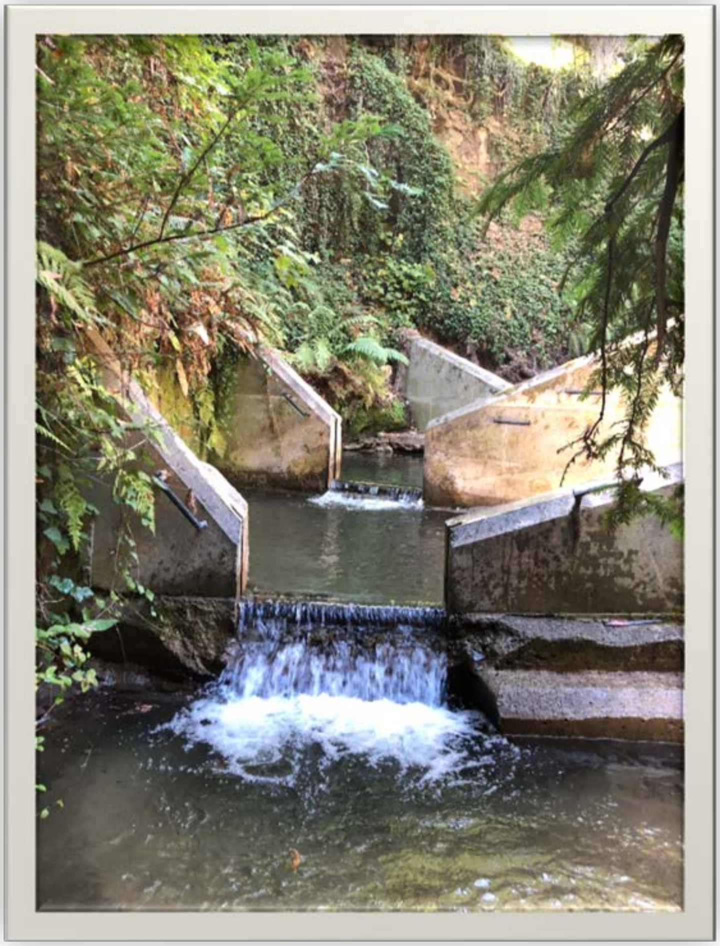
Fisheries Resource Considerations for the San Lorenzo River Watershed Conjunctive Use Plan *(Revised Final)*



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Acronyms and Abbreviations

°C	degrees Celsius
af	acre-feet
afy	acre-feet per year
ASR	aquifer storage and recovery
Balance	Balance Hydrologics, Inc.
CDFG	California Department of Fish and Game (now CDFW)
CDFW	California Department of Fish and Wildlife (formerly CDFG)
cfs	cubic feet per second
DWA	D.W. Alley & Associates
ft	feet
ft msl	feet above mean sea level
gpm	gallons per minute
in-lieu recharge	practice of providing surplus surface water to historical ground-water users, thereby leaving groundwater in storage for later use
mm	millimeters
MHA	Mount Hermon Association
NMFS	National Marine Fisheries Service
PHABSIM	Physical Habitat Simulation
sq. mi.	square miles
SLRBT	San Lorenzo River at Big Trees (USGS gauging station)
SLVWD	San Lorenzo Valley Water District
SMGB	Santa Margarita Groundwater Basin
sq. mi.	square miles
SVWD	Scotts Valley Water District
USGS	U.S. Geological Survey
WAA	Water Availability Analysis (Exponent 2019)
WY	water year (i.e., October 1 through September 30)

CHAPTER 1
Introduction

1.1 Background

The San Lorenzo Valley Water District (SLVWD or District) and County of Santa Cruz (County) are jointly developing the *San Lorenzo River Watershed Conjunctive Use Plan* to identify opportunities for improving the reliability of surface and ground water supplies for the District through conjunctively managing its water supplies while also increasing stream baseflows for fish in the San Lorenzo River watershed. The District serves 22,000 customers with water sourced from eight currently active stream diversions on tributaries to the San Lorenzo River, one groundwater spring, and eight active groundwater wells within the Santa Margarita Groundwater Basin (SMGB). The District's operations are comprised of three largely independent water systems: (1) the North System located in the San Lorenzo Valley, (2) the South System located in the Scotts Valley area, and (3) the Felton System located in Felton (formerly the Citizens Utilities Company of California Service Area) (Figure 1-1). Theoretically, interconnection of these independent systems has the potential to provide the District with greater flexibility to move water supplies between the systems by utilizing surplus surface water to augment ground water supplies during winter and spring, and conversely, increasing reliance on groundwater sources during the low surface seasons of summer and fall, thereby enhancing habitat quality and quantity for the steelhead (*Oncorhynchus mykiss*) and coho salmon (*O. kisutch*) populations of the San Lorenzo River watershed during times when low baseflows limit fish growth and survival.

Through recent grant funding, the District has already developed some of the needed infrastructure, such as pipeline interties, to implement conjunctive use. In support of the conjunctive use plan development, the District analyzed existing water sources and demands to identify the timing and amount of surface water and groundwater that could be made available for transfer under various conjunctive use scenarios, and what the resulting effects of such transfers would be on downstream flows and groundwater storage. The *Water Availability Assessment for San Lorenzo River Watershed Conjunctive Use Plan* (WAA) prepared by Exponent (2019) analyzes a total of 22 conjunctive use scenarios that fall into four broad categories: (1) Optimizing the use of current sources of water under existing and modified conditions; (2) importing water from Loch Lomond; (3) development and operation of an Aquifer Storage and Recovery (ASR) project in the Olympia subarea of the SMGB; and (4) contributing to Scotts Valley area in-lieu recharge.

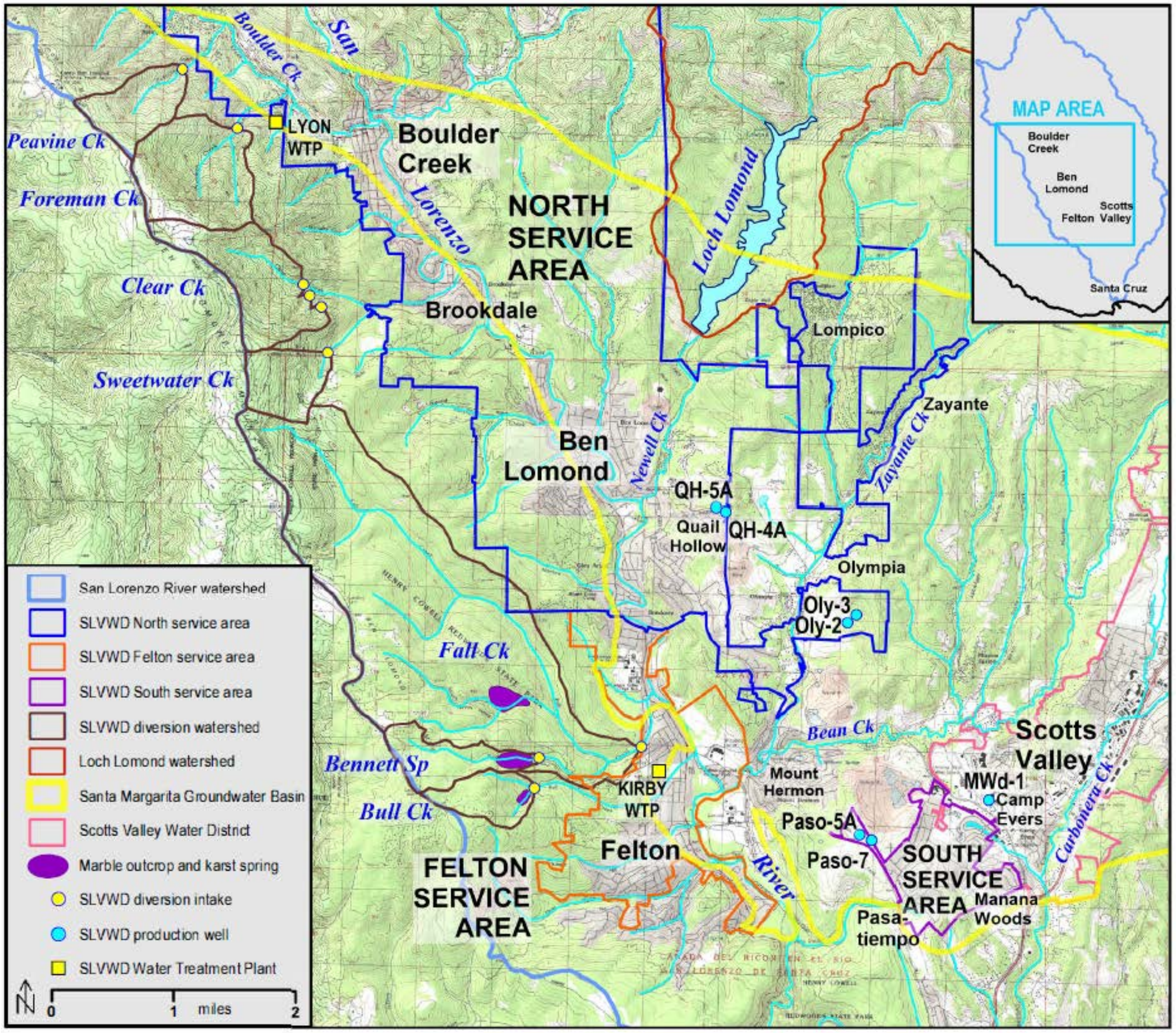

Figure 1-1
SLVWD Service Areas, Diversion Watersheds, Points of Diversion, Treatment Plants, and Production Wells

SOURCE: Exponent (2019)

The WAA defines the following four objectives for the Conjunctive Use Plan:

- Optimizing the conjunctive use of available water resources for water-supply reliability and long-term sustainability;
- Reducing Felton diversions to comply with low-flow and dry-period water rights restrictions;
- Reducing the effect of North system stream diversions and groundwater pumping on dry-period streamflows;
- Reducing groundwater pumping (e.g., by in-lieu recharge) to promote the recovery of groundwater storage and production in the South system and other portions of Scotts Valley.

In accordance with these objectives, the conjunctive use scenarios identified and analyzed in the WAA are focused primarily on water supply reliability and sustainability, with particular emphasis on groundwater sustainability. Based on the results of the WAA, SLVWD has selected three conjunctive use scenarios for moving forward toward implementation.

While potential indirect benefits to the fisheries resources of the San Lorenzo River watershed (e.g., increased drought baseflow levels in streams currently affected by groundwater pumping) are presented in the WAA, the conjunctive use scenarios were not developed or analyzed with a specific goal of maximizing benefits to fisheries. Exponent (2019) summarize the findings of the WAA as follows:

> "In summary, system interties combined with potential supplemental water supplies provide SLVWD with significant options and flexibility for increasing conjunctive use and improving stream baseflows. The results provide qualitative indications of the potential relative magnitude and effects of the various conjunctive use alternatives. Further application of this work and the development of conjunctive use alternatives are expected to occur in the context of in-stream flow objectives proposed by fishery biologists, in addition to cost, feasibility, and water rights considerations."

The purpose of this conjunctive use fisheries resources considerations assessment is to (1) evaluate and summarize the expected effects to fisheries resources of the three conjunctive use projects identified by SLVWD for advancing; (2) evaluate and summarize conjunctive use scenarios presented in the WAA that would be expected to maximize fisheries benefits; and (3) recommend a combination of scenarios that, if implemented together over time, would promote watershed-wide improvements to instream flows.

1.2 Approach to Analysis

For the past two decades, SLVWD, the County, and other stakeholders have funded an extensive steelhead monitoring program in the San Lorenzo River watershed conducted by D.W. Alley &

Associates (DWA). The annual reports prepared for this monitoring program, as well as the *San Lorenzo River Enhancement Plan* (Alley et al. 2009), provide a wealth of information regarding salmonid habitat quality, population trends, and observations of potential limiting factors such as low flows, passage barriers, and sources of disturbance. For some streams in the watershed, available fisheries population and utilization data are limited. In these cases, the current version of the National Marine Fisheries Service (NMFS) Intrinsic Potential (IP) model for salmonid species (NMFS 2016) was reviewed to determine potential availability of steelhead and coho salmon habitat. The IP model describes the potential for a stream reach to exhibit habitat characteristics suitable for an anadromous salmonid species as a function of the geomorphologic and hydrologic characteristics of the landscape and provides an index (0.01 to 1.00) of the relative likelihood of suitable habitat occurring under pristine conditions. It should be noted, however, that IP data are sometimes misinterpreted as representing a rating of habitat *quality*, suggesting that a rating of “low”, for example, indicates that steelhead habitat of low quality is present within the reach. That is not the case. As described in the underlying documentation for the IP model (Agrawal et al. 2005), NMFS “used the IP modeling framework to estimate the likelihood—strictly speaking, the relative likelihood—that a stream reach will exhibit suitable habitat for juveniles of a particular species” and warns that the “IP models estimate neither the actual, fine-scale distribution of habitat within a basin nor the quality of habitat in a given reach under current or historical conditions.”

In addition to annual fish monitoring reports, DWA have prepared a number of stand-alone assessments such as focused water temperature evaluations and fish passage flow assessments. Moreover, the District’s watershed management plan (SLVWD 2009) provides a valuable overview of current water operations, infrastructure, and natural resources, while hydrologic assessment and monitoring work conducted by Balance Hydrologics (Balance) and others provide important baseline streamflow information for the District’s water supply system. A thorough review of the available sources of existing data provided the foundation for a synthesis of existing fisheries resource conditions in drainages affected by SLVWD surface water diversions and groundwater extractions (Chapter 2).

The existing effects of SLVWD’s diversions on fish and aquatic habitat were analyzed based on data provided by Balance and DWA, as well as preliminary instream flow needs estimates developed for comparative purposes. The methods used for the analysis, as well as its results, are presented in Chapter 3.

