Chapter 3
Hydrology

3.1 Introduction

This chapter discusses the regional hydrologic environment, identifies the potential impacts of the proposed project and alternatives on hydrology in the project vicinity, and prescribes mitigation measures to avoid or minimize those impacts.

3.2 Affected Environment

For the purpose of this chapter, the affected environment consists of the construction and operation areas.

3.2.1 Sources of Information

Information in this chapter is based primarily on

- Truckee River Chronology (Nevada Division of Water Resource Planning 1996);
- Physical Modeling Report (McLaughlin Water Engineers Ltd., Chinook Engineering, and John Anderson [Architect] 2001);
- Truckee Meadows Flood Control Project—Reconnaissance Report (U.S. Army Corps of Engineers 1997);
- Orr Ditch Decree (U.S. District Court of Nevada 1944); and
- ongoing hydrologic studies and analysis of the Truckee River watershed (i.e., materials associated with the TROA).

3.2.2 Regional Setting

Major hydrologic features of the Truckee River Basin include Lake Tahoe and the Lake Tahoe Basin, the Truckee River, lesser upstream storage lakes and reservoirs, various tributaries, and the Truckee River's terminus, Pyramid Lake.

The project area is located in the upper portion of the Truckee River Basin, between Lake Tahoe and the Truckee Meadows. This upper basin includes drainage areas that encompass the Lake Tahoe Basin, the Truckee River between Lake Tahoe and the town of Truckee, the Donner Lake drainage area west of Truckee, the Martis Creek drainage south and east of Truckee, the Prosser Creek and Little Truckee River drainage areas north and east of Truckee, and the upper Truckee Canyon from below Hirschdale to Verdi, Nevada. The following paragraphs provide a narrative description of the Truckee River and the locations of the major tributary inflows (figure 3-1). Table 3-1 shows inflows from the major upper Truckee River Basin tributaries to the Truckee River above the proposed Farad Diversion Dam. Seasonal distribution of flow is presented in the next section, "Flow at the Farad Gaging Station." There are no substantial tributary inflows between the confluence of the Little Truckee River, below Boca Reservoir, and the Farad gaging station, at the downstream end of the project area. Therefore, the flow data from the Farad gage provide a cumulative measure of the seasonal inflows from all of the upstream tributaries.

Table 3-1. Selected Upper Truckee River Basin Truckee River Inflows Above the Farad Gaging Station (Average Annual Runoff Volumes in Acre-Feet [Flow Rates in Cubic Feet per Second])

Gaging Station Location	Average-Water Year (af [cfs])	Low-Water Year (af [cfs])	High-Water Year (af [cfs])
Lake Tahoe Outlet (at Tahoe City) (USGS Gaging Station 10337500)	161,450 [223 cfs]	110 [0.15 cfs]	832,570 [1,150 cfs]
Donner Creek (at SR 89) (USGS Gaging Station 10338700)	60,890 [84.1 cfs]	18,750 [25.9 cfs]	102,800 [142 cfs]
Martis Creek (below Martis Dam) (USGS Gaging Station 10339400)	19,470 [26.9 cfs]	5,000 [6.90 cfs]	53,940 [74.5 cfs]
Prosser Creek (below Prosser Dam) (USGS Gaging Station 10340500)	65,950 [91.1 cfs]	17,660 [24.4 cfs]	154,930 [214 cfs]
Little Truckee River (below Boca Dam) (USGS Gaging Station 10344500)	123,800 [171 cfs]	40,250 [55.6 cfs]	340,270 [470 cfs]
Bronco Creek (at Floriston, California) (USGS Gaging Station 10345700)	9,920 [13.7 cfs]	4,400 [6.06 cfs]	15,420 [21.3 cfs]

af = acre-feet
cfs = cubic feet per second
USGS = U.S. Geological Survey

Source: Nevada Division of Water Resource Planning 1996.

