may improve water quality and enhance sediment deposition.
Fine Sediment Reduction	Deposition areas created by the large wood structures may capture fine sediment both in the channel and along the narrow inset floodplain present in some sections of the channelized stream corridor.
Habitat	By enhancing physical processes, the large wood will increase the diversity and quality of habitat present within the channelized reach. The large wood will also provide cover for aquatic species, and may enhance riparian vegetation communities.

cbec eco engineering, H.T. Harvey & Associates, Susan Lindstrom. 2016. Donner Basin Watershed Assessment. Prepared for Truckee River Watershed Council. January 2016.

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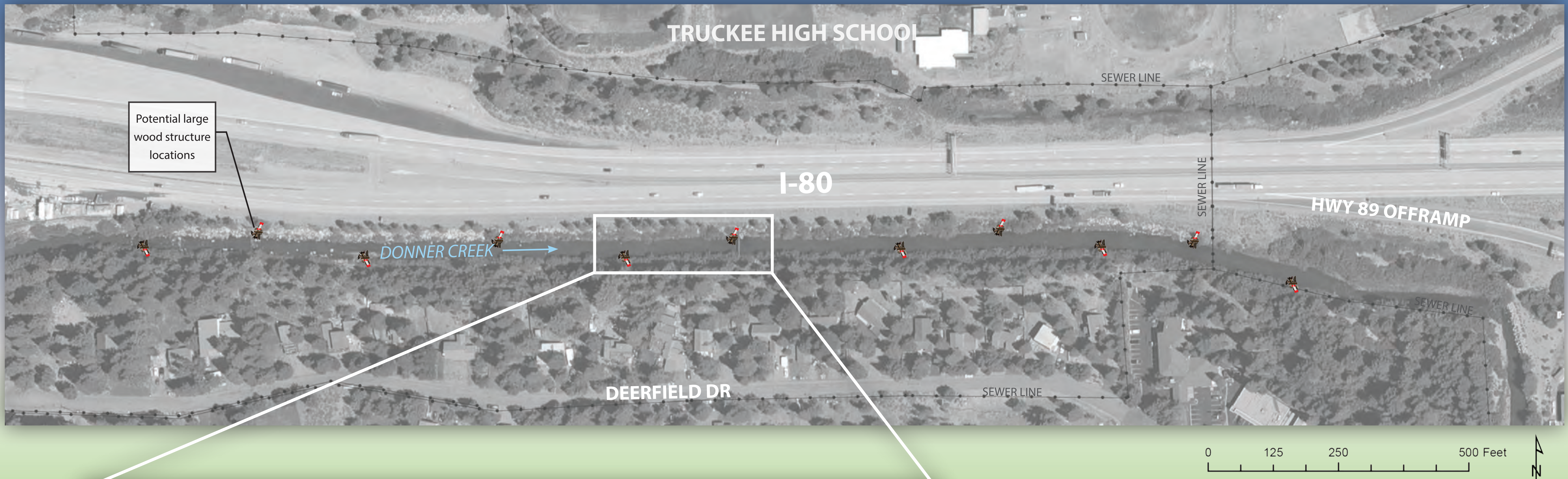
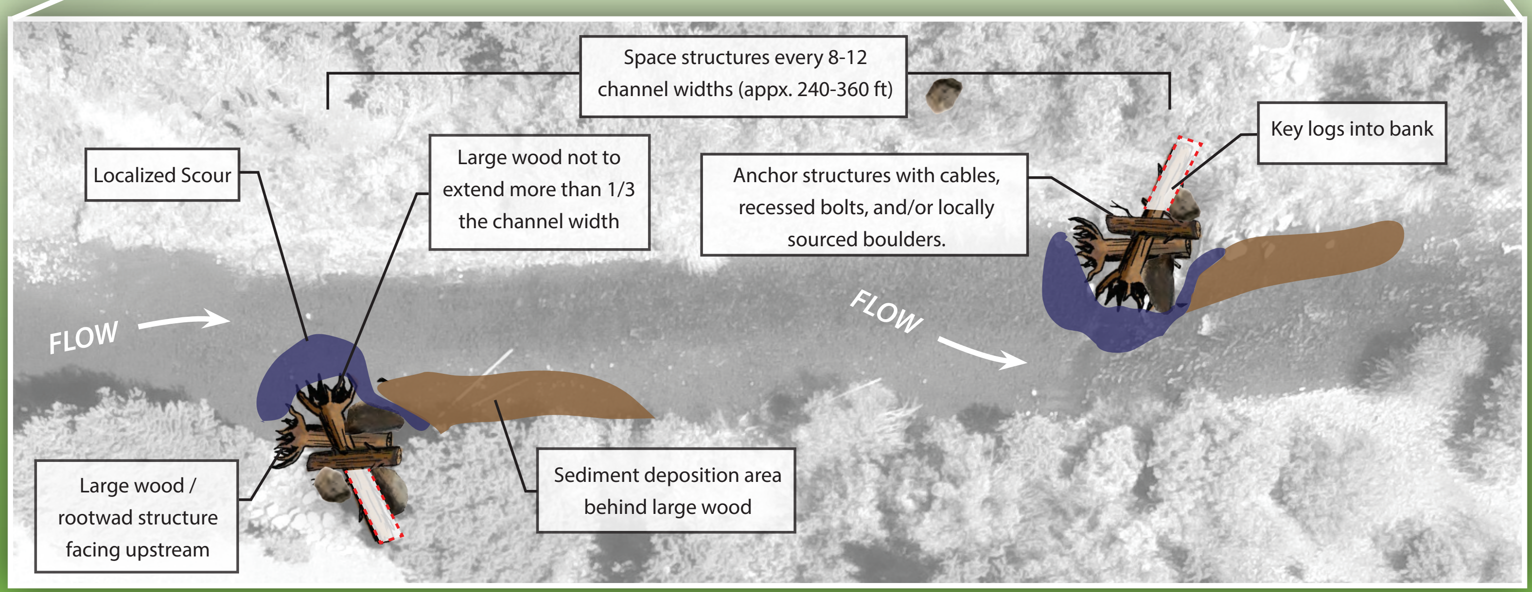
Project Reach





Concept Design

Example of large wood recruitment in Donner Creek. Looking downstream. Photo by Jai Singh, cbec (2015).

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Donner Basin
Stream and Floodplain Restoration at Donner and Cold Creek Confluence

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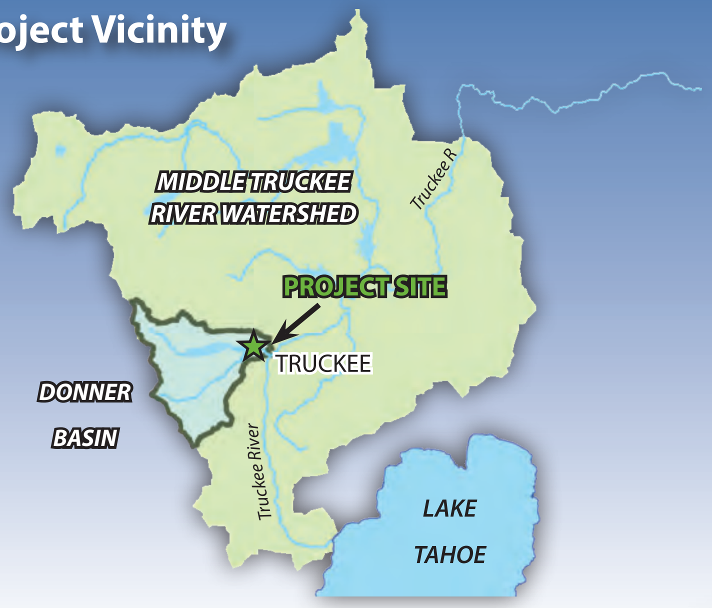
Aerial view of project area. Photo by Chris Bowles, cbec (2015).

Project Vicinity



Project Location

Location: The areas immediately southeast and southwest of the Donner and Cold Creek confluence.

Project Description

This project site offers a unique opportunity to significantly improve the health of the Donner and Cold Creek confluence. The vacant structures and parking lot will be removed from the property southwest of the confluence and the floodplain lowered through grading. Donner Creek will be moved further south and given a healthier and more sinuous channel. The land southeast of the confluence will also be lowered to further broaden the stream corridor and provide a more frequently activated floodplain. The opportunity exists to implement this project as part of the Town of Truckee's Coldstream Specific Plan (PC-1).

Problem

Today, the confluence of Donner and Cold Creeks has little capacity for dynamic behavior and both streams are largely disconnected from their floodplains. As it approaches the confluence, both banks of Donner Creek are heavily armored. To the southwest of the confluence, the floodplain was likely artificially filled in and is now the site of a vacant motel complex and parking lot. Historically, Cold Creek's alluvial fan supported secondary flood channels and sediment deposition while today the stream's corridor is much more narrow as it approaches the confluence.

Benefits

The project would significantly broaden the active stream corridor and enhance floodplain connectivity for both Donner and Cold Creeks. The streams would have more capacity for natural physical processes, and would be better able to create and maintain habitat without human intervention. Aquatic and riparian habitat areas would be greatly improved. The project site would also enable greater sediment deposition and improve water quality.

Constraints

Current land use and future development plans for the property southwest of the confluence both pose constraints to the project. A sewer line also crosses below Cold Creek approximately 250 ft upstream of the confluence.

Cost Estimate: $500,000 to > $1M

Timeline: 2 to 5 years

Project concept assumes support of all land owners, land managers, and stakeholders.

Heavily armored banks at confluence. Photo by Jai Singh, cbec (2015).

Fine sediment delivery from Cold Creek from summer thunderstorm. Photo by Jai Singh, cbec (2015).

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Project Benefits

Benefit	Comments
Geomorphic / Physical Processes	The project would create a much wider active stream corridor and enable more frequent floodplain inundation. The design will also rehabilitate the streams' natural physical processes and their capacity to create and maintain aquatic and riparian habitat.
Hydrology	The broadened stream corridor and more active floodplain would enhance infiltration of flood flows into the shallow groundwater table. Pocket depressions in floodplain areas may also provide temporary storage of flood waters.
Water Quality	The larger and more frequently inundated floodplain areas would provide opportunities for sediment deposition and the capture of pollutants.
Fine Sediment Reduction	Greater levels of fine sediment deposition will likely occur with the broader stream corridor and more active floodplain. The project will also reduce the entrenchment of the stream channels and may reduce future fine sediment loading from stream bank erosion.
Habitat	The project would significantly enhance the aquatic and riparian habitats at the confluence. Reconnecting the floodplain with the active creek channels would enhance riparian and wetland habitats and could significantly improve the health and extent of the existing riparian vegetation. Re-establishing natural geomorphic processes and removing bank armor could also improve aquatic habitat diversity within the creek and support the natural recruitment of wetland and riparian vegetation in the active floodplain.

cbec eco engineering, H.T. Harvey & Associates, Susan Lindstrom. 2016. Donner Basin Watershed Assessment. Prepared for Truckee River Watershed Council. January 2016.

For more information about this project, please visit truckeeriverwc.org

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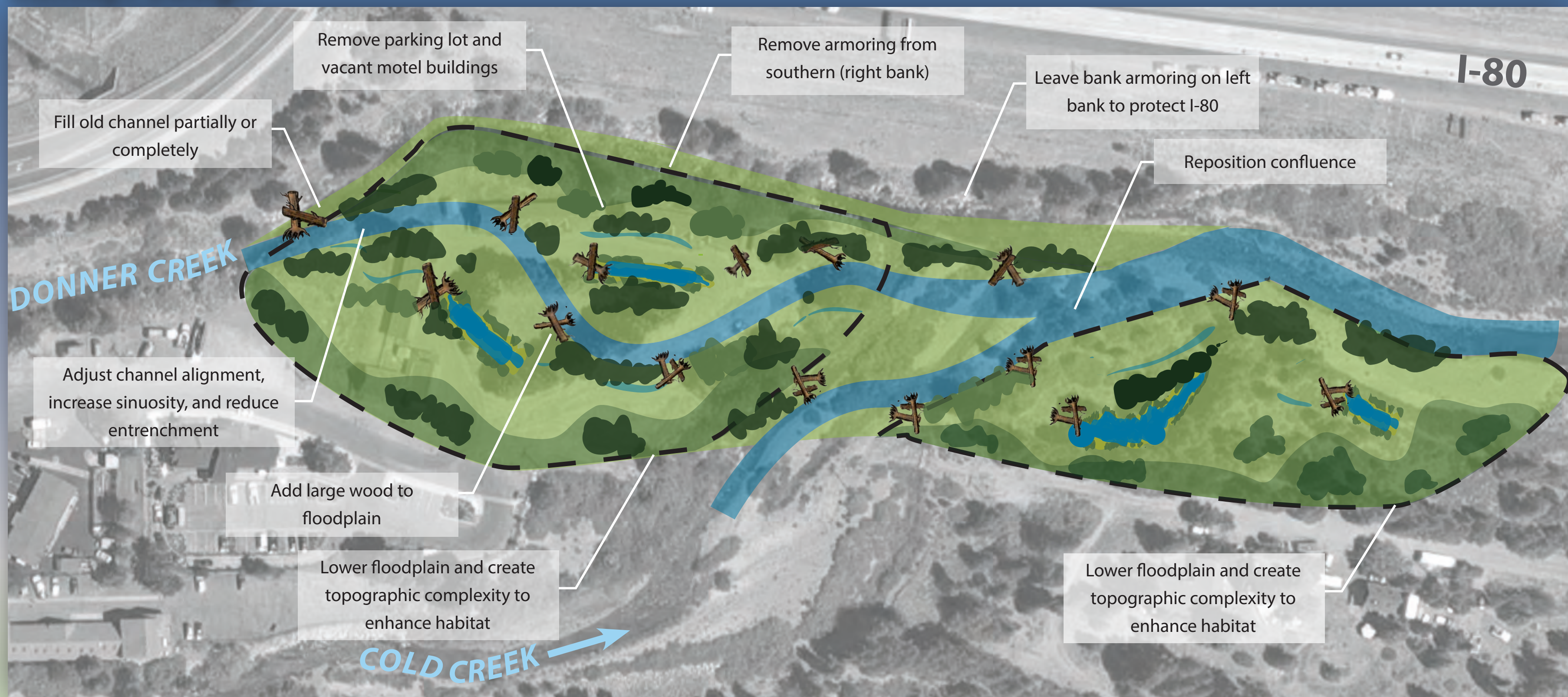
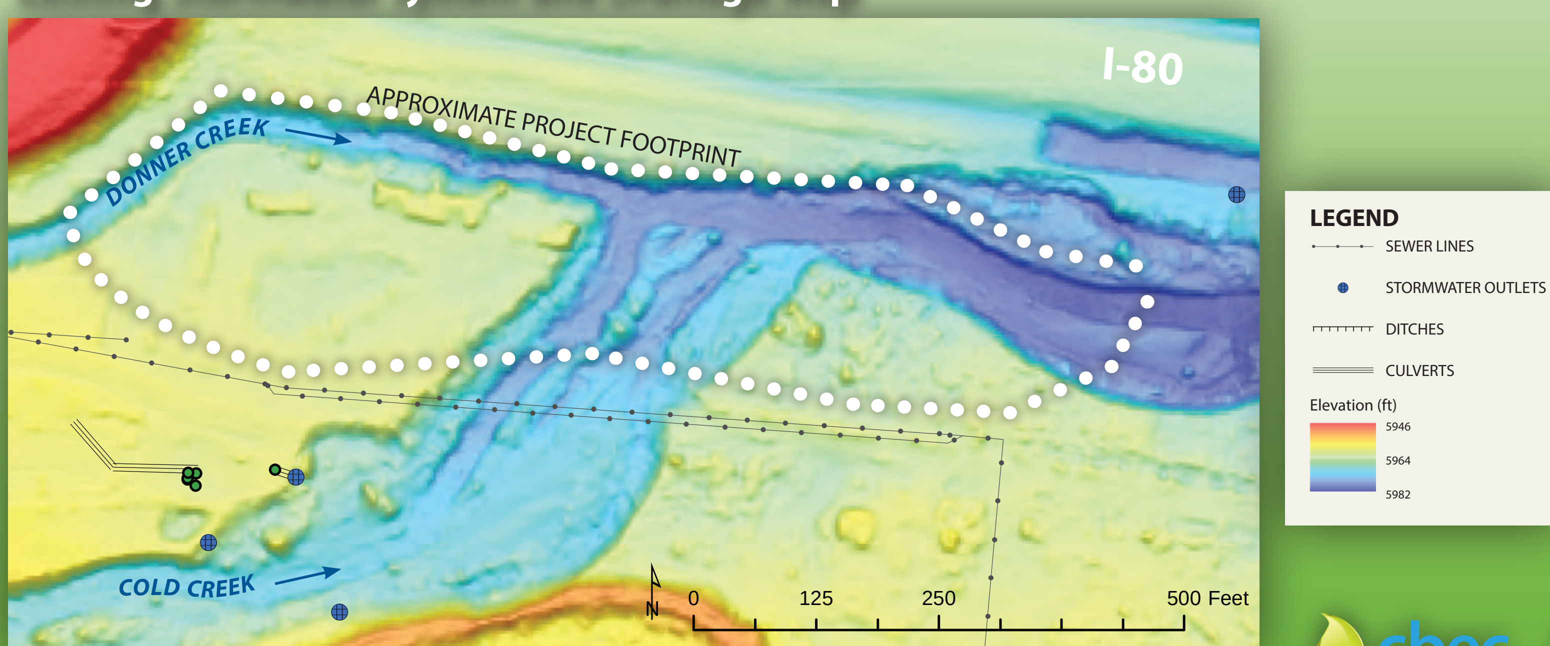
Concept Design



Project Footprint (Looking West)

Photo by Chris Bowles, cbec (2015).

Existing Stormwater System and Drainage Map



Elevation data from USFS 2014 LiDAR dataset.

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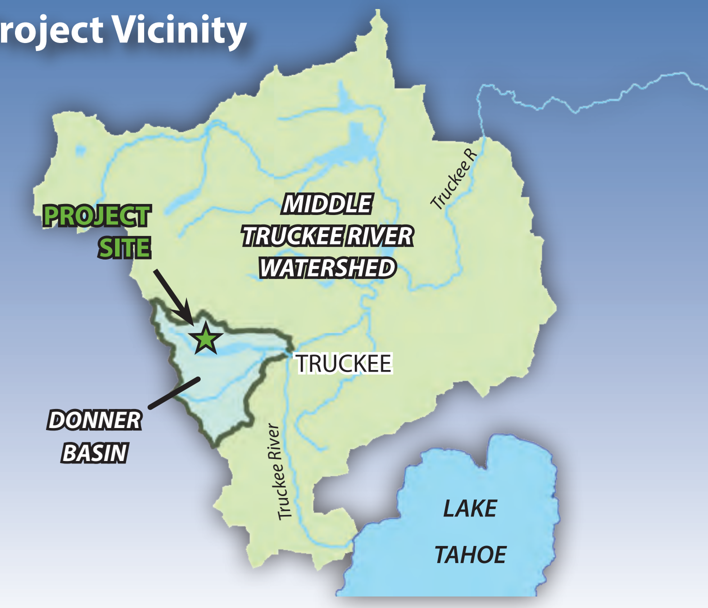
Project Footprint (Looking East)

Photo by Chris Bowles, cbec (2015).

Donner Basin
Gregory Creek Meadow Habitat and Floodplain Enhancement

Photo by Chris Bowles, cbec (2015).

Project Vicinity



Project Location

Location: Large open space immediately downstream of Gregory Creek tributary confluence and immediately north of I-80.

Project Description

The open space will be converted into a floodplain meadow and wetland complex. Site grading will be combined with increases to the stream bed elevation to encourage floodplain connectivity. A secondary channel will also be constructed through the open space. The floodplain will be designed to have wetland depressions to capture fine sediment coming from the upper watershed. Stormwater treatment wetlands will also be constructed to capture and treat I-80 runoff.

Problem

A large open space currently exists that was likely a snow storage site or other staging area for Interstate 80. The site features a small concrete pad as well as a large gravel and dirt surface, which contributes to sedimentation and provides little to no habitat value. A fairly narrow riparian buffer separates Gregory Creek from the open space.

Benefits

The project would significantly improve habitat conditions and provide additional meadow, wetland and floodplain environments. Physical processes and floodplain connectivity would also be enhanced. Depending on project design, the site would capture large volumes of suspended sediment and improve downstream water quality.

Constraints

Elevation of existing open space relative to the stream may require significant bed elevation increases and/or grading efforts to facilitate floodplain connectivity.

Cost Estimate: $100,000 to > $1M

Timeline: 2 to 4 years

Project concept assumes support of all land owners, land managers, and stakeholders.

Proposed meadow area. Photo by Jai Singh, cbec (2015).

Concrete pad to be removed. Photo by Jai Singh, cbec (2015).

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Project Benefits

Benefit	Comments
Geomorphic / Physical Processes	The project will promote floodplain connectivity and enhance physical processes. It may also help capture excess fine sediment that is generated by hillslope erosion from historic logging practices and that may affect downstream stream health.
Hydrology	The broadened stream corridor and more active floodplain would enhance infiltration of flood flows into the shallow groundwater table. Pocket depressions in floodplain areas may also provide temporary storage of flood waters. The project will also capture runoff from I-80.
Water Quality	The enhanced floodplain connectivity will provide greater opportunities for sediment deposition and the capture of pollutants. The stormwater wetland feature will also reduce stormwater pollutant loading from I-80 runoff before it enters Gregory Creek.
Fine Sediment Reduction	The project may help capture excess fine sediment that is generated by hillslope erosion from historic logging practices at higher elevations in the Gregory Creek watershed.
Habitat	This wetland complex would substantially benefit habitat values for residential and migratory wildlife. Wetlands, wet meadows, and riparian habitats provide relatively high value to wildlife and are relatively scarce in the watershed. The restoration of this complex in line with the Gregory Creek channel and existing migratory corridors would provide greater habitat diversity and substantially increase the availability of important habitat types to wildlife.

cbec eco engineering, H.T. Harvey & Associates, Susan Lindstrom. 2016. Donner Basin Watershed Assessment. Prepared for Truckee River Watershed Council. January 2016.

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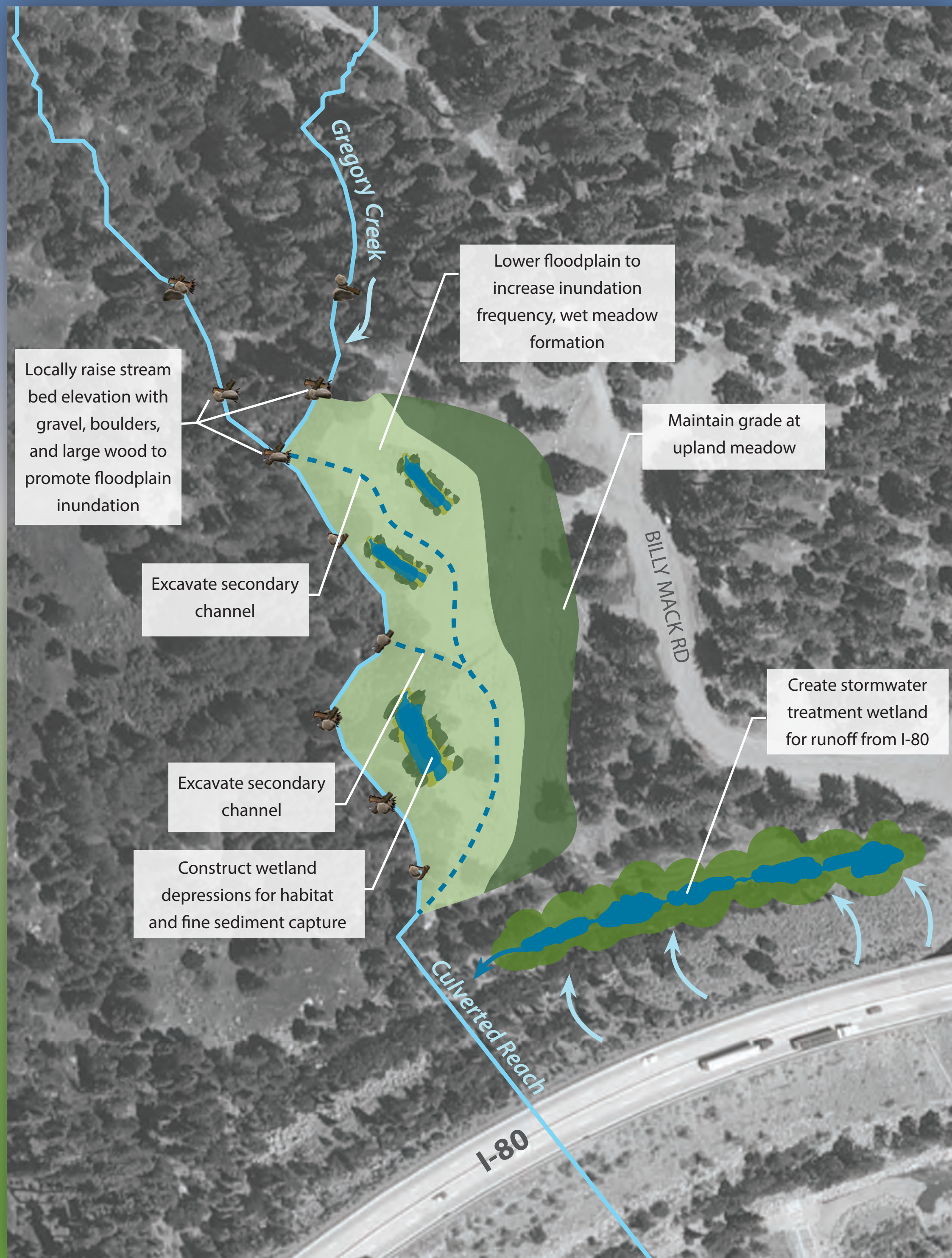
Concept Design



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Project Footprint

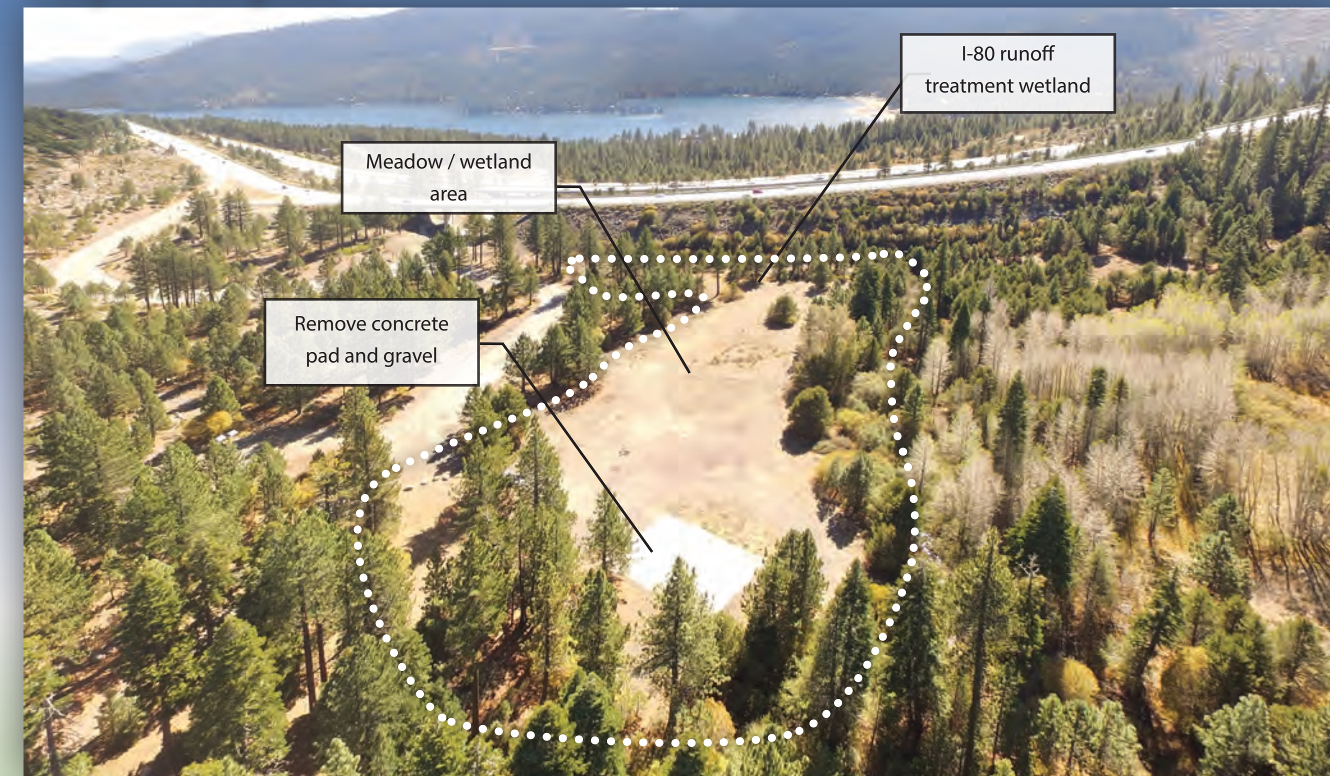
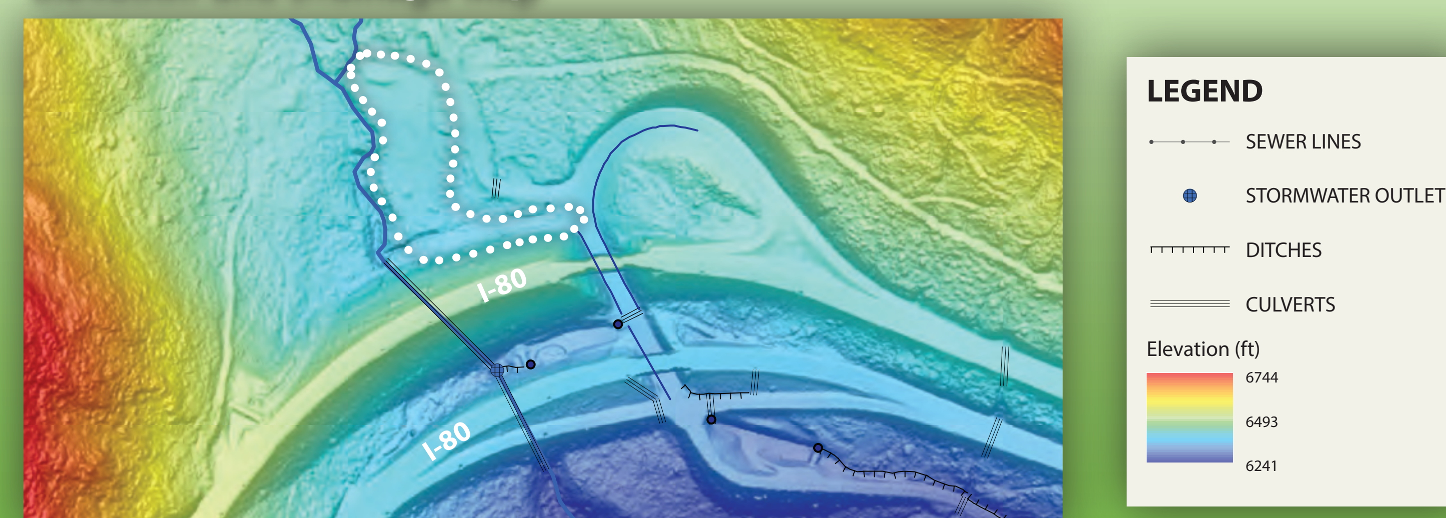


Photo by Chris Bowles, cbec (2015).

Elevation and Drainage Map



Elevation data from USFS 2014 LiDAR dataset.

0 125 250 500 Feet

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Donner Basin
Unpaved Road Stabilization and Erosion Treatment

Sediment accumulated behind fallen log downhill from an eroding backcountry road. Photo by Jai Singh, cbec (2015).

Project Vicinity

Project Location

Location: Numerous sites throughout the Donner Basin, most of which are located in backcountry areas.

Project Description

Unpaved roads in the Donner Basin that exhibit erosion issues should be decommissioned or improved to reduce or eliminate local erosion problems. Projects may consist of full hillslope recontouring, addressing drainage problems, reducing road width, and other maintenance and stabilization actions. The scale of unpaved road maintenance and / or decommissioning will depend on severity of erosion, funding and coordination with land managers. Preliminary site identification should draw on the Erosion Hazard Analysis and the preliminary road prioritization based on slope and soil erodibility (see figure on reverse side of page). Sites should then be further evaluated and prioritized through field studies and existing land manager knowledge.

Problem

Numerous unpaved roads, particularly in backcountry areas, exhibit significant erosion problems today and contribute large volumes of fine sediment to the watershed. Many of these roads were created for logging purposes and are no longer actively used or maintained. Due to steep slopes and unstable soils, many areas continue to suffer from unabated erosion issues.

Benefits

The stabilization of eroding unpaved roads will reduce fine sediment yields to the watershed and help improve water quality. Projects may also lessen historic hydrologic impacts associated with logging and road construction. Upland forest and meadow habitat will be improved directly, and may improve indirectly from reduced backcountry off-road vehicle traffic.

Constraints

The scale and coverage of projects will depend significantly on funding. Further site prioritization will be necessary and will likely require additional field efforts. Coordination with land managers will be required, especially where roads provide access (e.g., to the railroad). The ability to revegetate steep hillslopes successfully may be challenging due to harsh climatic conditions.

Cost Estimate: $100,000 to > $1M

Timeline: 0.5 to 10+ years

Project concept assumes support of all land owners, land managers, and stakeholders.

Gully erosion on backcountry road. Photo by Jai Singh, cbec (2015).

Backcountry road showing signs of sheet erosion. Photo by Jai Singh, cbec (2015).

Project Benefits

Benefit	Comments
Geomorphic / Physical Processes	These projects will reduce hillslope erosion from rilling and gullying, thus lessening excessive fine sediment loading and associated impacts to sediment dynamics in receiving streams.
Hydrology	Decommissioning and improving roads will lessen historic impacts to the basin's hydrology by lessening the concentration of runoff along artificial flow paths. This in turn will promote infiltration and reduce peak flows in receiving streams.
Water Quality	These projects will improve water quality by reducing fine sediment loading to receiving streams and Donner Lake.
Fine Sediment Reduction	These projects will stabilize eroding roads and hillslopes, thus addressing one of the largest human-induced sources of fine sediment to the basin.
Habitat	Decommissioning roads will provide local improvements to forest and meadow habitat. It may also provide indirect benefits by reducing off-road vehicle traffic and creating more contiguous habitat areas. The stabilization of unpaved roads will alleviate active erosion and likely reduce fine sediment loads to Donner Lake tributaries, thereby improving aquatic habitat quality.

cbec eco engineering, H.T. Harvey & Associates, Susan Lindstrom. 2016. Donner Basin Watershed Assessment. Prepared for Truckee River Watershed Council. January 2016.

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Preliminary Unpaved Road Erodibility Map

The erodibility mapping is based on slope value and soil erodibility factor. The erodibility mapping is intended only to be used as preliminary assessment tool to identify likely areas of erosion concern. The mapping does not draw on road erosion conditions, road width, drainage concerns, and numerous other factors that will significantly influence erosion and downhill fine sediment delivery.

Elevation data from USFS 2014 LiDAR dataset.

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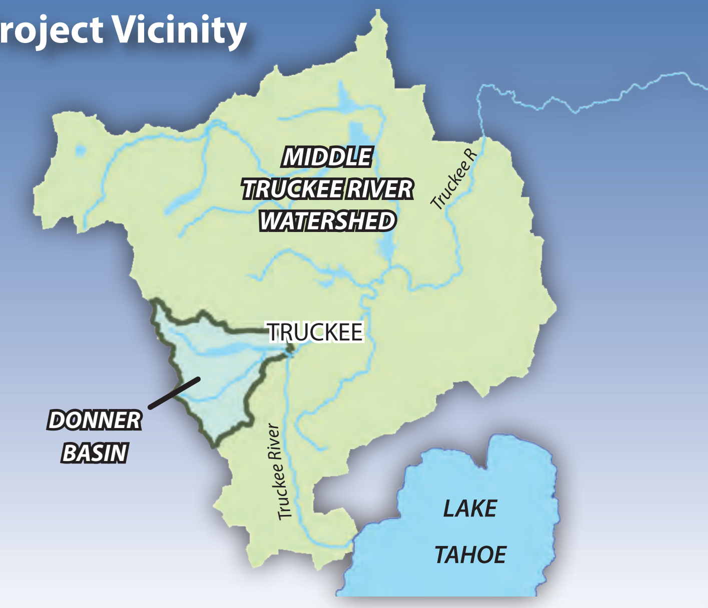
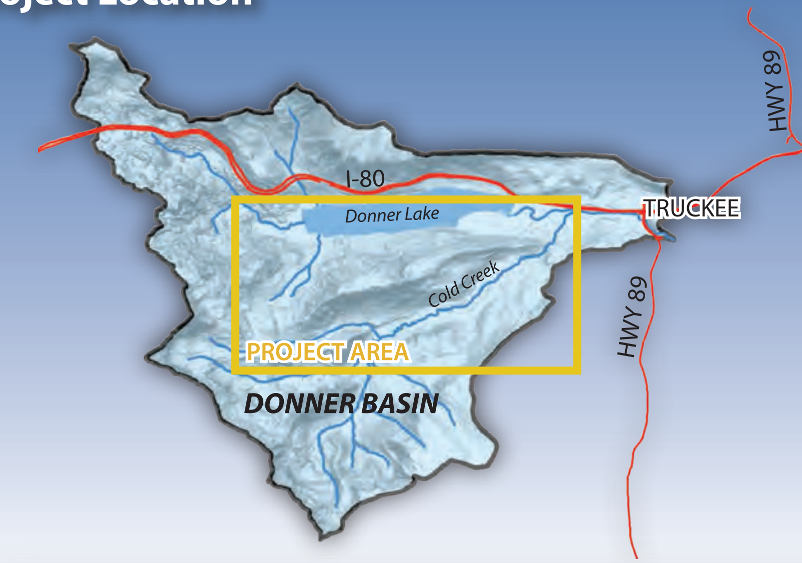
Donner Basin
Railroad Grade Hillslope Erosion Stabilization


Erosion along retired railroad grade. Photo by Jai Singh, cbec (2015).

Project Vicinity



Project Location



Location
Various locations along railroad corridor.

Project Description
Eroding hillslopes along the railroad grade should be stabilized using a combination of various materials including large wood or logs, soil amendments, natural fabrics (such as coir or jute) and revegetation with native, drought-tolerant grasses and sedges. In some cases, more intensive geotechnical stabilization efforts may be necessary.

Problem
Grading for the railroad tracks created steep, bare hillslopes in many areas along the railroad line. Particularly where these steep hillslope coincide with easily erodible soils, the erosion caused by grading has failed to stabilize. Ongoing hillslope erosion transports significant volumes of fine sediment to Summit Creek, Lakeview Canyon and Donner Lake.

Benefits
The stabilization of eroding hillslopes will reduce fine sediment yields to the watershed and help improve water quality. Projects may also lessen historic hydrologic impacts associated with the railroad's construction. Upland forest and meadow habitat may improve.

Constraints
Coordination with the railroad will be required. The scale and coverage of erosion stabilization projects will depend significantly on funding. Further site prioritization will be necessary and will likely require additional field efforts. The ability to revegetate steep hillslopes successfully may be challenging due to harsh climatic conditions. Soil erodibility and slope stability may also pose challenges in some areas.

Cost Estimate: $100,000 to > $1M

Timeline: 1 to 10+ years

Project concept assumes support of all land owners, land managers, and stakeholders.


Severely eroding gully along railroad grade. Photo by Jai Singh, cbec (2015).


Hillslope erosion along retired railroad grade. Photo by Jai Singh, cbec (2015).

Project Benefits

Benefit	Comments
Geomorphic / Physical Processes	These projects will reduce hillslope erosion, thus lessening excessive fine sediment loading and associated impacts to sediment dynamics in receiving streams.
Hydrology	Stabilizing hillslopes along the railroad grade will lessen historic impacts to the basin's hydrology by reducing the concentration of runoff along artificial flow paths. This in turn will promote infiltration and reduce peak flows in receiving streams.
Water Quality	These projects will improve water quality by reducing fine sediment loading to receiving streams and Donner Lake.
Fine Sediment Reduction	These projects will stabilize eroding hillslopes, thus addressing a very significant human-induced source of fine sediment to the to Donner Lake and the basin's stream network
Habitat	Hillslope stabilization will alleviate active erosion and likely reduce sediment loads into Lakeview Canyon, Summit Creek, and Donner Lake, thereby improving aquatic habitat quality in these systems. It will also provide local improvements to forest and meadow habitat.

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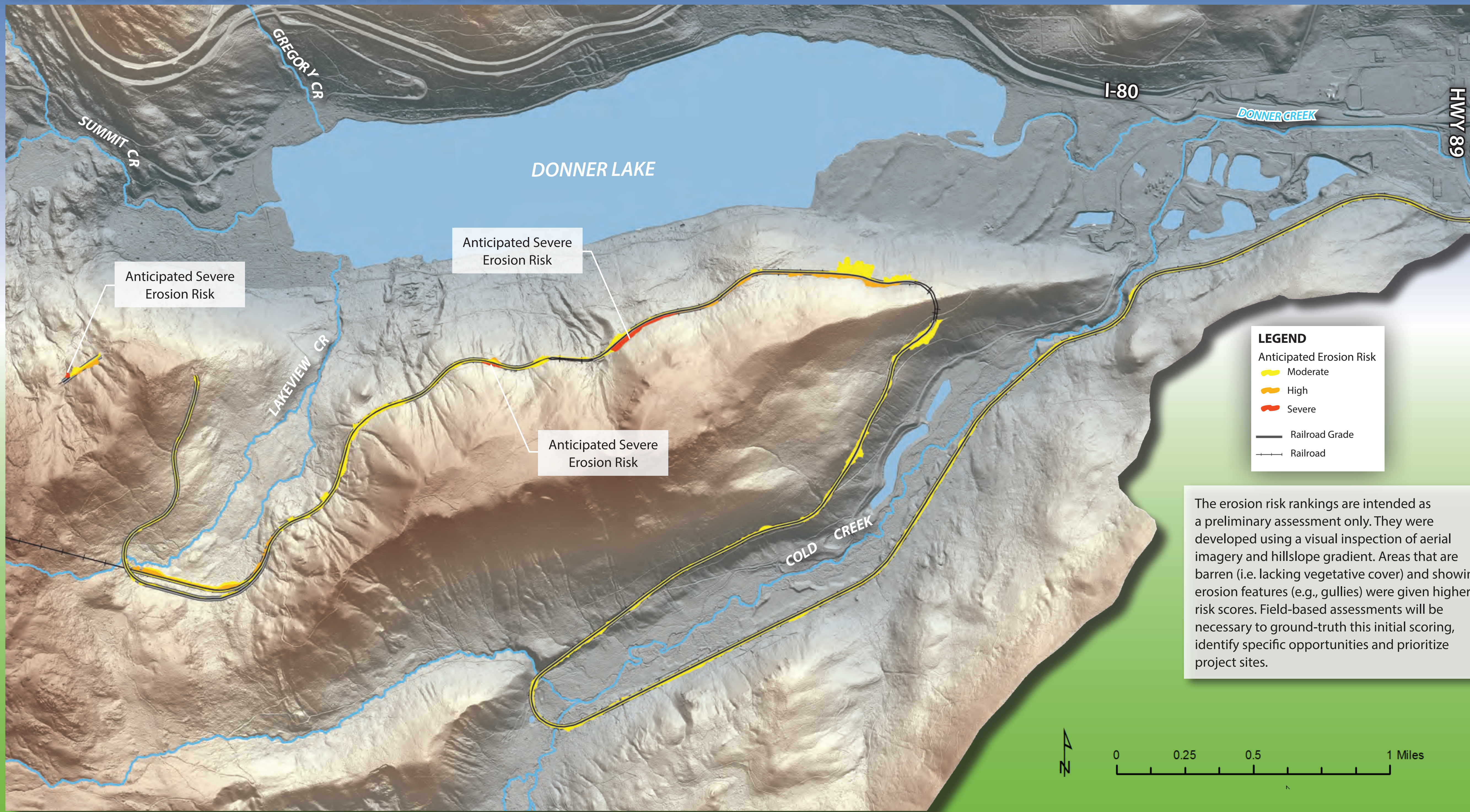
Reconnaissance-Level Railroad Grade Erosion Risk Assessment



LEGEND

Anticipated Erosion Risk
- Moderate
- High
- Severe
- Railroad Grade
- Railroad

The erosion risk rankings are intended as a preliminary assessment only. They were developed using a visual inspection of aerial imagery and hillslope gradient. Areas that are barren (i.e. lacking vegetative cover) and showing erosion features (e.g., gullies) were given higher risk scores. Field-based assessments will be necessary to ground-truth this initial scoring, identify specific opportunities and prioritize project sites.

N

0 0.25 0.5 1 Miles

Elevation data from USFS 2014 LiDAR dataset.

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Donner Basin
Stormwater Treatment Wetland Complex and Educational Site

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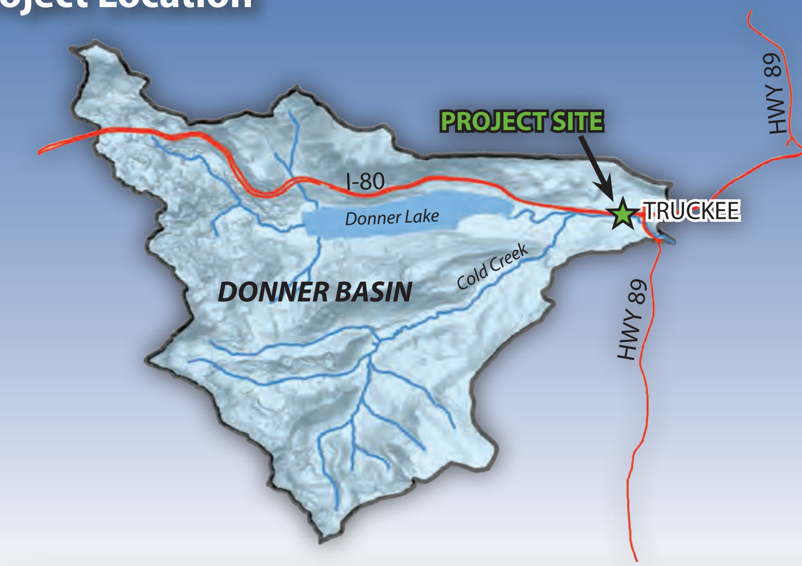
Photo by Chris Bowles, cbec (2015).

Project Vicinity

Project Location



Location: North of I-80 near Truckee High School and athletic fields

Project Description

We propose to construct a stormwater treatment wetland complex in the area of the existing ditch. Multiple wetlands or treatment cells will capture stormwater and improve water quality. The complex will create a living classroom for the neighboring high school's environmental education programs, featuring a board walk and signs. The site offers an unusual opportunity within a highly developed portion of the basin to intercept stormwater from a significant urban area before it enters Donner Creek.

Problem

Stormwater from commercial areas, roads, the high school and athletic fields currently drains to a ditch along the north side of I-80 and into Donner Creek. This ditch offers minimal stormwater treatment and many pollutants flow directly into Donner Creek. At present, land alongside the ditch has minimal use, particularly to the north.

Benefits

The treatment wetland complex will improve water quality by capturing urban stormwater pollutants and fine sediment. Depending on the design of the wetland complex, the project will help reduce peak stormwater flows entering Donner Creek. The complex will also provide a wetland habitat area and improve the quality of riparian habitats.

Constraints

The project will require the support of land managers and the repurposing of land as a stormwater treatment wetland complex. A sewer line passes through the project site.

Cost Estimate: $100,000 to > $1M

Timeline: 2 to 5 years

Project concept assumes support of all land owners, land managers, and stakeholders.

Sediment accumulation at culvert inlets which convey water to Donner Creek. Photo by Jai Singh, cbec (2015).

Stormwater outlet from high school in project site. Photo by Jai Singh, cbec (2015).

Project Benefits

Benefit	Comments
Geomorphic / Physical Processes	The capture of stormwater and fine sediment in the wetland complex would help reduce impacts to physical processes occurring in both upland areas and within Donner Creek.
Hydrology	The wetland complex could store a significant volume of stormwater, helping reduce the impacts of urbanization on the basin's hydrology and lessening peak stormwater flows entering Donner Creek.
Water Quality	Urban stormwater pollutants coming from roads, parking lots, athletic fields, and commercial areas could be captured by the treatment wetland before entering Donner Creek.
Fine Sediment Reduction	The wetland complex would help reduce stormwater velocities and capture fine sediment that would otherwise drain into Donner Creek.
Habitat	The complex would support wetland habitat with native vegetation and could enhance riparian habitats adjacent to the complex. Wetlands, wet meadows, and riparian habitats provide relatively high value to migratory birds and other wildlife.

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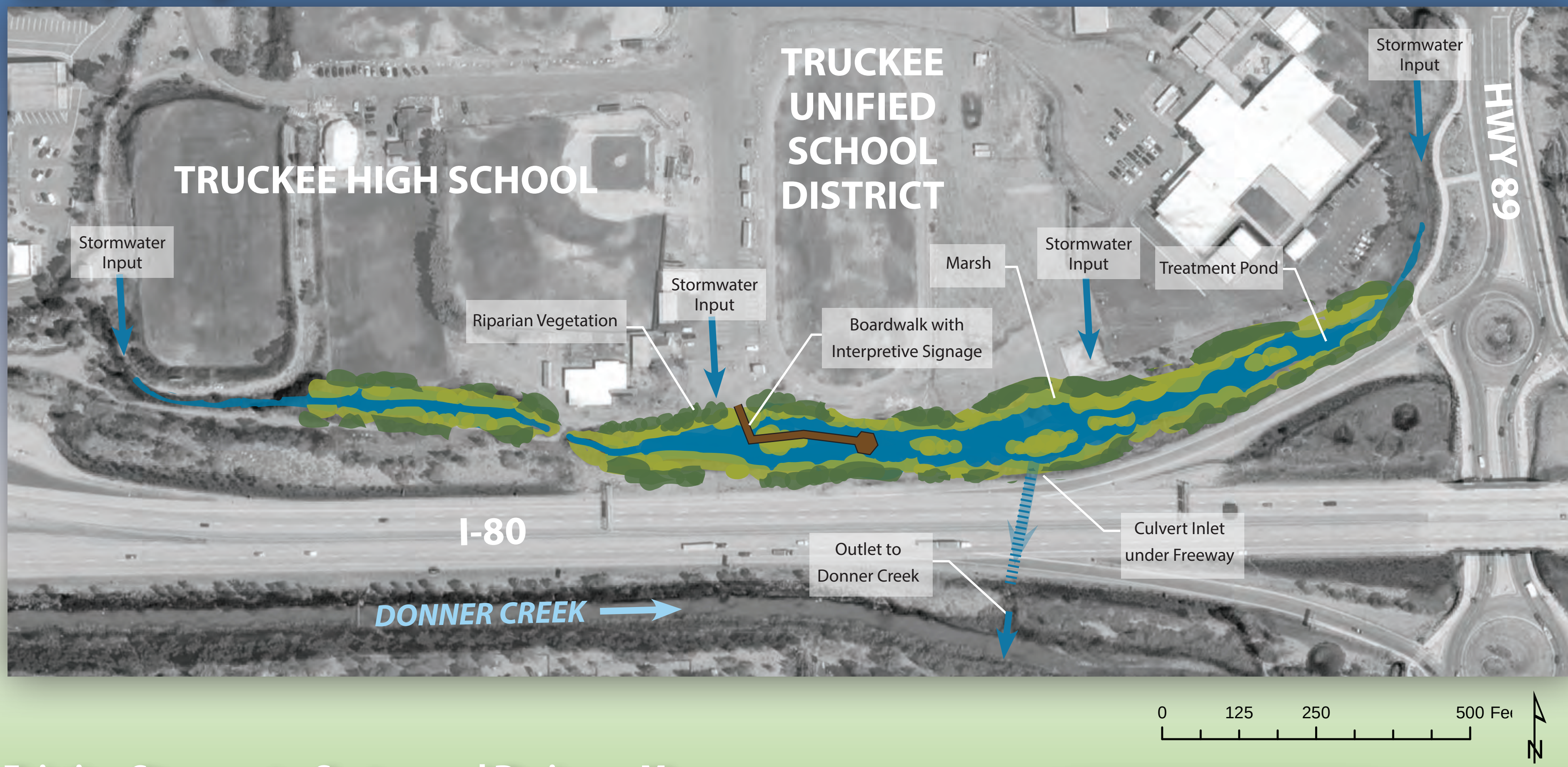
Concept Design



Existing Stormwater System and Drainage Map

Elevation data from USFS 2014 LiDAR dataset.

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Project Footprint

Photo by Chris Bowles, cbec (2015).

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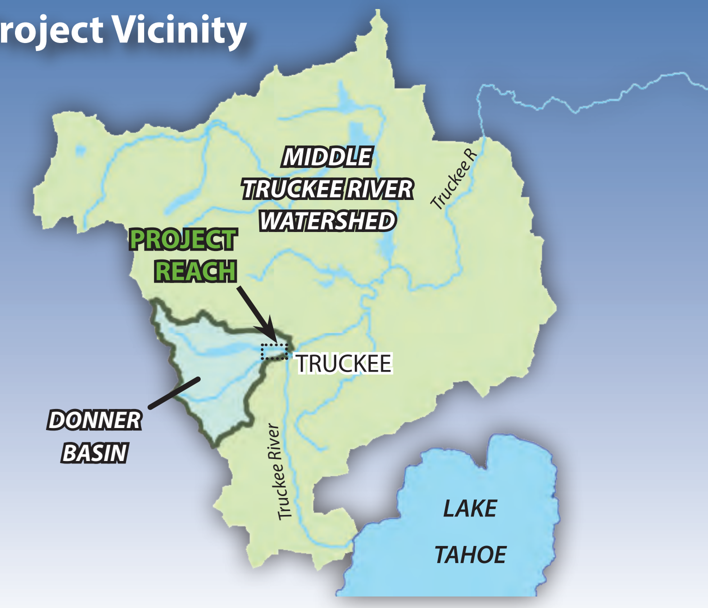
Donner Basin
Stormwater Infiltration and Treatment Along I-80


Photo by Chris Bowles, cbec (2015).

Project Vicinity



Project Location

Location: The southern edge of I-80 along the highly straightened section of Donner Creek between Cold Creek Rd and Highway 89

Project Description

Stormwater from the interstate will be captured in a stormwater treatment feature constructed immediately between the southern edge of pavement and the top of the Donner Creek stream bank. Designs will involve a stormwater trench, percolation drain or grass swale. The feature will be divided into cells to further enhance treatment and infiltration. Soil amendments or replaceable media will also be used to enhance capture of stormwater pollutants.

Problem

Much of the stormwater from the interstate's east-bound traffic currently drains directly off the edge of the pavement and into Donner Creek. This stormwater likely transports a large array of pollutants as well as trash into Donner Creek, leading to water quality impairment and trash accumulation.

Benefits

Most significant will be the water quality improvements realized from capturing stormwater pollutants. The stormwater treatment feature will help reduce and attenuate some of the hydrology impacts by detaining a portion of the runoff from the interstate. The feature may also assist with reducing fine sediment loading from pulverized traction sand and minor hillslope erosion due to stormwater concentration.

Constraints

Available space along the highway corridor between the edge of pavement and Donner Creek's stream bank is limited. Depending on the project design and materials, regular maintenance may be required.

Cost Estimate: $100,000 to > $1M

Timeline: 2 years

Project concept assumes support of all land owners, land managers, and stakeholders.


Existing buffer between I-80 (right) and Donner Creek (left). Photo by Jai Singh, cbec (2015).


Localized erosion and debris from I-80 runoff. Photo by Jai Singh, cbec (2015).

Project Benefits

Benefit	Comments
Geomorphic / Physical Processes	The capture of stormwater and fine sediment by the vegetated buffer strip and infiltration trench will help reduce impacts to physical processes within Donner Creek.
Hydrology	The infiltration trench will store stormwater and promote infiltration, thereby reducing the impacts of urbanization on the basin's hydrology and lessening the peak stormwater flows entering Donner Creek.
Water Quality	The project will capture a portion of the stormwater pollutants from the interstate, reducing the loading of hydrocarbons, metals, trash and other contaminants from the road surface before they enter Donner Creek.
Fine Sediment Reduction	The vegetated buffer and infiltration trench will help capture fine sediment derived from traction sand applied to the interstate during the winter season that is subsequently pulverized by vehicle traffic.

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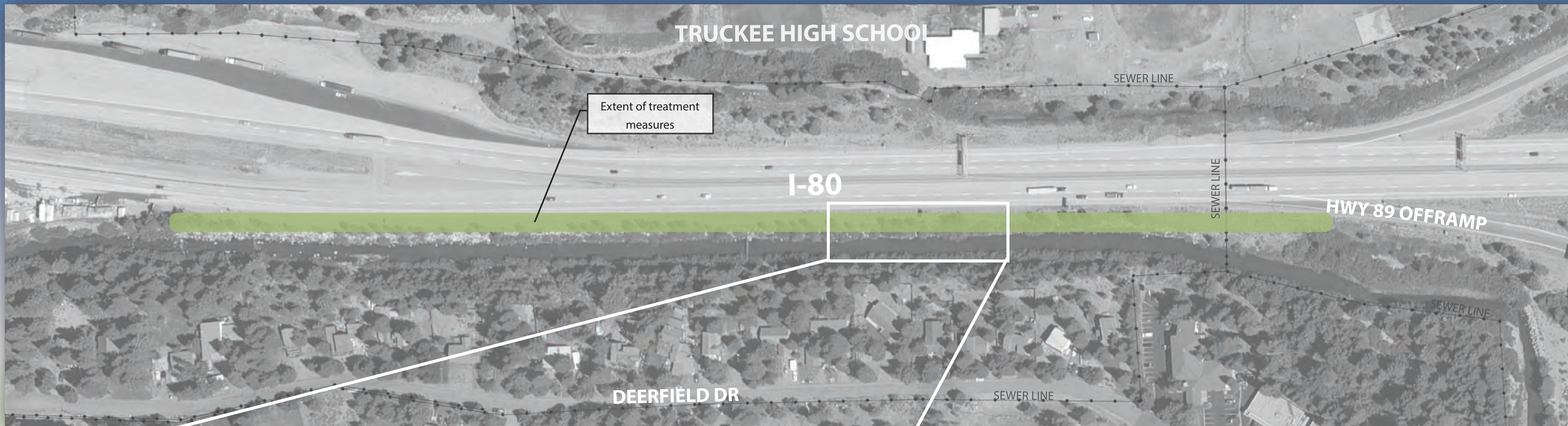
Project Reach



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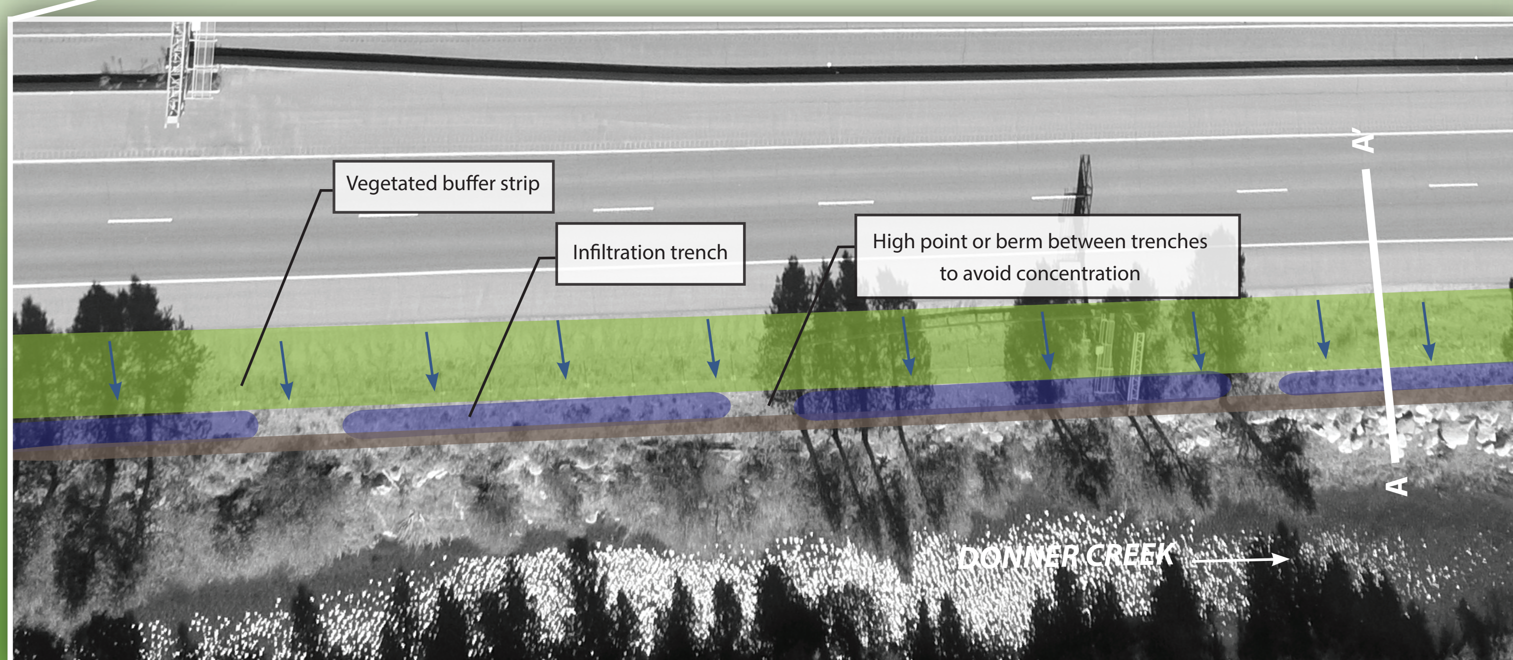
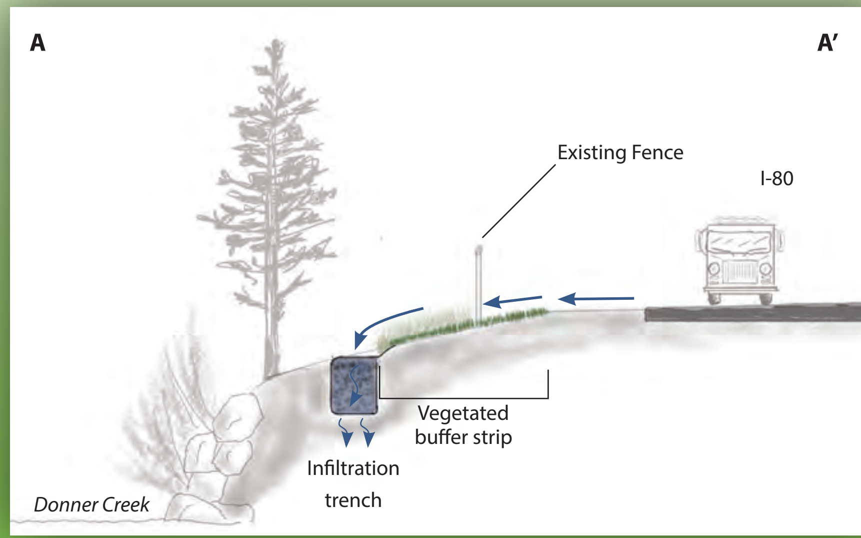


Concept Design



Stormwater Capture and Treament Design

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Donner Basin
I-80 Stormwater Management and Erosion Reduction Projects

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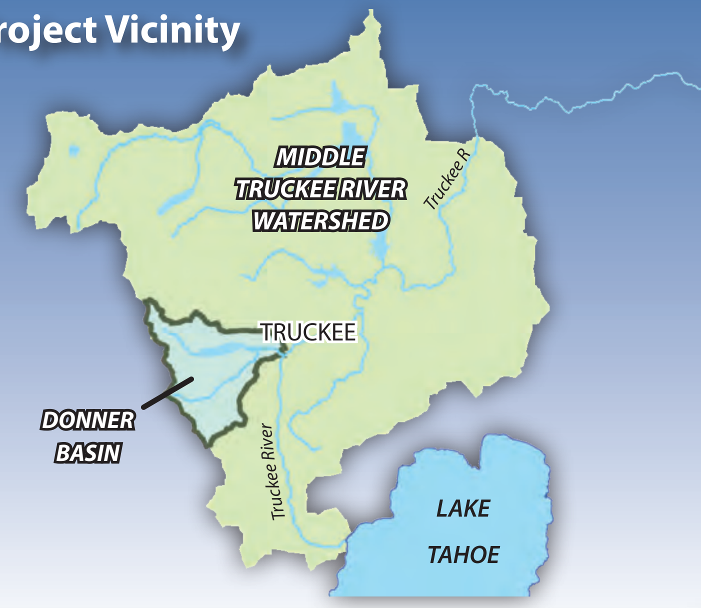
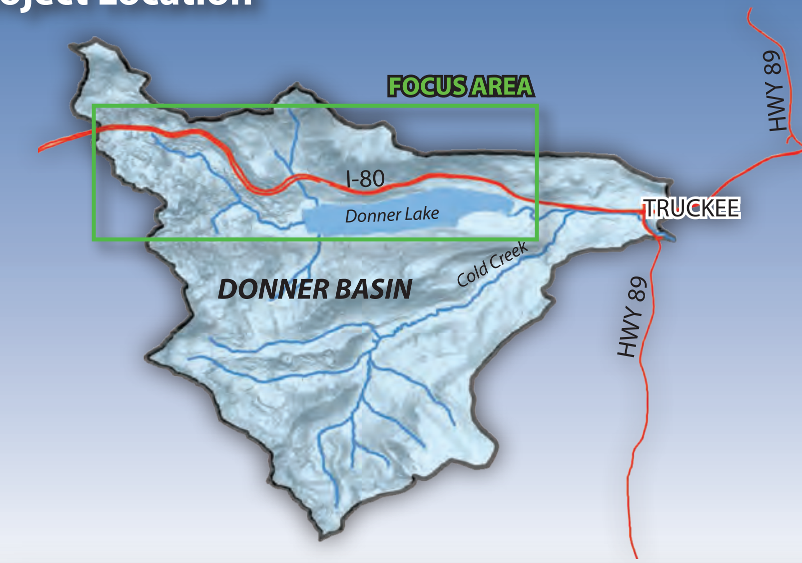
Photo by Chris Bowles, cbec (2015).

Project Vicinity



Project Location



Location

The I-80 corridor, particularly in steeper portions of Donner Basin (i.e. those west of the eastern end of Donner Lake).

Project Description

To address the concentration of runoff and associated erosion problems, small-scale stormwater management or "Best Management Practices" (BMPs) should be installed at the outlets of stormwater culverts. Where space is available, small settling basins or infiltration features should be developed. In other locations where little to no space is available, energy dissipation devices, slope drains, "hydro brakes" and other BMPs could be pursued.

Problem

In many locations, the construction of the interstate resulted in the artificial concentration of runoff from uphill areas into stormwater drains and culverts passing under the highway. Combined with increased runoff volumes from the paved road surfaces, this concentrated stormwater causes hillslope erosion problems and gullying, and carries pollutants from the roadway to downstream channels and Donner Lake. Hillslope erosion and gullying are worst in areas with steep slopes and highly erodible soils.

Benefits

Projects will reduce the concentration of stormwater on the downhill side of Interstate 80. In turn, this will reduce the hillslope erosion and gullying that currently occurs in some areas thereby reducing the fine sediment loading to tributaries and Donner Lake.

Constraints

Space availability for BMPs along the interstate is very limited, especially in the steeper sections of Donner Basin. Retrofitting many sites may be cost-prohibitive.

Cost Estimate: $100,000 to > $1M

Timeline: 0.5 to 10+ years

Project concept assumes support of all land owners, land managers, and stakeholders.


Existing sediment detention area below I-80. Photo by Jai Singh, cbec (2015).


Sediment being transported from I-80 hillslope in Billy Mack Canyon, potentially a combination of hillslope material and I-80 traction sand. Photo by Jai Singh, cbec (2015).

Project Benefits

Benefit	Comments
Geomorphic / Physical Processes	The reduction in stormwater volumes and associated gullying and erosion issues will reduce the delivery of fine sediment to receiving streams and Donner Lake. In turn, this will lessen the impact of the I-80 on sediment dynamics within these tributaries, mostly notably Gregory and Billy Mack Creeks.
Hydrology	The recommended stormwater BMPs will reduce hydrologic impacts to the basin by capturing and dissipating stormwater runoff and promoting infiltration.
Water Quality	Stormwater BMPs will reduce fine sediment loading and, depending on the features installed, may also capture roadway pollutants or encourage their natural remediation before runoff reaches receiving streams.
Fine Sediment Reduction	The recommended BMPs will address hillslope erosion and gullying due to stormwater concentration, thereby reducing fine sediment loading to downstream tributaries.
Habitat	These projects will likely reduce the amount of fine sediment that enters receiving streams, thereby improving aquatic habitat conditions.

cbec eco engineering, H.T. Harvey & Associates, Susan Lindstrom. 2016. Donner Basin Watershed Assessment. Prepared for Truckee River Watershed Council. January 2016.

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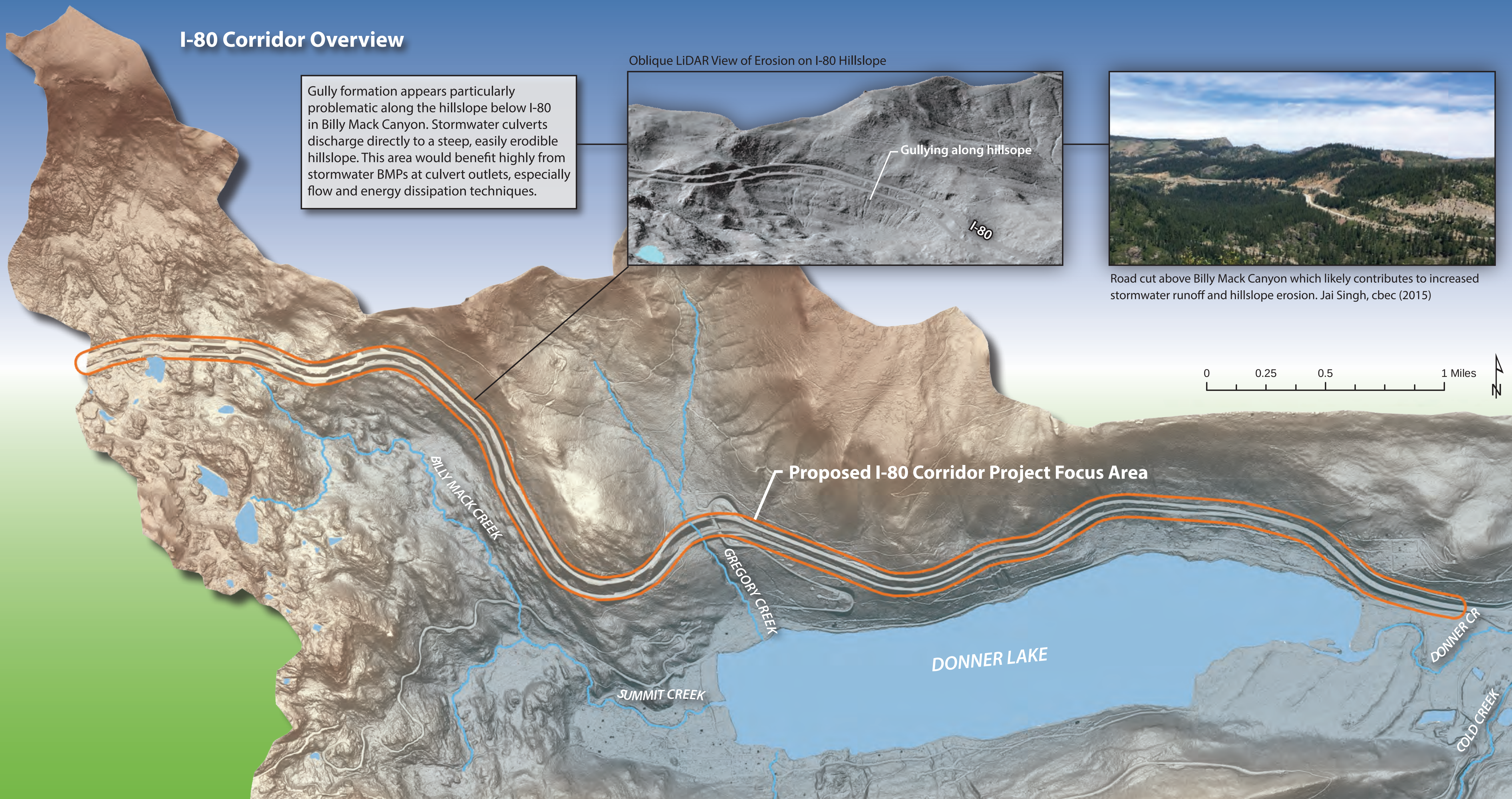
I-80 Corridor Overview

Gully formation appears particularly problematic along the hillslope below I-80 in Billy Mack Canyon. Stormwater culverts discharge directly to a steep, easily erodible hillslope. This area would benefit highly from stormwater BMPs at culvert outlets, especially flow and energy dissipation techniques.

Oblique LiDAR View of Erosion on I-80 Hillslope



Road cut above Billy Mack Canyon which likely contributes to increased stormwater runoff and hillslope erosion. Jai Singh, cbec (2015)

Elevation data from USFS 2014 LiDAR dataset.

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5.3 RECOMMENDED STUDIES

5.3.1 Additional Water Quality Monitoring

As discussed in Section 2.5, fish in Donner Lake have been shown by the State Water Resources Control Board, California Department of Fish and Wildlife, and the California EPA to contain mercury, arsenic, polychlorinated biphenyls (PCBs) and chlordane. These constituents are known to be toxic and to bioaccumulate, meaning that relatively low environmental concentrations of these compounds may be concentrated through the aquatic food chain and result in fish tissue concentrations much higher than those observed in water. Consequently, these contaminants may pose a health risk to people who regularly consume fish caught from Donner Lake. However, existing fish tissue sample data is relatively sparse and the most recent testing identified in this report was conducted in 2007. In order to better understand the contaminant sources, concentrations and distribution in the lake, and the risks to human health, we recommend that the following monitoring actions be conducted. These studies can be used to develop a conceptual model of water quality contamination in the Donner Basin intended to answer the following questions:

1) What contaminants are currently present in the lake and at what concentrations?
2) How are the contaminants distributed?
3) What are the contaminant sources?
4) What long-term contamination trends exist in Donner Lake?

The following recommendations are presented in order of priority to help answer the above questions. They begin with fish tissue sampling to address current human health concerns, and continue on to characterizing lake contamination and pollutant sources. However, we recommend that the following monitoring plan be implemented in an iterative manner such that it is continually adapted as new data becomes available. As more data is collected and a better understanding of contamination in Donner Lake is acquired, it is likely that certain pollution sources can be ruled out and that some monitoring actions will not be necessary. Additionally, it may be advisable to expand future water quality monitoring, particularly sampling of surface water in Donner Lake and its tributaries, to include additional pollutants such as hydrocarbons and nutrients.

1. Conduct Additional Fish Tissue Monitoring

The most significant human health concern created by the water quality contamination of Donner Lake is the consumption of affected fish. In order to better understand this risk, additional fish tissue sampling should be conducted to evaluate the concentration of mercury, arsenic, PCBs and chlordane in a variety of fish species (with specific focus placed on those that are commonly consumed). This data will inform current consumption risks to humans and help identify any long term trends in contamination.

2. Characterize Distribution of Contaminants in Donner Lake Water and Sediments

a. Monitor Donner Lake Surface Water

To establish a baseline understanding of constituent concentrations in the water column, surface water samples should be collected at various locations around the lake. Results from the monitoring may also help inform source attribution of various contaminants. As an example, the congener profile of PCBs will help in determining whether or not their source is atmospheric deposition).

b. Monitor Donner Lake Sediment

Due to the chemical properties of PCBs, chlordane, and methylmercury, these constituents are more likely to adsorb or "stick" to organic matter. Consequently, their concentrations are expected to be higher in lake bed sediments than in the water column. While human exposure to lake bed sediments is less common than exposure to the lake water, these pollutants can be transferred up the food chain from sediments to small organisms which are then consumed by fish.

Sediment samples should be collected at various points around Donner Lake and evaluated for their constituent concentrations. Sampling should also be conducted specifically for lake bed sediments near the mouths of Summit Creek, Gregory Creek and Lakeview Canyon to help determine whether any of these tributaries is contributing or has contributed particularly high levels of any of these constituents. Sampling can be conducted with sediment cores and soil profile dating techniques can be leveraged to provide information about historic trends in pollutant loading rates. This sediment sampling effort will help in determining the distribution of contaminants and potential source attribution.

3. Characterize Potential Sources of Contamination

a. Monitor Stormwater Runoff

Stormwater runoff from the tributaries and from drainage channels could also be sampled for contaminant concentrations. As a starting point, samples could be taken immediately upstream of the lake to provide representation of the full sub-basin. Sampling of different types of precipitation events would also be valuable (e.g., summer thunderstorms, rain on snow events, spring snowmelt, etc.). This monitoring would help in determining whether runoff and/or erosion of contaminated soils are important sources of pollution.

b. Monitor Streambed Sediment in Tributary Creeks

If lake bed sediment sampling near stream mouths indicates that specific tributaries are contributing contaminants to Donner Lake, additional sediment cores could be sampled along the stream beds. It is likely that ongoing localized terrestrial contamination that is entering the lake through stormwater runoff will be present in stream bed sediments along contaminant flow paths. Iterative sampling efforts could provide a more cost-effective method for identifying specific sub-basins that act as contamination hotspots.

c. Monitor Precipitation

Significant amounts of PCBs, chlordane, and mercury may be transported from other regions by the atmosphere and deposited directly into the basin during precipitation events. Studies have shown that atmospheric transport is a major source of PCBs in the Lake Tahoe basin. To evaluate atmospheric transport as a mechanism for Donner Lake contamination, samples of rainwater and snow should be collected and tested for target pollutant concentrations.

d. Investigate Soil Contamination at Potential Point Source Releases

Accidental contaminant releases have occurred at numerous sites in the basin and could serve as present or historic point-source pollution sources. Locations of concern include spills along Interstate-80, the railway or gas pipeline, gas pipeline compressor stations (if present), and electrical substations (if present). Chlordane may have been applied as an insecticide along highway and railway right-of-ways. Soils at these sites can be tested for the target pollutants to identify current and historic sources of contamination for Donner Lake.

5.3.2 Sediment Load Monitoring of Donner Lake Tributaries

While field observations and stakeholder comments indicate that sediment loads in the tributaries to Donner Lake (Summit, Billy Mack, Gregory and Lakeview Creeks) are unnaturally high due to watershed disturbances, the actual sediment loads in these creeks are unknown. Of particular concern is suspended sediment, which negatively affects aquatic habitat within stream channels and contributes to water quality impairment. One option for quantifying suspended sediment loads is to conduct a combination of continuous turbidity monitoring and repeat sediment sampling (to determine suspended sediment concentration) during a range a flow conditions. However, this approach can be costly, especially on streams where flow gauging is not already being conducted.

A second, lower cost and potentially more accurate option for quantifying sediment loads in Donner Lake tributaries is to conduct repeat bathymetric surveys of the deltas of the three streams. Bathymetric surveys are conducted using single-beam or multi-beam echosounders to map the bed of a lake, river or other water body. Repeat bathymetric surveys could be used to determine the change in lake bed elevations due to sediment deposition, and hence develop estimates of sediment loads to the lake on an annual time scale (or other time scale of choice). Sediment cores could be used to characterize the relative contributions coming from suspended sediment and bed load[9]. Comparing these sediment monitoring data with precipitation, stream flow and lake level data from other parts of the watershed would provide a helpful indication of typical annual sediment loads within the three tributaries.

[9] Suspended sediment refers to the portion of a stream's sediment load that is transported within the water column and usually consists of small particles (e.g., clay, silts and fine sands). Bed load refers to the portion of sediment transported along the stream bed by saltating (hopping), rolling or sliding and typically consists of larger materials such as gravels, cobbles and boulders. Intermediate sized particles (e.g., coarse sand) may be transported as either suspended sediment or bed load, depending on the velocity of the stream.

5.3.3 Sediment Monitoring of Coldstream Canyon Tributaries

Field observations (e.g., Figure 42), stakeholder comments and previous suspended sediment monitoring (Balance, 2014) indicate that Coldstream Canyon contributes a significant portion of the suspended sediment load observed in Donner Creek. Due to the combination of historic logging impacts, steep slopes and highly erodible soils, many sites within Coldstream Canyon experience ongoing erosion problems, many of which are due to or have been exacerbated by human disturbance. In order to better characterize fine sediment contributions to Cold Creek and determine priority areas for erosion treatment projects, suspended sediment monitoring could be conducted along a subset or all of the tributaries to Cold Creek. Depending on available funding and resources, monitoring efforts could range from event-based or periodic sediment sampling (to determine suspended sediment concentration) and streamflow gauging efforts to continuous turbidity and streamflow monitoring integrated with repeat sediment sampling over a range of flow conditions.

5.3.4 Additional Unpaved Road Erosion Assessment

Field reconnaissance, observations by CA State Parks personnel and GIS analysis indicate that many the of unpaved roads, particularly those in the backcountry, exhibit ongoing erosion problems and contribute to fine sediment loading to streams and Donner Lake. Much of the backcountry road network was creating for logging purposes and, despite no longer being used, many of these areas are susceptible to unabated erosion issues due to the combination of steep slopes, unstable soils, drainage problems and other factors. Given that GIS analysis of 2014 LiDAR data undertaken by cbec indicates that the unpaved road network in Donner Basin exceeds 190 miles in length, addressing erosion issues along unpaved roads is a high priority project for the Donner Basin. However, a comprehensive field based assessment and prioritization of the road network will require a considerable effort and was outside the scope of this effort.

We recommend a combination of additional desk and field-based assessment to better prioritize project sites within the backcountry road network. Priority sub-catchments can be identified using the Erosion Hazard Analysis (see Section 2.4.7). Target road segments can also be selected using a preliminary road prioritization based on slope and soil erodibility (see second page of the Unpaved Road Stabilization and Erosion Treatment project sheet). These tools and consultation with various land managers (e.g., CA Dept. of Parks and Recreation, Truckee Donner Land Trust, etc.) should then be used to focus additional field assessment efforts. Field studies should ground-truth desk-based findings, characterize road erosion conditions and identify specific opportunities for road improvement, modification, and decommissioning projects. Following these additional field assessments, specific project sites can be prioritized and erosion problems addressed as coordination with land managers occurs and funding becomes available.

5.3.5 Synthesis of Unpublished Data for Donner Lake from University of Nevada, Reno

Limnologists and aquatic biologists at the University of Nevada, Reno have conducted water quality sampling and, more recently, aquatic invasive species surveys in Donner Lake, Donner Creek, and tributaries to the lake (UNR 2014). A significant amount of this information has been reported only in grey literature and/or has not been published in scientific literature (Chandra pers. comm.). A synthesis of existing unpublished information (e.g., a “white paper” or similar) would both contribute to an understanding of the water quality and ecology of Donner Lake, and help to identify information gaps where further research or surveys are needed. Ecological information needed to inform future management decisions include fish population trends, water quality trends, and the effects of recent aquatic invasive species introductions.

6 CONCLUSIONS AND RECOMMENDATIONS

Over the past 150 years, the Donner Basin has been extensively impacted by human uses including transportation, logging, residential and commercial development, water supply and recreation. Land development and historic impacts have altered the basin's hydrology and increased upland erosion rates. Today, greater volumes of stormwater and fine sediment are delivered to receiving streams and Donner Lake. Water quality is also affected by the discharge of untreated stormwater runoff from numerous sources and contamination from PCBs, chlordane, arsenic and mercury. The management of Donner Lake as a water supply reservoir drives lake levels, affects shoreline conditions and aquatic communities, and influences downstream geomorphic processes and habitat conditions. Donner Lake and Donner Creek have also been colonized by Asian Clam and, due to high levels of recreation activity, the basin is at risk for additional aquatic invasive species introductions. Perhaps the most severe impact is the channel realignment, stream corridor narrowing and land development within floodplains. These impacts have impaired physical processes and greatly reduced the quality and abundance of aquatic and riparian habitats along Donner Creek and the residential reaches of Donner Lake's tributaries.

Impacts to the basin's stream network are most significant in the residential areas at the western end of Donner Lake and along Donner Creek between the eastern boundary of the Donner Memorial State Park and it's confluence with the Truckee River. The construction of Interstate 80 was perhaps the single largest impact to Donner Creek, and required major realignment of the stream channel and dramatically reduced floodplain connectivity and habitat quality.

