Santa Cruz Water Department

in association with

San Lorenzo Valley Water District

San Lorenzo River and North Coast Watersheds Sanitary Survey Update

February 2018

Kennedy/Jenks Consultants

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February 2018

Prepared for

City of Santa Cruz
715 Graham Hill Rd.
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In association with
San Lorenzo Valley Water District

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Executive Summary

The narrative below is a high-level summary of the major Watershed Sanitary Survey topics discussed in detail in this Watershed Sanitary Survey (WSS) Update for the City of Santa Cruz Water Department (SCWD) and the San Lorenzo Valley Water District (SLVWD), which merged with the Lompico County Water District in 2016.

Watersheds and Water Supply Systems: - The City of Santa Cruz (City) owns 3,640 acres, and SLVWD owns 2,231 acres, and also owns, through merger with the Lompico County Water District about 13 acres of additional land of the estimated 76,400 total acres within the San Lorenzo River upstream of the Tait Street diversion. Land ownership provides the ability to influence water quality management activities within the lands under agency control including prohibitions on timber harvest. In addition, there are other entities including Santa Cruz County, State of California Parks (Parks), and non-profit organizations such as Sempervirens Fund that can own, regulate and/or protect watershed lands for water quality benefit. Almost one-quarter of the lands in the San Lorenzo River are under ownership by entities that retain them as preserves.

The North Coast watershed sources fall under a range of public and private ownership with associated benefits and challenges, such as public access and associated water quality risks. The 7,600 acres of the North Coast watershed sources are mostly under private ownership. However in 2011, a large swath of the CEMEX properties were acquired by a group of private organizations which results in the protection of an additional 8,532 acres of land, called San Vicente Redwoods, some of which drains into the upper reaches of Laguna Creek. Only a portion of this land is upstream of the City's diversion The land is owned by the Sempervirens Fund and Peninsula Open Space Trust (POST) with funding support from Save the Redwoods League, the Nature Conservancy, the Santa Cruz County Land Trust, and a number of foundations. The San Vicente Redwoods lands is currently under the management of the Land Trust of Santa Cruz County and includes plans for a park ranger program. Access to the San Vicente Redwoods may be provided through the adjacent federally owned Cotoni Coast Dairies National Monument which will be managed by the US Bureau of Land Management. In addition, the quarry in the Liddell Springs watershed which is one of the City's North Coast sources is also privately owned.

Potential Contaminant Sources: As discussed in Section 3, Section 6.2 and summarized in Table 6-2, there are a number of contaminant sources that can contribute sediments, pathogens, and chemicals that are potentially significant to drinking water quality which include:

- Cannabis Cultivation
- Wastewater and Urban Runoff
- Confined Animal Facilities
- Unauthorized Activity
- Roads including Timber Harvest Roads
- Mining/Quarry Activities
- Geologic Hazards and Fires including landslides after significant rains
- Chemical Spills
- Pesticides and Herbicides

Watershed Management Activities: As discussed in Section 4, watershed management jurisdiction in the San Lorenzo and North Coast watersheds is distributed; the majority of the watershed is governed by Santa Cruz County and/or regulated by Federal and state agencies such as National Oceanic and Atmospheric Administration (NOAA) Fisheries, US Army Corps of Engineers, California Regional Water Quality Control Board (RWQCB), Parks, California Department of Forestry and Fire Protection (CalFire), and California Department of Fish and Wildlife (CDFW) with the water purveyors jurisdiction limited mostly to those areas that they have land ownership as summarized earlier. In addition, local non-governmental organizations can play a role in watershed protection and water quality improvement as partners as well as individually.

Watershed management includes regulatory activities and management/planning activities which are detailed in Section 4. Regulatory activities include the County's ordinances on cannabis cultivation, wastewater management, water quality, riparian and sensitive habitats; State regulations on beneficial use and permitting of stormwater, urban runoff, riparian zone construction, and timber harvest by the California Regional Water Quality Control Board (RWQCB); and federal water quality regulations for waste discharge and wetland filling. Specific discussion regarding the non-drinking water quality regulatory activities is discussed further below.

Management and planning activities also occur at the local, state and federal levels and include the City's draft watershed lands management plan that can include patrol of riparian areas; the County's General Plan, cannabis cultivation ordinances and regulations that are under development, San Lorenzo River Watershed, Wastewater, and Nitrate Management Plans as well as County road maintenance manuals; the activities of local non-governmental organizations to educate and work with landowners on horse stable management, fire protection, and water quality improvement; and State fire and fuel management plans within the State Parks as well as on other lands. Collectively, these regulations and watershed management plans generally provide a high level of oversight of activities that impact and improve water quality which is supported by the water quality data. However, coordination between the entities and their activities can be improved upon.

In addition, City staff has been creative in implementing measures that have the potential to directly improve water quality. Measures include spearheading the San Lorenzo River 2025 collaborative effort for habitat restoration and watershed protection; wildfire planning; funding riparian area patrols as well as establishing conservation agreements on private lands that allow City staff to patrol upstream of drinking water diversions. These efforts include restoring and improving the waterway especially as related to fisheries habitat improvements. On a broader San Lorenzo River watershed basis, the City has partnered with non-governmental organizations (NGOs) such as the Resource Conservation District of Santa Cruz County (RCD) to educate watershed users by installing watershed identification signs and signs at creek crossings and watershed divides; has vastly increased its watershed interpretive and outreach programming in recent years. The City has also been involved in significant fire preparedness work on its watershed lands surrounding Loch Lomond Reservoir. Other water quality improvement activities of NGOs including participation in a county-wide Fire Safe council as well as continuing to support efforts by organizations such as Sempervirens Fund and POST's efforts to acquire and protect watershed lands; both of which provide significant benefit to drinking water quality.

Non- Drinking Water Regulatory Challenges: Regulatory challenges such as water quality Total Maximum Daily Loads (TMDLs) administered by the RWQCB and fisheries-related Habitat Conservation Plans (HCP) administered by National Oceanic And Atmospheric (NOAA)-National Marine Fisheries Service (NMFS) as well as weak enforcement of County and State regulations within the watersheds continue to challenge the City. For example, implementation of TMDLs for pathogens and nutrients will ultimately benefit water quality but the City must rely on many other individuals to remove these constituents. In addition, implementation of the instream flow targets for HCPs, described in greater detail in Section 2.3.5, may limit the City's use of their high quality North Coast water sources which will increase reliance on other sources with higher total organic carbon and resulting disinfection challenges.

Water Quality Data Summary: Water quality data for the period from 2011-2016 found in Figures and Tables in Section 5 indicate no unexpected changes in total coliform, turbidity, or nitrate concentrations in the City's North Coast or the San Lorenzo River watershed sources for the City or SLVWD; expected seasonal and dry/wet year variations have occurred. The North Coast sources, in particular Liddell Spring, have continued to have lower total coliform levels when compared to the San Lorenzo River sources.

Conclusions and Recommendations: The San Lorenzo and North Coast watersheds are generally providing a high water quality, with some expected variability during the wet season, particularly during the heavy winter rains of 2016-2017. The agencies closely manage the high turbidity events by bypassing stormflows, using stored water and/or alternative sources, that, when combined with the water treatment processes at the WTPs, are delivering a consistently safe drinking water to the residents. However, the City faces some future regulatory challenges as well as interest in wintertime flows for regional water supply reliability, may make it more difficult to continue to meet the drinking water regulations. The City has evaluated the water quality data in greater detail and has identified some potential changes, for discussion with Division of Drinking Water (DDW) staff, which can be implemented to ensure it continues to meet drinking water regulations in the future.

More specific conclusions and recommendations are discussed in Section 6 and summarized in Table 6-4 and include activities such as continuing:

- Coordination of acquisition and review of water quality monitoring data, particularly as it relates to cannabis cultivation
- Implementation of County wastewater management and other management plans, cannabis regulations, road maintenance manual, and ordinances as well as coordinating with County agencies such as Emergency Response for toxic spills
- Review of developments in the watersheds including accessory dwelling units in rural areas, especially near diversions
- Support of local non-governmental organizations in public education and implementation of best management practices for roads and confined animals as well as land acquisition for preserves
- Improving collaboration with state regulatory agencies with regard to timber harvests, forest fuel management, illegal cannabis cultivation (especially State Water Resources Control Board regulations), and fisheries habitat improvement

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SECTION 1:INTRODUCTION

Sanitary surveys are required by the State Water Resources Control Board, Division of Drinking Water (DDW) formerly the California Department of Public Health to be completed for each watershed that is a drinking water source. Updates are required every five years per the State of California Surface Water Treatment regulations (Chapter 17, Title 22). These requirements incorporate the Surface Water Treatment Rule (SWTR) mandated by the United States Environmental Protection Agency (EPA) and enforced by DDW as a primacy agency for federal regulations.

This sanitary survey includes the San Lorenzo River and North Coast watersheds, all within Santa Cruz County, California (Figure 1-1). The first sanitary survey for this area was completed in 1996 by Camp Dresser & McKee, was updated in 2001 by the City of Santa Cruz Water Department (SCWD or City), and subsequently updated in 2006 and 2013. The sanitary surveys include content for the SLVWD and the Lompico County Water District (LCWD) which merged with SLVWD in 2016[1], which share portions of the San Lorenzo River watershed. This sanitary survey update is based on numerous discussions with utility and regulatory staff, review of various reports, an evaluation of historic and recent water quality monitoring results, and analyses of the ongoing management practices within the watershed area.

1.1 Study Area

Figure 1-1 illustrates the approximate watershed boundaries of the San Lorenzo River and North Coast watersheds, all within Santa Cruz County. The San Lorenzo River is the watershed for numerous water purveyors including SCWD and SLVWD. The North Coast watersheds included in this study provide water only to the SCWD. Several large surface water intakes are located throughout the study area.

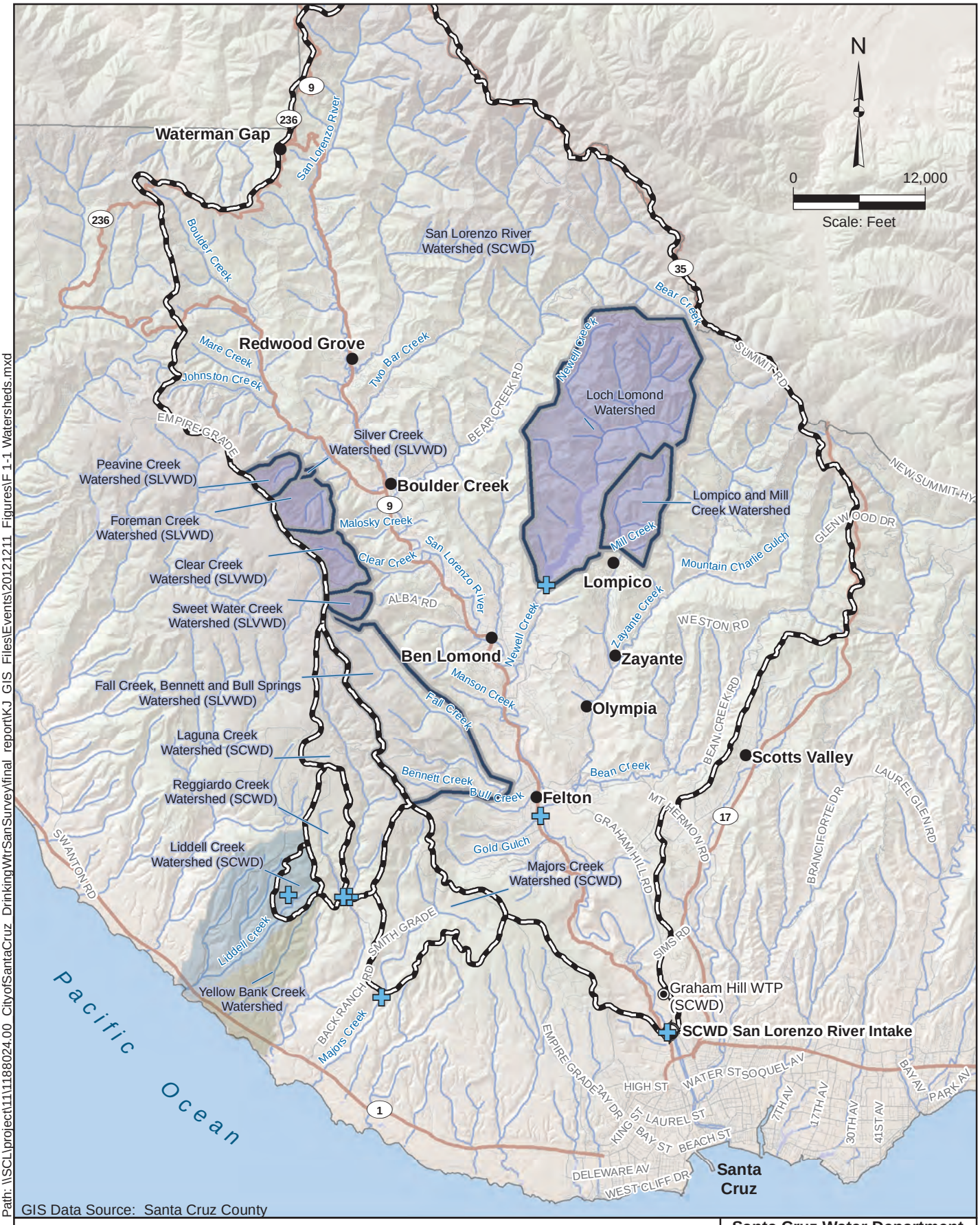
1.2 Watershed Sanitary Survey Requirements

A watershed sanitary survey is a detailed evaluation of surface water sources and their vulnerability to contamination. It is more comprehensive than a Source Water Assessment (SWA) and can be used in place of a SWA to fulfill the requirements of California's 1996 Drinking Water Source Assessment and Protection (DWSAP) Program. Whereas a SWA ranks and inventories possible contaminating activities (PCAs) located within the source area, a sanitary survey provides more background, descriptive information, and review of all relevant monitoring data.

Specific sanitary survey requirements are:

- Conduct a sanitary survey of the watershed(s) at least every five years.
- Describe the hydrological conditions of the watershed, summarize source water quality data, describe activities and possible contamination sources, and identify any significant changes since a previous survey was conducted.
- Describe watershed control and management practices.

[1] Reference to SLVWD includes the areas previously known as Lompico County Water District which merged with SLVWD in 2016.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0
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Waterman Gap
Redwood Grove
Boulder Creek
Ben Lomond
Lompico
Zayante
Olympia
Felton
Scotts Valley
Graham Hill WTP (SCWD)
SCWD San Lorenzo River Intake
Santa Cruz
San Lorenzo River Watershed (SCWD)
Loch Lomond Watershed
Lompico and Mill Creek Watershed
Silver Creek Watershed (SLVWD)
Peavine Creek Watershed (SLVWD)
Foreman Creek Watershed (SLVWD)
Clear Creek Watershed (SLVWD)
Sweet Water Creek Watershed (SLVWD)
Fall Creek, Bennett and Bull Springs Watershed (SLVWD)
Laguna Creek Watershed (SCWD)
Reggiardo Creek Watershed (SCWD)
Liddell Creek Watershed (SCWD)
Majors Creek Watershed (SCWD)
Yellow Bank Creek Watershed
Pacific Ocean
GIS Data Source: Santa Cruz County
Area Locations
Graham Hill WTP
Santa Cruz Water Department Diversions
City of Santa Cruz Wells (GWUDI only)
Santa Cruz City Water Supply Watersheds
Sub-Watershed
Santa Cruz Water Department
WSS Update
San Lorenzo Valley and North Coast Watersheds
Path: \\SCL\project\111188024.00 CityofSantaCruz DrinkingWtrSanSurvey\final reportKJ GIS Files\Events\20121211 FiguresIF 1-1 Watersheds.mxd

Figure 1-1

- Evaluate compliance with the SWTR with a focus on disinfection requirements.
- Recommend corrective actions to maintain or improve water quality.

1.3 Objectives

The objectives of this project are to:

- Prepare a stand-alone document that complies with the DDW requirements to update the 2013 watershed sanitary survey.
- Identify potential sources where chemical and microbiological contaminants may enter the water supply.
- Establish the baseline information needed for a watershed management program.
- Recommend actions to enhance water quality protection and watershed management.

The drinking water purveyors involved in this project should use this report to compare existing water quality conditions with future monitoring data, implement practices to improve water quality, and reduce the risk of source water contamination.

1.4 Participating Drinking Water Utilities

Two drinking water utilities are participating in this project because they receive surface water from the San Lorenzo River watershed area. The water purveyors that participated in this update include:

- City of Santa Cruz Water Department
- San Lorenzo Valley Water District (merged with LCWD in 2016)

1.5 Report Organization

This report follows the format in the *Watershed Sanitary Survey Guidance Manual* as required by DDW so that it conforms with reports developed by other suppliers for their watershed areas. Specific sections are:

Section 1: Introduction
Section 2: Watershed and Water Supply System
Section 3: Potential Contaminant Sources in the Watersheds
Section 4: Watershed Management and Control Practices
Section 5: Water Quality Regulations and Evaluation
Section 6: Conclusions and Recommendations

Figure 1-1, located at the front of this report, illustrates the approximate watershed boundaries, key subwatersheds, location of the large raw water intakes, primary roadways, and streams within the study area.

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SECTION 2:WATERSHEDS AND WATER SUPPLY SYSTEMS

2.1 Watershed Description

The San Lorenzo River and North Coast watersheds and water purveyors which use surface water are described in this section. The watershed area, subwatersheds within the San Lorenzo Valley, and approximate land areas are listed in Table 2-1.

Table 2-1: Watershed Areas and Drinking Water Purveyors Served [1]

Watershed Area	*Utilities Served*	*Watershed Area[3]*	
		Acres	*Square Miles*
San Lorenzo River (upstream of the SCWD intake in Santa Cruz)	SCWD, SLVWD [2]	74,000	115
Subwatersheds			
Loch Lomond Reservoir on Newell Creek	SCWD and SLVWD	5,728	8.95
Fall Creek, Bennett and Bull Springs	SLVWD	2,600	4.1
Sweetwater Creek	SLVWD	180	0.3
Clear Creek	SLVWD	460	0.7
Foreman Creek	SLVWD	500	0.8
Silver Creek	SLVWD	20	0.03
Peavine Creek	SLVWD	230	0.4
Lompico Creek (currently unused)	SLVWD	1,470	2.29
North Coast Watersheds			
Liddell Spring	SCWD	3,994	6.24
Laguna Creek	SCWD	2,560	4.0
Reggiardo Diversion	SCWD	3,584	5.60
Majors Creek	SCWD	2,500	3.9

[1] Figure 1-1 shows the study area primary watersheds and subwatersheds within the San Lorenzo River, the North Coast watersheds, and the general locations for each utility.

[2] Numerous other drinking water purveyors with less than 200 service connections use surface water from this watershed.

[3] The watershed area is the drainage area above the intakes and not the full watershed for the water body

2.1.1 Regional Hydrologic Setting

The project area includes the San Lorenzo River watershed and the North Coast watersheds which include Majors Creek, Laguna Creek, and Liddell Creek watersheds in north central Santa Cruz County. The City diverts water from Reggiardo Creek, which provides a minimal amount of flow, into Laguna Creek where a larger diversion exists. The San Lorenzo River watershed is the largest contiguous watershed area in the area with an overall area of about 74,000 acres or 115 square miles above the San Lorenzo River Intake in Santa Cruz. The smaller North Coast watersheds are west of the City of Santa Cruz and drain the coastal side of Ben Lomond Mountain[2]. The North Coast watersheds have a total area of about 7,000 acres, or approximately 11 square miles. The SCWD maintains the Loch Lomond Reservoir on Newell Creek-- a tributary to the San Lorenzo River, located near the town of Ben Lomond.

[2] Because Ben Lomond Mountain is so asymmetrical, with a steep eastern face, it is likely that subsurface flows from near its crest drains eastward into the San Lorenzo Valley (see Hecht, 1978; Johnson, 1999). Hence, headwardmost portions of the Laguna and Majors topographic watersheds may be recharge areas to San Lorenzo Valley sources.

2.1.2 Prior Studies

The City and County of Santa Cruz, as well as the area water purveyors, have conducted evaluations of watershed management, water supply, and water quality protection. Key existing information sources include hydrologic and water quality studies conducted by the County of Santa Cruz, U.S. Geological Survey, U.S. Army Corps of Engineers, Central Coast Regional Water Quality Control Board (Regional Board), California Department of Water Resources, local water purveyors, and consulting specialists. Much of this work is considered and cited in several summary reports (Ricker, 1994; Hecht and others, 1991; Camp Dresser & McKee, 1994; Swanson, 2001; and the San Lorenzo River Watershed Plan Update, 2001). Recent studies have included a US Department of Agriculture low-level water quality analysis in 2012, SCWD water quality analyses for contaminants of emerging concern and studies related to karst geology in 2016. Pertinent findings of these investigations are incorporated into this report.

Streamflow in the area has been measured by several resource agencies throughout the last several decades. On the San Lorenzo River, the U.S. Geological Survey (USGS) operates long-term stream gages at Big Trees (at the Henry Cowell State Park entrance road) and at Santa Cruz (near the SCWD San Lorenzo River intake in Santa Cruz) as shown on Figure 1-1.

In the past, USGS operated gages for multi-year periods at: San Lorenzo River near Boulder Creek, Boulder and Bear Creeks near Boulder Creek, Newell Creek (prior to the construction of Loch Lomond Reservoir), Zayante Creek at Zayante, Bean and Carbonera Creeks in Scotts Valley, and Branciforte Creek in Santa Cruz. In the North Coast watersheds, the USGS operated gages for multi-year periods at: Majors Creek, Laguna Creek, and San Vincente Creek, an adjoining watershed of similar size immediately to the west of Laguna Creek.

From 2000 to the present, the City established ten gaging stations within the study area to help manage the water resource and in-stream habitat, some of which occupy former USGS gaging stations. Two gages are located within the San Lorenzo River watershed: on Newell Creek, above and below Loch Lomond. Eight gages are located in the North Coast watersheds: three gages are on Laguna Creek; three gages are located on Majors Creek; and two gages are located on Liddell Creek. Some of these stations are equipped with specific conductance and temperature sensors or have had such measurements made routinely over the past several years. Historically, Scotts Valley Water District had two gaging stations on Bean Creek near Scotts Valley: one at Mount Hermon Camp, and the other upstream at Mount Hermon Road (former USGS site); these gages may restart soon.[3]

Water quality stations were operated for several years at the San Lorenzo River gages by the USGS or the California Department of Water Resources (DWR).[4] Water quality and instantaneous flow were monitored intermittently in Kings, Two Bar, Love, Fall, and Lompico Creeks, and on lower Zayante Creek below Bean Creek, although no daily records were developed. Much of the USGS water-quality information has been summarized in a report by Sylvester and Covay (1978). Santa Cruz County has routinely sampled an array of other stations in the San Lorenzo River watershed. The City regularly samples water quality from San Lorenzo River sources (Loch Lomond, the Felton Diversion, and the intakes in Santa Cruz) and from North Coast sources (Liddell Spring, Laguna Creek, and Majors Creek). The City measures turbidity, with varying frequency, for each of its water sources. The SLVWD regularly samples water quality at each point of diversion: Clear Creek, Peavine Creek, Sweetwater

[3] Bean Creek at Mount Hermon is a continuous turbidity monitoring station, while upstream Bean Creek at Mount Hermon Road is a continuous specific conductance monitoring station.

[4] DWR also sampled the coastal streams for water quality on a monthly, and then on an intermittent basis, during the 1960s and 1970s.

Creek and Foreman Creek. Meters have been installed on all diversions to measure diverted water. Bypass flows are metered electronically on Clear Creek and data is available online at: http://www.balancehydrologics.com/clear/. SLVWD completed Parts I- Existing Conditions and II- Goals, Objectives, and Policies of the Watershed Management Plan for the SLVWD watersheds in 2009 and 2010 respectively.

SLVWD staff sample at the Lompico Creek intake structure; these data are recorded and kept on-site in case Lompico Creek is used as a water supply in the future.

While streamflow gaging has diminished in the San Lorenzo Valley over the past 25 years, the number of stations at which water-quality sampling is conducted generally remained consistent, although periodic changes to frequency of sampling and the number of constituents tested can occur, particularly for special studies.

2.1.3 Significance of Storms, Droughts, Geology, and Baseflow

Streamflow in the Santa Cruz Mountains varies seasonally. About 85 percent of annual rainfall occurs in the six months from December through May. Winter precipitation generally does not increase streamflow until after soil saturation occurs, following the initial rains of the season, with the highest flows typically occurring from late December through March. Streamflow declines sharply after the winter rains cease. Snows are relatively rare in the Santa Cruz Mountains and do not create a snowmelt-runoff season. Since the 2013 WSS Update, California and the western states have been affected by a multi-year drought with below average rainfall starting in 2012 and continuing into the fall of 2016. The drought was followed by an extremely wet winter with precipitation from October 2016 to March 2017 at 162 percent of average.

The longest continuous period of record for streamflow in the area is the USGS gage on the San Lorenzo at Big Trees located just south of Felton (USGS Station No. 11160500). This gage has operated since 1937 and measures discharge from about 85 percent of the watershed upstream of the SCWD San Lorenzo River intake in Santa Cruz. The maximum recorded discharge was 30,400 cfs (19,600 million gallons per day or 'mgd') on December 23, 1955. The minimum instantaneous daily discharge was 5.6 cfs (3.6 mgd) on July 27 and 28, 1977, during an intense drought. The annual mean runoff for the period of water year 1937 to water year 2017 is 128 cfs (83 mgd). As described earlier, the recent above average water year resulted in high stream flows in the San Lorenzo River. January – March 2017 experienced ten distinct, major storm systems that produced very significant peak flows, five of which registered higher than 10,000 cubic feet per second at times. The highest events on January 10 and February 7 resulted in flooding and some damage of critical water system infrastructure.

Surface water quality in the San Lorenzo River watershed fluctuates seasonally in relation to streamflow. During periods of high runoff, sediment and organic debris, urban runoff, animal wastes and wastewater from septic systems enter the surface water system. High levels of turbidity and pollutants during these events can limit the source water available for treatment. During dry periods and droughts, groundwater sustains baseflow to the area streams. The groundwater quality varies widely because of both geologic and human influences. As groundwater contributes to streamflow, it may carry dissolved constituents from the bedrock formations, discharges from septic systems, and other constituents that have percolated into the aquifer.

In general, water quality in the San Lorenzo River watershed is primarily influenced by the three geologic subareas bounded by the Zayante and Ben Lomond faults (c.f., Battleson, 1966; Ricker and others, 1977; Sylvester and Covay, 1978). North of the Zayante fault, streams

draining the older sedimentary formations contain relatively high concentrations of dissolved solids (c.f., Philips and Rojstaczer, 2001). The upper watersheds of the San Lorenzo River, and Kings, Two Bar, Bear, Zayante and Newell Creeks are all underlain mainly by erosive sedimentary formations, principally the Butano sandstone, Two Bar shale, Rices mudstone, Vaqueros sandstone, and Lambert shale.

South of the Zayante Fault and east of the Ben Lomond fault, streams originate in the younger sedimentary formations and contain water of intermediate quality. Rainfall runoff tends to occur slowly because of the higher permeability soils that have developed on parts of the Santa Margarita sandstone, Lompico sandstone and Purisima formation (most commonly a water-bearing sandy shale, but locally quite sandy). These geologic formations are shown on Figure 2-4 and discussed further in Section 2.3. Less permeable geologic formations in these eastside streams include the Monterey formation and the Santa Cruz mudstone. The high rates of recharge and relatively large available groundwater volumes within the Santa Margarita sandstone have resulted in extensive development of its water resources. Use of wells has lowered ground-water levels and diminished streamflow, altered the direction of groundwater flow, and helped to induce increases in the dissolved solids ('salts') and nitrate levels in this aquifer, originating (respectively) from ground-water inflow from deeper aquifers and from partial recharge from leach fields or other sources that contribute human or livestock wastes. The larger streams with seasonal baseflows from these formations include Bean, Zayante, Lompico, and Love Creeks.

West of the Ben Lomond fault, San Lorenzo tributary streams drain the igneous and/or metamorphic rocks, have relatively lower concentrations of dissolved solids and tend to provide high quality water at reasonably constant rates. The weathered upper zone of the rocks (principally granodiorite, quartz diorite, schist, and limestone/marble karst) exposed on Ben Lomond Mountain serves to recharge precipitation and provide dry-season baseflow to the streams that drain the east side of Ben Lomond Mountain. These include Jamison, Peavine, Foreman, Malosky, Clear, Fall, and Shingle Mill Creeks, and Hubbard and Gold Gulches, as well as Bennett Corvin, and Pogonip Springs. Flows in Boulder Creek during dry seasons or drought years are also sustained primarily by flows emanating from these crystalline rocks. Hare Creek and upper Boulder Creek drain similar watersheds from Ben Lomond Mountain, but are underlain by sedimentary rocks generally yielding much lower rates of summer baseflow (Hecht, 1977).

In the North Coast watersheds, surface water in the streams are also influenced by the same crystalline rocks of Ben Lomond Mountain. In addition, the Lompico sandstone, Monterey formation, and Santa Margarita sandstone overlay the crystalline rocks of Ben Lomond Mountain and provide ground-water storage and baseflow to the streams. Sinkholes and cavernous fractures (i.e. karst formations) occur in several parts of the Laguna and Majors Creek watersheds and at Liddell Spring, which serves as the most distant and reliable North Coast source of water for the SCWD. These karst formations provide subterranean connectivity between the Laguna and Liddell watersheds, essentially increasing the Liddell Spring drainage area by up to 2,000 acres (P.E. LaMoreaux & Associates Inc., 2005a). Upstream of the City's diversion, Majors Creek has been generally and actively incising into the underlying alluvium and weathered sedimentary rocks since at least the 1960s (Hecht and others, 1968; Hecht, 1978), contributing waters that are typically more turbid than in Laguna Creek or at Liddell Spring (Camp Dresser McKee, 1996).

2.2 Land Use and Water Quality

This subsection describes land use and aspects of the natural setting that may affect potential contaminant sources. In general, there have been limited changes to land uses in the watershed since the 2013 sanitary survey.

2.2.1 Land Use

There are a variety of land uses in the watershed including: timber production, quarrying, agriculture, ranching, rural residential and unincorporated communities with urban densities as found on Figure 2-1. Almost one-quarter of the San Lorenzo River watershed lands are in public or private ownership for natural resource conservation. In the 1960's and 1970's, Santa Cruz County experienced rapid growth in both population and development. The San Lorenzo Valley entered a period of transition from primarily seasonal vacation homes to full-time residences which are nearly complete today. The subsequent pressure on existing infrastructure and natural systems has led to several water quality issues worthy of note

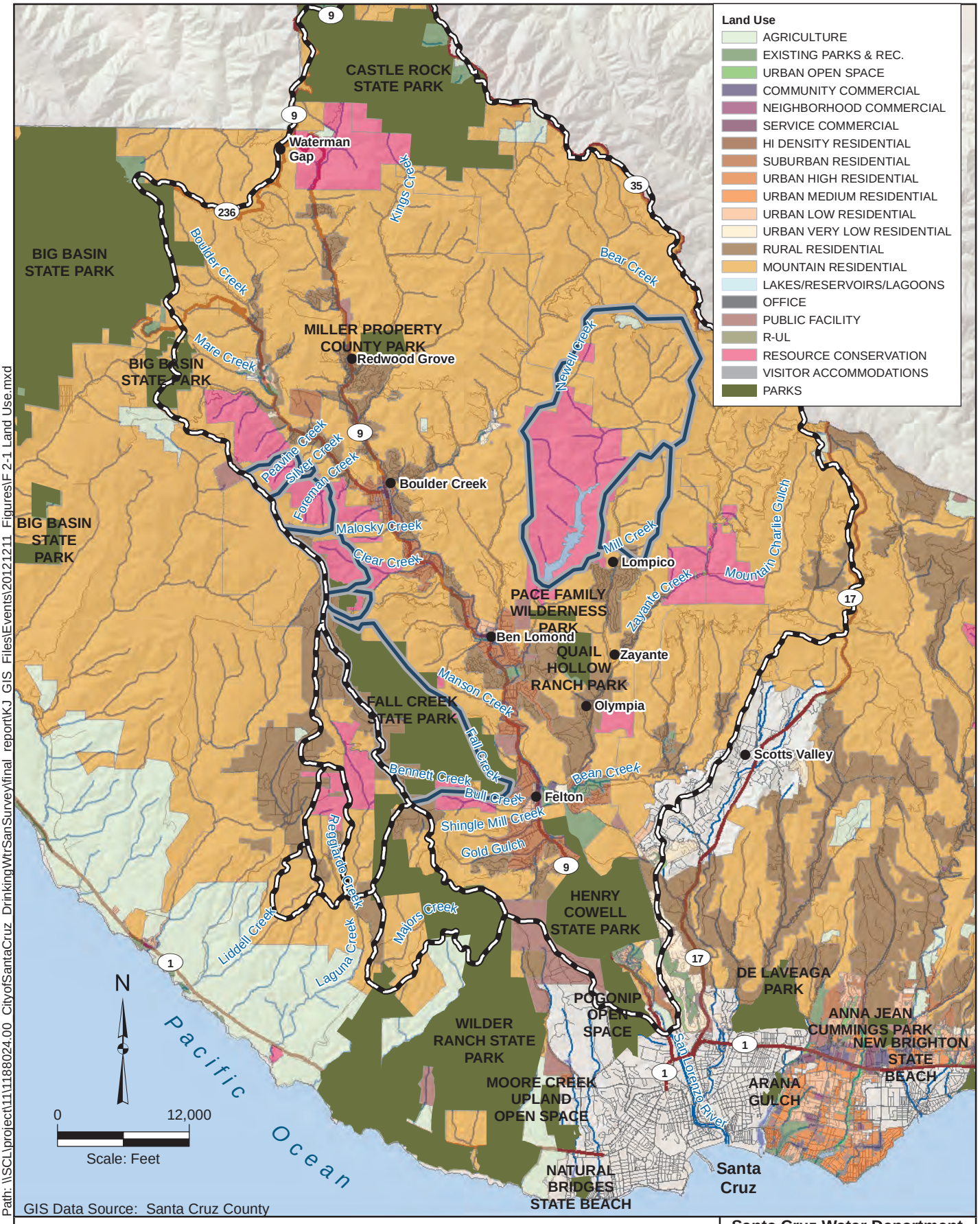
During the period of rapid growth, year-round residential occupancy of properties that were originally developed for summer use increased which resulted stress on on-site disposal systems in the San Lorenzo River watershed. Systems designed for seasonal use struggle with both the added load and the issue of higher groundwater during the winter months that has been found to communicate undesirably with the disposal systems. At the same time, new residential development occurred which added more on-site disposal systems at increased density.

Existing and new development activity occurring in steep and remote areas of the watersheds increasing runoff and erosion, leading to increases in sedimentation and persistent turbidity in water supply streams. The resulting water quality issues also impact riparian corridors and can thus be attributed both to decisions made at the level of individual lots with respect to grading and land clearing as well as cumulative impacts of widespread development. Similarly, activities and development in the riparian areas can also impact water quality in a manner similar to those in steep and remote areas.

Furthermore, continuous use of unpaved roads to access residences, especially in wet periods, contributes both sediment and turbidity to receiving waters. Partially offsetting these trends is growing acreage of lands no longer open to logging, most significantly in the headwaters of the San Lorenzo River and on lands of the San Lorenzo Valley Water District and the City of Santa Cruz Water Department. In addition, additional effort related to riparian area enhancement is envisioned as discussed in Section 4.9.

Many of the same dynamics have affected land use in the North Coast watersheds, although the initial proportion of seasonal homes was much lower. Residential growth has been steady through the past 40 years but has flattened in recent years. As in the San Lorenzo River watershed, virtually all wastewater disposal is through leach fields, so the volume and areas of watershed affected are growing.

Figure 2-1 shows the general developed areas within the watersheds as well as the protected public park lands within the San Lorenzo River watershed. As detailed in the following sections, regulations related to Accessory Dwelling Units (2.2.2 Residential), the impacts of cannabis cultivation in the San Lorenzo River watershed (2.2.3 Agricultural), and potential public access of additional lands (2.2.6 Recreation) are land use changes with water quality impacts.



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Santa Cruz Water Department
WSS Update

Land Use

Figure 2-1

2.2.2 Residential

Within the survey area, the majority of the population is concentrated along Highway 9 on the floor of the San Lorenzo Valley. Steep slopes and rugged terrain have long been a significant constraint to commercial and residential development in all areas of Santa Cruz County. As a result, the county is rural in character, heavily forested, and visually dominated by open space.

The 2015 ACS 5-year population estimate indicated a population of 41,814 people in the San Lorenzo Valley (Census Tracts 1203 through 1209), which is 0.7 percent greater than the population of 41,538 reported in the 2010 census. The 2015 census gave a population for the North Coast (Census Tract 1202) of4,405, an increase of just 2.9 percent compared with the 2010 census population of 4,283. The actual population in the North Coast water supply watersheds is significantly less than the census tract value because the latter includes residents of Davenport, Swanton, and dispersed residences along Highway 1 which lie outside of the small watersheds above the SCWD intake structures.

Within the San Lorenzo Valley, the majority of the population lives in unincorporated communities located along the San Lorenzo River. Felton, Ben Lomond, Brookdale, and Boulder Creek stretch out along State Highway 9. Other communities have developed along major tributaries to the San Lorenzo, including the areas along Zayante Creek and Lompico Creek. Several closely-packed residential communities which originated as summer 'encampments' also exist in the area. These include the Paradise Park, Forest Lakes, Mount Hermon, Riverside Grove and San Lorenzo Park subdivisions. Conventional 1960s and 1970s subdivision communities established throughout the Valley include: the Boulder Creek Golf and Country Club, Galleon Heights, Bear Creek Estates, Quail Hollow and Glen Arbor, and the portions of Rollingwood and Pasatiempo which lie within the San Lorenzo watershed. There are, in fact, relatively few valleys without a few clusters of homes, now typically occupied year-round. More recently, stand-alone mountain residences have been arrayed along most ridgelines.

The population in the North Coast drainages is far less than that of the San Lorenzo Valley. The largest area in the North Coast drainage with a concentrated population is known as Bonny Doon. Most of the population lives in rural and mountainous areas, mainly along the major roads: Empire Grade, Smith Grade, and Bonny Doon and Martin Roads.

Scotts Valley population was estimated to be 10,774 in its 2015 Urban Water Management Plan. Scotts Valley is an incorporated city within the San Lorenzo watershed but most of the city lies beyond the eastern edge of the sanitary survey area, within the Carbonera Creek and Branciforte Creek subwatersheds. However, key commercial and industrial centers of Scotts Valley drain to Bean Creek, which is within the study area.

The County of Santa Cruz Health Services Agency estimates that just under 13,500 parcels in the San Lorenzo River watershed are served by individual on-site wastewater disposal systems, most of which meet current standards (John Ricker, personal communication, 2011). Residences in the North Coast watersheds are also served by septic systems. However, there are relatively few community or institutional wastewater treatment and disposal systems within the survey area due to the remote nature and dispersed population of the watershed. Community on-site disposal systems serve: Bear Creek Estates, Boulder Creek Golf and Country Club (County Service Area (CSA) 7), the Mt. Hermon Association, and Big Basin State Park. Institutional disposal systems are in service at: the San Lorenzo Valley Unified School District, Camp Harmon, Camp Campbell and at several other camps or conference centers in the San Lorenzo Valley. More recently Rollingwood (CSA 10), has been connected to the City of Santa Cruz wastewater collection, treatment, and ocean disposal system.

Zoning and land development standards for the unincorporated portions of the county reflect an area-wide awareness of the potential adverse effects of wastewater disposal and other development-related impacts on water supply. Within the area, mountain residential is the lowest density range, where minimal services are available. These areas include various open space and natural resource conservation areas unsuitable for more intense development. Rural residential areas are the next highest density range, requiring access from roads maintained to rural road standards. Suburban residential areas require service from a public water system to develop at the highest allowed density. The most densely populated areas along Highway 9 — Felton, Paradise Park, and Boulder Creek — have been developed at density levels typical of many urban areas despite their rural surroundings. County policies designate that these communities be limited to urban low density development unless community disposal systems are available. Santa Cruz County established CSA 12 in 1989 to promote better septic system management and maintenance and imposes an annual fee to fund the on-site wastewater management program.

In addition, regulation related to Accessory Dwelling Units (ADU) are under development at both the state and county level in an effort to address affordable housing challenges in the region. However, an increase in ADU development may pose future challenges especially in rural areas since the adequacy of aging, existing septic systems may be insufficient to meet both health and environmental needs. In addition, rural unpaved roads continue to be a likely contributor of sediments and adding ADU can increase traffic and impacts of roads on water quality.

2.2.3 Agricultural Uses and Animal Grazing

Agricultural acreage in the San Lorenzo River and North Coast watersheds is limited because of the steep topography and limited tillable land. Following the widespread initial logging of the late 1800's and early 1900's, apples and other orchard fruits were, however, planted on the flatter newly opened slopes throughout the subject watersheds. Much of this acreage has been abandoned and now supports chaparral, second growth redwood forests, and residential development.

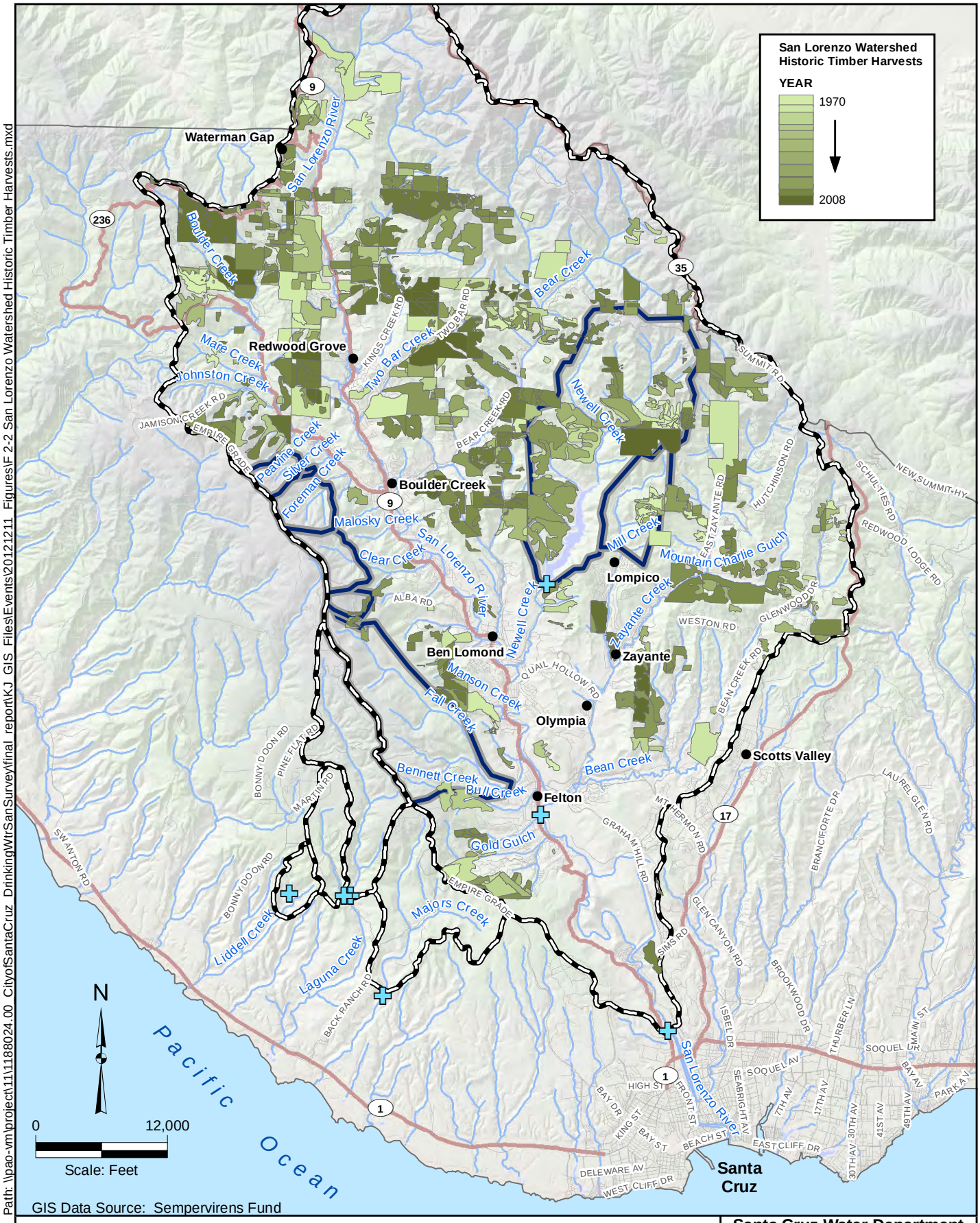
Vineyards and Christmas tree farms occupy the largest amount of agricultural acreage in the watersheds of interest tracked by the agricultural commissioner. Other agricultural uses such as cannabis are not currently tracked. Licensed cannabis cultivation, when regulations are complete, is expected to increase significantly. Expansion of the cannabis industry in the San Lorenzo River watershed is likely to result in further land clearing with grading and pesticide/herbicide use, increased upstream water use, as well as additional traffic on rural roads, many of which are unpaved. Reduced availability of water in the San Lorenzo River may require the City to use Loch Lomond more which also has impacts on raw water quality especially as it relates to Total Organic Carbon (TOC).

Majors Creek has the most significant agricultural land use of the tributary watersheds as shown on Figure 2-1. The lowest coastal terraces, downstream of the SCWD supply intakes in the North Coast watersheds, are used for pasture or are cultivated for brussel sprouts and other row crops. Agricultural activity along the coast does not extend into the watersheds of the supply intakes. Agricultural or animal grazing is limited to that associated with residential uses in the SLVWD subwatersheds. Limited cattle grazing occurs in the North Coast drainages. Grazing leases are held on private lands and vary from year to year. Horses, on the other hand, are commonly kept by rural residents, and by several commercial stables. Confined animals are considered to be a potential source of nitrogen and pathogens (c.f., Hecht and others, 1991; White and Hecht, 1993, Ricker 1995, Ivanetich, 2006) and can also contribute to persistent turbidity in the area's streams.

2.2.4 Timber Harvests

Timber resources historically formed the foundation of the major industry in the Santa Cruz Mountains as shown on Figure 3-3. Timber harvests continue in many parts of the watersheds, and the average timber harvest size in the San Lorenzo River watershed from 2006 to 2008 was about 400 acres. A history of timber harvests from the 2013 WSS update is shown graphically on Figure 2-2 based on information provided by Sempervirens Fund; Sempervirens representatives confirmed that they do not have updated information. Recent CalFire data on timber harvests indicated that there are two under process as of 2017 in the Bean Creek watershed and other timber harvests in the San Lorenzo River watershed were completed within the 2013-2016 time frame as discussed in Section 3.11.

Both the San Lorenzo Valley Water District and the City of Santa Cruz have stopped timber harvesting on their respective watershed lands, instead managing their watershed lands for source water protection and for open-space uses. SLVWD ceased timber harvesting since the 1970s and adopted a prohibition on timber harvesting in 1986. SLVWD continues to cooperate in several different ways with Sempervirens Fund and other conservation groups to limit harvesting in their water-supply watersheds. Major cessations of harvesting have occurred or are in the process of occurring through this cooperative set of efforts in the SLVWD watershed lands on the east slope of Ben Lomond Mountain, in the upper San Lorenzo watershed, and in the upper Lompico watersheds.



Path: \\pao-vm\project\111188024.00_CityofSantaCruz_DrinkingWtrSanSurvey\final_report\KJ_GIS_Files\Events\20121211_Figures\F 2-2 San Lorenzo Watershed Historic Timber Harvests.mxd

Santa Cruz Water Department
WSS Update

San Lorenzo Watershed
Historic Timber Harvests

Figure 2-2

2.2.5 Mining

Sand mining is the major mineral extraction activity in the survey area, although a number of operations have been closed over the past decade, most recently the CEMEX Bonny Doon marble (locally called 'limestone') and shale mine. There are several active sand operations in the vicinity of Scotts Valley. Decomposed or weathering granitic rock is mined at Felton Quarry. Sand is still mined at the Quail Hollow Quarry. However, mining activities have been discontinued since 2004 at the Olympia and Hanson ('Kaiser') Quarries although reclamation and monitoring activities continue. A landslide in the vicinity of Conference Drive below the Hanson Quarry had significant movement in winter 2017 which resulted in sand erosion into Bean Creek and downstream. There are no commercial or informal instream gravel mining operations in the subject watersheds.

Exploratory drilling for oil and gas has been conducted throughout the survey area, principally during the 1950s and 1960s. No current or shut-in (potentially re-activatable) production is reported. The principal water-effects of drilling have been unquantified increases in the salinity of the local stream system associated with deep, highly saline waters emanating from several abandoned boreholes (c.f., Hecht, 1975). Naturally-occurring asphaltum or bituminous sandstone outcrops at the edges of the Majors Creek watershed, where it was mined about 100 years ago. No effects on waters of Majors Creek have been reported.

2.2.6 Recreation

Santa Cruz and its surroundings have served as a center of recreation for more than 150 years. In the San Lorenzo River Valley, much of the recreation is focused on summer use of the streams and riparian corridors. Use of the San Lorenzo River and its tributaries includes swimming in natural pools, canoeing, fishing, hiking, and equestrian activities. Visitor use – especially the traditional river-based water-contact recreation – is both a motivation for cleaner streams as well as a secondary contributor to bacteria, nitrate, and possibly turbidity levels.

The California Department of Parks and Recreation manages about 15 percent of the watershed, including Henry Cowell (including Fall Creek), Castle Rock and portion of Big Basin Redwood State Parks. See Figure 2-1 for locations of parks and open space within the Santa Cruz City Water Supply Watersheds. Managers continue to pursue restoration projects, when funds allow, and completed removal of a leaking earthen dam and series of culverts on Tin Can Creek. Since there was no spillway for the 45-foot dam, there had been gullying and consistent erosion around the structure. Managers also continue to use controlled burns to maintain open grasslands (Portia Halbert, personal communication, 2012), and typically burn areas every other year, mostly in the Waddell and Wilder Creek watersheds (Tim Hyland, personal communication, 2012).

City-operated recreation facilities at Loch Lomond will continue to emphasize boating, picnicking, and trail uses. However, concerns by first responders at the city and state levels regarding fire risk and access for emergency response are likely to limit additional public access beyond that which is already available.

Recreational use of the Majors and Laguna Creek watersheds covered by the survey are diffuse and typical of rural residential areas, concentrated along the roads and trails. Significant portions of the southeastern side of the Majors Creek watershed are within the sectors of the Grey Whale Ranch and Wilder Ranch State Park that will likely remain closed to visitor use during the coming five years as there are insufficient resources to maintain and patrol trails (T. Hyland, 2018). Public access and recreation are limited in the SLVWD watersheds except for the Fall Creek, Bennett and Bull Springs portion of the SLVWD watershed which are largely

within the Fall Creek State Park which has hiking and equestrian trails. Additional discussion regarding the potential water quality threats from recreation occurs in Section 3.1.2.

Off road vehicles and mountain-bike use can be locally common. Trail (bike, horse, and hiker) and off-road vehicle use can be sources of erosion adding to background levels.

In recent news, 5,800 acres of land surrounding the coastal City of Davenport were designated as the Cotoni-Coast Dairies National Monument in May 2016. Relatively few people have seen this land since public access has been limited for more than a century. The Bureau of Land Management (BLM) is expected to develop a plan to manage traffic, trash, and public safety, In speaking with the BLM staff, it is understood that the lands, regardless of its status as a monument will likely be accessible to the public, pending federal approval and funding. However, in April 2017, a Presidential Executive Order has resulted in review of the formation of this National Monument. In addition, the former CEMEX property adjacent to the National Monument has also been preserved as the San Vicente Redwoods and will also have future public access. Although much of these lands are downstream of the City intake, concerns remain that public access can result in increased fire danger, and other risks that could impact water quality.

2.2.7 Reservoir Sedimentation

Sedimentation rates in Loch Lomond Reservoir are small relative to its capacity, perhaps because the watershed of the reservoir is maintained primarily in open space, and are not expected to constrain the water supply functions of the reservoir for many years to come. The City has commissioned four separate sedimentation surveys of Loch Lomond by USGS, beginning in 1971 (Brown, 1973), followed by a 1982 survey by Fogelman and Johnson (1986), and then a 1998 survey by McPherson and Harmon (2000).

The most recent 2009 sedimentation survey by McPherson and others (2009) used a new, state-of-the-art method combining bathymetric scanning with multibeam-sidescan sonar, and topographic surveying with laser scanning (LiDAR) to obtain information about temporal changes in the upper reach of the reservoir where the water is shallow or the reservoir may be dry, as well as to obtain information about shoreline changes throughout the reservoir. Results indicate that this method accurately captures the features of the wetted reservoir surface and along the shoreline that affect the storage capacity calculations. Comparison of the 2009 reservoir-bed surface with the surface defined in 1998 indicates that sedimentation is occurring throughout the reservoir. About 320 acre-feet of sedimentation has occurred since 1998, as determined by comparing the revised 1998 reservoir-bed surface, with an associated maximum reservoir storage capacity of 8,965 acre-feet, to the 2009 reservoir bed surface, with an associated maximum capacity of 8,646 acre-feet. This sedimentation is more than 3 percent of the total storage capacity that was calculated on the basis of the results of the 1998 bathymetric investigation.

2.3 Natural Conditions and Water Quality

The San Lorenzo River watershed and the North Coast water supply drainages are located in north central Santa Cruz County, California. These watersheds drain runoff from the Santa Cruz Mountains into the Pacific Ocean at or near the north end of Monterey Bay (see Figure 1-1).

The Santa Cruz Mountains extend south to southwest for about 100 miles from San Francisco to the Pajaro River. The ridge of the Santa Cruz Mountains rises between San Francisco Bay

and the Santa Clara Valley on the east and the Pacific Ocean on the west. The topography of the area is moderately rugged, with elevations ranging from sea level to over 2,600 feet along the crest of Ben Lomond Mountain, and over 3,300 feet at several locations along the northeastern edge of the watershed. Steep slopes of over 30 percent are common, and most of the streams discussed in this report flow through deep canyons cut into bedrock. This is particularly true in the San Lorenzo River watershed, whose many streams are deeply shaded by a dense growth of redwood and Douglas fir trees.

The region has a Mediterranean climate with cool, dry summers and moderate-to-heavy rainfall in the winter months from November through March. Average annual rainfall ranges from about 30 inches along the coast to about 50 inches along the ridge of Ben Lomond Mountain. Coastal fog is common during the summer months and tends to spread inland at night.

The crest of Ben Lomond Mountain forms the topographic divide between the San Lorenzo River watershed to the east and the North Coast watersheds (Majors and Laguna Creeks) to the west. Coastal terraces, in the North Coast drainages, are a mosaic of grasslands, oak woodlands, steep forested canyons, and chaparral.

2.3.1 Soils and Geology

The area is underlain by a complex mosaic of alluvial and terrace deposits of Quaternary age; mudstone, shales, and sandstones of tertiary age; and fractured granitic rocks, schists, and metamorphosed limestones. Soils are highly variable, with a dense mosaic, depending on the underlying parent materials, and other factors such as climate, aspect, vegetation cover, and local relief. Alluvial and terrace soils of varying ages have formed on the alluvial and terrace deposits along nearly all of the major streams. Some of these soils have well-developed clay subsoils, inhibiting use of leach fields.

In the most general terms, soils underlain by permeable sandstones, as well as igneous and metamorphic rocks, are deep and well-drained. These loamy and sandy loam soils are found throughout the heavily forested reaches of the survey area. Soils formed from the Santa Margarita and several other sandstone formations are also sandy, deep, and well drained as shown on Figure 2-3. In the sandy soils, organic-matter content and cation exchange capacities are often about 15 to 25 percent of those found in many forest soils in coastal California. Sandy soils can infiltrate quickly which can pose a threat to groundwater and/or base flow if septic systems are located on sandy soils.

Santa Cruz County has been providing training and information on approaches and technologies to control erosion in these soils, and to improve nitrogen and pathogen removal in discharges from septic systems. Soils formed from mudstones and shales also tend to be deep, yet somewhat less well-drained. Overall, soil depth is often limited by shallow bedrock, steep slopes and the gradual loss of topsoil to erosion.

In the alluvial areas of the San Lorenzo and North Coast watersheds, soils are also deep and well drained, although soil depth may be limited by low-permeability layers of fines. In the marine terraces of the North Coast, soils are characterized as deep to very deep and range from well-drained to somewhat poorly drained where claypans have developed. As in the San Lorenzo Valley, depths vary with slope and aspect.

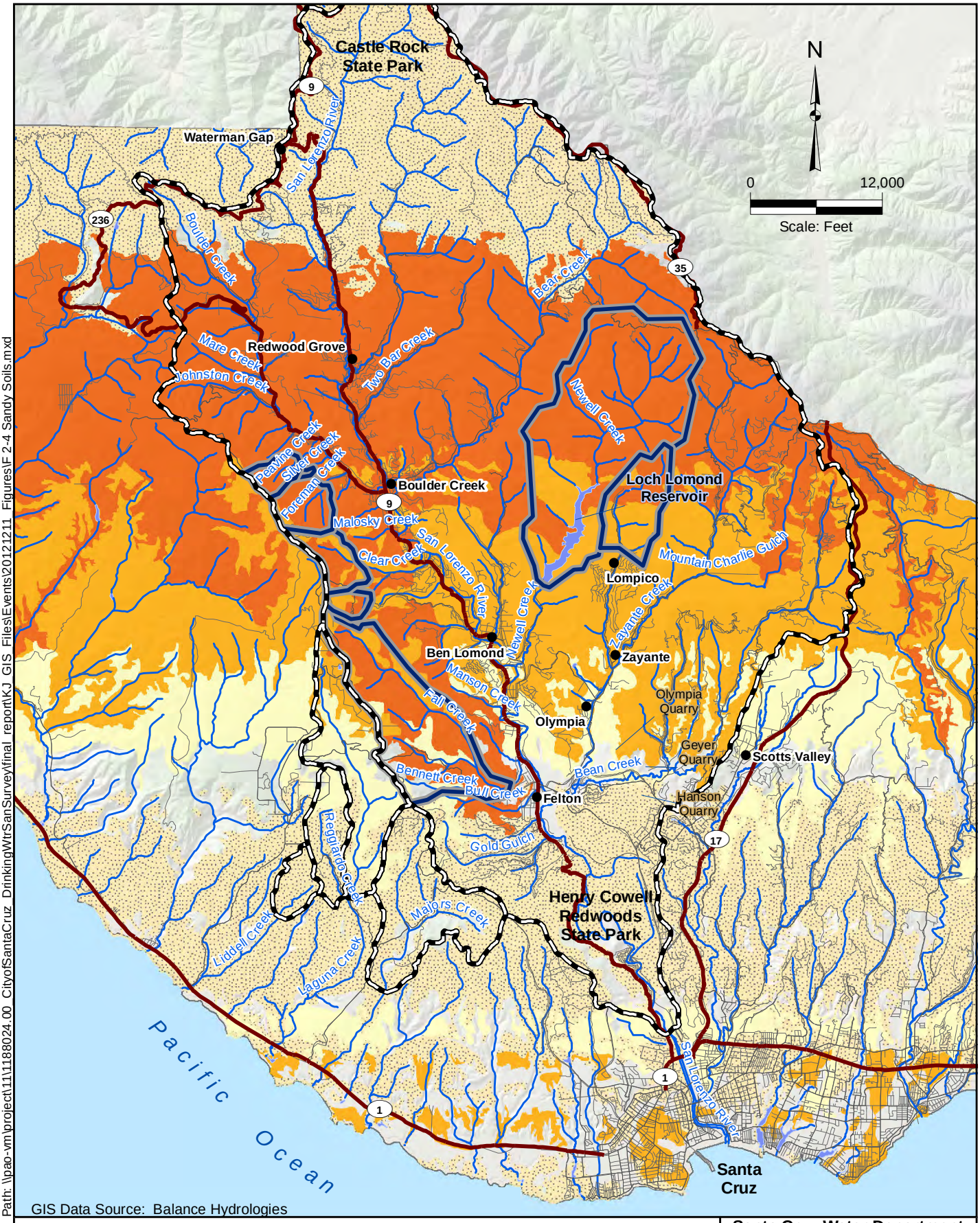

Castle Rock State Park
Waterman Gap
San Lorenzo River
Boulder Creek
Redwood Grove
Mare Creek
Johnston Creek
Two Bar Creek
Bear Creek
Newell Creek
Loch Lomond Reservoir
Peavine Creek
Silver Creek
Foreman Creek
Boulder Creek
Malosky Creek
Clear Creek
San Lorenzo River
Mountain Charlie Gulch
Lompico
Zayante Creek
Zayante
Ben Lomond
Newell Creek
Manson Creek
Fall Creek
Olympia
Olympia Quarry
Geyer Quarry
Scotts Valley
Bean Creek
Bennett Creek
Bull Creek
Felton
Hanson Quarry
Gold Gulch
Reggiardo Creek
Majors Creek
Henry Cowell Redwoods State Park
Liddell Creek
Laguna Creek
Pacific Ocean
San Lorenzo River
Santa Cruz
N
0
12,000
Scale: Feet
9
236
35
17
1
GIS Data Source: Balance Hydrologies
Area Locations
Stream
Streets
Lakes
Santa Cruz City Water Supply Watersheds
Sub-Watershed
Sandy Soils
Hyper Sandy > 6"/hr
Very Sandy > 2"/hr
Sandy > 0.6"/hr
Sandy, shallow Limited Recharge
Santa Cruz Water Department
WSS Update
Sandy Soils
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Figure 2-3

Naturally-occurring cadmium occurs in portions of the Monterey shale and (to a much lesser extent) Santa Cruz mudstone geologic units. Because cadmium is tightly bound to minerals and clays in the local soils, elevated levels of cadmium are seldom if ever encountered in the water diverted from either the San Lorenzo River or North Coast watersheds. Higher levels are found in stream sediments and vegetation, and cadmium can be bioconcentrated by organisms living in the sediments and soils. The distribution of cadmium in western Santa Cruz County is explained in Golling (1983). Zinc and other trace elements often co-occurring with cadmium are not reported to be elevated in the local soils and sediment derived from the Monterey formation. The same formations tend to be rich in phosphorus, which is widespread in the streams of all surveyed watersheds. With organic carbon also abundant, the ecosystems of these streams are nearly always nitrogen-limited (Aston and Ricker, 1979 Butler, 1978).

Portions of the watershed areas are underlain by karst geology which poses a different type of risk to water quality because the large voids in karst allow for direct connection of contaminants to drinking water. Recent work by the City to map karst springs and marble outcrops associated with karst are overlain on Figure 2-4 which indicates that the Liddell Creek, Laguna Creek and portions of the Fall Creek, Bennett and Bull Springs watersheds exhibit these features.

2.3.2 Faults and Seismic Activity

Faulting and seismicity pose a potential geologic hazard in the Santa Cruz Mountains. The San Andreas fault parallels the northern boundary of the project area approximately two miles to the north. Numerous faults cross the project area. In the San Lorenzo Valley, the most notable faults include: the Zayante fault, which runs primarily east-west, crossing Loch Lomond; Ben Lomond fault, with a trace roughly paralleling the San Lorenzo River from Santa Cruz to the Boulder Creek area; and the Butano fault, which crosses the northern, highest portions of the San Lorenzo watershed. No recent movement has been recorded on any of the three faults but these faults, as shown on Figure 2-4 control groundwater flow and quality in the region.

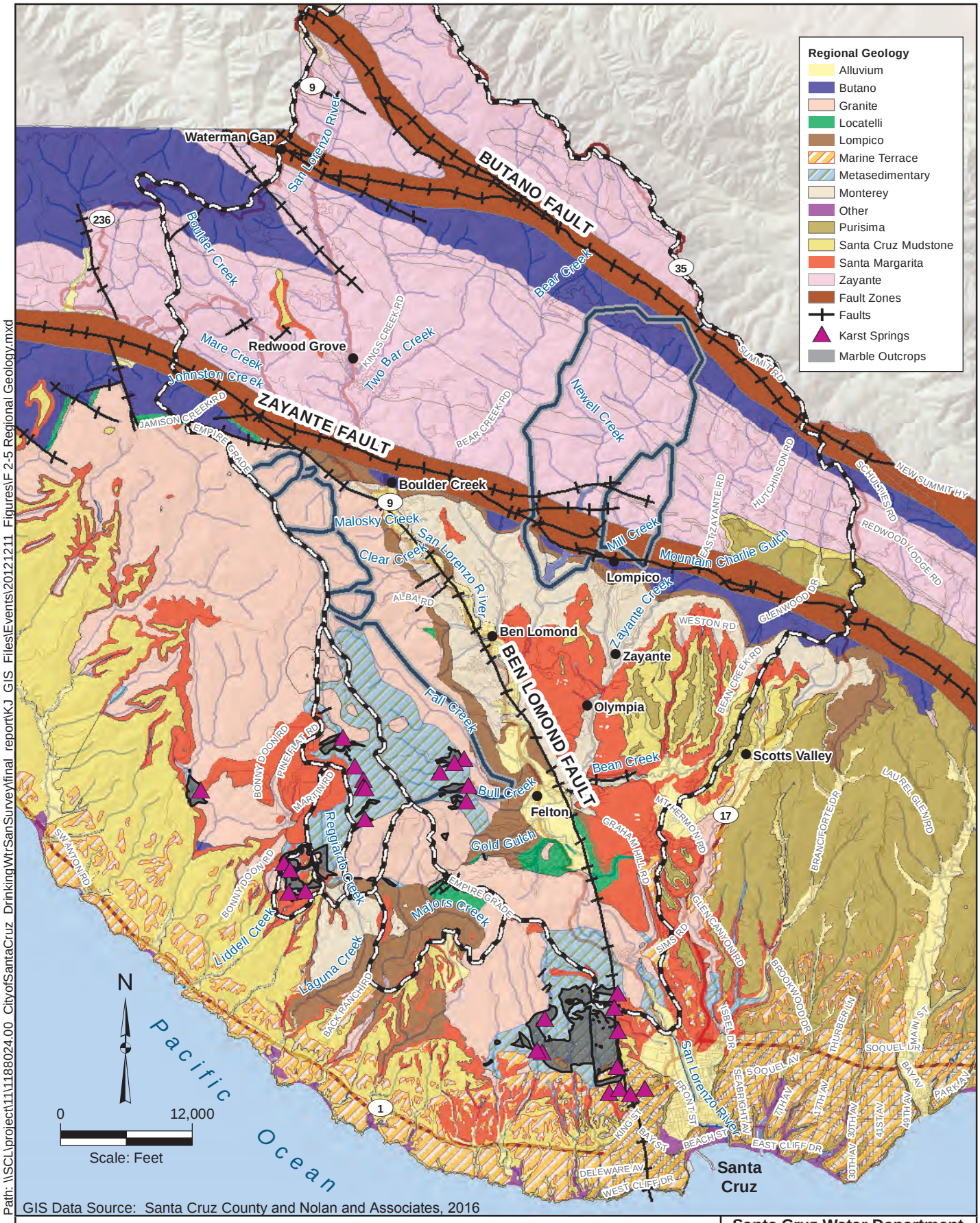
The principal fault in the North Coast area is the San Gregorio fault zone, which trends north-northwestward several miles offshore from the mouths of Laguna and Majors Creeks. It is active and has sustained recurrent activity for several million years.

Santa Cruz County experiences low-level seismic activity on a regular basis. The most significant recent event was the 1989 Loma Prieta earthquake. Significant damage to structures, roadways, and utilities occurred, including damage to water systems occurred following the magnitude 7.1 Loma Prieta earthquake. Landslides, debris flows, and the reconstruction of residences and infrastructure contributed to persistent turbidity in area streams and surface waters for a period thereafter. Future seismic activity should be anticipated and this expectation should be a major factor in public policy and management of local water supplies.

In the past three years, the closest significant earthquake to the San Lorenzo Valley region occurred in San Juan Bautista with a magnitude of 4.2. Even a moderate earthquake in this area could result in death, property damage, and economic upset as well as water quality upsets, particularly after a wet winter which resulted in landslides.

2.3.3 Volcanic Activity

While known for their seismic activity, the Santa Cruz Mountains are highly unlikely to experience any volcanic activity in the foreseeable future.



GIS Data Source: Santa Cruz County and Nolan and Associates, 2016

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Area Locations
Santa Cruz City Water Supply Watersheds
Sub-Watershed
Lakes
Stream
Streets

Santa Cruz Water Department
WSS Update

Regional Geology

Figure 2-4

2.3.4 Vegetation

The watershed lands evaluated in this survey area are dominated by dense forests consisting of a mix of deciduous and evergreen trees and hardy shrubs. Second growth coast redwood is the dominant forest species in the steep canyons, particularly where coastal fog can supply summer moisture. Several species of oak, as well as Douglas fir, tanoak, and madrone form mixed stands on drier slopes and aspects. Some ridges are covered by dense chaparral, composed mainly of manzanita and chamise. Ponderosa pine, a forest species not generally found in the Coast Range, forms a distinct community in the locations where the coarse sands of the Santa Margarita formation are exposed.

While scattered grasslands can still be seen in the San Lorenzo River watershed, most have been converted to residential uses or have reverted to chaparral and second growth forests. The coastal terraces support larger grasslands, but are also subject to the same sorts of residential development pressures and conversion to chaparral and coastal scrub. Within the area grasslands, few native bunchgrasses are found, having long ago been replaced by the exotic annual grasses introduced by early European settlers.