The results of the WAA of 22 conjunctive use scenarios (Exponent 2019) were reviewed and evaluated for potential effects on fisheries resources in the context of existing diversion effects (Chapter 4). In particular, three scenarios selected by SLVWD for further consideration were evaluated for their expected relative benefits to fisheries habitat. Furthermore, an additional scenario aimed at maximizing fisheries benefits of conjunctive use, based largely on a modified version of one of the WAA-analyzed scenarios, is presented and analyzed for consideration.

Chapter 5 provides a summary of the conclusions of this analysis and outlines a recommendation for a conjunctive use approach.

Similar to the approach used in the WAA, the results of this analysis of fisheries resource considerations for the *San Lorenzo River Watershed Conjunctive Use Plan* are suitable for a planning-level evaluation of conjunctive use alternatives. Due to the limited precision of the synthesized monthly records of water supply (Exponent 2019), the results should not be used to evaluate compliance with specific regulatory, water-right, or habitat requirements. Instead, this comparative analysis is intended to identify the relative fisheries benefits of individual conjunctive use scenarios and to narrow down the selection of potential projects to move forward in the planning process.

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CHAPTER 2
Existing Conditions

2.1 Watershed Overview

The following overview of the San Lorenzo River watershed is based, in large part, on the thorough descriptions presented in the *San Lorenzo River Salmonid Enhancement Plan* (Alley et al. 2004) and the District's Watershed Management Plan (SLVWD 2009).

The San Lorenzo River drains a 138 square mile (sq. mi.) watershed located in northern Santa Cruz County (Figure 2-1). It consists of a 25-mile long mainstem and 9 principle tributaries that include Branciforte, Carbonera, Zayante, Bean, Fall, Newell, Bear, Boulder, and Kings creeks. Much of the watershed is forested with pockets of urban areas (e.g., Santa Cruz, Scotts Valley, Felton, Ben Lomond, and Boulder Creek) and an increasing proportion of rural residential developments. Paved and unpaved roads occur in stream corridors, providing access to the small mountain communities and towns that occur throughout the San Lorenzo Valley (e.g., Felton, Ben Lomond, Brookdale, Boulder Creek, Lompico, Zayante, and Mt. Hermon).

Elevations in the watershed range from the 3,214 feet at the summit of Castle Rock Peak, down to sea level at the mouth of the river in the City of Santa Cruz. With its headwaters at an elevation of approximately 2,900 feet, the San Lorenzo River drops 2,000 feet in the first 3 miles. Small, steep tributaries feed the river from the west at Ben Lomond Mountain, while wider, more gently sloping tributaries feed the river from the east and northeast.

Annual rainfall varies between 15 inches to more than 100 inches throughout the watershed, depending upon location and year (SLVWD 2009). Ben Lomond Mountain, source of the SLVWD's surface water, averages near the high end of the range. Rainfall averages approximately 46 inches per year in the watershed upstream of Felton, but less than that in the remainder of the watershed. Coastal fog is an important part of the summer climate, creeping into inland valleys at night and in mornings. Average daily temperatures vary throughout the watershed and by season, generally ranging from 30°F and 90°F.

2.2 Fisheries Resources

The San Lorenzo River and its estuary are inhabited by at least 25 different species of native fish (DWA 2009). These include salmonids such as central California coast (CCC) steelhead and historically CCC coho salmon. These species are anadromous fish that occupy freshwater streams and rivers as juveniles, migrate to the ocean to grow and mature, and then return to spawn in their natal freshwater streams. Both of these species are afforded protections under the federal

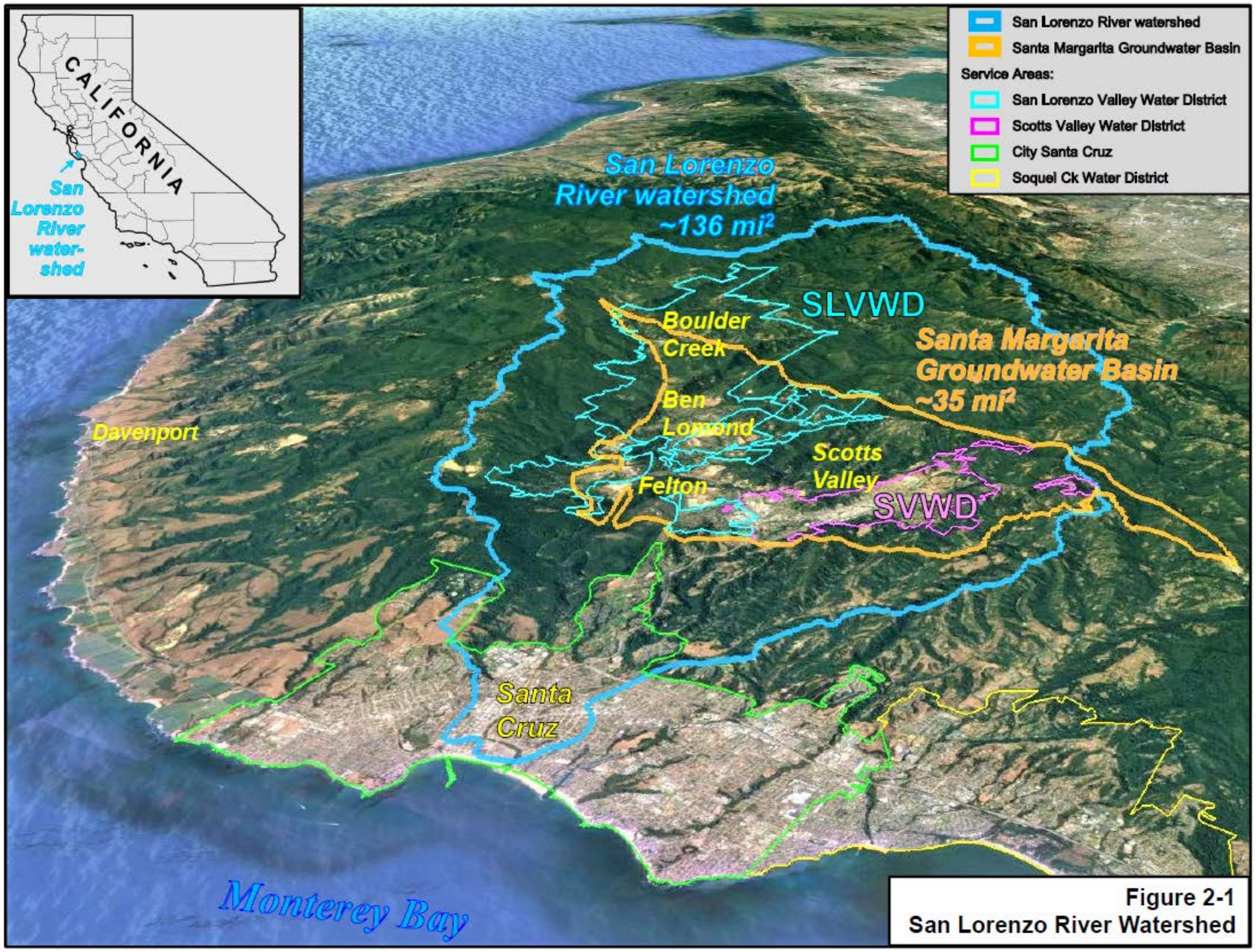

Figure 2-1
San Lorenzo River Watershed

SOURCE: Exponent (2019)

Endangered Species Act and are the primary focus of this conjunctive use plan assessment. While other native species are also important for a diverse and balanced aquatic ecosystem, steelhead and coho salmon are generally considered keystone species, and ecological management practices aimed at benefitting these salmonids are generally accepted to provide suitable conditions for other native fish species that have coevolved with steelhead and coho salmon. This assessment has been prepared to provide relevant fisheries considerations for the development of the San Lorenzo River Watershed Conjunctive Use Plan. A general understanding of the life history cycle and habitat requirements of steelhead and coho salmon has been assumed for purposes of this report, with the focus of this assessment placed on information relevant to enhancing instream flow conditions. For a thorough discussion of the life history cycle and habitat requirements of salmonids and other native fish in the San Lorenzo River, the reader is referred to DWA (2009).

SLVWD does not operate water diversion facilities directly on the mainstem San Lorenzo River, but all of its existing surface and groundwater supply facilities are located within drainages tributary to the mainstem. Past and current salmonid population trends in the San Lorenzo River are the subject of an extensive long-term monitoring program and have been summarized in numerous reports (e.g., Alley et al. 2004; DWA 2009; DWA 2017a) and an online database (County of Santa Cruz 2019). While salmonid population densities fluctuate from year to year and overall trends are difficult to define conclusively in the absence of unbiased estimates of spatial structure based on stratified-random sampling and annual estimates of adult recruitment and spawning success, general estimates of population and habitat utilization trends are available. The following overview of existing salmonid habitat conditions and utilization in the mainstem San Lorenzo River is based largely on the thorough discussion provided by DWA (2009) in SLVWD’s Watershed Management Plan (SLVWD 2009).

The upper San Lorenzo River mainstem (i.e., upstream of the Boulder Creek confluence) has relatively low but cool spring and summer baseflow. Juvenile steelhead growth is generally slow in this well-shaded reach, but relatively high densities of yearlings are thought to contribute a significant portion of adult steelhead returns to the watershed. Immediately upstream of Boulder Creek, the mainstem river channel has a low gradient, steep canyon walls with tall redwoods, and is dominated by long, sediment-laden pools separated by short, shallow riffles. As stream gradient increases further upstream, pools become shorter and habitat variety increases. Limiting factors to salmonids in the upper mainstem include low spring and summer streamflow and sedimentation from erosion.

The middle mainstem extends from the Boulder Creek confluence downstream to the Zayante Creek confluence. This reach has higher annual streamflow than the upper mainstem and a wider, more open canyon. Water temperatures are warmer in the middle mainstem than in the upper mainstem, and juvenile steelhead tend to occupy fastwater habitat at riffles, runs and heads of pools where food (aquatic insect) production is higher. The majority of the middle mainstem is dominated by long, deep pools containing lower food supplies. Spawning habitat availability is considered limited and juvenile steelhead densities are generally low (DWA 2017a).

The lower mainstem San Lorenzo River below the confluence of Zayante Creek has much greater spring and summer baseflow than upstream reaches, providing higher food availability even during summer baseflow conditions. Based on limited scale analyses, steelhead growth rates in this reach appear to be high enough to allow many juveniles to reach smolt size after one growing season. The lower mainstem was estimated to be a major contributor to adult returns. Spawning habitat is poor due to high sand content in spawning glides, and most juveniles rearing in this reach likely originate in the upstream tributaries.

San Lorenzo River estuary is located in the center of the City of Santa Cruz, discharging to the Monterey Bay at Main Beach and the Santa Cruz Beach Boardwalk. The historic San Lorenzo River lagoon surface area has been reduced by over 80% as a result of road and railroad crossings, extensive floodplain development, and flood control levee construction and maintenance, thereby dramatically simplifying the morphologic complexity of the lagoon (2NDNATURE 2006). The necessity of flood control has eliminated the adjacent low-lying marsh habitat that would typically be inundated during winter runoff and summer lagoon conditions. The lagoon area downstream of Riverside Drive is extremely exposed, devoid of any vegetation and its substrate is homogenous beach sand. Annual vegetation management in the active channel is conducted each fall to maintain flood capacity. Nevertheless, the San Lorenzo River lagoon supports seasonal juvenile steelhead rearing as well as a population of tidewater gobies (*Eucyclogobius newberryi*), a federal endangered species. Sandbar-formed lagoons such as the San Lorenzo River lagoon may provide highly productive rearing habitat in which juvenile steelhead grow fast enough during their first year of lagoon rearing to migrate to the ocean, and most enter the ocean at a larger size than the same year class fish rearing in freshwater habitats of the stream system (Bond et al. 2008). Larger size greatly improves survival in the ocean, and the lagoon-reared fish represented a large majority of the returning adult spawning population (Bond et al. 2008). Juvenile steelhead population estimates for the San Lorenzo River lagoon vary seasonally and annually, but high growth rates are regularly documented (e.g., HES 2017).

2.3 Existing Conditions

2.3.1 Surface Water Resources

North System

The surface water components of SLVWD's North System consist of diversions located on the eastern slope of Ben Lomond Mountain from Boulder Creek to Brookdale, with multiple diversion boxes that feed into a gravity pipeline (Five-Mile Pipeline) and ultimately to the Lyon Treatment Plant in Boulder Creek. SLVWD's North System includes surface water diversions on Peavine Creek and Foreman Creek (tributaries to Boulder Creek), Clear Creek (tributary to the mainstem San Lorenzo River), and Sweetwater Creek (tributary to Clear Creek). Historically, SLVWD also diverted approximately 10 acre-feet per year (afy) from Silver Creek, a small drainage tributary to Boulder Creek. However, this diversion has been inactive for the past 10 years, and SLVWD has no plans to reactivate it in the near future (Balance 2019).

SLVWD has pre-1914 appropriative rights to divert water from Peavine, Foreman, Clear, and Sweetwater creeks, which generally enable it to supply water from these streams to its North System without restriction. SLVWD has an agreement with a downstream water user to allow 30 gallons per minute (gpm) to bypass its Clear Creek diversion at all times.

Peavine Creek

Peavine Creek is a tributary to Boulder Creek northwest of the community of Boulder Creek and has a total drainage area of 285 acres (0.45 square mile). SLVWD diverts from an intake at elevation 1,264 feet above mean sea level (msl). The mapped length of Peavine Creek upstream of the diversion is approximately 3,100 feet, and the drainage area above the diversion is approximately 230 acres (0.36 square mile). No information regarding the fisheries resources of Peavine Creek appear to be available. NMFS (2016) rates the lowermost 0.4 miles of Peavine Creek as having a low intrinsic potential for exhibiting habitat characteristics suitable for juvenile steelhead, as a function of the geomorphologic and hydrologic characteristics of the landscape. However, the majority of this stream, including the reach containing SLVWD's diversion site, is located in the steep terrain typical of the eastern slopes of Ben Lomond Mountain and does not have an intrinsic potential to support steelhead. NMFS (2016) rates the entire Peavine Creek drainage as not intrinsically suitable for juvenile coho salmon. Balance (2018a) note that the Brook Lane crossing of Peavine Creek near its confluence with Boulder Creek presents a 12-ft vertical drop. This feature presents a significant impediment to fish movement into this tributary. Based on the available information, Peavine Creek is not considered to have anadromous salmonid value for the purpose of this assessment.