While returning the watershed to its pre-disturbance condition is highly infeasible, significant opportunities exist for restoration, management and protection of the basin's physical and ecological health. Both Donner Lake and the basin's stream network would benefit highly from projects in upland areas aimed at reducing erosion and treating urban stormwater runoff. Unpaved roads in backcountry areas that exhibit ongoing erosion problems should be decommissioned or otherwise improved to reduce fine sediment delivery to downstream water bodies. Erosion stabilization efforts along the railroad hillslope cut are also strongly encouraged. For both backcountry roads and the railroad corridor, we recommend additional field assessment and stakeholder coordination to ground-truth desk-based assessments, identify additional opportunities and prioritize project sites. Where stormwater is currently discharged from Interstate 80 without capture or treatment, stormwater management features should be installed to dissipate energy, reduce peak flows and erosion, and capture pollutants. This is particularly important in portions of the Billy Mack Creek watershed, along the northern shore of Donner Lake, and along the channelized portion of Donner Creek. Within residential and commercial areas, programs such as TRWC's River Friendly Landscaping should be expanded to reduce stormwater and soil erosion from developed areas.

Donner Lake would also benefit from a number management actions and future studies. It is critical that watercraft inspections for aquatic invasive species be continued and continuously adapted in response to new or increased threats of introduction. These efforts should be complemented with public education programs to inform waters users of the risks of transporting aquatic invasive species and to prevent introductions of new aquatic invasive species. Comprehensive forest management practices are strongly encouraged to enhance forest health and habitat diversity in upland portions of the watershed. Conducting additional water quality monitoring is suggested to further characterize existing PCB, chlordane, arsenic and mercury contamination, identify pollutant sources, and inform future remediation strategies. Developing a "Care For Our Watershed" program would also benefit Donner Lake by educating residents and visitors on ways to reduce water quality contamination risks.

Within the stream channel network, the most meaningful restoration opportunities are located along Donner Creek. As is the case in many urbanized settings, space is limited for large-scale restoration efforts. However, three sites were identified for floodplain and channel restoration along Donner Creek between the Cold Creek and Truckee River confluences that would significantly improve physical processes, habitat conditions and water quality. Large wood can also be installed in the stream channel to provide in-stream habitat complexity where space is otherwise limited. Improving in-stream habitat diversity and reconnecting historic floodplains with the creek will enhance associated upland and riparian habitats. Donner Creek's downstream reach within Donner Memorial State Park also exhibits the highest functioning stream habitat observed along the creek and should be managed and protected to maintain healthy conditions. Additionally, two bank stabilization opportunities along the downstream-most 0.6 miles of Donner Creek would significantly reduce fine sediment loading to Donner Creek and the Truckee River. In all cases, restoration, management, and enhancement of the Donner Basin will require ongoing coordination and cooperation with land managers that include but are not limited to California Department of Parks and Recreation, USFS, Truckee Donner Land Trust, Town of Truckee, CALTRANS, and a large array of private land owners in the basin.

7 REFERENCES

Hydrologic Assessment

Balance Hydrologics, Inc (Balance). 2012. Middle Truckee River Total Maximum Daily Load (TMDL) Suspended Sediment Monitoring Report, Water Year 2012, Nevada County, California. Prepared for Truckee River Watershed Council. Prepared by Balance Hydrologics, Inc.

Balance Hydrologics, Inc (Balance). 2013. Middle Truckee River Total Maximum Daily Load (TMDL) Suspended Sediment Monitoring Report, Water Year 2013, Nevada County, California. Prepared for Truckee River Watershed Council. Prepared by Balance Hydrologics, Inc.

Balance Hydrologics, Inc (Balance). 2014. Middle Truckee River Total Maximum Daily Load (TMDL) Suspended Sediment Monitoring Report, Water Year 2014, Nevada County, California. Prepared for Truckee River Watershed Council. Prepared by Balance Hydrologics, Inc. December 2014.

Belmecheri, Soumaya, et al. "Multi-century evaluation of Sierra Nevada snowpack." *Nature Climate Change* (2015).

California Energy Commission. "Snowpack: Decadal Averages Map." *Cal-Adapt*. Web. 23 Sept. 2015.

Dettinger, Michael D., et al. "Simulated hydrologic responses to climate variations and change in the Merced, Carson, and American River basins, Sierra Nevada, California, 1900–2099." *Climatic Change* 62.1-3 (2004): 283-317.

Integrated Environmental Restoration Services (IERS). 2010. Negro Canyon Watershed Assessment. Prepared for Truckee River Watershed Council. Prepared by Integrated Environmental Restoration Services. May 2010.

Luers, Amy Lynd, et al. "Our changing climate: assessing the risks to California." *Summary report from the California Climate Change Center, CEC-500-2006-077* (2006).

Maurer, Edwin P. "Uncertainty in hydrologic impacts of climate change in the Sierra Nevada, California, under two emissions scenarios." *Climatic Change*82.3-4 (2007): 309-325.

River Run Consulting (RRC). 2007. Cold Creek Canyon Watershed Assessment. Prepared for Truckee River Watershed Council. Prepared by River Run Consulting and Hydro Science. Mar 2007.

Stewart, Iris T., Daniel R. Cayan, and Michael D. Dettinger. "Changes in snowmelt runoff timing in western North America under abusiness as usual'climate change scenario." *Climatic Change* 62.1-3 (2004): 217-232.

USGS. 1998. Magnitude and Frequency of Floods of January 1997 in Northern and Central California – Preliminary Determinations. Open-File-Report 98-626. Prepared by U.S. Geological Survey in cooperation with Federal Emergency Management Agency.

U.S. Geological Survey, 2012, The StreamStats program for California, online at http://water.usgs.gov/osw/streamstats/california.html.

PERSONAL COMMUNICATIONS

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Geomorphic Assessment

Balance Hydrologics, Inc (Balance). 2012. Middle Truckee River Total Maximum Daily Load (TMDL) Suspended Sediment Monitoring Report, Water Year 2012, Nevada County, California. Prepared for Truckee River Watershed Council. Prepared by Balance Hydrologics, Inc.

Balance Hydrologics, Inc (Balance). 2013. Middle Truckee River Total Maximum Daily Load (TMDL) Suspended Sediment Monitoring Report, Water Year 2013, Nevada County, California. Prepared for Truckee River Watershed Council. Prepared by Balance Hydrologics, Inc.

Balance Hydrologics, Inc (Balance). 2014. Middle Truckee River Total Maximum Daily Load (TMDL) Suspended Sediment Monitoring Report, Water Year 2014, Nevada County, California. Prepared for Truckee River Watershed Council. Prepared by Balance Hydrologics, Inc. December 2014.

Birkeland, P.W. 1964. "Pleistocene glaciation of the northern Sierra Nevada, north of Lake Tahoe, California." The Journal of Geology, 72(6): 810-825.

Blackwelder, E.B. 1931. "Pleistocene glaciation of the Sierra Nevada and Basin Ranges." Geologic Society of America Bulletin 42:865-922.

CDM Smith. 2014. Town of Truckee / County of Placer: Final Joint Annual Monitoring Report for: Implementation of the Truckee River Water Quality Monitoring Plan, Water Year 2014. Prepared jointly for Town of Truckee and County of Placer, CA. December 2014.

Cluer, B. and Thorne, C. 2013. "A Stream Evolution Model Integrating Habitat and Ecosystem Benefits." *River Research and Applications,* 30(2):135-154.

LANDFIRE, 2012, Existing Vegetation Type Layer, LANDFIRE 1.1.0, U.S. Department of the Interior, Geological Survey. Accessed 24 August 2015 at http://landfire.cr.usgs.gov/viewer/.

Nanson, G.C and Croke, J.C. 1992. "A genetic classification of floodplains." *Geomorphology*, 4 (6), 459-486.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Soil Survey Geographic (SSURGO) Database. Available online at http://sdmdataaccess.nrcs.usda.gov/. Accessed 5 June 2015.

Water Quality Assessment

2nd Nature, inc. (2008). Truckee River Water Quality Monitoring Plan. Final Plan: Prepared for Placer County and the Town of Truckee.

Agency for Toxic Substances and Disease Registry (ATSDR) (2007). Toxicological Profile for Arsenic. Chapter 6: Potential for Human Exposure.

California Office of Environmental Health and Hazard Assessment (OEHHA). (2010). DDTs in Sport Fish: Information for Fish Consumers.

California Office of Environmental Health Hazard Assessment (OEHHA). (2011). Donner Lake Frequently Asked Questions. http://oehha.ca.gov/fish/so_cal/pdf_zip/DonnerFAQ012711.pdf.

Daly, G. L., and F. Wania**.** (2005). "Organic Contaminants in Mountains." *Environmental Science & Technology* 39**:**385-398.

Datta, S., K. Ohyama, D. Y. Dunlap, and F. Matsumura**.** (1999). "Evidence for Organochlorine Contamination in Tissues of Salmonids in Lake Tahoe." *Ecotoxicology and Environmental Safety* 42**:**94-101.

EPA (2000) Chlordane: Hazard Summary. http://www.epa.gov/ttnatw01/hlthef/chlordan.html.

Fitzgerald, W. F., D. R. Engstrom, R. P. Mason, and E. A. Nater**.** (1998). "The case for atmospheric mercury contamination in remote areas." *Environmental Science & Technology* 32**:**1-7.

Geosyntec Consultants. (2013) Final Draft Integrated Monitoring Report. Part B: PCB and Mercury Loads Avoided and Reduced via Stormwater Control Measures. Prepared for Bay Area Stormewater Management Agencies Association.

Klasing S. and Brodberg, R. (2008). Development of Fish Contaminant Goals and Advisory Tissue Levels for Common Contaminates in California Sport Fish: Chlordane, DDTs, Dieldrin, Methlymercury, PCBs, Selenium and Toxaphene.

Lim, L., Brodberg, R., Gassel, M., Klasing S. (2011). Health Advisory and Safe Eating Guidelines for Fish from Donner Lake (Nevada County, CA). Pesticide and Environmental Toxicology Branch, Office of Environmental Health Hazard Assessment, California Environmental Protection Agency

Morel, F. M. M., A. M. L. Kraepiel, and M. Amyot**.** (1998). "The chemical cycle and bioaccumulation of mercury." *Annual Review of Ecology and Systematics* 29**:**543-566.

Neff, J. M. (1997). "Ecotoxicology of arsenic in the marine environment." *Environmental Toxicology and Chemistry* 16**:**917-927.

Ohyama, K., Angermann, J., Dunlap, D.Y., Matsumura, F. (2004). Distribution of Polychlorinated Biphenyls and Chlorinated Pesticide Residues in Trout in the Sierra Nevada. Journal of Environmental Quality. 33:1752-1764

Smedley, P. L., and D. G. Kinniburgh**.** (2002). "A review of the source, behaviour and distribution of arsenic in natural waters." *Applied Geochemistry* 17**:**517-568.

State Water Resources Control Board (SWRCB) (2010). GROUNDWATER INFORMATION SHEET: Arsenic https://clu-in.org/download/contaminantfocus/arsenic/Arsenic-CAfs.pdf

State Water Resources Control Board (SWRCB). (2012) Final California 2012 Integrated Report (303(d) List/305(b) Report). http://www.waterboards.ca.gov/water_issues/programs/tmdl/2012state_ir_reports/00460.shtml#20226

Surface Water Ambient Monitoring Program (SWAMP). (2010) SWAMP Lakes Fish Contaminant Data

U.S. Department of Health and Human Services (USDHHS) Public Health Service. Agency for Toxic Substances and Disease Registry., 1994. Toxicological Profile for Chlordane.

Biological Resources Assessment

Aubry, K.B. 1997. The Sierra Nevada red fox (*Vulpes vulpes necator*) Mesocarnivores of Northern California: Biology, Management, and Survey Techniques. Humboldt State University. Arcata, CA.

Baldwin, B, D. Goldman, D. Keil, R. Patterson, and T. Rosatti. 2012. The Jepson Manual. Vascular Plants of California, 2nd ed. University of California Press. Berkeley, CA. 1600 pp.

Beck, T. W., and J. Winter. 2000. Survey protocol for great gray owl in the Sierra Nevada of California. USDA Forest Service, Pacific Southwest Region. Vallejo, CA.

Beedy, E. C. and S. L. Granholm. 1985. Discovering Sierra birds. Yosemite Natural History Association. El Portal, CA.

Beier, P and R. Barrett. 1989. Beaver distribution in the Truckee River Basin, California. California Fish and Game 75:233-238.

Bombay, H. L., M. L. Morrison, and L. S. Hall. 2003a. Scale perspectives in habitat selection and animal performance for willow flycatchers (*Empidonax traillii*) in the central Sierra Nevada, California. Studies in Avian Biology 26:60-72.

Bombay, H. L, T. M. Benson, B. E. Valentine, and R. A. Stefani. 2003b. A willow flycatcher survey protocol for California. USDA Forest Service, Pacific Southwest Region. Vallejo, CA.

Borgmann, K. L. 2010. Mechanisms underlying intra-seasonal variation in the risk of avian nest predation: implications for breeding phenology. Ph.D. Dissertation. University of Arizona. Tucson, AZ.

Bossard C., J. Randall, and M. Hoshovsky. 2000. Invasive Plants of California's Wildlands. University of California Press. Berkeley, CA. 360 pp.

Buskirk, S.W. and R.A. Powell. 1994. Habitat ecology of fishers and American martens. Pages 283-296 in S. W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell (eds). Martens, Sables, and Fishers: Biology and Conservation. Cornell University Press. Ithaca, NY.

Cain, J. W. III and M. L. Morrison. 2003. Reproductive ecology of dusky flycatchers in montane meadows of the central Sierra Nevada. Western North American Naturalist 63:507-512.

Cain, J. W., III, Morrison, M. L., and Bombay, H. L. 2003. Predator activity and nest success of Willow Flycatchers and Yellow Warblers. Journal of Wildlife Management 67:600-610.

[CNPS] California Native Plant Society. 2015. Inventory of Rare and Endangered Plants (online edition, v8-01a). California Native Plant Society. Sacramento, CA. [online]: http://www.rareplants.cnps.org/. Accessed 3 October 2012.

[CCH] Consortium of California Herbaria. [online] http://ucjeps.berkeley.edu/consortium/. Accessed 4 October 2012.

Cory, B. L. 1962. Life-history and behavior differences between ranids in isolated populations in the Sierra Nevada. American Zoologist 2:515.

Cory, B. L. 1963. Effects of introduced trout on the evolution of native frogs in the high Sierra Nevada Mountains. Proceedings of the XVI International Congress of Zoology 2:172.

Cicero, C. 1997. Boggy meadows, livestock grazing, and interspecific interactions: influences on the insular distribution of montane Lincoln's Sparrows (*Melospiza lincolnii alticola*). Great Basin Naturalist 57:104-115.

[CDFW] California Department of Fish and Wildlife. 2015. California Natural Diversity Database, RareFind 4 (online edition). [online] https://nrm.DFW.ca.gov/cnddb/view/query.aspx.

Erman, N. 1984. The use of riparian systems by aquatic insects. Pages 177-1982 in R. E. Warner and K. Hendrix (eds). California Riparian Systems: Ecology, Conservation, and Productive Management. University of California Press. Berkeley, CA.

Erman, N. A. 1996. Status of aquatic invertebrates. Pages 987–1008 in D. C. Erman (ed). Sierra Nevada Ecosystem Project: Final Report to Congress, Vol. II, Assessments and Scientific Basis for Management Options. Centers for Water and Wildland Resources. University of California, Davis. Davis, CA.

Fausch, K.D., B.E. Rieman, M.K. Young, and J.B. Dunham. 2006. Strategies for Conserving Native Salmonid Populations at Risk from Nonnative Fish Invasions: Tradeoffs in Using Barriers to Upstream Movement. General Technical Report RMRS-GTR-174. USDA Forest Service, Rocky Mountain Research Station. Ft. Collins, CO.

Freel, M., and R. E. Stewart. 1991. A literature review for management of the marten and fisher on National Forests in California. USDA Forest Service, Pacific Southwest Region.

Gannon, W. A. 2003. Bats - Vespertilionidae, Molossidae, Phyllostomidae. Chapter 3 in G. A. Feldhamer, B. C. Thompson, and J. A. Chapman (eds). Wild mammals of North America: Biology, Management and Conservation. Johns Hopkins University Press. Baltimore, MD. 1216 pp.

Gaines, D. 1992. Birds of the Yosemite Sierra. Artemisia Press. Lee Vining, CA.

Gray, L. J. 1993. Response of insectivorous birds to emerging aquatic insects in riparian habitats of a tallgrass prairie system. American Midland Naturalist 129:288-300.

Green, G. A., H. L. Bombay, and M. L. Morrison. 2003. Conservation assessment of the Willow Flycatcher in the Sierra Nevada. USDA Forest Service, Region 5. Sacramento, CA.

Gregory, S. V., F. J. Swanson, W. A. McKee, and K. W. Cummins. 1991. An ecosystem perspective of riparian zones. Bioscience 41:540-550.

Grinnell, J., J. S. Dixon, and J. M. Linsdale. 1937. Fur-Bearing Mammals of California. University of California Press. Berkeley, CA. 777pp.

Grinnell, J. and A. H. Miller. 1944. The distribution of the birds of California. Pacific Coast Avifauna 27:1-617.

Gutiérrez, R. J., A. B. Franklin, and W. S. LaHaye. 1995. Spotted Owl (*Strix occidentalis*). In A. Poole and F. Gill (eds.). The Birds of North America No. 179: Life Histories for the 21st Century. The Philadelphia Academy of Sciences and The American Ornithologists' Union. Washington, DC.

Hall, E, R. 1981. Mammals of North America. Second ed. Vol. 1. John Wiley & Sons. New York, NY.

Harris, J. 1990. Life history account for the pallid bat (*Antrozous pallidus*). California Wildlife Habitat Relationships System, California Department of Fish and Wildlife, California Interagency Wildlife Task Group.

Harris, J. 2000. Life history account for the Townsend's big-eared bat (*Corynorhinus townsendii*). California Wildlife Habitat Relationships System, California Department of Fish and Wildlife, California Interagency Wildlife Task Group.

Harris, J. H., S. D. Sanders, and M. A. Flett. 1987. Willow Flycatcher surveys in the Sierra Nevada. Western Birds 18:27–36.

Hatfield, R. G., and G. LeBuhn. 2007. Patch and landscape factors shape community assemblage of bumble bees, *Bombus* spp. (Hymenoptera: Apidae), in montane meadows. Biological Conservation 139:150-158.

Heath, S. 2008. Yellow Warbler (*Dendroica petechia*). Pages 332-339 in W. D. Shuford and T. Gardali (eds). California Bird Species of Special Concern: a Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California. Studies of Western Birds 1. Western Field Ornithologists and California Department of Fish and Game. Camarillo and Sacramento, CA.

Heath, S. K., and G. Ballard. 2003. Patterns of breeding songbird diversity and occurrence in riparian habitats of the eastern Sierra Nevada. Pages 21-34 in P. M. Faber (ed.). California Riparian Systems: Processes and Floodplain Management, Ecology and Restoration. Riparian Habitat and Floodplains Conference Proceedings, Riparian Habitat Joint Venture. Sacramento, CA.

Hermanson, J. W. and T. J. O'Shea. 1983. *Antrozous pallidus*. Mammalian Species 213:1-8.

Hoefler, G., and R. Duke. 1990. Life history account for the snowshoe hare (*Lepus americanus*). California Wildlife Habitat Relationships System, California Department of Fish and Wildlife, California Interagency Wildlife Task Group.

Holland, R. F. 1986. Preliminary description of the terrestrial natural communities of California. State of California Resources Agency. Department of Fish and Game. Sacramento, CA. 156 pp.

Homer, C.H., Fry, J.A., and Barnes C.A. 2012. The National Land Cover Database. U.S. Geological Survey Fact Sheet 2012-3020. 4 pp.

Hornocker, M. G., and H. S. Hash. 1981. Ecology of the wolverine (*Gulo gulo*) in northwestern Montana, USA. Canadian Journal of Zoology 59:1286-1301.

Humphrey, S. R., and T. H. Kunz. 1976. Ecology of a Pleistocene relict, the western big-eared bat (*Plecotus townsendii*) in the southern Great Plains. Journal of Mammalogy 57:470-494.

Hull, J. M., J. J. Keane, W. K. Savage, S. A. Godwin, J. A. Shafer, E. P. Jepsen, R. Gerhardt, C. Stermer, and H. B. Ernest. 2010. Range-wide genetic differentiation among North American great gray owls (*Strix nebulosa*) reveals a distinct lineage restricted to the Sierra Nevada, California. Molecular Phylogenetics and Evolution 56:212-221.

Hunter, J. E. 2008. Vaux's Swift (*Chaetura vauxi*). Pages 254-259 in W. D. Shuford and T. Gardali (eds). California Bird Species of Special Concern: a Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California. Studies of Western Birds 1. Western Field Ornithologists and California Department of Fish and Game. Camarillo and Sacramento, CA.

Hunting, K. 2008. Long-eared Owl (*Asio otus*). Pages 234-241 in W. D. Shuford and T. Gardali (eds). California Bird Species of Special Concern: a Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California. Studies of Western Birds 1. Western Field Ornithologists and California Department of Fish and Game. Camarillo and Sacramento, CA.

Ingles, L. G. 1965. Mammals of the Pacific states. Stanford University Press. Palo Alto, CA. 506pp.

James, C. and R. Lanman. 2012. Novel physical evidence that beaver historically were native to the Sierra Nevada. California Fish and Game 98:129-132.

Jaramillo, A. 2008.Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*). Pages 444-450 in W. D. Shuford and T. Gardali (eds). California Bird Species of Special Concern: a Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California. Studies of Western Birds 1. Western Field Ornithologists and California Department of Fish and Game. Camarillo and Sacramento, CA.

Johnson, V. 1990. Life history account for the California wolverine (*Gulo gulo*). California Wildlife Habitat Relationships System, California Department of Fish and Wildlife, California Interagency Wildlife Task Group.

Johnston, D. S. and M. B. Fenton. 2001. Individual and population-level variability in diets of pallid bats (*Antrozous pallidus*) Journal of Mammalogy 82:362-373.

Johnston, D. S., B. Hepburn, J. Krauel, T. Stewart, and D. Rambaldini. 2006. Winter roosting and foraging ecology of pallid bats in Central Coastal California. Bat Research News 47:115.

Keane, J. 2008. Northern Goshawk (*Accipiter gentilis*). Pages 156-162 in W. D. Shuford and T. Gardali (eds). California Bird Species of Special Concern: a Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California. Studies of Western Birds 1. Western Field Ornithologists and California Department of Fish and Game. Camarillo and Sacramento, CA.

Knapp, R.A. 1996. Non-native trout in natural lakes of the Sierra Nevada: an analysis of their distribution and impacts on native aquatic biota. Pages 363- 407 in D. C. Erman (ed). Sierra Nevada Ecosystem Project: Final Report to Congress, Vol. III, Assessments, Commissioned Reports, and Background Information. Centers for Water and Wildland Resources. University of California, Davis. Davis, CA.

Knapp, R.A., P.S. Corn, and D.E. Schindler. 2001. The introduction of nonnative fish in wilderness lakes: good intentions, conflicting mandates, and unintended consequences. Ecosystems 4:275-278

Knopf, F. L. and Kennedy, J. L. 1980. Foraging sites of white pelicans nesting at Pyramid Lake, Nevada. Western Birds 11:175-180.

Krott, P. 1982. The glutton (*Gulo gulo*) in the ecosystem. Saeugetierkd Mitt 30:136-150.

Kucera, Thomas E., William J. Zielinski, and Reginald H. Barrett. 1996. Current distribution of the American marten, *Martes americana*, in California. California Fish and Game 81:96-103.

La Rivers, I. 1994. Fishes and Fisheries of Nevada. University of Nevada Press. Reno, NV.

Lanman, R. H. Perryman, B. Dolman, and C. D. James. 2012. The historical range of beaver in the Sierra Nevada: a review of the evidence. California Fish and Game 98:65-80.

[LTBWCG]. Lake Tahoe Basin Weeds Coordinating Group. 2011. Priority Invasive Weeds of the Lake Tahoe Basin. [online] http://tahoeinvasiveweeds.org/weeds/pdf/LTBWCG_Priority_Invasive_Weeds_List_2011.pdf. Accessed 3 October 2012.

Lehman, R.N. 1979. A survey of selected habitat features of 95 bald eagle nest in California. California Department of Fish and Game. Wildlife Management Branch Administrative Report 79-1. Sacramento, CA. 23 pp.

Lehman, R.N., D.E. Craigie, P.L. Colins and R.S. Griffen. 1980. An analysis of habitat requirements and site selection criteria for nesting bald eagle in California. Report prepared for USDA Forest Service, Region 5. San Francisco, CA. 106 pp.

Lewis, J. C., K. L. Sallee, and R. T. Golightly. 1993. Introduced red fox in California. Report prepared for California Department of Fish and Game. Sacramento, CA.

Lynn, S., M. L. Morrison, A. J. Kuenzi, J. C. C. Neale, B. N. Sacks, R. Hamlin, L. S. Hall. 1998. Bird use of riparian vegetation along the Truckee River, California and Nevada. Great Basin Naturalist 58:328-343.

Mathewson H. A, M. L. Morrison, H. L. Loffland, P. Brussard. In press. Ecology of willow flycatchers in the Sierra Nevada, California: the role of meadow characteristics and weather on demographics. Ornithological Monographs.

Maser, C., B. R. Mate, J. F. Franklin, and C. T. Dyrness. 1981. Natural history of Oregon coast mammals. General Technical Report PNW-133. USDA Forest Service Pacific Northwest Forest and Range Experiment Station. Portland, OR. 496pp.

McCreedy, C. and S. Heath. 2004. Atypical Willow Flycatcher nesting sites in a recovering riparian corridor at Mono Lake, California. Western Birds 35:197-205.

Moriarty, K.M., W.J. Zielinski, A.G. Gonzales, T.E. Dawson, K.M. Boatner, C.A. Wilson, F.V. Schlexer, K.L. Pilgrim, J.P. Copeland, and M.K. Schwartz. 2009. Wolverine confirmation in California after nearly a century: native or long-distance immigrant? Northwest Science 83(2):154-162.

Morton, M. L. 1991. Postfledgling dispersal of green-tailed towhees to a subalpine meadow. Condor 93:466-468.

Moyle, P. B., R. M. Yoshiyama, and R. A. Knapp. 1996. Pages 953 - 973 in D. C. Erman (ed). Sierra Nevada Ecosystem Project: Final Report to Congress, Vol. II, Assessments and Scientific Basis for Management Options. Centers for Water and Wildland Resources. University of California, Davis. Davis, CA.

Novinger, D.C. and F.J. Rahel. 2003. Isolation management with artificial barriers as a conservation strategy for cutthroat trout in headwater streams. Conservation Biology 17:772-781.

Orr, R. T. 1940. The rabbits of California. Occasional Papers No. 19. California Academy of Sciences. San Francisco, CA. 227pp.

Orr, R. T., and J. Moffitt. 1971. Birds of the Lake Tahoe Region. California Academy of Sciences. San Francisco, CA.

Paxton, E. H., M. K. Sogge, S. L. Durst, T. C. Theimer, and J. R. Hatten. 2007. The ecology of the southwestern willow flycatcher in central Arizona: a 10-year synthesis report. U.S. Geological Survey Open File Report 2007–1381. Flagstaff, AZ.

Pearson, O. P., M. R. Koford, and A. K. Pearson. 1952. Reproduction of the lump-nosed bat (*Corynorhinus rafinesquei*) in California. Journal of Mammalogy 33:273-320.

Perrine, J. D., J. P. Pollinger, B. N. Sacks, R. H. Barrett, and R. K. Wayne. 2007. Genetic evidence for the persistence of the critically endangered Sierra Nevada red fox in California. Conservation Genetics 8:1083-1095.

Pierson, E. D. and W. E. Rainey. 1998a. Townsend's big-eared bat (*Corynorhinus townsendii pallescens* and *C. t. townsendii*). Pages 35-42 in B. C. Bolster (ed.). Terrestrial Mammal Species of Special Concern in California. Draft Final Report prepared by P. V. Brylski, P. W. Collins, E. D. Pierson, E. E. Rainey, and T. E. Kucera. Report submitted to California Department of Fish and Game Wildlife Management Division, Nongame Bird and Mammal Conservation Program for Contract No. FG3146WM. Sacramento, CA.

Pierson, E. D. and W. E. Rainey. 1998b. Distribution, status, and management of Townsend's big-eared bat (*Corynorhinus townsendii*) in California. State of California Department of Fish and Game. Bird and Mammal Conservation Program Technical Report Number 96-7. Sacramento, CA.

Polite, C. 2005. Life history account for mountain beaver (*Aplodontia rufa*). California Wildlife Habitat Relationships System, California Department of Fish and Wildlife, California Interagency Wildlife Task Group.

Powell, R. A. 1981. *Martes pennanti*. Mammalian Species 156:1-6.

Ray, S. M. 1903. Land birds of Lake Valley, CA. Auk 20:185.

Sedgwick, J.A. 2001. Geographic variation in the song of willow flycatchers: differentiation between *Empidonax traillii adastus* and *E. t. extimus*. Auk 118:366-379.

Ross, A. 1961. Notes on food habits of bats. Journal of Mammalogy 42:66-71.

Sawyer, J. and T. Keeler-Wolfe. 1995. A Manual of California Vegetation, 1st ed. California Native Plant Society. Sacramento, CA. 471 pp.

Sawyer, J., T. Keeler-Wolfe, and J. Evens. 2009. A manual of California Vegetation, 2nd ed. California Native Plant Society. Sacramento, CA. 1300 pp.

Self, S., and S. Kerns. 2001. Pacific fisher use of a managed forest landscape in Northern California. Sierra Pacific Industries. Redding, CA.

Shuford W. D. 2005. Historic and current status of breeding American white pelicans in California. Waterbirds 28 (Special Publ. I) 35-47.

Shuford W. D. 2008a. American White Pelican (*Pelecanus erythrorhynchos*). Pages 130-135 in W. D. Shuford and T. Gardali (eds). California Bird Species of Special Concern: a Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California. Studies of Western Birds 1. Western Field Ornithologists and California Department of Fish and Game. Camarillo and Sacramento, CA.

Shuford W. D. 2008b. Black Tern (*Chlidonias niger*). Pages 193-198 in W. D. Shuford and T. Gardali (eds). California Bird Species of Special Concern: a Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California. Studies of Western Birds 1. Western Field Ornithologists and California Department of Fish and Game. Camarillo and Sacramento, CA.

Shuford, W.D. and T. Gardali (eds). 2008. California Bird Species of Special Concern: a Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California. Studies of Western Birds 1. Western Field Ornithologists and California Department of Fish and Game. Camarillo and Sacramento, CA.

Siegel, R. B., R. L. Wilkerson, and D. F. DeSante. 2008. Extirpation of the willow flycatcher from Yosemite National Park. Western Birds 39:8-21.

Spencer, W.D., R.H. Barrett, and W.J. Zielinski. 1983. Marten habitat preference in the northern Sierra Nevada. The Journal of Wildlife Management 47:1181-1186.

Sterling, J. 2008. Yellow Rail (*Coturnicops noveboracensis*). Pages 163-166 in W. D. Shuford and T. Gardali (eds). California Bird Species of Special Concern: a Ranked Assessment of Species, Subspecies, and Distinct Populations of Birds of Immediate Conservation Concern in California. Studies of Western Birds 1. Western Field Ornithologists and California Department of Fish and Game. Camarillo and Sacramento, CA.

Stewart, R. M., R. P. Henderson, and K. Darling. 1977. Breeding ecology of Wilson's warbler in the High Sierra Nevada, California. Living Bird 16:83-102.

Tahoe National Forest. 2015. Species occurrence records from Forest Service NRIS database provided by Tahoe National Forest Biologist Tina Marks to Helen Loffland. Electronic copy filed with H. T. Harvey & Associates.

Taylor, M. 2000. Subalpine fireweed (*Epilobium howellii*). Pages O-13 to O-15 in: D. Murphy and C Knopp (eds.). Lake Tahoe Watershed Assessment: Volume II. General Technical Report PSW-GTR-175. USDA Forest Service, Pacific Southwest Research Station. Albany, CA.

Truckee River Watershed Council. 2015. Weed Warriors website. [online] http://www.truckeeriverwc.org/weed-warriors. Accessed 17 September 2015.

Unitt, P. 1987. *Empidonx traillii extimus*: an endangered subspecies. Western Birds 18:137-162.

[UNR] University of Nevada, Reno. 2015. Inventory of aquatic invasive species and water quality in lakes in the Lower Truckee River Region: 2014. Prepared by Timothy J. Caldwell and Dr. Sudeep Chandra. Department of Biology. Reno, Nevada.

Urie, S. 2000. Torrey's buckwheat (*Eroigonum umbellatum* var. *torreyanum*). Pages O-15 to O-17 in: D. Murphy and C Knopp (eds.). Lake Tahoe Watershed Assessment: Volume II. General Technical Report PSW-GTR-175. USDA Forest Service, Pacific Southwest Research Station. Albany, CA.

[USACE] United States Army Corps of Engineers. 2009. Lake Tahoe Region Aquatic Invasive Species Management Plan, California - Nevada. 84 pp + Appendices.

U.S. Forest Service. 2001. Sierra Nevada Forest Plan Amendment Final Environmental Impact Statement. USDA Forest Service, Pacific Southwest Region. Vallejo, CA.

U.S. Forest Service. 2008. Sierra Nevada forests bioregional management indicator species (MIS) report: life history and analysis of management indicator species of the 10 Sierra Nevada national forests: Eldorado, Inyo, Lassen, Modoc, Plumas, Sequoia, Sierra, Stanislaus, and Tahoe National Forests and the Lake Tahoe Basin Management Unit. USDA Forest Service, Pacific Southwest Region. Vallejo, CA. 128 pp.

[USFWS] United States Fish and Wildlife Service. 2015. Species Report: Sierra Nevada Red Fox (*Vulpes vulpes necator*). August 14. Sacramento, CA. [online] http://www.fws.gov/sacramento/outreach/ 2015/10-07/docs/20150814_SNRF_SpeciesReport.pdf. Accessed 1 January 2016.

[USFWS] United States Fish and Wildlife Service. 2006. Twelve-month finding for a petition to list the California spotted owl (*Strix occidentalis occidentalis*) as threatened or endangered. Federal Register 71:29886-29908.

[USFWS] United States Fish and Wildlife Service. 2004. Twelve-month finding for a petition to list the West Coast distinct population segment of the fisher (*Martes pennanti*). Federal Register 68:18770–18792.

[USFWS] United States Fish and Wildlife Service. 1986. Recovery plan for the Pacific bald eagle. United States Fish and Wildlife Service. Portland, OR.

[USFWS] U.S. Fish and Wildlife Service. 2003. Short-term Action Plan for Lahontan Cutthroat Trout in the Truckee River Basin. August. Developed by the Truckee River Basin Recovery Implementation Team. Reno, Nevada.

[USFWS] U.S. Fish and Wildlife Service. 2009. Lahontan Cutthroat Trout 5-Year Review. March. Reno, Nevada.

Verner, J., K. S. McKelvey, B. R. Noon, R. J. Gutierrez, G. I. Gould, Jr., and T. W. Beck, tech coords. 1992. The California spotted owl: a technical assessment of its current status. General Technical Report PSW-GTR-133. USDA Forest Service, Pacific Southwest Research Station. Albany, CA. 285 pp.

Voth, E. H. 1968. Food habits of the Pacific mountain beaver, *Aplodontia rufa pacifica*. Ph.D. Dissertation. Oregon State University. Corvallis, OR. 263pp.

Williams, D. F. 1986. Mammalian species of special concern in California. Administrative Report 86-1. California Department of Fish and Game. Sacramento, CA. 112pp.

Winter, Jon. 1986. Status, distribution, and ecology of the great gray owl *(Strix nebulosa)* in California. M.S. Thesis. San Francisco State University. San Francisco, CA. 121 p.

Zielinski, William J., Keith M. Slauson, Carlos R. Carroll, Christopher J. Kent, and Donald G. Kudrna. 2001. Status of American martens in coastal forests of the Pacific states. Journal of Mammalogy 82:478-490.

Zielinski, William J., Richard L. Truex, Fredrick V. Schlexer, Lori A. Campbell, and Carlos. Carroll. 2005. Historical and contemporary distributions of carnivores in forests of the Sierra Nevada, California, USA. Journal of Biogeography:1-23.

Zweifel, R.G. 1968. *Rana muscosa*. Catalogue of American Amphibians. Reptiles:65.1-65.2

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Patrick Stone. H. T. Harvey & Associates wildlife ecologist. Personal observation of beaver signs and activity in the Truckee/Donner area and Tahoe Basin.

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- Truckee Shell
- Truckee Tahoe Unified School District
- Truckee Sanitary District
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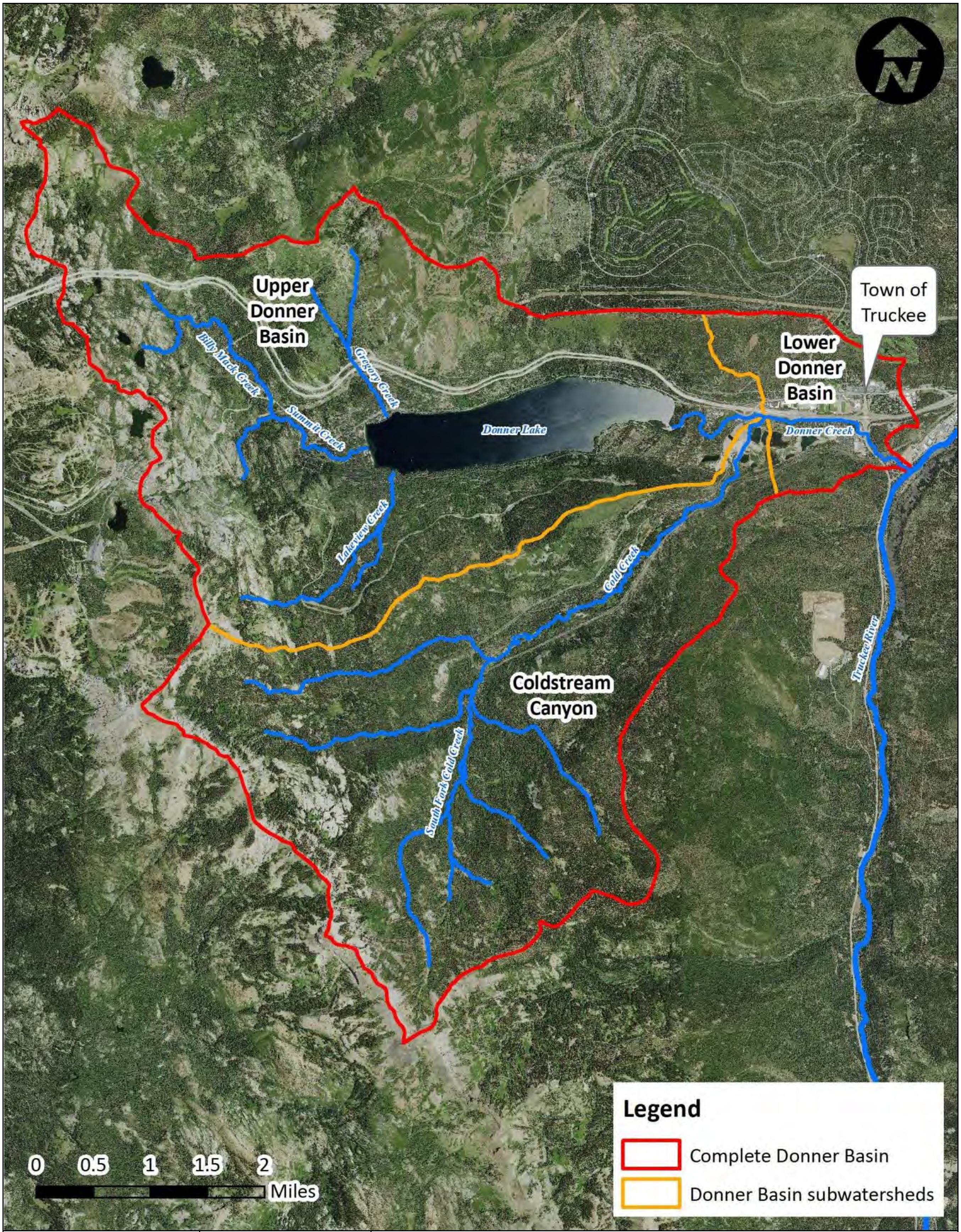
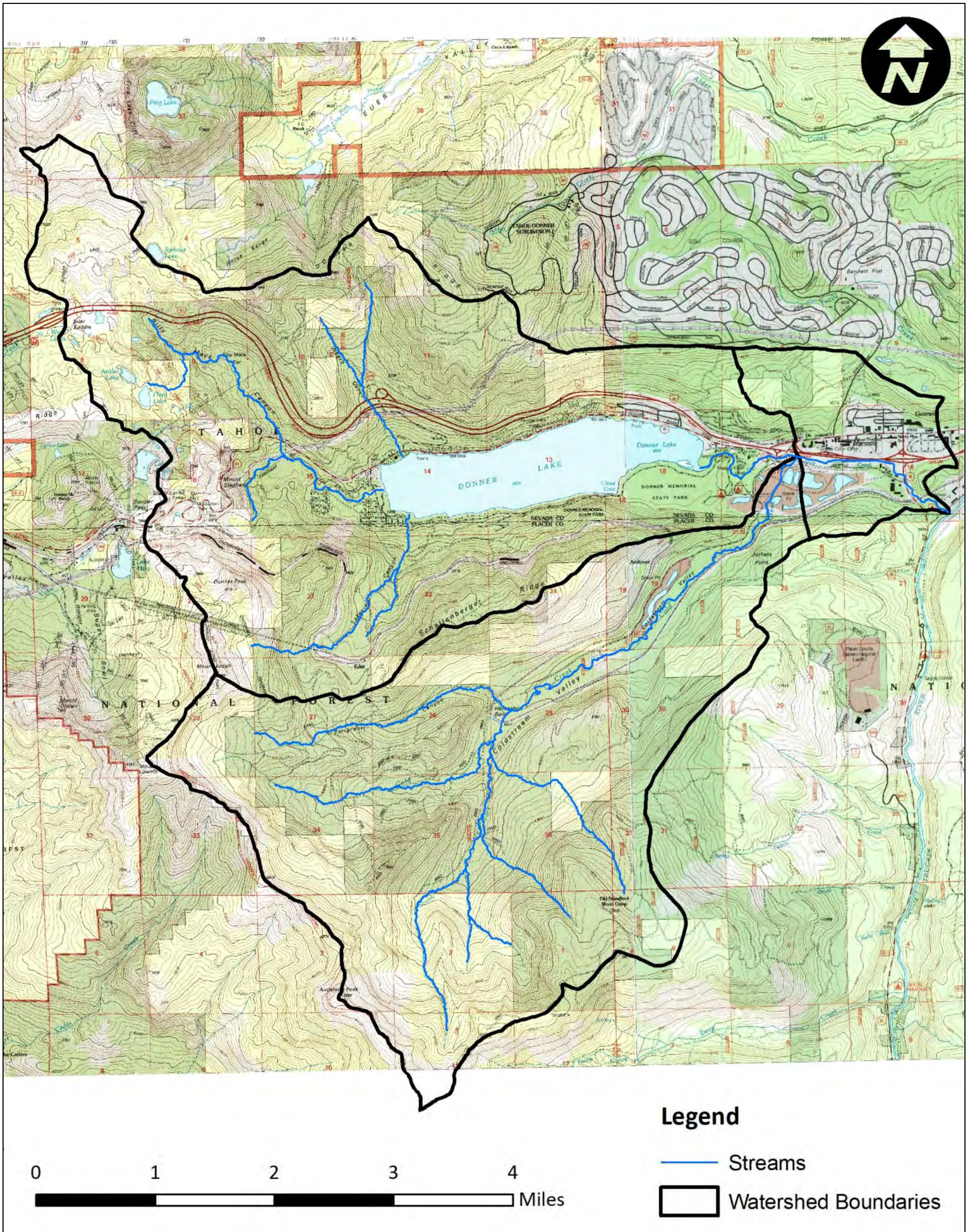


Notes: Subwatersheds delineated using NHD Plus HUC 16 data.	cbec eco engineering	*Donner Basin Watershed Assessment* **Donner Basin overview**		
		Project No. 15-1011	Created By: WJL	**Figure 1**



Notes: USGS 1:24,000 Norden and Truckee quadrangle maps (2000)

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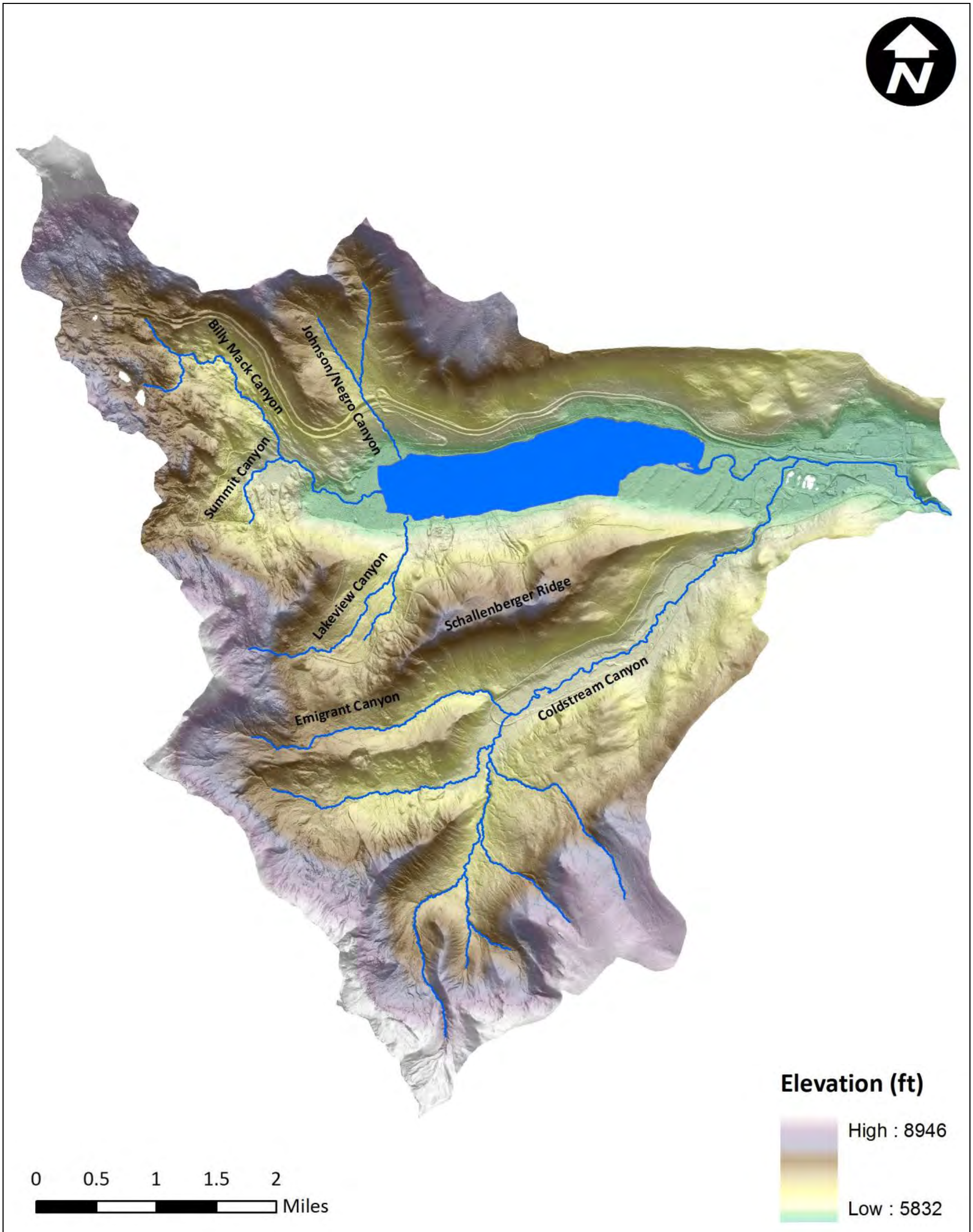
Donner Basin Watershed Assessment

Donner Basin USGS topography

Project No. 15-1011	Created By: WJL	**Figure 2**

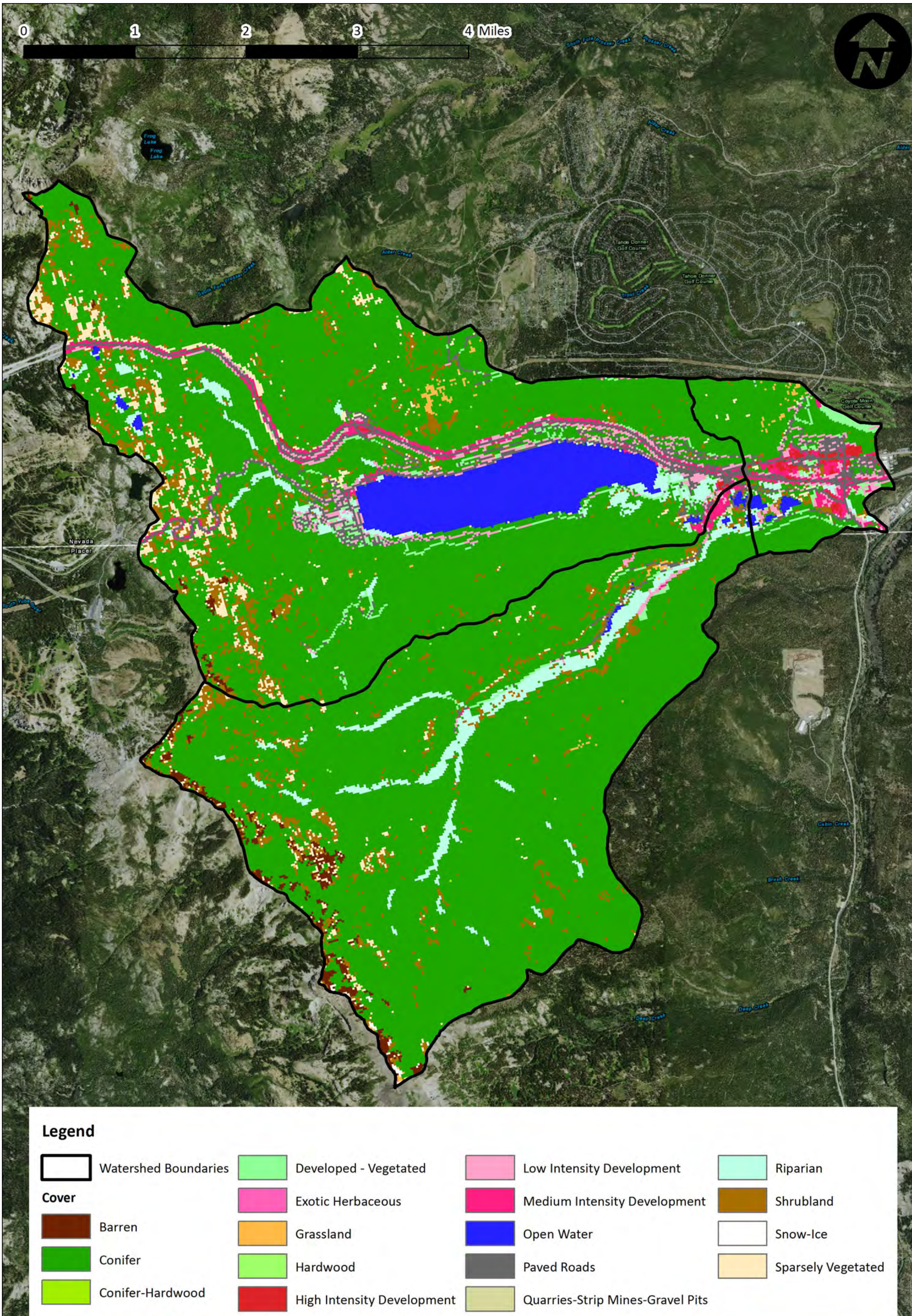


Notes: 1 m LIDAR data supplied by Forest Service

Donner Basin Watershed Assessment

Donner Basin topography

Project No. 15-1011	Created By: WJL	**Figure 3**



Notes: Land use data was obtained from the Landfire 2012 vegetation type raster dataset.

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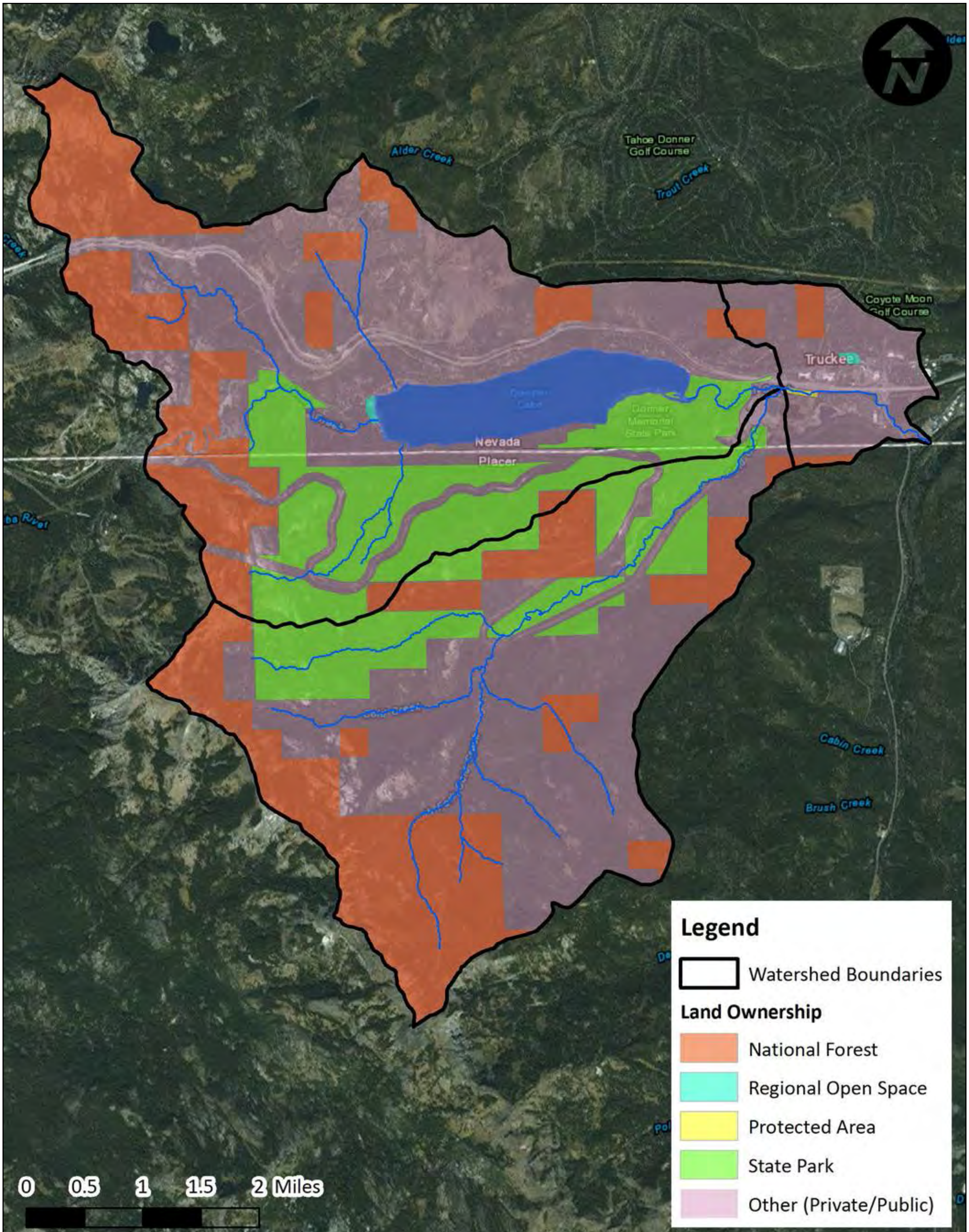
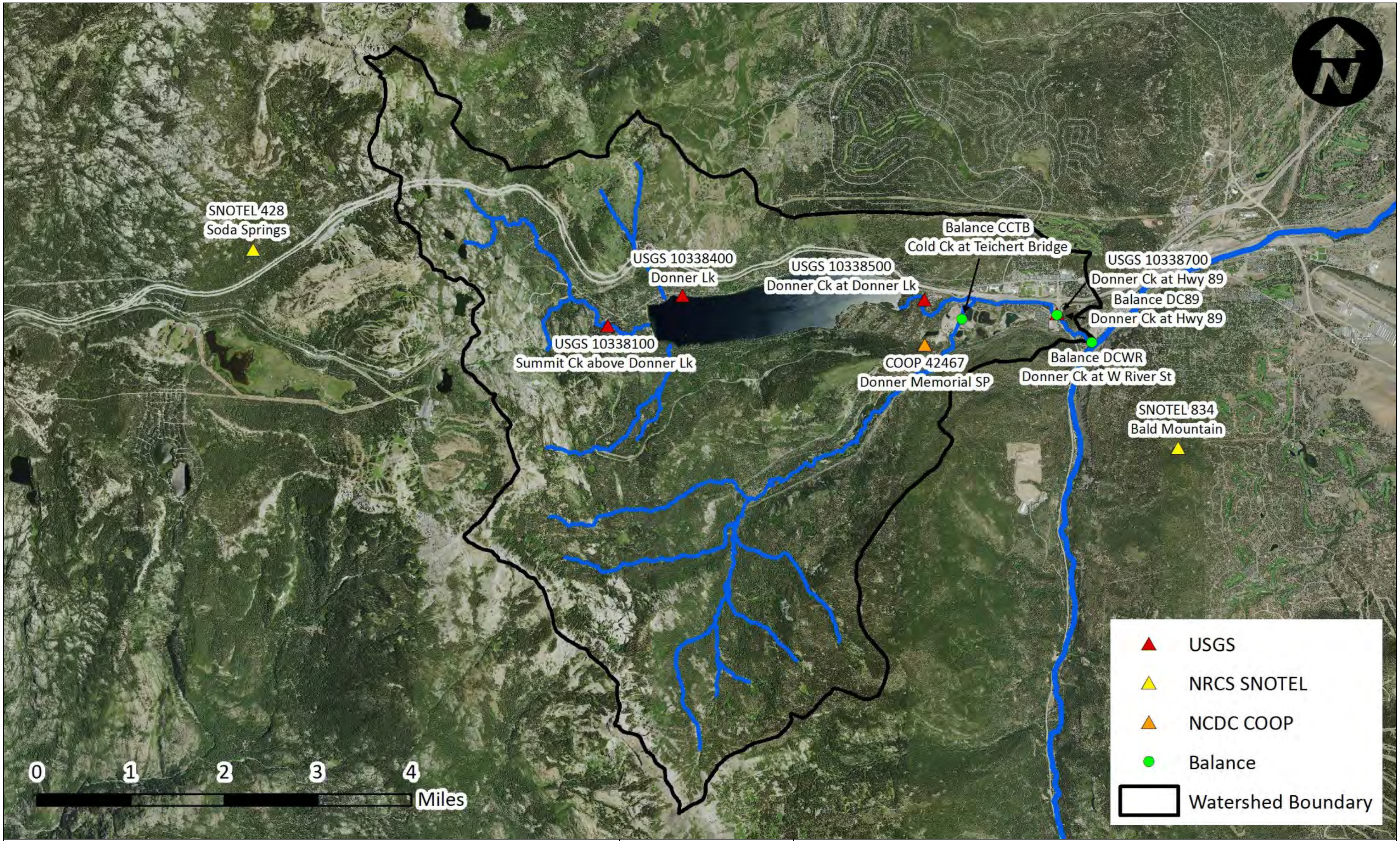
Donner Basin Watershed Assessment

Donner Basin land use

Project No. 15-1011 | Created By: WJL | **Figure 4**



Notes:		*Donner Basin Watershed Assessment* **Donner Basin land ownership**		
		Project No. 15-1011	Created By: WJL	**Figure 5**



Notes: Balance locations indicate suspended sediment monitoring locations by Balance Hydrologics for WY 2011 to 2014. Balance DC89 is co-located with USGS 10338700. Balance DCWR (W. River St) was only monitored WY 2012 to 2014.

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Donner Basin Watershed Assessment

Gauge locations

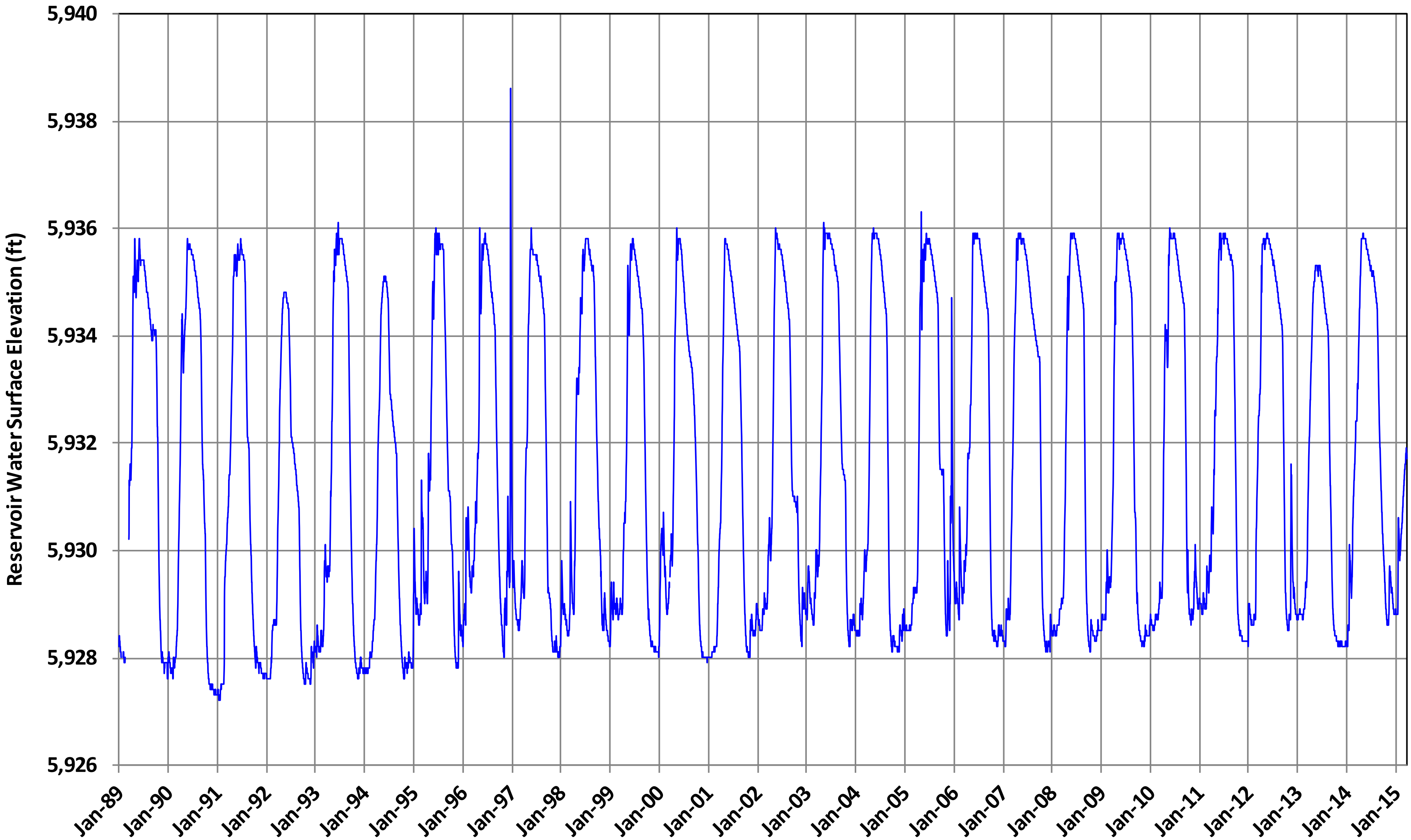
Project No. 15-1011 | Created By: WJL | **Figure 6**

Notes: View looking upstream (above) and downstream (below)

Donner Basin Watershed Assessment

Donner Lake Dam

Project No. 15-1011	Created By: JDS	**Figure 7**



Notes: (1) Source: USGS 10338400 Donner Lake Truckee, CA; (2) Reservoir Water Surface Elevation observations at midnight

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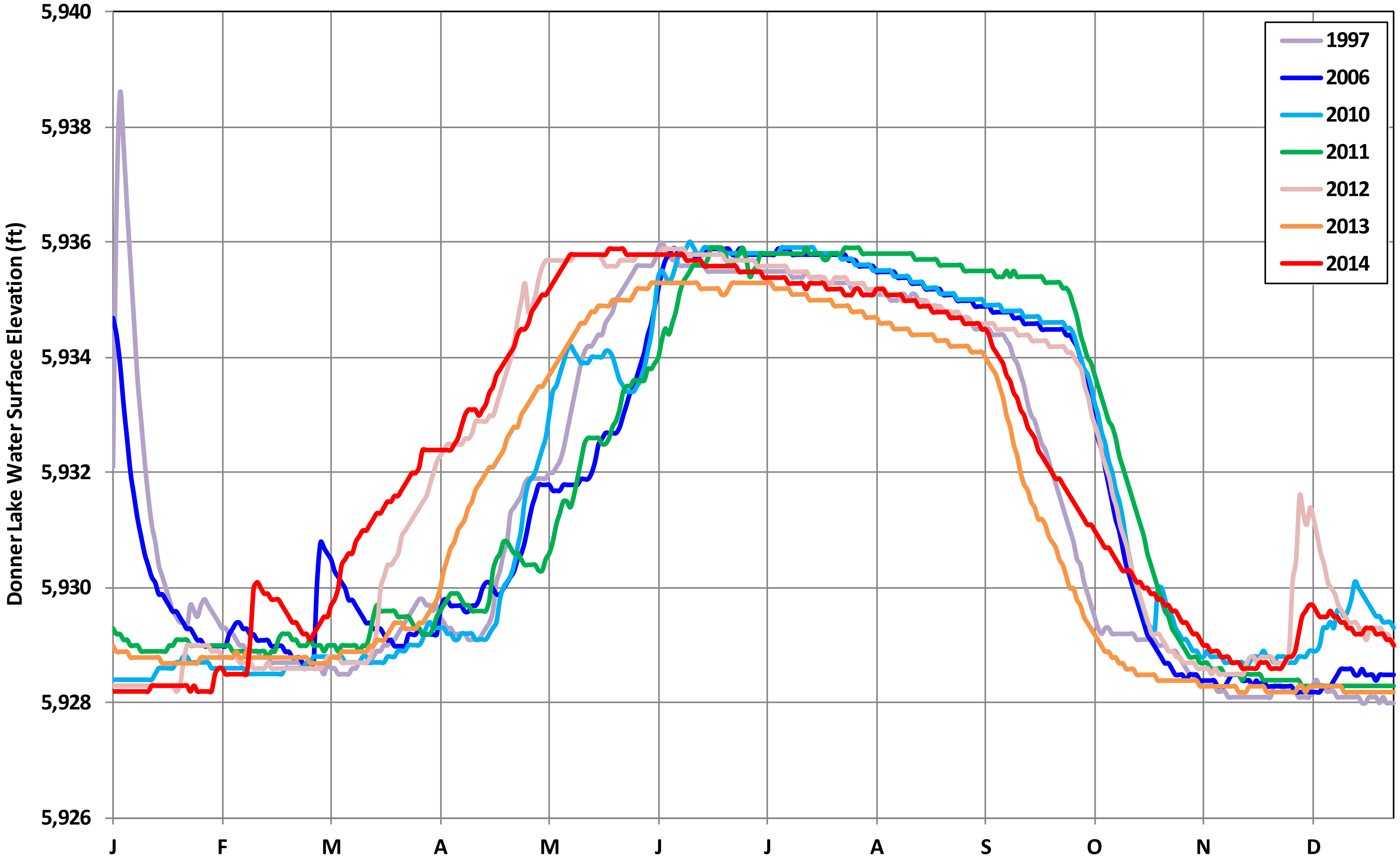
Donner Basin Watershed Assessment

Donner Lake levels

Project No. 15-1011 | Created By: SP | **Figure 8**

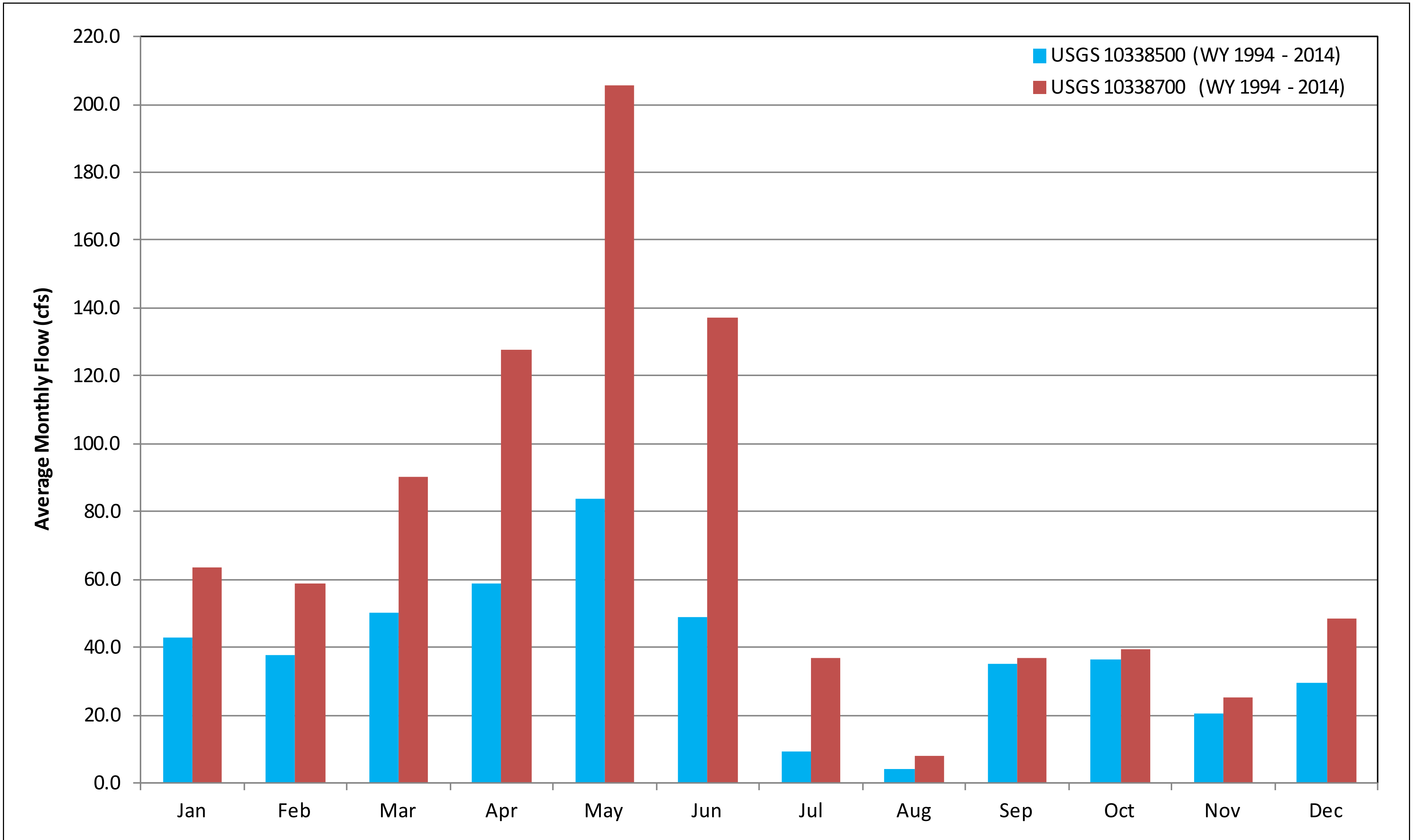


Notes:
Calendar years use for presentation purposes

Donner Basin Watershed Assessment

Donner Lake levels for select years

Project No. 15-1011	Created By: SP	**Figure 9**



Notes:
USGS 10338500 – Donner Creek at Lake Outlet (drainage of 14.3 square miles)
USGS 10338700 – Donner Creek at Hwy 89 (drainage of 29.1 square mi)

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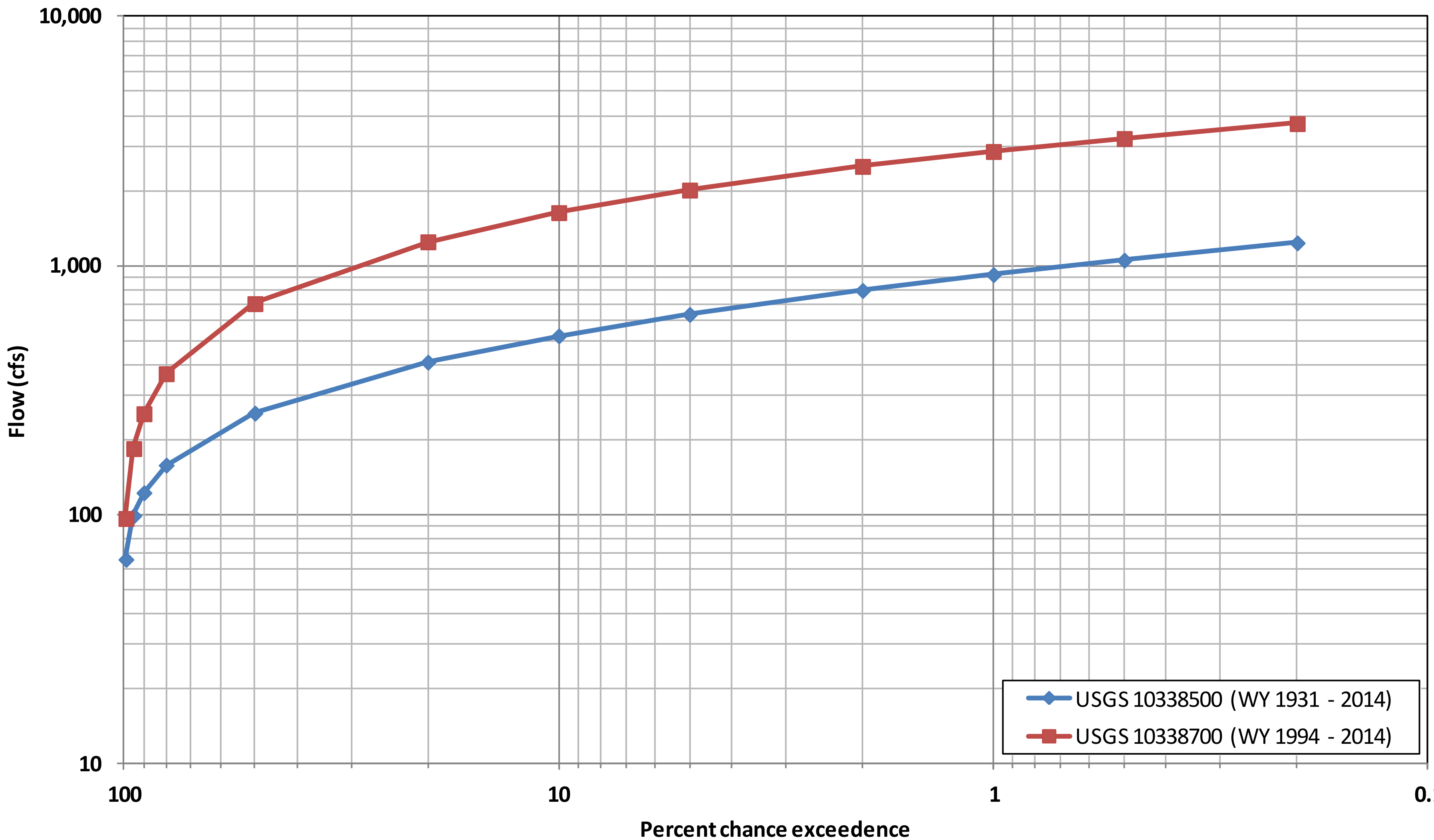
Donner Basin Watershed Assessment

Monthly average flow in Donner Creek

Project No. 15-1011	Created By: SP	**Figure 10**

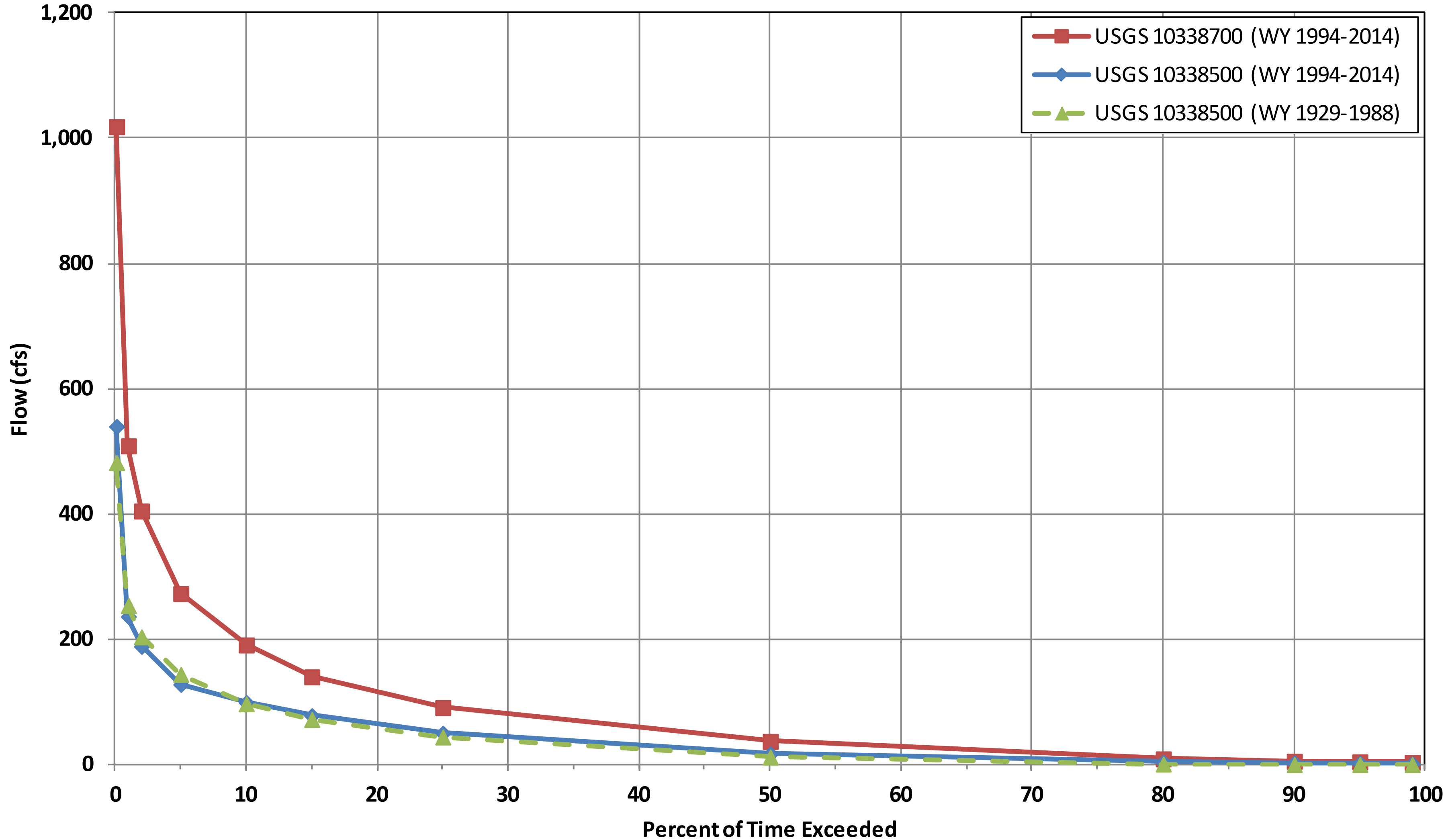


Notes: Flood frequencies based on median plotting position and station skew;
USGS 10338500 – Donner Creek at Lake Outlet (based on data for WY 1931 – 2014)
USGS 10338700 – Donner Creek at Hwy 89 (based on data for WY 1994 – 2014)

Donner Basin Watershed Assessment

Flood frequency curves

Project No. 15-1011 | Created By: SP | **Figure 11**

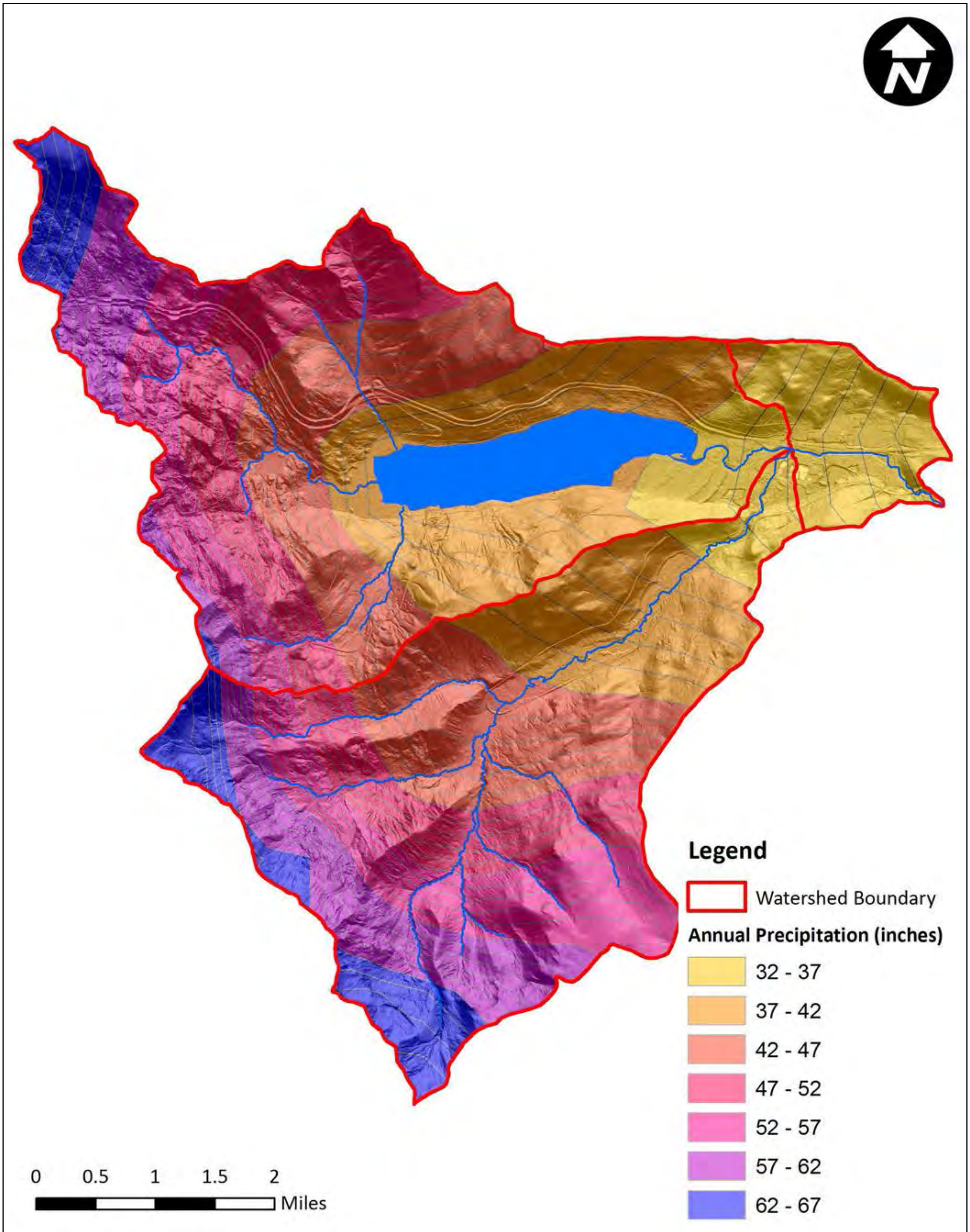


Notes:
USGS 10338500 – Donner Creek at Lake Outlet
USGS 10338700 – Donner Creek at Hwy 89