Riparian plant communities are established along all streams in the surveyed watersheds, although human activity or debris from unstable slopes often encroaches in these areas. Several species of willow and alder, as well as big leaf maple, box elder, sycamore, and cottonwood are the most common tree species. California blackberry, poison oak, stinging nettle, in addition to numerous species of sedge and rush, make up much of the understory streambank vegetation. In disturbed riparian areas, non-native vegetation such as French broom, English or cape ivy, poison hemlock, periwinkle, and acacia have become established and compete with native species. These riparian zones are thought to play vital roles in protecting and maintaining water quality in most of the water supply watersheds.

2.3.5 Wildlife

Numerous wildlife species inhabit the California Coastal Ranges. The steep topography, extensive open space, and vegetation communities that range from aquatic and riparian to woodland and chaparral, provide a wide range of habitats for terrestrial and avian species. The area supports such mammalian species as: black-tail deer, mountain lion, bobcat, gray fox, California ground squirrel and a variety of other small terrestrial mammals. A number of non-native species have become established in the Santa Cruz Mountains, including bullfrogs, New Zealand mudsnail, wild pig, Norway rat, common opossum, and feral domestic dogs and cats.

The number of bird species found in the Santa Cruz Mountains reflects the variety of habitats and the location along the Pacific Coast migratory route of waterfowl and songbirds. The riparian habitats fringing the San Lorenzo River and the smaller streams of the region have the highest breeding bird density of all habitat types in the area. Several species of wading birds live in the area, including great blue heron, green heron, and black crested night heron. Belted kingfishers, Stellar's jays, and wood ducks are also residents. Raptors are common throughout the area and include red-shouldered hawks, red-tailed hawks, and Coopers hawks, while occasionally golden eagles can also be encountered in the watershed. Wild turkey sightings have increased in the last several years since the 2013 Update.

Reptile and amphibians are also abundant in local riparian habitats. Notable species in the County include the western pond turtle, California red-legged frog, legless lizard, and several species of salamander although specific presence in the watersheds varies.

The San Lorenzo River supports many species of fish. Steelhead trout and coho salmon are considered native to the coastal streams in Santa Cruz County and the San Lorenzo River supports the region's largest steelhead run. Once a hotbed for anglers, the San Lorenzo fisheries have suffered a decline, widely thought to result from sedimentation and other land-use effects. In 1964 the estimated run consisted of 20,000 steelhead (Ricker, 1979). Runs of 500 to 1,500 adult steelheads are more typical of current conditions. Coho salmon, with a historically smaller run, have also declined. Since 1981, coho have been intermittently observed in the San Lorenzo River, though local populations are on the verge of extirpation. Both steelhead and coho are federally listed as threatened under the Endangered Species Act, while coho are listed by the State under the more-critical 'endangered' designation. The primary threats to these species include: loss of high quality rearing and spawning habitats due to flow reductions and excessive fine sediment loads; and barriers to migration due to dams, culverts, and flow-depleted critical riffles (Alley and others, 2004).

The SCWD is currently engaged in negotiations for an instream flow agreement that supports a pending Habitat Conservation Plan (HCP) in order to operate and maintain water facilities while considering the needs of these endangered species. The streamflow restoration elements of the HCP, especially in the San Lorenzo River at Tait Street and Laguna Creek, are intended to maximize instream habitat using the City's existing infrastructure. To accommodate, natural flow variations, flow targets vary monthly by hydrologic year type (wet to critically dry) as well as by naturally occurring seasonal variations. These minimum instream flow targets have been developed to maintain all life history stages (spawning, incubation, rearing, and migration) of steelhead and coho salmon. As of March 2017, there is a one year agreement on instream flows It is expected that these minimum instream flow targets will decrease availability of the North Coast sources, including Laguna Creek, and increase dependence on San Lorenzo River water stored in Loch Lomond which has higher organic carbon resulting in higher potential for formation of disinfection by products.

2.4 Water Supply Systems Background

2.4.1 History

The San Lorenzo Valley and North Coast Watersheds provide drinking water for numerous communities in the Santa Cruz area. Table 2-2 lists the water supply sources and general treatment processes used by the purveyors participating in this sanitary survey update (SCWD and SLVWD). These purveyors use surface water and have over 200 total service connections. Table 2-3 lists the same information for non-participating purveyors many of which have less than 200 service connections. All the purveyors listed in Tables 2-2 and 2-3 use surface water in the San Lorenzo Valley Watershed. The following sections focus on the larger utilities, listed in Table 2-2, which include SCWD and SLVWD. The watershed areas for each participating utility are shown on Figure 1-1.

Table 2-2: Summary of Drinking Water Purveyors Serving Surface Water With More Than 200 Service Connections in the Study Area

Utility Name and Number of Service Connections	*Surface Water Sources*	*Treatment Process*	*Average Flow*	*Primary Disinfectant*	*Last DDW Inspection Report*
Santa Cruz Water Department (City of Santa Cruz) 24,534 Service Connections	San Lorenzo River/Loch Lomond Reservoir and North Coast Springs & Creeks	Conventional Filtration at the Graham Hill WTP Microfiltration at Loch Lomond WTP	10 mgd (from 2015 UWMP) 7 gpm/15 gpm maximum	Chlorine Chlorine	June 2016 June 2010
San Lorenzo Valley Water District 5,868 Service Connections	Clear Creek, Foreman Creek, Peavine Creek, and Sweetwater Creek	Lyons WTP - (Trident Microfloc) 1,200 gpm WTP w/Conventional Treatment Equivalency	1.92 mgd (includes use of groundwater sources) (2000 - 2008 Average Production)	Chlorine	Feb-2012
San Lorenzo Valley Water District - Felton 1,355Service Connections	Fall Creek, Bull Springs and Bennett Spring	Kirby WTP - CPC Microfloc-Trimite TM-350	1.0 mgd capacity	Chlorine	May 2012
Lompico County Water District (merged with SLVWD in 2016) 500 Service Connections	Lompico Creek below Mill Creek, SLVWD Connection	Mill Creek WTP – Off line	Microfiltration	Chlorine	-Sept 2011

Data source: Waterboards.ca.gov
Data source: 2009 SLVWD Water Supply Master Plan
Note to Reviewers: Big Basin MWC participated in the 1996 sanitary survey and is included in Table 2-3.

Table 2-3: Summary of Small and Non-Participating Drinking Water Purveyors in the San Lorenzo River Watershed

Name	*Watershed Location*	*Number of Connections*	*Filtration System/Type*	*Disinfection Strategy*	*Other Comments*
Big Basin Water Company	Four surface sources; Jamison Springs (No. 1 and 2), Corvin Springs, Well No. 5 (horizontal under the influence of surface water)	593	Jamison WTP; Conventional Processes with Capacity to Treat 150 gpm (Neptune Microfloc/ Trimite)	Chlorine	--
Brackenbrae Mutual Water Company[(1)]	North of Boulder Creek	24	Package WTP (3M bag filter)	Chlorine	Protected streams and spring
Forest Springs Mutual Water Company[(1)]	North of Boulder Creek	128	Sedimentation only	Chlorine	Spring source
Bonnymede Mutual Water Company[(1)]	On Reggiardo Creek	10	--	Ozone	--
Olympia Mutual Water Company[(1)]	n/a	n/a (<200)	Filtration	Chlorine	Annexation with SLVWD in progress
Quaker Center	Near Ben Lomond	Non-Community System (<200) 1	Package WTP (3M bag filter)	Chlorine	--
River Grove Water System[(1)]	Near Felton	25	Slow sand filtration	Chlorine	--

Data source: 1996 Sanitary Survey
Data source: Waterboards.ca.gov
n/a = Information is not applicable for this project.
.
[(1)] Small water companies represented by Santa Cruz County

2.4.2 Santa Cruz Water Department (SCWD)

As described in greater detail in Section 2.6, generally, the private water companies that preceded the City of Santa Cruz began establishing water rights to area streams and underflow in the late 1800s. The riparian rights to the North Coast sources were purchased from downstream landowners. The City has appropriative rights to San Lorenzo River water via licenses. These licenses allow the withdrawal of water at the San Lorenzo River Intake in Santa Cruz for delivery to the Graham Hill water treatment plant and the Felton diversion for storage at Loch Lomond Reservoir. In 1960, Newell Creek Dam was constructed to create Loch Lomond Reservoir, with a then-reported capacity of 8,500 of acre-feet.[5] Jointly, these three surface water sources are the primary supply for the City.

Source water development and the supply history of the Santa Cruz Water Department through 1986 were described in detail in the 1996 sanitary survey. During1986, the City upgraded the Graham Hill Water Treatment Plant (WTP) to improve treatment performance. Improvements consisted of replacing the filter media; modifying the chemical feed systems, flocculators, monitoring and control system, and sludge collectors; and installing tube settlers in the sedimentation basins. There have been a few changes in the SCWD water supply and treatment system that have occurred since the 2013 sanitary survey update including replacement and rehabilitation of wells at the Tait wellfield and rehabilitation and upgrades at the Graham Hill WTP which are discussed in Section 2.7.

2.4.3 San Lorenzo Valley Water District (SLVWD)

The SLVWD, originally the San Lorenzo Valley County Water District, was formed by a special election of the residents of Santa Cruz County on April 3, 1941. At that time the boundaries were established to include 58 square miles of the San Lorenzo Valley in the Santa Cruz Mountains. During the late 1940's, the SLVWD purchased large areas of land with an initial intent of potential reservoir development; as philosophies changed these lands were later preserved for watershed protection in the early 1980s. In 1958, the SLVWD sold 2,500 acres of land to the City of Santa Cruz for the placement of Loch Lomond Reservoir.

Major events in the development of the current SLVWD water supply system are described in detail in the 1996 sanitary survey. The District has not used springs as water sources since 1993 when the Lyons surface water treatment plant was constructed. More recent developments include the annexation of the Mañana Woods Mutual Water Company and the acquisition of protected lands in the Malosky Creek watershed both of which occurred in 2006 and are described in the 2006 watershed sanitary survey.

In 2008, SLVWD acquired the Felton Water System from California-American Water Company. Felton is supplied water from two (2) spring sources and one (1) surface water diversion. The spring sources are Bennett Spring and Bull Spring. The surface water source is Fall Creek.

Supply water from the combined springs is routed through a raw water transmission line to the Kirby Street Water Treatment Plant. Supply water from Fall Creek is also routed through separate raw water transmission line to the Kirby Water Treatment Plant (Kirby WTP). The Kirby Street Water Treatment Plant was brought on line in January 1997 to meet the requirements of the Surface Water Treatment Rule. The nominal capacity of the Kirby Street Water Treatment Plan is 1.0 mgd using two (2) 350 gpm rated, two stage filtration constant adsorption clarification/tri-media filtration units (CPC Microfloc-Trimite TM-350). Disinfection is

[5] Re-surveys indicate a current capacity of about 8,600 acre-feet above the spillway elevation (McPherson, 2011)

provided at the Kirby Street Water Treatment Plant by contact mixing with sodium hypochlorite prior to introduction into the treated water distribution system.

The area formerly served by LCWD is now a part of the SLVWD North system and has approximately 500 service connections (which has not changed as of 1996) , which generally surrounds the Lompico area. Lompico is shown just east of the Loch Lomond Reservoir in Figure 1-1.

Through the merger with LCWD, SLVWD now owns the 425-acre Lompico headwaters property, which previously supplied water to the community of Lompico. The lands were first purchased by the Sempervirens Fund which then transferred the purchased land to LCWD prior to the merger with SLVWD.

2.5 Water Sources

2.5.1 Santa Cruz Water Department

The existing SCWD water supply system is described in detail in the 2015 Urban Water Management Plan. The SCWD supply system is comprised of four main production elements: (1) the North Coast streams and Liddell Spring; (2) the San Lorenzo River (San Lorenzo River Intake, Tait Wells and Felton Diversion); (3) Loch Lomond Reservoir on Newell Creek; and (4) the Live Oak wells. All but the Live Oak wells system, entirely a groundwater supply source, are described in the following paragraphs. The main water supply facilities are shown on Figure 1-1.

2.5.2 North Coast

The North Coast water supply system consists of surface diversions from three coastal streams and one natural spring located approximately six to eight miles northwest of downtown Santa Cruz. These sources are Liddell Spring, Laguna Creek, Reggiardo Creek, and Majors Creek. A few changes to the facilities described in the 1996 sanitary survey have been made including repairs at the Majors Dam following a failure and sediment transport improvements including new drain valves and operational improvements required by CDFW at Laguna and Majors Creeks. Rehabilitation and maintenance of the diversions, several of which were damaged in the 2017 winter storms, is currently being initiated. A brief summary follows, for reference. More detailed descriptions are found in the 1996 sanitary survey.

Liddell Spring — Liddell Spring, is a natural spring used for water supply. The spring box/diversion is located at elevation 584 feet. Water from the spring is directed through a 10-inch steel pipeline into the Coast Pipeline for transmission to the SCWD service area.

Laguna Creek and a tributary, Reggiardo Creek — Flows from Reggiardo Creek, which are quite limited, are captured at a diversion dam located at elevation 630 feet. Diversions from Reggiardo Creek are diverted through about 850 feet of pipeline to Laguna Creek and are not monitored separately from Laguna Creek. Combined flows from Laguna Creek and diversions from Reggiardo Creek are captured at a concrete and limestone dam located at elevation 623 feet on Laguna Creek. The original dam constructed in 1890 is still in use today. These diversions are sent through 12,400 linear feet of 14-inch steel pipeline to the junction with the transmission pipeline from Liddell Spring. The junction is known as the Laguna-Liddell "Y".

Majors Creek — Flow from Majors Creek is diverted from a concrete dam located at elevation 352 feet. As noted earlier, a dam failure in the winter of 2011, was repaired to restore the

original diversion in the summer of 2011. Diversions from Majors Creek are conveyed through 11,300 linear feet of pipeline varying between 10 and 16 inches in diameter before joining the main Coast Pipeline along Highway 1. Because the Majors Creek diversion is located at a much lower elevation than the other North Coast sources, use of the Majors Creek Diversion has historically been limited by the available supply from the other North Coast sources (i.e. the Majors Creek flows can enter the Coast Pipeline only when the head from the other sources is low). Reduced production at Laguna and the need for fish bypass flows, allows more of Majors Creek flows to enter the Coast Pipeline.

Water from the North Coast diversions flows by gravity to the SCWD system via the Coast Pipeline, which varies from 16 inches in diameter between the Laguna-Liddell "Y" and Majors Creek up to 24 inches in diameter near Bay Street Reservoir. Projects have been underway over the last 10 years to replace badly deteriorated sections of the Coast Pipeline with the most recent project completed in 2017.

Water from the Coast Pipeline is boosted at the Coast Pump Station to the Graham Hill WTP for treatment.

2.5.3 San Lorenzo River – Intake in Santa Cruz and Tait Wells

San Lorenzo River flows are diverted at the Intake in Santa Cruz just north of Highway 1. Water is diverted at a concrete check dam into a screened intake sump where three vertical turbine pumps are used to pump the water to the Graham Hill WTP. Two of the pumps are converted to a variable frequency drive (VFD) to better match pump output to demand and available flow while one pump is set at a constant speed. These pumps are located in the same building as the pumps for the North Coast diversions. High flows during winter of 2017 have scoured the river bottom in the vicinity of the intake allowing for inspection which indicated that some damage has occurred. This downcutting may have had some water quality benefit as the river flow now has greater velocity in the vicinity of diversion.

The San Lorenzo River Intake in Santa Cruz also includes three production wells, located on the east side of the river. Two replacement wells, Tait Well No. 1B and Tait Well No. 3B were drilled in 2016 andare about 89 feet deep One well, Tait Well No. 4, was rehabilitated in 2016, and is 71 feet deep. These wells are tied to the City's appropriative rights for San Lorenzo River flows as there is evidence that the Tait wells are hydraulically connected to the river. The DDW classifies water from the Tait wells as GWUDI (Ground Water Under Direct Influence of Surface Water).

Water produced by the Tait wells is also delivered to the San Lorenzo River intake sump at the Coast Pump Station. The ground water is then pumped into a common transmission pipeline used to convey water from both the North Coast and San Lorenzo River sources to the Graham Hill WTP for treatment.

2.5.4 San Lorenzo River - Felton Diversion

There have been no major changes or modifications to this system in the last five years. The Felton Diversion is located on the San Lorenzo River just downstream of the Zayante Creek confluence, which is approximately five river miles north of the Coast Pump Station and San Lorenzo River Intake. The diversion structure consists of an inflatable rubber dam to divert flows into a screened intake sump. Flows are then pumped through the Felton Booster Station into Loch Lomond for storage via the Newell Creek Pipeline. The desired diversion rate is regulated

by using different combinations of the three pumps at the Felton Diversion and the five pumps at the Felton Booster Station.

2.5.5 Loch Lomond Reservoir on Newell Creek

The Loch Lomond Reservoir was created by the construction of Newell Creek Dam, located about ten miles north of Santa Cruz and northeast of the town of Ben Lomond. The reservoir was constructed in 1960, and currently has a maximum storage capacity of about 8,600 acre feet.[6] Loch Lomond is the only major reservoir in the San Lorenzo River watershed. There have been no major changes in this system in the last five years.

Newell Creek Dam is an earthfill dam, 190 feet high and 750 feet long at the crest. The spillway crest is at elevation 577 feet. Releases from the reservoir are made through outlet works on the upstream face of the dam. Water released from Loch Lomond for use by SCWD is conveyed to the Graham Hill WTP through the Newell Creek Pipeline. The water flows by gravity from the reservoir to the Felton Booster Station, approximately 4.3 miles downstream of the dam. The water is then pumped at Felton Booster Station to clear a ridge in Henry Cowell State Park at an elevation of about 580 feet. To meet fluctuating head and flow conditions, five pumps and alternative valving configurations that allow various pump combinations are available at the Felton Booster Station.

2.5.6 SLVWD

Clear Creek, Foreman Creek, Peavine Creek, Silver Creek, and Sweetwater Creek are the primary surface water sources for the Lyons WTP which serves the northern portion of SLVWD;s service area. The current average stream diversion yearly total is about 900 acre-feet from these sources. SLVWD has appropriative rights to these creeks. These sources are perennial creeks and are located west of Highway 9 along the Ben Lomond Mountain. The watersheds of the creeks are contiguous and rugged with extremely steep slopes. The watersheds above the creek intakes are largely uninhabited. In addition, the SLVWD's Felton system is served by Fall Creek and Bennett and Bull Springs. The approximate location of each creek intake and watershed area is illustrated in Figure 1-1.

The original surface water source for the Lompico portion of the SLVWD north system was Lompico Creek, downstream of the Mill Creek confluence which has a watershed area of about 1,470 acres. SLVWD now has the appropriative water rights for Lompico Creek which dates to the mid-1940's. The estimated population for the service area is about 1,500 people. The average drinking water use is about 0.10 mgd, which is supplied SLVWD. The drought of 2011-2015 reduced Lompico Creek flows; there was no flow in 2015. The supply insufficiency precipitated first an emergency connection between LCWD and SLVWD and ultimately resulted in the merger with SLVWD. In 1996, LCWD constructed a new water treatment plant (WTP), a microfiltration unit, to comply with SWTR requirements; the WTP is currently offline. The Lompico Community Center sponsors a community creek clean-up event annually.

[6] Per a 2009 survey discussed in Section 2.2.7

2.6 Water Rights

2.6.1 SCWD

Table 2-4 lists the SCWD water rights, as listed in the 2015 Urban Water Management Plan. There have been no changes in the SCWD water rights since the preparation of the 1996 sanitary survey although SCWD is developing and submitting filings for a change to the water rights that would allow direct diversion at Felton for delivery to the Graham Hill WTP.The HCP that is under preparation, as discussed earlier, may limit diversions from some of SCWD's most important water sources.

Table 2-4: Summary of SCWD Water Rights

Source	*Period*	*Maximum Diversion Rate (cfs)*	*Fish Flow Requirement (cfs)*	*Annual Diversion Limit (mg/year)*
North Coast [1] Liddell Spring Laguna/Reggiardo Creeks Majors Creek	Year-round	No limit	None	None
San Lorenzo River				
Intake and Tait Wells	Year-round	12.2	None	None
Felton Diversion to Loch Lomond Reservoir	September	7.8	10	977
	October	20	25	
	November-May	20	20	
	June-August	---	---	
Loch Lomond Reservoir on Newell Creek				
Collection	September-June	No limit	---	1,825
Withdrawal	Year-round	---	1	1,042

[1] Water rights for the North Coast Sources are pre-1914 rights containing all downstream rights. Therefore, the SCWD may divert up to the full natural flow of each stream. SCWD owns all downstream riparian water rights on the North Coast sources.

It should be noted that the drought emergency starting in 2014, required SCWD file for a Temporary Urgency Change with the State Water Resources Control Board, Division of Water Rights for relief from the bypass and release requirement at Loch Lomond Reservoir in order to maintain water in storage to meet the community's needs for water for essential health and safety needs. In addition, SCWD is initiating a Water Rights Reliability Project process to conform water rights that will change the place of use of the San Lorenzo River water and allow flexibility in the use of the various surface waters available to Santa Cruz.

2.6.2 Other Utilities

Table 2-5 summarizes the water rights for the larger utilities in the watershed area in the San Lorenzo Valley watershed. The large utilities, such as SLVWD, have more than 200 service connections. The smaller utilities have less than 200 service connections and are monitored by the County Health Services Agency. This table also lists the limiting flow rates or diverted flow rates from the different surface waters, if applicable.

Table 2-5: Summary of Surface Water Rights for Utilities With More Than 200 Service Connections

Utility	*Source(s)*	*Rights*	*Limitations*
Santa Cruz Water Department (SCWD)	San Lorenzo River Intake and Tait Wells	Year-round use; There are no fish flow requirements or annual flow limitations based on water rights but limitations are proposed under the minimum instream flow targets under the HCP (see Section 2.3.5)	12.2 cfs (7.9 mgd) maximum withdrawals per day.
	Felton Diversion	Can divert 20 cfs (12.9 mgd) from October through May to Loch Lomond	Must provide at least 25 cfs in October and 20 cfs from November through May for fish flows. Maximum allowable diversion is 977 mgy .
	Loch Lomond Reservoir	Can withdraw year-round	1 cfs September thru June; greater of 1 cfs or equal to inflow July thru August; into Newell Creek ; 5,600 acre-feet annual collection with 3,200 acre-feet maximum annual withdrawal;
	Coast sources including Liddell Spring, Laguna/Reggiardo Creeks, and Majors Creek	Fully appropriated rights There are no fish flow requirements or annual flow limitations based on water rights but bypass flows are proposed and currently provided under the minimum instream flow targets under the HCP (see Section 2.3.5)	None
San Lorenzo Valley Water District (SLVWD)	Clear Creek, Foreman Creek, Peavine Creek, Sweetwater Creek, Fall Creek, Bennett and Bull Springs	Fully appropriated rights Fully appropriated rights Not to exceed 1.7 cfs and 345 mg/year	None Required minimum bypass flows vary from 0.05 – 1.5 cfs, depending on the cumulative monthly runoff of the San Lorenzo River, as measured at the Big Trees gage; cannot divert once Big Trees drops below 20 cfs per seniority
SLVWD	Lompico Creek	Appropriative Rights	Diversion of up to 24,000 gallons per day of surface water and must have 0.1 cfs bypass

Source: DDW Annual Inspection Reports and State Water Resources Control Board Water Rights Database

Note to Reviewers: Info for Big Basin MWC is not included in this table but was included in the 1996 survey.

2.6.3 SLVWD

SLVWD has pre-1914 appropriative water rights to divert from the northern tributaries to the San Lorenzo River and appropriative water rights transferred during SLVWD's acquisition of the Felton System for Fall Creek and Bennett and Bull Springs.

The appropriative water right to divert up to 24,000 gallons of surface water at the Lompico Creek intake structure was originally owned by LCWD but has now been transferred to SLVWD since the 2016 merger. Historically, LCWD did not exceed their allowable diversion.

2.6.4 Water Quantity

Table 2-6 summarizes the water sources and the quantity of water available for each large utility. This table lists the surface water sources for each utility, the approximate average surface water supply capacity for the source, the total supply capacity (including ground water), and the total average day use. Each of the large utilities has a limited supply of water for drinking water purposes. For example, SCWD has about 11.4 to 15.7 mgd of combined ground and surface water available for drinking water purposes, of which about 75 percent comes from flowing surface diversions, about 5 percent from groundwater and the remaining 20 percent from water stored in Loch Lomond at the present time. The average day use from 2015 was about 6.7 mgd, with a potential average demand in 2030 of up to 8.8 mgd (2015 UWMP: Tables 4-4). Although average water demand appears to be met with the available supply, during periods of drought, flows in the San Lorenzo River and coast sources run low and cannot support average dry-season demands. This situation can stress the system, especially given the unpredictable nature of climate conditions. SCWD will be challenged to consistently provide and achieve the desired supply capacity, especially during extended drought periods, under the minimum instream flow targets for the HCP, and in the future with the current supply sources.

Although efforts are made to maximize the volume of water available from surface water sources, especially the San Lorenzo River, after a storm event, the City operates under a maximum turbidity level for withdrawal from the San Lorenzo River sump of 10 NTU at the Coast Pump Station; the sump is a blend of San Lorenzo River and Tait well water. During first flush storm events in the early season, turn outs are bypassed as soon as it starts raining. The City is considering a winter diversion program that could be used for in-lieu conjunctive use of groundwater to improve seawater intrusion conditions which may result in adjustments to the turbidity criteria.

Table 2-6: Summary of Water Sources Available for Utilities With More Than 200 Service Connections

Utility	*Source(s)*	*Average Surface Water Supply*	*Average Groundwater Supply*	*Average Supply Available*	*Demand Average (mgd)*	*Notes*
City of Santa Cruz Water Dept.	San Lorenzo River	1,882 mgy	N/A	3,252 mgy	10	Total supply available depends on annual rainfall
	Loch Lomond Reservoir	595 mgy	N/A			
	Coast Sources including Liddell Spring, Laguna/Reggiardo Creeks, and Majors Creek	637 mgy				
	Beltz Wells[2] (Active wells only)	N/A	138 mgy			
San Lorenzo Valley Water District	Clear Creek, Foreman Creek, Peavine Creek, Sweetwater Creek	1.2 mgd	N/A	5.0 mgd	1.9 mgd	Most of the demand is in surface water service area (about 70 percent)
	Quail Hollow, Olympia, and Pasatiempo Wells	N/A	3.3 mgd			
	Fall Creek, Bennett and Bull Springs	0.5 mgd	N/A			
Lompico County Water District (merged in 2016 with SLVWD)	Lompico Creek	0.06 mgd	N/A	0.12 mgd	0.082 mgd	
	Well Sources (3 wells) SLVWD Connection	N/A	0.06 mgd			

Mgy= million gallons per year; mgd = million gallons per day

Source: 2015 Urban Water Management Plan

N/A - Not applicable

[1] Tait Street wells are considered a surface water because they are hydraulically influenced by the San Lorenzo River flow.

2.6.5 Source Management

Each of the utilities in the area manages their sources in an attempt to satisfy the water demands for their specific systems. All utilities are dependent upon the surface flows from the various creeks, streams, and springs that make up their drinking water source. Factors such as highly turbid water caused by stormwater runoff make the water more difficult to treat, requiring diversion of the source to be discontinued until the water quality returns to acceptable levels. For example, SCWD does not use water from the San Lorenzo River Diversion during storm events when the sump turbidity which is blend of San Lorenzo River and Tait Wells exceeds

about 10 NTU. When flows are diminishing towards the end of a storm and/or on the receding limb of the hydrograph, turbidity of about 25 NTU is diverted. Also, SLVWD does not use highly turbid water at their Lyon and Kirby WTPs during high-turbidity periods.

One of the major issues that continues to face SCWD is the proposed in-stream flow requirements for Endangered Species Act (ESA) requirements under the HCP will be established on some of the North Coast streams, potentially reducing the volume of flow available from these sources. As discussed in Section 2.3.5, the consequence of reduced North Coast flows would be higher reliance on water from Loch Lomond Reservoir, which has a higher TOC concentration, and hence a higher potential for formation of disinfection byproducts (DBP). DBP formation can be managed/inhibited/ from both the treatment perspective by carefully selecting source water for lower TOC as well as in the distribution system where regular water sampling occurs for DBP compliance.

City staff has continued to discuss, at a conceptual level, the implications of ESA in-stream flow requirements as well as potential future winter water production for regional water supply reliability, which could include modifying the treatment process and/or constructing horizontal wells at the San Lorenzo River diversion -- both of which are activities that will require many years to plan and implement. In addition, Graham Hill WTP improvements to meet LT2 and Stage 2 rule requirements were evaluated in 2010. These improvements include alternatives that could be implemented to meet more stringent D/DBPR requirements and reduce the higher levels of DBP that are associated with elevated TOC concentrations.

Water utilities must therefore balance the need to satisfy their customer demand with the requirement to comply with drinking water regulations. Most utilities, large and small, experience difficulty in treating highly-turbid water, and therefore prepare and adjust for such operations before, during, and after storms events as does SLVWD.

2.7 Facilities

2.7.1 Raw Water Reservoirs

With the exception of small diversions in creeks and streams, the only large raw water reservoir in this study area is Loch Lomond, which is managed by SCWD. This roughly 8,600 acre-foot capacity reservoir, located on Newell Creek northeast of Felton and east of Ben Lomond, also stores San Lorenzo River water diverted at the Felton Diversion structure. The SLVWD is entitled by contract to receive a portion of the water stored in Loch Lomond.

SCWD recently launched a project to either rehabilitate or replace the inlet/outlet pipeline that serves the Loch Lomond Reservoir. A valve on this pipeline was inspected in 2012 and was found to be stuck partially open and no longer operable. An interim plan was agreed to with Division of Safety of Dams in 2015 and the potential design options for the project are currently being considered.

2.7.2 Intakes/Conveyance Systems

The locations of major water intakes are shown in Figure 1-1. Table 2-7 describes the intake and conveyance systems for the large utilities. Note that the San Lorenzo Valley and North Coast watersheds have extensive intake and conveyance systems needed to efficiently use the readily available supply of water in this area. Many of the intake structures have been

constructed to prevent contamination from outside sources. Some of the key intake and conveyance systems are discussed below.

Table 2-7: Summary of Conveyance/Intake Facilities for Utilities With More Than 200 Service Connections

Utility	*Source*	*Intake Details*	*Pipeline Dimensions*	*Pump Station Capacity*	*Other*
City of Santa Cruz Water Department	San Lorenzo River Intake	Combination concrete check dam and screened intake sump with vertical turbine pumps on wells	Varies	7.8 mgd	
	San Lorenzo River - Felton diversion	Inflatable rubber dam, screened intake pump	N/A	Felton Diversion P.S. at 2,850 gpm	Diverts water to Loch Lomond
	Loch Lomond Reservoir	Large earthen dam with multi-stage outlet tower	44,000 lf pipeline; 18 to 27 inches diameter	Gravity flow to Felton with Felton Pump Station at 13.5 MGD	Used in specific months to augment supply or when other sources have high turbidity that is difficult to treat
	Coast sources	These sources have small diversion structures or a protected spring box	Diameter varies - total pipelines	Gravity flow	Gravity flow to the Coast pump station then; pumped to GHWTP
	Majors	Concrete full-span dam with wire screened intake	10”	Gravity flow	Gravity flow to the Coast pump station then; pumped to GHWTP
	Laguna	Concrete/stone full span dam with wire screened intake	14”	Gravity flow	Gravity flow to the Coast pump station then; pumped to GHWTP
	Reggiardo	Concrete/stone full span dam with wire screened intake	8”	Gravity flow	Gravity fed to Laguna impoundment
	Liddell	Concrete/Corrugated Aluminum springbox with wire screened intake	16”		Gravity flow to the Coast pump station then; pumped to GHWTP
San Lorenzo Valley Water District	Clear Creek	Protected spring box at elev 1250 ft,	8-inch pipe to Foreman Creek	N/A	Gravity flow to Lyon WTP
	Sweetwater Creek	Protected spring box at elev. 1230 ft.		N/A	Gravity flow to Lyon WTP
	Peavine Creek	Small diversion structure at elev 1264 ft.	8 in. pipeline to Foreman Creek	Gravity	Gravity flow to Lyon WTP , Christmas tree farm in watershed
	Foreman Creek	Small diversion structure at elev 927 ft.	8 in. pipeline to WTP	Gravity	Gravity flow to Lyon WTP, small subdivision in headwaters
	Fall Creek	Small wire screen structures	8-inch	500 gpm	Gravity flow to Kirby WTP, Fall Creek St Park
	Bennett Spring	Protected spring box	4-inch	N/A	Gravity flow to Kirby WTP
	Bull Spring	Protected spring box for #1 and #2	4-inch	N/A	Gravity flow to Kirby WTP,
Lompico County Water District (merged with SLVWD in 2016)	Lompico Creek	Secured, screened structure adjacent to creek impoundment dam with concrete deep well and 1 HP pump	2” PVC Raw water line to holding tank 260-ft away	30 gpm Pump	N/A

N/A Not applicable or available.

Note to Reviewers: Info for Big Basin MWC is not included in this table but were included in 1996.

2.7.2.1 SCWD

Figure 1-1 shows approximate intake locations for the SCWD system. These include pipelines from the North Coast watershed and the San Lorenzo Valley. The details of these intakes and conveyance systems are described in Section 2.5 and in the 1996 sanitary survey.

2.7.2.2 SLVWD

Figure 1-1 shows the locations of the surface water sources used by the SLVWD. The Sweetwater Creek and Clear Creek intakes have been relocated further upstream on each creek to minimize the impact from human activity. However, this relocation has also moved the intakes closer to Empire Grade Road and reduced the runoff area. The impact of this relocation should be beneficial unless there is a significant chemical spill upstream of one or both intakes.

SLVWD has an intake, currently unused, on Lompico Creek below the Mill Creek confluence. About 15-20 houses are located upstream of the intake structure. Originally, the LCWD obtained about 25% of its water from the Lompico Creek surface intake and the other approximately 75% is obtained from groundwater wells. Should Lompico Creek be used in the future, relocation of the creek intake structure upstream of existing houses and installation of fish passage facilities is recommended.

2.7.3 Treatment Plants/Processes

The water treatment plant facilities for the large utilities in the watershed study areas are summarized in Table 2-8 and are described in more detail below.

Table 2-8: Summary of Surface Water Treatment Facilities for Utilities With More Than 200 Service Connections

Utility/Treatment Plant (Capacity)	Subject Watershed Source(s)	Pretreatment Process	Coagulant/ Flocculation Process	Sedimentation	Filtration (Rate)	Disinfection
Santa Cruz Water Dept. Graham Hill WTP [(1)] (24 mgd)	San Lorenzo River, Loch Lomond, and North Coast sources	Potassium permanganate or chlorine for oxidation, powdered activated carbon and potassium permanganate for taste and odor removal	Alum and cationic polymer Horizontal paddle mixers	Conventional - enhanced using tube settlers	Dual media (6gpm/ft2)	Sodium Hypochlorite with liquid chlorine back-up[(2)]
San Lorenzo Valley Water District - Lyon WTP (1.0 mgd)	Clear Creek, Foreman Creek, Peavine Creek, Sweetwater Creek	Chlorine for oxidation	Adsorption clarification/ filtration (Neptune Trident Microfloc)	Adsorption onto floating media which is equivalent to sedimentation	3 Multi-media filters at 350 gpm rating each (6gpm/ft2)	Sodium Hypochlorite
San Lorenzo Valley Water District - Kirby WTP (0.5 mgd)	Fall Creek, Bennett and Bull Springs	Sodium Hypochlorite	Adsorption clarification/ filtration (Neptune Trident Microfloc)	Adsorption onto floating media which is equivalent to sedimentation	2 – filters at 350 gpm rating	Sodium Hypochlorite
San Lorenzo Valley Water District – Mill Creek WTP (on standby)	Lompico Creeks	None	None	None	Microfiltration membrane 0.5 gpm/m2 of membrane area	Chlorine Post-treatment

Source: DDW Annual Inspection Reports

N/A = Not applicable

(1) Beltz WTP is not included because it is a groundwater source and Loch Lomond Recreation Area WTP is not included because it is a transient non-community water system.

(2) Orthophosphate is added for corrosion control in the water distribution system to prevent leaching of lead and copper

Note to Reviewers: Info for Big Basin MWC is not included in this table but was included in 1996.

2.7.3.1 SCWD

Figure 2-5 represents the approximate layout of the facilities at Graham Hill Water Treatment Plant site. The Graham Hill WTP is a conventional treatment plant with key processes such as preoxidation, coagulation, carbon/potassium permanganate contactors (for taste and odor control), flocculation, sedimentation, filtration, and disinfection. These processes are fully described in the 2016 Inspection Report by DDW. Recent upgrades at the Graham Hill WTP include upgrades to the filter and replacement of tube settlers.

The Loch Lomond Reservoir Recreational Area (LLRRA) water system uses a microfiltration system to provide water for park users and the caretakers of the reservoir watershed. This system produces about 15 gallons per minute (gpm) of reservoir water through a microfiltration unit, equivalent to about 20,000 gallons per day. The microfiltration membranes were last replaced in 2010.

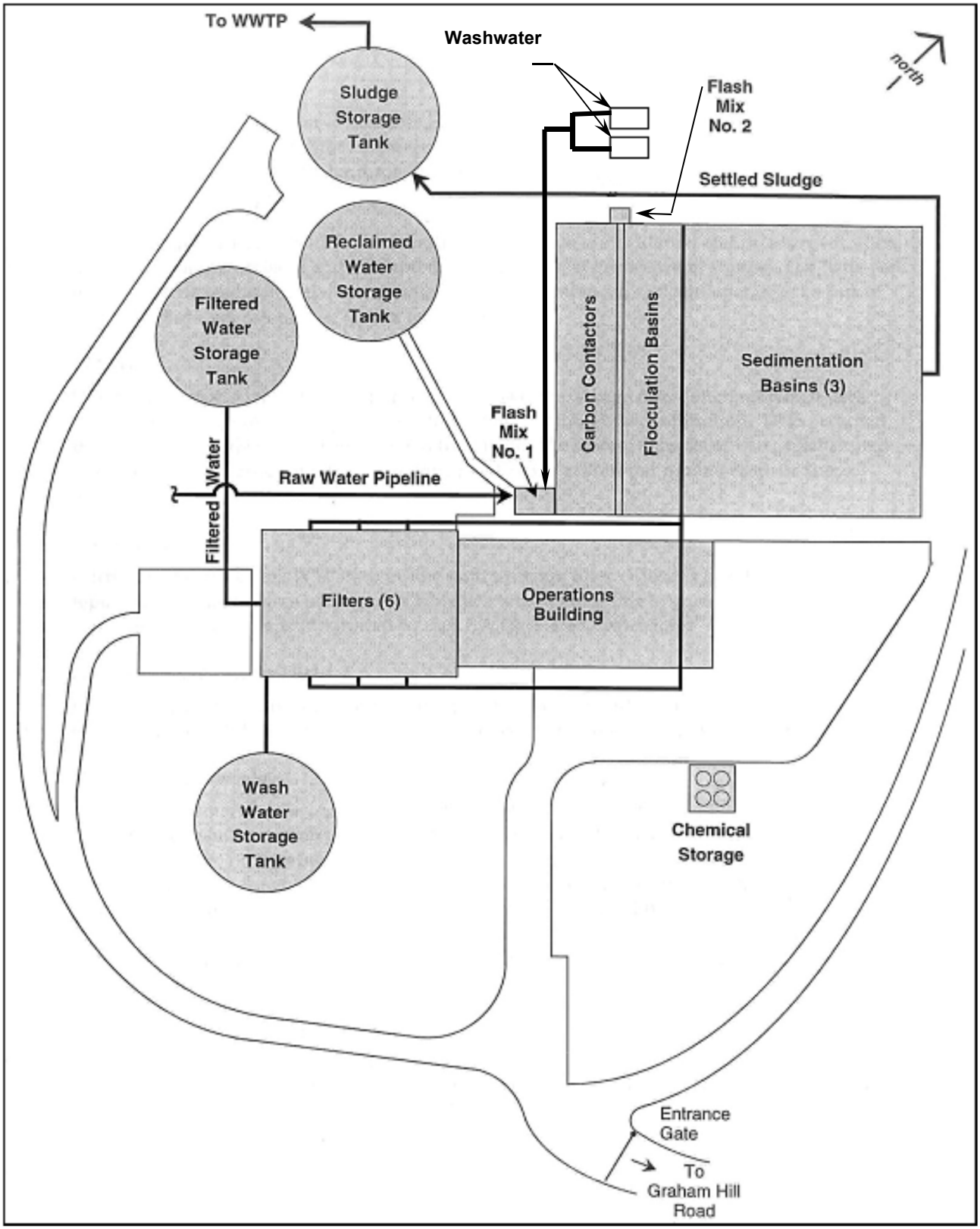
SCWD also operates two treatment facilities that serve the the Live Oak (previously Beltz) Wells. These facilities are only used to treat groundwater and are not fully described in this update. Details on the Live Oak Wells Filtration Plant are provided in previous surveys.

2.7.3.2 SLVWD

SLVWD constructed the Lyon WTP in 1994, a two-stage package filtration plant which uses floating media to remove floc particles followed by a granular media filtration. DDW accepted this process as equivalent to conventional treatment. The system consists of three prefabricated adsorption, clarification, and filtration units each rated at 420 gpm. Due to piping system constraints, however, the maximum treated water production rate is 1,150 gpm.

In addition, SLVWD operates the Kirby WTP in Felton which is described in Section 2.4.3

The Lompico Creek water source was treated with a a pressure filtration system with microfiltration facilities for the Mill Creek WTP constructed by LCWD in 1996. While the treatment system is currently unused, it can treat surface water from Lompico Creek using a sand trap for pre-treatment, followed by a cartridge filter, then to a 400-gallon equalization tank that provides a constant flow rate to the microfiltration membranes. Following membrane filtration, the water passes through granular activated carbon for taste and odor control and disinfected with sodium hypochlorite before entering the disinfection system. SLVWD staff find that the relatively low flows do not merit the high labor effort necessary to operate the treatment facilities.



Source: CDM - Camp Dresser & McKee Inc., 1996

Figure 2-5 Process Layout of the Graham Hill Water Treatment Plant, Santa Cruz Water Department.

2.7.4 Pipeline Data, Capacity

Table 2-9 summarizes the pipeline data for each of the large utilities. Table 2-10 lists the distribution system reservoirs for each of the large utilities. The distribution system storage capacity for these utilities appears sufficient to account for short-duration periods when the lower quality water is diverted and water treatment facilities are not used. The maximum storage capacity for these utilities is about two to ten times more than the average daily use, with SCWD typically at the lower end of that range. Therefore, each utility has enough storage to allow a short-term period when water treatment facilities are not operational.

Table 2-9: Summary of Distribution Systems for Utilities With More Than 200 Service Connections

Utility	*Number of Service Connections*	*Total Pipeline Length*	*Notes*
City of Santa Cruz Water Department	24,523 in 11 pressure zones	300 miles (4 in. to 18 in.)	Satellite disinfection available at 4 locations
San Lorenzo Valley Water District	6,000 in 23 pressure zones 1,300 in 6 pressure zones for Felton System 484 in 3 pressure zones in Lompico System	155 miles (SLVWD 125 miles, Felton 30 miles, Lompico System 32 miles) (2 in. to 16 in.)	Satellite disinfection available at 2 locations

Note to Reviewers: Info for Big Basin MWC is not included in this table but was included in 1996.

Table 2-10: Summary of Distribution System Storage Reservoirs for Utilities with more than 200 Service Connections

Utility	*Reservoir Name*	*Capacity (Gallons)*
City of Santa Cruz Water Department (16 reservoirs total)	Carbonera	1,000,000
	University #5	2,000,000
	University #4	400,000
	University #2	1,000,000
	Bay St. (2 tanks)	12,000,000
	DeLaveaga 1	1,000,000
	DeLaveaga 2	1,000,000
	S.C Gardens 1	250,000
	S.C Gardens 2	250,000
	Rollingwoods	270,000
	Pasatiempo 1	750,000
	Pasatiempo 2	300,000
	Finished Water Tank @ GHWTP	1,000,000
San Lorenzo Valley Water District (37 reservoirs total)	Echo	1,000,000
	Reader	150,000
	Brookdale	750,000
	Big Steel	1,400,000
	Lyon	3,000,000
	Little Lyon	250,000
	Blue Ridge	40,000
	Huckleberry	125,000
	Bear Creek Estates	75,000
	Ralston	10,000
	Eckley	4,000
	Blackstone 1	11,000
	Blackstone 2	11,000
	Highland	60,000
	Nina 1	64,500
	Nina 2	64,500
	South 1	9,000
	South 2	9,000
	South 3	9,000
	South 4	9,000
	Spring	65,000
	Swim 1	10,000
	Swim 2	10,000
	Quail 1	211,000
	Quail 2	240,000
	University	51,000
	Reagon	500
	Probation	100,000
	Lower Pasatiempo	100,000
	Upper Pasatiempo	100,000
	Blue Tank	65,000
	Charlie Tank	45,000
	Felton – Kirby	250,000
	Felton - Blair	255,000
	Felton - El Solyo	20,000
	Felton – McCloud	284,000
	Felton Acres	100,000
Lompico County Water District (merged with SLVWD in 2016)	Clear well	48,000
	Tank 1	65,000
	Tank 2	100,000
	Tank 3	100,000
	Tank 4	100,000
	Tank 5	100,000
	Tank 6	100,000

2.7.5 Satellite treatment facilities

Besides small chlorination systems for numerous wells used throughout the area, the main satellite treatment facilities are chlorination facilities used by SCWD at the University Reservoir. Satellite chlorination equipment is housed in a separate room from the source. SCADA systems are used to control and monitor these facilities. The targeted chlorine residual leaving these facilities to the appropriate pressure zones is about 0.5 mg/l of free chlorine. SLVWD has a similar facility at one of its reservoirs.

2.8 Emergency Plans

Most utilities experience periodic emergencies that disrupt water treatment or water supply. The SWTR requires utilities to develop standard and emergency response plans for specific types of emergency episodes. These include chemical spills, fires, equipment failure, serious power failure, and deliberate water fouling. Some emergency plans may include responses to seismic episodes, floods, and droughts. In addition, the Bioterrorism Act of 2002 requires that drinking water systems serving a population greater than 3,300 (or 1,000 service connections) complete a vulnerability assessment in regard to terrorist activity and modify their emergency plans to reduce the risk posed by terrorist attacks.

Most of the utilities in the study area have developed emergency response plans as part of the Operations Plans for each WTP. Also, the County uses the emergency response dispatch, NETCOMM, to notify drinking water utilities of chemical spills, fires, and other emergencies in the watershed. The Emergency Plan includes a response when episodes are notified via the 911 emergency telephone number. However, SCWD staff has indicated that notifications are not always made; therefore a recommendation to have an annual discussion with emergency response dispatchers has been made. Specific emergency plans for each utility are discussed below.

2.8.1 SCWD

The SCWD issued a revised *Emergency Operations Plan* in 2013, which addresses natural and man-made disasters such as earthquakes, tidal waves, flood, fire, vandal-caused disasters, and chemical spills. This *Emergency Operations Plan* would be used in the event of contamination of the water supply by acts of terrorism or vandalism. The response to equipment failures and serious power failures at the WTP is included in the September 2016 GHWTP Operations Manual.

SCWD has conducted a seismic risk evaluation called the Earthquake Response Procedures for the Newell Creek Dam and Other Critical Structures. This information is available in the 2005 *General Emergency Plan* SCWD also has a Water Shortage Contingency Plan which was adopted by resolution of the Santa Cruz City Council in August 2016 and an Ordinance (Santa Cruz Municipal Code Chapter 16.01) that implements water shortage regulations and restrictions. Both of these documents are included as appendices to the 2015 *Urban Water Management Plan* and call for an aggressive conservation effort and public relations program to reduce the drinking water demand of the customers during emergencies.

In addition, SCWD conducted a comprehensive assessment of the Newell Creek Dam and spill way concurrent with an update to the dam Emergency Action Plan.. During the winter of 2017, SCWD increased dam inspections from monthly to daily during the heaviest rains. The dam was also inspected at a reconnaissance level by the Division of Safety of Dams in Spring 2017 as a precaution; the state inspection identified potential geologic, structural or performance issues

that could pose a risk during a flood event. It is anticipated that these risks will be further studied and remedies proposed during the comprehensive dam assessment currently underway.

The broader 2015 *Santa Cruz County Operational Area*[7] *Emergency Management Plan* addresses the consequences of any emergency or disaster which may occur within the County. The plan also provides a means by which State and Federal assistance is requested if necessary. Depending on the size and complexity of the incident, an emergency operations center (EOC) may be activated under the direction of the Santa Cruz County Office of Emergency Services. The Santa Cruz Operational Area transitioned to a Standardized Emergency Management System (SEMS) in 2007 that is compliant with the National Incident Management System (NIMS). NIMS was developed by the Department of Homeland Security to improve national readiness to respond to not only terrorist events but all types of disasters (Santa Cruz County Office of Emergency Services, 2005).

2.8.2 SLVWD

SLVWD recently updated their emergency response plans which are contained in the *Lyon WTP Operations Plan*. This plan includes a response to most natural disasters and chemical spills in the watershed. For other emergencies, SLVWD can rely on the County EOC infrastructure.

Prior to the merger, LCWD had an Emergency Response Plan which SLVWD should review and update prior to active use of the WTP and intakes. Some emergency response measures available for the Lompico portion of the North System include:

- For fires, SLVWD has maintained fire breaks around all treated water reservoir sites.
- For emergency power, a trailer-mounted emergency generator that will provide 30 kilowatts power is available for use at booster stations which are outfitted with quick-disconnect emergency-hookup switches.
- For earthquakes, five of the six water storage tanks have been rehabilitated with restraint hold-downs and flexible fittings to minimize any lateral movement. All structures within the original LCWD facilities have been evaluated for seismic risk.

[7] The Santa Cruz Operational Area consists of the County and all political subdivisions within the County.

Section 3: POTENTIAL CONTAMINANT SOURCES IN THE WATERSHEDS

3.1 Survey Methods

The survey consisted of a combination of discussions and meetings with several County staff and Water Department staff, update calls to selected agencies, and a review of several agency websites and files. Contacts are listed in Table 3.1. The survey work was also supplemented with additional data and report review and discussions with various agency staff. This section discusses the specific potential contaminant sources.

Table 3-1: Santa Cruz Watershed Sanitary Survey Contacts

Category	Contact	Agency	Phone Number
Drinking Water Regulations/Treatment	Jan Sweigert	CA DDW(Monterey)	(831) 655-6934
Processes/Quality Control	Querube Moltrup	CA DDW (Monterey)	(831) 655-6936
General Watershed Information	Chris Berry	SCWD	(831) 420-5483
	John Ricker	SCCo Environmental Health Services	(831) 454-2750
	Jen Michelsen	SLVWD	(831) 430-4625
	Chris Spohrer	CA Parks and Recreation	(831) 359-7420
	Matt Johnston	Santa Cruz County Planning	(831) 454-3114
Drinking Water Production/Treatment	Dustin Holtzclaw	SCWD	(831) 420-5461
	Brian Lee	SLVWD	(831) 430-4625
	Troy Boone	SCCo Environmental Health Services	(831) 454-3069
	David McNair	Scotts Valley Water District*	(831) 438- 2363
	Rachel Arias	Big Redwood State Park MWC*	(831) 335-6311
	Michael Stus	Sequoia Seminar*	(831) 336-5060
	Bob Runyan	Quaker Center*	(831) 336-8333
	Dale Pollock	Mt. Hermon*	(831) 430-1204
		* = non-participants in this Sanitary Survey	
Urban Runoff	Rachael Fatoohi	SCCo	(831) 454-2810
	Bridget Hoover	Monterey Bay National Marine Sanctuary	(831) 647-4217

Table 3-1. Santa Cruz Watershed Sanitary Survey Contacts (cont'd)

Category	Contact	Agency	Phone Number
Land Use (Agricultural, etc.)	Matt Johnston	SCCo Planning Department	(831) 454-3114
	John Ricker	SCCo Environmental Health Services	(831) 454-2750
	David Sanford	SCCo Agricultural Commissioner	(831)
	Jennifer Michelsen	SLVWD	(831) 430-4627
	Whit Haraguchi	USDA NRCS	(831) 227-2901
Concentrated Animal Facilities	John Ricker	SCCo Environmental Health Services	(831) 454-2750
	Chris Berry	SCWD	(831) 420-5483
	Jennifer Michelson	SLVWD	(831) 430-4627
	Angela Gruys	SCCo RCD	(831) 464-2950
	Jennifer Harrison	Ecology Action	(831) 425-1404
	Howard Kolb	RWQCB	(831) 549-3332
Pesticide and Herbicide Use	Kris Griffin	CalTrans - Landscape Specialist	(805) 549-3124
	Tom Barnett	CalTrans - Santa Cruz Area Supt	(831) 476-1351
	Steve Tjosvold	UC Cooperative Extension	(831) 763-8013
	Dawn Harman	SCCo Road Maintenance	(831) 477-3999
	Chris Berry	SCWD	(831) 420-5483
	Gar Eidam	SCWD, Loch Lomond	(831) 335-2586
	Juan Hidalgo	SCCo Agricultural Commissioner	(831) 227-2901
	Bill Keller	Boulder Cr. Golf and Country Club	(831) 338-3717
Wild Animals	Chris Spohrer	CA DPR	(831) 359-7420
	Jennifer Michelson	SLVWD	(831) 430-4627
	Gar Eidam	SCWD, Loch Lomond	(831) 335-2586
	Chris Berry	SCWD	(831) 420-5483
	Don Kelly	CDFW Warden	(831) 649-2942
	Chris Wilmers	UCSC	(650) 208-5766
Quarries	Chris Berry	SCWD	(831) 420-5483
	David Carlson	SCCo Planning Department	(831) 454-3173
	Terry Tompkins	SCWD	(831) 420-5454
	Barry Hecht	Balance Hydrologics	(510) 704-1000
Solid and Hazardous Waste Disposal Facilities	Scott Carson	SCCo Environmental Health Services	(831) 454-2758
	Jose DeAnda	SCCo Environmental Health Services	(831) 454-2759
	Tim Fillmore	SCCo Environmental Health Services	(831) 454-2761
	Tom Sayles	RWQCB	(805) 542-4640
	Thea Tryon	RWQCB	(805) 542-4776
	Kasey Kolassa	SCCo Public Works Department	(831) 454-2377

Table 3-1. Santa Cruz Watershed Sanitary Survey Contacts (cont'd)

Category	Contact	Agency	Phone Number
Timber Harvesting	Matt Johnston	SCCo Environmental Health Services	(831) 454-3114
	Jennifer Michelson	SLVWD	(831) 430-4627
	Chris Berry	SCWD	(831) 420-5483
	Rich Sampson	Cal Fire	(831) 335-6742
	Terris Kastner	CDFW	(408) 365-1066
	Sheila Shoderberg	RWQCB	(805) 542-3592
Recreation	Gretchen Illif	SC Co Parks	(831)-454-7908
	Chris Spohrer	CA Parks and Recreation	(831) 359-7420
	Jennifer Michelson	SLVWD	(831) 430-4627
	Chris Berry	SCWD	(831) 420-5483
	Mauro Garcia	City of Santa Cruz Parks and Recreation	(831) 420-5366
Unauthorized Activity	Chris Berry	SCWD	(831) 420-5483
	Gar Eidam	SCWD	(831) 335-2586
	Jennifer Michelson	SLVWD	(831) 430-4627
	Matt Johnston	Santa Cruz County Planning	(831) 454-3114
	Jose DeAnda	SCCo Environmental Health Services	(831) 454-2759
	John Bucchanon	Cal Fire	(831) 423-0528
	Rich Sampson	Cal Fire	(831) 335-6742
Traffic Accidents and Spills	Scott Carson	SCCo Environmental Health Services	(831) 454-2758
	Jose DeAnda	SCCo Environmental Health Services	(831) 454-2759
	Rebecca Supplee	SCCo Environmental Health Services	(831) 454-2761
Geologic Hazards	Joe Hanna	SCCo Planning Department	(831) 454-3175
Fire	Tim Hyland	CA Parks and Recreation	(831) 335-6384/345-3331
	Gar Eidam	SCWD, Loch Lomond	(831) 335-2586
	Chris Berry	SCWD	(831) 420-5483
	Chris Spohrer	CA Parks and Recreation	(831) 359-7420
	Jim Rust	Cal Fire	(831) 335-6723
	Mike Gagarin	Cal Fire	(831) 427-2430
	Jennifer Michelson	SLVWD	(831) 430-4627
	Chief John Stipes	Zayante Fire Dept.	(831) 335-5100
Wastewater	Forest Revere	SCCo Public Works	(831) 454-2407
	Troy Adams	City of Scott's Valley	(831) 438-0732
	Rick Rogers	SLVWD	(831) 430-4624
	Dale Pollock	Mt Hermon	(831) 430-1204
	Harvey Packard	RWQCB	(805) 542-4639
	John Ricker	SCCo Environmental Health Services	(831) 454-2750
	Cheryl Wong	SCCo Environmental Health Services	(831)-454-3219

3.2 Wastewater

A number of communities and organizations are served by package wastewater treatment systems that discharge to common leachfields as shown on Figure 3-1. These entities include: County Service Area No. 7 in the vicinity of the Boulder Creek Golf and Country Club, Bear Creek Estates, the Mt. Hermon Association, the San Lorenzo Valley Unified School District, Camp Harmon, Camp Campbell and several other camps and conference centers. Recently, County Service Area No. 10 - Rollingwood Estates was connected to the City of Santa Cruz wastewater treatment plant which discharges the wastewater through the City of Santa Cruz ocean outfall.

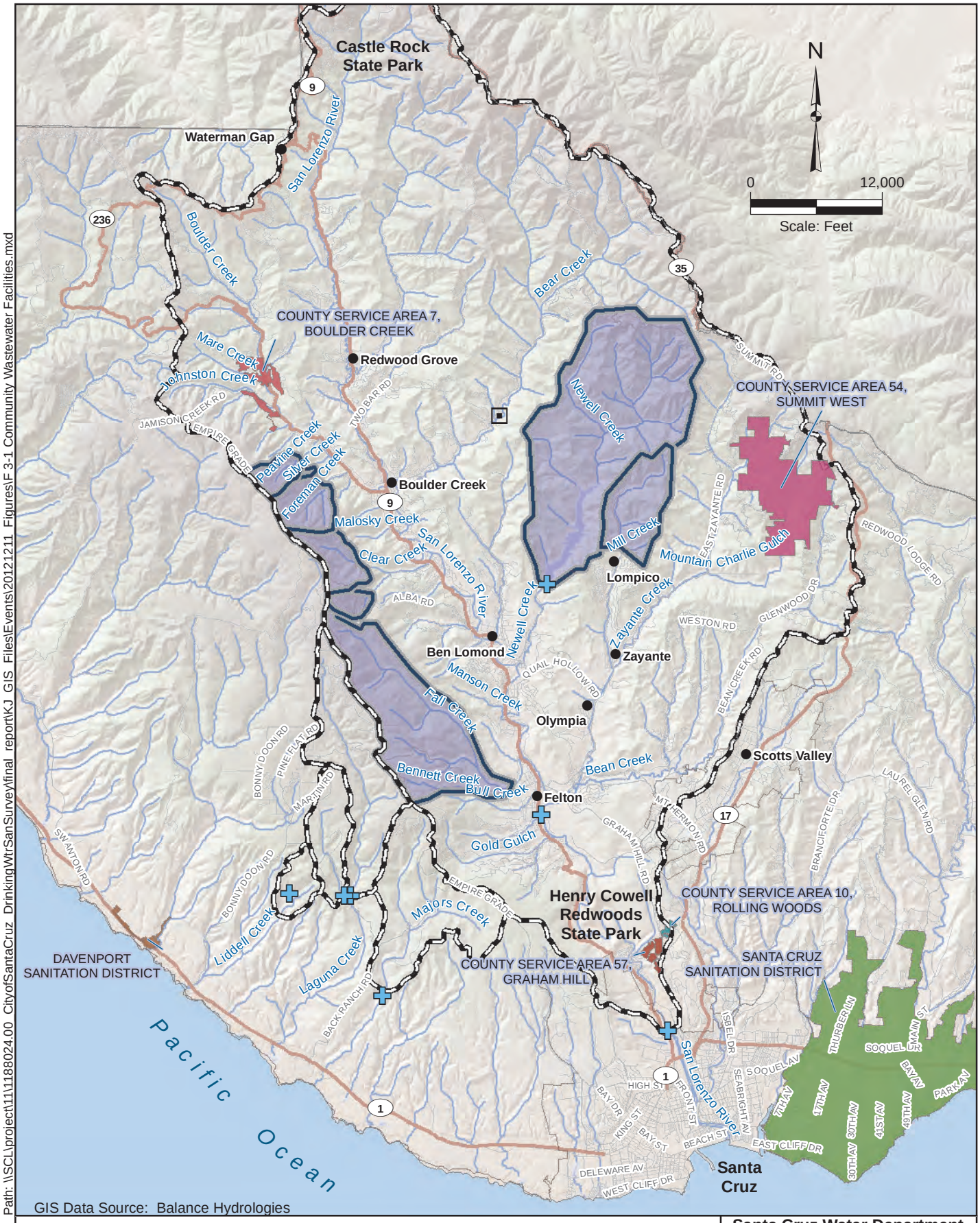
However, the great majority of the residences and businesses in the San Lorenzo River watershed are on individual or community (e.g., trailer parks) septic systems. The dispersed rural population in the North Coast watersheds is served by individual septic tank and leachfield systems. There are no direct discharges of municipal wastewater to surface waters in the San Lorenzo Valley or North Coast watersheds.[8]

As shown on Figure 2-1, the majority of the SLVWD watershed areas are either in a state park or is protected land designated as Resource Conservation Land Use. The state park has hiking trails but no wastewater facilities as the nearby park entrance station, outside of the drainage, has visitor facilities. Only a small portion of the SLVWD watershed lands are designated rural residential with associated septic systems; these lands are near the upper watershed, quite a distance from the diversion locations.

Septic systems have the potential to contaminate surface water either by percolation of wastewater through the soil into ground water which recharges surface water, or by direct surface runoff. If septic systems are improperly designed or installed in highly-permeable soils, such as sandy soils noted earlier, wastewater constituents can leach into ground water and from there seep into nearby surface waters. Surface water contamination from septic systems can also occur by system 'failure', or insufficient percolation rates leading to ponding and surfacing of effluent. A 'failing' septic system can allow large amounts of nutrients, viruses and bacteria to contaminate nearby surface waters. The portions of the San Lorenzo Valley that overlie high permeability soils has a higher probability of nitrates entering groundwater from the individual septic systems through excessively rapid percolation to ground water rather than by system failures as a result of the sandy soils discussed in Section 2.3.1. It is estimated that 11% of septic systems are located in high permeability soils.

There are about 15 homes upstream of the Lompico Creek intake currently unused, one of which was documented as failing in the 1996 sanitary survey. Since the LCWD merger with SLVWD, this water source is no longer used. However, if the former LCWD intake were to be reactivated, septic system performance should be reviewed.

[8] The Watkins Johnson site in Scotts Valley, has had declining levels of TCE and PCE that have been treated and released. The site owners are currently negotiating with the USEPA to formally close the site.


Castle Rock State Park
Waterman Gap
San Lorenzo River
Boulder Creek
Bear Creek
COUNTY SERVICE AREA 7, BOULDER CREEK
Mare Creek
Johnston Creek
Redwood Grove
COUNTY SERVICE AREA 54, SUMMIT WEST
Newell Creek
Peavine Creek
Silver Creek
Foreman Creek
Boulder Creek
Malosky Creek
Clear Creek
Mill Creek
Mountain Charlie Gulch
Lompico
Zayante Creek
Ben Lomond
Manson Creek
Fall Creek
Olympia
Zayante
Scotts Valley
Bennett Creek
Bull Creek
Bean Creek
Felton
Gold Gulch
Majors Creek
Henry Cowell Redwoods State Park
COUNTY SERVICE AREA 10, ROLLING WOODS
COUNTY SERVICE AREA 57, GRAHAM HILL
SANTA CRUZ SANITATION DISTRICT
DAVENPORT SANITATION DISTRICT
Liddell Creek
Laguna Creek
Pacific Ocean
Santa Cruz
N
0
12,000
Scale: Feet
GIS Data Source: Balance Hydrologies
Area Locations
Streets
Stream
Lakes
SLVWD Bear Creek WWTP
Santa Cruz Water Department Diversions
Santa Cruz City Water Supply Watersheds
Sub-Watershed
Santa Cruz Water Department
WSS Update
Community Wastewater Facilities
Figure 3-1
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Surface water contamination by nutrients and coliform bacteria from septic systems in the San Lorenzo Valley has been intensively studied. The 1979 Watershed Management Plan identified improperly functioning septic systems as one of the major pollutants sources to the San Lorenzo River. In 1995, the County Board of Supervisors and the Regional Board adopted the Wastewater Management Plan for the San Lorenzo River Watershed which has been considered a model for the on-site septic wastewater management standards in the State under AB 885 as discussed in Section 4.9.

The Wastewater Management Plan contains management practices to prevent further degradation of water quality from septic systems and corrective measures to improve existing systems and reduce the loading of pollutants to the San Lorenzo River. The County implements a series of activities including septic tank pumping reporting to manage on-site wastewater systems as discussed in Section 5. Many of these measures were emplaced after extended field trials at sites throughout the valley under a range of soil and slope conditions. Since 2010, the County has approved over 130 septic upgrades for remodel, 78 alternative septic repairs, over 60 minor septic or monitoring well repairs, and over 680 repairs to septics or wells for a total over about 950 septics that have been repaired/modified in the watershed (John Ricker, personal communication 2017).

Recent estimates indicate that wet season septic failures rates are less than 0.5%. About 50 complaints/year regarding septic systems have been recorded in the San Lorenzo River Watershed, which is significantly less than the 130-160 failures per year recorded in the 1990s. Of those 50 complaints, about 50 percent had documented failures requiring improvements. Furthermore, the rate of new septic system addition has also reduced from about 15 systems per year down to 4 systems per year which further reduces the risk of water quality contamination from septic systems. Since 2010, the County has approved 11 new alternative septic systems and 34 new septic systems, some of which have enhanced treatment, in the San Lorenzo River and North Coast watersheds which equates to about 5 systems per year (John Ricker, personal communication, 2017). Since 2015, the County has provided a septic evaluation service to potential home buyers.

Review of the County's inspection and complaint records indicate that, within the watersheds, there were 8 complaints with septic -related failure or violations, in 2013 – 2014; 6 in 2014 – 2015, 19 in 2015 – 2016, and 28 in 2016-2017. Some cases in 2015-2016 and 2016-2017 were pending resolution.

3.2.1 Contaminants of Concern

Contaminants in wastewater can be divided into those that present an acute health risk and those that may pose a chronic, or long-term health risk. An acute health risk is posed by the presence of pathogenic microorganisms. A chronic health risk is posed by excessive concentrations of compounds present in the source water or formed in the water treatment process.

Wastewater contains a number of pathogenic microorganisms responsible for causing diseases, such as hepatitis, typhoid, cholera, dysentery, salmonella, giardiasis, and cryptosporidiosis. In a properly functioning septic system, the effluent is treated by the soil and the microorganisms are

removed. If the system is not functioning properly, incompletely treatied effluent may enter streams, or reach ground water.

Wastewater also contains high concentrations of nutrients and organic carbon. Most nitrogen in wastewater is converted to the nitrate form, which is highly soluble and readily transmitted through the soil to ground or surface waters. Nutrients can stimulate biological productivity in surface waters leading to high concentrations of organic carbon at downstream water intakes. Organic carbon combined with disinfectants used at water treatment plants produces trihalomethanes (THMs), five haloacetic acids (HAA5) and other disinfection byproducts (DBP) which can have long-term health implications. Excessive algal growth, promoted by introducing additional nitrate into a natural system in which phosphorus is widely available, also causes taste and odor problems in drinking water systems.

Blooms of blue-green algae (cyanobacteria), which form in nutrient-rich, non-turbulent waters, could cause more serious problems as some of these organisms produce harmful toxins. In September 2009, the EPA finalized its Drinking Water Contaminant Candidate List to include cyanobacteria which prioritizes this issue for further investigation. Usually, management practices to control taste and odor help to reduce the likelihood of toxic blue-green algal blooms; however, prevention is the preferred method because some types of treatment can rupture the cells and release the toxins.

County policy requires permitting of greywater sumps and includes connection of all greywater to an adequately sized septic system for the winter time when irrigation demands are low. SB 1258 passed in 2008 directs the California Department of Housing and Community Development to develop a more wide-ranging set of greywater standards for both indoor and outdoor uses than current law allows. These standards are expected to be incorporated in California Plumbing Code updates. Proposed standards include consideration of source water protection through containment on the site where generated and disposed of, prohibition on ponding and runoff, and prohibition of the use of greywater containing infectious (e.g. diapers) or hazardous contaminants. Both the County and the City provide guidance for use of graywater systems.

