California Regional Water Quality Control Board
Central Coast Region

Total Maximum Daily Loads Technical Report and Recommendations for Site-Specific Numeric Water Quality Criteria for Chloride and Sodium

for the

Jalama Creek Subwatershed, Santa Barbara County, California

Final Project Report

Prepared March 27, 2013
for the
May 30 – 31, 2013 Central Coast Water Board Meeting

This document is identified as a TMDL for Jalama Creek (Santa Barbara County, California) and is officially submitted to the U.S. Environmental Protection Agency to act upon and approve as a TMDL

JALAMA CREEK TMDLS FOR CHLORIDE AND SODIUM – CONCISE SUMMARY **California Regional Water Quality Control Board, Central Coast Region**	
Waterbody Identification	Jalama Creek and tributaries from confluence with Jalama Creek estuary upstream to the headwaters. WBID: CAR3151005119990304115034
Location	Santa Barbara County, California Hydrologic Unit Code # 180600130101
TMDL Pollutants of Concern	Chloride, Sodium
Pollutant Sources	Natural background
Beneficial Uses Currently Supported *(on the basis of chloride and sodium numeric water quality guidelines)*	Protected for drinking water supply (MUN). Protected for aquatic habitat (WARM, SPWN). Protected for most agricultural uses (AGR), including stock watering, support of vegetation for range grazing, and irrigation for most crop types.
Beneficial Uses Impaired *(on the basis of chloride and sodium numeric water quality guidelines)*	Impaired for potential or future use of irrigation supply (AGR) for sprinkler irrigation on sodium and chloride-sensitive crops, depending on situation-specific conditions of crop, soil, and method of irrigation.
Loading Capacity *(on the basis of chloride and sodium TMDL numeric targets)*	Chloride: 303 pounds per day and not to exceed 106 mg/L in receiving waters. Sodium: 197 pounds per day and not to exceed 69 mg/L in receiving waters.
TMDL Numeric Targets *(on the basis of numeric guidelines used in 303(d) assessment)*	Chloride not to exceed 106 mg/L (in receiving waters) Sodium not to exceed 69 mg/L (in receiving waters)
Interim Numeric Targets *(interim water quality targets reflective of local natural conditions)*	Chloride not to exceed 185 mg/L (in receiving waters) Sodium not to exceed 120 mg/L (in receiving waters)
Implementation Strategy: **Proposed Actions to Correct 303(d)-Listed Impairments**	Implement revised water quality guidelines, which may include site-specific water quality objectives, for chloride and sodium based on the assessment that exceedances are naturally occurring and no current impacts to agricultural supply (AGR) beneficial uses.

Adopted by the
California Regional Water Quality Control Board
Central Coast Region
on May 30, 2013, 2013

and approved by the
United States Environmental Protection Agency
on September 4, 201, 2013

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http://www.waterboards.ca.gov/centralcoast/water_issues/programs/tmdl/docs/jalama_creek/index.shtml

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List of Acronyms and Abbreviations

This report contains numerous acronyms and abbreviations. In general, staff wrote an acronym or abbreviation in parentheses following the first time a title or term was used. Staff wrote the acronym/abbreviation in place of that term from that point throughout this report. The following alphabetical list of acronyms/abbreviations used in this report is provided for the convenience of the reader:

Basin Plan	Water Quality Control Plan for the Central Coastal Region
BMP	Best Management Practice
CCAMP	Central Coast Ambient Monitoring Program
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
DFG (or CDFG)	Calif. Dept. of Fish and Game
DOGGR	California Division of Oil, Gas and Geothermal Resources
DWR	California Department of Water Resources
ESNERR	Elkhorn Slough National Estuarine Research Reserve
FMMP	Farmland Mapping and Monitoring Program
HUC	Hydrologic Unit Code
LA	Load allocation
NCDC	National Climatic Data Center
NHD	National Hydrography Dataset
SSO	Site specific water quality objective
SWRCB	State Water Resources Control Board (State Board)
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
Water Board	California Central Coast Regional Water Quality Control Board

1 EXECUTIVE SUMMARY

Jalama Creek was listed on the 2010 Clean Water Act Section 303(d) list on the basis of not meeting University of California Cooperative Extension recommended guidelines for chloride and sodium in agricultural irrigation supply water applied via sprinklers. Jalama Creek is identified as a Category 5 water segment on the U.S. Environmental Protection Agency (USEPA) approved 2010 California 303(d) List of Water Quality Limited Segments. A "Category 5" designation is defined as *"a water segment where standards are not met **and a TMDL is required**, but not yet completed".*[1] Therefore, the 303(d) listing of this creek prompted Water Board staff to develop TMDLs to address the constituents of concern in the waterbody. A concise tabular summary of the proposed Jalama Creek total maximum daily loads (TMDLs) is presented below in Table 1-1.

Table 1-1. Tabular summary of Jalama Creek TMDLs for chloride and sodium.

JALAMA CREEK TMDLS FOR CHLORIDE AND SODIUM − CONCISE SUMMARY California Regional Water Quality Control Board, Central Coast Region	
Waterbody Identification	Jalama Creek and tributaries from confluence with Jalama Creek estuary upstream to the headwaters. WBID: CAR3151005119990304115034
Location	Santa Barbara County, California Hydrologic Unit Code # 180600130101
TMDL Pollutants of Concern	Chloride, Sodium
Pollutant Sources	Natural background
Beneficial Uses Currently Supported *(on the basis of chloride and sodium numeric water quality guidelines)*	Protected for drinking water supply (MUN). Protected for aquatic habitat (WARM, SPWN). Protected for most agricultural uses (AGR), including stock watering, support of vegetation for range grazing, and irrigation for most crop types.
Beneficial Uses Impaired *(on the basis of chloride and sodium numeric water quality guidelines)*	Impaired for potential or future use of irrigation supply (AGR) for sprinkler irrigation on sodium and chloride-sensitive crops, depending on situation-specific conditions of crop, soil, and method of irrigation.
Loading Capacity *(on the basis of chloride and sodium TMDL numeric endpoints)*	Chloride: 303 pounds per day and not to exceed 106 mg/L in receiving waters. Sodium: 197 pounds per day and not to exceed 69 mg/L in receiving waters.
TM DL Numeric Targets *(on the basis of numeric guidelines used in 303(d) assessment)*	Chloride not to exceed 106 mg/L Sodium not to exceed 69 mg/L
Interim Numeric Targets *(interim water quality targets reflective of local natural conditions)*	Chloride not to exceed 185 mg/L Sodium not to exceed 120 mg/L
Implementation Strategy: **Proposed Actions to Correct 303(d)-Listed Impairments**	Implement revised water quality guidelines, which may include site-specific water quality objectives, for chloride and sodium based on the assessment that exceedances are naturally occurring and no current impacts to agricultural supply (AGR) beneficial uses.

[1] See Category 5 303(d) List for California: http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml

Individual Total Maximum Daily Loads (TMDLs) for chloride and sodium are developed and contained within this report in accordance with section 303(d) of the federal Clean Water Act.

The purpose of this TMDL report is to assess conditions, establish TMDLs for chloride and sodium for the lower reaches of Jalama Creek to the creek's confluence with the Jalama Creek Estuary, and make recommendations to establish site specific numeric water quality criteria for chloride and sodium that are appropriate for natural background conditions. Additionally, staff has developed this TMDL, in part, to be consistent with state anti-degradation policy. This policy requires, in part that when the existing quality of water is better than the quality of water established as objectives, such existing water quality shall be maintained unless otherwise provided for by the provisions of State Water Resources Control Board Resolution No. 68-16.

Staff finds that non-attainment of the agricultural irrigation supply guidelines that were used in the 2010 303(d) assessment for chloride and sodium in Jalama Creek are due to non-controllable, local natural conditions. Given the natural, non-controllable nature of chloride and sodium load in Jalama Creek, staff concludes that the irrigation supply water quality guidelines used in the 2010 303(d) assessment for Jalama Creek are not reliable indicators of water quality impairment for Jalama Creek. Therefore, staff proposes an implementation strategy to address the 303(d)-listed chloride and sodium impairments which includes development and implementation of site specific water quality objectives for these constituents based on the assessment that exceedances are naturally occurring. Staff recommends development of a basin plan amendment to promulgate site specific objectives (SSOs) for these constituents at a future Central Coast Water Board public hearing.

Further, staff also determined that drinking water supply, groundwater recharge, and aquatic habitat designated uses are currently being supported in Jalama Creek on the basis of numeric criterion for chloride that pertains to MUN and aquatic habitat. Therefore, the elevated levels of chloride do not constitute a serious or systematic water quality problem or threat to beneficial uses.

The purpose of developing a proposed site-specific water quality objectives (SSOs) basin plan amendment is to recognize that potential or future use of sprinkler irrigation supply for sodium and chloride-sensitive crops, (depending on situation-specific conditions of crop, soil, and method of irrigation) beneficial use may not attainable on the basis of the 303(d) listing assessment water quality criterion used to list the creek. Consequently, the 303(d) listing assessment criterion cannot be attained in the lower reaches of Jalama Creek due to natural background conditions.

2 INTRODUCTION

2.1 Clean Water Act Section 303(d) List

Section 303(d) of the federal Clean Water Act requires every state to evaluate its waterbodies, and maintain a list of waters that are considered "impaired" either because the water exceeds water quality standards or does not achieve its designated use. For each water on the Central Coast's "303(d) Impaired Waters List", the California Central Coast Water Board must develop and implement a plan to reduce pollutants so that the waterbody is no longer impaired and can be de-listed. Section 303(d) of the Clean Water Act states:

Each State shall establish for the waters identified in paragraph (1)(A) of this subsection, and in accordance with the priority ranking, the total maximum daily load, for those pollutants which the Administrator identifies under section 1314(a)(2) of this title as suitable for such calculation. Such load shall be established at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality.

The State complies with this requirement by periodically assessing the conditions of the rivers, lakes and bays and identifying them as "impaired" if they do not meet water quality standards. These waters, and the pollutant or condition causing the impairment, are placed on the 303(d) List of Impaired Waters. In addition to creating this list of waterbodies not meeting water quality standards, the Clean Water Act mandates each state to develop Total Maximum Daily Loads (TMDLs) for each waterbody listed. The Central Coast Regional Water Quality Control Board is the agency responsible for protecting water quality consistent with the Water Quality Control Plan for the Central Coastal Basin (Basin Plan), including developing TMDLs for waterbodies identified as not meeting water quality objectives.

2.2 Constituents of Concern Addressed and Causes for Listing

Jalama Creek was listed on the 2010 Clean Water Act Section 303(d) list on the basis of exceeding recommended water quality guidelines for chloride and sodium in agricultural irrigation supply water applied via sprinklers. Therefore, TMDLs for chloride and sodium are developed in this report in accordance with the requirements of section 303(d) of the federal Clean Water Act.

2.3 California Impaired Waters Policy

On June 16, 2005, the State Water Resources Control Board (SWRCB) adopted the Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options (State Water Board Resolution 2005-0050); hereafter referred to as the *Impaired Waters Policy*. The *Impaired Waters Policy* provides policy and procedures for adopting Total Maximum Daily Loads and addressing impaired waters in California. The *Impaired Waters Policy* states that the Regional Water Quality Control Boards have independent discretion, broad flexibility, numerous options, and some legal constraints that apply when determining how to address impaired waters.

In accordance with the *Impaired Waters Policy*, the TMDL process typically culminates in the selection of one of three alternatives: (1) delisting of an impaired waterbody based on new data or enhanced understanding of existing data relative to the defined impairment; (2) modification of water quality standards or water quality criterion through refined numeric criterion or alteration of designated beneficial uses; (3) a TMDL with a defined pollution reduction strategy of some sort to improve water quality and for attainment of water quality standards.

The *Impaired Waters Policy* further states:

> *"Presently, the EPA has designated <u>all pollutants as suitable for TMDL calculation under proper technical conditions*</u>. Thus, before undertaking an action to correct an impairment, the Loading Capacity of the pollutant must be calculated for impaired waters, and thus the load reductions necessary (considering seasonal variations and a margin of safety) to attain standards. Corrective action will implement the assumptions and requirements of the Loading Capacity using any combination of existing regulatory tools.*
>
> ** emphasis added by Central Coast Water Board staff*

In the case of most TMDLs, a pollution reduction strategy of some sort is warranted. However, in some instances during TMDL development the identified water quality impairment is due to problems with the water quality standards or the numeric water quality assessment criteria themselves; for example: when natural background levels alone are incompatible with standards or applicable assessment criteria. In these cases, the *Impaired Water Policy* indicates that the TMDL process may be used to undertake a limited review of the standards and that the TMDL process **may be used to create or recommend a strategy to resolve the impairments by modification of the standards.** For example, the TMDL may recommend a site-specific water quality objective (SSO), or other appropriate modification of a water quality standard.

Relevant narrative from the *Impaired Waters Policy* is reproduced below:

> *While in most cases the existing standards are appropriate and amenable to TMDL development, periodically investigation during the development of a TMDL or its implementation plan may reveal that the standards may be inappropriate or imprecise, thus rendering water quality attainment impossible unless standards are modified. In such cases, staff will undertake a limited review of the standards. The purpose of standards review during the TMDL process is not to reassess the Water Boards' previous policy determinations that underlie the Beneficial Use Designations or Water Quality Objectives, but rather to ensure that the standards are amenable to an appropriate implementation plan….*
>
> *Unlike the triennial review process, the TMDL process is not designed to evaluate standards' appropriateness, but to create a strategy to attain those standards that have already been established. If staff determines that the policies underlying the existing standards should be revisited, in lieu of crafting an implementation plan under this policy, the impaired water shall be referred to the Water Quality Standards staff for consideration of an appropriate standards action, through the appropriate processes.*
>
> *From: Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options. California State Water Resources Control Board, Adopted by Resolution 2005-0050.*

Supplementing the aforementioned *Impaired Waters Policy*, the SWRCB has also published technical guidance to facilitate TMDL implementation in: *A Process for Addressing Impaired Waters in California, State of California S.B 469 TMDL Guidance, adopted by Resolution 2005-0050*, hereafter referred to as the *State of California TMDL Guidance.*

According to the *State of California TMDL Guidance* while in most cases the existing standards are appropriate and amenable to TMDL development, in some circumstances, investigation during the development of a TMDL reveals that the standards may be inappropriate or imprecise, thus rendering water quality attainment impossible through the TMDL process. **For those constituents a site-specific objective water quality objective (SSO) may be an appropriate action apart from, or in addition to, source control measures.** Likewise, it may be appropriate to consider seasonal or subcategories of uses or refinements to objectives to allow consideration of the dynamic or variable conditions that exist and often affect the assimilative capacity of the water body (see *State of California TMDL Guidance* page 6-5).

SSOs or refinements in the water quality objective are often considered when a numeric objective is in question (e.g., chloride or sodium recommended guideline values) and not the use itself. Refinements to the numeric water quality objectives and criterion may be appropriate if the water quality criterion was based on questionable or inappropriate water quality information. If an incorrect water quality criteria or recommended water quality guideline was assumed for a site, the criteria would be incorrect as well. In these instances, collection of appropriate water quality data may be used to refine the existing water quality criteria for the waterbody in question, and changes are made in terms of the data used to calculate the objective, not the objective itself (see *State of California TMDL Guidance* page 6-4).