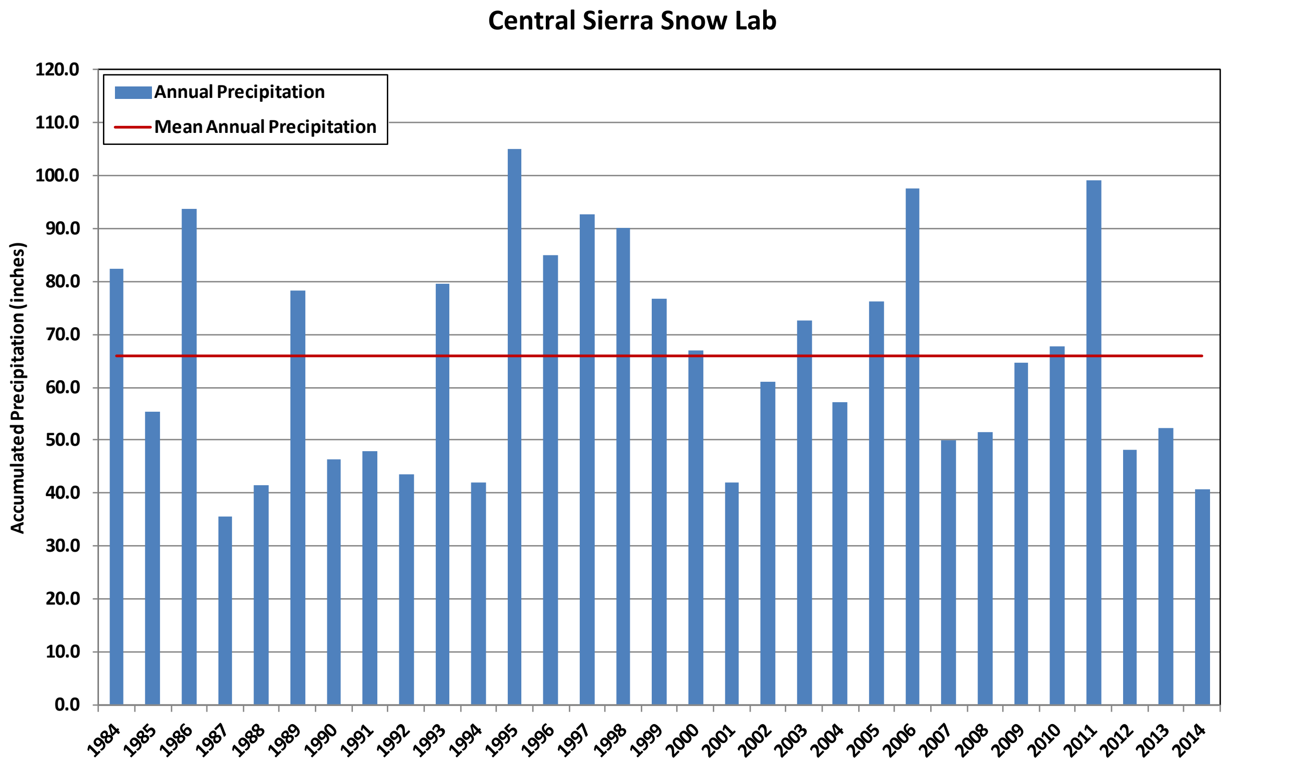
Donner Basin Watershed Assessment

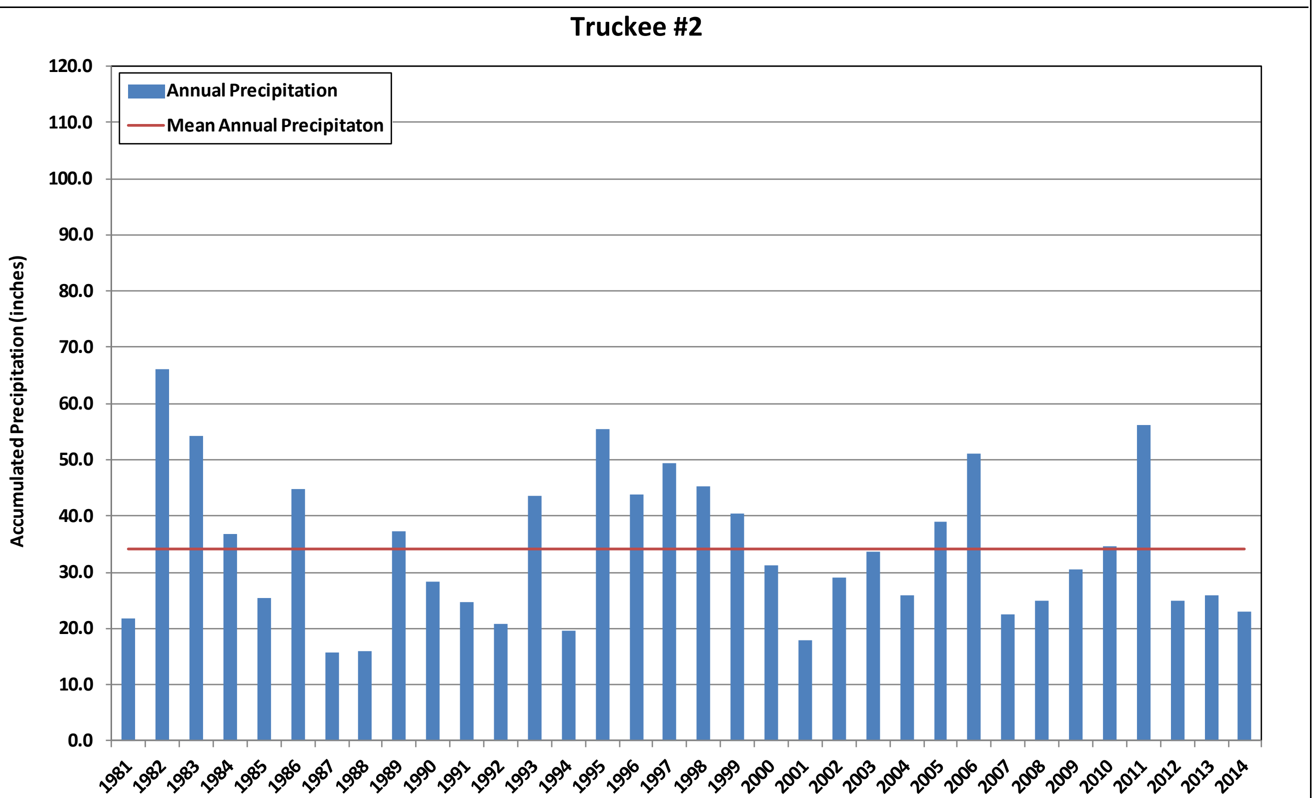
Flow duration curves

Project No. 15-1011	Created By: SP	**Figure 12**

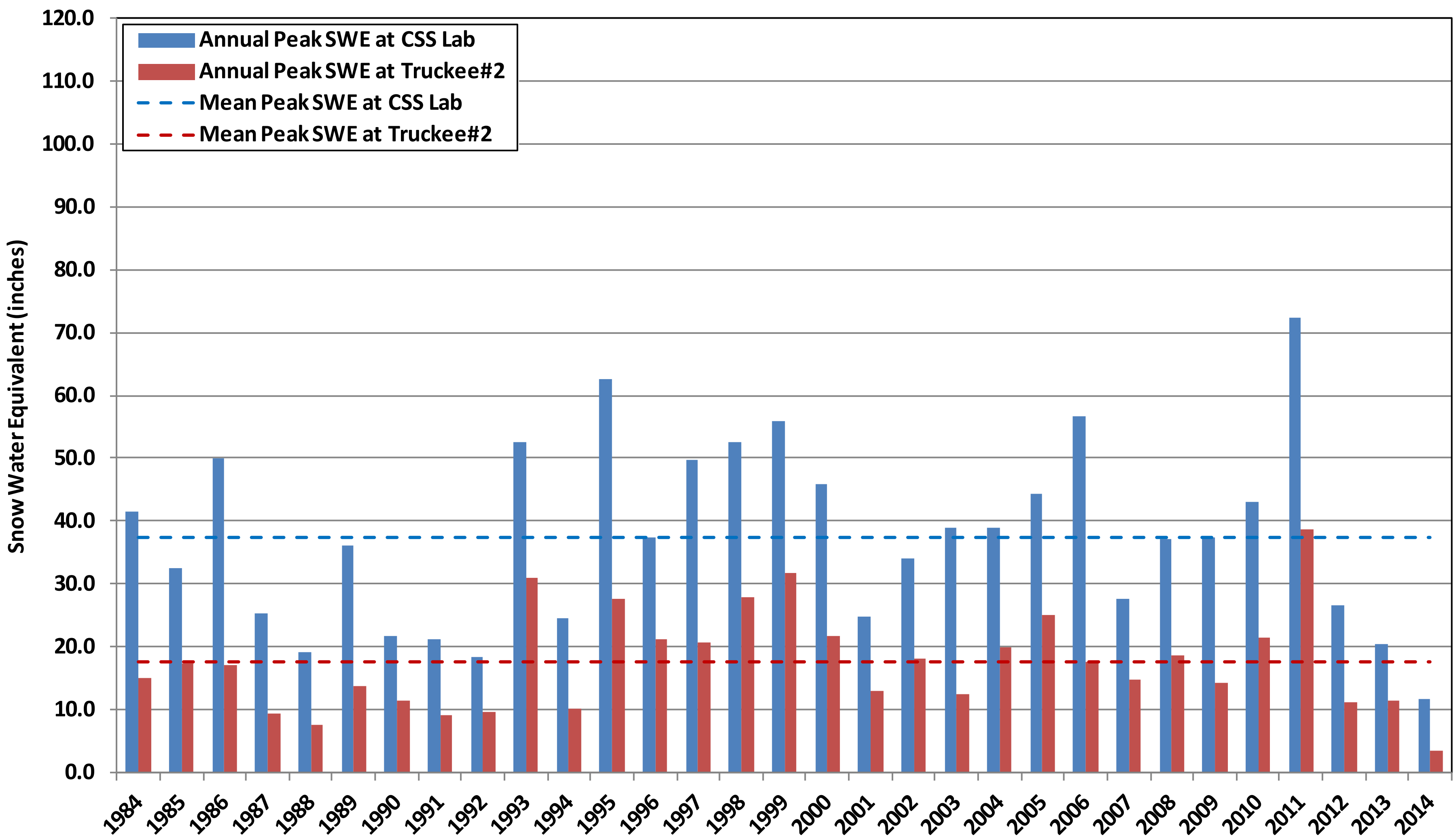


Notes: Slope calculated from 1 m LIDAR data supplied by US Forest Service.	cbec eco engineering	*Donner Basin Watershed Assessment* **Mean annual precipitation mapping**		
		Project No. 15-1011	Created By: WJL	**Figure 13**

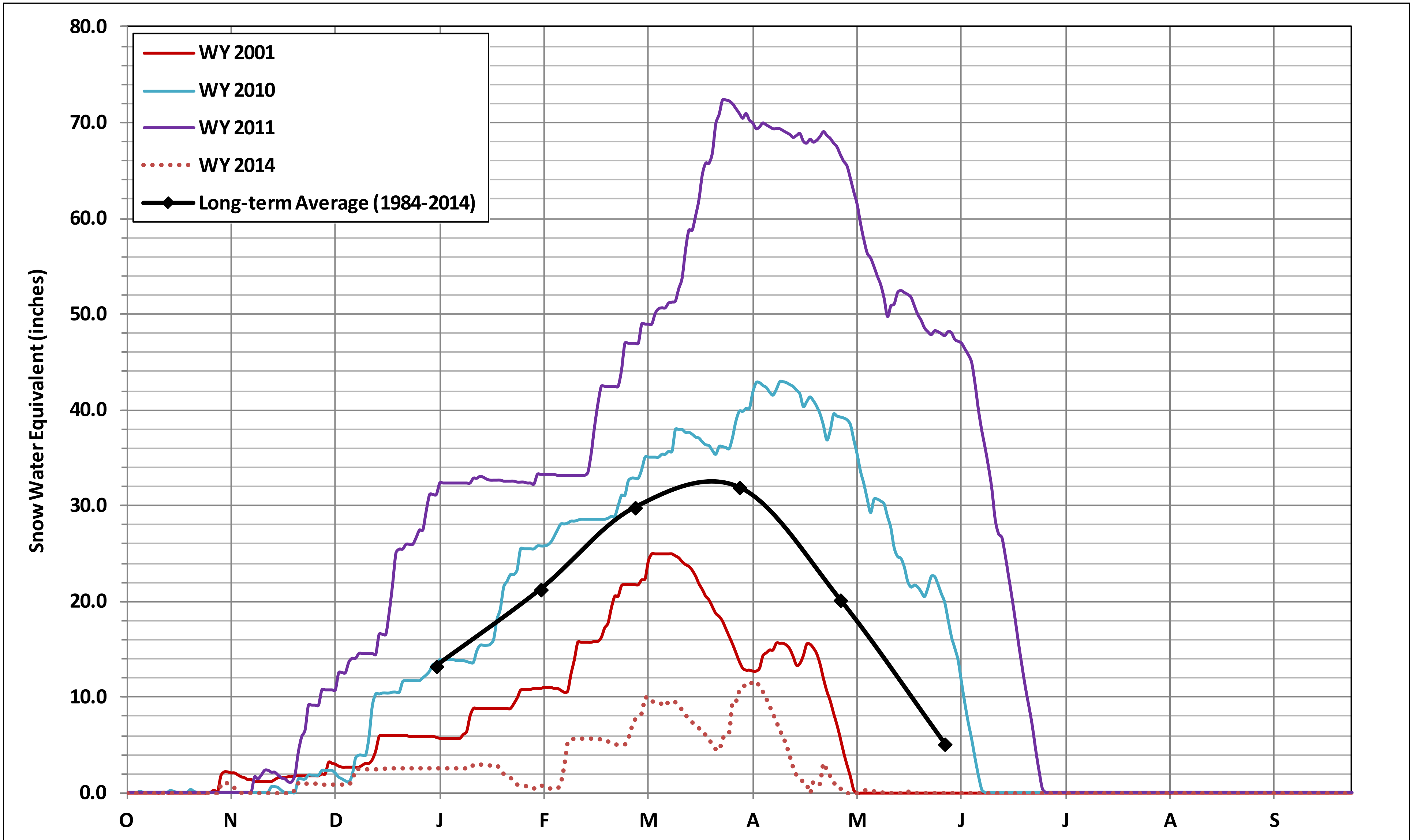




Notes:	cbec eco engineering	*Donner Basin Watershed Assessment* **Annual precipitation at SNOTEL sites**
		Project No. 15-1011 | Created By: SP | **Figure 14**



Notes:	cbec eco engineering	*Donner Basin Watershed Assessment* **Annual peak snow water equivalent**		
		Project No. 15-1011	Created By: SP	**Figure 15**



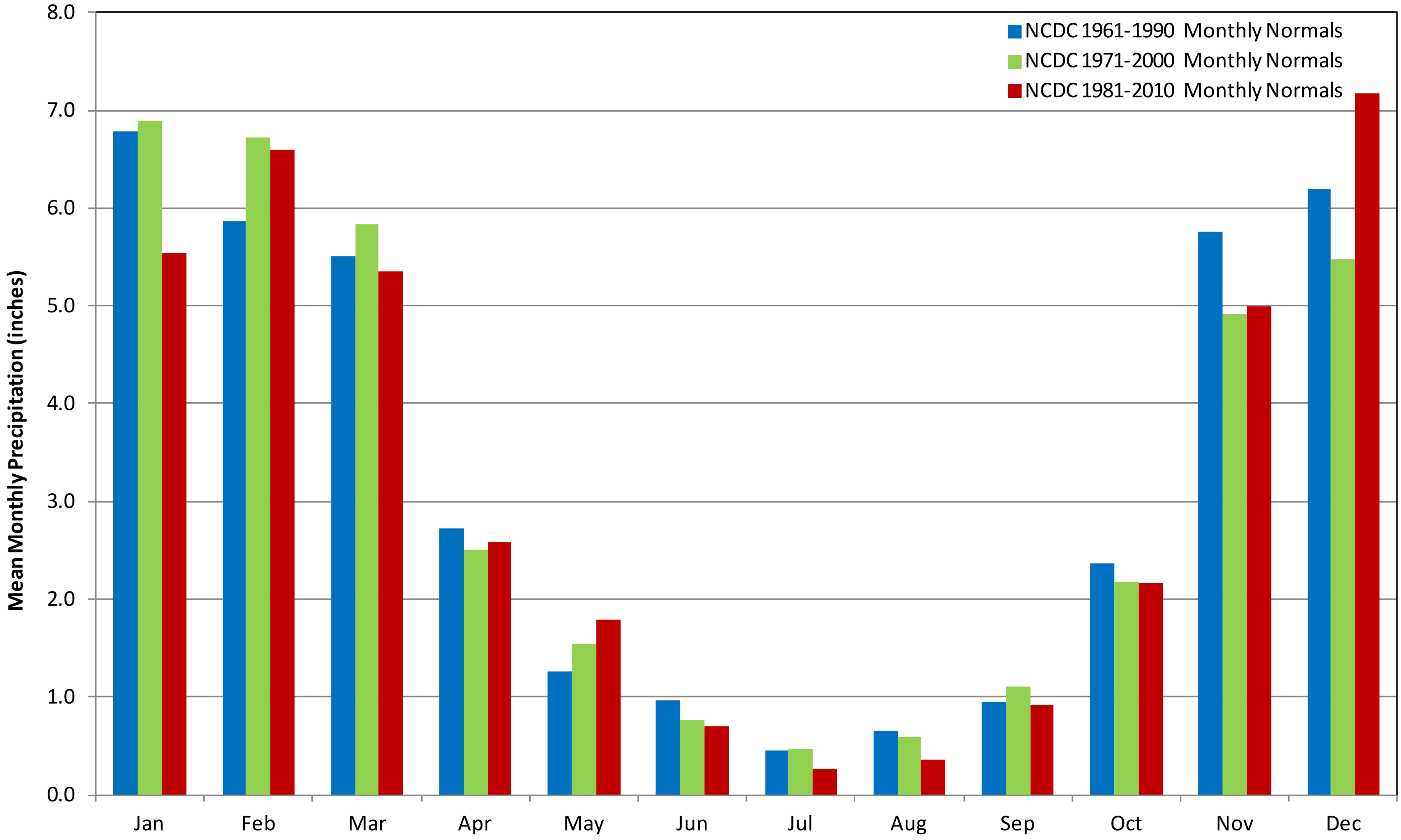
Notes: Long-term average (1984-2014) values based on 30-year mean SWE on the first of every month from January to June.

cbec eco engineering

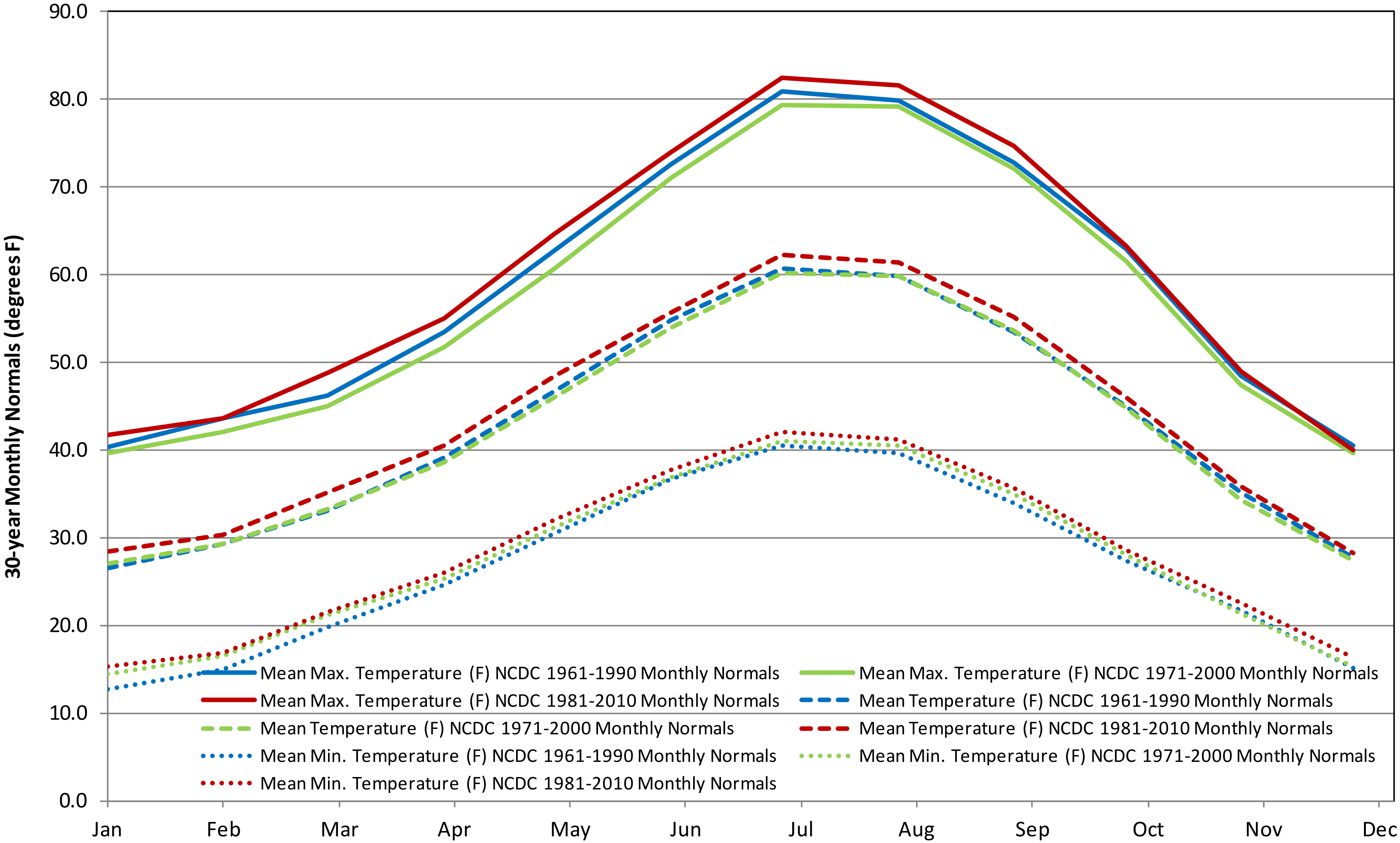
Donner Basin Watershed Assessment

Snow water equivalent at Central Sierra Snow Lab

Project No. 15-1011	Created By: SP	**Figure 16**



Notes: Data from National Climatic Data Center (NCDC) Cooperative Observer Program (COOP) Station at Donner Memorial State Park	cbec eco engineering	*Donner Basin Watershed Assessment* **30-year precipitation normals**
	Project No. 15-1011	Created By: SP	**Figure 17**



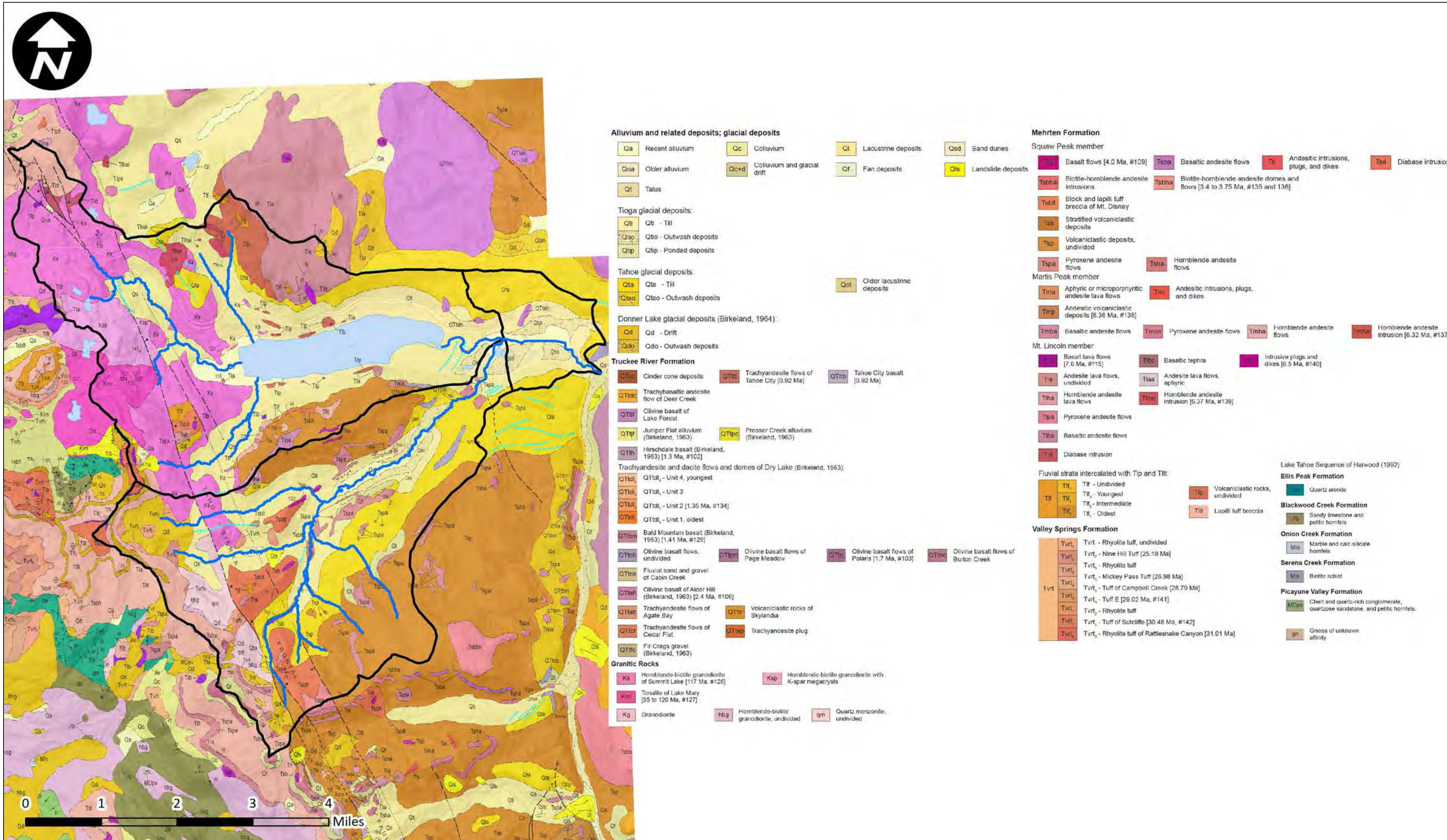
Notes: Data from National Climatic Data Center (NCDC) Cooperative Observer Program (COOP) Station at Donner Memorial State Park

cbec eco engineering

Donner Basin Watershed Assessment

30-year temperature normals

Project No. 15-1011 | Created By: SP | **Figure 18**



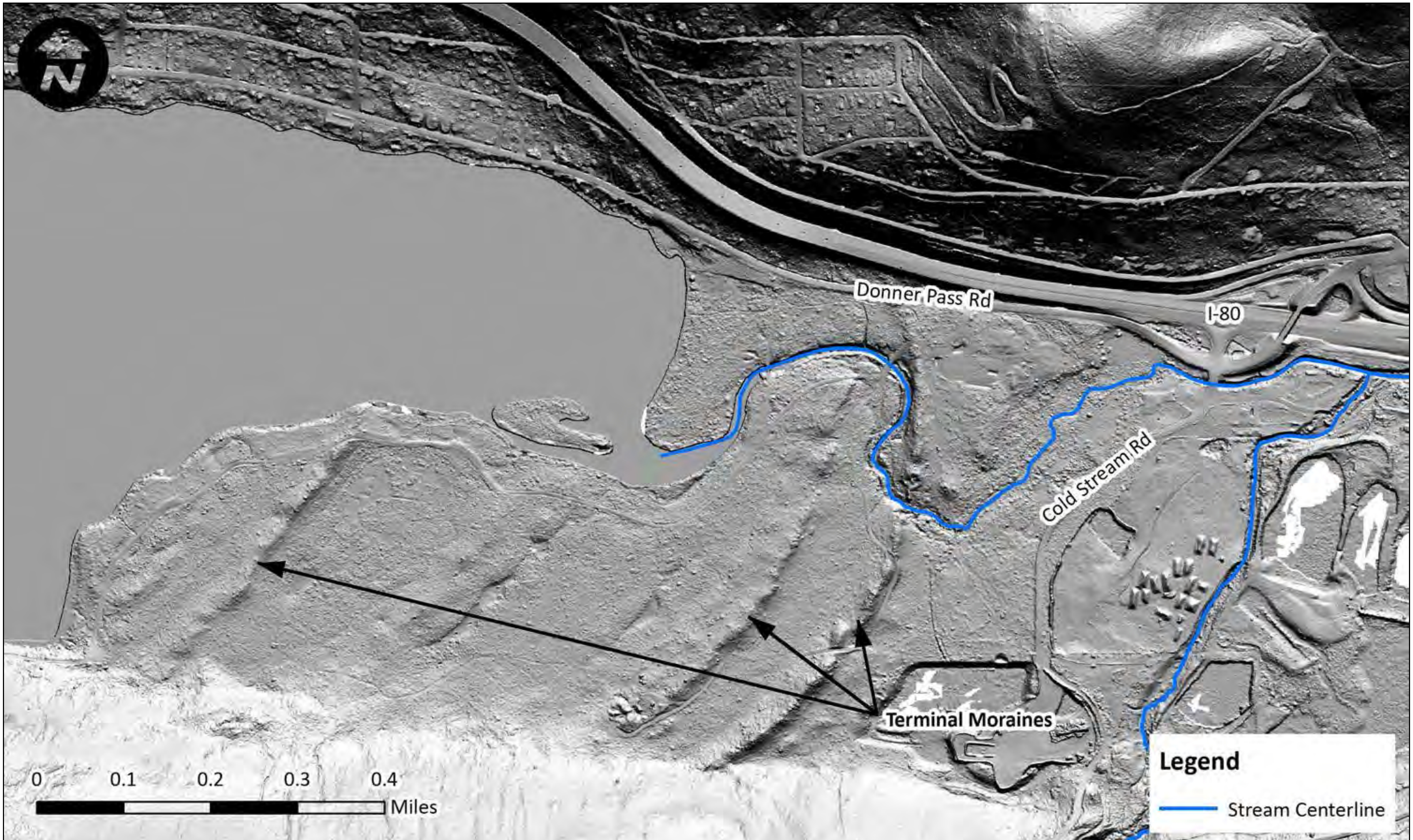
Notes: Background – Geologic Map of the North Lake Tahoe–Donner Pass Region, Northern Sierra Nevada, California (Sheet 60), 1:48,000, 2012, California Geologic Survey, California Department of Conservation, Sacramento, California

cbec eco engineering

Donner Basin Watershed Assessment

Donner Basin geology map

Project No. 15-1011 | Created By: WJL | **Figure 19**



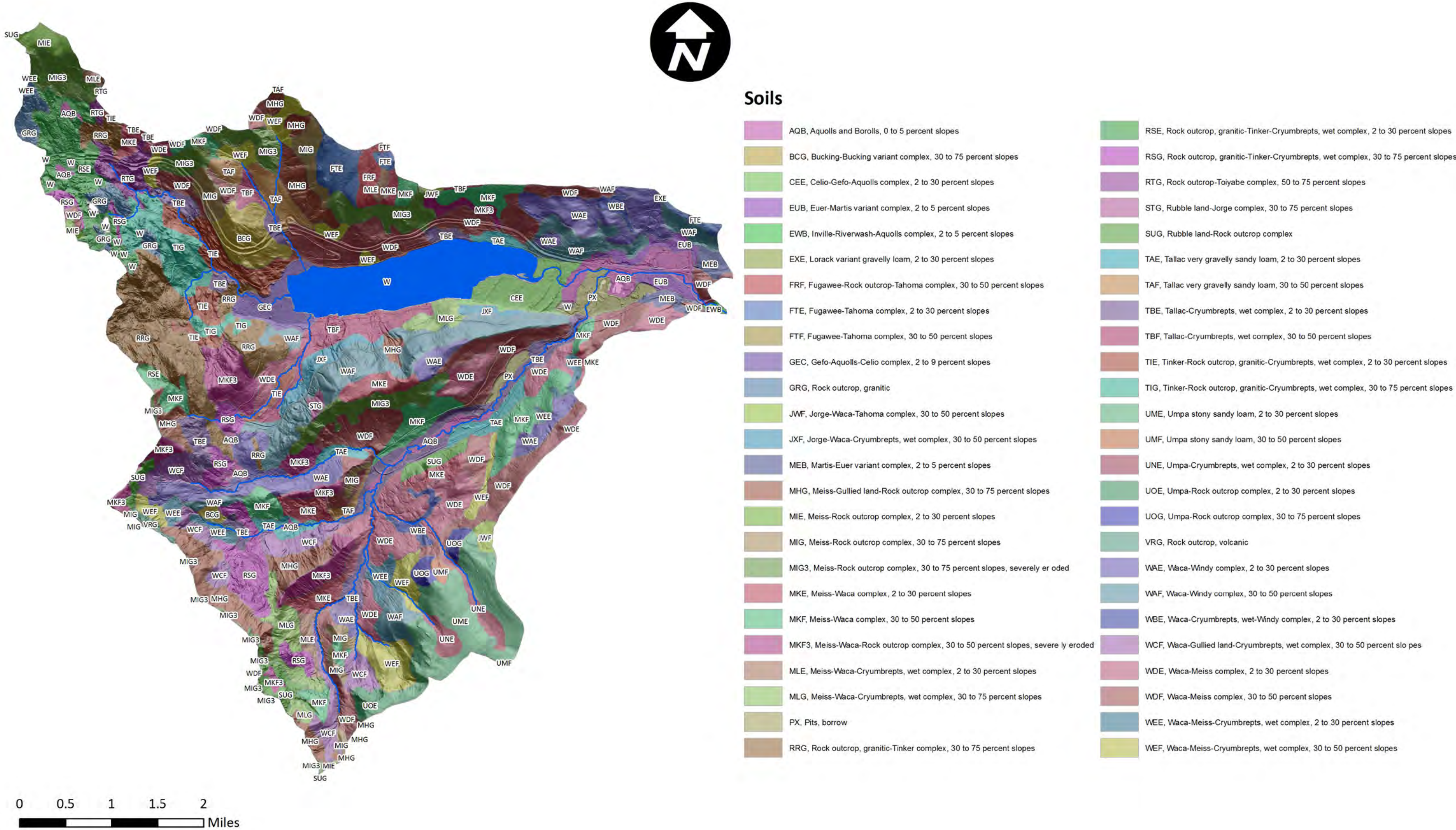
Notes: Background image hillshade generated from 1 meter resolution LIDAR DEM

cbec eco engineering

Donner Basin Watershed Assessment

Terminal moraines at lake outlet

Project No. 15-1011	Created By: WJL	**Figure 20**



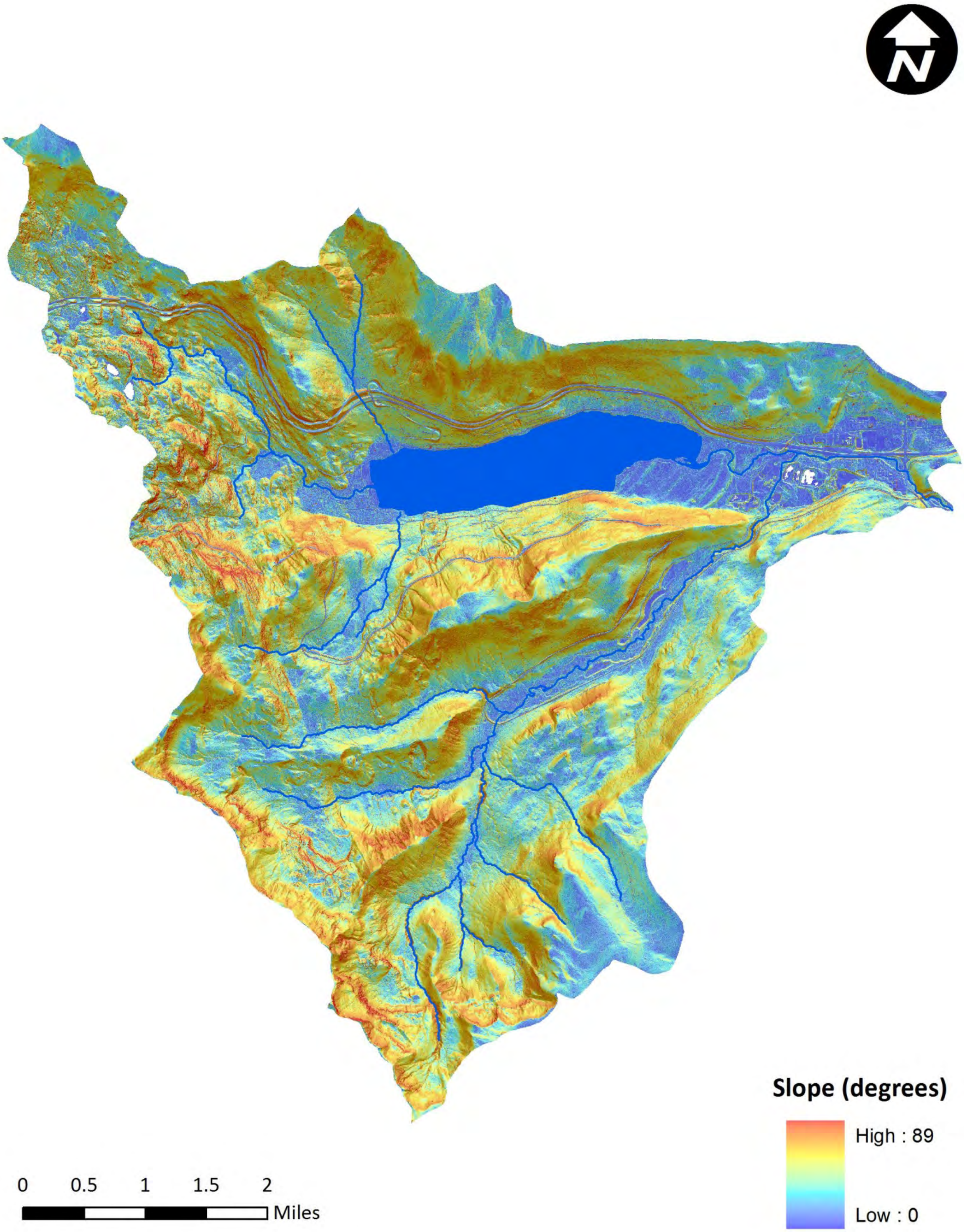
Notes: Soil data from NRCS SSURGO database

cbec eco engineering

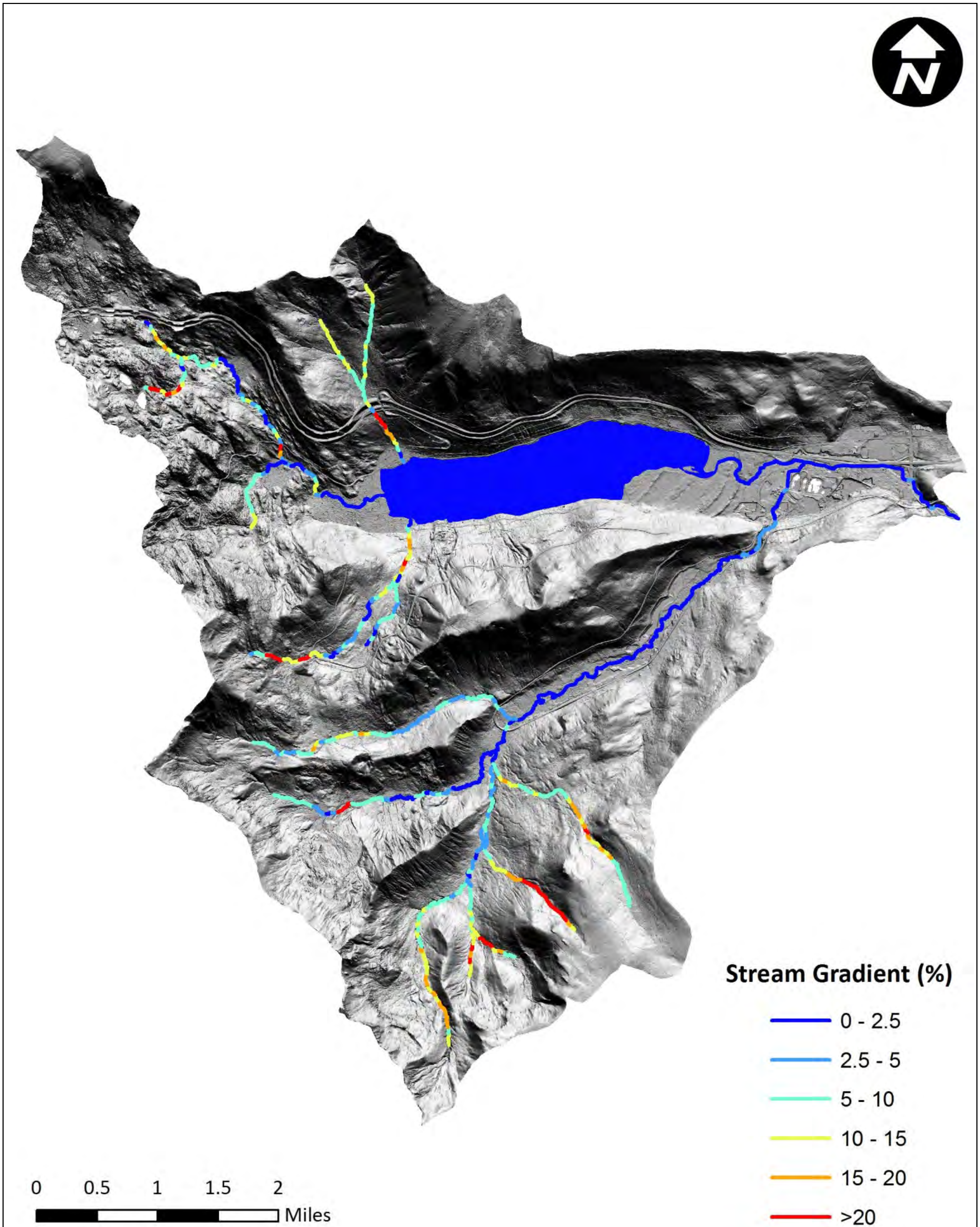
Donner Basin Watershed Assessment

Donner Basin soils mapping

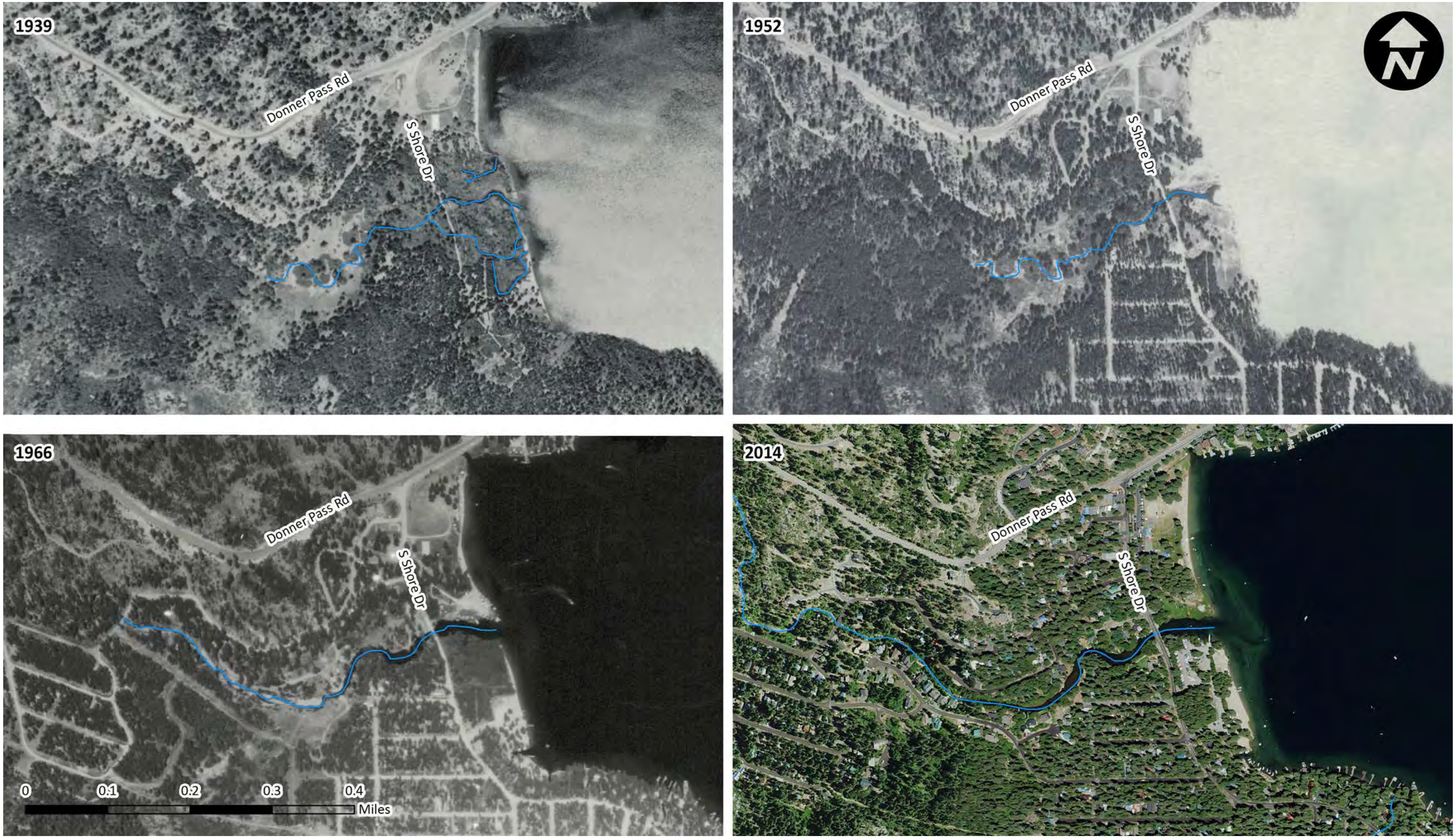
Project No. 15-1011	Created By: WJL	**Figure 21**



Notes: Slope calculated from 1 m LIDAR data supplied by US Forest Service.	cbec eco engineering	*Donner Basin Watershed Assessment* **Watershed slope mapping**	
		Project No. 15-1011	Created By: WJL	**Figure 22**



Notes: Average stream gradient was calculated for 300 ft reach segments.	cbec eco engineering	*Donner Basin Watershed Assessment* **Stream gradient**	
		Project No. 15-1011	Created By: WJL	**Figure 23**



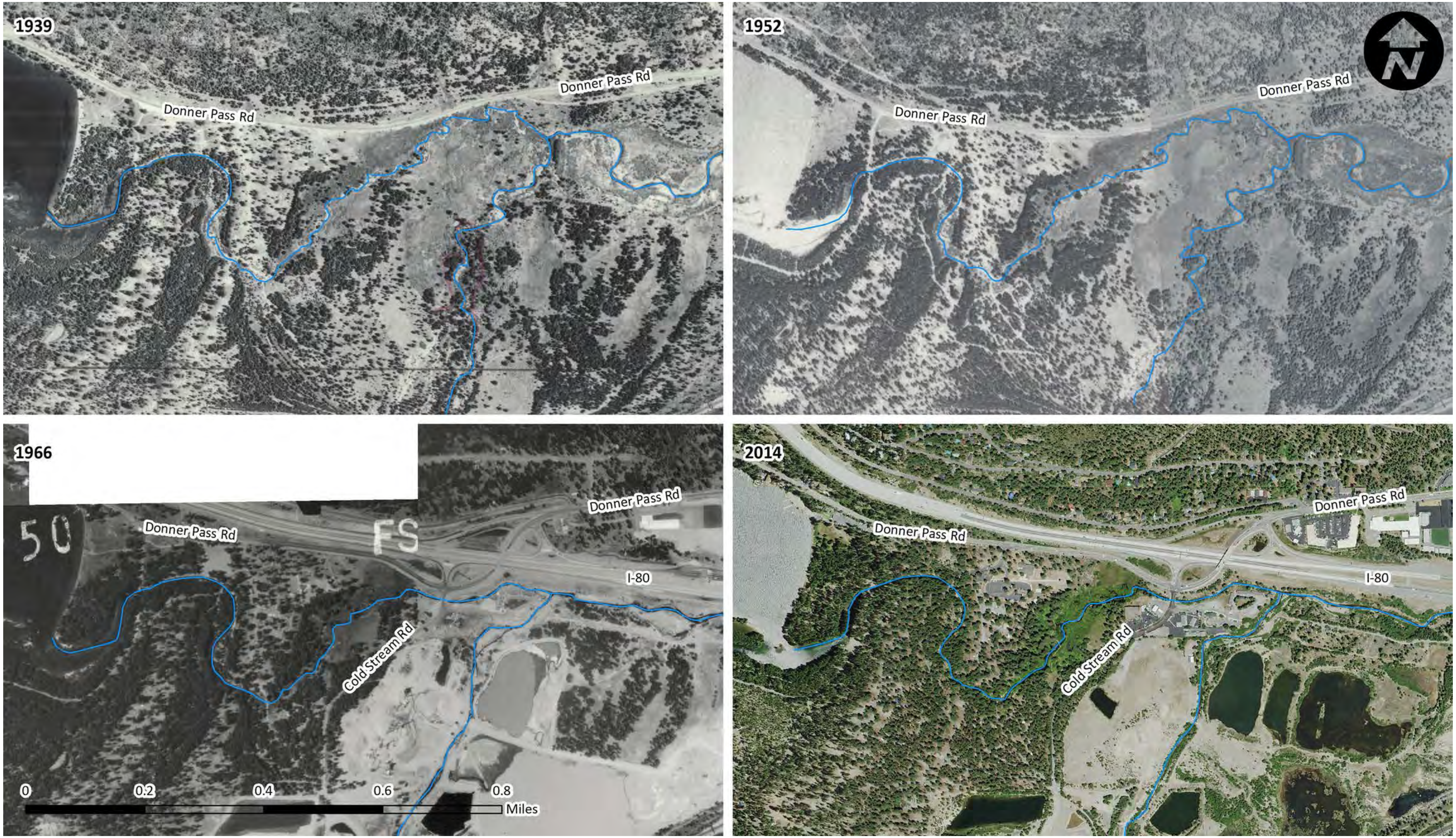
Notes: Historic aerial images courtesy of the US Forest Service. 2014 aerial image from National Agriculture Imagery Program. Historic images were georeferenced using known points in 2014 aerial images. Stream centerlines were digitized by hand from aerial images.

cbec eco engineering

Donner Watershed Basin Assessment

Historic channel alignments – above Donner Lake

Project No. 15-1011 | Created By: WJL | **Figure 24**



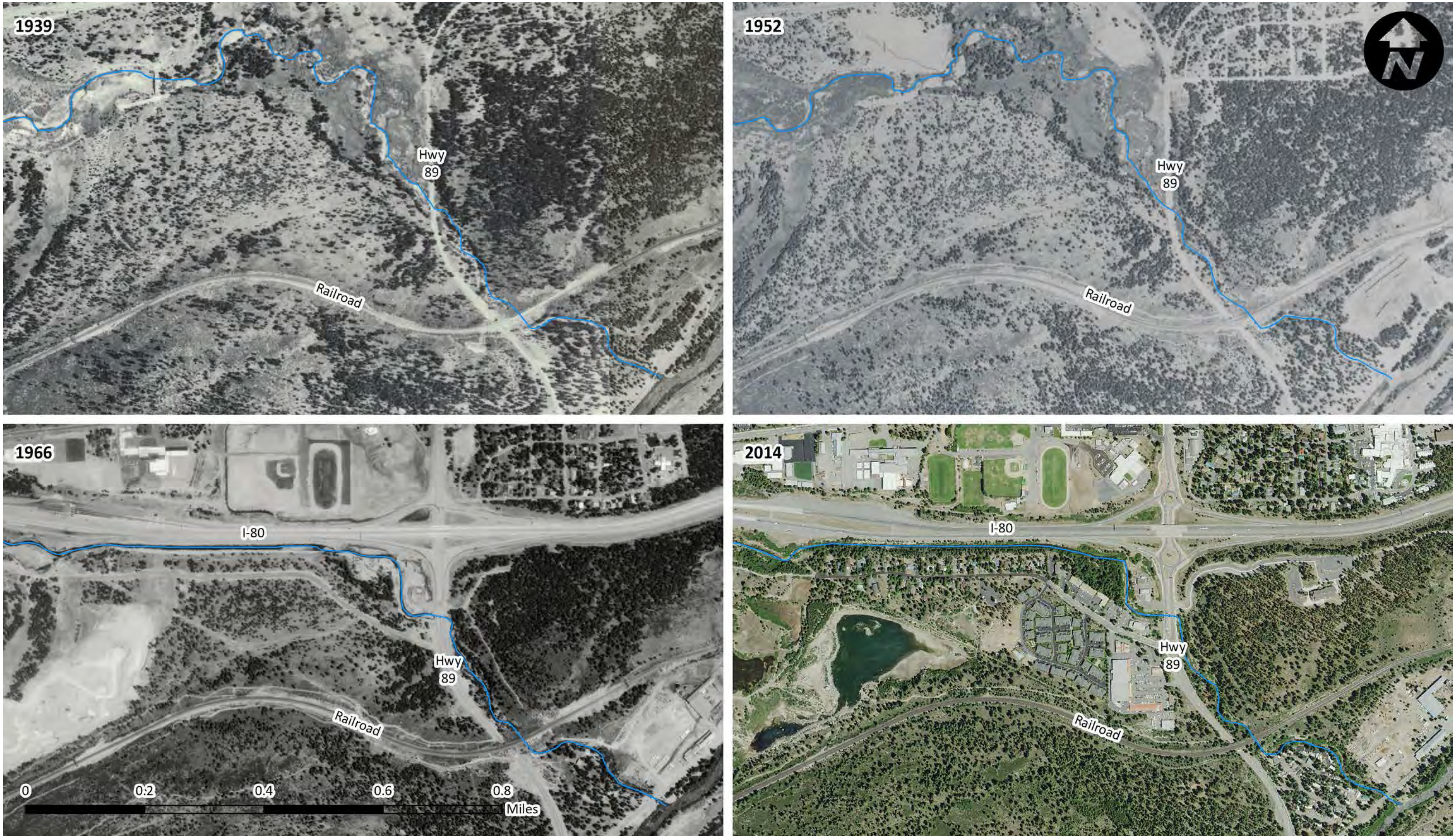
Notes: Historic aerial images courtesy of the US Forest Service. 2014 aerial image from National Agriculture Imagery Program. Historic images were georeferenced using known points in 2014 aerial images. Stream centerlines were digitized by hand from aerial images.

cbec eco engineering

Donner Basin Watershed Assessment

Historic channel alignments – above Cold Creek confluence

Project No. 15-1011	Created By: WJL	**Figure 25**



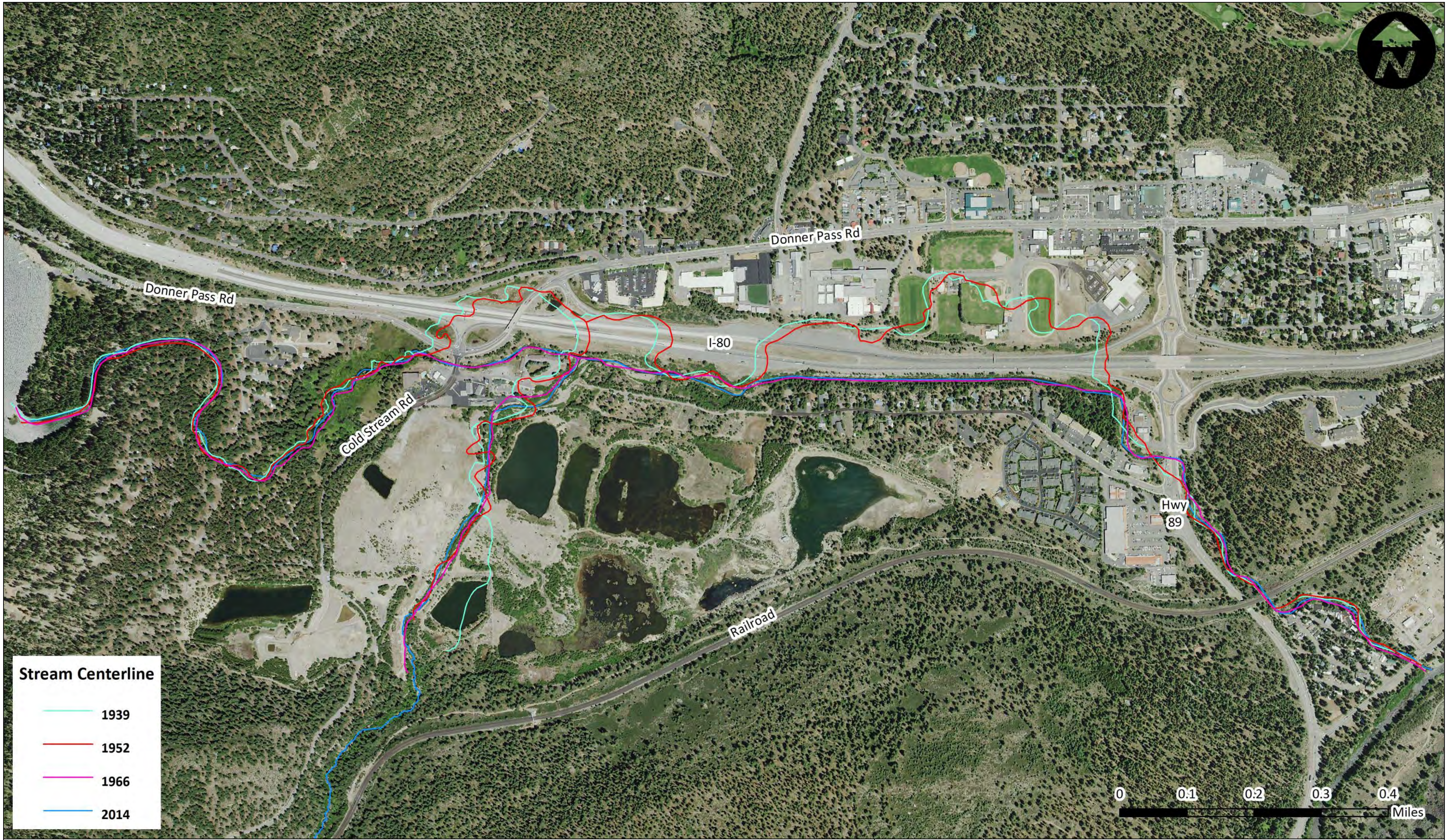
Notes: Historic aerial images courtesy of the US Forest Service. 2014 aerial image from National Agriculture Imagery Program. Historic images were georeferenced using known points in 2014 aerial images. Stream centerlines were digitized by hand from aerial images.

cbec eco engineering

Donner Basin Watershed Assessment

Historic channel alignments – below Cold Creek confluence

Project No. 15-1011 | Created By: WJL | **Figure 26**



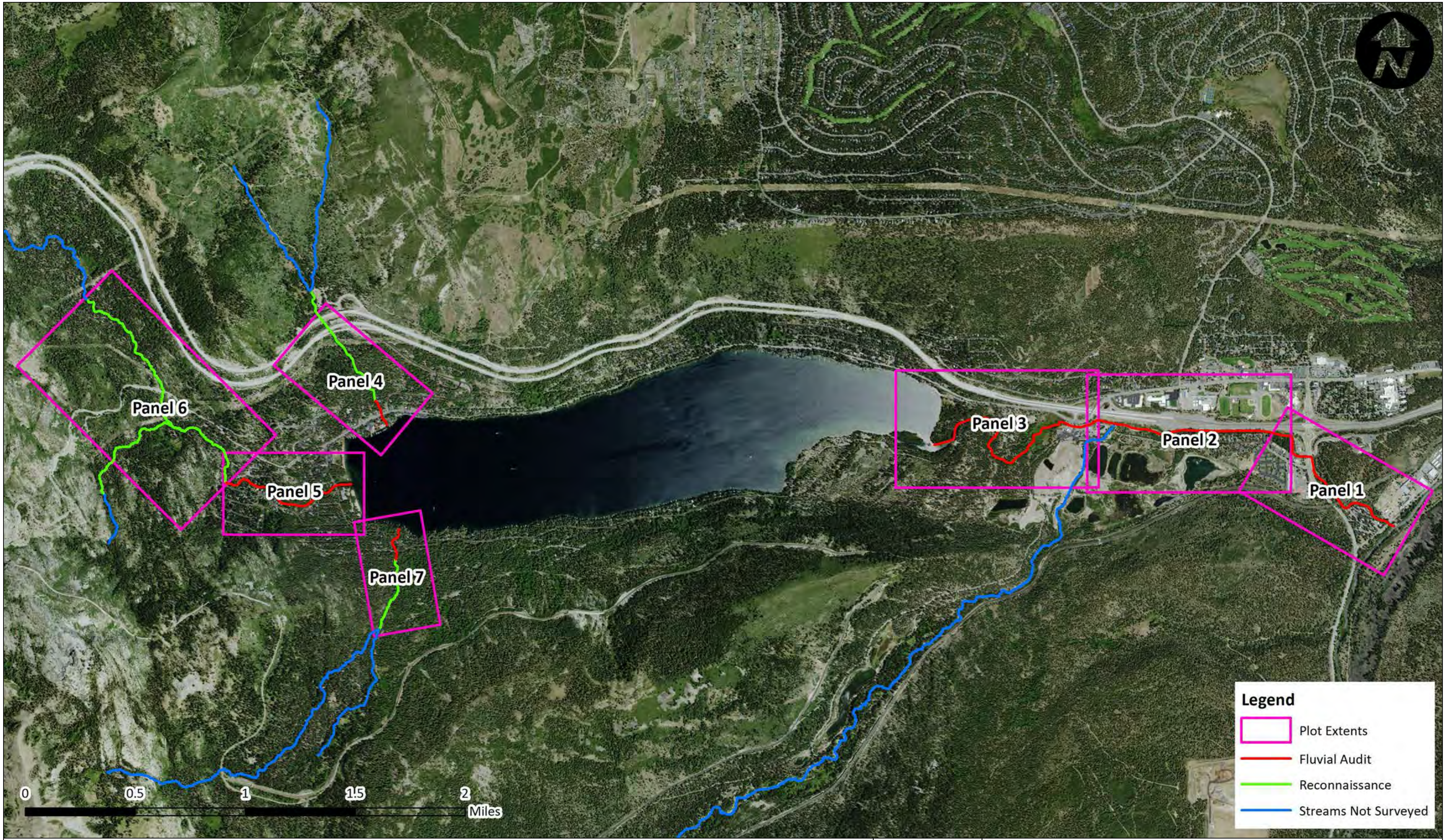
Notes: Stream centerlines were digitized from georeferenced historic aerial images. Not all areas of historic images aligned correctly with comparable known locations in 2014 imagery, due to limitations in georefrencing. As such, stream centerline locations should be considered relative rather than absolute.

cbec eco engineering

Donner Basin Watershed Assessment

Historic channel alignments – Donner Lake to Truckee River

Project No. 15-1011	Created By: WJL	**Figure 27**



Notes:

cbec eco engineering

Donner Basin Watershed Assessment

Fluvial audit - overview

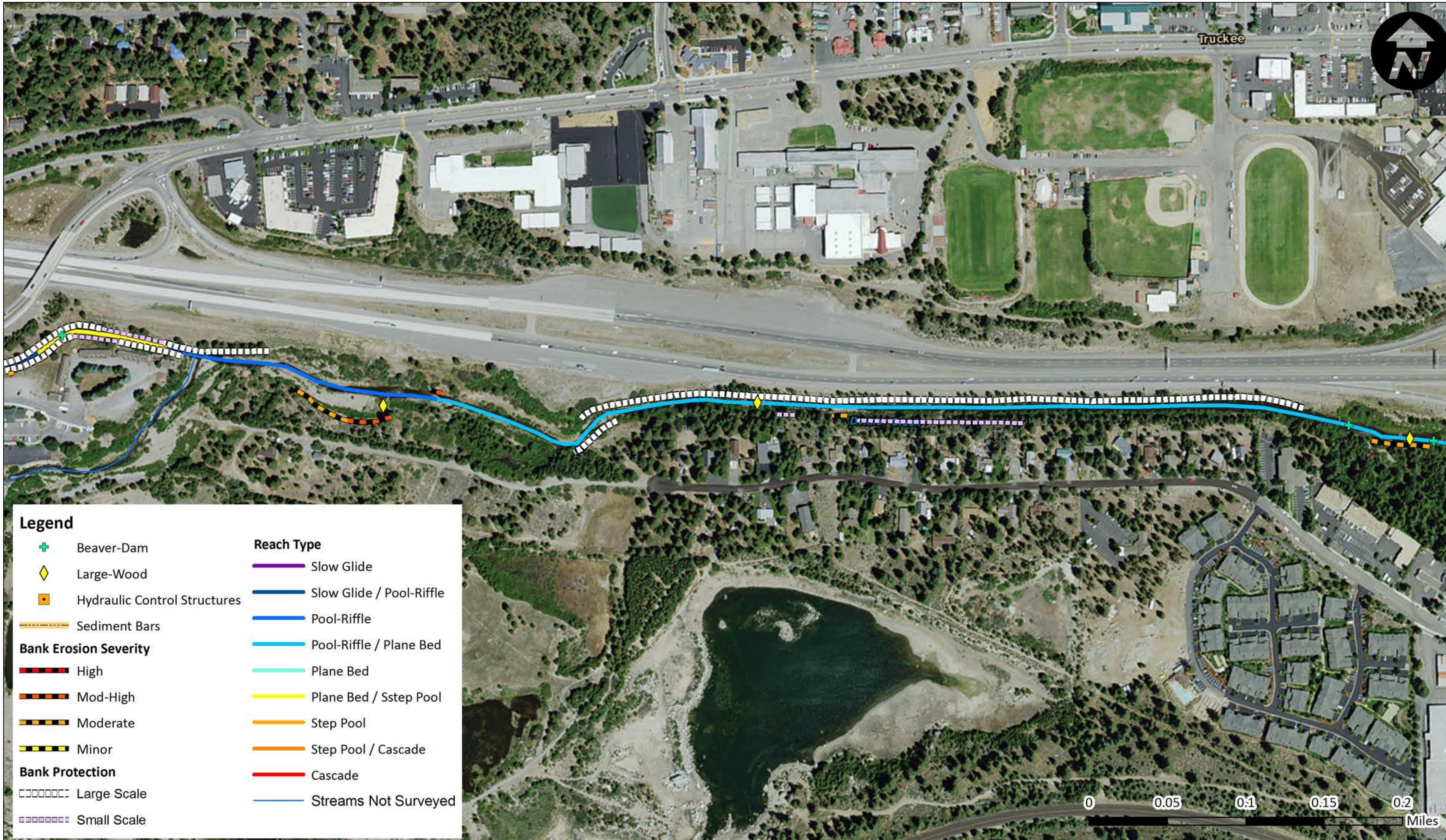
Project No. 15-1011 | Created By: WJL | **Figure 28**

Notes:

Donner Basin Watershed Assessment

Fluvial audit – Donner Creek (Panel 1)

Project No. 15-1011	Created By: WJL	**Figure 29**



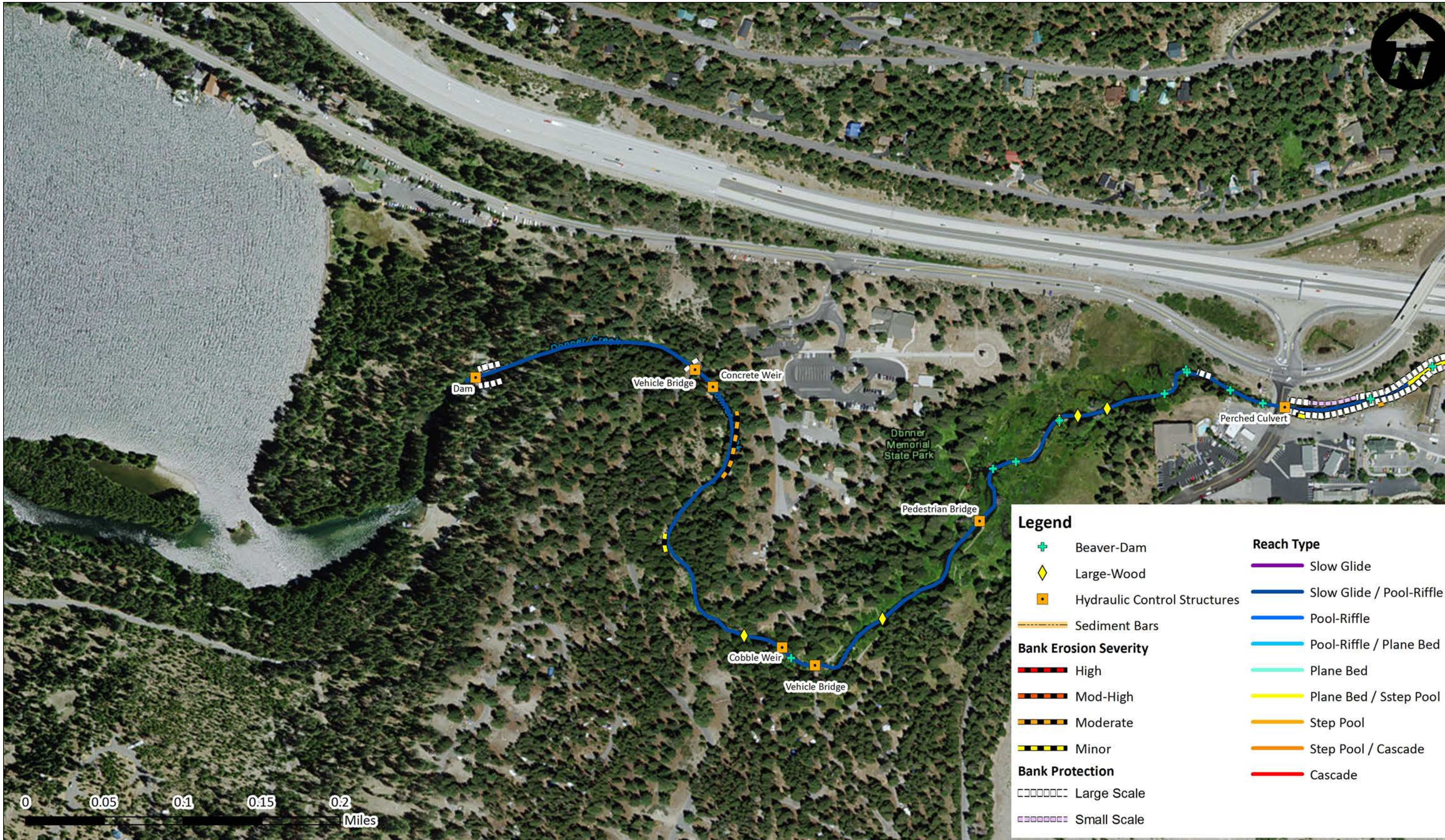
Notes:

cbec eco engineering

Donner Basin Watershed Assessment

Fluvial audit – Donner Creek (Panel 2)

Project No. 15-1011	Created By: WJL	**Figure 30**



Notes:

Donner Basin Watershed Assessment

Fluvial audit – Donner Creek (Panel 3)

Project No. 15-1011 | Created By: WJL

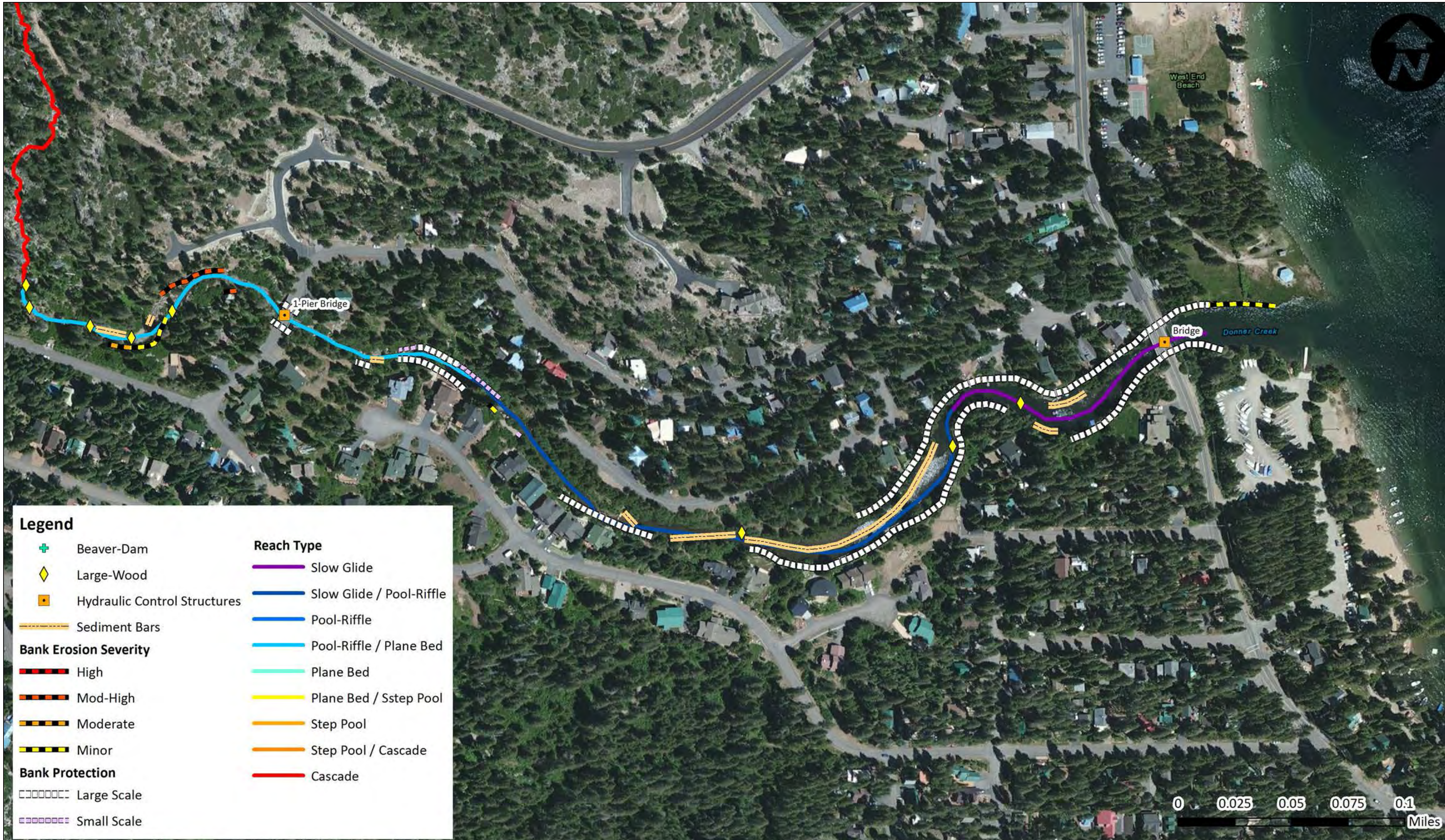
Figure 31

Notes:

Donner Basin Watershed Assessment

Fluvial audit – Gregory Creek (Panel 4)

Project No. 15-1011 | Created By: WJL | **Figure 32**



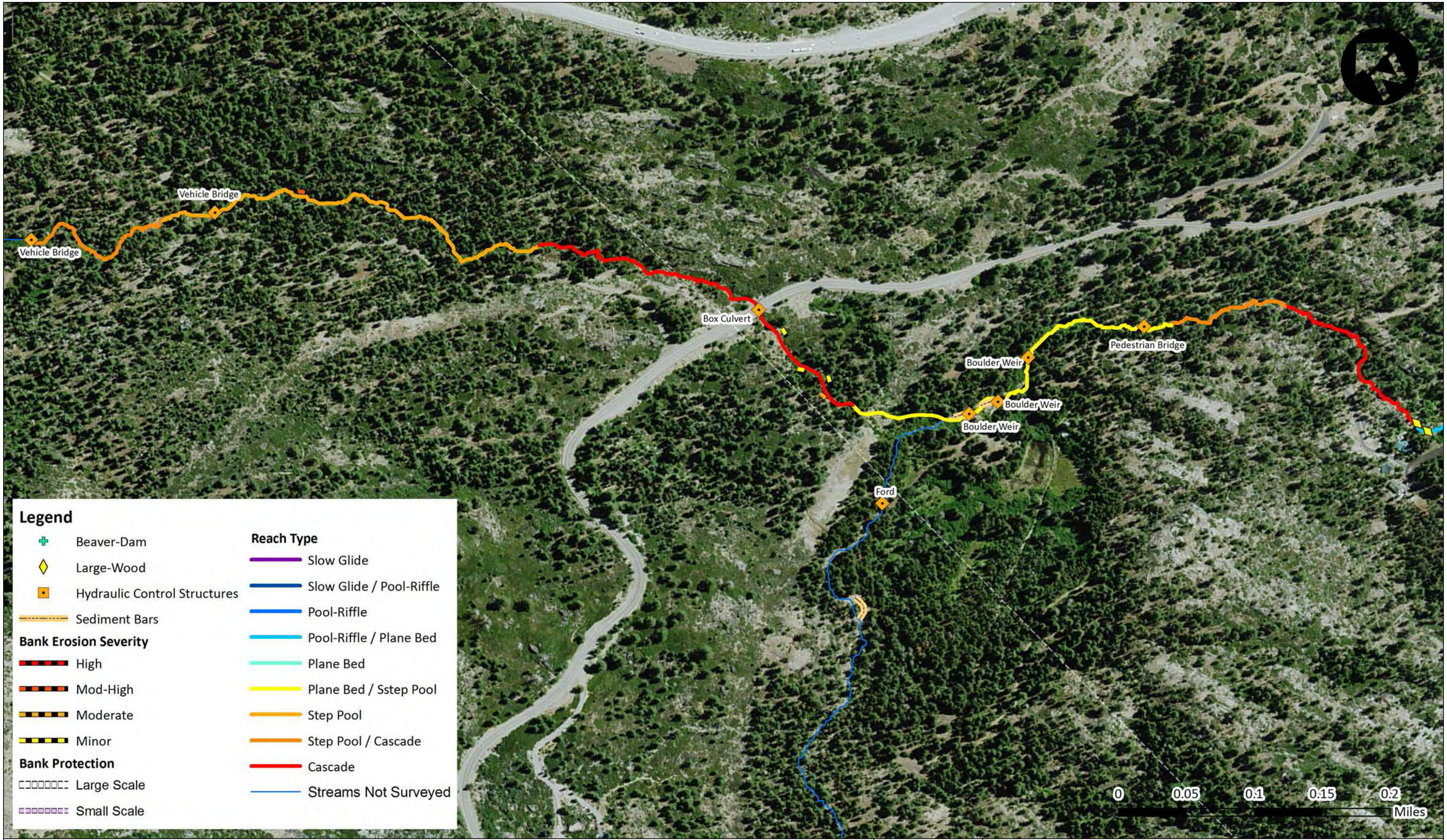
Notes:

cbec eco engineering

Donner Basin Watershed Assessment

Fluvial audit – Summit Creek (Panel 5)

Project No. 15-1011	Created By: WJL	**Figure 33**



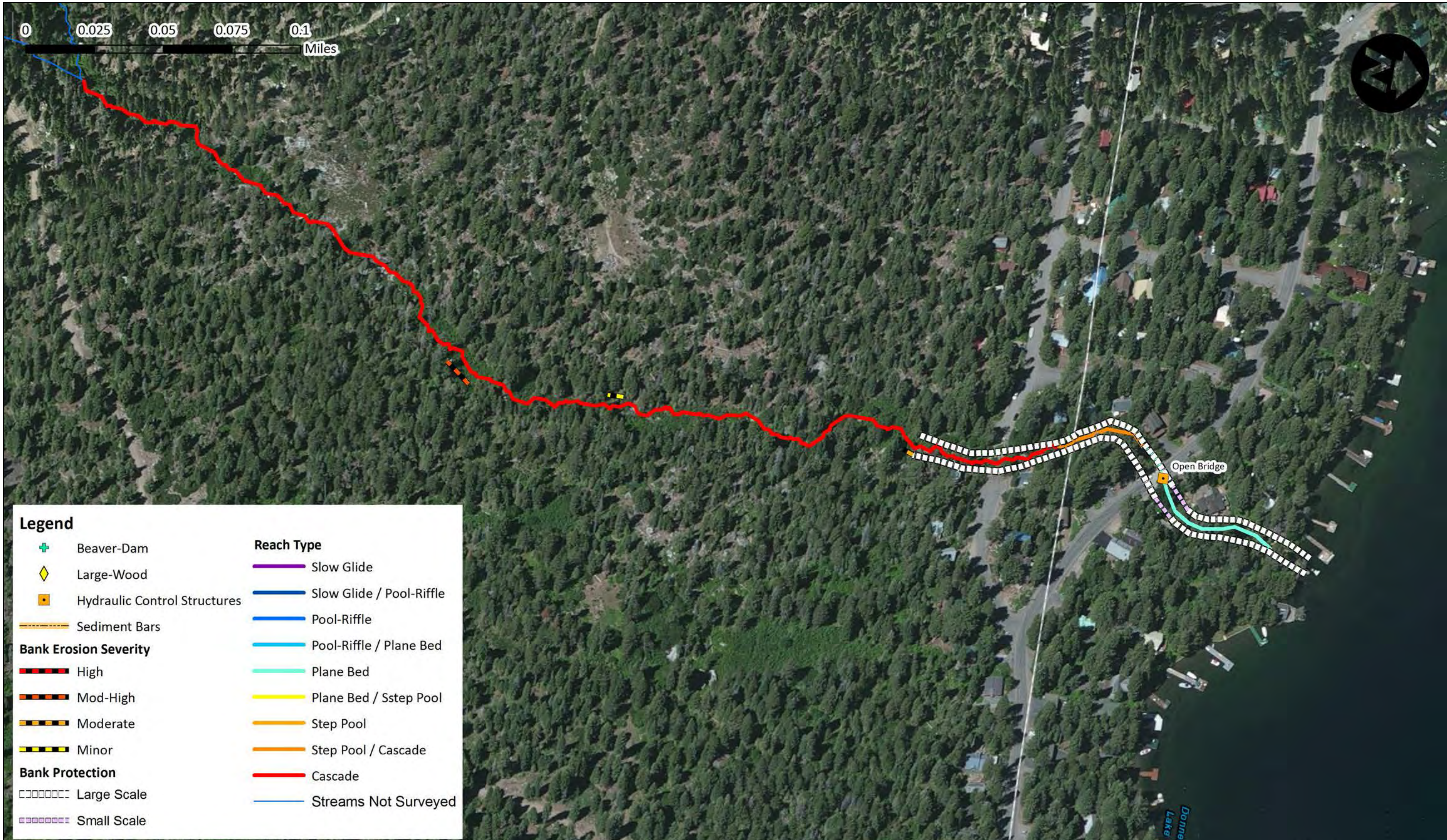
Notes:

cbec eco engineering

Donner Basin Watershed Assessment

Fluvial audit – Summit Creek (Panel 6)

Project No. 15-1011	Created By: WJL	**Figure 34**



Notes:

Donner Basin Watershed Assessment

Fluvial audit – Lakeview Creek (Panel 7)

Project No. 15-1011 | Created By: WJL

Figure 35

Notes: Railroad culvert on Donner Creek (above) and perched culvet at Cold Stream Rd Bridge (below)	cbec eco engineering	*Donner Basin Watershed Assessment* **Hydraulic control structures**		
		Project No. 15-1011	Created By: JDS	**Figure 36**

Notes: Weir above Hwy 89 crossing over Donner (above) and along Summit Creek (below)		*Donner Basin Watershed Assessment* **Constructed weirs in Donner and Summit Creeks**		
		Project No. 15-1011	Created By: JDS	**Figure 37**

Notes: Erosion down-stream of RR culvert (above) and along Hwy 89 (below)	*Donner Basin Watershed Assessment* **Bank erosion along lower Donner Creek**		
	Project No. 15-1011	Created By: JDS	**Figure 38**

Notes: Boulder rip rap and gabian baskets in Donner Creek. Examples of large scale protection.	cbec eco engineering	*Donner Basin Watershed Assessment* **Bank protection along Donner Creek**	
		Project No. 15-1011	Created By: JDS	**Figure 39**

Notes: Bar feature on Donner below Cold Creek confluence (above) and on Summit Creek (below)	cbec eco engineering	*Donner Basin Watershed Assessment* **Depositional bar features**		
		Project No. 15-1011	Created By: JDS	**Figure 40**

Notes: Beaver dam in Donner Memorial State Park (above) and alongside I-80 (below)	cbec eco engineering	*Donner Basin Watershed Assessment* **Beaver dams on Donner Creek**	
		Project No. 15-1011	Created By: JDS	**Figure 41**