A greywater system collects and disposes of wastewater from systems such as the washing machine, shower, and bathroom sink. Greywater sumps are used by some homeowners to reduce loadings on a septic system with inadequate leaching capacity and to be able to reuse greywater for landscape irrigation. Although greywater contains fewer pathogens, solids, and nutrients than toilet wastes, it can still present a significant health hazard. According to the County Health Services Agency, bacterial concentrations in greywater from shower or bath water can reach 400,000 fecal coliforms/100 milliliter (ml) and 3 million total coliforms/100 ml. Washing machine wastewater can range from 2,000 to 10 million fecal coliforms/100 ml. In addition, there are roughly 200 enteric virus/Liter (L) of undisinfected greywater from showers and baths and 3,000 viruses/L from washing machines.

As noted earlier, the County requires building permits for installation of a greywater system while for projects and County records indicate that since 2012, 2 new greywater systems and 5 minor greywater system repairs were permitted. Within the City limits, Laundry to Landscape systems requires registration with the City Public Works Department by submitting an Installation and Maintenance Agreement form.

3.2.1.1 Bacteria

A number of studies have been conducted to evaluate the proportion of the bacterial contributions resulting from wastewater discharge versus the proportion resulting from other sources, including waterfowl, livestock, pet waste, failing septic systems, sewer system leaks, encampments, and urban runoff. Ground-water monitoring conducted in Boulder Creek and as part of the County's ongoing monitoring program has shown that fecal coliform levels decrease to background levels more than 25 feet from septic systems. Beginning in 1981 the County has assessed fecal coliform concentration in shallow ground water underlying developed areas. The absence of fecal coliforms indicates that incidents of bacterial contamination of surface waters do not result from cumulative contamination of ground water but result from failures and discharges to the ground surface from individual systems.

Rapid detection of failing septic systems under the Wastewater Management Program, especially through the 1990s and the resulting system repairs and/or upgrades have substantially improved dry-season bacteria levels in the San Lorenzo River upstream from Santa Cruz (Santa Cruz County, 2003). As discussed below in Section 3.3 (urban runoff), results of recent microbiological source tracking indicate that birds are by far the major source of microbial contamination in the river, although human waste is a significant contributor, particularly during the wet season and downstream from suburban areas, such as Felton, and within the City of Santa Cruz (Ricker and Peters, 2006).

Blue-green algae (cyanobacteria), which are closer to bacteria than algae, have occasionally been reported in Loch Lomond Reservoir during warm summer conditions.

3.2.1.2 Nitrate

Although nitrate concentrations in the San Lorenzo River had increased five to seven times over background levels (Ricker, 1995), as discussed in Section 5, it was estimated that 50 to 80 percent of this increase is attributable to nitrate from wastewater (Ricker, 1989). Approximately two thirds of the nitrate load in the river comes from the area of the watershed underlain by the highly permeable Santa Margarita sandstone. Unlike bacteria, there has been a significant cumulative release of nitrate from septic systems in the watershed, particularly in areas underlain by sandy soils.

A Nitrate Management Plan was first implemented in 1995 and was subsequently formalized as a total maximum daily load (TMDL) for nitrate in 2000 as a result of the rising nitrate levels and is discussed in Section 4.9.1. The extensive effort in improving wastewater management since 1995 has also resulted in reduced nitrate levels. More recently, nitrate levels in the San Lorenzo River are not apparently increasing and County staff has indicated that further reductions to nitrate concentrations will be challenging (J. Ricker, Personal Communication, 2012). Since San Lorenzo River water is pumped to Loch Lomond Reservoir, the linkage between nitrate, algae production and the resulting odors and disinfection-by-product precursors will continue to be a challenge, especially for the SCWD as well as for SLVWD.

3.2.2 San Lorenzo River Watershed

The Regional Water Quality Control Board is responsible for permitting and management of wastewater systems that discharge greater than 20,000 gallons per day (gpd). As part of County

Service Area No. 7, the County-operated Boulder Creek Wastewater Treatment Plant serves the neighboring country club, 18-hole golf course, tennis facilities, restaurant and pro shop, as well as about 200 townhouses and residences built along the fairways. The collection system includes 24 miles of 6- and 8-inch gravity mains, a 4-inch PVC force main, and five lift stations. The plant was upgraded to tertiary treatment in 1996 and has a capacity of 104,000 gpd. The treated effluent is pumped to a leachfield, where it is disposed of by subsurface discharge. In the past, tertiary treated water has also been delivered to the Boulder Creek Golf and Country Club, blended with raw water and used for irrigation. Since 2010, process improvements to reduce the nitrate concentration, improved distribution of effluent to the leachfield, as well as force main upgrades to reduce spills between the treatment plant and leachfield have been implemented. (J. Ricker, Personal Communication, 2012). The force main and other improvements have particularly reduced spills to Boulder Creek.

The Bear Creek Estates Wastewater Treatment Plant, which is owned and operated by the SLVWD, serves units 3, 4, and 5 of Bear Creek Estates. SLVWD has a waste discharge permit to treat up to 12,000 gallons per day of wastewater, then discharge it to a community leachfield. In 2005, SLVWD installed improvements for nitrogen removal pursuant to the Regional Water Quality Control Board's minimum discharge requirement of 50 percent nitrogen removal, prior to subsurface disposal. Heavy winter rains in 2016-2017 resulted in groundwater infiltration resulting in overflows which have been reported to the RWQCB and County. SLVWD is considering a replacement of the WWTP to provide more reliable treatment. In addition, there are about 150 septic systems within 3 of the SLVWD source water sheds (SLVWD Watershed Management Plan, 2010).

The Mt. Hermon Association is another significant community wastewater disposal system in the watershed. The Mt. Hermon Association is served by a sequential batch reactor package plant that treats wastewater from a hotel, cabins and homes. The plant has a permitted capacity of 63,000 gpd but operates at about 45,000 gpd. Treated effluent is pumped uphill and discharged to a community leachfield above the plant. More recently, the Rollingwood subdivision of about 30 homes, near Scotts Valley has been connected to the City of Santa Cruz Wastewater Treatment Plant.

Significant institutional wastewater disposal systems in the San Lorenzo Valley include those serving Camp Harmon, Camp Campbell and other organized camps, as well as the San Lorenzo Valley Unified School District (high school, junior high school, elementary school) facility in Felton. The latter system is unique in that treated effluent is further polished in a constructed wetland prior to being discharged to a leachfield.

There are also approximately 13,292 individual septic systems in the San Lorenzo watershed Including Carbonera and Branciforte Creeks (J. Ricker, 2017). The density of systems is higher than that of any other comparable area in California watershed. Overall, the density of development in the creek bottoms, both along the river itself and on the river's tributaries, is quite high. Many residences were originally used as summer homes and are now occupied year-round. Some homes were built with part of the building supported by stilts, over the floodplain. In many areas the density is akin to urban areas in California which are served by municipal sewer systems.

There are a number of limitations to on-site disposal systems in the San Lorenzo Valley watershed, as described in the 1995 *Wastewater Management Plan:*

- Approximately 55 percent of the developed parcels are less than 15,000 square feet and 11 percent are less than 6,000 square feet. This significantly limits the size of leachfields and the opportunity to install back-up/replacement leachfields.

- Two-thirds of the systems are substandard in size and did not meet the repair standards of 1995. Significant improvements have been made to at least 3,000 systems since 1986.

- About 40 percent of the systems were constructed before 1975 and have not experienced significant additions (i.e. remodels/expansions/subdivisions) or do not have second leachfields.

- About 14 percent of the systems are located less than 100 feet from a stream.

- Winter ground-water levels are less than 10 feet from the surface in 30 to 50 percent of the systems and less than 3 feet from the surface in 3 to 6 percent of the systems.

The County has conducted numerous surveys and evaluations of the septic systems in the watershed since 1986. The County has continued to have a low frequency of septic-system surveys since the late 1990s, as relatively few changes were reported and the value of continuing the surveys does not compete effectively with enforcement or other County Environmental Health Service priorities (John Ricker, personal communication, 2017). Because there is real value to neighborhood- or community-scale discussion, the community-scale results from the 1996 sanitary survey are included and updated as appropriate[9]:

Kings Creek - The greater Kings Creek area includes 800 developed parcels in the neighborhoods of Wildwood, Redwood Grove, River Rights, Lower Kings Creek, Sunbeam Woods, Blue Ridge, Madrona and Sequoia Drives, Lower Two Bar Creek, and Juanita Woods. This area has soils with significant clay content, high winter ground-water levels, small lots, and steep slopes. Despite potential significant constraints to septic systems, over 80 percent of the systems were found to be performing without any signs of failure during the wet winter of 1986. During the wet winter of 1993, the overall failure rate was below 2 percent. Most of the failing systems could be adequately upgraded using conventional systems. The *Wastewater Management Plan* concludes that a community system is not feasible because it lacks a disposal site.

Boulder Creek - The Boulder Creek area includes the developed areas centered around downtown Boulder Creek and extending a short distance up the valleys along Bear Creek, Boulder Creek, and the San Lorenzo River. This area has relatively permeable alluvial soils with some localized areas of clay soils. Winter ground-water levels are less than 10 feet below the surface in most of the area. Ground-water underlying Boulder Creek probably contributes

[9] Balance Hydrologics staff also reviewed the long-term data provided by the County and City for indications that the 1989 Loma Prieta earthquake or the storms of 1995 and 1998 may have damaged sufficient systems to make a difference in bacterial or nitrate loadings. Neither constituent appears to have been affected by the three events queried

nitrate to the San Lorenzo River. There have been repeated instances of septic system failure, with discharge of untreated effluent to roadside areas and eventually to the San Lorenzo River. During the early period of the County's wastewater management program, the river downstream from Boulder Creek had the highest incidence of contamination by sewage of any area in the watershed. Conditions have improved significantly during recent years. During the winters of 1987 and 1988, 85 percent of the parcels surveyed were performing adequately and 4 percent were found to have surfacing sewage. In 1991, re-inspection of systems repaired as a result of the survey found that 90 percent were performing satisfactorily, and 95% of the systems were performing adequately in 1999 and 2001 (John Ricker, personnel communication, 2007). A feasibility study was conducted for a community sewage disposal system for the downtown area but it was found to be too costly. A community service district provides a regular pumpout service for the downtown area, with disposal outside of the watersheds.

Ben Lomond - The Ben Lomond area includes 780 developed parcels. There are no constraints to septic system performance in most of the Ben Lomond area. Historically the water quality in Ben Lomond has been the best of any developed area in the watershed. The survey conducted from 1989 through 1991 showed a 1 percent failure rate. In 1993, the failure rate was down to 0.5 percent. A community sewage disposal system is not warranted because of the cost and the low incidence of problems in this area.

Glen Arbor - The Glen Arbor area includes 500 parcels south of Ben Lomond. The area consists of three distinct zones; an upland area underlain by the Santa Margarita sandstone, an area of relatively steep slopes, and a lower area on well drained soils of the river terrace. Although the upland systems perform well, the effluent discharged to the highly permeable sandy soils contributes to elevated nitrate levels in the river. The lower portions of Glen Arbor have contributed to bacterial contamination of the river caused by high ground water and some pockets of clay soil. In recent years, a number of systems have been repaired. During the 1990 through 1993 surveys, a failure rate of 2 percent was found. A community disposal system was judged to be infeasible because of high cost and potential impacts on the Quail Hollow ground-water basin. Most homes in the Glen Arbor area were constructed during the late 1960s through late 1980s. Relatively few changes in the number of homes or of waste disposal systems since the early 1990s (White and Hecht, 1993) suggests that little if any change in effects on downstream community water supplies would be expected.

Felton - The Felton area includes 820 developed parcels. This area was surveyed in 1989 and 1991. Much of the Felton area is on a broad alluvial flat, with high ground water and small lot sizes being the main constraints to proper septic system functioning. Failure rates in 1993 were 0.6 percent. El Solyo Heights is a separate neighborhood of 80 developed parcels at the north end of Felton. Failure rates in this area were 13 percent in 1989. Constraints to proper septic tank functioning include high ground water, clay soils, shallow depth to bedrock, moderate slopes, and presence of cuts and fills. Alternative systems are being required on a case by case basis. A community disposal system feasibility study concluded that there was not an adequate disposal site and that the project would be too costly to justify.

Brook Lomond - The Brook Lomond area consists of 120 developed parcels between Ben Lomond and Brookdale. This area has permeable alluvial soils with high ground water and some areas of clay soil. In the 1987 survey, 6 percent of the parcels were found to have failing septic systems. The County recommends improved onsite disposal rather than a community disposal system.

Forest Lakes - The Forest Lakes area includes 970 developed parcels immediately south of Felton. This area has small lots, and localized pockets of high ground water and dense clay soils. The 1990 and 1991 survey found a failure rate of 2 percent. There has been no indication of wastewater contamination in Gold Gulch, the stream that drains most of the area. Because of the scattered occurrence of problem parcels, community collection and disposal is not a feasible alternative to onsite treatment.

The two most significant potential impacts of wastewater disposal on the drinking water supplies in the San Lorenzo watershed are the release of pathogenic organisms and excessive nutrients. However, close focus to wastewater management by the County as well as connection of some on-site systems to community wastewater treatment with off-site disposal has reduced the risk of contamination by wastewater.

Wastewater facilities in the SVLWD, are limited to residential septic systems, none of which are located near the diversion locations.

3.2.3 Loch Lomond Reservoir Subwatershed

Most of the watershed is owned by the City of Santa Cruz and the structures under the City's jurisdiction are park visitor facilities and the ranger's residence. There are a handful of homes on parcels not held by the City and two wineries and several medical marijuana grow facilities that drain to Loch Lomond Reservoir; all of which are served by septic systems. County staff has noted road development in these headwater areas (see Section 3.15.3). Loch Lomond stores wastewater from its recreational areas in vaults, which are pumped periodically and transported to the City Wastewater Treatment Plant.

3.2.4 North Coast Watersheds

Most septic systems in the North Coast watersheds are not anticipated to be a significant source of contamination because of: (a) very low residential densities, (b) a highly-dispersed pattern of residential settlement, and (c) soils and underlying geologic units which are generally loamy or crystalline and favorable for the use of conventional on-site systems. Scattered areas in these watersheds have substrates with limited percolation rates, principally in some of the older soils along Empire Grade (including the Pineridge subdivision), some shallow soils along Ice Cream Grade, and small areas underlain by shales in the upper Majors watershed. Karst, which is associated with subsurface connectivity through the limestone, can occur in portions of the watersheds including the upper portions of the Liddell Spring and Laguna Creek drainages as shown on Figure 2-4. These areas are sparsely populated and it is not known if wastewater sources directly overlie karst areas. The largest community in the area, Bonny Doon, does not drain to the watersheds of Laguna or Majors creeks.

The water quality data presented in Figure 5-2 in Section 5 indicate that the annual geometric mean of the total coliform bacteria concentrations in the Laguna and Majors Creek watersheds have varied from 177 MPN/100 ml up to 936 MPN/100 ml over the past 10 years. Liddell Spring's total coliform data are consistently lower with a geometric mean of less than 10 MPN/100ml. The County's 2006 microbiological source tracking effort (Ricker and Peters, 2006) did not collect data for North Coast streams but instead focused on the San Lorenzo River watershed, where development is concentrated and is the subject of a pathogen TMDL. The

County has also focused bacteriological testing on County beaches at the River mouth and to the south, which receive the greatest number of visitors. Failing septic systems are a potential source of increased coliforms in these streams, as are wildlife, waterfowl and livestock.

The nitrate data presented in Section 5 shows an increasing trend in annual median nitrate concentrations in Liddell Spring and Majors Creek over the past 30 years, with no long-term trend distinguishable in Laguna Creek. However, data from the past five years (2001-2006) shows a slight increasing trend in Laguna Creek, while median nitrate concentrations in Liddell Spring and Majors Creek appear to be declining.

The hydrogeologic report on the Bonny Doon quarry (Watkins-Johnson, 1992) indicated that nitrate concentrations were high (over 6 mg/l as nitrogen) in monitoring wells upgradient of the quarry. Because very little development exists upstream of this facility, the report suggested without elaboration that septic systems or a former poultry operation along Smith Grade as the sources of this nitrate.[10] Among other potential sources are explosives in use at the quarry. The likely sources of nitrate in the Laguna Creek and Majors Creek watersheds are the same as for microbial contamination.

3.2.5 Significance

After many years of study, the County and the Regional Board have concluded that the large majority of existing septic systems do not consistently contribute significantly to dry-season microbial concentrations measured in surface waters. Occasionally, failing septic systems are responsible for significant localized degradation of bacterial quality in surface waters during summer months. However, bacterial contributions from septic systems are probably greater during or following wet periods when runoff can convey surfacing sewage from failing systems to the San Lorenzo River. Efforts made since 1995 to improve septic system performance have reduced the septic failure rate and therefore the water quality degradation related to septic systems. As noted earlier, the elevated bacteria levels in Lompico Creek are indicative of septic system pollution and have resulted in higher treatment levels.

The San Lorenzo Nitrate Management Plan (Ricker, 1995) concluded that an estimated 84 percent of the nitrate load in the River resulted from human activities in the watershed. Two-thirds of the nitrate was attributed to wastewater discharges, particularly from septic systems in the highly-permeable Santa Margarita sandstone.

3.3 Urban Runoff

Urban runoff is that portion of stream flow originating from urban or densely-suburbanized areas. Most urban runoff occurs during storms; however, inter-storm period nuisance flows from urbanized areas can account for significant components to flow during those times. Urban runoff flows and contaminant concentrations are highly variable. Some factors affecting this variability include duration and intensity of rain events, specific urban land use (residential, commercial, industrial), and the length of the preceding dry period during which pollutants build

[10] The former poultry farm, in a highly karstic area locally known as the 'sinkhole plain', was discontinued at least 30 years ago, and should no longer seriously be considered as a discernible source of nitrogen in this sanitary survey.

up on the land surface. In addition to specific land uses, the atmosphere and automobiles are significant contributors to the contaminant load in urban runoff.

In October 1990, the EPA issued final regulations requiring NPDES Municipal Stormwater permits for urban runoff from cities with a population of 100,000 or greater, from certain types of industries, and from construction sites which involve a land disturbance of greater than 5 acres (Phase I). Although there are no cities this large in Santa Cruz County, the Central Coast office of the Regional Board, which administers the NPDES stormwater permit program, worked with County and municipal staff in anticipation of future regulations. In 1999, EPA expanded the NPDES Municipal Stormwater permit program to require permits for urban runoff discharges from cities with a population of less than 100,000 and from industries or construction sites which result in a land disturbance of from 1 to 5 acres (Phase II). The City and County subsequently developed comprehensive Storm Water Management Plans (SWMPs) describing compliance with the new regulations. The plans were submitted and approved by the Regional Board with applications for coverage under the Phase II permit. The County of Santa Cruz also joined the Central Coast Regional effort to develop hydromodification criteria by October 2012. Additional details about urban runoff regulations are included in Section 5 of this sanitary survey.

Watersheds in the study area are relatively unindustrialized, so there are few facilities which must comply with the state's NPDES General Industrial Stormwater permit program. The state permit requires industrial facilities to implement pollution prevention measures and to collect monitoring data during rainfall events. Each industrial facility files a Notice of Intent (NOI) which certifies that it will comply with these permit requirements. There is currently little oversight and enforcement of the industrial stormwater permit program because most of the state's effort has been channeled into simply identifying facilities which should be under permit. Types of industrial facilities which must file a NOI to comply with the state permit include: manufacturers (food, textiles, lumber, paper, chemicals, petroleum, rubber, plastic, metals, stone, clay, glass, machinery, electric, electronic, equipment, instruments, cement, phosphate, asphalt, fertilizer); confined animal facilities with over 700 animals; printing operations; recyclers; landfills; mining operations; transportation businesses (such as bus and trucking companies and airports); petroleum bulk plants; all NPDES wastewater dischargers with a design flow greater than 1.0 million gallons per day; Superfund sites; and steam electric power generator facilities.

A list of active industrial stormwater permittees in Santa Cruz County was downloaded from the SWRCB database in January 2012. Only 77 facilities county-wide have filed a NOI with the SWRCB. Most of these are located in Watsonville (28) and the City of Santa Cruz (24), outside of the sanitary survey study area. In Scotts Valley, both a computer technology manufacturer and a construction site in the Bean Creek watershed have filed for a NOI. In Felton, five companies have filed for a NOI within the San Lorenzo watershed: Granite Construction Company (for work in the Felton Quarry), Granite Rock Company (for an industrial site), Santa Cruz County (for improvements on Graham Hill Road), Hillcrest Vineyard, and Chevron Environmental Management (for the construction of automotive service shop). Lastly, in Ben Lomond, the San Lorenzo Valley School District also filed for a NOI (for their bus transportation yard). Quarries in the Scotts Valley and Bonny Doon area are not in the SWRCB database. The historic airport in Scotts Valley is inactive, while the one in Bonny Doon may receive occasional use by small private aircraft.

Since 2009, any construction activities greater than 1 acre requires permitting under the revised statewide Construction General Permit (CA 2009-0009-DWQ.) The local jurisdictions (City and

County) have construction best management practices that are required for smaller projects to control erosion and sediments that could negatively impact water quality.

3.3.1 Contaminants of Concern

The urban runoff contaminants of most concern to drinking water are microbial organisms and suspended sediments. Sources of microbes in urban runoff include: animal wastes from pets, birds and rodents; human waste from sewer system leaks and encampments; diffuse (nonpoint source) runoff, and decaying organic material in storm drains. Suspended sediment levels are often high in urban runoff because of the ease of mobilization and transport of small particles on impervious surfaces. In addition, suspended sediments are higher in runoff from erosion from newly-developed areas prior to establishment of vegetation. Suspended sediments in urban runoff contribute to high turbidities in the stream system during wet weather and also are significant because contaminants may be adsorbed to the sediment particles and transported into the streams. Note that construction of new impervious surfaces in urban areas can result in higher peak flows which, without mitigation, can lead to increased in-stream erosion and turbidity.

Other common contaminants of concern in urban runoff include: metals (notably copper, lead, and zinc), hydrocarbons, and pesticides. These contaminants can be significant to aquatic life in the receiving stream but at the levels found in the Santa Lorenzo River, have not been shown to be of exceptional significance to the drinking water quality.

3.3.2 San Lorenzo River Watershed

The urbanized population in the San Lorenzo River watershed centers on the communities of Boulder Creek, Ben Lomond, Brookdale and Felton. There are also pockets of development in the Boulder Creek Golf and Country Club area, along Newell Creek (Rancho Rio), lower Bear Creek, Zayante Creek, Lompico Creek, and Paradise Park, and in numerous small valleys confluent with the San Lorenzo River. Rural residential areas along Bean Creek Road at the fringes of Scotts Valley are also experiencing growth. The rest of the watershed, as noted above, is sparsely populated.

Many houses and residential areas were built during several speculative vacation housing booms in the 1890s, 1900s and from 1920 to 1940. A large percentage of existing homes were built before 1960. More recent housing has been primarily for year-round residences. Many of the older vacation homes were built very close to the creeks. Further development within the riparian corridors is currently limited, requiring County exemptions. Riparian corridors now extend out to the edge of the riparian woodland if the woodland is extensive enough to have been mapped on County vegetation maps. Otherwise, they are defined to be 50 feet from the high water mark for a perennial stream, less for an intermittent stream, and more in the coastal zone area. As discussed in Section 3.13.2, violations of County riparian corridor disturbance ordinances occurs but limited enforcement resources are available to limit potential damage. Most new housing has been infills or on rural acreage, with few if any major subdivisions within County jurisdiction. Future residential growth is expected to be mostly accommodated with minor land divisions.

The San Lorenzo River watershed is in Zone 8 of the Santa Cruz Flood Control District. Drainage in the towns along Highway 9 consists of a combination of sheet flow, roadside swales and ditches, and some inlets and piping in low spots. In smaller population centers, the engineered drainage system consists mostly of cross culverts to move stormwater across roads. There is an urban runoff control structural feature, a detention basin, and several check dams downstream of the Rancho Rio subdivision. These facilities were installed by the County Planning Department after construction of the subdivision to minimize the considerable erosion resulting from disturbance of this sandy area.

The County's Water Resources Program has been sampling the San Lorenzo River since 1968 for chemical and microbial constituents. The program currently includes collection and analysis of weekly samples from 15 regular sites throughout the County as well as at an additional 30 locations weekly for trend evaluation and source tracking. Heavy metals (e.g., zinc, copper, cadmium, and lead) and toxic organic compounds, such as pesticides and PCBs, have often been detected at low levels in ambient receiving waters of the San Lorenzo River watershed and occasionally at higher levels in storm drain discharges. Because these constituents can bioconcentrate in tissues, the County conducted a study focused on sampling sites in the lower River, including analysis of tissues from freshwater clams (Ricker and others, 2001). The results were generally consistent with previous monitoring studies in the watershed, the region, and the State (c.f. EPA Nationwide Urban Runoff Program): low levels of pesticides and PCBs (at 2 to 7 percent of hazardous thresholds), elevated concentrations of cadmium and zinc (both of geologic origin); and elevated levels of lead (potentially from prior use in gasoline or from the prior use of lead shot at a gun range near Castle Rock State Park). In all cases, concentrations were below levels of biotic or regulatory concern.

Bacteria levels in the San Lorenzo River have often exceeded County water quality objectives and on May 8, 2009, the San Lorenzo River Watershed Pathogen TMDL was approved by RWQCB Central Coast Region. However, bacteria levels in the upper watershed are typically much lower than those at the mouth of the river, and recent monitoring data show considerable improvement in dry-season bacteria levels, which in summer months, now generally meet standards for safe swimming at locations upstream from Santa Cruz (John Ricker, personal communication, 2012). Bacteria concentrations during storm events remain high, and are more elevated at downstream stations (i.e. at Felton vs upstream Sycamore Grove station), reflecting proportionally greater contributions from suburban and urban areas than from more rural areas. Despite progress in reducing bacteria levels, the Regional Board combined the TMDLs for the Branciforte Creek/San Lorenzo River Estuary with the TMDL for the Lompico Creek/upper San Lorenzo River watershed, based on elevated bacteria levels at two locations on the River during summer 2006, and higher-than-expected bacteria levels in 2005-2006 sampling.

Funded by a Proposition 13 grant from the SWRCB, the County analyzed over 2,000 water samples collected from 2002-2004 in storm drains, stream reaches, and beaches in an effort to identify the source and causes of elevated bacteria levels (Ricker and Peters, 2006). Ribotyping, a method of microbiological source tracking that differentiates human *E. coli* from other types of *E. coli*, was employed to discriminate between fecal coliform sources. Overall, birds were found to account for over 50 percent of bacterial contamination in samples from the San Lorenzo River, and 64 percent of summer bacteria samples in the upper watershed. In contrast, human waste was identified in approximately 11 percent of all samples, and in none of the dry-season samples from the upper watershed. Human contributions in the River were

found to increase significantly between Sycamore Grove and the mouth, due to inflows from urban areas, and were higher in wet weather when runoff scours storm drains and mobilizes waste from developed areas, encampments and the occasional failing septic system. Decomposing organic materials and sediments in storm drains were found to provide a good environment for bacteria to thrive and multiply.

Work in coastal San Mateo County (Ivanetich and others, 2006) was also able to distinguish fecal bacteria originating from dog, deer, horse, seagull and human sources. It is notable that the Santa Cruz County microbial source assessment study found that dogs alone accounted for about 7 percent of the dry-season bacteria in the upper watershed, and about 12 percent of wet-weather bacteria at Felton (Ricker and Peters, 2006). Waste from domestic animals such as cats, dogs and chickens probably contribute greatly to the high fecal coliform counts in the first flush of stormwater through urbanized areas. The County has not conducted further ribotyping work since the 2006 watershed sanitary survey. Further inquiries into sources and travel pathways of pathogens in the San Lorenzo Valley watershed, in particular, would be worthwhile, with special attention to streams reaches downstream of densely-urban communities and in areas receiving summer baseflow from sandy aquifers.

3.3.3 Loch Lomond Reservoir and the Upper Newell Creek Watershed

Urban runoff into Loch Lomond is effectively limited to contributions from Bear Creek Road, which are minor in magnitude. However, urban runoff constituents from the water pumped from the San Lorenzo River to Loch Lomond may be present in Loch Lomond.

3.3.4 North Coast Watersheds

There are no major towns in the North Coast watersheds. The Bonny Doon Airport is a small landing strip for private planes.

3.3.5 SLVWD

Based on conversations with staff from the SLVWD, there is no urban runoff that influences surface water in their watersheds. Most of the roads within the watershed of the SLVWD are district owned and maintained or are private access roads. Only the staff of the SLVWD has access to District roads.

There are approximately 20 residences located above the unused Lompico Creek surface water intake, if the intake is brought into service, urban runoff potential should be evaluated. and/or the intake should be moved upstream as planned.

3.3.6 Significance

Overall, urban runoff directly contributes a significant part of the total microbial load in the river system during summer and winter, it enriches summer baseflows with added nutrients, and it contributes some part of the sediment load entering the River during rain events.

Most development in the San Lorenzo Valley is residential. Many of the residents seek a rural lifestyle, and the contributed contaminants (microbes from both domestic and wild animals,

nutrients, sediment) may best be seen in that light. There are homes in the four main communities that are very close to and positioned well above the stream system, such that contaminants can move rapidly from neighborhood areas in the main communities into the channels. In these areas, source control to reduce runoff as well as redirecting runoff to areas for infiltration has particular value as a way of reducing contaminants. In particular, the results of the microbial source tracking study show that efforts to minimize or prevent dry-season runoff from landscape irrigation and other human activities would reduce transport of bacteria and other contaminants to storm drains and the River during the summer months when dilution is minimal and recreational use is at its peak.

Development overlying sandy soils contribute a disproportionate volume of nutrients which enter the streams through the sandy aquifers. As discussed further in Sections 5 and 6 later, nutrient concentrations are elevated during summer months in the streams with appreciable sandy soil areas in their watersheds, offering different source-control opportunities in the sandy areas away from the streams. Because sandy soil areas occur in both the North Coast and San Lorenzo watersheds, efforts to address the particular issues of sandy soils can be especially effective over a period of decades. There are few industrial facilities or large expanses of paved areas.

3.4 Agricultural Land Use

Santa Cruz is a strongly agricultural county. However, the majority of the existing row-crop acreage is located along the coast, in the Pajaro Valley in South County and on the marine terraces of the North Coast, neither of which extend into the watersheds of this survey. Commercial cropping with the study area watersheds is presently limited to small areas of vineyards and Christmas tree farms. Both watershed areas once supported widespread cultivation of apples and other orchard fruits wherever suitable sites with deep soils and southern exposures were found, but most such areas had already gone out of commercial production before the onset of extensive pesticide use in orchards began during the early 1960s. In scattered locations throughout the study area row crops are grown on a commercial or horticultural basis but these operations are on limited acreage and typically use organic practices. As discussed earlier regulation of cannabis cultivation is currently underway and potentially poses significant water quality threats if not appropriately managed.

3.4.1 Contaminants of Concern

The primary contaminant of concern from these types of agricultural uses is sediment from erosion of fallow or improperly tilled land and from eroding drainages downstream from cultivated areas. Other potential contaminants include nutrients, pesticides, herbicides, and organic matter in stormwater runoff.

3.4.2 San Lorenzo River Watershed

In the San Lorenzo Valley, vineyards and Christmas tree farms occupy the largest agricultural acreage. Several established vineyards exist in the area; in Felton (Hallcrest Vineyard and the Organic Wine Works), next to Bear Creek Road on the ridge above Loch Lomond (Byington, David Bruce, and Bear Creek Vineyards), and in side valleys near Boulder Creek (P & M Staiger and Equinox), along Bean Creek in Scotts Valley (Roudon Smith Vineyard), up Highway 9 near

Waterman Gap (Ahlgren) and along the top of the watershed divide at Skyline Boulevard (Zayante Vineyard). Small personal vineyards are commonly seen on larger residential parcels with adequate sunlight. Land clearing for vineyards has the potential to be problematic, if not done correctly, e.g., poor drainage design, improper grading, and inadequate erosion control. Santa Cruz County regulates agricultural grading in an effort to protect water quality but has limited enforcement resources to monitor grading in general.

Unlike vineyards, Christmas tree farms are operated with little cultivation or disturbance to the soil surface. Field visits to several of these operations throughout the watershed showed that annual grasses, forbs and bracken serve as a cover crop between rows of spruce and fir. The roads in the tree farms are intermittently used, with the greatest use generally during the two months prior to Christmas.

To a lesser extent, apples and other tree fruits are still grown in the old and declining orchards in the sunnier aspects of the Santa Cruz Mountains. According to County Agricultural Commission staff, little to no new commercial acreage has been developed during the last two decades. The existing orchards tend to be managed organically or with few applications of chemical pesticides or fertilizers, and minimal tillage.

Small commercial greenhouse operations and flower farms exist along Bean Creek and in the San Lorenzo Valley. Rhododendrons are no longer grown in the Bean Creek subwatershed, nor elsewhere in the San Lorenzo Valley (Roberta Haver, former owner, personal communication, 2006). Pesticide use is minor. University of California Agricultural Extension staff indicated that the primary potential contaminant in these container greenhouses is nitrogen, which is flushed through the containers by proper irrigation, and which exceeds crop needs typically by 20 percent during each watering. These operations are located on the extremely permeable Santa Margarita sandstones, which provides the excellent drainage needed for these uses, but which may permit the greenhouses to become a source of nitrogen to both Bean Creek and the Santa Margarita aquifer.

3.4.3 Loch Lomond Reservoir Subwatershed

In addition to the vineyards described above, there is are also small medical cannabis operations in the Loch Lomond subwatershed. In the past, small-scale diversions associated with covert cannabis plantations have been reported on tributaries that drain into Newell Creek and Loch Lomond.

3.4.4 North Coast Watersheds

The coastal terraces of northern Santa Cruz County are one of the classic agricultural areas of California, supporting far more cultivated acreage than the San Lorenzo Valley. The crops are grown mainly on the lowest two terraces along Hwy 1, *below the diversion points* on the North Coast streams. These areas are farmed primarily for brussel sprouts and (less frequently) artichokes. Both crops require the unique climate dominated by marine fog found on these lower terraces. Other crops include lettuce, strawberries, broccoli, and flowers.

Four vineyards operate in the North Coast, the Bonny Doon and McHenry Vineyards, and recently the Rancho Madera Roja[11] in the upper Liddell Creek watershed and Redwood Meadows Ranch Winery and Beauregard Vineyards in the upper Majors Creek watershed. Cattle are occasionally grazed on the mosaic of grasslands, oak/madrone woodland, and mixed evergreen forests which separate the belt of row crops along the coast from the residential areas and orchards of the Empire Grade portion of the Bonny Doon area. A small portion of this area drains to Majors Creek upstream of the intake. Some Christmas tree farms are also located in Bonny Doon, near the northern end of Empire Grade.

3.4.5 SLVWD

The only known commercial agriculture known to be present is a Christmas Tree farm along Upper Empire Grade Road within the Foreman Creek watershed. There has been no contamination observed due to this farm's operations.

There are no known commercial agricultural land uses within the Lompico Creek watersheds.

3.4.6 Significance

As a minor land use in the water supply watersheds, agricultural production does not appear to be a major source of concern at present and in the foreseeable future. The two most visible crops in the watersheds, Christmas trees and grapes, tend to be grown at higher elevations, along ridges and in areas above the fog line, away from the major streams. Past observations at Christmas tree farms in the survey area suggest that these are unlikely to be major sources of contamination, or erosion. Vineyards, on the other hand, are typically located on slopes with loose, sandy soils, and controlling weeds by harrowing between rows leaves soils exposed to rainfall and rill erosion. Marginal to poor drainage design and inadequate erosion control can result in vineyards being a source of sediment and persistent turbidity. Some vineyards use organic practices; others employ pesticides to a light or a moderate degree.

Cultivation of other crops is less likely to affect the quality of water supplies, because of the minimal acreage of land under cultivation and the generally low level use of pesticides. Pesticide and herbicide use is discussed in Section 3.7.

3.5 Grazing Livestock

Watersheds in the study area are primarily forested or vegetated brushlands of various types, so the extent of grazed areas is also limited, particularly in the San Lorenzo watershed. The North Coast watersheds are better suited for livestock and have had several cattle and dairy operations working in the subject water supply drainages. Throughout the watersheds, impacts from grazing cattle are less than those of confined horses, except in areas where cattle are watered from streams. This section includes discussion of cattle and individual or small horse groupings; the main discussion of horses as they affect water quality is within Section 3.6.

[11] The lack of erosion control in the winter of 2008 resulted in a violation, but the issue has since been resolved (Chris Berry, personal communication, 2012).

3.5.1 Contaminants of Concern

Erosion and waste products are of primary concern. Where unfenced, destruction of streambanks and wetland vegetation by grazing animals causes an increase in erosion, indirect loss of channel stability (eventually generating pulses of sediment entering directly into the creeks), and persistent turbidity. Manure, urine, and pathogens such as cryptosporidium from young calves, may be introduced directly into streamflow year round, with elevated rates of transport into waterways during wet periods.

3.5.2 San Lorenzo Valley

Residential development of the valley bottoms, stream terraces, and sunny ridgelines in the survey area puts a premium on "buildable" land. This trend, combined with the gradual succession from grassland to chaparral, in the absence of wildfire, has gradually reduced cattle and sheep operations in the San Lorenzo Valley.

No active commercial cattle operations are known in the San Lorenzo watershed, other than occasional use of small acreages in the Bean Creek subwatershed. Equestrian use is widespread in the watershed and horses are kept on residential parcels and at commercial or boarding stables. The latter facilities typically have more horses but also have larger pastures for grazing (and dispersal of animal wastes). As a result of the low numbers, grazing animals pose a minor threat to the water quality of the San Lorenzo watershed. Concentrated animals such as horse stables upstream of water intakes pose a greater threat and are discussed in Section 3.6.2.

3.5.3 Loch Lomond Reservoir and upper Newell Creek watershed

No grazing animals were encountered in the Loch Lomond area during prior visits to the lake and upper watershed. The City does not allow riding animals in the watershed area.

3.5.4 North Coast Watersheds

As discussed above, a limited amount of rangeland drains to Majors Creek upstream of the City's diversion structure, including the northern parts of Grey Whale Ranch. These areas seem to be grazed intermittently, principally by individual horses or small groups of horses, with occasional cattle grazing (apparently) under lease arrangements. Most of these grasslands are located along ridgelines or on slopes distant from the streams, reducing but not eliminating the potential for contributing nutrients, pathogens, and sediment to the streams. Further downstream on Liddell Creek, beyond the boundaries of the survey area, issues of livestock management are being addressed by the County. Trails, and roads used as trails, do come close to the main stem and east fork of Majors Creek; these could prove to be a small, but perhaps growing, source of sediment and pathogens.

3.5.5 SLVWD

There is no commercial grazing livestock present within the SLVWD. Based on conversations with staff from the district, indicated that there may be a limited number of residences that may have goats and chickens, but these would be unlikely to impact the watershed.

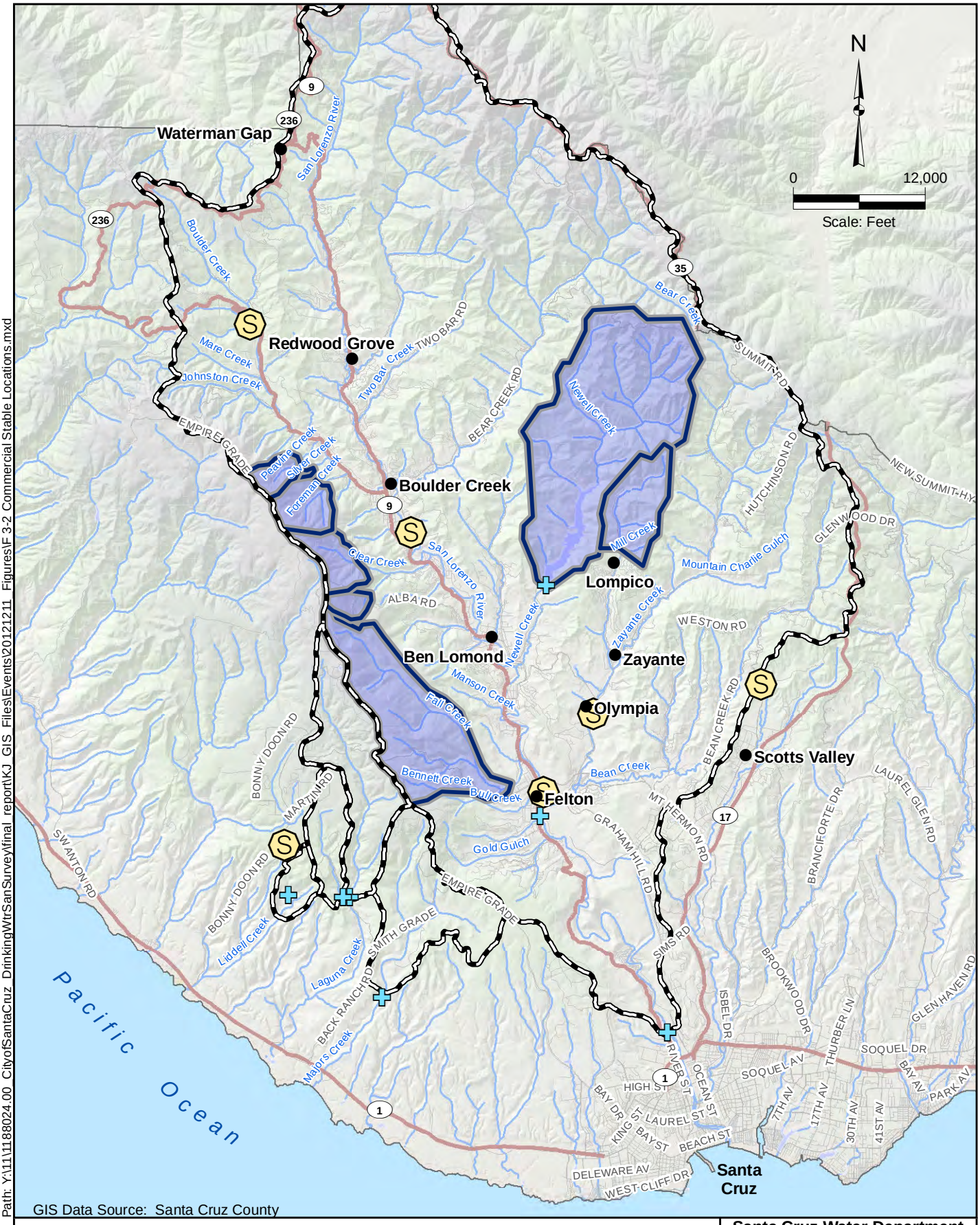
As in the SLVWD, there is no known commercial grazing livestock present within the Lompico Creek Watershed although horses are known to be present at one residence within the watershed and there are some chickens and goats at other homes. It is believed that that it would be highly unlikely for any runoff from these residences to reach Lompico Creek.

3.5.6 Significance

The San Lorenzo River Pathogen and Nitrate TMDL list livestock as sources of the respective constituents. Pathogenic microorganisms are the major source of concern when contact between grazing animals and water supplies occurs. Hecht and others (1991) identified horses as a significant contributor to the San Lorenzo Valley nitrate budget and the County has taken measures to assess and control equine nitrate contributions to both surface and ground waters (c.f., the 1995 Wastewater Management Plan and the 2001 Watershed Management Plan Update) to reduce costs of treatment for taste and odor problems. Where access to water is limited only to streams, degradation of habitat and bank stability is evident (see also Section 3.6). Development of improved water sources for grazing animals has played a significant part in limiting erosion impacts on water quality. Fencing, which is associated with water source improvements also reduce the impacts of manure and urine by creating buffer zones between grazing animals and waterways. That said, percolation of urine, especially in areas overlying sandy soils may be a source of nutrients from grazing livestock. Since 2005, the Santa Cruz County Resource Conservation District has partnered with a local non-governmental organization to provide resources in a Livestock and Land program, described in greater detail in Section 3.6.1 to assist homeowners in proper management measures to reduce water quality impacts of livestock and small agricultural activities.

3.6 Concentrated Animal Facilities

While traveling through the watershed it is apparent that although there are a number of commercial stables which house larger numbers of horses as found on Figure 3-2, there are also many residences that support one or two horses, despite small lot sizes and/or limited acreage suitable for pasturing horses or applying manure. While many of these small residential facilities are well-managed, it is also common to observe corral areas that are bare or partially denuded of vegetation from overgrazing, and manure management is often limited to stockpiling on site. Conditions contrast with the commercial facilities, which tend to have greater capacity to manage drainage and manure accumulations responsibly, in part because of their greater visibility and liability.



GIS Data Source: Santa Cruz County

Path: Y:\11\1188024.00_CityofSantaCruz_DrinkingWtrSanSurvey\final report\KJ GIS Files\Events\20121211_FiguresIF 3-2 Commercial Stable Locations.mxd

- Area Locations
- Santa Cruz Water Department Diversions
- Santa Cruz City Water Supply Watersheds
- Stables
- Sub-Watershed

Santa Cruz Water Department
WSS Update

Commercial Stable Locations

Figure 3-2

3.6.1 Contaminants of Concern

Horses are considered a major source of pathogens and nitrogen and can also contribute to persistent turbidity in the water supply watersheds. While horses were a relatively newly-recognized concern during the 1996 sanitary survey, some important actions were taken to protect water quality and improve care of the animals.

One key step was publication of *Horsekeeping: A Guide to Land Management for Clean Water,* in 2001 (CABRCD, 2001). This manual for horse owners, developed by the Council of Bay Area Resource Conservation Districts and the USDA NRCS, explains water quality concerns, provides technical assistance with design and implementation of structural control measures, and includes a directory of conservation-related resources for further exploration. Based on use of this manual, and with funding from the SWRCB through Propositions 13 and 50 (Manure and Erosion Prevention), the Santa Cruz County Resource Conservation District (RCD) and Ecology Action developed a Livestock and Land Program to educate owners about best management practices to improve manure management. Working with both commercial and residential facilities, and coordinating with the Santa Cruz County Horsemen's Association, the Program has provided technical assistance and cost-sharing to install filter strips, energy dissipaters, and other practices at a number of demonstration sites. Previously, the RCD reported that these measures have also been widely-installed at residential sites following owner attendance at technical trainings and workshops sponsored by the Program, and through outreach via a Peer Leader Program (Angela Stuart, personal communication, 2007). Currently, lack of funding has limited significant outreach.

Ecology Action estimated that raw manure loads were reduced by 328,500 pounds per year in 2007 as a result of the nutrient management practices implemented at horse facilities, such as manure bunkers, regraded pastures and/or paddocks to re-direct runoff to a filter area, exclusionary fencing, retention/sediment basins, and reduction in numbers of animals living in properties (Rose, 2011). Load reductions have increased since 2009 as the program reaches more owners (Nick Sudano, personal communication, 2012). From 2006 to 2009, eleven individual horse facility improvement projects were implemented in the San Lorenzo Watershed. Manure management plans are required for new development with greater than four horses and complaints. Ecology Action, in coordination with the RCDs, continues to support manure management through its Livestock and Land Program.

It is estimated that the equine population in the survey area has not changed over the last five years based on permitting of facilities and review of commercial stable listings. While many more horses are now boarded in private paddocks or boarding facilities with control measures in place than was the case at the time of the 1996 sanitary survey, City and County staff still report problems, particularly with new ownership and unpermitted facilities such as one upstream of the City's Majors Creek diversion (Chris Berry, personal communication, 2017). Throughout the subject watersheds, stables or paddocks are sometimes located on the edges of properties, often in swales and along waterways. This bare ground can be a source of sediment, and offers minimal breakdown of manure and nitrogen uptake by plants. The net result is often a rapid transport of these pollutants into surface and shallow ground waters during periods of rain.

3.6.2 San Lorenzo Watershed

The County does not maintain a comprehensive inventory of stables but staff estimate that there may be more than 300 horses in large stables within the San Lorenzo River watershed, and an equal number in smaller residential stables (John Ricker, personal communication, 2012). While numbers of animals at commercial stables vary from year to year, some of the largest stables are Covered Bridge, formerly Chaparral Stables (70 to 100 horses) in Felton, Eddy Ranch (40 to 50 horses) on Bear Creek, Zayante Equestrian Center, formerly Horse Haven (20 to 40 horses) on Zayante Creek, Glenwood Equestrian Center (20 to 25 horses) on Bean Creek, and Lichen Oaks (15 horses) in Quail Hollow. A review of commercial stables indicates that there have been no changes since 2012. Additionally, the Santa Cruz County Horsemen's Association operates a regular calendar of events at the Graham Hill Showgrounds, including overnight and short-term stays for multiple animals.

Livestock in riparian areas also occurs. It has also been noted there is a flock of sheep grazing the riparian areas on private lands adjacent to the San Lorenzo River upstream of the City's Tait intake.

3.6.3 Loch Lomond Reservoir Subwatershed

No confined animal facilities are reported or were noted in this watershed.

3.6.4 North Coast Watersheds

The numbers of animals kept in the North Coast watersheds are not available. Some homes are on one to five acre parcels, often with one or two horses, several chickens, and other domestic animals. Areas of bare soil are sometimes seen in the paddocks and associated areas. The Vigne Farms is a commercial stable located in Bonny Doon which is not in the surface drainage to Liddell Spring. However, the underlying karst in the area may provide a subsurface conduit to Liddell Spring. The County regulates the facility which has covered, concrete floored manure storage and surface water monitoring as a condition of approval. Continued attention by regulatory and NGOs to manure management at confined animal facilities, especially those near surface waters upstream of diversions is an important element of pathogen and nitrate control.

3.6.5 SLVWD

There are no known concentrated animal facilities within the SLVWD.

3.6.6 Significance

The San Lorenzo River Pathogen and Nitrate TMDLs list domestic animals/stables as sources of the respective constituents. Wastes from horses have been estimated to contribute significantly to the pathogen and nitrogen load in the region's upper watersheds. One systematic study (Hecht and others, 1991) estimated that horses in the San Lorenzo Valley contributed nitrogen equal to one fifth or more of the amount released from septic systems. The San Lorenzo Nitrate Management Plan estimated that livestock and stables contributed about 6 percent of the nitrate load in the River (Ricker, 1995). The microbial source assessment found

that horses were responsible for 10 percent of the wet weather *E. coli* samples at the Felton station but less than 2 percent of the wet weather *E. coli* load downstream (Ricker and Peters, 2006). No bacteria contributions from horses were noted in dry season samples. Most other types of confined animal facilities do not appear to be a major concern in the subject area except those located close to riparian areas such as the sheep upstream of the Tait diversion.

Both commercial stables and backyard paddocks can be found in almost all sub-watersheds of the San Lorenzo and North Coast water supply drainages, and animal wastes receive less treatment than human wastes and are more easily mobilized into streams. These facts suggest that effective manure management at all times of the year, but especially during winter and spring months, is critically important in reducing nitrogen and pathogen transport to ground and surface waters. Nitrate data, described in Section 5, indicate that nitrate concentrations have declined and stabilized in recent years suggesting that livestock management, as well as other management measures, has been successful in improving water quality.

3.7 Pesticide and Herbicide Use

Pesticides and herbicides are chemical compounds specifically formulated for their lethal effects on animal and plant life. Pesticides and herbicides are used in: (1) agriculture, (2) rights-of-way along roadsides, (3) landscaped areas such as parks and golf courses, (4) for structural pest control, and (5) by individuals. Volumes of specific chemicals used annually for the first four uses are represented in the reported use information collected by the County Agricultural Commissioner and reported to the State Department of Pesticide Regulation (DPR). The fifth use, by individuals in the home and garden, is unreported. Thus, a complete accounting of the chemicals used or the amounts applied is unavailable. The toxicity of compounds available to individuals – and generally to licensed professional applicators as well – has decreased markedly since the late 1980s.

All pesticides and herbicides used by licensed applicators (such as crop dusters, landscape maintenance professionals, and structural control businesses) are reported and sales of "restricted" chemicals are also reported by distributors. The Department of Pesticide Registration determines whether a pesticide/herbicide is classed as restricted based on its potential hazard to humans, animals, crops, or the environment in general. The County Agricultural Commissioner enforces related laws and regulations within the county, issues Restricted Materials Permits, and collects the use data which is then reported to the DPR. In addition, the City's Integrated Pest Management (IPM) policy guides pesticide and herbicide use on City-managed lands. Using a limited data set, the RWQCB has listed the San Lorenzo River under CWA Section 303d for a suite of pesticides and prepared a TMDL in 2014 for chlorpyrifos on Zayante Creek and the San Lorenzo River below Felton.

Comprehensive information on the specific types and locations of pesticide and herbicide use throughout the North Coast and San Lorenzo River watersheds was not developed for the original 1996 sanitary survey or any subsequent updates. Logically, such use will be a tiny fraction of the applications throughout Santa Cruz County. Most pesticides for which regional records are kept are used for agricultural activities in the Watsonville area and in the marine terrace agriculture downstream of the North Coast watersheds, rather than within the North Coast and San Lorenzo watersheds. Similarly, most of the reported structural pest control use will be from the urban and industrial areas which are mostly outside the survey watersheds; i.e.

the Cities of Santa Cruz, Watsonville, and Scotts Valley. However, the San Lorenzo River has been 303d listed for the organophosphate insecticide, chlorpyrifos (source unknown), indicating that residues from commercial and/or residential applications are regularly reaching the river.

In 2012, the USDA conducted a water quality study for a range of insecticide, herbicide, fungicide, and metabolite compounds at the low parts per trillion detection levels. Out of over 4,000 treated water samples analyzed weekly over nine months, only two detectable results were found and at levels 1,000 times lower than the public health goal set for the compound. The diligence paid to pesticide/herbicide use in the watersheds indicate that the raw water remains at a low risk for contamination from these compounds.

3.7.1 Contaminants of Concern

While all pesticides and herbicides can be considered undesirable in a drinking water source, the legacy pesticide, chlordane, and the organophosphate pesticide, chlorpyrifos, are of greatest concern as shown by the 303d listing and TMDL prepared in 2014 is for these constituents recently established by the Regional Board. Other specific chemicals of concern are the synthetic organic chemicals (SOC) regulated under the Phase II/V Rules (see Section 5). The Phase II/V pesticides and herbicides are those which EPA has established requirements for drinking water (see Section 5).

3.7.2 San Lorenzo River Watershed

The most sensitive right-of-way in the watersheds, because of its proximity to the San Lorenzo River is State Highway 9 maintained by the California Department of Transportation (Caltrans). Caltrans staff report that herbicide use along Highway 9 has been reduced 50 percent or more since the early 1990s under the agency's NPDES permit for roadside vegetation maintenance (Kris Griffin, personal communication, 2012). Targeted applications of less-toxic materials at low rates immediately adjacent to fixed safety hardware (e.g., signposts, guardrails, reflectors), maintaining a minimum 20-foot buffer between the spray zone and the edge of live streams or the River. Caltrans staff currently applies two herbicides annually, both in late fall/early winter: a systemic pre-emergent, Goaltender 2 (oxyfluorfen), and a more typical pre-emergent, Oust (sulfometuron methyl), that also has some post-emergent properties. Oxyfluorfen disperses readily in water, is slightly mobile and is acutely toxic to aquatic organisms but practically non-toxic to terrestrial biota and birds. Sulfometuron methyl is also readily dispersible in water and moderately mobile, but practically non-toxic to both aquatic and terrestrial biota. Both materials are moderately persistent.

Caltrans uses spot treatments as needed with the broad spectrum (non-selective) systemic herbicide Roundup (glyphosate), and the selective (broadleaf) systemic herbicide Garlon 4 (triclopyr) for brush control in the highway right-of-way, to remove woody vegetation such as blackberries, poison oak and tree seedlings before they interfere with visibility or impinge on the roadway. Roundup has been considered to be one of the more benign herbicides from a drinking water point-of-view, because the active ingredient, glyphosate, is practically non-toxic to aquatic and terrestrial biota and effectively immobile, being strongly adsorbed to soil. However, recent research suggests that at least one of the inert ingredients in Roundup has higher toxicity. Triclopyr is slightly soluble in water, moderately persistent, potentially mobile, and slightly toxic to mammals but highly toxic to aquatic biota.

Vegetation maintenance along County roads in the San Lorenzo River watershed has relied on targeted mowing since the Board of Supervisors passed a moratorium on roadside herbicide spraying in May 2005 (Dawn Harman, personal communication, 2012).

Because mowing is far more labor intensive than spraying, mowing efforts concentrate on maintaining safe sight distance at critical intersections, road curves and other areas. While roadside maintenance in riparian areas involves herbicides to clear brush for flood control purposes, the County is exploring alternatives, such as organic substances, to reduce the environmental impact of conventional spraying. When used, herbicides are typically applied using a brush on the cut branch to minimize overuse.

The four State parks in this watershed are: Big Basin Redwoods State Park, Castle Rock State Park, Fall Creek State Park[12] and the Henry Cowell State Park. These parks use very little pesticides and herbicides as they are mostly preserved natural environments with very little landscaped area.

The four County parks in this watershed are: Felton Covered Bridge, Highlands Park, Ben Lomond Mill Street Park, and Quail Hollow Ranch. The County uses essentially no pesticides and herbicides – only one application of Roundup was used along fence lines and on baseball fields at Pinto Lake and Polo Grounds Parks last year and both these parks are outside of the survey area (Gretchen Illif, personal communication, 2012).

The golf course at the Boulder Creek Golf and Country Club is managed based on IPM principles and use of least toxic materials at the lowest rates feasible. The course employs two licensed pesticide applicators and primarily uses broadleaf weed control herbicides and fungicides (Bill Keller, personal communication, 2007). Confront (Triclopyr and Clopyralid), a post-emergent selective (broadleaf) herbicide is applied to fairways annually. Greens are treated approximately monthly from April to October with fungicides, rotating products regularly to inhibit build-up of resistance. The fungicides currently used comprise the contact fungicide Daconil Weatherstik (Chlorothalonil), which is mixed with one of several systemic fungicides: Banner Maxx (Propiconazole), Signature (Fosetyl-Aluminum) or Heritage (Azoxystrobin). The active ingredient in each of these products has low to very low mammalian toxicity. Triclopyr, clopyralid, propiconazole and fosetyl-aluminum are slightly toxic to practically non-toxic to aquatic species, while azoxystrobin and chlorothalonil are extremely toxic to fish and aquatic invertebrates.

SLVWD is in the process of preparing an Integrated Pest Management Plan for its watersheds. (J. Michelsen, Personal Communication, 2017).

3.7.3 Loch Lomond Reservoir and upper Newell Creek watershed

The Loch Lomond Recreation Area is mostly non-landscaped and uses mechanical weed control for road right-of-way and other park maintenance. Although no pesticides, herbicides, or fertilizers are applied in these areas, consistent with the City of Santa Cruz policy, City policy will allow applications of Roundup, an herbicide containing glyphosate, on the firebreaks/ridgetops if necessary to reduce fuel loads; the City has historically applied Roundup

[12] More correctly, the Fall Creek unit of Henry Cowell State Park. Popular nomenclature use

as part of its fire preparation program. The need to reduce forest fuel loads in an effort to reduce fire and therefore sediment is balanced with the use of Roundup and associated water quality impacts. In addition, a volunteer program to reduce invasive French broom to allow space for native vegetation to control erosion has also been implemented in conjunction with the local American Fisheries Society.

The City has attempted several methods to control algae (primarily blue-green algae or cyanobacteria) in the reservoir. Historically, pesticides containing copper as the active ingredient were successfully used.

At present, the City uses a combination of sodium bicarbonate and hydrogen peroxide (PAK 27). When algal blooms do occur or are predicted to occur, chemical algaecide applications are made to the Loch Lomond Reservoir to protect against degradation of beneficial uses (e.g., objectionable taste and odor, production of disinfection by-product precursors and cyanotoxins, and oxygen depletion and subsequent fish kills). These algaecide applications are regulated by an NPDES permit and implementation is described in the City's Aquatic Pesticide Application Plan (Chris Berry, personal communication, 2012).

3.7.4 North Coast Watersheds

Use of pesticides and herbicides in these watersheds is likely to be very small as agriculture and landscaped areas are a very minor land use, and there are no large urban areas or major thoroughfares. Pesticides are not being used within the SCWD managed watershed lands, consistent with City policies favoring mechanical and other IPM control methods.

3.7.5 SLVWD

SLVWD's watershed management plan, restricts, and where feasible, excludes the use of pesticide or herbicide within SLVWD lands. SLVWD also supports the minimal and restricted use of herbicides and pesticides in the District' service area as well as contributing to the control of herbicide and pesticide use in the greater San Lorenzo River watershed.

3.7.6 Significance

The RWQCB's decision to place the San Lorenzo River on the 303d list for chlordane and the 2014 TMDL for chlorpyrifos suggest pesticides and herbicides as well as chemicals are becoming a contaminant source of concern. However, SCWD has provided written input to the RWQCB that the dataset on which the 303d list is limited since pesticides or herbicides have not been detected in the raw water for the SCWD at their diversions. In the TMDL report, RWQCB acknowledged SCWD's comment and noted that for chlorpyrifos, the detections are located downstream of the SCWD intakes.

3.8 Wildlife

3.8.1 Contaminants of Concern

Wildlife may pose a threat of contamination to public water supplies under certain conditions. The likeliest condition is the contact between water supply sources and animal or waterfowl waste. The potential for transmission of waterborne pathogens such as Giardia cysts and Cryptosporidium oocysts varies with fluctuations in wildlife populations. While considered a potential problem, the relative importance is lessened when compared with the impacts of domestic and confined animals.

3.8.2 San Lorenzo Valley, North Coast Watersheds, and SLVWD

The wild animals that have the greatest potential impact in the San Lorenzo Valley and the North Coast watersheds are wild pig, black tailed deer, California ground squirrel, and the other local terrestrial mammals. NRCS District Conservationist Rich Casale stated that he has seen evidence of pig populations in every part of Santa Cruz County. Where there has been a noticeable increase in wild pig populations, there can be erosion problems caused by the foraging and wallowing habits of this species. SCWD staff noted increased sightings of wild turkey and more bullfrogs at Loch Lomond. While there has been historical wild animal activity in the vicinity of their constructed intakes, especially the Foreman intake, SLVWD staff indicate that pigs no longer appear to be as rampant a problem. Past activity may be associated with residential development encroaching on the wildlands, thereby reducing hunting, or wetter-than-normal conditions prevalent during the decade prior to the previous update contributing to growing populations.

California ground squirrels are a minor potential source of sediment and fecal coliform bacteria. Ground squirrels are a source of bank instability in grassland areas and along levees and earthen dam structures. This instability often necessitates eradication efforts that when done by rodenticides may be a source of chemical contamination to adjacent water sources. In small spring systems, it was noted that occasionally other rodents, like the dusky footed woodrat and deer mice, as well as a variety of lizards may foul water supplies when they die and decompose in water sources. This issue illustrates the need for vigilance on the part of the small-scale water suppliers and spring owners.

3.8.3 Significance

Pigs and other wild animal populations do not appear to have a great potential for contamination of surface waters at this time.

3.9 Quarries/Mine Runoff

There are four quarries in the San Lorenzo River watershed and one quarry in the Liddell Spring watershed that could impact the quality of public drinking water supplies. Mineral extraction in the San Lorenzo River watershed consists of rock, gravel, and sand for the construction and glass industries.

The quarries are regulated under California's Surface Mining and Reclamation Act (SMARA) and by the County's Mining Ordinance. The County Mining Ordinance requires that the application package be submitted to the water purveyor in the drainage area of the quarry. The County inspects the quarries four times each year and the state inspects them annually. The County conducts an extensive review each five years. At that time, the County Planning Commission can impose conditions on the quarry as part of the Certificate of Compliance. The Regional Board issues NPDES permits that set limits on contaminants that can be discharged to surface waters from quarries.

3.9.1 Contaminants of Concern

Sediment, nitrate, dissolved metals and minerals are all contaminants of concern related to quarry operations. The Felton Quarry has historically been a source of dissolved minerals, sulfate, iron, and manganese in moderately elevated concentrations while the Bonny Doon Quarry for limestone, which recently closed, was associated with high sulfate, turbidity, sediment and nitrate. The other quarries in the watersheds are closed but may be a source of sediment if not properly maintained. Each quarry is discussed further in Section 3.9.2.

3.9.2 San Lorenzo River Watershed and SLVWD

This section presents existing conditions of the four quarries in the San Lorenzo River watershed. Again, two quarries are still active (Felton and Quail Hollow) and two are presently inactive (Hanson and Olympia).

Felton Quarry - Felton Quarry, mined by Granite Construction Company, is a 262-acre granite quarry rising in elevation from 550 feet at the eastern edge to 1,550 feet at the northwest corner. The Felton Quarry mineral deposit, a spatially-limited unit of fractured and stained granitic rock (mapped as adamellite, also known as alaskite), is located on the southeastern side of Ben Lomond Mountain. The quarry consists of an active open pit, an asphalt plant, a washwater recirculation system, a polymer clarifier system, and settling ponds. It produces both decomposed granite used in construction and a stained aggregate marketed as a high-value landscaping rock under the 'California Gold' trademark.[13]

Mining occurs on approximately 85 acres of the site (Carlson, 2005). The quarry has been active since the early 1970s, and has been operated under the present permit for 31 years with an additional 19 years of feasible mining projected. Limestone Brook drains through the center of the site in a southerly direction forming the headwaters of Gold Gulch, which flows east to the San Lorenzo River. Washwater is recirculated and stored in three detention ponds. It is not discharged except during major storm events. Stormwater runoff from the site is also stored in the three on-site detention ponds. Prior to major storm events, water is pumped from the ponds and discharged to Gold Gulch to increase pond capacity for stormwater runoff. The ponds are designed to handle a 2-hour, 100-year storm, providing a median detention time of at least 20 to 40 minutes. During extreme storm events the capacity of the detention ponds is exceeded and stormwater flows out of the ponds to downstream receiving waters. Discharges to surface

[13] See Hecht, 1978 for a discussion of the hydrogeologic and weathering conditions which have led to deep weathering and the lightly-stained rock mined at the site.

waters are regulated under an NPDES permit issued by the Regional Board. The quarry submits quarterly discharge reports to the Regional Board.

Granite monitors groundwater and surface-water quality twice each year at a number of monitoring locations. Ground-water levels are measured in nine wells and samples are collected for pH and conductivity. Surface water samples are collected at 16 locations including the settling ponds, springs, Gold Gulch, and Limestone Brook. All samples are analyzed for pH and specific conductance. Selected samples are analyzed for general water quality parameters such as total dissolved solids, calcium, and sulfate. In April 1995, a sample was collected from the effluent of the clarifier and analyzed for the 13 priority pollutant metals. Most of the metals were not detected. Lead and nickel were detected at concentrations well below drinking water standards. High concentrations of sulfate, calcium, iron, and manganese have been detected in the ground-water basins of Limestone Brook and Gold Gulch. County requirements call for developing a set of protective measures should water quality change by more than 20 percent. The Felton Quarry has controlled erosion at the site by revegetation with native plants.

Historically there was concern that the quarry's operations might affect the water supply of the Forest Lakes Mutual Water Company, as the quarry's product of partly-weathered rock is part of the source aquifer for the Company's wells. A hydrogeologic assessment study (Hecht, 1978) showed that there was no impact on ground-water levels; however, the operator drilled a new well for Forest Lakes MWC that provides 18 acre-feet of water to the water district each year. Conditions of approval for the quarry require that if the water supply were to diminish, Granite would be required to provide a new water supply to this purveyor.

Quail Hollow - The Quail Hollow Quarry encompasses 240 acres and is located on Quail Hollow Road near the community of Ben Lomond (Carlson, 2005). Mining is estimated to continue for decades from the present and is permitted for a amaximum production rate of 250,000 tons per year. The Santa Margarita Sandstone is mined for sand which is used in the construction industry; however the Quail Hollow quarry is locally unique in that it also contains fine, industrial grade sand used by the glass industry (Carlson, 2005). The quarry consists of an open pit, a washwater recirculation system, and detention ponds. In 1998, the Planning Commission certified an EIR for the project and approved the Mining Approval and Certificate of Compliance.[14] In 2007, the first permit review since the 1998 approval was conducted and staff concluded that the quarry was in substantial compliance with the Conditions of Approval (Carlson, 2007). Additional best management practices were installed to better manage stormwater runoff. The capacity of the site to retain stormwater runoff has been exceeded under extreme conditions, such as occurred during the 2016-2017 wet season, and further improvements to the storm water pond system have been implemented and additional improvements are planned to better manage and treat stormwater runoff before it leaves the site (Carlson, 2018).

In 2008, Graniterock finalized the Long Term Management and Maintenance Plans (LTMMP), which was a stipulation of their 1998 Mining Approval and Certificate of Compliance. The purpose of the Plan is to implement the conservation goals of the Habitat Conservation Plan by describing the management and maintenance actions that will be undertaken to preserve

[14] There are actually two Approvals for the Quail Hollow Quarry and two corresponding sets of conditions of approval. The approval for the "Current Mining Area" was in 1994, and that for the "Future Mining Area" was in 1998.

conservation and reclaimed areas of the mine in perpetuity (Carlson, 2008). The LTMMP calls for a more comprehensive monitoring program to include, invasive species mapping, vegetation community mapping and plan plant species mapping, as well as an adaptive and research-oriented approach that will allow management to be refined and improved as new information is obtained.

Hanson Quarry - The Hanson Quarry is a 275-acre quarry in the Bean Creek watershed mining the Santa Margarita sandstone. The quarry consists of an open pit, a washwater recirculation system, a polymer clarifier system, and four settling ponds. Operations at this facility ceased in 2004, and since then, a number of reclamation activities have occurred at the site including implementation revegetation activities and an approved basin management plan. The processing plant, and fuel and oil storage tanks have been removed. The quarry floor was graded and large-scale plantings have been completed. A major repair of storm damage to Conference Drive at the quarry entrance was completed in 2006, and this included installation of major drainage improvements to handle runoff that had been handled by the former processing plant water recycling system. Studies have been conducted to assess the feasibility of using the former quarry pit as a recharge facility in association with a larger conjunctive use ground-water program for the lower San Lorenzo River. There is no specific project, or funding for a project, at this time. In addition, the Hanson Quarry contains some preserved *sandhills* habitat and undisturbed areas around the east, south, and west rim of the quarry pit are covered by conservation easement (David Carlson, personal communication, 2012).