Foreman Creek

Foreman Creek consists of about 1.3 stream miles and is tributary to Boulder Creek. It drains a watershed area of approximately 580 acres (0.9 sq. mi.). SLVWD diverts from an intake at elevation of 927 feet msl. The mainstem Foreman Creek channel above the intake is approximately 3,800 ft. long and an additional eastern branch located upstream of the diversion consists of approximately 3,000 ft of channel. In total, the drainage area above the diversion is approximately 480 acres (0.75 square miles). Baseflows in Foreman Creek may be augmented by groundwater recharged within a roughly 120-acre area immediately west of the watershed divide along the crest of Ben Lomond Mountain (SLVWD 2009).

Resident rainbow trout (the non-anadromous form of *O. mykiss*) or steelhead were noted in Foreman Creek during a 1959 survey of stream condition by the California Department of Fish and Game (CDFG, now the California Department of Fish and Wildlife [CDFW]) staff. In a 1996 memo concerning habitat limitations in central coast streams, CDFG staff noted that water diversions reduce flows sufficiently to impact Foreman Creek, particularly during summer when low flow occurs naturally (Becker and Reining 2008). However, a steelhead and coho salmon distribution map produced by the County based on information from CDFW and local fishery biologists indicates that Foreman Creek is not utilized by salmonids "due to channel steepness and/or lack of suitable habitat" (County of Santa Cruz 2004). NMFS (2016) rate the lowermost 0.3 miles of Foreman Creek as having a moderate intrinsic potential to exhibit habitat characteristics suitable for juvenile steelhead. Similar to Peavine Creek, the remainder of Foreman Creek, including the reach containing SLVWD's diversion site, has excessively steep gradients and is not rated as having an intrinsic potential to support steelhead. NMFS (2016) rates the entire Foreman Creek drainage as intrinsically unsuitable for juvenile coho salmon. Based on the available information, Foreman Creek is not considered to have anadromous salmonid value for the purpose of this assessment.

Boulder Creek

SLWVD does not have any water diversion facilities on Boulder Creek, but as described above, Peavine and Foreman Creeks are tributaries to Boulder Creek, and therefore SLVWD's diversions from these two subbasins have the potential to affect Boulder Creek streamflows and fish habitat. Boulder Creek is the uppermost tributary to the middle mainstem San Lorenzo River, as defined in the *San Lorenzo River Salmonid Enhancement Plan* (Alley et al. 2004).

DWA (2009) describe Boulder Creek downstream of the Hare Creek confluence as flowing through a heavily shaded canyon with steep, near-vertical walls and a streambed dominated by large granitic cobbles and boulders in turbulent riffles and runs. Relatively deep pools are present but contain virtually no instream fish refuge except from depth and large, unembedded boulders. High winter water velocities within the confined channel tend to wash out large wood and likely also flush out overwintering juvenile steelhead more easily than in other tributaries. Spawning-sized gravels and small cobbles are limited, and steep boulder riffles may impede adult passage at lower flows. Summer water temperatures in Boulder Creek are among the coolest in the San Lorenzo River watershed. Juvenile steelhead growth is relatively slow in Boulder Creek and low spring and summer baseflows may limit steelhead populations. (DWA 2009)

DWA have sampled fish populations at two sites on Boulder Creek annually since 1997; one site (17a) is located near Boulder Creek's confluence with the mainstem San Lorenzo River and downstream of both the Peavine and Foreman creeks confluences; the other site (17b) is located downstream of the Bracken Brae Creek confluence and upstream of the Peavine and Foreman creeks confluences. Based on data from 1997 through 2018 (County of Santa Cruz 2019), the average total density of juvenile steelhead at the two sampling sites have been fairly similar. At the downstream site (17a), population densities have ranged from a low of 8.1 fish/100 feet of channel to a high of 142.9 fish/100 ft, with an average of 47.8 (± 37.4) fish/100 ft. At the upstream site (17b), the range of total juvenile densities has been narrower at 26.0 to 108.7 fish/100 ft for an average of 60.3 (± 25.1) fish/100 ft. During most years, total juvenile steelhead densities are somewhat higher at the upstream site (i.e., outside the influence of SLVWD's diversions) than the downstream site (i.e., within the influence of the diversions), but considering the temporal variability in site-specific habitat conditions (County of Santa Cruz 2019) and the large standard deviations in the population estimates, it is difficult to correlate variations in population densities to the effects of water diversions. Nevertheless, the hydrologic effects of SLVWD diversions on Boulder Creek are not insignificant (see below) and it is reasonable to assume juvenile steelhead rearing habitat in Boulder Creek would benefit from increased summer flows.

Clear Creek (including Sweetwater Creek)

Clear Creek is a tributary to the middle mainstem San Lorenzo River near Brookdale and drains a watershed area of approximately 1,050 acres (1.64 sq. mi.). SLVWD operates three separate water intakes on Clear Creek; one on the mainstem and two on unnamed tributaries. Water intakes range in elevation from 1,330 to 1,358 feet msl. Clear Creek diversions were moved upstream in 1995 to allow gravity conveyance to the District's new treatment plant. The mapped length of Clear Creek upstream of the main-stem diversion is approximately 3,800 feet, and the drainage area above the diversions is approximately 435 acres (0.68 sq. mi.). Baseflows may be augmented by groundwater recharge within a roughly 300-acre area immediately west of the watershed divide along the crest of Ben Lomond Mountain (SLVWD 2009).

SLVWD also operates a diversion on Sweetwater Creek, a tributary to Clear Creek accounting for approximately 30 percent (335 acres) of the total Clear Creek watershed upstream of its San Lorenzo River confluence. The Sweetwater Creek diversion was also moved upstream in 1995 and is now located at elevation 1,330 feet msl. The drainage area upstream of the Sweetwater Creek diversion is approximately 660 acres (1.03 sq. mi.) and the mapped length of upstream channel is approximately 1,300 feet.

When surveyed by the CDFG in January 1957, Clear Creek was described as unimportant for steelhead because a permanent bedrock barrier at the mouth precluded upstream migration of adult spawners (Titus et al. 2010). No fish were observed in the creek, despite plantings of hatchery reared resident rainbow trout in 1945 and 1947, nor were any fish seen in the lower stream in October 1959 (Titus et al. 2010). During a fish passage barrier survey in mid-May 1980, three resident rainbow trout were observed in lower Clear Creek, but the creek mouth still contained a complete migration barrier, and other barriers were identified upstream (Titus et al. 2010). However, DWA (2002) note that Clear Creek is "known to contain steelhead from past sampling and observation", but no recent information on steelhead presence or abundance appears to be available. A 1996 CDFG memorandum notes that water diversions reduce flows sufficiently to impact Clear Creek, particularly during summer when low flow occurs naturally (Becker and Reining 2008). A county-wide stream crossing inventory and fish passage evaluation concluded that the Clear Creek Road crossing of Clear Creek is fully passable to fish, but that another crossing immediately downstream of Clear Creek Rd "appears very undersized and is probably a barrier" (Ross Taylor & Associates 2004). The report furthermore ranks Clear Creek a low priority stream for fish passage enhancement, in part due to its "limited length of poor-quality habitat" (Ross Taylor & Associates 2004). NMFS (2016) rate approximately 1.4 miles of Clear Creek and approximately 0.1 mile of Sweetwater Creek as having a moderate intrinsic potential to support habitat characteristics suitable for juvenile steelhead rearing, but no intrinsic potential to support coho salmon. Based on the available information, Clear Creek is considered to have limited anadromous salmonid value for the purpose of this assessment.

Felton System

SLVWD's Felton System relies entirely on surface water diversions from Fall and Bull creeks, tributaries to the middle San Lorenzo River, and Bennett Spring and Creek, tributary to Fall Creek. SLVWD diverts from Fall Creek via a diversion gallery installed in the stream bed which is backwatered by a v-notch weir fitted with a fish ladder. Water is pumped by pipeline to the nearby Kirby treatment plant in Felton. The Bull and Bennett Creek intakes are primarily spring-fed diversions that are combined into a single diversion line to Kirby treatment plant. The Felton System diversions are operated under a permitted appropriative right limited to a combined total diversion rate of 1.7 cubic feet per second (cfs) and a total annual diversion volume of 1,059 afy. The permitted right includes bypass flow requirements on Fall Creek, defined separately for dry and non-dry years, and diversions are not permitted from any Felton source during defined low-flow conditions in the San Lorenzo River. Dry-year and low-flow conditions are defined in terms of the gauged flow of the San Lorenzo River at Big Trees (SLRBT) USGS gage.

The water rights permit defines Fall Creek bypass flows as follow:

Dry years:	0.75 cfs during November 1–March 31
	0.50 cfs during April 1–October 31
Other years:	1.5 cfs during November 1–Mar 31
	1.0 cfs during April 1–October 31

Dry years are defined as water years in which cumulative flows at SLRBT are less than the following amounts:

October:	< 500 af
October–November:	< 1,500 af
October–December:	< 5,000 af
October–January:	< 12,500 af
October–February:	< 26,500 af

Diversions are not permitted from any of the Felton system sources during low-flow conditions when SLRBT flows are less than the following rates:

September:	10 cfs
October:	25 cfs
November–May:	20 cfs

Fall Creek (including Bennett Spring)

Fall Creek is a tributary to the middle mainstem San Lorenzo River in Felton and drains a watershed area of approximately 3,155 acres (4.93 sq. mi.). SLVWD's water intake is located at an elevation of 350 msl, approximately 0.5 miles upstream of the San Lorenzo River confluence. The watershed area upstream of the intake is 2,770 acres (4.33 sq. mi.) and includes the 285-acre (0.45 sq. mi.) Bennett Spring subbasin. Approximately 5.5 miles of mapped steam channel are located upstream of the diversion. The Bennet Springs intakes are located at elevations of 800-900 ft msl, and the watershed area above the intakes is approximately 225 acres (0.35 sq. mi.).

Fall Creek is known to support steelhead. Juvenile coho salmon were observed in Fall Creek in 1981 (DWA 2009) but have not been detected there since (DWA 2017a). Based on a summary description by DWA (2009), Fall Creek is one of the most shaded and coolest tributaries in the San Lorenzo River watershed. For example, from June 10 through September 30, 2016, the maximum weekly average water temperatures (MWAT) in Fall Creek remained below 15.5°C near its confluence with the San Lorenzo River, and below 16.0°C immediately above SLVWD's diversion weir (DWA 2017b). Even though much of the creek is within Henry Cowell Park, it is subject to large sediment inputs from steep hillslopes prone to landslides. The landscape is apparently still recovering from past clear-cut logging and limekiln operations. Stream gradient is moderate to steep and the channel is dominated by shallow, fast riffles with relatively few pools.

DWA (2015) conducted habitat typing on Fall Creek upstream and downstream of the SLVWD intake. The 0.5-mile reach immediately downstream of the diversion (Reach 15a) consists of a moderate-gradient (3 percent), entrenched, narrow and heavily shaded channel reach dominated by shallow riffle habitat with limited pool habitat for rearing yearling steelhead or coho salmon. Riffles account for 50 percent of habitat units, while pools account for only 25 percent of available habitat within the reach. Pools are generally shallow with mean and maximum depths of less than one foot (DWA 2015). Upstream of the diversion, DWA (2015) found similar habitat conditions. While the upper survey reach (Reach 15b) is less confined, riffles account for an even higher percentage (61 percent) of habitat, with pools accounting for 24 percent. Juvenile steelhead growth is very slow in Fall Creek despite relatively high summer baseflows, and steelhead are limited by poor pool development, a highly sedimented streambed, and heavy shading (DWA 2009). SLVWD is currently in the process of upgrading the fish ladder to ensure it provides fully passable conditions for both adult and juvenile salmonids.

DWA have sampled juvenile salmonid populations in Fall Creek annually in the fall. Index reach 15b, located upstream of SLVWD's Fall Creek intake was sampled annually between 1997 and 2001, and from 2008 through the present. Index reach 15a, located downstream of the intake, has only been sampled since 2014. During the five years (2014-2018) that both sites were surveyed, the average total juvenile steelhead density was 37.1 fish/100 ft (± 20.2) at the upstream site (15b) and 34.9 fish/100 ft (± 7.7) at the downstream site (15a). Average densities of fish less than 75 millimeters (mm) standard length during that period were 29.1 fish/100 ft (± 19.7) at the upstream site and 28.5 fish/100 ft (± 7.3) at the downstream site. As such, in addition to presenting similar habitat conditions, baseflow juvenile steelhead densities are also comparable upstream and downstream of SLVWD's Fall Creek diversion.

Bennett Creek joins Fall Creek approximately 0.3 miles upstream of SLVWD's Fall Creek diversion intake. In 1980, CDFG staff stated, "Bennett Creek is impassable to upstream migrating fish", but in terms of streamflow contributions, the drainage has been characterized as a "significant perennial tributary" to Fall Creek (Becker and Reining 2008).

Bull Creek

Bull Creek is a tributary to the middle mainstem San Lorenzo River in Felton and drains a watershed area of approximately 455 acres (0.71 sq. mi.). SLVWD operates two water intakes on Bull Creek at an elevation of approximately 800 ft msl. The combined drainage area upstream of the two diversion points is approximately 175 acres (0.27 sq. mi.).