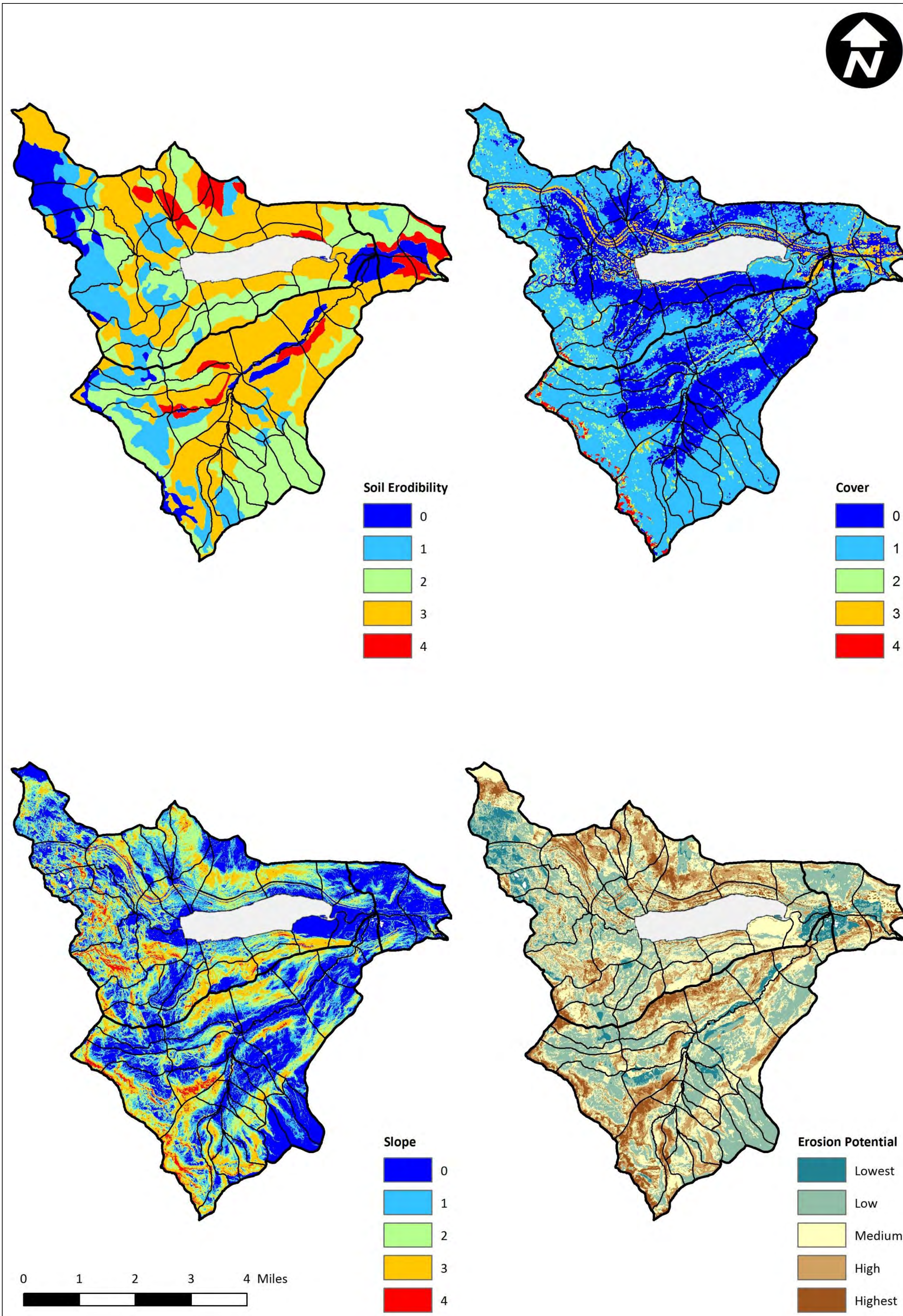
Notes: Confluence after a summer thunderstorm; high sediment load from Cold Creek	cbec eco engineering	*Donner Basin Watershed Assessment* **Donner and Cold Creeks confluence**	
		Project No. 15-1011	Created By: JDS	**Figure 42**

Notes: Hillslope erosion along Donner Lake Rd (above) and S. Shore Drive (below)	cbec eco engineering	*Donner Basin Watershed Assessment* **Roadside hillslope erosion**	
		Project No. 15-1011	Created By: JDS
			Figure 43

Notes: Confluence after a summer thunderstorm; high sediment load from Cold Creek	cbec eco engineering	*Donner Basin Watershed Assessment* **Erosion occurring from Interstate-80 stormwater**		
		Project No. 15-1011	Created By: JDS	**Figure 44**

Notes: Backcountry road erosion (above) and sediment deposition behind log (below).	cbec eco engineering	*Donner Basin Watershed Assessment* **Backcountry road erosion**		
		Project No. 15-1011	Created By: JDS	**Figure 45**

Notes: Hillslope erosion at railroad grade. View of old grade (above) and downhill (below)	cbec eco engineering	*Donner Basin Watershed Assessment* **Erosion along railroad grade**	
		Project No. 15-1011	Created By: JDS	**Figure 46**



Notes:

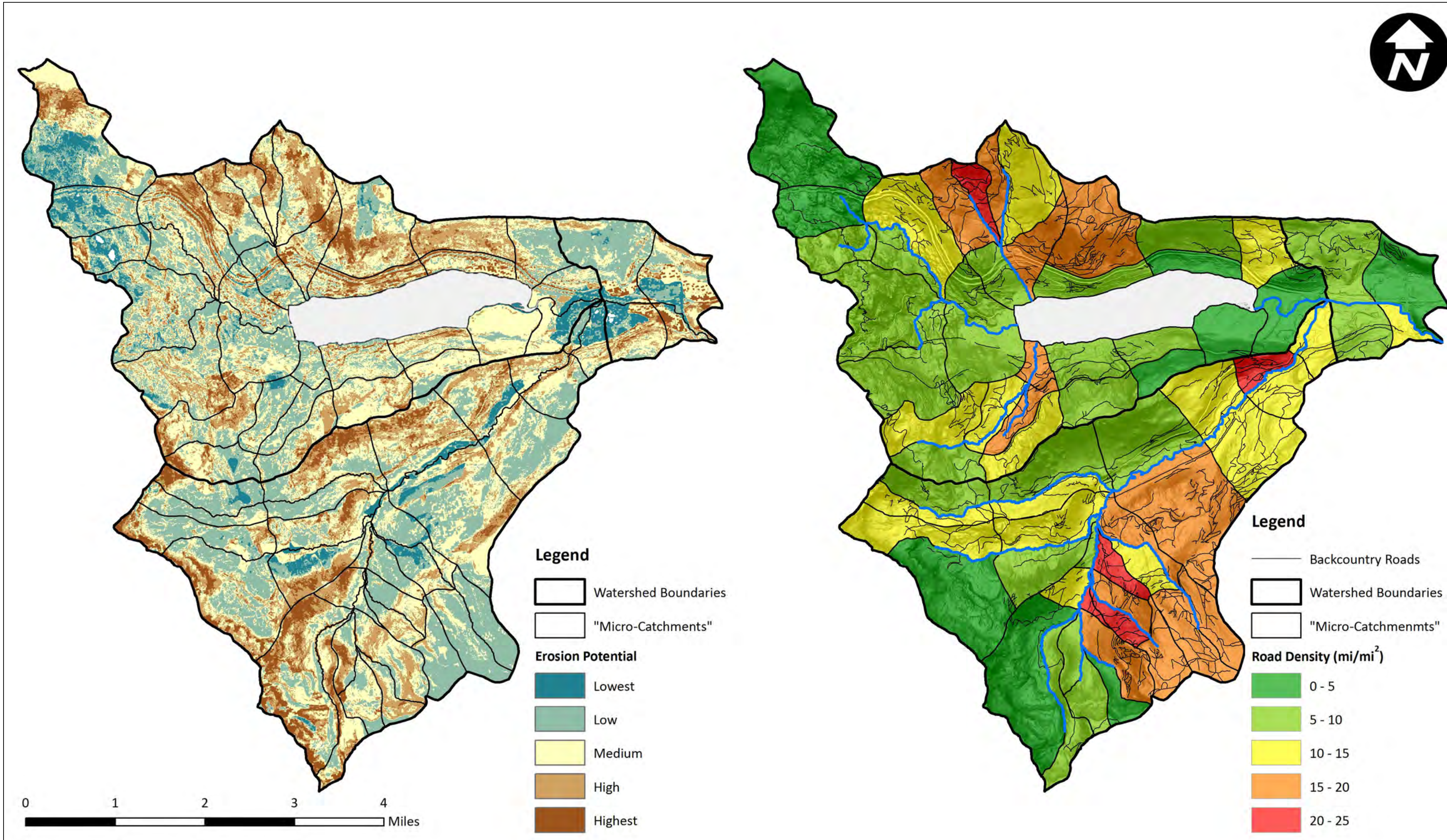
cbec eco engineering

Donner Basin Watershed Assessment

Erosion potential factors

Project No. 15-1011 | Created By: WJL

Figure 47



Notes:

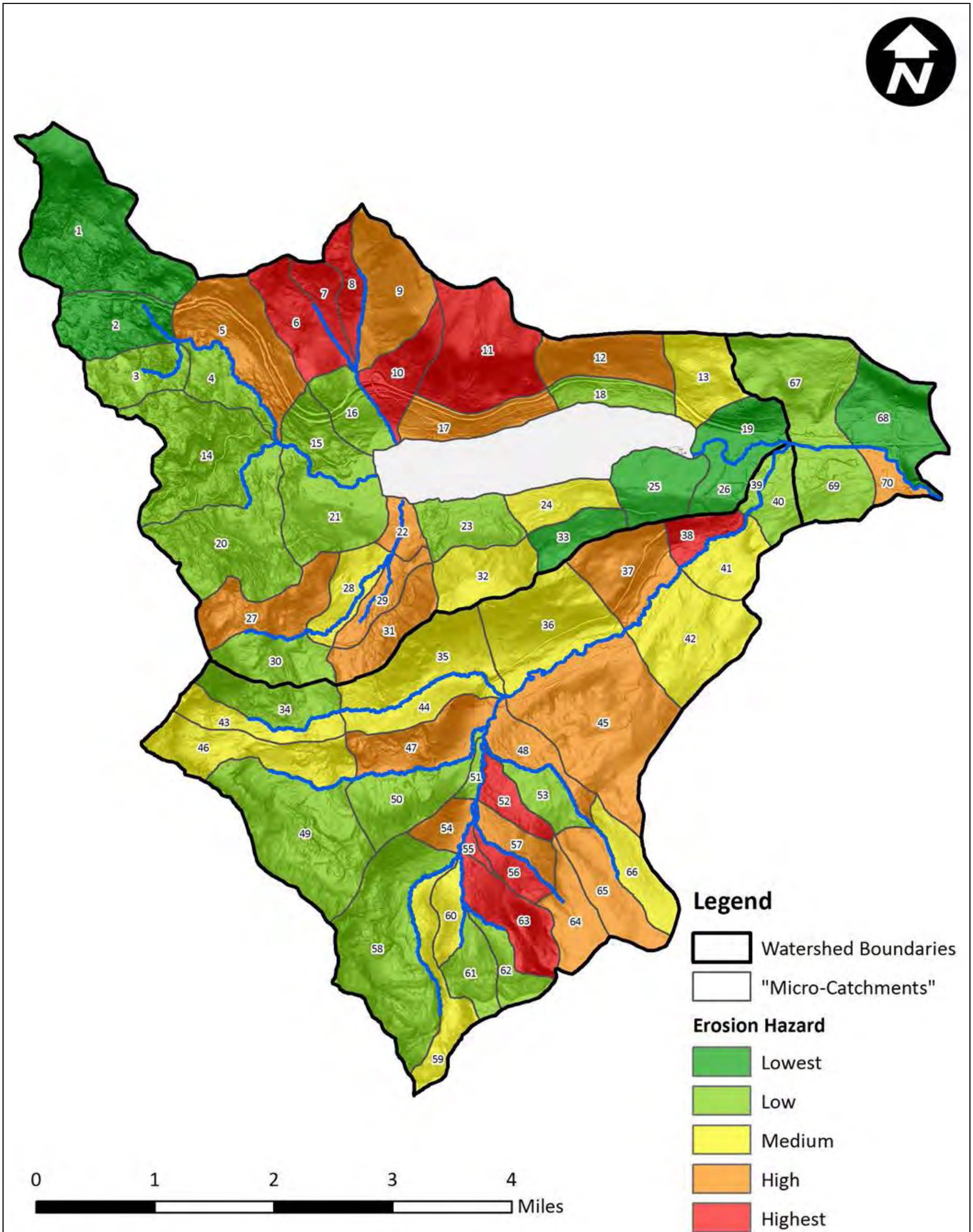
cbec eco engineering

Donner Basin Watershed Assessment

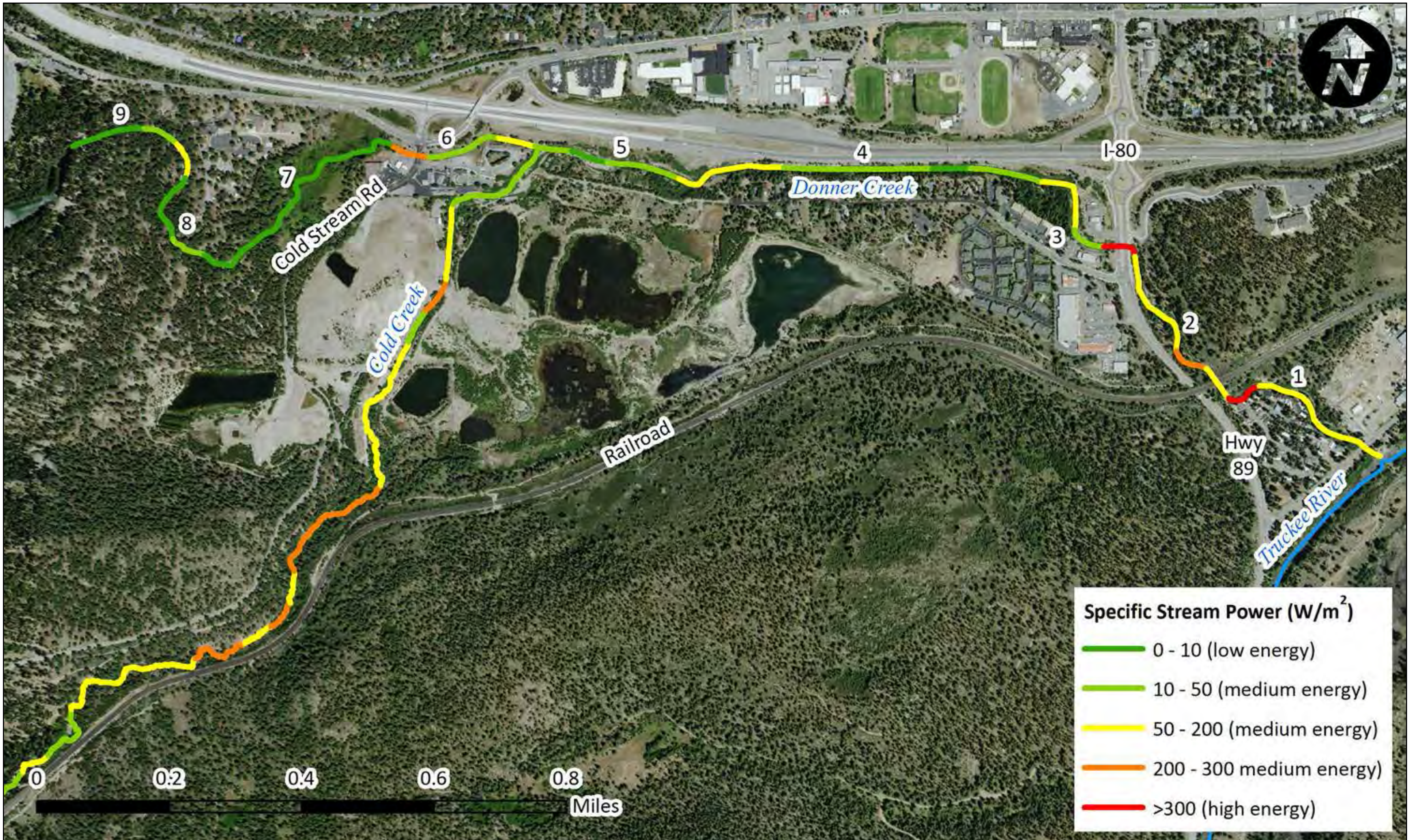
Erosion Potential

Project No. 15-1011 | Created By: WJL

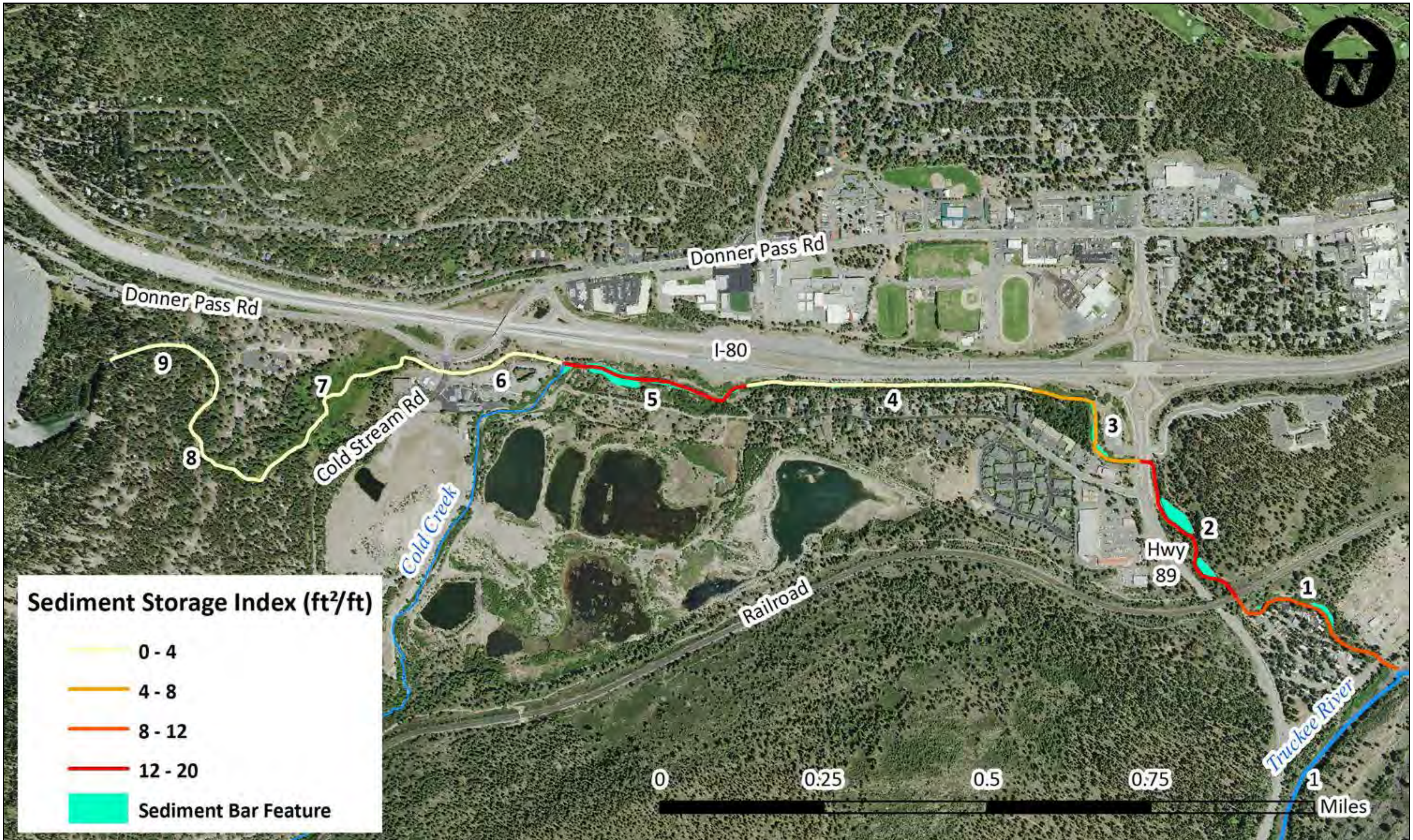
Figure 48



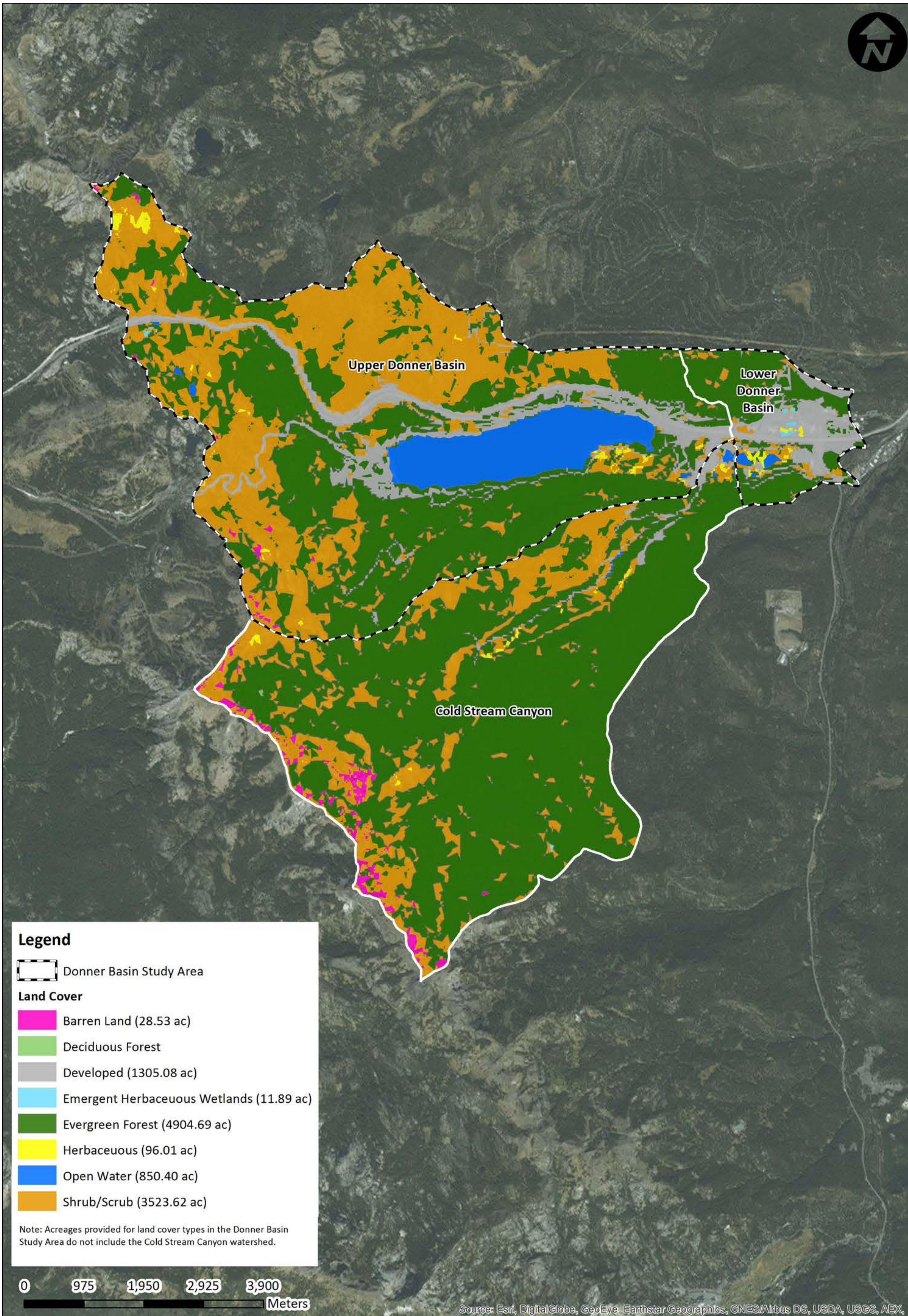
Notes:	cbec eco engineering	*Donner Basin Watershed Assessment* **Erosion hazard**	
		Project No. 15-1011	Created By: WJL	**Figure 49**



Notes:		*Donner Basin Watershed Assessment* **Specific stream power**		
		Project No. 15-1011	Created By: WJL	**Figure 50**



Notes: Sediment bar features were digitized using GPS locations and aerial imagery. Sediment storage index was calculated by summing the total area of sediment bar features within a reach and dividing by the length of the reach.	cbec eco engineering	*Donner Basin Watershed Assessment* **Sediment storage index – Donner Creek**	
		Project No. 15-1011	Created By: WJL	**Figure 51**



Notes:	cbec eco engineering / H. T. HARVEY & ASSOCIATES Ecological Consultants	*Donner Basin Watershed Assessment* **Plant communities and land cover types**		
		Project No. 15-1011	Created By: CF	**Figure 52**

Notes:

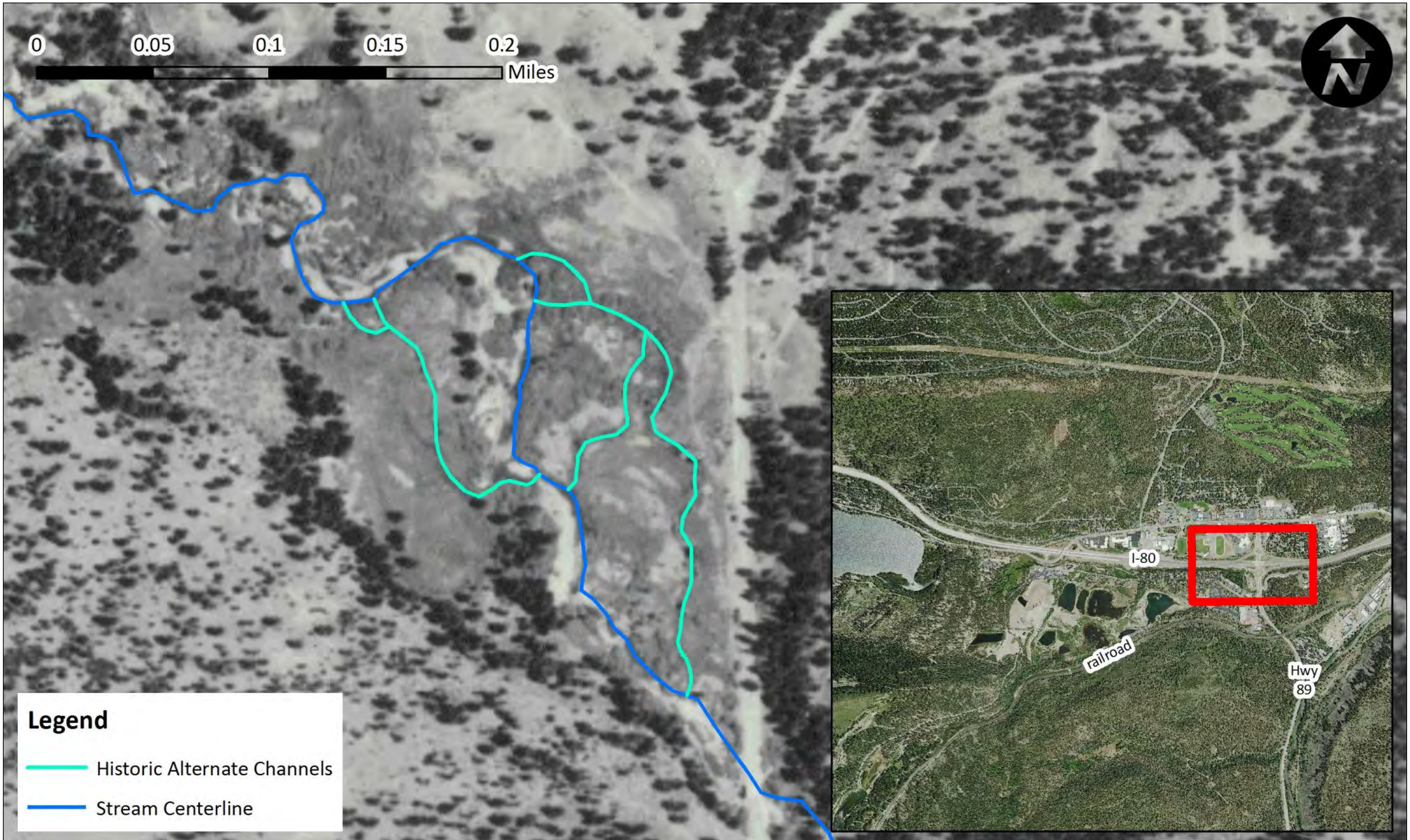
cbec eco engineering | H. T. HARVEY & ASSOCIATES Ecological Consultants

Donner Basin Watershed Assessment

Asian clam occurrence

Project No. 15-1011 | Created By: CF | **Figure 53**

Notes: Beaver dams, wet meadows and well connected floodplain in State Park	cbec eco engineering	*Donner Basin Watershed Assessment* **Reference reach at Donner Memorial State Park**
	Project No. 15-1011	Created By: JDS	**Figure 54**

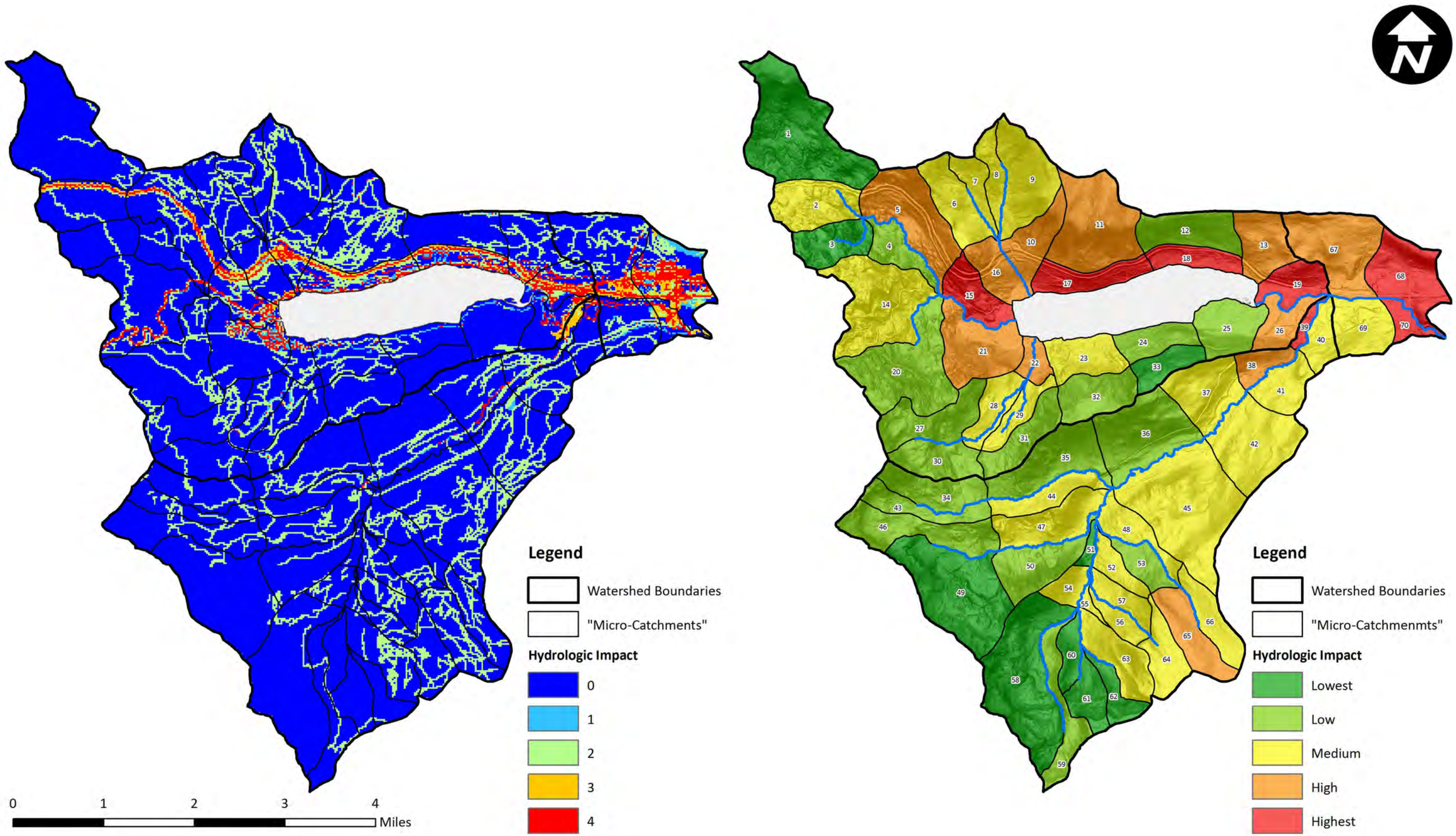


Notes: Background image is georeferenced 1939 aerial photograph

Donner Basin Watershed Assessment

Historic meadow channel threads

Project No. 15-1011	Created By: WJL	**Figure 55**



Notes:

Donner Basin Watershed Assessment

Hydrologic impact

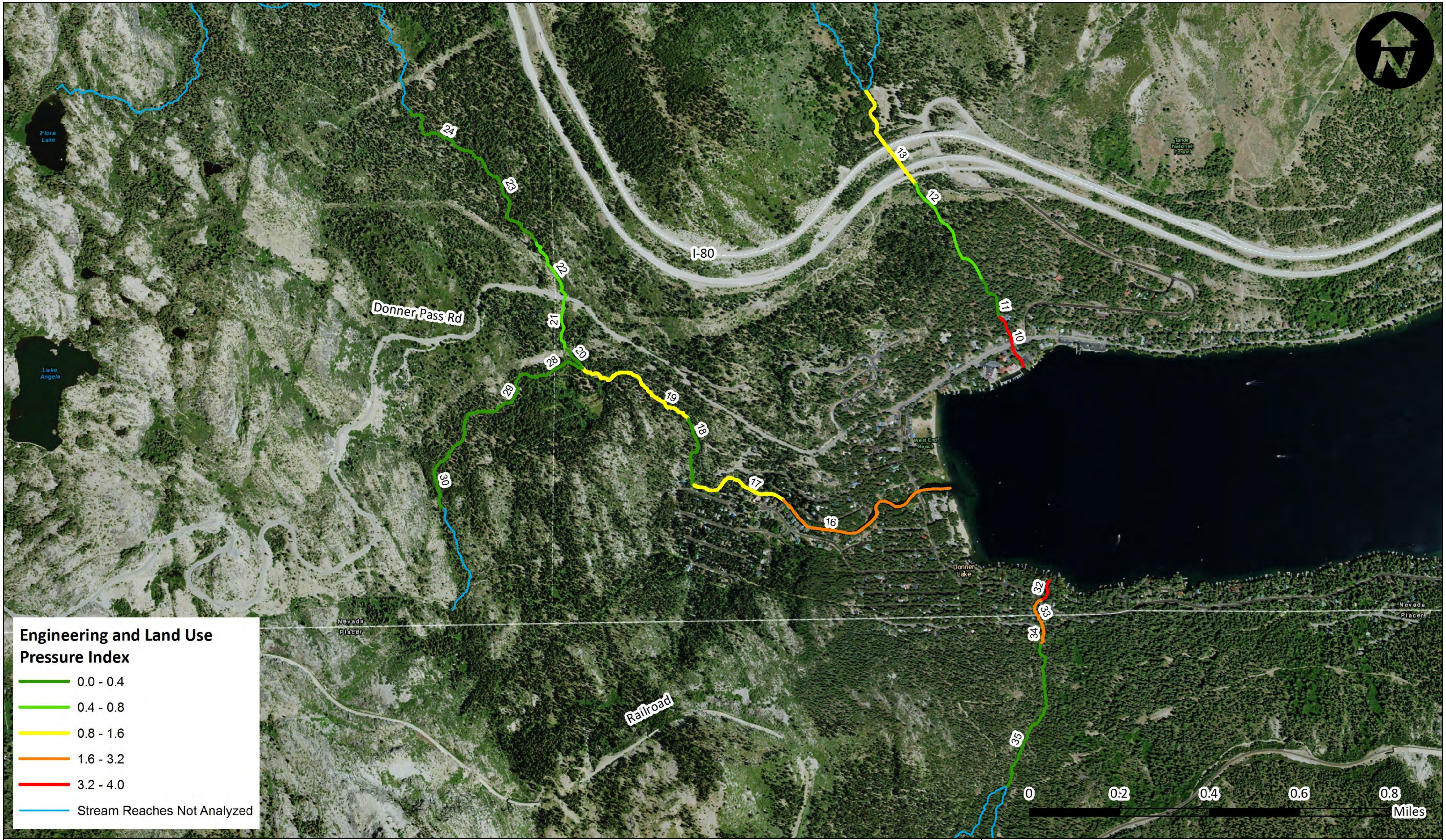
Project No. 15-1011	Created By: WJL	**Figure 56**

Notes:

Donner Basin Watershed Assessment

Engineering and Land Use Pressure Index - Donner Creek

Project No. 15-1011 | Created By: JDS | **Figure 57**



Notes:

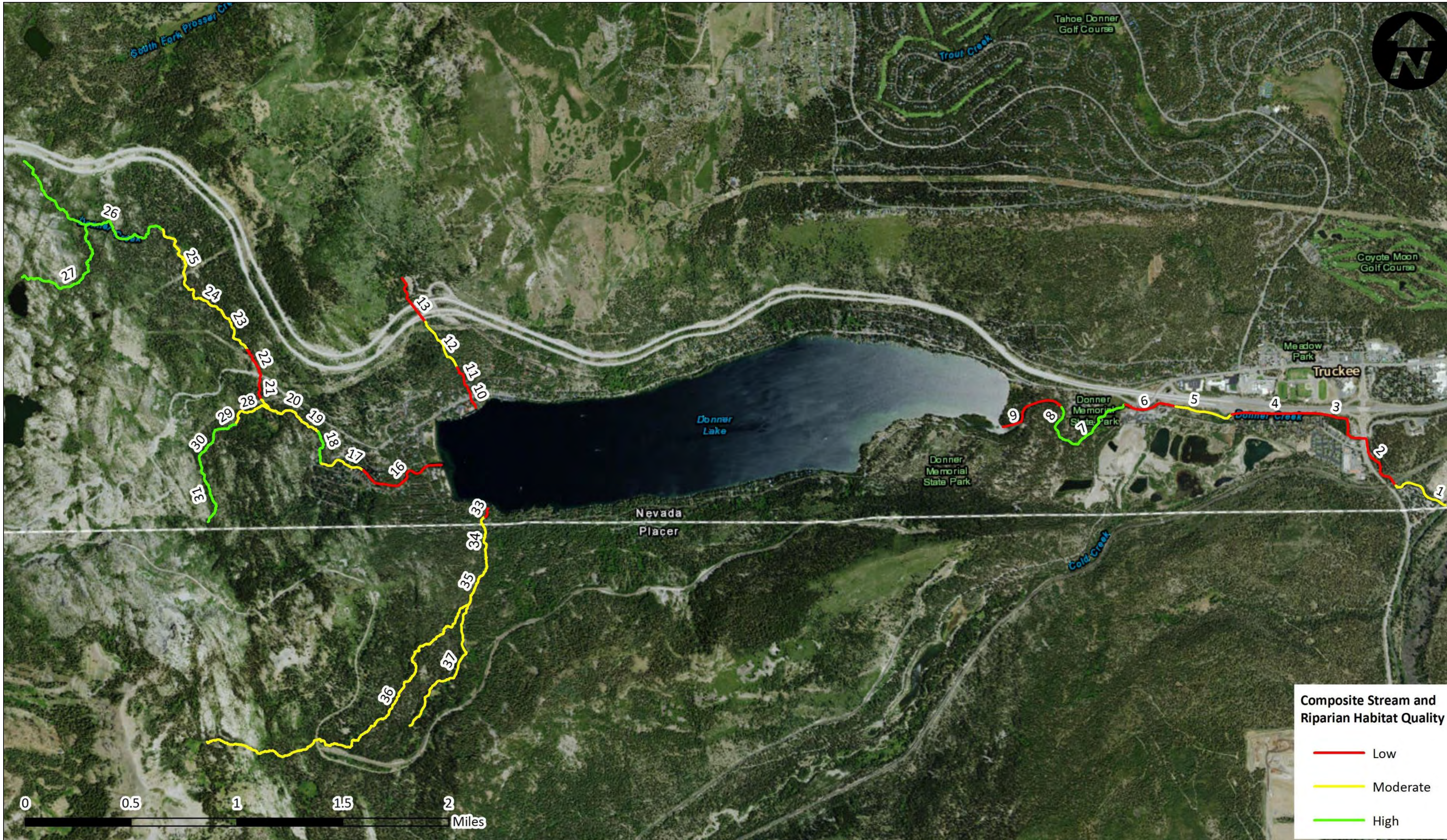
cbec eco engineering

Donner Basin Watershed Assessment

Engineering and Land Use Pressure Index - Tributaries

Project No. 15-1011 | Created By: JDS

Figure 58



Notes:

Donner Basin Watershed Assessment

Stream and riparian habitat quality

Project No. 15-1011 | Created By: WJL | **Figure 59**

cbec eco engineering — H. T. HARVEY & ASSOCIATES Ecological Consultants

Notes: Site numbers correspond to opportunities listed in Table 10. For opportunities depicted on the map with labels featuring an asterisk (*) after the site number (e.g., 52*), the site location is either one specific location for a project type that would involve multiple locations (e.g., Residential Stormwater and Erosion Treatment) or management actions that involve the full basin (e.g., Invasive Weed Inventory, Removal and Management) or a larger area within the basin (Two-Stroke Engine Phase Out on Donner Lake).

cbec eco engineering

Donner Basin Watershed Assessment

Project opportunity locations - lower watershed

Project No. 15-1011 | Created By: JDS | **Figure 60**

Notes: Site numbers correspond to opportunities listed in Table 10. For opportunities depicted on the map with labels featuring an asterisk (*) after the site number (e.g., 52*), the site location is either one specific location for a project type that would involve multiple locations (e.g., Residential Stormwater and Erosion Treatment) or management actions that involve the full basin (e.g., Invasive Weed Inventory, Removal and Management) or a larger area within the basin (Two-Stroke Engine Phase Out on Donner Lake).

Donner Basin Watershed Assessment

Project opportunity locations - full watershed

Project No. 15-1011 | Created By: JDS | **Figure 61**

APPENDIX A - LAND USE HISTORY WORKBOOK

A Note to the Reader

Appendix A provides a detailed review of the land use history and cultural resources of the Donner Basin in the form of a workbook. As a standard archaeological protocol, the workbook is developed as a standalone report, and consequently provides discussion of the physiography, geology, climate, ecology and other elements of the Donner Basin that is intended only to provide context for the cultural component of the assessment. Where redundant sections exist, the reader should refer to the text in the main body of the report.

DONNER BASIN

WATERSHED ASSESSMENT

A CONTEXTUAL OVERVIEW OF HUMAN LAND USE

AND

ENVIRONMENTAL CONDITIONS:

WORKBOOK

report prepared by

Susan Lindström, Ph.D. (RPA), Consulting Archaeologist

Truckee, California

report prepared for

cbec, inc. eco engineering

West Sacramento, California

on behalf of

TRUCKEE RIVER WATERSHED COUNCIL

Truckee, California

December 2015

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27. USGS Truckee 7.5' Quad 1955/photo revised 1969

28. USGS Norden 7.5' Quad 1955/photo revised 1979

29. Lumbering History of the Truckee River Basin 1856-1936

30. Tahoe National Forest Map (undated, hand-drawn and showing historic sawmill sites, logging railroads and timber harvest dates)

NOTE TO THE READER

Although the work book appears as an appendix to the Donner Basin Watershed Assessment, it has been prepared as a stand-alone report, which according to standard archaeological protocol, is to be filed independently with the North Central Information Center at California State University, Sacramento, an adjunct of the State Office of Historic Preservation's archaeological master data center. As such, sections pertaining to the physical environment, climate and ecology of the Donner Basin that appear in the both the main body of the document and the work book appendix may seem redundant. However, discussions of the physical environment within the work book (e.g., geology, hydrology, biology, etc.) are not intended as a substitute for the more scholarly treatment contained within the main body of the Donner Basin Watershed Assessment. Rather, topics covering the physical environment presented in the work book are to be considered as supplemental information with which to gain a better understanding of the cultural component of the physical environment.

PROJECT BACKGROUND

The Donner Basin encompasses a 29.5-square-mile watershed situated along the eastern flank of the Sierra Nevada crest that drains into the Middle Truckee River watershed. It is contained in both Placer and Nevada counties, California, and within the Town of Truckee (Figure 1). Donner Lake, which occupies the center of the watershed, is fed by several major tributaries (Gregory, Summit and Lakeview creeks), which ultimately drain into Donner Creek at its dam-regulated outlet at the east end. For over a century, the lake has served as a significant water supply reservoir for northern Nevada, as well as a recreational focus for residents and visitors.

Over the past 150 years, the Donner Basin has endured physical and ecological impacts that have negatively altered the health of the watershed's hydrology, geomorphic processes, water quality, and biological resources. Anthropogenic disturbances are associated with western migration and the development of major transportation arteries, along with natural resource exploitation involving logging, fishing, ranching and grazing, ice harvest, water reclamation, recreation, and impacts due to land and community development.

The Truckee River Watershed Council (TRWC) has initiated an assessment of the Donner Basin as part of its coordinated water management strategy in order to evaluate the watershed's natural attributes, disturbances, existing conditions, and opportunities for restoration. To accomplish this work, the TRWC has retained a multidisciplinary team led by cbec inc., eco engineering, and joined by H.T. Harvey & Associates and Susan Lindström, Ph.D., Consulting Archaeologist to evaluate the hydrology, biological resources and history of the Donner Lake Basin in an effort to better assess prior and on-going impacts to its water quality and habitat. Human beings are a significant component of the Donner Basin watershed ecosystem and the watershed has had a long period of human occupation, beginning with use by the Washoe Tribe and their prehistoric ancestors. Watershed restoration efforts can benefit from an understanding of the long-term ecological role of aboriginal peoples, as well as historical Euro-American populations, in the dynamics of wild plant and animal populations and alterations of the physical environment. Interdisciplinary science team collaboration is a productive means to explore the direct link between culture history and contemporary project design and implementation in order to provide the science and policy information needed to establish a baseline to direct restoration and protection projects within the watershed.

As part of this multidisciplinary study, readily available archaeological, ethnographic and historic background data have been assembled in order to assist project planners in assessing potential restoration opportunities and constraints attendant to any alteration of the existing hydrological condition in the Donner Lake Basin. This report presents a contextual history of human land use and past environmental conditions that can be used as an independent and corroborative tool to document human disturbances and link these historic conditions to contemporary environmental restoration and protection efforts. This document also identifies the relative sensitivity of lands potentially targeted for watershed restoration improvements with regards to prehistoric and historic archaeological sites and Native American and Euroamerican traditional cultural properties. Data are compiled into a "work book" format, in anticipation that additional archival and field research will follow.


Upper Donner Basin
Town of Truckee
Lower Donner Basin
Donner Lake
Donner Creek
Summit Creek
Lakeview Creek
Cold Creek
South Fork Cold Creek
Truckee River
Coldstream Canyon
Legend
Complete Donner Basin
Donner Basin subwatersheds
0 0.5 1 1.5 2
Miles
Notes: Subwatersheds delineated using NHD Plus HUC 16 data.
cbec
Donner Basin Assessment
Donner Basin overview
Project No. 15-1011
Created By: WJL
Figure 1

The work book begins as a historical narrative, followed by appendices including: (1) Native American correspondence; (2) a summary time line of human history; (3) relevant notes from the 1865-1866 General Land Office field survey keyed to the survey plats; (4) meanders of "Lake Donner"' (5) a detailed summary of human land uses (drawn from Lindström's research as part of a 1984 State Lands Commission study); (6) historical maps; and (7) historical photographs. Findings presented in this work book are preliminary. Field archaeological surveys will be conducted as part of restoration design and environmental review (CEQA, NEPA).

DATA SOURCES AND CONTACTS

Research for the Donner Lake Basin Watershed Assessment was conducted by Susan Lindström, Ph.D. Lindström meets the Secretary of Interior's Professional Qualifications Standards in archaeology, history and related disciplines (48 FR 44738-44739). She has 42 years of professional experience in regional prehistory and history, holds a doctoral degree in anthropology/archaeology and has maintained certification by the Register of Professional Archaeologists (formerly Society of Professional Archaeologists) since 1982.

Prior work within and adjacent to the Donner Lake Basin indicates that it is highly sensitive to contain heritage resources. Zones of greatest sensitivity fall along the Donner Lake shoreline and Donner Pass, within upland forest-valley meadow ecotones, on knolls and elevated points at meadow margins and wet meadows, within boulder rock out-croppings, and on flats near streams and other water sources. Areas of lower sensitivity comprise the moderate to steep forested slopes.

- The west and east ends of the lake in particular, as well as the Summit Creek corridor leading over Donner Pass, contain Native American sites marked by prehistoric flaked stone and milling feature complexes and petroglyphs.

- The Truckee Route of the Emigrant Trail (1844-1852) passes along the south side of the lake within the corridor of Donner Pass Road.

- Donner Pass Road also marks the route of the Dutch Flat and Donner Lake Wagon Road (1864-1913), the Lincoln Highway (1913-1925), the Victory Highway ca. (1921-1927), and U.S. 40 (1927-1956). Interstate-80 (ca. 1960) traverses the north slope above the lake, descending down into the Donner Creek floodplain.

- The route of the first transcontinental railroad contours along the south slope above Donner Lake and Chinese railroad construction camps (dating from the mid 1860s) accompany its alignment, especially in the vicinity of Donner Pass. The railroad, Emigrant Trail, Lincoln Highway, Victory Highway, and U.S. 40 all represent the first transcontinental routes for their respective time periods.

- Donner Pass also serves as a major communications corridor, being the location of the first transcontinental telegraph line, and subsequent telephone and power lines. A buried fiber-optic cable and petroleum pipeline also traverse the pass.

- Donner Lake is a historic reservoir with initial damming for water reclamation dating from the 1870s and again in1889.

- Glacial outwash gravels below Donner Lake have been mined for decades.
- Ice was harvested from both its east and west ends.
- During the late 19th century, the lake supported a commercial fishery and a fish hatchery was located at its east end, where stock was later grazed in the adjoining meadowlands.
- The long-standing transportation corridor along the north side of Donner Lake brought automobile parties for summer camping on its shores and small resorts were established.
- Subdivision development began soon after the turn of the 19th-20th centuries, with escalated building beginning after World War II.
- The Department of Parks and Recreation operates Donner State Park at the lake's east end, one of the most visited parks in the California parks system.

RESEARCH ARCHIVES AND CONTACTS

Research involved a broad-based literature survey of pertinent historic and prehistoric themes and a selective review of prior regional archaeological investigations to assess the overall archaeological sensitivity of the study area. Results disclosed that portions of the project area have been subject to prior archaeological study and a number of archaeological sites have been recorded. A comprehensive site inventory awaits a formal records search at the master data center located at the North Central Information Center of the California Historical Resources Information System, an adjunct of the State Office of Historic Preservation, California State University, Sacramento. This records search, a task that is outside the scope of the current study, would be completed in advance of specific restoration projects.

The contextual discussion presented in the report text and accompanying appendices is drawn from the existing literature, supplemented by personal notes and experience. Over 40 years of miscellaneous research compiled by Lindström and involving the Donner Basin watershed was cursorily reviewed and more focused studies regarding the Donner Lake Basin were consulted, e.g., Lindstrom's Ph.D. dissertation on fisheries of the Truckee River Drainage, research notes in the 1984 California State Lands Commission court case regarding the navigability of Donner Lake (appendices 2 and 6), archaeological work in the aftermath of the 1999 Santa Fe Pipeline jet fuel spill at the headwaters of Summit Creek, and SCUBA studies concerning submerged tree stumps and lake level changes, etc. (Appendix 5). This overview is far from exhaustive and data are uneven. Mostly assembled at an earlier time and for a different purpose, information has been adapted to fit into the Donner Lake Basin assessment framework.

A number of other sources were reviewed to include historic documents, photographs and maps on file in the consultant’s personal library. Referenced maps appear in Appendix 7 and include: early surveys (Degroot's Map of Nevada Territory 1863, General Land Office 1865-1866, Map of the Placerville Route 1867-1868, maps of the California Geological Survey 1870, Von

Leicht and Hoffman 1874, and Wheeler 1876-1877); county maps (Nevada County 1880 and 1913, Placer County 1887); USGS quadrangles (1889, 1889/1897, 1940/1946, 1940/1951); Truckee and Donner Pass 15' Quad (1955); Truckee and Norden 7.5' quads (1955, 1969, 1979); U.S. Forest Service maps (1911, 1921, 1930, 1962); Metsker's Map of Nevada County (ca. 1938); and miscellaneous maps showing historic saw mills by Knowles (1942) and the Tahoe National Forest (undated) and early maps by the Donner Lake Development Company (1948), State of California (1974), the Santa Fe Pacific Pipeline (ca. 1957-1993), and the Truckee Donner Public Utility District (ca. 2001). In addition, general local and state histories, regional inventories, miscellaneous unpublished manuscripts, and newspaper articles were examined. Other resources are listed in the references cited section at the end of this report.

Karl Casperson, Land Surveys, U. S. Forest Service, Tahoe National Forest was visited on May 11, 2015 and the General Land Office Field Notes on file in Nevada City were reviewed. Files are summarized in appendices 3 and 4 and include:

- "Transcript of the Field Notes of the Survey of the Subdivision Lines of Township 17 North, Range 15 East, Mount Diablo Meridian, California as executed by James E. Freemen, Deputy Surveyor under contract of June 21, 1866."
- "Transcript of the Field Notes of the Survey of the Subdivision Lines of Township 17 North, Range 16 East, Mount Diablo Meridian, California as executed by E. Dyer, Deputy Surveyor, commenced August 31, 1865, completed September 9, 1865."
- "Field Notes of Exterior North and West Boundary Lines of Township 17 North, Range 16 Mt. Diablo Meridian as executed by El Dyer, Deputy Surveyor, under his contract of May 24, 1865."

Cursory research into the files of the Truckee Donner Historical Society was conducted periodically between May and July 2015 in order to locate pertinent historical photographs, maps, aerial photographs, oral histories, newspaper accounts, and other unpublished resources.

Early-period photos (1865-1869) appearing in Appendix 8 are credited to: Alfred L. Hart, artist and official photographer for the Central Pacific Railroad 1869 (Kibbey 1996:63); the Mead Kibbey Collection; the Leon Schegg Collection; and the Truckee Donner Historical Society.

NATIVE AMERICAN CONSULTATION

Prior ethnographic studies indicate that the Washoe and possibly the Nisenan (Southern Maidu) are the applicable tribal authorities for lands encompassing the project area. Accordingly, Darrel Cruz, Tribal Historic Preservation Officer (THPO) for the Washoe Tribe of Nevada and California, and April Moore, Nisenan Native American Consultant, were contacted on August 14th and 28th (respectively) in order to incorporate opinions, knowledge and sentiments regarding traditional Native American lands within the study area (Appendix 1). Project background information, location maps and archaeological survey results were mailed. While no project-specific concerns have yet been identified, it is anticipated that both groups emphasize the traditional importance of the Donner Lake Basin and the need to protect and preserve all Native American archaeological sites.

SETTING

PHYSICAL ENVIRONMENT

Topography

Donner Lake occupies a glacial basin lying due east of the crest of the main Sierra Nevada at an elevation of nearly 6,000 feet. Its ordinary water surface is about 2½ miles long by ½ mile wide. The lake drains through a single outlet on its east end that is emptied by Donner Creek. The Donner Lake glacial basin extends eastward beyond the limits of the lake as a valley and joins the Truckee River drainage basin near the town of Truckee. Surrounding uplands crest westward to Donner Pass and along the northern base of Donner Peak (formerly known as Crested Peak and shown on Alfred Hart's image #253, Kibbey 1996).

The geographic setting of the study area, along with the dramatic and spectacular views from Donner Pass (Photo 1), have undoubtedly had important implications for both Native American and Euroamerican land use here.

As noted by Lindstrom (1978), the northern Sierra (i.e., Tahoe Sierra) is set apart from the central and southern Sierra by a broader and more broken crest zone. Throughout time, the relatively gentler terrain, enhanced by resource-rich upland catchments, has both enabled and encouraged trans-Sierran contact through the strategic Donner Pass transportation corridor between people from its respective flanks. The Washoe have a tradition of making long treks across Tahoe Sierran passes for the purpose of hunting, trading, visiting and gathering acorns. These aboriginal trek routes, patterned after game trails, are often the precursors of historic and modern road systems.

At just over 7,000 feet, historically Donner Pass was charted as the most feasible crossing of the Sierra Nevada. The first emigrant wagon party to cross the Sierra Nevada passed through Washoe territory by way of the Truckee and Tahoe basins. Early travel through this corridor paved the way for a series of major trans-sierran travelways, including the first transcontinental railroad and the first transcontinental highway. As George Stewart (1964:58-59) wrote:

> …the keynote for the whole area has been transportation. Out of the opportunity to cross the mountains at this point, the whole history of the region has developed. Thus, also, it remains.

Geology

The geology, as mapped on the 1965 California Division of Mines and Geology, Chico Sheet, shows the Donner Pass area to be in units of Mesozoic granitic rocks and Tertiary volcanic pyroclastic rocks associated with localized faulting. Birkeland (1963, l964) has also described the Quaternary geology of the Truckee-Tahoe area. More recently and prior to 40,000 years ago, Pleistocene trunk glaciers flowed down Donner Pass into the Donner Lake Basin on the east and into the South Yuba River drainage on the west, sculpting the terrain into its present form. Holocene glaciation within the past l0,000 years was limited to the advance of small cirque glaciers along the sierran crest. Moraines and glacial outwash are remnants of these events. Soils are derived from volcanic, granitic and andesitic rock, from glacial till, and from mixed alluvium.

This glacial landscape presented both opportunities and constraints to human populations. While the smooth granite domes and low-angle benches provided a desirable substrate for the creation of prehistoric rock art, the steep-sided cirque basins, such as the one at the head of Donner Pass, with its high, stepped benches and boulder-strewn draws, made passage by the first Euroamerican emigrants nearly impossible.

Flora and Fauna

The study area lies within Storer and Usinger's (l97l) Subalpine Belt. Slopes are currently forested with western white pine (*Pinus monticola*), Jeffrey pine (*P. jeffreyi*), red fir (*Abies magnifica*), and mountain hemlock (*Tsuga mertensiana*). Rocky, drier areas are dominated by shrub species such as pinemat manzanita (*Arctostaphylos nevadensis*), chokecherry (*Prunus emarginata*), gooseberry/currant (*Ribes* spp.), huckleberry oak (*Quercus vaccinifolia*), and mules ears (*Wyethia* spp.). Gregory, Summit and Lakeview creeks drain the study area. A number of perennial springs flow from the northern slopes of the Donner Lake Basin, many of which were tapped to supply water to the growing community of Truckee. Small wetlands, support a luxuriant growth of willows (*Salix* spp.), grasses (*Carex* spp.), forbs, and red mountain heather (*Phyllodoce breweri*). Typical fauna associated with these plant communities include mule deer (*Odocoileus hemionus*) and black bear (*Ursus americanus*), along with numerous small mammals.

The ethnographic and historic records suggests that during the mild season, small groups traveled through high mountain valleys collecting edible and medicinal roots, seeds, and marsh plants. However, contemporary plant and animal communities may not closely resemble their pristine counterparts. Many plants and animals were of economic importance to early inhabitants. Native bunchgrasses, whose nutritious seeds were once an important staple for Native Americans, have been replaced by unpalatable introduced species. In the higher elevations and along mountain passes such as Donner, men hunted large game (mountain sheep, antelope and deer) and trapped smaller mammals. The presence of petroglyphs on Donner Pass may substantiate prehistoric hunting activities here.

Truckee River Fishery

The modern Truckee River fishery (including Donner Lake and its tributaries) is unremarkable, being sustained primarily by an extensive program of planting non-native species. Yet, the biological and paleoenvironmenal record suggest that the Truckee River fishery was once an exceedingly productive, reliable and well-timed resource that was available throughout the period of human history (nearly 10,000 years). Species native to the Donner Basin include Lahontan cutthroat trout (*Salmo clarki henshawi*), Tahoe sucker (*Catostomus tahoensis*), mountain sucker (*C. platyrhynchus*), mountain whitefish (*Prosopium williamsoni*), tui chub (*Gila bicolor*), Lahontan redside (*Richardsonius egregius*), Paiute sculpin (*Cottus beldingi*), and speckled dace (*Rhinichthys osculus*). Their collective life histories are summarized in Lindström (1992, 1996).

Comments on the bountiful fishery found their way into numerous historic-period writings. Historic accounts focused on larger bodies of water such as lakes Tahoe and Pyramid, but catches in Donner Lake are also noteworthy. For example:

> ...a 19 lb. trout is shown at [Donner Lake) Sisson Wallace and Company. [*Truckee Republican* 4/28/1877]

> DeQuille (1877:421; 1889:129) observed that Donner Lake was "...full of trout of the same species as are found in Lake Tahoe, with minnows of several kinds, known as chubs and whitefish."

> Dave and Charlie Cabona, two fishermen, caught 46 pounds of trout in Donner Creek last Saturday. [*Truckee Republican* 4/5/1905]

> DeQuille (1877:413, 421) noted the "...fine trout fishing in all the brooks near the Sierran Summit... [with an]...abundance of trout in the small brooks putting down from the mountains."

It should be noted, however, that the harvest of large numbers of large fish during historic times may have been biased by an overrepresentation of old and large adults relative to smaller juvenile populations, in part due to the construction of dams (such as the one on Donner Creek) that obstructed spawning runs and caused the unnatural congregation of spawning fish (Lindström 1992, 1996).

A commercial fishery thrived from 1860 until 1917, supplying local towns and mining camps and markets as far east as Chicago. The enormously productive fishery of the Truckee River drainage was blithely regarded as inexhaustible and the superabundant fish resource was pillaged by commercial over-fishing using wasteful methods (e.g., poison, traps, dams, nets, grab hoods, and even dynamite). The fishery was further annihilated by pollution, dams obstructing spawning runs, and by the introduction of non-native sport fishery. By 1929 cutthroat trout could not migrate up the Truckee River and by 1938 the Tahoe strains of cutthroat trout were extinct. Efforts to restore the native Lahontan cutthroat fishery in the middle and upper reaches of the drainage have been unsuccessful.

Paleoenvironment

Paleoenvironmental data (including issues related to landscape evolution, drought, floods, and changing fire regimes) enhance an understanding of the frequencies, durations, magnitudes and rates of climatic change and the environmental responses to these changes. The findings may be used to derive predictions regarding the possible paths that the ecosystem may take in the future, under given scenarios of future climate and the impacts of anthropogenic activities and how to anticipate these changes in restoration planning for the Donner Lake Basin.

A three-part model of climatic change for the 10,000-year Holocene period (Antevs 1925) subdivides the period into the cool-moist Early Holocene, the hot-dry Middle Holocene and the cool-moist Late Holocene. Changing aspects of the natural environment, which were of special importance to human populations inhabiting the Tahoe Sierra during the last 9000 years, are summarized below (after Lindström et al. 2000:24-34).

Early Holocene (10,000-7000 BP)

During the Late Pleistocene, more than 13,000 years before present (BP), glaciers occupied much of the Sierra Nevada and Carson Range, and a vast pluvial lake (known as Lake Lahontan) flooded much of the western Great Basin. By the Early Holocene, 10,000-7000 years BP, warming and drying caused glaciers to melt and Lake Lahontan to shrink. Although climates were relatively cool and moist, compared to those of today, they were considerably warmer than those of the Late Pleistocene. Winter dominance of precipitation, which had characterized the Late Pleistocene, continued during the Early Holocene. With the final arrival of montane woodland at higher elevations, sparse human populations entered the region and engaged in a highly mobile foraging economy based on large game hunting

Middle Holocene (7000-4000 BP)

The Early Holocene was followed by a much warmer and dryer Middle Holocene period from about 7000-4000 BP, which caused the final desiccation of many lakes in the western Great Basin and the retreat of montane and semi-arid woodlands to elevations higher than those at which they are currently found. Locally, the water level of Lakes Tahoe and Pyramid declined, but were among the few that did not dry up completely. Middle Holocene aridity in the Tahoe Sierra is further documented by the remains of submerged tree stumps, which stand rooted on the floor of Lake Tahoe, as deep as 20 feet below its present surface. These ancient drowned forests date from between 6300-4800 BP (Lindström 1990, 1997). Shallowly submerged prehistoric milling features (bedrock mortars) occur lake-wide and may date from this and/or subsequent droughts. About 5500 BP the harshest period of Middle Holocene drought came to an abrupt end, as manifest by the drowned shore-side forests at Lake Tahoe. During this period, prehistoric populations increasingly exerted their influence in altering the landscape and affecting fauna and flora. Archaeological evidence indicates a gradual decrease in overall residential mobility, greater land-use diversity, a broadened diet, and intensified use of plant resources.

Late Holocene (4000 BP to present)

The Late Holocene record appears to be punctuated by alternating intervals of cool-moist and warm-dry periods. More intensive human use of the Tahoe Sierra occurred during this period, as increasing populations of mixed-mode foragers-collectors ventured into the highlands on seasonal gathering, fishing, and hunting forays.

<u>Neoglacial Period (4000-2000 BP)</u>. Climates became cooler and moister initiating the Neoglacial (or Neopluvial) period that lasted for the next 2000 years. Climates reached their Late Holocene cool-moist climax by 4000 BP causing the rebirth of many Great Basin lakes, the growth of marshes, and, apparently, minor glacial advances in the Sierra.

<u>Drought Intervals</u>. A dry interval seems to have persisted from 2200-l600 BP. Relatively dry conditions continued, with summer-shifted rainfall and less severe winters between 1600 and 1200 BP. This time is characterized by strong swings between very wet periods and very dry periods. Wet cycles allowed significant expansion of single-leaf pine into the semi-arid woodlands east of Lake Tahoe, with forests becoming more densely packed. Dry times appear to have coincided with a rise in fire frequency in the montane woodlands in the Carson Range, an event linked with increased slope erosion and channel filling in the central Great Basin. After 1200 BP increasingly drier conditions caused the retreat of both semi-arid and montane woodlands. There is evidence of gradual drying from 1345-1145 BP, as trees grew on Ralston Ridge Bog south of Lake Tahoe due to low water tables. Analysis of a number of ancient woodrat nests (middens), recovered from the upper walls and ceiling of the cave at Cave Rock along Tahoe's southeastern shore, dated

at about 1360 BP, reveal the increasingly warm dry conditions that represented the beginning of the much drier period than has characterized the last millennium (Lindström et al. 1998). However, the occurrence of a brief wet interval around 1100 years ago is suggested by the presence of buried A-horizon soils in association with a sand lens near Taylor Creek, indicating a rise in the level of Lake Tahoe and deposition of lake deposits as sand (Lindströ 1985).

A period of intense drought occurred from 1100-900 BP (AD 900-1100). Relict Jeffrey pine stumps, rooted in the Walker River stream bed, date to 920 BP (AD 1030) and 660 BP (AD 1290). Submerged stumps along the Walker Lake shorelands also yielded carbon-14 ages of 980 BP.

Intense drought returned again around 700-500 BP (AD 1300-1500). The relationship between tree growth and stream flow in the upper Truckee River watershed indicates that intermittent drought conditions prevailed around 675 BP (AD 1275; Hardman and Reil 1936). Relict Jeffrey pine stumps, rooted in the Walker River stream bed, date to 660 BP (AD 1290) (Stine 1994). Evidence of a dry period around 690 BP (AD 1260) is provided by a series of deeply submerged tree stumps in Independence Lake north of Truckee (Lindström 1997; Lindström and Bloomer 1994).

In addition, 11 submerged tree stumps have been inventoried up to 30 feet below the present day level of Donner Lake near Truckee (see Appendix 5; Photo 2a and 2b); carbon-14 samples from one stump date from 490 BP (AD 1433) and 460 BP (AD 1490) (Lindström 1997; Lindström and Bloomer 1994).

Another warm period, documented by reduced Truckee River run-off and the relatively narrow tree rings of pines growing in proximity to the river (Hardman and Reil 1936), is dated between 371-365 BP (AD 1579-1585), and again around 320 BP (AD 1630) (Hardman and Reil 1936). A dated woodrat midden stratum from Cave Rock indicates that as late as 360 BP (AD 1590), climates were still very warm and dry in the Tahoe Basin (Lindström et al. 1998).

Little Ice Age and Formation of Truckee-Tahoe's Old Growth Forest (350-175 BP/AD-1600-1775). Between 350 and 175 years ago (AD 1600-1775) a cool-wet climate, comparable to the Little Ice Age event of Western Europe, dominated the region. Lake levels again rose and cirque glaciers reformed in the Sierra, reaching their greatest extent since the latest Pleistocene. The Little Ice Age is marked by the expansion of both semi-arid and montane woodlands. Many of the old growth forests remaining in the Sierra and the Cascades today began to develop during this period. (Note some rather remarkable "diameter-breast-height" measurements on mature conifers as reported in the 1865 General Land Office Survey Field Notes, Appendix 3.)

At the end of the Little Ice Age, about AD 1825, drier conditions caused retreat of forests to higher elevations. Fire frequency increased, as the lower-elevation and water-stressed portions of these forests dried.

Beginning about the mid 1700s through the mid 1800s, the level of Lake Tahoe (which supplies about 75 percent of the flow of the Truckee River in normal years) may have contributed relatively little water to the Truckee River. The decline of Little Ice Age climates is documented by radiocarbon dates of currently submerged tree stumps in the Tahoe Sierra (Lindström 1990, 1997; Lindström and Bloomer 1994; Lindström et al. 2000). These include a stump in Lake Tahoe near the mouth of Upper Truckee River dating from about AD 1720 (230±50 BP uncalibrated), one in Emerald Bay dating to AD 1840 (110±60 BP uncalibrated), one from Moon Dune Beach at Tahoe Vista dating from AD 1802 (148.5±mod uncalibrated), and one from Cave Rock with a calibrated date of AD 1695-1725 and 1815-1920. In addition, two submerged stumps from Independence Lake date from AD 1780 (170±50 BP uncalibrated) and AD 1850 (100±mod uncalibrated), respectively. Another stump from Donner Lake (see Appendix 5; Photo 2a and 2b) dates from AD 1800 (150±50 BP uncalibrated). (Given the problems of radiocarbon-dating materials less than 250 years old, these dates may also include the Little ice Age event.)

Later 19th Century and Beyond (AD 1875 to present). The 40 years between AD 1875-1915 were the longest period (during the historical record) in which the flow of the Truckee River was above average. Tahoe reached its recorded high, with a lake surface level of 6231.26 feet recorded on July 14-18, 1907; this is 8.26 feet above its natural rim, measured at 6223 feet. This wet interval encompasses all of historic-era logging and fluming activities and includes the first few decades of forest regeneration. Relying on "above-average" precipitation, water reclamation projects were planned and initiated in the Truckee-Tahoe basins (including Donner Lake). Intensive livestock grazing began during the latter part of this wet period.

During the severe drought of AD 1928-1935, Lake Tahoe ceased to flow from its outlet for six consecutive years. The water crisis prompted several unsuccessful attempts by downstream water users to cut down or blast Tahoe's rim and dredge the Truckee River channel; all were blocked by Tahoe lakeshore property owners. Eventually a compromise was reached and millions of gallons of water were pumped out of the lake and into the Truckee River.

Wet years during the period 1982-1986 contributed to an average annual snow water content of up to 200 percent of normal. The year 1983 became the standard "High Water Year" for virtually all water ways within the Truckee River drainage basin.

Between 1987 and 1994 there was a period of drought in the Truckee River drainage basin. Although of the same duration as the 1928-1935 drought, the 1987-1994 drought was far worse. In the Lake Tahoe Basin, the average annual snowpack water content was recorded at 29 percent of normal. On November 30, 1992 the surface of Lake Tahoe reached its record low at 6220.27 feet, 2.72 feet below its natural rim of 6223 feet. Sustained drought increased the vulnerability of forests to severe insect attacks. By 1991 an estimated 300 million board feet of timber were dead or dying.

In 1995 a near-record year of precipitation in the Lake Tahoe and Truckee River basins recharged groundwater and replenished near-empty reservoirs. A brief trend of normal to above-normal precipitation continued to the present, when drought again has revisited the region. Investigations as part of the 1996 *Sierra Nevada Ecosystem Project*, a study commissioned by Congress to aid policy makers planning for the future of the Sierra Nevada, revealed that Sierran climate influences the source of much of California's and western Nevada's water, may be getting drier overall. Century-long droughts that have occurred within the last 1200 years may recur in the near future.

The rapidity of hydrologic response to changes in climate is highlighted by the impact of the El Niño cycles of the last 25 years. Even slight increases in precipitation can have an amplified effect on runoff, where strong stream flow enhances erosion and delivery of sediments and nutrients to water bodies in the Truckee-Tahoe basins (including Donner Lake). Increased moisture has also promoted plant growth and added to the accumulation of forest fuels and, with subsequent droughts both fire severity and frequency will increase.

PREHISTORY

A large view divides the prehistory of the Sierra Nevada and adjoining regions into intervals marked by changes in adaptive strategies that represent major stages of cultural evolution. In broadest terms, the archaeological signature of the Truckee-Tahoe basins marks a trend from hunting-based societies in earlier times to populations that were increasingly reliant upon diverse resources by the time of historic contact (Elston 1982, 1986; Elston et al. 1977, 1994, 1995). The shift in lifeways reflects the adaptive strategies used in prehistory to cope with changing environments, a shifting subsistence base, demographic change, and evolving social dynamics.

Current understanding of northern Sierra Nevada and western Great Basin prehistory is framed within a hypothetical sequence spanning nearly 12,000 years of environmental change and human adaptation (Elston 1986; Grayson 1993). The archaeological phenomena are organized into five time periods (known as the Western Great Basin Adaptive Sequence). Within this overarching framework, a regional chronology for the Eastern Sierra Front was developed through substantial programs of archaeological investigation throughout the northern Sierra and the Truckee Meadows (Elston 1971; Elston et al. 1977; Elston et al. 1994, 1995; Moore and Burke 1992). The Eastern Sierra Front Chronology provides a relevant temporal framework for comparing and interpreting the archaeology of the Truckee-Tahoe basins. Cultural chronologies and their paleoenvironmental correlates, as summarized by Lindström and Bloomer (1994), Lindström et al. (2002) and Bloomer and Lindström (2006) are excerpted below.

The earliest recognized period in western Great Basin prehistory, from ca. 11,500 to 10,000 before present (B. P.), is marked by the presence of fluted projectile points found along the shores of shallow Late Pleistocene/Early Holocene lakeshores.

Pre-Archaic sites date from 10,000 to ca. 7,000 B. P. and cluster around lakeshores, river terraces, and high ground above valleys. The localized archaeological record suggests that following the retreat of Sierran glaciers, prehistoric populations began to occupy the Tahoe Sierra by at least 8,000 to 9,000 years ago during the Tahoe Reach Phase. Climates warmed and dried rapidly, although conditions remained relatively cool and moist. The earliest archaeological evidence of human presence in the region is found at South Lake Tahoe along Taylor Creek (Martin 1998) and along the Truckee River near Squaw Valley (Elston et al. 1977). Early populations around Tahoe are represented by scant occurrences of isolated projectile points (large stemmed, edge-ground projectile points of the Great Basin Stemmed series), typically manufactured from a local banded metamorphic toolstone (gneiss) that was procured from a stone quarry on Tahoe (Gardner's) Mountain at South Lake Tahoe. Populations were highly mobile in the pursuit of large game animals.

The Early Archaic Period (or Spooner Phase ca. 7,000 to 4,000 B. P.) begins with a mid-Holocene warming trend, during which lakes and marshes receded, and drought-tolerant vegetation communities expanded. Drying lowlands may have prompted sparse populations to travel into upland resource zones like the Tahoe Basin to hunt and fish and gather plants. Archaeological sites dated to the Early Archaic are rare and no diagnostic projectile point types have been identified until ca. 5,000 B. P., which is when the Martis Contracting Stem and Martis Split Stem atlatl dart points appear.

Late Holocene archaeology, beginning with the later Early Archaic, is better known and Late Holocene chronologies are well developed. Populations appear to be on the rise. The Early Archaic at this time is characterized by Martis Contracting Stem and Martis Split Stem points and diversified land use, with large sites located near permanent water. Big game hunting continued supplemented by intensified seed processing and storage.

Late Holocene climate (after ca. 4,000 B. P.) saw a trend toward cooling and increased moisture. Population densities increased and more intensive prehistoric use of the Tahoe Sierra began during this period, as mixed-mode foragers-collectors moved into the highlands on seasonal gathering, fishing and hunting forays. The Middle Archaic Period begins at about 4,000 years ago, during the Early Martis Phase, and continues through the Late Martis Phase to ca. 1,300 B. P. The Martis Contracting Stem and Martis Split Stem points reflect an early aspect of the Middle Archaic, but Martis Corner-notched and Elko Eared projectile points (ca. 3,000 to 1,300 B. P.) are the predominant Middle Archaic time markers. A hallmark of Middle Archaic prehistoric culture in the Tahoe Sierra is the use of basalt in the manufacture of stone tools and production of large bifaces.

The Late Archaic Period spans about 1,300 years ago to historic contact. This period is marked by an overall drying trend, punctuated by cool-moist episodes alternating with extended severe drought that lasted until about 500 years ago. Such extreme climatic fluctuations may have allowed for year-round residence in the Tahoe Sierra highlands at some times and prohibited even seasonal occupation at other times. Throughout the Late Archaic, prehistoric populations continued to rise, as reflected archaeologically in more intensive use of all parts of the upland environment and a greater emphasis on plants, fish and small game. The early half of this period (Early Kings Beach Phase ca. 1,300 to 700 B. P.) is characterized by Rose Spring series arrow points and the later half (Late Kings Beach Phase; ca. 700 – 150 B. P.) is marked by Desert Side-notched and Cottonwood arrow points. The bow and arrow (with emphasis on core/flake technology) replaced the atlatl and dart (and production of large bifaces). This period has been associated with the Washoe Indians. It is estimated that the prehistoric Washoe had one of the highest population densities in the western Great Basin. Relatively high estimates are attributed to the bountiful environment in which they lived (Price 1962:2). Historic declines in Washoe population and traditional resource use were caused by disruptions imposed by incoming Euroamerican groups. The Washoe regard all "prehistoric" remains and sites within the Truckee-Tahoe basins as associated with their own history. In support of this contention, they point to the traditions of their neighbors (the Northern Paiute, California Indians, and non-Indian Americans) that include stories about migrations and movement, whereas theirs do not (Rucks 1996:6).

ETHNOGRAPHY

Although Donner Pass is consistently reported in ethnographies as inside Washoe trading routes and territory, use by neighboring Maidu, Miwok, and Northern Paiute groups is not ruled out. d'Azevedo (1984:23) pointed out that much of the Washoe range, including the core territory, was used jointly by adjacent non-Washoe peoples and constituted a ventilated corridor of trade and travel. He further noted that, in terms of clear-cut tribal boundaries, the overall picture is one of extensive interaction among Washoes and their neighbors, an arrangement that engaged in cooperative practices of trade, inter-visiting and intermarriage between Washoe subgroups and the Pyramid Lake and Walker River Paiute, the Miwok, and the Maidu (Beals 1933:366; d'Azevedo 1984:32, 1986:471; Downs 1966:51; Riddell 1960:75; Stewart 1966). Co-occupation of Donner Summit and environs is most likely for the Washoe and Southern Maidu (or Hill Nisenan).

Nisenan

The Southern Maidu (or Hill Nisenan) held the foothill and mountainous portions of the drainages of the Yuba, Bear and American Rivers and the lower drainages of the Feather River (Kroeber l925; Wilson and Towne l978). Nisenan occupation of the high country was most probably by small groups during hunting, fishing and plant collecting forays in the uplands above their more permanent villages along the sierran west slope. The area around Donner Pass has been variously described as totally within Nisenan territory (Wilson and Towne l978), or as a "no man's land" between the Nisenan and the Washoe (Littlejohn l928), or as Washoe peripheral territory (Price 1962).

For the Hill Nisenan, like most hunters and gatherers, vegetable food resources formed the subsistence baseline. They utilized a wide range of floral and faunal species although they apparently made extensive use of only a small percentage of these. The least productive time of the year was late winter-early spring. The salmon run began in late spring. Throughout the summer, nuts and seeds were gathered. Acorns became available in massive quantities in the autumn, which was also the time of deer hunting. Groups went on hunting and gathering expeditions within the mountains in the fall. Temporary camps were located along creeks where temporary lean-to structures with some mud covering at the base were constructed (Beals 1933; Wilson and Towne 1978).

Nisenan villages consisted of from four to l2 separate dwellings, housing a nuclear or polygamous family with the main cooperative or corporate unit being an informal bilateral "family" (Beals l933:344). Larger social organizations, called tribelets (Kroeber l925), were formed by several villages uniting under a single chief. Boundaries of such tribelets were formed by using natural ridges between streams. However, the higher elevation areas were apparently not included in any one tribelet's territory.

Washoe

In consideration of the above, the Donner Lake Basin seems most firmly within Washoe territory and the Washoe themselves regard all "prehistoric" remains in this general region as associated with their own past. Within their traditional territory, the Washoe people differentiate three geographic areas that define their history and ancestry: the *Páwa'lu'* or "valley people" from Carson Valley; the *Hángalelti'* or "southerners" from the Woodfords area; and the *Wélmelti'* or "northerners." *Wélmelti'* traditional territory encompasses the Truckee Basin and

Donner sub-basin, the Sierra Valley, the Truckee Meadows (Reno) and Washoe Valley (Downs 1966; Nevers l976).

Washoe Place Names and Fish Camps

In a recent ethnographic study of Washoe encampments, Rucks (2005) reported on the noteworthy concentration of settlements along the Truckee River between Donner Creek and the Little Truckee River at Boca, suggesting that this stretch of river was unusually productive (d'Azevedo 1956; Rucks 2005). These camps may have centered claims on resource catchments, including easier-to-fish feeder streams, but the river itself may have been regarded more as a common source of the fish (Rucks 2005). It was the feeder streams that were the favored fishing locations, because "the water was too rough and there were too many bears along the Truckee River" (d'Azevedo 1955 field notes in Rucks 2005). Donner Creek was better fishing than the Truckee; it was smaller and could be diverted (Freed 1966:81, #14).

The focus of fishing was gauged according to the fish runs up the streams and their return to the lakes. The actual spawning runs were times of most intense activity, when people waded into the streams armed with baskets and scooped up fish and tossed them onto the bank (Downs 1966:14). Quiet, shallow water provided ideal environments for spearing, bag/dip/lift-netting, gill-netting, trot lines, traps, and moveable weirs. Along river outlets and bars, harpoons were successfully used. Stream riffles were good for harpooning, trapping or driving. Stream shallows with moderate and even water flows over smooth bottoms were suited for weirs, from which spearing, dip-netting, and trapping were conducted. Smaller creeks (such as Donner) were best for short weirs with basketry traps, rock dams, and hook and line fishing. Stream eddies triggered the use of lifting nets from platforms or fish blinds. Falls and cascades called for bag/dip nets, traps, harpoons, or basket traps. Sluggish waters and deep pools were for fish driving. Ice fishing was done by driving fish into nets set through holes in the ice. Harvesting and processing, some fish for immediate consumption and some fish for storage, would have occurred close to these fishing facilities. Main habitation sites were located at a convenient location but not adjacent to the stream itself (Rucks 2005). Hudson (1902 quoted in Rucks 2005:A-5) noted that fish hooks, fish spears and seines were used by Washoe who camped on the south side of the river across from Truckee town (located less than a mile downstream from its confluence with Donner Creek).

The variety of fishing techniques listed above represents two basically different Washoe fishing strategies that involve either private or communal property rights. For example, the presence of fish blinds and platforms (from which fish were speared) characterize a fisheries resource that was allocated to individuals and their families who would assert their right to it. In contrast, communal fishing practices could draw a large gathering from various camps, where labor was pooled in order to share the bounty. One communal fishing method, once practiced on Donner Creek, is referenced as the *yutsim* or "draining away the creek to get fish from drained pools" (d'Azevedo 1956:54, #129). Where the stream was temporarily dammed, large numbers of stranded fish were scooped out of the water, tossed to people on the bank and processed on the spot (d'Azevedo 1956). The *yutsim* at Donner Creek targeted the late-season whitefish runs and was one of the last harvests before winter. The stores of whitefish may have sustained those Washoes who elected to remain in the Truckee River uplands into the winter season. d'Azevedo's Washoe consultants specifically referenced over-wintering at higher altitudes, up the Truckee River to Donner Lake and in eastern Sierra Valley, as an interim strategy during mild winters and/or poor pine nut harvests:

> [They] Lived there [along Donner Creek] all year round—even in deep snow when just the roofs of the *galis dangal* [winter homes] were showing. This was possible because there was plenty of wood there, and also they could gather an abundance of food for winter. [d'Azevedo 1956:54)]

This view is supported by James Clyman's encounter with Washoe in the still severe winter conditions of early May 1846 near Donner Lake and in Martis and Dog valleys (d'Azevedo 1984:33 and quoted in Rucks 2005). Clyman is the first to record their name, writing that they called themselves "*Washee, Washew, Waushu*" (Camp 1960 in d'Azevedo 1984:146 and quoted in Rucks 2005).