2.4 USEPA Approval of TMDLs which Address 303(d) Listings Attributable to Background Conditions

In some instances during TMDL development the identified water quality impairment is due to problems with the water quality standards or the numeric water quality assessment criteria themselves; for example: when natural background levels alone are incompatible with standards or with the applicable assessment criteria that prompted the 303(d) listing.

Accordingly, note that USEPA has approved TMDLs addressing 303(d) listings which result from pollutant sources attributable to natural background conditions (see for example: Louisiana Dept. of

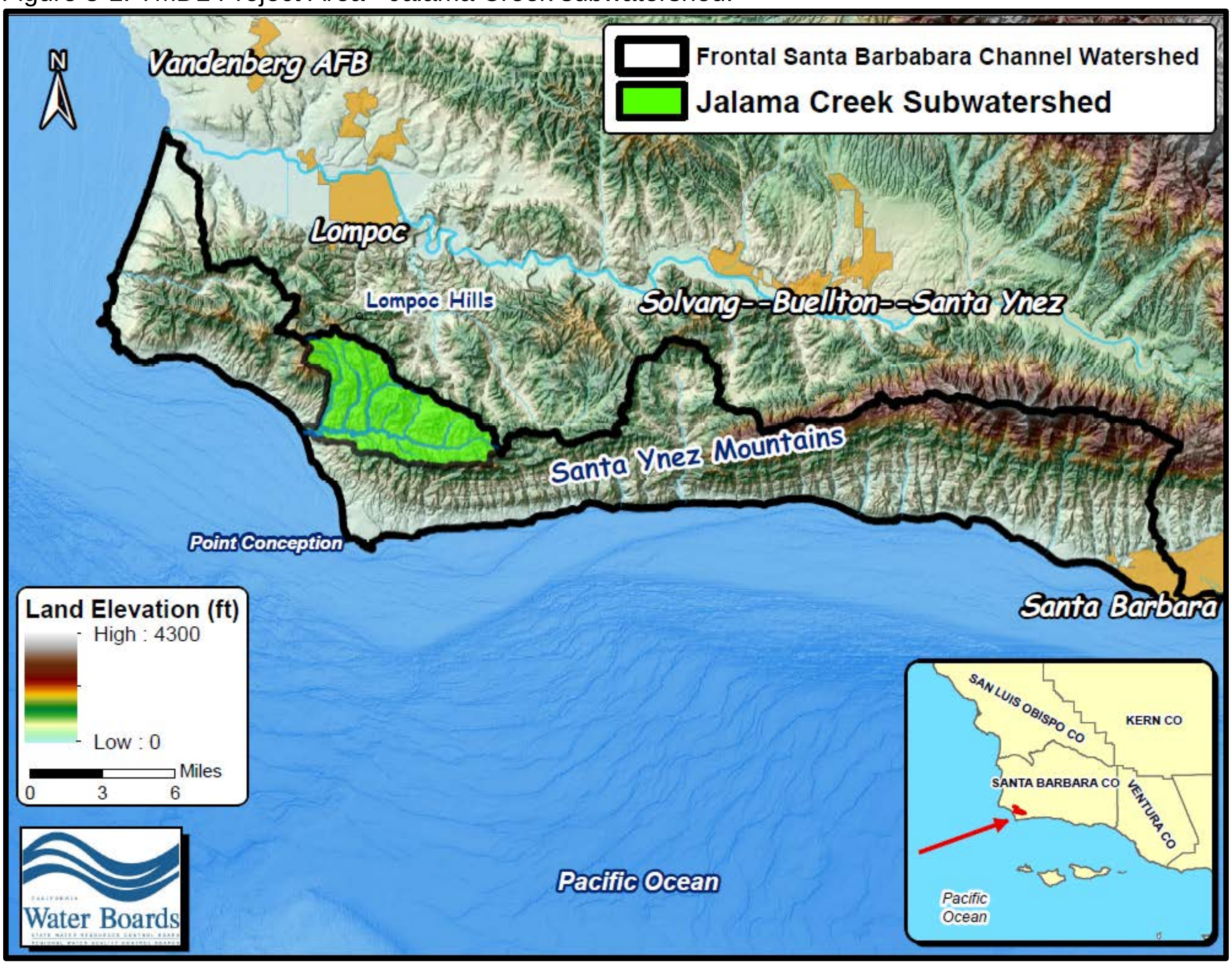
Environmental Quality, 2001a, Louisiana Dept. of Environmental Quality, 2001b, Louisiana Dept. of Environmental Quality, 2001c[2], and Kansas Dept. of Health and Environment, 2005[3]).

3 PHYSICAL SETTING & WATERSHED DESCRIPTION

3.1 Project Area

The geographic scope of this TMDL encompasses approximately 24 square miles of the Jalama Creek subwatershed in Santa Barbara County (see Figure 3-1). According to U.S. Census Bureau data there are fewer than 20 people and only a few housing units within the subwatershed. The subwatershed is comprised primarily of native vegetation; human activities in the subwatershed are primarily limited to livestock grazing operations in rangeland reaches of the subwatershed upstream of monitoring site 315JAL.

Figure 3-1. TMDL Project Area - Jalama Creek subwatershed.



2 These Louisiana TMDLs state that "LDEQ concludes that natural background loading is the most likely source of lead"

3 Page 21 of this Kansas Eagle Creek TMDL for copper states that "copper impairment is due to natural contributions".

ESRI™ ArcMap® 10.1was used to create watershed layers for the project area. The drainage boundary of the Project Area was delineated on the basis of the Watershed Boundary Dataset[4], which contain digital hydrologic unit boundary layers organized on the basis of Hydrologic Unit Codes (HUCs). The Jalama Creek subwatershed (HUC-12 scale) is nested within the larger Frontal Santa Barbara Channel watershed (HUC-12 scale), as previously illustrated in Figure 3-1.

Individual drainage catchments nested within the Jalama Creek subwatershed were delineated by clipping CalWater22 planning watershed (PWS) shape files to HUC 180600060104. Based on CalWater22 delineations, there are two distinct subdrainages/catchments nested within the Jalama Creek subwatershed: 1) Gasper Creek drainage (Calwater22 ID 3310.310203); and the 2) Palo Alto Hill drainage (Calwater22 ID 3310.310202). An illustration of the regional watershed hierarchy is presented in Table 3-1.

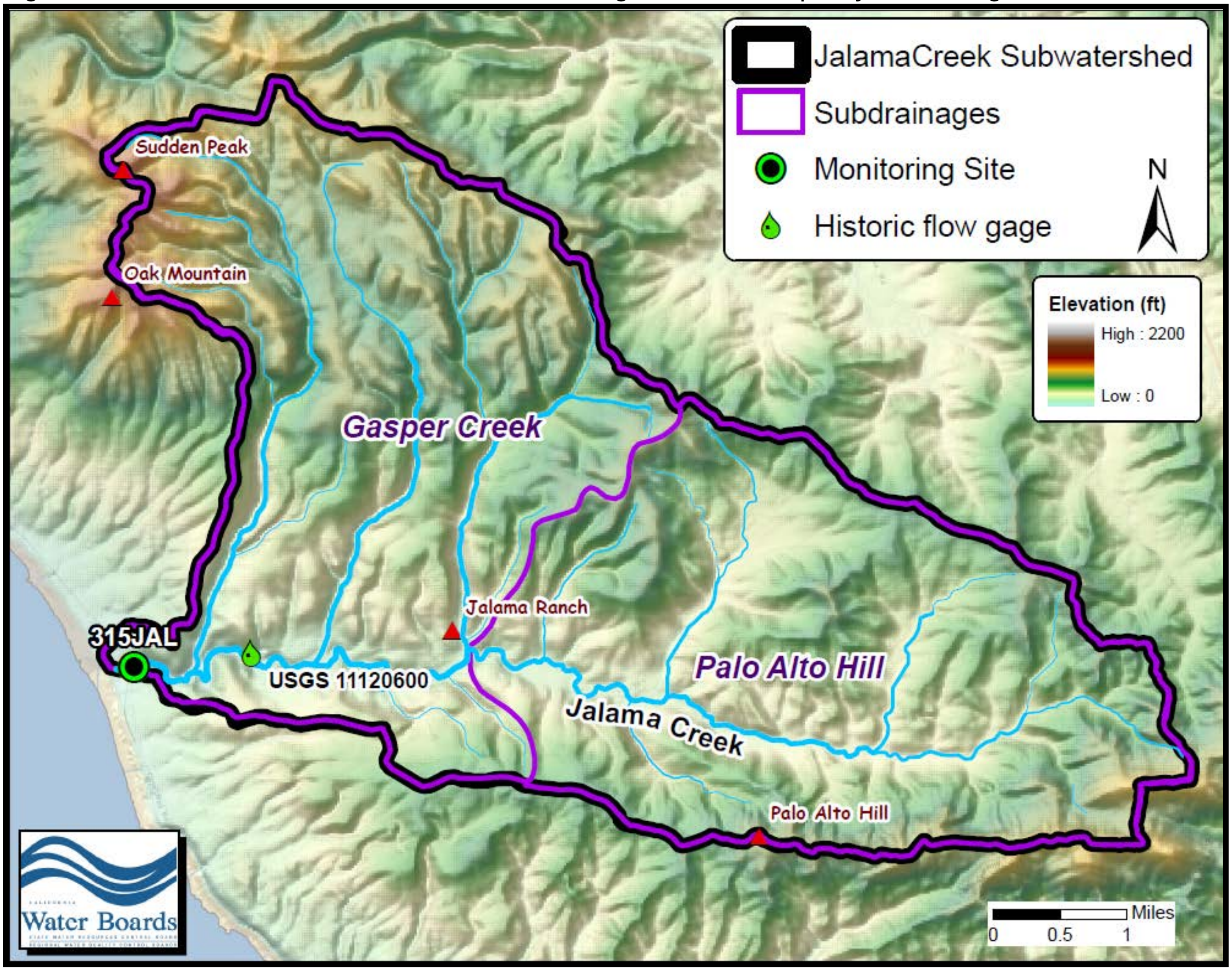
Figure 3-2 illustrates the Jalama Creek subwatershed, and the subdrainage catchments (the Gasper Creek and Palo Alto Hill drainages) nested within the subwatershed.

Table 3-1. Watershed hierarchy.

Name	**Hydrologic Scale**	**Data Source**
Frontal Santa Barbara Channel Watershed	**Watershed** refer to Figure 3-1	WBD 10-digit Hydrologic Unit Code
Jalama Creek	**Subwatershed** *within Frontal Santa Barbara Channel Watershed*	WBD 12-digit Hydrologic Unit Code
Palo Alto Hill	**Subdrainage / catchment** *within Jalama Creek subwatershed*	Calwater22 PWS unit
Gasper Creek	**Subdrainage / catchment** *within Jalama Creek subwatershed*	Calwater22 PWS unit

[4] The Watershed Boundary Dataset (WBD) is developed by federal agencies and national associations. WBD contains watershed boundaries that define the areal extent of surface water drainage to a downstream outlet. WBD watershed boundaries are determined solely upon science-based principles, not favoring any administrative boundaries.

Figure 3-2. Jalama Creek subwatershed, subdrainages and water quality monitoring site.



3.2 Land Use and Land Cover

Figure 3-3 illustrates land use and land cover in the TMDL project area, based on the National Land Cover Dataset (2001). NLCD is available from the Multi-Resolution Land Characterization (MRLC) consortium is a group of federal agencies who coordinate and generate consistent and relevant land cover information at the national scale for a wide variety of environmental, land management, and modeling applications.Table 3-2 tabulates the distribution of land use in the project area.

Figure 3-3. Jalama Creek subwatershed: land use – land cover.

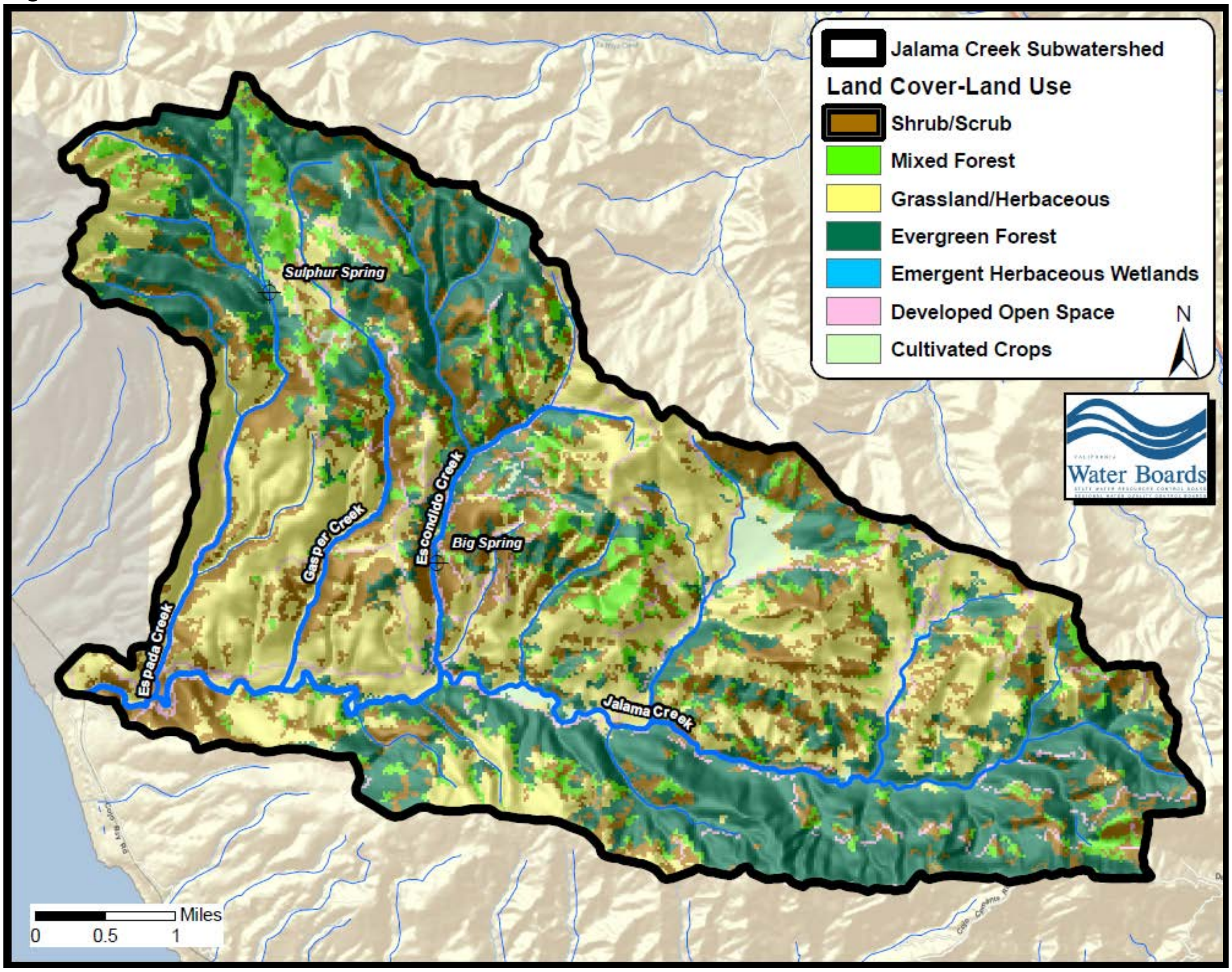
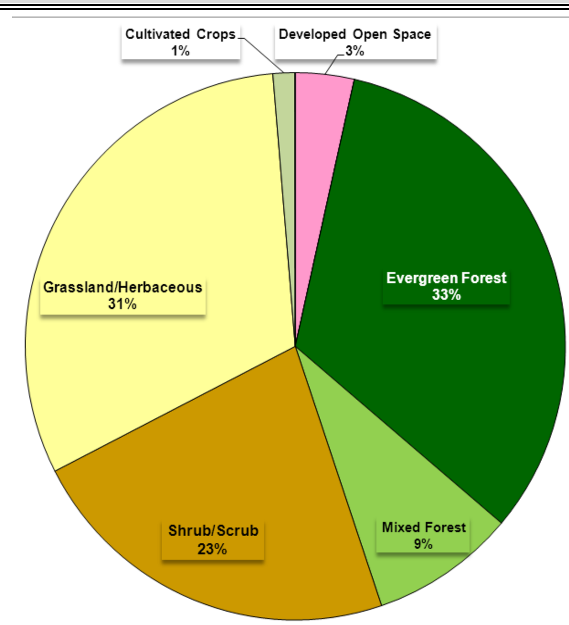