A 1975 CDFG protest to the water right application on Bull Creek attributes steelhead "spawning and nursery areas" to the creek but does not provide evidence of steelhead observations (Becker and Reining 2008). CDFG staff interviewed a local landowner in the Bull Creek watershed who noted that he had never seen salmonids in the stream (Becker and Reining 2008). A 2014 fishery assessment of Bull Creek concluded that the drainage provides very limited, poor quality habitat for a small, presumably resident rainbow trout population (DWA 2014). Spawning conditions were noted to be very poor in this highly sedimented stream. A 900-foot culvert system near its confluence with the San Lorenzo River was deemed to effectively prohibit or severely limit passage for adult steelhead into Bull Creek (Kittleson 2017). DWA (2014) concluded that habitat conditions in Bull Creek "would not likely improve with higher baseflow due to very poor pool development" and that "no measures are warranted to improve steelhead or coho access to this small tributary or to consider instream flows for steelhead or coho salmon in Bull Creek." Based on the available information, Bull Creek is not considered to have anadromous salmonid value for the purpose of this assessment, but Kittleson (2017) notes that Bull Creek should be managed to protect or enhance habitat for the existing resident rainbow trout population.

Loch Lomond Reservoir

In 1958, SLVWD sold 2,500 acres of land encompassing a portion of the San Lorenzo River tributary watershed of Newell Creek to the City of Santa Cruz (City) with the agreement that SLVWD would be entitled to purchase 12.5 percent of the annual safe yield from a reservoir planned by the city. The City created Loch Lomond Reservoir with the completion of Newell Creek Dam in 1960. The reservoir has a drainage area of 8.3 sq. mi. and a reservoir capacity of approximately 9,000 af. The City's Newell Creek appropriative water right license authorizes a maximum of 5,600 afy of water to be diverted to storage between September 1 and July 1. The maximum amount of withdrawal of water from storage in the Loch Lomond Reservoir under this license is limited to 3,200 afy. The City is also authorized to divert water from the San Lorenzo River at the Felton Diversion Facility under two separate water right permits that allow for a combined maximum diversion of 3,000 afy to storage at Loch Lomond Reservoir between September 1 and June 1 under one permit and October 1 and June 1 under the other permit (City of Santa Cruz 2018). Water diverted at Felton is transported by a large diameter pipeline and a series of pump stations to Loch Lomond Reservoir for storage. Water from both the Felton Diversion and Newell Creek are stored in Loch Lomond Reservoir, and the total maximum amount of water that is authorized to be held in the reservoir is 8,624 afy (City of Santa Cruz 2018).

SLVWD began receiving a portion of the reservoir yield after the dam was completed, although records are only available for 1976–77, when it received 353 af. SLVWD has not received any water from Loch Lomond since 1977. Since implementation of the Federal 1989 Surface Water Treatment Rule, SLVWD has not had the means to treat diversions from Loch Lomond. In 1996, the City and SLVWD reached a draft agreement that allows SLVWD to purchase up to 313 afy of raw Loch Lomond water or purchase the same amount of treated city water with the understanding that it would be interruptible during declared water-shortage emergencies (Kocher 1996). SLVWD has yet to exercise either allowance under this agreement. To exercise its allotment, SLVWD may need to connect to the City's raw water line and expand the Kirby water treatment plant (SPH Associates 2010, cited in Exponent 2019).

Since 2001, the City has been developing a Habitat Conservation Plan (HCP) with NMFS and CDFW for federal and California Endangered Species Act compliance for water supply operations that may affect steelhead and coho salmon (City of Santa Cruz 2018). As part of the HCP process, the City, NMFS, and CDFW negotiated minimum flow requirements for streams affected by the City's diversions, including Newell Creek and the San Lorenzo River at Felton, the two sources of Loch Lomond water. Moreover, the City has committed to implementing these minimum flows as part of its water rights modification process regardless of the final outcome of the HCP process (City of Santa Cruz 2018). Although SLVWD has the right to a 313 afy allotment of stored Loch Lomond water, this water is diverted by the City pursuant to applicable bypass requirements at Newell Dam and the Felton Diversion for the protection of steelhead and coho salmon. SLVWD therefore does not have any bypass flow requirements associated with its Loch Lomond allotment.

2.3.2 Groundwater Resources

SLVWD draws approximately 45 percent of its average annual water supply from three loosely defined groundwater subareas of the SMGB (Exponent 2019). In addition to SLVWD, the Scotts Valley Water District (SVWD) and Mt. Hermon Association (MHA) also operate groundwater wells within the SMBG. Wells in the Quail Hollow and Olympia areas are part of SLVWD's North System, and the Pasatiempo area wells are part of SLVWD's South System, which is supplied solely by groundwater. As described in the WAA (Exponent 2019), wells operated by SLVWD do not draw directly from alluvial aquifers and do not directly induce streamflow infiltration because area groundwater levels are generally higher than the elevation of the gaining streams that dissect or bound the groundwater subareas. As such, SLVWD's wells may intercept groundwater flowing *toward* springs and streams, but generally do not draw water directly *from* streams (Exponent 2019). The streams assumed to be indirectly affected by SLVWD's groundwater production are primarily Bean and Zayante creeks, and to a lesser extent Newell Creek and the mainstem San Lorenzo River (Exponent 2019). The fishery resources of these streams are briefly described below.

Zayante Creek

Zayante Creek is a major eastern tributary to the San Lorenzo River in Felton and the confluence marks the dividing line between the middle and lower San Lorenzo River, as defined in Alley et al. (2004). Based on a DWA (2009) synopsis of salmonid habitat conditions, Zayante Creek and its tributary Bean Creek (discussed below) are significant contributors to the juvenile steelhead population and adult index of the San Lorenzo River watershed. Lower Zayante Creek, downstream of the Bean Creek confluence, receives heavy sediment inputs from Bean Creek, but supports relatively high growth rates for juvenile steelhead in wetter years with higher spring and summer baseflow. Juvenile densities are typically low. Between the Bean Creek confluence and the Lompico Creek[1] confluence, long pools dominate the stream. Stream shading is moderate and instream wood and overhanging vegetation provide good cover. Upstream of Lompico Creek, the stream gradient increases and step-run habitat units become more abundant. Large yearling steelhead are abundant in pools. Despite higher annual streamflows than other San Lorenzo River tributaries, low summer streamflow and sedimentation are considered the primary factors limiting fish habitat in Zayante Creek (Alley et al. 2004).

Bean Creek

Based on the summary description of DWA (2009), the lower reaches of Bean Creek near Mount Hermon are prone to heavy fine sediment loading from landslides and recreational use has

[1] In 2015, SLVWD assimilated the Lompico County Water District, including its diversion on Lompico Creek. However, SLVWD does not currently operate this diversion, and this water source is not considered in the conjunctive use plan evaluation.

degraded summer habitat for salmonids. A short reach between Mt. Hermon Road and Ruins Creek has historically supported an intact riparian corridor and good pool cover provided by instream wood in a meandering stream channel. This short reach is periodically a very productive steelhead segment. Upstream of the Ruins Creek confluence, summer baseflows are low, with variable segments frequently drying out. Upstream of the Mackenzie Creek confluence summer streamflows remain low and steelhead are restricted to available pool habitats. Juvenile coho salmon were observed in this low gradient, cool water reach in 2005 (DWA 2009). Surface flow in upper Bean Creek is thought to be vulnerable to groundwater pumping (DWA 2009).

Newell Creek

Newell Creek is a tributary to the San Lorenzo River in Ben Lomond. The Loch Lomond Reservoir is located approximately 1.7 miles upstream of the San Lorenzo River confluence. The Newell Creek watershed area is approximately 9.9 sq. mi, with the reservoir capturing runoff from approximately 8.3 sq. mi. Below the reservoir, Newell Creek has approximately one mile of easily accessible steelhead habitat below a bedrock chute that presents a significant impediment to fish passage (HES 2014). Winter spawning flows are likely much reduced in Newell Creek until the reservoir fills and spills in winter (DWA 2009). The water right license for Loch Lomond requires year-round minimum releases of 1 cfs to Newell Creek. Hydrologic modeling indicates that the operation of the reservoir results in a slight reduction in median flows through the anadromous reach (compared to reservoir inflows) during the early part of the juvenile salmonid rearing period in wet, normal and dry years, and in an augmentation of median flows during the latter part of the rearing period due to the 1 cfs minimum release (ENTRIX, Inc. 2004, cited in HES 2012). Total juvenile steelhead densities in Newell Creek near its confluence with the San Lorenzo River have fluctuated greatly between 2009 and 2018, ranging from less than 10 fish/100 ft during the drought years of 2014 through 2016, to over 35 fish/100 ft in 2012 and 2013 (County of Santa Cruz 2019). The 10-year average total juvenile density for the Newell Creek sampling site is 19.0 (± 13.6) fish/100 ft (County of Santa Cruz 2019).

CHAPTER 3
Existing Effects Analysis

3.1.1 Methods

The WAA for the San Lorenzo River Watershed Conjunctive Use Plan (Exponent 2019) presents alternative scenarios for optimizing the conjunctive use of existing and potential water sources to improve SLVWD's water-supply reliability within the San Lorenzo River watershed. To support the comparative analysis of conjunctive use alternatives, Exponent (2019) simulated monthly streamflow estimates and potential diversions based on estimated frequencies of mean daily flow adjusted for month and hydrologic year-type (e.g., wet, dry, etc.) over a 48-year climatic cycle spanning water years (WY) 1970-2017. As noted by Exponent (2019), the results of the WAA provide qualitative indications of the potential relative magnitude and effects of the various conjunctive use alternatives and are suitable for planning-level evaluations, but the synthesized monthly records of water supply and use "have limited precision and should not be used to evaluate compliance with specific regulatory, water-right, or habitat requirements." As such, the synthetic streamflow estimates developed for the WAA were not used to evaluate potential existing effects of SLVWD's surface water diversions on salmonid habitat conditions, but rather as a comparative tool for differentiating the relative potential benefits of the different conjunctive use scenarios presented in Chapter 4.

Since 2014, SLVWD has contracted with Balance Hydrologics, Inc. (Balance) to gage and analyze streamflows in channels serving as surface water sources to better understand how its diversions may affect flow and aquatic habitat in the San Lorenzo River and its tributaries. Although the hydrologic record developed through this intensive monitoring program extends over only four water years (2014-2017), it includes the severe drought conditions of WYs 2014 and 2015, near-average conditions of WY 2016, and the record-setting wet conditions of WY 2017 (i.e., 300 percent of mean 1937-2017 annual flow at SLRBT), and therefore provides a valuable range of actual streamflow and habitat conditions that steelhead, coho salmon, and other native fishes may reasonably be expected to experience in the San Lorenzo River watershed. Balance has prepared four separate annual monitoring reports (Balance 2015, 2018a, 2018b, and 2019)[2]. The data summaries provided in these reports informed the evaluation of existing effects of SLVWD's diversions on fisheries habitat.

In support of Balance's streamflow monitoring effort, DWA (2018a) evaluated potential water temperature effects of SLVWD's surface water diversions during the same four WY (2014-2017)

[2] References to Balance streamflow data presented in this effects analysis frequently span all four monitoring years and associated annual reports. As such, these data are simply cited as "Balance", without reference to specific report publication years.

period. Summer baseflow water temperatures were recorded with continuous data loggers deployed in tributary streams affected by SLVWD diversions as well as in the mainstem San Lorenzo River upstream and downstream of the confluences of those tributaries. Applying widely-cited salmonid temperature studies, DWA (2018a) used maximum weekly average temperature (MWAT) threshold criteria of 20 degrees celsius (°C) and 16.7°C to evaluate rearing habitat suitability for juvenile steelhead and coho salmon, respectively. The results of this study were applied to the analysis of existing effects of SLVWD diversions on fisheries habitat suitability.

DWA (2018b) also conducted an assessment of salmonid fish passage flow requirements in Fall Creek downstream of SLVWD's Fall Creek diversion using a critical riffle analysis methodology based on CDFW's standard operating procedure for such analyses (CDFG 2012). Critical riffle analyses consist of empirical evaluations of the relationship between stream discharges and water depths across the most critical (i.e., shallowest) riffles. The CDFW standard protocol specifies conservative minimum depth requirements for various life stages of salmonids (i.e., adults, smolts, and juveniles), but DWA (2018b) developed alternative minimum depth criteria based on available regional data of fish sizes. Based on the results of the analysis, DWA (2018b) estimate a 17-27 cfs instream flow requirement for adult steelhead and coho salmon passage and spawning, approximately 7 cfs for yearling and older juvenile salmonids, and 1-2 cfs for young-of-the-year juvenile movement (Table 3-1).

Instream flow criteria, such as those derived from critical riffle analyses or Physical Habitat Simulation (PHABSIM) studies, are used by fisheries managers and regulatory agencies to determine site-specific bypass flow requirements at surface water diversions. For the purposes of this conjunctive use plan evaluation, however, such criteria are arguably of lesser value because, from a fisheries perspective, the overall goal of the plan is to *increase* summer baseflow levels to the greatest extent possible in stream reaches where baseflows are most limiting to juvenile salmonid growth and survival. As such, a conjunctive use scenario that is estimated to increase summer baseflows in a priority salmonid stream by 0.25 cfs would be considered more beneficial for fisheries resources than one that would not increase baseflows in that stream, regardless of specific summer juvenile salmonid rearing flow requirement estimates that may have been developed for this stream. Furthermore, any increases in winter high flow diversions considered in the WAA for some conjunctive use scenarios would be relatively minor and consist only of diverting water that exceeds winter demand at existing diversion rates and capacities[3] for transfers to another system (e.g., for in-lieu recharge). As documented by Balance and described below, SLVWD's existing surface water diversions in the North and Felton system are relatively small and therefore have negligible effects on the high winter flows necessary for adult salmonid passage and spawning. As natural stream flows gradually recede in the spring, the relative effects of SLVWD diversions on flows increase. Based on available data, however, SLVWD's diversion

[3] The WAA analyzes three conjunctive use scenarios (1c, 1d, and 1e) under which SLVWD would double the diversion, conveyance, and treatment capacities of the North and Felton system diversions. However, SLVWD did not select either of these scenarios for implementation in the foreseeable future. Should such an expansion of diversion capacities be considered in the future, more detailed instream flow requirement analyses should be conducted to assess the potential effects of increased diversion rates on downstream fisheries habitat.

rates do not appear to significantly affect spring flows necessary for juvenile salmonid (smolt) migration to the ocean either. Balance (unpublished) compared the frequencies with which the DWA (2018b) minimum smolt passage flow requirement of 7.1 cfs was met or exceeded upstream and downstream of SLVWD's Fall Creek diversion during the spring (March 15 – June 30) period of WY 2014-2017. On average, the passage threshold was exceeded on 38 days upstream of the diversion and on 37 days downstream of the diversion, suggesting that diversions rarely affect attainment of the smolt instream flow recommendation on Fall Creek.