"Extensive use and habitation" of Donner Creek, were reported to Heizer and Elsasser (1953:7) by their Washoe consultants during the 1950s. In Washoe terms, Donner Lake is generally mentioned as *datsásut*, without the qualifier for "lake" or *dá'aw* (d'Azevedo 1956:53, #126). Nevers (1976:4; Nevers, personal communication in Rucks 2005) refers to the lake as *behézing wí.giya* or "little eye", as it looks like a little eye when viewed from above. Freed (1966:81, #14) described a Washoe camp, *deiubeiyulElbEthi* **(**"water flowing down") at the confluence of Donner Creek and the Truckee River, "…where *welmelti* got much of their fish and game. Just upstream was the ethnographic settlement of *dat'sa sut ma'lam detde'yi'* ("mouth of stream + tributary + live there"), located on Donner Creek ¼ mile downstream from where State Route 89 crosses the creek and on the sunny side of the hill where a lumber mill was once located. A large rock containing a bedrock mortar or *lam* marks the camp. These were the people who may have discovered the Donner Party when they were going there for a *yutsim*, as Bertha Holbrook recounted to d'Azevedo:

> They fed the Donner Party for awhile but then they had to quit because they had just enough to barely last them through the winter themselves [d'Azevedo 1956: 54, #129]

> Washoe legends abound concerning ancestors who witnessed the [Donner Party] ordeal while trekking or hunting on snowshoes from nearby encampments. They were too frightened of the strange people to make themselves known. They did, however, leave food in sight of the party and took back tales of death and cannibalism to their people (d'Azevedo 1984:147 and quoted in Nevers 1976:44-45).

Much has been written of the Donner Party tragedy in the Euro-American the literature, but with the exception of a few entries from emigrant diaries, perspectives of Native Americans who witnessed these events are largely absent and encounters between the two groups are not widely known. One example comes from Patrick Breen, who wintered at the Donner Lake camps and entered in his diary on Sunday, February 28, 1847:

> Froze hard last night, today fair and sunshine, wind SE, 1 solitary Indian passed by yesterday, come from the lake, had a heavy pack on his back, gave me 5 or 6 roots resembling onions in shape, taste something like a sweet potato, all full of little tough fibers.

King (1994:91) wrote in a modern secondary account of the event:

> Years later, John Breen said of the Indian that "he did not seem to be at all curious as to how or why there was a white man alone (as it must have seemed to him) in the

> wilderness of snow." When the Indian saw Breen he halted and gestured to him not to come any nearer, then took the roots and laid them on the snow, all the while cautioning Breen not to approach until he was out of reach. John further reported that the roots were very palatable.

The emigrant Isaac Wistar passed through the area in 1849 and wrote:

> We surprised and caught the two Indians, both naked as they were born, and without arms, which they had probably concealed…remembering their kindness to the Donner Party in 1846, we treated them gently and gave them a little of our vanishing hard tack…and released them. [Wistar 1914:110 quoted in d'Azevedo 1984:147]

Washoe Land Use and Economy

The Washoe once embodied a blend of Great Basin and California in their geographical position and cultural attributes. While they were an informal and flexible political collectivity, Washoe ethnography hints at a level of technological specialization and social complexity for Washoe groups, which is non-characteristic of their surrounding neighbors in the Great Basin. Semi-sedentism and higher population densities, concepts of private property, and communal labor and ownership are reported and may have developed in conjunction with their residential and subsistence resource stability (Lindström 1992, 1996).

The ethnographic record suggests that during the mild season, small groups traveled through high mountain valleys collecting edible and medicinal roots, seeds and marsh plants. In the higher elevations, men hunted large game (mountain sheep, deer) and trapped smaller mammals. Donner Lake and Donner Creek were important fisheries year-round. Suitable toolstone (such as basalt) was quarried at various locales north of Truckee town. Archaeological evidence of these ancient subsistence activities are found along the mountain flanks as temporary small hunting camps containing flakes of stone and broken tools. In the high valleys more permanent base camps are represented by stone flakes, tools, grinding implements, and house depressions.

Although some Washoe trekked to distant places for desired resources, most groups circulated in the vicinity of their traditional habitation sites due to the large variety of predictable resources close at hand (d'Azevedo 1984; l986:472). While there was a tendency for groups to move from lower to higher elevations during the mild seasons, and to return to lower elevations the remainder of the year (Downs l966), a fixed seasonal round was not rigidly adhered to by all Washoe and some Washoe may have wintered in the Tahoe Sierra during milder seasons (d'Azevedo 1984; l986:472-473).

Their relatively rich environment afforded the Washoe a degree of isolation and independence from neighboring peoples and may account for their long tenure in their known area of historic occupation (d'Azevedo 1984; 1986:466, 471; Price 1962). The Washoe are part of an ancient Hokan-speaking population, which has been subsequently surrounded by incoming Penutian speakers such as the Sierra Miwok and Southern Maidu-Nisenan and Numic speakers, such as the Northern Paiute (Jacobsen 1966). Even into the 21st Century, the Washoe have not been completely displaced from their traditional lands. The contemporary Washoe have developed a Comprehensive Land Use Plan (Washoe Tribal Council 1994) that includes goals of reestablishing a presence within the Truckee-Tahoe basins and re-vitalizing Washoe heritage and cultural knowledge, including the harvest and care of traditional plant resources and the protection of traditional properties within the cultural landscape (Rucks 1996:3).

HISTORY

Historic events in the Donner Lake Basin are tied to the history of the community of Truckee. Truckee's beginnings are marked by the arrival of Joseph Gray, who built a stage station near the present-day downtown in l863. This tiny way station grew from two structures into a thriving town that accommodated emigrants, stagecoach travelers and freight wagons in route westward to California's gold fields and eastward to the Comstock Lode in Nevada. The completion of the transcontinental railroad through Truckee in l868 gave rise to other developments in the transportation, lumbering, ice, agriculture, dairying, fishing, water reclamation, and the tourism industry, all of which were to become the essential economic bases of Truckee. The following summary of historic themes in the Donner Lake Basin draws heavily from previous work by Lindström (1987), who developed an overview of the area based upon her research assembled for a State Lands Commission court case regarding the historic navigability of Donner Lake (Lindström n.d., 1984), and Nesbitt (1990), who followed-up Lindström's preliminary work with a further research of deeds and other county records.

Early Explorations

The growing interest in the American far west stimulated the U.S. government to dispatch expeditions to explore the region, produce accurate maps, and report back on the region's inhabitants and resources. One of the first of these expeditions to reach the Donner Pass region was that of John C. Fremont. His campaign of l845-1846 moved up the Truckee River, camping at Coldstream on December 3, l845. They passed along the northern periphery of Donner Lake, crossed Donner Pass and traveled down to Sutter's Fort. The party moved quickly through the area to avoid being caught by winter weather (Simpson l859:22, map insert; Farquar l965:59; Jackson et al. l982:l3). Fremont returned to the west on his third expedition in the fall of 1845. He re-traced his steps westward over Donner Pass, reaching Sutter's Fort on December 9th.

Transportation

Emigrant Travel

Beginning in l84l, overland emigrant travelers entered California on foot or with wagons and mounting the Sierra Nevada was their last major obstacle of the journey. A portion of the Truckee River Route of the Overland Emigrant Trail traversed the north side of Donner Lake (then known as Truckee Lake) along the present route of Donner Pass Road and crossed westward over Donner Pass (Photo 3). The route up the Truckee River, over Donner Pass and down into the Central Valley was first opened by the Stevens-Murphy-Townsend Party. The emigrant party ascended the Truckee River and arrived at its confluence with Donner Creek in mid-November of l844, the only group to travel this route that year. The group split here. A pack train traveled on to Lake Tahoe and crossed the divide at the headwaters of McKinney Creek and into the American River Canyon. However, they were forced to leave six of their 11 wagons at the east end of Donner Lake, entrusting three men to guard the supplies until the following spring. Two of the three men later crossed the pass on foot, leaving the ailing Moses Schallenberger to winter alone until he was rescued in the spring. It is reported that the wagons that first crossed the summit were disassembled and pieces were lifted up the sheer cliffs. The oxen were freed from their yokes and led up and around to meet the wagons again at the top of the cliffs. This laborious process, pioneered by the

Stephens-Murphy-Townsend Party, was allegedly repeated many times by later emigrant parties who crossed this tortuous portion of the trail (Graydon l986:l3).

The Stevens-Murphy-Townsend wagon train party, guided by mountain man "Old Greenwood", deserves recognition for being the first to use the Truckee River Canyon/Donner Pass route and the first to take wagons over the crest of the Sierra Nevada. As later events proved, this was one of the best-led and organized parties to make the crossing into California (Graydon l986:6). It is a tribute to the trail judgment of Elisha Stevens and other members of the Stevens-Murphy-Townsend Party that the subsequent Dutch Flat and Donner Lake Wagon Road, the Central Pacific Railroad, the Lincoln/Victory/Old 40 Highway, and finally U.S. Interstate 80 all cross the Sierra close to the route they pioneered (Map 2). It is ironic that the name Stevens soon went down into oblivion while the pass that he opened is known only as Donner Pass, named after a party that never successfully crossed it (Graydon l986:l4).

In l845 about 50 wagons made the crossing over Donner Pass. Winters' west-to-east horse train followed this same route in May of l845 (Jackson et al. l982:l4). The Swasey-Todd Party crossed Donner later that same year. In l846 several wagon groups followed the Emigrant Trail along Donner Lake and over Donner Pass. It should be emphasized that the Donner Pass route was used for only a two-year period and by very few emigrants. The Donner Party unsuccessfully attempted to cross this same route later in 1846. This group of emigrants was trapped near Donner Lake during the winter of l846-1847. Half of the group perished and some of those that survived did so by canibalizing the dead. During that winter, rescue parties traversed the route along the north side of Donner Lake to bring back several members of the ill-fated Donner Party. Events surrounding the grim events at Donner Lake now memorialized at the east end of the lake at Donner Memorial State Historic Park (California Historical Landmark l34) and have been studied in a series of archaeological investigations (Hardesty l990; Hardesty and Lindstrom l990).

During the period l845-l848 it is estimated that about 2,600 individuals traveled from "the States" to California, with most using the Truckee/Donner Pass gateway (Unruh l979:ll9). However, by l846 and thereafter, emigrants who traveled the Truckee Route of the California Trail sought to avoid the steep wall of Donner Pass and instead went southward from Donner Lake into Coldstream Valley, following a branch of the Truckee River Route first scouted by the Joseph Aram Party. At the head of Coldstream, they crossed the northernmost notch between Mount Judah and Mt. Lincoln, also known as Roller Pass or South Pass. This saddle was 7,850 feet high and less than two miles south of Donner Pass, also referenced as North Pass. Its approach was relatively easy until the final 400 feet, which rose precipitously up a thirty-degree slope. This final obstacle soon led to the discovery of another pass located between Mount Judah and Donner Peak. This third pass, known as Coldstream Pass or Middle Pass, was easier than the other two and it followed a relatively gradual ascent to the summit. All three routes are shown on Map 1. The route through Cold Stream Canyon appears on Map 5. Since emigrants accessed both Roller Pass and Coldstream Pass along a branch of the Truckee Route in Coldstream Canyon, all three pass routes are considered to be part of the Truckee Route. These three passes were but local variants in what was basically one route over the Sierra (Howard 1998:39). Just as alternative routes were found over these three main passes, it seems likely that alternative “sub-routes” were also scouted and followed in the vicinity of each of these three main passes.

According to the accounts of the emigrants themselves, the crossing of the sierran crest was the most difficult section of the route on the long trek from the Missouri River (Graydon l986:l) and

Donner Pass was the most difficult crossing on the Truckee Route. Donner Pass was especially hard to negotiate because of the many large rocks. Moses Schallenberger described the ordeal in his story (even though he never crossed the pass with main emigrant party in 1844), as recounted by Graydon (1986:39).

> "The worst place was about halfway up where there was a vertical rock about ten feet high. They managed to find a little rift in the rock and through it they forced the oxen one by one. Then they yoked the oxen again, put chains down to the wagons …brought the wagons one by one over the ledge."

Although Graydon (1986:40) noted that this huge boulder stands today as monument to this early crossing, he did not describe its location.

In 1848 Benjamin Franklin Bonney related a similar experience in his diary entry that is similar to Moses Schallenberger's account.

> "After a day's travel we came to a rim rock ledge where there was no chance to drive up, so the wagons were taken to pieces and hoisted to the top of the rim rocks with ropes. The wagons were put together again, reloaded and the oxen which had been led through a narrow crevice in the rim rock were hitched up and went on."

> In 1846 Edwin Bryant expressed equal trepidation in crossing Donner Pass.

> "To mount this was our next difficulty. Standing at the bottom and looking upwards at the perpendicular, and in some places impending, granite cliffs, the observer, without any further knowledge on the subject, would doubt that man or beast ever made good a passage over them."

By l848 much of the wagon traffic was shifted away from the more difficult Truckee Route, either southward to the Carson Route or northward to the Lassen Route of the California Trail. Nonetheless, the Truckee Route was still crowded by several thousand wagons during the gold rush of l849. After that time, the trail over Carson Pass became the preferred route. As of l852 travel again shifted northward, this time to Henness Pass and Beckwourth Pass; after this time, Donner Lake was seldom visited by emigrant trains.

The Dutch Flat and Donner Lake Wagon Road

In 1864 the Dutch Flat and Donner Lake Wagon Road (DF&DLWR) opened over Donner Pass and followed basically the same route through Truckee that the earliest emigrants had followed (maps 2-5, 7-12). The freight and passenger wagon road was situated near the proposed alignment of the first transcontinental railroad, the Central Pacific Railroad (CPRR), being designed to facilitate the transport of supplies to points along the rail line (photos 4 and 5). Moreover, tolls charged on the wagon road infused cash into the railroad construction.

S. G. Elliott surveyed the DF&DLWR from Dutch Flat eastward in l860, a survey that was financed by Dutch Flat residents (*Daily Alta California* 11/16/1860/1:7). In June of l864 the DF&DLWR was opened for traffic. By July the California Stage Company was operating its stages on the turnpike. It traversed the road between Dutch Flat and Virginia City in a record time of l3 hours (*Sacramento Daily Union* l/2/l865/3:6), nine hours less than the stage route via Placerville.

The *Union* also reported that within six months time the DF&DLWR had been used by 3,280 wagons, l69 buggies, l,278 horsemen, and 3,280 head of loose livestock. The DF&DLWR became increasingly popular and by 1866, more of the freight traffic was diverted away from the Placerville route as the CPRR railhead progressed closer to Donner Pass. In September of 1866, Wells, Fargo and Company introduced a "Fast Freight and Passenger" service over the DF&DLWR. The 22 hour trip between Alta (then the terminus of the CPRR) and Virginia City cost $5 and travelers were accommodated with a box to sit on and a blanket. Winter travel was accomplished by sleigh. An estimated 200 freight wagons traversed the road daily during 1867. Train service to Cisco, combined with the wagon and stage service over the DF&DLWR, boasted the fastest stage and freight time between Sacramento and Virginia and the route over Donner Pass generated a million dollars annual revenue.

The road formed the final link in a continuous freight and passenger road from Dutch Flat to the Comstock mines near Virginia City. Soon after the DF&DLWR was opened to traffic, wayside inns and toll stations dotted the route and serviced early-day travelers. One of the first wayside inns was built by D. L. Pollard at Donner Lake’s northwest end. Several other way stations were established west of Donner Lake and up the grade to Donner Pass. One mile from the head of Donner Lake, D.L. Dale and Charles Coomb's operated a hotel (with barn) known as the Forest Dale House. J. H. Witherspoon built a house and barn on the DF&DLWR about three miles west of the lake. William Mac (or Mack) operated a hotel and barn on the DFDLWR 1½ miles west of Donner Lake. (This is the origin of "Billy Mack Flat", which figures later in the area's lumbering history.) Donner Lake House was prominently situated at the east end of Donner Lake (maps 4 and 5, 7-9, 11-12, and 14).

During the construction of the CPRR, locomotives, rails, cars, and parts were hauled over the DF&DLWR to Coburn's Station (Truckee). Completed in 1869, the CPRR superseded road travel across California and throughout the Truckee-Donner area. The DF&DLWR fell into disrepair shortly thereafter and its usefulness as a primary transmontane thoroughfare ended. However, it was still used as an artery of local transportation. In 1879, a variant of the original route was established on the north side of the Summit Creek drainage in order to avoid recurrent blockages due to avalanches down the steep slopes beneath the railroad snow sheds. This variant was later to become part of the early Placer County road system. Other smaller variations were developed farther down the Summit Creek canyon. The respective counties controlled the road until it was taken into the State Highway system in l909, when it was rebuilt as an auto and truck road. In 1912 a short section east of Donner Summit was channeled through a subway beneath the railroad tracks in order to avoid dangerous crossings by autos (Map 2).

Lincoln Highway/Victory Highway/U.S. 40

The route of the DF&DLWR, including the segment along the north side of Donner Lake and over Donner Pass, was later to be designated as part of the Lincoln Highway, the nation's first transcontinental auto road (Photo 15). The Lincoln Highway concept was conceived in the fall of 1913 by the Lincoln Highway Association, in concert with the fledgling auto industry and its support industries. Packard, Goodyear Tire & Rubber Company, and General Motors (among others) who contributed to their support (Protteau 1988). Highway plans entailed the development of a continuous, connecting, improved road from the Atlantic to the Pacific, which joined New York and San Francisco, a distance of 3,331 miles. Contiguous segments within the existing regional road systems were designated as interconnecting links in the new transcontinental road.

The Lincoln Highway that officially opened in 1913 was a "highway" in name only. By modern standards, it began as a two-track road formed from disconnected township and county roads, fence lines and trails. Nearly all of it was unpaved. At this time there was no federal highway program and no coordination among states and counties for the building of roads, and so the Lincoln Highway Association had to use innovative methods as incentive to complete the road from coast to coast. The construction of so-called "seedling miles" was arranged to encourage communities to build stretches of the road from donated concrete. Some of the best sections of roads developed were in California (Byrd 1992:51-52).

Road construction in the 1920s consisted principally of grading and gravel surfacing and providing some drainage. Road widths were typically 24 feet wide, with right-of-way widths of 66 to 80 feet. Road profiles were slightly crowned to facilitate moisture run-off. Major improvements up the east flank of Donner Pass were made in 1923 and in 1926 with the construction of Rainbow Bridge due east of Donner Pass (Photo 16). Here, the original route of the earliest emigrants and the DF&DLWR west of Donner Lake was mostly abandoned and the new road was modified and improved to become the road known today as Old U.S. Highway 40 or Donner Pass Road. During the 1930s-1940s roads began to approach modern engineering standards in order to accommodate higher traffic speeds and increased truck traffic. Traveling surfaces remained around 24 feet wide but rights-of-way were up to 200 feet wide. Subgrades were constructed of gravel fill to support heavier autos and trucks. The typical late 1940s and 1950s highway consisted of a paved (asphalt), two-lane road, 24 feet wide, with relatively gentle gravel shoulders, and a moderately steep embankment leading down to a borrow ditch (Francis 1994:n.p.).

Upon reaching Reno, motorists traveling west along the Lincoln Highway had a choice of two routes over the Sierra Nevada. The southern branch of the Lincoln Highway headed south to Carson City and then west via South Lake Tahoe and Placerville and on into Sacramento. The northern portion of the Lincoln Highway crossed the Sierra by way of Truckee and Donner Pass and then on to Auburn and Sacramento on California State Route 37. Prior to improvements in the early 1920s the road shared the right of way with the Southern Pacific Railroad down from Donner Summit. An early map of the route warned motorists to "note whether trains are approaching before entering snowsheds" (Byrd 1992:52).

In the 1920s portions of the Lincoln Highway were re-designated as the "Victory Highway", a redundant road system that ran between Denver and San Francisco (maps 20 and 21). However, the rather confusing reference to both northern and southern segments as the Lincoln Highway continued (Bryd 1992:53-54.). Conceived as a memorial to veterans of World War I, the Victory Highway, or "Route of Triumph", extended for 3,205 miles (Bryd 1992:52). In 1921 the Federal Aid Road Act named the route of the Victory Highway as a "primary" road, thus assuring over $2 million for the improvement of the highway (Bryd 1992:53). The Victory Highway Association incorporated in 1923 as a proponent of the road to San Francisco through the Humboldt Basin in northern Nevada, rather than an alternative route through southern Utah to Los Angeles. While the Lincoln Highway was the first transcontinental motorway to be developed and promoted, the Victory Highway was the first cross country road to be completed as a through route (Bryd 1992:52). Construction and aggressive promotion in the West was carried out in large part by the California State Automobile Association. The highway over Donner Pass and down the Truckee River Canyon was completed in 1926.

In 1925 the federal government began adopting a numbering system for its highways; as a result, named highways gradually fell out of fashion (Bryd 1992:54). In 1928 the northern Lincoln/Victory Highway was incorporated into the Federal Highway system and designated as U.S. Route 40. In 1927 the Lincoln Highway Association disbanded as a business association. U.S. 40 underwent several re-routings. In 1963 portions of the two-lane U.S. 40 were incorporated into the new interstate highway system and became the four-lane Interstate 80, completed in 1964 over Euer Saddle (now referred to as Donner Pass and located two miles north of the actual Donner Pass). The interstate is shown under construction on the 1962 Tahoe National Forest Map (Map 26). Maintenance of the U.S. 40 roadway and its bridges were assumed by Nevada County, with some segments now under the jurisdiction of the Town of Truckee. Upon dedication in 1964, Interstate 80 became the new Sierra crossing. The remaining portions of the U.S. 40 alignment were relinquished to the counties through which they passed. The subject section of U.S. 40 became Donner Pass Road by act of Nevada County in 1967. Although portions of the two-lane U.S. 40 were incorporated into the new interstate highway system in 1963, a continuous segment of "old" U.S. 40 escaped impact by the new four-lane freeway. This historic section, which traverses the study area, extends from the (Glenshire) bridge five miles east of Truckee, westward to Cisco Grove.

Transcontinental Railroad

The route of the first transcontinental railroad (designated State Historic Landmark No. 780) passes through the Donner Lake Basin. The building of the railroad had an immense impact on the region immediately adjacent to it, as well as on the areas that were served by it. In Truckee, economic activities such as logging, commercial fishing, the ice industry, agriculture, and recreation were all stimulated or expanded by the market provided by the railroad. Its completion ended California's effective isolation from eastern markets and eastern goods and brought California into the U.S. economy in a way it had never been before.

As early as May l, l852 the California legislature called upon the federal government to build a railroad to the Pacific (Kraus l969:7). By l853 Congress had instructed the U.S. Army to survey feasible routes for a railroad. Theodore D. Judah (in whose honor Mount Judah is named) made his first examination of a potential route for the railroad via Donner Pass in the fall of l860. Construction was to take place from both ends and, as a preliminary measure he prompted the government to build a wagon road (the DF&DLWR) parallel to the rail route (Howard 1998:165). The Pacific Railroad Bill was passed in 1862, mandating the construction of a railroad and telegraph line from the Missouri River to the Pacific Ocean (Kraus 1969a:7; McClain 1995:8). Although a completion date was set, “before July 4, 1876”, a junction point was not pre-determined, thus turning the transcontinental endeavor into a race (Kibbey 1996:18). The Central Pacific Company (CPRR) was selected to build the rails to the east and the Union Pacific Company (UPRR) was chosen to construct a railroad westward. The terms of the railroad act provided that both the Union Pacific and the Central Pacific be allotted bonds in proportion to the miles of track they laid. The act also provided for timber and quarrying rights and for 20 sections of land for each mile of rail. Each company was granted a 200-foot-wide strip of land on both sides of the right-of-way and 6,400 acres (one square mile) for each mile of railroad completed, to be awarded in a checkerboard pattern on alternating sides of the track. The companies could then sell this land to raise more money. Apparently the land and subsidies attracted the CPRR's "Big Four" more than the railroad itself (comprised of Leland Stanford, Charles Crocker, Mark Hopkins, and Collis P.

Huntington). This led to differences between Judah and his partners that eventually resulted in Judah's expulsion from the company.

The first rail was laid at Sacramento on October 27, l863. Construction moved ahead in l864-1866. Heavy snow and tunneling through granite rock near Donner Pass presented major obstacles. By the summer of l867 the railroad was still not completed between Cisco and Truckee. A second phase of construction, east of the summit, was worked simultaneously with that at the summit. In 1864 the DF&DLWR was opened over Donner Pass to aid in transporting supplies to points along the line, including locomotives, rails, cars, and parts. By May of l868 the railroad was completed between Truckee and Reno but the line between Cisco and Truckee was not completed until June l5, l868. The entire transcontinental route was finished on May l0, l869, with the last rail joining the CPRR and the Union Pacific Railroad at Promontory, Utah (Kraus l969:9).

Chinese Labor. Up to 15,000 Chinese were employed in construction of the railroad. However, as railroad engineer John Gillis (1870:161) reported, the force at work on the road probably averaged from six to ten thousand, nine-tenths of them being Chinese. Charles Crocker was tolerant of other ethnic groups and initiated the move to hire Chinese in order to meet a serious labor shortage, believing that "the race of people who built the Great Wall of China could certainly run a railroad over the mountains" (Earl 1989:1). Huntington, Stanford and Hopkins, along with Construction Superintendent, J.H. Strowbridge, were originally opposed to employing the Chinese due to their small size, among other reasons. Soon railroad officials were characterizing them favorably:

> "The Chinamen were as steady, hard-working a set of men as could be found. [Gillis 1870:161]
>
> quiet, peaceful, patient, industrious and economical…[and]…they are contented with less wages. [CPRR 1865:7; Earl 1989:1]

Many Chinese, who were already organized into sophisticated societies for mutual aid and assistance, came directly from Canton Province through labor exchanges set up by Crocker and shrewd and intelligent Chinese businessmen (CPRR 1865a:8; Earl 1989:1).

Chinese railroad laborers worked from sunrise to sunset, six days per week. Workers were initially paid one dollar per day; later this wage was raised to $35 per month, leaving $20 to $30 per man in gold, after deducting their living expenses. Non-Asian men were paid about the same, but with their board included (Gillis 1870:161). Chinese workers were divided into gangs of about 12 to 20 each. Each gang had a "head man" and a cook who not only served items in the traditional Chinese diet (dried oysters and abalone, dried bamboo, seaweed, mushrooms, dried fruits, rice, crackers, vermicelli, salted cabbage, Chinese sugar, peanut oil, Chinese bacon, pork, and poultry) but was also required to serve barrels of lukewarm tea during the work day (Photo 8) and provide a large boiler of hot water for each worker to sponge bathe and change into clean clothes before the evening meal (Chinn 1969). Non-Asian workers drank cold water, which was too often contaminated and caused illness. The company provided the Chinese with low cloth tents, but many preferred to live in dugouts or to burrow into the earth (Chinn 1969; Earl 1989:1).

The feats of the Chinese railroad construction workers were remarkable and many were killed by avalanche or died of exposure or construction accidents (Earl 1989:1). The heaviest snowstorms occurred in 1866. Forty-four storms were recorded in that winter, varying in length from a short snow squall to a two-week gale and in depth from a quarter of an inch to ten feet (Gillis 1870:155). Accounts by railroad engineer John R. Gillis further illustrated the extreme challenges and dangers of living and working at Summit Camp.

> Snow-slides or avalanches were frequent…Near the close of one storm, a log-house with board roof, containing…some fifteen or sixteen men in all, was crushed and buried…The event startled us, for at the top of the cliff, in front of the camp, was a snow-wreath forty or fifty feet long, projecting twenty feet, and of about the same thickness…We were uncertain when it would come down and where it would stop. A keg of powder was put down behind it next morning and fired…then the whole hill-side was in motion… [Gillis 1870:157]

Time was of the essence in the race against the UPRR and the CPRR and Crocker, halted by the relentless snows on the summit was forced to move some of his operations further down the east slope where more moderate weather prevailed. Advance railroad gangs populated Donner City (later shown as Tamarack on Map 13), at Donner Lake's west end (Meschery 1978:35).

With the completion of the railroad in May of 1869, many Chinese laborers moved on to other railroad construction jobs, or were channeled into the lumber industry or became entrepreneurs in restaurants and laundries.

<u>Tunnels</u>. In order to maintain a manageable grade, Judah anticipated the blasting of tunnels and also that sections of line would require fill. Seven tunnels are crowded within two miles east of Donner Summit, more tunnels than original planned. While tunnels cost time and money, once constructed, they saved time and money otherwise spent on building retaining walls and snow sheds (Gillis 1870:154). Some 37 miles of tunnels were needed on the CPRR in order to keep the right-of-way open at the most strategic places (Gillis 1870:154; Steinheimer and Dorn 1989:51). Summit Camp was established between 1865 and 1869 as the main staging area for tunnel construction. The camp was strategically located along the Dutch Flat Donner Lake Wagon Road at Donner Pass. Railroad construction photos taken between 1864 and 1869 show Summit Camp, as well as a number of small structures (residences and workshops) that are nestled in small clearings and mid-slope benches down slope and east of the main camp (photos 4 through 9). Gangs worked three eight-hour shifts. Before the snow had acquired depth enough to interfere with the work, the tunnel headings were all started (Gillis 1870:158). Various phases of tunnel construction are shown on photos 5, 7 and 8. During the winter, the cuts at the tunnel entrances soon filled up with snow and snow tunnels were run through the drifts, in some instances large enough to drive a two-horse team and cart to haul waste rock. Inside the tunnels, progress was slow (averaging one to three feet per day), with blasting requiring the hand drilling of several holes, 18 or 20 feet long, and the insertion of a keg or two of black powder. Blasting was sometimes premature and many lives were lost. Nitroglycerin, manufactured at a factory at Summit Camp, was used in early 1867. It expedited the summit tunnel excavations by half or three-quarters time but, use was discontinued as it was too unstable and dangerous. When feasible, a shaft was driven down to track level from the surface to permit cutting both ways from the middle

Tunnel No. 6, commonly referred to as the "Summit Tunnel", was the most renown of the group. At 1,659 feet long, 16 feet wide and about 20 feet high, it was not only the longest on the rail line, but it was also one of the highest tunnels in the world, for its time (Gillis 1870:161; Kibbey 1996:19; Williams 1876:228). This, the last major tunnel drilled by hand, held up construction from the west for an entire year. East of Tunnel No. 6 and spanning a steep ravine between tunnels no. 7 and 8, the railroad rests on hand-piled, dry-lain rock wall known as "China Wall" (Photo 7).

Snow Sheds

Perhaps the most significant and certainly the most enduring obstacle for the railroad to overcome in operating over the high Sierra was (and still is) the weather and incessant snows on the summit that tormented the construction forces during the winter. Judah's critics emphasized the snow hazard, but having already assessed the snow situation on some of the higher rail crossings in the east, Judah anticipated snow removal problems over Donner Pass and proposed that the railroad establish work camps of snow-shovelers along the route (Howard 1998:166, 170). In his October 1861 report to the directors, Judah underestimated the snow problems to come, stating that..."no trouble will be anticipated." Judah's successor, Chief Engineer S. S. Montague, stated..."that portion of the line requiring this rather unusual protection does not exceed 100 yards" (Signor 1985:38). A total of nearly 40 miles of snow sheds were ultimately constructed (Kibbey 1996:35). Snow plows were also used to remedy the snow problem by charging the snow drift to blast it aside. After each pass, a series of chambers were excavated in the side of the snow banks into which the snow on the next charge of the plow could be deposited (Steinheimer and Dorn 1989:40). This routine necessitated an army of snow shovelers. In addition, snow, shoveled from the tracks was loaded onto rail cars and carted away. The subsequent development of the modern rotary plow became a much more effective means of high sierran snow removal and enabled the railroad effectively to reduce the costly miles of snow sheds. The necessity of providing proper fire protection for the sheds was a major priority and an elaborate system for fire prevention and control was eventually established comprising fire look-outs and fire engines.

Railroad Reorganization and Improvements. Concern over the CPRR's ability to meet its obligations on the government debt it had incurred during its construction days prompted its takeover by the Southern Pacific Company (SP) in 1899 (Myrick 1962:29; Signor 1985:51). With the reorganization of the railroad, upgrading efforts were initiated in an effort to reduce grades and curvature and increase safety. Just as the Donner grade served as a proving ground for the initial development, testing and improvement of railroad engineering and construction techniques, railroading technology was further advanced under SP ownership to suit the particular operating characteristics of the Donner grade. Innovations and improvements entailed extensive double-tracking, the design of a new "cab-forward" engine type, exhaust systems, and safety brakes, and the addition of new sidings, a turntable, and concrete snow sheds. Because the original No. 1 track at Donner Summit was steep and narrow, a new two-mile No. 2 track tunnel opened less than one mile south of the No. 1 track and under Mount Judah. This new tunnel (Tunnel No. 41) was in operation in 1925 and it held the record as the third longest in the continental U.S. (maps 18-21, 23, 25, 26, and 28). In 1926 the new station and snow shed settlement of Norden became the mountain "nerve center" for the newly-double-tracked railroad, and the old station at Summit (located outside the west portal of Tunnel No. 6 on the original Central Pacific line) was abandoned. Microwave technology finally brought an end to the Norden operations in 1985 (Steinheimer and Dorn 1989:39, 44, 47).

Most of the tunnels were reworked in conjunction with the double-tracking program. However in 1967, in order to make full use of the No. 1 track between Norden and Andover (Coldstream Canyon), tunnels no. 6 through 12 were brought up to current clearance standards. The century old bore of Tunnel No. 6 had been largely untouched since the 1860s and drill bits used in the original construction effort were still embedded in the vaulted ceiling of the tunnel. The original summit tunnel was enlarged by lowering the floor 3 ½ feet (Signor 1985:212).

In the early 1990s SP consolidated all traffic onto No. 2 track. Between 1993 and 1994, rails, ties and track hardware were removed from the historic alignment through the summit tunnels nos. 6 through 10, leaving the railroad bed as a gravel road (Kibbey 1996:33).

In 1996 the Southern Pacific Company (formerly the Central Pacific Company) was purchased by the Union Pacific Company (*Sierra Sun* 1997) -- an ironic acquisition in that these two railroads, which had been rivals since the early 1860s, ultimately merged into one.

Donner Spur. A side track, known as Donner Spur, was built between the main line above Coldstream Creek, upstream from its confluence with Donner Creek. The spur passes through the southern edge of the former Teichert property and is still visible at some locales on Donner State Park properties. The spur was double-tracked in 1923. Gordon Richards (n.d.) as researched the spur and the following information is summarized from his unpublished manuscript.

The Donner Spur was originally built to serve the Towle Brothers sawmill on Donner Creek. The mill was located a few hundred yards southwest of the monumented Murphy's Cabin Site. During the 1870s, trains hauled firewood from the Donner Lake watershed.

A spur from the Donner Ice Company left the main line due east of the Teichert quarry, where a switch named "Donner" was established. It continued to function as a water and telegraph stop until 1928. After that year, the "Donner Station" name was transferred to a stop above Donner Lake at Lakeview Canyon.

Powered by the locomotives "White Bear" and "Buffalo", trains on the side track also carried recreational excursion trains to Donner Lake for group picnics and special events.

The *Truckee Republican* newspaper reported in 1874 that the Donner Spur accessed a quarry in Coldstream Valley. The CPRR found Coldstream Valley to contain the best ballast and fill rock in the region and opened a quarry there in 1874. In June of 1905 the *Truckee Republican* reported that gold had been discovered in the gravels once transported by ancestral Donner and Coldstream creeks, but no mining was ever done. Up through the 1960s, Teichert Corporation continued mining the deep deposits of glacial outwash transported by Donner and Coldstream creeks. The deposits of sand and gravel were used extensively during the latter half of the 20th century to build Interstate 80 and other local roads.

Lumbering

Logging was first initiated in the Truckee area after the discovery of the Comstock Lode in l859. When production began to fall in the mines in l867, the lumbering business also began to suffer. A new market for lumber was found in the CPRR. As the rails reached Donner Summit in l866-1867, a number of mills established operations in the Truckee Basin to supply the railroad with cordwood for fuel, lumber for snow shed construction and ties for the roadbed. Truckee soon became one of the major lumbering centers. After the completion of the railroad in l868-1869 lumber companies diversified and grew as new markets were opened to them.

The history of lumbering in the Truckee Basin had its beginnings at Donner Lake and several lumbermen operated in the Donner Lake Basin during the period from 1864 to 1904, serving lumber markets from California to Utah. Angus McPherson established a water-powered sawmill at the east end of Donner Lake in 1864. Between 1864 and 1867 Angus McPherson and his brother, John, were involved in a series of property transfers involving their holdings between the east end of Donner Lake, Coldstream Valley and the Truckee River. McPherson later transferred ownership to the Donner Lake Sawmill Company. Concurrent with the sawmill operations of McPherson and the Donner Lake Sawmill Company, the Towle Brothers were also logging at the east end of Donner Lake ca. 1872, where then had built (or reused) a dam along a prominent lateral moraine downstream Donner Creek (due south of the current state employee housing). Other sources (State of California Division of Water Resources 1945) state that the first dam was built at Donner Lake in 1867 by Towle Brothers for lumbering purposes. The sawmills at the east end of Donner Lake were small operations and the fact that they were operating in such close proximity indicates that their businesses were limited and conducted on a sporadic basis. Timber around Donner Lake was mostly cut out by 1881.

Logging activities after this time were limited to small-scale enterprises. In l904 the Truckee Lumber Company opened a mill at Billy Mack's Flat, two miles west of Donner Lake. The Truckee Lumber Company hauled logs by tractor on the Dutch Flat Donner Lake Wagon Road to Truckee (Lord l98l:29; *Truckee Republican* l906a, 1906b, l906c). Sawmills are shown on maps 7-8 and 29-30).

Fishing

As noted previously, Donner Creek was considered to be a notable Washoe fishery (Rucks 2005:A-5). In historic times, fantastic caches were reported in the major tributary lakes and streams of the Truckee River watershed. Commercial fishing on Donner Lake was given a boost by the completion of the transcontinental railroad. Fish caught in the Sierra Nevada lakes and rivers could be quickly transported fresh to the Comstock mines, Sacramento and San Francisco.

By ca. 1870 the dam owned by Towle Brothers (located about ½ mile below the outlet to Donner Lake) began obstructing fish runs. The trout-breeding farm of John Kelly and James Stewart was established in August 1871 below the outlet of Donner Lake on 400 acres at the junction of Donner Creek and Coldstream (in Section 17 on the former Teichert property). Kelly and Steward reared trout, salmon, shad, black bass, and perch (Richards n.d.). The fishery comprised three natural and three artificial ponds fed constantly by cold clear water, which kept the ponds from freezing. At the start of operations, their largest pond was 600 feet long by 40 feet wide, with another pond being 200 feet long by 100 feet wide. Their average depth was 10 feet. Later on, ponds were divided lengthwise. Fish were fed on native insects and a mush of liver, meat and bran. Debris was filtered through gravel beds and red flannel cloth. Fish eggs were incubated for 50 to 75 days, when fry hatched and were moved into small narrow rearing ponds. It took three years to raise the fish to a market weight of one to two pounds. By April 1872, Kelly and Stewart had 22,000 trout in their ponds and over half (12,000 trout) were two years old. A typical year's collection of eggs yielded 300,000 spawn and about 150,000 marketable fish were harvested over the course of a year and sold to local markets. In the face of declining populations State fish commissioners ordered stockings of non-native species (eastern trout, salmon and whitefish) beginning in 1878. The Commission also passed regulations outlawing fishing during spawning season and tried to curtail commercial fishing on Donner Lake. By 1901 fish ladders were added to the Donner Dam and sport fishing was on the rise (Richards n.d.).

Grazing

According to Richards (n.d.), Truckee butcher Joe Marzen Sr., purchased the ponds from Kelly and Stewart and operated them along with his cattle ranch. Residents picnicing in the meadow were allowed to catch fish for their dinner. By 1902 the western portion of the meadow had turned into a formal picnic area by "The Nifty Band", a small group of local musicians. A wooden platform band stand was constructed to accommodate dancing. In addition to Sunday picnics and evening dances, a baseball field was laid and the meadow became an increasingly more popular community resource for a decade or more.

Joe Marzen, Sr. began acquiring cattle herds in 1872 and he leased the unused portion of Kelly and Stewart's meadow and fenced it to grazing cattle in the summer. He bought the hatchery and meadow in 1874 and built corrals and a small barn. The meadow supported high-quality native grasses and Marzen developed ditches to irrigate it throughout the summer. It became known as Marzen's Meadow. In addition to beef cattle, Marzen raised hogs, chickens and sheep. In 1879 Marzen offered a portion of his land on the site of the Breen cabin to build a monument to the Donner Party, which later became the center piece of the present Donner Memorial State Park.

Marzen continued his operation into the 1880s. In 1901 he leased portions of his meadow to Truckee dairyman Joseph Von Flue to graze his dairy cows. Cattle continued to graze on Marzen Meadow until 1905 when the family sold the property to J. L. . Lewison with the Donner Ice Company.

A livestock business also developed around the high-elevation meadows flanking the Donner Basin and the growth of vegetation in recently logged areas provided temporary sources of stock feed. Sheep herders also grazed their flocks in surrounding mountain meadows and brought them to rail heads for shipping in the fall. Further incentive for sheepmen to bring their flocks into the high country was the fact that sheep bred better in cooler air, they remained cleaner, healthier and there were more multiple births (*Heirloom*, August 2013:2-3).

Ice

The Sierra Nevada ice industry developed greatly after the completion of the transcontinental railroad across the Sierra. Californians no longer had to import ice from Alaska or around Cape Horn from the east coast. From 1868 through the 1920s, the main center of the industry was located on tributaries of the Truckee River and around Donner Pass (Hansen 1987; Itogawa 1974). Sierra ice was noted for its crystal purity and it was proudly served in large hotels throughout the nation. Ice cooled the 140-degree temperatures deep in the shafts of the Comstock mines. In addition ice was essential to refrigerate California produce for rail shipment to the eastern markets. During the short harvest season, with freezing weather beginning about Christmas and continuing through January or February, only two or three ice crops were anticipated. Lumbermen released from seasonal logging work usually found employment in Truckee's ice industry. From 1868 through the 1920s, ice harvesting was an important business in the Truckee area. Competition from artificial ice gradually forced the closing of the ice ponds in the Truckee Basin by 1927. By the time the ice business died out, more than 26 companies had worked the Sierra's ice harvests.

While Donner Lake wasn't cold enough for consistent ice production, ice operations were set up along its perimeters and tributaries (Photo 14). Up to 35,000 tons of ice were harvested in one year at Donner Lake (Meschery 1978:48).

Mr. Grant, proprietor of the Donner Lake House at the foot of the lake, sold ice in 1869 (*Truckee Tribune* 5/12/1869). His icehouse served as a bathhouse in the summer.

Passing reference to the Sitka Ice Company building at the east end of Donner Lake is noted in the *Truckee Republican* (1/15/1874, 8/17/1874), as it was used as a datum point for taking depth soundings of Donner Lake in 1874.

A new wooden ice storage dam was completed in the fall of 1889 at the Donner Lake outlet (Goodwin 1977:n.p.).

To cool his cured meats, Joe Marzen built a small ice pond on Donner Creek above the railroad bridge at the lower end of the meadow and cut and stored his own ice. In 1894 he established the Donner Ice Company and built a 16-foot-high dam on Donner Creek in Marzen Meadow (Richards n.d.). The pond flooded 150 acres that could produce 14,000 tons of 12-inch ice under ideal conditions. He built a large wooden icehouse and sold ice to cool agricultural products that passed nearby on the train. Marzen also constructed a railroad spur from the railroad main line to his icehouse, which was abandoned by 1903 when all of the Donner Creek ice was transferred to a large icing station in Truckee.

In 1906-1907 the Donner Ice Company was sold to the Southern Pacific Railroad under the control of the Pacific Fruit Express Company, which later acquired the Pacific Ice Company. The Pacific Ice Company had its facility on Donner Creek near the former site of the State Agricultural Inspection Station. It was one of the largest users of Truckee ice. The company installed a new steam-powered elevator to efficiently move blocks into the ice house and expanded its capacity to 30,000 tons. A new power plant was constructed in 1909 and in 1910 the original wooden dam was removed and a new 220-foot-long concrete dam was built that doubled the capacity of the ice pond. The ice house burned in December of 1910 and was never rebuilt. The Union Ice Company monopoly purchased the operation to keep it out of production.

In 1895 the Donner Ice Company (of Chicago) purchased holdings within in sections 16 and 17, T17N/R16E and developed its pond below the junction of Coldstream and Donner Creek outlets. At the turn of the century, the Donner Ice Company was an active ice producer on Donner Creek (MacAulay personal communication 1984 in Lindström 1987:22).

Communications

Donner Pass falls squarely within the major trans-sierran communications corridor and several generations of utility lines cross through the study area. The Pacific Railroad Bill of 1862 called for the construction of a railroad and telegraph line across the country (Kraus 1969a:7; McClain 1995:8). The fact that this telegraph line was built in close proximity to the railroad is also implied in Kraus' (1969b) quote:

> At times the lack of wagons make it impossible to keep up the supply of poles and the telegraph gangs, who pride themselves on never letting the track get ahead of them utilize sage brush, barrels, ties – surreptitiously taken from the track – or anything else that would

> keep the wire off the ground until the supply of poles again equal the demand. Then comes a wagon bearing a reel of wire which unrolls as the wagon goes ahead. As the wire uncoils it is carried upon the poles and made fast to the insulators.

The 1865 General Land Office (GLO) survey plat for Township 17 North/Range 16 East shows a telegraph line, which ran from Sacramento to Virginia City and Austin, Nevada via Donner Lake's east end and north shore (Map 4). Although the line does not appear on the adjoining GLO plat for Township 17 North/Range 15 East (Map 5), it is probable that this same line crossed the summit near the route of the transcontinental railroad and through the project area, as documented in a prior archaeological study by Lindström et al. (1999). A correspondent writing for the *Union* newspaper also referred to a telegraph office at Donner Lake in 1865. This telegraph line was operated by the California State Telegraph Company (*Sacramento Union* 1864a, 1864b).

The telegraph line was followed by the main transcontinental lead of the telephone line. The line was later placemented underground to avoid constant damage by the heavy winter snows (Stewart 1964:58-59).

Three major transmission lines crossed Donner Pass -- one in 1923, one in 1937 and one in 1949. A 1923 map of the "Summit-Washoe Transmission Line" shows a transmission line trending through east Truckee to join a larger line that crossed over Donner Summit (Lindström et al. 2007). This may be the same line operated by the Sierra Pacific Power Company and its precursors, Truckee River General Electric Company and Truckee River Power Company. The Truckee River General Electric Company formed in 1899 out of a combine of seven small California and Nevada electric and gas companies to built a series of power plants along the Truckee River to provide electricity to the Comstock. The Company reincorporated as the Truckee River Power Company in 1923. That year increased demand and prolonged drought conditions in Nevada prompted the company to construct a 60-kilovolt transmission line to obtain electricity from Pacific Gas and Electric Company (PG&E) in California. The line went over Donner Summit and down along the Truckee River canyon. The firm of Stone and Webster, which was a majority stock holder for the Truckee River Power Company for much of the 20th century, surveyed the line in 1923. The route is shown on their 1923 map entitled, “Summit to Washoe [Verdi] Transmission Line 60 KV.” In 1928 the Truckee River Power Company (formerly known as the Truckee River General Electric Company) changed its name to the Sierra Pacific Power Company. The early beginnings of the Sierra Pacific Power Company (SPPC) are embedded with a number of small and independent water companies that formed to supply water to the mines of the Mother Lode and the Comstock Lode. Over time, smaller companies were bought-out by larger companies, some of which were to become predecessors of the Sierra Pacific Power Company. The SPPC continued to grow after this time by acquiring stocks of other companies and initiating mergers (Johnson 2006:109-110; SPPC 1977:19). To keep up with increasing demands for power, in 1937 the company constructed a second transmission line to connect with the PG&E facilities in California at Drum (Johnson 2006:33, 110). Sierra Pacific Power Company constructed a third interconnecting line to PG&E ca. 1949 (Johnson 2006:110; Siegle, personal communication 2006 in Lindström et al. 2007). To supplement imported power supplies, the Sierra Pacific Power Company began constructing its own generating plants. A wildfire at Donner Pass in the early 1960s burned the 60kv line and the 120kv line; both lines were replaced. Sierra Pacific Power Company now operates two

120kv lines and one 60kv line over Donner Summit (Siegle, personal communication 2006 in Lindström et al. 2007).

In 1956 the Southern Pacific Railroad installed a pipeline under the auspices of their subsidiary company, Southern Pacific Pipeline Corporation (Map 32). Cut into a series of granite benches along the headwaters of Summit Creek, the eight-inch-diameter pipe was laid into a trench dug from three to five feet deep and two to three feet wide. The pipeline carries gasoline, diesel and jet fuel from Bay Area refineries to as far as Powell Air Force Base in Nevada. On March 1, 1997 a leak in the Santa Fe Pacific fuel pipeline was discovered by cross-country skiers who smelled a petroleum odor about three miles west of Donner Lake. The product flowed down slope in a northerly direction along the pipeline and across granite rock surfaces (located south of old U.S. Highway 40) and into the headwaters of Summit Creek. The product was transported downstream towards Donner Lake. Once the release of petroleum hydrocarbons was known, SFPP immediately shut down operation of their underground pipeline and conducted extensive emergency response and remedial activities.

Water Reclamation

The earliest evidence for damming Donner's outlet relate to lumbering interests during the 1860s and 1870s. There is also general reference to an "original dam of wood" constructed in 1874 (Correspondence: Orrick to SPPC 18 December 1943 in Lindström 1984).

Damming Donner Lake, specifically for the purpose of water reclamation for downstream users, was initiated by Nevada Senator Francis Newlands, as part of a comprehensive plan to irrigate arid desert lands in western Nevada. The plan was to immediately commence construction of a dam at the site of the old Towle mill (referenced as being located ½ mile downstream from the dam at the lake’s outlet. which would raise the surface of the lake about 20 feet (*Reno Evening Gazette* 10/14/1889). Thus, Donner Lake would become part of a chain of lakes in a large water storage system. Newlands purchased lakeside properties at the outlet and also downstream, as shown on a 1913 map of Nevada County (Map 15). Under contract to Newlands, in 1889 the Truckee Lumber Company replaced an earlier dam and excavated a canal, which allowed the lake to be raised six feet (*Reno Evening Gazette* 11/25/1889). Within a few weeks of this transaction, a canal, four feet deep and 16 feet wide, had been constructed in Donner Creek from the lake's outlet to the existing dam, the current site of the Donner Lake Dam and Bridge (*Reno Evening Gazette* 11/25/1889). Excavations continued downstream from the dam for about 1,150 feet to the proposed site of a second dam that was located on land purchased from the Towle Brothers.

> The dam is a solid piece of work. Mr. Mayberry dug down to a depth of six feet below the bottom of the canal to a cement foundation, and filled it in with solid concrete work, which makes it impossible for the dam to spring a leak anywhere through the concrete foundation. He has put in gates ten feet wide by four feet deep, and continued the dam up to a hight [sic] of twelve feet above the surface by two hundred feet long and thirty feet wide on the bottom, built of heavy timber cribs filled with rocks and substantially planked on the upper side. Then he has continued the canal on down a distance of seventy rods further to the site of the proposed other dam on the land purchased from Towle Bros…to complete the system another dam is contemplated by Mr. Newlands, to be constructed on the Towle property, a distance of 90 rods below the present dam… [*Reno Evening Gazette* 11/25/1889].

Plans never materialized for construction of the second dam, neither did more grandiose schemes to impound the waters of both Donner Valley and Cold Creek Valley put forth during this same time.

> One project for the utilization of Donner Basin contemplated the closing of this outlet gap by a high dam, and of the main valley opening, between the intermediate morrainal ridge and the northern mountain spur, by another dam, thus forming a reservoir covering the entire Donner Valley and lake, and at the same time the opening of Cold Creek Valley. Another project contemplated the construction of a long, low dam across the entire valley, following the location of a later terminal moraine situated about half a mile from the lower end of the present lake…A canal line survey was next made, commencing in the former main opening of the Donner Basin, north of the intermediate morainal ridge mentioned, at the site of the proposed dam No. 2 of the Donner Basin reservoir scheme, and extending around north of the town of Truckee to command lands lying between Truckee River and Prosser Creek [USGS 1890-1891:173-174 in Lindström 1984].

A subsequent plan (USGS 1892-1893:389-390) proposed construction of four dams, which would impound waters of Donner and Cold Stream, inundating both valleys, including the present site of Donner State Park. None of these grand schemes progressed beyond the planning stages.

Meanwhile, Nevada's water reclamation plans shifted and the Newlands dam fell into disrepair, with Newlands finally selling his Donner Lake interests in 1917 to a precursor of the Donner Lake Company.

> Several years ago Hon. Francis G. Newlands had constructed across Donner Creek, a few hundred yards below the lake, a timber dam of sufficient height to raise the water 10 or 11 feet above the low-water plane. This structure was not kept in repair, however, and it is now in condition only to retain the water to a height of 6½ or 7 feet [Taylor 1902:52 in Lindström 1984].

By 1929 a new dam of concrete was built by the Donner Lake Company. It was located about 1,600 feet east of the outlet and raised the lake level about 12 feet above the natural level; however, the sill of the dam remained the same as the original wood dam (Orrick 1943 and Senate Journal 1946:684 in Lindström 1984), being at the level of the lake's rim (West 1977:3:685 in Lindström 1984). An agreement between contractor and builder, R.A. Burrows and L.H. Taylor (dated September 29, 1927) delineated the construction agreement. Copies of photographs of dam construction ca. 1928 showing the "old Newlands dam" and the "present dam" (Lindström n.d.) indicate that original photographs may still be on file with the Sierra Pacific Power Company.

The outlet was cleaned out at various times. Work in 1929 was accomplished with a dragline dredge.

> It happens that the Truckee-Carson Irrigation District is now dredging the outlet of Donner Lake so that water may be drawn out to the level of the sill which is the bottom of the lowest gate. Mr. Devore was asked when the channel was last dredged and he said he thought it was about 1926. It appears that there was a sawmill on the South side of the lake several years ago, the sawdust from which was mixed with sediment and filled the outlet several feet deep. Present dredging operations according to Mr. Devore, will lower

> the outlet channel about 12 feet [State of California Division of Water Resources 1945:3 in Lindström 1984].

On August 6, 1931, J. W. Mason, President of the Donner Lake Company, submitted an application to the State Engineer for approval of plans for the Donner Lake Dam. In this application he stated that the dam was rebuilt in 1927 and prior to 1929 (State of California Division of Water Resources 1945 in Lindström 1984).

Meanwhile, former plans were revived ca. 1930 to increase the capacity of Donner Lake "reservoir" and promote larger flows at an estimated total cost of $396,395.00 (West 1977:Exhibit 5:81-83 in Lindström 1984).

> The present outlet structure is a combination bridge and gate structure of reinforced concrete adequate for an increased range in lake levels except that the gates are not set low enough. Of the 3 present gates, 4' x 4' in section, one is set at elevation 5936.8 and two at elevation 5926.8. The spillway lip is at elevation 5936.8. The plan herein contemplated proposes an 11 foot fluctuation of lake levels between elevations of 5921 and 5936 with a storage capacity of 11,680 acre feet in accordance with the tentative agreement drawn up by the Donner Lake Company and the Truckee Carson Irrigation District, the only change from present operations being a lowering of the minimum levels by about 3 feet. The gates would be lowered with their sills at elevation 5918.25 to permit withdrawal of 50 second feet of water at the specified minimum lake level of 5921. For this purpose the present floor of the structure would be removed, the abutments would be carried downward and a new floor constructed. The outlet channel to be dredged along the present stream channel would have a total length of 5500 feet, a bottom width of 12 feet and an average depth of nearly 10 feet. Outlet capacity would increase from 50 second feet with a lake elevation of 5921 to 1800 second feet with a lake elevation of 5936. To augment the water supply of Donner Lake a diversion canal would be constructed from Cold Creek to Donner Lake with a capacity of 500 second feet and a length of 6500 feet…Excavation for the outlet channel and diversion canal will be largely gravel and heavy boulders with much water in the case of the outlet channel. It will no doubt also be required that spoil banks be leveled down, at least in the case of the outlet channel…[additional money]…has been included for raising ground levels around buildings now in place at the west end of the lake, although the plan does not contemplate a raise in present lake levels.

Furthermore, regarding the sill elevation of the lowest of the three gates in the outlet structure, records in the office of the State Engineer (Correspondence: State of California Department of Public Works Division of Water Resources December 17, 1943, In West 2977:Exhibit 8 in Lindström 1984) indicate an intent by planners:

> to build the outlet structure with the bottom or sill of the lowest of the three gates at elevation 5923.8 U.S.G.S. datum. In constructing the combination bridge and dam, however, it appears from the physical facts that the original plan was altered by the inclusion of a steel plate cemented into the sill of the bottom gate which apparently was an afterthought. This conclusion is drawn because the visible appearance tends to show that the original sill elevation was built up by cement grout into which the steel plate was laid. This was probably

done to reduce scour or erosion, because other places in the structure show that scour is a factor which should be considered.

Apparently, the dam was already beginning to show wear as of 1943.

Partial water rights were transferred from the Donner Lake Company to Sierra Pacific Power Company (SPPC) and Truckee Carson Irrigation District (TCID) between 1924 and 1943. Under these agreements, the maximum elevation to which water could be stored was fixed at 5,935.8 feet, this elevation being the maximum to which the lake could be raised without flooding the resort owned by the Donner Lake Company at the west end of the lake. The lake could not be drawn down prior to September 1st of any year below the elevation of 5,932 feet, thus assuring a high enough level to permit the recreational use of the lake (Senate Journal 1945:684). In 1943 Donner Lake was drained below the agreed legal limit, to an elevation of 5,925.86, to permit the SPPC and TCID to clean up the Donner Creek channel to the existing dam (West 1977:Interrogatory No. 9) causing local residents to become concerned about the true intentions of the SPCC and TCID and prompting a U.S. Senate investigation (Senate Journal 1946). The senate investigations produced photo documentation of level rods showing lake elevations ca. mid 1940s.

In its function as a water storage reservoir, Donner Lake's level has fluctuated widely through the years for which records have been kept. Lake level statistics as of 1987 are presented in Lindström (1987:24-25). Donner Lake has a surface level area of roughly 850 acres and a depth of 225 feet. The natural lake level, in the absence of any dam, is 5924 feet elevation and the current lake level capacity with the dam is 5936 feet, entailing a normal rise of 12 feet. Melt-off from the “huge” snow pack of 1889-1890 brought overflowing conditions at Donner Lake, which were feared too much for the new ice dam completed in the fall of 1889 at the east end of the lake (Goodwin 1977). The gates were thrown open to lower the lake level and reduce the pressure to the dam. Its greatest recorded fluctuation is 17.7 feet, with a record high of 5938.7 feet elevation (reported during flood stage on 12/10/1937). At that time "old" U.S. 40 was flooded when the dam was bypassed and channels were cut that had to be backfilled in order to restore the lake to the desirable level (Senate Journal 1946:685 in Lindström 1984). A record low of 5921 feet elevation was reported on 12/1/1928 during dredging operations, one of several that served to clear the channel of debris and sediment and thereby maintain the reservoir at its minimum level.

Community Development and Tourism

Small resorts and hotels were established around Donner Lake in the 1860s as the railroad rendered Truckee and Donner Lake accessible. By 1864 the *Dutch Flat Enquirer* (10/1/1864) reports that at the lower end of Donner Lake there was "...quite a settlement...2 hotels, a store, blacksmith shop, express office and several dwellings..." This is the earliest settlement activity at Donner Lake and it centered at King and Ingraham's Station and McPherson's Donner House. In 1866 B.I. Meeder ran a blacksmith shop on Donner Lake Road at the foot of Donner Lake. Potter and Sawyer operated a meat market on Donner Lake Road, one-half mile east of Donner Lake. In 1866 Billy Yeng was assessed for his house at the foot of Donner Lake on the Donner Lake Road. J.R. Cross owned a house at the east end of Donner Lake that was also used as a saloon in 1867. Sisson, Egbert and Company operated a store at the foot of Donner Lake on the Donner Lake Road and was assessed as of 1867. In 1869 Grants Hotel was in operation at the east end of Donner Lake, complete with bathhouse and rowboat rentals (*Truckee Tribune* 5/12/1869). In 1872 Sam Welsch leased the Grant Hotel at the lower end of the lake for five years (*Territorial Enterprise* 7/18/1872).

The *Truckee Republican* (6/2/1906) announced the opening of the Donner Lake House in 1906. (This may have been the new name for the old Grant Hotel.) Donner City/Donner Resort was established at the west end of Donner Lake and current site of the Truckee Donner Parks and Recreation Beach (Map 19, Photo 13). Boats were rented on the lake and a steamer ("Minnie Moody") plied its waters (Photo 12).

With its favored location adjacent to the railroad, and later to transcontinental highways, the Truckee area also became a focal point of early mountain residential development. Residential subdivisions along Donner Lake date to the 1910s. In 1917 Newlands sold his interests in the area to the Occidental Land and Improvement Company, a corporation precursor to the Donner Lake Company. The company began subdividing lots in 1919, starting with the Donner Lake Company's Lakeview Subdivision. Lake waters were used by the Donner Lake Company and by a limited number of its grantees, who during the summer occupied homes near the lake and also by guests of the company's Donner Lake Resort at the west end (Orrick 1943 in Lindström 1984). The Donner Dam and Bridge, built in 1927, replaced a series of wooden crib dams, whose initial construction may have dated to 1874 (Lindström 1987). Embellishments (non-typical of a dam or bridge intended only for water reclamation use) were incorporated into the design of the new bridge, such as decorative concrete railings and light standards that were described as "pretentious" in early reports. These improvements reflect the intent of the Donner Lake Company to incorporate the dam as a main travel way within their new resort and residential retreat. A historic road, which accesses the northern end of the dam and present-day U.S. 40 and extends to the southwestern boundary of Donner State Park, likely dates from at least the Lincoln/Victory Highway era (ca. 1913-1925) and may date from the 1860s, when the Dutch Flat and Donner Lake Wagon Road was the main travelway. The Donner Lake Company had planned this road as the main connector between "old" U.S. 40 and their planned development on the south side of Donner Lake.

General lot sales continued until World War II. After the war, the Occidental Land Company reemerged in 1946 as the Donner Lake Development Company. The Donner Lake Development Company compiled a lot map in 1948 (Map 31) based upon initial lot divisions laid out on a 1926 map by J. P. O'Connor. Most of these lots were essentially built-out by the mid 1950s to 1960s. Subdivision development along the east end of Donner Lake was halted when the State of California bought the land from the Donner Lake Company in 1948. The area surrounding the Pioneer Monument (completed in 1918 to honor emigrant passage during the mid to late 1840s) had already been added to the State Park in 1928 (Nesbitt 1990). As a further part of their exit plan, between 1924 and 1943, the Donner Lake Company transferred partial water rights to the Sierra Pacific Power Company and Truckee Carson Irrigation District. Under these agreements, the dam at Donner Lake fixed the maximum lake level at 5,935.8 feet, just under the flooding point for resort docks owned by the Donner Lake Company at the west end of the lake.

The Truckee-Donner area is unique among turn-of-the-century mountain communities, in that winter-sports enthusiasts could easily reach the area in winter via the first transcontinental railroad or the first transcontinental highway. By the mid-1890s nearby Truckee was host to ice carnivals, drawing people from both east and west of the Sierra in order to enjoy the mountain winters. Sleighing, tobogganing, dog races, two large ice palaces, and Hilltop's ski area and ski jump were some of the attractions offered to tourists (Photo 17). "Snow-Ball" special excursion trains accessed developing ski areas around Soda Springs. The first known ski lift in America was reportedly built in Truckee in 1913. The development of Truckee's Hilltop ski hill and ski jump during the 1910s-1930s and the 1960 Winter Olympics at nearby Squaw Valley secured Truckee's position as a center point for year-round recreation.

Public Utilities

The growing needs of Truckee prompted the establishment of several private water companies. One of the earliest water sources was developed as part of the McGlashan water system. The McGlashen water system extended from McGlashan Springs (located along the north flank of the Donner Basin and within present-day Tahoe Donner subdivision in the vicinity of Bermgarten Road). The system extended eastward along the ridge to the Northside/Town Station above downtown Truckee. The McGlashan Spring domestic water use dates from the incorporation of the McGlashan Water Company in August of 1889. This water, originally piped to Truckee for use in the McGlashan Addition subdivision on High Street, contributed to the Truckee water supply into the 1970s (Richards to Board of Directors 2006).

Small independent systems were unable to supply enough sanitary water to the growing town and most of these older systems were later consolidated under the Truckee Donner Public Utility District (TDPUD), which was incorporated in 1927 (TDPUD 1968:18, 25-26; 1971:II-45). The TDPUD purchased the McGlashan Water Company in 1943 (Tahoe Donner Association Archives McGlashan File-Bill of Sale McGlashan Water Co. to "Truckee Public Utility District" [now TDPUD] April 26, 1943). The TDPUD now owns 160 acres of undeveloped land to the west of Northwoods Boulevard, which it acquired along with the McGlashan water system in 1943. The parcel contains springs that were part of the McGlashan water system and were used by the PUD water system for several years. The District ceased using the spring water because the cost of maintaining the spring boxes, treating the spring water and maintaining the piping system became impractical considering the quantity of water provided (Holzmeister to Board of Directors 6/2/2006). The TDPUD rehabilitated the McGlashan Springs in June 1960.

In ca. 2000 the TDPUD also assumed control of the Donner Lake Water Company, which historically tapped a number of springs within the Donner Basin to service its customers. The TDPUD has since initiated a number of upgrades to the Donner Lake System (maps 33 and 34).

CONCLUSIONS AND RECOMMENDATIONS

This preliminary heritage resources assessment confirms the moderate to high potential for important heritage resources to occur within the study area and impacts to these resources could result with implementation of the various project alternatives under consideration. The completion of additional archaeological tasks are required prior to any project action. These tasks are standard archaeological protocols outlined in state antiquities guidelines under the California Environmental Quality Act (CEQA Section 5024, Public Resource Code) and federal guidelines under Section 106 of the National Historic Preservation Act of 1966, as amended (16 USC§ 470 *et seq*.). Recommended archaeological tasks, which outline the proper protocol for heritage resource management, are summarized below in the appropriate order of their completion. The relative level of effort and timing for completion of each of these archaeological tasks would likely be determined at a later date in the restoration planning process.

(1) On-going Consultation

- contact with tribal representatives (Washoe and Nisenan)
- oral history interviews with individuals knowledgeable in local history (Donner Summit Historical Society and Truckee Donner Historical Society)
- consultation with Department of Parks and Recreation (DPR) archaeologists

(2) Archival Research

- records search at the North Central Information Center, California State University, Sacramento
- records search of DPR files
-

(3) Archaeological Field Research

- field verification of known archaeological sites to assess their current content and integrity
- archaeological field reconnaissance in order to detect any newly discovered archaeological resources; the field reconnaissance should be conducted by a qualified archaeologist and involve a local Native American representative

(4) Preparation of Final Report

- final report must be in compliance with Section 106 of the National Historic Preservation Act (NHPA) of 1966 (as amended 16 USC§ 470 *et seq*.) and guidelines established by Placer and Nevada counties under the California Environmental Quality Act (CEQA Section 5024, Public Resource Code)
- review and concurrence by agency personnel, in consultation with the State Historic Preservation Officer (if appropriate) and other interested parties (including Washoe and Nisenan tribal representatives).

(5) Archaeological Monitoring

- public access into the study area is likely to increase over time and the potential for increased archaeological site vandalism should be monitored on a periodic basis
- monitoring of archaeological sites during the implementation of restoration projects may be required

(6) Public Interpretation

- Selected archaeological sites (that have been studied/stabilized and where vandalism is not likely to occur) should be developed as part of a program to further educate the public regarding the prehistory and history of Donner Lake Basin.

REFERENCES CITED

Antevs, E.

1925 On the Pleistocene History of the Great Basin. In *Quaternary Climates Washington D.C.: Carnegie Institution Washington Publication* 325:51-114.

Avery, Benjamin

1874 "Summering in the Sierra". *Overland Monthly and Out West Magazine* (Page175). February, 1874.

Beals, R. L.

l933 The Ethnology of the Nisenan. *University of California Publications in American Archaeology and Ethnology* 3l(6). Berkeley.

Birkeland, Peter W.

l963 Pleistocene Volcanism and Deformation of the Truckee Area, North of Lake Tahoe, California. *Geological Society of America Bulletin* 74:l452-l464.

l964 Pleistocene Glaciation of the Northern Sierra Nevada, North of Lake Tahoe, California. *Journal of Geology* 72:8l0-825.

Bloomer, William and Susan Lindström

2006 Archaeological Investigations at Squaw Valley. Report on file North Central Information Center, California State University, Sacramento.

Bryant, Edwin

1848 *What I Saw in California*. (page 232). Boston: IndyPublish.com.

Bryd, Davis S.

1992 Roads and Trails in the Tahoe National Forest: A Contextual History, 1840-1940. *Tahoe National Forest Cultural Resources Report Number* 39. Nevada City.

Central Pacific Railroad

n.d. “Map of that Portion of the Railroad of the Central Pacific Railroad Company of California Lying within the State of California” (scale: 1 inch = 1 mile). Map on file California State Railroad Museum. Sacramento.

1861 Report of the Chief Engineer on the Preliminary Survey and Cost of Construction of the Central Pacific Railroad of California, across the Sierra Nevada Mountains from Sacramento to the Eastern Boundary of California. October 1, 1861. Report on file California State Railroad Museum Library. Sacramento.

1865a Central Pacific Railroad. Statement made to the President of the United States and Secretary of the Interior of the Progress of the Work, October 10, 1865. Sacramento: H.S. Crocker & Co. Printers. Publication on file California State Railroad Museum Library. Sacramento.

1865b Reports of the President and Chief Engineer upon Recent Surveys, Progress of Construction, and Estimated Revenue of the Central Pacific Railroad of California. December 1865. Report on file California State Railroad Museum Library. Sacramento.

1867a Railroad Communication with the Pacific, with an Account of the Central Pacific Railroad, California: The Character of the Work, its Progress, Resources, Earnings and Future Prospects, and the Advantages of its First Mortgage Bonds. May 1867. New York: Hosford & Sons, Stationers and Printers. Publication on file California State Railroad Museum Library. Sacramento.

1867b "Diagram Showing the Connection of the Central Pacific Railroad with the Public Surveys" (scale: 1 inch = 1 mile), October 1867. Map on file California State Railroad Museum. Sacramento.

Chinn, Thomas W.

1969 *A History of the Chinese in California: A Syllabus.* San Francisco: Chinese Historical Society of America.

Daily Alta California

1860 (11/16/1860) Dutch Flat, California.

d'Azevedo, W. L.

1955 Washoe Place Names. Ms. on file with the author. Reno.

1984 The Washoe. Unpublished manuscript in possession of the author. Reno.

1986 Washoe. In Great Basin, edited by W. L. d'Azevedo. *Handbook of North American Indians Volume* 11. Washington: Smithsonian Institution. pp. 466-498.

DeQuille, D.

1877 *The Big Bonanza.* American Publishing Company. Hartford Connecticut. Reprint Spring 1974.

Downs, James F.

1966 *The Two Worlds of Washoe. An Indian Tribe of California.* Holt, Rinehart, and Winston, New York.

Dutch Flat Enquirer

1864 (10/1/1864) Dutch Flat, California.

Earl, Phillip I.

1989 Scaling the Sierra by Rail. *North Lake Tahoe Bonanza*, Tahoe Life, Section A, Page 1. Wednesday, May 31, 1989. Incline Village, Nevada.

Elston, R. G.

1971 A Contribution to Washo Archaeology. *Nevada Archaeological Survey Research Papers* 2. Reno.

1982 Good Times, Hard Times: Prehistoric Culture Change in the Western Great Basin. In *Man and the Environment in the Great Basin*, edited by D. B. Madison and J. F. O'Connell, pp. 186-206. SAA Papers No. 2. Society for American Archaeology, Washington D.C.

1986 Prehistory of the Western Area. In Great Basin, edited by W. L. d'Azevedo, pp. 135-148. *Handbook of North American Indians, Vol* 11, W. G. Sturtevant, general editor, Smithsonian Institution, Washington D.C.

Elston, R. G., K. A. Ataman, and D. P. Dugas

1995 A Research Design for the Southern Truckee Meadows Prehistoric Archaeological District. Report on file Toiyabe National Forest. Sparks.

Elston, R., J. Davis, A. Leventhal, and C. Covington

1977 *The Archaeology of the Tahoe Reach of the Truckee River.* Prepared for the Tahoe-Truckee Sanitation Agency by the Northern Division of the Nevada Archaeological Survey, University of Nevada, Reno.

Elston, R. G., S. Stornetta, D. P. Dugas, and P. Mires

1994 Beyond the Blue Roof: Archaeological Survey of the Mt. Rose Fan and Northern Steamboat Hills. Ms. on file, Intermountain Research, Silver City.

Farquar. F.A.

1965 *History of the Sierra Nevada*. Berkeley: University of California Press.

Francis, Julie

1994 *Historic Context and Evaluation of Automobile Roads in Wyoming*. Wyoming Department of Transportation. Draft.

Freed, S.

1966 Washo Habitation Sites in the Lake Tahoe Area. In Notes on Western Nevada Archaeology and Ethnography. *University of California Archaeological Survey Reports* 66(3):73-84. Berkeley.

Gillis, John R.

1870 Tunnels of the Pacific Railroad. *American Society of Civil Engineers Transactions*, XIII, Volume 1. pp. 153-169. A paper read before the Society January 5, 1870.

Goodwin, Victor

1977 Water and Related Land Resources: Central Lahontan Basin with Flood Chronology, Truckee River Subbasin: Volume 3. U.S. Forest Service.

Graydon, C.

1986 *Trail of the First Wagons over the Sierra Nevada.* Gerald, Missouri: Patrice Press.

Grayson, Donald K.

1993 *The Desert's Past: A Natural Prehistory of the Great Basin*. Washington, DC: Smithsonian Institution Press.

Hansen, Richard

1987 Truckee Basin's Ice Age. *Sierra Heritage.* December. Auburn.

Hardesty, D.L.

1990 *The Archaeology of the Donner Party*. Reno: University of Nevada Press.

Hardesty, D.L. and S.G. Lindstrom

1990 The Archaeology of the Murphy Cabin. In *The Archaeology of the Donner Party*. Reno: University of Nevada Press.

Hardman, G. and O. E. Reil

1936 *The Relationship Between Tree Growth and Stream Runoff in the Truckee River Basin*. California-Nevada. Bulletin 141, Nevada Agricultural Experiment Station. Reno.

Heirloom

2013 Donner Summit Historical Society Newsletter, Bill Oudegeest, editor. August 2013. Soda Springs, California.

Heizer, R. and A. Elsasser

1953 Some archaeological Sites and Cultures of the Central Sierra Nevada. *University of California Archaeological Survey Report*, No. 21, Berkeley and Los Angeles. (Cited in The Martis Complex Revisited by Elsasser and Gortner 1991)

Holzmeister, Peter to Board of Directors

2006 Correspondence, Truckee Donner Public Utility District, Truckee.

Howard, Thomas F.

1998 Sierra Crossing: First Roads to California. Berkeley: University of California Press.

Itogawa, Eugene M.

1974 The Natural Ice Industry in California. M.A. Thesis. Thesis on file, California State University, Sacramento.

Jackson, W. T., R. Herbert and S. Wee

1982 History of Tahoe National Forest 1840-1940. Report on file Tahoe National Forest, Nevada City, California.

Jacobsen, W.

1966 Washo Linguistic Studies. In The Current Status of Anthropological Research in the Great Basin, 1964, edited by W. d'Azevedo, pp. 113-136. *Desert Research Institute Publications in the Social Sciences*. 1:113-136.

Johnson, Erika

2006 Along the Smooth and Slender Wires: A Historic Context for Overhead Communication and Electrical Lines in Nevada. Report prepared for Sierra Pacific Power Company by Summit Envirosolutions, Inc. Carson City.

Kibbey, Mead B.

1996 *The Railroad Photographs of Alfred A. Hart, Artist.* Sacramento: The California State Library Foundation.

King, Joseph A.

1994 *Winter of Entrapment*, *A New Look at the Donner Party*. Revised Edition. Lafayette, California: K and K Publications.

Knowles, C. D.

1942 *A History of Lumbering in the Truckee Basin from 1855 to 1936.* Report on file U.S. Forest Service, Lake Tahoe Basin Management Unit, South Lake Tahoe. (Index and annotations by R. M. Trespel and D. L. Drake, 1991.)

Kraus, George

1969 *High Road to Promontory*. Palo Alto: American West Publishing Co.

Kroeber, A. L.

l925 Handbook of the Indians of California. *Bureau of American Ethnology, Bulletin* 78. Washington D. C.

Lindström, Susan G.

n.d. Exhibits. “Motion for Summary Adjudication Navigability of Donner Lake” (testimony; declarations; memoranda in opposition to summary judgments; historic maps, manuscripts, photographs, deeds, assessments, special collections, publications, periodicals, and newspapers; dissertations and theses; government reports; government survey field notes; boundary line determinations; limnological data; personal communications; etc.) on file, Susan Lindström Library, Truckee.

1978 An Archaeological Reconnaissance of the Pacific Crest Trail, Tahoe National Forest, Parts I & II. Report on file Tahoe National Forest, Nevada City, California.

1984 State Lands Commission research. Information on file, Susan Lindström Library, Truckee.

1985 Archaeological Investigations at Tallac Point (CA-Eld-184). Prepared under U.S. Forest Service Contract No. 91U9-657, Lake Tahoe Basin Management Unit, South Lake Tahoe.

1987 A Historical Context of Donner Memorial State Park. Manuscript prepared for and on file with Donner State Park, Truckee, California.

1990 Submerged Tree Stumps as Indicators of Mid-Holocene Aridity in the Lake Tahoe Basin. *Journal of California and Great Basin Anthropology* 12(2).

1992 Great Basin Fisherfolk: Optimal Diet Breadth Modeling of the Truckee River Prehistoric Subsistence Fishery. Ph.D. Dissertation. University of California, Davis.

1996 Great Basin Fisherfolk: Optimal Diet Breadth Modeling of the Truckee River Prehistoric Subsistence Fishery. In *Prehistoric Hunter-Gathering Fishing Strategies*, edited by M. Plew. Boise State University Press. Boise, Idaho.

1997 Lake Tahoe Case Study: Lake Levels. In Status of the Sierra Nevada Addendum, Sierra Nevada Ecosystem Project Final Report to Congress. *Wildland Resources Center Report* No. 40. Appendix 7.1 pp. 265-268. University of California. Davis.

Lindström, Susan G., John Betts, Leon Schegg, and Don Wiggins

1999 The Archaeology of Donner Pass. Santa Fe Pacific Pipeline Donner Pass Incident Heritage Resource Inventory. Report prepared for Santa Fe Pacific Pipeline Partners, L.P. on behalf of the U.S. Forest Service, Tahoe National Forest, Truckee, California. Report on file North Central Information Center, California State University, Sacramento.2001Royal Gorge Lodge and Home Sites at Summit Valley Heritage Resource Inventory, Soda Springs, California. Report on file North Central Information Center, California State University, Sacramento.

Lindström, S.G. and W.B. Bloomer

1994 Evaluation of Site Data Potential for 26Wa5322 (TY3437/05-19-280), Tahoe Meadows Prehistoric Site Complex, Segment 17 of the Tahoe Rim Trail near Mt. Rose, Lake Tahoe, Nevada, Washoe County. Report (TY-94-1004) on file Toiyabe National Forest. Sparks.

Lindström, S.G., W.B. Bloomer, P. Rucks, D. Craig Young

2002 Archaeological Test Excavations at CA-PLA-718/H Volume 1: Contextual Background: Lake Tahoe Outlet. Report prepared for State of California, Department of General Services, Real Estate Services Division. West Sacramento, California.

Lindström, S.G., W.L. d'Azevedo and P. Caterino

1998 Cave Rock Heritage Resource Protection Management Plan. Report on file Tahoe Regional Planning Agency. Lake Tahoe, Nevada.

Lindström, Susan, Penny Rucks and Peter Wigand

2000 A Contextual Overview of Human Land Use and Environmental Conditions. In Lake Tahoe Watershed Assessment: Volume 1. Dennis D. Murphy and Christopher M. Knopp (eds.). USDA Forest Service General Technical Report PSW-GTR-174. May 2000. pp. 23-130.

Lindström, Susan, Sharon Waechter, Penny Rucks, Ron Reno, Charles Zeier

2007 From Ice Age to Ice Works: Archaeological, Ethnohistorical and Historical Studies for the Truckee River Legacy Trail Project (Phase 3). Far Western Anthropological Research Group, Inc. and Susan Lindström, Consulting Archaeologist. Report on file North Central Information Center (#8960), California State University, Sacramento.

Littlejohn, Hugh W.

1928 Nisenan Geography. Manuscript in Bancroft Library, University of California, Berkeley.

Lord, Paul A.

l98l *Fire and Ice*. Truckee: Truckee Donner Historical Society.

McClain, Jim

1995 Drilling through Granite: Construction of the Summit Tunnel. *Sierra Heritage*, November/December 1985. Auburn, California.

McGuire, Kelly, Sharon Waechter, D. Craig Young, and Daron Duke

2006 Volume 1. Prehistoric Sites: Archaeological Investigations at the Alder Hill Prehistoric Basalt Quarry, Nevada County, California. Far Western Anthropological

Research Group, Inc., Davis, California. Prepared for East West Partners, Truckee, California.

Meschery, Joanne

1978 *Truckee*. Truckee: Rocking Stone Press.

Moore, M. and T. Burke

1992 Cultural Resource Inventory and Evaluation: Truckee River Flood Control Project, Washoe and Storey Counties, Nevada. Summary Report. Archaeological Research Services. Virginia City. Report on file Army Corps of Engineers. Sacramento.

Myrick, David

1962 *Railroads of Nevada Volume I*. San Diego: Howell North Books.

Nesbitt, P.

1990 The Cultural Resources of Donner Memorial State Park. Ms. On file Sierra District, Cultural Resource Unit Files, Tahoma.

Nevers, J.

l976 *Wa She Shu: A Tribal History*. University of Utah Printing Service. Salt Lake City.

Newlands, F. G.

1890 An Address to the People of Nevada on Water Storage and Irrigation. In Susan Lindström unpublished manuscript, 1984. Truckee.

Orrick, W.H.

1943 Correspondence: W.H. Orrick, Attorney, to Sierra-Pacific Power Company relative to ownership of bed of Donner Lake. Ms. on file Susan Lindström Library, Attachment 9. Truckee. In Susan Lindström unpublished manuscript, 1984. Truckee.

Price, J. A.

l962 Washo Economy. *Nevada State Museum Anthropological Paper* 6. Carson City. Washington.

Protteau, Lynn

1988 *The Dutch Flat and Donner Lake Wagon Road: Its History and Location*. Typescript. October 13, 1988. (Caltrans, "Lincoln Highway" folder).

Reno Evening Gazette

1889 (10/14/1889; 11/25/1889) Reno, Nevada.

Richards, Gordon

n.d. Donner Meadow History. Unpublished manuscript on file Susan Lindström Library, Truckee, California.

Richards, Gordon to Board of Directors

2006 Correspondence. Truckee Donner Historical Society to Truckee Donner Public Utility District, 6/1/2006, Truckee.

Riddell, F.A.

1960 Honey Lake Paiute Ethnography. *Nevada State Museum Anthropological Papers* No. 4. Carson City.

Rucks, M.

1996 Ethnographic Report for North Shore Ecosystems Heritage Resource Report (HRR#05-19-297). Ms. on file, USFS - Lake Tahoe Basin Management Unit, South Lake Tahoe.

2005 Notes on Washoe Ethnography and History in the Vicinity of Donner-Truckee. Contributions by Jo Ann Nevers. Report prepared for Summit Envirosolutions, Inc., Carson City, on behalf of Sierra Pacific Power Company, Reno.

Sacramento Daily Union

1865 (1/2/1865) Sacramento, California.

Sierra Sun

1997 Truckee, California.

Signor, John R.

1985 *Donner Pass: Southern Pacific's Sierra Crossing*. San Marino, California: Golden West Books.

Simpson, James H.

1859 *Report of Explorations Across the Great Basin 1859 by Captain J. H. Simpson.* Reno: University of Nevada Press.

State of California

1991 Department of Parks and Recreation (map of the Truckee Route of the Emigrant Trail). Sacramento.

State of California Division of Water Resources

1945 Division of Water Resources internal memo commenting on Deputy Attorney General's memo relative to Donner Lake. Ms. on file Susan Lindström Library, Attachment 11. Truckee.

Stewart, O. C.

l966 Tribal distributions and boundaries in the Great Basin. In W. L. d'Azevedo (ed.), the Current Status of Anthropological Research in the Great Basin: l964. *Desert Research Institute of Social Sciences and Humanities Publication No. 1*. Reno.

Steinheimer, Richard and Dick Dorn

1989 *Diesels over Donner*. Glendale, California: Interurban Press.

Stewart, George R.

1964 *Donner Pass and Those Who Crossed It*. Menlo Park, California: Lane Book Company.

Stewart, O. C.

l966 Tribal distributions and boundaries in the Great Basin. In The Current Status of Anthropological Research in the Great Basin: l964 (W. d'Azevedo, ed.). *Desert Research Institute of Social Sciences and Humanities Publication No. 1*. Reno.

Stine, Scott

1994 Extreme and Persistent Drought in California and Patagonia during Medieval Time. *Nature* 369(6481):546-549.

Storer, T. and R. Usinger

l97l *Sierra Nevada Natural History*. Berkeley: University of California Press.