Olympia Quarry - Olympia Quarry occupies 210 acres. The quarry consists of an open pit, wash water recirculation system, sand loading facilities, and a detention pond. Operations were discontinued at this facility in 2002. Reclamation and revegetation of the site remains stalled due to difficulty aligning reclamation plans with United States Fish and Wildlife Service requirements to protect two on-site endangered species – the Mt. Hermon June beetle and the Zayante band-winged grasshopper (David Carlson, personal communication, 2012).

3.9.3 Loch Lomond Reservoir and the upper Newell Creek watershed

There are no quarries in this watershed.

3.9.4 North Coast Watersheds

Bonny Doon Quarry - The Bonny Doon Quarry, purchased by CEMEX, is located immediately upslope and up-watershed of the SCWD Liddell Spring intake. Quarry operations started in August 1970 and, in January 2010, CEMEX officially decided to cease operations and the property was purchased by a group of local non-governmental organizations for preservation as described earlier. Since closure of the mine, the mine operator has been working to implement the approved reclamation plan. Several amendments to the reclamation plan are needed to address current conditions not addressed in the original approved plan. Various technical studies are in process addressing the changed conditions. Water quality monitoring during major reclamation activities may be advisable. (Carlson, 2018).

Nitrate sources have been previously reported upgradient of the quarry (Watkins-Johnson, 1992). The same study also reports that the quarry area ground-water was affected by nitrate before the commencement of quarry operations. Time-series data dating back to the 1970's

indicates a slight upward trend in background nitrate concentrations of Liddell Spring discharge. The source(s) of nitrate which reaches Liddell Spring, if it is indeed increasing, has however not yet been identified. Closure of the Bonny Doon Quarry should be taken into account in considering sources of nitrate at Liddell Spring.

3.9.5 Significance

Within the four quarries in the San Lorenzo River watershed, occasional heavy sedimentation can occur because of exceedance of settling pond capacities during major storms. This condition is not likely to change in the foreseeable future. The potential water quality impact is more significant with the operational quarries at Felton and Quail Hollow. With the closure of the Bonny Doon quarry, Liddell Spring water quality will no longer be negatively impacted by blasting events. The Peninsula Open Space Trust and Sempervirens Fund with other organizations acquired the San Vicente Redwoods from CEMEX in the winter of 2011. In 2014, these organizations joined with others to collaborate on the Living Landscape Initiative design for a plan that protects wildlife habitat, recreation and sustainable timber harvesting for the 8,500-acre property which includes the Bonny Doon quarry site. As noted earlier, allowing public access to these lands increases risk of wildfire with associated water quality risks

3.10 Solid and Hazardous Waste Disposal Facilities

In California, there are three main categories of waste disposal facilities: (1) solid waste disposal facilities, (2) hazardous waste treatment, storage, and disposal (TSD) facilities, and (3) illegal dump sites. Solid waste facilities are regulated by the California Department of Resources, Recycling and Recovery (CDRRR, formerly the State Integrated Waste Management Board), although pollution problems are handled by the Regional Boards. Hazardous waste facilities are overseen by the State Department of Toxic Substances Control (DTSC). The County removes trash and abandoned articles from illegal dump sites.

There is one closed solid waste facility in the San Lorenzo River watershed, discussed below. A review of Geotracker, the database of TSD facilities showed there are no new active TSD facilities in any of the watersheds and that the former Santa Cruz Lumber Company and Valeteria Dry Cleaners sites in Felton remain under state oversight.

3.10.1 Contaminants of Concern

Leachate from waste disposal facilities is a liquid formed as infiltrating rainwater seeps through the landfilled material mobilizing a variety of contaminants. Leachate is typically a highly mineralized liquid containing heavy metals, dissolved solids, nutrients, and organic chemicals. The composition of leachate from any particular landfill will depend on the nature of the decomposing landfilled materials. Although regulations aim to minimize or eliminate leachate from contaminating the underlying groundwater and nearby surface waters, complete leachate control is difficult to achieve.

3.10.2 San Lorenzo River Watershed

There are no active solid waste disposal facilities in the watershed. The County provides trash pick-up service in all the watersheds and transports the material to one of the two operating landfills, both of which are outside the watershed areas for this study.

There is one closed County landfill, the former Ben Lomond Landfill. This facility was in operation since the early 1950s and was classified first as a Class II Landfill, then later as a Class III Landfill. The landfill ceased acceptance of waste in July 1991 and it is now used as a transfer station and recycling center and is known as the Ben Lomond Transfer Station. It is located on the north side of Newell Creek, downstream of Loch Lomond, in the highly permeable Santa Margarita sandstone which is underlain in this area by the south-southeast dipping Monterey shale.

Requirements for management of active landfills, closure of landfills, and air and water quality testing are described under Subchapter 15 of the California Code of Regulations. The CDRRR implements source reduction and recycling requirements, waste handling and landfill design, and waste disposal standards. Landfills are to be designed and closed to permit no off-site movement of leachate. Both active and inactive solid waste disposal sites are required to conduct monitoring specifically to identify the content of any leachate leaving the site and whether there are water quality problems posed by the site. The monitoring results are reported to the Regional Board in Solid Waste Assessment Test (SWAT) reports.

The entire Ben Lomond Landfill is now under a clay cover. Regional Board staff report this cover has been effective in reducing the cadmium levels. Closure measures include gas extraction, installation of a sedimentation basin, and installation of a drainage system. The County submitted a closure plan to the Regional Board in 1996.

There is a ground-water plume beneath the Ben Lomond Landfill but concentrations of most monitored constituents are at low levels. A few VOCs are detected above MCLs in three of the wells close to the landfill perimeter. Downgradient groundwater monitoring wells, however, show no evidence of VOC contamination. Monitoring of Newell Creek shows some increases in mean constituent concentrations from upstream to downstream of the landfill, including an apparent increase in turbidity. Leachate inflow into Newell Creek would be unlikely to cause the turbidity increase; this apparent increase may have some other source, possibly erosion within the Rancho Rio subdivision on the opposite creek bank.

3.10.3 North Coast Watersheds and the Loch Lomond Reservoir

There are no identified and no permitted waste disposal facilities in any of the other watershed areas.

3.10.4 Significance

Waste disposal facilities most likely are not a significant threat to the water quality of the San Lorenzo River or the creeks in the North Coast watershed. There are no hazardous waste disposal facilities in any of the watersheds. The closed Ben Lomond Landfill in the Newell Creek watershed appears to have created a low-concentration groundwater plume with a few

elevated VOCs but the plume does not appear to be migrating into the creek. There is an apparent turbidity increase in the creek from upstream to downstream of the landfill. The landfill leachate, however, is unlikely to be the source of this turbidity increase.

3.11 Timber Harvests/Logging

Logging is part of the land-use mosaic and tradition in Santa Cruz Mountains. Most old-growth redwood had been cut by 1915. Douglas fir and hardwoods have also been extensively logged. Timber harvests were historically an integral part of the local economy but have been superceded in recent decades with other activities.

Logging was a major land-use in the watersheds historically although actual timber harvest activities have generally declined over the last several decades and are now focused largely in the San Lorenzo River watershed. Nearly half the County is zoned for timber production. Logging is done of both hardwoods (mostly for firewood) and redwoods and Douglas fir (for lumber). Virtually all logging in the watershed study area is on privately owned lands and is limited to selection harvests with no clear cutting allowed. The City of Santa Cruz has discontinued timber harvesting within its watershed lands. The San Lorenzo Valley Water District has sold much of its timberlands to Sempervirens Fund and has policies against harvesting on remaining watershed lands. No known timber harvests have occurred in the Lompico County Water District watershed in the recent past. Much of the Timber Production Zone (TPZ) land, which is land designated as suitable for commercial logging, is owned by individuals with relatively small acreages. Only a few private companies and the SCWD own TPZ lands in areas greater than 2,500 acres. Thus, the location of logging changes every year, depending on the decisions of many individual land owners and the price of timber. Some TPZ lands are retired from timber harvesting, particular those in public ownership. Conservation groups (e.g., Save the Redwoods) continue to purchase forested acreage, retiring it from timber production. Some smaller water purveyors continue to sell timber; logging is not allowed in the State or County parks.

On private lands, the California Department of Forestry and Fire Protection (Cal Fire) is responsible for regulating timber harvesting by enforcing the regulations of the 1973 California Forest Practice Act, contained in Title 14 of the California Code of Regulations as revised in January 2017. The logging season is generally April 15 through October 15, but tree-cutting may continue all year long, and Cal Fire may approve winter operations. Prior to 1983, counties could regulate timber harvesting within their county area. Then, SB856 prohibited local regulation and reserved jurisdiction to the state under the Cal Fire. At that time, special County rules were incorporated into the Forest Practice Act and includes Forest Practice Rules Section 926 Santa Cruz County rules that apply within the boundaries in Santa Cruz County and include consultation with water agency representatives.

The basic structure of the Cal Fire requirements are:

1. A Sustained Yield Plan is required for TPZ lands greater than 2,500 acres, describing the attributes of the timber and how the land will be managed to sustain the land as a productive timber area producing a certain number of board feet per year. The SCWD has developed a timber management plan which is similar to a sustained yield plan for

its TPZ lands in the Loch Lomond, Laguna Creek, and Zayante Creek watersheds, but has discontinued harvests. This plan is discussed further in Section 4.

2. A Timber Harvest Plan (THP) or Non-industrial Timber Management Plan (NTMP) is required for each specific project on all parcels if the product is to be sold. The plan submitter must retain a registered professional forester (RPF) to prepare the THP. The skill of the RPF directly affects the water-quality effects of each cut. Actual logging is usually put out for bid to logging companies. THPs are discussed in some detail below.

3. Certain exemptions from the THP process are allowed. Parcels less than 3 acres do not require a THP but must abide by cutting standards and other requirements for the Cal Fire district. Exemptions from the THP requirement are also allowed for Christmas tree cutting, and removal of dead or diseased trees, removal of trees within 150 feet of a residence for fire control. Clear cutting for conversion to other land uses (such as orchards or vineyards) can be done. However, this practice now requires a report from a registered professional forester and Cal Fire now inspects to verify conversion.

Cal Fire Southern SubDistrict requirements, which the THPs must show they meet, include conformance with cutting standards, return cycle cutting, slash treatment, road construction and design, and post-logging erosion-control measures. The San Lorenzo River and North Coast watersheds are in Cal Fire's Southern SubDistrict of the Coast Forest District. Cutting standards for this District allow only selective harvesting. The registered professional forester determines the level of cut within District standards and marks individual trees. Portions of the North Coast watersheds are in Coastal Commission special treatment areas and must comply with additional rules. A specific area may be logged no more than once every 10 years. All slash must be cut to rest a maximum of 18 inches off the forest floor.

Permanent, seasonal, and temporary roads are the three categories of roads recognized by Cal Fire. Permanent roads are asphalted or otherwise surfaced. Seasonal roads are dirt roads on which erosion control features must be installed by October 15. Temporary roads are physically destroyed or blocked after the logging. Most road construction in the watersheds for timber harvesting is of seasonal roads. Road building plans must be discussed in detail in the THP including use of soil generated during the road building. The THP must identify the installation of erosion control features for roads, such as water bars. Water bars are a swale/berm combination that cut across roads to act as a cross drains. Additional erosion control features include construction of outfacing slopes (outsloping) on roads, avoiding inside slope drainage, and "armoring" susceptible areas to dissipate energy from storm flow.

Post-disturbance erosion control is site specific. The application of straw, wood chips, hydromulch, slush, or fabrics to a skid road or other feature is dependent on such factors as slope, proximity to a watercourse, rating of the watercourse as to sensitivity, and professional judgment. Since the early 1990s, stream crossings have received particular attention and care, with respect to not only inhibiting sediment delivery during washouts but also protecting adult passage of salmonids.

Cal Fire requires that erosion-control features be maintained for an additional 1 to 3 years after completion of the first winter after harvest. Cal Fire staff inspect a logging operation a minimum of three times: before, during, and after the harvest. However, they can and do inspect more frequently if appropriate. After the harvest is closed, Cal Fire inspects the roads during the

extended maintenance period. Beyond this period Cal Fire cannot control any subsequent destruction or non-maintenance of the roads.

3.11.1 Contaminants of Concern

Timber harvesting is responsible primarily for the contribution of additional sediment through erosion from logging roads. With the sediment, nutrients and bacteria are also introduced into the streams. The relationship between timber harvesting and sediment yield is poorly defined and related to specific site conditions including geology, slope, and stream proximity as well as specific timber harvesting practices. Limited local studies have been conducted to measure effects of erosion from timber harvesting roads.[15] One field-based study in the Zayante, Newell, and Love Creek watersheds (Swanson and Dvorsky, 2001) suggests that roads related to timber entry (past and present) are sources for perhaps 30 to 50 percent of sediment delivered to the creek system, with values differing substantially by (a) subwatershed, (b) sandy vs. non-sandy soils, and (c) inner gorge versus hillslope location.[16] Similarly, no local data are available addressing the relationship of timber harvests and road construction in general (as well as other surface-disrupting activities) on dissolved organic carbon, a constituent of concern in water treatment.

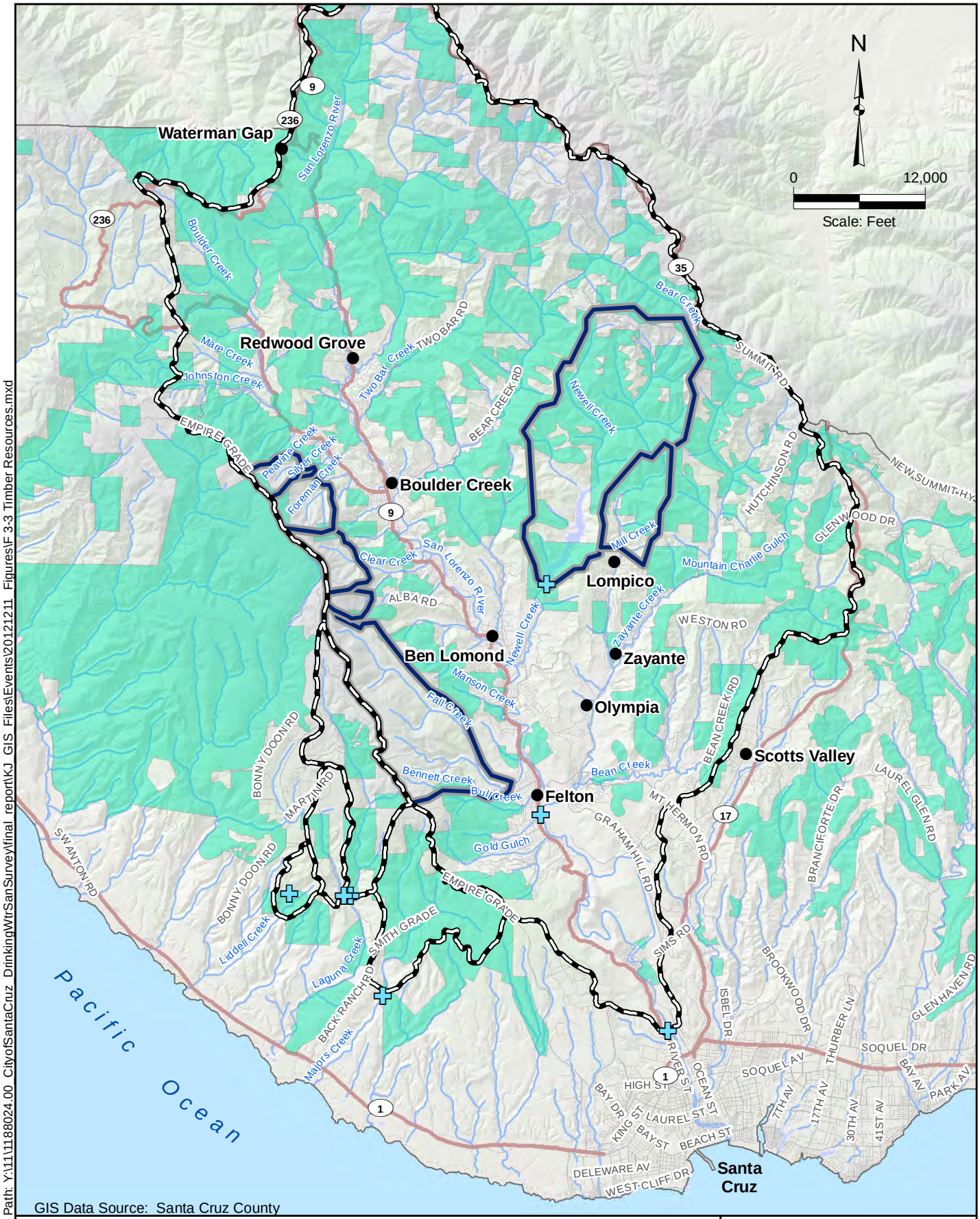
3.11.2 San Lorenzo River Watershed

Timber harvests occur throughout the surveyed watersheds, but primarily in the San Lorenzo River watershed. Virtually all portions of this watershed are affected as timber resources as designated by the County are in a large portion of the watershed (Figure 3-3). Using the GIS data displayed on Figure 2-2, a compilation of historic permitted timber harvests in the San Lorenzo River Valley developed by Sempervirens Fund shows that 893 acres of the 71,900 acres in the watershed – or about 1.2 percent -- were likely harvested commercially during 2007 and 2008 after which Sempervirens' has not collected data. This can be compared to the average annual timber harvest of about 280 acres per year for the period from 2001 – 2006 to about 447 acres per year for 2007 and 2008. When a five-year running average of timber harvest acreages is calculated, the number of acres that have been harvested appear to be declining since a peak acreage of timber harvest in the early 1990s.

There are some indications that recent increases in timber prices is resulting in some increase in timber harvest. A review of CalFire timber harvest plan (THP) database indicate that there are three active THP reviews underway in Bean, Carbonera, and Kings Creek totaling on about 262 acres. In the years from 2012-2016, a review of the CalFire THP information indicates 1- 2 THPs are permitted per year in the SCWD and SLVWD watersheds. In addition, there are increasing concerns that timber harvest (permitted or not) that supports cannabis cultivation should be monitored closely in the next years as the County initiates regulation.

[15] The County Planning Department once applied for and was awarded a 205j grant to study this issue, but could not find a landowner willing to cooperate in field monitoring, The grant funds were returned to the state.

[16] Values are approximate, as the study area considered in this report is not truly representative of the two surveyed watershed, but these findings are both important and applicable; table ES-1 from the report provides additional information.



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GIS Data Source: Santa Cruz County

- Area Locations
- Streets
- Stream
- Lakes
- Santa Cruz Water Department Diversions
- Timber Resources
- Santa Cruz City Water Supply Watersheds
- Sub-Watershed

Santa Cruz Water Department
WSS Update

Timber Resources

Figure 3-3

There is no known timber harvesting that occurs within the SLVWD other than a Christmas Tree farm that exists on the Upper Empire Grade within the Foreman Creek watershed. This operation does not compare to the size and scale of a timber harvesting operation, and it is unlikely to impact the watershed to the extent of a commercial timber harvesting operation. If there were to be any timber harvest within any of the SLVWD watershed lands, the District would be notified and proper planning and inspection would be assessed. SLVWD has a prohibition on commercial timber harvest on District lands.

3.11.3 Significance

The cumulative impact of timber harvests, both at individual sites and cumulatively on downstream channels, must be considered significant, although the reduction in acreage of timber harvest in recent years, which is one indicator of water quality risk associated with timber harvest, has somewhat reduced the potential water quality impact. In addition to the timber harvest itself and the slopes and soils of the harvest lands, the primary potential problem arises with erosion resulting from the roads constructed to access the logging area, particularly after Cal Fire oversight ceases and erosion control measures may not be maintained. Cal Fire requirements do not limit road density within a watershed. NOAA fisheries uses road density (measured as the ratio of miles of road per square mile (mi./sq. mi.) of watershed) as an indicator of watershed conditions in salmonid habitat assessments. NOAA fisheries has found that road densities greater than 3 mi./sq. mi. may indicate impaired ecosystem function (NMFS, 1996). In addition, Swanson (2001) found that legacy and current logging roads are the source of 30 to 50 percent of sediment delivered to the Zayante Creek. If extended throughout the sanitary survey study areas, as is reasonable based on underlying soils and geology, Swanson's study compels attention.

As noted earlier, Cal Fire recently issued 2017 Forest Practice Rules that includes topics specific to the Southern District and the Regional Board has issued Order no. R3-2012-0008 which is a General Conditional Waiver of Waste Discharge Requirements Timber Harvest Activities in the Central Coast Region. Timber Harvest Plans or Non-industrial Timber Management Plans are required by Cal Fire prior to approval which address erosion and sediment control. These documents should be reviewed to evaluate whether they are sufficient to address the specific geologic concerns.

3.12 Recreation

Principal recreational activities in the watersheds include swimming, fishing, hiking, and horseback riding. Recently, there has been a surge of interest in mountain biking occurring on trails in the watersheds including development of illicit trails upstream of the City's water intakes. Water contact recreation (swimming) occurs primarily during fair weather and relatively warm temperature conditions, conditions typical of May through October on both the San Lorenzo River and some of the tributaries. The peak water-contact recreation season is traditionally from the Memorial Day through the Labor Day weekend and is limited to natural swimming holes as temporary rubber dams are limited by CDFW; however, a summer dam on Zayante Creek exists at Mount Hermon just upstream of the Bean Creek confluence. In addition, weekend use is generally more intensive than weekday use. Swimming and wading has been listed as the most popular recreational activity in the watersheds. Recent water quality sampling has found the insect repellent DEET in the San Lorenzo River at Felton in September,

November, and December 2015 which could potentially be associated with recreational activity. Hiking, mountain biking, and horseback riding are more year-round activities (County General Plan).

3.12.1 Contaminants of Concern

Water-contact recreation is a potential source of viruses, pathogens, and bacteria, principally from the introduction of human fecal matter (most likely from infants and children) directly into the stream. Hiking, mountain biking, and particularly horseback riding, can contribute to erosion and increased turbidity, especially where conducted off established trails and at stream crossings. Human access to watersheds also exacerbates fire hazard. Fishing activity is limited to catch-and-release steelhead, except at Loch Lomond, and is unlikely to be a source of contaminants. In addition, live bait at Loch Lomond is limited to night crawlers to prevent invasive species introduction.

3.12.2 San Lorenzo River Watershed

There are three state parks, four county parks, one City recreation area, one private country club, and several public and private swimming holes within the watersheds. Water contact recreation is prohibited in the City recreation area but is widespread elsewhere in the creek system. The state parks include Castle Rock State Park, the Henry Cowell State Park, and a small portion of the Big Basin Redwoods State Park. The state parks are essentially open spaces. Big Basin Redwoods State Park has more than 18,000 acres with many miles of trails for hiking, biking, and horseback riding, 147 developed campsites, 6 trail camps, and 36 tent cabins. Castle Rock State Park has more than 5,000 acres and 32 miles of trails for hikers and equestrians. Camping is for backpackers only. Henry Cowell State Park consists of two units; a main park area of about 1,800 acres and the Fall Creek Unit which has about 2,500 acres and has about 20 miles of trails. Some trail sections are designated for horses, leashed dogs, or bicycles but most trails are for hiking. There is also a 112-unit campground. Illicit recreational uses in Henry Cowell State Park and adjacent lands have recently increased, particularly mountain biking off the designated trails; reduced state funding and closure for state parks will further reduce enforcement of park regulations. The City has been working with the State Parks staff to set up stake outs to improve enforcement of regulations. (C. Berry, 2017. Personal Communication) There is significant concern that additional demands for access for recreation including mountain biking will exacerbate erosion and other water quality concerns.

The County parks include the Felton Covered Bridge County Park (playground, covered bridge, horse trail access, volleyball); Highlands County Park (senior center, swimming pool, picnicking, playing fields, nature trail); Ben Lomond Mill Street Park (picnicking, small playing field); and Quail Hollow Ranch County Park (equestrian facility).

The Boulder Creek Golf and Country Club is a private facility which provides an 18-hole golf course as well as other recreational facilities, such as tennis courts and a swimming pool.

Historically, there were several small dams constructed across creeks to afford summer swimming holes at locations that included, San Lorenzo Woods, Bear Creek Scout Camp, Gold Gulch in Forest Lakes, and Zayante Creek in Mt. Hermon. Swimming holes are now limited to natural swimming holes which are located in less accessible portions of the watershed although

illegal dams constructed of cobbles and plastic are frequently constructed. The County Health Services Agency continues to monitor coliform bacteria along the creek system and uses the data to issue health advisories against swimming, when coliform counts are high. The coliform data can indicate sewage contamination from failing septic systems, urban runoff, domestic animal wastes, wildlife, birds, and/or water contact recreation itself.

3.12.3 Loch Lomond Reservoir and the upper Newell Creek watershed

Loch Lomond Recreation Area occupies the east side of the reservoir and is owned and operated by the SCWD. Recreational use averages around 55,000 visitors per year. There is day use only, with picnicking, fishing, and boating as the primary activities. Only electric powered boats and manually paddled boats such as rowboats are allowed. There is no water contact recreation allowed

Wastewater is trucked out of the recreation area and virtually no pesticides or herbicides are used in the area. The park is open from March 1 to September 15 and on weekends after Sept 15 until the second weekend in October from 6 AM roughly to sunset (varying times). In private lands of the upper Newell Creek watershed, there are a few septic systems to serve homes and wineries.

3.12.4 North Coast Watersheds

There are several recreation areas or regional parks in the North Coast watersheds such as the recently formed San Vicente Redwoods, some of which drains into the Laguna watershed, California Fish and Wildlife's Bonny Doon Ecological Reserve which drains into the Reggiardo and Laguna Creeks; the Wilder Ranch State Park, some of which drains Majors Creek and the Coast Dairies State Park which is located on the lower portions of Laguna Creek. In addition. there are informally established horse trails in the watersheds.

3.12.5 SLVWD

The Fall Creek State Park is available for day use, and is located just upstream of the Fall Creek intake. Since this area is only available for day use, there is a limited chance of contamination occurring. Recreation activities consist mainly of family picnics and hiking. The road along fall creek is gated just past the campground, so vehicles other than SLVWD vehicles, do not have access beyond Fall Creek State Park.

The Olympia Wellfield is open to hiking and equestrian use. There are no surface water diversions on site.

Recreational use is restricted within other areas of the SLVWD lands but are occasionally subject to illicit use by hikers and mountain biking to which the District responds by deterring trespass through various methods.

Lompico Creek has limited recreation activities within its watershed. There is a small pool below the Lompico Creek intake that local children swim in during warmer monthswhich should be evaluated should Lompico Creek be used. Other activities that may exist in the watershed are limited to hiking and possibly some mountain biking.

3.12.6 Significance

Many recreational activities are relatively benign and non-polluting. Large recreational areas, especially those which are mostly open space like Henry Cowell State Park, or are managed specifically for water quality such as the Loch Lomond Recreation Area, appear to enhance water quality. As discussed above, bacterial water quality appears to improve as the water passes through large open space parks (Henry Cowell State Park) or resides in a reservoir for extended periods (Loch Lomond Reservoir).

Recreational activities generally considered of most significance involve water contact recreation. However, an evaluation of the County fecal coliform bacteria data conducted during prior watershed sanitary surveys, conducted by the County Health Services Agency, found no significant increase in bacteria in the swimming areas of the San Lorenzo River system.

An examination of the geographical distribution of the County fecal coliform data from 2012-present continues to show that the urbanized portions of the river system, generally between Boulder Creek and Felton, have fairly similar average and median values. Historically, there has been an apparent trend of decreasing coliform counts through reaches that pass through the State Parks, which are mostly open space. Current data indicate that total coliform counts at Loch Lomond are lower than the counts at the Tait Street and Felton Diversions as shown in Section 5. The County's wastewater management program evaluation found no significant increases of fecal coliform bacteria in the swimming areas of the San Lorenzo River system, indicating that water contact recreation at parks and designated recreation areas is not a significant source of the bacterial load in the river (John Ricker, personal communication, 2017).The potential for erosion from hiking, horseback riding, and mountain biking may also be significant and has been observed in locations such as Henry Cowell State Park and upstream of the Tait diversion on the San Lorenzo River. Illegal trespass and damage caused by recreational activity, particularly unauthorized equestrian and off-road vehicle use, was an issue in the Olympia Wellfield of the San Lorenzo Valley Water District, but additional patrol, fencing, and blocking of access with appropriate horse crossings has improved protection of biotic and water resources of the property (SLVWD, 2010).[17] Downhill biking continues to be increasingly popular biking-induced damage (including the building of illegal jumps) has stirred controversy in the San Lorenzo River Watershed (Betsy Herbert, personal communication, 2012). There are few signs to alert bikers coming from legal trails on UCSC's upper campus that they are entering closed trails under state park control, and law enforcement has issued tickets to riders exiting Henry Cowell State Park onto Highway 9. Signage has been vandalized and/or removed in Henry Cowell State Park which requires monitoring and replacement.

There are a limited number of formal trails in the county for downhill bikers such as in the Soquel Demonstration Forest and a few other locations which cannot meet demand, There have been preliminary conversations between officials and bikers represented by the Mountain Bikers of Santa Cruz over building a park on federal land maintained by the Bureau of Land Management near Davenport at the Cotoni Coast Dairies National Monument. More recently, a mountain bike park is proposed for development in an open space at the Mount Hermon

[17] SLVWD does not actively manage much of its land for recreational purposes; however, in 2011, SLVWD approved limited recreational use (equestrian, walking, and dog walking) on the Olympia watershed property.

Association properties where there currently is an adventure park with ziplining and ropes course.

3.13 Unauthorized Activity

Unauthorized activities are found at varying levels throughout the San Lorenzo Valley and North Coast watersheds and include unpermitted grading, illegal timber harvests, and unauthorized dumping of solid and liquid wastes, often associated with homeless encampments. Area resource managers find that land clearing, road construction, and maintenance by individual landowners are the primary sources of avoidable erosion. Cannabis cultivation, which has occurred illegally, is soon to be regulated is known to occur and is associated with many of the above activities and also poses a fire risk as discussed in Section 3.16.

Homeless encampments can also be a source of human waste and are the subject of targeted enforcement.

3.13.1 Contaminants of Concern

Generally, sediment caused by eroding land is the primary contaminant of concern, though illegal human waste discharges also contribute pathogens, particularly to the San Lorenzo River and illegal clearing for cannabis cultivation can also contribute chemicals and fuels. In 2011, Cal Fire opened 22 cases of unpermitted timber harvest against illegal cannabis cultivation in the Santa Cruz Mountains; it is not known how many of these cases are in the San Lorenzo or North Coast watersheds. By contrast, Cal Fire opened 3 cases of unpermitted timber harvest in 2010. In addition to the fire and erosion risk, chemical spills including pesticides, herbicides, and fuels pose additional water quality threats.

3.13.2 San Lorenzo River Watershed

Numerous violations of the Santa Cruz County Erosion Control Ordinance can be seen throughout the subject watersheds, primarily in connection with roads. County staff estimate that in the project area, there are scores of "active" violations of the County Grading and Erosion Control, the Riparian Habitat Protection, and the Sensitive Habitats Protection Ordinances. In addition, several large illegal roads in the Bear Creek and King Creek watersheds remain open and are a significant source of sediment and persistent turbidity. County enforcement staff do their best to obtain compliance for these situations, however with limited resources, violations are prioritized based upon severity and overall threat to life and safety. For larger land clearing or grading violations it may take years to ultimately resolve the violation due to many factors including the magnitude of the violation as well as the property owner's willingness and financial ability to comply.

Besides grading and brush clearing by individual landowners, unpermitted timber harvests for firewood occasionally occur in the watersheds. Illegal timber harvests are seen by resource managers as causing more aesthetic damage than water supply damage.

Other unauthorized activities that may have an adverse impact on water quality are associated with homeless encampments in and around the San Lorenzo River from the Highway 1 bridge to Paradise Park. Reports on homelessness in Santa Cruz County indicate that the homeless

population has likely increased by almost 15 percent since 2015 to an estimated homeless population of 2,249 in 2017. It should be noted that this is a reduction since 2011 when the homeless population was estimated to be 2,771 (Applied Survey, 2017).

The upper portion of this corridor is upstream of the Tait Street intake, the downstream limit of the survey area. The wooded riparian area just upstream of the Tait Street Diversion has historically been used as an informal settlement with efforts made by the City to resolve homeless issues with multiple approaches including providing social services. Because there is a lack of sanitary facilities in the vicinity of the encampments, these sites may be a source of human waste. The City has increased patrols in the area, and has been actively negotiating with riparian landowners upstream of the Tait Street intake for the right to conduct maintenance and restoration along the river (Chris Berry, personal communication, 2012). Homelessness is a complex issue, and while cleaning up one site does not solve the underlying problem, it is significant that the City has been working to keep riparian areas clean. Encampments in the Pogonip remain an issue and have been addressed with increased patrols; they likely have less of an adverse impact on San Lorenzo River water quality than those along the river because of the greater distance.

3.13.3 Loch Lomond Reservoir Subwatershed

While the upper Newell Creek watershed is sparsely populated, a number of rural residential parcels have been developed. Formerly almost inaccessible, this area was cited by County resource planners as an area to watch. Old roads have been regraded to provide better access for the few households that have developed. Because of this new increased intensity of use, including year-round use, City staff has seen increased damage from vehicles to roadways in the last several years.

3.13.4 North Coast Watersheds

County enforcement staff indicated that numerous violations of the grading and erosion control ordinances, sensitive habitat protection ordinance, and timber harvest plans have occurred in the North Coast area. Sedimentation of Majors Creek has been cited as evidence of a general trend towards erosion and illegal grading and a potential TMDL is discussed further in Section 4.9. Although the general consensus was that violations are widespread throughout the subject watersheds and will continue, legacy logging roads are still considered the primary sediment source.

3.13.5 SLVWD

There has been no sign of unauthorized activity within the SLVWD. There are no regular or recurring inspections of the entire SLVWD lands because much of the watersheds are inaccessible to SLVWD staff, however, the staff do make visits to diversions sights and intakes approximately once per week when intakes are in service and prior to placing an out of service intake into service. Signs are posted throughout the watersheds that notify the public that the streams and surrounding areas are used for public water supply. Signs of vandalism have been rare, and most intakes are accessed by roads that are gated to control access by the public. With the exception of the Fall Creek intake and the Bennett Spring intake, intakes are not fenced but are behind gated roads. A few intakes are only accessed by roads that cross private

lands, for which the District has easements in order to cross. Per conversations with SLVWD staff, no signs of dumping or illegal activity have been witnessed by the staff or have been reported to the district. SLVWD staff have noted that there is the possibility of illegal cannabis grows in the Upper Lompico Watershed Reports are usually forwarded to Santa Cruz County so that they may look into potential unauthorized activity.

3.13.6 Significance

Unauthorized activities are significant sources of sediment from eroding property in the watersheds. Small-scale grading and timber harvest frequently use poor practices which lead to barren, unprotected roads, yards, etc. Illegal cannabis cultivation can contribute chemicals and fuels in addition to sediments. Pending regulation of cannabis cultivation may mitigate some of the water quality impacts through implementation of best management practices. Finally, homeless encampments can increase the concentration of microbial and particulate contaminants in streams, and are identified as a source contributing to water quality objective violations in the San Lorenzo River Pathogen TMDL.

3.14 Vehicle Upsets and Spills

Vehicle upsets are potential sources of contamination of hazardous materials into surface waters through the spilling or rupturing and subsequent discharge of the materials being transported. In addition to spilling of any cargo being carried, collisions can release petroleum products from the vehicles themselves. Factors that affect the level of risk for vehicle spills include overall traffic volume, amount of hazardous materials being transported, highway characteristics, and road conditions. There are no prohibitions on the transport of hazardous materials within the study area watershed.

There are two major transportation routes suited for heavy vehicles, both in the San Lorenzo River watershed. State Highway 9 is the major traffic route through the San Lorenzo Valley, while State Highway 17 skirts the eastern edge of the San Lorenzo watershed (see Figure 1-1). There are no major transportation routes in the North Coast watersheds. Empire Grade Road skirts the east boundary – and the west boundary of the San Lorenzo River watershed -- but is not as heavily traveled as Highways 9 and 17. The risk for spills is generally present, and several spills were noted by City staff including an event that resulted in a fish kill in Brookdale, near the Clear Creek and the San Lorenzo River, cars that had entered the creek near Lompico, and the application of fire-fighting foam some of which entered the creek during the wildfires described in Section 3.16.

The Santa Cruz County Hazardous Materials Area Plan was updated in January 2017 and summarizes how local agencies have planned, prepared, and will respond to such an event in Santa Cruz County. The document is an annex to the County Operational Area Plan describing how county resources will be utilized to deal with many different kinds of emergencies affecting the county. Any public safety official on scene can declare a hazardous materials incident, and should immediately call 911. The dispatchers at 911/NetCom (Santa Cruz Consolidated Emergency Communications Center) will route the call to the appropriate local agency. Depending on its size and significance, the incident could be handled by local fire departments, by specialized hazmat teams, or coordinated by an operational area Emergency Operations Center. County staff then preliminarily assess the nature of the contamination, how far it has

gone, and whether it has entered a waterway. County staff will then request assistance from the CDFW if a waterway is affected and will directly notify the downstream water user if appropriate. City staff report that timely notification from the County is an ongoing area of concern and continues not to be performed in a consistent manner (Chris Berry, personal communication, 2017).

3.14.1 San Lorenzo River Watershed

Within the town of Felton, there are three known ground-water contamination plumes which are seeping into the San Lorenzo River. These are the only sites known to be impacting stream water quality. They are under the jurisdiction of the Regional Board.

3.14.1.1 Valeteria Dry Cleaners (6539 Highway 9)

This site was identified when perchloroethylene (PCE) was detected in the San Lorenzo River in 1985 (0.5 µg/l). Further monitoring tracked the PCE, in 1988, to a spring near this dry cleaner shop which continues to show evidence of PCE in the 2017 Annual Report. The source was determined to be contamination of soils in the dry cleaner's septic system and leachfield originating during the 1960s. The owner conducted a remediation which included removal of sludge within the on-site waste disposal system, steam-cleaning the redwood septic tank, and backfilling with sand. The remediation proved insufficient, and the site was re-excavated in 2002 (U.S. EPA, 2002). The leachfield was then relocated and contaminated soil was exported. Groundwater monitoring results continue to show elevated PCE and TCE concentrations at a location approximately 20 feet upgradient of the San Lorenzo River, and downstream San Lorenzo River monitoring results also show low PCE concentrations. This suggests that the wastes released at the site have migrated, and may continue migrating downgradient. The responsible party is now required to submit a Corrective Action Plan to evaluate and select remedial alternatives for controlling groundwater contamination plume from further migration and impacting the river and for complete cleanup of the groundwater contaminations (Briggs, 2011). The Felton Diversion, which is about 1 mile downstream of the dry cleaner's, has detected PCE as high as 1.7 µg/L on November 1, 2011 relative to an at-the-tap maximum contaminant level of 5.0 µg/L. According to the State of California Geotracker web site, this site continues to be open as remediation continues.

3.14.1.2 Chevron Underground Storage Tank Leak (6325 Highway 9)

A ground-water plume beneath this site caused by a leaking underground storage tank is contaminating a nearby seep to the river. Chevron has installed an interception sump which collects the seepage. In the seep, recent levels of total purgeable hydrocarbons have been measured at 67 to 7,400 µg/L and benzene has been measured at 2 to 1,700 µg/L, which were consistent with historical concentrations (Stantec Consulting Corporation, 2011). During dry weather, this system appears to be effective in intercepting much of the gasoline-contaminated ground water. During long wet periods, however, the effectiveness is limited. Monitoring occurs quarterly. Currently, Chevron is doing bi-weekly free product pump outs and high-vacuum groundwater extractions on a regular basis and is in the process of getting a commingled plume agreement with the Cornerstone property at 6320 Hwy 9, Felton. Until this is completed, Chevron will continue the groundwater monitoring (Tom Sayles, personal communication, 2012). According to the State of California Geotracker web site, this site is eligible for closure.

3.14.1.3 Sturdy Oil (former Exxon Station) Storage Tank Leak(s) (6225 Graham Hill Road)

The former Exxon Station near the Covered Bridge in Felton reported leaking conditions in 2000. A ground-water cleanup program was initiated, and, following a brief uptick in gasoline and MTBE concentrations in early 2005, this site is now deemed currently in compliance, with ongoing quarterly monitoring. The on site concentrations of MTBE has dissipated over time, due to the high solubility of MTBE in water, to non-detect concentrations. Residual MTBE concentrations have moved down-gradient and appear to be centered around an off-site monitoring well (Hydro Analysis, 2011). According to the State of California Geotracker web site, this site has been closed.

3.14.1.4 Other Sites with Potential Plumes

Watkins-Johnson operates an extraction and remediation program at its manufacturing facility next to Bean Creek in western Scotts Valley. Watkins-Johnson used a variety of chemicals in the manufacture of industrial furnaces and electronic parts. Past operations resulted in contamination of the underlying Santa Margarita sandstone with methylene chloride, chloroform, and TCE. The plume contributed TCE to Bean Creek. The site is overseen by the EPA and has an ongoing remediation system which consists of several pumping wells and treatment by granular activated carbon adsorption. The treated water is considered contaminant-free and is either recharged to the aquifer through a leach field, re-used on-site as non-process cooling water, or discharged to Bean Creek. In addition to monitoring the treated discharge, Bean Creek is monitored at one upstream and two downstream sites. Contaminants are now non-detectable in Bean Creek. According to the State of California Geotracker web site, this site continues to be open with remediation and monitoring continuing.

3.14.2 Significance

The existing County system is used to report and clean-up traffic accident and other surface spills. Notification of the downstream water user is part of the response process although it is inconsistent and City staff made efforts to improve notification. Remediation occurred at all four groundwater contamination sites and resulted in a lessening of the contaminant levels seeped to the river at three sites, and possibly at the fourth.

3.15 Geologic Hazards

The two main geologic hazards affecting the quality of drinking water in the study area are earthquakes and landslides. These, along with other infrequent or less challenging geologic hazards, are discussed in this section.

3.15.1 Seismic Events

Few areas of the state are as familiar with the effects of an earthquake on public water supply systems as Santa Cruz County. Santa Cruz County purveyors had to repair a substantial number of emergency main breaks and re-sanitize their distribution systems in the days immediately following the 1989 Loma Prieta event. Observed or potential effects on water supply sources include:

Significant changes in the flow of springs — The yield of Liddell Spring reportedly increased to about 8 to 10 mgd for two months following the October 17, 1989 earthquake and returned to normal, less than 2 mgd, in March 1990. The yield of the nearby quarry spring is reported to have doubled. Many other streams and springs in the region reported similar responses.

Source water quality may change — The mineral quality of most of the northern San Lorenzo tributaries changed noticeably following the 1989 event, and seem to be gradually returning to pre-event conditions. The bacterial pathogen levels of any of the surface sources can potentially change as surface soils and debris are dislodged and enter the stream system. This is particularly a risk with the sources emanating from karstic watersheds. Also, soils and surficial debris can be dislodged by seiches (waves in lakes generated by earthquakes or landslides), and enter Loch Lomond.

Constituent release from reservoir-bottom sediments — While not reported after the 1989 earthquake, other earthquakes could potentially cause the release of gases, pathogens, and oily substances, all of which were observed in Searsville Lake near Palo Alto following the 1906 earthquake (Lawson and others, 1908).

3.15.2 Significance

Seismic events are a significant potential source of contamination and structural damage to existing water supply systems throughout the project area. The ability of treatment plants to anticipate and respond to damage to their own facilities, while also responding to fluctuating water quality and quantity, is a critical factor in the overall management of drinking water in the project area.

3.15.3 Landslides and Other Major Slope Instabilities

Landslides are prevalent throughout the Santa Cruz Mountains, and particularly in the San Lorenzo Valley. Nonetheless, the SCWD and other purveyors have been quite successful in maintaining continuity of service and in avoiding the elevated turbidity and other water quality problems associated with landslides upstream of water intakes. This record reflects, in part, an awareness of the chronic landslide hazard which prevails throughout the subject watershed, and the judgment of senior staff of the purveyors in avoiding water sources which are especially prone to landslides. Large slope instabilities, including landslides, do occur periodically within the subject watersheds, and are expected to keep recurring. Landslides constrain local water systems well beyond concerns over turbidity. Sediment entering the channels limits habitat values that can result in regulatory burdens including need for greater in-stream flow, change in release timing, and other water agency action that can limit water availability in the long-term. For example, the sandy material which has been entering Bean Creek for the past 20 years from the Mount Hermon slide does not appear to elevate turbidities either at the Felton Diversion or at San Lorenzo River Intake at low flows, although the sandy sediment does complicate and add to the cost of diversions and causes other critical environmental damage. Hence, landslides might be seen as constraining water supplies both *when (and just after) they occur* as well as *during the subsequent period when habitat is impaired* downstream -- generally the following spring and summer, when water may not be divertible because it is needed to sustain sufficient habitat.

During the past several decades, there have been a number of very large landslides along nearby streams in settings similar to those which prevail near certain intakes. In addition to the Mount Hermon slide, and Bean Creek slides in general, two examples are:

Baldwin Creek — A very large rock fall completely dammed and impounded Baldwin Creek. Based on observations made by project staff in 1968, the rockfall may have occurred during the prior 10 or 20 years. The setting in which this rockfall occurred is very similar geologically to those found near the Majors Creek intake and along Laguna Creek downstream of the intake.

Love Creek Landslide — In January 1982, a landslide occurred in moderately dipping fractured Monterey shales, such as occur upstream of a number of other areas west of Highway 9 between San Lorenzo Valley High School and Boulder Creek.

The heavy rains in 2017 were associated with significant landslide activity in the watersheds. Some study work by the US Geological Survey is underway to evaluate the landslide activity.

3.15.4 Weather-related Events

Occasional major wind storms or snow falls can introduce a very large amount of organic debris to the watersheds upstream of the intakes. For example, a snowstorm during the first week of January 1974 broke off an astounding number of branches, mainly of oaks and other hardwoods, many of which fell directly into the stream system and decomposed in place. Access to intakes was greatly inhibited for a period of several days to a week or longer.

A series of small to moderate landslides occurred during the winter storms of 2017, greatly impacting the watershed lands and facilities of SCWD and SLVWD. The combination of several years of drought followed by extremely wet conditions with many severe storms with heavy rainfall seemed to produce optimum conditions for landslides and slope failures that significantly impacted diversions, pipelines, and treatment facilities.

3.15.5 Significance

Landslide and slope failures are common occurrences in the Santa Cruz Mountains. The greatest potential impact is at points of diversion and immediately upstream. Major landslides may occur as a result of seismic activity and/or rainfall throughout the subject watersheds and it can be difficult to differentiate weather related impacts from landslides as they often occur in similar time periods. Damage to intakes, pipelines and stream channels in their vicinities may render such facilities inoperable from a period of days to several weeks. In the case of several smaller purveyors, such an occurrence could prevent the delivery of treated surface water to their service areas.

3.16 Fires

The California Department of Forestry and Fire Protection (CalFire) is responsible for fire suppression and management in State Responsibility Areas (SRAs) and the Santa Cruz County Fire jurisdiction. Outside of SRAs, local governments typically have jurisdiction, e.g., fire districts in Boulder Creek, Felton, Ben Lomond, Zayante, and Scotts Valley. Since the last

watershed survey, there have been two major wildfires, Loma Fire (485 acres) and Bear Fire, (391 acres) in Santa Cruz County.

As discussed in the 2013 survey, the CalFire San Mateo-Santa Cruz Unit, RCD for San Mateo County, and Santa Cruz County developed the Community Wildfire Protection Plan (CWPP), a strategic plan identifying risks and hazards associated with wildland fires in the wildland urban interface (WUI) based on input from local stakeholders and the general public and adopted by the Board of Supervisors for both counties (CALFIRE and others, 2010). The plan identifies some critical resources such as Lexington Reservoir but omits Loch Lomond and makes recommendations aimed at preventing and reducing both infrastructure and ecosystem damage associated with wildland fires.

Fuel reduction projects identified in the CWPP receive priority for federal funds. The funding is made available primarily through the California Fire Safe Council's grant clearinghouse. The Fire Safe Council (FSC) provides resources for local communities to form their own FSC. Since 2008, the Soquel, South Skyline, and Bonny Doon FSCs have formed, each of which has submitted roadside and neighborhood shaded fuel breaks project proposals to the CWPP. In addition, a county-wide FSC was formed in 2017 in order to ensure that prevention services can be provided county-wide. Fire management in the region is primarily done on a small-scale, working with FSCs and landowners on projects to reduce fuels and create defensible space. The FSCs are also leading update of the CWPP.

The 2016 Wildfire Safety Recommendations to the Cannabis Cultivation Choices Committee (C4) convened by the Santa Cruz County Board of Supervisors, indicates that while cannabis related fires are not specifically tracked by Santa Cruz County Fire or CAL FIRE, the consensus among the Incident Commanders of recent wildland fires is that 2014 saw a 35% increase in cannabis related fires over dozens in 2013. While 7 of the 11 fires were controlled before they reached ¼ acre; compared to the statewide wildfire average of 98%. The remaining 4 grew to 4, 6, 7, and 22 acres. The cannabis related 22-acre Castle Rock Fire in 2008, required air tankers and helicopters to suppress the fire, which drove the cost to $20 million. Containment prevented the spread of the fire, up steep brushy slopes to consume the entire Skyline Boulevard area. A cannabis related fire off Lost Valley Road in 2014 burned within 1300 feet horizontally and 1000 feet vertically of the 125 homes in the Los Cumbres residential neighborhood above. (Santa Cruz County Cannabis Cultivation Choices Committee, 2016). Similarly the 4,500 acre Loma Fire in 2016 was caused by a generator used in cannabis grow and the 400 acre Bear Fire in 2017was in an area within ½ mile of a cannabis grow. Wildfire safety recommendations to the C4 notes that regulation of cannabis cultivation needs to include permanent permitted residence that are compliant with building and fire codes to mitigate the threat of wildfire. Other activities and recommendations are discussed in Sections 4 and 6 respectively.

3.16.1 San Lorenzo River Watershed

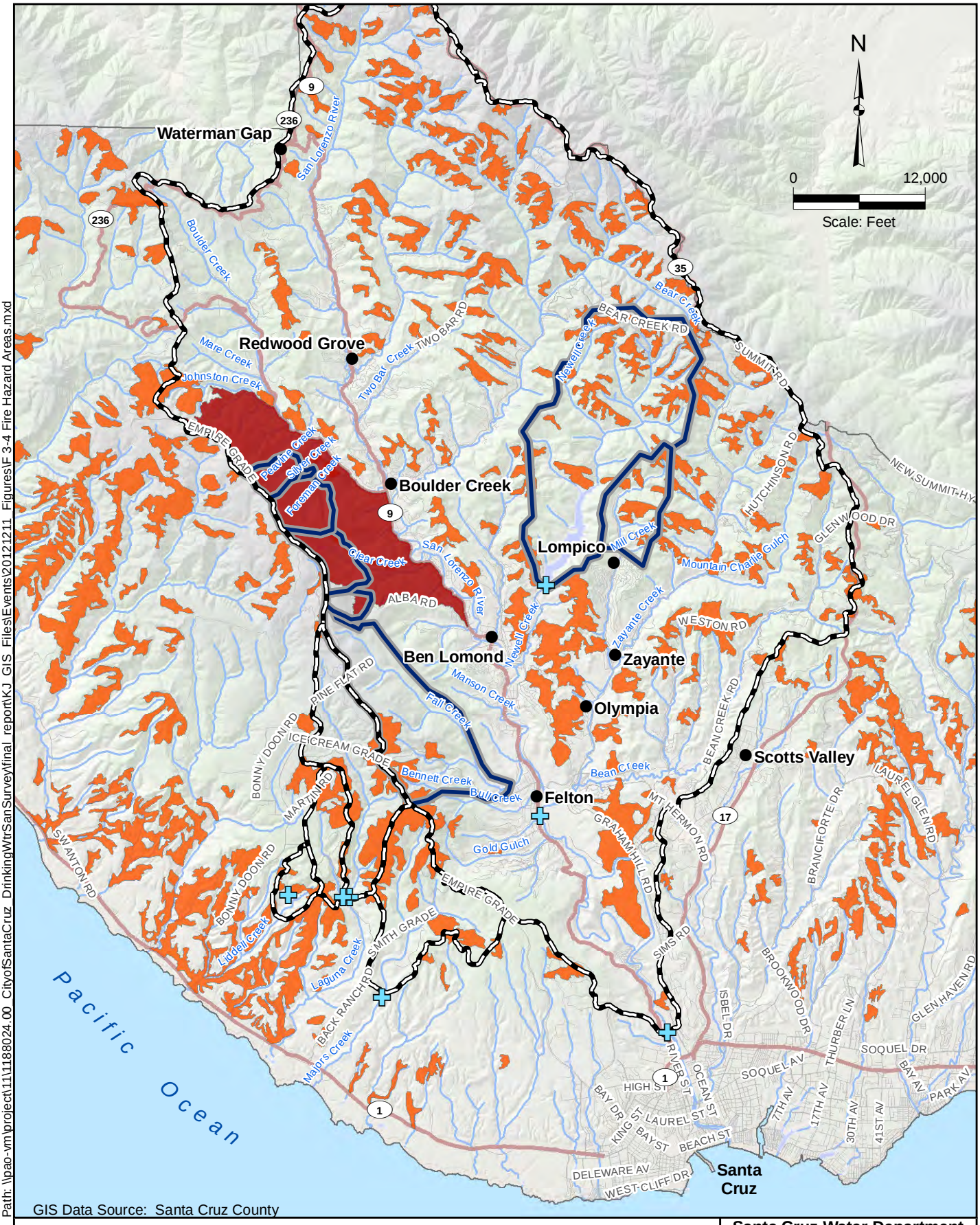
The San Lorenzo watershed contains substantial areas of fire-adapted vegetation, reported to burn at historical intervals of typically 40 to 80 years (Hecht and Kittleson, 1998). Several fires occurred in the 1930's and 1940's, with a large fire known as the Sawmill Fire in the 1950's. One other fire of note was the Love Creek fire in 1970. Numerous small fires occur every year, including the Bear Fire near Boulder Creek in October 2017 yet in total, they have not had much impact on reducing total fuel load. The approximately 400-acre Bear Fire is suspected to be a

consequence of a lack of code enforcement creating an environment where fire could easily spread in a rural area. City fire was part of mutual aid for the Bear Fire and specifically asked for a fire line to be developed to keep it away from Loch Lomond Reservoir. The potential for a large-scale fire with multi-year consequences for water supply remains which could be exacerbated by sudden oak death syndrome as well as vegetation stressed by drought.

3.16.2 Loch Lomond Reservoir and the upper Newell Creek watershed

The City has taken several steps to address fire hazards within Loch Lomond and other watersheds that may fill gaps in the CWPP. The City has a draft fire plan for watershed properties and routinely meets with fire chiefs to review maps, keys, gates and field conditions, ensuring access to City watershed property for fire suppression and minimizing wildfire hazards. Additionally, the City installed a weather station at Loch Lomond to aid in decisions of how to prepare for potential fire and the Ben Lomond/Lompico fuel break was expanded in 2016 and plans made to improve the Loch Lomond/Love Creek fuel break in 2018. Maintenance of fuel breaks including cutting brush and removing dead trees occurs as needed in the winter; with periodically more intensive fuel management efforts also occur. (G. Eidam, personal communication, 2017)

No significant fires were noted in the Loch Lomond subwatershed since 1959, which burned about 1,000 acres on both sides of the lake. Evidence of this fire can be seen on the east side of the lake, where numerous snags have been left to tower above the regrowth.



GIS Data Source: Santa Cruz County

Path: \\pao-vm\project\111188024.00_CityofSantaCruz_DrinkingWtrSanSurvey\final_report\KJ_GIS_Files\Events\20121211_Figures\F 3-4 Fire Hazard Areas.mxd

- Area Locations
- Streets
- Stream
- Lakes
- Sub-Watershed
- Santa Cruz Water Department Diversions
- Fire Hazard Areas
- High Fire Hazard Area
- Santa Cruz City Water Supply Watersheds

Santa Cruz Water Department
WSS Update

Fire Hazard Areas

Figure 3-4

3.16.3 North Coast Watersheds

Brushfires in the North Coast watersheds have occurred periodically, both by human sources (i.e., arson, prescribed burns) and lightning fires. The 2008 Martin Fire was predominantly fuel-driven, and March through June rainfall amounts were the lowest ever recorded for the area, about eight percent of normal (Gordon and Ferreira, 2009). Since the fire, the Regiardo Creek crossing has been completed, a new fuel break in Bonny Doon was completed in cooperation with CalFire in 2016.

3.16.4 SLVWD

There have been no recent fires within the SLVWD subwatershed lands.

3.16.5 Significance

There are three issues related to fire in the subject watershed.

First and foremost, the absence of wildfire increases the chance of a major event which could seriously alter surface hydrology and sedimentation in any or all subject water supply streams. Elevated levels of turbidity are likely to persist from several months to several years following an extensive fire. Because turbidities persist much longer in reservoirs than in springs or run-of-the-stream diversions, post-fire turbidity persistence may prove to be more challenging for the SCWD, which draws heavily upon Loch Lomond Reservoir during the summer. Experience with major floods or fires has shown that reservoirs of similar size can remain turbid throughout the summer (or two) following an extensive burn or other disruptive event. Wildfires can also result in increased Total Organic Carbon which contribute to disinfection by product issues.

Second, fire suppression activities include creation of temporary roads and firebreaks that can be a source of persistent sedimentation and turbidity if not properly abandoned following fire events. Recent philosophies with post fire restoration has avoided traditional reseeding of burned slopes and mulching exposed soils because of changes to the vegetation community that result in reduced biodiversity and potential for a more fire prone landscape in the future. Therefore, the use of erosion control techniques is balanced against the potential for significant erosion to occur following a wildfire.

Third, fire retardants can have adverse effects on water quality. Historically, retardants used by Cal Fire have included borate salts and bentonite clay in water. Borate salts are long lasting, but they are also phytotoxic and soil sterilants. Bentonite clay is less persistent. Use then shifted to ammonium-based fire retardants, which as a group accounted for nearly all chemical retardants used to control wildland fires. The retardant now used by CalFire is Phos-Chek, which is a dry powder made of diammonium sulfate and ammonium phosphate that gets mixed with non-potable water at the air attack base (Hollister, San Andreas, or Sonoma) and then dropped by fixed-wing airplanes along ridgelines or other control points to retard the fire from spreading (Angela Bernheisel, personal communication, 2012). If the retardant is applied directly to stream surfaces, it may cause fish mortalities (Buhl and Hamilton, 1998) and alter aquatic conditions by elevating nitrogen and causing eutrophication downstream (Camp and others, 1996). However, CalFire avoids drops along water courses (Angela Bernheisel, personal communication, 2012).

Fire suppressant foams applied by fire trucks and helicopters may have adverse impacts on water quality, and are more toxic to aquatic biota than the ammonium-based fire retardants (Gaikowski and others, 1996). Application requires leaving a buffer between the spray zone and live streams. Studies by the US Forest Service have shown that the water quality impacts of these materials vary with three elements: the characteristics of the application (i.e., how much dropped and where), the characteristics of the site (steepness, vegetation types, extent of riparian stream cover), and the characteristics of streamflow (higher, turbulent flows result in better mixing, dilution, and reduced toxicity to aquatic life). In general, it can be said that adverse water quality impacts decrease as the distance of application from a stream increases

The inevitability of a major wildfire has been echoed by state, county and local natural resource managers. When a major fire does occur, water resources may suffer immediately and significantly as homes, roads and infrastructure are rebuilt. In subsequent years, the water utilities will likely see a decrease in turbidity and sedimentation, as vegetation becomes re-established and reconstruction activity decreases. Hulda McLean, a former County supervisor and owner of Rancho Los Osos in lower Waddell Creek, emphasized the importance of turbidity persistence after the 1948 Pine Mountain fire by noting that it took five years before Waddell Creek ran clear at any time during the winter months – a lesson on the effects of a watershed-scale fire (Hecht and others, 2010).

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SECTION 4: WATERSHED MANAGEMENT AND CONTROL PRACTICES

4.1 Introduction

This section summarizes existing policies and control measures of the various entities which manage, control or influence land and resource use in the San Lorenzo and North Coast watersheds. The control measures discussed in this section are those watershed management practices that may impact water quality of the San Lorenzo River and its tributaries, as well as the SCWD's water supply on the North Coast.

The following sub-sections, which in large part follow the structure of the AWWA *Watershed Sanitary Survey Guidance Manual*, are included in Section 4:

- Water Utility Management Practices
- Inspection and Surveillance of the Watersheds
- Key County Watershed Management Activities
- Watershed Control Authority
- Open Space Policies
- Erosion Control/Soil Management Policies
- Fire Management
- Santa Cruz County Riparian Corridor and Wetlands Protection Ordinance
- Pertinent State and Federal Legislation

Sub-sections of this chapter continue to evolve with the completion of each survey update but the chapter generally maintains the organization dictated by the AWWA manual referenced above. The details of several sub-sections have not changed since the previous reports and are thus only summarized in the present sanitary survey. Table 4-1 lists the general policies and practices that impact water quality in the project study area and summarizes their effectiveness. Generally, while there appears to be a comprehensive group of regulations, policies, and practices in place that can be used to manage watershed activities, more active input by the City as proposed in Section 6 could improve the effectiveness of these activities, especially in light of upcoming legalizationof Cannabis cultivation activities and associated state and local regulation.

Table 4-1: Updated Summary of Policies and Practices Which Impact Water Quality

Agency/Utility	Primary Watershed Objective	Policies or Controls Which Impact Water Quality	Effectiveness of Policies and Practices
Water Utilities – notably City of Santa Cruz Water Department and San Lorenzo Valley Water District	• Protect drinking water supply. • Protect water quality of drinking water sources and manage to minimize quality change. • Manage to avoid microbiological and chemical contamination. • Manage drinking water source areas for environmental quality.	• Control or disallow public access to watershed lands. • Manage secure intake structures. • Implementation and growth of the SCWD Watershed program. • Advocacy and environmental review of proposed projects in watershed lands. • Conservation easements or licenses on private lands	• SCWD Watershed program is resulting in the collection of valuable data which are used to plan for more effective lands management. • Continued success in working with other agencies/groups on projects which enhance water quality protection measures including the multiagency San Lorenzo River 2025 to improve the river and includes the Riparian Conservation Program to improve stream conditions in the County jurisdiction. • Increased patrolling of source facilities is helping to minimize impacts associated with trespassing and illicit land use.
Santa Cruz County (e.g., Parks, Health Services Agency, Planning Department)	• General Plan established a regulatory approach to plan future development. • Regulate septic systems. • Protect riparian and wetland systems. • Regulate erosion control practices. • Regulate small water systems. • Regulate cannabis cultivation • Provides for open space access.	• County General Plan. • Ordinances for Cannabis cultivation, erosion control, water quality control, riparian corridor/wetlands protection, sensitive habitat • Surveillance of parks. • Control illegal or mis-implemented grading, development and dumping. • Reduce nitrates, pathogens and sediment in streams. • San Lorenzo River Watershed management plan. • County Forest Practice Rules. • Wastewater/Nitrate management plan.	• Cannabis cultivation regulations • Grading/erosion control ordinance can be too cumbersome to small homeowners or small projects. • Exceptions to ordinances often granted and enforcement is limited. • San Lorenzo Watershed management plan is well thought out and presents tangible recommendations for betterment of water quality. • Turbidity, nitrate and pathogen monitoring in support of the 303(d) impairment listing is providing needed data to track trends and responses to implemented projects. • Insufficient staffing has been exacerbated by budget cuts.
California Dept. of Forestry and Fire Protection (Cal Fire)	• Suppress wildland fires (fire protection division). • Control logging (resource management division). • Fire preparedness	• Prescribed burning to minimize impact of larger fires. • Require Timber Harvest Plans for logging of more than 3 acres. • Fuel management • Monitor and enforce forest practice rules. • Coordinate fire fighting efforts.	• Several wildfires have occurred in the area in 2008, 2009, and 2017 as discussed in Section 3.16. • Excessive fuel levels and substantial urban/rural interface area could result in severe wildfire. • Harvest Plans are comprehensive, though follow through, especially in critical years after the harvest is often not sufficient. • Some harvests cause roadway erosion. • Timber harvest plan rules should provide water quality protection.

Table 4-1 Updated Summary of Policies and Practices Which Impact Water Quality			
Agency/Utility	**Primary Watershed Objective**	**Policies or Controls Which Impact Water Quality**	**Effectiveness of Policies and Practices**
California State Water Resources Control Board and the Regional Water Quality Control Board - Central Coast Region (SWRCB and RWQCB)	• Adopt area-wide water quality control plans (Basin Plans). • Control/coordinate water quality issues. • Control quality and quantity of discharges from wastewater treatment facilities, stormwater, and construction activities.	• Enforcement power to issue permits with specific water quality requirements. • Enforcement power of State Water Code. • Issue NPDES permits to specific entities for waters-of-the-state discharges. • Establish water quality objectives. • Impaired Water Body listings and Pathogen, Nitrate and Sediment TMDL for San Lorenzo River. • Provide some funding for septic tank system improvements. • Administering Phase II NPDES and Construction Stormwater regulations.	• Regional Board is coordinating with County's efforts to reduce nitrates. Approved nitrate TMDL and Sediment TMDL in 2000 and 2003, respectively. • Pathogen TMDL approved in 2009 and chlorpyrifos TMDL in 2014. • Implementing programs to emphasize watershed protection from both point and non-point discharges. • Regional Board was more active in the review of Timber Harvest Plans and attendance pre harvest inspections from a water quality perspective in the years prior to 2007 but activity appears to have declined in recent years. • Implementation of Stormwater Management Plan by RWQCB for county and cities under Phase II NPDES permit
California Department of Fish and Wildlife (CDFW)	• Protect fish and wildlife. • Permit diversions from waterways.	• Enforcement power of state code. • Limit diversions from waterways. • 1600 permits now require CEQA review. • Fisheries Restoration Grants Program is viable mechanism for drinking water source protection.	• CDFW has specific regulations to control water quality. • CDFW has initiated Watershed Enforcement Program with Watershed Enforcement Teams for cannabis to improve enforcement of applicable regulations that affect water quality • Staff turnover may limit effectiveness.

Table 4-1 Updated Summary of Policies and Practices Which Impact Water Quality			
Agency/Utility	**Primary Watershed Objective**	**Policies or Controls Which Impact Water Quality**	**Effectiveness of Policies and Practices**
Cal-Trans and County Public Works	• Construct and maintain primary and secondary roadways. • Respond to accidents and landslides. • Design of drainage systems and in-stream habitat improvements	• Minimize herbicide use. • Avoid dumping debris into streams from roads projects. • Quick response to chemical spills.	• Storage, sidecast, and transfer of roadway debris can lead to increased sediment in streams. • Endangered Species Act requirements may improve road practices. • Implementing projects which improve in-stream salmonid habitat and riparian habitat in conjunction with roads projects.
National Marine Fisheries Services (NMFS or NOAA Fisheries) under US Department of Commerce	• Protection-restoration of special status species (Coho Salmon and Steelhead Trout) in the San Lorenzo and North Coast watersheds.	• Implement and enforce the Endangered Species Act (ESA).	• City of Santa Cruz plans to issue a draft Habitat Conservation Plan in 2018 for steelhead and coho to address ESA related issues related to operations of the City's water facilities. • Sediment reduction which benefits listed salmonids will improve turbidity in raw water. • Potential source loss from the north coast surface sources through ESA compliance will result in a degradation of the City's raw water supply quality and limit production flexibility.
United States Fish and Wildlife Service (USFWS) under US Department of the Interior	• Protection-restoration of special status species (Red-legged Frog, etc.) in the San Lorenzo and North Coast watersheds.	• Implement and enforce the Endangered Species Act.	• City of Santa Cruz is presently engaged in ESA related negotiations as a part of the City's draft Habitat Conservation Plan.

4.2 Water Utility Management Practices

The SCWD, the SLVWD, the California Department of State Parks, Santa Cruz County Parks, and some private landowners of camps and timber properties are the largest watershed property managers in the project area as shown on Figure 2-1; however, several of the smaller water purveyors own and/or manage land adjacent to their wells, springs and surface water intakes. Watershed management practices vary for each utility agency. The SCWD, for example, manages its lands to maintain optimal water quality and to limit recreation at the Loch Lomond Reservoir. SLVWD also manages its watershed lands, through administration of their Watershed Management Plan, to maintain optimal water quality, limit access, and minimize potential land disturbances.

4.2.1 Jurisdiction

The jurisdictional area of this sanitary survey is within Santa Cruz County. Within the sanitary survey watersheds, the City of Santa Cruz serves the Pasatiempo and Sycamore Grove areas.

The other water utilities participating in the Sanitary Survey are located in the San Lorenzo River watershed and are in unincorporated portions of Santa Cruz County, except for a portion of the middle Bean Creek watershed within the City of Scotts Valley. Most of the City of Scotts Valley drains to the San Lorenzo River via Carbonera Creek and Branciforte Creek, which flow into the San Lorenzo River below the SCWD Tait Street Diversion. This portion of Scotts Valley shares most watershed management issues with the San Lorenzo Valley but was not part of the 2012 watershed sanitary survey.

