

6.1 Introduction

This chapter describes existing aquatic resources of the Truckee River system and project area, potential impacts of the proposed project and alternatives on aquatic resources, and recommended mitigation measures.

6.2 Affected Environment

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

6.2.1 Sources of Information

Information was gathered from published and unpublished literature, communication with biologists familiar with the Truckee River, and previous engineering and modeling reports for the proposed project. The primary sources of information were

- *Recovery Plan for the Lahontan Cutthroat Trout* (U.S. Fish and Wildlife Service 1994);
- *Physical Modeling Report for the Farad Diversion Restoration* (McLaughlin Water Engineers, Ltd., et al. 2001);
- *Instream Flow Requirements, Truckee River Basin, Lake Tahoe to Nevada* (California Department of Fish and Game 1996);
- *Alternative Evaluation & Design Development for the Farad Diversion Restoration* (McLaughlin Water Engineers, Ltd. 2001); and
- *Truckee River Operating Agreement Draft Environmental Impact Statement/Environmental Impact Report* (U.S. Bureau of Reclamation 1998).

6.2.2 Regional Setting

The Truckee River system supports a number of native and nonnative fish species. Common native fish species include mountain whitefish, Lahontan cutthroat trout, Tahoe sucker, mountain sucker, Lahontan redbreast, speckled dace, Paiute sculpin, and Tui chub. Nonnative species include brown trout, rainbow trout, largemouth bass, green sunfish, black crappie, and carp (La Rivers 1962, Griffith 1988).

The higher elevations of the Truckee River system are dominated by salmonid species. As elevation decreases, warmwater species become more abundant. The distribution of salmonids reflects a decline in the availability of suitable spawning and rearing habitat from upper to the lower elevations related to increasing summer water temperatures and total dissolved solids (TDS) (Dickerson and Vineyard 1999).

6.2.2.1 Affected Species

Table 6-1 summarizes the spawning and rearing requirements of fish that may be found in the Truckee River in the project area.

6.2.2.2 Lahontan Cutthroat Trout

6.2.2.2.1 Status and Distribution

Lahontan cutthroat trout were listed as an endangered species under ESA on October 13, 1970, but it was reclassified as a threatened species on July 16, 1975 (FR 40:[1975]:29864) to facilitate its management (Gerstung 1988).

Lahontan cutthroat trout are endemic to the Lahontan basin in northern Nevada, eastern California and Southern Oregon. Their historic range encompassed Carson City, Churchill, Douglas, Elko, Eureka, Humboldt, Lander, Lyon, Mineral, Nye, Pershing, Storey, and Washoe Counties in Nevada; Alpine, El Dorado, Lassen, Mono, Nevada, Placer and Sierra Counties in California; and Harney and Malheur Counties in Oregon (FR 11061 1993).

Lake Tahoe, Pyramid and Winnemucca lakes supported the largest historic populations of Lahontan cutthroat trout populations in the Truckee River system (Gerstung 1988). Fish harvested from Pyramid Lake and the Truckee River supported a active commercial and sport fisheries. However, by the turn of the 20th century, the fishery began to decline and by the early 1940s the Lahontan cutthroat trout fishery was extinct in Pyramid Lake (Trelease 1952 in Gerstung 1988). Following the extinction of Pyramid Lake Lahontan cutthroat trout, hatchery stocking of four strains of Lahontan cutthroat trout (Heenan, Walker,

Table 6-1. Spawning Requirements of Some Fish Species Found in the Truckee River

Species	Habitat	Spawning Season/ Temperature Requirement	Spawning Habitat	Fry Habitat
Native Fish				
Lahontan cutthroat trout <i>Oncorhynchus clarki henshawi</i>	Cold/cool water	Spring: April–June, 50–59°F	Gravel riffles	Quiet water close to shore
Mountain whitefish <i>Prosopium williamsoni</i>	Cold/clear water	Fall: Oct–Nov, 39–45°F	Loose gravel	Shallow area of streams, deep area of lakes
Pauite sculpin <i>Cottus beldingi</i>	Coldwater bottom dweller	Spring: May–June, 39–45°F	Loose gravel/rubble	Rocks
Lahontan redbside shiner <i>Richardsonius egregius (Girard)</i>	Variable shallow areas	Spring-Summer: May–Aug, 55–75°F	Sand/gravel shallows	Quiet shallows of lakes/streams
Speckled dace <i>Rhinichthys osculus</i>	Variable shallow areas	Spring: June–July, 46°F +	Sand/gravel/ rubble/shallows	Quiet shallows of lakes/streams
Mountain sucker <i>Catostomus platyrhynchus</i>	Variable	Spring-Summer: May–Aug, 52–66°F	Gravel riffles	Shallow quiet area of streams
Nonnative fish				
Rainbow trout <i>Oncorhynchus mykiss</i>	Cold/cool water	Spring: Apr–July, 50–59°F	Gravel riffles	Quiet water close to shore
Brown trout <i>Salmo trutta</i>	Cold/clear water	Fall: Oct–Nov, 43–50°F	Gravel riffles	Quiet water close to shore, under large rocks

Source: Truckee River Operating Agreement Draft Environmental Impact Statement/Environmental Impact Report (U.S. Bureau of Reclamation 1998).

Summit, and Independence lakes) created a popular sport fishery. Since the 1980s, Lahontan cutthroat eggs have been taken almost exclusively from Pyramid Lake spawners, and reared to juveniles for release into the lake (U.S. Fish and Wildlife Service 1995).

Lahontan cutthroat trout habitat has declined dramatically. Historically, the Truckee River system supported 373 miles of cutthroat trout habitat. However, in 1988, Gerstung identified only 3.1 miles of streams supporting self-sustained Lahontan cutthroat populations. The only remaining genetically pure Lahontan cutthroat trout are in Independence Lake, California. Lahontan cutthroat trout from Independence Lake were recently transplanted into the upper Truckee River and a tributary (Pole Creek) near Squaw Valley, California). Although a small amount of successful spawning does occur, the reestablished cutthroat population in Pyramid Lake is maintained by hatchery stocking. No Lahontan cutthroat trout have been found at the project area as Derby Dam is currently an impediment to upstream migration. However, restoration efforts are in place in the upper tributaries of the Truckee River system, and Lahontan cutthroat trout may be present in the project area in the future.