Tahoe Donner Association Archives

1943 McGlashan File-Bill of Sale McGlashan Water Co. to "Truckee Public Utility District" [now TDPUD] April 26, 1943.

Territorial Enterprise

1872 (7/18/1872) Virginia City, Nevada

Truckee Donner Public Utility District

1968 Water Master Plan, Truckee Donner Public Utility District. Report on file Truckee Donner Public Utility District, Truckee.

Truckee Republican

various Truckee, California.

Truckee Tribune

1869 (5/12/1869) Truckee, California.

Unruh, John D. Jr.

1979 The Plains Across: The Overland Emigration and the Trans-Mississippi West, 1840-1860. Urbana: University of Illinois Press.

U.S. Geological Survey

Water Supply Paper No. 68. Ms. on file Susan Lindström Library Attachment 4. Truckee.

U.S. Geological Survey

1890-1891 Eleventh Annual Report of the U.S. Geological Survey, Part II, Irrigation. Washington D.C. Ms. on file Susan Lindström Library. Truckee.

1892-1893 Thirteenth Annual Report of the U.S. Geological Survey, Part II, Irrigation. Washington D.C. Ms. on file Susan Lindström Library. Truckee.

United States Senate Journal

1946 Senate Journal excerpt, 19 February 1946, pps. 684-685. Ms. on file Susan Lindström Library, Attachment 12. Truckee.

Washoe Tribal Council

1994 *Comprehensive Land Use Plan*. Ms. on file, Tribal Government Headquarters, Gardnerville.

West, James M.

1977 "Declaration" in the matter of Branderburger e. al. vs. State of California. Sacramento. Exhibits 1-11. Ms. on file Susan Lindström Library. Truckee.

Weston, Charis Wilson and Edward Weston

1940 *California and the West.* New York: Duell, Sloan and Pearce. Excerpts on file Donner Summit Historical Society. Soda Springs, California.

Williams, Henry T.

1876 *The Pacific Tourist, Willliams' Illustrated Trans-Continental Guide of Travel from the Atlantic to the Pacific Ocean: A Complete Traveler's Guide of the Union and Central Pacific Railroads*. New York: Henry T. Williams, Publisher.

Wilson, N. and A. Towne

l978 Nisenan. In: *Handbook of North American Indians California, Vol*. 8. R. F. Heizer (ed.). William G. Sturtevant, general editor. Washington DC: Smithsonian Institution, pp. 387-397.

Woodward, James

2001 Donner Memorial State Park History. Ms. on file Sierra District, Department of Parks and Recreation Cultural Resource Files. Tahoma.

DONNER LAKE BASIN

WATERSHED ASSESSMENT

A CONTEXTUAL OVERVIEW OF HUMAN LAND USE

AND

ENVIRONMENTAL CONDITIONS

WORKBOOK

APPENDIX 1: Native American Correspondence

Susan Lindström, Ph.D. (RPA), Consulting Archaeologist

Truckee, California

August 2015

Susan Lindström, Ph.D.

Consulting Archaeologist

P.O. Box 3324
Truckee CA 96160
530-587-7072
slindstrom@cebridge.net

DATE: August 14, 2015

TO: Darrel Cruz, Tribal Historic Preservation Officer
Washoe Tribe of Nevada and California
919 Hwy 395 South, Gardnerville, NV 89460
775-782-0014 (775-546-3421 cell)
darrelcruz@washoetribe.us

RE: Donner Lake Basin Watershed Assessment Project

The Truckee River Watershed Council (TRWC) is conducting an initial watershed study of the Donner Lake Basin, an area over 10,800 acres in size. Donner Lake is a critical resource in the Truckee River watershed and the goal of the Donner Lake Basin Watershed Assessment is to provide the science and policy information needed to establish a baseline to direct restoration and protection projects within the watershed.

As you know, the Donner Basin watershed has had a long period of human occupation, beginning with use by the Washoe Tribe and their prehistoric ancestors and it is highly sensitive to contain Native American resources. The TRWC maintains that watershed restoration efforts can benefit from an understanding of the long-term ecological role of aboriginal peoples in the dynamics of wild plant and animal populations and alterations of the physical environment and wishes to explore the direct link between culture history and contemporary project design and implementation. In this effort, Tribal input is encouraged at this early stage of project.

I wish to bring this study to the Washoe Tribe's attention and I invite your opinions, knowledge and sentiments regarding traditional Native American lands within the project area. I look forward to hearing from you if you have any additional information and would welcome your formal response in a brief memo/letter regarding the project that I might include in the cultural resource study report.

Thank you very much.

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Susan Lindström, Ph.D.

Consulting Archaeologist

P.O. Box 3324
Truckee CA 96160
530-587-7072 voice
slindstrom@cebridge.net

DATE: August 28, 2014

TO: April Moore
19630 Placer Hills Road
Colfax, CA 95713
530-637-4279

RE: Donner Lake Basin Watershed Assessment

The Truckee River Watershed Council (TRWC) is conducting an initial watershed study of the Donner Lake Basin, an area over 10,800 acres in size. Donner Lake is a critical resource in the Truckee River watershed and the goal of the Donner Lake Basin Watershed Assessment is to provide the science and policy information needed to establish a baseline to direct restoration and protection projects within the watershed.

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I wish to bring this study to your attention and I invite your opinions, knowledge and sentiments regarding traditional Native American lands within the project area. I look forward to hearing from you if you have any additional information and would welcome your formal response in a brief memo/letter regarding the project that I might include in the cultural resource study report.

Thank you very much.

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DONNER LAKE BASIN
WATERSHED ASSESSMENT

A CONTEXTUAL OVERVIEW OF HUMAN LAND USE
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APPENDIX 2: Time Line of Human History

Susan Lindström, Ph.D. (RPA), Consulting Archaeologist

Truckee, California

August 2015

DONNER LAKE BASIN WATERSHED ASSESSMENT
TIME LINE OF HUMAN HISTORY
***SUMMARY OF HERITAGE THEMES**

Date	Event
Prehistory	
9,000 years ago-1840s	-prehistory/Washoe Indian history -fishing techniques (construction of rock dams and stream diversions along Donner Creek)
Transportation	
1844-1852	emigrant travel along north side Donner Lake over Donner Pass; multiple routes of the Emigrant Trail up and over Donner Pass are likely
1857-1859	toll road from Donner Pass to Donner Lake
1864	Dutch Flat and Donner Lake Wagon Road (DFDLWR) opens as a major trans sierran wagon and stage route built over Donner Pass, and along the north side of Donner Lake to Truckee
1864	construction of Central Pacific Railroad (CPRR, first transcontinental railroad) approaches Donner Pass
1867	steamers across Donner Lake
1868-1869	completion of CPRR over Donner Pass, along the south side Donner Lake to Truckee
1874	stage coach service between Truckee and Donner Lake
1875	CPRR lays side track to Donner Lake to pick up 10,000 cords of wood, stacked for two years
1909	State highway over Donner Pass to west end of Donner Lake with reroutes of DFDLWR west of Donner Pass
1913/1914-1925	Lincoln Highway (first transcontinental highway) constructed over Donner Pass and north side of Donner Lake to Truckee
1923	new grade of Lincoln Highway constructed between the pass and Donner Lake's west end
1928	route incorporated as U.S. 40 (State Route 37)
1964	I-80 completed over Euer Saddle and U.S. 40 reverts to county jurisdiction
***Water Reclamation*	
1865-1866	natural lake level (in the absence of any dam) is 5924 feet
1867	dam built by Towle Bros. Lumber Co.
1870	dam across outlet owned by Towle Bros. obstructs fish run

1871 or 1877	original dam construction
1874	"The outlet of the lake through Donner Creek is very narrow, which is the cause of the rise in the water." (no mention of a dam)
1870-1880	construction of dam 1000 feet east of outlet
1889	dam construction at outlet; plans to construct a second dam 1500 feet downstream (Newlands project)
1889	canal constructed from outlet to first dam; canal continued 1150 feet to proposed site of second dam
1889	Truckee Lumber Co (TLC) builds 6-foot dam at outlet
1889	Newlands purchase Donner Lake dam and downstream properties
1889	a new wooden ice storage dam at outlet
1902	existing dam in disrepair
1902	land purchased around Donner Lake and a dam has been constructed
1908	Donner Lake proposed as a reservoir
1920	concrete dam replaced wooden crib dam
1926	reference to "prior" dredging (of outlet?)
1927	dam rebuilt
1928-1929	use of Donner lake as a reservoir for irrigation; more dredging of outlet and Donner Creek (dredging by dragline dredge)
ca. 1928	dam spillway lip is 5936.8 feet; sill gates lowered to accommodate 5921 feet minimum; outlet channel dredged (5500 feet long, 12 feet maximum depth, 10 feet average depth); diversion canal from Cold Creek to Donner Lake (6500 long)
12/1/1928	allowable fluctuations as per agreement between Donner Lake Development Co. (DLDC) and Truckee Carson Irrigation District (TCID) are 5921-5936 feet; fill along designated bungalows at west end (5937 feet); fill along shoreline (5934 feet); construct dam at Coldstream and diversion canal to Donner Lake; dredging rights (at outlet) to maintain minimum level
1929	dam construction by DLDC has not changed elevation of the sill of the original dam; no evidence of excavation to drop lake below natural level
1937 (fall)	highway (Donner Pass Road?) flooded; dam bypassed
1943	Sierra Pacific Power Co (SPPC) lowered lake to clean out channel of sediment and sawdust; outlet dredging lowers channel 12 feet
1946	current lake level (capacity with dam) is 5936 feet
1929-1952	high water point (5938.7 feet); low water point (5925.86 feet)

Logging

1864	McPherson sawmill with water wheel at foot of Donner Lake started the lumbering business of Truckee
1865 or 1866	Towle Bros mill; first sawmill near Truckee provided lumber for CPRR; narrow gage railroad above the lake

1872	Old Towle mill 1/4 mile from lake and 100 yards from Donner Party camp
1874	skating on "Donner Mill Pond"
1874	no mention of Towle Bros. at Donner Lake after this date
1875	CPRR lays side track to Donner Lake to pick up 10,000 cords of wood, stacked for two years
9/1881	timber around Donner Lake is largely cut out
1881-1882	3000 cords of wood furnished by Donner Lake site to CPRR
1903	Davies sawmill moved from Alder Creek to east end of Donner (mill burned later that year and was relocated to Martis Creek)
1904	TLC mill at Billy Mack's Flat, 2 miles west of Donner Lake
1906	TLC negotiating to haul logs by tractor on the county road from above Donner Lake to Truckee
1940s-1970s	timber stand re-entry/modern-era logging

Ranching/Grazing

1875	Hog farm and alfalfa fields at east end
1902	seasonal dairy farm at head of lake

Fishing

1870	dam across outlet owned by Towle Bros. obstructs fish run
1871	trout breeding farm 1/2 mile below outlet
1878-1881	Donner Lake stocked
1886-1894+	commercial fishing on Donner Lake

Ice

1869	Grant sells ice at Donner Lake House (east end)
1874	Sitka Ice Co. building at east end
1883	photo of ice harvest on Donner Lake
1889	new wooden ice-storage dam completed at outlet
early 1900s	Donner Ice Co. active ice production on Donner Creek
n.d.	35,000 tons of ice harvested in one year at Donner Lake (note: Donner Lake wasn't cold enough for consistent ice production)

Recreation

1863	first recreational boat launched at Donner Lake
1864-present	Donner Party camp becomes tourist attraction
1864 (summer)	Donner Lake House in operation at east end of lake
1865-1866	Pollard's Lake House operates on west end
1867	CPRR "tracks-end" tourist excursion trains commence with staging to Donner Lake and steamers across the lake
1872	Grant Hotel at east end (same locale as Donner Lake House?)

1874-1881	*Minnie Moody* sailboat tourist excursions
1874	skating on "Donner Mill Pond"
pre-1883	hotel at Donner City burned
1883	skating at Donner Lake
1883	Donner Lake is yearly visited by hundreds
1886-1888	steamers, *Comet* and *Nora*, operated for tourism and fishing
1886	Echo Station (resort on north side of Donner Lake)
1902	summer resort on north shore
1906	Donner Lake House (re?) opens
1928-1929	resort on west end

Community Development

1844-1845	Schallenberger constructed cabin at east end and wintered over
1846-1847	Donner Party constructed cabins and wintered at east end of lake; all other emigrants passed quickly through the area
1864	wayside inns and toll stations develop along DFDLWR -D. L. Pollard's (Donner Lake's northwest end) -Forest Dale House (one mile west of the lake) -J. H. Witherspoon's (three miles west of the lake) -William Mac's Hotel (1 1/2 mile west of the lake)
1864 (summer)	Donner Lake House in operation at east end of lake
1865-1866	McPherson's barn at east end of Donner Lake
1865-1866	W. H. Hatch's house near (T17N/R15E/S 12/13 1/4 corner)
1865-1866	store owned by Sisson, Egbert and Co. (purveyors of Chinese goods) at east end
1867	advance railroad gangs populated Donner City (west end Donner Lake)
1867-pre 1883	Donner City (west end of lake)
1865-1869	Summit Camp railroad construction camp at Donner Pass occupied by hundreds of Chinese laborers
1886	Echo Station (resort on north side of Donner Lake)
1902	summer resort on north shore
1906	Donner Lake House (re?) opens
1919	DLDC subdivides lots for a resort/residential retreat on east end (now Donner State Park)
1927	DLDC builds decorative bridge across dam
1928	area surrounding Pioneer Monument added to the State Parks system
1948	State of California purchased land at east end of lake from DLDC
1928-1929	resort on west end

Utilities

1865-1866	telegraph line passed along north side of lake over Donner Pass

1923	Truckee River Power Company (TRPC) constructed a 60-kilovolt transmission line over Donner Summit
1937	Sierra Pacific Power Company (SPPC) constructed a second transmission line over Donner Pass
1949	SPPC constructed a third interconnecting line over the summit (?)
1956	Santa Fe Pacific (jet fuel) Pipeline (SFPP) installed over Donner Pass
early 1960s	wildfire at Donner Lake/Donner Pass burned the 60kv line and the 120kv line; both lines were replaced
ca.1988	AT&T fibre optic line over Donner Pass
3/1/1997	leak in the SFPP line east of Donner Pass prompted a series of emergency containment, remediation and restoration projects down to Donner Lake's west end
ca. 1999	Williams Fibre optic line over Donner Pass

* see Lindström (1984) for more detail

** see Lake Level Data: Summary for more detail (Lindström 1984)

References Cited

Lindström, Susan G.

1984 Uses of Donner Lake and Lake Level Summary. Manuscript in possession of author. Donner Lake. (All references cited in this report are on file in Lindström's personal library.)

DONNER LAKE BASIN

WATERSHED ASSESSMENT

A CONTEXTUAL OVERVIEW OF HUMAN LAND USE

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WORKBOOK

APPENDIX 3: General Land Office Survey Field Notes (excerpts)

Susan Lindström, Ph.D. (RPA), Consulting Archaeologist

Truckee, California

August 2015

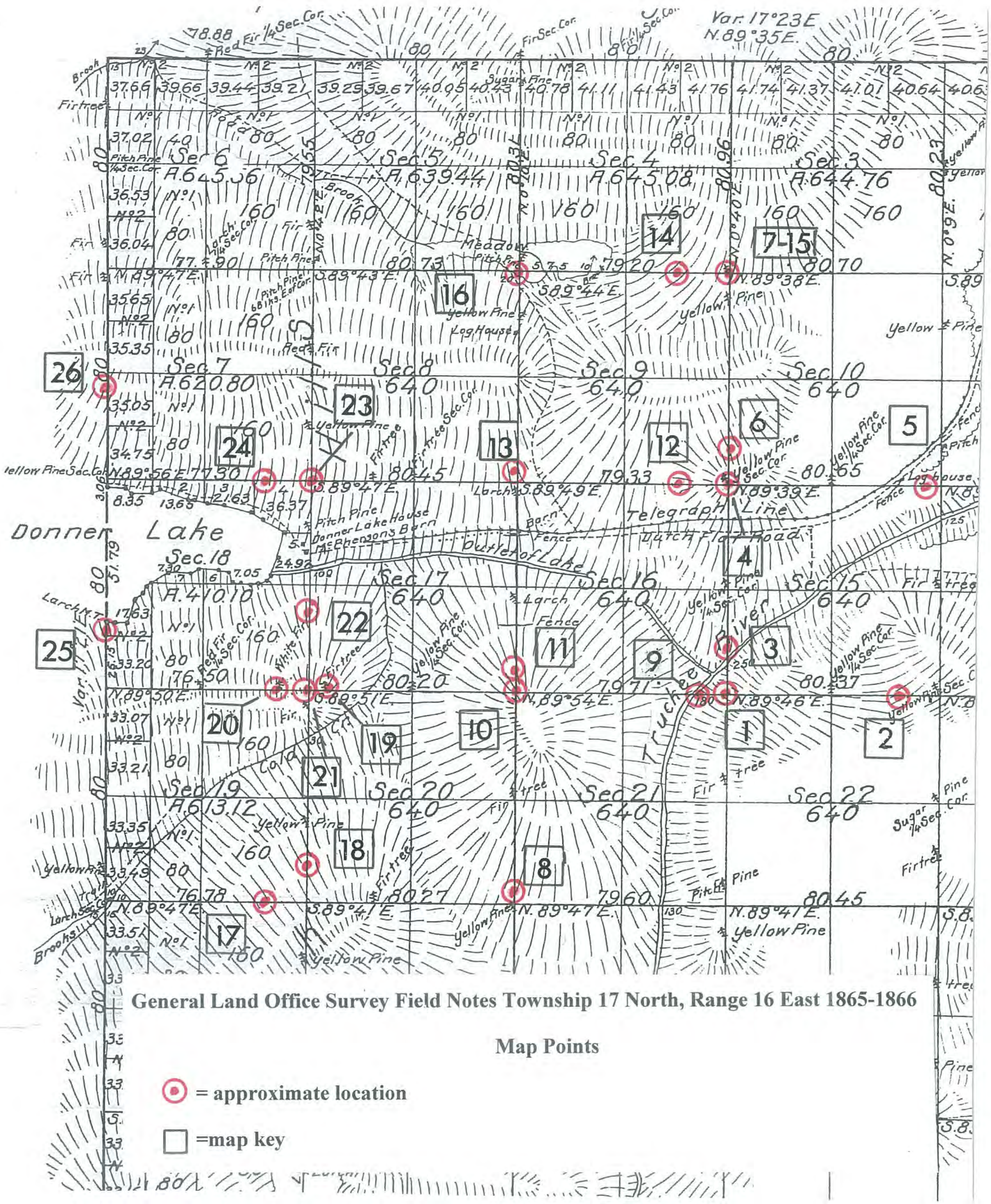
Summary of General Land Office survey field notes for Township 17 North, Range 15 East and Township 17 North, Range 16 East 1865-1866

Map Key	Page #	Section line	Notes (1chain = 66 feet; 100 links = 1 chain; 1 link = 7.92 inches)
Field Notes for the Survey of Subdivision Lines in Township 17 North, Range 15 East, Mount Diablo Meridian, CA, as Executed by James E. Freeman, Dep. Surveyor under Contract of June 21, 1866			
1	4	23/24	Top of ridge; fir 16 " dia; fir 12" dia; stake of survey of CPRR; tamarac 12" dia; tamarac 16" dia; pine 4" dia; tamarac [sic] 24"; land, hilly, soil, 2nd rate; timber good, fir, spruce, pine, some chaparral;
	5		A stream 10 links wide runs north; a trail bears north and south; pine 50" dia
2	5	13/14/23/24	Land broken, hilly and rocky; soil second rate; timber good, fir, spruce, pine (10/16/66)
3	5	13/14	Enter ravine; leave ravine; spruce 48" dia; so. shore Donner Lake
	6		Distance on line across the lake 39.78 chains plus a total distance on line 56.57 chains; Dutch Flat Donner Lake Road
4	8	12/13	W.H. Hatch's house bears south 15° E
	9		Stream 4 links wide runs south; stream 5 links wide runs south; trail bearing SE and NW
5	14	22/23	-survey of CPRR; trail bears NE and SW; enter small valley, contains about 4 acres; leave valley; a creek 13 liinks wide runs N 30° W
	15		Trail bears SE and NW; enter a creek, course N
6	15	14/23	Road bears SE and NW; stream 10 links wide runs N; stream 4 links wide runs north;
	16		Land broken and rocky, soil 2nd rate; timber good, fir, spruce and pine., dense chaparral
7	16	14/15	Road bears NW and SE; enter lake bottom NW and SE; creek 15 links wide runs SE; trail bears NE and SW; J.A. Pollards Hotel bears N 50° E; Dutch Flat Donner Lake Road bears NE and SW; S side of J.A. Pollard's barn on line; leave lake bottom
8	17	10/11/14/15	Lake bottom mostly tamarac (10/22/66)
9	17	11/14	Stream 12 links wide runs SE; stream 5 links wide runs S; stream 3 links wide runs S; stream 3 links wide runs S 30° W
10	18	10/11	Stream 10 links wide runs E; stream 10 links wide runs S 15° W
11	23	21/22	Creek 3 links wide runs N 80° E; (RR stake); Henry Witherspoon's Hotel bears 32° W; mouth of tunnel on the rr bears 76° E
12	24	16/15/21/22	Impractical to establish corner; spring branch 3 links wide runs N 20° W
	25		Land mountains, broken, rocky; timber, sparse, pine, fir, tamarac

			(10/25/66)
13	25	15/16	Dutch Flat Donner Lake Road; dry bed of a creek courses E; house bears S 60° E 3 chains distance; branch of the Dutch Flat Donner Lake Road bears E and W; dry bed of a creek runs east; trail from Coombs to Summit City bears N 30° W and S 30° E; stream 12 links wide runs S 30° E; Charles Coombs house bears S 23° W
14	27	9/10	Trail from C. Coombs to Summit City bears SE and N 30° W; stream 15 links wide runs SE; brush fence bears NE and SW; enter a valley, contains about 10 acres lying mostly in S9; trail bears NW and S 60° E
15	32	21/28	Stream 8 links wide N 80° W; old emigrant road bearing SE and N 75° W
16	35	16/21	Shaft on the center of the tunnel of the CPRR bears N 19 1/4° W 8 chains distant; Dutch Flat Donner Lake Wagon Road bears N and S; Henry Witherspoon's house bears N 25° E; cross survey of CPRR bearing NW and SE; Charles Coombs house bears N 42° E; Henry Witherspoon's house bears N 49° W
17	37	16/17	Dry bed of a stream runs west; dry bed of a small stream runs west; dry bed of a stream branch runs S 30° E; Lake Angela
18	37	9/16	End notations
Field Notes of Subdivision Lines of Township 17 North, Range 16 East, MDM by E. Dyer, Deputy. Surveyor under his Contract May 24, 1865, survey commenced August 31, 1865, survey completed September 9, 1865			
18	1	15/16/21/22	Pitch pine 21" dia; pitch pine 37" dia; land, hilly and rocky; soil 2nd and 3rd rate; timber, yellow and pitch pine and fir
18	2	E on 15/22	Ascend rocky bank; yellow pine 47" dia; land, rolling hills; soil, 3rd rate; timber, yellow and pitch pine and fir;
19	3	N on 15/16	Truckee River 2.50 chains wide, course at 25° E; ascend; yellow pine 33" dia; fence bears E and W; Dutch Flat Road bears E and W; telegraph line; yellow pine 17" dia;
19	4	9/10/15/16	Summit of ridge bears E and W; land, rolling; soil, 2nd and 3rd rate; timber, yellow and pitch pine, larch and fir (Sept 4, 1865)
19	5	E on 10/15	Cross telegraph line; Dutch Flat Road bears N 20° E and S 20° W; fence bears N 20° E and S 20° W; a log house bears N about 1.00 chains distance
20			Mark yellow pine 16" dia
20	6	N on 9/10	Brook 15 links wide, runs NE; pitch pine 30" dia; top of ridge trending NE and SW; yellow pine 30" dia; mark on fir 35" dia
20	7	3/4/9/10	Land hilly; soil 2nd and 3rd rate; timber white fir, yellow and pitch pine and sugar, red fir and poplar; laurel and manzanita undergrowth
24	8	N on 20/21	Fir 85" dia; ascend; descend top of ridge; fir 25" dia; yellow pine 35" dia; land high rolling hills; soil 2nd and 3rd rate; timber yellow and pitch pine; laurel and manzanita undergrowth
24	9	E on 16/21	Descend

25			Truckee River 1.80 chains wide, runs NE; ascend
25	10	16/17/20/21	Land hilly; soil 3rd rate; timber pitch and yellow pine, fir and larch with laurel undergrowth
25	11	N on 16/17	Fence bears E and W; larch 28" dia; outlet of Donner's Lake, course S 80° E; ascend; fence bears E and W
26			Dutch Flat Road bears E and W; barn bears E about 60 links distance; telegraph line; larch 17" dia; land hilly; soil 1st, 2nd, 3rd rate; timber fir, yellow and pitch pine and larch
26	12	E on 9/16	Descend; ascend; road bears NW and SE; yellow pine 37" dia; land, S slope of hills; soil 2nd and 3rd rate; timber yellow and pitch pine and fir
27	13	N on 8/9	Pitch pine 32" dia; yellow pine 32: dia; log house bears N about 1.50 chains distance; yellow pine 32" dia; road bears NW and SE; brook 20 links wide, course SE; yellow pine 40" dia; larch 17" dia; pitch pine 16" dia;
27	14	E on 4/9	Brook 5 links wide runs SE
28			Brook 7 links wide runs NE; brook 5 links wide runs SE; enter valley bears NW and SE; brook 10 links wide runs N; leave valley and enter timber
28	15	3/4/9/10	Larch 20" dia; pitch pine 20" dia
29	16	4/5/8/9	Land, W 1/2 miles level; land E 1/2 miles rolling hills; soil 3rd rate; timber larch fir, yellow, pitch and sugar pine and willow
32	17	W on 19/30	Descend; brook 10 links wide course NE; brook 10 links wide course NE
33			Yellow pine 37" dia; land, W slope of ridge; soil 3rd rate; timber yellow and pitch pine, fir, alder and willow; laurel and manzanita undergrowth
33	18	N on 19/20	Yellow pine 40" dia; yellow pine 40" dia; yellow pine 40" dia; Cold Creek 30 links wide course NE; descend; top of ridge trending E and W; descend; fir 37" dia; fir 45" dia; land hilly; soil 3rd rate; timber yellow and pitch pine and fir (Sept. 7, 1865)
33	19	E on 17/20	Descent; Cold Creek running NE; ascend
34	20	W on 18/19	Along N slope of ridge; red fir 25" dia; white fir 25" dia
34	21	17/18/19/20	Land N slope of ridge; soil 3rd rate, rocky; timber red and white fir, yellow and pitch pine, laurel and manzanita undergrowth
34	22	N on 17/18	Base of ridge; larch 25" dia; yellow pine 50" dia; Outlet of Donner Lake course N 80° E, 1.00 chain wide; ascend; S side of McPhearson's Barn; N side of McPhearson's Barn; Dutch Flat Road course E and W; Donner Lake House bears W 2.38 chains distance; telegraph line; pitch pine 37" dia
35	23	7/8/17/18	Yellow pine 32" dia; yellow pine 45" dia; yellow pine 37" dia; pitch pine 14" dia; land rolling hills; soil 1st, 2nd and 3rd rate; timber fir, yellow and pitch pine; laurel undergrowth
36	24	W on 7/18	Pitch pine 20" dia; yellow pine 40" dia; land SW slope of ridge, rocky; soil 2nd and 3rd rate; timber yellow and pitch pine and fir
41			General Description: Section 18 is made fractional by Donner

			Lake, a beautiful sheet of clear, pure water, about 3 1/2 miles in length, trending E and W. Its greatest width, which is where the Township line crosses, is 51.79 chains. This lake receives its name from a party of Immigrants, under the leadership of a Mr. Donner, who in the early immigration to California, were caught in the snow at that point and through ignorance of the country, and dissention among themselves, and after some eighty of the party had perished from famine, the remainder were saved by a relief party from Sacramento Valley, after having resorted to cannibalism, as it is believed, to sustain life. Several parties of engineers are now engaged in the location and survey of the Pacific RR which passes on the S side of the lake, thence following its outlet to the Truckee will run down the same as far as the state boundary.
Field Notes of Exterior N and W Boundary lines of Township 17 North, Range 16 East, Mt. Diablo Meridian, CA by E. Dyer, Deputy Surveyor under his contract of May 24th, 1865. Survey commenced August 29th, 1865. Survey completed August 30th, 1865.			
2	25	N on W boundary of 18	S bank of Donner Lake
3			Distance across lake 57.99 chains, which added to 25.15 gives 76.94; Dutch Flat Road course E and W; yellow pine 30" dia;
3	26	N on W boundary of 7	Yellow pine 3" dia; yellow pine 27" dia; summit of ridge



General Land Office Survey Field Notes Township 17 North, Range 16 East 1865-1866

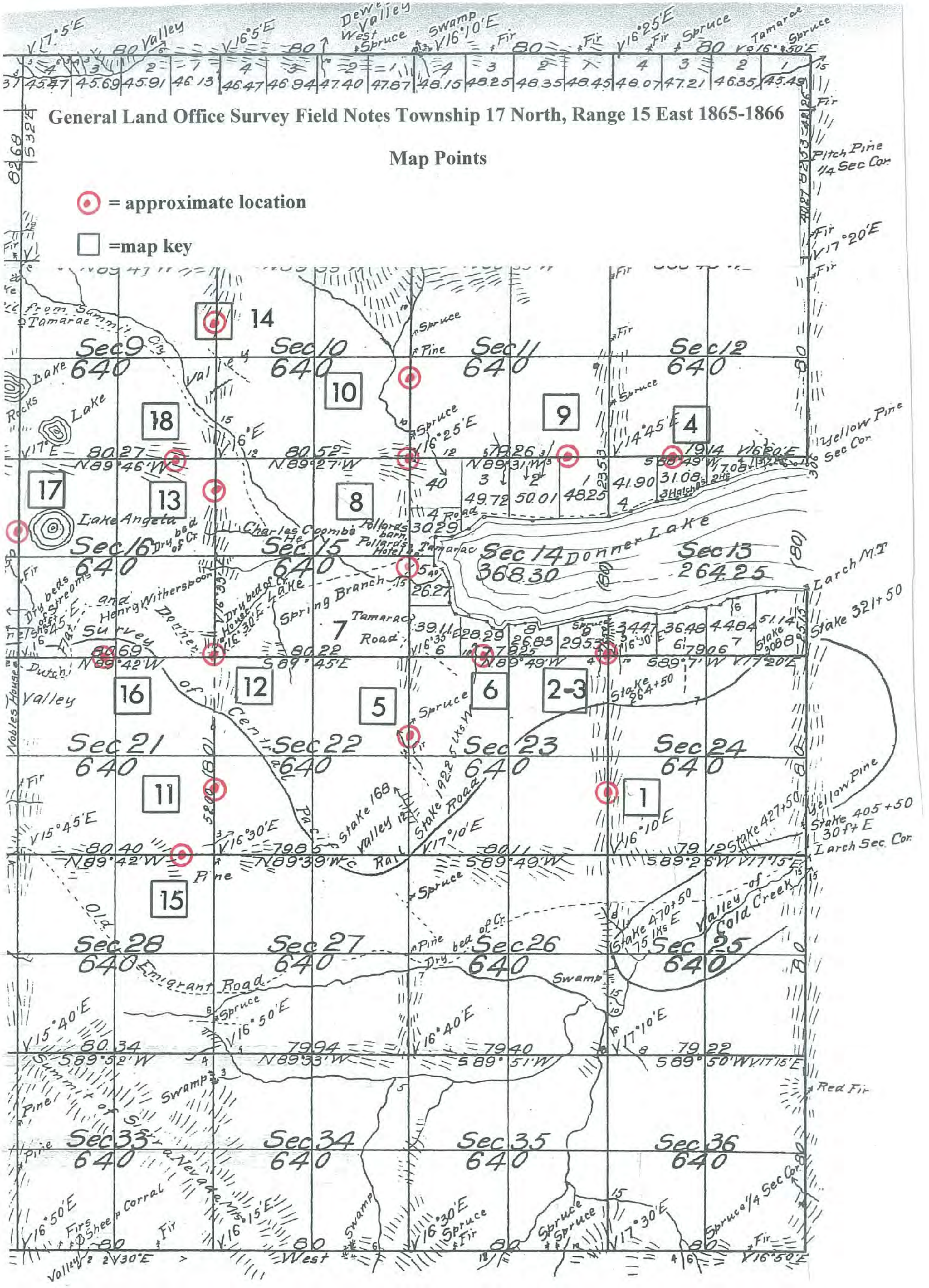
Map Points

= approximate location

=map key

General Land Office Survey Field Notes Township 17 North, Range 15 East 1865-1866

Map Points



DONNER LAKE BASIN

WATERSHED ASSESSMENT

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APPENDIX 4: General Land Office Survey Field Notes (Meanders of Lake Donner)

and

Survey Map of the Boundary of State Ownership in the Bed of Donner Lake 1974

Susan Lindström, Ph.D. (RPA), Consulting Archaeologist

Truckee, California

August 2015

37.90	Road, bears S. E. & N. W.
40.00	Set stone for temp. 1/4 sec. cor.
63.00	Road, bears N. W. & S. E.
79.55	Intersect N. bdy., 98 lks. N. of cor. to secs. 5, 6, 31 & 32, from wh. cor. I run S. 0°, 42' W. on a true line bet. secs. 5 and 6.
	Var. 17°, 18' E.
39.55	Set a stone 17 X 9 X 4, for 1/4 sec. cor.
63.38	Fir, 20 in. dia.
77.55	Pitch Pine, 47 in. dia.
79.55	Cor. to secs. 5, 6, 7 & 8.
	Land, rolling hills.
	Soil, 3rd rate.
	Timber, Red Fir & White, Pitch Pine & Yellow. Laurel undergrowth.

Meanders of Lake Donner in Sec. 18.

Began at cor. to fractional secs. 13 and 18 on W. bdy. of Tp., and on N. bank of said Lake and run in sec. 18 as follows.

Course	Distance
S. 80° E.	6.60.
" 62° E.	3.20.
S. 89¼ "	8.50.
" 64 "	2.00.
S. 75 "	11.00.
" 87½ "	2.70.

S. 71½° E.	5.30.	
" 85° "	6.70.	
" 78½° "	11.00.	
" 56° E.	4.30.	
" 60½° "	9.20.	
" 9½° W.	10.00.	
" 24° "	8.00.	Outlet of Donner Lake.
	8.40.	
" 37¾° "	1.10.	
" 68½° "	4.00.	
" 85¾° "	3.00.	
N. 69° "	3.50.	
" 84 "	2.60.	
" 42½° "	3.50.	
" 69½ "	3.50.	
" 87 "	8.00.	
S. 63° "	3.20.	
" 84° "	9.40.	
" 63½° "	7.50.	
" 46° "	1.80.	
" 37° "	3.20.	
" 53½° "	3.60.	
" 15° "	9.60.	
" 88½° W.	4.70.	Meander post cor. to fractional secs. 13 & 18 on W. bdy., & on S. side of Lake
N. 82½° "	3.50.	

Sept. 9th 1865.

 GLO 1866

T.17 N. R.15 E. Mt.Diablo Meridian.

Meanders of Donner Lake.

Begin at the corner to fractional sections 13 and 18 on the range line 25.15 chains north of the corner to sections 13, 18, 19, 24.

N. 87° W. 11.95 chains, thence
S. 84-3/4 W. 4.50 chains, thence
S. 76-3/4 W. 12.00 chains, thence
S. 73½ W. 3.30 chains, thence
S. 64-3/4 W. 4.30 chains, thence (At 2.25 chs.
S. 87-3/4 W. 3.40 chains, thence (a stream 6 links wide
S. 80½ W. 2.10 chains, thence (emptying into the Lake.
S. 78½ W. 3.80 chains, thence
S. 85° W. 3.40 chains, thence
S. 69½ W. 5.50 chains, thence
S. 80° W. 7.50 chains, thence
N. 79° W. 9.80 chains, thence
N. 88½ W. 2.00 chains, thence
S. 76° W. 7.50 chains, thence to the corner to fractional sections 13 and 14 on the south side of the Lake, thence in section 14
S. 80½ W. 10.90 chains, thence
S. 80° W. 18.40 chains, thence
N. 7° W. 2.50 chains, thence
N. 89° W. 4.50 chains, thence
S. 78½ W. 5.10 chains, thence
W. 2.72 chains, thence
S. 55° W. 3.00 chains, thence
N. 85-3/4 W. 3.10 chains, thence
N. 39° W. 4.00 chains, thence
N. 71½ W. 8.60 chains, thence
N. 82-3/4 W. 5.60 chains, thence
N. 24½ W. 4.50 chains, thence
N. 6° W. 8.50 chains, thence(At 7.90 chains
N. 20½ W. 5.90 chains, thence(a stream 40 links wide
N. 82° W. 2.90 chains, thence(emptying into the Lake.

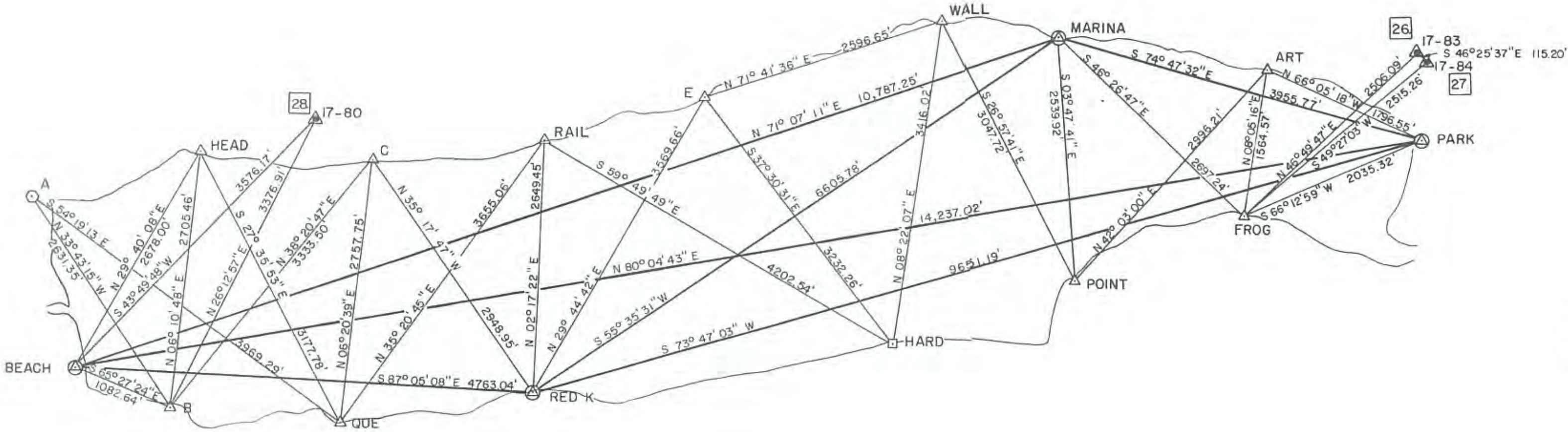
N.	3/4 W.	12.20	chains, thence
N. 86°	E.	7.00	chains, thence
N. 63-3/4	E.	6.80	chains, thence
N. 50½	E.	8.50	chains, thence
S. 83°	E.	19.50	chains, thence
N. 86½	E.	31.90	chains, thence to the corner to fractional sections 13 & 14 on the N. side of the Lake, thence in section 13
N. 76°	E.	8.20	chains, thence
N. 70½	E.	11.00	chains, thence
N. 81°	E.	9.00	chains, thence
N. 70°	E.	5.00	chains, thence
N. 55°	E.	5.50	chains, thence
N. 73¼	E.	11.80	chains, thence
N. 69	E.	18.00	chains, thence
S. 86°	E.	6.00	chains, thence
N. 81°	E.	3.50	chains, thence
N. 85½	E.	5.10	chains, thence

to the corner to fractional sections 13 and 18 on the north side of the Lake and on the range line.

The south side of the Lake hilly, broken and rocky, with boulders of granite. Timber, good fir, pine, tamarac, underwood and chaparral. The west shore of the Lake is sandy with cottonwood and tamarac timber. The north shore broken and rocky with pine and timber (open).

October 17, 1866.

North	89° E on a random line between sections 12 and 13, Variation 14° 45' east.
27.25	W. H. Hatch's house bears south 15° east.
40.00	Set post for temporary quarter section corner.



All bearings shown on this plat based on Old U.S. Highway 40 as st on plans filed at Page 537, Book 7 Official Records, Nevada County.

LEGEND

- Set CSLC brass cap
- Set capped t-bar
- Set lead and tack in large boulder
- Set boat nail and shiner
- Found unmarked brass cap in conc.
- Index number to descriptions of found and set monuments (sht.3)

0 1000 2000 3000

FEET

PRELIMINARY
SUBJECT TO REVISION

SURVEY OF THE

BOUNDARY OF STATE OWNERSHIP

IN THE BED OF DONNER LAKE

NEVADA COUNTY, CALIFORNIA

JUNE, 1974

SCALE : 1 INCH = 1000 FEET

SHEET 4 OF 18

DONNER LAKE BASIN

WATERSHED ASSESSMENT

A CONTEXTUAL OVERVIEW OF HUMAN LAND USE

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APPENDIX 5: Donner Lake Submerged Stumps Data

Susan Lindström, Ph.D. (RPA), Consulting Archaeologist

Truckee, California

August 2015

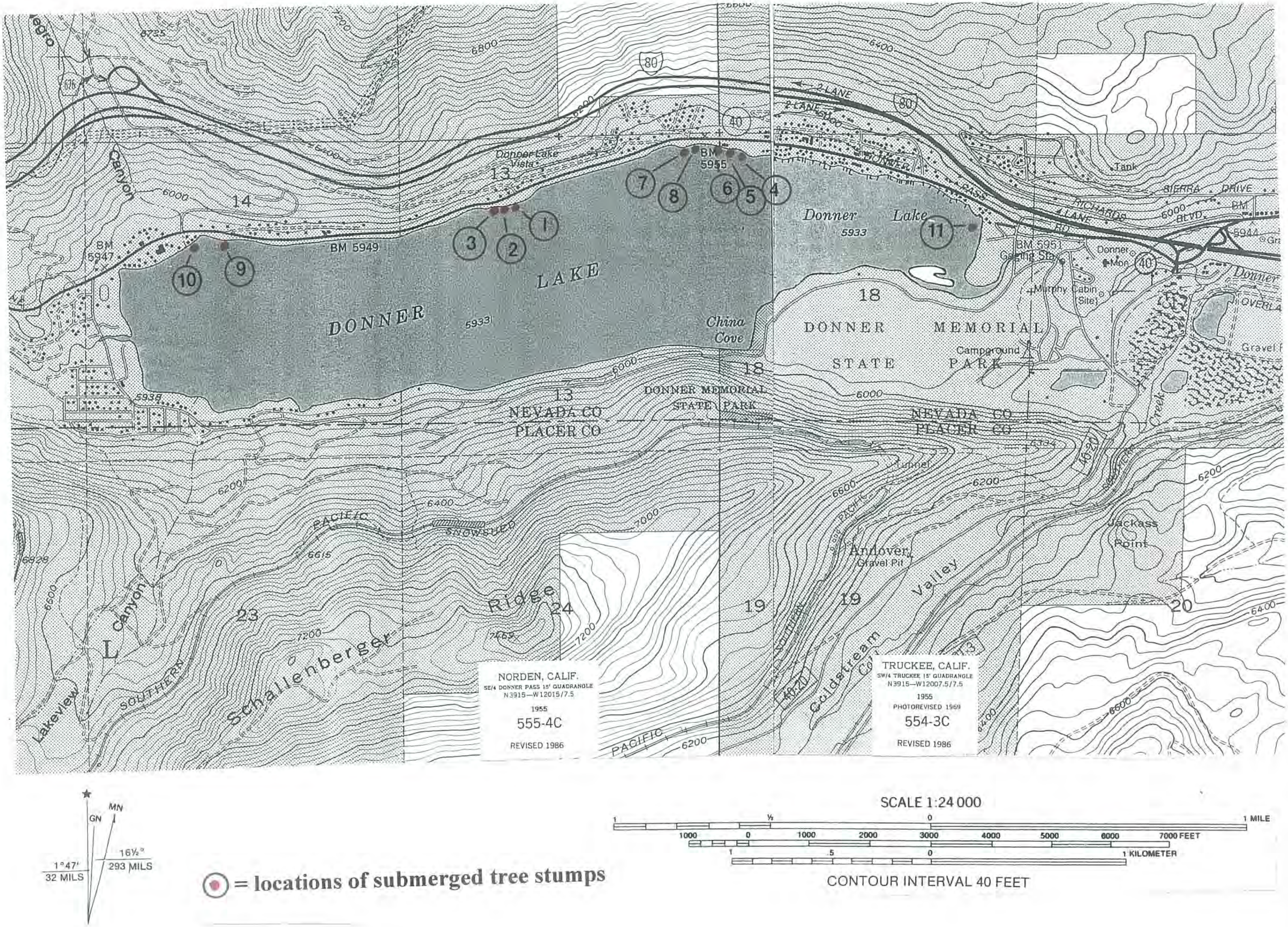
*Summary Table of Submerged Stumps in Donner Lake, California (Nevada and Placer Counties)

Map No.	*Locale*	***Depth*	*Date*	***Comments*
#1	30 ft east of entry point on west side of Shoreline Park; 10 ft off shore and 30 ft east	34	10-16-93	Burned stump approx. 4 ft diameter, 25 ft tall; C-14 sample Beta-70013 = 470 ± 50 BP (calibrated age = AD 1433); C-14 sample Beta-70014 = ± 60 BP (calibrated age AD 1440); Beta lab report dated 2/10/94
#2	Same entry as above on east side of Shoreline Park; 10 ft off shore	21	10-17-93	
#3	West of #1 approx 40 ft	12-15	10-17-93	
#4,5,6	West end of public access marker (east end of lake); 60 ft straight out from brown pump station	6-8	12-10-93	3 burned stumps
#7,8	11 paces west of dock by brown pump station near public access marker; 20 ft off shore	5	12-23-93	2 burned stumps
#9	East end of guard rail near public boat ramp; 15 ft west of dock w/painted red front	15	1-2-94	Burned
#10	Donner Lake Lodge, west of public boat ramp; in front of big tree right of lodge	10	1-13-94	Burned stump 12-18 inches tall
#11	Northeast end; 80°/300 ft to east shore boat ramp; 5°/125 ft to small dark gray boat house	17.1	1-22-94	Stump 73 inches tall w/62-inch circumference; C-15 sample Beta-87324 = 150±50; Beta lab report dated 12/14/95

*SCUBA reconnaissance performed by Phil and Ruth Moyer, Phil Caterino and Susan Lindström; C-14 analysis conducted by Beta Analytic

** approximate depth in feet below surface on date observed

***submerged stumps on island at southwest cove are not included; other on-shore stumps that are periodically submerged and inundated and are not included



= locations of submerged tree stumps

BETA ANALYTIC INC.

DR. J.J. STIPP and DR. M.A. TAMERS

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964
E-mail: beta@analytic.win.net

REPORT OF RADIOCARBON DATING ANALYSES

R: Dr. Susan Lindström
Truckee, California

DATE RECEIVED: November 16, 1995
DATE REPORTED: December 14, 1995

Sample Data	Measured C14 Age	C13/C12 Ratio	Conventional C14 Age (*)
eta-87324	150 +/- 50 BP	-25.0* o/oo	150 +/- 50* BP

AMPLE #: DL-1
NALYSIS: radiometric-standard
ATERIAL/PRETREATMENT:(wood): acid/alkali/acid

OTE: It is important to read the calendar calibration information nd to use the calendar calibrated results (reported separately) when nterpreting these results in AD/BC terms.

Dates are reported as RCYBP (radiocarbon years before present, "present" = 1950A.D.). By International convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

BETA ANALYTIC INC.

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UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Mr. Steve Michel
Donner Memorial State
Historic Park

DATE RECEIVED: January 21, 1994
DATE REPORTED: February 10, 1994
SUBMITTER'S PURCHASE ORDER #

TECHNIQUE AND BASIS:

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ± 1σ	C13/C12	C13 adjusted age
ta-70013	DL 1a (wood)	490 +/- 50 BP	-25.7 0/00	470 +/- 50 BP
ta-70014	DL 1b (wood)	460 +/- 60 BP	-24.6 0/00	460 +/- 60 BP

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

DONNER LAKE BASIN

WATERSHED ASSESSMENT

A CONTEXTUAL OVERVIEW OF HUMAN LAND USE

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APPENDIX 6: Summary of Lake Level Data and Human Uses of Donner Lake

(Lindström research notes April 19, 1984)

Susan Lindström, Ph.D. (RPA), Consulting Archaeologist

Truckee, California

August 2015

I. USES OF DONNER LAKE

RECREATION

7,8/1854	Lola Montez and party excursion on horseback from Nevada City to The Truckee River via the summit and Donner Party cabins at Donner Lake (Nev Co Hist Soc 1983 37(2):9-13)
1860s	Donner Lake House, Lake House, Donner House (Jackson 1982:122)
1863	first boat launched by D.B. Towner (Edwards 1883:67-68)
1864	Donner House, Lake House, summer of 1864 (Jackson 1982:93,122)
1864	Donner camp site becomes tourist attraction at Donner Lake (Jackson 1967:31)
1865-66	Pollard's on west end; Donner Lake House and telegraph line on east end (GLO Plats 1865-66; Placer County 1866:594-95)
1867	Donner House, Donner Lake Hotel, Lake House (Jackson 1967:31; Daily Advertiser 12/6/67, 12/10/67)
1867	Pollard's Lake House (Bean 1867:328)
7/1872	Grant Hotel at lower end of lake; Sam Welsch leased for 5 years (Territorial Enterprise 7/18/1872)
pre-1883	hotel at Donner City burned (Edwards 1883:67)
1883	skating on Donner Lake (Edwards 1883:67)
1886	Echo Station, Hugh Porter proprietor (Truckee Republican 8/21/86, 9/11/86)
1886-88	2 steamers operate on Donner Lake; owners encourage tourist excursions (Truckee Republican 7/2/87, 7/16/87, 10/5/87, 5/2/88, 5/9/88)
1902	summer resort on north shore (USGS 1902:n.p.)
1906-07	Stewart McKay and others plan to build resorts at Donner Lake (Truckee Republican 3/24/1906, 4/24/1907, 5/22/1907, 7/27/1907)
1906	Donner Lake House opens (Truckee Republican 6/2/1906)
1928-29	resort on west end (TCID 1928-29:78)

LINDSTROM/DRAFT 4/19/84

II. ALTERNATIVE TRANSPORTATION ROUTES/POPULATION CENTERS

RAILROAD ROUTES

1867 advance railroad gangs; population at Donner City with 2 hotels, a general store and a sawmill (Meschery 1978:35)

ca 1867 "tracks-end" excursion trains, staging to Donner Lake; steamers across lake (Meschery 1978:35)

4/3/68 C.P.R.R. arrives in Truckee; completion to Nevada state line in June (Jackson 1982:99, State of California, Department of Parks and Recreation 1979:75; Price 1980:13; NCHS 1976 30(3):2)

6/1868 completion of C.P.R.R. to Nevada; C.P.R.R. captures road travel (Jackson 1982:93; TRPA/USFS 1971:9)

pre-1883 ". . . the railroad came along and the inhabitants (of Donner Lake) gradually betook themselves to Coburn and Truckee and the solitude once more brooded over the scene"(Edwards 1883:67)

LINDSTROM/DRAFT 4/19/84

I. USES OF DONNER LAKE

BOATS AND WATER VESSELS

1863	small boat launched by D.B. Towner (Edwards 1863:67-68)
1865	Doten sails on boat from Donner Lake House (Van Tilburg Clark 1973:860)
1867	C.P.R.R. "tracks-end" excursion trains, staging to Donner Lake, steamers across the lake (Meschery 1978:35)
1867-68	J.D. Pollard's Lake House advertises sail and row boats (Bean 1867:328)
5/1874	The Plunger (Minnie Moody), building at the lake, will be ready for launching next week (Truckee Republican 5/28/74)
6/1874	The Plunger will not be launched on Donner Lake but taken to Lake Tahoe (Truckee Republican 6/20/74)
7/1874	trial run of Minnie Moody on Donner Lake; Cap't Elliot plans to take it to Lake Tahoe (Truckee Republican 7/2/74)
1874	Minnie Moody sailboat on Donner Lake for 1 trial run (Scott 1957:398-99)
pre-1883	Minnie Moody dismantled and taken to Tahoe (Edwards 1883:67)
7/1881	Minnie Moody conveys freight from Tahoe to Glenbrook, available for tourist excursions (Tahoe Tatler 7/9/1881:ad, cert. copy pending, CA St. Library)
10/1881	Minnie Moody wrecked near Crystal Bay, laden with merchandise for Marlette and Folsom, owned by J.M. Short (Truckee Republican 10/8/ 81: 3-2, cert. copy pending, CA St. Library)
11/1881	Minnie Moody launched on Lake Tahoe (Truckee Republican 11/5/81:3-4, cert. copy pending, CA St. Library)
1884	Minnie Moody destroyed by storm on Lake Tahoe (Scott 1957:399)
1886	Leach launches his Donner Lake steamer, Comet, for tourism and fishing (Truckee Republican 3/20/86, 5/5/86, 5/22/86)
6/1886	Comet sold to Roberson (Truckee Republican 6/16/1886)
6/1886	steamer, Nora, to be launched on Donner Lake, owned by Messrs, Kruger, Sonne, et al (Truckee Republican 5/5/1886)
1886-87	Roberson runs steamer, Comet, for tourist excursions and fishing, sometimes free of charge (Truckee Republican 6/19/86, 6/23/86, 7/28/86, 8/18/86, 8/21/86, 9/8/86, 9/11/86, 4/30/87)
6/1887	Burckhalter purchased interest in Nora (Truckee Republican 6/18/87)
6/87	boat race between Comet and Nora (Truckee Republican 6/22/87, 6/29/87)
1887-88	steamer owners encourage tourist excursions (Truckee Republican 7/2/ 7/16/87, 10/5/87, 5/2/88, 5/9/88)

BOATS AND WATER VESSELS (cont)

8/87 Comet sold at Constable's sale (Truckee Republican 8/24/87)

1908 rough-going for motor launches, east to west, on Donner Lake (Truckee Republican 8/15/08); Doten, 1865, had similar problems sailing

1984 Donner Lake steamboats in 188[illegible] ([illegible] 6/28/1984:[illegible])

LINDSTROM/DRAFT 4/19/84

I. USES OF DONNER LAKE

FISHING

1871	trout breeding farm of Kelly and Stewart located ½ mile below outlet; commenced with 22,000 small fish (Lindstrom 1983c:8; Edwards 1883:67; Thompson and West 1880:166)
1871	2 fish hatcheries near Donner Lake, breeding over ½ million trout; abandoned 10 years later (Meschery 1978:48)
1870-71	begin enforcement of conservation measures; obstruction by Towle Bros. dam below the lake outlet (State of Ca Appendix Journal Senate Assembly Report of Commissioners of Fisheries 1870-71:21-22)
7/1872	fish ponds containing 27,000 fish of Stewart and Kelly located ½ mile below Donner Lake (Territorial Enterprise 7/18/72)
4/1874	conservation measures (Jackson 1982:122; Territorial Enterprise 4/5/74)
1878-79	Donner Lake stocked (Jackson 1982:122; State of CA Appendix Journal Senate Assembly Report of Commissioners of Fisheries 1878-79:9,12)
1880-81	Donner Lake stocked (Jackson 1982:122; State of CA Appendix Journal Senate Assembly Report of the Commissioners of Fisheries 1881-82:17-18)
1886	commercial fishing on Donner Lake (Jackson 1982:122)
1887	concern for fish migration into Donner Creek (Truckee Repbulican 6/18/87)
1893-94	commercial fishing on Donner Lake; supply San Francisco markets (Jackson 1982:122)

I. USES OF DONNER LAKE

ICE FARMING

ca 1860s	Schallenberger's ice ponds in Coldstream Canyon near Horseshoe Bend (Wiley 2/19/84: oral interview;
1866	earliest ice industry in Truckee Basin (Goodwin ms n.d.:n.p.)
1868	first ice company in Truckee Basin at Boca (Thompson and West 1880: 166; MacAulay 1/10/84: oral interview; Goodwin ms n.d.:n.p.)
5/12/69	Grant sells ice at Donner Lake House (Truckee Tribune 5/12/1869)
1/15/74	Sitka Ice Co. building noted at east end of Donner Lake (Truckee Republican 1/15/1874, 8/17/1872)
1880s	7 ice companies located in Truckee Basin (Nevada County Historical Society Bulletin 1976 30(3):6)
1883	photo of ice harvest on Donner Lake (Meschery 1978:46-47)
1889	new wooden ice-storage dam completed in the fall at outlet (Goodwin 1977:n.p.)
9/26/95	land transfer from J. Marzen to Donner Ice Co along Donner Creek ½ mile below outlet ((Lindstrom 1983:8)
ca 1900s	Donner Ice Co active ice producer on Donner Creek (MacAulay 2/19/84: oral interview)
ca 1900s	Coldstream Ice Co near Horseshoe Bend in Coldstream Canyon (MacAulay 2/19/84:oral interview)
n.d.	Donner Ice Co was located at Donner Lake (Lord 1981:37)
ca 1902, 1907	Pacific Ice Co (later Pacific Fruit Express Co) owns land on Donner Creek ½ mile below outlet (Lindstrom 1983:8); operates as holding company for distribution and price controls; no active ice harvest (MacAulay 2/19/84:oral interview)
n.d.	Pacific Ice Co had plant on Donner Creek near State Agricultural Inspection Station (Lord 1981:37)
10/1/07	land transfer from Donner Ice Co to Pacific Fruit Express Corp on property ½ mile below outlet on Donner Creek (Lindstrom 1983:8)
n.d.	35,000 tons of ice harvested in 1 year on Donner Lake (Meschery 1978:48)
n.d.	Donner Lake wasn't cold enough for consistent ice production (MacAulay 2/19/84:oral interview)

LINDSTROM/DRAFT 4/19/84

I. USES OF DONNER LAKE

CARRYING GOODS ACROSS THE LAKE

1846	Donner relief parties crossed Donner Lake on ice (Morgan 1963:328)
1873	logs rafted from west end to east end mill (Crofutt 1873:166-167)
1903	logs towed from upper to lower end (Knowles 1942:41)
n.d.	logs floated on Donner Lake (Meschery 1978:46)
n.d.	"companies operating on Donner and Independence Lakes also used lumber boats" (Jackson 1982:104)

LINDSTROM/DRAFT 4/19/84

II. ALTERNATIVE TRANSPORTATION ROUTES/POPULATION CENTERS

POPULATION CENTERS

1846-50 Coldstream route developed over South Pass (Roller Pass or Mt. Lincoln/Mt. Judah) and Middle Pass (Mt. Judah/Donner Pk.) to compete with North Pass (Donner Pass) (Curran 1982:175)

1850+ migrant travel favored Carson Pass (Jackson 1967:19-20)

1865-66 telegraph line at east end (USGLO Plats 1865-66)

6/21/66 W.H. Hatch's house near Section 12 and 13 ¼ corner, T17N, R 15E (Freeman's survey field notes)

6/1868 C.P.R.R. captures road travel; (Jackson 1982:93)

6/17/75 land transfer from J. Kelly to J. Marzen, owner of hog farm and alfalfa fields at east end (Lindstrom 1983:8; Baker 1/10/84:oral interview)

pre-1883 "serenity restored at Donner Lake with Minnie Moody dismantled and hotel at Donner City burned" (Edwards 1883:66)

pre-1883 country store owned by Sisson, Egbert and Co. at Donner Lake (Edwards 1883:66)

1883 "Donner Lake is yearly visited by hundreds" (Edwards 1883:66)

1902 seasonal dairy farm at head of lake (USGS 1902)

var. chain of title (Nevada County Assessors Office 11/10/1943)

1867 advance railroad gangs; population at Donner City with 2 hotels, a general store and a sawmill (Meschery 1978:35)

II. ALTERNATIVE TRANSPORTATION ROUTES/POPULATION CENTERS

MINING

1863 "Red, White and Blue Mining District"; Knoxville on east bank of Truckee River at confluence with Squaw Creek; Claraville on west bank 1 mile upstream on Truckee River; ore devoid of precious metals (Meschery 1978:29-30; McGlashan 1940:149; Scott 1973:150, 198; Knowles 1942: 14; TRPA/USFS 1971:9)

n.d. "Gold has never been discovered on the very shore of Donner Lake." (McGlashan 1940:149)

II. ALTERVATIVE TRANSPORTATION ROUTES/POPULATION CENTERS

PROXIMITY TO URBAN CENTERS

1863 Grays Toll Station (Meschery 1978:34; NCHS 1976 30(3):1)

1864 Coburn's Station (Gudde 1969:345; NCHS 1949 2(5):n.p.; 1976 30(3):1)

1868 Truckee (Jackson 1967:33; Gudde 1969: 345; NCHS 1949 2(5):n.p.; 1976 30(3):2)

LINDSTROM/DRAFT 4/19/84

II. ALTERNATIVE TRANSPORTATION ROUTES/POPULATION CENTERS

WAGON ROUTES, STAGE COACH ROUTES

1857-59	toll road from Donner Pass to Donner Lake, followed 1844-45 emigrant route (Wiley 1979:9; oral interview 2/19/84)
1860-61	survey of Dutch Flat & Donner Lake Wagon Road by S.G. Elliott; organization of Lake Pass Turnpike Co (Jackson 1967:28; 1982:92-93)
1862-63	DF&DLWR construction (Edwards 1883:13; Jackson 1967:28-29; TRPA/USFS 1971:9)
6/15/64	DF&DLWR opened (Jackson 1967:30; 1982:93; Hoover, Rensch and Rensch 1966:267; NCHS 1976 30(3):2)
1864	way stations along DF&DLWR by summer (Jackson 1967:31; 1982:93)
1865	toll gates at Donner Lake (Jackson 1967:33)
1865-66	DF&DLWR (USGLO Plats 1865-66)
1867	staging to Donner Lake from "tracks-end" excursion trains by C.P.R.R. (Meschery 1978:35)
pre-1868	toll gates had been used at Donner Lake (Jackson 1967:33; 1982:93)
6/1868	C.P.R.R. captures road travel (Jackson 1982:93; TRPA/USFS 1971:9)
1874	staging from Truckee to Donner Lake (Jackson 1967:34)

Brandenburger vs. State of California

ARCHAEOLOGICAL SURVEY RESULTS

1. "Old Towle Mill" site and "Donner Mill" site (?)

   The site is located approximately 100 meters west of the Murphy Cabin site along the north bank of Donner Creek at a point where Donner Creek leaves its more steeply cut channel and enters a broad, flat flood plain (see map).

   Diagnostic artifacts indicate the sites age to be pre-1880s. Artifacts observed include: 1 large metal pully wheel, rusted heavy metal fragments; cut nails; tin can fragments with lead soldering; black glass fragments; Chinese brownware and white glazed earthen ceramic fragments.

   Features noted include: (1) an area containing a concentration of broken glass and ceramics (possibly an old cook house?); (2) numerous unnatural mounds and depressions; (3) remains of an old earthen dam (which may be part of the "second dam" for the proposed Newlands Project ca. 1880s-90s); and (4) the dredged channel of Donner Creek from the point of this "second dam" , upstream to its outlet.

2. Donner Lake House and McPherson's Barn site (?)

   The site is located south of present-day Donner Pass Road, just east of Tahoe-Donner Beach in a sagebrush flat and grassy meadow (see map).

   Diagnostic artifacts indicate the site's age to be ca. 1860s and later. Artifacts observed include: numerous broken glass fragments (black, amethyst, etc.); Chinese and Euroamerican ceramic fragments; metal fragments; etc.

   Features noted include: (1) slag pit and concrete foundations; (2) an old road bed lined with decaying logs layed end to end (this could be the original location of Donner Pass road?); (3) an old telegraph T-shaped pole with wire and cut nails; a virgin stand of enoumous lodgepole pines, two are joined by wire which has girdled both trees.

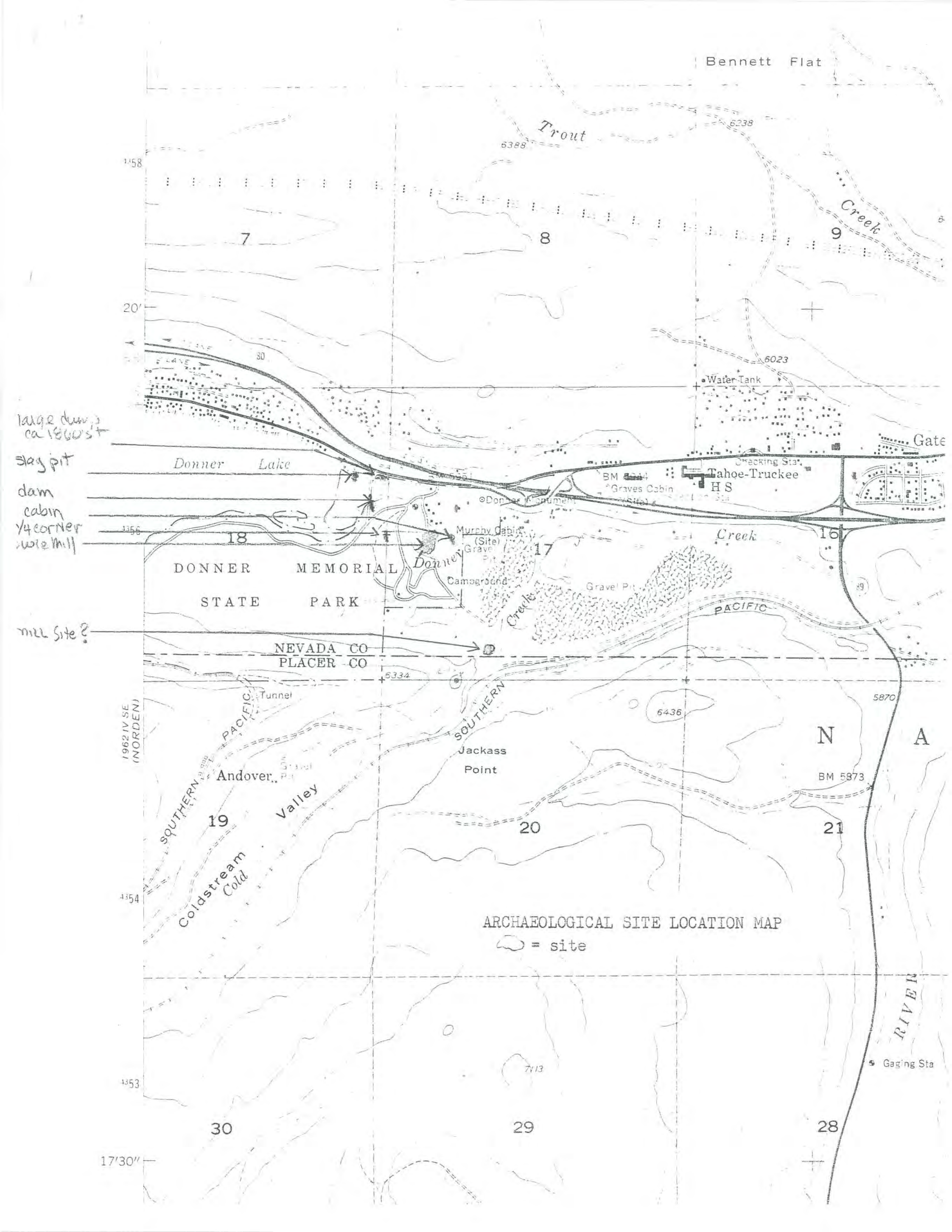
3. Schallenberger Ridge

   The ridge was given a general archaeological reconnaissance (see map). No evidence of early logging was observed (i.e. log chutes, high cut stumps, etc.). The area east of Lakeview Canyon appears to be a climax, virgin stand of red fir and recent logging was observed only west of Lakeview Canyon within Lodgepole stands (confirmed by US Forest Service).

   Several isolated artifacts were noted near the rail tracks (can fragments with soldered seams, shovel blades, amber, amethyst, olive glass fragments, etc.). Recent artifacts noted include bricks, rebar, stove door, sheet rock, pipe fittings, tin cans, rusted cable, etc., all of which were observed in the western and central portions of the ridge. Dirt roads and skid trails were seen in the western and west central ridge area. No roads or skid trails were observed in the eastern portion of the ridge.

4. Coldstream Canyon

   Remains of a mill site (?) ca. 1860s, were observed along a flat on the west side of Cold Creek, just below the point where Cold Creek leaves a steep canyon. Teich rt Gravel Pits have disturbed all the area downstream from this locale. Artifacts observed include: large metal fragments; cut and square nails, ceramic fragments, black and amethyst glass fragments.



Bennett Flat
Trout
Creek
6388
6238
7
8
9
20′
80
6023
Water Tank
large dump ca 1860's
slag pit
dam
cabin
1/4 corner
wire mill
Donner Lake
Gate
Checking Sta
BM 5944
Graves Cabin (Site)
Tahoe-Truckee H S
Donner Monument
Murphy Cabin (Site)
18
17
16
Creek
DONNER MEMORIAL STATE PARK
Donner
Gravel Pit
Campground
Creek
PACIFIC
mill site?
NEVADA CO
PLACER CO
6334
Tunnel
1962 IV SE (NORDEN)
PACIFIC
SOUTHERN
6436
5870
N
A
Jackass Point
Andover
BM 5873
SOUTHERN
Valley
19
20
21
Coldstream
Cold
ARCHAEOLOGICAL SITE LOCATION MAP
= site
RIVER
Gaging Sta
7113
30
29
28
17′30″

Susan Lindström

Archaeologist

P.O. Box 3324
Truckee, CA 95734
916-587-7072

20 August 198[illegible]

Greetings Hutch;

Enclosed are: (1) distance and bearings to various points from the Section 18/17 ¼ corner; (2) 2 maps with plotted locations; and (3) some comments.

Distance and approx. bearing from ¼ corner of 17 & 18 to the present dam = 335°/200meters.
Distance and approx. bearing from same ½ corner to Murphy Cabin = 90°/350 meters.
Distance and approx. bearing from same ¼ corner to the site where we thought the Towle Mill was located = 90°/200 meters from ½ corner to its west boundary and 90°/280 meters to its east boundary.
Distance and bearing from same ¼ corner to the "slag pit" = 330°/375 meters.
Distance and bearing from same ¼ corner to the "dump ca. 1860s+" = 355°/300 meters.

Comments regarding the mill site:

- On Becker's Map, the sawmill location at the completion of the creek bend as it trends to the southeast fits the possible Towle site location on the ground, but makes no sense according to the section numbers -- should be in Section 17; and the sharp creek bend to the northeast should be partially located in Section 18 according to modern maps.
- The outlet configuration shown on the 1865 GLO Map hardly resembles the current outlet!

Comments regarding the Donner Lake House,etc.:

- The large dump area ca. 1860s+ seems to more closely correspond to the location of the D.L. House/McPherson's Barn as shown on the 1865 GLO Map and to the eastern-most double set of structures (titled "D.L. House") as shown on Becker's Map.
- The slag area seems to more closely correspond to the eastern-most double set of structures shown on Becker's Map.
- I noticed during the field survey that the large dump area ca. 1860's is located just north of an old road bed (as can be seen today). As the 1865 GLO Map shows both the D.L House and McPhersons on the north side of the DFDLWR this may have been the original route, with the current Donner Pass road having been moved at some time later, further to the north???

All my best to you and Red . . . Susan

P.S. What a comprehensive synthesis! Thanks for the copy.

DONNER LAKE BASIN

WATERSHED ASSESSMENT

A CONTEXTUAL OVERVIEW OF HUMAN LAND USE

AND

ENVIRONMENTAL CONDITIONS

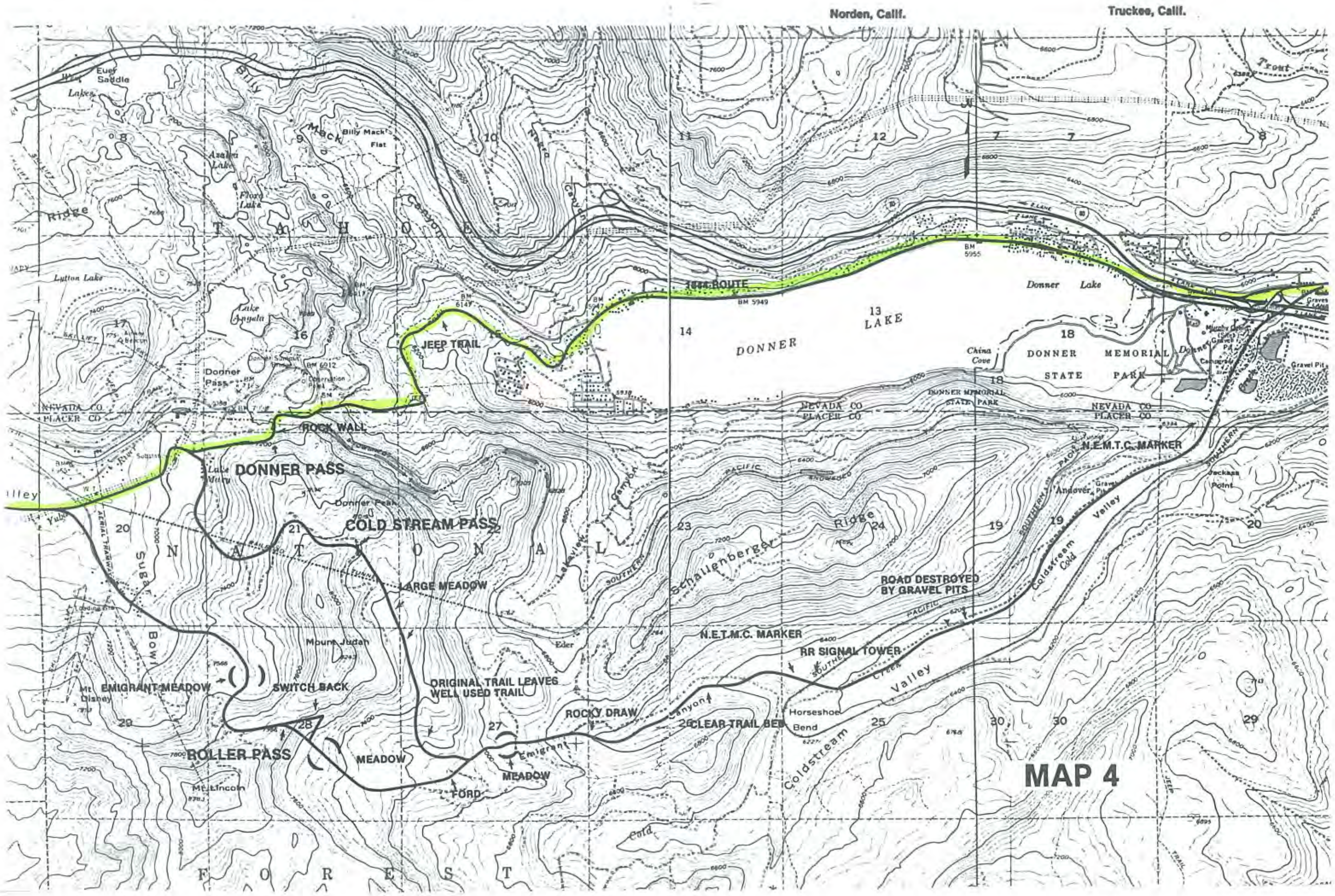
WORKBOOK

APPENDIX 7: Historic Maps

Susan Lindström, Ph.D. (RPA), Consulting Archaeologist

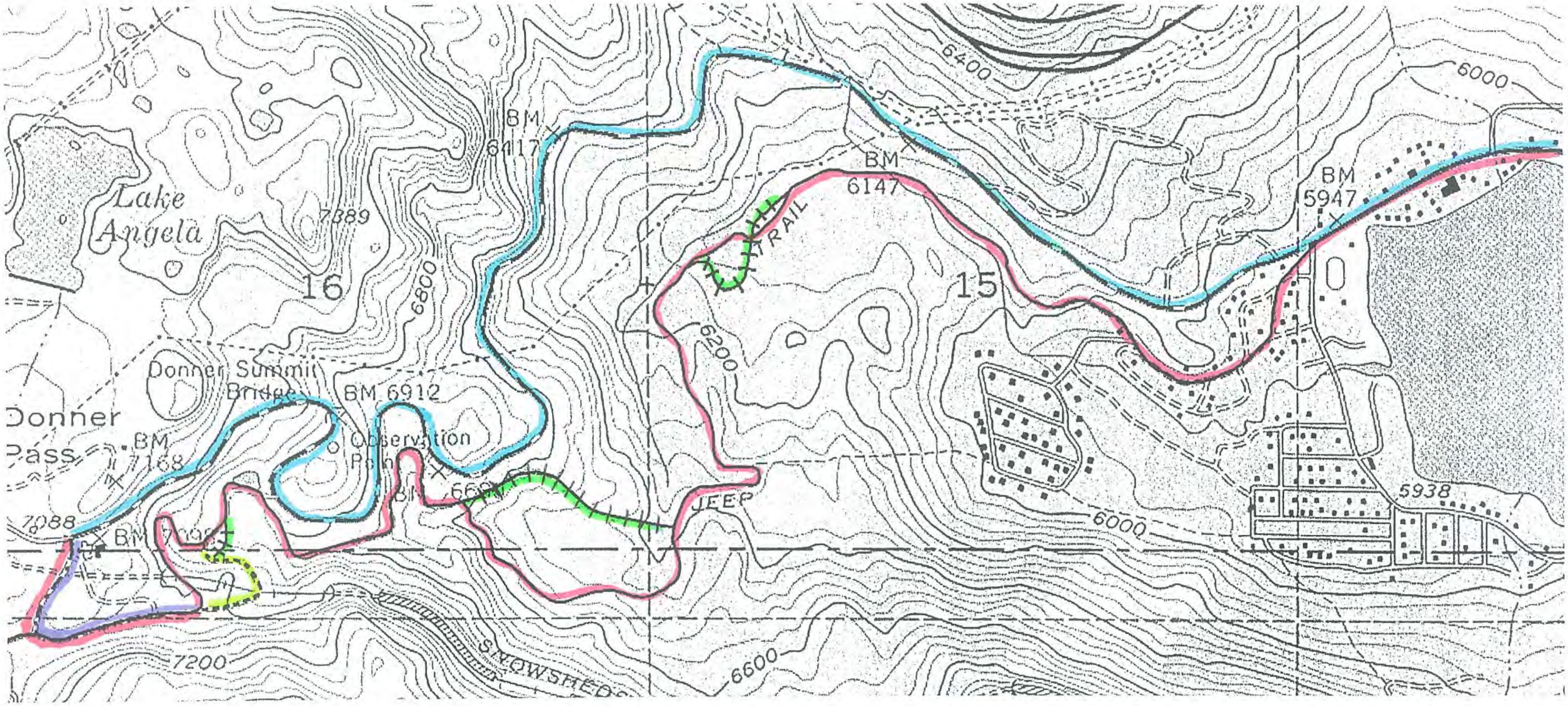
Truckee, California

August 2015



Map 1. Map of the Truckee Route of the Emigrant Trail (after Grayson 1986:37 Map 4)

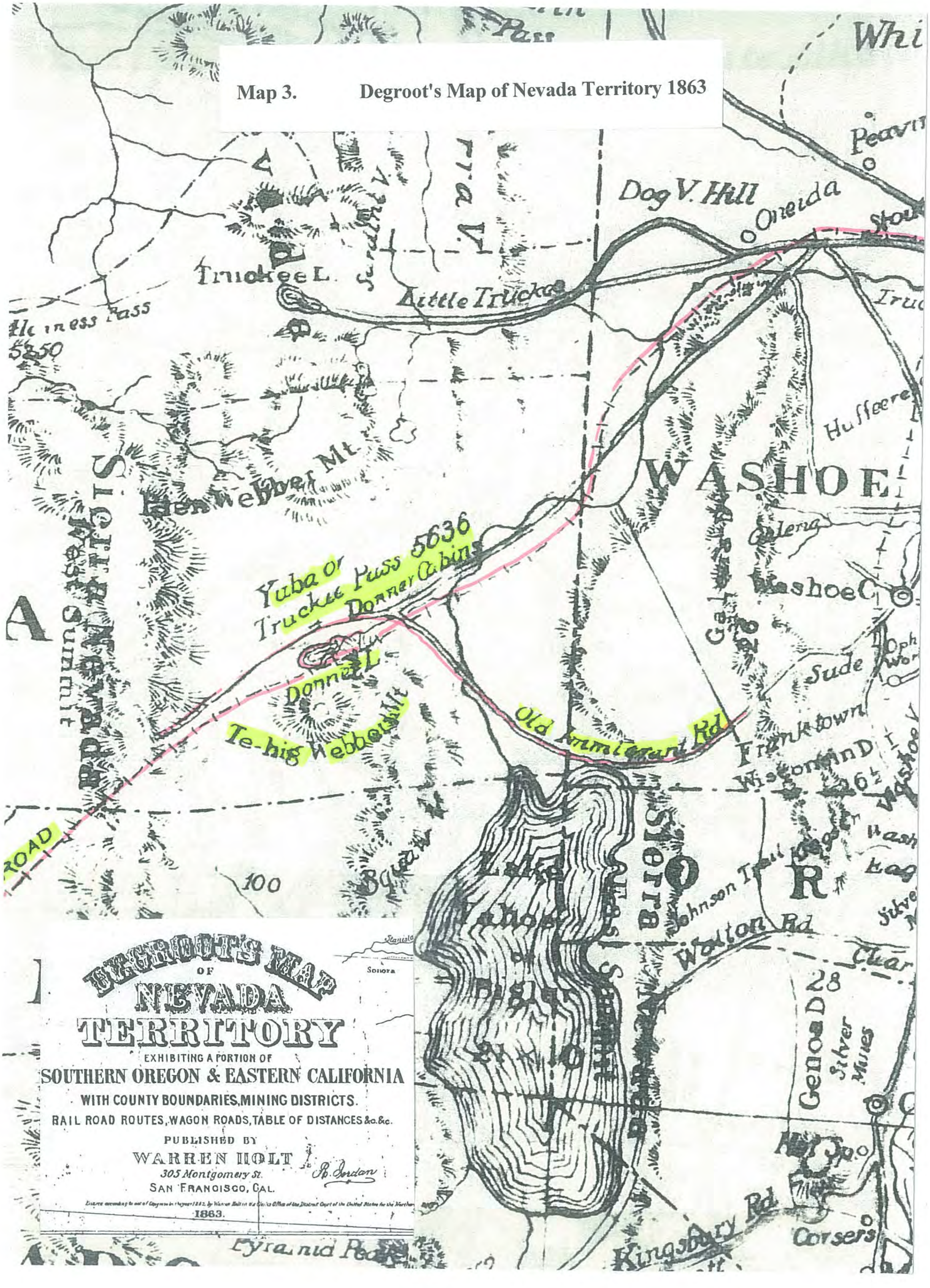
DONNER PASS TO DONNER LAKE HISTORIC ROAD SEGMENTS



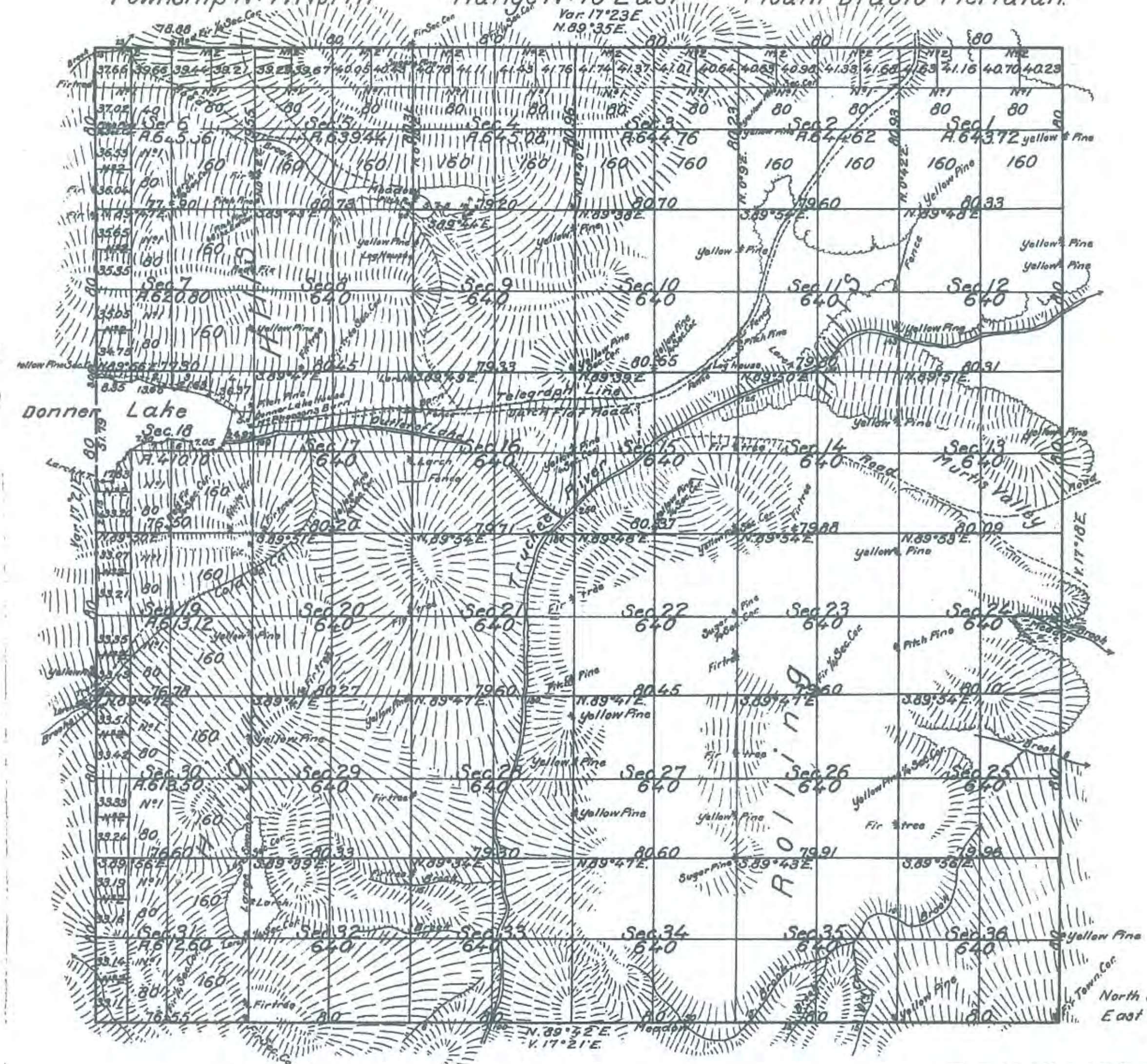
1864 Dutch Flat & Donner Lake Wagon Road
1912 State Highway Relocation
1924 Highway 37 / U.S. 40
1926 Highway 37 / U.S. 40
ASI Road 1924 - 1928
Road Variants

Map 2. **Donner Pass to Donner Lake Historic Road Segments (after Lindström et al. Plate 2)**

Map 3. Degroot's Map of Nevada Territory 1863



Township N° 17 North   Range N° 16 East   Mount Diablo Meridian.