In-lieu of extensive instream flow needs assessments with limited relevance to this conjunctive use evaluation, a standard setting hydrology-based "desktop" procedure applied by CDFW (2017) to develop interim instream flow determinations was used for this analysis to provide rough theoretical estimates of relative flow targets for the two primary fisheries streams affected by SLVWD surface water diversions, Boulder Creek and Fall Creek. Insufficient hydrologic data were available to conduct a similar analysis on the significant fisheries tributaries affected by groundwater extractions (Bean and Zayante creeks)[4]. The CDFW (2017) methodology consists of the application of the following three standard setting methods to identify flow needs for priority stream functions:

- R2 Consultants (2008) regression formula using watershed area, mean annual discharge, and minimum passage depth requirement to estimate an appropriate passage flow (Qfp). The equation was developed using data from cross sections collected in 13 streams in Mendocino, Sonoma, Napa, and Marin counties, is considered to be descriptive of streams over a broader region (R2 Consultants 2008).

- Hatfield & Bruce (2000) regression equations for adult spawning and juvenile rearing. These equations were developed using the "peak of the curve" results (i.e., optimum flow) from 127 PHABSIM studies conducted across western North America, with most of the data representing California, Washington, Idaho, and Oregon.

- Tessmann (1980) adaption of the Tennant (1975) method for basin wide hydrology.

The results of the standard setting hydrology-based analysis for Fall Creek compared favorably to the empirical estimates provide by DWA (2018b) (Table 3-1), suggesting that the Boulder Creek estimates are sufficiently applicable for planning-level purposes.

[4] Exponent (2019) provide mean monthly unimpaired flow estimates for streams containing SLVWD surface water diversions, but not for stream affected by groundwater extractions.

TABLE 3-1

LIFESTAGE-SPECIFIC INSTREAM FLOW RECOMMENDATIONS (CFS) FOR FALL CREEK AND BOUDLER CREEK BASED ON EMPIRICAL AND STANDRAD-SETTING METHODOLOGIES

	Fall Creek (DWA 2018b)	Fall Creek (CDFW 2017)	Boulder Creek (CDFW 2017)
Adult migration/spawning	17-27	16.6	19.6
Smolt migration	7.1	7.1	8.4
Juvenile movement/rearing	1-2	1.9	2.0

3.1.2 Surface Water Resources

North System

Boulder Creek

SLVWD's diversions on Peavine and Foreman creeks affect streamflow in Boulder Creek. The combined maximum capacity of these two diversions is 2.7 cfs, but maximum diversion rates in the North System generally cannot occur simultaneously because of limited raw water conveyance and treatment capacities (Exponent 2019). Based on SLVWD production records and diversion gaging conducted by Balance during May 2014 through September 2017, the highest average monthly combined diversion rate at the Peavine and Foreman facilities was approximately 2.0 cfs in March and April of 2017, in the midst of a water year with approximately 300 percent of the historic (1937-2017) mean annual discharge for the San Lorenzo River watershed (Balance 2019). During the drought years of 2014 and 2015, the combined mean monthly diversion rates from the Boulder Creek tributaries only exceed 1.0 cfs on one occasion (December 2015) and were less than 0.25 cfs during July through September baseflow conditions.

Balance compared gaged daily mean flows in Boulder Creek to the combined monthly mean SLVWD diversion rates in Peavine and Foreman creeks to calculate the relative percentages of decreased Boulder Creek flow downstream of the tributary confluences resulting from the diversions. Based on this analysis, SLVWD diverts between 0.1 to 38.3 percent of Boulder Creek flows at the Peavine and Foreman diversions annually. As would be expected based on limited diversion capacities and variable seasonal streamflows, SLVWD's diversions generally account for less than 5 percent of Boulder Creek flows during the winter and early spring. Beginning in May, SLVWD's diversions account for gradually increasing percentages of the unimpaired flow and typically decrease Boulder Creek summer baseflows by over 25 percent in July through September. It should be noted that the highest relative diversion-related reductions in Boulder Creek flows documented by Balance occurred in July through September of very wet WY 2017. In below-normal (2014 and 2015) and normal (2016) water years, the Peavine and Foreman diversions are largely limited to a combined total of less than 0.25 cfs by low summer baseflows in these two tributaries, but higher WY 2017 baseflows enabled SLVWD to maintain combined average monthly diversion rates exceeding 1.0 cfs, thereby accounting for a greater portion of Boulder Creek flows. Nevertheless, even with SLVWD's higher average diversion rates, WY 2017 impaired flows in Boulder Creek remainder above the instream flow recommendation level

(2.0 cfs) derived from application of the CDFW (2017) methodology for much of the July through September baseflow period. During the relatively normal water year of 2016, however, impaired Boulder Creek flows measured during July through September were slightly below the CDFW (2017) flow recommendations. During WYs 2014 and 2015 drought conditions, July through September, even unimpaired Boulder Creek streamflows were well-below the CDFW (2017) recommendations. Although adding SLVWD diversions back into the impaired monthly mean flows would not have attained recommended instream flow levels, even the limited summer diversions that occurred during these two years likely exacerbated already critically low and presumably stressful streamflow conditions for juvenile salmonids and other native fish in Boulder Creek.

Summer water temperature monitoring conducted by DWA (2018a) in WYs 2014-2017 indicates that temperatures remained below the juvenile steelhead target MWAT threshold of 20°C at three Boulder Creek monitoring sites (upstream of the Peavine Creek confluence, downstream of the Foreman Creek confluence, and immediately upstream of the mainstem San Lorenzo River) during all four years. Based on these data, DWA (2018a) concluded that SLVWD water diversions appeared unlikely to result in adverse temperature impacts to steelhead in Boulder Creek.

Maximum weekly average temperatures at the three Boulder Creek sites exceeded the conservative target MWAT threshold of 16.7°C for juvenile coho salmon in 2014 and 2015 (DWA 2018a). In 2016, the coho salmon criterion was met upstream of Peavine Creek, but was exceeded below Foreman Creek and above the San Lorenzo River for one week (DWA 2018a). Notably, the coho salmon criterion was exceeded for one week upstream of Peavine Creek and for over two weeks downstream of Foreman Creek during the above-average WY 2017. As noted by Balance (2019), review of the data from four years of monitoring suggests that more flow does not necessarily mean lower water temperatures, either universally within the valley or (seemingly) in specific cases where known special geologic or other natural factors apply.

Balance (2018b) also monitored and analyzed streamflow and water temperature data when all diversions from the North System, including Peavine and Foreman, were shut down for maintenance of the Lyon Water Treatment Plant from September 1 to 7, 2016. Based on the analysis, shutting down the Peavine and Foreman diversions did not have a discernible effect on stream temperature during the shutdown period (Balance 2018). It is important to note, however, that the shutdown occurred during a time of regionally cool temperatures, which may have masked the effects of the additional cool water inflows from the streams usually used for diversions into the SLVWD system (Balance 2018).

Clear Creek

As described above, available fisheries resource information for Clear Creek and its tributary, Sweetwater Creek, is limited. Due to its steep topography, noted limited habitat, and lack of definitive evidence of utilization by anadromous salmonids, SLVWD's diversions in the Clear Creek drainage were evaluated in the context of their potential effects on downstream fisheries resources in the mainstem San Lorenzo River. This focus on the mainstem should not be interpreted as implying that Clear Creek does not support valuable ecological functions, but rather that this tributary is considered a lower priority for conjunctive use-related enhancements to salmonid habitat than streams with consistently documented salmonid utilization.

The combined maximum diversion capacity of Clear Creek diversion boxes 1, 2 and 3 is 0.7 cfs, and the capacity of the Sweetwater Creek diversion is 0.6 cfs (Exponent 2019). As discussed above, existing limitations in the North System's delivery and treatment capacity mean that these maximum capacities are rarely, if ever, fully utilized. Based on Balance monitoring, the monthly mean diversion rate from Clear Creek was typically less than 0.25 cfs during WYs 2014-2017, and the highest diversion rate was 0.45 cfs (April 2016). July through September diversion rates were typically less than 0.1 cfs. For the Sweetwater Creek diversion, monthly mean diversion rates were typically less than 0.2 cfs, and the highest rate was 0.34 cfs (January 2016). Water is rarely diverted at the Sweetwater diversion during the July-September baseflow season. SLVWD typically operates the Clear Creek system to bypass at least 35 gpm (0.08 cfs) to provide for a 30 gpm downstream water right.

Based on synoptic streamflow measurements conducted by Balance, the combined Clear Creek and Sweetwater Creek diversions typically account for a reduction of less than approximately 9 percent of mainstem San Lorenzo River flows, with the greatest relative reductions occurring during the summer baseflow period. For example, measurements collected in August 2016 show a combined diversion rate of 0.31 cfs and a mainstem San Lorenzo River streamflow of 3.17 cfs below the Clear Creek confluence.

Water temperatures in Clear Creek tend to remain cool throughout the summer, consistently satisfying the juvenile steelhead MWAT threshold of 20°C and exceeding the 16.7°C coho salmon threshold only occasionally for short periods of time (DWA 2018a). In comparison to temperatures in Clear Creek, water temperatures in the San Lorenzo River below Clear Creek are typically about 1-4°C warmer. The San Lorenzo River upstream and downstream of the Clear Creek confluence exceeded the steelhead temperature criterion during 2014 and 2015 drought conditions, but generally remained below that threshold in 2016 and 2017 (DWA 2018a). The coho salmon criterion was not satisfied above or below the Clear Creek confluence in either of the four monitoring years. During the summer months, Clear Creek serves to cool the San Lorenzo River to a small degree, but not sufficiently to affect attainment of temperature criteria. It should be noted, however, that deep pools in the San Lorenzo River below Clear Creek are, at times, stratified and provide cooler refuge conditions for salmonids (DWA 2018a). Cool water inflows from Clear Creek likely help maintain the cooler pool temperatures at depth.

Fall Creek

Fall Creek is a well-documented steelhead stream and is known to have supported coho salmon in the past. As such, SLVWD's diversion on Fall Creek has the potential to affect salmonids in Fall Creek as well as in the San Lorenzo River downstream of Fall Creek. SLVWD's Bennet Spring diversions are located upstream of the limit of anadromy, but diversions may also affect Fall Creek and San Lorenzo River fisheries resources. The maximum capacity of the Fall Creek diversion is 0.6 cfs and approximately 0.5 cfs for the Bennett Spring diversions (Exponent 2019). However, as is the case in the North system, the Felton system is limited by treatment capacities. Felton system diversions (including from Bull Creek) are processed by the Kirby water treatment plant, which has a design capacity of 700 gpm (1.6 cfs) but typically operates at half capacity using only one of two units (Exponent 2019). The maximum continuous monthly production rate of the Kirby WTP is approximately 425 gpm (1.0 cfs). During WYs 2014-2017, mean monthly diversions at Fall Creek never exceeded 0.5 cfs. Unlike North system diversions, however, Fall Creek diversions do not vary greatly from season to season. Based on SLVWD production records, diversions from Bennett Spring rarely reach 0.4 cfs.

Balance measures Fall Creek streamflow at two gaging sites. Since August 2013, Balance has maintained a stream gage about 150 feet upstream of the Fall Creek diversion. This open-channel flow gage is in a straight and confined reach of the creek located within the Fall Creek Unit of Henry Cowell Redwoods State Park. This gage is located downstream of the Bennett Creek confluence. A stage recorder is also operated by SLVWD just upstream and next to the Fall Creek diversion weir, recording data at 2-minute intervals, facilitating calculation of bypass flow through SLVWD's V-notch weir for the full year. Prior to peaks in very high-flow events, SLVWD removes the V-notch weir to protect it from damage. Balance staff have developed a rating curve for the V-notch weir, to a maximum calibrated flow of 5.8 cfs. The stage data and operations logs from SLVWD are used by Balance to complement and validate the upstream gaging record. However, Balance (2019) notes that the calibration of flow past the v-notch weir in relation to the upstream gage is challenging due to the coarse resolution of the staff plate at the v-notch and a high degree of turbulence and water-level fluctuations at the sensor location. The temporary dewatering of the Fall Creek fish ladder immediately downstream of the v-notch weir in 2018 also revealed a substantial amount of leakage through and around the weir (Podlech pers. obs.), therefore resulting in underestimation of bypass flows measured by the v-notch stage recorder. To better estimate flow at the v-notch weir, or flow bypassed past the diversion, Balance began using SLVWD's analog spiral graphs of instantaneous diversion records to quantify bypass flows, where flow downstream was calculated by subtracting diversion from the upstream flow record.

Based on WY 2014-2017 flow data, summer baseflows in Fall Creek upstream of the diversion were approximately 1 cfs during the drought years of 2014 and 2015, 2 cfs in the near-normal year 2016, and 3 cfs in the above-average year 2017. Mean monthly Fall Creek diversion rates during July through September 2014-2017 ranged between 0.3-0.5 cfs, thus reducing flows below the diversion by that amount. During drought years (e.g., 2014 and 2015), these diversion rates may reduce Fall Creek flows by up to 50 percent (e.g., Balance 2018a), but DWA (2018b) note that even during those conditions, juvenile steelhead reared successfully downstream of the diversion under the cool water conditions typical for Fall Creek. DWA (2018b) estimate that a baseflow of approximately 1-2 cfs in Fall Creek is sufficient to provide hydrologic connectivity (defined as minimum depth of 0.1 ft across the shallowest riffles) during the spring and early summer juvenile redistribution period, but also note that juvenile steelhead reared successfully below the diversion during lower drought (WYs 2014 and 2015) baseflows conditions.