The Truckee River flows out of Lake Tahoe at Tahoe City toward the town of Truckee, California, which is located nearly 15 miles downstream. Along this reach, numerous small streams enter the Truckee River. Donner Creek, which drains from Donner Lake, enters the Truckee River about 1 mile above the town of Truckee. Martis Creek enters the Truckee River about 4 miles below the town of Truckee. Prosser Creek enters the river about 3 miles below the river's confluence with Martis Creek. Two miles below Prosser Creek, the Truckee River receives the waters of the Little Truckee River flowing out of Boca

Reservoir. Juniper Creek enters the river about 2 miles below the Little Truckee River. An additional 3 miles downstream, the waters of Gray Creek intermittently enter the Truckee River.

Two miles below Gray Creek, the Truckee River passes the site of the Farad Diversion Dam located at the community of Floriston, California. Here, waters were diverted, until the diversion was washed out in 1997, into the Farad flume to be used about 2 miles further downstream at the Farad hydroelectric power plant.

The Farad U.S. Geological Survey (USGS) gaging station is approximately 1 mile below the Farad hydropower plant. This gaging station is the most important water-flow measurement site along the entire Truckee River system because it is used to ensure that the river system meets “Floriston” rates (as described in appendix B, “Summary of Truckee River Operations”) are met. About 2.5 miles downstream from the Farad gaging station, the Truckee River is again diverted for electrical generation at the Fleish power plant. A mile beyond this diversion, the Truckee River leaves California and enters Nevada, where a portion of the river is diverted into the Steamboat Ditch. A mile further downstream it receives the return waters from the Fleish power plant. Less than 1 mile beyond this point, a portion of the Truckee River’s waters are diverted again, into the Verdi Power Ditch. Below this point, the Truckee River reaches Verdi, Nevada, and after another several miles, the Truckee River enters the Truckee Meadows.

Groundwater in the project area is limited to the relatively shallow fluvial deposits adjacent to the Truckee River. Because the river in the project area is confined by shallow bedrock, there are little gains or losses from or to groundwater. Because of the narrow canyon, the groundwater levels are essentially the same across the entire cross section of the canyon. Groundwater levels are essentially the same as the water surface elevation of the river and, unlike the Martis Valley upstream of the project area and the Truckee Meadows downstream of the project area, do not show seasonal fluctuations that are not directly related to river stage.

3.2.2.1 Flow at the Farad Gaging Station

The drainage area above the Farad gage is 932 square miles. Releases from lakes and reservoirs, which affect flows at the gage, are regulated in accordance with operating rules described in appendix B, "Summary of Truckee River Operations."

Flow at this gaging station has been measured continually since September 1899. The minimum mean daily flow of 37 cfs occurred on September 15, 1933; the maximum mean daily flow of 13,400 cfs occurred on December 23, 1955. The maximum instantaneous flow of 17,500 cfs occurred on November 21, 1950. The average annual runoff is 561,800 acre-feet. Table 3-2 shows the mean monthly flow rates, mean monthly runoff, and the distribution of annual runoff.

Table 3-2. Mean Monthly Flow Rates, Mean Monthly Runoff, and the Distribution of Annual Runoff at the Farad Gaging Station

Month	Mean Monthly Flow (cfs)	Mean Monthly Runoff (af)	Distribution of Annual Runoff (%)
October	384	24,719	4.4
November	422	25,843	4.6
December	539	31,461	5.6
January	605	33,146	5.9
February	669	35,393	6.3
March	811	49,438	8.8
April	1,286	77,528	13.8
May	1,748	106,742	19.0
June	1,286	76,405	13.6
July	662	41,573	7.4
August	512	32,023	5.7
September	466	28,090	5.0
Total		**561,800**	**100.0**

Source: U.S. Geological Survey 2000.

3.2.2.2 Dry, Normal, and Wet Year Flows

Diversions from and reservoir releases to the Truckee River are regulated by a complex set of rules, described in appendix B, to meet Floriston rates. The Floriston rates require a mean flow of 500 cfs from April through September, and a variable rate from 300 to 500 cfs for the balance of the year based on Lake Tahoe elevations (table B-1). Figure 3-2 illustrates that under the current operational rules, in effect since 1968, the 3 driest, 3 wettest and 3 most normal (closest to the median) flow years the system has operated to provide the required flows. Representative normal, dry, and wet years are plotted on the same scale axis in figure 3-3. Generally, during all 3 year types, flows of 400–500 cfs are maintained as long as possible to maintain Floriston rates, and the hydrographs show variation as a result of rainfall in the winter and snowmelt in the spring, although these peaks are substantially smaller during the driest years. During the driest years, flows are maintained at 400 cfs as long as possible to meet the Floriston rates; then flows drop considerably in September or October to less than 100 cfs, and the reservoirs are nearly empty. During average and wet years Floriston rates are maintained as frequently as possible, although there are periods when the flow rates substantially exceed Floriston rates because of snowmelt, usually beginning in April and ending in June, or large precipitation events.