6.2.2.2 Life History

Most information on Lahontan cutthroat trout life history and distribution is from Moyle (1976a) and Gerstung (1988). Lahontan cutthroat trout are stream spawners. Spawning takes place from April to July, depending on streamflow and temperature. Spawning migrations of stream fish are limited, but lake-dwelling fish may migrate far upstream to spawn. Stream fish mature in 2–3 years of age, whereas lake fish mature in 3–5 years. As with many other salmonid species, eggs are deposited in gravel redds. Egg incubation requires water temperatures between 43°–56° F and dissolved oxygen concentration of at least 5 mg/L or high mortality can occur. Eggs generally hatch in 4–6 weeks, and fry begin feeding 2 weeks later. Some juveniles migrate downstream into lakes during their first year while others remain in streams for 1 or more years. The diet of stream fish consists primarily of insect drift. Lake residents consume zooplankton, benthic invertebrates, and insects; larger individuals (fork length > 300 mm) often are piscivorous (i.e., they eat fish). Growth rate ranges from approximately 50 mm to 150 mm per year and is temperature dependent. However, faster growth occurs when forage fish are available.

6.2.2.3 Factors Affecting Abundance

Lahontan cutthroat trout have hybridized with Yellowstone cutthroat trout and rainbow trout so extensively that only a few genetically isolated populations of uncertain purity have been detected (McAfee 1966, Moyle 1976a). Hybridization either decreases phenotypic variability or allows the rainbow trout phenotype to become dominant (Moyle 1976a). In addition, hybridization

reduces the fitness of Lahontan cutthroat trout by causing the production of less fertile offspring (McAfee 1966).

Another factor that has contributed to the decline of Lahontan cutthroat trout populations is competition and predation by nonnative species. Lahontan cutthroat trout were present historically in streams and lakes throughout the Lahontan system, including the Truckee River basin. However, brook, rainbow, and brown trout have replaced Lahontan cutthroat trout throughout much of the latter's former range, in large part because Lahontan cutthroat trout evolved in the absence of these more aggressive, territorial and specialized salmonid species (Griffith 1988). The extirpation of populations in Lake Tahoe and Pyramid Lake prior to 1950 was partly a result of commercial fishing; nevertheless, competition with introduced lake trout was a contributing factor in Lake Tahoe. In addition, Lahontan cutthroat trout are very susceptible to angling and more easily caught than other salmonids (Varley and Gressell 1988, Griffith 1988).

Habitat degradation (i.e., dam construction, water diversions, channel modifications) is another factor influencing Lahontan cutthroat trout abundance in the Truckee River basin (McAfee 1966). Degradation of spawning and rearing habitat have been caused by reduced flows; increased water temperature caused by lack of riparian vegetation; and reduced availability of suitable substrate, cover, and food sources (U.S. Fish and Wildlife Service 1993a, Gerstung 1988). In addition, ongoing diversions of water from the Truckee River into the Carson River basin greatly reduced the accessibility and suitability of spawning streams (Gerstung 1988).

Heavy exploitation of fishery resources has also contributed to the decline of this species. Approximately 45,000–90,000 kg (99,208–198,416 pounds) of fish were harvested annually in Pyramid Lake and the Truckee River (Gerstung 1988) during the late 1800s; in addition, those areas supported world-renowned sport fisheries in the 1920s. Fishing activities in Pyramid Lake and the Truckee River ceased by 1940 because Lahontan cutthroat trout had become extinct in Pyramid Lake (Trelease 1952 in Gerstung 1988).

6.2.2.3 Rainbow Trout

6.2.2.3.1 Status and Distribution

Rainbow trout is native to California. These trout were originally found in small coastal streams; the Sacramento and San Joaquin Rivers and their tributaries; and the Russian, Eel, Klamath, and Smith drainages (McAfee 1966). In the Truckee River, rainbow trout were introduced before the turn of the 20th century and became established by the 1930s (Gerstung 1988). The Truckee River between Boca and the state line supports a healthy trout population with some of the largest fish in the river.

6.2.2.3.2 Life History

Rainbow trout are found in cool, clear, fast-flowing waters that provide high oxygen concentrations. Females become sexually mature during their third year, whereas males become mature during their second or third year (Raleigh et al. 1984). Spawning takes place in riffles and at the lower ends of pools and may not occur until July or early August in cold waters at high elevations (McAfee 1966). Eggs may hatch in 28–40 days depending on temperature (Cope 1957 in Raleigh et al. 1984). After emerging, juvenile fish first stay in schools close to shore, then disperse to establish feeding territories, where they feed on drift organisms (Moyle 1976b). As rainbow trout grow older, their diet becomes more diverse and may include macroinvertebrates and fishes. Generally, rainbow trout live an average of 6 years, with some individuals living up to 11 years.

DFG (1996) developed a set of recommended instream flows for rainbow trout. These flows include preferred and minimum flows for spawning, incubation, and rearing habitats. Preferred flows for spawning, incubation, and rearing are 200 and 250 cfs between Boca and the state line, whereas minimum flows for spawning, incubation, and rearing are 150 cfs.

6.2.2.3.3 Factors Affecting Abundance

Planting has been a major factor affecting the abundance of rainbow trout in the Lahontan basin. The rainbow trout fishery was sustained largely by planting until last year, when DFG stopped planting to assist the U.S. Fish and Wildlife Service's recovery efforts for Lahontan cutthroat trout. Approximately 6,000 rainbow trout were stocked in the Truckee River by DFG in May 2000.

A wild trout section was established in the Truckee River upstream of the project area from Trout Creek to the outflow of Boca Reservoir (Little Truckee River). Specific regulations apply to the wild trout section to maintain recreational values.

Habitat degradation has also affected rainbow trout populations in the Lahontan Basin. Flows in the Truckee River are regulated by dams and diversions for water supply, power production, and flood protection. Dams have blocked access to trout spawning and rearing habitat. Flow regulation, dams, and various land uses have caused changes in channel form. These physical changes have altered the aquatic biota of the river and adversely affected the general health of the system (California Department of Fish and Game 1996).

6.2.2.4 Brown Trout

6.2.2.4.1 Status and Distribution

Brown trout, a native of Europe and western Asia, was introduced in North America in 1883 (Moyle 1976a). Like rainbow trout, brown trout was introduced to the basin before the turn of the 20th century and became established in the Truckee River by the 1930s.