As described in Section 2.3.1 above, surveys conducted by DWA have documented similar baseflow habitat conditions and juvenile steelhead densities upstream and downstream of SLVWD's Fall Creek diversion. Moreover, the juvenile steelhead MWAT threshold of 20°C was satisfied both upstream and downstream of the Fall Creek diversion in all four monitoring years

(DWA 2018a). The significantly lower coho MWAT criterion of 16.7°C was also satisfied at both locations most of the time, with a period of 1.5 weeks in 2015 and 2 days in 2017 at the downstream location being the only exceptions (DWA 2018a). However, even during those short periods, the MWAT at the lower site did not exceed 17°C.

Based on available streamflow, physical habitat, water temperature, and fish density data, SLVWD's Fall Creek diversions do not appear to have discernable effects on the fisheries resources of this tributary stream, although diversions during severe drought conditions likely exacerbate already stressful conditions.

Based on synoptic streamflow measurements conducted by Balance, diverted flow versus total flow in the San Lorenzo River downstream of Fall Creek during water years 2014-2017 ranged from about 1 percent to slightly over 10 percent. As would be expected, the greatest relative percentages are higher (up to 10 percent) under the drought conditions prevalent during WYs 2014 and 2015, and lower (5 percent or less) during years of normal or wet conditions such as 2016 and 2017, respectively. At the time of the greatest measured effect (10.8 percent) of Fall Creek diversions on San Lorenzo River flows, measurements collected in September 2015 show a mainstem flow of 3.89 cfs below the Fall Creek confluence. Adding SLVWD diversions back in would have resulted in an estimated mainstem flow of 4.36 cfs, assuming no streamflow gains or losses between the diversion facility and the mainstem.

Based on water temperature monitoring conducted on the San Lorenzo River immediately upstream and downstream of the Fall Creek confluence, inflows to the mainstem river helped reduce the period of juvenile steelhead temperature threshold exceedances during 2014 and 2015 drought conditions from 4.5-5.5 weeks upstream of Fall Creek to only one week (during which it was nearly met) downstream of Fall Creek (DWA 2018a) in each of the two years. DWA (2018a) note that water diversion from Fall Creek may have prevented the temperature criterion from being fully met in the mainstem river below Fall Creek downstream to the Bull Creek confluence during the drought years of 2014 and 2015. The coho salmon temperature criterion was never satisfied during four years of monitoring, either upstream or downstream of the Fall Creek confluence (DWA 2018a). Unlike some of the tributary streams, summer water temperatures in the mainstem San Lorenzo River are generally considered too warm for juvenile coho salmon rearing.

During normal and above-normal water years, SLVWD's Fall Creek diversions are unlikely to have discernable effects on San Lorenzo River mainstem fisheries resources due to the relatively minor relative contributions of Fall Creek flows to the mainstem San Lorenzo River. However, the relative contributions from Fall Creek to the mainstem are much higher during prolonged drought conditions due to the tributary's karst geology providing more persistent (multi-year) groundwater outflows (Balance 2018b). During these extreme low flow conditions, Fall Creek diversions account for up to 10 percent of potential loss to mainstem flows. While even impaired Fall Creek inflows help to improve mainstem salmonid habitat quality (e.g., reduced water temperatures) during severe drought conditions, this relative loss of inflow may exacerbate already stressful conditions in the mainstem San Lorenzo River.

Bull Creek

As described above, Bull Creek is a small tributary to the San Lorenzo River characterized by poor salmonid habitat quality and a significant migration barrier in its lowermost reach precluding anadromous salmonid access. A resident rainbow trout population is present in Bull Creek. SLVWD's diversions from Bull Creek were evaluated primarily in the context of potential effects on downstream fisheries resources in the mainstem San Lorenzo River.

The maximum capacity of SLVWD's Bull Creek diversion is 0.5 cfs (Exponent 2019). Based on Balance monitoring, the monthly mean diversion rate from Bull Creek during WYs 2015-2017, was typically less than 0.25 cfs, and the highest documented monthly diversion rate was 0.32 cfs (February 2016). July through September diversions were typically around 0.1 cfs.

Balance's synoptic flow investigations on the mainstem San Lorenzo River did not include measurements immediately downstream of Bull Creek, and the potential relative reduction in streamflow resulting from the Bull Creek diversions is not known. However, given that Bull Creek diversion rates are similar to those on Clear Creek, particularly during the July-September low flow period, and San Lorenzo River flows are higher below Bull Creek than below Clear Creek, it is reasonable to assume that Bull Creek diversions reduce San Lorenzo River flows by less than 5 percent during the low flow season.

Water temperature in Bull Creek tends to remain cool throughout the summer, consistently satisfying the juvenile steelhead MWAT threshold of 20°C and satisfying the 16.7°C coho salmon threshold during the normal and wet water years of 2016 and 2017, respectively (DWA 2018a). However, due to the limited relative contribution of Bull Creek flows to the mainstem, accretions from this tributary do not appear to affect San Lorenzo River water temperatures, with the steelhead criterion generally being met both upstream and downstream of the Bull Creek confluence while the coho salmon criterion was never met upstream or downstream during the monitoring period.

3.1.3 Groundwater Resources

The potential effects of groundwater extractions on surface water streamflows, and thereby on fisheries resources, is more difficult to quantify. Groundwater pumping reduces the amount of groundwater that flows to streams and, in some cases, can draw streamflow into the underlying groundwater system. As described by Exponent (2019), SLVWD's wells may intercept groundwater flowing toward springs and streams, but generally do not draw water directly from streams because area groundwater levels are generally higher than the elevation of the gaining streams that dissect or bound the groundwater subareas. As such, Exponent (2019) evaluated the potential effects of groundwater pumping by comparing rates of average annual pumping to minimum (drought) rates of stream baseflow. This approach assumes that monthly average pumping rates are similar throughout the year and that the relative effects of pumping on streamflow increase as streamflows decrease, with the greatest effects occurring during minimum baseflow conditions. To develop estimates of the potential effects of current pumping on streamflow, Exponent (2019) compared estimates of minimum monthly impaired baseflow with recent average monthly groundwater pumping rates. Because the effects of pumping are already reflected in the gauged and estimated streamflow records (i.e., impaired flows), Exponent (2019) estimated the potential percent reduction in minimum monthly baseflow as the average groundwater pumping rate divided by the combined rates of baseflow and pumping to calculate the percent of baseflow remaining as a result of pumping. It should be noted that this approach assumes a 1:1 relationship between pumping and streamflow reductions. In other words, the analysis assumes that every acre-foot of groundwater pumped represents an acre-foot of surface water flow reduction, and is therefore a conservative (i.e., worst-case) estimate of pumping effects on streamflow. A more refined evaluation of potential surface water-groundwater interactions would require the use of a numerical groundwater flow model, which was beyond the scope of the WAA study.

Based on this method, Exponent (2019) estimated that the average rates of SLVWD, SVWD, and MHA groundwater pumping may reduce Newell, Zayante, and Bean creek baseflows by roughly 50 percent during worst-case drought conditions (see WAA Table 5-3). Drought baseflow reductions in the San Lorenzo River at the SLRBT gage are estimated at almost 30 percent. For example, the combined effects of SLVWD, SVWD, and MHA groundwater pumping is estimated to reduce drought baseflows in Bean Creek at the Zayante Creek confluence from approximately 0.5 cfs to 0.25 cfs. Such reductions in streamflow during critically stressful conditions likely have detrimental effects on juvenile salmonids growth and survival.

3.1.4 Summary

SLVWD's typical surface water diversion rates constitute a minor portion of the winter high flow season. Beginning in May, the diversions account for gradually increasing percentages of the unimpaired flow. During summer (July through September) baseflow conditions, SLVWD's have variable effects on fisheries resources depending on water year type, diversion rates, and downstream resource sensitivity. During drought baseflow conditions, surface water diversions likely reduce streamflows sufficiently to exacerbate already stressful juvenile salmonid rearing conditions, particularly in Boulder Creek. Water temperatures are generally not affected by surface water diversions such that rearing habitat suitability downstream of the diversions is altered.

The effects of groundwater extractions on eastern watershed tributaries (e.g., Zayante and Bean creeks) are also largely inconsequential during most of the year, but can result in reductions of up to 50 percent of drought minimum baseflows in these streams at critically stressful times.

Table 3-2 summarizes typical effects of SLVWD's diversions and pumping on San Lorenzo River watershed streams.

TABLE 3-2

SUMMARY OF ESTIMATED EFFECTS OF SLVWD SURFACE WATER DIVERSIONS AND GROUNDWATER EXTRACTIONS ON SAN LORENZO RIVER WATERSHED STREAMS

Surface Water Sources	Typical maximum diversion rate (cfs)	Typical Jul-Sep diversion rate (cfs)	Jul-Sep diversion % of receiving stream* flow	Steelhead MWAT met below diversion	Coho salmon MWAT met below diversion
Peavine/Foreman Creeks	2.0	<0.25	>20	✓	X ✓
Clear/Sweetwater Creeks	0.7	<0.1	<9	✓	✓
Fall/Bennett Creeks	0.9	0.5	<10	✓	✓
Bull Creek	0.3	0.1	<5	✓	X ✓

Groundwater Sources	Estimated Mean Monthly Loss (cfs) from SLVWD Groundwater Production	% Loss of Drought Minimum Baseflow from SLVWD Groundwater Production
Newell Creek at San Lorenzo River	0.1	49
Zayante Creek above Bean Creek	0.4	53
Zayante Creek at San Lorenzo River		27
Bean Creek at Zayante Creek	0.9	23
San Lorenzo River above Fall Creek	0.1	7
San Lorenzo River at USGS gage		16

* = next downstream named waterbody (e.g., San Lorenzo River in the case of Fall Creek)
✓= typically meets criterion
X ✓= typically meets criterion during wet and normal water years, but not in dry years

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CHAPTER 4
Conjunctive Use Effects Analysis

Of the 22 individual conjunctive use scenarios simulated by Exponent (2019) in the WAA, SLVWD selected three scenarios for further consideration. SLVWD based its selection primarily on operational and infrastructure opportunities and constraints. The three selected scenarios represent conjunctive use projects that could be implemented in the near future. The first part of this section discusses the anticipated effects of SLVWD-selected scenarios on salmonid resources. While these scenarios may not represent the greatest fisheries benefits possible from the various conjunctive use scenarios presented in the WAA, the ability to implement these options fairly quickly may be considered a fisheries benefit in and of itself.

The second part of this section discusses the expected effects of a modified WAA scenario identified through this analysis as potentially representing the most beneficial options for fisheries resources. Its implementation, however, would require more extensive operational and funding considerations, and it is therefore identified here for consideration in longer-term conjunctive use planning efforts.

4.1 SLVWD-Selected Scenarios

4.1.1 Scenario 1b – Felton System Complies with Required Bypass Only

SLVWD's Felton water right permit contains two separate bypass flow terms (Section 2.3.1). One requirement establishes minimum bypass flows (i.e., 1.5 cfs winter/spring and 1.0 cfs summer/fall during normal water years; 0.75 cfs winter/spring and 0.5 cfs summer/fall during dry water years) to be maintained in Fall Creek below the diversion, and the other requirement is intended to protect minimum low flows in the San Lorenzo River at the SLRBT gage (i.e., 10 cfs in September; 25 cfs in October; and 20 cfs November through May). Under WAA Scenario 1b, SLVWD would comply with its Fall Creek bypass flow requirement but would seek a water right permit modification to relieve it of the SLRBT low-flow requirements that at times prevent all diversions for the Felton system.

Exponent (2019) analyzed the frequency of low-flow conditions at SLRBT, as defined by the water right permit terms, during a 48-year period of SLRBT records (WYs 1970-2017). On an average monthly flow basis, SLVWD diversions from the Felton System would not have been allowed during the month of October in 31 out of 48 years (65 percent) and in the month of November in 11 out of 48 years (23 percent) (Table 4-1). Because the SLRBT low-flow criteria are applicable on a daily basis, this is likely an under-estimate of the number of months during which non-compliant diversions would occur (Exponent 2019).

TABLE 4-1

FREQUENCY OF LOW-FLOW CONDITIONS PROHIBITING FELTON SYSTEM DIVERSIONS DURING A 48-YEAR PERIOD OF SLRBT RECORDS (WYS 1970-2017) ON AN AVERAGE MONTHLY FLOW BASIS

October	65%	April	2%
November	23%	May	13%
December	6%	June	0%
January	4%	July	0%
February	2%	August	0%
March	0%	September	17%
		All months	**11%**

Source: Exponent (2019)

One of the stated goals of the Conjunctive Use Plan is to enable SLVWD to fully comply with its existing permitted water right for the Felton system. While SLVWD's ability to fully comply with the current terms of its permits is clearly an important legal and regulatory consideration, the primary purpose of this fisheries assessment is to identify best approaches for conjunctively using existing water supplies for the benefit of fisheries resources in the San Lorenzo River watershed. The underlying purposes of water right permit restrictions on diversions broadly fall into one of two categories: (1) protecting the water rights of senior permit holders, and (2) protecting other beneficial uses, including environmental resources such as fisheries. Based on a review of State Water Resources Control Board (SWRCB) Decision 1611 (SWRCB 1986) granting Citizens Utility Company of California (prior owner and operator of the Felton system) water right application 24652, the existing water right contains both categories of permit terms. The bypass flow requirements for Fall Creek are based on protest dismissal terms recommended by the CDFG and the County of Santa Cruz for the protection of fisheries resources in Fall Creek below the diversion. The bypass requirement at the SLRBT gage, on the other hand, appears to have been included primarily to protect the City of Santa Cruz's senior water rights at the Felton Diversion, which include the same bypass terms. In Decision 1611, SWRCB (1986) noted that "to the extent that flows in the San Lorenzo River below the Felton Diversion Weir exceed these required bypass flows, the appropriation of water from Fall Creek will not interfere with the City's diversion at the Felton Diversion Weir."