4.2.2 Watershed and Reservoir Management Practices

4.2.2.1 City of Santa Cruz Water Department

The SCWD owns watershed land in the Newell Creek (2,880 acres), Zayante Creek (880 acres), and Laguna Creek (240 acres) watersheds.

The SCWD has a Watershed section comprised of the Water Resources Management and Recreation workgroups. The primary objective of the Water Resources Management workgroup is to focus on environmental compliance with applicable State and Federal regulations related to the source water watersheds and SCWD operations. The Watershed section coordinates the activities at Loch Lomond with the Water Resources Management staff focusing on outreach and the Recreation staff assisting with interpretive events, watershed land patrols and watershed/creek sign programs.

Within the last several years, a recreation area study to expand recreation at Loch Lomond was conducted but input from Calfire indicated that additional recreation is not advised because of the increased risk of fire. The SCWD has conducted a watershed lands assessment of natural resources in order to make more informed decisions regarding management of watershed lands for water quality and quantity protection and protection of special status species and their habitats. In addition, the SCWD partnered with the Santa Cruz RCD in a program for watershed identification and signage at creek crossings, educational outreach programs to the San Lorenzo Valley schools, and the State of the San Lorenzo River Symposium annual workshop.

The Loch Lomond Recreation Area (LLRA) is managed for water quality as well as recreational benefits. One of the most significant reservoir practices is management of blue-green algae (cyanobacteria) blooms at Loch Lomond Reservoir through the use of PAK 27™ – a non-copper-based algaecide. PAK 27™ is characterized as an environmentally safe algaecide/algaestat which produces oxygen and hydrogen peroxide by-products, neither of which are reported to be harmful to aquatic species, such as fish, or other forms of algae, such as green algae or diatoms. However, it is also important to consider that a recent ruling by the State Water Resources Control Board grants the City of Santa Cruz an exception for the use of copper-based algaecides, if the need arises (Water Quality Order No. 2013-002-DWQ, General Permit No. CAG990005). In addition to blue-green algae management, wastewater is trucked out of the recreation area, human body contact recreation is not allowed at the reservoir, and no cattle or horses are permitted in the watershed.

4.2.2.2 San Lorenzo Valley Water District

The SLVWD service boundaries encompass 37,120 acres in the San Lorenzo Valley watershed, including a small portion of the Pescadero drainage which is northwest of the San Lorenzo River watershed. Watershed lands owned by the SLVWD include approximately 1,623 acres in one continuous piece on Ben Lomond Mountain, around the tributaries of the San Lorenzo River that supply the SLVWD's surface water (Clear Creek, Sweetwater Creek, Peavine Creek, Foreman Creek, and Silver Creek), and in the Malosky Creek and Harmon Creek drainages. The SLVWD also owns approximately 163 acres in the recharge area of its Olympia wellfield. Marked trails on these watershed areas are used by horse riders. SLVWD now has some deeded riparian lands from nearby private land owners on Lompico Creek that will not be developable and could protect Lompico Creek if it is used as a source in the future. In early 2012, SLVWD initiated a formal agreement with the Santa Cruz Land Trust to provide patrol service. The primary concerns continue to focus on trespassers and off-road vehicles. Public access is limited.

Timber harvesting continues to not be permitted on SLVWD watershed lands. No pesticide/herbicide use is permitted on SLVWD lands. Watershed Lands Acquisition

The SLVWD purchased the 188-acre Malosky Creek property from Sempervirens Fund in 2006. This property had been on the District's list of most wanted watershed acquisitions for years. The District's 5-mile long pipeline crosses the property. As part of the transaction, the SLVWD agreed to retire the timber rights on the property. The SLVWD has had a no-commercial logging policy on its watershed lands since the 1980s.

SLVWD acquired the Felton Water System from California-American Water Company in 2008 which also included about 252 acres in the Fall Creek watershed that supply the Felton water system. The 2016 acquisition of LCWD included about 500 acres of Lompico Creek watershed lands.

In addition, as discussed in the Executive Summary, the acquisition of the 8,532 acres of CEMEX lands on the North Coast watersheds by a number of land preservation organization has resulted in the potential for protection of habitat and water quality, particularly for the community of Davenport but, with additional public access, could increase the risk of fire and resulting water quality challenges. Future activities to acquire lands and easements to protect water quality are discussed in Section 6.

4.3 Inspection and Surveillance of the Watersheds

Inspection and surveillance of watershed lands in the project area are performed by numerous agencies, depending on ownership and type of use. For example, State Parks regulations are enforced by Parks staff. County Parks, like Quail Hollow County Park (about 300 acres), are managed by County Parks personnel. Surveillance of the purveyor-owned watershed lands is conducted by the water purveyors themselves. In addition, the SCWD staff has advocated for increased patrols in the Pogonip Preserve open space area upstream of the Tait Street diversion as well as acquiring licenses which have expanded the ability to monitor and control activities on private lands upstream of the City's Tait St. intake. Efforts to prioritize limited patrol resources towards water quality remain a challenge. The remainder of the project area is under the jurisdiction of Santa Cruz County.

Within the Loch Lomond subwatershed, the City has instituted a comprehensive security program that includes installing cameras with motion sensors and infrared capability, fences, and gates on the City's portion of the watershed and increased patrols. The City has also installed a weather station at Loch Lomond to improve preparation for fire. As of 2017, there were 4 full-time rangers, one of whom lives at Loch Lomond, 2 full time ranger assistants, and 2 seasonal ranger assistants. The ranger and ranger assistants conduct patrols by truck, all-terrain vehicle or on foot with a focus on high use areas.

The County of Santa Cruz's Planning Department, Health Services Agency, and Department of Public Works develop and enforce water-quality related county ordinances and provide review and permitting of development plans, timber harvest plans, erosion control plans, quarry plans, and maintenance of county roads. The Santa Cruz County Fire Department and the Office of Emergency Services participate in the development of fire-related development standards and post-fire restorations efforts, in addition to the review and updating of the countywide Disaster Contingency Plan and Critical Fire Hazard Maps.

4.4 Key County Watershed Management Activities

As previously mentioned, Santa Cruz County developed a comprehensive management plan for the San Lorenzo River watershed in 1979. The San Lorenzo River Watershed Management Plan was updated in 2001 through a collaborative process with the Regional Board, a citizen and landowner group, and other agencies. The ongoing efforts by the County and the completed update to the watershed management plan underscore the continued efforts of the County to implement practices, programs and ordinances which aim to improve water quality in the San Lorenzo River watershed. Pertinent efforts and data from those efforts will be used for the purposes of this report to summarize water quality and watershed management activities in the San Lorenzo River watershed.

4.5 Watershed Control Authority

Policies and control measures adopted by the governmental agencies are described in this subsection. All the watersheds in this area are located in Santa Cruz County, and are therefore subject to the policies adopted by the County *General Plan*. Key goals and policies outlined in the *General Plan* are described below.

4.5.1 The County General Plan and the Local Coastal Program (LCP)

The *1994 Santa Cruz County General Plan* and the *Local Coastal Program (LCP)* is a combined planning document that serves two primary purposes and have not been updated since the 2013 watershed sanitary survey. First, it establishes a regulatory framework against which all proposed development is measured. Second, it serves as a vision statement for the desired future of the county. The *General Plan* was prepared to meet the requirements of both the State Planning Laws and the Coastal Act.

The *General Plan* sets up numerous goals, objectives, policies, and programs related to the protection of water resources and sensitive habitats. The County adopted an *ecosystem* approach while drafting ordinances pertinent to water quality concerns. In other words, there is

a clear understanding that by preserving and enhancing the natural systems of the county, a secure and safe drinking water supply will most likely be obtained. *General Plan* elements that contain goals most pertinent to the protection of water resources are as follows: Chapter 5 - Conservation and Open Space, Chapter 6 - Public Safety and Noise, and Chapter 7 - Parks Recreation and Public Facilities. The *General Plan* Conservation and Open Space, Public Safety and Noise, and Parks and Recreation and Public Facilities elements have not been updated since 1994. The Safety, Noise and Housing elements were scheduled for updated in 2015 and the Land Use, Circulation and Community Design were scheduled for updated in 2016 and 2017.

4.5.2 Wastewater Discharge

Wastewater discharge requirements for point source discharges from wastewater treatment plants or from industrial facility plants directly to receiving streams are established through National Pollutant Discharge Elimination System (NPDES) permits administered by the Regional Board under the federal Clean Water Act. These NPDES permits control the discharge by establishing numerical effluent limitations for specific constituents and parameters which the treatment plant or industrial facility must meet. The constituents for which effluent limitations are established are specific to the type of discharge. Suspended solids and coliform bacteria may be regulated, depending on the type of plant or facility. Each NPDES permittee collects data which it reports to the Regional Board on a regular basis. This self-monitoring data demonstrates compliance status with the specific effluent limitations.

Wastewater discharges to septic systems are regulated by the County within guidelines established by the Regional Board. Although no changes have been made to the County Sewage Disposal Ordinance, policies have been adopted to provide for tighter oversight and maintenance of alternative technology systems. In addition, a State-revolving fund was historically used to promote the use of such systems through a low-interest loan program. However, this loan program is no longer available.

The County's comprehensive Wastewater Management Program previously served as a model for draft statewide wastewater management and was adopted by the State Water Resources Control Board.

The SWRCB adopted state-wide On-site Wastewater Treatment (septic) policy in 2012 as required under AB 885, detailed in Section 4.9.2.4, will provide some strengthening of local septic regulations, particularly within the area 2,500 ft upstream from a surface water intake.

4.5.3 Stormwater Regulations

Municipalities with populations greater than 100,000 and certain classes of industries (including construction sites which involve a land disturbance of more than 1 acre) are regulated under the NPDES Phase I permit program administered by the Regional Board. Municipal permits are specific and individual to the municipality in question, but all contain provisions for management of specific activities (e.g., construction, new development planning, industries, illicit discharges, public agency activities such as street sweeping and public education) and for monitoring. Certain classes of industries are required to file a Notice of Intent (NOI) to comply with the provisions of the State General Industrial Stormwater NPDES Phase I Permit. The industry

makes this notification to the SWRCB and, thereafter, is expected to comply with the general permit provisions which focus on pollution prevention and good housekeeping measures. Construction sites with a land disturbance greater than 1 acre must file a NOI with the SWRCB to comply with provisions of the state General Construction Activities Stormwater NPDES (Order No. 2009-0009 DWQ). This permit focuses on sediment control and waste management. The SWRCB maintains a database of industries and construction sites which have filed NOIs.

The County of Santa Cruz and the City of Santa Cruz have each completed and submitted a complete Phase II NPDES application to the Regional Board, and the Regional Board approved their submitted Storm Water Management Plans in 2009. The County and City both require construction phase and post-construction phase erosion control plans for construction projects encompassing an area of less than 1 acre and for which grading is part of the construction plan. The plans typically must include best management practices (BMPs) which protect against illegal discharge of pollutants to the creeks and streams in the project area. The Phase II regulations provide support for existing County and City ordinances which establish the criteria for protection of water quality and natural resources.

The County adopted its current Stormwater Management Program in 2010 that meets the established requirements of the statewide NPDES Permit and serves as the Stormwater Pollution Prevention Plan for the County and the City of Capitola. Related to the Stormwater Management Program, County Ordinance No. 5117 added Chapter 7.79 Runoff and Pollution Control to the Santa Cruz County Code in 2012. The City completed a Stormwater Management Plan Guidance Document in July 2013 and has included an Ordinance for Stormwater and Urban Runnoff Pollution Control as part of the municipal code since 2003 with updates through 2012.

4.5.4 Mines and Quarries

Surface discharges from both active and inactive mines to receiving streams are regulated by the Regional Board under the Waste Discharge Requirement permit program. Permit conditions for discharges from active mines usually allow only inert or non-hazardous waste releases. Mines typically meet these requirements by implementing various best management practices.

Regulation of mine and quarry operations in the watershed study area is covered under the County Mining ordinance. Mineral Resource Areas are designated by the State Geologist and State Mining and Geology Board. The County classifies these areas as within the County Mineral Zone Extraction District (M-3) and requires environmentally sound quarry operations and reclamation practices in accordance with the state Surface Mining and Reclamation Act (SMARA), which emphasizes the primacy of post-reclamation uses and the need to plan and limit mining to be compatible with such uses. Development on M-3 lands is restricted to mining and other compatible uses. Compliance with the California Environmental Quality Act (CEQA) for mining operations is required. Mining operations adjacent to riparian corridors must be conducted in accordance with the Riparian Corridor and Wetlands Protection ordinance. Quarry operations are overseen by the County Planning Department Quarry Coordinator. There have been no changes made to the County Mining Ordinance since completion of the 1996 sanitary survey.

4.5.5 Animal Keeping Regulations in Santa Cruz County

The County of Santa Cruz does not currently have a specific ordinance regulating domestic and confined animals in residential and rural areas. General animal keeping and breeding regulations, however, are outlined in the County Code under Chapter 13.10, Part VI, Article IV (animal regulations). The Article provides regulations for animal enclosures (stables and paddocks), care of animals (animal hospitals and kennels), animal keeping (horses, cows, sheep, etc.) different types of animal raising (family raising, poultry, bird, turkeys, etc.) and biomedical animal operations.

4.5.6 Recreational Activities and Policies

Agencies which administer the recreational and open space areas in the watershed study area include the County Parks Department, the Boulder Creek Recreation and Park Department, the California Department of Parks and Recreation, and the SCWD. Management policies in the SCWD's Loch Lomond Recreation Area were previously described in Section 4.2.2. In addition, the City prepared a draft Parks Master Plan 2030 which is out for public review as of September 2017 and focuses on recreation opportunities inside the City limits while acknowledging opportunities within the County. One element of the draft Parks Master Plan is acknowledgement of the need to create a legal, supervised campground for homeless to deter sleeping in parks and along the San Lorenzo River.

Overall, recreational policies and open space policies in the watershed are described in the County's *General Plan*. Since the *General Plan* has not been updated since 1994, recreational policies and open space policies have not changed since completion of the 1996 sanitary survey. It should be noted that County Parks Department initiated a Strategic Planning process in 2017.

The County Health Services Agency continues to routinely monitor creek and river swimming areas in the San Lorenzo Valley for fecal coliform bacteria. This monitoring is conducted to obtain information on when to issue advisories avoiding swimming areas, and is part of larger County-wide program. The State parks in the watershed study area are essentially open spaces. The County *General Plan* promotes cooperation with state activities and specifically encourages expansion of state ownership at the Fall Creek and Henry Cowell park units.

4.6 Open Space Policies

The Santa Cruz County *General Plan* goals for open space protection are as follows:
"To retain the scenic wooded, open space and rural character of Santa Cruz County; to provide a natural buffer between communities; to prevent development in naturally hazardous areas; and to protect wildlife habitat and other resources."

Within the project watersheds, the majority of the population is concentrated along Highway 9 on the floor of the San Lorenzo Valley. Steep slopes and rugged terrain have long been a significant constraint to commercial and residential development in all areas of Santa Cruz County. As a result, the area is rural in general character, heavily forested, and visually dominated by open and undeveloped space.

Henry Cowell Redwoods State Park, the Fall Creek unit of Henry Cowell, Castle Rock State Park, and Big Basin Redwood State Park are all managed as public open space. The water purveyors' watershed lands are managed for water resource protection, and to a limited extent, for recreation. Several land trusts, including the Santa Cruz County Land Trust and the Sempervirens Fund own and/or manage open spaces in the project area.

A portion of the University of California Santa Cruz - Upper Campus and the Pogonip Open Space are adjacent to Henry Cowell Redwoods State Park in the San Lorenzo Valley. Several summer camps, conference centers, and retreats operate small water systems and own watershed lands. Private owners hold the remainder of lands in the project area.

4.7 Erosion Control/Soil Management Policies

The County has an Erosion Control Ordinance with the purpose of eliminating and preventing conditions of accelerated erosion that may lead to degradation of water quality, loss of fish habitat, damage to property, loss of topsoil and vegetative cover, disruption of water supply, and increased danger from flooding. The policies in the ordinance that are intended to protect water supply are as follows:

- Streams or drainage courses shall not be obstructed or disturbed except for approved road crossings, unless disturbance of a drainage course will improve overall site design and be consistent with the purpose of the ordinance.

- Erosion control measures specified in, or pursuant to, this ordinance, shall be in place and maintained at all times between October 15 and April 15.

- Runoff from activities subject to a building permit, land division permit, or development permit shall be properly controlled to prevent erosion and adequate for runoff from a ten-year storm.

- Land clearing shall be kept to a minimum and vegetation removal shall be limited to that amount necessary for building, access, and construction.

When no land development permit has been issued, the following types of land clearing require an erosion control plan:

- Any amount of clearing in a sensitive habitat.

- One-quarter acre or more of clearing in the Coastal Zone if also in a least disturbed watershed, a water supply watershed, or an area of high erosion hazard.

- One acre or more of clearing in all areas not included in the above items.

When a land development permit has been issued, land clearing may be done in accordance with the approved development plan; however, approval of land clearing requires that “all disturbed surfaces shall be prepared and maintained to control erosion and to establish native or naturalized vegetative growth compatible with the area.”

Despite the fact that the Erosion Control Ordinance has not changed since the 2013 sanitary survey update, new stormwater discharge regulations under Phase II of the NPDES permitting system administered by the Regional Board are followed by both the City and the County through administration of various permits, including most notably construction permits. Both entities require erosion control plans covering the construction and post-construction phases of projects that are less than one acre in size. The erosion control plans are developed to protect against illegal discharge of sediment and other contaminants to creeks, streams and other water bodies. Projects larger than one acre in size are regulated by the SWRCB, while the Region Boards and the local storm water jurisdictions (County or City) that issue development/building, grading and other permits implement sediment and erosion controls on projects less than an acre. Enforcement efforts remain limited by staff availability at all levels.

4.7.1 Roads

Caltrans and the County Department of Public Works are responsible for roadway maintenance on specific corridors. Both agencies have policies to truck roadway debris to designated dump sites. For example, they should not "broad-cast" or "side-cast" debris to the side of any road, especially roads near streams. However, significant winter storms such as occurred in 2017 can generate significant land slide material which can be difficult to move in a timely manner and can pose a water quality risk as a new storm comes into the area. Also, some county roads are owned jointly and shared among residents in rural areas. The County has established numerous roadway associations to tax residents and fund maintenance, culvert design and construction for these roads. This keeps the County in control of the maintenance activities and proper techniques are typically followed to mitigate erosion. The County's Road Maintenance Manual links directly to the FishNet 4C Roads Manual: Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance published by the Fishery Network of the Central California Coastal Counties which indicates the sensitivity to proper road maintenance activities to minimize water quality impacts.

In addition, when funding has been available, the Santa Cruz County Resource Conservation District (SCCRCD) has historically undertaken a private roads rehabilitation program aimed at identifying those private road segments (after being approached by private landowners or roads associations) which contribute sediment to creeks and streams and further identifying repair schemes for the sediment contributing road segments. As a partner in this effort, the Coastal Watershed Council has developed a Rural Roads Sediment Inventory Manual which Council and Conservation District staff can use while conducting roads inventory work. In addition, the SCCRCD applied for and obtained funding that allowed rural road erosion control projects, some of which are also described in Section 5.5 to continue starting in around 2008 are continuing through 2016. As of 2017, funding for rural roads is not available.

4.8 Fire Management

The *General Plan* fire management objective is "to protect the public from the hazards of fire through citizen awareness, mitigating the risks of fire, responsible fire protection planning, and built-in systems for fire protection and suppression."

The San Lorenzo Valley and North Coast watersheds are within the jurisdiction of Cal Fire, locally headquartered on Highway 9 in Felton. Cal Fire is equipped to suppress wildland fires

throughout the project area. Local fire districts take primary responsibility for fighting domestic and commercial fires in their specific areas of jurisdiction. At the county level, the Santa Cruz County Fire Marshall is responsible for the coordination between neighboring fire districts, particularly during first alarm response. The Santa Cruz County Office of Emergency Services provides communication and warning services to area residents and fire districts. As discussed in Section 3.16, a Community Wildfire Protection Plan has been developed and is in the process of update by the Fire Safe Council.

Prescribed burning by the California Department of Parks and Recreation at the perimeters of Henry Cowell Redwoods State Park and Big Basin State Park were conducted in 2016 and 2017 to minimize the potential spread of a major conflagration either into or out of the parks. Prescribed burns are also used to promote fire-tolerant native vegetation threatened by invasive non-natives.

In addition, the City has prepared a draft Fire Plan for watershed properties to improve fire management planning on City properties. The City has also focused on maintaining fuel breaks and roads in their watershed. Maintenance has included the use of herbicides at the ridge top firebreaks as part of an integrated pest management (IPM) approach to fire preparedness.

4.9 Other Local, State and Federal Regulations

In addition to the topic-specific watershed management practices, activities, and controls described in previous sections, other surface water quality environmental regulations exist that affect how water purveyors can meet drinking water quality regulations within the San Lorenzo River and North Coast watersheds.

4.9.1 Local Regulations

4.9.1.1 Santa Cruz County Water Quality Control Ordinance [1974]

Santa Cruz County developed a water quality ordinance in 1974 to manage the turbidity level of natural waters in relation to projects which may impact these turbidity levels. Numerical criteria were established in relation to the impact on natural water turbidity levels from the implementation of any project. If the criteria are exceeded due to activity of any permitted project, then the project is deemed to be in violation of the permit. The County criteria are valid unless more stringent permit criteria are established by the California Department of Fish and Wildlife or the Regional Water Quality Control Board.

4.9.1.2 Santa Cruz County Riparian Corridor and Wetlands Protection Ordinance

The purpose of this ordinance is to eliminate or minimize encroachment into the riparian corridors of Santa Cruz County to preserve, protect, and restore riparian corridors. No development activities are allowed within the riparian corridor other than those allowed through the following key exemptions and exceptions:

Exemptions

- The continuance of any pre-existing nonagricultural use, provided such use has not lapsed for a period of one year or more. This includes changes of uses which do not significantly increase the degree of encroachment into or impact on the riparian corridor as determined by the Planning Director.

- The continuance of any pre-existing agricultural use, provided such use has been exercised within the last five years.

- Control or eradication of a pest as defined in Section 5006, Food and Agriculture Code, as required or authorized by the County Agricultural Commissioner.

- Drainage, erosion control, or habitat restoration measure required as a condition of County approval of a permitted project.

Exceptions are granted on a case by case basis after a filing with the County and based on findings by the Zoning Administrator that include that there are special circumstances affecting the property; that the exception will not be detrimental to the public or injurious to other downstream properties and is in accordance with ordinance. Conditions may be imposed that include maintenance of a protective vegetated strip between the activity and the water body; installation and maintenance of water breaks, sediment and erosion control including reseeding and other surface treatments and sediment catch basins.

The ordinance has not been updated since the 2013 sanitary survey but the County Fish and Wildlife Advisory Commission (formerly Fish and Game Advisory Commission) is currently considering changes to recommend to the County Board of Supervisors. The Santa Cruz County Fish and Wildlife Commission and the National Marine Fisheries Service (NMFS) have recommended to the Board of Supervisors that the County code regarding protection of riparian corridors be strengthened with new standards for streamside development and with targeted implementation and enforcement in water supply and coho salmon recovery watersheds and receives periodic updates on environmental compliance topics at their meetings. In 2014, the Santa Cruz County Planning Department initiated a Code Compliance roundtable to coordinate work programs among the Fish and Wildlife and Water Advisory commissions as well as the Commission on the Environment. In addition, the City is leading a Riparian Conservation Program effort through the San Lorenzo 2025 Initiative in areas adjacent to the critical water ways in the County jurisdiction as discussed in Section 6.

In addition, since 2003, a Stream Care Guide has been available by Santa Cruz County Planning Department http://www.sccoplanning.com/Portals/2/County/Planning/env/streamcare.pdf?ver=2013-09-16-134201-870 that provides information for homeowners on maintaining and improving the riparian corridors.

4.9.1.3 Santa Cruz County Sensitive Habitat Protection Ordinance

The purpose of the Sensitive Habitat Protection Ordinance is to minimize the disturbance of biotic communities which are rare or especially valuable because of their special nature or role

in an ecosystem. Lakes, wetlands, estuaries, lagoons, streams, rivers, and riparian corridors are among the habitats considered sensitive.

Sensitive habitat policies of interest to this survey include:

- No toxic chemical substance shall be used in such a way as to have deleterious effects on the habitat unless an emergency has been declared, or such use has been deemed necessary by the California Department of Fish and Wildlife to eliminate or reduce a threat to the habitat itself, or a substantial risk to public health will exist if the toxic chemical substance is not used.
- The Agricultural Commissioner, when reviewing an application to use a restricted material, shall consider the potential effects of the material on a sensitive habitat, and mitigation measures shall be required as necessary to protect the habitat. No approval shall be issued if adverse impacts cannot be mitigated.
- A biotic assessment shall be required for all development activities and applications in areas of biotic concern.
- No development activity shall commence until approved, unless such activity has been reviewed concurrently with the review of a development or land division permit.

Any development within any sensitive habitat area shall be subject to the following conditions:

- All development shall mitigate significant environmental impacts.
- Dedication of an open space, conservation easement, or equivalent measure shall be required as necessary to protect the portion of a sensitive habitat which is undisturbed by the proposed activity or to protect a sensitive habitat on an adjacent parcel.
- Restoration of any area which is a degraded sensitive habitat or has caused or is causing the degradation of a sensitive habitat shall be required, provided that any restoration required shall be commensurate with the scale of the proposed development.

No new development shall be allowed adjacent to marshes, streams, and bodies of water if such development would cause adverse impacts on water quality which cannot be mitigated or will not be fully mitigated by the project proponent. Development that has received a riparian exception according to the provision of the Riparian Corridor and Wetlands Protection Ordinance may be exempted from the provisions of this ordinance if the Planning Director has determined that the activity has received a review that is equivalent to the review required by the Sensitive Habitat Protection Ordinance.

Finally, the City and County are in the process of developing a Karst Protection Zone Policy with a formal request from the City to the County in late 2016. Karst is known to occur in several areas of Santa Cruz County, primarily in Bonny Doon, Felton, and the southeastern end of Ben Lomond Mountain in the vicinity of Pogonip and UCSC as shown on Figure 2-4. Since karst aquifers have unique recharge properties, current regulations designed for non-karst aquifers having fairly regular porosity, transmissivity, and hydraulic conductivity provide inadequate protection (Berry, 2016, Personal Communication,).

4.9.1.4 Draft Santa Cruz County Cannabis Cultivation Ordinance

Santa Cruz County has drafted a Cannabis cultivation ordinance and an accompanying draft Environmental Impact Report (EIR) to provide specific, local regulation resulting from the statewide legalization of cannabis. The comments for the EIR closed on October 31, 2017 and the ordinance will likely be finalized in 2018. The City has provided numerous comments and suggestion to the ordinance including support for requirement of metering and reporting of onsite water sources and/or valid water rights associated with surface water diversion; prohibitions on use of generators, licensing parcels with outstanding code violations, and manufacturing of concentrates on cultivation sites; adding grounds for revocation of licensing; and alignment with state requirements for water resource protection plans and/or adherence to site-specific environmental protection standards (especially with regard to activities in water bodies critical to anadromous fish) including adherence to existing County environmental codes.

4.9.2 California State Regulations

4.9.2.1 California Porter-Cologne Water Quality Act [1969]

The California State Water Resources Control Board (State Board) and the nine California Regional Water Quality Control Boards (Regional Board or RWQCB) have the authority in California to protect and enhance water quality, both through their designation as the lead agencies in implementing the Section 319 nonpoint source program of the federal Clean Water Act (CWA), and from the state's primary water-pollution control legislation, the Porter-Cologne Water Quality Control Act. The Porter-Cologne Water Quality Act is the state law governing nonpoint-source water quality regulation. The State Water Resources Control Board (SWRCB) has responsibility for the State's water quality and water rights programs. State policies set forth by the SWRCB are administered by nine Regional Water Quality Control Boards. The Porter-Cologne Act refers to the Regional Boards as "principal state agencies with the primary responsibility for the coordination and control of water quality" (Section 13001). The Regional Boards are also directed to adopt water quality control plans (Basin Plans) for all regions within the State. Santa Cruz County is within the Central Coast Region, which includes San Luis Obispo, Monterey, Santa Barbara and San Benito Counties, along with small portions of Santa Clara, San Mateo, Kern and Ventura Counties.

CWA Section 303, discussed in Section 4.9.3 that follows, and the Porter-Cologne Water Quality Control Act establish water quality objectives for all waters in the State. These objectives are implemented locally through Water Quality Control Plans, the National Pollutant Discharge Elimination System (NPDES) permits for discharges to receiving waters, and waste discharge requirements (WDRs) for discharges to land.

In addition to obtaining WDRs for wastewater treatment plant discharges, individual or NPDES permits must be obtained for stormwater discharges. The NPDES Municipal Stormwater Permit program is divided into Phase 1 regional permits for municipal separate storm sewer systems (MS4's) servicing populations greater than 100,000, and a statewide Phase 2 (Small MS4) program covering populations less than 100,000. Industrial dischargers in specific industries are required to obtain coverage under site-specific NPDES Industrial Stormwater Permits. Construction sites where disturbance to more than 1 acre is proposed must obtain coverage under the NPDES Construction General Permit.

Land management activities that have the potential to affect water quality and are not covered under the NPDES program are regulated by the Regional Boards under the authority of the Porter-Cologne Act. The Regional Board issued a general conditional waiver of WDRs for timber harvest activities that are not subject to individual conditional waivers or WDRs. The conditional waiver was renewed in 2012 under Order No. R3-2012-0008. The general conditional waiver boosts the role of the Regional Board in review of THPs during the Cal Fire approval process and requires notification by timber harvesters once the THP has been approved. In addition, the waiver's Monitoring and Reporting Program results in post-harvest inspections by Regional Board staff. The level of activity of Regional Board staff is limited by budget priorities.

Water quality impacts of cannabis cultivation has also become a focus of the Regional Board as a result of recent Cannabis legalization in California and a permitting process for commercial cannabis cultivators is expected to be in place in January 2018.

4.9.2.2 California Environmental Quality Act (CEQA) [1970]

CEQA was modeled after the National Environmental Policy Act (NEPA) and establishes the state's basic framework for the environmental review of new development projects. CEQA provides the effected agencies and the public with a role in the review of proposed development and sets forth standards of significance when evaluating the potential effects of projects. CEQA requires that potential significant impacts be identified and mitigated

4.9.2.3 California Department of Fish and Wildlife

The California Department of Fish and Wildlife is responsible for the regulation of impacts to wetlands, rivers, and lakes through the mandate of Sections 1601-1603 of State Fish and Wildlife Code. The department is required to review projects with the potential to divert or obstruct natural flows of waters in streambeds and wetlands. Alteration of wetlands, river, streams and lakes must be done with the permission of the Department of Fish and Wildlife, which places conditions of approval on the proposed action to mitigate any adverse effects to the habitat to be altered.

The Department of Fish and Wildlife also regulates the hunting and trapping of wild and feral pigs on public and private lands. The Department of Fish and Wildlife developed a Memorandum of Understanding to control the pig population. The memorandum includes requirements for disposal of pig carcasses, reporting program results, and maintenance of specific records.

4.9.2.4 Statewide On-Site Wastewater Treatment Policy Assembly Bill (AB) 885

In 2000, the California Legislature passed AB 885, which requires the State Water Quality Control Board to adopt regulations for the operation of on-site wastewater treatment systems (OWTS). The policy took effect in May 2013. Designed to ensure that surface waters and groundwater are not contaminated by septic systems, the policy provides minimum OWTS standards for local agency OWTS management programs and indicates that permits for OWTS in the same drainage as and within 1,200 feet of surface water intake be reviewed by the public water system owner. and the permit application also be provided to the CDDW Drinking Water

Program. The policy indicates that these agencies shall have 5 days from receipt of the permit application to provide recommendations and comments to the permitting agency.

Several other key state acts affect the management of pollutants and the potential impacts to water quality that may result from their use:

- Pesticide Contamination Act [1967]
- Forest Practice Act [1973]
- Subdivision Map Act [1974]
- Hazardous Waste Control Act [1982]
- Underground Storage and Hazardous Waste Substances Act [1983]
- Safe Drinking Water and Toxic Enforcement Act [1986]
- Integrated Waste Management Act [1989]

4.9.3 Federal Regulation

Federal provisions pertinent to the sanitary survey are described below. Drinking water regulations are discussed in Section 5.

4.9.3.1 Clean Water Act – NPDES and TMDL

The Federal Water Pollution Control Act of 1972, also known as the Clean Water Act (CWA), was enacted to “restore and maintain the chemical, physical, and biological integrity of the Nation's water." Some concerns exist that enforcement of the CWA could weaken under the 2017 presidential administration. The CWA established the NPDES permit program described above under California regulations; California’s typically more stringent regulation may mitigate changes at the federal level.

The CWA also includes Section 303(d), which specifically requires states to identify those water bodies not meeting established water quality goals relative to a pollutant or a suite of pollutants. Once a water body is found to not meet applicable water quality goals, it must be added to the 303(d) list as an impaired water body and a TMDL must be developed for the specified pollutants. 303(d) listing recommendations are made by the Regional Board and approved by the State Board. The San Lorenzo River is 303(d) listed for nutrients (1996), pathogens (1998), sediment (1998), chlordane (2010), chlorpyrifos (2010) and PCBs (2010), and the Lower Newell Creek is listed for pH (2010). Based on the 303(d) listing for nutrients, pathogens and sediment in the San Lorenzo River, TMDLs have been adopted for nitrate (2000), pathogens (2009), sediment (2003) and chlorpyrifos (2014). The sources contributing chlordane, chlorpyrifos and PCBs to the San Lorenzo River and sources contributing pH to Lower Newell Creek have not been identified and adoption of TMDLs for these constituents is not anticipated until 2021.

4.9.3.2 CWA 303d list and Total Mass Daily Loads

Table 4-2 that follows provides a summary of the Total Mass Daily Loads that have been approved or are in process through 303d impaired water body listing for the waterways in the watershed.

Table 4-2: 303d List/TMDLs Summary Status and Drinking Water Relationship

TMDL	Status of Regulation	Relation to Drinking Water	Impact/Benefit to Water Treatment	Regional Implications
San Lorenzo River Pathogen TMDL	A pathogen TMDL was approved for the San Lorenzo River in May 2009 due to impairment of water contact recreation beneficial use. 2016 303d list added specific pathogens of Enteroccocus, E. Coli, Fecal coliform	Implementation of the TMDL will improve SCWD's source water quality.	Improved water quality potentially reduces water treatment costs.	Implementation of the TMDL requires the County, City of Santa Cruz and City of Scotts Valley to potentially invest additional resources in management of: wastewater (especially for on-site systems), stormwater, and riparian-area homeless encampments.
San Lorenzo River Sediment TMDL	A sediment TMDL was approved for the San Lorenzo River in May 2003 due to impairment of fish and wildlife beneficial use. RWQCB staff recommend revision of the existing numeric targets to sediment and biological indicators.	Implementation of the TMDL will improve TSS and turbidity, which will improve SCWD's source water quality.	Improved water quality potentially reduces water treatment costs.	Implementation of the TMDL requires the County, City of Santa Cruz and City of Scotts Valley to invest additional resources in stormwater management improvements especially as they relate to upstream sediment discharge and hydromodification.
San Lorenzo River Nitrate TMDL	A nitrate TMDL was approved for the San Lorenzo River in September 2000 due to potential to adversely affect municipal and domestic water supply beneficial use and water contact and non-contact water recreation beneficial uses.	While nitrate is not violating the drinking water standard for nitrate, implementation of the TMDL will improve SCWD's source water quality. Nitrate can create taste and odor problems through the promotion of biological growth. Biological growth is also a concern as it can lead to higher TOC concentrations and higher potential for DBP formation as well as increased growth downstream that results in a higher upstream regulatory burden for the City with respect to threatened and endangered species.	When taste and odor often associated with algae blooms, were a problem, SCWD had to spend $60,000/year on treatment of the problem. Additional studies would be necessary to assess the connection between nitrate/biological growth and water treatment	There are likely secondary impacts (i.e. biological growth formation at the Lagoon) from nitrate concentrations; therefore, the river is still considered impaired for nitrate. Nitrate levels continue to vary year to year. To decrease nitrate levels will require additional investment in nitrate reduction measures.
San Lorenzo River Chlorpyrifos TMDL	TMDL adopted May 29, 2014 with impairments in San Lorenzo River (below Zayante Creek confluence near Felton), Branciforte and Zayante Creek and Arana Gulch. 2010/2011 data indicate that numeric targets are currently being met	Chlorpyrifos, if present, may not be removed by current treatment and may require additional treatment	Chlorpyrifos removal may be accomplished by adsorption onto activated carbon and potentially breakdown with strong oxidants like free chlorine and peroxide.	Chlorpyrifos may be detrimental to aquatic life.
San Lorenzo River 303d listings for Chlordane, Chloride, PCBs, Sodium	Regional Board 2016 303d list revisions include maintaining chlordane and PCBs on list, and addition of chloride and sodium based on sample of SLR at Laurel St downstream of Tait to 303d list	Like chlorpyrifos, chlordane, if present, may not be removed with current treatment and may require additional treatment; Chloride/sodium likely not a raw water issue	Chlordane removal may be accomplished by adsorption onto activated carbon and potentially breakdown with strong oxidants like free chlorine and peroxide.	Chlordane may be detrimental to aquatic life.
Proposed San Lorenzo River 303d Listing for Temperature	Regional Board 2016 response to comments indicated that temperature is a medium priority with a 2023 target TMDL Completion date	Temperatures are already elevated in some locations beyond tolerance for some salmonids, and can contribute to algae blooms	Increased temperature when combined with available nutrients can result in algae blooms with associated increases in TOC and result in DBP formation	Elevated temperatures will be exacerbated as effects of climate change are manifested with longer, hotter, dry seasons.
Proposed Newell Creek (Lower) 303d listing for pH	Regional Board 2016 Fact sheet indicate that a 2027 target TMDL completion date, based on 1971-2006 SC County data	Nominal changes for pH adjustment may be required	Nominal impact	Potential impacts to cold freshwater habitat
Proposed Loch Lomond 303d List for Mercury	Regional Board Decision 51458 indicates that no listing is indicated at this time	Mercury could be associated with sediments that would likely be removed with current treatment	Limited water treatment impact anticipated	Mercury could bioaccumulate in downstream aquatic life

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4.9.3.3 Section 404 Wetland Filling and/or Dredging Permit Program

Section 404 of the CWA regulates the discharge of dredged and fill material into wetlands and water of the United States, and establishes a permit program to ensure that such discharge complies with environmental requirements. The 404 permit process is administered by the U.S. Army Corps of Engineers (ACOE) and the U.S. Environmental Protection Agency (EPA).

The activities regulated by Section 404 include channel construction and maintenance, filling wetlands to create development sites, transportation improvements, and water resource projects. Some activities that may adversely impact wetlands and rivers, such as drainage or ground-water pumping, are often conducted without discharging dredged or fill material and are not regulated under Section 404. The exemptions to Section 404 that are pertinent to the sanitary survey study area include: normal farming, ranching and silvicultural practices; maintenance and emergency repair of levees and bridges; construction or maintenance of farm or stock ponds; construction of temporary sedimentation basins; and construction or maintenance of farm and forest roads, if best management practices are followed.

4.9.3.4 Endangered Species Act Section 7 and Section 10

Compliance with the federal Endangered Species Act is required for all activities that have the potential to impact special status species identified as threatened or endangered. The Act provides for the conservation of species that are threatened or endangered throughout all or a significant portion of their range, and the conservation of the ecosystems on which they depend. Section 7 of the act requires consultation by any federal regulator with the USFWS and NOAA fisheries prior to the approval of an authorization or permit. Section 10 of the act allows for consultation to occur between non-federal entities and the federal regulators USFWS and NOAA fisheries without a nexus to a federal authorization or permit.

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SECTION 5: WATER QUALITY REGULATIONS AND EVALUATION

5.1 Water Quality Regulations

The U.S. Environmental Protection Agency (EPA) and/or state agencies regulate the water quality of drinking water systems. EPA delegates primary enforcement responsibility for drinking water program implementation and enforcement to the State. In California, the State Water Resources Control Board, Division of Drinking Water (DDW) (formerly Department of Public Health) is the primacy agency for drinking water regulations. To maintain primacy, the authority to enforce drinking water regulations, under the Safe Drinking Water Act (SDWA), DDW must adopt drinking water regulations at least as stringent as the Federal regulations and meet other relevant criteria. State drinking water regulations may be more stringent than the federal regulations, but not less stringent.

The City of Santa Cruz 1996 Watershed Sanitary Survey provides a detailed account of the development of water quality regulations in the United States. Subsequent updates to the 1996 sanitary survey in 2001, 2006, 2013 describe a number of regulations that were the most current at the time those documents were written. These regulations still apply. The paragraphs below provide a brief summary of the main surface water quality regulations.

Table 5-1: Regulatory Schedule

	FEDERAL		STATE	
Rules	**Promulgation Date**	**Compliance Date**	**Promulgation Date**	**Compliance Date**
Revised Total Coliform Rule	February 2013	April 2016	February 2017 (CA)	April 1, 2016 (effective date for federal Revised Total Coliform Rule)
Federal Groundwater Rule	August 2009	August 2011		August 2011
Federal Long Term 2 Enhanced Surface Water Treatment Rule[(1)]	January 2006	October 2012 (for < 100,000 population)	February 2013	July 2013
Stage 2 Disinfectants and Disinfection Byproducts Rule[(1)]	December 2005	April 2012	December 2011	June 2012 (effective date)
Drinking Water Arsenic Rule	January 2001	January 2006		November 2008
Radionuclides Rule	December 2008	December 2003		June 2006
Interim Enhanced Surface Water Treatment Rule	December 1998	January 2002	Anticipated in 2007	January 2008
Stage 1 Disinfectants and Disinfection Byproducts Rule	December 1998	January 2004	June 2006	June 2006
Surface Water Treatment Rule	June 1989	December 1990		

[(1)] Each of these two rules include data collection tasks with "early compliance dates" six months after the publication date for sampling plans, and 24 months after rule promulgation for both data collection and report submission.

5.1.1 Surface Water Treatment Rule (SWTR)

The Surface Water Treatment Rule (SWTR) was implemented to provide protection against Giardia cysts and pathogenic enteric viruses. The federal SWTR requires that the water treatment process achieve a minimum of 99.9 percent (3-log) removal and/or inactivation of Giardia cysts and 99.99 percent (4-log) removal and/or inactivation of enteric viruses. This must be accomplished through a combination of physical removal and disinfection. The DDW generally requires that the water treatment process provide the minimum removal and/or inactivation requirements for Giardia and viruses in the federal SWTR (99.9 percent (3-log) for Giardia cysts and 99.99 percent (4-log) for viruses).

The Department of Public Health (DPH), the agency name prior to becoming DDW, published a guidance document, "Surface Water Treatment Staff Guidance Manual" in May 1991 that summarizes the treatment requirements in the SWTR as adopted by the State in the California Code of Regulations (CCR). Appendix B of the DPH guidance manual establishes guidelines for determining when source waters will require more than the minimum levels of 3-log Giardia and 4-log virus removal. The guidance indicates that treatment can be based on total coliform levels and that for water sources with significant sewage, recreation or agricultural hazards where median monthly total coliform concentration exceeds 1,000 MPN/100 ml, treatment must provide 4-log Giardia removal and 5-log virus removal.

Based on sampling performed during August 1996 through March 1998, DDW concluded that SCWD should be required to meet the higher level of treatment of 4-log Giardia removal and 5-log virus removal as described in the July 13, 1998 letter to SCWD. This requirement would be in effect at GHWTP until a watershed sanitary survey or continued monitoring could demonstrate that lesser levels of treatment should be required. A report was completed in 2013 documenting additional analysis conducted for the SCWD found in Appendix A, and DDW has accepted that the 4-log Giardia removal can be reduced to 3.0-log removal since the GHWTP filters were demonstrated to provide 1-log removal for Giardia through a combination of reducing the inactivation requirement and increasing the removal credits. The 5-log virus removal is not proposed to be changed. If necessary, additional chlorine contact time could be implemented at the risk of increased DBP formation with an associated expense on the order of $25 – 40 million to comply with BMP limits. Historic high raw water pathogen levels on Lompico Creek resulted in 4-log Giardia and 5-log virus removal requirements; this water source is not currently in use. In addition to further protect public health, significant effort has been made in identifying and managing pathogen sources.

As indicated in previous sections, a pathogen TMDL was been established for the San Lorenzo River in 2009 and progress has been made in reduced pathogen levels. However, SCWD recognizes that median monthly total coliform levels still exceed 1,000 MPN/100 ml at times as shown in Section 5.4.1. SCWD is in the process of reviewing source water quality data to evaluate how often the median monthly total coliform level is consistently less than 1,000 MPN/100 ml; this information will enhance SCWD's Source Selection Procedure as another level of protection. The goal of the Source Selection Procedure is to guide when each of the source waters would be suitable for treatment to ensure that the total coliform MPN would be less than 1,000 MPN/100 ml (for each of the source waters and hence also for the blend). This should enable the City to reliably select source water that only require 3-log Giardia and 5-log virus reduction as requested in Appendix A.

5.1.2 Interim Enhanced Surface Water Treatment Rule (IESWTR)

The final federal Interim Enhanced Surface Water Treatment Rule (IESWTR) was published in the Federal Register on December 16, 1998 and became effective in January 2002. California adopted the IESWTR in January 2008. The California IESWTR includes several additional monitoring requirements that create a more stringent filtered water performance standard. The IESWTR includes a 2-log *Cryptosporidium* oocyst removal requirement which can be achieved by maintaining filtered water turbidity less than or equal to 0.3 NTU in at least 95 percent of the filtered water samples collected during each month. As discussed in the 2016 filter performance study conducted (found in Appendix A), 95th percentile filter turbidity data are consistently less than 0.3 NTU which meets the IESWTR requirements.

5.1.3 Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR)

The LT2ESWTR was published in the Federal Register on January 5, 2006. The draft State LT2ESWTR was last revised on February 8, 2012. The State adopted the LT2ESWTR on July 1, 2013. Prior to State adoption of the LT2ESWTR, DDW was responsible for monitoring water suppliers for compliance with the rule, and the EPA was responsible for enforcement of the rule.

The LT2ESWTR requires that all water supplies collect source water data on Cryptosporidium, and it sets new treatment requirements that include treatment plant performance standards for each water supply based on the relative risk due to presence of Cryptosporidium in the source water.

5.1.4 Stage 1 and Stage 2 Disinfectants/Disinfection Byproducts Rule

In conjunction with the federal IESWTR, the USEPA promulgated another new drinking water regulation on December 16, 1998: the Stage 1 Disinfectants/Disinfection Byproducts Rule (Stage 1 D/DBPR). The State of California adopted the Stage 1 D/DBPR in June 2006. The Stage 1 D/DBPR focuses on controlling production of DBPs, while also meeting disinfection requirements. It revised the THM MCL, created a new MCL for HAA5, and also included MCLs for bromate and chlorite as part of the new regulations. The Total THM (TTHM) MCL was reduced from 0.1 mg/l (100 µg/l) to 0.080 mg/l (80 µg/l). The HAA5 MCL was set at 0.060 mg/l (60 µg/l). The bromate MCL was set at 0.010 mg/l (10 µg/l) and the chlorite MCL was set at 1.0 mg/l. In addition, the Stage 1 DBPR included maximum residual disinfectant levels (MRDLs) for chlorine at 4.0 mg/L (as Cl_2), chloramine at 4.0 mg/L (as Cl_2), and chlorine dioxide at 0.80 mg/L (as ClO_2). For SCWD, D/DBPR1 requires that the system-wide running annual average (RAA) concentration based on the quarterly samples for TTHM be less than 80 µg/L and for HAA5 be less than 60 µg/L.

The Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 D/DBPR) was published in the Federal Register on January 4, 2006. The THM and HAA5 MCLs remain at 80 µg/l and 60 µg/l, respectively, but the new Stage 2 D/DBP Rule differs from the Stage 1 Rule by requiring that each of the locations monitored meet the TTHM and HAA5 concentration limits based on its individual locational RAA. This approach, referred to as the locational running annual average (LRAA), differs from current requirements, which determine compliance by calculating the

running annual average of samples from all monitoring locations across the system. Given SCWD's more stringent Giardia and virus reduction requirements, which are discussed in Section 5.1.1, it may be difficult to meet the LRAA DBP requirements in the Stage 2 D/DBPR. Moreover, the Stage 2 D/DBPR may be even more difficult to meet in the future if the City has to use a source water that is higher in DBP precursors because the other North Coast water sources are not available for environmental reasons; other regulatory forces that affect treatment are summarized in Table 4-2.

The State of California adopted the D/DBPR1 four and one-half years after the rule's compliance date (January 1, 2002), and 9 years after the rule was published in the Federal Register. During this four and one-half year period, the DDW was responsible for monitoring water suppliers for compliance with this rule, and the EPA was responsible for enforcement of the rule. The D/DBPR2 was adopted to be effective in June 2012.

5.1.5 Revised Total Coliform Rule

The Revised Total Coliform Rule (RTCR) was published by US EPA on 13 February 2013 as a revision to the 1989 Total Coliform Rule (TCR). Minor corrections were published on 26 February 2014. All public water systems must comply with the RTCR starting 1 April 2016. California is embarking on its RTCR process and California water agencies will comply with the original TCR as well as the provisions of the federal RTCR until California can adopt the RTCR.

One of the main provisions of the RTCR is the setting of a treatment technique based on total coliforms and E. coli, and an MCL for E.coli. The RTCR also includes requirements for monitoring total coliforms and E. coli, provisions for allowing transition from the existing TCR to RTCR, requirements for seasonal systems, requirements for assessments and corrective actions, public notification requirements for violations and specific language to be included in Consumer Confidence Reports should a E. coli MCL violation occurs.

5.2 Water Quality Constituents of Concern

EPA, as well as DDW, has developed Maximum Contaminant Limits (MCLs) for over 100 organic and inorganic compounds, some occurring naturally in water supplies but many occurring as a result of contamination. Major sources of contamination include discharges from manufacturing processes, leaks from storage or disposal containers, and runoff from areas treated with pesticides. Treatment techniques are available for removing these contaminants from water supplies. Protecting source waters from contamination, however, is often more effective than treatment at eliminating contaminants. A list of MCLs for compounds regulated by EPA and DDW is included in Appendix B.

MCLs are developed based upon a number of factors including health risk, analytical detection limits, effectiveness of the best available treatment, and economic considerations. Federal maximum contaminant level goals (MCLG) are set at the level in which no adverse health effects are seen; in many cases, this is zero. In addition, California sets public health goals (PHG), which for carcinogens represents a 1 in 1,000,000 lifetime risk. Both MCLG and PHG are found in Appendix B1.

5.2.1 Cryptosporidium and Giardia

There have been no significant regulatory changes associated with Giardia since 2006. However, as discussed in Section 5.1.1. SCWD was able to demonstrate filter performance that provided a 1-log Giardia credit towards the, 4-log Giardia reduction.

Cryptosporidium is specifically addressed in the IESWTR adopted by California in 2008 and in the LT2ESWTR published by EPA in 2006. The IESWTR includes a Maximum Contaminant Level Goal (MCLG) for Cryptosporidium set at zero, and the treatment technique standard will require systems that use conventional filtration treatment to achieve at least a 2.5-log removal of Cryptosporidium oocysts up to a total of 5.5 log depending on the bin classification. Additionally, the LT2 ESWTR required facilities to undergo a two-year Cryptosporidium monitoring plan to determine if source water quality requires additional treatment for removal/inactivation which was completed in March 2009 by SCWD. Recent monitoring is reported in Table 5-19.

5.2.2 Turbidity

The IESWTR strengthened previous turbidity performance regulatory requirements. The following are current regulatory standards for turbidity, which serve to demonstrate compliance with pathogen log removal requirements.

Individual Filter Effluent (IFE): Facilities are required to conduct continuous turbidity monitoring for each individual filter and submit an exceptions report to DDW if:

- IFE has a turbidity level greater than 1.0 NTU based on two consecutive measurements taken 15 minutes apart

- IFE turbidity is greater than 0.5 NTU at the end of the first 4 hours of filter operation, based on two consecutive measurements taken 15 minutes apart.

- Combined Filter Effluent (CFE): The turbidity level of the filtered water is required to be less than or equal to 0.3 NTU in at least 95 percent of the measurements taken each month and not to exceed 1.0 NTU at any time. Compliance is based on measurements taken at four-hour intervals.

5.2.3 Disinfection and Disinfection Byproducts

The current Stage 1 Disinfectants and Disinfection Byproducts Rule (D/DBPR) for total trihalomethanes (TTHMs) and the five haloacetic acids (HAA5) MCLs are 80 μg/L and 60 μg/L, respectively. The Stage 1 D/DBPR compliance is based on a system-wide running annual average (RAA). The Stage 2 D/DBPR includes more stringent regulatory requirements for TTHM and HAA5. The Stage 2 D/DBPR requires that each water purveyor perform an Initial Distribution System Evaluation (IDSE) to identify locations in their distribution system that are most vulnerable to DBP formation. The RAA MCLs will remain in effect and an additional limit of 80 μg/L of TTHMs and 60 μg/L of HAA5, based on a locational running annual average (LRAA) at sites identified in the IDSE, will be instituted. The IDSE plan prepared by SCWD was

submitted by April 1, 2007 and identified monitoring and other actions necessary to comply with the Stage 2 D/DBPR; the monitoring was completed, and the report submitted in July 2009.

The Stage 1 D/DBPR set MCLs for bromate (10 μg/L), and chlorite (1.0 mg/L). The Stage 2 D/DBPR does not change the existing MCLs for these DBPs. Since the water purveyors do not use ozone or chlorine dioxide at their WTPs, these two MCLs should not impact treatment operations. DBPs are of concern primarily in the distribution system but DBP precursors, discussed below, are related to source water quality.

5.2.4 Total Organic Carbon (TOC)

The Stage 1 D/DBPR requires applicable systems that use conventional filtration treatment to remove a certain target level of TOC (DBP precursor) by enhanced coagulation. The required removal level is based on Source Water alkalinity and TOC concentration.

There has been no further significant regulatory change associated with this constituent since 2010. While there have been no water treatment regulatory changes, other surface water quality regulations discussed in Section 4 may have the potential to restrict SCWD to source water with higher concentrations of TOC, which may require changes to SCWD operations.

5.2.5 Perchlorate

Previously regulated through the establishment of a public health goal (PHG) and a notification level of 6 μg/l, perchlorate is now a contaminant of concern with a respective, enforceable, MCL in the state of California. As of October 2007, water systems in the state are required to produce water at or below this concentration.

5.2.6 Arsenic Rule

The final federal Arsenic Rule, published by EPA on January 22, 2001, established the MCL for this constituent at 0.010 mg/L (10 μg/L). The Rule was to become effective on March 23, 2001, 60 days after publication. The rule established that the revised MCL for arsenic is 0.010 mg/l (10 ug/l) and became enforceable on January 23, 2006.

The State of California completed drafting the Revised Drinking Water Standard for Arsenic, which became effective on November 28, 2008 and officially adopted an MCL equivalent to the EPA standard of 0.010 mg/l.

5.3 Groundwater Regulations

Although these regulations do not apply to the surface water sources directly within the City's control, they may be applicable to well sources within the Santa Cruz system (e.g. Beltz wells) and SLVWD's Manana Woods wells and are thus included here for completeness. In addition to those detailed below, recent changes include invalidation of the California hexavalent chromium regulation, effective September 2017 and the addition of a MCL for 1,2,3 - Trichloropropane (1,2,3- TCP) at 5 parts per trillion adopted on July 18, 2017.

5.3.1 Radionuclides Rule

The Federal Radionuclides Rule was promulgated in December 7, 2000 and the MCLs published therein became effective in December 2003. Additionally, by the end of 2007, four quarters of initial monitoring are required for each entry point to the distribution system of agencies treating groundwater. The state Radionuclide Drinking Water Regulations became effective June 11, 2006.

5.3.2 Groundwater Rule

On August 9, 2000 EPA proposed a rule specifying the appropriate use of disinfection in ground water and addresses other components of ground water systems to assure the protection of public health. The Ground Water Rule (GWR) establishes multiple barriers to protect against bacteria and viruses in drinking water obtained groundwater sources and will establish a targeted strategy to identify groundwater systems at high risk for fecal contamination. The GWR provides four elements that target risks to the system. The rule requires regular sanitary surveys, source water monitoring when a positive sample occurs its TCR monitoring, corrective actions upon evidence of fecal contamination, and compliance monitoring.

The California Groundwater Rule became effective on August 18, 2011.

5.3.3 Groundwater Replenishment using Recycled Water

The federal government does not regulate the use of recycled water, and leaves regulation up to the state. The California Groundwater Replenishment using Recycled Water Rule was promulgated and adopted in 2014 and establishes requirements for Groundwater Replenishment Reuse Projects (GRRPs), which are projects that involve the use of recycled water for the replenishment of a groundwater basin for use as a source of water supply. Requirements include sampling of the aquifer prior to operation of the GRRP, retention of recycled water prior to recharge, maps of the GRRP and area of effects, a hydrogeological assessment of the GRRP's setting, and a plan to mitigate the potential effects of contamination on water supply due to the GRRP. Permits to operate a GRRP must be approved by both the DDW and the Regional Board.

5.4 Water Quality Evaluation

The following subsections summarize the key water quality concerns in the San Lorenzo River and North Coast watersheds based on review of data available from SCWD databases. Generally, the discussion focuses on microbiological parameters, turbidity and sediment, and nitrates. Other parameters discussed are odors, organic contamination and general mineral and metals content.

A major reason for emphasizing total coliform, turbidity, and nitrate is because of the findings from previous studies and field surveys and because the River is listed as impaired for each of these parameters, with TMDLs already being implemented (pathogens, sediment, and nitrate). Coliform bacteria are the primary microbial group measured to determine the health of a drinking water supply. Total coliform bacteria are considered a good general indicator of contamination but do not indicate specific contamination sources. The turbidity parameter is

used commonly in drinking water treatment to quantify water quality, primarily because it is easily measured and provides virtually instantaneous results. Also, high turbidity has been correlated with high protozoa (and bacteria) concentrations in some waters. Nitrate has been a targeted parameter in the subject watersheds, mostly because of the predominance of septic tanks as the domestic wastewater treatment technique, especially from systems located on or near highly permeable soils. Elevated nitrate levels promote algal growth which, upon decay, produces taste and odor compounds that increase water treatment costs. Nitrate-rich water also favors growth of cyanobacteria, some of which produce harmful toxins.

5.4.1 Coliform Bacteria

Coliform bacteria data are evaluated in this subsection. SCWD analyzes sources water weekly, with each source sampled 2 to 3 times per month. SLVWD also samples raw water bi-weekly and weekly respectively. Each sample is analyzed for total coliform and *E. coli* data but SCWD does not measure fecal coliform, a subset of total coliform bacteria, also known as thermotolerant coliforms. The County has measured, among other microbiological parameters, total and fecal coliform bacteria, but discontinued fecal coliform in favor of *E. coli*.

Drinking water and sanitary microbiological experience has established the presence or absence of coliform bacteria as an indicator of the sanitary quality of drinking water supplies. The significance of coliform tests and the interpretation of results are well authenticated and have been used as a basis for standards of bacteriological quality of water supplies (Standard Methods for the Examination of Water and Wastewater, 21st Edition).

Most drinking water purveyors determine the most probable number (MPN) of total coliform and *E. coli* bacteria present in the drinking water sources of supply. All purveyors are also required to determine the presence or absence of total coliform and fecal coliform bacteria in the distribution system.

Total coliform bacteria are a relatively broad group, which includes species that can live for extended periods outside a host body. These sometimes-termed “environmental” coliform bacteria are present in waters exposed to urban development and wildlife activities. Drinking water utilities are required to resample the distribution system in areas where detectable total coliforms are found and eliminate any fecal coliform in the distribution system, as described in the water quality regulation portion of this section. The presence of fecal coliform in the distribution systems can indicate contamination or an improper disinfection process at the treatment works.

Thermotolerant (formerly fecal) coliform bacteria can be present in the gut and feces of warm blooded animals, soil, and organically enriched waters and are detected in the laboratory by the characteristic of fermenting lactore to produce gas at 44.5˚C. This differentiation yields valuable information concerning the possible source of pollution in water sources.

The fecal coliform to fecal streptococci (FC:FS) ratio has been used to determine if the contamination source originated from human wastes. A ratio greater than 4 was considered indicative of human contamination. Conversely, a ratio less than 0.7 suggested the contamination was non-human related and most likely livestock, poultry or wildlife. This tool has been questioned of late because of variable survival rates among the fecal streptococcus

species, and some researchers do not recommend the use of the FC:FS ratio to evaluate bacteria origin.

Current efforts to differentiate sources of bacterial contamination focus on use of QCPR (quantitative polymerase chain reaction) analysis. The County of Santa Cruz previously used ribotyping, a method of microbiological source tracking that differentiates human *E. coli* from other types of *E. coli*, to assess the source and causes of elevated bacteria levels at local beaches (Ricker and Peters, 2006). Overall, of 1200 bacterial isolates tested between 2002 and 2004, only 15 percent could not be attributed to a particular source. Study results relevant to this sanitary survey update include findings that: contamination by birds was a dominant source of bacteria in both upstream and urban (lower River) locations; cracks in storm drains and sewer pipes, as observed by videography, could facilitate cross-contamination; storm drains and sumps appear to promote incubation and multiplication of bacteria; bacteria loadings from human, pet and livestock wastes, while significant, are much lower than avian loadings; and human contributions in the River were much higher in wet weather, when runoff scours storm drains and mobilizes waste from developed areas, encampments and the occasional failing septic system as well as exacerbating high groundwater levels that can come into septic leach lines. E.Coli, cryptosporidium and giardia are discussed in Section 5.4.6.14.

5.4.1.1 SCWD Surface Water Sources

As discussed in Section 4 earlier, on May 8, 2009, the San Lorenzo River Watershed Pathogen TMDL was approved by RWQCB Central Coast Region, where fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200 MPN per 100 mL, nor shall more than 10 percent of samples collected during any 30-day period exceed 400 MPN per 100 mL (for the San Lorenzo River and Estuary, Branciforte Creek, Camp Evers Creek, Carbonera Creek and Lompico Creek). The City does not measure fecal coliform.

The results of an analysis of total coliform data for SCWD's San Lorenzo River and North Coast sources are presented on Figures 5-1 and 5-2. Figure 5-1 shows the annual geometric mean of total coliform since water year 2011 for SCWD's San Lorenzo River sources (Loch Lomond, Felton Diversion, and Tait Street).[18] With the exception of 2011 values along the San Lorenzo River are greater than 1,000 MPN/100 ml, and vary slightly over time. Values from Loch Lomond are less than 1,000 MPN/100 ml, but have been increasing since 2013. This suggests that the type of water year can influence total coliform in Loch Lomond, where drier years or years following a dry year; and very wet years, like 2017 have higher values.

Figure 5-2 shows the annual geometric mean of total coliform since water year 2011 for SCWD's North Coast sources (Liddell Spring, Laguna Creek, and Majors Creek). Values for North Coast sources are generally lower than the Felton Diversion or Tait Street sources, with Liddell Spring and Laguna Creek almost one order of magnitude lower. Values for Majors Creek significantly fluctuated during the period of 2011 through 2017, decreasing by about an order of magnitude from 2011 through 2014 and increasing from 2014 to similar levels as the Felton Diversion or Tait Street sources anticipated for 2017. A nearby commercial equestrian facility could be associated with this fluctuation. The City prefers the use of the North Coast sources,

[18] A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which is helpful since levels may vary anywhere from 10 to 10,000 over a given period.

when available, because of the lower coliform levels and therefore higher source water quality. However, as discussed earlier, other environmental surface water regulations related to fisheries recovery may restrict the availability of the North Coast water sources in the future.

5.4.1.2 SLVWD Surface Water Sources

The Annual Geometric Mean of Total Coliform for sources from the SLVWD is graphically represented on Figure 5-3. The data presented is from 2011 to June 2017. In 2013, SLVWD modified their coliform analytical method to be one that reports in Colony Forming Units (CFUs) which reports a definitive number, while MPN reports the probability of occurrence. Results seem to be rather consistent from year to year, however the 2013 water year results are slightly elevated based on the limited data (two results) have been made available thus far. The annual geometric mean was calculated from bi-weekly data collected over the separate water years. Periods where data were unavailable or simply labeled as “Present” or “Absent” were left out of the geometric mean calculations. The following raw water sources were included in the graph: Bennett Springs, Bull Springs-1, Bull Springs-2, Clear Creek, Fall Creek, Foreman Creek, Peavine Creek, and Sweetwater Creek. SLVWD staff has continued to sample Lompico Creek on a limited basis for bacteriological parameters with total coliform values > 2,200 MPN/100 mL and E coli values ranging from 2 up to 579.4 MPN/100 mL in 2014 and 2016.

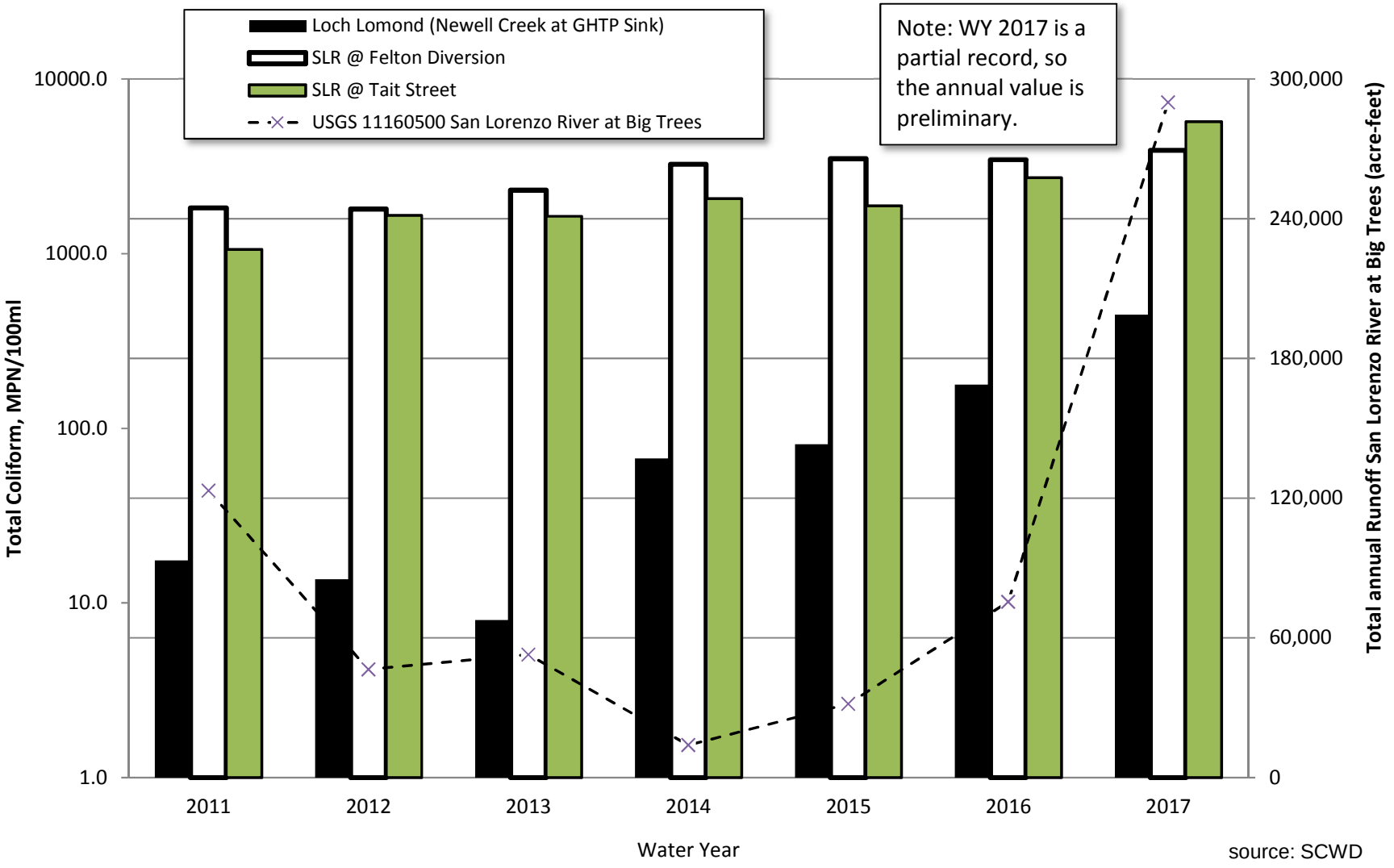


Figure 5-1

Annual geometric mean of total coliform in the SCWD's San Lorenzo River Sources, 2011-2017 (through February 2017)

Common maximum thresholds for data analysis were 23, 230, 2400, and 24000 MPN/100ml. Common minimum thresholds for data analysis were 1, 1.1, and 4.5 MPN/100ml. SCWD uses the San Lorenzo River at Big Trees as an index of water supply conditions. According to its classification system, WYs 2011 & 2016 were normal, 2012-2015 were critically dry and 2017 was wet.