6.2.2.4.2 Life History

Brown trout are stream spawners. Most brown trout mature at the end of their second and third year (Staley 1966). Spawning occurs when water levels are low during the fall or winter (November and December). Brown trout prefer gravel riffles and the tail of pools to spawn. Eggs hatch usually in 7–8 weeks, depending on water temperature. After emergence, fry inhabit quiet waters close to shore, where they hide from potential predators under large rocks or overhanging vegetation, and begin feeding after 3–6 weeks. Brown trout feed on a variety of prey. Their diet changes as they become larger; juveniles feed mostly on drift organisms, and older fish feed on prey fish, bottom macroinvertebrates, and drift organisms. Brown trout can reach up to 9 years of age in California. However, their average life span is 5–6 years.

DFG (1996) developed a set of recommended instream flows for brown trout. These flows include preferred and minimum flows for spawning, incubation, and rearing. Preferred flows for spawning, incubation, and rearing are 200 and 250 cfs between Boca and the Nevada state line, whereas minimum flows for spawning, incubation, and rearing are 150 cfs. These criteria have also been proposed under the TROA.

6.2.2.4.3 Factors Affecting Abundance

As with rainbow trout, stocking and habitat degradation are the main factors affecting brown trout abundance in the Lahontan Basin. Planting has supported most of the brown trout fishery in the river. However, planting was discontinued after May 2000 (Redfern pers. comm.).

6.2.2.5 Other Fish Species

Another species of importance is smallmouth bass, a species that is abundant and widespread in the Sierra Nevada. It was introduced to provide additional fishing opportunities. In general, this warm-water species will occur in the Sierra Nevada because of reduced flows due to diversions (Moyle et al. 1996).

6.2.2.6 Aquatic Invertebrates

Invertebrates are an important component of aquatic ecosystems. They influence functional processes such as decomposition, primary production, and nutrient spiraling. Invertebrates also connect primary producers with fish (Rader 1997). Decomposition and the rate at which this process takes place are affected by macroinvertebrates that are able to digest and process coarse and fine particulate organic matter (i.e., decomposing vascular plants, decomposing detrital particles, algae and bacteria), making them available to the rest of the food web. Invertebrate grazing may stimulate or inhibit primary productivity in aquatic ecosystems depending on the invertebrate biomass (Bott 1983). These secondary consumers in turn serve as prey for invertebrate and fish predators.

Available information on benthic macroinvertebrate populations is limited to population estimates conducted by Koch and Hainline (1976) that covered data from 1973 to 1975 collect at the Farad gaging station. Conditions at the time of the study were influenced by operational flows from the Farad diversion. Estimated production of macroinvertebrates from 1973 to 1974 was approximately 9.13 grams per square meter (0.02 pound per 10.75 square feet) per year. This estimate is an underestimate due to high velocity of water (Koch and Hainline 1976). The dominant genera identified during this study include *Baetis* and *Ephemerella* (mayflies) and *Arcynopteryx* (stonefly). Data from a recent sampling program conducted 3 miles downstream of Truckee will soon be analyzed (Harrington pers. comm.). However, because there is high spatial and temporal heterogeneity among invertebrate populations, extrapolation of invertebrate species composition and structure from the sampling site in Truckee to the project area is not recommended.

Invertebrate populations that experience water fluctuations caused by dams and water diversions behave differently than populations under natural flood conditions (Erman 1996). Invertebrate biomass in the water is highest during the high water period (winter) and lowest in the summer and fall when the water is low because many insects are in their terrestrial stage or are in a small larval stage (Erman 1996). Under managed conditions, invertebrates are stranded when water volume declines suddenly and stream channels dry up (Erman 1996). Invertebrates may also increase their drift downstream in response to flow changes (Minshall and Winger 1968). Rapid flow changes can cause catastrophic drift. This increase in drift may be caused by a decrease in depth that reduces living space and increases competition, thereby forcing entry into the current (Minshall and Winger 1968). In addition, a physiological effect may be at play. As water velocity decreases, respiratory stress increases, causing invertebrates, such as ephemeroptera, plecoptera, and trichoptera, to enter the current (Minshall and Winger 1968). Changes in suspended sediment and water quality can also induce drift.

Genera known to occur in the Truckee River include *Baetis* and *Ephemerella* (mayflies) and *Arcynopteryx* (stonefly). In addition, an endemic caddisfly, *Desmona bethula*, has been classified as a species of concern by USFWS. Information on its population status is limited. This species inhabits high

elevation streams (about 2,154.4 yards) in the Sierra Nevada (Erman 1996), more specifically, in Plumas and Sierra Counties (Opler and Lattin 2000). *D. bethula* leaves the stream on summer nights as an aquatic larvae to feed on terrestrial vegetation (Erman 1981). *D. bethula* lives in slow, unshaded stretches of small spring streams (Erman 1981); therefore, it is unlikely that the species is present within the reach of the project area.

6.2.3 Regulatory Setting

6.2.3.1 Endangered Species Act

Section 7 of the ESA requires all federal agencies to participate in the conservation and recovery of threatened and endangered species. Section 7(a)(2) requires federal agencies, in consultation with USFWS and/or NMFS, to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of designated critical habitat. The ESA requires federal agencies to consult with USFWS and/or NMFS when there is discretionary federal involvement or control over an action (e.g., issuance of a federal permit).

For the proposed project, the USACE must consult with USFWS to assess the effects of Section 404 authorization on listed species that may be present in the project area. As part of formal consultation, USACE must prepare a biological assessment to inform USFWS of potential project effects on listed species. Formal consultation is required for Lahontan cutthroat trout, which is currently listed as threatened under ESA. USFWS is required to issue a biological opinion on whether the proposed project will jeopardize the continued existence of Lahontan cutthroat trout and other listed species. If USFWS concludes that the project will cause jeopardy, USFWS will identify reasonable and prudent alternatives that can meet project objectives and avoid jeopardy. If USFWS concludes that the project will not cause jeopardy, but could result in take (i.e., harm, harassment, or mortality) of any listed species, USFWS will identify reasonable and prudent alternatives to reduce or avoid impacts and minimize take. In this case, USFWS will prepare an incidental take statement that prescribes terms and conditions that implement the reasonable and prudent alternatives.