Although the City's permitted bypass terms at SLRBT were originally "proposed by the Department" (i.e., CDFW) "to protect fisheries within the river" (SWRCB 1986), Decision 1611 notes that the City's stated concern regarding the potential adverse effects of Citizens United's application on fish in the San Lorenzo River "is unsubstantiated since the proposed diversion is small compared to the total flow in the mainstem San Lorenzo River especially during the fish migration months of November through June" (SWRCB 1986).

The original CDFW justification for proposing the inclusion of the SLRBT bypass terms in the City's permits, and by extension in SLVWD's permit, is not provided in Decision 1611 and was not available for this assessment. From a fisheries perspective, potential justifications for the SLRBT requirements are difficult to conceive of, primarily due to the unusual monthly steps in bypass requirement levels that do not appear to be founded in the life history periodicity of anadromous salmonids in the San Lorenzo River. The permitted bypass requirement schedule increases from 10 cfs in September to 25 cfs in October, prior to the onset of the typical adult steelhead (December) and coho salmon (November) migration periods. Chinook salmon (*O. tshawytscha*) are the only central California anadromous salmonid migrating as early as October, and this species does not occur in the San Lorenzo River. Furthermore, unless a major storm event has occurred by the time the October bypass threshold goes into effect, the sandbar at the San Lorenzo River Lagoon would most likely still be closed, thereby preventing all adult salmonid entry into the watershed. More confounding than the September-to-October increase in the bypass requirement, however, is the subsequent *decrease* to 20 cfs in November, the early onset of potential adult salmonid migration. Per the permit terms, this requirement remains in effect through May and thus the entire salmonid migration and spawning season.

The permitted increase in bypass flow requirements in early fall and subsequent decrease for late fall through spring is highly unusual and possibly unique in flow management and regulations for the benefit of steelhead and coho salmon in California and does not appear to be ecologically justified. Regardless of this scheduling anomaly, however, the permitted bypass flow requirements themselves may also be insufficient for the assumed purpose of protecting adult salmonid passage in the San Lorenzo River below the SLRBT gage. Salmonid passage flow needs in the San Lorenzo River below the City's Felton Diversion have previously been estimated by a number of researchers, as summarized by Berry (2016). Based on its interpretation of the findings of these studies, the City has recently proposed a commitment to bypassing up to 40 cfs at the Felton Diversion during the period of December through May to protect adult salmonid migration and spawning flow needs (City of Santa Cruz 2018). SLVWD's combined diversions from the Felton system (1.6 cfs system maximum capacity; 1.0 cfs maximum historic production) represent less than 4 percent of the City's proposed instream flow commitment and are therefore highly unlikely to affect attainment of the 40 cfs adult salmonid migration and spawning flow needs, especially since such flows would occur during the wet season when water demands on the Felton system decrease.

During the period of September-November, the City proposes to continue complying with its existing water right permit terms. However, the City rarely, if ever, exercises its rights during that period. The City operates the Felton Diversion to allow for a flushing flow each fall to scour any debris accumulated during low flow periods and only begins diverting after there have been two flow events, each exceeding 100 cfs (ENTRIX, Inc. 2004, as cited in HES 2012). Since the City does not typically exercise its water right at the Felton Diversion during the September-November period unless flows at SLRBT are significantly higher than the existing permit terms, relieving SLVWD of those permit terms would be unlikely to affect the City's senior rights.

While it may be argued that the biological justification for the pre-adult migration season minimum flow requirements in September and October were intended to protect juvenile salmonids rearing in the river, this does not appear to be the case since neither the City's nor SLVWD's water right permits stipulate minimum flow thresholds for the June through August summer rearing period. The City's water right permit does not allow for diversions during that period, thereby negating the need for instream flow requirements. However, SLVWD's water right allows for year-round diversions, and the fact that the permit terms do not stipulate minimum flow requirements for the warm, low flow period of June-August, but do stipulate instream flow requirements starting in September, is further evidence that the goal of the SLRBT requirements in SLVWD's permit was to protect the City's senior rights.

The existing September-November bypass flow requirements and the City's proposed commitment to higher bypasses during the December-May period are appropriate fisheries protection measures for the City's Felton Diversion, which relies on periodically diverting large amounts of water (up to 20 cfs permitted) to storage during high flow events. However, imposing these restrictions on SLVWD's Felton system diversions, which rely on direct diversions at a maximum effective rate of less than 1.0 cfs (or maximum permitted rate of 1.6 cfs) on a year-round basis, significantly constrains SLVWD's water supply without providing discernable fisheries protection or enhancement in the San Lorenzo River. Moreover, SLVWD's bypass flow requirements on Fall Creek ensure that proportionally appropriate contributions of Fall Creek flows to the mainstem are protected during summer and fall baseflow conditions. Under conjunctive use Scenario 1b, SLWVD would continue to comply with the Fall Creek bypass flow requirements.

Based on WAA simulated water supply effects, Scenario 1b would reduce, but not eliminate, the Felton system's unfulfilled demand to an average of 35 afy and a maximum of 85 afy due to the lack of a supplemental source of water during deficit months (Exponent 2019). Under Scenario 1b, the percentage of minimum flow remaining below the Fall Creek diversion is simulated to increase from 32 percent to 49 percent under Scenario 1b (see WAA Table 6-6). However, those results are based in part on the assumption that SLVWD would have been out of compliance with its Fall Creek bypass flow requirements during simulated years that preceded the District's purchase of the Felton system. In practice, SLVWD has rarely been out of compliance with the Fall Creek bypass permit term. From a fisheries perspective, Scenario 1b could potentially allow SLVWD to rely more heavily on diversions from the lower priority Bull Creek drainage and thereby reduce reliance on Fall Creek diversions during summer baseflow conditions.

Scenario 1b does not represent a true "conjunctive use" project as it simply assumes that SLVWD would no longer have to comply with its existing SLRBT bypass requirements. However, Scenario 1b would provide SLVWD with more flexibility in its operation of the Felton system in a manner that does not appear to adversely affect fisheries resources in the San Lorenzo River while potentially improving fish habitat conditions in Fall Creek.

4.1.2 Scenario 1f – South System Imports North System Unused Potential Diversions

Under Scenario 1f, SLVWD would export unused potential diversions from the North system to the South system as a substitute for pumping groundwater from the Pasatiempo wells, thereby providing in-lieu recharge of the SMGB. The WAA defines the term "unused potential diversions" as potential diversions within permitted water rights and diversion capacities that exceed demand within the service area within which they are diverted, but which potentially could be transferred to another system or used for aquifer storage and recovery (ASR). In other words, existing diversion capacities or rates in the North system would not increase under

Scenario 1f. Rather, some water that is currently left in the stream un-diverted because simulated monthly demands in the North system are fully met would be diverted under Scenario 1f and transferred to the South system via the existing North-South intertie.

Based on the results of the WAA, an average of 115 afy and a maximum of 300 afy would be transferred to the South system, as needed, to fulfill demand during months when potential diversions exceed North system demand (Exponent 2019). Implementation of this conjunctive use project is estimated to result in an overall 32 percent reduction in South system groundwater pumping. The percent of simulated monthly flow remaining downstream of North system diversions under Scenario 1f is only slightly less (≤1 percent) than under the existing base case scenario. This is because diversions in excess of North system demand would mostly occur during high streamflow months when diversions comprise only a small percentage of unimpaired flows.

The majority of the transferred water would originate from the combined Clear Creek and Sweetwater Creek diversions (see WAA Figure 6-12) because these account for approximately 85 percent of the North system's average unused potential of 289 afy (Exponent 2019). Peavine and Foreman creeks account for a combined North system unused potential of only 44 afy (15%), and high flows in Boulder Creek are therefore not expected to be adversely affected by the additional diversion of unused potential from Peavine and Foreman creeks under Scenario 1f when compared to existing baseline conditions (see WAA Figure 6-12). Since the capacities of the existing diversions would remain unchanged and the diversion of unused potential would only occur during high flow months, the effect of additional diversions on flows in the San Lorenzo River would be negligible under Scenario 1f.

The 32 percent reduction in South system groundwater pumping simulated for Scenario 1f is estimated to increase the percentage of drought baseflow remaining as a result of assumed groundwater pumping effects by 4 percent in Bean Creek at the Zayante Creek confluence, 3 percent in Zayante Creek at the San Lorenzo River confluence, and 1 percent in the San Lorenzo River at SLRBT compared to existing baseline conditions. These estimated increases in drought baseflows are modest (approximately 0.1 cfs) but biologically relevant during the most critically low flow years in these tributaries where low summer streamflows are considered a primary factor limiting fish habitat even in non-drought years (Alley et al. 2004).

Overall, the simulated effects of Scenario 1f would result in no discernable impact to high surface flows, a meaningful reduction in groundwater pumping promoting in-lieu recharge, and a modest but potentially important increase in minimum drought baseflows in eastern tributary streams. Implementation of this conjunctive use project only requires SLVWD to receive permission to use an existing intertie constructed on an emergency basis for normal (i.e., non-emergency) operations, and therefore represents a "low-hanging fruit" project with long-term water supply benefits and modest but timely fisheries benefits.

4.1.3 Scenario 2b – South System Imports from Loch Lomond for In-Lieu Recharge

SLVWD staff selected Scenario 2b, the import of its Loch Lomond water allotment to the South system as a substitute for pumping the Pasatiempo wells. However, as conceived and simulated in the WAA, Scenario 2b incorporates Scenario 2a, the import of an average of 4 afy of Loch Lomond water to the North system and an average of 50 afy to the Felton system to help meet unmet demand in those systems. SLVWD staff have indicated that the District currently does not plan to import Loch Lomond water to the North and Felton systems. While the imports to the South system account for the majority (78 percent on average) of SLVWD's 313 afy Loch Lomond allotment, and therefore comprise the bulk of the simulated effects to water supply, streamflow, and groundwater levels estimated in the WAA for Scenario 2b, it is important to keep in mind that Exponent (2019) did not simulate a stand-alone scenario comprised of Loch Lomond imports to only the South system, as selected by SLVWD for the Conjunctive Use Plan. As such, results for the Scenario 2b simulation presented in the WAA must be considered in this context.

Scenario 2b assumes that the South system imports an average of 245 afy from Loch Lomond, ranging between 120 and 290 afy. The South system's use of Loch Lomond water would result in a simulated 67 percent reduction in groundwater pumping from the Pasatiempo wells. This in turn would results in an estimated 8 percent increase in drought minimum baseflows remaining in Bean Creek at the Zayante Creek confluence, and a 7 percent increase in drought minimum baseflows in Zayante Creek at the San Lorenzo River confluence (see WAA Table 6-11), equivalent to a drought baseflow increase of approximately 0.15 cfs in both streams. The mainstem San Lorenzo River at SLRBT would receive a 3 percent (0.2 cfs) increase in drought baseflow levels.

Water is diverted and stored in Loch Lomond Reservoir under the City of Santa Cruz's water right permits pursuant to applicable permit terms related to diversion season, maximum diversion rate, and minimum flow requirements for Newell Creek and the San Lorenzo River. Furthermore, the City is in the process of finalizing and implementing a Habitat Conservation Plan (HCP) aimed at avoiding and minimizing effects of its diversions on steelhead and coho salmon, including the agreed-upon increase in bypass flows during the adult salmonid migration and spawning season (see Section 4.1.1). SLVWD's allotment of water stored in Loch Lomond therefore represents environmentally "free" water, or water for which the potentially adverse effects of diversion will have already been avoided or minimized. In other words, no additional adverse effects to streamflows and fisheries habitat would occur if SLVWD were to exercise its Loch Lomond allotment under Scenario 2b. From a fisheries perspective, therefore, Scenario 2b represents an entirely beneficial conjunctive use project.

Moreover, it should be noted that while the estimated increase of approximately 0.15 cfs in minimum drought baseflow levels in Bean and Zayante creeks may be considered modest, the combined implementation of scenarios 1f and 2b may result in a cumulative increase of approximate 0.25 cfs in both creeks during drought conditions, representing a not-insignificant benefit to fisheries resources in these tributaries during the most stressful juvenile rearing periods.

4.2 Fisheries Benefits-Based Scenario

SLVWD lacks significant water storage infrastructure, such as reservoirs, and therefore currently lacks the ability to increase surface water diversions during the high flow winter and spring seasons for storage and later use during the low-flow summer and fall periods. Groundwater levels at the South system's Pasatiempo wells have declined substantially since the early 1980s, and the North system's Olympia wells have exhibited a slight long-term downward trend as well, suggesting that higher rates of extraction may be unsustainable without augmenting recharge (Exponent 2019). SLVWD's 313 afy Loch Lomond allotment provides a potential source of stored water, and conjunctively using this allotment to supply South system demand and promote in-lieu groundwater recharge, as envisioned under Scenario 2b discussed above, is expected to enhance groundwater sustainability and drought baseflow levels in important fisheries tributaries. However, SLVWD's ability to reduce surface water diversion rates in the North and/or Felton systems to enhance fisheries habitat during the low flow period is significantly constrained by a lack of substitute water supply storage infrastructure.