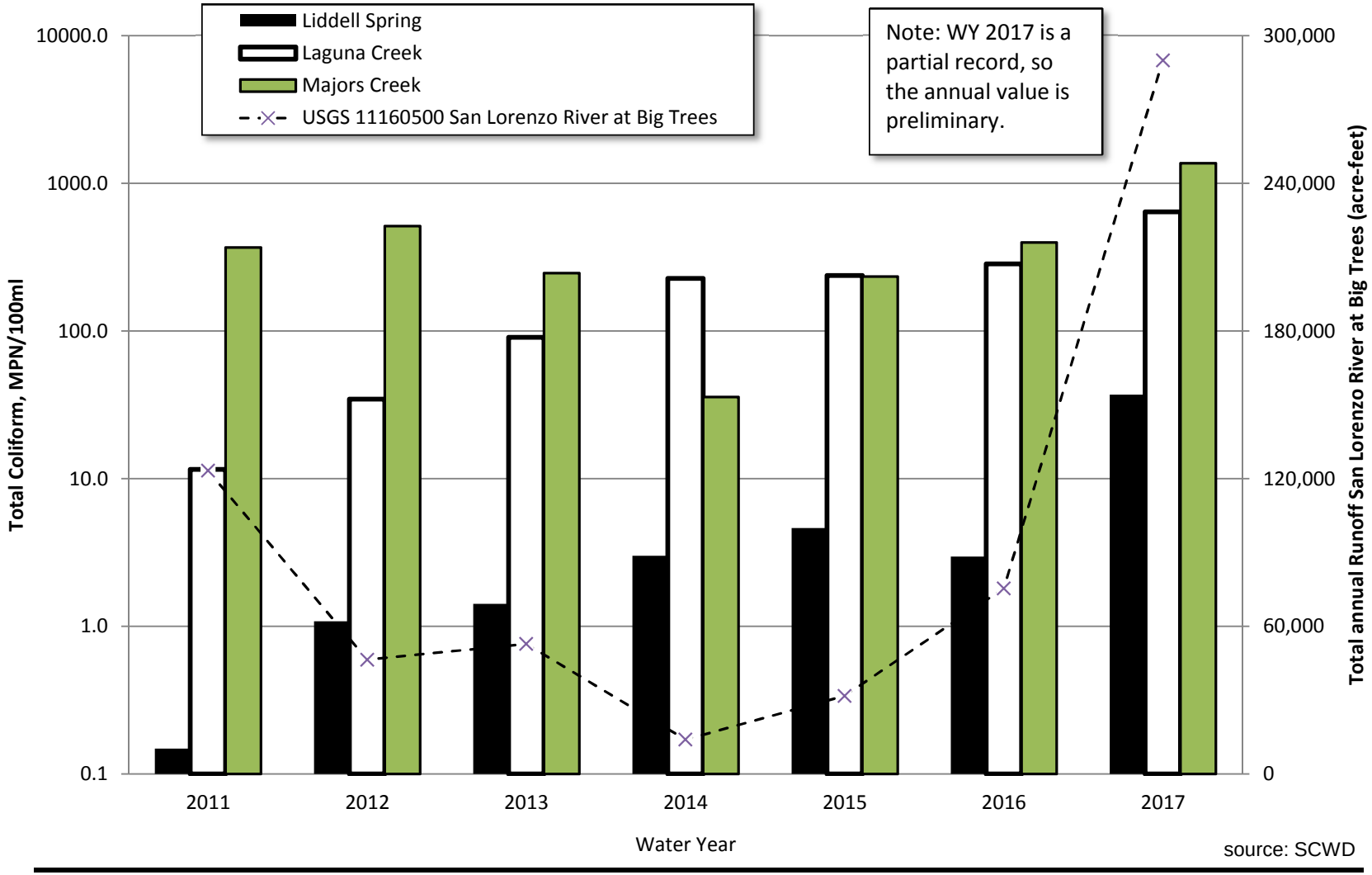
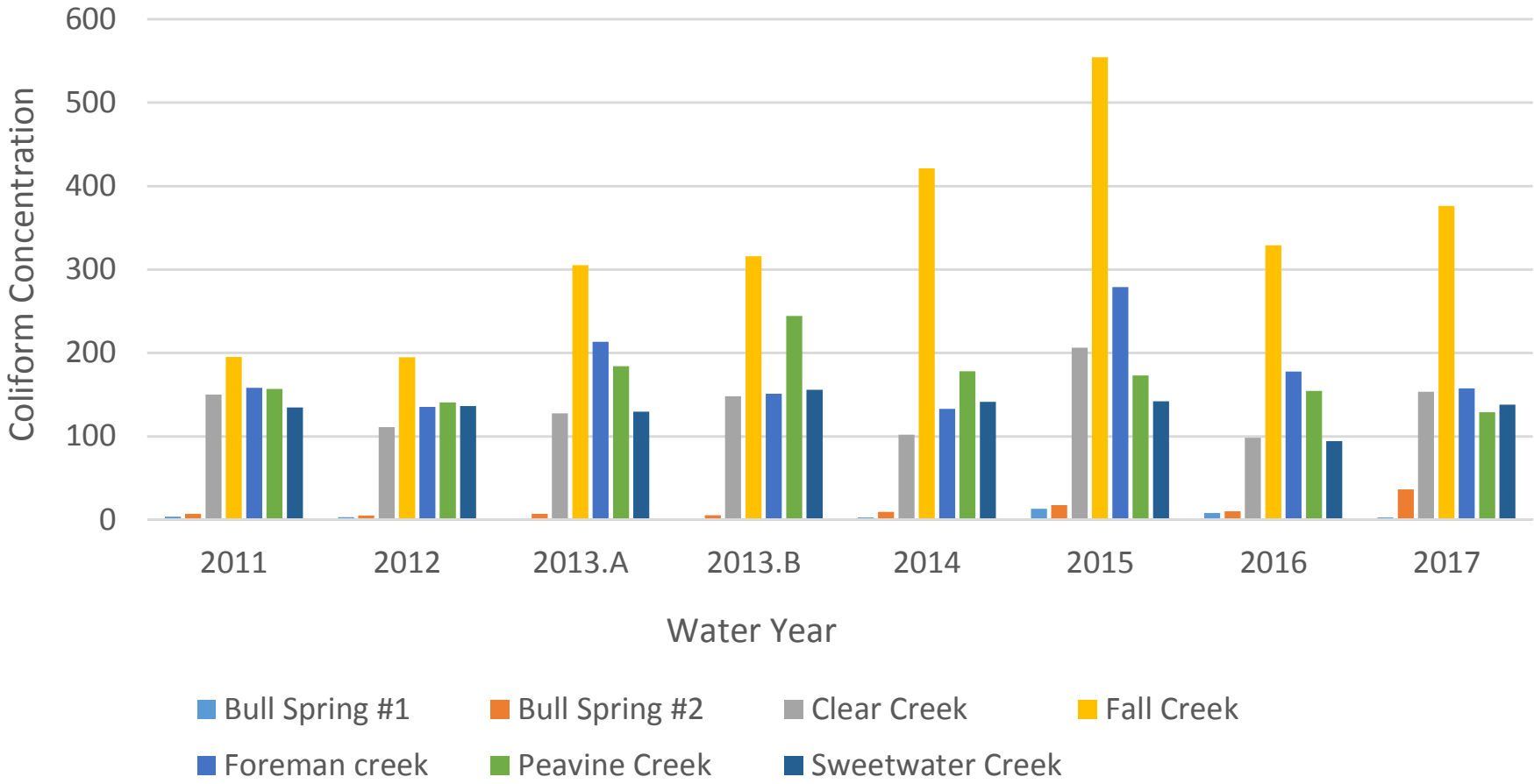


Figure 5-2

Annual geometric mean of total coliform in the SCWD's North Coast Sources 2011-2017 (through February 2017).

Common maximum thresholds for data analysis were 23, 230, 2400, and 24000 MPN/100ml. Common minimum thresholds for data analysis were 1, 1.1, and 4.5 MPN/100ml. SCWD uses the San Lorenzo River at Big Trees as an index of water supply conditions. According to its classification system, WYs 2011 & 2016 were normal, 2012-2015 were critically dry and 2017 was wet.

Figure 5-3: Annual Geometric Mean of Total Coliform from Detectable Results for SLVWD, 2011-2017



2011-2013A, Units: MPN/100mL, 2013B-2017, Units: CFU/100mL

5.4.2 Turbidity

Disruption of the river and creek beds, small to large landslides, and runoff from barren earth areas tend to extend high turbidity events, especially in high rainfall/runoff years. These are common occurrences in California caused by the geology, topography, and climate. Many of the water utilities experience treatment problems during the initial few days of high stormwater runoff periods. It is often useful to distinguish 'persistent turbidity' as a set of issues with different causes and likely responses. The definition of persistent turbidity as accepted by the County for quarry facilities is turbidity which precludes diversions for more than about 3 days for smaller streams, and up to 5 days for the San Lorenzo River after a significant storm. In Liddell Spring, according to the 1964 County-CEMEX contract, persistent turbidity increases in turbidity over the baseline which exceed 2 units for 48 hours following the storm event. Usually, persistent turbidity occurs in streams receiving a continuing supply of fine-grained sediment from banks, tributaries, or cutslopes. The continuing supply often can be traced to a particular disturbance, such as a landslide, poorly-executed timber harvest, road failure, or large wildfire. In addition, review of turbidity data during active quarry operations at Bonny Doon in the Liddell Springs watershed indicated blast-related turbidity spikes which have ceased since closure of the quarry (E. Bean, 2017).

Because high turbidity has correlated with increased protozoa concentrations in some surface waters, it is prudent to have some contingency treatment plan during the initial "flush" of the wet year. Avoiding highly turbid water and relying on alternative sources in the short-term seems to be good, well-practiced policy and is implemented in the City's Source Selection Policy to the greatest extent possible.

Streams which experience extensive disturbances (such as might be caused by a major landslide or fire) are often 10 to 100 times as turbid as baseline, or best-case conditions, at least for the first year or two following the event. The same streams which take longer to clear after a storm are usually also affected by excess turbidity persisting into late spring or early summer. These include creeks downstream from large impoundments which can continue to be turbid for a year or longer.

As summarized earlier in Section 4, on May 16, 2003, the RWQCB Central Coast Region adopted a TMDL for sediment for the San Lorenzo River, Carbonera Creek, Lompico Creek and Shingle Mill Creek and incorporated the TMDL and associated Implementation Plan into the Basin Plan.

The RWCQB documented various actions implemented by the City, County, and RCD to reduce sediment loading over the past five years, namely reducing the risk of culvert failure and road erosion (Rose, 2011):

- The City completed culvert removals/improvements in the Newell Creek watershed, estimated to prevent up to 500 yards of sediment from being discharged to Newell Creek over this time period.
- The County used GIS to prioritize erosion problems based on soils and high erosion hazards and implemented six high-priority sediment reduction projects, including five cross-culvert repairs along Kings Creek and one culvert retrofit along Gold Gulch.

Implementation of these projects will reduce the risk of culvert failure and the deposition of an estimated 2,378 cubic yards of sediment. The County also completed two other sediment reduction projects on Upper East Zayante and Glenwood Drive estimated that they will reduce sediment transported into the San Lorenzo River watershed by 0.54 tons/year and 3.58 tons/year respectively.

- The RCD implements a rural roads erosion control assistance program, which provides technical and cost share assistance to private road associations to facilitate the implementation of erosion control projects using best management practices to reduce sediment delivery associated with roads. This program also provides education and outreach workshops and trainings that promote the stewardship of healthy watersheds. Between December 1, 2006 and November 30, 2009, the RCDSCC rural roads erosion control assistance program implemented 16 erosion control projects on rural non-county roads in the San Lorenzo River watershed. Additionally, four demonstration projects were completed in October 2010. Over the next 10 years, these projects will prevent approximately 5,837 tons of sediment from entering the San Lorenzo River.

Parke and others (2010) monitored streamflow and suspended-sediment in water year 2009 and 2010 and used sequential rating-curve analysis[19] to compare sediment-transport rates over the past three decades for Zayante Creek, the San Lorenzo River, and Soquel Creek. A substantial decrease in transport at a given flow can be seen in each case, although lumping all the 1970s and 1980s data probably disproportionately increases the earlier yields, as this period includes several episodic or disruptive events, most notably the January 1982 storms.[20] With possible load reductions between 464- and 106-percent, it is important to note that these differences are large relative to the 24- to 27-percent reductions sought as part of the San Lorenzo Sediment TMDL staff report. This may be extremely challenging as winters with significant rainfall, such as occurred in 2017, can trigger landslides throughout the County which are associated with large sediment loads.

To demonstrate progress towards achieving load-based allocations and beneficial use protection, RWQCB staff recommended revision of the San Lorenzo Sediment TMDL to replace existing numeric targets with the sediment and biological indicators recommended in Herbst et al. (2011) (Rose, 2011) although no action has been taken as of 2017.

5.4.2.1 SCWD Surface Water Sources

SCWD currently has some capability to use different water sources if turbidity increases for one or more of the sources for reasons other than rainfall (e.g., landslides). This source water flexibility can be offset by requirements to meet fish flows, particularly in the North Coast sources. During heavy rain events, however, all surface sources and Liddell Spring are often not used due to elevated turbidity, leaving Loch Lomond Reservoir as the only source with

[19] An increase in sediment transport at a given flow generally means that more sediment is readily available on the bed for transport, and (generally) that habitat conditions have deteriorated; conversely, less transport at a given flow is usually associated with improvements in bed conditions and in the relative success of erosion-control efforts.

[20] Episodic events do increase sediment yields and do temporarily move sediment-rating curves 'upward', or to the left (Hecht, 2007), sometimes substantially.

which to meet customer demands. During moderate events Liddell and Laguna can be available for use. The evaluation findings are:

Figure 5-4 and Figure 5-5 show the turbidity measurements from July 2011 to March 2017 for the San Lorenzo River and North Coast sources, respectively. There is no apparent overall increasing or decreasing trend over the entire period and variations appear to be storm-related, as expected.

Figures 5-6 and 5-7 show similar data as above, but is a 10-sample running average to clarify the trends over the past 5 years. With the exception of the events in late 2016, early 2017, Loch Lomond shows relatively lower storm-related increases in turbidity than the other sources. All other sources, except Majors Creek, show relatively higher storm-related increases in turbidity in normal and wet years as compared with dry years, e.g., 2016 versus 2013.[21] The North Coast sources experience significantly less turbidity than the San Lorenzo River sources. Overall, these North Coast sources provide consistent low turbidity, treatable water.

5.4.2.2 SLVWD Surface Water Sources

SLVWD provided a single result per year for Turbidity, so no continuous plot of Turbidity has been provided. Table 5-2 below, shows the turbidity results taken from eight raw surface water sources within SLVWD. With the exception of the 2008 results, most of the data between 2009 and 2012 was sampled in the month of April or early May.

Table 5-2: Turbidity Results for SLVWD (Unit: NTU)

Year	Bennett Spring	Bull Spring #1	Bull Spring #2	Clear Creek	Fall Creek	Foreman Creek	Peavine Creek	Sweetwater Creek	Lompico Creek
2011	0.39	0.51	0.48	0.54	1.5	0.72	1.9	1.4	0.98
2012	0.52	0.48	NR	0.72	1.3	0.63	1.1	2.2	1
2013	0.56	0.49	NR	0.53	1	0.61	14	0.8	0.8
2014	0.28	0.37	0.49	0.43	0.72	0.52	1.1	0.8	0.96
2015	0.28	0.42	0.35	0.4	0.56	0.55	0.68	0.42	6.8
2016	0.23	0.42	0.34	NR	0.58	0.28	1.3	1.2	0.45
2017	0.28	0.31	1.1	3.2	4.7	< 0.10	1.1	5	NR

Source[1]: SLVWD
Note: NR = Not Recorded

[21] At Majors Creek, however, continuous turbidity data shows that flows of 2 to 3 cfs can elevate turbidity to 10 NTU (Hastings, unpublished data). Based on field reconnaissance of Upper Majors Creek, there appears to be a chronic supply of sediment, much of which from the East Branch, underlain by weakly cemented Lompico sandstone that weathers by scour and mass wasting. Measurable sources of sediment were found in-channel storage (behind logjams or filling pools) (Hastings and Strudley, 2011).

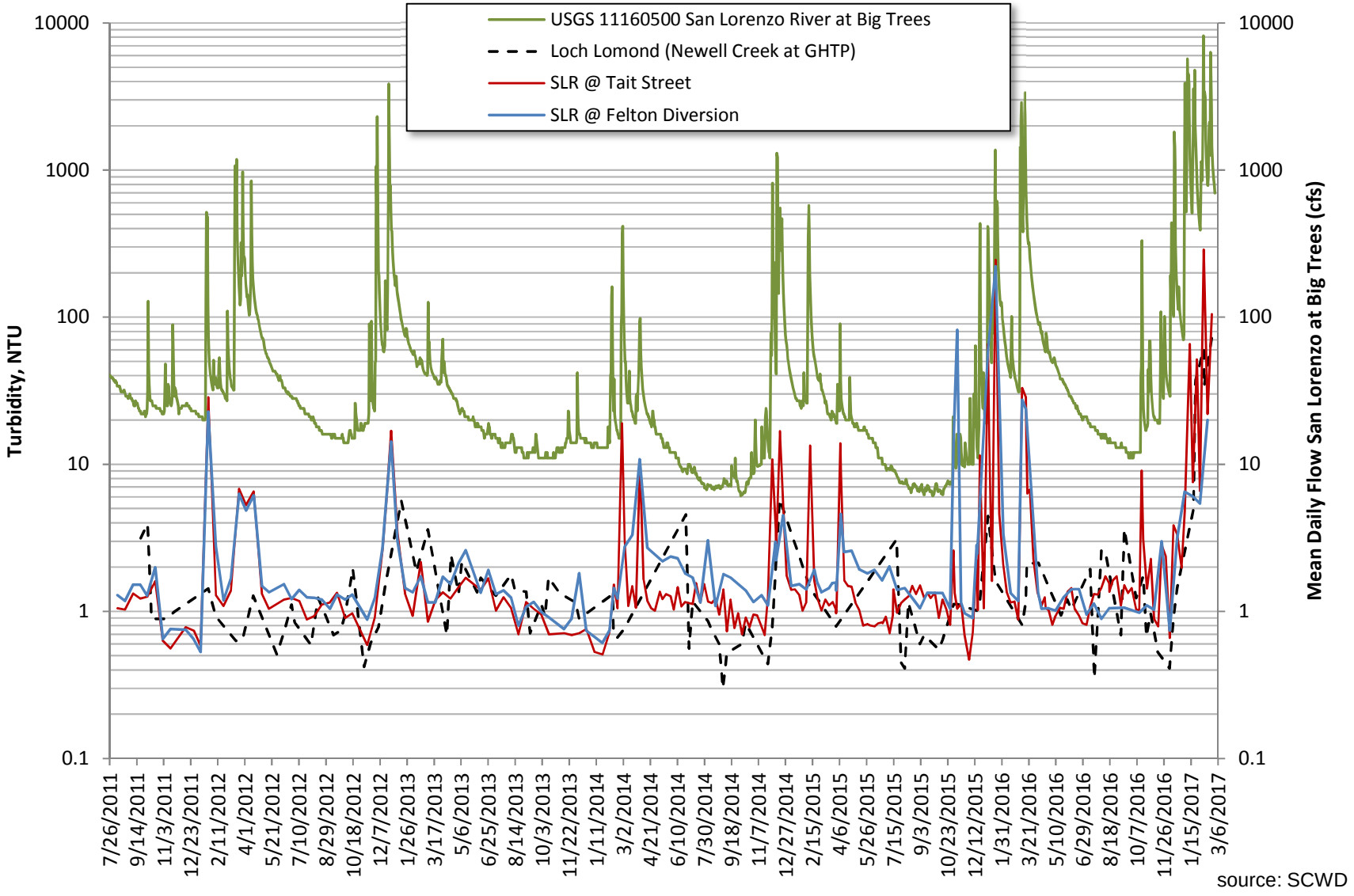


Figure 5-4

Turbidity in SCWD's San Lorenzo River Sources, 2011-2017 (through February 2017)
Turbidity data is collected once or twice a month. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to sediment transport conditions.

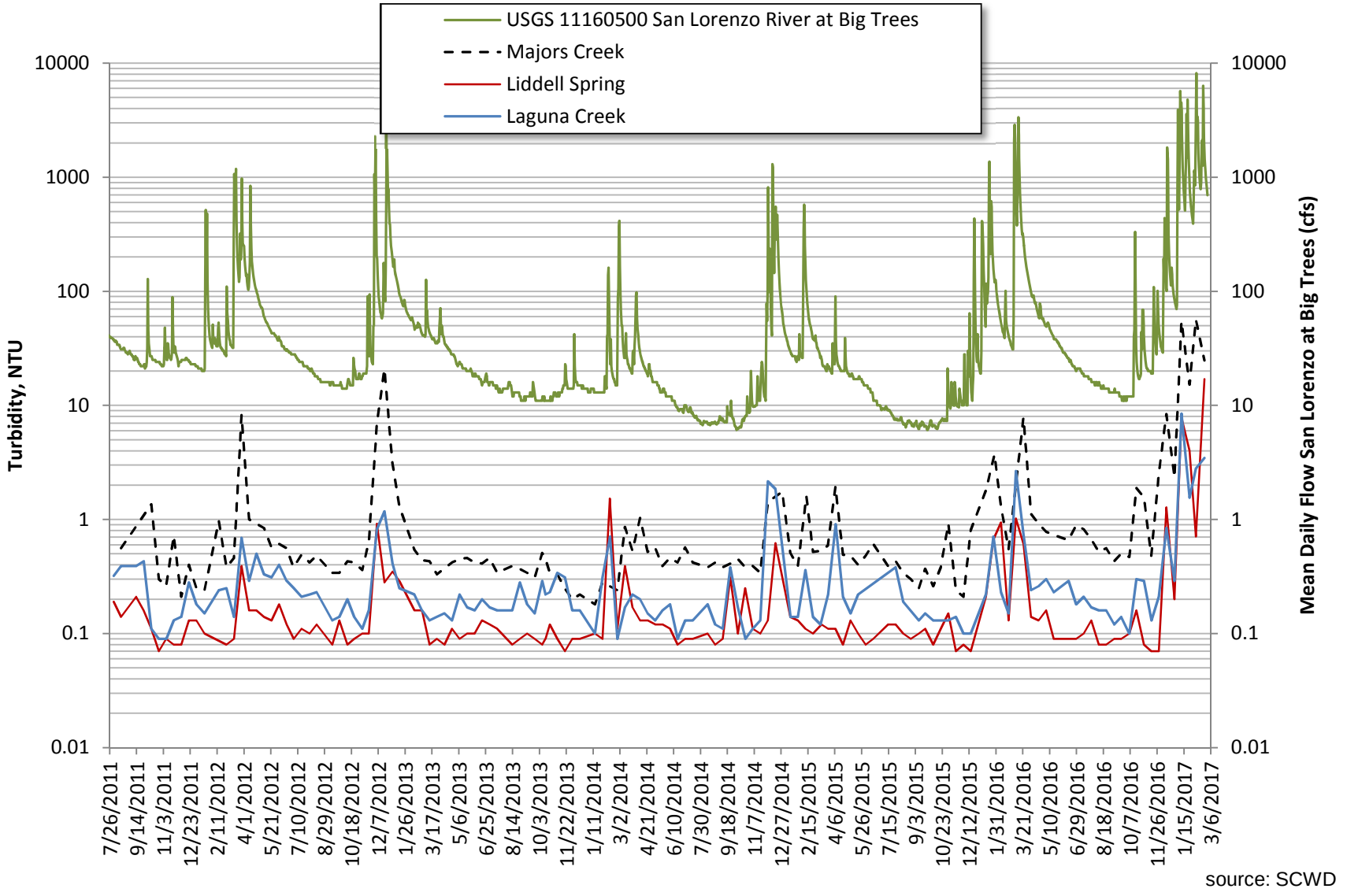


Figure 5-5

Turbidity in SCWD's North Coast Sources, 2011-2017 (through February 2017)

Turbidity data is collected once or twice a month. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to sediment transport conditions.

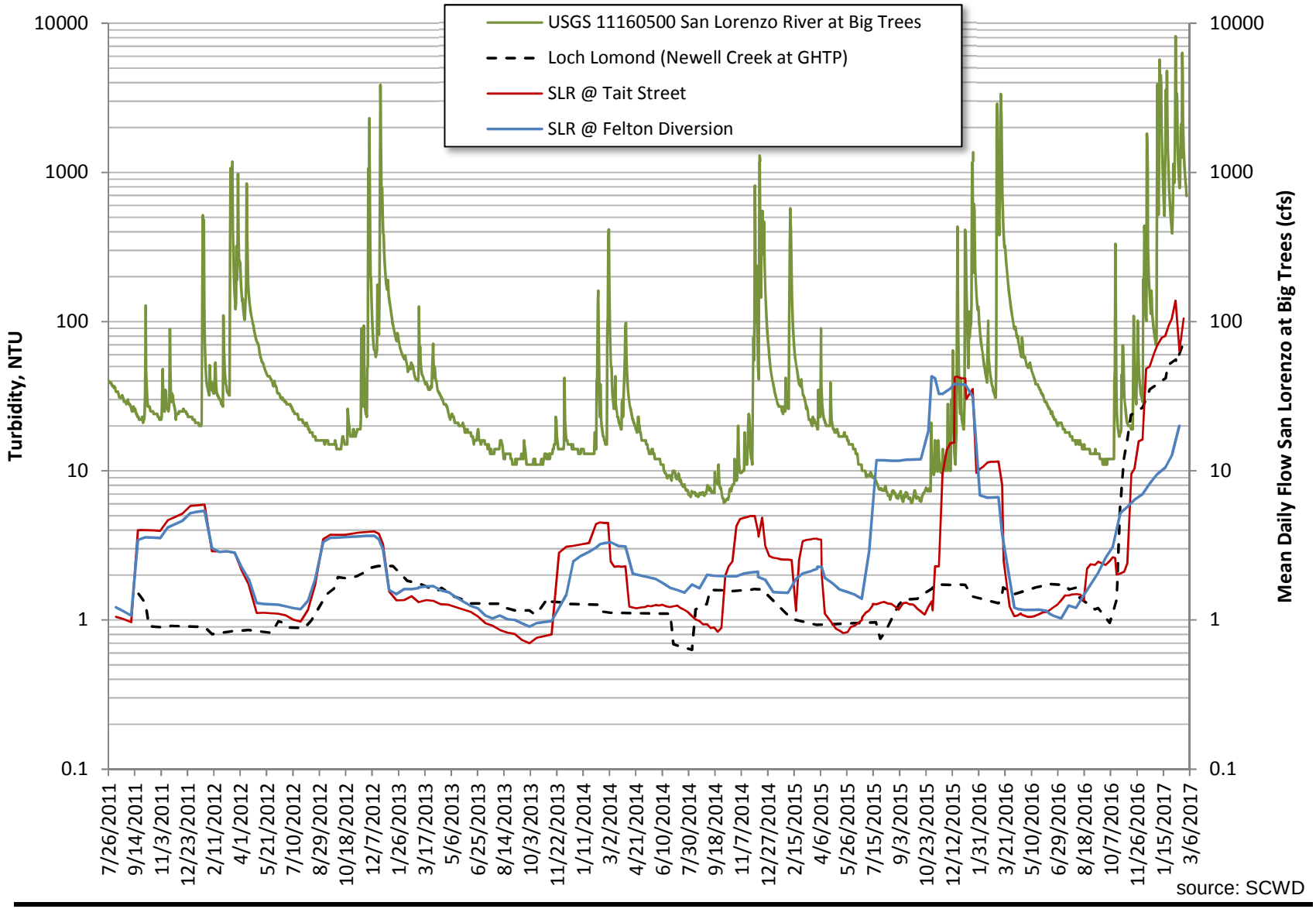


Figure 5-6 **Turbidity in SCWD's San Lorenzo River Sources, 2011-2017 (through February 2017).**
Ten point running average shown for clarity; data taken at varying intervals. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to sediment transport conditions.

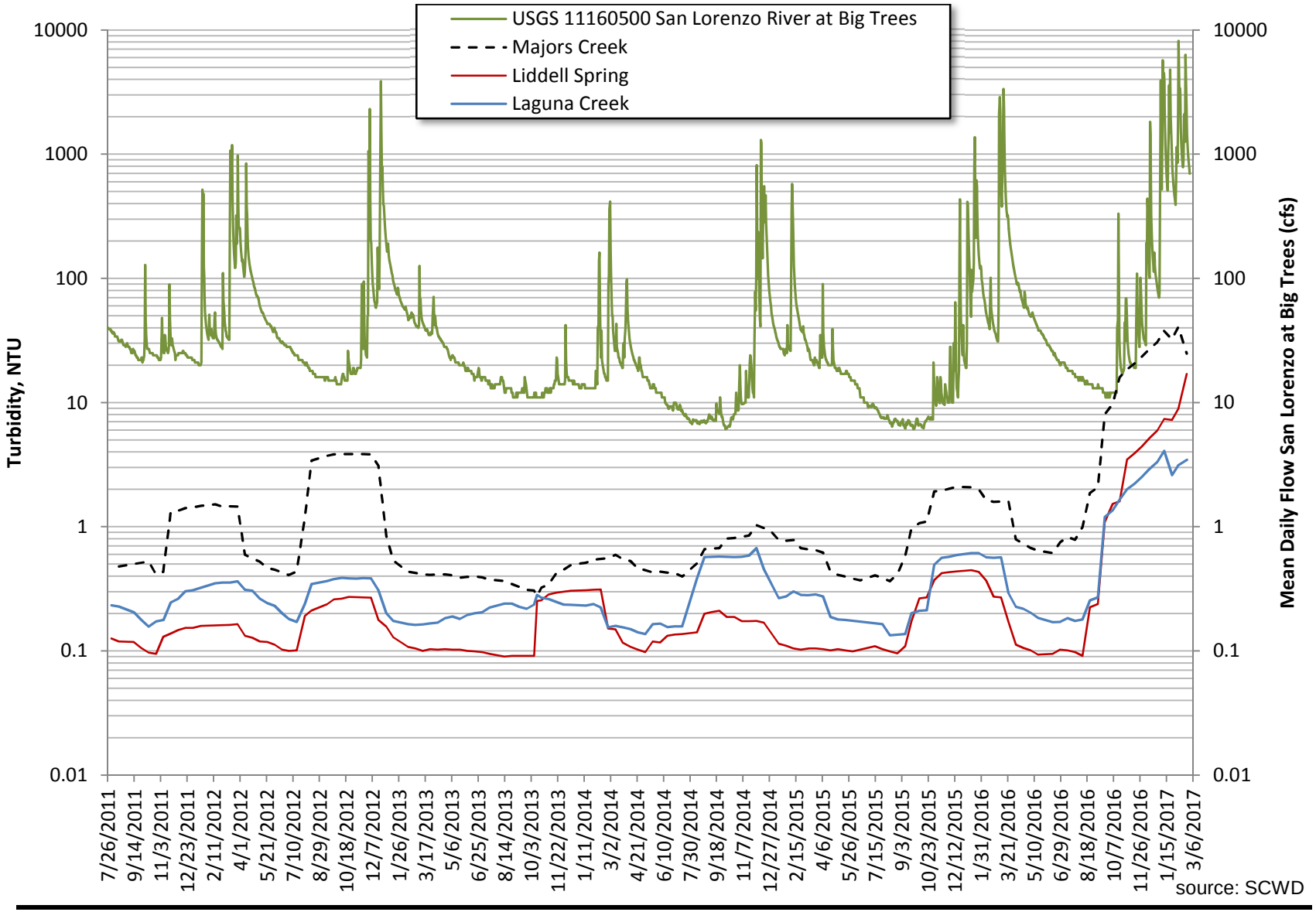


Figure 5-7 **Turbidity in SCWD's North Coast Sources, 2011-2017 (through February 2017)**

Ten point running average shown for clarity; data taken at varying intervals. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to sediment transport conditions.

5.4.3 Nitrate

The MCL for nitrate in drinking water is 10 mg/L as nitrogen, or 45 mg/L as nitrate. The nitrate concentrations in the surface water systems located within the watersheds do not approach this limit. However, in response to the 303(d) listing for nutrient impairment and implementation of the resulting nitrate TMDL, the County and the Regional Board have implemented numerous management and regulatory actions to reduce nitrate loadings to the river and tributary creeks. The primary source of nitrate is from septic leach fields located in sandy soil areas (Santa Margarita sandstone), mostly located east of the San Lorenzo River. Other key sources are septic systems near waterways, a community leach field at the Boulder Creek Country Club, and the Scotts Valley nitrate plume. Table 5-3 provides a summary of the nitrate data provided. Additional graphs and narrative for each water purveyor follows.

Table 5-3: Summary of Nitrate Data Evaluated

Utility/Location	Nitrate (mg/L as N)				No. of Samples	Water Year	
	Average	Median	Low	High		From	To
Santa Cruz Water Department[1]							
Liddell Spring	1.32	1.30	1.05	1.94	42	2011	2017
Laguna Creek	0.37	0.38	0.00	0.78	47	2011	2017
Majors Creek	1.26	1.35	0.00	2.00	41	2011	2017
Loch Lomond	1.09	1.08	0.00	1.84	48	2011	2017
SLR @ Tait Street	1.39	1.51	0.00	2.28	78	2011	2017
SLR @ Felton	2.16	2.17	0.92	3.17	52	2011	2017
San Lorenzo Valley Water District[2]	YEAR						
	2011	2012	2013	2014	2015	2016	2017
Bennett Spring	< 0.1	< 0.1	< 0.1	NR	< 0.10	0.13	< 0.10
Bull Springs-1	< 0.1	< 0.1	< 0.1	< 0.10	0.11	< 0.10	< 0.10
Bull Springs-2	<0.1	NR	NR	NR	NR	NR	NR
Clear Creek	NR	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10
Fall Creek	NR	<0.1	NR	< 0.10	< 0.10	< 0.10	< 0.10
Foreman Creek	NR	<0.1	NR	< 0.10	< 0.10	< 0.10	< 0.10
Peavine Creek	NR	< 0.1	< 0.1	< 0.10	< 0.10	< 0.10	< 0.10
Sweetwater Creek	NR	< 0.1	NR	< 0.10	< 0.10	< 0.10	0.15
Lompico Creek	ND	ND	ND	ND	ND	ND	NR

[1]Source: SCWD
[2]Source: SLVWD, 2017 data is 6 months Note: NR = Not Recorded; ND = Non-detectable
SLR = San Lorenzo River

5.4.3.1 SCWD Surface Water Sources

SCWD has monitored the nitrate levels in its water sources since the late 1960's. The following paragraphs describe the key findings of the nitrate evaluation.

Figure 5-8 shows the nitrate data over the past 6 years for the SCWD's San Lorenzo River sources. While values are higher for the two river sources compared to Loch Lomond, values for Loch Lomond reached nearly the same levels as the other two sources in 2015, which was a very dry year with relatively high contributions of groundwater (versus direct runoff) to streams.[22] In early 2017, which saw record-level rain events, values for all three sources were significantly reduced compared to previous years. Overall, sample concentrations are less than 1.0 mg/L as N and have remained relatively unchanged since 2017.

Figure 5-9 shows the nitrate trend over the past 6 years for the SCWD's North Coast sources. While Laguna Creek has the lowest concentrations, values for Laguna Creek spike in early 2017 during the record rain events, while values for Majors Creek are significantly reduced. Liddell Springs does not have any nitrate spikes since CEMEX ceased operation of the quarry in 2010. Values are similar for the San Lorenzo River and North Coast sources.

Figure 5-10 provides an additional historic perspective on nitrate concentrations. Three time-based lines of best fit have been provided for the data with the first-time period from 1967 to 1990 that indicates potential increasing trend in nitrate, a second-time period from 1991 to 2010 that shows levelling of nitrate, while a third from 2011-2017 that indicates a potential decreasing trend after a jump from 2010 to 2011. Long-term evaluation of nitrate data should be continued in the future to assess the continued focus on water quality, and particularly on-site wastewater management, that has occurred since about 1995.

5.4.3.2 SLVWD Surface Water Sources

The summary of nitrate data for the SLVWD surface water sources is included in Table 5-3. The nitrate results were often found to be below reporting limits, and for this reason no graph illustrating these results was provided.

[22] Groundwater typically has a higher dissolved ion concentration than direct runoff, which presumably enters the channel shortly after precipitation with little residence time in the groundwater reservoir and limited contact with soil or vegetation.

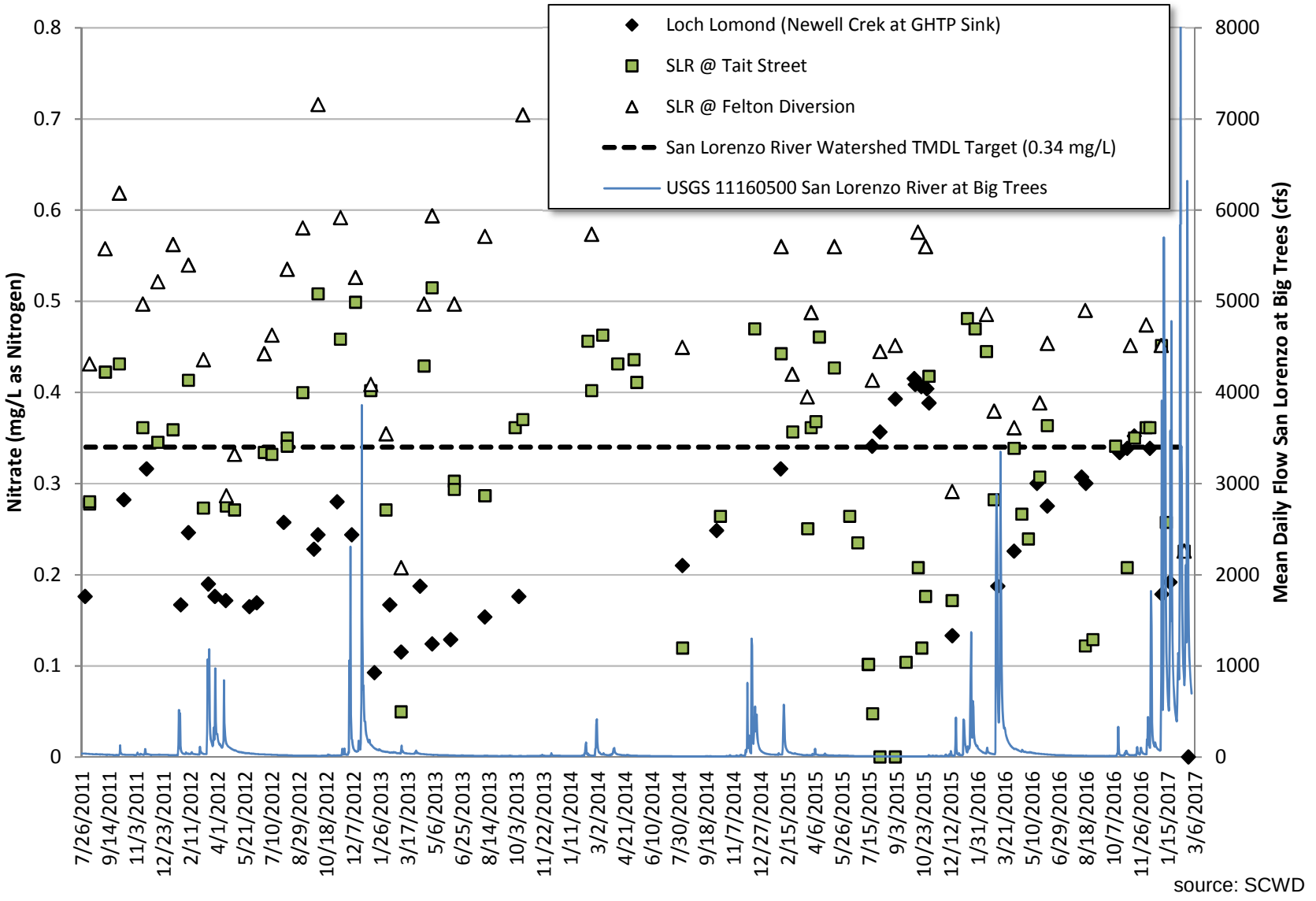


Figure 5-8

Nitrate Concentrations in the SCWD San Lorenzo River Sources, 2011-2017 (through February 2017)

Mean daily flows from San Lorenzo River at Big Trees are shown for reference to runoff conditions

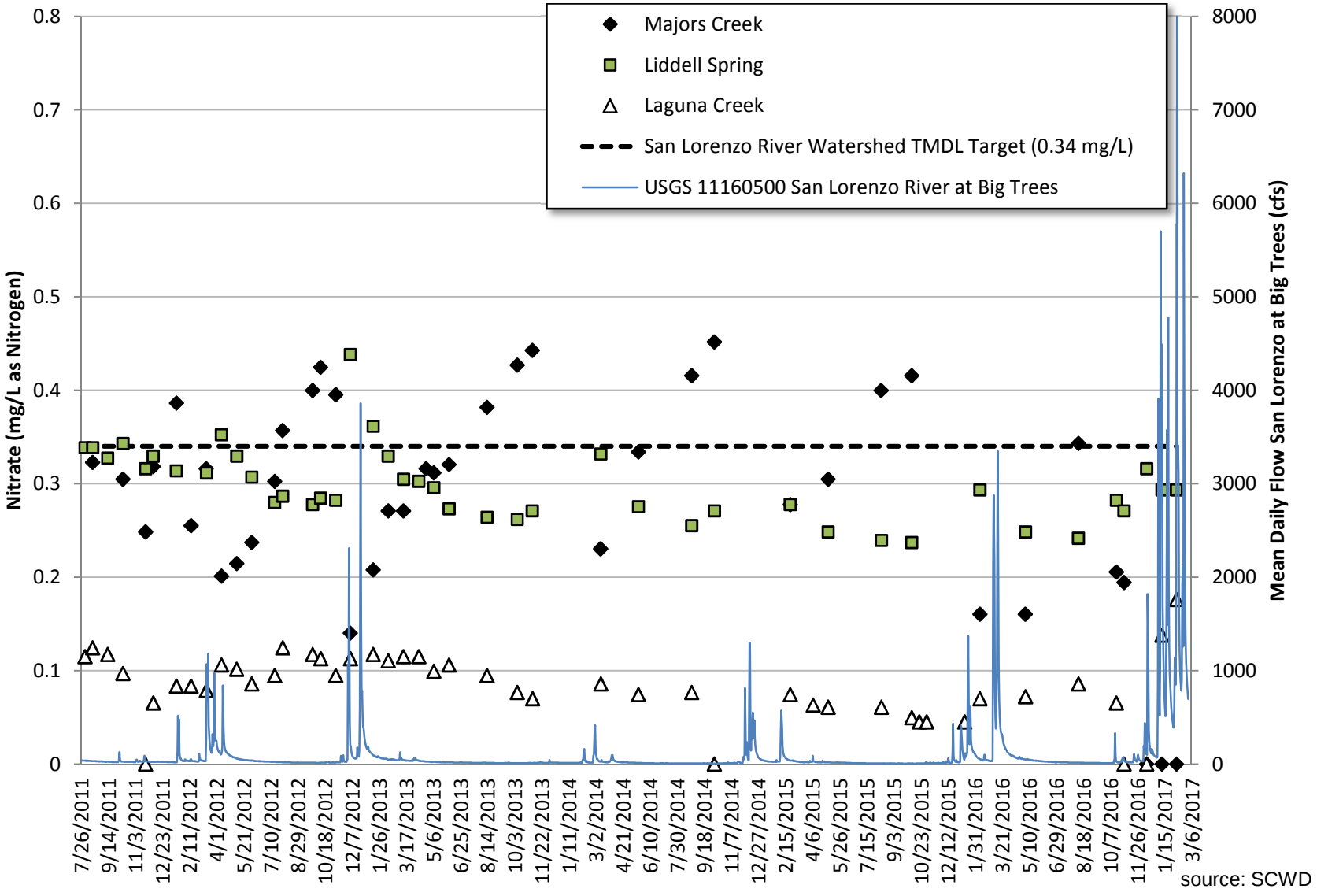


Figure 5-9

Nitrate Concentrations in the SCWD North Coast Sources, 2011-2017 (through February 2017)

Mean daily flows from San Lorenzo River at Big Trees are shown for reference to runoff conditions

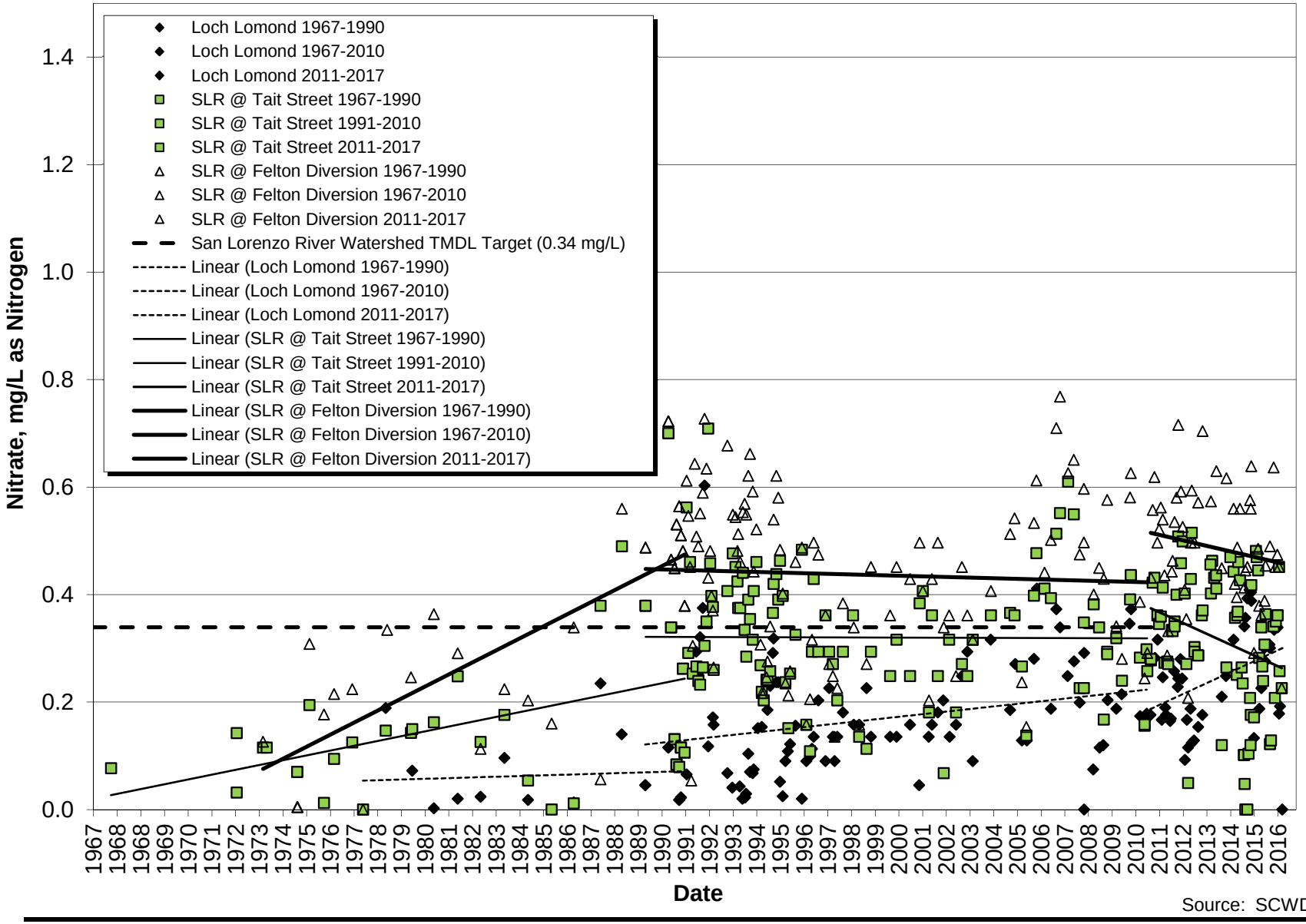


Figure 5-10. **Nitrate Concentrations in the SCWD San Lorenzo River Sampling Sites, 1967-2017**

Numbers in parenthesis are median values.

Trend lines drawn for each site based on a linear best fit.

5.4.4 Odors

Odors of raw water typically relate to natural organic matter and algae degradation products. The SCWD has extensive data on the Threshold Odor Numbers (TON) parameter. Raw and treated TONs were monitored more aggressively starting in the mid-1980s, primarily because of customer complaints.

Figure 5-11 shows TON values for the SCWD's San Lorenzo River sources over the last 6 years. TON at Loch Lomond, Tait Street, and the Felton Diversion appear relatively constant, which may align with both a focus on odor control [?] and a stabilizing in the nitrate concentrations and therefore a relatively lower algae production rate. A significant spike in early 2016 for Tait Street and Felton Diversion may be attributed to the first significant rain event after the historic three-year drought prior. Values following that event for all sources dropped to lower values immediately after.

Figure 5-12 shows TON values for SCWD's North Coast sources over the same 6-year period. TON at Liddell Spring is much lower than at Laguna and Majors Creeks. Values are higher for the San Lorenzo River than the North Coast sources.

5.4.5 Organic Contaminants

Generally, state-mandated Title 22 sampling reports indicate very little presence of contamination of surface water sources with man-made organic constituents. The four contamination sources described in previous sections, the dry-cleaner, two service stations, and manufacturing facility have historically discharged PCE, TCE, TPH, benzene or toluene to surface or groundwater of the San Lorenzo River Watershed. Trace amounts of tetrachloroethylene (PCE) have been detected at the San Lorenzo River Henry Cowell Park Bridge in 2012 and 2013 with values ranging from 0.51-0.67 ug/L, which is much less than the 5 ug/L MCL. No other detections of organic compounds have been documented; as discussed in Section 3.7.2, a USDA study discontinued sampling for herbicides and pesticides when little evidence of these chemicals was found. As previously mentioned in Section 3, corrective and/or modified action is currently under review or in development for the active sites by the RWQCB.

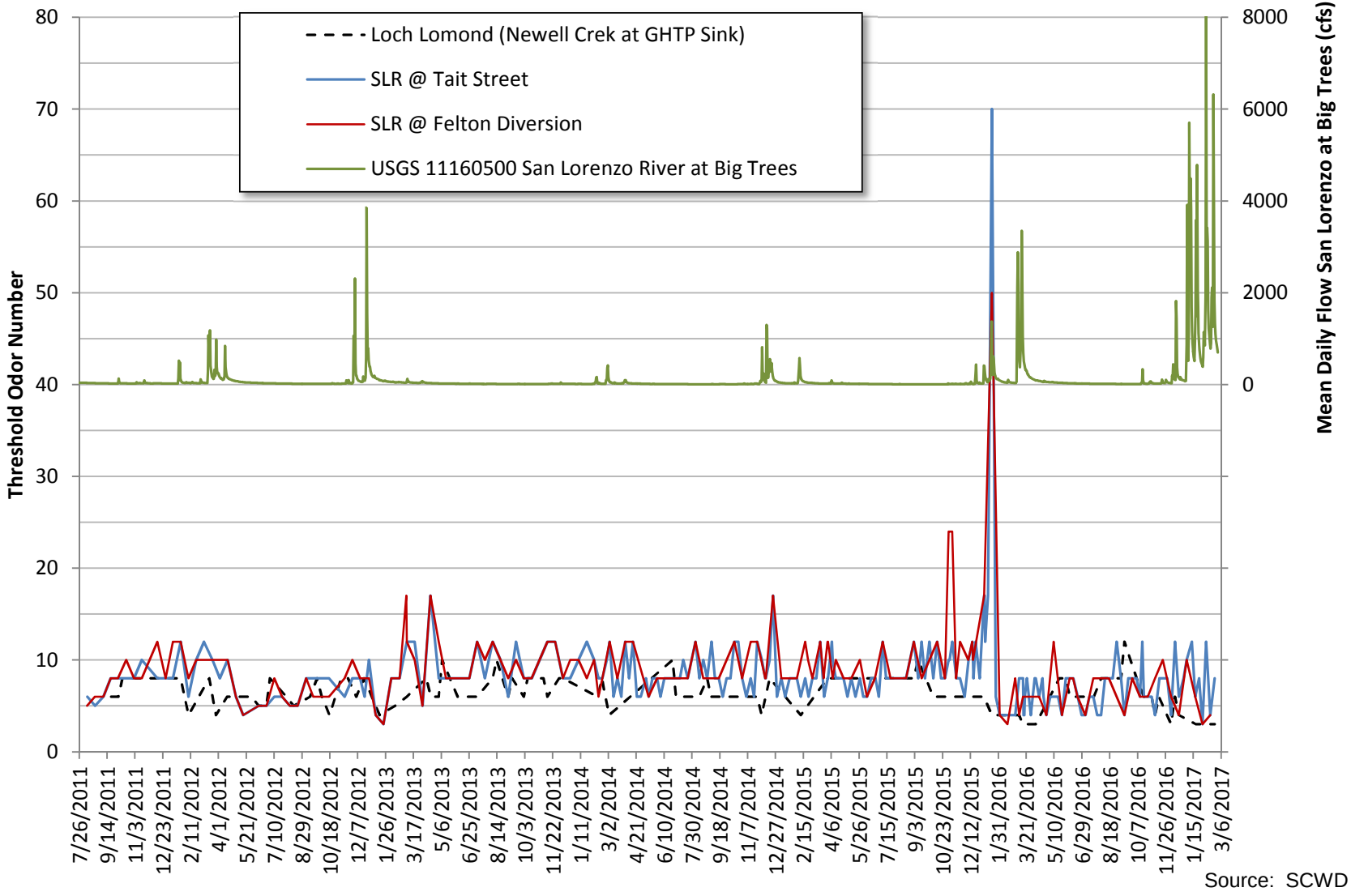


Figure 5-11 **TON measured in SCWD's San Lorenzo River Sources, 2011-2017 (through February 2017)**
Odor data is collected twice a month. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to runoff conditions. Values greate than or equal to 20 correspond with significant rainfall, with the highest numbers during severe storm events.

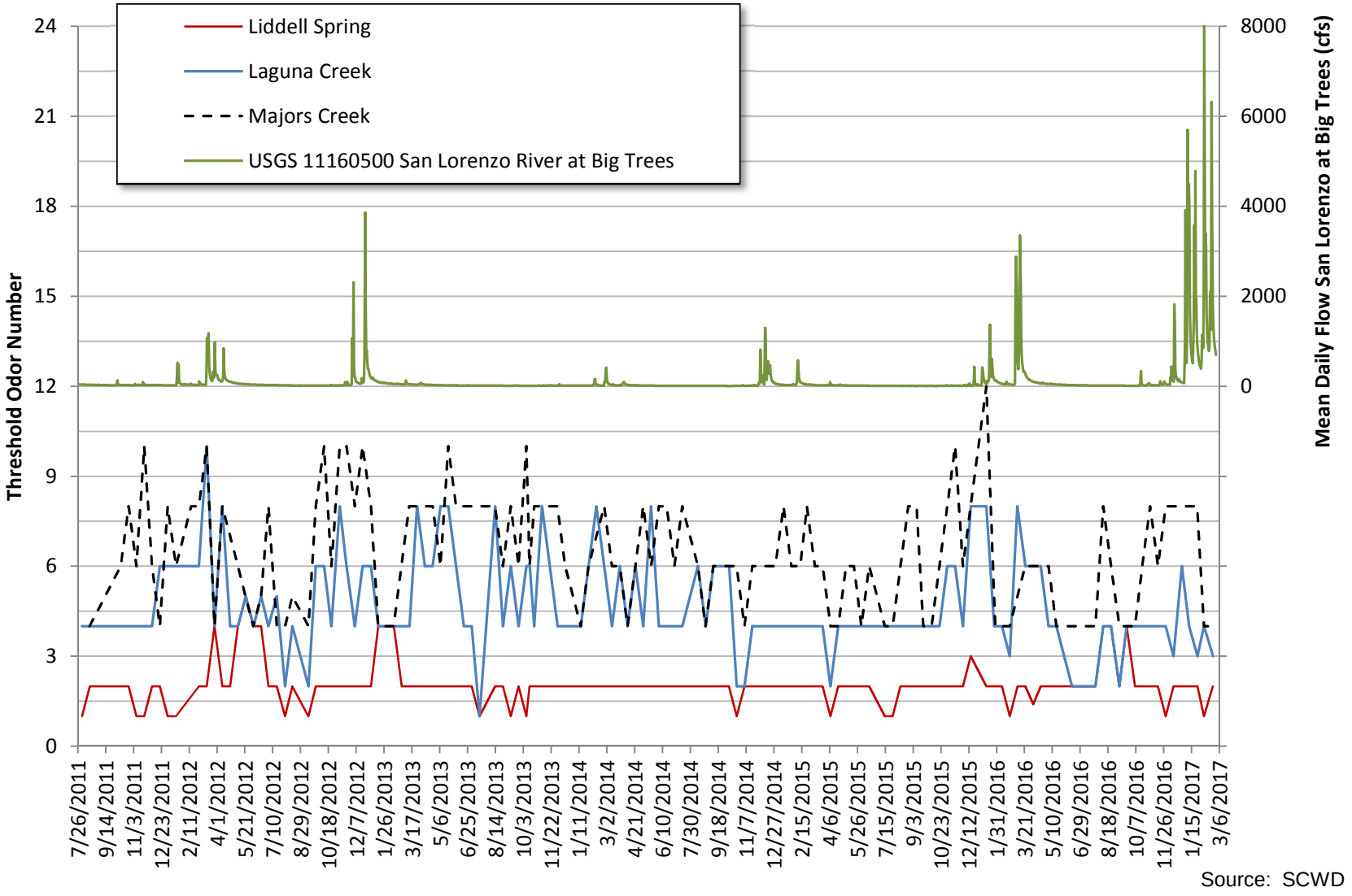


Figure 5-12 **TON measured in SCWD's North Coast Sources, 2011-2017 (through February 2017)**
Odor data is collected twice a month. Mean daily flows from San Lorenzo River at Big Trees are shown for reference to runoff conditions. Values greate than or equal to 20 correspond with significant rainfall, with the highest numbers during severe storm events.

5.4.6 Other Water Quality Parameters

Tables 5-4 through 5-17 summarize the recent historical data for other water quality parameters in the general mineral category. The data includes summary tables for Total Hardness, calcium, magnesium, sodium, potassium, alkalinity, sulfate, chloride, fluoride, pH, Total Dissolved Solids (TDS), conductivity, color, and Methylene Blue Active Substances (MBAS), which are indicative of soaps/detergents:

5.4.6.1 Total Hardness

Table 5-4: Total Hardness — Most data indicate that most area surface waters are moderately hard, with values around 140 to 270 mg/l as CaCO3. One SCWD source, Liddell Spring, has average and median hardness values of above 250 mg/l as CaCO3. This is most likely caused by the extensive limestone (karst) geology in the spring vicinity. SLVWD samples were generally one time per year. Most SLVWD creek waters have significantly lower hardness than SCWD waters, while spring waters are similar to Liddell Spring.

Table 5-4: Total Hardness Summary of Available Data (mg/L as CaCO3)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	269.3	258.0	223.0	400.0	135	2011	2017
Laguna Creek	137.3	142.0	56.0	174.0	132	2011	2017
Majors Creek	134.4	141.0	44.0	178.0	129	2011	2017
Loch Lomond	159.8	162.5	110.0	186.0	106	2011	2017
SLR @ Tait Street	148.0	152.0	60.0	188.0	237	2011	2017
SLR @ Felton Diversion	150.1	152.0	64.0	188.0	150	2011	2017
San Lorenzo Valley Water District[2]	Year						
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Bennett Spring	220	230	220	NR	220	NR	NR
Bull Springs-1	290	290	270	290	280	300	260
Bull Springs-2	210	220	230	240	260	220	210
Clear Creek	46	50	58	60	68	44	38
Fall Creek	97	98	110	110	110	92	91
Foreman Creek	49	52	61	65	71	46	42
Peavine Creek	58	66	79	80	85	68	50
Sweetwater Creek	68	73	86	80	94	63	68
Lompico Creek	98	110	140	190	200	180	NR

[1]Source: SCWD
[2]Source: SLVWD, NR = Not Recorded

5.4.6.2 Calcium

Table 5-5: Calcium — This table lists similar results as for hardness; moderate values for most sources (e.g., about 45 mg/l) except for Liddell Springs (e.g., above 90 mg/l). SLVWD samples were generally one time per year. Several of SLVWD's calcium values that were analyzed are lower than those of SCWD

Table 5-5: Calcium Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	97.1	93.0	78.0	130.0	10	2011	2017
Laguna Creek	41.9	45.0	15.0	57.0	10	2011	2017
Majors Creek	41.2	43.5	12.0	60.0	10	2011	2017
Loch Lomond	46.2	45.0	30.0	57.0	11	2011	2017
SLR @ Tait Street	41.8	43.0	29.0	48.0	12	2011	2017
SLR @ Felton Diversion	42.5	45.0	30.0	47.0	11	2011	2017
San Lorenzo Valley Water District[2]	Year						
	2011	2012	2013	2014	2015	2016	2017
Bennett Spring	77	80	77	NR	77	NR	NR
Bull Springs-1	82	82	79	85	80	86	73
Bull Springs-2	< 1.0	NR	NR	NR	NR	NR	NR
Clear Creek	ND	NR	NR	NR	NR	NR	NR
Fall Creek	30	30	33	35	34	31.5[3]	28
Foreman Creek	ND	NR	NR	NR	NR	NR	NR
Peavine Creek	ND	NR	NR	NR	NR	NR	NR
Sweetwater Creek	ND	NR	NR	NR	NR	NR	NR
Lompico Creek	24	28	33	45	50	43	NR

Source[1]: SLVWD
Source[1]: SCWD, * Median based on 2011-2017 values
Source[2]: SLVWD,: NR = Not Recorded; ND= Non-Detectable
[3] Average of March and April 2016 values

5.4.6.3 Magnesium

Table 5-6: Magnesium — Magnesium concentrations are low compared to calcium. This indicates most of the total hardness is from calcium, as expected considering the geologic formations throughout the watershed area. SLVWD's Bull Springs source was slightly higher in magnesium than those of SCWD.

Table 5-6: Magnesium Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	11.2	11.0	8.5	16.0	10	2011	2017
Laguna Creek	5.1	5.2	2.8	6.6	10	2011	2017
Majors Creek	3.7	3.8	2.8	4.7	10	2011	2017
Loch Lomond	10.6	11.0	7.4	14.0	11	2011	2017
SLR @ Tait Street	8.9	8.7	7.0	11.0	12	2011	2017
SLR @ Felton Diversion	8.7	8.6	7.2	10.0	11	2011	2017
San Lorenzo Valley Water District[2]	Year						
	2011	2012	2013	2014	2015	2016	2017
Bennett Spring	7.3	7.9	7.4	NR	7.4	NR	NR
Bull Springs-1	20	20	18	20	19	21	18
Bull Springs-2	13	15	15	16	18	15	13
Clear Creek	4.1	4.6	5.4**	5.5	6.1	4	3.2
Fall Creek	5.1	5.7	6.1	6.3	6.6	5	5.1
Foreman Creek	5.3	5.8	6.8	7.2	6.9	5	4.4
Peavine Creek	5.8	6.8	8.0**	8	8.6	6.85	5
Sweetwater Creek	6.2	6.4	7.4	6.7	7.6	5.5	6.2
Lompico Creek	9	10	13	18	17	17	NR

Source[1]: SCWD, * Median based on 2011-2017 values
Source[2]: SLVWD, Note: NR = Not Recorded, ** indicates Intraday Average

5.4.6.4 Sodium

Table 5-7: Sodium — The average sodium content in SCWD waters ranges from about 10 to 25 mg/l. Lompico Creek had sodium analyses in the range of 18 to 28 mg/L which are higher than the other SLVWD's sources and more similar to most of SCWD's sources.

Table 5-7: Sodium Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	11.9	12.0	10.0	14.0	10	2011	2017
Laguna Creek	10.3	10.5	7.0	13.0	10	2011	2017
Majors Creek	15.1	16.5	8.6	20.0	10	2011	2017
Loch Lomond	22.9	24.0	13.0	31.0	11	2011	2017
SLR @ Tait Street	24.8	25.5	13.0	33.0	12	2011	2017
SLR @ Felton Diversion	25.0	27.0	13.0	30.0	11	2011	2017
San Lorenzo Valley Water District[2]	Year						
	2011	2012	2013	2014	2015	2016	2017
Bennett Spring	6.7	7.1	7	NR	6.7	NR	NR
Bull Springs-1	8	9	9.2	9.4	9	8.9	7.7
Bull Springs-2	8.8	10	10	9.9	11	9.4	8.7
Clear Creek	7.6	8.3	9.5**	9.5	10	6.9	6.9
Fall Creek	8.2	9.5	10	9.6	10	9.25[3]	8.4
Foreman Creek	7.5	8.3	9.5	9.4	9.8	6.7	7.4
Peavine Creek	8	9.4	10**	10	11	8.7[3]	7.6
Sweetwater Creek	9.2	10	11	10	11	8.6	9.2
Lompico Creek	20	18	22	24	28	24	NR

Source[1]: SCWD* Median based on 2011-2017 values
Source[2]: SLVWD, Note: NR = Not Recorded, ** indicates Intraday Average [3] Average of March and April data

5.4.6.5 Potassium

Table 5-8: Potassium — The typical potassium content in SCWD waters is about 2 mg/l. Lompico Creek had potassium in a range from 1.1 to 1.4 mg/L which is slightly lower than SLVWD and SCWD values.

Table 5-8: Potassium Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	2.1	2.0	1.7	2.5	10	2011	2017
Laguna Creek	2.1	2.1	1.8	2.5	10	2011	2017
Majors Creek	2.0	2.0	1.6	2.7	10	2011	2017
Loch Lomond	2.3	2.3	1.9	2.8	11	2011	2017
SLR @ Tait Street	2.4	2.3	2.0	3.0	12	2011	2017
SLR @ Felton Diversion	2.1	2.1	1.9	2.6	11	2011	2017
San Lorenzo Valley Water District[2]	Year						
	2011	2012	2013	2014	2015	2016	2017
Bennett Spring	2.1**	2.2	2.2	NR	2	NR	NR
Bull Springs-1	1.8**	1.8**	2.0**	2.0**	1.8**	1.7**	1.6**
Bull Springs-2	1.5**	1.6**	1.7**	1.7**	1.6**	1.5**	1.5**
Clear Creek	1.6**	1.6**	2.0**	2.0**	2.0**	1.6**	1.5**
Fall Creek	1.9**	1.8**	2.1**	2.0**	1.9**	1.9**	2.0**
Foreman Creek	1.8**	1.8**	2.2**	2.1**	2.2**	1.6**	1.8**
Peavine Creek	2.2**	2.5**	2.8**	2.6**	2.7**	2.45**	2.2**
Sweetwater Creek	2.0**	2.0**	2.2**	2.1**	2.2**	1.7**	2.1**
Lompico Creek	1.4	1.1	1.2	1.3	2	1.3	NR

Source[1]: SCWD * Median based on 2011-2017 values
Source[2]: SLVWD, Note: NR = Not Recorded, ** indicates Intraday Average

5.4.6.6 Alkalinity

Table 5-9: Alkalinity — Alkalinity varies widely in SCWD, presumably because of high runoff periods. The average values for Liddell Springs is 207 mg/l as CaCO3, due to karst bedrock geology, and about 105 to 130 mg/l as CaCO3 for the other sources. Lompico Creek had an alkalinity range from 100 to 190 mg/L which is in the mid-range of SLVWD's other water sources; again highlighting that the spring sources with their contact to karst (limestone) have higher alkalinity compared to the creeks.

Table 5-9: Alkalinity Summary of Available Data (mg/L as CaCO3)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	207.1	208.0	102.0	234.0	135	2011	2017
Laguna Creek	131.2	136.0	44.0	164.0	132	2011	2017
Majors Creek	106.2	112.0	32.0	134.0	129	2011	2017
Loch Lomond	115.2	117.0	70.0	154.0	106	2011	2017
SLR @ Tait Street	114.1	122.0	40.0	146.0	237	2011	2017
SLR @ Felton Diversion	116.8	124.0	42.0	134.0	150	2011	2017
San Lorenzo Valley Water District[2]	Year						
	2011	2012	2013	2014	2015	2016	2017
Bennett Spring	220	210	210	NR	220	NR	NR
Bull Springs-1	270	260	260	200	280	280	250
Bull Springs-2	210	200	220	220	260	210	210
Clear Creek	53	56	66	69	78	47	43
Fall Creek	100	95	110	110	120	90	89
Foreman Creek	56	57	67	64	82	51	48
Peavine Creek	69	72	86	86	100	71	58
Sweetwater Creek	76	79	95	93	110	72	70
Lompico Creek	100	120	140	170	190	180	NR

Source[1]: SCWD
Source[2]: SLVWD, Note: NR = Not Recorded

5.4.6.7 Sulfate

Table 5-10: Sulfate — The secondary MCL for sulfate is 250 mg/l. The maximum value measured in annual samples of SCWD water was 210 mg/l in Liddell Spring. Averages range from 14 to 72 mg/l. Lompico Creek had sulfate in the range from 17 to 29 mg/L while the other SLVWD sources had sulfate values are lower than both SCWD and Lompico Creek.