Table 3-2. Tabulation of land use/land cover in the Jalama Creek subwatershed

Land Cover	Acres
Developed Open Space	551.5
Developed, Low Intensity	0.2
Barren Land (Rock/Sand/Clay)	0.2
Evergreen Forest	5130.8
Mixed Forest	1358.5
Shrub/Scrub	3556.2
Grassland/Herbaceous	4902.2
Cultivated Crops	204.6
Woody Wetlands	1.3
Emergent Herbaceous Wetlands	2.4
Total	15,708

Land Cover Pie Chart



3.3 Hydrology

Assessing the hydrology of a watershed is an important step in evaluating the magnitude and nature of pollutant transport and loading in waterbodies. The entire drainage area contributing to flow in the TMDL Project Area (i.e., the Jalama Creek subwatershed) encompasses 24 square miles.

Jalama Creek is classified[5] as having near-perennial or sustained flows from the confluence at the Jalama estuary upstream to the confluence with Escondido Creek at approximately Jalama creek mile 3.6. According to historic U.S. Geological Survey (USGS) flow records from gage 11120600, Jalama Creek had daily measurable flows about 81% of the days during the period of record (1965-1982).

A synthetic flow record for Jalama Creek at monitoring site 315 JAL was developed with historic daily flow records from USGS 11130600 in conjunction with daily flow records from nearby USGS gage 11132500 at Salsipuedes Creek as a suitable reference flow gage, Figure 3-4 illustrates the flow duration curve for Jalama Creek at monitoring site 310LBC. Flow duration curves are graphical representations of the flow regime of a stream at a given site. The horizontal axis is essentially a flow frequency distribution, depicting the percentage of times a certain flow is exceeded on a daily basis. As such, highest flows are represented on the extreme left side of the horizontal axis, lowest flows (or dry conditions) recorded are represented the extreme right side of the axis. The median flow occurs at a flow exceedance frequency of 50 percent.

The shape of the flow duration curve Jalama Creek at site 315JAL is typical for a near-perennial stream, with observable flows occurring about 75-80% of the time over the entire period of record.

Staff also considered the importance of groundwater contributions to stream flow. Consequently, flow separation analysis[6] (Figure 3-5) on Jalama Creek historical USGS gage 11141600 indicates a baseflow index[7] of 29% (see Figure 3-2 for location of USGS gage). While this USGS gage is located upstream of the current water quality monitoring site, and is not necessarily representative of the monitoring site, it does illustrate that, locally, baseflow originating from groundwater inputs can be a significant hydrologic process in this subwatershed.

[5] The source of these hydrologic classification attributes is from the USGS's high resolution National Hydrography Dataset (NHD).

[6] Flow separation was accomplished using the Web-based Hydrograph Analysis Tool (W.H.A.T.) developed by the Purdue University engineering department.

[7] Baseflow is the component of stream flow over the period of record that is attributable to groundwater discharge into the stream.

Figure 3-4. Flow duration curve, Jalama Creek at 315JAL.

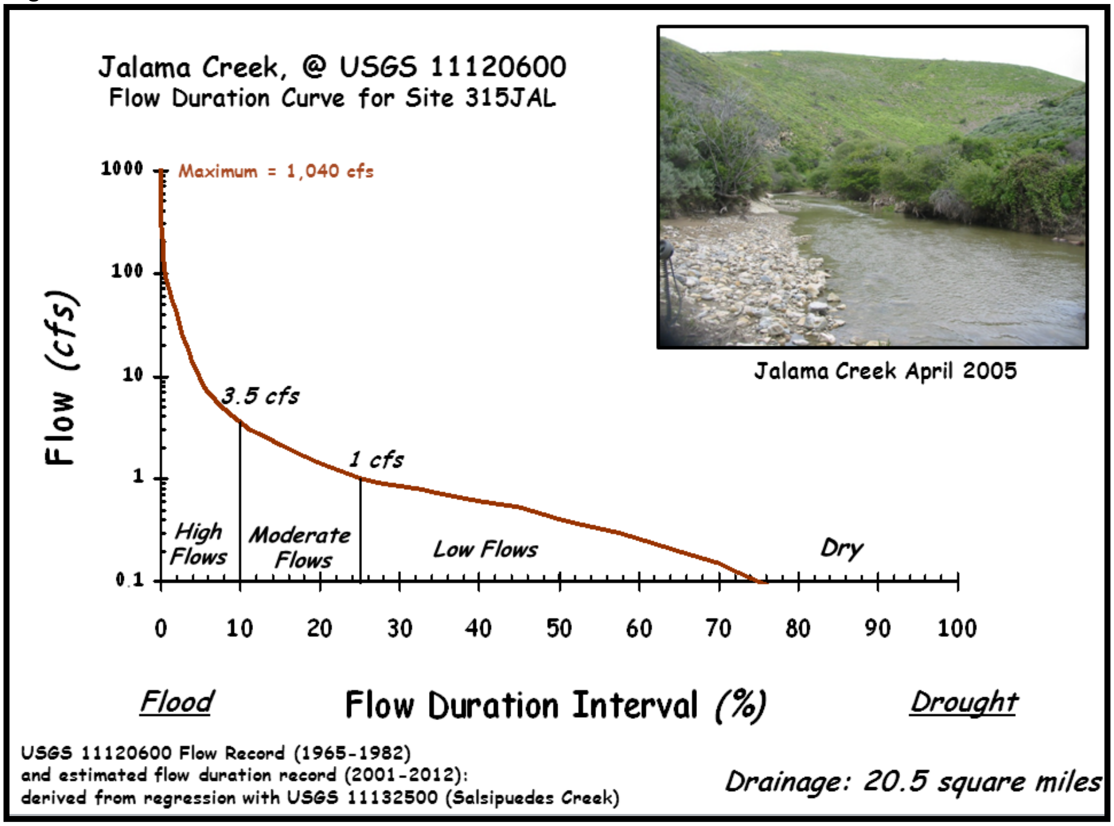
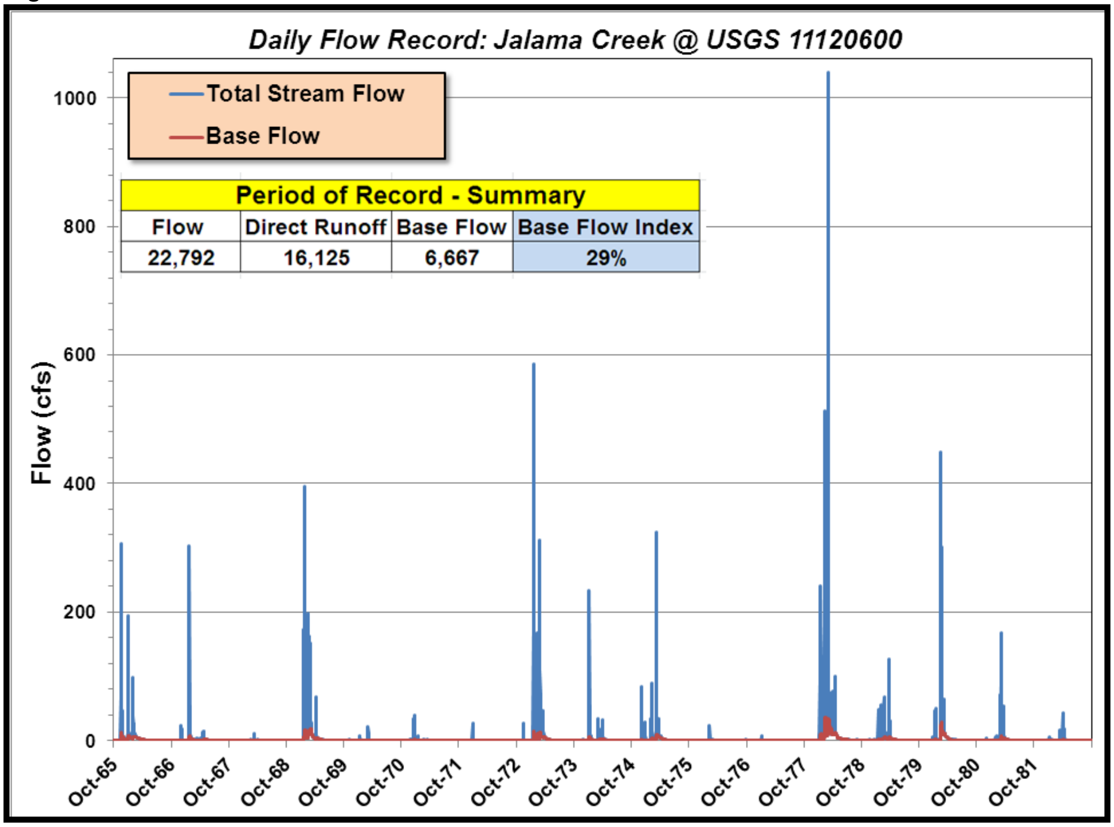


Figure 3-5. Baseflow index for Jalama Creek at USGS 11120600.



3.4 Geology

Given certain geologic and hydrogeologic conditions, geology and groundwater can locally have a significant influence on inorganic constituents (such as sodium and chloride) in streams (Reimann et al., 2009; Clow et al., 1996). The natural amounts of salts in streams are often largely determined by geologic bedrock underlying an area. Low salinity is generally expected in non-faulted areas with igneous, crystalline bedrock. Higher salts are generally expected in areas underlain by marine sediments, or in tectonically active areas where faulting and folding may cause saline subsurface pore fluids to interact and mix with shallow meteoric groundwater, springs, and surface waters.

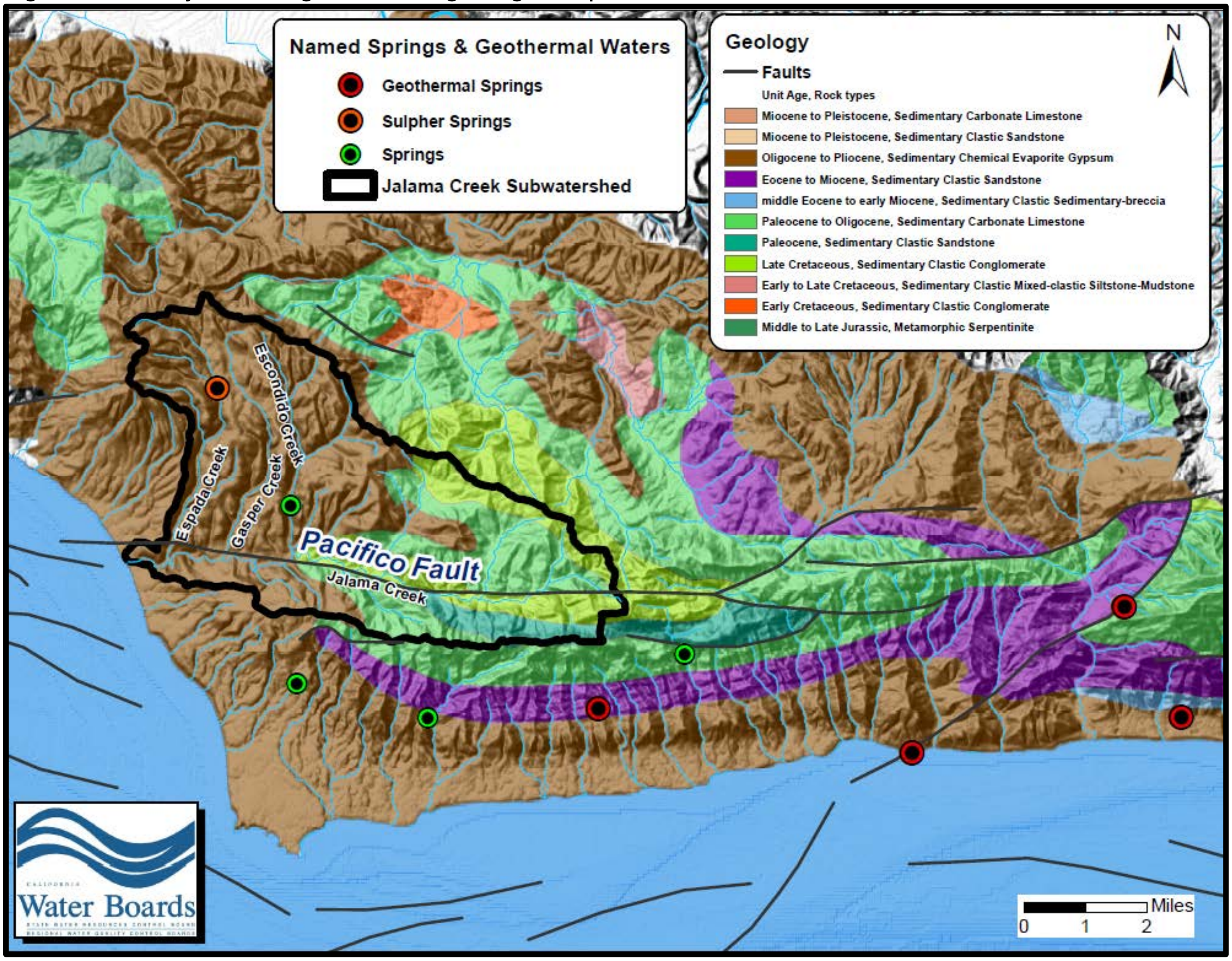
As such, it is relevant to assess regional and local geologic conditions associated with the TMDL project area. Furthermore, tectonics and geologic structure are important to consider in this TMDL, because information compiled during TMDL development indicates a potential nexus between elevated chloride and sodium in creek waters, and local geology, tectonics and subsurface waters. It should be reiterated here that groundwater (as baseflow) can be a source of chloride and sodium loads to surface water in streams. Baseflow is indeed estimated to be an important hydrologic process within this subwatershed (refer back to Section 3.3 and Figure 3-5).