6.2.3.2 Water Quality Control Plan for the Lahontan Region

The Water Quality Control Plan for the Lahontan Region (1995) lists the beneficial uses of waters that must be protected. Cold freshwater habitat (COLD), rare threatened or endangered species (RARE), migration of aquatic organisms (MIGR), and spawning reproduction and/or early development

(SPWN) are identified as beneficial uses in the Lahontan Region Water Quality Control Plan. The SWRCB will consider how the proposed project will affect these uses during the Section 401 water quality certification process.

6.2.3.3 California Streambed Alteration Agreement

Any person, government agency, or public utility proposing any activity that will divert or obstruct the natural flow or change the bed, channel, or bank of any river, stream, or lake, or proposing to use any material from a streambed, must first notify, consult, and obtain a streambed alteration agreement from DFG. As a general rule, this requirement applies to any work undertaken within the ordinary high-water mark (OHWM) of a wash, stream, or lake that contains or once contained fish and wildlife or supports or once supported riparian vegetation.

6.3 Impact Assessment Methodology

6.3.1 Analytical Approach

The effects of the proposed project alternatives on aquatic resources were assessed based on the habitat requirements of rainbow and brown trout relative to flows, water quality, and fish passage conditions. Qualitative assessment methods were used to assess the significance of flow, water quality, and fish passage effects based on the criteria presented below.

Rainbow and brown trout were selected as the primary evaluation species because they are the dominant game species and the primary focus of fish management activities in the Truckee River. Furthermore, the recommended minimum instream flows for protection of aquatic resources in the Truckee River system are based on the life history and habitat requirements of key life stages of rainbow and brown trout (California Department of Fish and Game 1996). Therefore, it is assumed that the results and conclusions of the following analysis generally apply to the aquatic community, including other fish species and invertebrate species. Because of basic similarities in life history and habitat requirements, it is also assumed that the predicted effects of the project on rainbow and brown trout generally apply to the federally listed Lahontan cutthroat trout, which may eventually be restored to the project area.

6.3.1.1 Flow Assessment Methods

Flow-related impacts on rainbow and brown trout were evaluated qualitatively based on DFG's recommended minimum and preferred instream flows for key life stages. DFG's recommendations were based on relationships between flow and habitat availability generated by the physical habitat simulation (PHABSIM) system, a set of computer programs that combine hydraulic and biological

models to evaluate changes in physical habitat availability as a function of flow for a given species and life stage. PHABSIM is a component of the Instream Flow Incremental Methodology (IFIM), which was developed as a water management tool to quantify the biological effects of alterations in flow regimes or the relative benefits or impacts of different flow regimes on aquatic habitat (Bovee 1982). Major assumptions of the IFIM are that habitat availability, as measured by weighted usable area (WUA), accurately reflects the quantity and quality of habitat available to a selected species and life stage, and that habitat availability is a key factor governing population size and production (appendix E).

Table 6-2 presents DFG’s preferred (or optimum) and minimum flow recommendations for the reach between the Nevada state line and Boca (Reach 1), which encompasses the project operation area reach. Reach 1 is being managed to maintain self-sustaining rainbow and brown trout populations. The optimum flow recommendations are based on the goal of maximizing habitat availability for rainbow and brown trout spawning and incubation and for adult rainbow trout. The minimum flow recommendations for Reach 1 are based primarily on the goal of maximizing habitat availability for juvenile rainbow trout and secondarily on the goal of maintaining at least 50% of maximum habitat values for all other life stages. DFG considers the minimum flow acceptable, contingent on incorporation of a spawning and rearing habitat improvement program in TROA for the mainstem Truckee River and remaining spawning tributaries (Prosser and Donner Creeks). Studies conducted by USFWS and DFG in the Truckee River system indicate that, when spawning and incubation conditions are sufficient, juvenile rearing habitat is the primary factor limiting adult production (California Department of Fish and Game 1996).

Table 6-2. Instream Flow Recommendations for Fishery Resources in the Truckee River System, California

	Brown Trout				Rainbow Trout			
	October–January Spawning and Incubation		February–March Rearing		April–July Spawning and Incubation		August–September Rearing	
	Preferred	Minimum	Preferred	Minimum	Preferred	Minimum	Preferred	Minimum
Truckee River— Reach 1: Nevada to Boca	200	150	250	150	200	150	250	150

Minimum flow conditions require improved spawning and rearing conditions at low flows within the mainstem and listed tributaries. Preferred flows represent optimum flow versus habitat conditions.

Controlled releases exceeding twice the highest, preferred flows in the Little Truckee River downstream of Stampede Reservoir and in Prosser Creek will require channel modifications to prevent stranding in secondary channels and shelter from high flows.

Target flows should be identified based upon storage and projected runoff conditions such that flow conditions will be sustained during the life stage period to as close to preferred conditions as possible.

Balanced system should be pursued to ameliorate fluctuation in flow conditions resultant from the alternative, exclusive use of reservoirs to accommodate downstream needs. Percent variation in flow between regulated reaches should be minimized. Percent variation is the percentage difference between minimum and preferred flow.

For the purposes of the present analysis, it was assumed that the habitat-flow relationships for Reach 1 are generally applicable to the operation area. Unfortunately, the PHABSIM results specific to the operation area were not available to test this assumption. DFG's habitat mapping results indicate that the operation area has a higher percentage of pocket water and a lower percentage of runs compared to other subreaches and Reach 1 as a whole. However, the potential effect of these differences on the habitat-flow relationship cannot be reliably determined with the available data. Therefore, assessments of potential habitat impacts based on the overall habitat-flow relationships for Reach 1 should be considered preliminary until more definitive information is available.

The potential effects of project-related flow changes on habitat availability in the project operation area were analyzed using the record of mean daily flows measured at the Farad gaging station from 1970 to 2000. This record best represents existing hydrologic conditions because most of the significant changes affecting Truckee River hydrology were made before 1970 (Sierra Pacific Power Company 1999a). Dry (1977, 1988, and 1990), average (1973, 1980, and 1981) and wet (1983, 1986, and 1997) years were selected to simulate the effects of the proposed project on flows in the operation area over a wide range of hydrologic conditions. Daily flows were reduced by up to 425 cfs (diversion plus 25 cfs transport loss) while maintaining a minimum flow of 60 cfs in the bypass reach. The effects of other bypass flow requirements (100, 150, 200, and 250 cfs) were also analyzed. These flows encompass the range of minimum and preferred flows recommended by DFG. Project impacts for each bypass flow were evaluated by comparing the number of days that the recommended minimum flow (150 cfs) would be met (i.e., equaled or exceeded) under each bypass scenario with the number of days that these flows would be met under existing conditions (no project) during dry, average, and wet conditions. Also presented is the number of days that DFG's preferred or optimum flows would be met under the No-Project Alternative and each flow bypass scenario.