Figure 3-4 illustrates the flow exceedance probability for the 3 driest, wettest, and most normal flow years that were depicted in figure 3-1. The exceedance probabilties indicate that the flows exceed minimum "Reduced Floriston" rates of 300 cfs approximately 60% of the time in the driest years, 95% of the time in normal years, and 99% in the wettest years. The flows exceed the maximum Floriston rate of 500 cfs approximately 10% of the time in the driest years, 55% in normal years, and 70% of the time in the wettest years.

3.2.2.3 Sierra Pacific Power Company's Water Rights

Required rates of flow for the Truckee River originated in 1908, when the Truckee River General Electric Company (predecessor of SPPC) formed an agreement with the Floriston Land and Power Company and the Floriston Pulp and Paper Company to ensure a minimum flow in the Truckee River throughout the year.

The Truckee River General Electric Decree of 1915, a decree that settled a long-standing controversy over who would control and operate the Lake Tahoe Dam at Tahoe City, granted the Truckee River General Electric Company the enforcement of minimum instream flows (the "Floriston rates") for generation of electrical power at its powerhouses along the river's reach. These rates of Truckee River flow have since been incorporated into the Truckee River Agreement (1935), which was later incorporated into the Orr Ditch Decree (1944). The Orr Ditch Decree provides a description of SPPC's water rights as they pertain to operation of the Farad Power Plant:

> The Sierra Pacific Power Company...is entitled to and is allowed to divert at all times from the Truckee River through the Farad Power Flume...sufficient water, with a priority year of 1899, to deliver, after transportation loss, to the wheel of the Farad Hydro-Electric power plant, 325 cubic feet of water per second and sufficient additional water with a priority of 1906 to deliver, after transportation loss, to the wheel of said power plant, 75 cubic feet of water per second...for the generation of electric power in said plant.

Further discussion of water rights in California, the Floriston rates, and relevant decrees and agreements is provided in appendix B, "Summary of Truckee River Operations."

3.3 Impact Assessment Methodology

3.3.1 Analytical Approach

Each potential impact was evaluated by qualitatively and, in some cases, quantitatively estimating the changes of the project on flows and comparing those changes to the significance criteria identified below.

3.3.2 Criteria for Determining Significance

Specific criteria for determining the significance of hydrologic impacts are based on criteria recommended in Appendix G of the State CEQA Guidelines. Water quality impacts are discussed in chapter 4, "Water Quality." The State CEQA Guidelines state that a project would normally have a significant impact on the environment if it would

- substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table;
- substantially alter the existing drainage pattern of the site or area, including through the alteration of the courses of a stream or river, in a manner that would result in substantial erosion or siltation on- or off-site;
- substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site;
- create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff;
- place housing within the 100-year flood hazard area as mapped by the Federal Emergency Management Administration (FEMA);
- place within the 100-year flood hazard area structures that would impede or redirect flood flows;
- expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a dam; or
- inundation by a sieche, tsunami, or mud flow.

Alterations to the hydraulic characteristics of surface waterways are considered beneficial if the alterations decrease the extent or severity of flooding from existing or projected future conditions.

3.4 Future Conditions under Alternative A: Proposed Project

3.4.1 Surface Water

Operation of the proposed project would substantially reduce the flow along 2 miles of the Truckee River between the Farad Diversion Dam and the point that water returns from the Farad Power Plant. The actual diversion rate, up to 435 cfs, depends on the flow in the Truckee River and the following operating criteria:

- SPPC has an informal agreement with the DFG to leave a minimum of 50 cfs in the Truckee River when water is available;
- a minimum of 100 cfs is required at the power house to operate the generating facility;
- 10 cfs is required to operate the fish screen on the diversion inlet (returns immediately downstream of diversion); and
- 25 cfs is required as carriage water (flume losses, a portion of which return to the river).