The TMDL project area of the Jalama Creek subwatershed lies within the east-west trending Transverse Ranges geologic province of southern California. The Transverse Ranges province is so named because it is comprised of a series of geologic structures and mountains that run transverse to the prevailing northwest-oriented topographic and structural trend characteristic of southern California. The Transverse Ranges consists of several discrete mountain ranges and intervening intermontane valleys. Within this province, the Jalama Creek subwatershed occurs within the Santa Ynez Range. Geologically, the mountains of the Santa Ynez Range and the Jalama Creek subwatershed are young, as indicated by the steep topography, and were uplifted beginning in the Late Miocene Epoch about five million years ago. Structural features associated with this uplift include active faulting – including the Santa Ynez fault zone and its southern extension the Pacifico Fault – as well as tightly folded and fractured sedimentary bedrock. The Jalama Creek follows the westerly trend of the Pacifico Fault; indeed the Jalama Creek valley is actually a topographic expression of the Pacifico Fault.

Figure 3-6 illustrates the geology of the Jalama Creek subwatershed. Strata in the Jalama Creek subwatershed include Late Cretaceous to Miocene-aged sandstones, silts, shales, and calcareous rocks of the Jalama Formation, the Vaqueros Sandstone, the Rincon Shale, and the Monterey Shale. Further, in part due to the nature of recent, rapid tectonic uplift and compression there are a number of named springs[8] in the Jalama Creek subwatershed and nearby areas. Evidence of tectonic activity, active faulting, and mineral-rich saline subsurface waters are also shown by the presence of sulfur springs and low-temperature geothermal waters as indicated on Figure 3-6.

[8] These are springs that have been given official names in the Geographic Names Information System (GNIS), but should not be considered to constitute all springs in the region or in the subwatershed.

Figure 3-6. Project Area generalized geologic map.

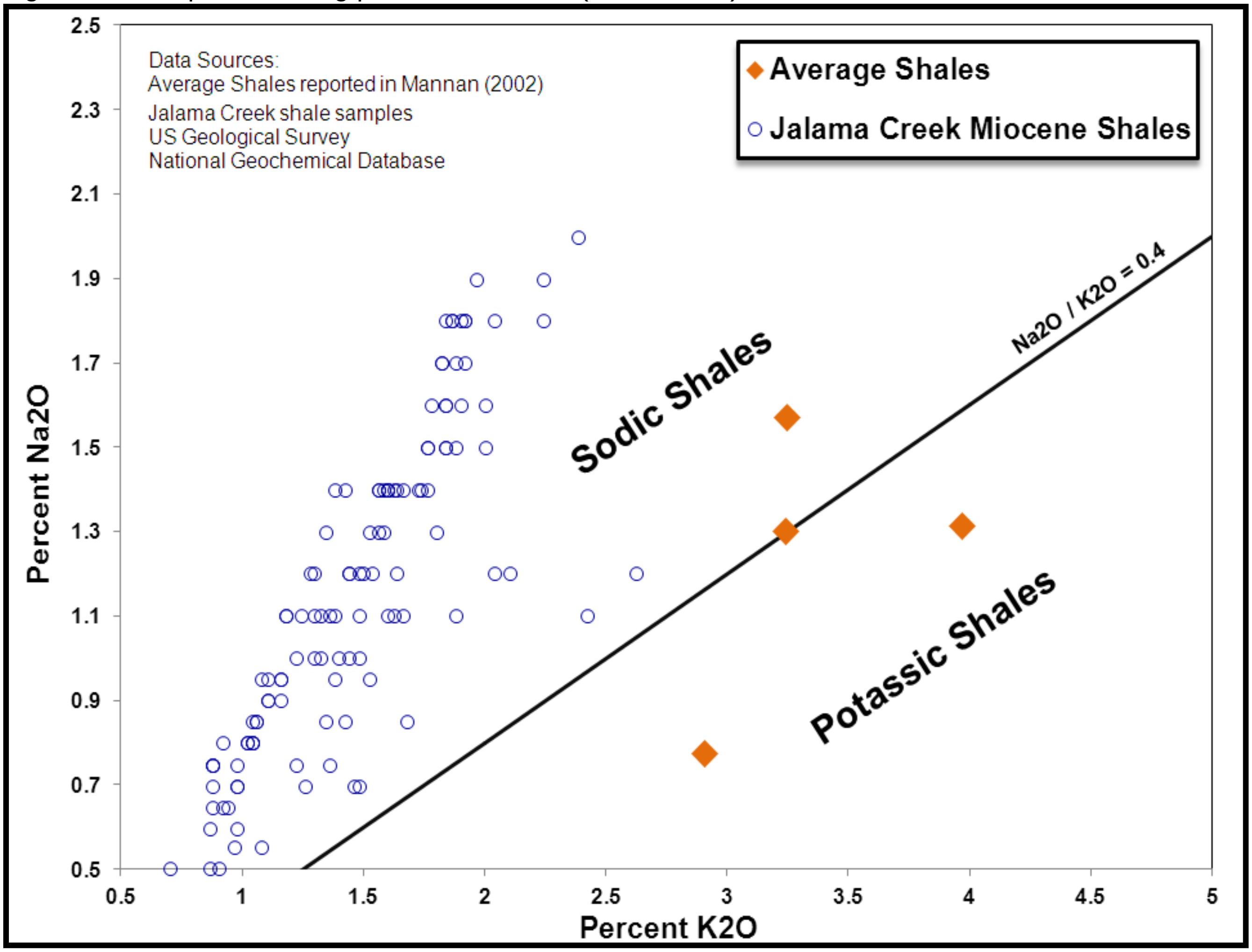


Further, there is some geochemical evidence suggesting that certain rock types in the Jalama Creek subwatershed are sodic (sodium-rich). For example, core sampling of shales within the Jalama Creek subwatershed[9] indicates that these rocks are compositionally quite sodic relative to the composition of global "average" shales reported in the scientific literature (see Figure 3-7).

It is unkown to what extent these sodic-rocks may influence elevated levels of sodium observed in Jalama Creek waters. However, sodic-shales are typically chiefly comprised of smectite clay minerals, a group of clay minerals typically having relatively high sodium content. Note that smectite minerals tend to be relatively geochemically unstable under most atmospheric or shallow subsurface conditions (Lanson et al. 2009), and will react with pore waters and metoric waters by chemically exchanging sodium for potassium in the clay mineral structure. This potentially results in the release of sodium to solution such as pore waters, groundwaters, and/or metoric waters.

[9] Data source: U.S. Geological Survey National Geochemical Database

Figure 3-7. Graph illustrating presence of sodic (sodium-rich) shales in Jalama Creek subwatershed.



Additionally, it may be important to consider potential tectonic and geologic structural controls on water-rock interactions within the Jalama Creek Subwatershed, for reasons that are outlined below.

As the Santa Ynez range was uplifted by compressional tectonic forces, the sedimentary strata were folded, faulted, and fractured to accommodate stresses imposed by the tectonic compression. The resultant structure of the Santa Ynez range is an anticlinorium[10], which is visually illustrated in cross-section in Figure 3-8, and as isostatic gravity anomalies[11] in map-view in Figure 3-9. These geologic structures are important to consider in development of this TMDL project for reasons described below.

[10] In structural geology, an anticlinorium is a series of anticlinal folds on a regional scale. An anticline itself is a single fold of rock strata that is convex up and has its oldest rock strata at its core.

[11] Isostatic gravity anomaly data are a geophysical attribute that measures density contrasts, and can be used as a proxy indicating subsurface geologic structure. Data source: U.S. Geological Survey, *Isostatic residual gravity anomaly data grid for the conterminous U.S.*, 1999.

Figure 3-8. Cross-section illustration of Santa Ynez Mountains anticlinorium[12].

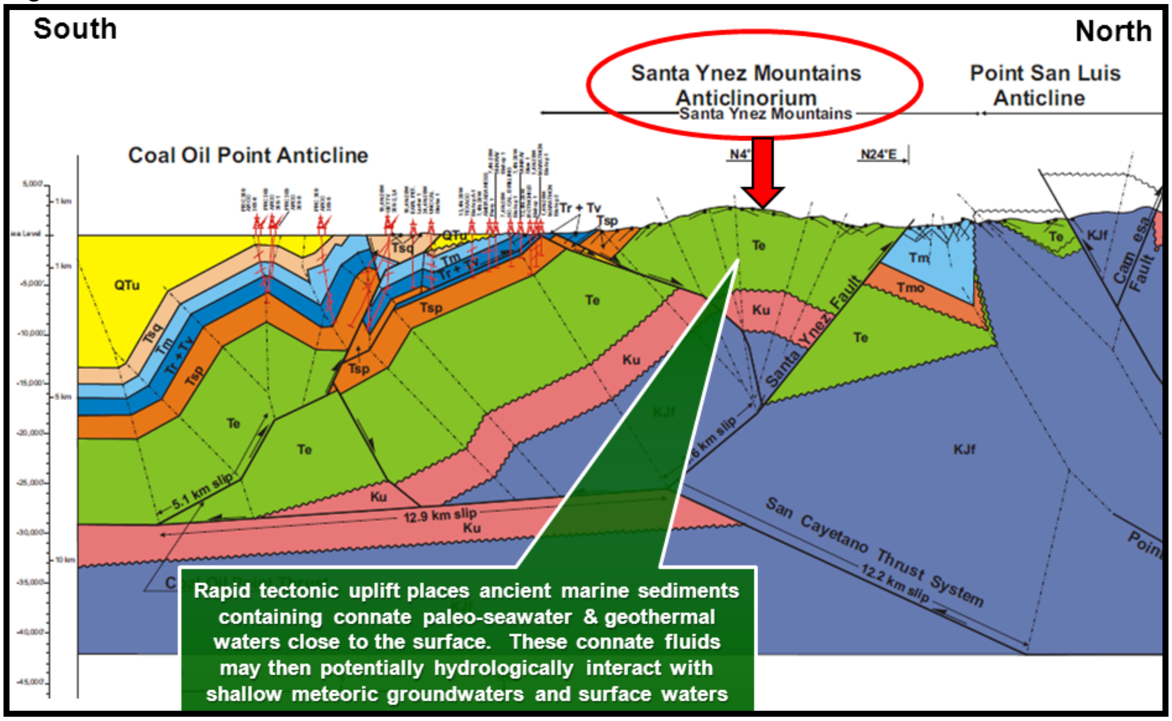
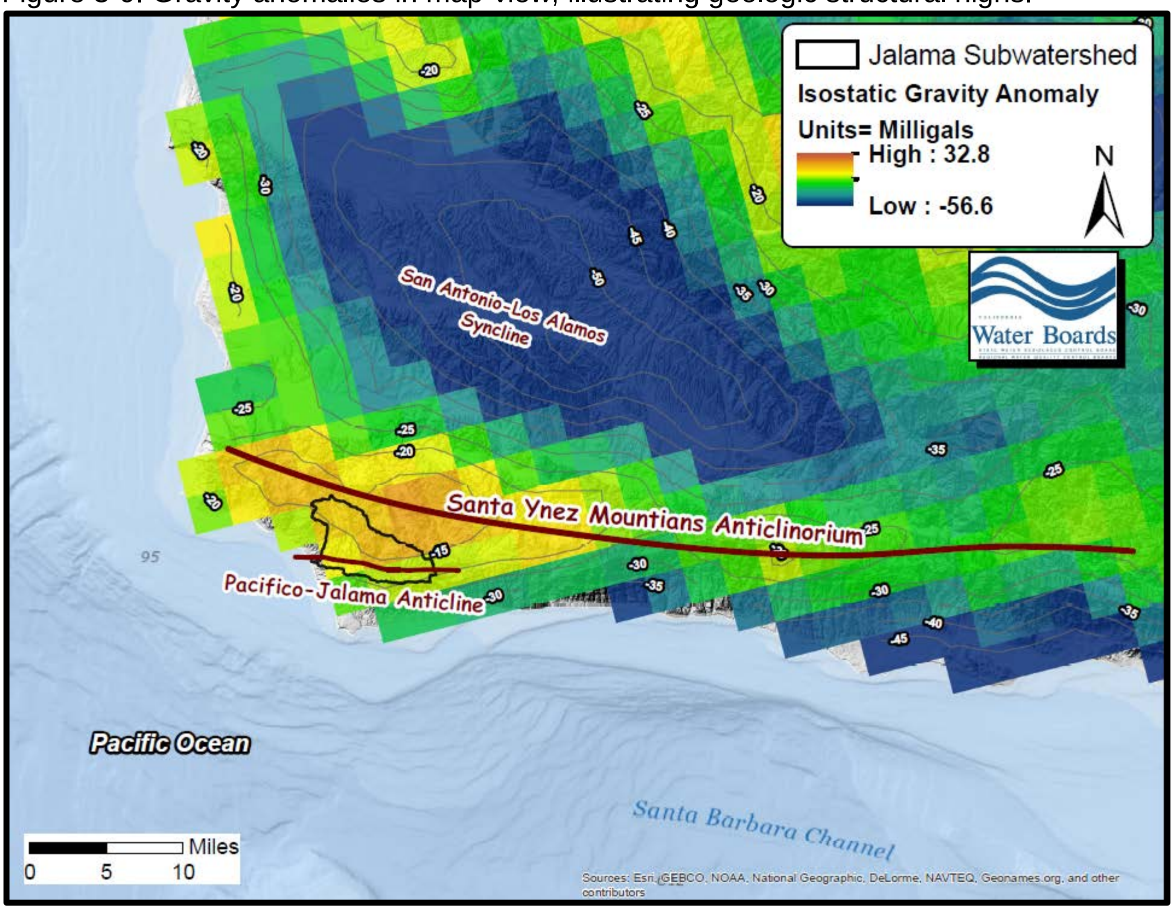


Figure 3-9. Gravity anomalies in map-view, illustrating geologic structural highs.



[12] Cross section source: Davis-Namson consulting geologists. Weblink: http://www.davisnamson.com/downloads/

The significance of anticlinoriums and anticlines is that older rock strata which potentially have salty connate pore fluids are tectonically uplifted close to the surface of the land, allowing older subsurface connate[13] pore fluids to potentially interact and mix with shallow meteoric groundwaters and surface waters (see Figure 3-10). In some cases, these older, connate fluids tend to be saline (sea water origin), and can have geochemical signatures indicating they have remained in place within the subsurface rock reservoirs for a significant period of geologic time, possibly since deposition (Unruh et al., 1995 and Davisson et al., 1994).

Additionally, as indicated in Figure 3-10, present day Jalama Creek occurs within an area of breached anticlines[14], and uplifted, faulted, folded, or fractured sedimentary strata. This is significant because the creek occurs in an area where older, marine sedimentary strata are presently exposed at surface and the tectonic compression in association with active faulting, folding, and fracturing of the rocks provide potential hydraulic conduits that may allow for saline, connate fluids originating from depth to discharge at the land surface or mix with shallow, fresh meteoric waters and surface waters. Indeed, recall that shown previously in Section 3.3 and Figure 3-5, baseflow in Jalama Creek is an important hydrologic process indicating that creek flow is partly attributable to groundwater-subsurface water inputs.