Table 5-10: Sulfate Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	72.4	57.4	43.1	210.0	28	2011	2017
Laguna Creek	14.3	14.9	5.7	17.6	35	2011	2017
Majors Creek	36.8	36.9	10.0	54.0	28	2011	2017
Loch Lomond	72.2	73.9	52.0	83.0	36	2011	2017
SLR @ Tait Street	52.1	48.8	32.7	81.0	59	2011	2017
SLR @ Felton Diversion	52.6	48.0	32.8	84.6	36	2011	2017
San Lorenzo Valley Water District[2]	Year						
	2011	2012	2013	2014	2015	2016	2017
Bennett Spring	9.3	11	9.6	NR	12	16	NR
Bull Springs-1	8	8.6	9.1	9.4	10	9.6	7.4
Bull Springs-2	6.9	8	9.1	9.7	11	8.6	6
Clear Creek	2.4	3	3	3.6	4.1	2.8	2.2
Fall Creek	7.3	8.2	9.2	10	11	9.1	5.9
Foreman Creek	3.6	4.3	5.2	8	4.7	3.7	2.7
Peavine Creek	2.2	2.7	3.2	3.4	3.8	2.75	2
Sweetwater Creek	3.1	3.7	3.8	4.3	4.4	4.2	2.8
Lompico Creek	17	21	24	34	29	25	NR

Source[1]: SCWD
Source[2]: SLVWD, Note: NR = Not Recorded

5.4.6.8 Chloride

Table 5-11: Chloride — The secondary MCL for chloride is 250 mg/l. The maximum value measured in SCWD water was 34 mg/l (at Tait Street). Averages range from 10 to 27 mg/l. Lompico Creek had chloride in the range of 16 to 25 mg/L, which is lower than the other SLVWD sources but similar to Majors Creek and Loch Lomond.

Table 5-11: Chloride Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	10.8	11.0	8.5	11.9	30	2011	2017
Laguna Creek	10.5	10.6	7.1	12.2	35	2011	2017
Majors Creek	16.2	16.7	9.2	17.8	28	2011	2017
Loch Lomond	16.1	16.9	7.3	19.0	36	2011	2017
SLR @ Tait Street	26.7	26.5	9.1	37.2	59	2011	2017
SLR @ Felton Diversion	27.2	26.8	9.9	36.2	36	2011	2017
San Lorenzo Valley Water District[2]	Year						
	2011	2012	2013	2014	2015	2016	2017
Bennett Spring	6.9	7.5	7.5	NR	7.1	6.8	NR
Bull Springs-1	8.7	9	9.9	9.9	9.5	9	8.7
Bull Springs-2	9.3	10	10	10	10	8.8	9.6
Clear Creek	5.6	5.8	6.3	8.1	6.6	5.1	5.5
Fall Creek	7.1	7.4	8	8.3	7.9	6.8	7.5
Foreman Creek	5.4	5.2	6.2	7	6.2	4.5	5.7
Peavine Creek	5.6	5.4	6	6.6	5.7	5.15	6.1
Sweetwater Creek	5.9	6.3	6.6	7.4	6.6	5.6	6.3
Lompico Creek	16	17	19	19	25	16	NR

Source[1]: SCWD
Source[2]: SLVWD, Note: NR = Not Recorded

5.4.6.9 Fluoride

Table 5-12: Fluoride — The primary MCL for fluoride is 2.0 mg/l (see Appendix B). The maximum value measured in annual samples of SCWD water is 0.30 mg/l in Loch Lomond. Averages range from 0.07 to 0.27 mg/l, with the North Coast sources having lower levels than the San Lorenzo River. Lompico Creek had fluoride in the range from 0.15 to 0.29 mg/L which is higher than most of the SLVWD and SCWD sources but similar to Loch Lomond.

Table 5-12: Fluoride Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	0.08	0.09	0.00	0.14	30	2011	2017
Laguna Creek	0.07	0.08	0.00	0.11	35	2011	2017
Majors Creek	0.07	0.08	0.00	0.13	28	2011	2017
Loch Lomond	0.27	0.27	0.21	0.31	35	2011	2017
SLR @ Tait Street	0.17	0.18	0.12	0.20	58	2011	2017
SLR @ Felton Diversion	0.18	0.18	0.14	0.20	36	2011	2017
San Lorenzo Valley Water District[2]	Year						
	2011	2012	2013	2014	2015	2016	2017
Bennett Spring	0.087	0.1	0.095	NR	0.1	NR	NR
Bull Springs-1	0.11	0.12	0.11	0.11	0.12	0.11	0.15
Bull Springs-2	0.11	0.12	0.12	0.11	0.12	0.11	0.14
Clear Creek	0.057	0.061	0.075	0.071	0.077	0.061	0.066
Fall Creek	0.058	0.06	0.07	0.067	0.081	0.064	0.081
Foreman Creek	0.077	0.085	0.092	0.091	0.08	0.086	0.084
Peavine Creek	0.071	0.08	0.083	0.081	0.086	0.084	0.074
Sweetwater Creek	0.053	0.059	0.079	0.084	0.091	0.064	0.064
Lompico Creek	0.15	0.2	0.19	0.25	0.24	0.29	NR

Source[1]: SWD
Source[2]: SLVWD, Note: NR = Not Recorded

5.4.6.10 pH

Table 5-13: pH — The pH values for SCWD waters have ranged from 6.8 to 8.4 units, with median values between 7.3 and 8.1. Lompico Creek had pH levels in the range of 7.6 to 8.2 which is similar to the other SLVWD sources waters but at the upper end of pH for the SCWD source waters.

Table 5-13: Summary of Available pH Data (units)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water[1] Department							
Liddell Spring	7.3	7.4	6.8	7.8	135	2011	2017
Laguna Creek	8.1	8.1	7.5	8.3	132	2011	2017
Majors Creek	7.9	7.9	7.2	8.2	129	2011	2017
Loch Lomond	7.4	7.3	7.0	8.4	106	2011	2017
SLR @ Tait Street	7.9	7.9	7.4	8.2	238	2011	2017
SLR @ Felton Diversion	7.8	7.8	7.5	8.1	150	2011	2017
San Lorenzo Valley Water District[2]	Year						
	2011	2012	2013	2014	2015	2016	2017
Bennett Spring	7.45	7.6	7.55	7.3	7.55	7.4	7.4
Bull Springs-1	7.6	7.4	7.35	7.45	7.35	7.25	7.45
Bull Springs-2	7.7	7.8	7.7	7.65	7.5	7.5	7.65
Clear Creek	7.75	8	7.85	7.85	7.65	7.8	7.7**
Fall Creek	7.85	8.2	8.15	8.25	8.1	8.1	8.1
Foreman Creek	7.8	8.0	7.8	7.85	7.9	7.95	7.7**
Peavine Creek	7.9	8.05	8.1	8.1	8.0	8.08**	7.85**
Sweetwater Creek	7.85	7.95	7.95	7.9	7.8	7.95	7.9**
Lompico Creek	8.0	8.2	8.2	8.0	7.6	8.0	NR

Source[1]: SCWD
Source[2]: SLVWD, Note: NR = Not Recorded, ** indicates Intraday Average

5.4.6.11 TDS and Conductivity

Tables 5-14 and 5-15: TDS and Conductivity — The secondary MCL for TDS is 500 mg/l. The maximum value measured in annual samples of SCWD water is 540 mg/l at Liddell Spring, with averages ranging from 177 to 368 mg/l. Lompico Creek had TDS values in the range from 190 to 280 mg/L which is in the middle of the TDS range of the other SLVWD sources and lower than many values in the SCWD watersheds. Conductivity (or specific conductance) can be used as a surrogate parameter for TDS. The secondary MCL for specific conductance is 900 umhos/cm, while the maximum value observed was 540 umhos/cm at Liddell Spring. Median values from all SCWD sources have ranged from 210 to 329 umhos/cm.

Table 5-14: Total Dissolved Solids Summary of Available Data (mg/L)

Utility/Location	***Average***	***Median***	***Low***	***High***	***No. Samples***	***Sample Dates (WY)***	
Santa Cruz Water Department[1]							
Liddell Spring	367.5	329.0	293.0	540.0	11	2011	2017
Laguna Creek	177.1	189.0	80.0	250.0	11	2011	2017
Majors Creek	201.8	210.0	90.0	276.0	11	2011	2017
Loch Lomond	260.5	270.0	180.0	310.0	14	2011	2017
SLR @ Tait Street	259.9	260.0	200.0	320.0	17	2011	2017
SLR @ Felton Diversion	261.1	261.0	200.0	310.0	16	2011	2017
San Lorenzo Valley Water District[2]	Year						
	2011	2012	2013	2014	2015	2016	2017
Bennett Spring	270	250	250	NR	280	NR	NR
Bull Springs-1	310	300	310	320	350	350	280
Bull Springs-2	260	240	280	280	320	280	250
Clear Creek	84	80	78	100	120	90	88
Fall Creek	140	140	150	180	180	140	140
Foreman Creek	92	82	88	110	130	98	94
Peavine Creek	90	96	110	140	140	115	110
Sweetwater Creek	100	110	100	130	150	110	110
Lompico Creek	190	210	220	270	280	280	NR

Source[1]: SCWD
Source[2]: SLVWD

Table 5-15: Conductivity Summary of Available Data (µmhos/cm)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	484.5	450.0	390.0	785.0	135	2011	2017
Laguna Creek	267.0	265.0	130.0	365.0	132	2011	2017
Majors Creek	291.6	290.0	120.0	405.0	129	2011	2017
Loch Lomond	377.0	355.0	290.0	480.0	106	2011	2017
SLR @ Tait Street	370.7	370.0	160.0	490.0	238	2011	2017
SLR @ Felton Diversion	362.6	360.0	170.0	500.0	150	2011	2017
San Lorenzo Valley Water District[2]	Year						
	2011	2012	2013	2014	2015	2016	2017
Bennett Spring	450	440	450	NR	460	NR	NR
Bull Springs-1	530	520	530	550	560	580	510
Bull Springs-2	420	420	470	520	530	450	430
Clear Creek	130	130	160	170	180	120	110
Fall Creek	230	220	260	270	270	220	210
Foreman Creek	56	57	67	64	82	51	48
Peavine Creek	150	160	200	220	220	165	140
Sweetwater Creek	170	180	210	220	240	170	170
Lompico Creek	280	330	380	450	500	440	NR

Source[1]: SCWD
Source[2]: SLVWD, Note: NR = Not Recorded

5.4.6.12 Color

Table 5-16: Color — Apparent color of SCWD source waters has been as high as 800 units, with the higher values from the San Lorenzo River sources. Median values range from 2 to 22 units. Treated water typically has very little or no detectable color. Lompico Creek had a range of color units from 100 to 190 units which is among the higher values when compared to the other source waters of the SCWD. The other SLVWD sources are very low by comparison.

Table 5-16: Apparent Color Summary of Available Data (units: CU)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	2.8	2.0	1.0	28.0	135	2011	2017
Laguna Creek	6.3	4.0	2.0	36.0	132	2011	2017
Majors Creek	13.4	8.0	3.0	140.0	129	2011	2017
Loch Lomond	22.4	18.0	8.0	120.0	106	2011	2017
SLR @ Tait Street	40.8	20.0	10.0	700.0	238	2011	2017
SLR @ Felton Diversion	43.9	20.0	8.0	800.0	150	2011	2017
San Lorenzo Valley Water District[2]	Year						
	2011	2012	2013	2014	2015	2016	2017
Bennett Spring	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
Bull Springs-1	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
Bull Springs-2	< 3.0	NR	NR	< 3.0	< 3.0	< 3.0	< 3.0
Clear Creek	3	3	< 3.0	< 3.0	< 3.0	NR	< 3.0
Fall Creek	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
Foreman Creek	5	3	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
Peavine Creek	7	3	30	< 3.0	< 3.0	< 3.0	< 3.0
Sweetwater Creek	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0	< 3.0
Lompico Creek	100	120	140	170	190	180	NR

Source[1]: SCWD
Source[2]: SLVWD, Note: NR = Not Recorded

5.4.6.13 MBAS

Table 5-17: MBAS (Foaming Agents) — The MCL for MBAS, or foaming agents, in drinking water is 0.5 mg/l. The maximum measured in annual samples of SCWD waters is 0.07 mg/l, with averages ranging from 0.00 to 0.01 mg/l. Of the SLVWD values measured, the MBAS values were very low

Table 5-17: MBAS Summary of Available Data (mg/L)

Utility/Location	*Average*	*Median*	*Low*	*High*	*No. Samples*	*Sample Dates (WY)*	
Santa Cruz Water Department[1]							
Liddell Spring	0.00	0.00	0.00	0.00	6	2011	2017
Laguna Creek	0.00	0.00	0.00	0.00	6	2011	2017
Majors Creek	0.00	0.00	0.00	0.00	6	2011	2017
Loch Lomond	0.00	0.00	0.00	0.00	7	2011	2017
SLR @ Tait Street	0.00	0.00	0.00	0.00	13	2011	2017
SLR @ Felton Diversion	0.01	0.00	0.00	0.07	10	2011	2017
San Lorenzo Valley Water District[2]	Year						
	2011	2012	2013	2014	2015	2016	2017
Bennett Spring	< 0.025	NR	ND	NR	ND	NR	NR
Bull Springs-1	< 0.025	NR	NR	< 0.025	< 0.025	< 0.025	< 0.025
Bull Springs-2	NR	NR	NR	< 0.025	< 0.025	< 0.025	< 0.025
Clear Creek	< 0.025	NR	NR	< 0.025	< 0.025	< 0.025	< 0.025
Fall Creek	< 0.025	< 0.025	NR	< 0.025	< 0.025	< 0.025	< 0.025
Foreman Creek	< 0.025	NR	NR	< 0.025	< 0.025	< 0.025	< 0.025
Peavine Creek	< 0.025	NR	NR	< 0.025	< 0.025	< 0.025	< 0.025
Sweetwater Creek	< 0.025	NR	NR	< 0.025	< 0.025	< 0.025	< 0.025
Lompico Creek	ND	ND	ND	ND	ND	ND	NR

Source[1]: SCWD
Source[2]: SLVWD, Note: NR = Not Recorded, ND= Non-Detectable

5.4.6.14 E. Coli, Cryptosporidum and Giardia

As part of the LT2 sampling, SCWD conducted sampling for *E.coli*, *Cryptosporidium* and *Giardia* for all of their raw water sources, for the period from 2011-2017 for *E. Coli* and 2016 through 2017 for *Cryptosporidium* and *Giardia*. SLVWD's sampling was from 2016-2017 using the Lyon WTP Influent sample point, which is made up from a combination of Foreman Creek, Sweetwater Creek, Clear Creek and Peavine Creek. During the months of March and April of 2017, Foreman Creek was the only raw source online at the Lyon WTP. Total coliform data are also reported in Section 5.4.1.

Table 5-18: SCWD E. Coli, Cryptosporidium and Giardia

Contaminant	***Average***	***Median***	***Low***	***High***	***No. Samples***	***Sample Dates (WY)***	
Santa Cruz Water Department							
E. Coli	228.5	52.0	1.0	24,810	660	2011	2017
Cryptosporidium	0.12	0.05	0.00	0.50	14	2016	2017
Giardia	0.09	0.00	0.00	0.30	14	2016	2017
San Lorenzo Valley Water District							
E. Coli	179.9	160.7	146.4	272.3	10	2016	2017
Cryptosporidium	0.8	0	0	4	10	2016	2017
Giardia	0.2	0	0	1	10	2016	2017

5.4.6.15 Constituents of Emerging Concern (CEC)

In 2015, SCWD initiated quarterly sampling at five locations including raw and treated water sampling locations as well as a first flush sampling of the San Lorenzo River at Felton and at Tait and analyzed them for 96 Constituents of Emerging Concern including herbicides, artificial sweeteners, personal care products, and pharmaceuticals. Most of the CECs (76) were never detected in source water, while the remainder were detected at very low levels. Like other water utilities, the SCWD uses a multi-barrier approach to protecting drinking water quality including source water protection, effective water treatment, and careful management of the treated water delivery system. The CEC study is contained in Appendix C.

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SECTION 6: CONCLUSIONS AND RECOMMENDATIONS

This section begins by discussing conclusions related to the Surface Water Treatment Rule (SWTR) and AWWA/DHS *Guidance Manual*, then presents specific conclusions related to contaminant sources, monitoring programs, and overall watershed management. Section 6.5 provides a summary of activities, some of which are detailed in Section 6.4, that SCWD and SLVWD can focus on over the next five years that contribute to maintaining and improving source water quality.

6.1 SWTR Disinfection Compliance Requirements

The SWTR requires a minimum of 4 log (or 99.99 percent) virus and 3 log (99.9 percent) Giardia cyst removal/inactivation. DDW requires utilities that report monthly median total coliform concentrations greater than 1,000 MPN/100 ml to increase the minimum level of pathogen inactivation at their treatment plant. Previously, there was a 13 July 1998 letter from DDW's predecessor agency DHS, to SCWD requiring a 5 log (or 99.999 percent) virus and 4 log (99.99 percent Giardia) cyst removal/inactivation because the SCWD's August 1996 to March 1998 median monthly total coliform concentrations exceeded 1,000 MPN/100 ml in 12 out of 16 months. The SCWD has collected bi-monthly total coliform samples from the intakes of each water source and since 1996, and has also monitored total coliform and *E. coli* in the blended water as well as *E. coli* in the individual sources entering the Graham Hill Water Treatment Plant (GHWTP). As discussed earlier, in 2012 and 2013, SCWD submitted to DDW an evaluation of GHWTP filter performance data that resulted in a 1-log Giardia treatment credit.

As shown in Section 5.4.1, raw water total coliform for the utilities have ranged in the moderate to high (> 1,000 MPN/100 ml) concentrations, particularly in areas downstream of urbanization. It also should be noted that crypto and Giardia data presented in 5.4.6.14 indicate very low presence of these pathogens, relative to the total coliform. The waters sources that generally have stream intake structures located upstream of human developed areas (e.g., SLVWD) or downstream from open space areas typically have lower total coliform. The higher total coliform in raw water indicate that removal and inactivation of 4 log viruses and 3 log Giardia cysts is appropriate. The utilities continue to collect and evaluate total coliform data to verify the log removal and inactivation requirements for each system. As improvements are made to the upstream watershed, the data may suggest that review of the requirements are merited.

The one raw water source of most concern is the SCWD San Lorenzo River Intake in Santa Cruz. Between 2011-2017, the highest annual median values of total coliform were measured at the San Lorenzo River sources as have occurred in prior years as shown on Figure 5-1. Felton Diversion water is not pumped directly to GHWTP, rather is pumped to Loch Lomond Reservoir on Newell Creek for storage before use at GHWTP. Loch Lomond water, which is piped directly to the GHWTP, has relatively lower coliform levels; therefore meriting higher concern regarding the diversion at Tait Street as a source water.

The San Lorenzo River sources are not usually used during the first seasonal rains when turbidity, color and coliform counts can be significantly increased. The San Lorenzo River sources are put back into service after turbidity (which has an instantaneous reading and is a surrogate for coliform) and color return to baseline levels. When used, San Lorenzo River Intake is usually blended with North Coast and/or water from the Tait Wells, both of which

contain significantly lower total and *E.coli* coliform concentrations. The SCWD continually evaluates the need to modify the required level of treatment and disinfection, especially if in-stream flow requirements for fisheries result in source adjustments that do not allow the source blending that currently occurs.

6.2 Significant Contaminant Sources

From the survey findings, there are several sources of contaminants, detailed in Section 3, that are potentially significant to the drinking water sources (especially the San Lorenzo River). These sources include:

- wastewater including discharges from failing septic systems that can contribute pathogens and nutrients;
- urban runoff;
- confined animal facilities/stables;
- unauthorized activity including homeless encampments that can contribute microbial contaminants, illegal mountain bike trails contributing erosion and sediments;
- agriculture including cannabis cultivation (currently illegal, but soon to be regulated) which contributes many pollutants including sedimentation from soil disturbance for roads and cultivation, increased nitrate, pesticides/herbicides and increased water diversions from cultivation; it is expected that some operations will be permitted, but that unpermitted operations will also continue;
- timber harvest; and
- geologic hazards which can contribute sediments.

Recent listing by the Regional Water Quality Control Board of some pesticides/herbicides as impairment to the San Lorenzo River have changed pollution from pesticides from a non-significant to a significant contaminant source. While a TMDL for chlorpyrifos has been developed for the lower San Lorenzo River, SCWD and USDA sampling discussed earlier do not indicate this constituent is occurring very frequently as discussed in Section 5.4.5.

The contaminants on the Regional Board listings extend beyond the constituents found in the drinking water regulations which also poses complexities in managing these contaminants because they are not all under the control of the water purveyors. Table 6-1 associates the existing and proposed TMDLs found in Table 4-1 with the contaminants associated with these sources and the management actions currently undertaken in the watershed to address the TMDL sources. Discussion of individual sources of contamination follow in the sections that follow.

Table 6-1. Total Mass Daily Load (TMDL) Projects and Primary Sources: San Lorenzo Valley, Loch Lomond Reservoir and Upper Newell Creek, and North Coast Watersheds and Associated Management Activities

		Potential Contaminant Sources and Associated Management Activities					
	Target	***Wastewater*** *(septic systems)*	***Livestock/ stables***	***Urban runoff***	***Timber harvests/ logging*** *(including THP roads)*	***Geologic Hazards and Fires***	***Unauthorized activity*** *(e.g., small-scale grading and homeless encampments)*
				Includes Public/Private Roads			
San Lorenzo River Watershed[1]							
Pathogen TMDL *(May 8, 2009)*	Fecal coliform 30-day log mean < 200 MPN, where 10-percent of samples < 400 MPN	▪Continued implementation of the County Wastewater Management Program which may further improve meeting nitrogen and pathogen TMDLs.	▪Ecology Action's Livestock and Land program has reduced manure loads.	▪City adopted a stormwater ordinance ▪City, County and Scotts Valley have stormwater management plans	not applicable	not applicable	▪City working to obtain conservation easements on private lands in the County adjacent to creeks in order to limit unauthorized activities ▪City has increased funding for patrols of riparian corridors upstream of the Tait St. ▪Sheriffs department conducts homeless camp cleanups on an as needed basis
Sediment TMDL *(May 16, 2003)*	The sediment TMDL target is currently based on numeric targets for pool volumes for fish habitat and particle size and percent of fines for spawning gravel. RWQCB staff recommends revision of the San Lorenzo Sediment TMDL to replace existing numeric targets with the sediment and biological indicators recommended in Herbst and others (2011).[2]			▪County and City implemented 8 culvert repairs/retrofit projects which reduce sediment load ▪RCD implemented a rural roads erosion control assistance program. ▪County riparian, grading, erosion control ordinances ▪City stakeholder and school outreach including signage on creek crossings ▪City regulatory interaction including timber harvest review, County code violations, etc. ▪City retains certified erosion control specialist for road mgmt			
Nitrate TMDL *(September 15, 2000)*	Nitrate as nitrate levels <1.5 mg/L. (Nitrate as nitrogen levels < 0.34 mg/L)	▪ Continued implementation of the Wastewater Program has resulted in significant declines in on-site wastewater system failure rates and stopped the rise of nitrate. ▪SWRCB has adopted policy for on-site wastewater treatment systems pursuant to AB885. ▪ Sewering of areas close to sanitary sewer collection systems has occurred on a periodic basis.					
Chlorpyrifos TMDL	TMDL adopted May 29, 2014 with impairments in San Lorenzo River (below Zayante Creek confluence near Felton), Branciforte and Zayante Creek and Arana Gulch. 2010/2011 data indicate that numeric targets are currently being met			Urbanized areasand roadways are likely contributors			
Chlordane TMDL	TMDL to be developed by 2021						
PCBs TMDL	TMDL to be developed by 2021						
Temperature TMDL	TMDL to be developed by 2023						
Newell CreekWatershed							
pH 303d List	TMDL to be developed by 2027						
Loch Lomond							
Proposed Mercury 303d List	No TMDL date indicated at this time						
Notes							
[1] Date approved by RWQCB							

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6.2.1 Significance of Contaminants

Distinguishing between significant and less-than-significant contaminant sources is often difficult but is important, especially in Santa Cruz County, which is 100 percent reliant on local streams and aquifers for its water sources – a relatively rare situation in most of California. As described in the Watershed Sanitary Survey Guidance Manual, the significance of a potential contaminant source is intended to be comparative within the watershed and can be evaluated on a case-by-case basis. The relative significance of a contaminant source can be based on the relative health significance, the distance to the intake, the magnitude of the contaminant source as well as other factors. Microbial contaminants may result in acute illnesses while many chemical contaminants result in chronic illnesses.

Another burden in assigning contaminant significance is that some sources become significant only during years of extreme conditions or following episodic events. An additional threshold in establishing significance is the possibility that one or more sources may be permanently lost or lost long-term to any number of causes. Within this context of significance, a discussion of each contaminant source and potential recommendations are provided in the following paragraphs. Table 6-2 summarizes the significant contaminant sources and their relevance to the SCWD's water sources.

Table 6-2. Potential Contaminant Sources and Recommendations: San Lorenzo Valley, Loch Lomond Reservoir and Upper Newell Creek, and North Coast Watersheds

Contaminant Source	*San Lorenzo Valley*	*Loch Lomond Reservoir and upper Newell Creek*	*North Coast*	*Information supporting significance*
	✓ denotes significance			
Wastewater (septic systems)	✓	✓		Elevated nitrate in streams, downstream of more densely populated areas
				Elevated coliform counts downstream of urban areas.
Urban Runoff[1]	✓	✓		-Elevated coliform bacteria downstream of urban areas. Reduced coliform through open space areas. Baseline fecal coliform bacteria mostly attributed to non-human sources; in the San Lorenzo River no human contributions were identified in dry season sampling. Ribotyping found birds account for the majority of bacterial contamination. - Urban runoff is also associated with other pollutants as well as increased erosion. Urbanization over sandy soils is particular concern because they are prone to substantially more sedimentation than other soils and reduced recharge can increase concentration of constituents in groundwater.
Concentrated Animal Facilities	✓		✓	Horses are considered a major source of pathogens and nitrogen and can also contribute to persistent turbidity in the water supply watersheds. Hecht and others (1991) estimated that horses in the San Lorenzo Valley contributed nitrogen equal to one fifth or more of the amount released from septic systems.
Public/Private Roads and Timber Harvests	✓		✓	The primary potential problem arises with erosion resulting from the roads constructed to access residences and logging areas. Another major regional challenge especially specific to the San Lorenzo watershed is to reduce sediment delivery from erosion of road treads. Deep, multi-branched gully systems tend to develop on roads cut into weathered slopes within (especially) the Vaqueros and Butano sandstones. The gullies are left to continue growing, or are temporarily filled during spring re-opening of harvest areas only to re-erode with the next wet season.
Unauthorized Activity	✓	✓	✓	Small-scale grading and timber harvests frequently use poor practices, which increases sediment loading to the surface water streams. Trespass by vehicles and mountain bikes also results in erosion and sedimentation. Homeless encampments adjacent to waterways can be a source of human waste. Illicit methamphetamine laboratories and cannabis cultivation occur in the watershed.
Quarries	✓		✓	Of the 4 quarries in the San Lorenzo River Watershed, Felton and Quail Hollow Quarries are still active. Reclamation at Hanson Quarry is presently underway, while reclamation at Olympia Quarry is stalled due to endangered species issues. Mining ceased at the CEMEX Bonny Doon Quarry in the Liddell Springs Watershed, and reclamation is underway. Until reclamation is complete, closed mines can still impact water supplies.
Geologic Hazards and Fires	✓	✓	✓	▪Elevated sediment loading during the wet season, frequently caused by landslides or slumping of roads. ▪Persistent turbidity may be experienced for several months to several years following a major watershed-scale fire.
Vehicle Upsets and Spills (LUSTs)	Potential		Potential	▪ Valeteria Dry Cleaners LUST monitoring results in downstream San Lorenzo River show occasional PCE detections in 2012 and 2013 and ongoing groundwater detection in 2017 suggesting wastes released at the site have migrated, and may continue migrating downgradient - remediation is ongoing; while Chevron, Sturdy Oil, Watkins-Johnson show no indication of contamination within the stream network; and ▪The potential exists for significant chemical spills caused by traffic accidents and in recent years several accidents have affected local waterways. City staff report that timely notification from the County is an ongoing area of concern and is not consistently performed in a functional manner.
Pesticide and Herbicide Use	✓			-RWQCB TMDL for chlorpyrifos and recommendation to list San Lorenzo River for chlordane -City has continued its herbicide use to maintain fuel breaks on ridge tops for fire preparedness. -When algal blooms do occur or are predicted to occur, chemical algaecide applications are made to the Newell Creek Reservoir to protect against degradation of beneficial uses
Agricultural Land Use	Potential	Potential		While a small percent (Less than one tenth of one percent) of area of the watersheds is cultivated; illegal and legal cannabis grows occur and may increase. Some expansion of agricultural use in the Majors Creek watershed has occurred. Wineries may require National Pollutant Discharge Elimination System (NPDES) permits for process waters. Legal cannabis cultivation will make this a more significant source with water diversions, pesticide/herbicide/fertilizer use, and access road construction.

Notes

[1]Point source discharges regulated by the RWQCB do not exist in the watershed area

[2]These recoemmendations are supportive of the draft Habitat Conservation Plan for Steelhead and Coho Salmon that has been prepared by the

6.2.1.1 General Land use and Urbanization Conclusions

As discussed in Section 3.2, the San Lorenzo Valley has a large number of septic systems, on both sandy and non-sandy soils as well as some systems that overlie karst; septic systems are recognized as a major source of nitrate to the river and its tributary streams. Wastewater, urban runoff, and horses, other domestic animals and pets also contribute to elevated nitrate levels. Microbial contaminants are associated with failing septic systems, urban runoff, and horse stables.

The County's wastewater management program endeavors to address problem septic systems, promoting system upgrades where feasible, requiring alternative systems where appropriate, and encouraging connection to wastewater treatment/disposal systems that discharge outside the watershed as has occurred at the Rollingwoods subdivision. The Bear Creek Estates package plant, serving 54 homes, was upgraded in 2005 yet still experienced spills during the heavy rains of 2017. SLVWD is considering upgrading the WWTP to improve operational reliability. The package plant at Boulder Creek Golf and Country Club was upgraded to reduce nitrates and wastewater spills from the force main. Implementation of the San Lorenzo River Nitrate TMDL and the County's Nitrate Management Plan shows evidence of stabilizing nitrate concentrations per Figure 5-10 and may be indicating potential reductions in nitrate in the recent past in water quality improvements.

Previous studies have indicated that septic systems, wildlife, livestock and pets, and urban runoff are all significant sources of microbial contaminants in the San Lorenzo River. More recently, homeless encampments adjacent to the rivers and tributaries have also been identified as a source of microbial contamination.

The County's microbial source tracking study showed that, based on ribotyping, birds are the primary source of elevated levels of coliform bacteria in the San Lorenzo River. The San Lorenzo Valley does not have a system of curbs, gutters and storm drains to convey runoff to the River; it should be noted that roadways with curbs, etc can also have unintended consequences of concentrating runoff if not well maintained, especially during storms. Water quality impacts of road runoff can be mitigated by protecting existing open space areas near stream banks to filter runoff, to focus public education on source control and prevent contamination of runoff, and to maintain the water treatment plants in optimal working condition. When considering the contaminant reduction in the six stream miles in Henry Cowell Redwoods State Park between southern Felton and northern Santa Cruz, it may also be that the reaches of undeveloped stream between the communities which are characteristic of many areas of the San Lorenzo Valley – are one reason why nitrate and bacterial loadings have remained at lower levels than many experts predicted in the past.

6.2.1.2 Water Utilities Influenced

Utilities which obtain surface water from an urbanized watershed area are influenced by both septic system and urban runoff discharges to area streams. These include primarily the Santa Cruz Water Department and selected areas of the San Lorenzo Valley Water District including Lompico Creek.

6.2.1.3 Wastewater Discharge Recommendations

To minimize the impacts from wastewater treatment discharges, primarily septic systems, recommended actions include:

- The County should continue implementation of the Wastewater Management Plan and revise in accordance with AB885 as discussed in Section 4.9. Records of inspections and upgrades should be kept in both tabular and in map form, preferably on the County's GIS system to allow focus on problem areas especially those overlying sandy soils and/or karst.
- Purveyors should continue to collect, tabulate and review the water quality data on a frequent basis (e.g., annually) to evaluate the effectiveness of ongoing management programs These data should be reviewed in collaboration with the County Environmental Health and the Regional Water Quality Control Board so that appropriate follow-up action can be taken by the appropriate agency.
- The drinking water purveyors should inform County Environmental Health when elevated coliform or nitrate levels are detected in raw water sources. The need for an update of the nitrate study that resulted in the County's 1995 Nitrate Management Plan should be evaluated.
- Water purveyors should review development plans for sites upstream of source water intakes to verify that measures are in place that will address key issues such as septic system discharges and urban runoff. Specifically, SCWD (and secondarily, SLVWD) should work with County Environmental Health and Planning to review proposed developments upstream of their intakes, such as the San Lorenzo River Intake, to verify that acceptable control measures planned and that mitigation measures have been appropriately implemented and maintained.

6.2.1.4 Urban Runoff Recommendations

Recommendations to control water quality impacts from urban runoff include:

- Evaluate development of best management practices such as low impact development (LID), and management measures directed at the unique properties of sandy soils and karst within watersheds, which call for a common set of measures to minimize nutrient loads, maintain aquifer recharge and the resulting baseflow, minimize erosion, sedimentation, and channel incision, and protect springs/seeps/wetlands and riparian-zone resilience during dry months and dry years.
- The County should implement of the SWMP in the watersheds as accepted by the Regional Board. This includes conversion of existing urbanized areas to LID, especially in areas of high water quality benefit.
- Coordinate with Santa Cruz Integrated Regional Water Management (IRWM) program on stormwater management including implementing public education/involvement program to minimize contaminant loading from stormwater runoff. The IRWM program can be used to supplement efforts by the purveyors and the County to inform customers and watershed residents of the ongoing water quality and supply issues. Many residents are not aware or do not appreciate the dual nature of the San Lorenzo Valley – a rural

residential area, locally approaching urban densities, and the central water-supply source for the region.

- The County should improve its enforcement of ordinances (e.g. grading, riparian corridor and wetlands protection, sensitive habitat protection, and water quality control) in coho recovery and water supply watersheds to maximize and protect riparian setbacks from drainageways and streams.
- The County should proceed with its planned strengthening of the riparian ordinance discussed in Section 4.9.1.2.

6.2.2 Confined Animal Facilities

6.2.2.1 Conclusions

Horses, the main confined animals in both the North Coast and San Lorenzo River watersheds, can be a major source of wet season nitrate and bacteria levels in surface waters, and a contributor to persistent turbidity as well. Nutrients and pathogens can be mobilized from uncovered manure piles. Trails which cross stream channels degrade stream banks and facilitate direct contamination of surface waters. Similar effects are observed where paddocks adjoin waterways and horses traverse stream banks to reach the water. The County, the NRCS, the RCD, Ecology Action and various equestrian and watershed groups have developed programs to educate horse owners and assist them with design, installation and funding of measures to control pollution from horsekeeping. The County requires that manure management programs are developed for all new permittees and is also able to apply its riparian ordinance to provide the buffers and access management required to minimize nutrient, bacterial, and sediment loadings to surface waters. Although this is an area where substantial improvements have been realized since the original 1996 sanitary survey, primarily through voluntary methods that are discussed in Section 3.6.2, continued sustained effort is needed on both education regarding voluntary programs as well as on enforcement of existing ordinances by the County.

6.2.2.2 Water Utilities influenced

Utilities which draw surface water downstream from bankside stables or areas intensively used by horses can observe higher turbidity and coliform counts. These entities include the Santa Cruz Water Department and the San Lorenzo Valley Water District.

6.2.2.3 Confined Animal Facilities Recommendations

It is recommended that the voluntary measures such as the Livestock and Land Program, with particular focus on horse owners near the waterways, be continued and supported. In addition, it is recommended that the County track complaints and permit violations as well as conduct periodic inspection and monitoring targeting those stables closest to the streams and river. Prior to enforcement, it is suggested that these stable owners should be made aware of the voluntary programs, and only if non-compliance consistently and broadly occurs should enforcement (including referral to the RWQCB) or development of an ordinance be considered. If developed, an ordinance should include simple and effective control measures coordinated through user groups and/or non-regulatory entities with stricter enforcement reserved for significant non-compliance. As an alternative to enforcement, opportunities to develop

conservation easements and/or partnerships with land trusts and alternative funding should be considered. Horse stable runoff control practices should be implemented regularly, but particularly emphasized during the fall months in order to minimize contaminant loading during the next rainy season.

6.2.3 Unauthorized Activity

6.2.3.1 Conclusions

Activities, such as non-permitted grading and mountain biking outside of designated areas, cause significant sediment loading to streams as well as posing a fire threat, drawing valuable first responder resources, and introducing invasive species. Homeless encampments can contribute microbes. As discussed in Section 3.13.1, illegal cannabis cultivation in the watershed appears to be increasing, although may be moving to indoor cultivation which has fewer water quality impacts but produces more greenhouse gas as a result of the energy usage for lighting and ventilation. Legal cannabis cultivation is expected to increase once County regulations are finalized. Cannabis cultivation contributes a range of contaminants including sediments from tree removal and grading, chemicals/nutrients, sanitary waste as well as diverting water valuable to ecosystems and others. Illegal water diversions can require SCWD to use Loch Lomond when other higher quality sources are not available. The cumulative impact of such activities in and near channels can significantly increase turbidity and other water quality threats in streams.

Changes to the City municipal code in 2004 facilitated code enforcement by authorizing SCWD rangers to take enforcement actions on City-managed lands that may be outside of the City limits (eg Loch Lomond and the San Lorenzo River). In addition a conservation easement/license program has been established to expand the City's enforcement area to private lands between the San Lorenzo River Intake and Sycamore Grove and is a part of the City's Riparian Conservation Program. Coordination with other officials in the watershed, e.g. State Parks has occurred and should continue.

6.2.3.2 Water Utilities Influenced

Utilities which use surface water collected from developed and undeveloped watershed areas are influenced by unauthorized activities. This includes the Santa Cruz Water Department, San Lorenzo Valley Water District, and the Lompico County Water District prior to its 2016 merger with SLVWD, as well as smaller purveyors throughout the survey area.

6.2.3.3 Unauthorized Activities Recommendations

As discussed in Section 3.13, unauthorized activities are considered a chronic and ongoing source of contamination. It is recommended that:

- Outreach to homeowners, perhaps through the existing programs such as Lands and Livestock, be continued regarding negative impacts of grazing
- Improved collaboration with State Parks, CDFW, CalFire, and/or non-governmental agencies, regarding other threats so that water utilities can be prepared for potential contaminants.

- The SCWD should continue to patrol and advocate for and support removal of homeless encampments, education of the mountain biking community regarding water quality impacts of illegal tails, as well as developing conservation easements/licenses on riparian properties.
- Seeking compliance with existing ordinances and providing education and enforcement should be prioritized, with water-quality protection in mind.

6.2.4 Roads

6.2.4.1 Conclusions

As discussed in Section 3.3 Urban Runoff, Section 3.11 Timber Harvests/Logging, and Section 3.15 Geologic Hazards, roadways are a source of a range of contaminants including sediments and chemicals. This includes roads maintained by private landowners, as part of roads associated with residences and timber harvest and management, as well as public roads maintained by the County Public Works Department, and by Caltrans. Clearing of landslide debris on roadways and poor maintenance of public and private roads increase erosion and sediment loading to local streams. Roads which require recurrent replacement due to failure of the underlying slopes disproportionately contribute to sedimentation, turbidity, and persistent turbidity.

6.2.4.2 Water Utilities Influenced

All of the drinking water purveyors which rely on surface water supplies located downstream from any roadway are influenced by this source.

6.2.4.3 Roadway Maintenance Recommendations

In the past, Caltrans and the County Public Works Department have taken significant measures to improve roadway debris control and general maintenance. This includes developing suitable practices to stabilize and dispose of landslide material and to control runoff from stockpiled material. The County, in consultation with water agencies, should identify areas suited to establish additional road maintenance service sites, and mechanisms to quickly move stockpiled material to long-term storage areas, such as has been implemented at the Cabrillo Quarry in Aptos.

As discussed in Section 4.7.1, the County has a Road Maintenance Manual that is used for road maintenance activities to minimize water quality impacts. In addition, the RCD and the NRCS have developed a Rural Roads Sediment Inventory Manual which evaluated rural private roads and developed a maintenance training program which has acquired a statewide reputation over the past 10 years These programs and manuals help assure that appropriate measures are being implemented on both private and public roads and can be a resource for those individuals embarking on licensing of legal cannabis cultivation. The County has also secured grants to evaluate improved roadside maintenance practices in riparian areas (herbicide reduction/elimination) and to prepare a new manual for road maintenance practices (erosion and sedimentation reduction). Herbicide use on road right of ways, discussed in Section 3.7.2, are likely the largest source of herbicides in the watersheds, therefore herbicide reduction should be a priority to the County. The inventory of potential sediment sources along county

roads in the San Lorenzo Watershed identified priority projects for designed, permitting and implementation through the Integrated Watershed Restoration Program (IWRP) with funds from the Coastal Conservancy, State water bonds such as Proposition 1, and other sources.

Roads do, however, remain a major source of turbidity, and road systems periodically contribute large volumes of sediment when culverts are blocked or when concentrated runoff from roads cause incision: (a) into slopes between the road and the stream network, and (b) within the channels, by concentrating runoff and magnifying peak flows in streams.

It is recommended that:

- The County continue to use and augment the road maintenance measures and procedures developed by CalTrans and Public Works including measures to control the downstream incision and bank erosion described above, as well as pesticide and herbicide use measures;

- Water purveyors support the rural road program to private residential and timber-harvest roads within the County (especially those in proximity to diversions and intakes).

6.2.4.4 Timber Harvests Roadway Recommendations

The recommendations stated above for roadway maintenance should also be applied to roads allowing access for timber harvests by CalFire, owners, and other participants in THP review. Other recommendations are:

- For major portions of road networks, owners should require properly abandoned or rested (closed until next harvest) roads after logging activities are completed and regulatory agencies should confirm this with monitoring. This includes blocking access to the area and restoring road cuts to the original slopes, especially in areas where road densities exceed 3.0 miles per square mile (as recommended by NOAA Fisheries) within portions of a particular watershed within the THP ownership and adjacent to it.

- Purveyors should advocate for follow-up restoration of roads from NOAA fisheries road density analysis for key water-supply watersheds, using NOAA fisheries threshold of 3 mi./sq. mi. as an indicator of ecosystem health.
- Purveyors and the County should work with CalFire to aggressively enforce existing requirements to minimize area damage and maintain roadways, especially in segments close to streams, especially for emergency exemptions for salvage logging in high erosion hazard areas.
- Support effort to prohibit salvage logging in key municipal and public water district watersheds.
- Monitor RWQCB implementation of 2012 updated conditional waiver of waste discharge requirements for timber harvests.

- The SCWD and other water purveyors should lobby for inclusion in the official THP review team, rather than be limited to an advisory role particularly for those harvest that have high potential water quality risk.

6.2.5 Mining/Quarry Activities

6.2.5.1 Conclusions

Quarries have been identified as a potential source of sediment during major storm events, reportedly caused by the failure of on-site settling/retention ponds to contain event stormwater runoff.

In the North Coast watersheds, Bonny Doon Quarry operations, specifically blasting, have caused and contributed to periodic turbidity and nitrate spikes at Liddell Spring which pose challenges at the SCWD's water treatment plant.

However, as discussed in Section 3.9, the Bonny Doon Quarry is now closed and undergoing reclamation. Therefore, this sediment source has decreased. In addition, nitrate data collected at Liddell Spring since 1967 suggests that background nitrate levels at the Spring had been steadily increasing from about 0.3 mg/l in the late 1960s to values above 1.0 mg/l in the 1990s. More recent data from 2001 to 2011 as shown on Figure 5-8 show a peak value of 2.3 mg/l in 2001 with most values around 0.5 mg/l. A possible source of some of the elevated nitrate levels could be from quarry blasting (ammonium nitrate) at Bonny Doon Quarry – however, this was never confirmed and unlikely to be an issue with closure of the quarry.

6.2.5.2 Utilities influenced

The SCWD has been periodically influenced by turbidity increases in the Liddell Spring source. In the San Lorenzo River watershed, the SCWD is affected by sediment contributions from the one active sand quarry (Quail Hollow), one rock quarry (Felton) and from discontinued quarries (Olympia and Hanson) should stormwater containment facilities fail.

6.2.5.3 Quarries and Mines Recommendations

- The SCWD should advocate for water quality monitoring during closure and reclamation.
- The SCWD should also continue to review staff and EIR reports including closure and post-closure water quality monitoring reports.
- Quarry operators and downstream water users should also:
    - Develop trends of water quality data collected. This will help to identify effectiveness of implemented BMPs or any failure of on-site treatment practices, as well as promote meaningful input from purveyors into appropriate modifications of conditions during the 5-year permit-renewal process through the County.
    - Establish specific water quality objectives for springs and streams located downstream of quarries and request additional water quality data, if and where necessary.

- o Inspect quarries routinely, including visits in the fall period to verify the capacity and condition of on-site settling/retention ponds and erosion control structures, and that these are prepared for heavy rainfalls.

6.2.6 Geologic Hazards and Fires

6.2.6.1 Conclusions

Landslides are the most frequently occurring geologic event affecting the drinking water supply, causing elevated turbidities following major storm events. Earthquakes and erosion from fire areas can severely increase sediment and natural organic matter loading to surface waters, both initially and during the process of 'recovery' from these episodic events. Finally, erosion following major fires, floods, landslides and possibly droughts or earthquakes can disrupt use of some or many surface water intakes for periods ranging from several months to several years, or deliver a pulse of sediment to the channel which may take years to dissipate.

6.2.6.2 Utilities influenced

All utilities which use surface water can be influenced by geologic hazards and fires in these watersheds. Water treatment plant operators are usually aware of the potential turbidity spikes that may occur through review of online turbidity information.

6.2.6.3 Recommendations

Many of the recommendations from Section 6.2.4 for Roads are relevant for Geologic Hazards. Further recommendations regarding fires, some of which were discussed in Section 4.8, include:

- Continue to manage fuels and reduce wildfire hazards.
- For the watershed that drains to Loch Lomond the City should continue to meet with fire management staff to communicate changes to security, field conditions, and other information necessary for fire management as well as incorporate recommendations of the fire plan for watersheds, when completed, for future reports.
- Enhance collaboration with CalFire on improving Community Wildfire Protection Plan (CWPP) projects and lobby for Loch Lomond recognition as an asset at risk under CWPP.
- Maintain fuel breaks on watershed lands including development of an Integrated Pest Management Program to address appropriate herbicide application for fuel break maintenance.
- Most purveyors drawing upon surface or spring supplies should anticipate extended turbidity events following a large fire in their watersheds. Planning should focus on alternative sources of supply during the months or years following the fire, and for protecting diversion or distribution facilities from post-fire erosion and slope instability.

6.2.7 Chemical Spills

6.2.7.1 Conclusions

Three ground-water chemical plumes in Felton have been reasonably contained by contemporary standards. Supplemental remedial activity is imminent at the former Chevron and Exxon stations, and may take place at the Valeteria site as well. The potential remains for chemical spills on highways, on major County roads such as Felton Empire Road or Smith Grade.

6.2.7.2 Utilities influenced

All utilities which obtain surface water from developed watershed areas are potentially influenced by spills on local roadways which should be managed by halting water diversion until clean-up has been completed and the pollutant has passed. In addition, long-term discharges such as from leaking underground tanks can be a source that eventually make their way to the creeks and rivers. Currently, the Santa Cruz Water Department is the only utility which has detected any solvent-type chemicals in the water. One chemical, PCE has been detected at levels 5 to 10 times below the regulated limit at the Felton Diversion, and not at any intake used to supply water directly to the treatment plant.

6.2.7.3 Recommendations

In an effort to minimize the impacts of chemical spills, it is recommended that:

- Increased raw water for testing of chemical contaminants, especially those that may be associated with cannabis cultivation

- Collaboration with the Santa Cruz County Hazardous Materials Interagency Team (SCHMIT). regarding notification of long-term spills and advocate for control of hazardous materials transport be improved through periodic calls/meetings. SCHMIT responds to major hazardous materials incidents county-wide and is staffed by hazardous materials technicians from several area fire departments r; and

- Continue efforts to communicate with dispatchers at NetCom and on-scene responders to discuss water agency spill notification procedures.

6.2.8 Pesticides and Herbicides

6.2.8.1 Conclusions

While the RWQCB established a TMDL for chlorpyrifos for the lower San Lorenzo River including the area of the San Lorenzo River Intake and is recommending that the San Lorenzo River be listed as impaired for chlordane as well as for PCBs, the occurrence of pesticides/herbicides has been low as discussed in Section .5.4.5. However, data are limited to a few samples and chemical usage in the past has been limited.

6.2.8.2 Utilities influenced

All utilities which obtain surface water from watershed areas are potentially influenced by pesticides/herbicides, especially as illegally used for cannabis cultivation and for other agriculture such as vineyards, in the watershed.

6.2.8.3 Recommendations

In an effort to minimize the impacts of pesticide/herbicide use, Ii is recommended that:

- Continued implementation of an Integrated Pest Management Program to address appropriate herbicide application for fuel break maintenance.
- Coordinate with agricultural users (e.g. legal cannabis cultivation, vineyards and tree farms) to identify sources.
- Advocate for organic only agriculture in the watershed.
- Consider periodic pesticide/herbicide scans of raw water to identify in alignment with timing of application for vineyard/tree farm cultivation for potential frequency and severity of water quality impact.

6.2.9 Agricultural Land Use

Although agricultural acreage continues to remain very small in both total acreage and individual operations, legalization of cannabis cultivation raises concerns with potential for significant effects on water supply remains. Therefore this topic has been moved to the significant category with the future legal cannabis cultivation described earlier. Non cannabis agricultural has some relatively low risk. Vineyards potentially pose more a more serious challenge than Christmas tree plantations or organic vegetable farms, due to tillage disruption of steep slopes that result in erosion and use of chemicals for pest control. The chemical contributions from agriculture are discussed in Section 6.2.8.

6.3 Potential Contaminant Sources That Are Not Significant

Table 6-3 lists the potential contaminant sources which are not deemed to be significant contributors affecting public health at this time. The table lists the supporting information and exceptions when noted. Given the particular Santa Cruz County environment, most of these sources could become significant at times, conditions, or with events discussed above (Section 6.1). Conclusions for these potential contaminant sources are discussed in the following paragraphs.

Table 6-3: Potential Contaminant Sources Less Significant: San Lorenzo Valley, Loch Lomond Reservoir and Upper Newell Creek, and North Coast Watersheds			
Contaminant Source	***Supporting Information***	***Exceptions***	***General Conclusion***
Wildlife	SLVWD staff indicate that feral pigs no longer appear to be an erosion problem near intakes.		Pigs and other wild animal populations do not appear to have a great potential for contamination of surface waters at this time.
Solid/Hazardous Waste Facilities	The Ben Lomond municipal landfill closed in 1987. No known hazardous waste facilities exist in the watershed.	Any remaining plume is not deemed a threat to water supply. County has needed to remove naturally-occurring cadmium which leaches from shales as a result of their exposure to the atmosphere as a result of landfill excavating activities.	Down-gradient monitoring indicates no contamination of surface waters.
Recreation	Recreational activities generally considered of most significance involve water contact recreation. However, an evaluation of the County fecal coliform bacteria data, conducted by the County Health Services Agency, found no significant increase in bacteria in the swimming areas of the San Lorenzo River system. Bacterial water quality appears to improve as the water passes through large open space parks (Henry Cowell State Park) or resides in a reservoir for extended periods (Loch Lomond Reservoir).	The introduction of fecal matter from horses may be significant, especially at stream crossings. The potential for erosion from hiking, horseback riding, and mountain biking may also be significant.	There is an apparent trend of decreasing coliform counts through reaches that pass through the State Parks, which are mostly open space. Erosion control measures have spread quickly throughout the survey area, both on public and private lands. Law enforcement has begun issuing tickets to bikers using illegal trails.

6.3.1 Wildlife

The County's microbial source assessment study identified birds as the major contributor to elevated bacteria levels in the San Lorenzo River and tributary streams as discussed in Section 6.2.1.1. Other wildlife was also found to be a significant source of bacteria. Along with the SLVWD, all utilities with surface and/or spring water intakes in the upper watershed are potentially influenced by birds and other wild animals in the area. If wildlife access at diversions is occurring, fencing and providing alternative water supply should be considered.

6.3.2 Grazing Animals and Livestock

Grazing is not widespread in the subject watersheds. Most of the existing grazing occurs away from local streams.

6.3.3 Solid or Hazardous Waste Facilities

The one closed landfill in the San Lorenzo River watershed (the Ben Lomond Landfill) does not appear to be contaminating the nearest stream, Newell Creek. Overall, illegal dumping is not a significant contaminant source in any of the watersheds, with respect to drinking water quality.

6.3.4 Recreational Uses

The long-term fecal coliform data indicates that swimming may not appreciably impact the microbiological water quality of the streams. In addition, the number of summer swimming holes has decreased as inflatable dams for recreational swimming have been limited in the watershed; a summer dam on Zayante Creek has been observed in recent years and other informal swimming holes may have come into use in 2017 since heavy rains may have continued the runoff period. County monitoring of swimming holes have not indicated significant water quality problems. (J. Ricker, 2017) The most potentially significant recreational activities are horseback riding, trail maintenance and use of off-road vehicle of various types and sizes, all of which constitute locally significant sources of sediment. The continued vehicle use on City property and illicit recreational use in Henry Cowell State park may increase erosion and sedimentation. To the extent that these trails and uses are routed away from stream channels, or are at least separated from them by setbacks or open space areas, sediment and microbial contributions to the adjoining streams will be reduced.

The City conducted a study for expansion of recreational use at Loch Lomond, which concluded, with input from Cal Fire, that additional recreational use is not advisable because of the increase to fire risk as well as other risks associated with access.

6.3.5 NPDES Point Sources

Only small wastewater facilities exist in the San Lorenzo watershed. These include the 1970s-vintage package treatment plant at the Boulder Creek Golf and Country Club, the Bear Creek Estates Wastewater Treatment Plan constructed in 1986 and upgraded in 2008, and the new facility at the San Lorenzo Valley schools in Felton. As noted earlier, SLVWD is considering upgrades at Bear Creek to improve operational reliability. These facilities are currently located

with on-site wastewater disposal and operated in a manner to minimize downstream water quality impacts. Furthermore, the Country Club is investigating the feasibility of reclaiming treated wastewater to a quality suitable for on-site irrigation.

6.4 Other Conclusions and Recommendations

6.4.1 Water-Quality Monitoring

6.4.1.1 Conclusions Regarding Water Quality Monitoring Programs

The drinking water purveyors participating in this study conduct the required monitoring for raw surface water quality. Results are submitted to regulatory agencies, and in many cases will be available to the public through various purveyor and County web sites. Bacterial data, collected weekly, are routinely tabulated with some analysis now conducted by staff. The County website makes beach water quality data readily available to the public for assessing risk for water contact recreation, however long-term river data are less available in a form that allows for evaluation. Budget and staffing constraints continue to limit the ability to improve sharing of water quality data beyond what is currently available. The data collected by individual agencies are sufficient for water treatment plant operators to make real-time operating decisions regarding bypass of high turbidity source waters.

6.4.1.2 Recommendations Regarding Water Quality Monitoring Programs

Water purveyors should consider the following improvements to their monitoring programs:

- Weekly raw water blend and bi-weekly source water total coliform and *E. coli* data collection should be continued.
- As described earlier under Section 6.2.9 for Pesticides and Herbicides, the raw water-quality data programs should be augmented for pesticides and herbicides, particularly from legal cannabis cultivation, because of the potential vulnerability of the water source to this type of contamination. Augmentation should intrinsically include electronic recordation and dissemination of data.
- Evaluate the data regularly to identify any adverse or improving trends and the underlying cause(s) of significant changes.
- Store the data in computerized systems to facilitate easier transmittal of the data to other agencies or to generate graphical water quality trends. The data can then be electronically transferred to a lead agency/utility for routine evaluations.
- As discussed in Section 6.2.6 – Mining/Quarry Activities, current utility water quality databases should be augmented with data collected by quarry operators or other projects responsible for water-quality monitoring in surface or ground waters in either watershed. One potential quarry related monitoring activity is during reclamation grading of the closed Bonny Doon Quarry, which could require significant earth moving.
- Purveyors and the County should seek an assessment of water-quality trends following episodic events, such as large wildfires, earthquakes, and major storms such as occurred in 1982, 1998, 2012 and 2017, such that trends may be anticipated,

contingency plans developed, and any needed interties or backup facilities identified. Western Santa Cruz County appears to have an unusual number and range of such events, and the experience from such events in and near the County could be readily distilled such that responses to these types of events can be readily planned and implemented.

- Prepare for the next watershed sanitary survey update in 5 years by carefully noting and recording concerns or problem areas, and implementing control measures applicable to specific watershed conditions.

6.4.2 Watershed Management Practices

6.4.2.1 Conclusions Regarding Watershed Management Practices

Established policies, ordinances, and regulations in the County's General Plan are available to improve surface water quality that are implemented by the County's Health Services Agency and Planning Departments. As noted in the prior sanitary survey updates, the City has engaged in watershed management activities with a formal emphasis on source protection since 1997, and as discussed in Section 4.2.2.1, has a pool of staff that includes some full-time positions and support from other City staff such as ranger patrols and others that provide education and outreach. The City developed a comprehensive draft watershed lands management plan which includes no commercial logging on City watershed lands. SLVWD updated its watershed plan in 2010 and has had a no-commercial logging policy in place since 1985. The County updated its Watershed Management Plan for the San Lorenzo River Watershed in 2001.

County and local non-profit organizations efforts have led to numerous structural improvements and involvement with citizen groups to educate the general public, most notably during prior County-wide effort to develop watershed assessment and enhancement plans for selected watersheds, including the San Lorenzo Valley. Recent activities include a City-led coordinated effort called San Lorenzo River 2025 which targets action to improve riparian habitat that can leverage several resources including the County, RCD and non profits. Multiple staff commitments, however, tend to interfere with watershed management program progress. Therefore, it seems prudent to dedicate County staff to a watershed management program or to augment program activities with water purveyor and local non-profit organization staff. Local non-profits have been successful, for example, in engaging private horse owners in improving stable and manure management.

6.4.2.2 Recommendations for Water Utilities

Most of the ongoing watershed management efforts are coordinated by County staff as part of the wastewater management program, regional erosion-control efforts, and programs to promote salmonid recovery. Therefore, the drinking water utilities should continue to be active in current watershed management programs, in part to meet the specific objectives for drinkable waters. Some programs to consider, many of which are discussed in prior recommendations are:

Public Education/Relations —Formalize coordination with local non-governmental organizations on public education program may be effective at minimizing soil disruption, improving erosion

control practices, and reducing urban runoff contamination. Purveyors can increase programs to mail educational pamphlets or develop informational websites.

Increase Watershed Surveillance — Staff should report activities within the watershed which can impact water quality. For example, utilities can establish and publicize a watershed "hotline" telephone number to report illegal, unauthorized, or detrimental activities.

Political Support — Water utilities should enhance existing political support through activities such as collaboration on management plan activities, commenting on pending and proposed regulation, and inviting representatives to watershed focused events.

Special Sandy Soil Provisions – An *integrated* program meshing use of BMPs and other measures designed to minimize the erosion, sedimentation, nutrient and pathogen issues of Zayante and other sandy soils, plus protect the ground water, wetlands, and valuable stream habitats that they support should be developed and implemented. It will mean more recharge of aquifers with lower level of contaminants, less sand in streams, more water in wetlands and channels, and less maintenance of public facilities, in addition to cleaner water.

Road Restoration based on Road Density Analysis - Lobby Board of Supervisors and County Management to develop and fund road restoration program based on road density analysis for key water-supply watersheds developed as an indicator of ecosystem health. Identify grant funding to support these and other activities that benefit water quality and the Coho Recovery Plan.

San Lorenzo Valley Watershed Management Plan In 2001 County Environmental Health completed an update of the update to the 1979 Watershed Management Plan. Water utilities should emphasize to their staff and customers the benefits likely to accrue to drinking water quality from successfully achieving the programs goals. They should also continue their participation in the program, support implementation through the County's Integrated Regional Water Management Plan, and to help shape subsequent updates.

6.4.2.3 Recommendations for Watershed Managers

Other issues the County and water utilities should consider when developing watershed management programs include:

Continue to investigate and implement feasible management practices. Descriptions of alternative practices are available from numerous sources, especially from such agencies as the American Water Works Association (AWWA) and Water Environment Federation (WEF). Both of these agencies have recently sponsored research projects and conferences to assist communities improve watershed management and protection.

Publicize the programs and materials: These are available from the Resource Conservation District, other County agencies, and local non-governmental organizations which describe specific practices to control erosion from hillsides and roadways, stabilize slopes, construct silt fences construct spring boxes, and to site, construct and maintain septic or advanced on-site waste-disposal systems:

Investigate methods to integrate watershed management projects with other benefits. Some of the projects to enhance watershed management may be able to obtain Federal and State funding if other benefits (e.g., fishery improvements and groundwater storage) are integrated into the existing watershed management program. Several watershed management projects

are funded using this approach especially through the Department of Water Resources Integrated Regional Water Management (IRWM) program. Through IRWM program the City and County staff are able to meet with other agencies and utilities to discuss watershed management funding needs for specific programs. This includes establishing guidelines to propose projects to councils, boards, etc., and to request support from non-conventional sources for pilot programs, etc.

Development of a holistic approach to manage areas with sandy soils – As described earlier, these measures which (a) limit erosion, (b) reduce sedimentation of streams and drainage improvements, (c) maintain needed recharge to the sandy aquifers, critical to the region's drought-year water supply, (d) sustain sufficient recharge to protect water quality and control nitrate accumulation in the aquifers, and (e) allow springs and wetlands supported by these aquifers to maintain their functions and values.

6.4.3 Emergency Plans

All water purveyors now have vulnerability assessments, and have or are updating emergency plans linked to 911 and emergency services agencies. Continued maintenance and updating of these plans as well as conduct of emergency drills by the purveyors is needed. Improved maps are available to emergency crews through the County's GIS services, and via web-based mapping and aerial photography available through commercial websites at all times. As discussed in Section 6.2.8, continued efforts to improve notification of water utilities of chemical spills, and other water quality emergencies by dispatchers and on-scene planning is an important element of emergency planning.

6.5 Summary of Activities

Implementation of the broad range of recommended actions (as described in Section 6.4) is outside of SCWD's direct control; therefore collaboration with other agencies and non-governmental organizations is likely the most feasible means as reallocation of, or possibly additions to, existing staff is unlikely to occur. In addition, the City should continue to seek opportunities to identify and apply for funding for projects/programs that could be implemented by City law enforcement and Watershed staff as well as by non-governmental organizations. Therefore, the drinking water utilities and County should discuss the watershed issues with other entities and develop an implementation plan, including the need for additional staffing, for the selected management practices. The attached Table 6-4 summarizes the activities and identifies some preliminary timelines so that it can be used as a checklist for periodic review.

Table 6-4 Worksheet of Recommended Watershed Management Activities and Actions

	AGENCY PARTNERS																			Significant Contaminating Activities Targeted With Action								
	CITY		Santa Cruz County																									
Action Items	**SCWD**	Parks	**SLVWD**	Parks	Env Health	Sheriff	Planning	Public Works	RCD of SC	State and Federal Wildlife Agencies	Cal Fire	State Parks	RWQCB - Central Coast	Federal Agencies (eg NMFS)	CWC (Coastal WS Council)	Fire Safe Councils	MGA/SMGA	Local Clubs (eg VWC)	Sempirvirens/POST/ TNC	Wastewater (septic systems)	Urban Runoff[1]	Concentrated Animal Facilities	Unauthorized/ Illegal Activites	Cannabis Cultivation	Timber Operations	Geological/ Landslides	Wildfire (preparedness)	Pesticide and Herbicide Use
SLR 2025 Partnership Program Activities including:																												
Habitat Restoration and Watershed Protection including application of City Riparian Conservation Program in County areas/Coho Recovery Plan/ Advocate for wider riparian buffers in County projects and County riparian ordinance update	L		P		S		S		S	S	S	S			S					X	X	X		X	X			X
Wildfire Planning and Readiness	S		P			S	S		S		L	S				S							X	X	X		X	X
Flood Protection and Sea Level Rise	S		S		S		S	S													X							
Public access to natural areas	S		S	L								S											X				X	
Riparian Conservation Program																												
Establish Existing conditions and Assessment Data and Mapping; evaluate preparation of watershed report card	S		S						S				S							X	X	X	X	X	X	X	X	X
Riparian Habitat Protection including Existing Code Compliance Roundtable (CCR) and Creek School (eg Create opportunities for RCD training/follow up on roads, confined animals, other before formal enforcement)	S		S		S	S	L		S	S	S							S		X	X	X	X	X		X	X	X
Active Conservation including Identifying key parcels for land use agreements that will likely result in water qualtiy benefit	S		S				S		S			S					S	S		X	X	X	X	X	X	X	X	X
Education and Outreach for Riparian Conservation	L	S	P/L		S				S			S					S				X		X			X		X
Increase presence in watershed lands including riparian areas (e.g. upstream of Tait at Sycamore Grove and near and within State Parks land) re homeless, MTB, other unauthorized activities	L	S	S	S		S				S	S	L						S			X		X	X		X	X	
Review Emergency Plans for notification and contact info update. Discuss regular meeting with NETCOMM and first responders to share contacts and recent occurrences	L		S		S					S	S										X		X					
Confirm Karst protection language updates in County ordinances	L		P		S		S/L			S								S		X		X		X				
Meet with other local/state agencies to discuss Cannabis including: status of permits, complaints, inspection findings, and follow up (eg support existing code compliance round table)	S		S		L	S	S			S	S									X	X		X	X	X	X	X	X
Locate cannabis grows using County and State Data, target inspection (including downstream wq) based on proximity to intakes (i.e. upper Newell Creek, upstream of SLVWD intakes, etc.) and adapt testing/inspection accordingly; report to task force	S		L		S		L			S	S									X	X			X		X	X	X
Support sustainable agriculture in the water supply watersheds including consideration of third party certification, development of water resource protection or other farm management plans	S		S		S		L		S	S											X			X			X	X

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Appendix A: Engineering Report to Demonstrate that GHWTP Filters meet Turbidity Performance Requirements for Increased Giardia Log Removal Credit SCWD Graham Hill WTP Operations Permit Assistance

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6 June 2013

Technical Memorandum

To: Mr. Terry Tompkins, SCWD

From: Julia Sorensen Lund, PE
Todd Reynolds, PE
Craig Thompson, PE

Subject: Engineering Report to Demonstrate that the GHWTP Filters meet the Turbidity Performance Requirements for Increased *Giardia* Log Removal Credit
SCWD Graham Hill WTP Operations Permit Assistance
K/J 1268001*00

Introduction and Background

The Santa Cruz Water Department's (SCWD) Graham Hill Water Treatment Plant (GHWTP) is a conventional surface water treatment plant with pre-oxidation, taste and odor treatment with permanganate and powdered activated carbon, rapid mix (flash) coagulation, flocculation, sedimentation, granular media filtration, free chlorine disinfection, and corrosion control. The GHWTP receives source water supplies from three North Coast sources (Laguna Diversion, Liddell Springs, and Majors Diversion), the San Lorenzo River (Tait St Diversion, Tait Wells, and Felton Diversion via Newell Creek Reservoir), and Newell Creek Reservoir (Loch Lomond Reservoir). The raw source water entering the GHWTP for treatment often is a blend of the different sources.

Since 1998, the California Department of Public Health (CDPH) has required the GHWTP to achieve an increased level of pathogen removal and inactivation – a total of 4-log *Giardia* cyst and 5-log virus reduction – through filtration and disinfection to be in compliance with the California Surface Water Treatment Rule (SWTR). The basis for the increased removal-inactivation requirements is historically elevated levels of total coliform in the source water, primarily in the San Lorenzo River source water to the GHWTP.

The GHWTP has been able to meet the increased requirements by providing pathogen inactivation (1.5-log *Giardia* inactivation) through the addition of chlorine ahead of the settling basins to achieve the required disinfection CT (disinfectant concentration times contact time). However, the reaction of natural organic matter and the chlorine disinfectant in the settling basins creates disinfection byproducts (DBP) that are regulated by the Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 D/DBPR). As more water from Loch Lomond is treated at the GHWTP, the higher levels of organics in this water could lead to higher levels of DBPs.

The SCWD needs to meet SWTR requirements to control both acute microbial health risks from pathogens (*Giardia, Cryptosporidium*, and viruses) and chronic health risks from chlorinated DBPs. Complying with both the SWTR and the Stage 2 D/DBP Rules requires a balance

between providing removal and inactivation of pathogens while minimizing the formation of DBPs that come from the pathogen inactivation (disinfection) process.

Potential to Increase the Giardia Removal Credit for the GHWTP Based on Filter Performance

Kennedy/Jenks Consultants (Kennedy/Jenks) worked with SCWD staff to review the GHWTP source water quality data, to evaluate plant operations and performance data, and to identify opportunities for potential changes to the GHWTP operations permit, operations and facilities to help reduce DBP formation. In July 2012, Kennedy/Jenks completed the Graham Hill Water Treatment Plant Operations Permit Assistance Study Draft Report (Draft Report). One of the objectives in the Draft Report was to evaluate and provide supporting data for the SCWD to request an increase in the current GHWTP *Giardia* log removal credit from 2.5-log to either 3-log or 3.5-log based on treatment plant and filter performance data. The Draft Report evaluated filter performance data from February 2011 through March 2012.