6.3.2 Criteria for Determining Impact Significance

Impacts of the proposed project on aquatic resources include short-term and long-term impacts. Short-term impacts, which are related primarily to construction activities, may last from several hours to weeks. Long-term impacts may last months or years and generally involve the physical alteration of habitat.

Populations of fish and other aquatic organisms may be reduced because of increased mortality and changes in habitat availability and suitability. These changes would affect species survival, growth, and reproduction. In general, impacts on fish populations are significant when project construction or operation would cause or contribute to substantial short- or long-term reductions in abundance and distribution. Based on the State CEQA Guidelines, an impact is considered significant if it

- substantially reduces the abundance or range of a rare or threatened species;

- substantially threatens to eliminate an animal community;
- substantially reduces fish habitat or causes fish habitat to drop below self-sustaining levels; or
- does not meet SWRCB basin standards for protection of fish, wildlife, and other aquatic resources.

Impacts were considered significant if it was determined that conditions contributing to existing stress on aquatic resources would be worsened by the implementation of the project, resulting in a substantial reduction in population abundance and distribution. The definition of “substantial” varies with each species, depending on the ability of the population to sustain or increase current production levels in response to changes in environmental conditions. Many fish populations are resilient in the face of mortality caused by human activities and natural environmental variability. Others may be more sensitive because of their status and dependence on specific habitats or environmental conditions.

The significance criteria used for assessing project impacts on habitat availability were based on DFG’s minimum flow recommendation (150 cfs year-round), which is based on the primary objective of maximizing habitat availability for juvenile rainbow trout, and the secondary objective of maintaining at least 50% of the maximum habitat values for other life stages (150 cfs corresponds to 100%, 85%, 90%, and 89% of the maximum habitat values for juvenile rainbow trout, adult rainbow trout, spawning rainbow trout, and spawning brown trout, respectively). Thus, adverse impacts on rainbow trout and brown trout habitat were considered significant if proposed project operations would result in a 10% or greater reduction of the number of days that a flow of 150 cfs would be met compared to no-project conditions.

6.4 Impacts and Mitigation Measures of Alternative A: Proposed Project

6.4.1 Construction-Related Impacts

Water quality measures to reduce potential construction impacts to less-than-significant levels are described in detail in chapter 4.

Impact 6-1: Increased Mortality of Aquatic Organisms and Habitat Degradation Resulting from Increased Suspended Sediment and Turbidity during Construction

Excessive amounts of fine sediments and turbidity in stream environments have been linked to declines in abundance, distribution, and production of fish and other aquatic organisms. High concentrations of suspended sediment can reduce photosynthesis and primary production, force fish to abandon preferred feeding sites, impair the feeding ability of sight-feeding predators, and clog or damage the gills and food-gathering structures of fish and invertebrates. Excessive deposition of fine sediment on the streambed can cause mortality of embryos and fry of trout and other species by smothering them, impeding water flow through gravel nests, or preventing the emergence of fry. Excessive deposition of fine sediments can also reduce the quantity and quality of habitat for fish and bottom-dwelling invertebrates by reducing the amount of living space and cover. Because stream communities are adapted to natural seasonal variation in suspended sediments and turbidity associated with runoff, the magnitude of potential impacts depends on the timing, extent, and duration of increased suspended sediments and turbidity relative to naturally occurring levels. However, project-related sedimentation and turbidity will be minimized through the preparation and implementation of a SWPPP and a hazardous spill prevention and recovery program, and implementation of construction techniques and BMPs identified in the project description, as described in chapter 4, "Water Quality." Therefore, mortality and habitat degradation resulting from project construction is unlikely; this impact is considered *less than significant*. No mitigation is required.

Impact 6-2: Increased Mortality of Aquatic Organisms as a Result of Spills of Toxic Materials Used or Stored at Project Construction Area

Spills of hazardous materials into the stream environment can harm aquatic organisms and communities through a number of direct and indirect mechanisms. Potential impacts may include immediate mortality from exposure to lethal levels or delayed or indirect effects on survival, growth, or reproductive success from sublethal effects. The magnitude of potential impacts depends on the species, the life stages present, and the exposure concentration and duration. This effect will be minimized through the preparation and implementation of a SWPPP and a hazardous spill prevention and recovery program, and implementation of construction techniques and BMPs identified in the project description and described in chapter 4, "Water Quality." Therefore, mortality and habitat degradation resulting from project construction is unlikely; this impact is considered *less than significant*. No mitigation is required.

Impact 6-3: Disruption of Movement of Adult and Juvenile Fish during Construction

Movement of adult and juvenile fish past the construction area may occur at any time of year. The temporary diversion channel would provide the only route for upstream and downstream movements of fish during in-channel construction activities. If construction occurs over 2 or more years, the temporary diversion channel would be blocked at the end of each low-flow period and flow would be restored to the main river until the following year or low-flow period. However, fish passage may be impeded by inadequate water depths, excessive water velocities, or physical barriers in the temporary diversion channel or main channel during active or inactive construction periods. Because of the 2-year duration of construction activities, this impact is considered *significant*.

Implementation of Mitigation Measure 6-1 would reduce this impact to a less-than-significant level.

Mitigation Measure 6-1: Ensure that adequate fish passage conditions exist in the temporary diversion channel and main channel during construction

In order to ensure that adequate fish passage conditions exist in the temporary diversion channel and main channel during construction, the temporary diversion channel will be designed to meet the guidelines or biological criteria established by the resource agencies for passage of the target fish species. The proposed channel design will be reviewed and approved by USFWS and DFG. Key considerations will include channel dimensions, longitudinal and cross-sectional profiles, and hydraulic characteristics over the expected range of flows. Roughness elements may be needed to create fish resting areas. The channel will also be designed to prevent stranding of fish when the channel is dewatered after construction. If construction requires more than 1 year, the final plans and specifications will include guidelines for avoiding or minimizing conditions that may impede fish passage or subject fish to other hazards during the inactive construction period (e.g., stranding following high-flow events). Before construction is suspended, a qualified engineer or biologist will survey the construction area to identify any significant fish passage impediments. Consideration will also be given to conditions that may cause stranding or increased predation on young fish. Measures will be taken to correct or minimize these to the extent practicable before the inactive construction period.