When flows in the Truckee River exceed 485 cfs, SPPC would fully exercise its water rights and divert approximately 435 cfs (400 generating + 10 fish screen + 25 carriage water). Table 3-3 shows the distribution of flows through the facility under various flow conditions. To operate its hydroelectric facility, SPPC would leave at least 50 cfs through the low-flow roughened channel and 10 cfs through the fish screen. The flow split between low-flow roughened channel and inflatable dam would vary depending on the dam elevation. The high-flow roughened channel would begin to function when flows exceed 1,500 cfs upstream of the diversion. Existing flows and the flows that would occur with implementation of the proposed project are compared in figure 3-5.

Table 3-3. Flow Distribution through Proposed Project Facilities and Resulting Flows in the Truckee River

Truckee River upstream of diversion	Low-Flow Channel[1]	Inflatable Dam	High-Flow Channel	Fish Screen	Flume[2]	Power House	Truckee River downstream of diversion
#50	#50	0	0	0	5–7	0	# 50
>50	50	#175	0	0	5–7	0	>50
>185 #525	50	0	0	10	25	> 100 # 400	60
> 525	$ 50	$ 1	0	10	25	400	> 60
> 1,500	$ 50	$ 1,015	$ 1	10	25	400	> 1,075

Notes:
[1] Flow split between low-flow roughened channel and inflatable dam varies depending on dam elevation.
[2] Quantity of water required to prevent deterioration of flume.

3.4.2 Groundwater

Groundwater in the project reach is confined to fluvial deposits adjacent to the active river channel; consequently, the groundwater level is essentially the same as the water level in the river. Although surface flows would be substantially reduced, groundwater levels would be largely unaffected because of the hydraulic conditions, primarily slope, and the river stage would not substantially change with increases or decreases in flow in the 425-cfs magnitude of the diversion.

3.5 Impacts and Mitigation Measures of Alternative A: Proposed Project

3.5.1 Construction-Related Impacts

Impact 3-1: Erosion and Siltation Resulting from Project Construction

The proposed project would require a temporary diversion of the course of the Truckee River to facilitate construction of project facilities. As described in chapter 2, “Description of Project Alternatives,” the river would be diverted to a bypass channel east of the existing channel. The bypass channel would be excavated in fluvial deposits that have accumulated along the inside bend of the river. Although likely containing more fine material than the substrate in the active river channel, the deposit primarily consists of large boulders and cobbles that have been overlain by finer materials. The fine materials may be winnowed from the bypass channel’s bed and banks, but the large caliber of the remaining deposits would inhibit substantial erosion and failure of the bypass channel. Therefore, this impact is considered ***less than significant***. No mitigation is required.

Impact 3-2: Placement of Structures within the 100-Year Flood Hazard Area that Could Impede or Redirect Floodflows

Machinery, construction debris, supplies, temporary structures, and sediments carried away by floodflows may damage downstream bridges or structures and increase the severity of flooding by causing water to back up behind entrained debris. Structures may be damaged by moving debris or by increased hydrostatic pressure caused by accumulated debris that backs up water. Potential offsite damage caused by flood-entrained debris is considered a ***significant*** impact.

Implementation of Mitigation Measure 3-1 would reduce this impact to a less-than-significant level.

Mitigation Measure 3-1: Limit placement and construction of temporary structures in the 100-year floodplain

To ensure that structures do not impede or redirect floodflows, temporary structures, such as Baker tanks and debris piles, will not be sited in the 100-year floodplain during the flood season (from November 30 through May 1). If a temporary bridge or other structure must be located in the floodplain, it will not be buoyant and will be adequately anchored during the flood season to resist the hydrodynamic forces expected during a flood of up to a 100-year-recurrence interval.