R. G. .. - J. B. S. Jr.

Meanders of Donner Lake					
Sec	Course	Dist.	Sec	Course	Dist.
Beginning at Meander Cor.			18	S. 37¾ W.	1.10
ner on West boundary of Town-				" 68½ "	4.00
ship on North bank of Lake				" 85¾ "	3.00
thence along same				N. 69 "	3.50
18	S. 80° E.	6.60		" 84 "	2.60
	" 62 "	3.20		" 42½ "	3.50
	N. 89¼ "	8.50		" 69½ "	3.50
	" 64 "	2.00		" 87 "	8.00
	S. 75 "	11.00		S. 63 "	3.20
	" 87½ "	2.70		" 84 "	9.40
	" 71½ "	5.30		" 63½ "	7.50
	" 85 "	6.70		" 46 "	1.80
	" 78½ "	11.00		" 37 "	3.20
	" 56 "	4.30		" 53½ "	3.60
	" 60½ "	9.20		" 15 "	9.60
	" 9½ W.	10.00		" 88½ "	4.70
	" 24 "	8.40		N. 82½ "	3.50
		88.90			75.70
					88.90

Aggregate 164.60 - 2 Mls. 4 Chs. 60 lks.

Aggregate Area of Public land		22.713.30 Acres
" " " Donner Lake		205.10 "
Aggregate		22.918.40 "

North and South Section lines run at a Variation of 17°18' E ast
East and West " " " " " 17°38 "

Surveys Designated	By Whom Surveyed	Date of Contract	Amount of Surveys	When Surveyed
Township lines	E. Dyer	May 24th. 1865	————	1865
Section "	" "	" " "	59 mls. 68 chs. 53 lks	1865
Meander "	" "	" " "	2 - 4 - 60 -	September 9th. 1865

The above Map of Township N° 17 North, Range N° 16 East of Mount Diablo Meridian is strictly conformable to the field notes of the Surveys thereof on file in this Office, which have been examined and approved.

Surveyor General's Office,
San Francisco, California,
December 20th. 1865.

L. Upson
Surv. Gen'l Cal.

DEPARTMENT OF THE INTERIOR.
GENERAL LAND OFFICE,
Washington, D. C. Sept. 2?. 1907.
I hereby certify that this is a true copy of the plat of official survey of the lands to which it relates, on file in this office.

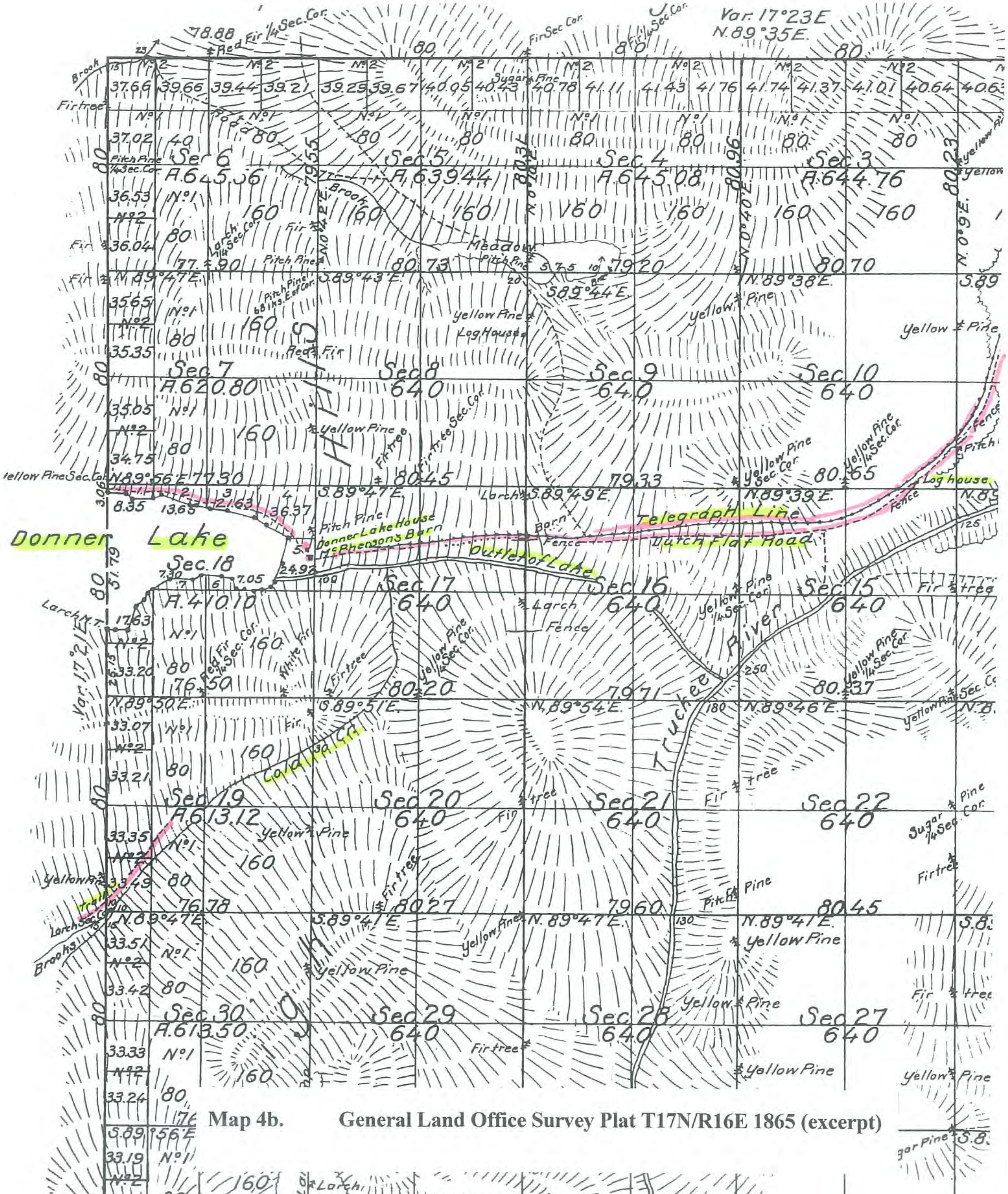
H. W. Sanford
Recorder, General Land Office.

30

Map 4a. **General Land Office Survey Plat T17N/R16E 1865**

411420

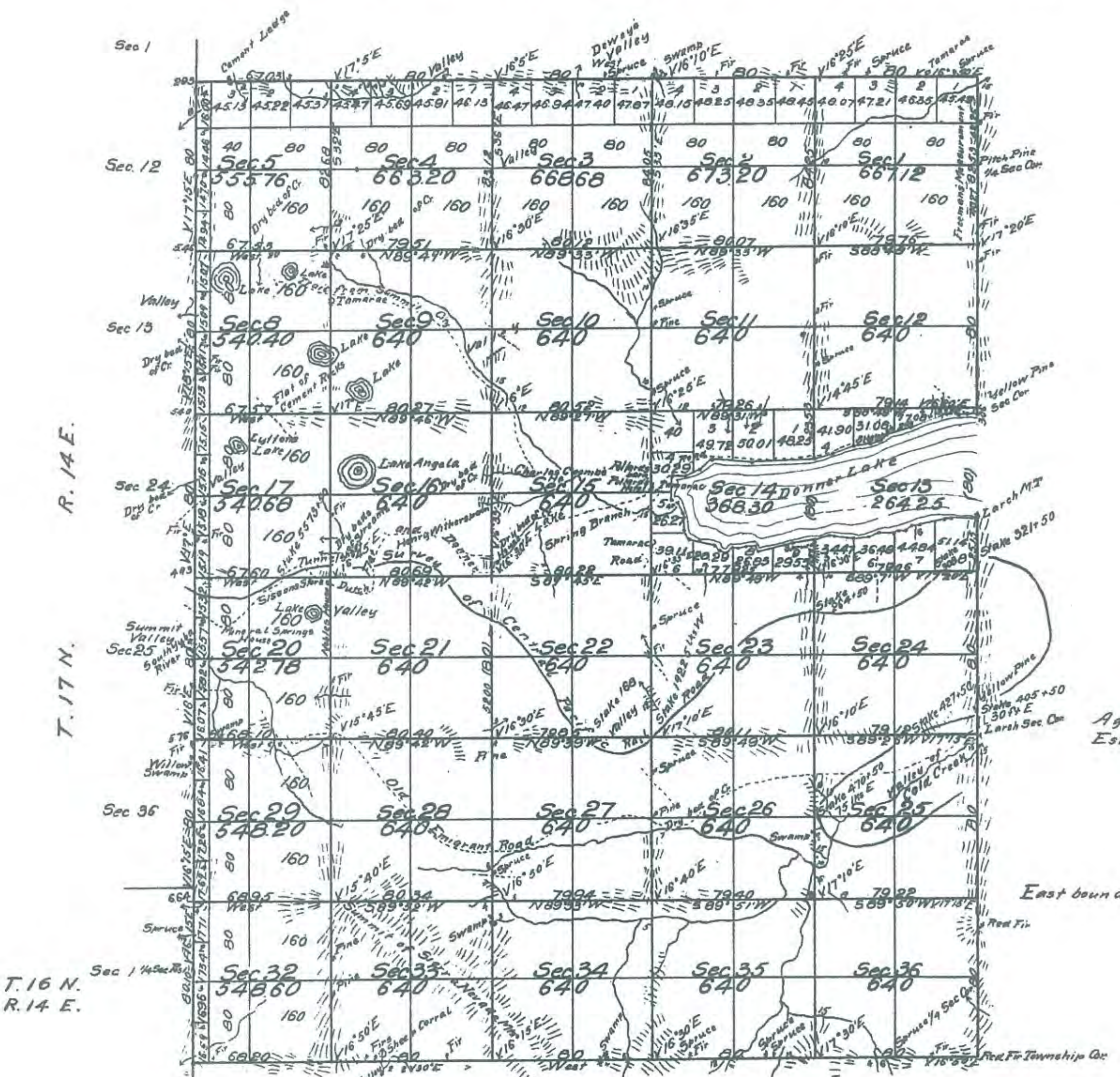
T17N. R16E. M.D.



Map 4b. General Land Office Survey Plat T17N/R16E 1865 (excerpt)

L.J.L.

Township No. 17 North, Range No. 15 East Mount Diablo Meridian



Meanders of Donner Lake					
Sec	Course	Dist	Sec	Course	Dist
Beginning at a post on Township line 25.15 Chs North of Cor. to Secs. 13 and 24			14	N. 39° W	4.00
				" 71½ "	8.60
				" 82¾ "	5.60
13	N 87° W	11.95		" 24½ "	4.50
	S. 84¾ "	4.50		" 6 "	8.50
	" 76¾ "	12.00		" 20½ "	5.90
	" 72¼ "	3.30		" 80 "	2.90
	" 64¾ "	4.30		" ¾ "	12.20
	" 67¾ "	3.40		" 88 E	7.00
	" 80½ "	2.10		" 65¾ "	6.80
	" 78½ "	3.80		" 50½ "	8.50
	" 85 "	3.40		S. 83 "	19.50
	" 69½ "	5.50		N 86¼ "	31.90
	" 80 "	7.50	13	" 76 "	8.20
	N. 79 "	9.80		" 70¼ "	11.00
	" 88½ "	2.00		" 81 "	9.00
	S. 76 "	7.50		" 70 "	5.00
14	" 80½ "	10.90		" 55 "	5.50
	" 80 "	18.40		" 73¼ "	11.80
	N. 7 "	2.50		" 69 "	18.00
	" 89 "	4.50		S 86 "	6.00
	S. 78½ "	5.10		N 81 "	3.50
	West	2.72		" 85½ "	5.10
	S 55° W	3.00			209.00
	N 85¾ "	3.10			131.27
		131.27	Aggregate		340.27
4 mls 20 Chs 27 lks					

Aggregate Area of Public Land 18101.17 Acres
Estimated " " Donner Lake 647.45 "
Aggregate 18748.62 "

East boundary of Sec. 1 re-surveyed but not charged

Surveys Designated	By whom Surveyed	Date of Contract	Amount of Surveys	When Surveyed
East boundary of Township	C. Dyer	May 24th 1865	—	1865
Rest of Township lines	J. E. Freeman	June 21st 1866	15 mls 58 chs 41 ks	1866
Section lines	" " "	" " "	46 " 30 " 10 "	1866
Meanders	" " "	" " "	4 " 20 " 27 "	November 3d 1866

The above Map of Township No. 17 North Range No. 15 East Mount Diablo Meridian is strictly conformable to the field notes of the Surveys thereof on file in this Office which have been examined and approved
Surveyor General's Office
San Francisco California
April 10th 1867

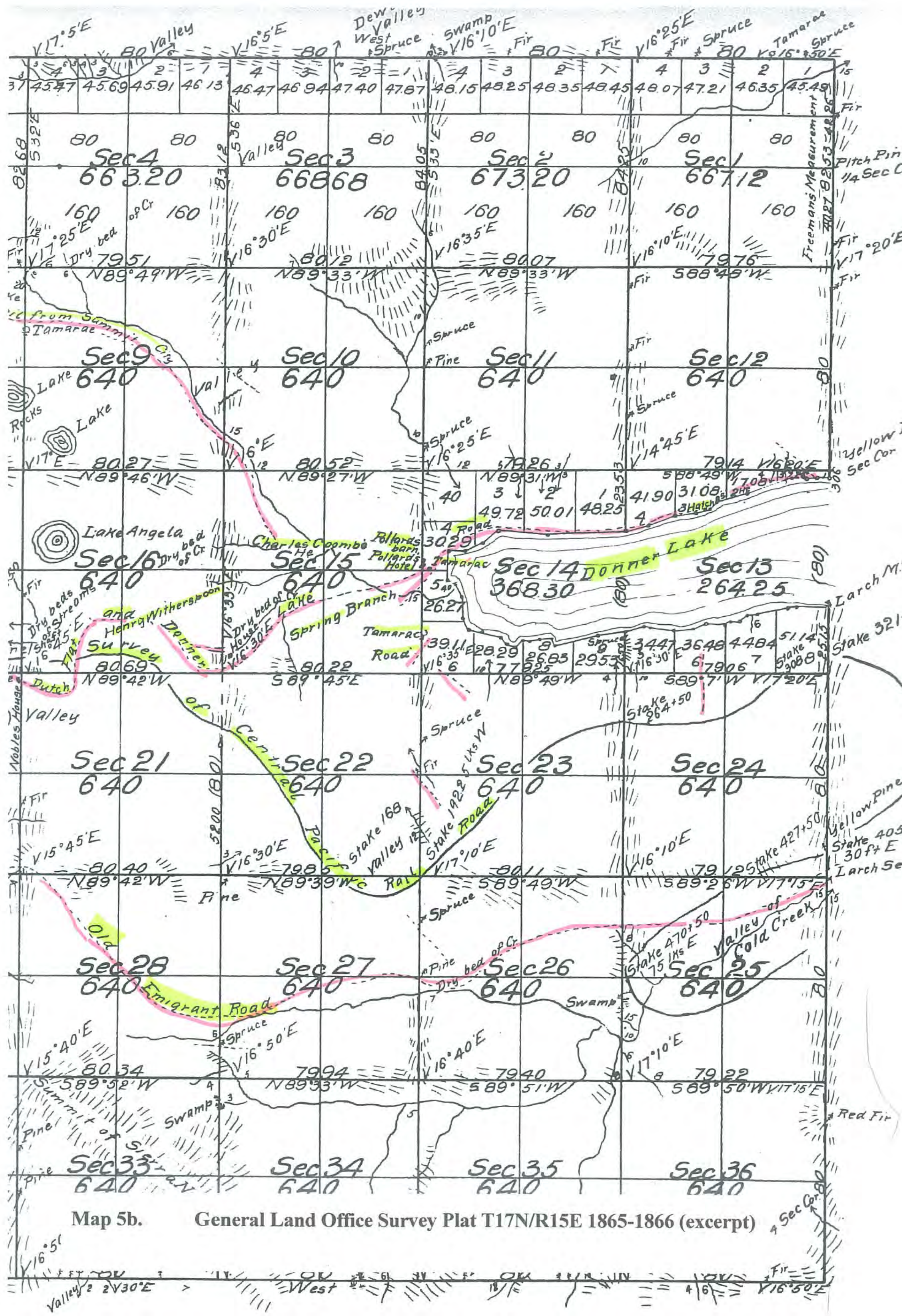
L. Upson Sur Gen. Cal.

DEPARTMENT OF THE INTERIOR,
GENERAL LAND OFFICE,
Washington, D. C. Sept. 6, 1907.
I hereby certify that this is a true copy of the plat of official survey of the lands to which it relates, on file in this office.

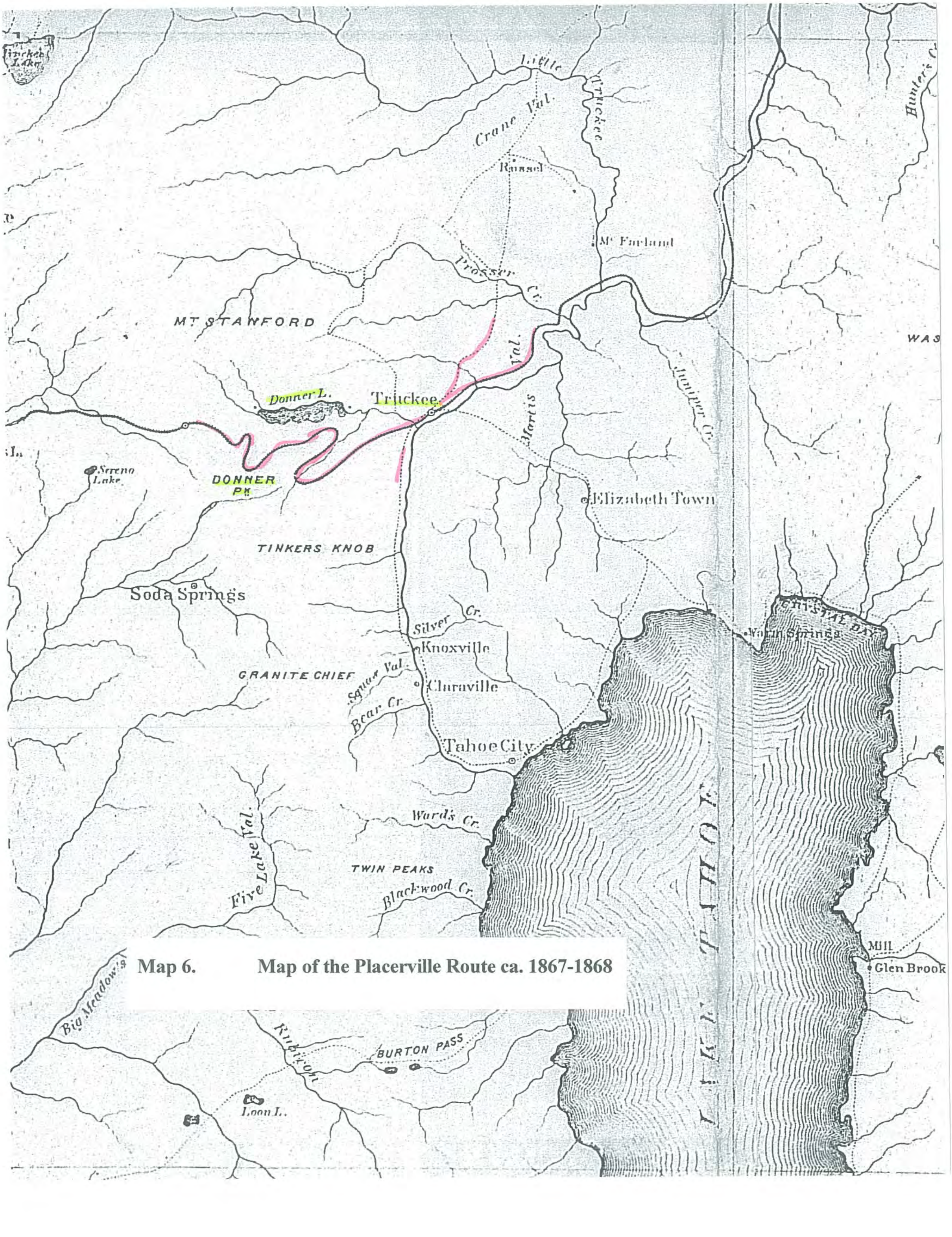
Recorder General Land Office.

Map 5a. **General Land Office Survey Plat T17N/R15E 1865-1866** 411419

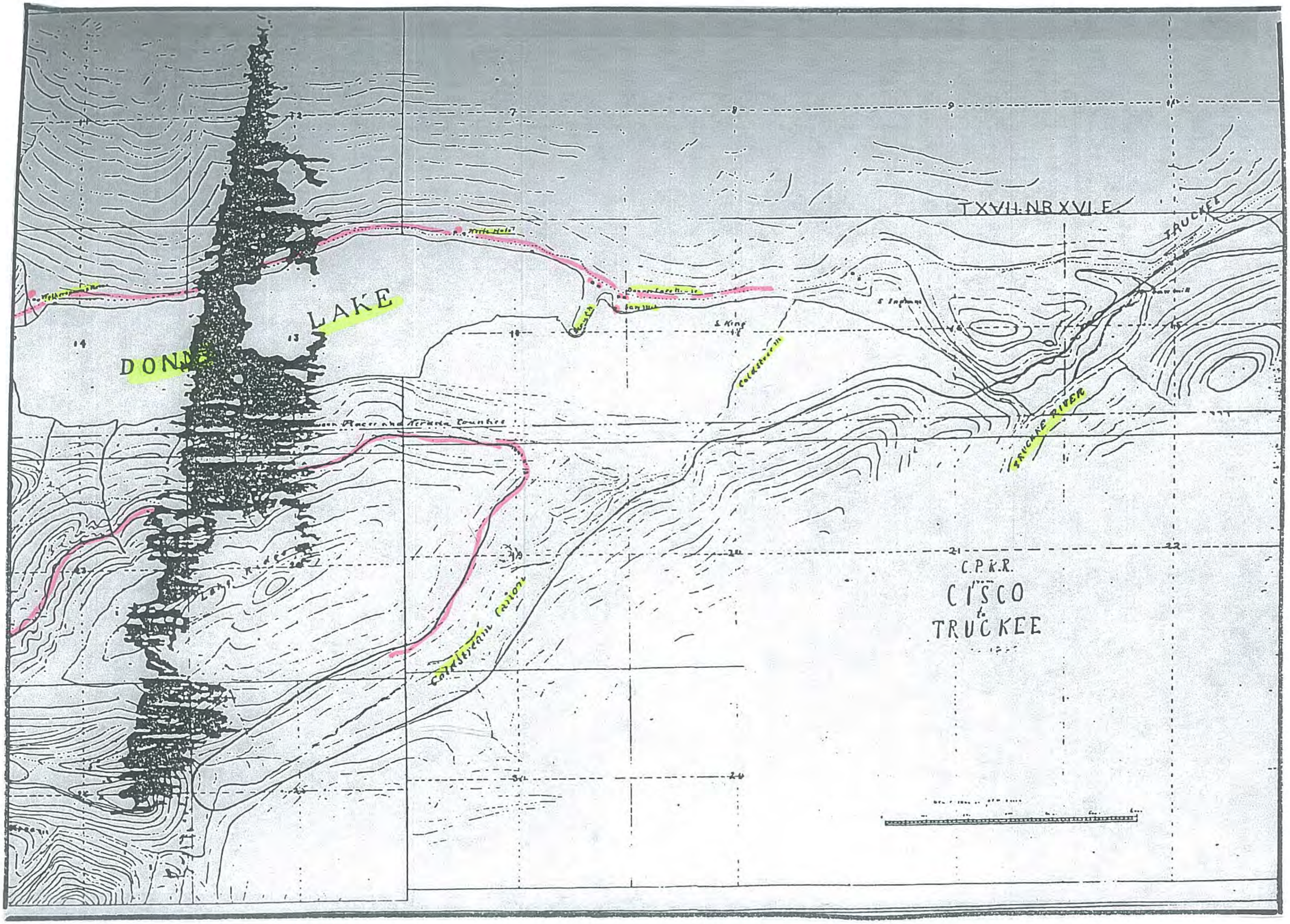
T17N. R15 E. M D.



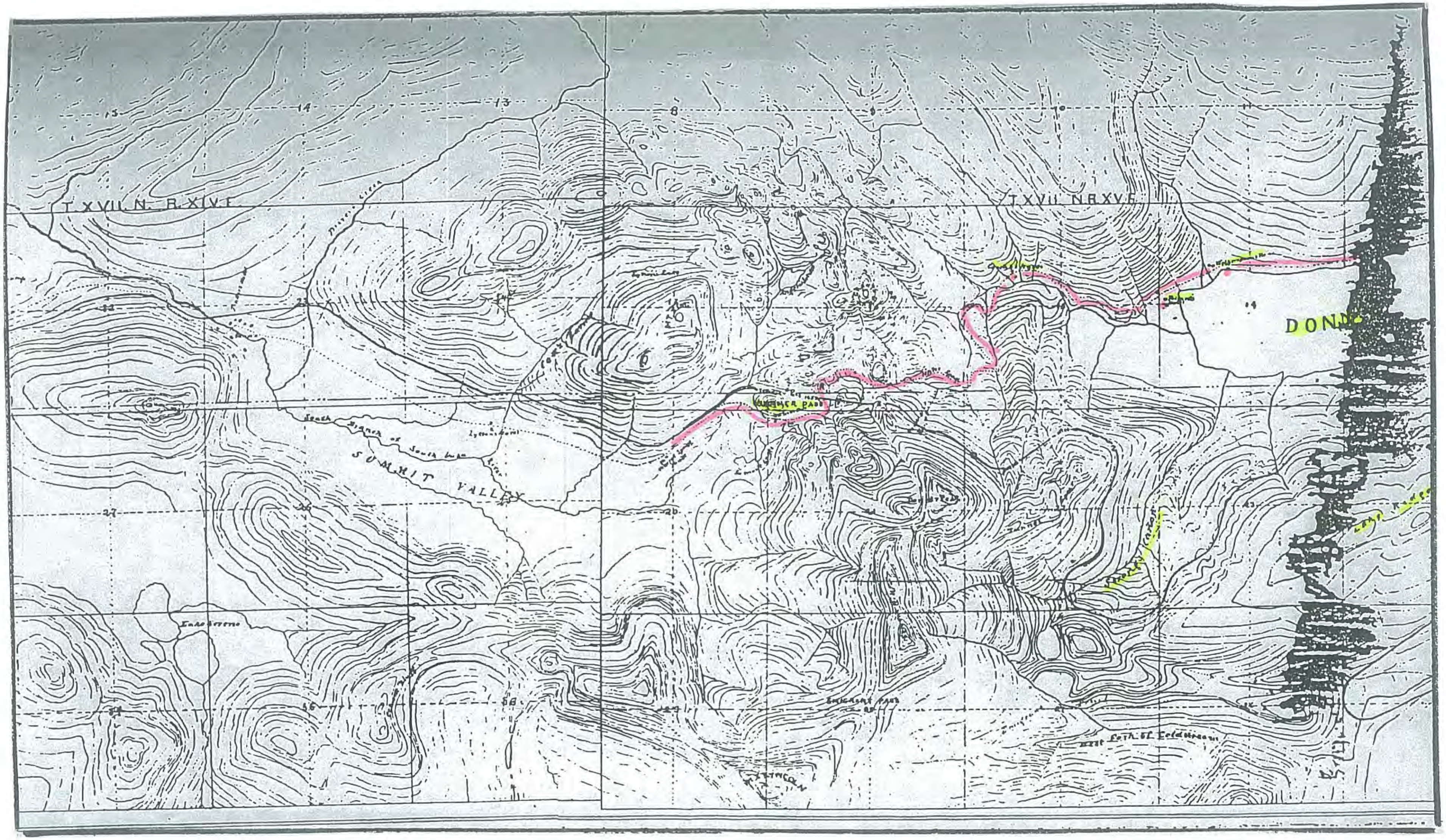
Map 5b. General Land Office Survey Plat T17N/R15E 1865-1866 (excerpt)



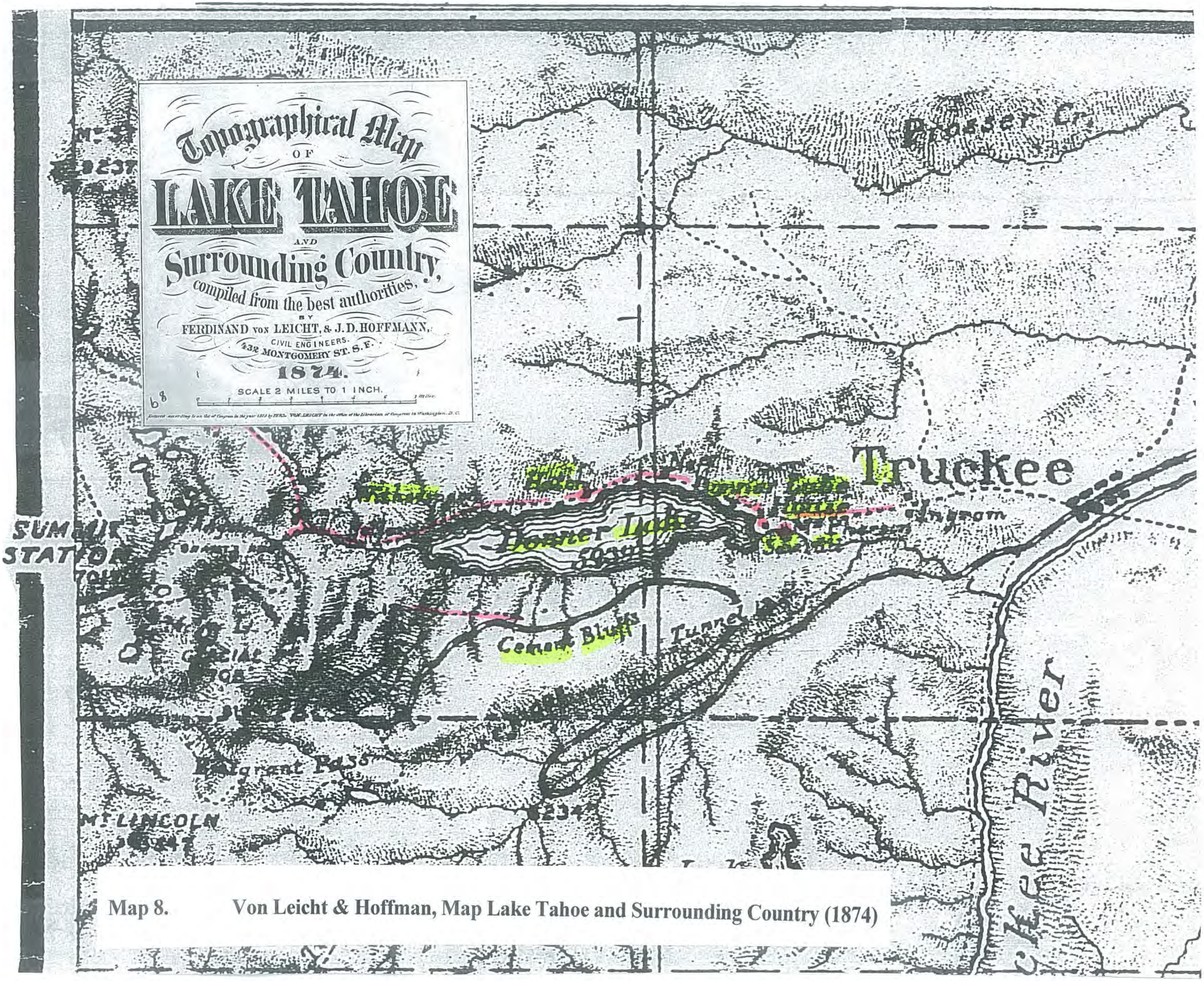
Map 6. Map of the Placerville Route ca. 1867-1868



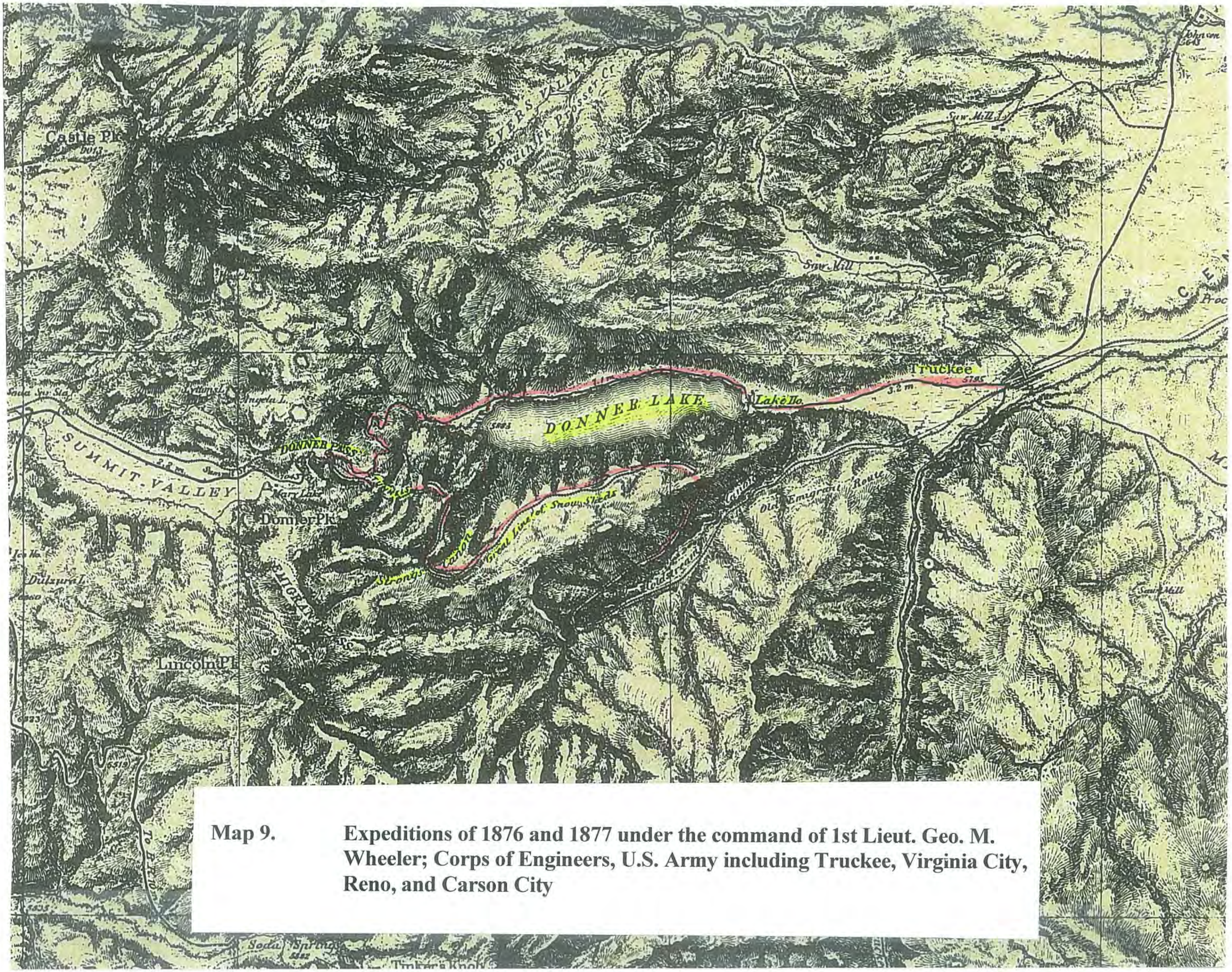
Map 7a. **Map, California Geological Survey Papers ca. 1870 (Donner Lake West)**



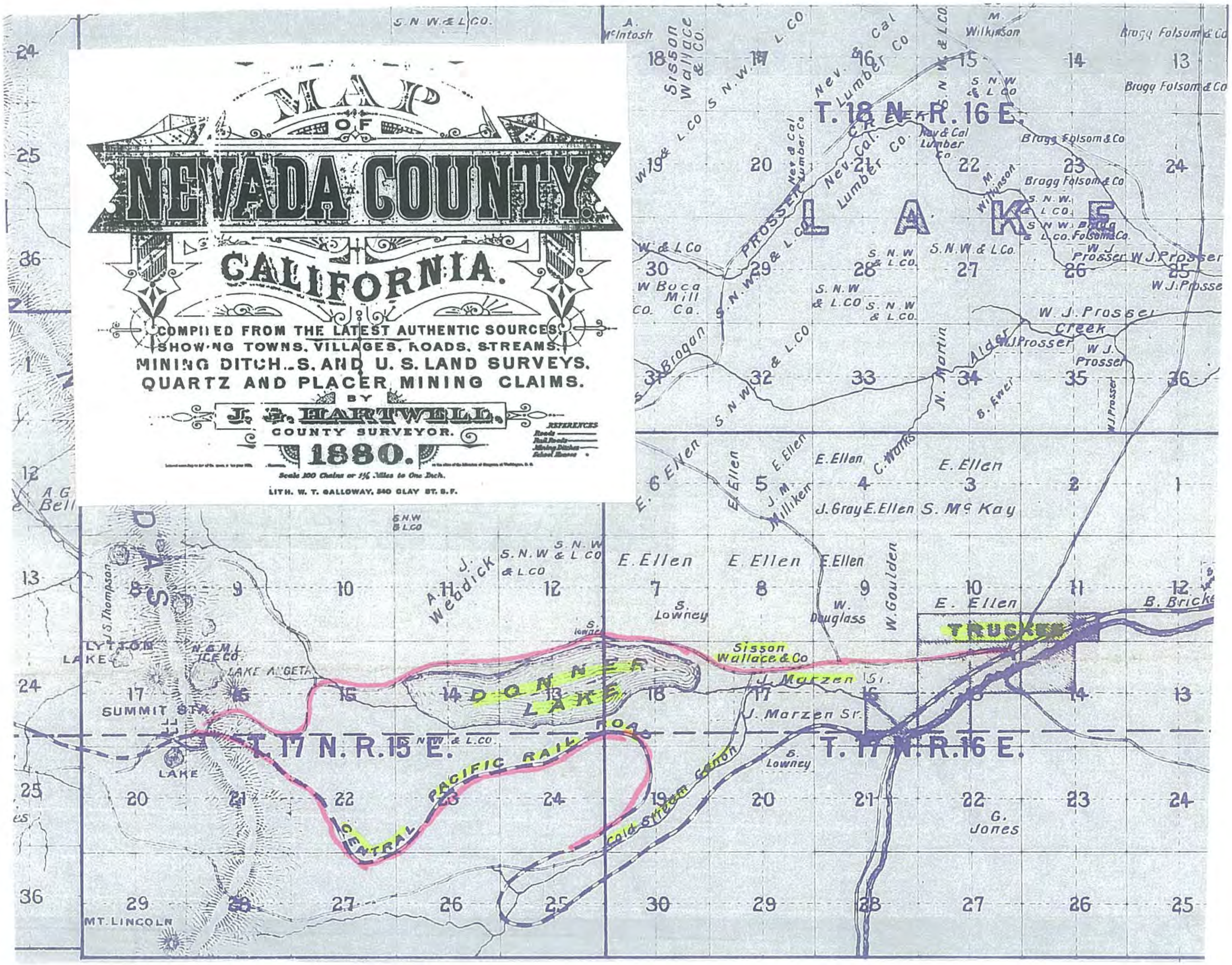
Map 7b. **Map, California Geological Survey Papers ca. 1870 (Donner Lake East)**



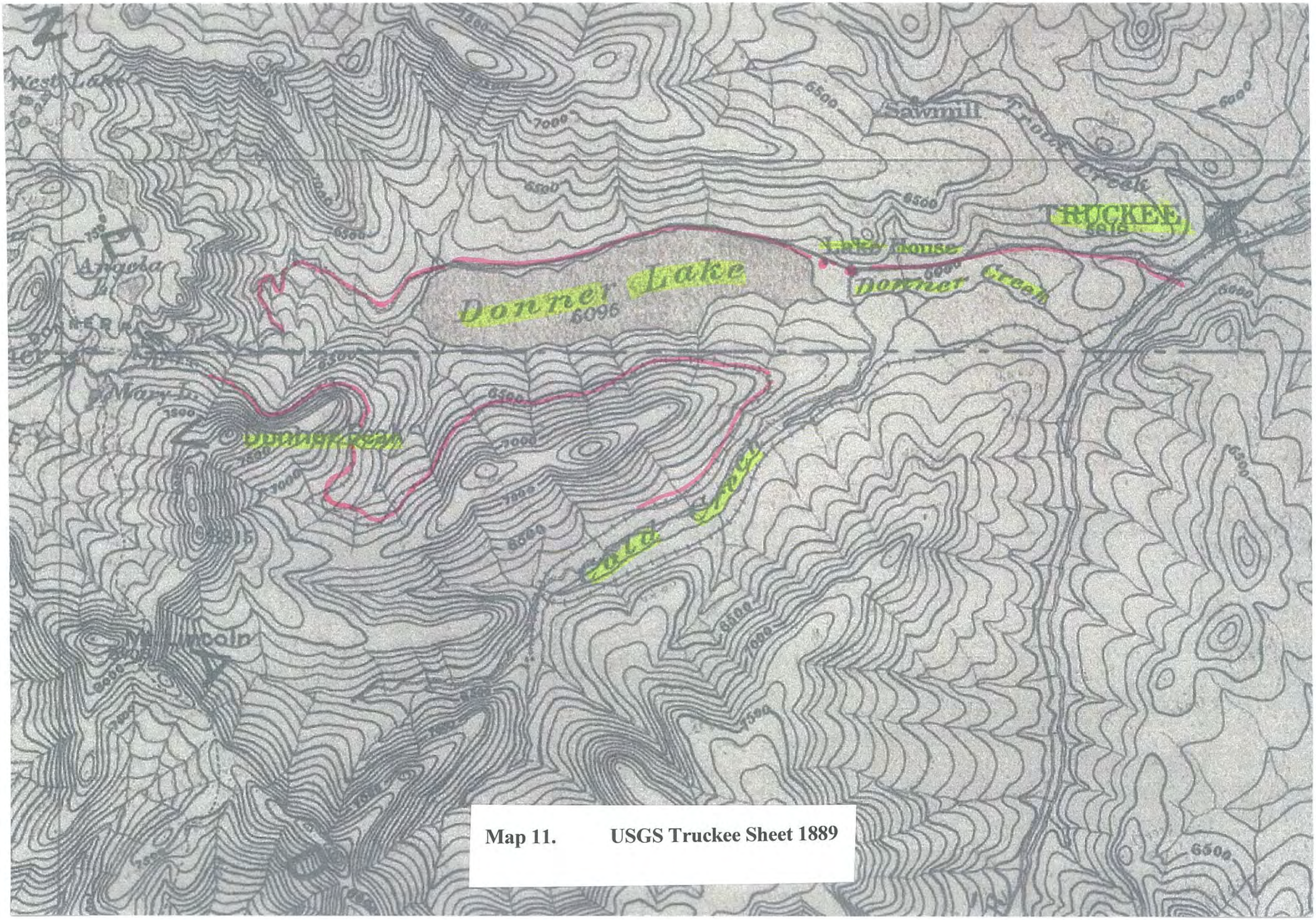
Map 8. Von Leicht & Hoffman, Map Lake Tahoe and Surrounding Country (1874)



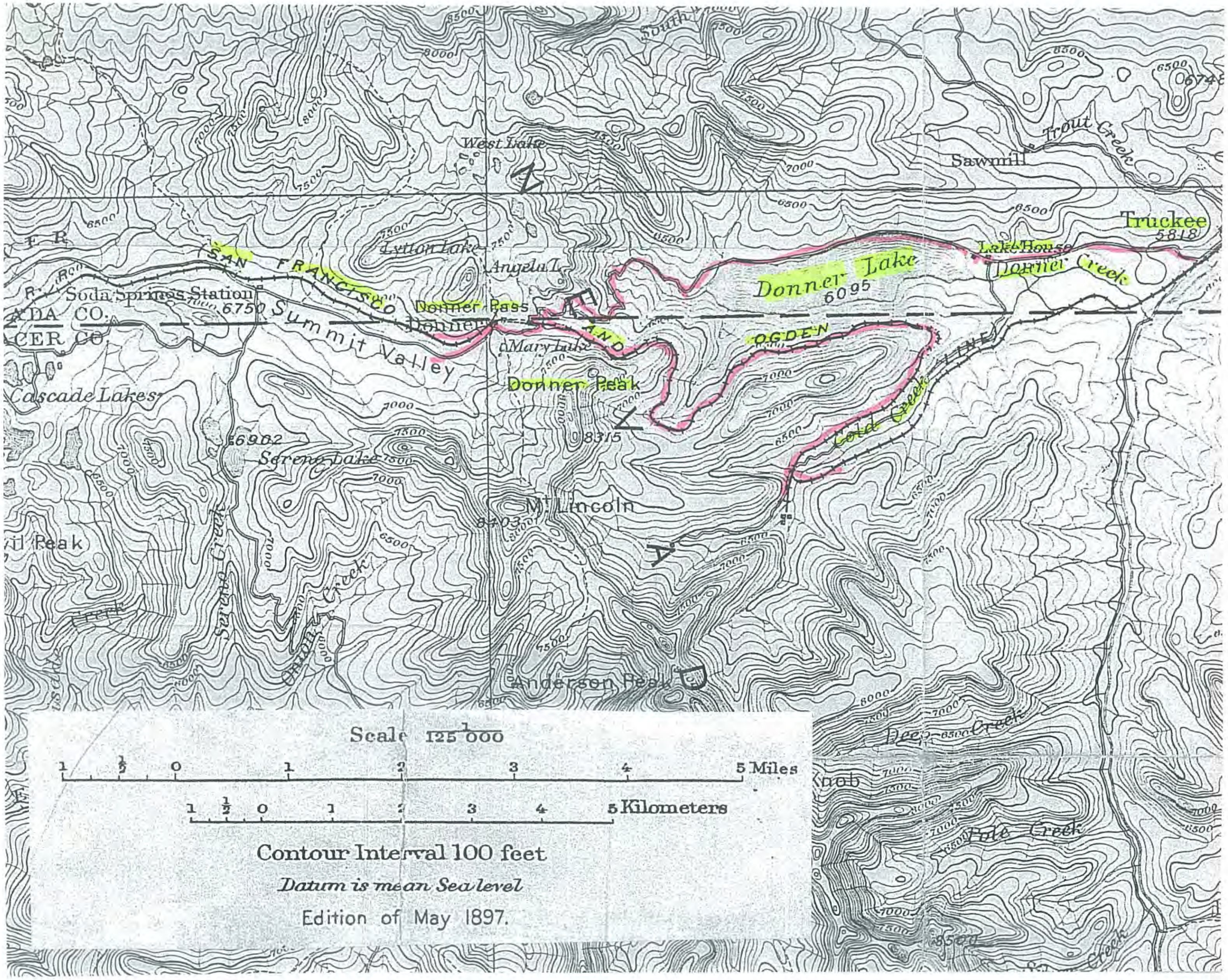
Map 9. Expeditions of 1876 and 1877 under the command of 1st Lieut. Geo. M. Wheeler; Corps of Engineers, U.S. Army including Truckee, Virginia City, Reno, and Carson City



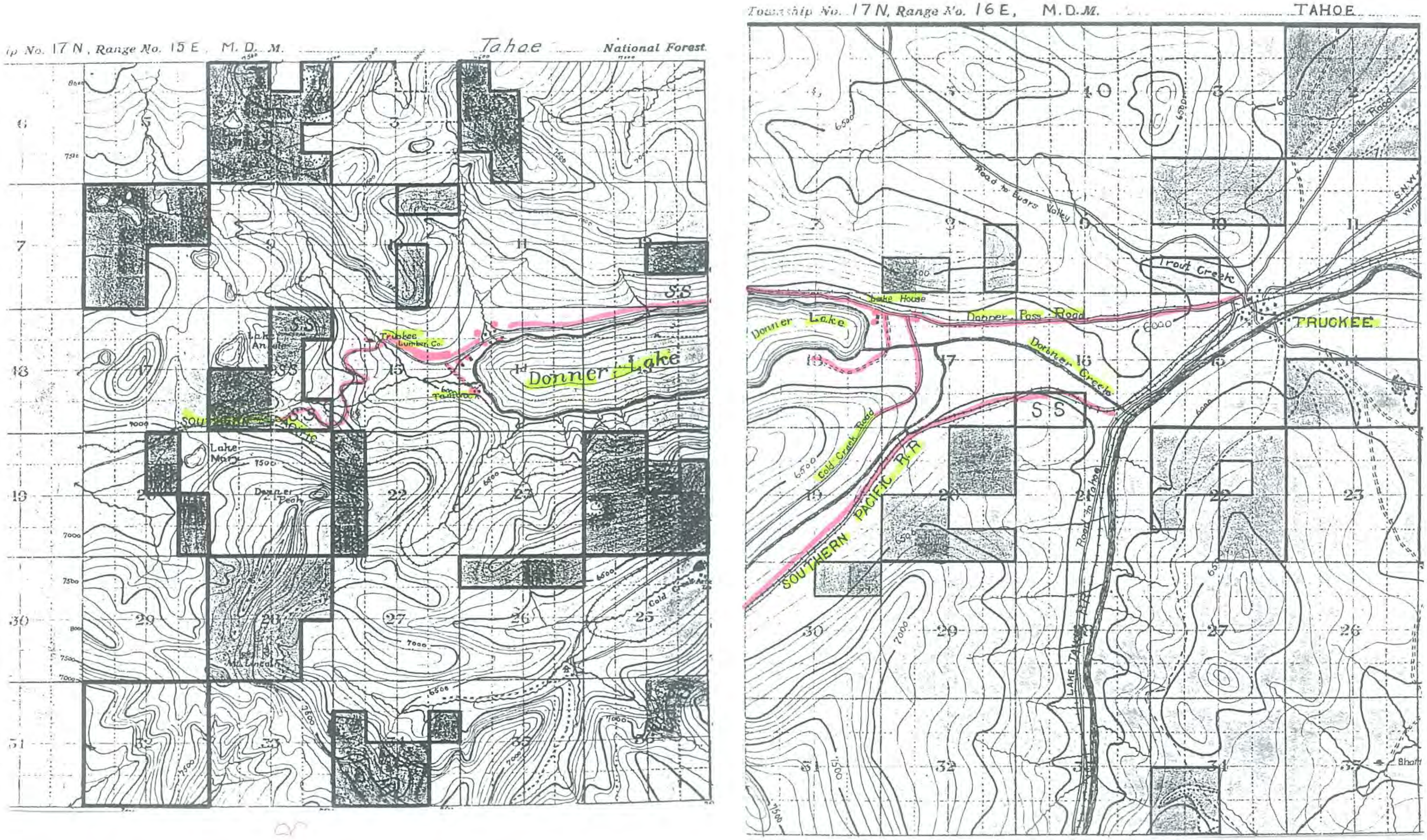
Map 10. **Map of Nevada County 1880**



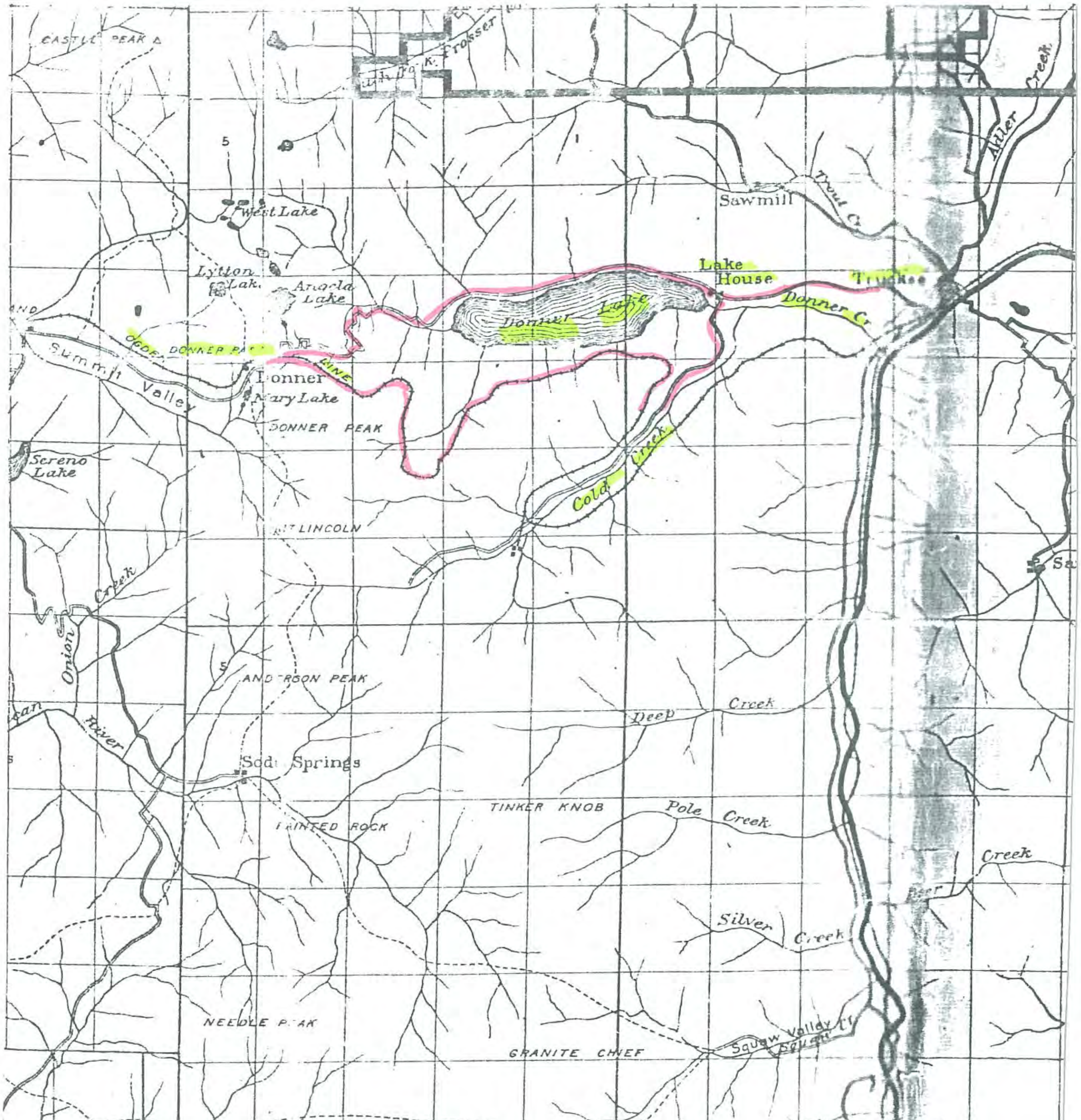
Map 11. USGS Truckee Sheet 1889



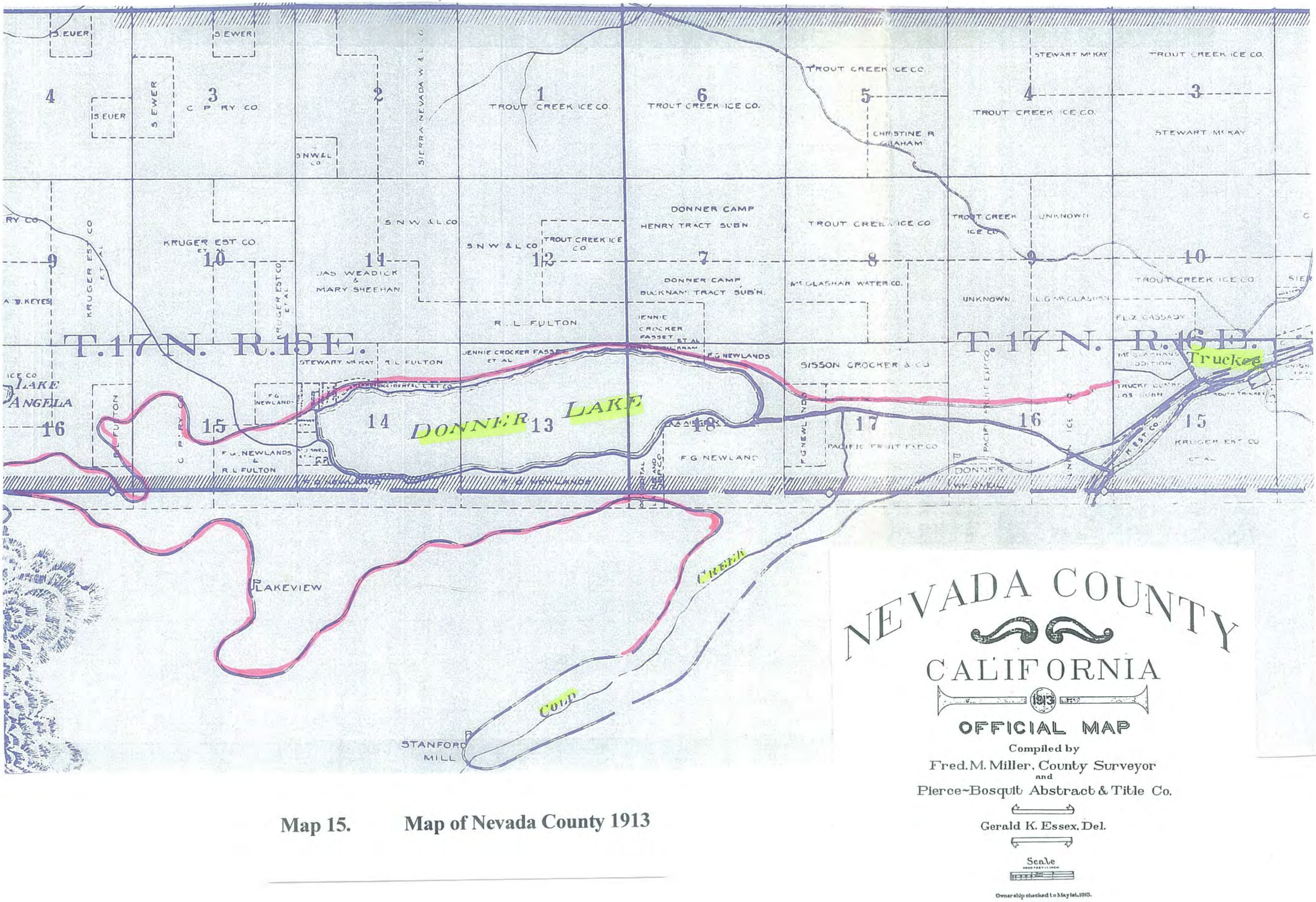
Map 12. **USGSs Truckee Quad 1889/1897 edition**



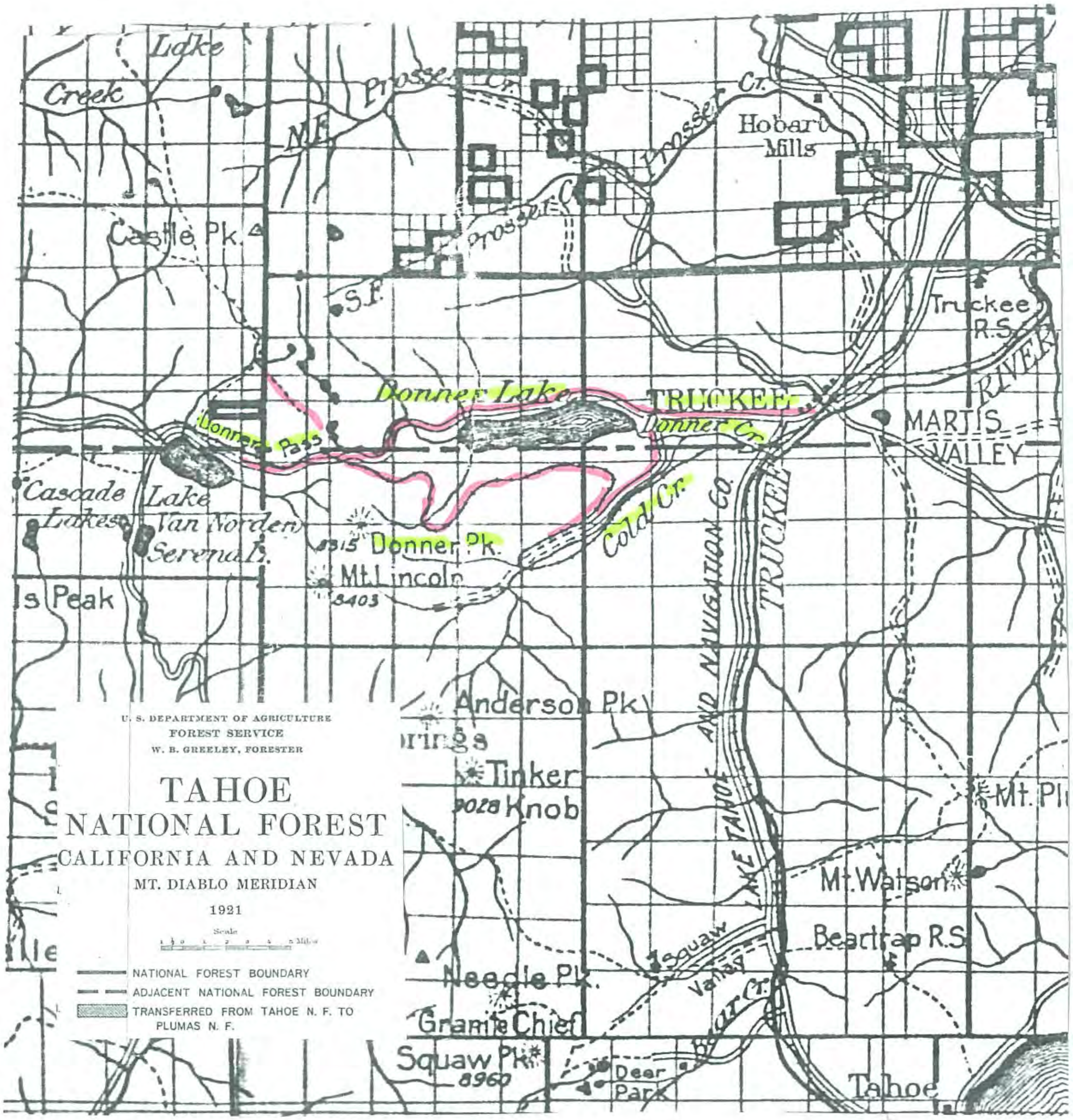
Map 13. Tahoe National Forest 1911 (grazing)



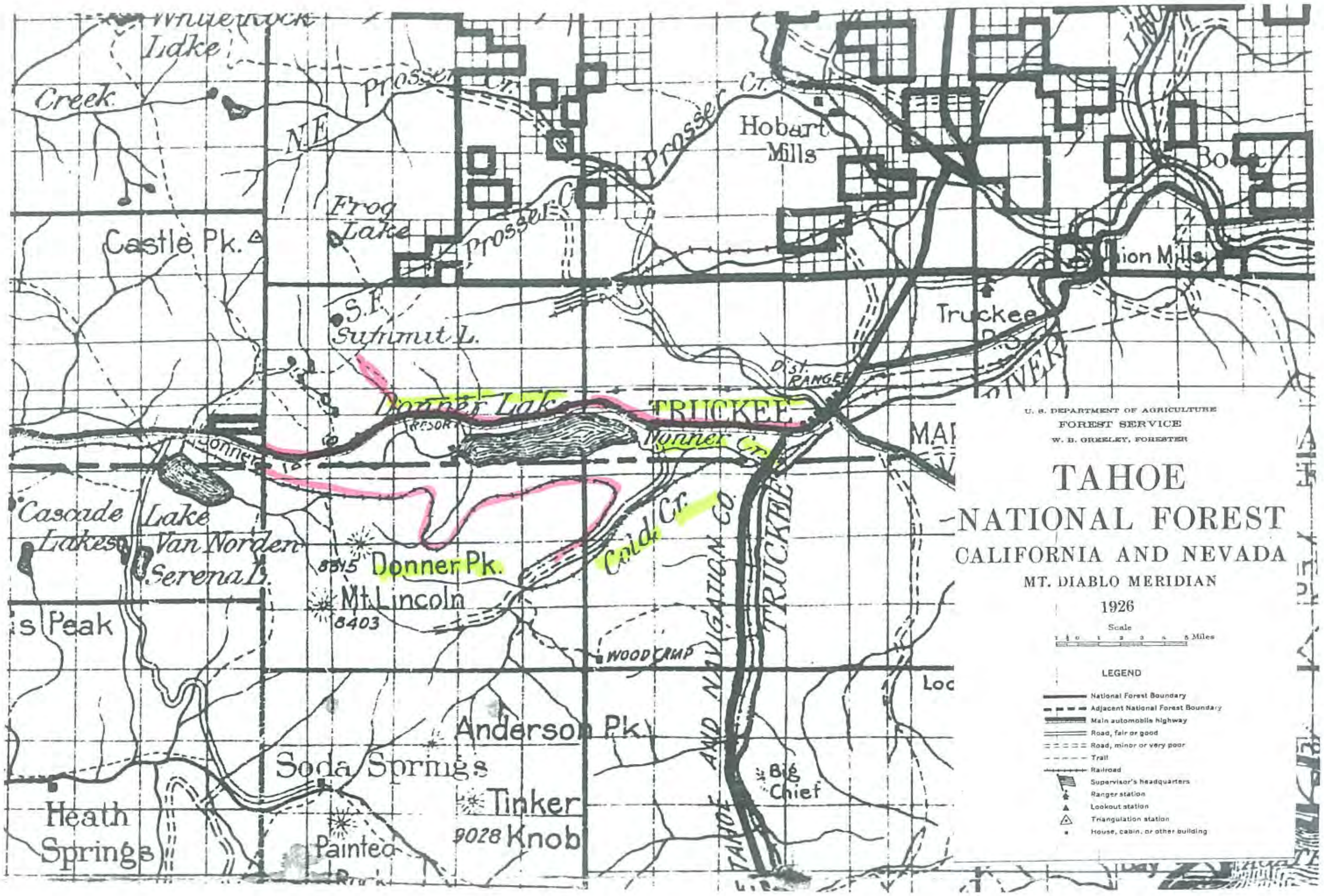
Map 14. Tahoe National Forest 1911



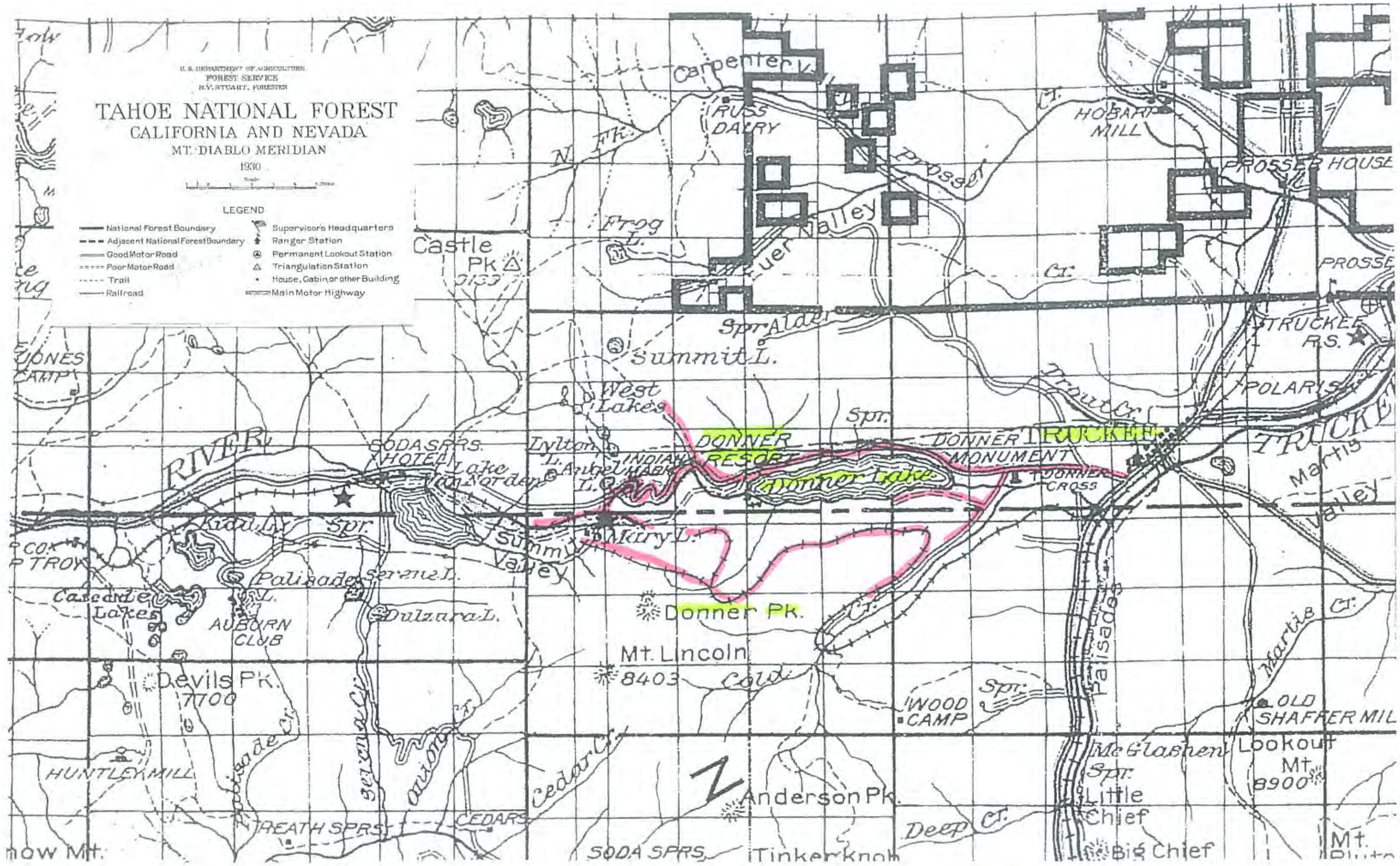
Map 15. **Map of Nevada County 1913**



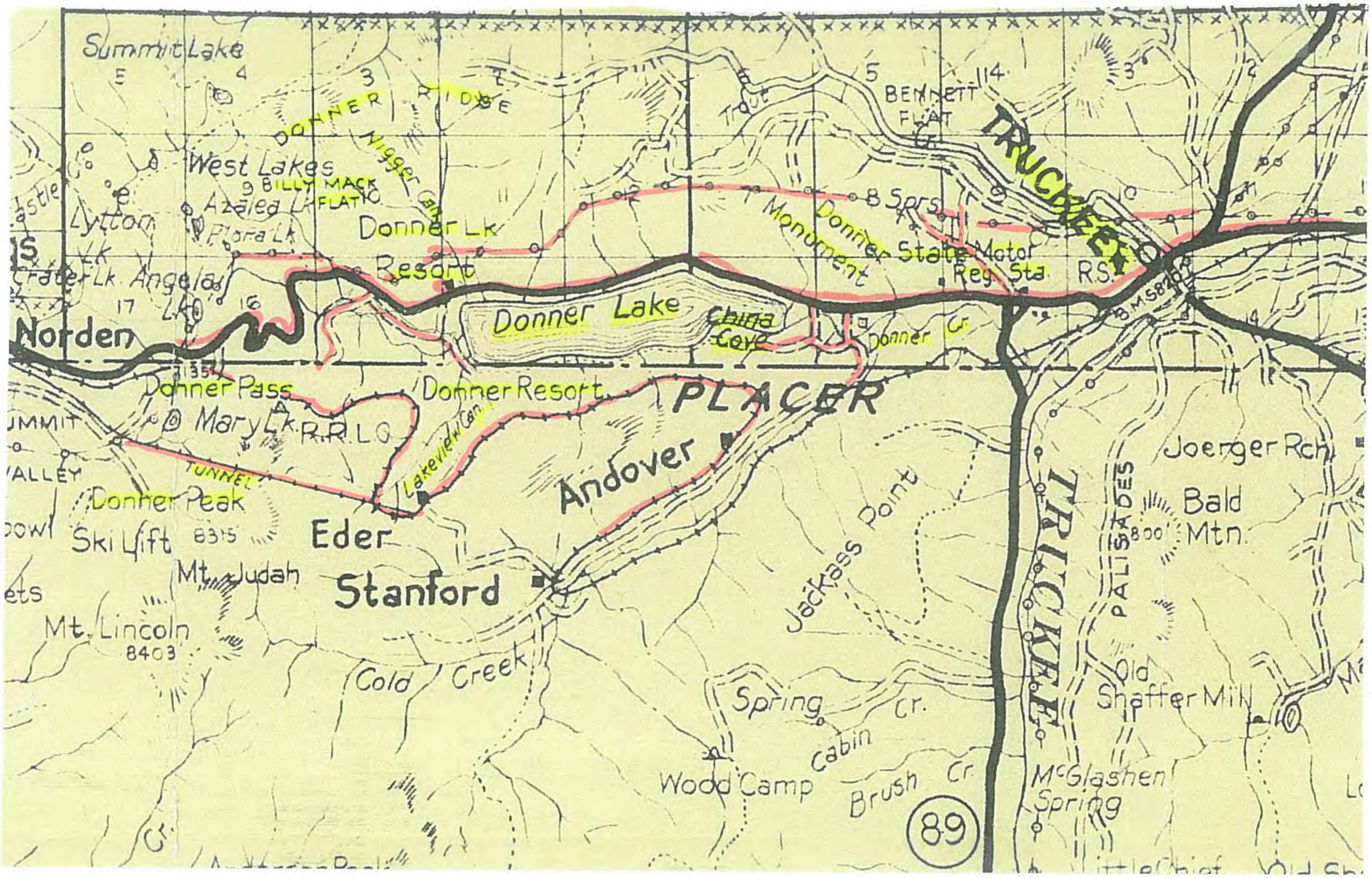
Map 16. Tahoe National Forest 1921



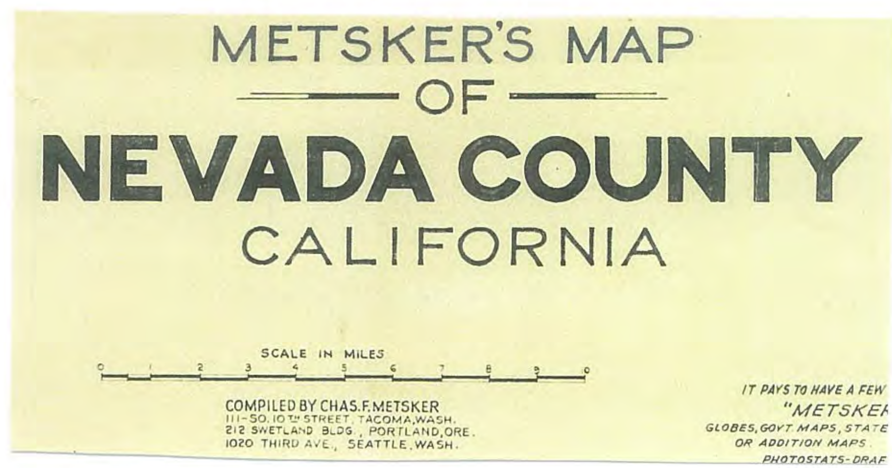
Map 17. **Tahoe National Forest 1926**

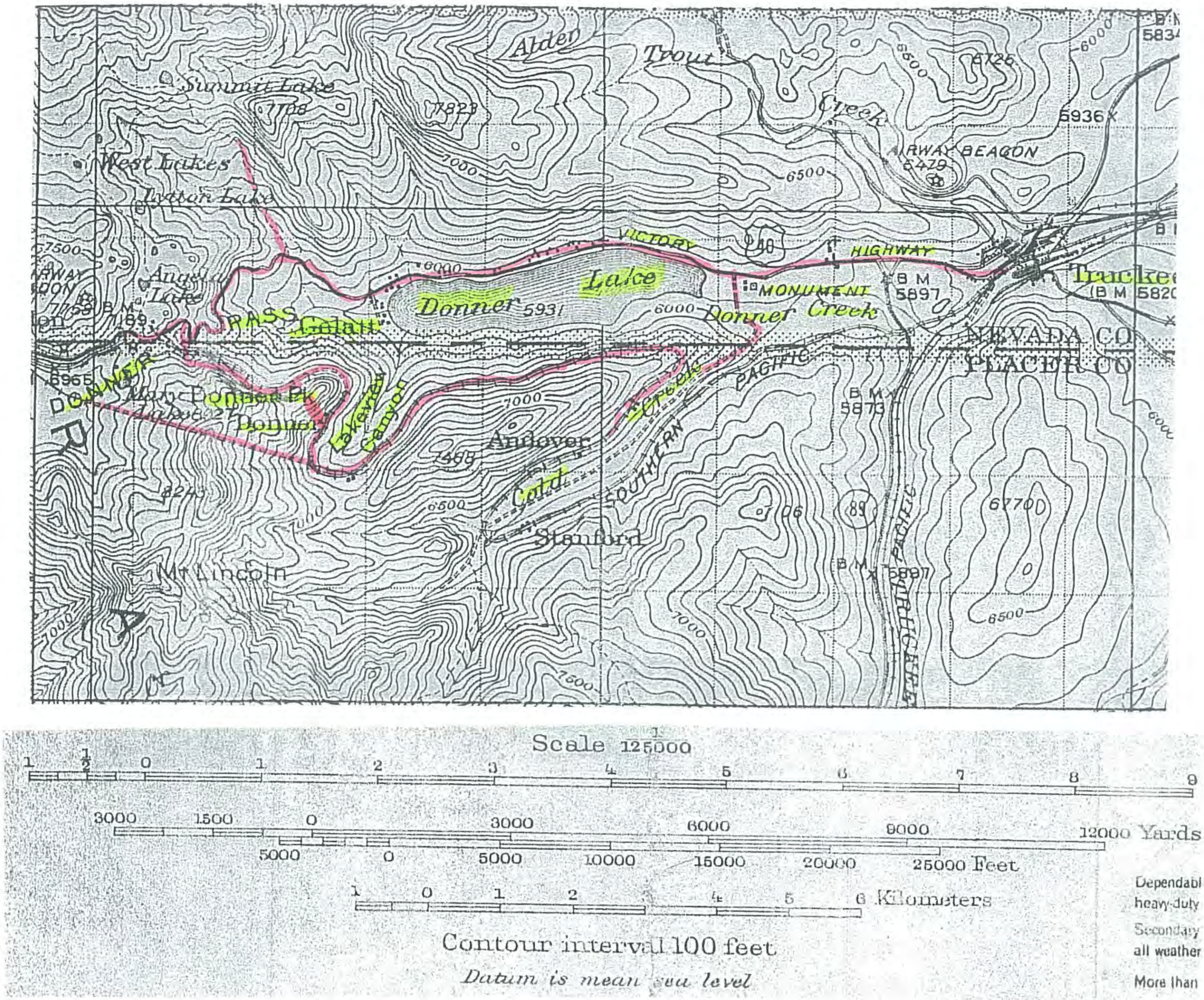


Map 18. **Tahoe National Forest 1930**

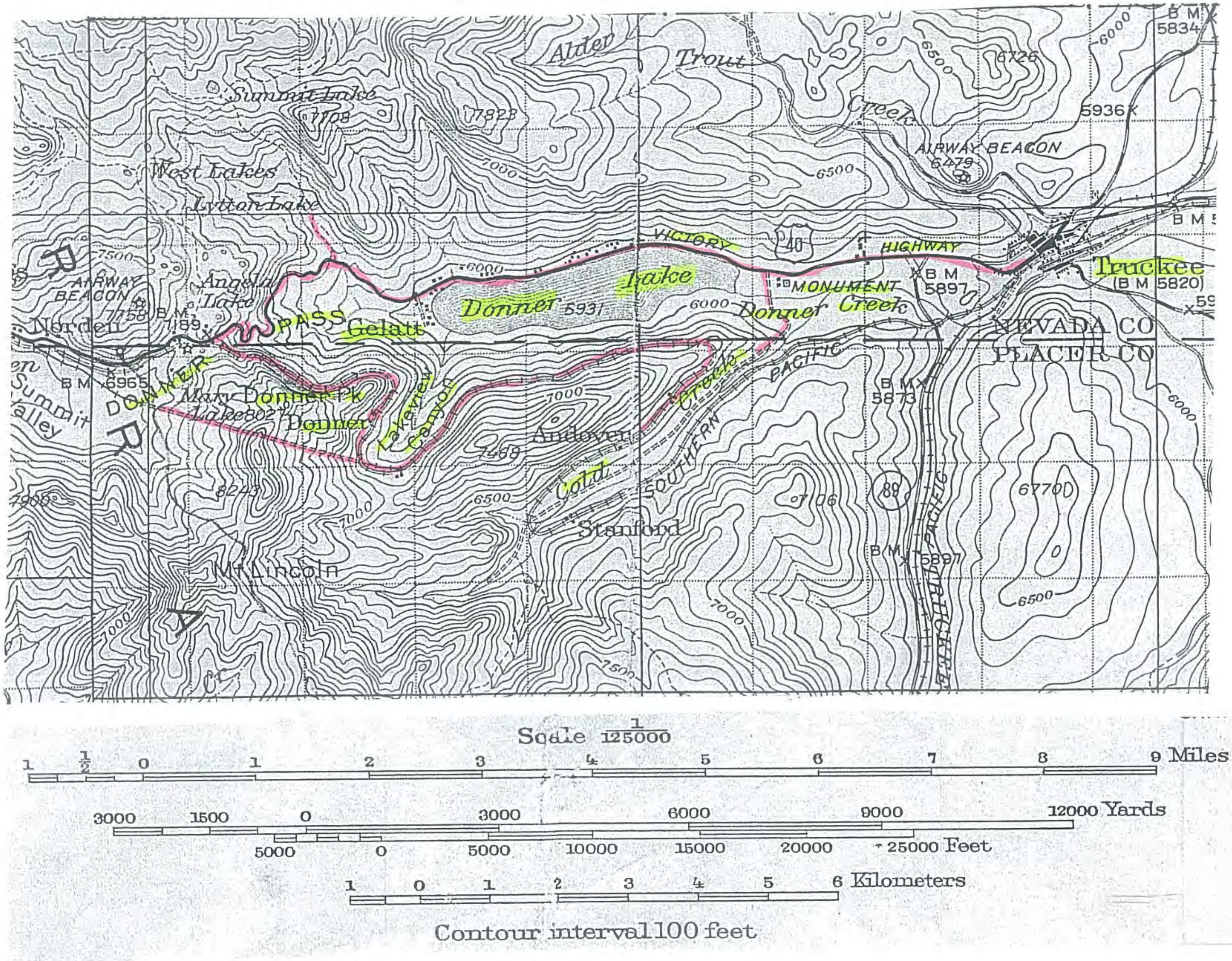


Map 19. **Metsker's Map of Nevada County ca. 1938**

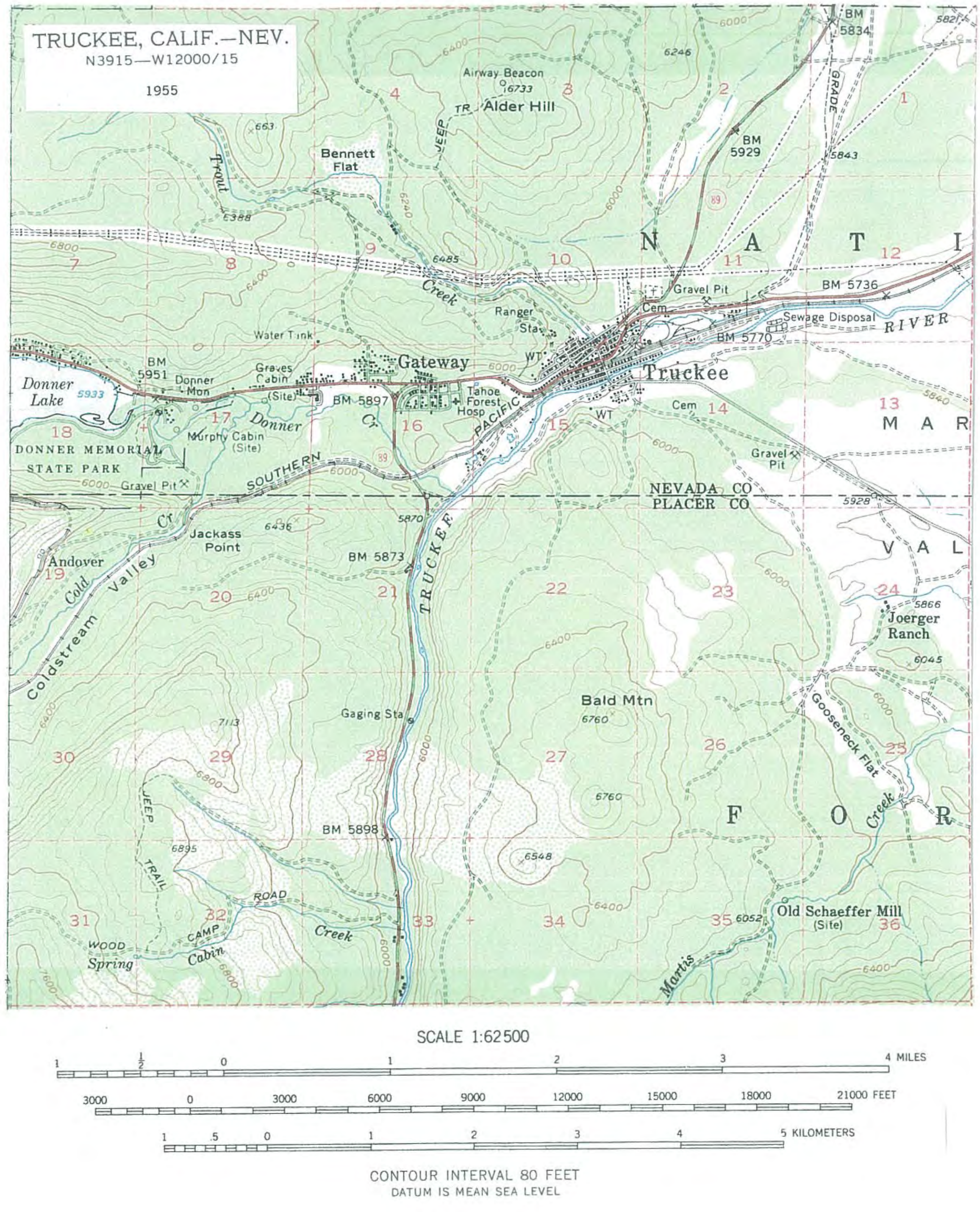




Map 20. USGS Truckee Quad 1940/1946 reprint



Map 21. **USGS Truckee Quad 1940/1951 reprint**



SCALE 1:62500

CONTOUR INTERVAL 80 FEET
DATUM IS MEAN SEA LEVEL

Map 22. USGS Truckee 15' Quad 1955

SCALE 1:62500

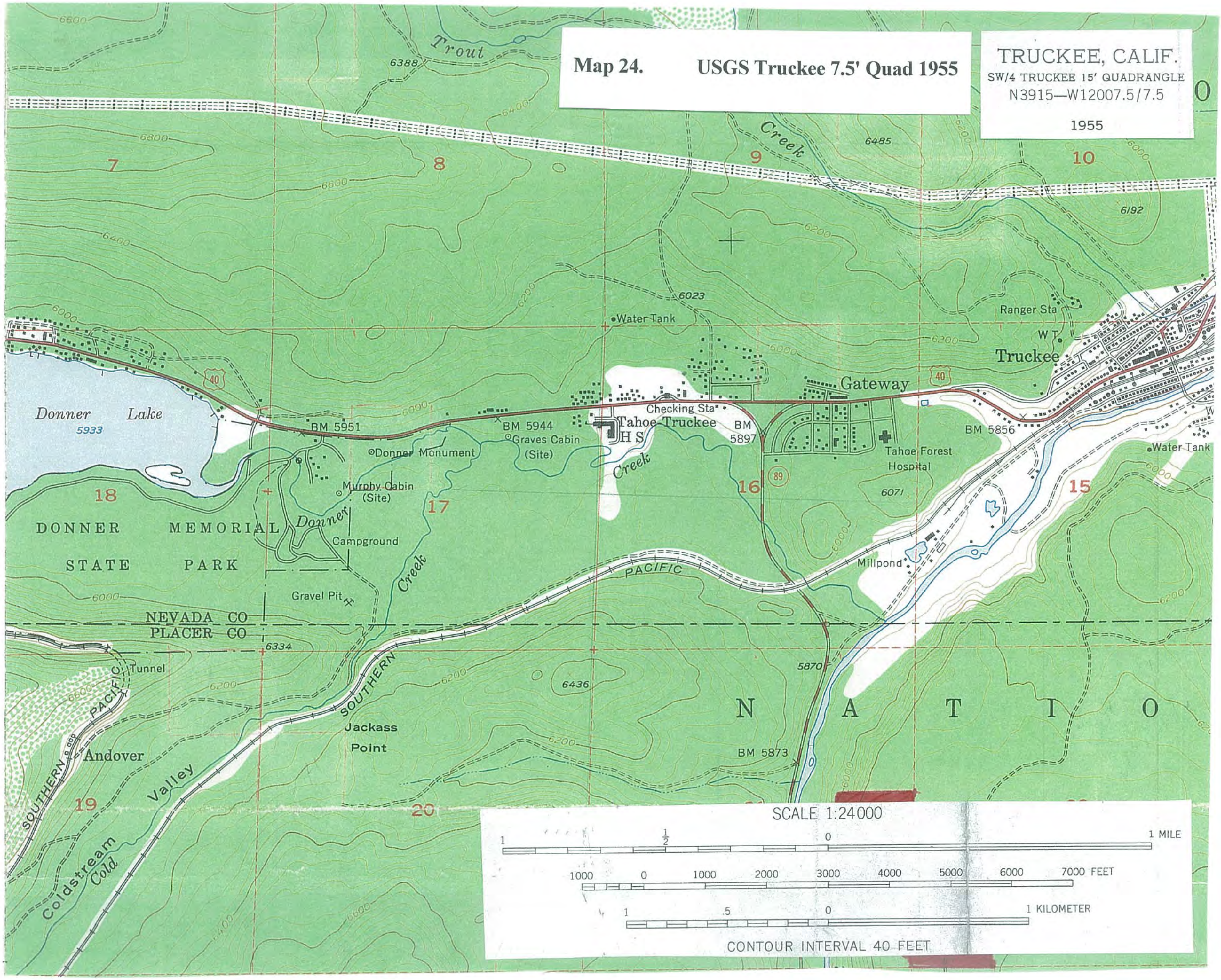
1 ½ 0 1 2 3 4 MILES

3000 0 3000 6000 9000 12000 15000 18000 21000 FEET

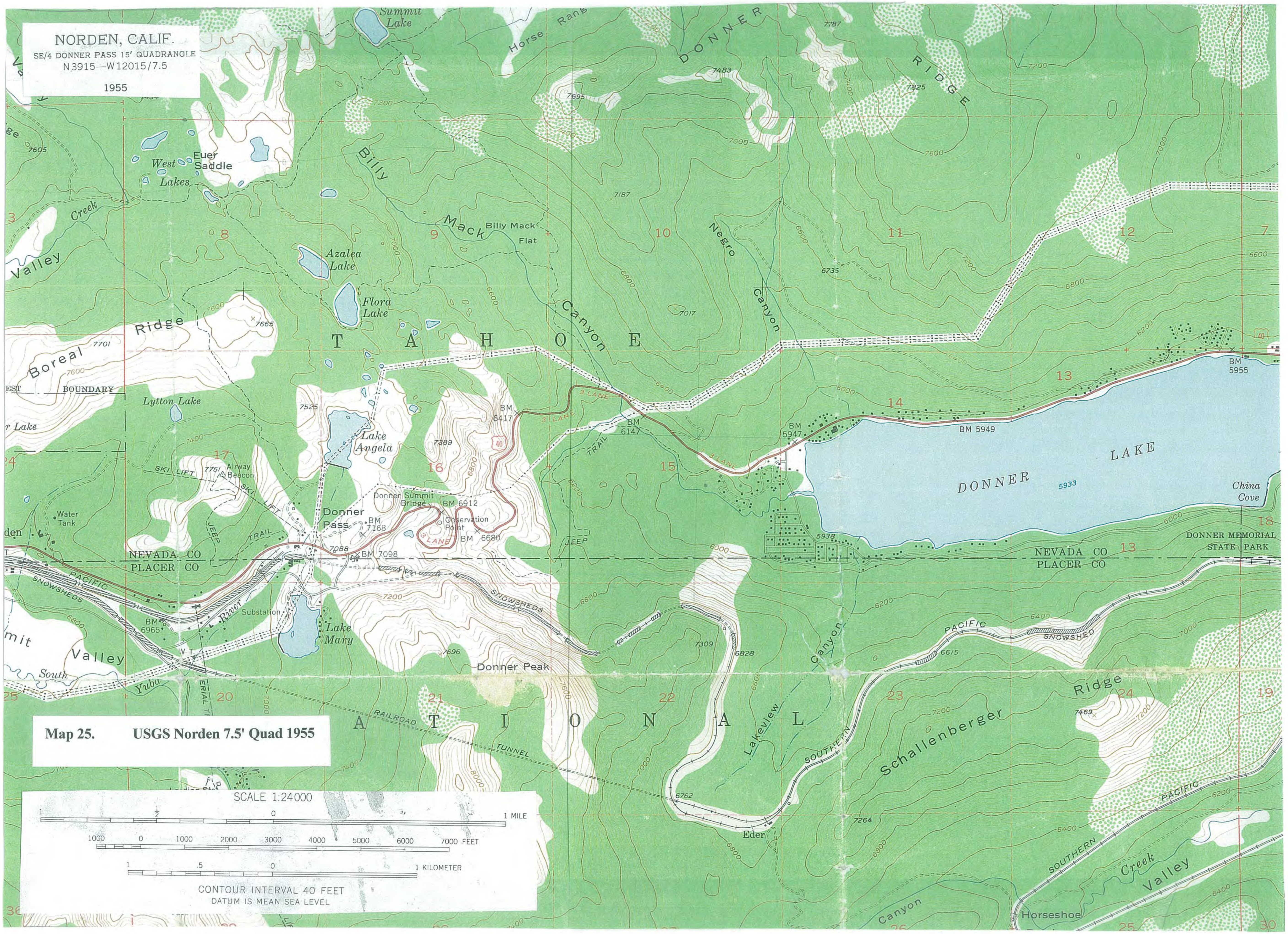
1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 80 FEET
DATUM IS MEAN SEA LEVEL