Impact 6-4: Temporary Loss of Aquatic Habitat and Displacement and/or Stranding of Fish and Other Aquatic Organisms during Construction

Temporary diversion of flow and dewatering of the main channel before in-channel construction activities would cause a temporary loss of habitat and displacement or stranding of fish and other aquatic organisms in the dewatered area of the channel. This impact is considered *less than significant* because it would affect only a small portion of the total available habitat and aquatic community. Mobile species and life stages likely would respond to disturbance by moving to available habitat upstream or downstream of the area. Less mobile or sedentary species and life stages (embryos and larvae) are more susceptible to exposure and stranding caused by dewatering. However, no sensitive or critical spawning or early rearing habitat has been identified in the construction area. It is likely that a large portion of the bottom-dwelling invertebrates in the area would die from exposure, but this impact is considered *less than significant* because these invertebrates represent a small fraction of the total invertebrate community and because invertebrates can rapidly recolonize the area after rewatering of the channel. No mitigation is required.

6.4.2 Operation-Related Impacts

Impact 6-5: Mortality, or Disruption of Movements, of Fish Caused by Project Operation

Design of the fish passage facilities (e.g., fish screen, bypass, roughened channels) was based on the needs of Lahontan cutthroat trout. Lahontan cutthroat trout was selected as the target species because recovery of this species partly depends on provision of adequate passage for adults and juveniles in the operation area. Considerable planning, design, and evaluation of the proposed diversion and fish passage facilities has been conducted by the project engineers (McLaughlin Water Engineers, Ltd, et al. 2001, Sierra Pacific Power Company 1999a). Meetings were held in consultation with USFWS and DFG, which helped to review alternative designs and establish biological design criteria. The fish-screening criteria established by DFG were used to guide development of the proposed fish screen and bypass design. The design is based on the needs of the smallest life stages of trout that would potentially encounter the fish screen. Further evaluations of the proposed design are currently underway to refine the fish screen and bypass design. These refinements are expected to lead to a final design that meets the fish-screening criteria and addresses all site-specific conditions that would affect the performance of the fish screen and bypass over the expected range of operating conditions. Entrapment of fish in the flume or inability to pass through the roughened channels is unlikely because of the extensive design work done by fisheries biologists and engineers.

However, because the design has yet to be implemented and tested on-site, unforeseen circumstances may result in conditions that adversely affect the performance of the fish passage facilities and lead to significant impacts on fish, such as fish mortality or disruption of upstream and downstream movements. This impact is considered *significant*.

Implementation of Mitigation Measure 6-2 would reduce this potential impact to a less-than-significant level.

Mitigation Measure 6-2: Prepare and implement a monitoring and evaluation program to ensure long-term fish protection

In order to prevent an increase in fish mortality or disruption of upstream and downstream movements, the project applicant will develop and implement a monitoring and evaluation program. The program will ensure that all fish passage facilities are effectively maintained and operated in conformance with established design criteria and objectives throughout the life of the project. The program will include specific fish protection objectives and descriptions of monitoring and evaluation methods, performance criteria, and protocols for addressing problems and identifying corrective measures as needed. The program will include start-up evaluations and regular monitoring of the project components. Monitoring activities will include regular inspections of the diversion structure, intake structure, diversion conduit, roughened channels, and fish screen and bypass system to identify hydraulic conditions or other hazards (e.g., accumulations of sediment, frazil ice, debris) that could adversely affect performance of these facilities or harm fish during transit. Hydraulic testing will be performed initially and at selected intervals to assess the performance of the fish passage facilities over a representative range of flows and hydraulic conditions. Hydraulic testing will include measurements of approach and sweeping velocities across the face of the fish screen. A draft monitoring and evaluation plan will be prepared in consultation with the regulatory agencies and submitted to the agencies for final approval. In the event that the performance criteria are not met, the project applicant, in consultation with the fisheries agencies, will implement corrective measures and further monitoring to ensure that these measures are effective.

Impact 6-6: Reduction in Physical Habitat Availability in the Operation Area during Operation

Table 6-3 presents the average number of days that the recommended minimum and optimum flows would have been met for key life stages of rainbow and brown trout in representative dry, average, and wet years under existing (no project) and with-project conditions.

Table 6-3. Average Number of Days and Percent Reduction that Minimum Flow Recommendations are Met for 60-, 100-, 150-, 200- and 250-cfs Bypass Flow Scenarios

AVERAGE NUMBER OF DAYS

Dry Years						
Bypass Scenarios	Minimum	Optimum*				
	Year-round	Oct-Jan	Feb-Mar	Apr-Jul	Aug-Sep	Feb-Mar + Aug-Sep
	Juvenile Rainbow Trout Rearing	Brown Trout Spawning	Adult Rainbow Trout Rearing	Rainbow Trout Spawning	Adult Rainbow Trout Rearing	Total Rainbow Trout Rearing
No Project	257	30	50	122	37	87
60 cfs	22	0	0	9	1	1
100 cfs	28	2	0	9	1	2
150 cfs	257	8	1	9	1	3
200 cfs	257	30	26	122	2	28
250 cfs	257	30	50	122	37	87

Average Years						
Bypass Scenarios	Minimum	Optimum*				
	Year-round	Oct-Jan	Feb-Mar	Apr-Jul	Aug-Sep	Feb-Mar + Aug-Sep
	Juvenile Rainbow Trout Rearing	Brown Trout Spawning	Adult Rainbow Trout Rearing	Rainbow Trout Spawning	Adult Rainbow Trout Rearing	Total Rainbow Trout Rearing
No Project	365	123	52	122	61	113
60 cfs	149	28	3	84	20	23
100 cfs	149	28	3	84	20	23
150 cfs	365	29	5	85	20	25
200 cfs	365	123	10	122	20	30
250 cfs	365	123	52	122	61	113

Wet Years						
Bypass Scenarios	Minimum	Optimum*				
	Year-round	Oct-Jan	Feb-Mar	Apr-Jul	Aug-Sep	Feb-Mar + Aug-Sep
	Juvenile Rainbow Trout Rearing	Brown Trout Spawning	Adult Rainbow Trout Rearing	Rainbow Trout Spawning	Adult Rainbow Trout Rearing	Total Rainbow Trout Rearing
No Project	365	123	59	122	61	120
60 cfs	239	43	55	106	20	75
100 cfs	239	43	55	106	20	75
150 cfs	365	43	55	106	20	75
200 cfs	365	123	55	122	20	75
250 cfs	365	123	59	122	61	120