It should be noted that the potential for tectonic compression and uplift of sediments containing saline connate pore waters (paleo-seawater), and the subsequent hydrologic interaction with shallow meteoric groundwaters and surface waters, is not simply theoretical or speculative. It has been well-established in the literature that regions undergoing tectonic compression can result in regional over-pressure (exceeding hydrostatic pressure) of subsurface saline connate pore fluids. This over-pressure may cause the connate fluids to migrate upward along hydraulic conduits and be expelled via springs at the land surface, or to mix with shallow meteoric fresh waters.

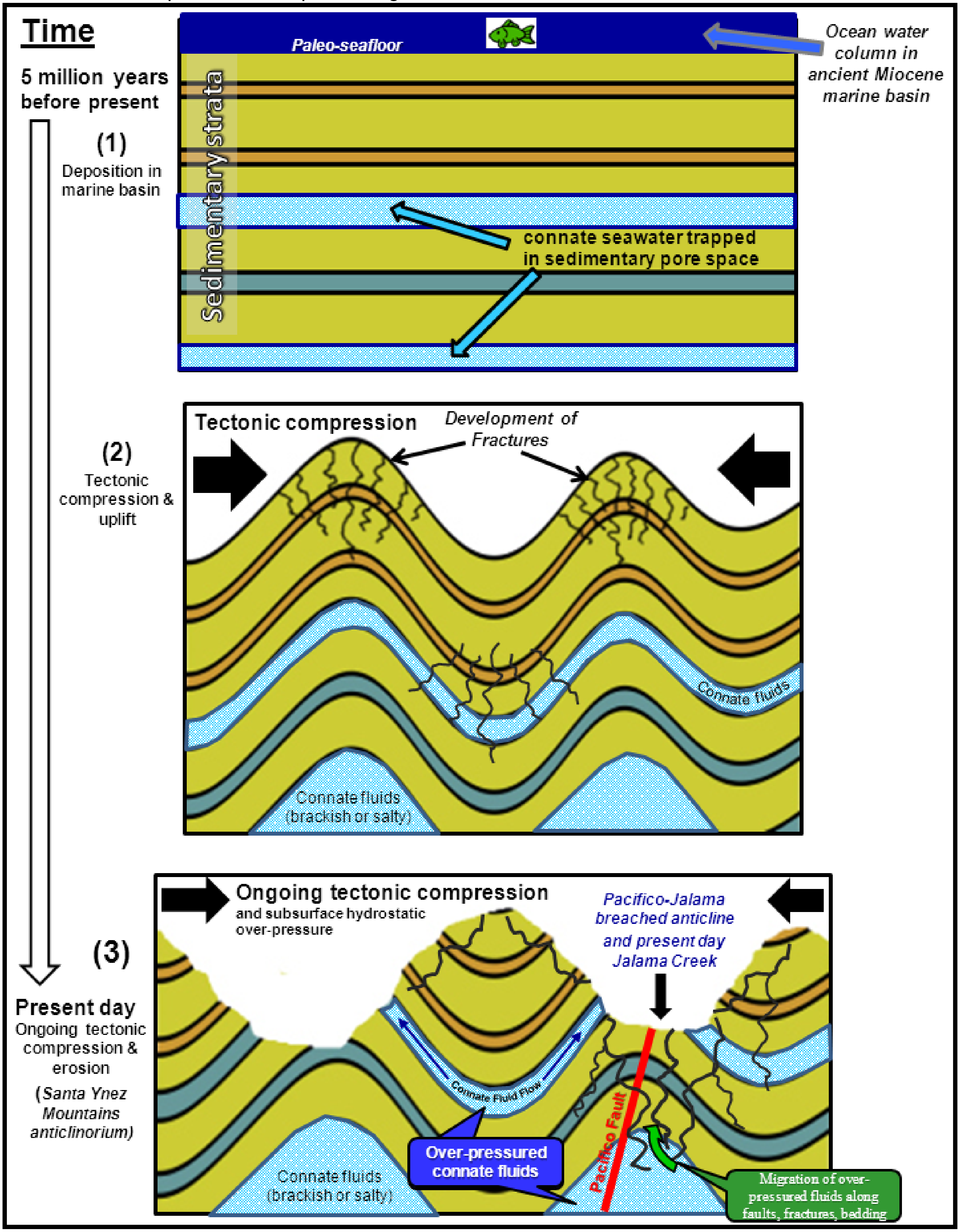
For example, isotopic studies of perennial springs found along ridge tops in the Rumsey Hills of Yolo County, California (an area also undergoing active tectonic compression), indicate these saline spring waters originate from deep, basinal connate waters, and that regional overpressure of subsurface fluids locally extends to the surface. This results in discharge of connate fluids originating from depth at the land surface (McPherson and Garven, 1999). Furthermore, the isotopic data from the Rumsey Hills study is consistent with mixing and hydraulic communication between shallow, meteoric groundwaters and saline connate waters originating from depth (Davisson et al., 1994).

With regard to the aforementioned information on the nexus between geology, tectonics, and the hydrologic communication of subsurface waters, note that the next section of this project report (Section 3.5) develops and presents information and supporting lines of evidence on subsurface waters. Consistent with the scientific literature reporting noted above, these data will likewise suggest that saline, connate fluids originating from depth are mixing with shallow meteoric waters and stream waters in the Jalama Creek subwatershed, likely contributing to elevated chloride and sodium in creek waters.

[13] Connate fluids are liquids – for example, ancient sea water - that were trapped in the pores of marine or continental sedimentary rocks as they were deposited and buried. In general, buried marine sediments often contain connate saline waters reflecting a paleo-seawater origin, whereas buried continental sediments will contain connate waters of freshwater meteoric origin.

[14] A breached anticline is an anticline that has been more deeply eroded and incised in the center part of the fold (typically by down-cutting streams) so that it is flanked by inward-facing erosional scarps.

Figure 3-10. Conceptual development of Santa Ynez anticlinorium; the Pacifico-Jalama breached anticline; and the potential over-pressuring of subsurface connate fluids.



3.5 Groundwaters & Geothermal Waters

It is well known that groundwater discharge to surface waters can be a source of chloride, sodium or other pollutants to any given surface waterbody. As such, it is relevant to consider the nexus between groundwaters and surface water in this TMDL project:

"Traditionally, management of water resources has focused on surface water or ground water as separate entities….Nearly all surface-water features (streams, lakes reservoirs, wetlands, and estuaries) interact with groundwater. Pollution of surface water can cause degradation of ground-water quality and conversely pollution of ground water can degrade surface water. Thus, effective land and water management requires a clear understanding of the linkages between ground water and surface water as it applies to any given hydrologic setting."

From: U.S. Geological Survey, 1998. Circular 1139: "Groundwater and Surface Water – A Single Resource"

"While ground water and surface water are often treated as separate systems, they are in reality highly interdependent components of the hydrologic cycle. Subsurface interactions with surface waters occur in a variety of ways. Therefore, the potential pollutant contributions from ground water to surface waters should be investigated when developing TMDLs."

From: U.S. Environmental Protection Agency, Guidance for Water Quality-Based Decisions: The TMDL Process – Appendix B. EPA 440/4-91-001

"Although surface water and groundwater appear to be two distinct sources of water, they are not. Surface water and groundwater are basically one singular source of water connected physically in the hydrologic cycle…Effective management requires consideration of both water sources as one resource."

From: California Department of Water Resources: Relationship between Groundwater and Surface Water
http://www.water.ca.gov/groundwater/groundwater_basics/gw_sw_interaction.cfm

Historical groundwater data collected in the Jalama Creek subwatershed and nearby vicinity indicate elevated levels of sodium and chloride (see Table 3-3). The location of the groundwater sample sites are shown in Figure 3-11. These sites are located in minimally impacted areas, which generally preclude substantial human impacts to groundwater; therefore these samples can plausibly be considered to be representative of natural, ambient groundwater conditions. Additionally, a local rancher reported to staff that sulfur springs are present in the Jalama Creek subwatershed, providing an additional independent line of anecdotal observational evidence that shallow subsurface fluids locally have high mineral content.

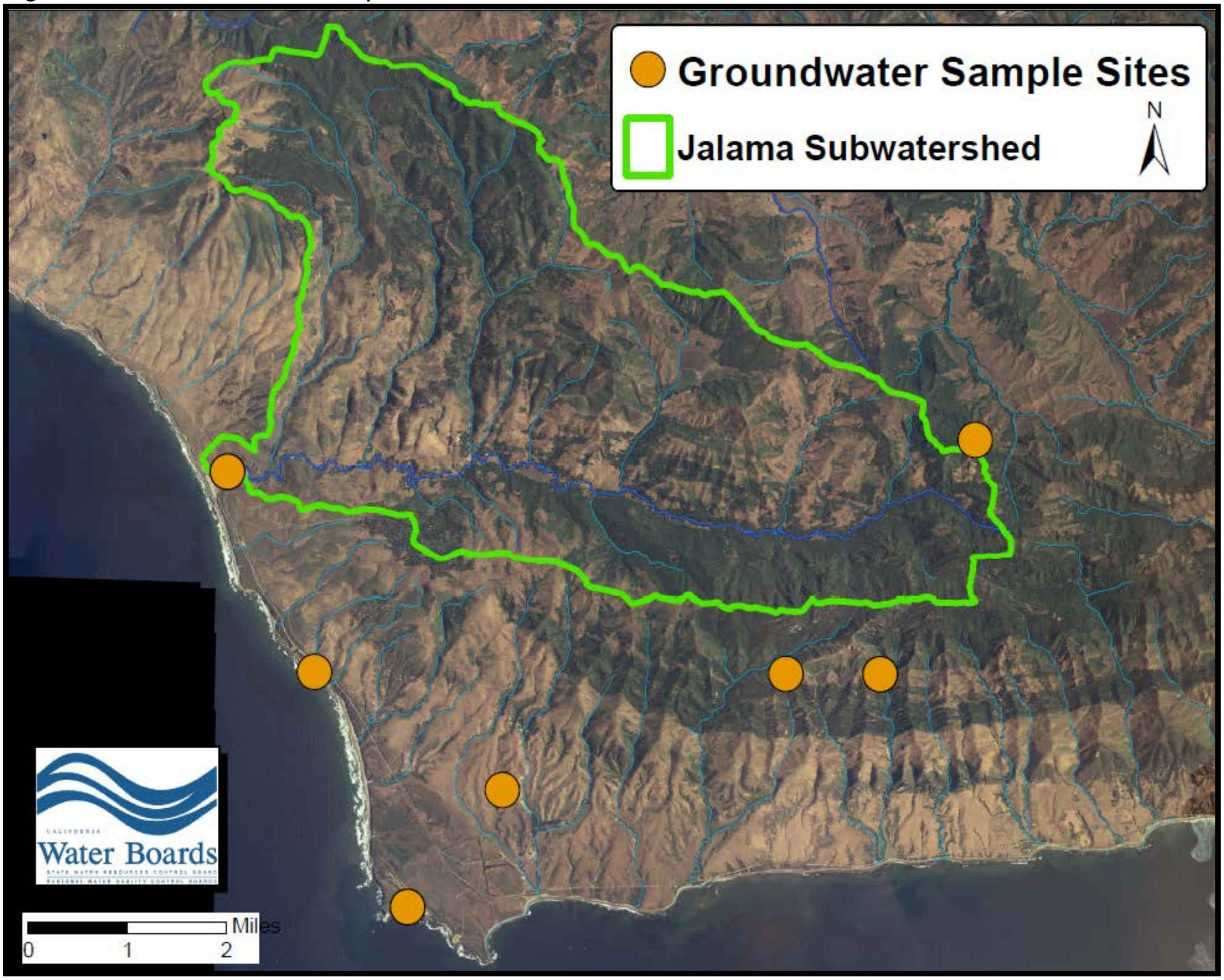
Recall that groundwater baseflow is a significant contributor to total stream flow in Jalama Creek (refer back to Section 3.3 and Figure 3-5), and that groundwaters can therefore contribute salts and other inorganic constituents to surface waters. The available groundwater data (Table 3-3) and hydrologic data suggest that elevated sodium and chloride concentrations in groundwater locally can contribute to observed sodium and chloride levels in Jalama Creek.

Table 3-3. Groundwater samples in Jalama Creek subwatershed and vicinity (1954 to 1967).

	Groundwater Samples (units = mg/L)							
Constituent	**No. of Samples**	**Temporal Representation**	**Minimum**	**25th percentile**	**Mean**	**Median**	**75th percentile**	**Maximum**
Chloride	13	Aug. 1954-April 1967	30	54	268	184	465	664
Sodium	12	Aug. 1954-April 1967	38	66	219	140	336	522

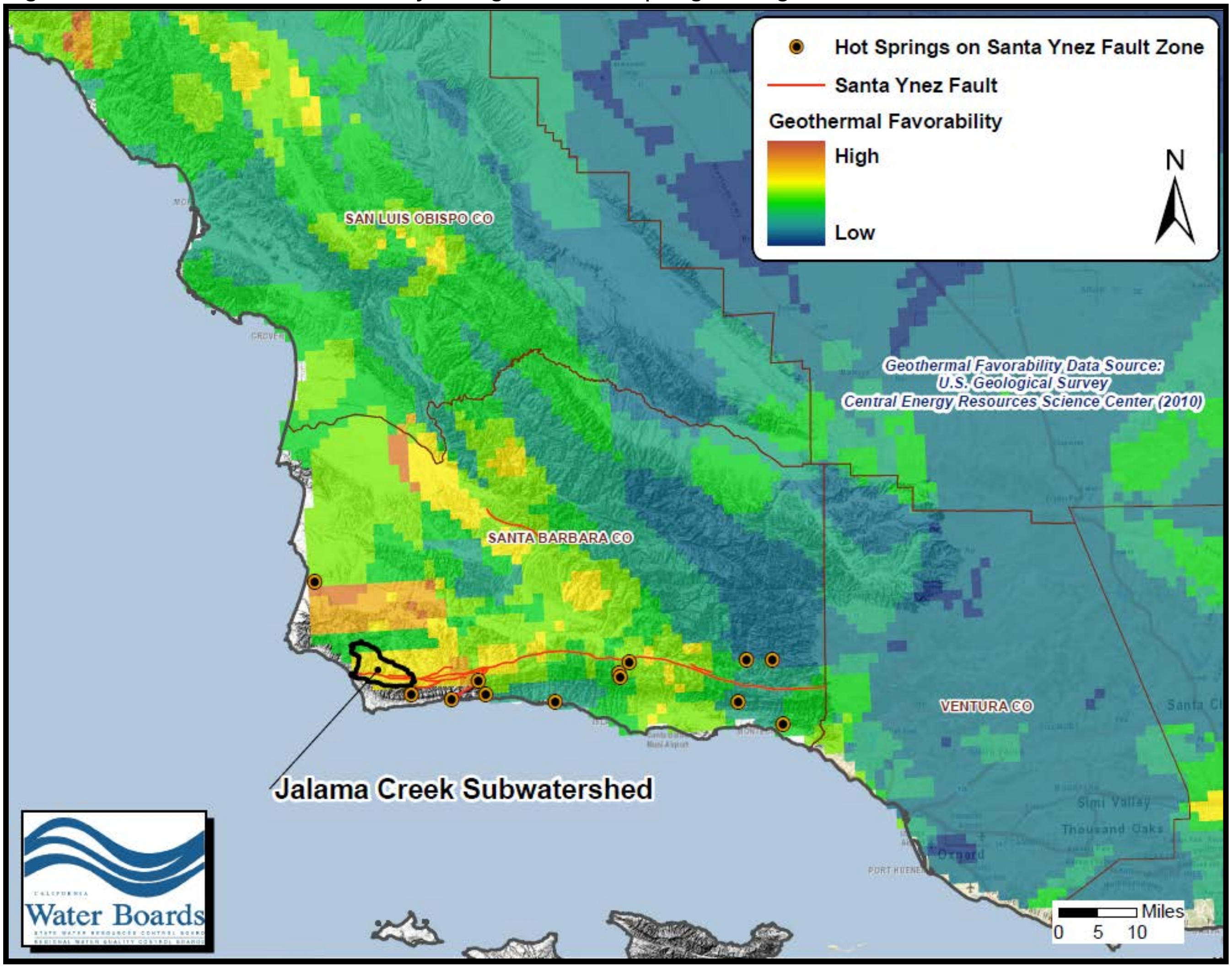
Data source: U.S. Environmental Protection Agency STORET Legacy Database

Figure 3-11. Groundwater sample sites.