3.5.2 Operation-Related Impacts

Impact 3-3: No Effect on Erosion and Siltation

Operation of the project would not have an effect on erosion or siltation. During the design process, several locations were evaluated for location of the replacement diversion structure. The project applicant developed a physical model of the proposed project to evaluate the fish passage, boat passage, and sediment transport under low and high flow conditions (McLaughlin Water Engineers Ltd. 2001). It was found that locating the diversion at the tail of an existing pool would minimize the potential for large sediments to accumulate behind the diversion structure. Fine sediments would pass through the low-flow and high-flow bypass channels and would not silt up the pool. Because the proposed project would pass most sediment, there would not be accelerated erosion or winnowing of fine materials downstream of the diversion structure.

As with any in-channel structure, some material may accumulate during unusually large flood events and require maintenance activities to ensure that the fish screens operate and that there is appropriate passage for both fish and boaters. However, the proposed project would not require regular instream maintenance to remove accumulated sediments.

Because of the proposed design and location of the diversion structure, the project would not cause an effect on erosion or siltation, and this impact is ***considered less than significant.*** No mitigation is required.

Impact 3-4: No Effect on the Rate or Amount of Surface Runoff

Neither construction nor operation of the proposed project would have an effect on the rate or volume of surface runoff because of the small amount of additional paved surface area created by project facilities. Also, because project facilities make use of an existing pool, the overall hydrology of this area of the river is not expected to change. Therefore, this impact is considered ***less than significant.*** No mitigation is required.

Impact 3-5: No Effect on Existing or Planned Stormwater Drainage Systems

Neither construction nor operation of the proposed project would have an effect on the rate or volume of surface runoff because of the small amount of additional paved surface area created by project facilities; consequently, the proposed project would have no effect on existing or planned stormwater infrastructure. The project would improve stormwater drainage along Old Highway 40 by preventing runoff from overtopping and eroding the embankment between the river and Old Highway 40. Therefore, this impact is considered ***less than significant.*** No mitigation is required.

Impact 3-6: Placement of Housing Within the 100-Year Flood Hazard Zone

The proposed project does not include any housing; therefore, no impact related to placement of housing would occur. No mitigation is required.

Impact 3-7: Reduction in Groundwater Levels Resulting from Project Implementation

Operation of the proposed project would substantially dewater 2 miles of the Truckee River between the Farad diversion dam and the point at which the water returns from the Farad Power Plant. Based on the mean monthly data presented in table 3-2, the diversion would remove 70% or more of the surface water from the affected reach from July through February.

Although surface flows would be substantially reduced, groundwater levels would be largely unaffected. Groundwater in the project reach is confined to fluvial deposits adjacent to the active river channel; consequently, the groundwater level is essentially the same as the water level in the river. Because of hydraulic conditions (primarily slope and roughness), generally the water level does not substantially change with increases or decreases of flow in the 425-cfs magnitude of the proposed diversion. At sites where the topography is locally less steep, such as point bars, the reduction in flow would have a greater effect on the shallow groundwater levels. However, the rate of seasonal groundwater level decline would not be substantially greater than under existing conditions. Therefore, this impact is considered ***less than significant***. No mitigation is required.

Impact 3-8: Exposure of People and Property to Substantial Risk of Loss, Injury, or Death Involving Flooding Resulting from Project Implementation

The proposed project would include a low-head diversion structure that impounds only a few feet of water. Even in the event of a catastrophic instantaneous failure of the entire diversion structure, the flood wave would be quickly dissipated before reaching populated areas downstream of the diversion site, such as Floriston or Verdi. Therefore, this impact is considered ***less than significant***. No mitigation is required. Chapter 9, “Recreation,” addresses recreational effects.

Impact 3-9: No Exposure of People and Property to Substantial Risk of Loss Involving Seiches, Tsunamis, or Mudflows Resulting from Project Implementation

Although the proposed project would be located in an area that may be affected by seismic activity such as ground shaking, the impoundment created by the diversion is so small that there would be almost no potential for seiche to cause significant damage. Because the active channel is confined by a steep canyon and there is not a shallow submerged terrace, there is no potential for waves to be magnified and run up the banks of the river. A seiche would be contained within the active channel. In addition, there are no structures adjacent to the pool that could be damaged. Implementation of the proposed project may reduce the risk of a mudflow by buttressing the western bank of the canyon with the concrete box conduit. Therefore, this impact is considered ***less than significant.*** No mitigation is required.