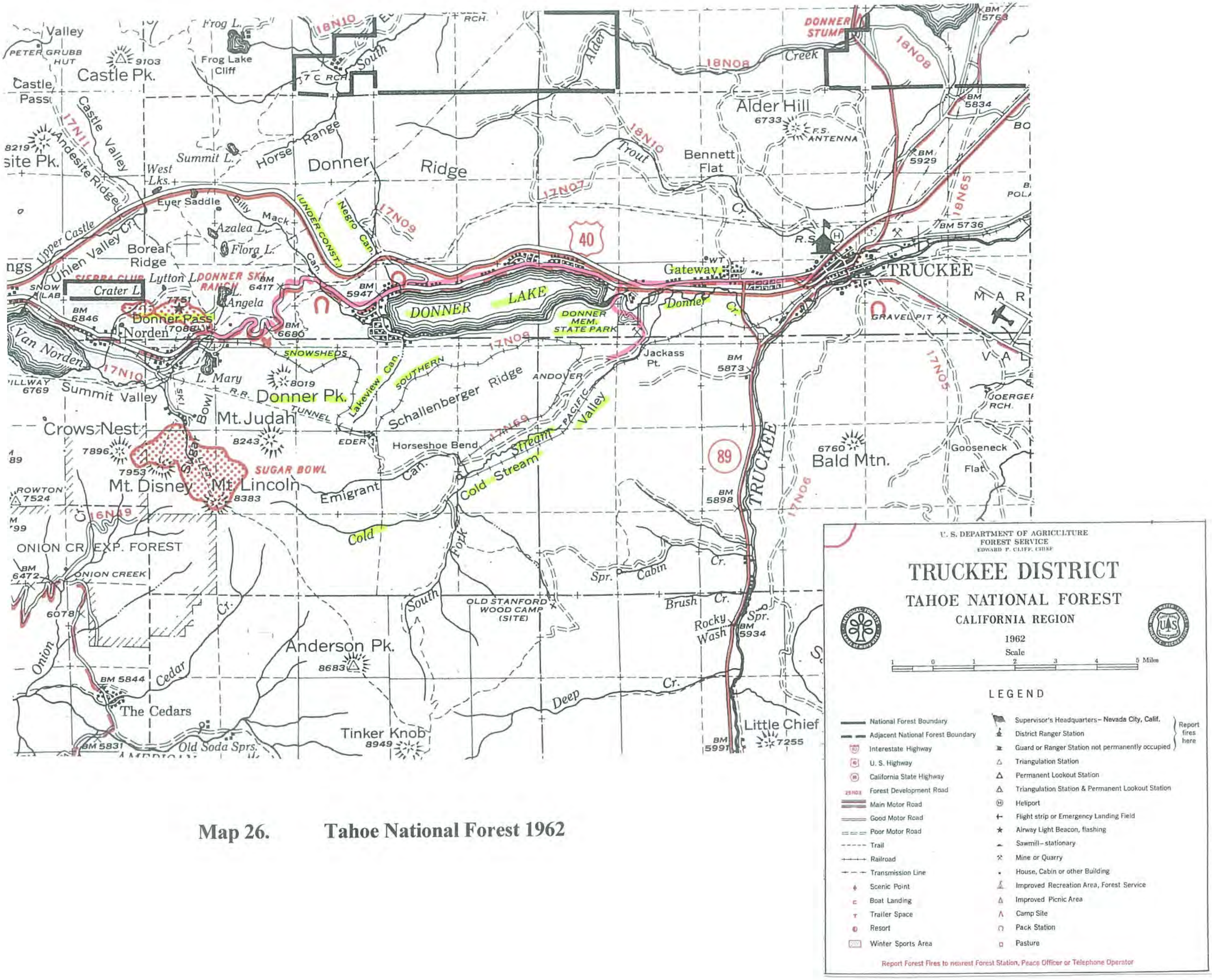
Map 23. USGS Donner Pass 15' Quad 1955



Map 24. USGS Truckee 7.5' Quad 1955

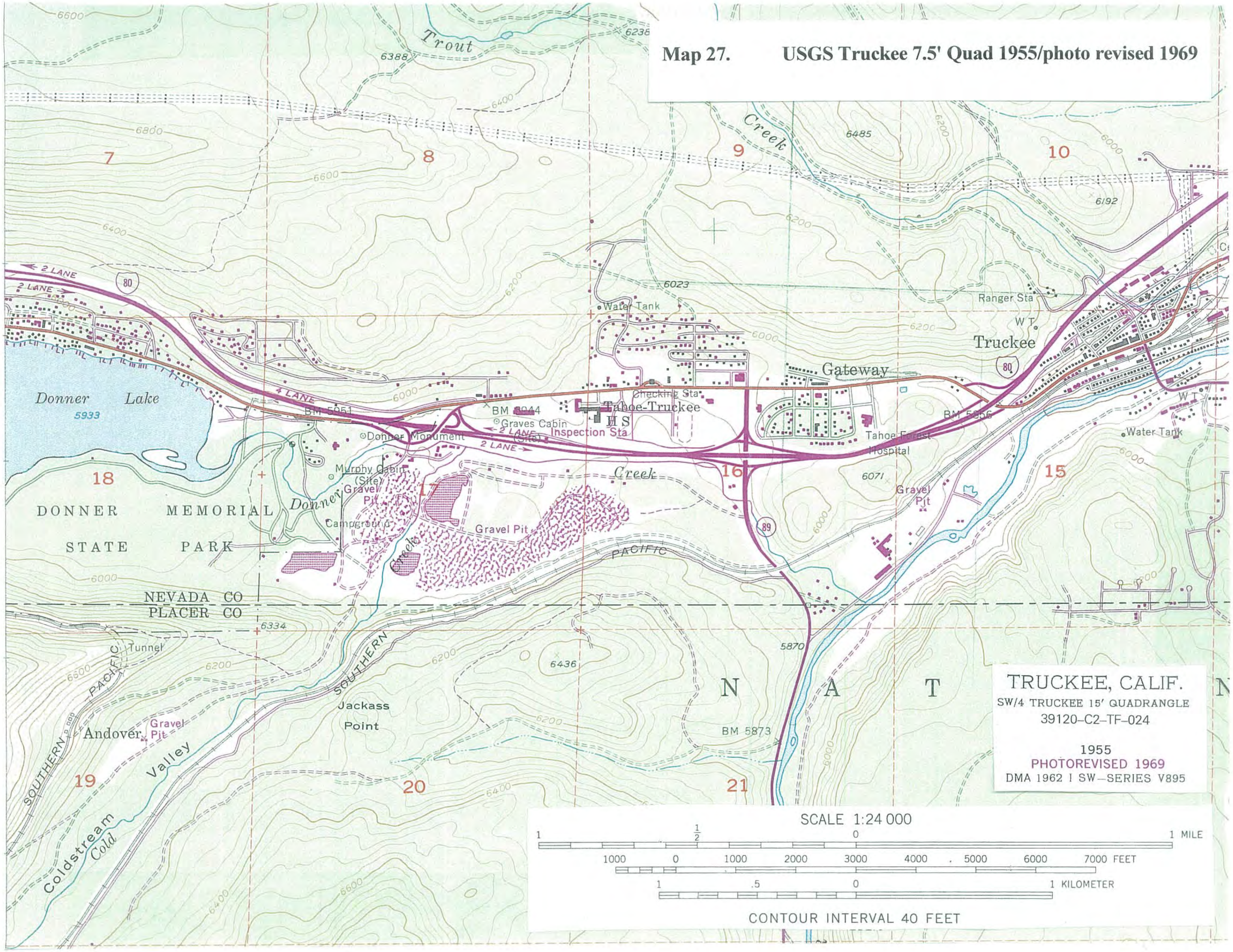


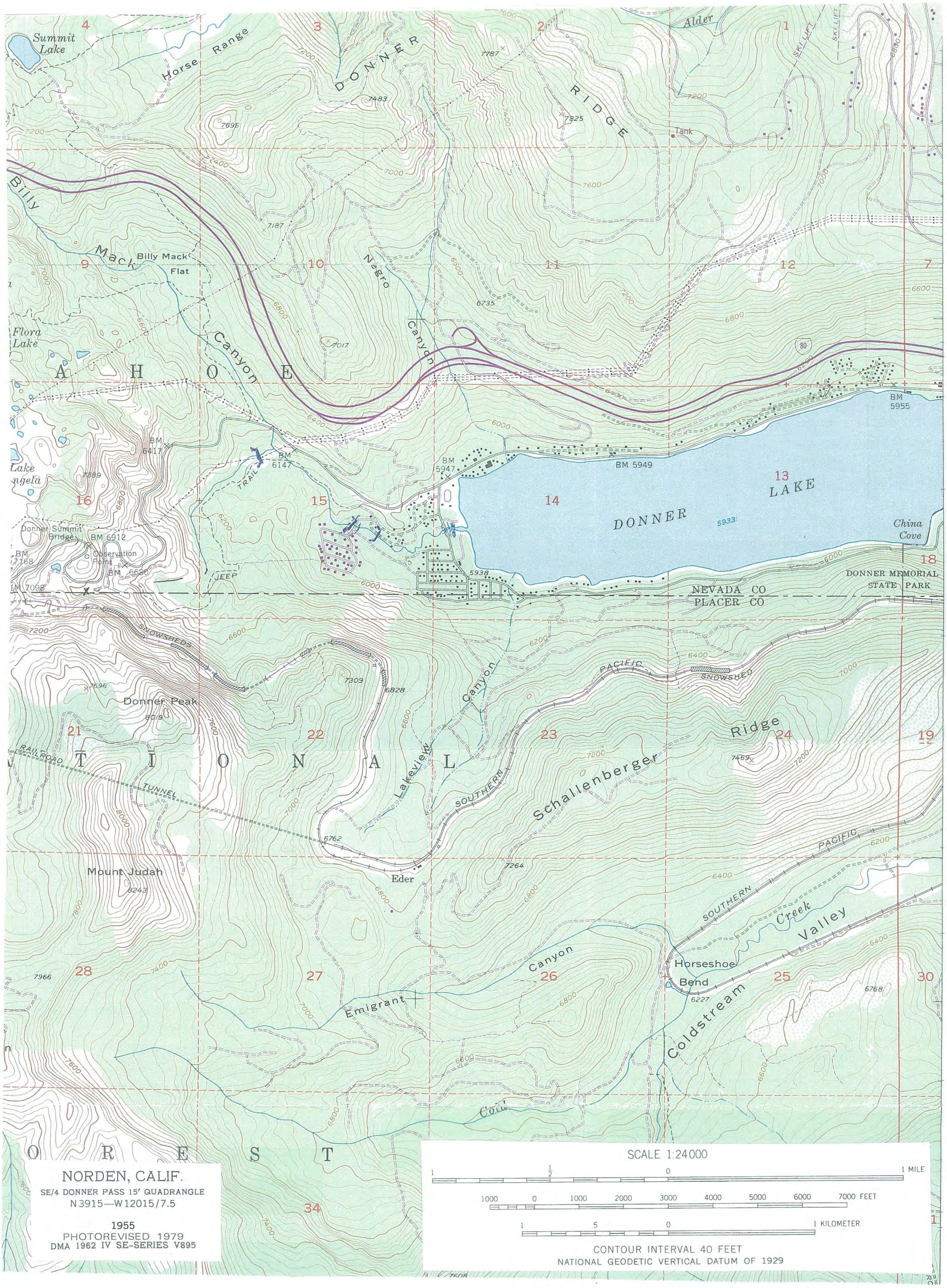
Map 25. **USGS Norden 7.5' Quad 1955**



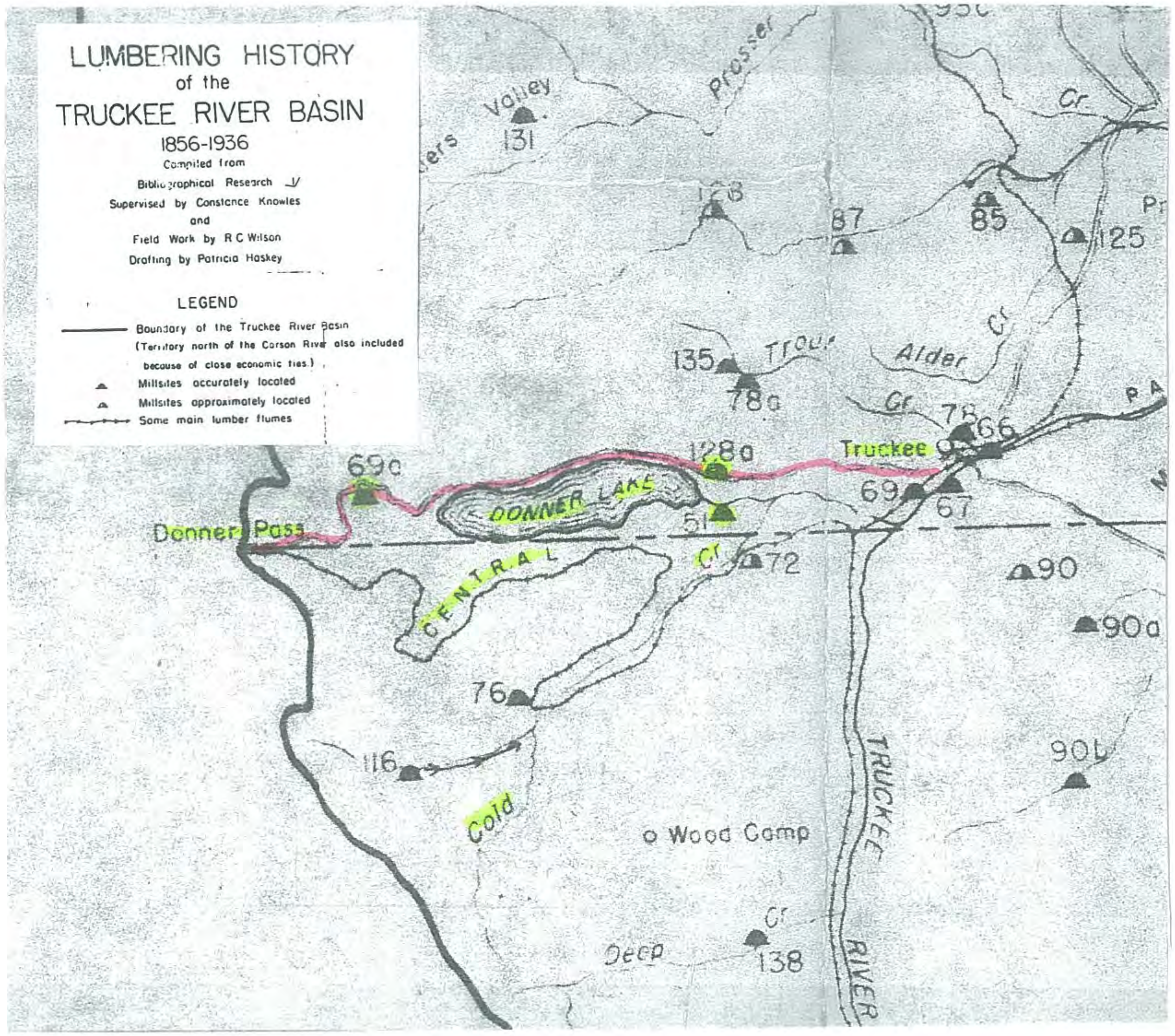
Map 26. **Tahoe National Forest 1962**

Map 27. USGS Truckee 7.5' Quad 1955/photo revised 1969



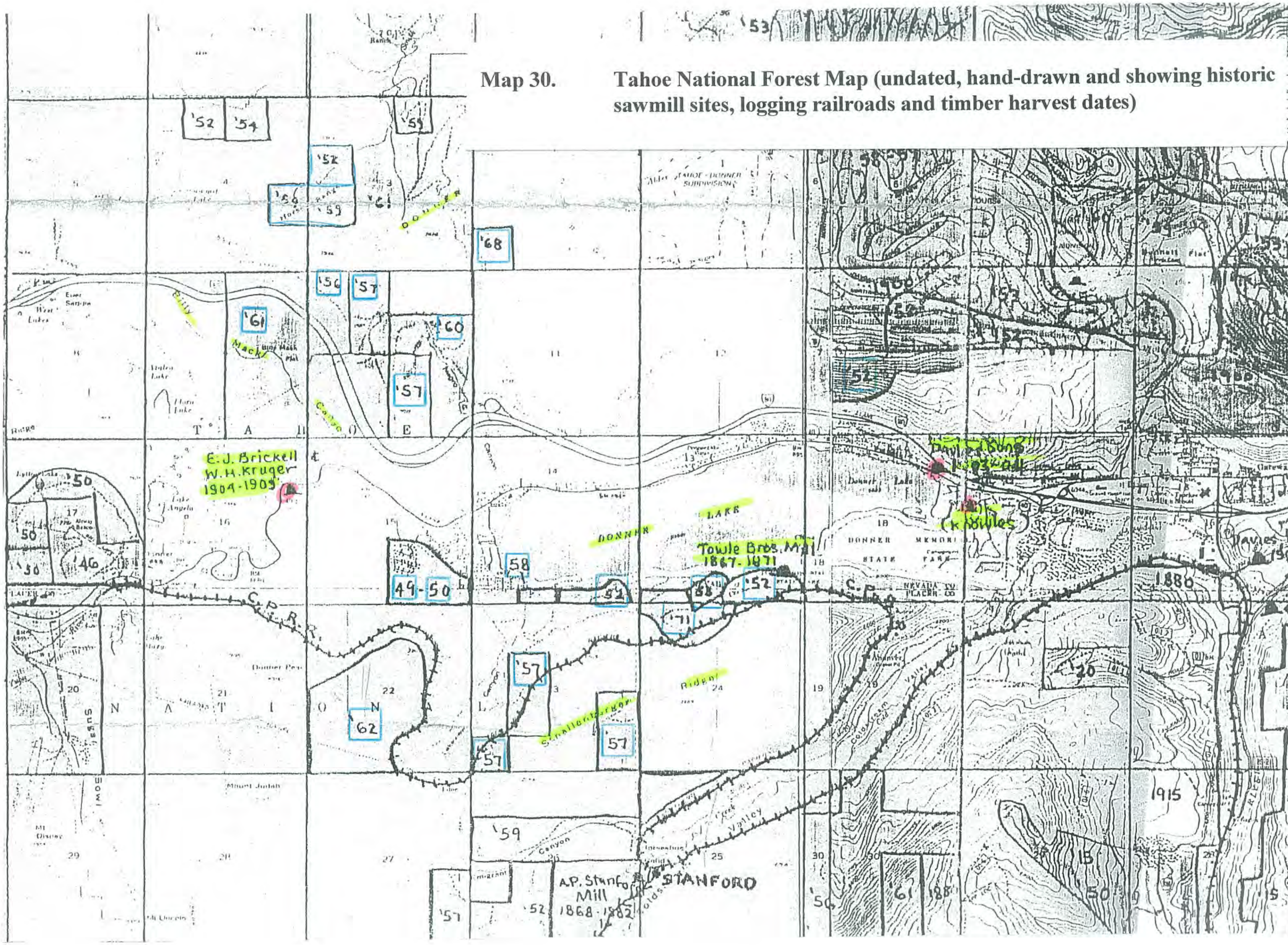


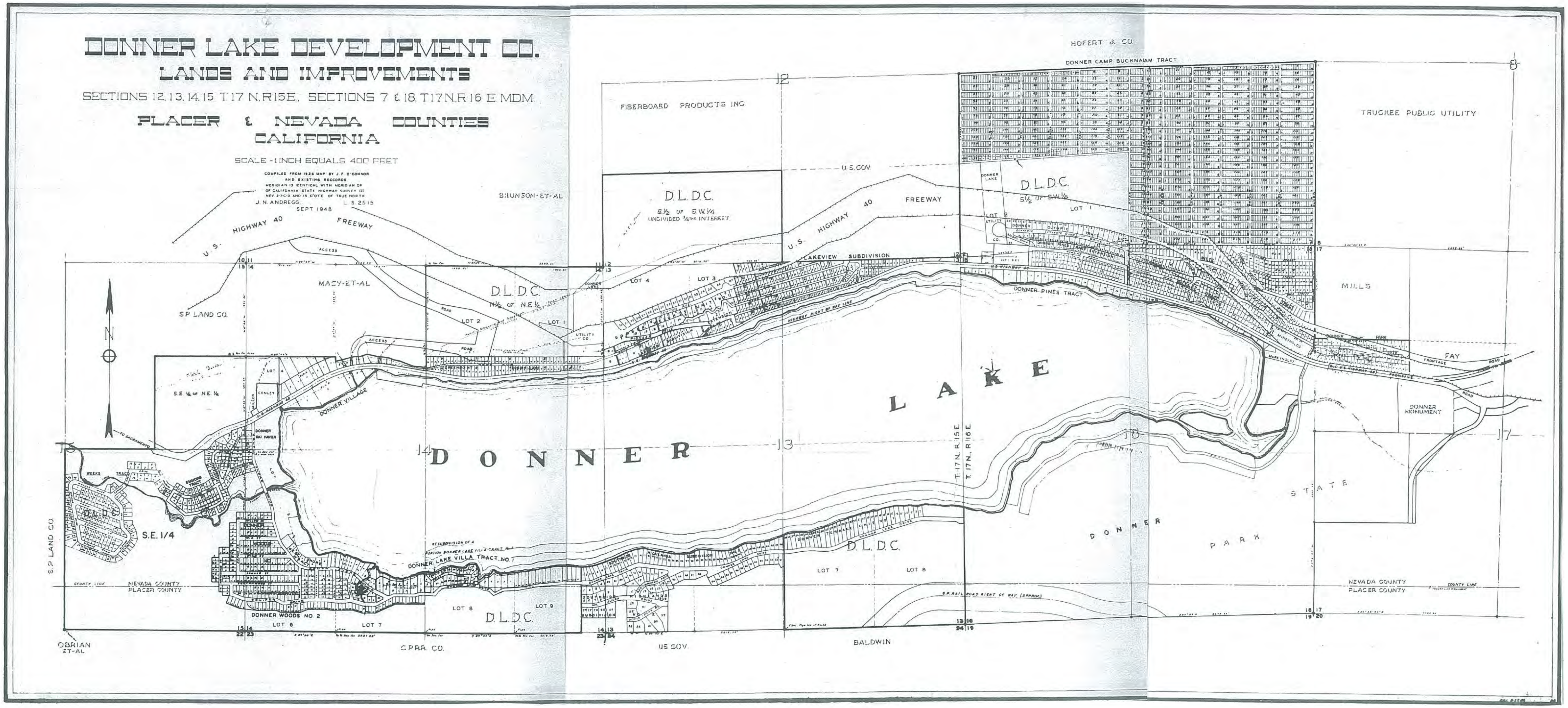
Map 28. USGS Norden 7.5' Quad 1955/photo revised 1979



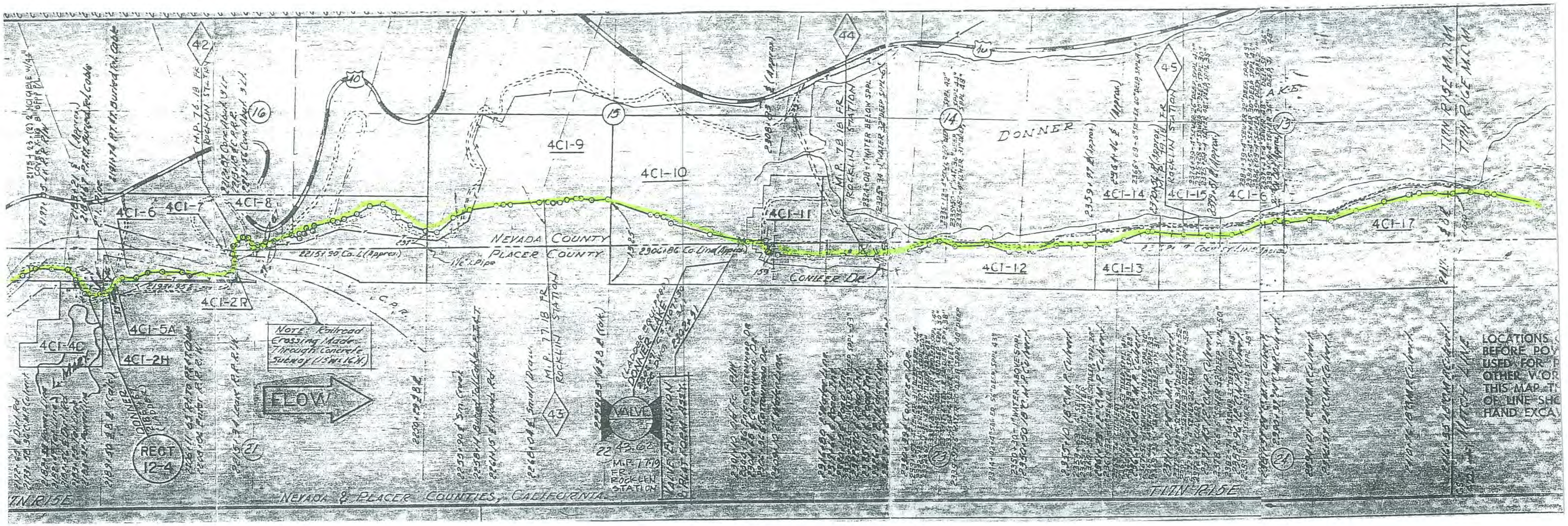
Map 29. **Lumbering History of the Truckee River Basin 1856-1936 (after Knowles 1942)**

Map 30. **Tahoe National Forest Map (undated, hand-drawn and showing historic sawmill sites, logging railroads and timber harvest dates)**

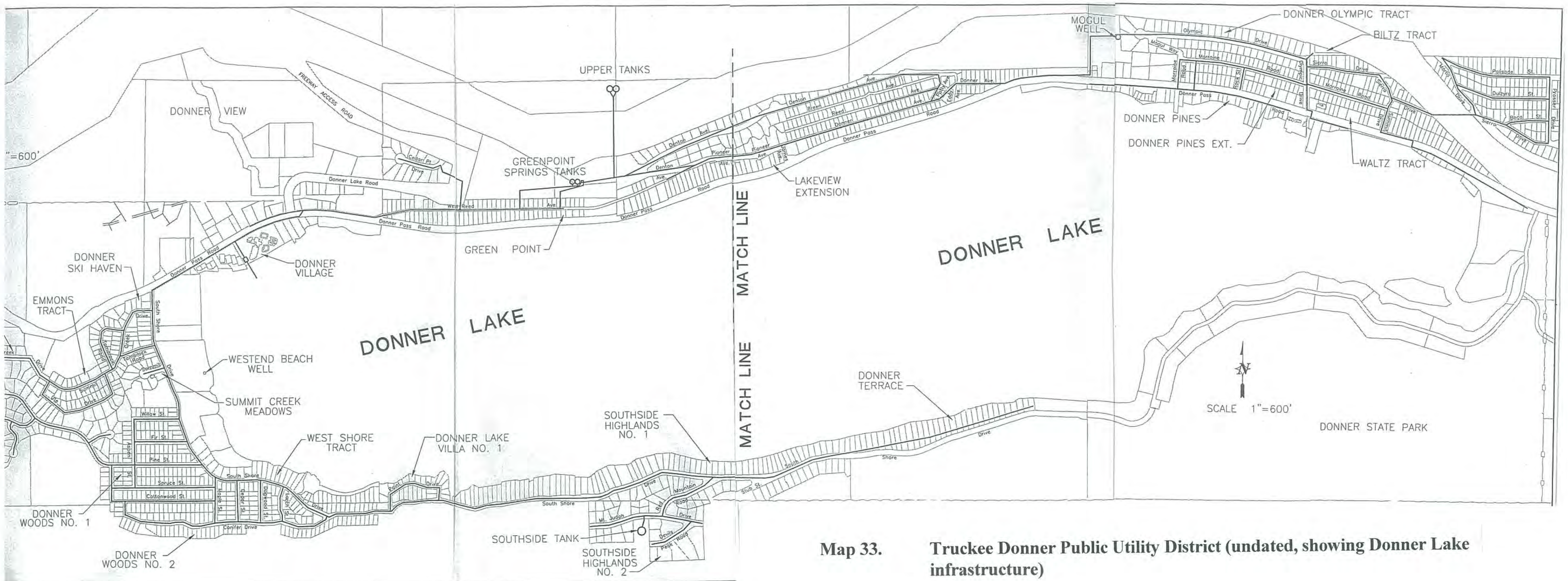




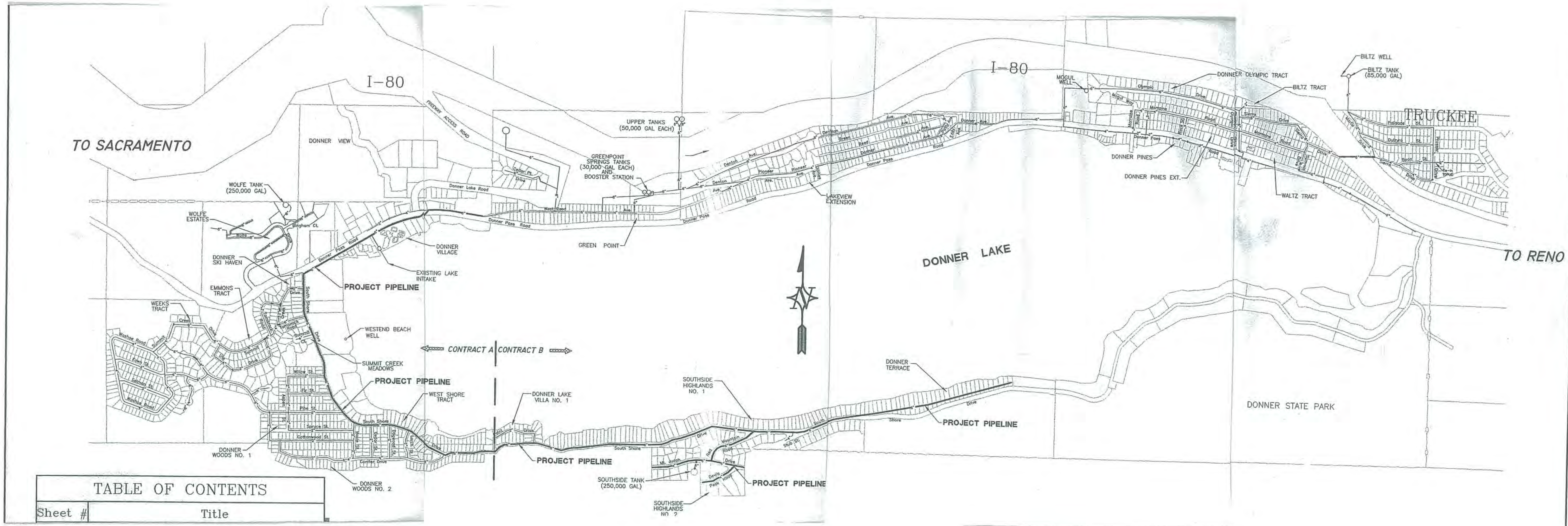
Map 31. Donner Lake Development Company Lands and Improvements 1948



Map 32. Santa Fe Pacific Pipeline 1956 (showing 1957-1993 upgrades)



Map 33. **Truckee Donner Public Utility District (undated, showing Donner Lake infrastructure)**



Map 34. Truckee Donner Public Utility District 2001 (showing pipeline replacements)

DONNER LAKE BASIN

WATERSHED ASSESSMENT

A CONTEXTUAL OVERVIEW OF HUMAN LAND USE

AND

ENVIRONMENTAL CONDITIONS

WORKBOOK

APPENDIX 8: Historic Photos

Susan Lindström, Ph.D. (RPA), Consulting Archaeologist

Truckee, California

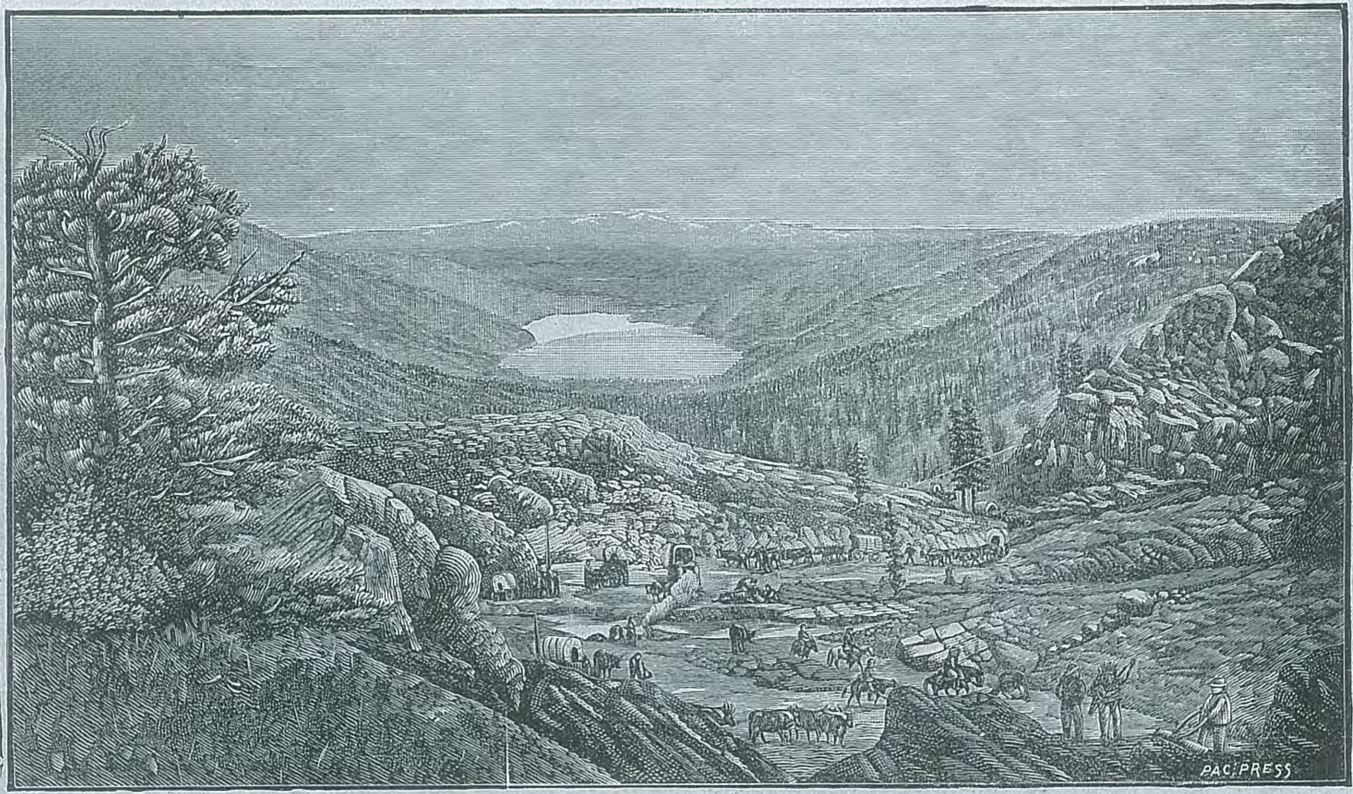
August 2015

DONNER LAKE

Photo 1. "Donner Lake" (undated painting; artist unknown)

Photo 2b. Fire scar at base of submerged stump pictured in Photo 2a (photo courtesy of Susan Lindström 1993)

Photo 2a. Submerged stump at Donner Lake looking from base of stump (rooted at 30 feet below lake level) up to the lake surface (photo courtesy of Susan Lindsröm 1993)



No. 3248.

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Photo 3. **19th-century etching of Donner Lake showing emigrants ascending the east flank of Donner Pass (undated; artist unknown)**

Photo 4. "Road and Rocks at Foot of Crested Peak"; eastern slope of Donner Summit; view (left) is to the south showing a line of wagons on the Dutch Flat and Donner Lake Wagon Road (A. A. Hart #124 ca. 1865-1869); same view (right) about 130 years later (photo courtesy of Leon Schegg Collection)

Photo 5. "East Portal, Summit Tunnel"; Summit Camp and Chinese laborers; looking west; freight wagons on Dutch Flat Donner Lake Wagon Road (A. A. Hart #199 ca. 1865-1868; photo courtesy of Mead Kibbey Collection)

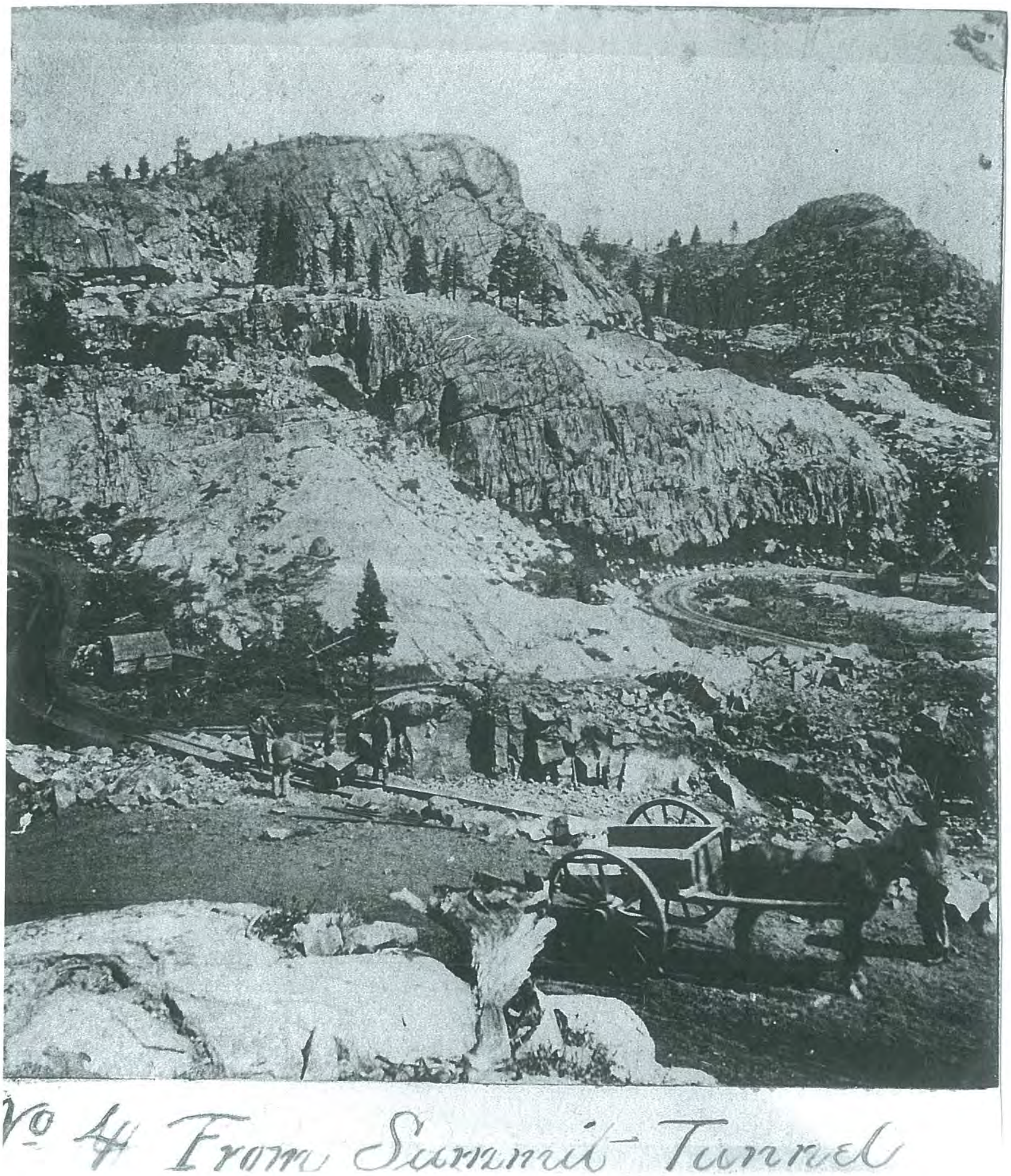

Photo 6. View to the northwest of Central Pacific Railroad construction ca. 1864-1868 showing a detail of Dutch Flat Donner Lake Wagon Road and houses in use; also note houses farther down the cirque canyon (far right); the crude wood rails for the dump cart (foreground) are not part of the wagon road; Grant's Peak (top center); Mt. Ida (right) (photo courtesy of Mead Kibbey Collection)

Photo 7. **East portals of Tunnel 6 (back center) and Tunnel 7(center); view to the west and taken from the cliffs above Tunnel 8; China Wall (front center) under construction; Summit Camp (upper left); Dutch Flat Donner Lake Wagon Road traverses down the cirque basin; (A. A. Hart #202 ca. 1865-1869; photo courtesy of Mead Kibbey Collection)**

Photo 8. Chinese tea carrier at east portal of Tunnel 8 (A. A. Hart #204 ca. 1865-1868); view to the west (photo courtesy of Susan Lindström Collection)

Photo 9a. "Camp near Summit Tunnel (A. A. Hart #116 ca. 1865-1869); view to the northwest and taken from the same point as Photo 9b but about 130 years later; Dutch Flat Donner Lake Wagon Road (foreground); Tunnel 6 (center and out of view); clusters of buildings located at historic Summit Camp; Mt. King is broad peak on the horizon (photo courtesy of Mead Kibbey Collection)

Photo 9b. Donner Pass area looking northwest; photo taken from the rock where A. A. Hart stood for his photograph ("Camp for Summit Tunnel Workers #116); Summit Camp (upper left and foreground); Dutch Flat Donner Lake Wagon Road (foreground); east portal Tunnel 6 and active utility line (center); west portal Tunnel 7 (right); Mt. King (broad peak on horizon at present-day Donner Ski Ranch); car is parked on railroad grade; photo courtesy of Mead Kibbey)

Photo 10. View from Donner Pass looking east to Donner Lake; note original route of Dutch Flat Donner Lake Wagon Road and 1912 variant (right); this road eliminated the at-grade crossing of the railroad by its realignment around Tunnel 7 and the construction of an underpass (subway) beneath the railroad; The east portal of Tunnel 6, the west portals of tunnels 7 and 8 and Tunnel 7 are visible on the right; note utility lines (center) (photo courtesy of Truckee Donner Historical Society)

Photo 11. Donner Lake House; view looking west across Donner Lake to Donner Peak (undated photo courtesy of Truckee Donner Historical Society)

Photo 12. **Boats at the east end of Donner Lake (undated photo courtesy of Truckee Donner Historical Society)**

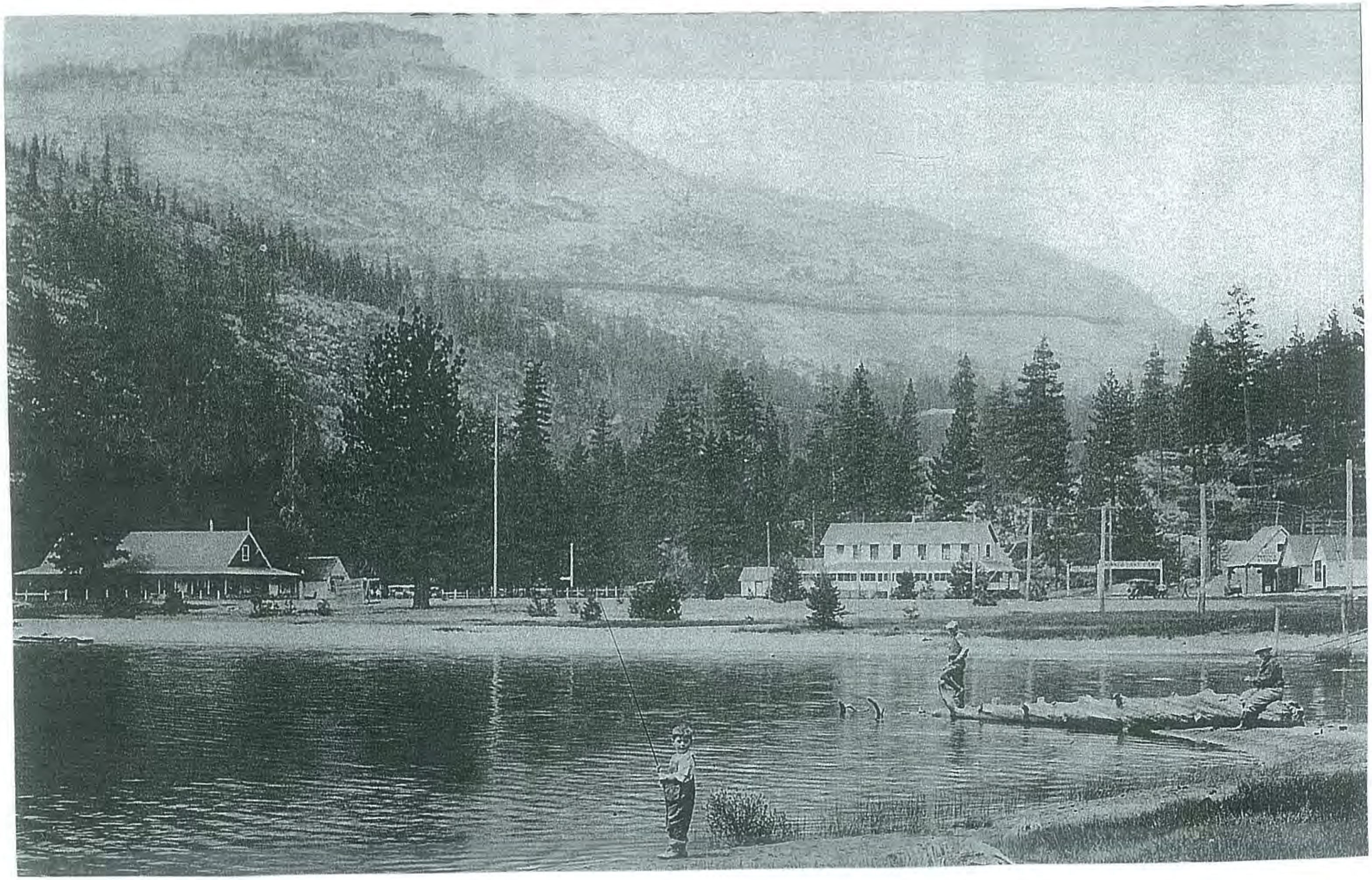

Photo 13. Donner City/Donner Resort at west end of lake (undated photo courtesy of Truckee Donner Historical Society)

Photo 14. **Ice works near the east end of Donner Lake (undated photo courtesy of Truckee Donner Historical Society)**

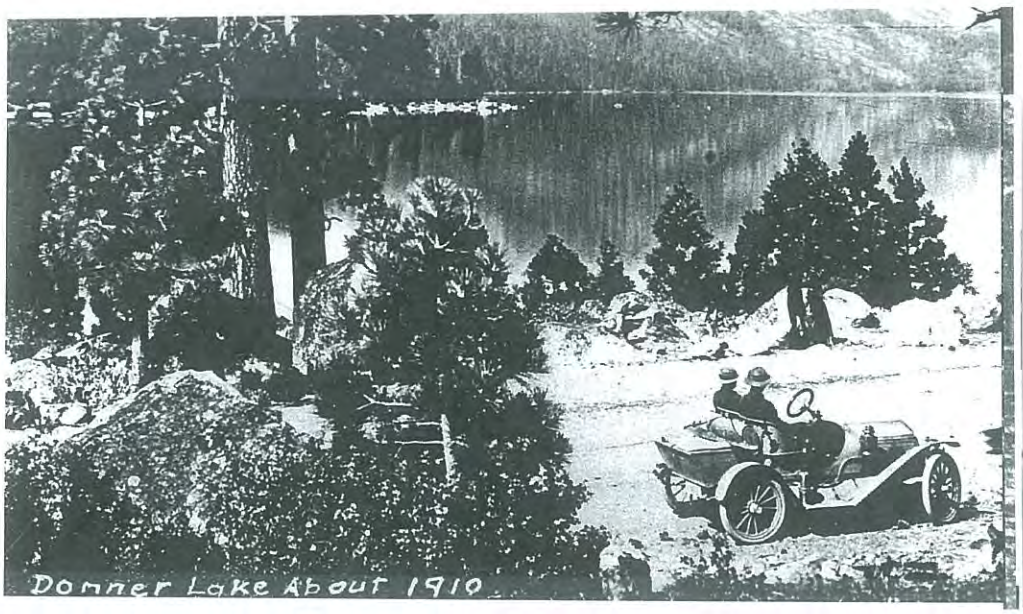

Photo 15. Auto travel along Donner Lake's north shore ca. 1910 (photo courtesy of Truckee Donner Historical Society)

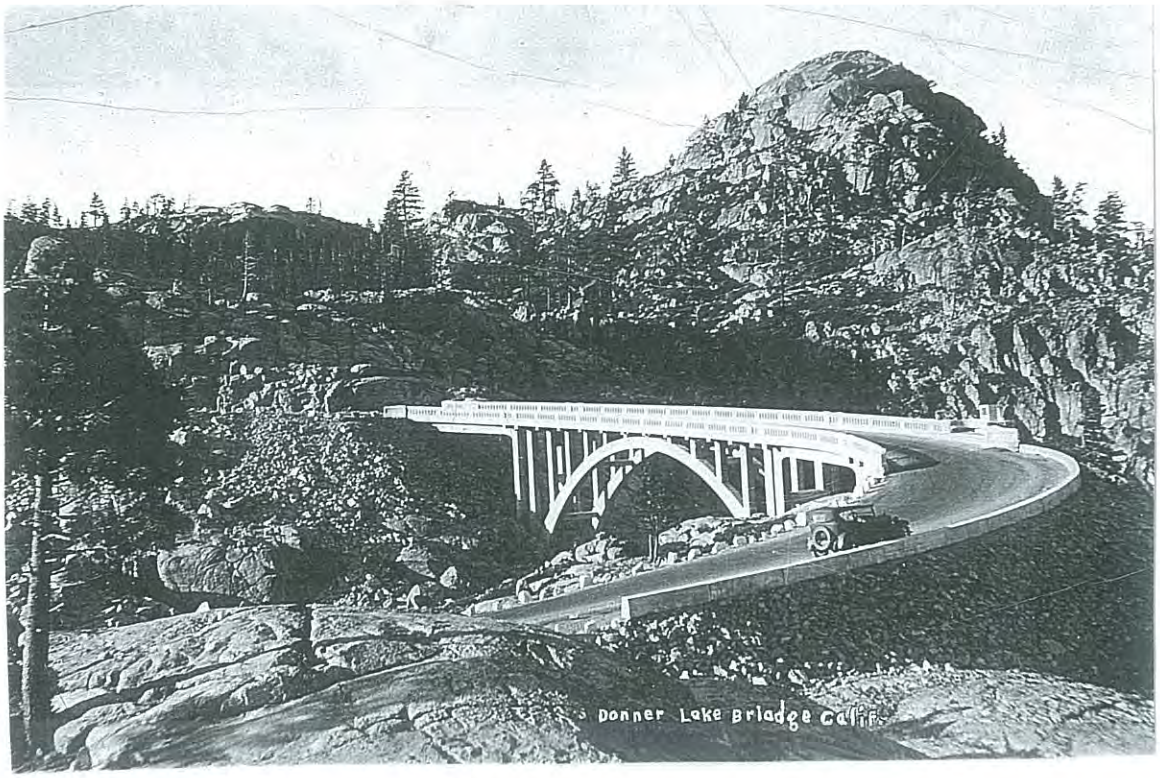

Photo 16. **Rainbow Bridge along the east flank of Donner Pass ca. 1920s (undated post card photo courtesy of Susan Lindström collection)**

Photo 17. Dog sleds teams on frozen Donner Lake (photo courtesy of Norm Sayler Collection)

Photo 18. "Donner Lake" (undated painting by Edwin Deakin (1838-1923)

APPENDIX B - ANNUAL LOW FLOW MEANS

Donner Creek near Lake Outlet (USGS 10338500)
Computed Annual Low Flows (1994 - 2014)

Year	1-day		3-day		7-day		15-day		30-day		60-day	
	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
1994	7/24/1994	0.4	7/25/1994	0.4	7/27/1994	0.8	6/17/1994	1.3	6/26/1994	2.1	6/17/1994	3.7
1995	10/4/1995	0.2	10/4/1995	0.4	10/4/1995	0.8	8/17/1995	2.9	8/22/1995	8.1	11/26/1995	21.3
1996	7/4/1996	1.4	7/4/1996	2	7/8/1996	3.9	9/8/1996	4.4	9/8/1996	4.6	9/8/1996	5.4
1997	8/26/1997	1.5	9/2/1997	1.5	9/1/1997	1.7	9/2/1997	2	9/2/1997	2.5	9/2/1997	3.1
1998	8/27/1998	4.2	8/28/1998	4.3	8/28/1998	4.3	9/3/1998	4.4	9/3/1998	4.9	9/6/1998	6.2
1999	1/3/2000	4.3	1/5/2000	4.4	1/9/2000	4.4	1/11/2000	4.5	1/11/2000	4.6	1/19/2000	5.5
2000	8/12/2000	2.1	8/14/2000	2.1	8/16/2000	2.4	8/23/2000	2.7	9/9/2000	3.2	9/18/2000	5.2
2001	6/11/2001	1	6/11/2001	1.1	7/28/2001	2	8/2/2001	2.3	8/17/2001	2.4	8/19/2001	2.9
2002	10/6/2002	0.4	10/7/2002	0.7	5/23/2002	1.3	10/17/2002	1.6	8/25/2002	1.8	8/25/2002	2.1
2003	4/27/2003	1.1	4/27/2003	1.2	7/22/2003	1.7	7/28/2003	2.1	8/8/2003	2.3	8/28/2003	2.5
2004	5/12/2004	1.3	5/12/2004	1.4	5/12/2004	1.6	7/26/2004	2.1	8/2/2004	2.5	8/31/2004	2.7
2005	7/7/2005	1.5	8/26/2005	1.8	8/16/2005	2	8/26/2005	2.1	8/27/2005	2.1	9/14/2005	2.3
2006	7/9/2006	1	7/30/2006	1.1	7/30/2006	1.6	7/31/2006	2.2	8/2/2006	2.7	9/3/2006	3.1
2007	6/23/2007	0.8	6/24/2007	1.3	6/24/2007	2	6/24/2007	2.1	7/5/2007	2.5	8/5/2007	2.7
2008	7/5/2008	0.7	7/5/2008	0.9	7/5/2008	1.1	7/5/2008	1.5	7/17/2008	2.1	8/16/2008	2.1
2009	7/22/2009	1.9	8/3/2009	2	8/5/2009	2	8/10/2009	2.2	8/10/2009	2.4	8/31/2009	2.8
2010	8/29/2010	1	8/29/2010	1.3	8/29/2010	1.5	9/9/2010	1.7	9/10/2010	2.1	9/26/2010	2.6
2011	3/1/2012	0.4	1/19/2012	1.3	9/15/2011	1.8	9/15/2011	2	9/25/2011	2.2	9/27/2011	3.3
2012	7/11/2012	1.6	7/11/2012	1.7	7/24/2012	2	7/24/2012	2.1	7/25/2012	2.2	8/17/2012	2.7
2013	11/3/2013	0	11/4/2013	0.5	1/10/2014	1.4	1/10/2014	1.6	1/11/2014	1.9	1/25/2014	2
2014	6/23/2014	1	6/23/2014	1	6/25/2014	1.1	6/26/2014	1.5	7/12/2014	2	8/9/2014	2.5

Donner Creek near Hwy 89 (USGS 10338700)
Computed Annual Low Flows (1994 - 2014)

Year	1-day		3-day		7-day		15-day		30-day		60-day	
	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)	Date	Flow (cfs)
1993	9/9/1993	3.2	9/9/1993	3.4	9/9/1993	3.7	9/9/1993	4	9/9/1993	5.9	1/6/1994	9.1
1994	8/21/1994	2.3	8/22/1994	2.3	8/25/1994	2.5	9/3/1994	2.5	9/5/1994	2.8	9/7/1994	13
1995	10/4/1995	3.6	10/4/1995	3.8	10/5/1995	4.4	10/12/1995	6.4	10/27/1995	15.5	11/26/1995	22.4
1996	9/8/1996	6.2	9/8/1996	6.6	9/8/1996	6.8	9/8/1996	7.6	9/8/1996	8.2	9/8/1996	12.1
1997	10/22/1997	3.3	10/22/1997	3.7	9/2/1997	3.9	9/2/1997	4.3	9/3/1997	4.9	9/10/1997	7.2
1998	9/2/1998	7.9	9/3/1998	8	9/3/1998	8.3	9/3/1998	9	9/4/1998	11.6	9/19/1998	20.3
1999	1/7/2000	8.4	1/9/2000	8.4	1/10/2000	8.5	1/10/2000	8.7	1/12/2000	8.9	1/16/2000	10.3
2000	8/15/2000	4.4	8/15/2000	4.5	8/16/2000	4.7	8/23/2000	4.8	9/9/2000	5.3	9/18/2000	7.7
2001	8/22/2001	2.8	9/2/2001	2.8	9/3/2001	2.9	9/3/2001	2.9	9/3/2001	3.6	9/4/2001	3.9
2002	10/6/2002	2.9	10/7/2002	3.1	10/11/2002	3.6	10/19/2002	3.7	11/1/2002	4.1	9/10/2002	5
2003	10/13/2003	3.1	10/13/2003	3.3	10/15/2003	3.7	10/24/2003	3.9	9/8/2003	5.1	9/9/2003	7.2
2004	8/31/2004	3.6	8/31/2004	3.8	8/31/2004	3.8	8/31/2004	4.1	8/31/2004	4.3	9/1/2004	5.2
2005	9/4/2005	4	9/6/2005	4.1	9/7/2005	4.2	9/14/2005	4.3	9/14/2005	4.7	9/20/2005	7.4
2006	9/20/2006	4.2	9/20/2006	4.4	9/20/2006	4.5	9/27/2006	4.6	9/27/2006	5	9/28/2006	5.8
2007	8/12/2007	3.2	8/12/2007	3.4	8/16/2007	4	9/17/2007	4.2	9/17/2007	4.2	9/30/2007	4.3
2008	8/29/2008	3.1	8/29/2008	3.2	9/1/2008	3.2	9/3/2008	3.3	9/6/2008	3.5	9/8/2008	4.5
2009	8/25/2009	4.2	8/27/2009	4.2	8/31/2009	4.2	8/31/2009	4.4	8/31/2009	4.6	9/3/2009	6.7
2010	9/8/2010	3.7	9/8/2010	3.8	9/8/2010	4.1	9/9/2010	4.2	9/17/2010	4.8	9/27/2010	5.8
2011	1/19/2012	4.4	1/19/2012	5.4	9/25/2011	6.1	1/19/2012	6.7	1/19/2012	6.8	1/19/2012	8
2012	8/28/2012	3.4	8/29/2012	3.5	8/31/2012	3.5	9/5/2012	3.6	9/5/2012	3.9	9/17/2012	4.3
2013	12/7/2013	2	12/8/2013	3	9/3/2013	3.4	8/20/2013	3.6	9/3/2013	3.7	1/26/2014	4.2
2014	8/3/2014	3.6	8/3/2014	3.9	8/3/2014	4.1	8/6/2014	4.3	8/6/2014	4.6	9/2/2014	5.2

Frequency distribution of annual minimum mean flows for Donner Creek at Lake Outlet USGS 10338500 (1994 – 2014)

Flow Range (cfs	1-day	3-day	7-day	15-day	30-day	60-day
0	5%	-	-	-	-	-
0 - 1	48%	29%	10%	-	-	-
1 - 2	33%	57%	71%	38%	14%	5%
2 - 3	5%	5%	5%	48%	62%	52%
3 - 4	-	-	5%	0%	5%	19%
4 - 5	10%	10%	10%	14%	14%	-
5 - 6	-	-	-	-	-	14%
6 - 7	-	-	-	-	-	5%
7 - 8	-	-	-	-	-	-
8 - 9	-	-	-	-	5%	-
9 - 10	-	-	-	-	-	-
> 10	-	-	-	-	-	5%
Average (cfs)	1.3	1.5	2.0	2.3	2.9	4.1
Minimum (cfs)	0.0	0.4	0.8	1.3	1.8	2.0
Maximum (cfs)	4.3	4.4	4.4	4.5	8.1	21.3

Frequency distribution of annual minimum mean flows for Donner Creek at Hwy 89 USGS 10338700 (1994 – 2014)

Flow Range (cfs	1-day	3-day	7-day	15-day	30-day	60-day
0	-	-	-	-	-	-
0 - 1	-	-	-	-	-	-
1 - 2	-	-	-	-	-	-
2 - 3	14%	10%	10%	5%	-	-
3 - 4	48%	38%	24%	19%	5%	-
4 - 5	19%	33%	43%	43%	24%	14%
5 - 6	5%	-	-	10%	19%	5%
6 - 7	5%	10%	10%	5%	5%	5%
7 - 8	5%	-	5%	-	24%	-
8 - 9	5%	10%	10%	10%	-	-
9 - 10	-	-	-	-	-	5%
> 10	-	-	-	10%	24%	71%
Average (cfs)	4.0	4.2	4.5	4.8	5.7	8.1
Minimum (cfs)	2.0	2.3	2.5	2.5	2.8	3.9
Maximum (cfs)	8.4	8.4	8.5	9.0	15.5	22.4

APPENDIX C - EROSION HAZARD ANALYSIS SUPPLEMENT

Donner Basin Erosion Potential

To assess potential priority areas for fine soil erosion mitigation, a relative index, herein called the erosion hazard, was calculated. Erosion hazard was derived as the sum of four factors: fine soil erodibility, cover, slope and road density. For the analysis, the watersheds were further divided into "micro-watersheds" (Figure XX). Micro-watersheds were defined using the USGS NHD Plus HUC-16 catchments as a guide, with some additional division of larger catchments using the streams, ridgelines, or major roadways to split catchments into more even sizes for analysis. The "micro-watersheds" were not entirely hydrologically determined, but they were useful for dividing hillslopes into areas with largely similar characteristics. The result of the erosion hazard analysis was a relative score from lowest to highest assigned at each micro-watershed (Figure XX).

The fine soil erodibility factor was created using the NRCS SSURGO soil data (Figure XX). Fine soil erodibility within SSURGO database was defined as K_f with values ranging 0-1, where 1 was the most easily erodible. Soil complexes within the SSURGO database commonly had more than one soil type, each with its own K_f value. Where more than one soil type was present in a soil complex, an overall K_f was calculated by weighted average using the percent each soil type comprised of the total soil complex. K_f values were then ranked and binned into five categories ranging from 0 to 4, with 4 representing the highest erosion potential (Appendix XX).

The cover factor was created using the Department of the Interior Landfire 2012 vegetation type dataset (Figure XX). The cover factor measures the ability of vegetation to protect against erosion whether through intercepting rainfall, by root network, or by vegetation density. Higher cover factors represent less protection against erosion with barren earth being the highest possible value. Vegetation types were assigned values ranging from 0 to 4 depending on vegetation type and density (Appendix XX). Urbanized or developed cover types were also classified using the same 0 to 4 ranking (Appendix XX). High intensity development and roads received a value of zero as they were determined to be paved and should not directly contribute fine sediment. Low and medium intensity development received values of 3 as these areas were largely associated with road cuts along I-80 that are mostly bare. It was noted that within the urban area of Truckee that low and medium intensity development cover types were associated with paved areas, but this was not considered an issue, as erosion potential was low within the urban area and cover was not considered to greatly affect that. Within the western edge of the Donner and Cold Creek watersheds it was observed that some areas classed as barren or sparsely vegetated were associated with rock outcrops. As such, the high cover values associated with barren and sparsely vegetated cover types would overestimate the erodibility of the rock outcrops. Within the granite outcrop area a value of one was assigned for the cover factor to reflect the low erosion potential.

The slope factor was created from a 1 meter resolution LIDAR DEM obtained from the US Forest Service. The slope was calculated using the ArcHydro tool to obtain the slope at a 1 m resolution. Slopes were binned according to Table XX and given values from 0 to 4, with higher values of slope representing greater erosion potential (Appendix XX). Initially, it was supposed that at slopes greater than 70% the erosion potential would decline due to slopes becoming too steep to stabilizie soil. Visual inspection of the watershed showed that the highest slopes were occurring in areas where barren slopes showed signs of severe erosion. This was especially true in the highest extent of the Cold Creek watershed, where steep slopes showed large gully and rill formations. For this reason the slopes above 70% were given the highest value.

The road density factor was calculated using road lengths from digitized backcountry roads within each “micro-watershed”. Backcountry roads were digitized using the hillshade generated from the 1 meter resolution LIDAR DEM and aerial imagery. Road lengths were calculated for each road segment and summed within each “micro-watershed”. The total road length per “mirco-watershed” was divided by the area to obtain the road density, expressed as miles per square mile. Road densities were then binned and given a road density factor value from 0 to 4, with higher values representing greater erosion potential (Appendix XX). In this analysis, road density described the potential for erosion due to soil compaction and increasing drainage density, but it was also intended to serve as a proxy for the effects of forestry associated with backcountry roads, such as removal of vegetation and soil compaction from skidding.

The soil erodibility, cover, and slope factors were summed to obtain the erosion potential, with a potential range from 0 to 12. Erosion potential was used to represent the potential of the landscape to contribute fine sediment in the absence human disturbance, such as road building. While this is not entirely accurate, as there are large areas of development as evidenced in the cover layer, the erosion potential largely serves as a good indicator of a hillslope’s natural susceptibility to erosion. In order to assess erosion hazard the mean erosion potential was assessed for each “micro-watershed” and added to the road density factor. The result is a relative index value for each “micro-watershed” that provides an average severity of erosion for the area, binned from lowest to highest.

In the Donner Creek watershed the erosion hazard was highest on the hillslopes along the north side of Donner Lake, above I-80, but it was also medium to high within Lakeview Canyon. Along the north side of Donner Lake, especially in the Negro Canyon drainage and just to the east of Negro Canyon, more erosive soils coincided with steep slopes and sparse vegetation or shrubs and grass, creating a high potential for erosion. This area also had some of the highest density of backcountry roads. Within Lakeview Canyon, the erosion potential was mostly low, except on the northwest edge of Schallenberger Ridge, however the road density in this area was moderate to high. Erosion hazard was low in the upper extent of the Donner Creek Watershed with generally lower slopes, more erosion resistant soils with large areas of rock outcrop, and low road density. Along the south side of Donner Lake there are some patches of medium erosion hazard, which were driven more by erosion potential than by road density, as road density in these areas was moderately low.

In the Cold Creek watershed, the erosion hazard seems to be more driven by road density on the hillslopes south of Cold Creek and by both erosion potential and road density along hillslopes north of Cold Creek. The erosion hazard was generally highest on hillslopes along the east side of the South Fork of Cool Creek. In this area the soil had moderately low soil erodibility, open-canopy forest cover, and limited areas of steep slopes, but the road density was very high. The lower portion of the Cold Creek watershed, below Emigrant Canyon, also had high erosion hazard. In this area, hillslopes on the south side of Cold Creek had mostly low to medium erosion potential due to lower slopes with dense cover, but road density was high. On the north side of Cold Creek, along the south slope of Schallenberger Ridge, erosion potential was high due to lower density tree coverage with more erosive soils overlaying steep slopes. Road density was also medium to highest along the south slope of Schallenberger Ridge, particularly on the eastern edge. Erosion hazard was medium to high between Emigrant Canyon and the North Fork of Cold Creek, owing mostly road density, except in “micro-watershed” number 47, which had steep slopes as well as some of the highest soil erodibility. In most of the highest elevation western extent of the Cold Creek watershed, the erosion potential was low. The upper extent of the watershed has some of the highest erosion potential, but the relative lack of roads resulted in a low erosion potential.

Slope	
0 - 40	0
40 - 50	1
50 - 60	2
60 - 70	3
70+	4

Soil erodibility	
0 - 0.02	0
0.02 - 0.09	1
0.09 - 0.12	2
0.12 - 0.16	3
0.16 - 0.28	4

Landcover	
Open water	0
Closed Tree Canopy	0
Paved Roads	0
High Intensity Development	0
Open Tree Canopy	1
Grassland	2
Shrubland	2
Medium Intensity Development	3
Low Intensity Development	3
Sparsely Vegetated	3
Quarries	4
Barren	4

Road Density (mi/mi^2)	
0 - 5	0
5 - 10	1
10 - 15	2
15 - 20	3
20 - 25	4

APPENDIX D - ENGINEERING AND LAND USE PRESSURE CALCULATIONS

Engineering and Land Use Pressure Score Calculations and Adjustments

General Category	Location	ID	Creek	Sub Reach	Structure Type	# Piers	Artificial Bed?	Feature Length (ft)	Length of BP (ft)	Bank Lateral Confinement (Protection SubScore)	Vertical Confinement	Bed Armoring SubScore	Potential for Hydraulic Effects Due to Undersized Infrastructure	Backwater or Hydraulic Effects due to grade control	Calculated Composite Score	Adjusted Overall Score
Hydraulic Controls	W River St - Old Bridge Piers	Hyd.Cntrl 1	Donner Creek	1	Relict Structure	3		18						250	250	300
Hydraulic Controls	W River St Bridge	Hyd.Cntrl 2	Donner Creek	1	Open Bridge	0		33	66	264	100				364	350
Hydraulic Controls	Railroad Culvert	Hyd.Cntrl 3	Donner Creek	2	Culvert	0	Partly	195	195	780	100	195	150	100	1,325	1,250
Hydraulic Controls	Hwy 89 Bridge	Hyd.Cntrl 5	Donner Creek	3	Culvert Bridge	0		100	140	560	100		50	100	810	800
Hydraulic Controls	Hwy 89 Gage Weir	Hyd.Cntrl 6	Donner Creek	3	Weir	0	Yes	8				16		300	316	350
Hydraulic Controls	McDonalds Weir	Hyd.Cntrl 7	Donner Creek	3	Weir	0	Yes	8				16		150	166	150
Hydraulic Controls	Shell Gas Station Weir	Hyd.Cntrl 8	Donner Creek	3	Weir	0	Yes	8						250	250	250
Hydraulic Controls	Cold Stream Road Culvert	Hyd.Cntrl 9	Donner Creek	6	Culvert	0	Yes	60	60	240	150	120	150	200	860	850
Hydraulic Controls	DMSP Pedestrian Bridge	Hyd.Cntrl 10	Donner Creek	7	Open Bridge	0		5	10	40	50				90	100
Hydraulic Controls	DMSP Access Rd Bridge	Hyd.Cntrl 11	Donner Creek	7	Culvert Bridge	0		10	20	80	150		150		380	400
Hydraulic Controls	DMSP Cobble Weir	Hyd.Cntrl 12	Donner Creek	7	Weir	0								20	20	20
Hydraulic Controls	DMSP Gage Weir	Hyd.Cntrl 13	Donner Creek	9	Weir	0	Yes	2		4				500	504	500
Hydraulic Controls	DMSP Gage Bridge	Hyd.Cntrl 14	Donner Creek	9	Culvert Bridge	0		24	40	160	150		150		460	450
Hydraulic Controls	Donner Lake Dam	Hyd.Cntrl 15	Donner Creek	9	Dam	0									-	1,600
Hydraulic Controls	Donner Pass Rd Bridge	Hyd.Cntrl 25	Gregory Creek	10	Culvert Bridge	0	Yes	56	56	224	100	56	100	100	580	600
Hydraulic Controls	I-80 East-Bound Culvert	Hyd.Cntrl 27	Gregory Creek	13	Culvert	0	Yes	320	320	1,280	100	640	100	150	2,270	1,400
Hydraulic Controls	I-80 West-Bound Culvert	Hyd.Cntrl 26	Gregory Creek	13	Culvert	0	Yes	400	400	1,600	100	800	100	100	2,700	1,300
Hydraulic Controls	S. Shore Drive Bridge	Hyd.Cntrl 17	Summit Creek	16	Open Bridge	1		40	40	160	100		50	200	510	500
Hydraulic Controls	Old Hwy Dr Bridge	Hyd.Cntrl 16	Summit Creek	18	Open Bridge	1		30	50	200	100		100	200	600	600
Hydraulic Controls	SP Bridge	Hyd.Cntrl 18	Summit Creek	19	Open Bridge	0		5								150
Hydraulic Controls	Artificial Boulder Weir 1	Hyd.Cntrl 28	Summit Creek	19	Weir	0										350
Hydraulic Controls	Artificial Boulder Weir 2	Hyd.Cntrl 29	Summit Creek	19	Weir	0										650
Hydraulic Controls	Artificial Boulder Weir 3	Hyd.Cntrl 30	Summit Creek	19	Weir	0										550
Hydraulic Controls	Ford	Hyd.Cntrl 19	Summit Creek	28	Ford	0										100
Hydraulic Controls	Donner Pass Rd Culvert	Hyd.Cntrl 21	Billy Mack Creek	22	Culvert	0		90	100	400	100	180	150	100	930	900
Hydraulic Controls	Open Bridge	Hyd.Cntrl 22	Billy Mack Creek	24	Open Bridge	0	Yes	15		60	100		100		260	350
Hydraulic Controls	Open Bridge	Hyd.Cntrl 23	Billy Mack Creek	25	Open Bridge	0		15		60	150		100		310	400
Hydraulic Controls	S. Shore Drive Bridge	Hyd.Cntrl 24	Lakeview Canyon	33	Open Bridge	0		40	40	160	100		50	50	360	350
Historic Channel Realignment	Between DMSP and Railroad Culvert		Donner Creek		N/A											
Historic Dredging	Between dam and terminal morraine		Donner Creek		N/A											
Levee	Shell Station at Hwy 89		Donner Creek		Berm / Levee			700							350	350

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