Additional lines of evidence of saline subsurface fluids in the Jalama Creek subwatershed and vicinity is available in the form of geothermal data. The Jalama Creek subwatershed, and the associated Santa Ynez Mountains and Santa Ynez Fault zone are well-known to be areas of higher-than-average geothermal activity; geothermal potential; and geothermal hot springs (for example, see Figure 3-12; also refer back to Figure 3-6 which also shows locations of named hot springs).

Figure 3-12. Geothermal favorability and geothermal springs along Santa Ynez Fault zone.

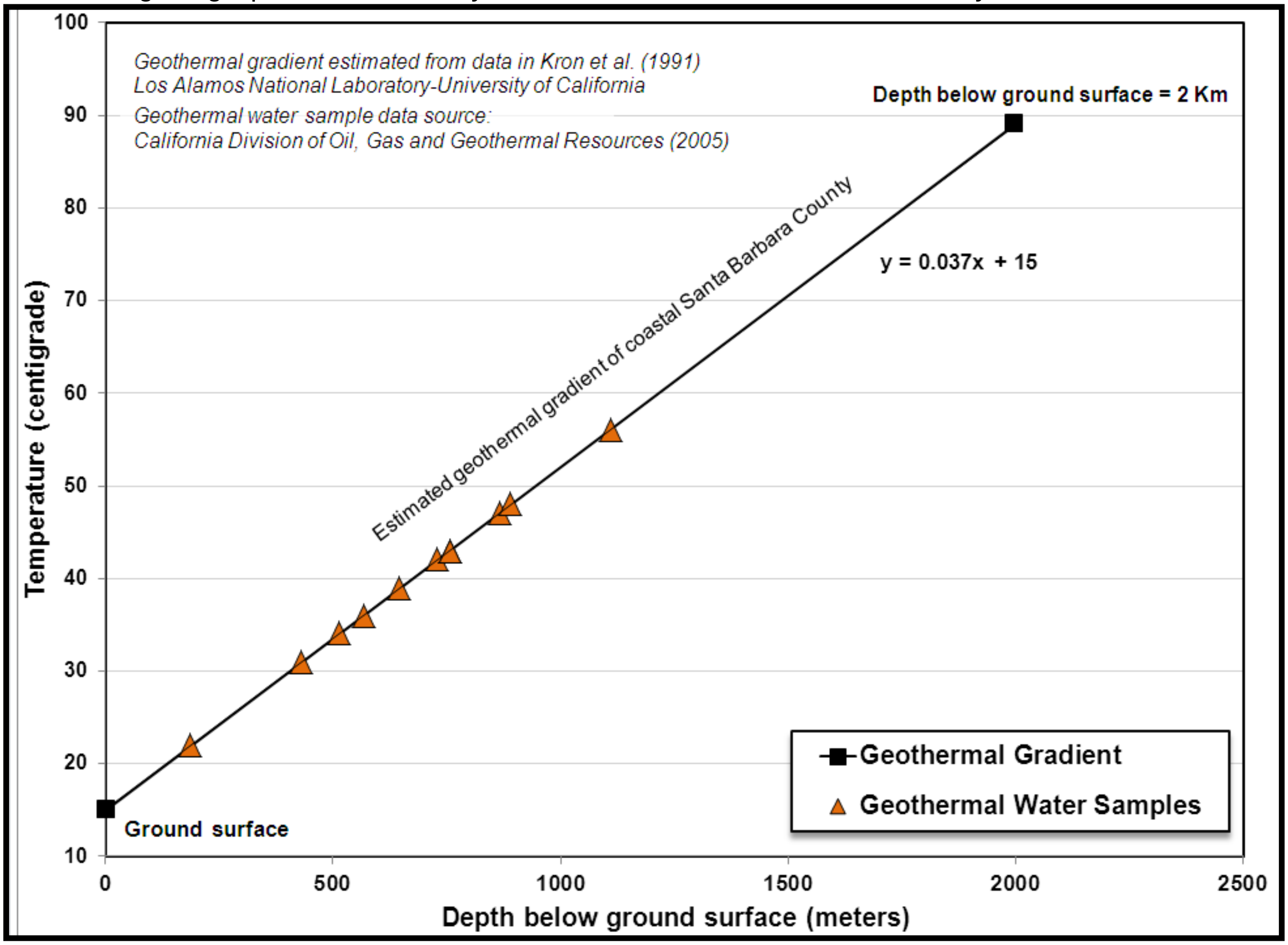


Geothermal fluids are fluids (either meteoric or connate) that circulate at depth, are typically saline or mineralized due to water—rock geochemical interactions, and may ultimately be discharged at the land surface via faults, fractures, stratigraphic bedding, or other favorable hydraulic conduits that allow the geothermal fluids to migrate from depth.

Indeed, temperature data available for geothermal spring waters in the vicinity of the Jalama Creek subwatershed suggest that – at a minimum – these waters originate from depths of several hundred meters to over a kilometer below ground surface[15] (see Figure 3-13). These data constitute another line of evidence that saline, subsurface fluids of connate or mixed connate-meteoric provenance and originating from depth can locally be in hydrologic communication with meteoric fluids associated with shallow groundwaters and Jalama creek surface waters.

[15] Staff estimated the local geothermal gradient from estimated local average surface temperatures (see report Section and a regional geothermal gradient published by Los Alamos National Labs. In deriving this estimate, staff also estimated average surface temperature on the basis of on spatial data developed by the U.S. Geological Survey (2010) entitled Attributes for NHDplus Catchments for the Conterminous United States, Average Daily Minimum and Maximum Temperatures, 2002. Staff estimated mean daily surface temperature by averaging the daily maximum and daily minimum temperatures. The estimated depth of origin of the geothermal water samples should be considered a minimum, since water temperature is measured at the surface and some cooling of the fluid could occur during its migration to the land surface.

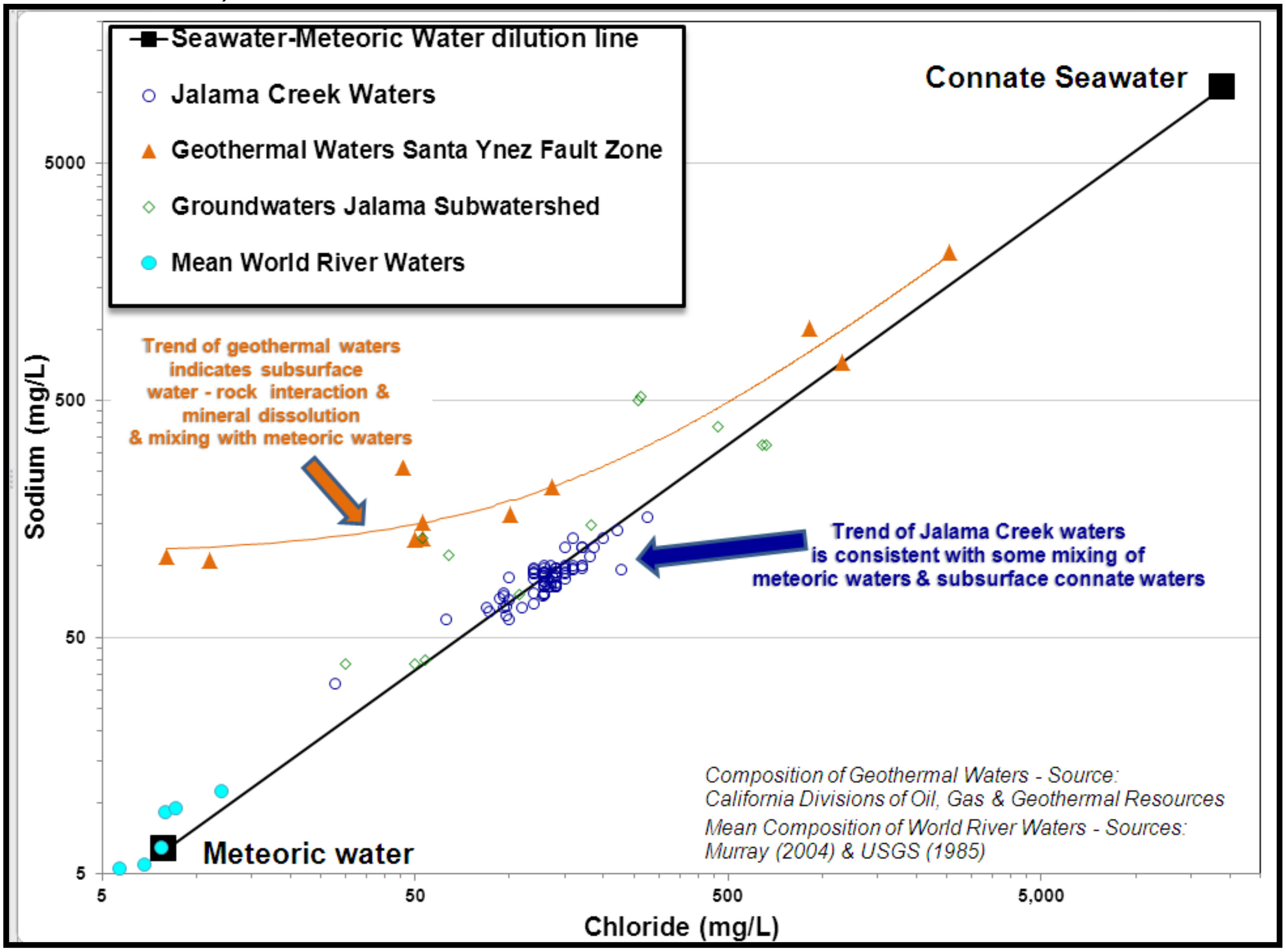
Figure 3-13. Estimated minimum depth of origin for geothermal spring waters from Santa Ynez mountains geologic province, in vicinity of Jalama Creek, Santa Barbara County.



This mixing of locally of deep, basinal saline waters with shallow meteoric groundwaters and surface waters would indeed be expected to increase chloride and sodium concentrations in Jalama Creek waters. Consequently, an additional line of water quality and geochemical evidence can also be developed which likewise indicates hydrologic communication between subsurface basinal saline waters and meteoric waters. Figure 3-14 illustrates that Jalama Creek water samples compositionally comport quite closely with a dilution trend line between seawater and average meteoric freshwater on the basis of chloride and sodium concentrations. This suggests that chloride concentrations in Jalama Creek waters are partially attributable with mixing with deep, connate paleo-seawater fluids originating from the uplifted marine sediments.

Figure 3-14 also shows that geothermal waters and groundwaters in the Jalama Creek subwatershed and vicinity also show dilution from a paleo-seawater baseline, which indicates some fraction of mixing between connate, paleo-seawater and fresh meteoric waters. However, the geothermal and groundwaters also tend to be relatively enriched in sodium relative to the seawater-meteoric water dilution line (note that the geothermal water samples deviate from the seawater-meteoric water dilution trend line, towards more sodium rich conditions). This sodium-enrichment is undoubtedly due to water-rock geochemical interactions that pore fluids undergo in the subsurface.

Figure 3-14. Sodium-chloride ratios in Jalama Creek surface waters, groundwaters, and local geothermal waters relative to dilution trend line between global mean seawater (represented here as connate seawater) and meteoric water.



Collectively, the aforementioned information and data presented in project report Section 3.4 and Section 3.5 constitute multiple lines of evidence that geology, tectonics, structural features, saline springs, groundwater chemistry, geothermal activity, and credible evidence of hydrologic communication between meteoric waters and deeper, saline connate fluids (paleo-seawater and geothermal waters) likely cause or contribute to elevated chloride and sodium levels observed in Jalama Creek.

4 WATER QUALITY STANDARDS AND DATA ASSESSMENT

4.1 Water Quality Standards

TMDLs are requirements pursuant to the federal Clean Water Act. The broad objective of the federal Clean Water Act is to “restore and maintain the chemical, physical and biological integrity of the Nation’s waters[16].” Water quality standards are provisions of state and federal law intended to implement the federal Clean Water Act. In accordance with state and federal law, California’s water quality standards consist of:

[16] Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.) Title 1, Section 101.(a)

- Beneficial uses, which refer to legally-designated uses of waters of the state that may be protected against water quality degradation (e.g., drinking water supply, recreation, aquatic habitat, agricultural supply, etc.)
- Water quality objectives, which refer to limits or levels (numeric or narrative) of water quality constituents or characteristics that provide for the reasonable protection of beneficial uses of waters of the state.
- Anti-degradation policies, which are implemented to maintain and protect existing water quality, and high quality waters.

Therefore, beneficial uses, water quality objectives, and anti-degradation policies collectively constitute water quality standards. Beneficial uses, relevant water quality objectives, and anti-degradation requirements that pertain to this TMDL are presented below in Section 4.2, Section 4.3, and Section 4.4 respectively.

4.2 Beneficial Uses

California's water quality standards designate beneficial uses for each waterbody (e.g., drinking water supply, aquatic life support, recreation, etc.) and the scientific criteria to support that use. The California Central Coast Water Board is required under both State and Federal law to protect and regulate beneficial uses of waters of the state. Table 4-1 presents the designated beneficial uses for Jalama Creek.

Table 4-1. Basin Plan designated beneficial uses for Jalama Creek (above estuary)

Waterbody Names	MUN	AGR	PROC	IND	GWR	REC1	REC2	WILD	COLD	WARM	MIGR	SPWN	BIOL	RARE	EST	FRESH	COMM	SHELL
Jalama Creek	X	X			X	X	X	X		X		X				X	X	

MUN: Municipal and domestic water supply.
AGR: Agricultural supply.
PRO: Industrial process supply.
IND: Industrial service supply
GWR: Ground water recharge.
REC1: Water contact recreation.
REC2: Non-Contact water recreation.
WILD: Wildlife habitat.
COLD: Cold fresh water habitat.
WARM: Warm fresh water habitat
MIGR: Migration of aquatic organisms.
SPWN: Spawning, reproduction, and/or early development.
BIOL: Preservation of biological habitats of special significance.
RARE: Rare, threatened, or endangered species
EST: Estuarine habitat
FRESH: Freshwater replenishment.
COMM: Commercial and sport fishing.
SHELL: Shellfish harvesting.