The WAA analyzed three scenarios (3a through 3c) that would increase the yield of the Olympia wellfield in the North System through operation of a hypothetical aquifer storage and recovery (ASR) project supplied by available surface water in excess of monthly water demand (December through May). In the case of Scenario 3a, the ASR would be supplied by an average of 194 afy of unused potential diversions from the North system, and under Scenario 3b, an average of 222 afy of unused potential diversion from the Felton system would be injected into the ASR. Scenario 3c combines the unused potential diversions from the North and Felton systems for an average ASR injection of 412 afy (Exponent 2019). As analyzed in the WAA, all three scenarios assume that the yield from such an ASR project would be used to offset groundwater pumping from the North system (Olympia and Quail Hollow wells). It is important to note that scenarios 3a through 3c all incorporate Scenario 2b (South System Imports from Loch Lomond for In-Lieu Recharge) selected by SLVWD and discussed above in Section 4.1.3.

Under Scenario 3c, the injection and subsequent extraction of an average of 412 afy would reduce North system groundwater pumping by an estimated 64 percent. Combined with the 68 percent reduction in South system pumping due to Loch Lomond imports, Scenario 3c would increase drought minimum baseflows in lower Newell, Zayante, and Bean creeks by 14 to 33 percent compared to existing conditions (see WAA Tables 6-10 and 6-11). These estimated drought baseflow increases are equivalent to approximately 0.26 cfs in Bean Creek at the Zayante Creek confluence, 0.37 cfs in Zayante Creek at the San Lorenzo River confluence, and 0.6 cfs in the San Lorenzo River at SLRBT, and therefore represent potentially significant enhancements of instream flows during the most critical periods. As is the case with all conjunctive use scenarios simulated to rely on currently unused potential diversions, the increased diversions for ASR would occur during wet periods and are not expected to lower minimum monthly flows remaining downstream of the diversions (see WAA Figures 6-15 and 6-16).

While the WAA assumed that all ASR extractions under Scenarios 3a through 3c would be applied to offsetting North system groundwater pumping, the following section discusses a potential modified version of Scenario 3c that utilizes a portion of the simulated ASR storage recovery supply to offset surface water diversions for fisheries enhancement. This modified scenario was identified conceptually during preparation of this fisheries resources assessment and was therefore not considered or analyzed in the WAA. However, Johnson (2019) subsequently analyzed the water supply and conjunctive use implications of this additional scenario, herein identified as Scenario 3d, and the results of the additional analysis informed the following discussion.[5]

4.2.1 Scenario 3d – North System Operates ASR Project Using North and Felton System Unused Potential Diversions, and Reduces Baseflow Diversions from North System

The underlying WAA assumption for Scenario 3c (discussed above) is that the injection and recovery of currently unused potential North and Felton systems diversions in an ASR project would be used to offset the amount of groundwater otherwise withdrawn at the Olympia wells to meet North system summer demand. Under Scenario 3d, SLVWD would implement Scenario 3c, but utilize a portion of the estimated ASR injection/extraction volumes to reduce or temporarily forego summer surface water diversions from the North system, specifically Peavine and Foreman creeks, for fisheries benefits in Boulder Creek and the middle San Lorenzo River reach.

Based on SLVWD production data for WY 2014-2017, average summer baseflow diversions (i.e., combined monthly diversion rates for the Peavine and Foreman diversions) ranged from 0.68 cfs in July to 0.33 cfs in September. The total average combined diversion volume for the July-September period was 91 afy. As such, the total average 2014-2017 summer baseflow diversions from Peavine and Foreman creeks represent less than 25 percent of the estimated average 417 afy of currently unused North and Felton systems high flow diversions to be stored in ASR under Scenario 3d. During drought years 2014 and 2015, SLVWD diverted a combined total of only 36 af and 27 af, respectively, during the July-September low flow period, yet these diversions represented over 20 percent of the unimpaired Boulder Creek flow during that period.

As documented by Balance (2018b), Boulder Creek summer baseflows rose by just under 1 cfs when SLVWD shut-off all its North System diversions for six days in September 2016 for treatment plant maintenance. After the diversions were reinstated, Boulder Creek flows receded gradually to pre-shutdown levels over a period of about two weeks, suggesting substantial shallow groundwater recharge had occurred during the shutdown. Using a portion of injected ASR water to reduce Peavine and Foreman Creek diversion when Boulder Creek flow drops below approximately 2.5 cfs, and foregoing those diversions entirely when Boulder Creek flows drops to approximately 1.5 cfs, would be expected to significantly enhance baseflow rearing conditions for juvenile steelhead and other native fish in Boulder Creek. Moreover, the fisheries benefits of reducing or foregoing baseflow diversions in the Boulder Creek subbasin would be expected to extend downstream into the middle reach of the San Lorenzo River, where Alley et

[5] Nicholas Johnson, formerly of Exponent, was the primary analyst and author of the WAA (Exponent 2019), and his subsequent analysis of Scenario 3d (Johnson 2019) was conducted consistent with methods applied to the previous WAA analyses.

al. (2004) noted the largest impacts of streamflow reductions on juvenile steelhead growth and densities in the mainstem during dry water years.

Johnson (2019) analyzed the water supply implications of Scenario 3d assuming SLVWD would entirely forego from Peavine and Foreman creeks during the period of July through September. Although the reduction in summer diversions from these two sources may be managed in a more nuanced manner based on ambient Boulder Creek streamflow levels, especially during above-average water years, the Johnson (2019) analysis provides a valuable bookend evaluation of the maximum potential fisheries benefit (i.e., complete elimination of summer diversions). Under Scenario 3d, the injection and subsequent extraction of an average of 417 afy would reduce North system groundwater pumping by an estimated 53 percent. Combined with the 68 percent reduction in South system pumping due to Loch Lomond imports, Scenario 3d would increase drought minimum baseflows in lower Newell, Zayante, and Bean creeks by 12 to 30 percent compared to existing conditions (Johnson 2019). These estimated drought baseflow increases are equivalent to approximately 0.22 cfs in Bean Creek at the Zayante Creek confluence, 0.32 cfs in Zayante Creek at the San Lorenzo River confluence, and 0.53 cfs in the San Lorenzo River at SLRBT, and therefore represent potentially significant enhancements of instream flows during the most critical periods. Consistent with Scenario 3c described above, the increased diversions for ASR would occur during wet periods and would not lower minimum monthly flows remaining downstream of the diversions (see WAA Figures 6-15 and 6-16).

While using a portion of the simulated ASR water supply as substitute for baseflow surface diversions (Scenario 3d) rather than applying all of it to reducing groundwater water pumping rates (Scenario 3c) would slightly reduce the WAA-estimated drought baseflow levels benefits to Newell, Zayante, and Bean creeks, the direct benefits to Boulder Creek, estimated at over 1 cfs in some years, as well as to the middle San Lorenzo River, outweigh the slight reduction in benefits to Newell, Zayante, and Bean creeks. In other words, Scenario 3d would distribute the potential benefits of ASR to fisheries habitat throughout a larger portion of the watershed than WAA-envisioned Scenario 3c.

As analyzed by Johnson (2019), SLVWD would utilize Lock Lomond water to meet Felton system unmet summer demand under Scenario 3d. However, SLVWD could potentially also draw from ASR storage to meet Felton system demand during times when diversions at Fall Creek diversions are restricted or prohibited due to Fall Creek bypass requirements, as occurred periodically during WYs 2014 and 2015 (Balance 2015 and 2018a). As described above, SLVWD’s simulated unmet demand in the Felton system under Scenario 1b (Felton System Complies with Required Bypass Only) is 35 afy on average and up to maximum of 85 afy. The use of an average 35 afy use of ASR water for meeting Felton unmet demand would account for approximately 8.4 percent of the simulated average of 417 afy of ASR storage under Scenario 3d.

Furthermore, SLVWD may consider voluntarily complying with the existing non-dry year bypass requirement of 1 cfs in Fall Creek even during dry years, when the currently permitted requirement for a bypass drops to 0.5 cfs. This would help maintain Fall Creek drought streamflows closer to the instream flow recommendations developed through application of the CDFW (2017) methodology as well as the levels identified by DWA (2018b) for unimpeded juvenile salmonid movement. Estimates of the amount of ASR water that would be needed to offset a voluntary increase in Fall Creek bypass flows during dry years are not provided by Johnson (2019), but should be analyzed if SLVWD elects to incorporate this additional fisheries enhancement component into the implementation and operation of Scenario 3d.

If SLVWD chooses to implement Scenario 3d, or any other conjunctive use project that includes temporary reductions in permitted surface water diversions, SLVWD should consider filing petitions for instream flow dedication pursuant to Water Code section 1707 with the State Water Resources Control Board. A section 1707 dedication serves to formally recognize the transaction, preserves the right holder’s rights to the water dedicated to instream flows, and protects the flow dedications from downstream diversion by other right holders.

CHAPTER 5
Summary and Recommendations

5.1 Summary

Based on a review of available fisheries, hydrology, and water supply information, the existing effects of SLVWD's water supply systems on fisheries resources of the San Lorenzo River watershed were analyzed. SLVWD's surface water diversion facilities are located in western tributaries to the mainstem San Lorenzo River that exhibit relatively stable and cool summer baseflows due to their limestone and granitic geology. Most of the diversion are located in steep terrain upstream of the extent of suitable salmonid habitat. Existing capacities and effective rates of SLVWD's surface water diversion are relatively small, accounting for less than 5 percent of flows in downstream streams supporting steelhead and coho salmon during most of the year. During summer baseflow conditions, the relative effects of some SLVWD's diversions increase to as much as 25 percent (e.g., in Boulder Creek). The diversions of cool tributary waters generally do not appear to adversely affect temperatures in downstream receiving channels in most years but may have some limited effect during drought years (e.g., below Fall Creek). Groundwater pumping from the SMGB by SLVWD and others affect baseflows in the sandstone-dominated eastern tributaries of the San Lorenzo River, particularly during below-average and drought years.

The results of the water availability analysis of 22 conjunctive use scenarios (Exponent 2019) were reviewed and evaluated for potential effects on fisheries resources in the context of existing diversion effects. In particular, three scenarios selected by SLVWD for further consideration were evaluated for their expected relative benefits to fisheries habitat. Scenario 1b would relieve SLVWD of existing minimum flow requirements at SLRBT and provide it greater flexibility in its operation of the Felton system in a manner that is not expected to adversely affect fisheries resources of the San Lorenzo River while potentially improving fish habitat conditions in Fall Creek. The other two SLVWD-selected scenarios would promote in-lieu recharge of the SMGB by supplying the South system with imports of North system unused potential diversions (Scenario 1f) or Loch Lomond allotment water (Scenario 2b). Both these scenarios are estimated to result in modest increases in drought minimum baseflow in Bean and Zayante creeks, as well as minor increases in the San Lorenzo River due to reduced pumping of the Pasatiempo wells.

Neither of the three conjunctive use scenarios selected by SLVWD, or of the 22 scenarios analyzed in the WAA, would enable SLVWD to reduce direct surface water diversions from salmonid-supporting streams during low summer baseflow conditions. Scenario 3d, a fisheries benefits-based scenario identified in this evaluation and based on WAA Scenario 3c, would utilize a portion of currently unused potential diversions from the North and Felton systems stored and recovered from an hypothetical ASR project to reduce or temporarily suspend surface water diversions from tributaries to Boulder Creek, as well as potentially Fall Creek, during low baseflow conditions. The majority of ASR-injected water would remain available for in-lieu recharge through reduced groundwater pumping from the Olympia wells, as envisioned by the WAA-analyzed version of Scenario 3c.

Table 5-1 provides a qualitative matrix summarizing and comparing expected effects of the four conjunctive use scenarios.

TABLE 5-1

QUALITATIVE SCORE MATRIX OF ASSUMED INSTREAM FLOW EFFECTS EXPECTED TO RESULT FROM IMPLEMENTATION OF FOUR CONJUNCTIVE USE SCENARIOS

Surface Water Sources	Scenario 1b	Scenario 1f	Scenario 2b	Scenario 3d
Boulder Creek wet season flow	0	0	0	0
Boulder Creek dry season flow	0	0	0	+2
Clear Creek wet season flow	0	-1	0	-1
Clear Creek dry season flow	0	0	0	0
Fall Creek wet season flow	0	0	0	-1
Fall Creek dry season flow	+1	0	0	+1
Bull Creek wet season flow	0	0	0	-1
Bull Creek dry season flow	0	0	0	0
Newell Creek drought minimum flow	0	0	+1	+2
Bean Creek drought minimum flow	0	+1	+1	+2
Zayante Creek drought minimum flow	0	+1	+1	+2
San Lorenzo River drought minimum flow	0	+1	+1	+2
Score:	**1**	**2**	**4**	**7**

Notes:
0 = minimal or no effect; +1 = moderate improvement
+2 = significant improvement; -1 = moderate reduction

5.2 Recommendations

The WAA analyzed 22 conjunctive use scenarios separately and largely on a stand-alone basis. Now that SLVWD has selected three potential scenarios for further consideration, and a fourth is presented here for potential additional benefits to salmonids and other native species in the San Lorenzo River watershed, the implementation, over time, of a feasible combination of scenarios should be analyzed. Based on the above analysis, near-term implementation of Scenarios 1b and 2b, combined with future implementation of Scenario 3d would provide basin-wide improvements to fisheries resources and water supply reliability, including increased summer baseflows in Boulder, Fall, Bean, and Zayante creeks and, by extension the mainstem San Lorenzo River, as well as reduced pumping and increased sustainability of groundwater sources of the SMGB. If fully implemented, this combination of conjunctive use projects would also enable SLVWD to fully comply with modified Felton system water right terms. It should be noted that Scenario 3d, as simulated by Johnson (2019), incorporates implementation of Scenario 2b.

SLVWD-selected Scenario 1f is recommended for short-term implementation as it represents the conjunctive use project that could be implemented with existing infrastructure. If and when Scenario 3d is implemented, however, Scenario 1f would need to be abandoned as both scenarios rely on unused potential diversion from the North system. Given the limited implementation needs and costs of Scenario 1f, it is assumed that SLVWD would be able to switch from Scenario 1f operations to Scenario 3d operations without additional effort or lost investment. Furthermore, implementation of Scenario 1f would provide SLVWD with additional operational flexibility if and when Scenario 3d is implemented.

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CHAPTER 6
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