SCWD submitted the Draft Report to the CDPH for review and consideration. CDPH provided a letter response, dated 8 March 2013, with review comments indicating that the GHWTP may qualify for and obtain additional *Giardia* log removal credit under an amendment to the Operating Permit. SCWD staff and Kennedy/Jenks met with CDPH staff on 4 April 2013 to further discuss the potential to obtain additional *Giardia* log removal credit for the GHWTP.

The basis for obtaining additional *Giardia* log removal credit, as discussed in the Draft Report and described in the CDPH letter, is as follows:

> "The USEPA Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) provides for conventional surface water treatment plants to receive additional 0.5-log *Giardia* removal credit if the filter performance consistently achieves a 95th percentile combined filter effluent (CFE) of 0.15 nephelometric turbidity units (NTU) or lower, based on recorded turbidity measurements collected at fifteen (15) minute intervals. An additional 0.5-log *Giardia* removal credit is allowable if the individual filter effluent (IFE) performance also consistently achieves a 95th percentile turbidity of 0.15 NTU or lower, based on recorded turbidity measurements collected at fifteen (15) minute intervals."

Therefore, by demonstrating that the existing conventional filters reliably meet the turbidity performance requirements outlined above, the GHWTP could receive up to an additional 1-log of *Giardia* removal credit (0.5-log for CFE performance and 0.5 log for IFE performance).

Purpose of Report

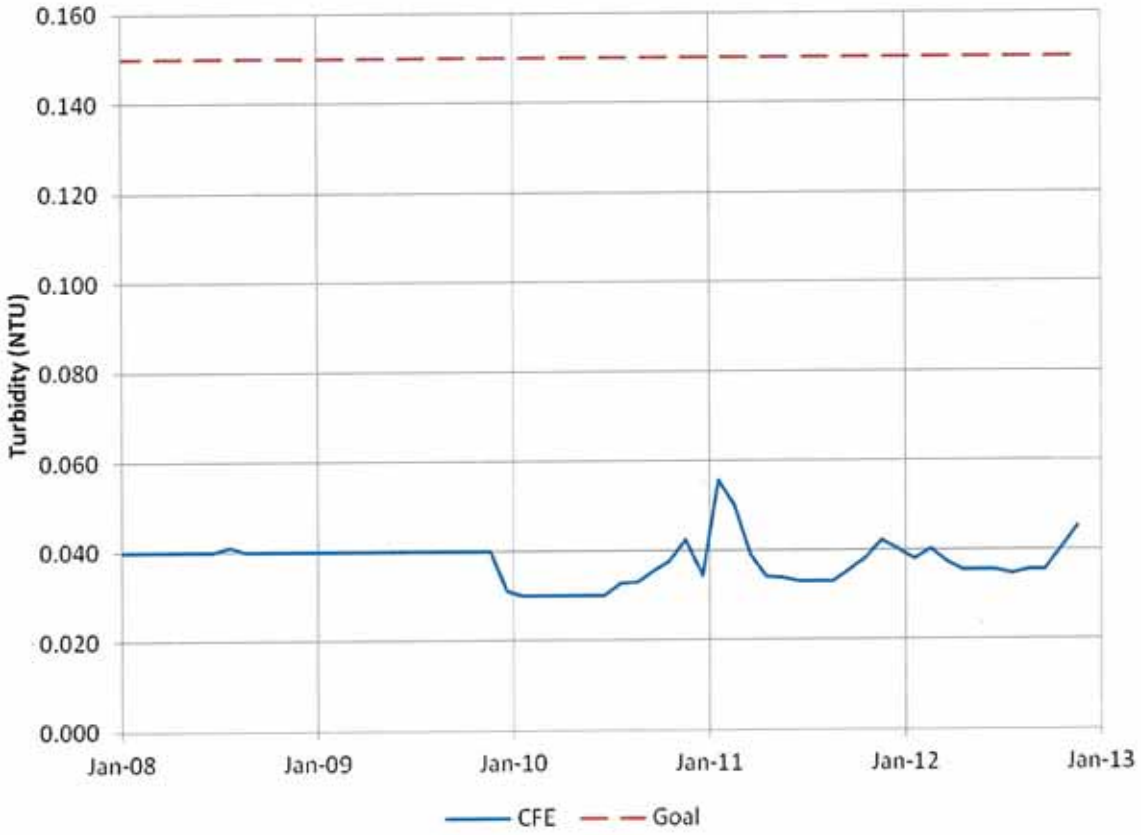
In the March 2013 CDPH letter and from discussions at the April 2013 meeting, the CDPH has requested an engineering report that demonstrates the existing conventional GHWTP filters can reliably achieve the filter turbidity performance requirements to receive additional *Giardia* log removal credits. CDPH indicated that the filter performance data evaluation should cover a five-year period. This technical memorandum (TM) is intended to serve as the requested engineering report to demonstrate that the GHWTP can reliably meet the filter turbidity requirements to receive an additional 1-log *Giardia* removal credit. The data evaluation in this report includes CFE and IFE data during the five-year period from January 2008 through December 2012.

GHWTP Filter Performance Turbidity Data Evaluation

SCWD provided one-minute filtered water turbidity data for the GHWTP CFE and each of the six bifurcated filters for January 2008 through December 2012. Data were sorted to select a data point at 15-minute intervals (to meet the request of CDPH and to be consistent with the previously evaluated data from February 2011 through March 2012). Between January 2008 and September 2010 (33 months of the 60-month period), each of the six filters had one turbidity measurement; in the following 27 months, twelve separate turbidity measurements were reported corresponding to the "left side" and "right side" of each of the six filters. Note that the previously evaluated data from February 2011 through March 2012 only included one turbidity measurement for each of the six filters. As part of the data review, unusual turbidity data (such as values > 0.3 NTU) were confirmed with SCWD to have occurred during filter maintenance, turbidimeter calibration, or other offline activities and were removed from the filtered water turbidity data used to determine the 95th percentile values. The monthly 95th percentile turbidity values for the CFE and IFE are shown in Figures 1 and 2, respectively, and are summarized in Table 1.

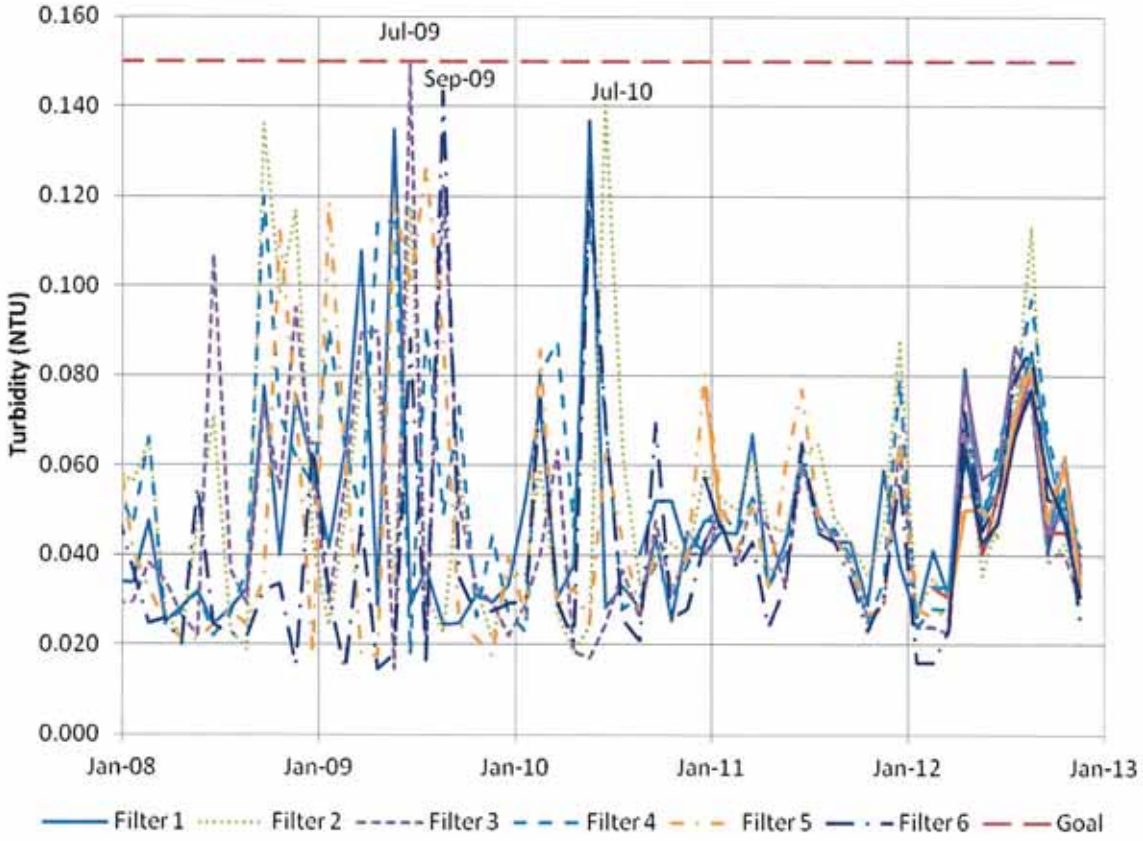
As shown in Figure 1 and Table 1, the CFE filter performance consistently achieves a 95th percentile of 0.15 NTU or lower, based on recorded turbidity measurements collected at fifteen-minute intervals. The 95th percentile CFE turbidity over the five year period was in the range of 0.04 to 0.06 NTU.

Figure 1 CFE Turbidity Monthly 95th Percentile Values, 2008 to 2012



As shown in Figure 2 and Table 1, the IFE filter performance consistently achieves a 95th percentile of 0.15 NTU or lower, based on recorded turbidity measurements collected at fifteen-minute intervals. The 95th percentile IFE turbidity data over the five year period have greater variability but are 0.15 NTU or lower. It is possible that some of the IFE turbidity peaks (such as the ones in July 2009, September 2009 and July 2010) correspond to maintenance or calibration events. Unusual turbidity data was only reviewed with SCWD for peaks exceeding 0.15 NTU.

Figure 2 IFE Turbidity Monthly 95th Percentile Values, 2008 to 2012



Based on the five years of CFE and IFE filter turbidity performance data, the existing GHWTP conventional filters reliably meet the performance requirements to receive an additional 1-log of *Giardia* removal credit.

Monthly maximum turbidity values also were reviewed to confirm that the GHWTP complied with the LT2ESWTR requirement that no individual filter may have a measured turbidity greater than 0.3 NTU in two consecutive measurements taken 15 minutes apart after four hours of operation. Based on the five years of IFE filter turbidity performance data, the GHWTP meets that requirement also.

Table 1 **95th Percentile Turbidity Data, January 2008 to December 2012**

Month	Filter[a,b]						
	1	2	3	4	5	6	CFE[c]
Jan-08	0.034	0.059	0.029	0.056	0.066	0.050	0.040
Feb-08	0.034	0.056	0.029	0.047	0.041	0.037	0.040
Mar-08	0.048	0.066	0.038	0.066	0.033	0.025	0.040
Apr-08	0.025	0.026	0.034	0.024	0.025	0.026	0.040
May-08	0.028	0.022	0.027	0.028	0.022	0.020	0.040
Jun-08	0.032	0.047	0.022	0.032	0.021	0.055	0.040
Jul-08	0.025	0.071	0.107	0.022	0.024	0.024	0.040
Aug-08	0.028	0.023	0.037	0.027	0.027	0.022	0.041
Sep-08	0.032	0.019	0.029	0.036	0.024	0.022	0.040
Oct-08	0.077	0.136	0.074	0.120	0.035	0.032	0.040
Nov-08	0.040	0.098	0.055	0.071	0.112	0.033	0.040
Dec-08	0.075	0.117	0.095	0.062	0.074	0.015	0.040
Jan-09	0.059	0.042	0.056	0.055	0.018	0.065	0.040
Feb-09	0.042	0.024	0.029	0.090	0.119	0.031	0.040
Mar-09	0.063	0.048	0.056	0.063	0.062	0.014	0.040
Apr-09	0.108	0.081	0.090	0.049	0.017	0.047	0.040
May-09	0.029	0.076	0.090	0.115	0.018	0.015	0.040
Jun-09	0.135	0.033	0.015	0.114	0.119	0.018	0.040
Jul-09	0.029	0.118	0.149	0.018	0.100	0.088	0.040
Aug-09	0.037	0.031	0.017	0.091	0.127	0.016	0.040
Sep-09	0.025	0.023	0.122	0.049	0.088	0.143	0.040
Oct-09	0.025	0.058	0.051	0.073	0.025	0.035	0.040
Nov-09	0.031	0.033	0.033	0.026	0.022	0.027	0.040
Dec-09	0.029	0.021	0.029	0.044	0.018	0.028	0.040

Table 1 **95th Percentile Turbidity Data, January 2008 to December 2012**

Month	Filter[a,b]												
	1		2		3		4		5		6		CFE[c]
Filter Side[d]	LS	RS											
Jan-10	0.033		0.036		0.022		0.027		0.040		0.029		0.031
Feb-10	0.053		0.036		0.029		0.023		0.026		0.030		0.030
Mar-10	0.074		0.060		0.040		0.081		0.086		0.075		0.030
Apr-10	0.030		0.027		0.063		0.088		0.028		0.029		0.030
May-10	0.038		0.018		0.018		0.046		0.033		0.021		0.030
Jun-10	0.137		0.024		0.017		0.115		0.025		0.123		0.030
Jul-10	0.028		0.140		0.024		0.068		0.062		0.070		0.030
Aug-10	0.033		0.062		0.037		0.028		0.043		0.026		0.033
Sep-10	0.028	0.040	0.033		0.026		0.031		0.028		0.021		0.033
Oct-10	0.044	0.052	0.040		0.048		0.038		0.040		0.070		0.035
Nov-10	0.025	0.052	0.043		0.032		0.031		0.033		0.026		0.038
Dec-10	0.045	0.040	0.039		0.040		0.038		0.040		0.028		0.042
	LS	RS	LS	RS	LS	RS	LS	RS	LS	RS	LS	RS	
Jan-11	0.040	0.048	0.059	0.067	0.040	0.043	0.048	0.057	0.080	0.077	0.043	0.057	0.034
Feb-11	0.045	0.048	0.052		0.048	0.050	0.050		0.052	0.048	0.048	0.046	0.056
Mar-11	0.045		0.050		0.038		0.045		0.041		0.037		0.050
Apr-11	0.067		0.062		0.053		0.053		0.051		0.043		0.039
May-11	0.033		0.047		0.046		0.033		0.033		0.024		0.034
Jun-11	0.043		0.045		0.033		0.040		0.060		0.033		0.034
Jul-11	0.061		0.063		0.060		0.063		0.077		0.065		0.033
Aug-11	0.049		0.065		0.046		0.045		0.048		0.045		0.033
Sep-11	0.043		0.048		0.045		0.046		0.043		0.043		0.033
Oct-11	0.043		0.043		0.038		0.040		0.040		0.035		0.036
Nov-11	0.029		0.035		0.026		0.025		0.027		0.023		0.038
Dec-11	0.059		0.046		0.029		0.034		0.028		0.031		0.042

Table 1 95th Percentile Turbidity Data, January 2008 to December 2012

Month	Filter[a,b]												
	1		2		3		4		5		6		CFE[c]
	LS	RS	LS	RS	LS	RS	LS	RS	LS	RS	LS	RS	
Jan-12	0.038		0.088		0.065		0.079		0.067		0.057		0.040
Feb-12	0.026		0.027		0.024		0.024		0.028		0.016		0.038
Mar-12	0.041		0.035	0.033	0.024		0.028	0.033	0.026		0.016		0.040
Apr-12	0.031	0.033	0.030	0.031	0.023	0.031	0.028	0.033	0.028	0.028	0.023	0.026	0.037
May-12	0.067	0.082	0.072	0.066	0.070	0.079	0.060	0.065	0.055	0.050	0.072	0.064	0.035
Jun-12	0.040	0.048	0.035	0.040	0.050	0.057	0.048	0.048	0.050	0.050	0.045	0.043	0.036
Jul-12	0.048	0.054	0.048	0.054	0.055	0.060	0.065	0.060	0.044	0.047	0.052	0.047	0.036
Aug-12	0.070	0.072	0.072	0.067	0.082	0.087	0.077	0.071	0.077	0.072	0.079	0.067	0.035
Sep-12	0.077	0.077	0.114	0.082	0.074	0.079	0.097	0.085	0.082	0.082	0.086	0.077	0.035
Oct-12	0.040	0.043	0.038	0.045	0.040	0.046	0.067	0.064	0.048	0.048	0.052	0.057	0.035
Nov-12	0.055	0.062	0.043	0.045	0.040	0.050	0.053	0.048	0.062	0.060	0.051	0.047	0.040
Dec-12	0.034	0.036	0.031	0.040	0.030	0.038	0.043	0.042	0.033	0.033	0.026	0.031	0.045

Notes:

(a) Values from January 2008 through February 2011 and from March 2012 through December 2012 are based on data collected at 1-minute intervals that has been filtered to select a data point at 15 minute intervals (to meet the request of CDPH and to be consistent with Note (b).

(b) Data for the period between February 2011 and March 2012 were analyzed as part of the the Draft Graham Hill Water Treatment Plant Operations Permit Assistance Study, dated 20 July 2012. The 95th percentile values were calculated based on data collected at 15-minute intervals that included one turbidity reading for each filter.

(c) CFE = combined filter effluent.

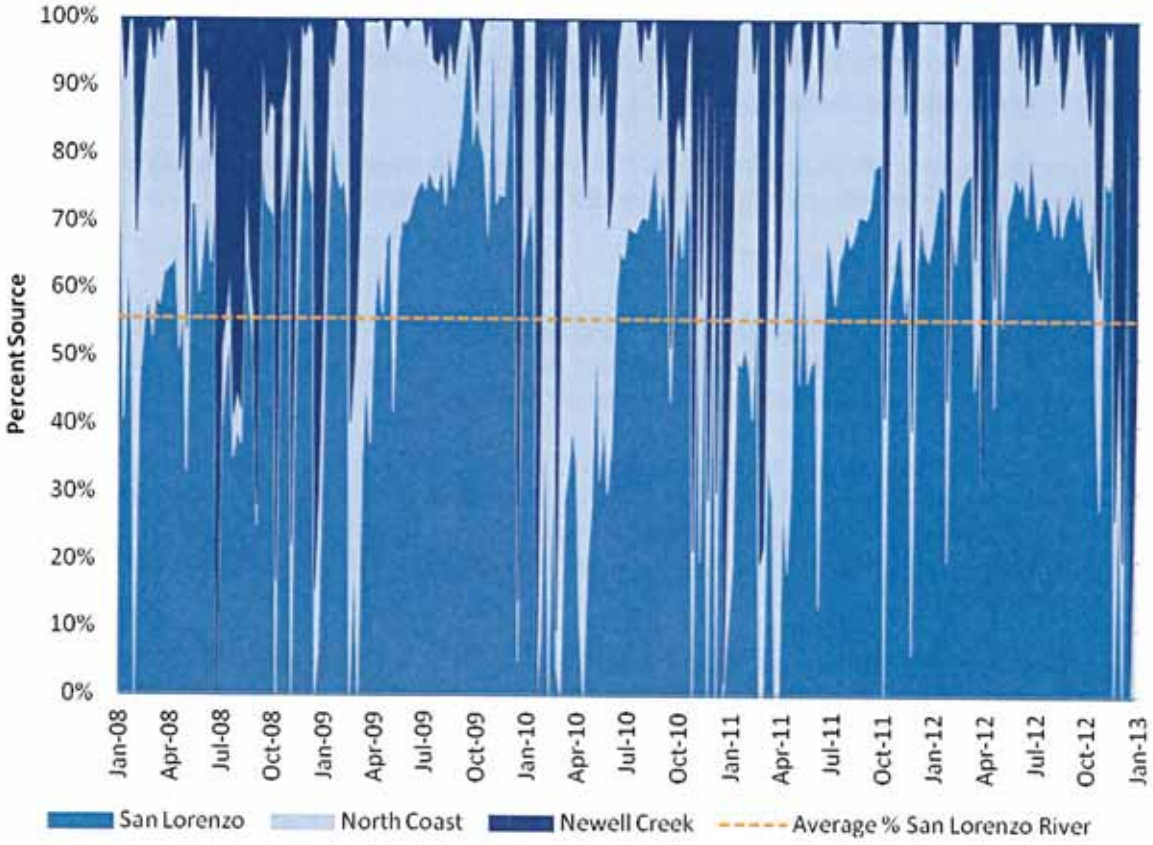
(d) LS = left side, RS = right side.

Source Water Portfolio Consideration

The GHWTP receives source water supplies from the San Lorenzo River, North Coast creeks, and Newell Creek. The raw source water entering the GHWTP for treatment is often a blend of the different sources. The source water portfolio during the period from 2008 to 2012 was reviewed to understand if the consistently low turbidity in the CFE and IFE was related to a consistent source water portfolio.

Between 2008 and 2012, the San Lorenzo River was the primary source of water, providing approximately 56% of the flowrate to SCWD. The North Coast and Newell Creek sources were used more often during winter months, providing up to 65% between November and March during this period. The cumulative source water percentages for 2008 to 2012 are shown in Figure 3 below.

Figure 3 Cumulative Source Water Percentages, 2008 to 2012



As shown in Figure 3, the source water blend to the GHWTP varied widely over this period of time. Although the amount of water from each source of water varied, the plant performance and the CFE and IFE turbidity remained consistently below the 0.15 NTU objective. The SCWD operations staff has a good understanding of the different characteristics of the various source waters and can reliably achieve the turbidity performance requirements to permit the GHWTP to receive additional *Giardia* removal credit.

Proposed Future Filter Improvements for the GHWTP

SCWD is in the process of evaluating and recommending rehabilitation and upgrade improvements for the conventional granular media filters at the GHWTP. The improvements are expected to be designed and constructed over the next few years and may include:

- New filter underdrains that permit deeper filter media design
- Deeper multi-media that increases the ratio of bed depth to average filter grain effective size (L/d ratio) from approximately 925 to 1,100
- Air scour to improve the backwash efficiency of the filters
- Polymer addition to the backwash supply water

These improvements will permit the GHWTP to continue to reliably achieve the turbidity performance requirements and to receive additional *Giardia* removal credit.

Summary and Conclusions

This TM serves as the engineering report, requested by CDPH in their March 2013 letter, to demonstrate that the GHWTP can reliably meet the filter turbidity requirements to receive additional *Giardia* removal credit. The findings of this TM are:

- Based on five years of operational data, the GHWTP CFE filter performance consistently achieves a 95th percentile of 0.15 NTU or lower, based on recorded turbidity measurements collected at fifteen-minute intervals. Therefore, the GHWTP meets the requirements to receive an additional 0.5-log *Giardia* removal credit for CFE filter performance.

- Based on five years of operational data, the GHWTP IFE filter performance consistently achieves a 95th percentile of 0.15 NTU or lower, based on recorded turbidity measurements collected at fifteen-minute intervals. Therefore, the GHWTP meets the requirements to receive an additional 0.5-log *Giardia* removal credit for IFE filter performance.

Therefore, the existing GHWTP conventional filters reliably meet the performance requirements to receive up to a total additional 1-log of *Giardia* removal credit. Furthermore, planned improvements to the GHWTP filters will permit the SCWD to continue to reliably achieve the turbidity performance requirements in the future.

Appendix B: Primary and Secondary Maximum Contaminant Limits

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MCLs, DLRs, and PHGs for Regulated Drinking Water Contaminants

(Units are in milligrams per liter (mg/L), unless otherwise noted.)

Last Update: January 10, 2018

This table includes:

California's maximum contaminant levels (MCLs)

Detection limits for purposes of reporting (DLRs)

Public health goals (PHGs) from the Office of Environmental Health Hazard Assessment (OEHHA)

Also, the PHG for NDMA (which is not yet regulated) is included at the bottom of this table.

For comparison:

Federal MCLs and Maximum Contaminant Level Goals (MCLGs) (US EPA)

	MCL	DLR	PHG	Date of PHG	MCL	MCLG
Chemicals with MCLs in 22 CCR §64431—Inorganic Chemicals						
Aluminum	1	0.05	0.6	2001	--	--
Antimony	0.006	0.006	0.001	2016	0.006	0,006
Arsenic	0.010	0.002	0.000004	2004	0.010	zero
Asbestos (MFL = million fibers per liter; for fibers >10 microns long)	7 MFL	0.2 MFL	7 MFL	2003	7 MFL	7 MFL
Barium	1	0.1	2	2003	2	2
Beryllium	0.004	0.001	0.001	2003	0.004	0.004
Cadmium	0.005	0.001	0.00004	2006	0.005	0.005
Chromium, Total - OEHHA withdrew the 0.0025-mg/L PHG	0.05	0.01	withdrawn Nov. 2001	1999	0.1	0.1
Chromium, Hexavalent - 0.01-mg/L MCL & 0.001-mg/L DLR repealed September 2017	--	--	0.00002	2011	--	--
Cyanide	0.15	0.1	0.15	1997	0.2	0.2
Fluoride	2	0.1	1	1997	4.0	4.0
Mercury (inorganic)	0.002	0.001	0.0012	1999 (rev2005)*	0.002	0.002
Nickel	0.1	0.01	0.012	2001	--	--
Nitrate (as nitrogen, N)	10 as N	0.4	45 as NO3 (=10 as N)	1997	10	10
Nitrite (as N)	1 as N	0.4	1 as N	1997	1	1
Nitrate + Nitrite (as N)	10 as N	--	10 as N	1997	--	--
Perchlorate	0.006	0.004	0.001	2015	--	--
Selenium	0.05	0.005	0.03	2010	0.05	0.05
Thallium	0.002	0.001	0.0001	1999 (rev2004)	0.002	0.0005
Copper and Lead, 22 CCR §64672.3						
Values referred to as MCLs for lead and copper are not actually MCLs; instead, they are called "Action Levels" under the lead and copper rule						
Copper	1.3	0.05	0.3	2008	1.3	1.3
Lead	0.015	0.005	0.0002	2009	0.015	zero
Radionuclides with MCLs in 22 CCR §64441 and §64443—Radioactivity						
[units are picocuries per liter (pCi/L), unless otherwise stated; n/a = not applicable]						
Gross alpha particle activity - OEHHA concluded in 2003 that a PHG was not practical	15	3	none	n/a	15	zero
Gross beta particle activity - OEHHA concluded in 2003 that a PHG was not practical	4 mrem/yr	4	none	n/a	4 mrem/yr	zero

Radium-226	--	1	0.05	2006		
Radium-228	--	1	0.019	2006		
Radium-226 + Radium-228	5	--	--	--	5	zero
Strontium-90	8	2	0.35	2006	--	--
Tritium	20,000	1,000	400	2006	--	--
Uranium	20	1	0.43	2001	30 µg/L	zero
Chemicals with MCLs in 22 CCR §64444 —Organic Chemicals						
(a) Volatile Organic Chemicals (VOCs)						
Benzene	0.001	0.0005	0.00015	2001	0.005	zero
Carbon tetrachloride	0.0005	0.0005	0.0001	2000	0.005	zero
1,2-Dichlorobenzene	0.6	0.0005	0.6	1997 (rev2009)	0.6	0.6
1,4-Dichlorobenzene (p-DCB)	0.005	0.0005	0.006	1997	0.075	0.075
1,1-Dichloroethane (1,1-DCA)	0.005	0.0005	0.003	2003	--	--
1,2-Dichloroethane (1,2-DCA)	0.0005	0.0005	0.0004	1999 (rev2005)	0.005	zero
1,1-Dichloroethylene (1,1-DCE)	0.006	0.0005	0.01	1999	0.007	0.007
cis-1,2-Dichloroethylene	0.006	0.0005	0.1	2006	0.07	0.07
cis-1,2-Dichloroethylene	--	--	0.013	2017 draft	--	--
trans-1,2-Dichloroethylene	0.01	0.0005	0.06	2006	0.1	0.1
trans-1,2-Dichloroethylene	--	--	0.05	2017 draft	--	--
Dichloromethane (Methylene chloride)	0.005	0.0005	0.004	2000	0.005	zero
1,2-Dichloropropane	0.005	0.0005	0.0005	1999	0.005	zero
1,3-Dichloropropene	0.0005	0.0005	0.0002	1999 (rev2006)	--	--
Ethylbenzene	0.3	0.0005	0.3	1997	0.7	0.7
Methyl tertiary butyl ether (MTBE)	0.013	0.003	0.013	1999	--	--
Monochlorobenzene	0.07	0.0005	0.07	2014	0.1	0.1
Styrene	0.1	0.0005	0.0005	2010	0.1	0.1
1,1,2,2-Tetrachloroethane	0.001	0.0005	0.0001	2003	0.1	0.1
Tetrachloroethylene (PCE)	0.005	0.0005	0.00006	2001	0.005	zero
Toluene	0.15	0.0005	0.15	1999	1	1
1,2,4-Trichlorobenzene	0.005	0.0005	0.005	1999	0.07	0.07
1,1,1-Trichloroethane (1,1,1-TCA)	0.2	0.0005	1	2006	0.2	0.2
1,1,2-Trichloroethane (1,1,2-TCA)	0.005	0.0005	0.0003	2006	0.005	0.003
Trichloroethylene (TCE)	0.005	0.0005	0.0017	2009	0.005	zero
Trichlorofluoromethane (Freon 11)	0.15	0.005	1.3	2014	--	--
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	1.2	0.01	4	1997 (rev2011)	--	--
Vinyl chloride	0.0005	0.0005	0.00005	2000	0.002	zero
Xylenes	1.75	0.0005	1.8	1997	10	10
(b) Non-Volatile Synthetic Organic Chemicals (SOCs)						
Alachlor	0.002	0.001	0.004	1997	0.002	zero
Atrazine	0.001	0.0005	0.00015	1999	0.003	0.003
Bentazon	0.018	0.002	0.2	1999 (rev2009)	--	--
Benzo(a)pyrene	0.0002	0.0001	0.000007	2010	0.0002	zero
Carbofuran	0.018	0.005	0.0007	2016	0.04	0.04
Chlordane	0.0001	0.0001	0.00003	1997 (rev2006)	0.002	zero
Dalapon	0.2	0.01	0.79	1997 (rev2009)	0.2	0.2
1,2-Dibromo-3-chloropropane (DBCP)	0.0002	0.00001	0.0000017	1999	0.0002	zero
2,4-Dichlorophenoxyacetic acid (2,4-D)	0.07	0.01	0.02	2009	0.07	0.07

Appendix B1- Comparison of National Primary Drinking Water Regulatons and California Drinking Water Standards

Di(2-ethylhexyl)adipate	0.4	0.005	0.2	2003	0.4	0.4
Di(2-ethylhexyl)phthalate (DEHP)	0.004	0.003	0.012	1997	0.006	zero
Dinoseb	0.007	0.002	0.014	1997 (rev2010)	0.007	0.007
Diquat	0.02	0.004	0.006	2016	0.02	0.02
Endothal	0.1	0.045	0.094	2014	0.1	0.1
Endrin	0.002	0.0001	0.0003	2016	0.002	0.002
Ethylene dibromide (EDB)	0.00005	0.00002	0.00001	2003	0.00005	zero
Glyphosate	0.7	0.025	0.9	2007	0.7	0.7
Heptachlor	0.00001	0.00001	0.000008	1999	0.0004	zero
Heptachlor epoxide	0.00001	0.00001	0.000006	1999	0.0002	zero
Hexachlorobenzene	0.001	0.0005	0.00003	2003	0.001	zero
Hexachlorocyclopentadiene	0.05	0.001	0.002	2014	0.05	0.05
Lindane	0.0002	0.0002	0.000032	1999 (rev2005)	0.0002	0.0002
Methoxychlor	0.03	0.01	0.00009	2010	0.04	0.04
Molinate	0.02	0.002	0.001	2008	--	--
Oxamyl	0.05	0.02	0.026	2009	0.2	0.2
Pentachlorophenol	0.001	0.0002	0.0003	2009	0.001	zero
Picloram	0.5	0.001	0.166	2016	0.5	0.5
Polychlorinated biphenyls (PCBs)	0.0005	0.0005	0.00009	2007	0.0005	zero
Simazine	0.004	0.001	0.004	2001	0.004	0.004
Thiobencarb	0.07	0.001	0.042	2016	--	--
Toxaphene	0.003	0.001	0.00003	2003	0.003	zero
1,2,3-Trichloropropane	0.000005	0.000005	0.0000007	2009	--	--
2,3,7,8-TCDD (dioxin)	$3x10^{-8}$	$5x10^{-9}$	$5x10^{-11}$	2010	$3x10^{-8}$	zero
2,4,5-TP (Silvex)	0.05	0.001	0.003	2014	0.05	0.05
Chemicals with MCLs in 22 CCR §64533—Disinfection Byproducts						
Total Trihalomethanes	0.080	--	0.0008	2010 draft	0.080	--
Bromodichloromethane	--	0.0010	--	--	--	zero
Bromoform	--	0.0010	--	--	--	zero
Chloroform	--	0.0010	--	--	--	0.07
Dibromochloromethane	--	0.0010	--	--	--	0.06
Haloacetic Acids (five) (HAA5)	0.060	--	--	--	0.060	--
Monochloroacetic Acid	--	0.0020	--	--	--	0.07
Dichloroacetic Adic	--	0.0010	--	--	--	zero
Trichloroacetic Acid	--	0.0010	--	--	--	0.02
Monobromoacetic Acid	--	0.0010	--	--	--	--
Dibromoacetic Acid	--	0.0010	--	--	--	--
Bromate	0.010	0.0050**	0.0001	2009	0.01	zero
Chlorite	1.0	0.020	0.05	2009	1	0.8
Chemicals with PHGs established in response to DDW requests. These are not currently regulated drinking water contaminants.						
N-Nitrosodimethylamine (NDMA)	--	--	0.000003	2006	--	--

*OEHHA's review of this chemical during the year indicated (rev20XX) resulted in no change in the PHG.

**The DLR for Bromate is 0.0010 mg/L for analysis performed using EPA Method 317.0 Revision 2.0, 321.8, or 326.0.

Source: https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/MCLsandPHGs.html

Table of Secondary Standards

Contaminant	Secondary MCL (Maximum Contaminant Level)	Noticeable Effects above the Secondary MCL (Maximum Contaminant Level) (Maximum Contaminant Level)
Aluminum	0.05 to 0.2 mg/L (Milligrams per Liter)* (Milligrams per Liter)	colored water
Chloride	250 mg/L (Milligrams per Liter)	salty taste
Color	15 color units	visible tint
Copper	1.0 mg/L (Milligrams per Liter)	metallic taste; blue-green staining
Corrosivity	Non-corrosive	metallic taste; corroded pipes/ fixtures staining
Fluoride	2.0 mg/L (Milligrams per Liter)	tooth discoloration
Foaming agents	0.5 mg/L (Milligrams per Liter)	frothy, cloudy; bitter taste; odor
Iron	0.3 mg/L (Milligrams per Liter)	rusty color; sediment; metallic taste; reddish or orange staining
Manganese	0.05 mg/L (Milligrams per Liter)	black to brown color; black staining; bitter metallic taste
Odor	3 TON (threshold odor number)	"rotten-egg", musty or chemical smell

pH	6.5 - 8.5	low pH: bitter metallic taste; corrosion high pH: slippery feel; soda taste; deposits
Silver	0.1 mg/L (Milligrams per Liter)	skin discoloration; graying of the white part of the eye
Sulfate	250 mg/L (Milligrams per Liter)	salty taste
Total Dissolved Solids (TDS (Total Dissolved Solids))	500 mg/L (Milligrams per Liter)	hardness; deposits; colored water; staining; salty taste
Zinc	5 mg/L (Milligrams per Liter)	metallic taste

*mg/L (Milligrams per Liter) is milligrams of substance per liter of water.

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Appendix C: Constituents of Emerging Concern Study

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WATER DEPARTMENT
212 Locust Street, Suite C, Santa Cruz, CA 95060 ◆ Ph: 831-420-5210

Constituents of Emerging Concern, August 2016 Report

INTRODUCTION

The mission of the City of Santa Cruz Water Department is to ensure public health and safety by providing a clean, safe, and reliable supply of water. We are passionate about providing our community with high-quality drinking water and consistently meet all regulated state and federal standards. In addition to complying with all required standards, we have begun voluntarily testing for unregulated constituents known as "constituents of emerging concern", or "CECs." This report provides results from our initial round of testing for CECs.

CECs typically result from pharmaceuticals, personal care products and insect repellant that enter water sources through runoff or wastewater system discharges. Some are known or suspected to be potentially endocrine-disrupting. Endocrine disruptors are chemicals that may interfere with the body's endocrine (or hormone) system, and may produce adverse developmental, reproductive, neurological, and immune effects in both humans and in wildlife. As you will see in the attached report, the levels of CECs we found in our recent water testing are not alarming. Most are at levels equivalent to a drop of water in three Olympic-size swimming pools. That said, results from the tests help inform our planning for future water treatment.

We know that when the public turns on their tap they want to feel comfortable that their water is safe. They want to know that we're doing all we can to protect their water at its source. They want to know that the treatment their water has received protects them from anything potentially harmful. They want to know that the infrastructure their water is delivered through is maintained, reliable and secure. This report identifies CECs that we found in recent, voluntary testing of unregulated constituents.

Results of the Santa Cruz Water Department
Initial Testing for Constituents of Emerging Concern[1]

In the fall of 2015, the Santa Cruz Water Department initiated new testing for the system's source water and treated water to begin to create a better understanding of the water quality characteristics of our community's source waters. This new testing includes looking at what trace levels of Constituents of Emerging Concern (CECs) might be finding their way into our community's drinking water supplies. This voluntary testing regime was undertaken largely to help inform planning for upcoming major investments in drinking water treatment that are necessary to address aging infrastructure at the Graham Hill Water Treatment Plant.

Santa Cruz's Water Supply

The drinking water for the City of Santa Cruz comes primarily from local watersheds which include coastal streams north of the city and the San Lorenzo River. The Water Department diverts water from rivers or streams (flowing sources) and sends it to water treatment facilities for processing and delivery to customers, or stores water available during the rainy season in Loch Lomond Reservoir for treatment and delivery to customers during the dry season. Protecting public health and providing a safe and reliable supply of water to our customers is job #1 for the Santa Cruz Water Department. Drinking water produced and delivered by the Santa Cruz Water Department complies with all current state and federal drinking water regulations; a source of professional pride and personal satisfaction for the dozens of water utility employees who work every day to make this statement true.

Like other water utilities, the Santa Cruz Water Department uses a tried and true strategy called a multi-barrier approach to protecting water quality and ensuring that we produce a high quality product. The first barrier is source water protection, the second is effective water treatment – which also includes multiple barriers, and the third is careful management of the treated water delivery system that keeps water quality from degrading as it moves from the treatment plant to the customer's tap.

To provide context for the discussion about CECs covered later in this paper, a brief discussion of each of the multiple barriers follows:

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[1]Constituents of emerging concern (CECs) is a term used to include a broad range of unregulated chemical components found at trace levels in many of our water supplies, including surface water, drinking water, wastewater, and recycled water. Other terms include "emerging constituents," "endocrine disrupting chemicals," or "pharmaceuticals and personal care products." From National Water Research Institute: http://www.nwri-usa.org/CECs.htm

Barrier #1 – Source Water Protection

Source water assessments and active watershed management are the key elements of any effective source water protection program. On an ongoing basis the Department keeps tabs on what's going on in the watersheds from which it draws water, and every three years the Department conducts a thorough sanitary survey of the watersheds from which our community's drinking water is drawn. These efforts keep Department staff aware of changes in activities or circumstances occurring in the watershed that may be sources of contaminants: either from natural conditions such as erosion that increases sediment loading in the source water, or human-caused sources such as agricultural run-off that may introduce fertilizers, herbicides, or pesticides into the water supply sources.

Barrier #2 – Water Treatment

Utilities using surface water sources (rivers, streams, lakes) are required by state and federal regulations to provide significant levels of water treatment, typically through a facility like the Department's Graham Hill Water Treatment Plant. The water treatment process is designed to specifically address the character of the water source feeding the treatment plant, for example the levels and types of microbes typically present in surface water sources, and to produce drinking water that protects public health and looks, smells, and tastes good.

Barrier #3 – Distribution System Management

Over the last 20 years, water utility managers have become increasingly sensitized to the need to operate their water distribution systems in a manner that recognizes that, in effect, water is a perishable product that can't just be sent out into the distribution system and left to languish. Water sitting in distribution storage tanks or dead-end water mains will eventually become more susceptible to microbial growth. Microbial contaminants can produce water borne disease outbreaks, an obvious public health threat. In addition, water that is subject to long residence times in distribution storage tanks or parts of the distribution system that has demand may have higher levels of disinfection byproducts, which are formed by the interaction of a disinfectant such as chlorine and naturally occurring organic carbon found in many surface water sources. Like microbial contaminants in distribution systems, disinfection byproducts are the subject of state and federal drinking water regulations.

Good management of a distribution system limits these potential threats to public health, but isn't as easy to achieve as it might seem. Distribution storage tanks and standpipes that are located throughout the distribution system are designed to hold a lot of water – much more

than is needed to meet customer demand – because a lot of water is needed to support fire-fighting, should it become necessary. Balancing the need for fire flows with drinking water quality requires system operators to conscientiously cycle tanks, ensure that dead-end mains are flushed, and match treatment plant production to water system demands in a much more sophisticated manner than ever before.

Ability to Test for Trace Amounts of CECs-What New Technology Enables Us to Discover in Public Drinking Water Supplies

The age of advanced technology has given humans the ability to view the world (and the universe, too) in new ways that would have been unfathomable only a relatively few years ago. By reading the newspaper or following news content online, we know that we have the technology now to do everything from discovering earth-like planets in star systems in far-away galaxies to being able to detect one drop of a compound of interest (1 drop = 0.00005 liter) in 50 million liters, which is equivalent to the volume of 15 Olympic sized swimming pools[2] (if the compound of interest is found at the level of 1 drop in 50 million liters, its concentration is described as 1 part per trillion or 1 nanogram per liter).

The first two elements of the multi-barrier approach described earlier makes a good framework for summarizing the results of the CEC testing that the Department has completed to date because, if present, CECs will enter the drinking water supply from the source water and the treatment provided will either effectively address them or it won't due to treatment process limitations.

The Department conducted testing for 96 different constituents, as listed in Attachment2. Most of them (76) were never detected in the source water, and the remainder were occasionally detected at very low levels. The data table for the available results is included as Attachment 1 to this document. All results are presented in nanograms per liter (1 nanogram per liter = 1 particle in a trillion particles). A cell with no entry means that that constituent was not detected in that sample. Only detected CECs are listed in Attachment 1.

[2] For source see slide 7 of Dr. Shane Snyder's presentation on Safe and Sustainable Water Reuse at http://www.lottcleanwater.org/pdf/symposiumsnyder.pdf

Source Water Protection

Relatively few of the nation's thousands of drinking water utilities have the benefit of drawing water from fully protected sources. Most utilities do what Santa Cruz has done and strategically purchase lands around critical facilities such as reservoirs and upstream of river intakes, and establish robust treatment systems to inactivate or remove microbes and naturally occurring or man-made chemicals. Not having a pristine source, however, does suggest the need to carefully monitor source water quality and take what source water protection steps can be taken to ensure a consistent and high quality source of water is provided to the water treatment plant.

Routine sanitary surveys of Santa Cruz's North Coast supplies indicate relatively low levels of development and natural or human-caused activities that could introduce contaminants into those sources of supply. On the other hand, however, the San Lorenzo River watershed has a long history of development – both for residential use, various kinds of recreational uses such as equestrian facilities, and for resource extraction uses such as timber harvesting, and sand, gravel, limestone, and granite quarrying.

While not a pristine watershed, the Department's many years of sanitary survey data for the San Lorenzo's watershed as well as water quality from the San Lorenzo source show that for the traditional issues of concern (e.g., bacteria, parasites, nitrates and sediments) the condition of the watershed and the quality of the source water are good, and generally stable or improving. Since the 1980's the County has been implementing a program to monitor and upgrade the septic systems in the watershed.

The CEC Sampling Program and Results

Beginning in the fall of 2015 and on a quarterly basis thereafter, untreated water samples were collected at the Coast Pump Station for a composite of the Department's North Coast sources, San Lorenzo River at both the Tait Street and Felton Diversions, and at Loch Lomond. Treated water samples were collected from water leaving the Graham Hill Water Treatment Plan, and in one case, an untreated water sample was taken of blended source waters just before they entered the Graham Hill Water Treatment Plant. Two other "event" related samples were collected and analyzed as well. One captured what is known as the "first flush," which typically happens as the weather transitions from dry to wet sometime in the October to December time frame. The second event sample was collected in April to represent a high, stable flow in the San Lorenzo River.

All samples were prepared for shipping and sent for processing to Eurofins/Eaton Analytical lab for processing. Attachment 2 provides a list of all the CECs for which testing was completed and the method reporting limit (MRL) for each.

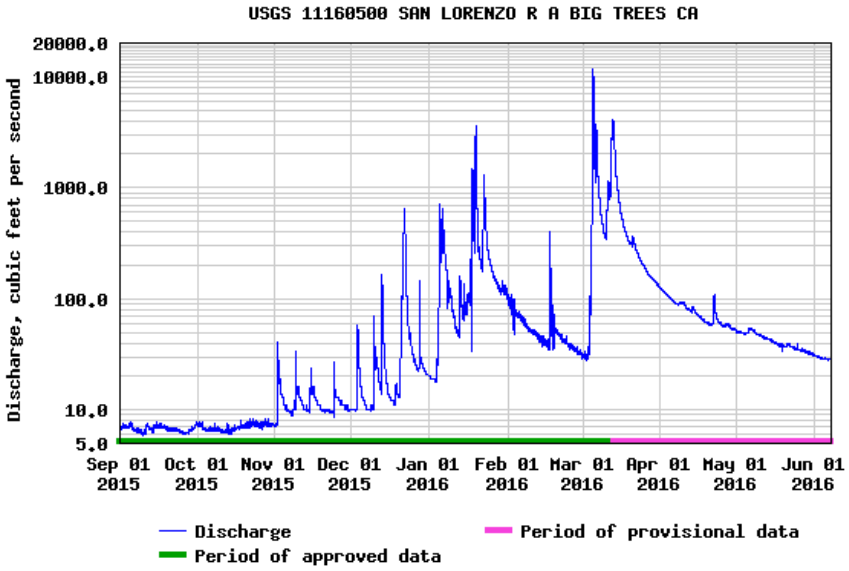
- ***Source Water CEC Results***

The source of CECs found in water supplies is invariably linked to human activity. For example, pharmaceuticals, personal care products, and insect repellant are all used by humans and end up in wastewater streams through human excretion or through being washed off during showering or recreational bathing in streams that are used as drinking water sources.
In Santa Cruz's case, the major sources of wastewater-related effluent which has the potential to reach the San Lorenzo River source is septic systems and the leach-fields associated with two small wastewater treatment plants in the Boulder Creek area. Prior to 1986, failing or improperly functioning septic systems in the mid and upper San Lorenzo basin were a significant source of nitrates reaching the river, and nitrates can be a significant threat to drinking water quality. In 1986, Santa Cruz County initiated a program to work with property owners to reduce the occurrence of failing septic systems as well as instituting new requirements for the construction and performance of new and existing septic systems.

The most common CECs detected in Santa Cruz untreated water source sampling are two types of artificial sweeteners, Sucralose (Splenda) and Acesulfame-K, (Sunett and Sweet One). These compounds were identified in most of the San Lorenzo River untreated water samples and are shown in **Blue type** in the sampling results provided in Attachment 1.

The most diverse set of CECs were found in the first flush samples from the San Lorenzo River collected on November 2, 2015. The first flush sample was drawn to reflect the influence of the first significant rain fall of the season on river flows and is intended to capture the impacts on water quality of both surface run-off and the rewetting of the streambed. Figure 1 is a hydrograph produced from data from the USGS Big Trees gauge that documents the transition of the river from a very low base flow during the late summer and early fall to a more typical rainy season flow pattern.

Figure 1 – USGS San Lorenzo Big Trees Gauge Results September 1, 2015 to June 7, 2016



Of the 20 CECs identified during the first year of sampling, 9 were only found in the first flush sample. The results table included as Attachment 1 shows these compounds and their sampling results in **Green type**. Included in this group are over-the-counter pain relievers, caffeine, two preservatives used in personal care products, one herbicide, one of the two medical imaging chemicals identified (the kind used in some x-ray testing), bisphenol A, and a prescription cholesterol drug.

The remaining compounds identified are shown in Attachment 1 in **Black type**, include DEET (a well-known insect repellant), a compound used in shampoos and soaps, two herbicides, an organic chemical used in the manufacture of dyes, some pharmaceuticals and vitamin B3, a second medical imaging chemical, pharmaceuticals to treat heart conditions and respiratory conditions such as asthma, and an antibiotic used to treat bacterial infections. These CECs were typically found more intermittently in the samples collected and also were found at lower levels than the artificial sweeteners.

Samples collected during drier months contained far fewer CECs than those collected during wetter periods. This result makes sense because the source of CECs entering the San Lorenzo supply is either surface water run-off or septic system effluent reaching the river through saturated underground water flow - both of which are less prevalent during the dry season than they are during wet periods.

Water Treatment

Drinking water quality is highly regulated by state and federal agencies and over time new regulations have been issued to address a broad range of water quality issues. Similarly, drinking water treatment technology has also evolved over time, but because a water treatment plant is typically a water utility's most expensive and least adaptable fixed asset, many utilities are using treatment processes and facilities designed to meet water quality conditions that were identified and well understood at the time the plant was designed and constructed.

The cost and complexity of water treatment facilities and processes often results in a kind of leap-frog effect, where new treatment processes or facilities are implemented in response to current knowledge, with somewhat murky assumptions about likely treatment needs for the next 20 years. Over those 20 years, new information about water quality issues emerges, and existing treatment facilities may or may not effectively address them. If existing treatment does not effectively address the issue, addressing the issue becomes an input to the next water treatment investment cycle. Drinking water treatment in Santa Cruz is among the key infrastructure issues to be addressed in the coming decade, which makes testing for CECs now particularly relevant.

- ***Treated Water CEC Results***

Treated water samples were collected as grab samples essentially at the same time as treatment plant influent water samples were collected. If the goal is to analyze the impact of water treatment on the CECs identified (if any) in the untreated water inflow to the Graham Hill Water Treatment plant, grab samples of treatment plant inflow and outflow collected at the same time won't effectively support that analysis because it doesn't take into account the approximately 8 hours of travel time between water reaching the plant and that same water emerging from treatment, ready to be delivered to customers.

As a refinement to the future sampling methodology for treated water, the treated water sample will be collected at a time that will allow for more refined analysis of the degree to which current treatment is effective in addressing CECs.

Even with this sampling limitation in mind, when compared to untreated water samples, treated water samples indicated that the current treatment process has at least some potential to eliminate or reduce the level of some CECs. In particular, the existing water treatment

process shows a reduction or, in some cases, an elimination of artificial sweeteners, DEET, and herbicides.

The results also indicate that some CECs may be less affected by current treatment. These include Atenolol (a pharmaceutical to treat heart conditions) and Iohexal (one of the two medical imaging contrasting agents found). Future testing using the revised sampling protocol will shed further light on the degree to which these or other CECs persist through the current treatment process.

With respect to the first flush sample results, only untreated water samples were evaluated for this condition. The Department typically avoids taking water from the San Lorenzo flowing sources (Felton Diversion and Tait Wells) during first flush events because of concerns about the quality of source water during the first flush and the ability of the current treatment processes to treat this water to required standards. The analytical results of this initial study, while focused only on CECs and not on the full suite of regulated constituents in drinking water, certainly support that there are reasons to be mindful about the quality of water during and immediately after first flush events.

Discussion of Results

What does the presence of CECs in our community's source water and, in some cases, in our treated drinking water mean? The potential health and environmental effects for some of the CECs identified are not known, but many of those identified so far are food products or medicines which typically receive extensive testing prior to being approved for human consumption.

As an example to provide context, caffeine is a well-known stimulant that has been used by humans and evaluated for positive and negative impacts on human health in a variety of studies over the last several hundred years. The one water sample collected which tested positive for caffeine showed a value of 270 nanograms per liter (1 liter equals approximately 34 ounces). The Center for Science in the Public Interest's Caffeine Chart (see: https://cspinet.org/caffeine-chart) would place caffeine consumption from 32 ounces of Starbucks Coffee at 660 milligrams. A milligram per liter is one part per million, while a nanogram per liter is one part per trillion. So 660 milligrams is about 2.4 million times as much caffeine as the amount that was identified in the one first flush sample that tested positive for this constituent.

Definitive data on the human or environmental health of CECs is not available at this time, but the very fact that water utilities, including the Santa Cruz Water Department, are looking for and incorporating results of testing for these compounds into its planning demonstrates a strong commitment to providing a high quality source of drinking water to their customers. Resources available from the federal Environmental Protection Agency and the California Water Resources Control Board offer some insights about the needs for data collection on occurrence and work that needs to be done to further understand both the potential for impacts to aquatic ecosystems and human health from exposure through treated drinking water. And in California, the potential for highly purified reclaimed wastewater to become a greater part of California's water supply makes the presence and treatment of CECs in wastewater streams a clear focus of research and potential rule-making.

Another resource is the Minnesota Department of Health (MDH), which appears to have in place a robust program focused on CECs.[3] In 2014, MDH published an informative poster describing the work they were doing on exposure assessments for CECs, including a discussion of the relative source contribution from water for a selected group of CECs. This poster is available for review.[4] Another example of the resources available from the MDH is its Information Sheets on various CECs.[5] The Information Sheets on bisphenol A[6] provides some information relevant to the one positive sample, at 14 parts per trillion, for Bisphenol A found in the first flush sample of water collected at Felton Diversion on November 11, 2015.

In response to the question of, "what is the MDH guidance value for BPA in drinking water," the MDH Information Sheets states,

> "based on the best available data, MDH developed a guidance value of 20 ppb. A person drinking water at or below these levels would have little or no risk of any health effects from BPA."

Twenty ppb is roughly 1,000 times the level of bisphenol A found in the one San Lorenzo River sample where this compound was found.[7]

---

[3] See: http://www.health.state.mn.us/divs/eh/risk/guidance/dwec/index.html.
[4] See: http://www.health.state.mn.us/divs/eh/risk/guidance/dwec/cecpostsra.pdf.

[5] See: http://www.health.state.mn.us/divs/eh/risk/guidance/dwec/chemunderrev.html#info).
[6] See http://www.health.state.mn.us/divs/eh/risk/guidance/dwec/acetamininfo.pdf)
[7] See also the MDPH Information Sheet on DEET at
http://www.health.state.mn.us/divs/eh/risk/guidance/gw/deetinfo.pdf

Next Steps

The Santa Cruz Water Department will continue to sample its water sources and work with regulatory agencies and the water industry to get a better understanding of the real and potential significance of CECs on human health. The sampling program will evolve as more is learned about how hydrologic conditions and watershed activities may influence the presence of low levels of CECs in the City's sources of drinking water. Data from the planned analyses will be made available on at least an annual basis and will be added to the information provided in this initial report.

ATTACHMENT 1

CITY OF SANTA CRUZ WATER DEPARTMENT

2015 - 2016 Constituents of Emerging Concerns Sampling Results

All Results in nanograms per Liter (1 part per trillion = 0.000000001 gram per Liter)
Results reflect only detected compounds -- analysis included testing for 96 Constituents of Emerging Concern

Sampling Dates		9/01/15: 1st quarter					11/02/15 First Flush		12/15/15: 2nd quarter					3/01/16: 3rd quarter					4/07/16: High steady flow					6/07/16: 4th quarter					
Sampling Locations (Note: Not all sampling locations were included in every sample collection)		GHWTP (treated water)	SLR @Felton	SLR @Tait	North Coast Composite	Loch Lomond	SLR @Felton	SLR @Tait	GHWTP (treated water)	SLR @Felton	SLR @Tait	North Coast Composite	Loch Lomond	GHWTP (treated water)	SLR @Felton	SLR @Tait	North Coast Composite	Loch Lomond	GHWTP (treated water)	SLR @Felton	SLR @Tait	North Coast Composite	Loch Lomond	GHWTP (treated water)	SLR @Felton	SLR @Tait	North Coast Composite	Loch Lomond	Raw Blend (treatment plant influent)
Chemical Type or Use with Common Name if Applicable	**Detected Analytes**																												
Herbicide	2,4-D						28																						
Artificial sweetener (Sunett and Sweet One)	Acesulfame- K	55	170	130			150	140		98	99			57	100	94				21	54		24	61	95	89			68
Beta blocker drug used to treat heart conditions	Atenolol						34	44	16		10			8.3	5.7	9.9		5.1											
Herbicide	Atrazine									6.2																			
Antibiotic	Azithromycin														68														
Fibrate drug used to treat high cholesterol	Bezafibrate							15																					
Industrial chemical found in polycarbonate plastics and epoxy resins	BPA (bisphenol A)						14																						
Stimulant (coffee, tea, some energy drinks)	Caffeine						270																						
Herbicide	Cyanazine							11		96	24	7.5	17			7.7													
Foaming agent and thickener used in cosmetics, shampoo and soaps	Diethanolamine (DEA)																										10		9.6
Insect repellent	DEET		30				32	13		12														20	27	33			44
Non steroidal anti-inflammation drug (NSADI) (Advil, Motrin)	Ibuprofen						63																						
Contrast media used for x-ray imaging	Iohexal							34	13	27			15																
Contrast media. IV use for CT scans	Iopromide						120																						
Paraben family of preservatives in personal care products (body lotion and deodorant)	Isobutylparaben						13																						
Paraben family of preservatives in personal care products (body lotion and deodorant)	Methylparaben						470																						
Non steroidal anti-inflammation drug (NSADI) (Aleve, Naprosyn)	Naproxen						29																						
An organic chemical used in the manufacture of a variety of other products such as dyes, some pharmaceuticals, and niacin (vitamin B3)	Quinoline																			12									
Artificial sweetener (Splenda)	Sucralose		110					230						150	300	280				150	160								190
Methylxanthine drug used to treat lung problems such as asthma, emphysema and chronic bronchitis.	Theophylline										41																		

GREEN	Detected only in 1st flush event
BLUE	Frequently detected in moderate parts per trillion amounts (50-300 ng/L)
BLACK	Infrequently detected in low parts per trillion amounts (<100 ng/L)
	Cells with no data = Non Detect (ND) or below Method Reporting Level (MRL)

Final July 29, 2016

-- eurofins
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AT-1807

Laboratory Report

for

City of Santa Cruz
Water Quality Laboratory
715 Graham Hill Road
Santa Cruz, CA 95060
Attention: Hugh Dalton
Fax: 831-420-5481

Date of Issue
1 31/

EUROFINS EATON
ANALYTICAL

ORELAP 4034

Report: 560847
Project: PPCP
Group: PersonalCare Products &CEC

YOM: Yolanda.O.Martin
Project Manager

- Accred1ted 1n accordance w1th TNI 2009 and ISOnEC 17025:2005.
- Laboratory cert1f1es that the test results meet all TNI2009 and ISOnEC 17026:2006 requirements unless noted under the 1nd1111dualanalys1s.
• Following the cover page are State Cert1ficat1on L1st ISO 17025 Accredited Method List. Acknowledgement of Samples Rece1ved Comments H1ts Report Data Report. QC Summary. QC Report and Regulatory Forms as applicable.
- Test results relate only to the sample(s) Jested.
' Th1s report shall not be reproduced except in full. without the wntten approval of the laboratory

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Laboratory Data
Report:660847

City of Santa Cruz
Water Quality Laboratory
Hugh Dalton
715 Graham Hill Road
Santa Cruz, CA 95060

Samples Received on:
11/04/2015 08:02

MRL is Method Recovery Limit

208-Felton Diversion (201511040048) Sampled on 11/02/2015 1511

LC-MS-MS • Endocrine Disruptors Positive Mode - SPE

Prepared	Analyzed	QC Ref #	Method	Analyte	Result	Units	MRL	Dilution
1210212015	22:00	876608	(LC-MS-MS)	1,7-0imethylxanthine	NO	ng/l	10	
1210212015	22:00	876608	(LC-MS-MS)	Acetaminophen	NO	ng	5	
1210212015	22:00	876608	(LC-MS-MS)	Albuterol	NO	ng/L	5	
1210212015	22:00	876608	(LC-MS-MS}	Amoxicillin (semi-quantitative)	NO	ng	20	
1210212015	22:00	876608	(LC-MS-MS)	Andorostenedione	NO	ng/L	5	
1210212015	22:00	876608	(LC-MS-MS)	Atenolol	34	ng/L	5	
1210212015	22:00	876608	(LC-MS-MS)	Atrazine	NO	ng/L	5	
1210212015	22:00	876608	(LC-MS-MS)	Azithromycln	NO (R7)	ng/L	20	
1210212015	22:00	876608	(LC-MS-MS)	Bezafibrate	NO	ng/L	5	
1210212015	22:00	876608	(LC-MS-MS)	Bromacil	NO	ng	5	
1210212015	22:00	876608	(LC-MS-MS)	Caffeine	270	ng/L	5	
1210212015	22:00	876608	(LC-MS-MS)	Carbadox	NO	ng/l	5	
1210212015	22:00	876608	(LC-MS-MS)	Carbemazepine	NO	ng/l	5	
1210212015	22:00	876608	(LC-MS-MS)	Carisoprodol	NO	ng/L	5	
1210212015	22:00	876608	(LC-MS-MS)	Chloridazon	NO	ng	5	
1210212015	22:00	876608	(LC-MS-MS)	Chlorotoluron	NO	ng	5	
1210212015	22:00	876608	(LC-MS-MS)	Cimetidine	NO (R7)	ng	5	
1210212015	22:00	876608	(LC-MS-MS)	Cotinine	NO	ngll	10	
1210212015	22:00	876608	(LC-MS-MS)	Cyanazine	NO	ng/L	5	
1210212015	22:00	876608	(LC-MS-MS)	OACT	NO	ng/L	5	
1210212015	22:00	876608	(LC-MS-MS)	OEA OEET	NO	ng	5	
1210212015	22:00	876608	(LC-MS-MS)	Oehydronifedipine	32	ngll	10	
1210212015	22:00	876608	(LC-MS-MS)	DIA	NO	ng	5	
1210212015	22:00	876608	(LC-MS-MS)	Diazepam	NO	ng	5	
1210212015	22:00	876608	(LC-MS-MS)	Oilantin	NO	ng	5	
12102/2015	22:00	876608	(LC-MS-MS)	Oiltiazem	NO (R7)	ng	20	
12102/2015	22:00	876608	(LC-MS-MS)		NO	ng	5	
12/02/2015	22:00	876608	(LC-MS-MS)	Oiuron	NO	ng/l	5	
1210212015	22:00	876608	(LC-MS-MS)	Erythromycin	NO	ngiL	10	
12102/2015	22:00	876608	(LC-MS-MS)	Flumeqine	NO (R7)	ngiL	10	
12102/2015	22:00	876608	(LC-MS-MS)	Fluoxetine	NO	ng/l	10	
1210212015	22:00	876608	(LC-MS-MS)	Isoproturon	NO	ng/L	100	
12102/2015	22:00	876608	(LC-MS-MS)	Ketoprofen	NO	ng/L	5	

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Laboratory Data
Report: 560847

City of Santa Cruz
Water Quality Laboratory
Hugh Dalton
715 Graham Hill Road
Santa Cruz. CA 95060

Samples Received on:
11/04/2015 08:02

Prepared	Analyzed	QC Rei#	Method	Analyle	Result	Units	MRL	Dilution
	12/02/2015 22:00	876608	(LC-MS-MS)	Ketorolac	NO	ng/L	5	
	12/0212015 22:00	876608	(LC-MS-MS)	Lidocaine	NO	ng/L	5	
	12/0212015 22:00	876608	(LC-MS-MS)	Lincomycin	NO (R7)	ng/L	10	
	12/02/2015 22:00	876608	(LC-MS-MS)	Linuron	NO (R7)	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	Lopressor	NO	ng/L	20	
	12/02/2015 22:00	876608	(LC-MS-MS)	Meclofenamic Acid	NO	ng/L	5	
	12/0212015 22:00	876608	(LC-MS-MS)	Meprobamate	NO	ng/L	5	
	12/0212015 22:00	876608	(LC-MS-MS)	Metazachlor	NO	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	Nifedlpine	NO (R7)	ng/L	20	
	12/02/2015 22:00	876608	(LC-MS-MS)	Norethisterone	NO	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	OUST (Sulfameturon,methyl)	NO	ng/L	5	
	12/0212015 22:00	876608	(LC-MS-MS)	Oxolinic acid	NO	ng/L	10	
	12/0212015 22:00	876608	(LC-MS-MS)	Pentoxifylline	NO	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	Phenazone	NO	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	Primidone	NO	ng/L	5	
	12/0212015 22:00	876608	(LC-MS-MS)	Progesterone	NO	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	Propazine	NO	ng/L	5	
	12/0212015 22:00	876608	(LC-MS-MS)	Quinoline	NO	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	Simazine	NO	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	Sulfachloropyridazine	NO	ng/L	5	
	12/0212015 22:00	876608	(LC-MS-MS)	Sulfadiazine	NO (R7)	ng/L	5	
	12/0212015 22:00	876608	(LC-MS-MS)	Sulfadimethoxine	NO	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	Sulfamerazine	NO	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	Sulfamethazine	NO (R7)	ng/L	5	
	12/0212015 22:00	876608	(LC-MS-MS)	Sulfamethizole	NO	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	Sulfamethoxazole	NO	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	Sulfathiazole	NO	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	TCEP	NO	ng/L	10	
	12/02/2015 22:00	876608	(LC-MS-MS)	TCPP	NO	ng/L	100	
	12/02/2015 22:00	876608	(LC-MS-MS)	TOCPP	NO	ng/L	100	
	12/02/2015 22:00	876608	(LC-MS-MS)	Testosterone	NO	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	Theobromine	NO	ng/L	10	
	12/02/2015 22:00	876608	(LC-MS-MS)	Theophylline	NO (R7)	ng/L	20	
	12/02/2015 22:00	876608	(LC-MS-MS)	Thiabendazole	NO	ng/L	5	
	12/02/2015 22:00	876608	(LC-MS-MS)	Trimethoprim	NO	ng/L	5	

LC-MS-MS - Endocrine Disruptors Negative Mode • SPE

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Laboratory Data
Report: 560847

City of Santa Cruz
Water Quality Laboratory
Hugh Dalton
715 Graham Hill Road
Santa Cruz, CA 95060

Samples Received on:
11/04/2015 08:02

Prepared	Analyzed		QC Ref#	Method	Analyte	Result	Units	MRL	Dilution
	12103/2015	1:26	876974	(LC-MS-MS)	2,4-D	28	ng/L	5	
	12103/2015	1:26	876974	(LC-MS-MS)	4-nonylphenol- semi quantitative	NO (L5,LEJ	ng/L	100	
	1210312015		876974	(LC-MS-MS)	4-tert-Octylphenol	NO (LS,IE)	ng/L	50	
	12103/2015	1:26	876974	(LC-MS-MS)	Acesulfame-K	150	ng/L	20	
	12103/2015	1:26	876974	(LC-MS-MS)	Bendroftumethiazide	NO	ngll	5	
	12103/2015	1:26	876974	(LC-MS-MS)	BPA	14	ng/L	10	
	1210312015	1:26	876974	(LC-MS-MS)	Butalbital	NO	ng/L	5	
	12103/2015	1:26	876974	(LC-MS-MS)	Butylparaben	NO	ngll	5	
	1210312015	1:26	876974	(LC-MS-MS)	Chloramphenicol	NO	ng/L	10	
	12103/2015	1:26	876974	(LC-MS-MS)	Clofibric Acid	NO	ng/L	5	
	12103/2015	1:26	876974	(LC-MS-MS)	Diclofenac	NO	ng/L	5	
	12103/2015	1:26	876974	(LC-MS-MS)	Estradiol	NO	ng/L	5	
	12103/2015	1:26	876974	(LC-MS-MS)	Estriol	NO	ngiL	5	
	12103/2015	1:26	876974	(LC-MS-MS)	Estrone	NO	ng/L	5	
	12103/2015	1:26	876974	(LC-MS-MS)	EthinylEstradiol- 17 alpha	NO	ngiL	5	
	12103/2015	1:26	876974	(LC-MS-MS)	Ethylparaben	NO	ng/L	20	
	12103/2015	1:26	876974	(LC-MS-MS)	Gemfibrozil	NO	ng/L	5	
	12103/2015	1:26	876974	(LC-MS-MS)	Ibuprofen	63	ng/L	10	
	12/03/2015	1:26	876974	(LC-MS-MS)	Iohexal	NO	ng/L	10	
	12/03/2015	1:26	876974	(LC-MS-MS)	Iopromide	120	ngll	5	
	12/03/2015	1:26	876974	(LC-MS-MS)	Isobutylparaben	13	ng!L	5	
	12/03/2015	1:26	876974	(LC-MS-MS)	Methylparaben	470	ng/L	20	
	12103/2015	1:26	876974	(LC-MS-MS)	Naproxen	29	ng/L	10	
	12/03/2015	1:26	876974	(LC-MS-MS)	Propylparaben	NO	ng/L	5	
	12/03/2015	1:26	876974	(LC-MS-MS)	Sucralose	NO	ng/L	100	
	12/03/2015	1:26	876974	(LC-MS-MS)	Tridocarban	NO	ng/L	5	
	12/03/2015	1:26	876974	(LC-MS-MS)	Triclosan	NO (LS,R2)	ng/L	10	
	12/0312015	1:26	876974	(LC-MS-MS)	Warfarin	NO	ng/L	5	

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