A narrative description of the designated beneficial uses of project area surface waters which are most likely to be potentially at risk of impairment by water column chloride and sodium are presented below.

4.2.1 Agricultural Supply (AGR)

Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing (see Basin Plan, Chapter 2, Section II.).

Chloride and sodium in irrigation water may cause toxic effects in cultivated crops. Typical toxicity symptoms are plant injury such leaf burn, scorch and dead tissue[17]. In accordance with the Basin Plan, interpretation of the amount of chloride and sodium which adversely effects of the agricultural

[17] United Nations Food and Agriculture Organization (1985), Water Quality for Agriculture. ISBN 92-5-102263-1

supply beneficial of waters of the State use shall be derived from the University of California Agricultural Extension Service guidelines, which are found in Basin Plan Table 3-3.

Accordingly, Table 3-3 of the Basin Plan (page III-8), water quality guidelines state that severe problems may occur when chloride exceeds 106 mg/L in irrigation supply water.

Further, Table 3-3 of the Basin Plan (page III-8), water quality guidelines state that severe problems may occur when sodium exceeds 69 mg/L in irrigation supply water.

It should be noted that the University of California Agricultural Extension Service guideline values for chloride and sodium are flexible, and may not necessarily be appropriate due to local conditions or special conditions of crop, soil, and method of irrigation. These guidelines have limitations in actual practice; in many instances a water may be wholly unsuitable for irrigation under certain conditions of use and yet be completely satisfactory under other conditions depending on soil permeability, temperature, humidity, rainfall, and other contributing factors. Further, sodium toxicity is not as easily diagnosed as chloride toxicity; sodium toxicity is relatively complicated and may involve calcium deficiency in the soil or other interactions. Sodium toxicity is often modified or reduced if sufficient calcium is available in the soil.

4.2.2 Municipal and Domestic Water Supply (MUN)

> *Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply. According to State Board Resolution No. 88- 63, "Sources of Drinking Water Policy" all surface waters are considered suitable, or potentially suitable, for municipal or domestic water supply except under certain conditions (see Basin Plan, Chapter 2, Section II.)*

The Basin Plan water quality objective protective of municipal and domestic water supply beneficial uses and which is most relevant to chloride pollution is the taste and odors general objective for all inland surface water, enclosed bays, and estuaries (Basin Plan Chapter 3, section II.A.2.a.). The taste and odors general objective is a narrative water quality objective that states:

“Waters shall not contain taste or odor-producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, that cause nuisance, or that adversely affect beneficial uses.”

Because excessive levels of chloride cause salty taste in drinking water supplies, the narrative taste and odor objective applies to chloride. The U.S. Environmental Protection Agency and the California Department of Public Health have established a recommended secondary maximum contaminant level (secondary MCL) for chloride as 250 mg/L. Secondary MCLs are not established for public health concerns, but address the esthetics of drinking water, such as taste and odor. This chloride secondary MCL level can therefore be used to assess attainment or non-attainment of the Basin Plan’s taste and odors objective and to ensure that MUN designated beneficial uses are being protected and supported.

4.2.3 Ground Water Recharge (GWR)

> *Uses of water for natural or artificial recharge of ground water for purposes of future extraction, **maintenance of water quality**, or halting of saltwater intrusion into freshwater aquifers. Ground water recharge includes recharge of surface water underflow. (emphasis added) - (see Basin Plan, Chapter 2, Section II.)*

The groundwater recharge (GWR) beneficial use is recognition of the fundamental nature of the hydrologic cycle, and that surface waters and ground water are not closed systems that act independently from each other. Most surface waters and ground waters of the central coast region are both designated with the MUN beneficial use. The MUN chloride secondary MCL applies to *both* the creek waters, and to the underlying groundwater. This chloride secondary MCL objective and the MUN designation of underlying groundwater is relevant to the extent that portions of Jalama Creek recharge the underlying groundwater resource. The Basin Plan GWR beneficial use explicitly states that the designated groundwater recharge use of surface waters are to be protected to maintain groundwater quality. As such, if and where necessary, the GWR beneficial uses of the surface waters need to be protected so as to support and maintain the MUN beneficial use of the underlying ground water resource. The Basin Plan does not specifically identify numeric water quality objectives to implement the GWR beneficial use, however a situation-specific weight of evidence approach can be used to assess if GWR is being supported, consistent with Section 3.11 of the California Listing Policy (SWRCB, 2004).

4.2.4 Aquatic Habitat (WARM, SPWN, WILD)

WARM: Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.

SPWN: Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

WILD: Uses of water that support terrestrial ecosystems including, but not limited to, preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

The Basin Plan water quality objectives protective of aquatic habitat beneficial uses and which is most relevant to water column chloride is the general objective for toxicity for all inland surface waters, enclosed bays, and estuaries (Basin Plan Section II.A.2.). The general toxicity objective is a narrative water quality objective that states:

"All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, toxicity bioassays of appropriate duration, or other appropriate methods as specified by the Regional Board."

Because excessive levels of chloride cause toxicity to fresh water aquatic life, the narrative toxicity objective applies to chloride. The U.S. Environmental Protection Agency has published non-regulatory recommended national ambient water quality criteria for chloride (USEPA, 1988). The USEPA ambient water quality criteria for chloride states: *"freshwater aquatic organisms and their uses should not be affected unacceptably if-the four-day average concentration of dissolved chloride, when associated with sodium, does not exceed 230 mg/L more than once every three years on the average and if the one-hour average concentration does not exceed 860 mg/L more than once every three years on the average."*

Since water quality data is not available for comparison to the aforementioned 4-day average concentration staff cannot assess chronic toxicity conditions on the basis of the 230 mg/L ambient criteria. Consequently, the USEPA 860 mg/L acute toxicity threshold for chloride in ambient waters is the appropriate metric to assess attainment or non-attainment of the Basin Plan's toxicity general objective and to ensure that WARM and SPWN designated beneficial uses are being protected and supported.

4.3 Water Quality Objectives, Criteria and Recommended Levels

The Central Coast Region's Water Quality Control Plan (Basin Plan) contains specific water quality objectives that apply to chloride and sodium. In addition, the Central Coast Water Board is required to use established, scientifically-defensible numeric criteria to implement narrative water quality objectives, and for use in Clean Water Act Section 303(d) Listing assessments. Relevant water quality objectives and scientifically-based numeric criteria to protect beneficial uses and support irrigation water supply are compiled in Table 4-2.

It should be noted that irrigation water quality criteria are guidelines which are flexible, and that chloride and sodium toxicity to cultivated crops depend on many environmental factors such as special conditions crop, soil, and method of irrigation. With drip and furrow irrigation, chloride and sodium injury do not generally occur in vegetable and row crops unless salinity in irrigation water is severe[18]. Tree and vine crops are generally sensitive to chloride and sodium toxicity; tolerance vary among varieties and rootstocks. Sensitive berries and avocado rootstocks can tolerate only up to 120 part per mil (ppm) of chloride, while grapes can tolerate up to 700 ppm or more. The ability of a tree to tolerate sodium varies considerably[19]. Almond, apricot, and citrus are relatively susceptible to foliar injury from chloride in sprinkler irrigation water whereas cauliflower, sunflower, and sugar beet are relatively tolerant of chloride and sodium in sprinkler irrigation water.

Consequently, it is important to recognize that irrigation water quality numeric criteria presented in Table 4-2 for chloride and sodium should be viewed as general guidelines.

Additionally, note that Appendix A presents supplemental information regarding the chloride and sodium tolerance of various crops, illustrating a wide range of crop sensitiviety to chloride and sodium.

[18] University of California-Davis and Natural Resources Conservation Service, peer reviewed Farm Water Quality Planning Reference Sheet 9.10, Publication 8066.

[19] *Ibid*

Table 4-2. Compilation of water quality objectives and numeric criteria for chloride and sodium.

Parameter	Source of Water Quality Objective/Criteria	Numeric Targets	Primary Use Protected
Chloride	Central Coast Basin Plan guideline values *University of California Agricultural Extension Service guideline values – see Table 3-3 in Basin Plan*[a]	Sprinkler Irrigation: Toxicity from foliar absorption if >106 mg/L = "may result in "increasing problems" Surface irrigation: Toxicity from root absorption if < 142 mg/L = "no problem" 142 to 355 mg/L = "increasing problems"	AGR irrigation water supply
	United Nations Food and Agriculture Organization *Water Quality for Agriculture – FAO Irrigation and Drainage Paper 29 Rev. 1 (Ayers and Westcot, 1994)*	Surface Irrigation <140 mg/L = "no degree of restriction on use" 140 to 350 mg/L = "slight to moderate degree of restriction on use" >350 mg/L = "severe degree of restriction on use" Sprinkler Irrigation <106 mg/L = "no degree of restriction on use" >106 mg/L = slight to moderate degree of restriction on use"	
	American Society of Civil Engineers (ASCE) *Agricultural Salinity Assessment and Management Manual, ASCE 1990 as reported in Colorado State University Extension (2007) Fact Sheet No. 0.506*	Susceptibility ranges for crops to foliar injury from saline sprinkler water <175 mg/L (apricot, plum, tomato) 175-350 mg/L (pepper, potato, corn) 351-700 mg/L (alfalfa, barley, sorghum) >700 mg/L (sugar beet, sunflower)	
Chloride	Basin Plan narrative objective for taste and odor[B]	250 mg/L *Secondary MCL* *USEPA and Calif. Dept of Public Health*	MUN –GWR drinking water and groundwater recharge
Chloride	Basin Plan narrative objective for toxicity[C]	860 mg/L *USEPA Ambient Water Quality Criteria for Chloride (acute toxicity maximum concentration threshold)*	Aquatic Habitat freshwater aquatic life protection
Sodium	Central Coast Basin Plan guideline values *University of California Agricultural Extension Service guideline value – see Table 3-3 in Basin Plan*[A]	Sprinkler Irrigation: Toxicity from foliar absorption if > 69 mg/L = "increasing problems" Surface irrigation: Toxicity from root absorption Adjusted SAR 4.0-10 = "increasing problems" Adjusted SAR > 10 = "severe problems"	AGR irrigation water supply
	United Nations Food and Agriculture Organization *Water Quality for Agriculture – FAO Irrigation and Drainage Paper 29 Rev. 1 (Ayers and Westcot, 1994)*	Surface Irrigation SAR < 3 = no degree of restriction on use" SAR 3 to 9 = "slight to moderate degree of restriction on use" SAR <9 = "severe degree of restriction on use" Sprinkler Irrigation <69 mg/L = "no degree of restriction on use" >69 mg/L = slight to moderate degree of restriction on use"	
	American Society of Civil Engineers (ASCE) *Agricultural Salinity Assessment and Management Manual, ASCE 1990 as reported in Colorado State University Extension (2007) Fact Sheet No. 0.506*	Susceptibility ranges for crops to foliar injury from saline sprinkler water <46 mg/L (apricot, plum, tomato) 46-230 mg/L (pepper, potato, corn) 231-460 mg/L (alfalfa, barley, sorghum) >460mg/L (sugar beet, sunflower)	

[A] The Basin Plan states that these guidelines are flexible and should be modified when warranted by local experience or special conditions of crop, soil, and method of irrigation.

[B] The Basin Plans General Objective for Taste and Odors states: *"Waters shall not contain taste or odor-producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, that cause nuisance, or that adversely affect beneficial uses."*

[C] The Basin Plans General Objective for Toxicity states: *"All waters shall be maintained free of toxic substances in concentrations which are toxic to, or which produce detrimental physiological responses in, human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, toxicity bioassays of appropriate duration, or other appropriate methods as specified by the Regional Board."*

4.4 Anti-degradation Policy

In accordance with Section II.A. of the Basin Plan, wherever the existing quality of water is better than the quality of water established in the Basin Plan as objectives, **such existing quality shall be maintained** unless otherwise provided by provisions of the state anti-degradation policy.

4.5 California CWA Section 303(d) Listing Policy

The Central Coast Water Board assesses water quality monitoring data for surface waters periodically to determine if they contain pollutants at levels that exceed protective water quality standards. In accordance with the Water Quality Control Policy for developing California's Clean Water Act (CWA) Section 303(d) List (SWRCB, 2004), water body and pollutants that exceed protective water quality standards are placed on the State's 303(d) List of impaired waters. The Listing Policy also defines the minimum number of measured exceedances needed to place a water segment on the 303(d) list for conventional or other pollutants (Listing Policy, Table 3.2). The minimum number of measured exceedances for conventional and other pollutants in Table 4-3.

Table 4-3. Minimum number of measured exceedances needed to place a water segment on the 303(d) list for conventional and other pollutants.

Sample Size	Number of Exceedances needed to assert impairment
5-30	5
31-36	6
37-42	7
43-48	8
49-54	9
55-60	10
61-66	11
67-72	12
73-78	13
79-84	14
85-91	15
92-97	16
98-103	17
104-109	18
110-115	19
116-121	20
For sample sizes greater than 121, the minimum number of measured exceedances is established where α and β < 0.2 and where |α - β| is minimized. α = Excel® Function BINOMDIST(n-k, n, 1 – 0.10, TRUE) β = Excel® Function BINOMDIST(k-1, n, 0.25, TRUE) where n = the number of samples, k = minimum number of measured exceedances to place a water segment on section 303(d) list	

4.6 CWA Section 303(d) Listings

The final 2010 Update to the 303(d) List and 303(d)/305(b) Integrated Report for the Central Coast contains chloride and sodium listing decisions for Jalama Creek as shown in Table 4-4.

Table 4-4. 303(d) listed waterbodies.

WATER BODY NAME	WBID	POLLUTANT NAME	LIST STATUS
Jalama Creek	CAR3151005119990304115034	Chloride	TMDL Required
Jalama Creek	CAR3151005119990304115034	Sodium	TMDL Required

4.7 Water Quality Data Analysis

4.7.1 Water Quality Data Sources and Monitoring Sites

The data used for this Project included water quality data from the Central Coast Ambient Monitoring Program (CCAMP). CCAMP is the Central Coast Water Board's regionally-scaled water quality monitoring and assessment program. The Water Board's CCAMP data is collected by the Board's in-house staff consisting of trained field scientists and technicians who adhere to the sampling and reporting protocols consistent with the State's Surface Water Ambient Monitoring Program (SWAMP). SWAMP is a state framework for coordinating consistent and scientifically defensible methods and strategies for water quality monitoring, assessment, and reporting.

The CCAMP water quality monitoring site for Jalama Creek (site name: 315JAL) is located on the creek upstream of the County Park at the rail road trussels. The location of the monitoring site in map-view was previously presented in Figure 3-2. Appendix B contains a tabulation of relevant water quality monitoring data for site 315JAL.

4.7.2 Water Quality Temporal Trends

Time-series temporal plots of chloride and sodium water quality from monitoring site 315JAL on Jalama Creek do not show any statistically significant or substantial temporal variation. Specifically, staff performed a Kendall's tau nonparametric correlation tests using R[20] on the time series datasets shown in Figure 4-1. Kendall's tau is a statistical measure of the monotonic association between two variables.