AVERAGE PERCENT REDUCTION

Dry Years						
Bypass Scenario	Minimum	Optimum*				
	Year-round	Oct-Jan	Feb-Mar	Apr-Jul	Aug-Sep	Feb-Mar + Aug-Sep
	Juvenile Rainbow Trout Rearing	Brown Trout Spawning	Adult Rainbow Trout Rearing	Rainbow Trout Spawning	Adult Rainbow Trout Rearing	Adult Rainbow Trout Rearing
No Project	257	30	50	122	37	87
60 cfs	91	99	100	93	97	99
100 cfs	89	92	100	93	97	99
150 cfs	0	74	97	93	96	98
200 cfs	0	0	47	0	96	68
250 cfs	0	0	0	0	0	0

Average Years						
Bypass Scenario	Minimum	Optimum*				
	Year-round	Oct-Jan	Feb-Mar	Apr-Jul	Aug-Sep	Feb-Mar + Aug-Sep
	Juvenile Rainbow Trout Rearing	Brown Trout Spawning	Adult Rainbow Trout Rearing	Rainbow Trout Spawning	Adult Rainbow Trout Rearing	Adult Rainbow Trout Rearing
No Project	365	123	52	122	61	113
60 cfs	59	77	94	31	68	80
100 cfs	59	77	94	31	68	80
150 cfs	0	76	90	31	68	78
200 cfs	0	0	81	0	68	73
250 cfs	0	0	0	0	0	0

Wet Years						
Bypass Scenario	Minimum	Optimum*				
	Year-round	Oct-Jan	Feb-Mar	Apr-Jul	Aug-Sep	Feb-Mar + Aug-Sep
	Juvenile Rainbow Trout Rearing	Brown Trout Spawning	Adult Rainbow Trout Rearing	Rainbow Trout Spawning	Adult Rainbow Trout Rearing	Adult Rainbow Trout Rearing
No Project	365	123	59	122	61	120
60 cfs	35	65	7	13	67	37
100 cfs	35	65	7	13	67	37
150 cfs	0	65	7	13	67	37
200 cfs	0	0	7	0	67	37
250 cfs	0	0	0	0	0	0

* Optimum flows for seasonally based on lifestages and flow are: April – July = Rainbow Trout Spawning (200 cfs); Oct – Jan = Brown Trout Spawning (200 cfs); Feb – Mar = Adult Rainbow Trout Rearing (250 cfs); Aug – Sept = Adult Rainbow Trout Rearing (250 cfs)

Recommended Minimum Flows

Under the No-Project Alternative, the number of days that the minimum flow recommendation (150 cfs, year-round) would be met, averaged 257, 365, and 365 in dry, average, and wet years, respectively. This number would decrease substantially under the 60- and 100-cfs bypass scenarios; the recommended minimum flow would be met on an average of 22–239 days, representing a 35–91% reduction relative to the No-Project Alternative. Under the 150-, 200-, and 250-cfs bypass scenarios, no change would occur in the number of days that the recommended minimum flow (150 cfs, year-round) would be met relative to the No-Project Alternative. Thus, project diversions that maintain minimum bypass flows of 60 and 100 cfs are considered to have a significant impact on juvenile, spawning, and adult life stages of rainbow and brown trout in all water year types.

Recommended Optimum Flows

Depending on water year type, the 60-, 100-, and 150-cfs bypass scenarios would result in small to substantial reductions (13–99%) reductions in the number of days that optimum flows would be met for rainbow trout spawning (200 cfs), rainbow trout adult rearing (250 cfs), and brown trout spawning (200 cfs). A bypass flow requirement of 200 cfs would result in 37–73% reductions in the number of days that the optimum flow would be met for adult rainbow trout rearing (200 cfs) and no change in the number of days that the optimum flow would be met for rainbow and brown trout spawning (250 cfs). A bypass flow requirement of 250 cfs would result in no change in the number of days that optimum flows would be met for rainbow and brown trout spawning and adult rearing.

Although the frequency of optimum flows for rainbow and brown trout spawning and adult rearing would be reduced under the 60-, 100-, 150-, and 200-cfs bypass scenarios, the 150-cfs scenario would continue to meet DFG's primary objective of maximizing juvenile rearing habitat availability (100%) while providing at least 50% of maximum habitat values for spawning and adult life stages. A flow of 150 cfs corresponds to 85–90% of the maximum habitat values for rainbow and brown trout spawning and adult rearing. Thus, project diversions that maintain minimum bypass flows of 150 cfs would have a less-than-significant impact on habitat availability for these life stages. However, the project applicant has proposed a 60-cfs bypass flow, which would have an adverse effect on juvenile, spawning, and adult life stages of rainbow and brown trout in all water year types; therefore, this impact is considered *significant*.

Implementation of Mitigation Measure 6-3 would reduce this impact to a less-than-significant level.

Mitigation Measure 6-3: Maintain a minimum flow of 150 cfs in the operation area at all times during project operation

In order to DFG's minimum flow requirement and maintain sufficient habitat for juvenile, adult, and spawning rainbow trout and spawning brown trout life stages, the project applicant will maintain a minimum flow of 150 cfs in the operation area at all times during project operation. Reducing diversions of water to the powerhouse may be necessary to maintain this level during low-flow periods. Based on DFG's habitat-flow relationships for Reach 1, a year-round minimum flow of 150 cfs would meet the minimum flow recommendation for juvenile trout while maintaining at least 50% of the maximum available habitat for adult and spawning life stages. A flow of 150 cfs corresponds to 100%, 85%, 90%, and 89% of the maximum habitat values for juvenile rainbow trout, adult rainbow trout, spawning rainbow trout, and spawning brown trout, respectively. Higher minimum flows may be necessary in some years and months for water temperature control (see Impact 6-7 and Mitigation Measure 6-4). Mitigation Measure 6-3 would result in restrictions on the project applicant and would reduce their overall power generation as indicated in appendix F.

Impact 6-7: Increases in the Magnitude and Frequency of Sublethal Water Temperatures

Changes in water temperature may affect fish populations through a number of mechanisms that directly or indirectly affect survival, growth, and reproduction. Each species and life stage has a specific temperature tolerance range bounded by upper and lower lethal thresholds, which are defined as the temperatures at which 50% mortality occurs for a given acclimation temperature. Existing knowledge of the effects of water temperature on fish is based largely on laboratory studies of the physiological performance of fish, as measured by growth, food conversion efficiencies, swimming ability, and other physiological parameters. Physiological performance is generally optimal over a relatively narrow range of water temperatures and degenerates as temperatures approach lethal thresholds. Chronic exposure to water temperatures outside the optimum range can lead to reduced survival through sublethal effects, including impaired development and viability of early life stages, reduced feeding and growth, and increased vulnerability to predators, disease, and pollutants. The effects of temperature on free-ranging fish are difficult to assess because of the interactive effects of numerous variables that influence a fish's response to water temperatures under natural conditions (e.g., fish size, temperature acclimation, food availability, genetic variation, water chemistry, predators, disease).

Temperature variations can affect critical life stages of aquatic organisms and change the nature and rate of nutrient and mineral cycles. Elevated water temperatures can have significant consequences for organisms adapted to a cold-water environment. A rise in water temperature of only a few degrees Celsius over ambient conditions can reduce the number of, or eliminate, sensitive

insects, such as stoneflies and mayflies, and fish such as trout. In general, sustained summertime water temperatures in excess of 21°C (70°F) are considered to be stressful, and perhaps lethal, to many cold-water organisms.

A water quality model was used to assess water temperature effects of the proposed project, as described in chapter 4, “Water Quality.” The results of these simulations (figure 4-1) show that the effect of the diversion on average water temperature at the downstream end of the diversion reach is minimal. The average water temperature just upstream of the Farad power plant was 17.6°C (63.7°F) with the 60-cfs scenario and 17.5°C (63.5°F) with the 485-cfs scenario. The diversion has a larger (but still small) effect on maximum water temperatures, with a 0.6°C increase between the 485-cfs and 60-cfs scenarios. Maximum water temperatures are affected more by the diversion because the reduction in flow causes a reduction in channel depth, which causes an increase in the diurnal temperature range (water temperature fluctuates more in shallow water). Temperatures downstream of the diversion are essentially unaffected by the diversion because the water returning through the Farad power plant restores the temperature to values similar to those expected without the diversion.

Whether a water temperature threshold would be crossed as a result of diversion is dependent on the temperature of the water entering the diversion reach. This temperature is variable and is dependent on the ratio of the coldwater to warmwater sources for the Truckee River (appendix C) and meteorological conditions. Even when water temperature is close to the maximum allowable temperature for streams designated as cold in the Basin Plan, 19°C (66°F), the diversion is unlikely to cause average temperatures to exceed 19°C because the expected increase in average temperature of 0.1°C is so small.

Based on simulated temperature increases, potential temperature effects in the diversion reach would meet Basin Plan standards for protection of fish and would not substantially reduce fish habitat. Therefore, this impact is considered *less than significant*.

Implementation of Mitigation Measure 6-4 would ensure that this impact is less than significant.

Mitigation Measure 6-4: Verify water temperature effects of the project and implement mitigation measures if warranted

The project applicant will monitor water temperatures during a minimum of the first 2 summers of diversion operation to verify that the modeled temperature effects are correct. If the model is accurate and indicates mean daily temperatures do not increase by more than 0.5°C, no additional mitigation will be required. If temperature increases exceed 0.5°C, the project applicant will determine, in cooperation with the regulatory agencies, the need for a water temperature management plan or other remedial measures. If warranted, the

project applicant will develop such a plan, which would describe conditions under which potentially stressful water temperatures occur in the operation area, whether and to what extent the project contributes to these conditions, and criteria that would trigger operational changes to minimize project impacts. The project applicant would implement the water temperature management plan and/or other remedial measures.

Impact 6-8: Stranding of Fish and Invertebrates as a Result of Flow Fluctuations during Project Operation

Flow fluctuations in regulated streams are generally more rapid than those in natural systems. Abrupt flow changes may adversely affect fish and aquatic invertebrates (Cushman 1985, Minshall and Winger 1968, Erman 1996). Rapid flow fluctuations in regulated streams may force fish to move from preferred habitats or become isolated or stranded in areas where they become vulnerable to predation, poor water quality, and desiccation (Higgins and Bradford 1996). The early life stages of fish (eggs and fry) are particularly vulnerable because of their inability or limited ability to respond to rapid flow changes. Fluctuating flows can also reduce populations of aquatic invertebrates by direct exposure or by stimulating them to drift downstream (Minshall and Winger 1968).

Project-related flow fluctuations include those caused by seasonal and daily variations in flows as a result of normal operations, maintenance, and bypass flow requirements (e.g., recreation flows). Because these fluctuations could potentially strand fish and invertebrates, this impact is considered **significant**.

Implementation of Mitigation Measure 6-5 would reduce this impact to a less-than-significant level.

Mitigation Measure 6-5: Limit the magnitude and rate of flow fluctuations that are under control of the operator

DFG recommended the following general restrictions on flow fluctuations for the Truckee River basin to prevent stranding and isolation of salmonid eggs, fry, and juveniles. These recommendations are expected to reduce potential adverse effects of flow fluctuations on fish and aquatic invertebrates to less-than-significant levels.

- *Flows will not be increased more than 100% during a 24-hour period;*
- *Flows will not be decreased more than 50% during a 24-hour period;*
- *Flow change during a 24-hour period will occur in a minimum of 3 proportional amounts (i.e., 1/3 the total 24-hour change per 8 hours).*

These recommendations generally apply to controlled conditions (i.e., nonflood or nonspill conditions) when flows are equal to or less than twice the optimum flow for the species and life stage of concern.

The potential impact of flow fluctuations on fish and invertebrates in a given river or reach is related to a number of factors, including the timing, magnitude, and rate of flow reductions; the presence and abundance of sensitive species and life stages; and channel and floodplain characteristics (Hunter 1990).

Therefore, the applicability of DFG's recommendations to the project reach is unknown. To evaluate the potential effect of flow fluctuations as a result of weekend recreation operations and normal project operations on the aquatic resources in the project area, the California Stream Bio-assessment Protocol will be conducted over a period of years to be decided by the State Water Resources Control Board. Invertebrate sampling will occur above and below the diversion dam. If project effects were to be detected, flow requirements that were adapted will be reevaluated and revised to minimize impacts.