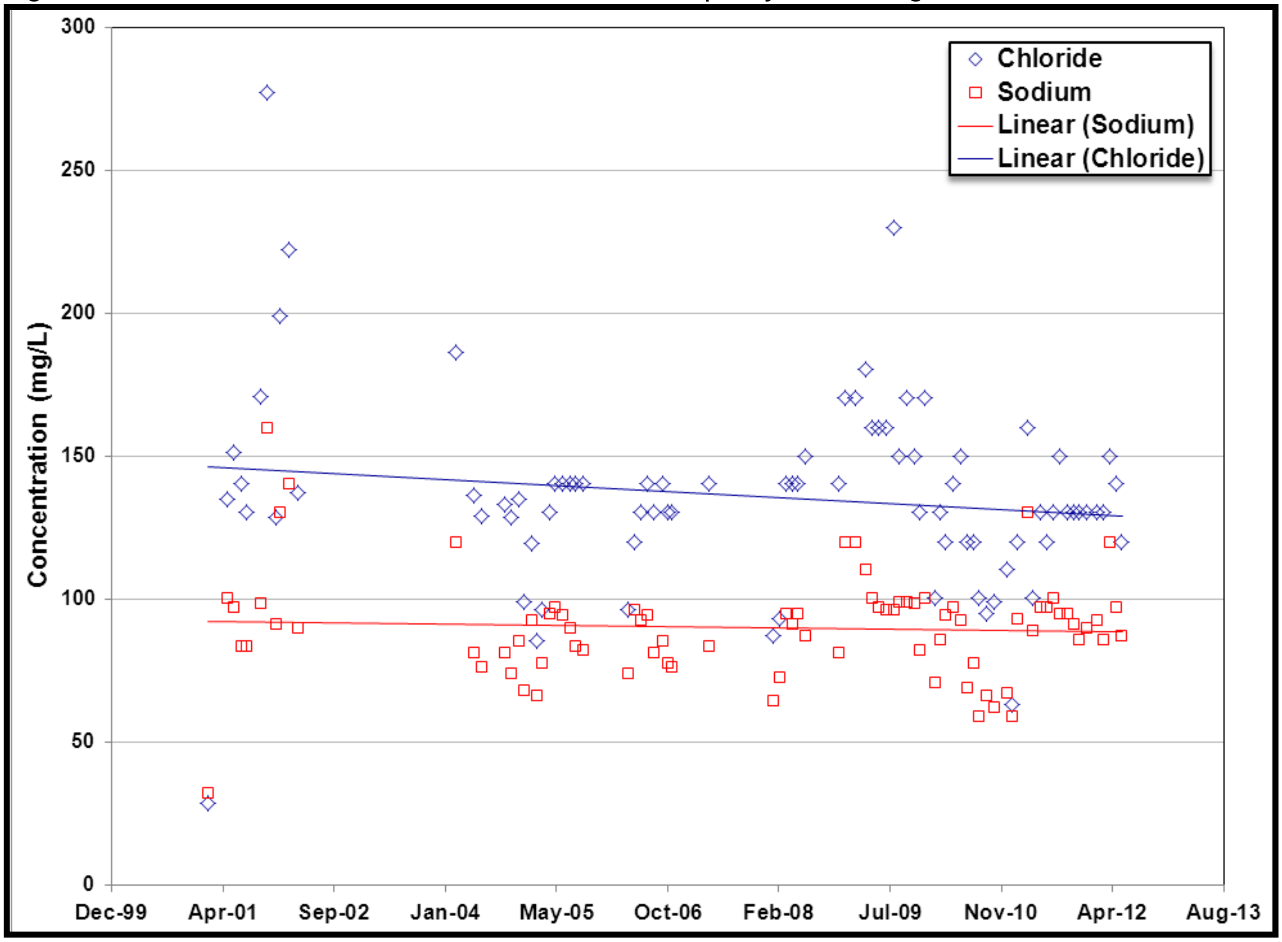
The correlation tests indicate that chloride and sodium have weak correlations with respect to time and are not statistically significant[21] with respect to time (i.e., monitoring date). Practically speaking, this means that there is no significant correlation or association between chloride/sodium concentrations and time.

Consequently, staff finds there is no evidence of temporal trends in chloride and sodium loading to Jalama Creek by these constituents.

[20] Citation: R Development Core Team (2011). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/.

[21] Chloride-Time p-value= 0.3315; Sodium-Time p-value = 0.7768. By convention, Kendall's tau correlation coefficients are considered to be statistically significant when probabilities (p-values) are less than 0.05.

Figure 4-1. Time series of chloride and sodium water quality monitoring data.



4.7.3 Water Quality Seasonal Trends

Box and whiskers plots of chloride and sodium water quality aggregated on a monthly basis do not show any discernible seasonal variation. Consequently, staff finds there is no evidence of seasonal variation in loading to the creek of these constituents.

Figure 4-2. Box and whiskers plot of monthly water quality data for chloride.

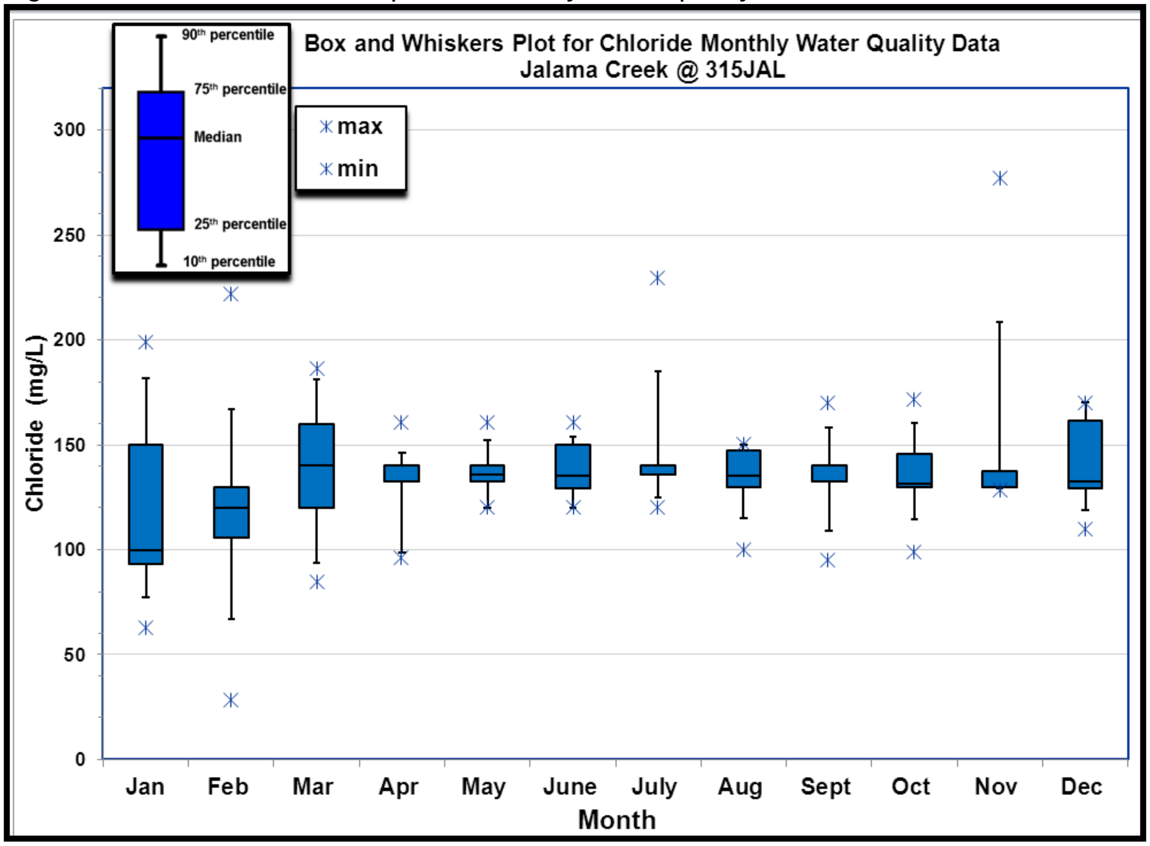
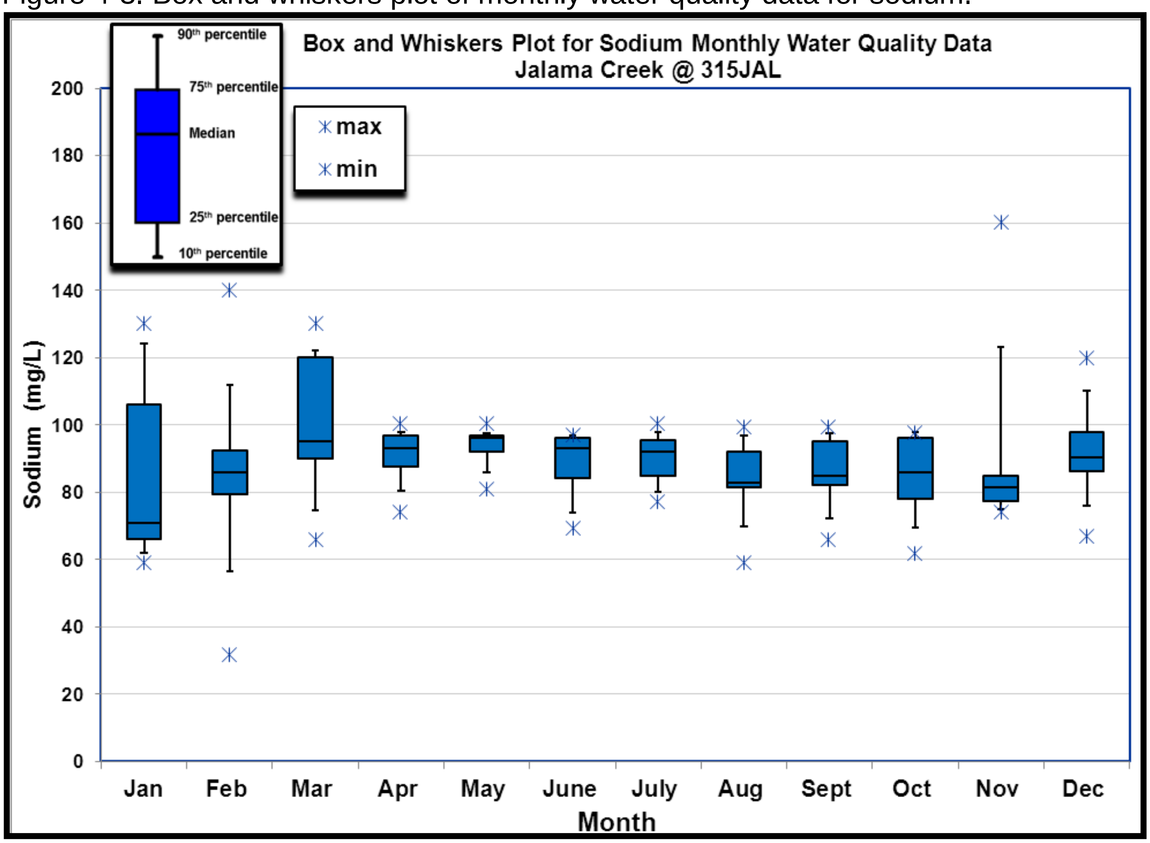


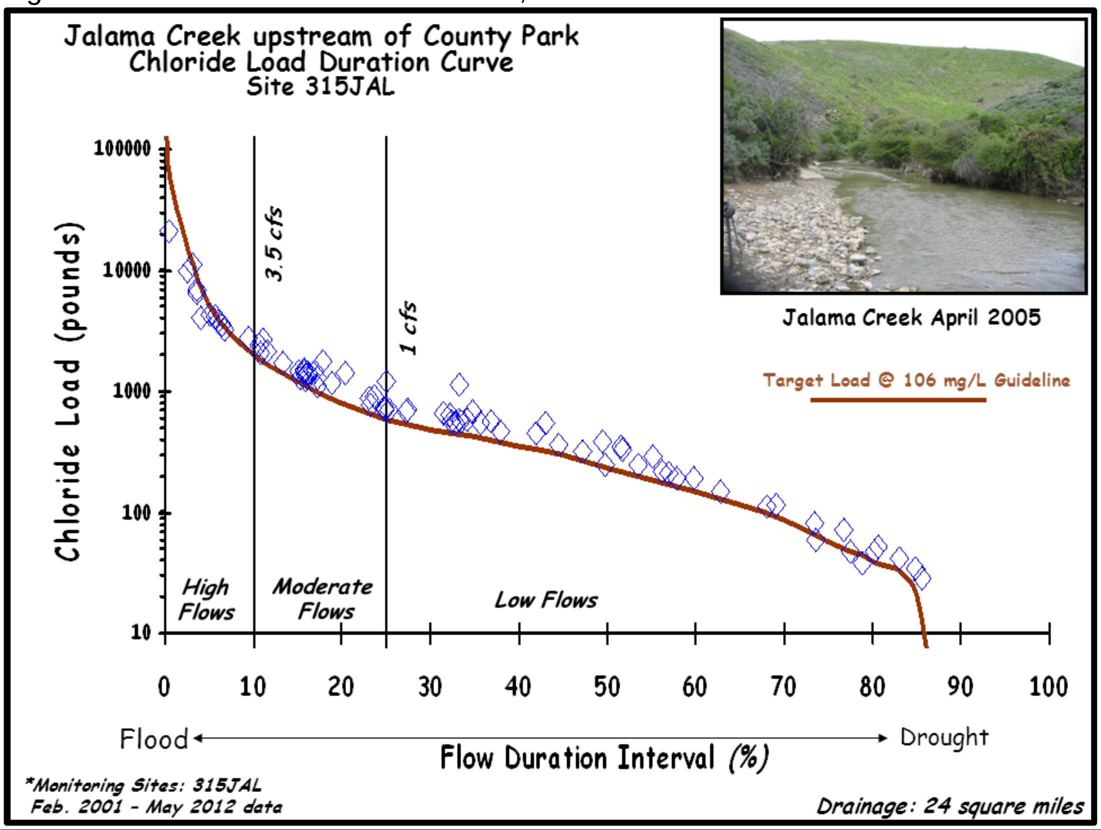
Figure 4-3. Box and whiskers plot of monthly water quality data for sodium.



4.7.4 Water Quality Flow-based Trends

Analysis of seasonal trends is not always appropriate as a surrogate for flow-based trends because of the California central coast's Mediterranean climate and flashy flow conditions. While precipitation-driven high flow conditions are typically limited to the wet season months, the flashy, event-driven nature of regional hydrologic flow patterns, as well as persistent drought conditions, means that there can be substantial and sustained periods of low flow and base flow conditions in the wet season. As such, it is relevant to assess possible flow-based patterns of chloride and sodium-loading to Jalama Creek. Load duration curve plots and tabular summaries of chloride and sodium water quality in Jalama Creek are presented in Figure 4-4 and Figure 4-5. The load duration curves are based on non-regulatory, guideline values for chloride (106 mg/L) and sodium (69 mg/L) in irrigation supply water[22]. The blue diamonds, (representing observed loads from water quality monitoring) that plot above the curve represent excursions exceeding the non-regulatory guideline target load. Flow duration records are presented in Appendix C.

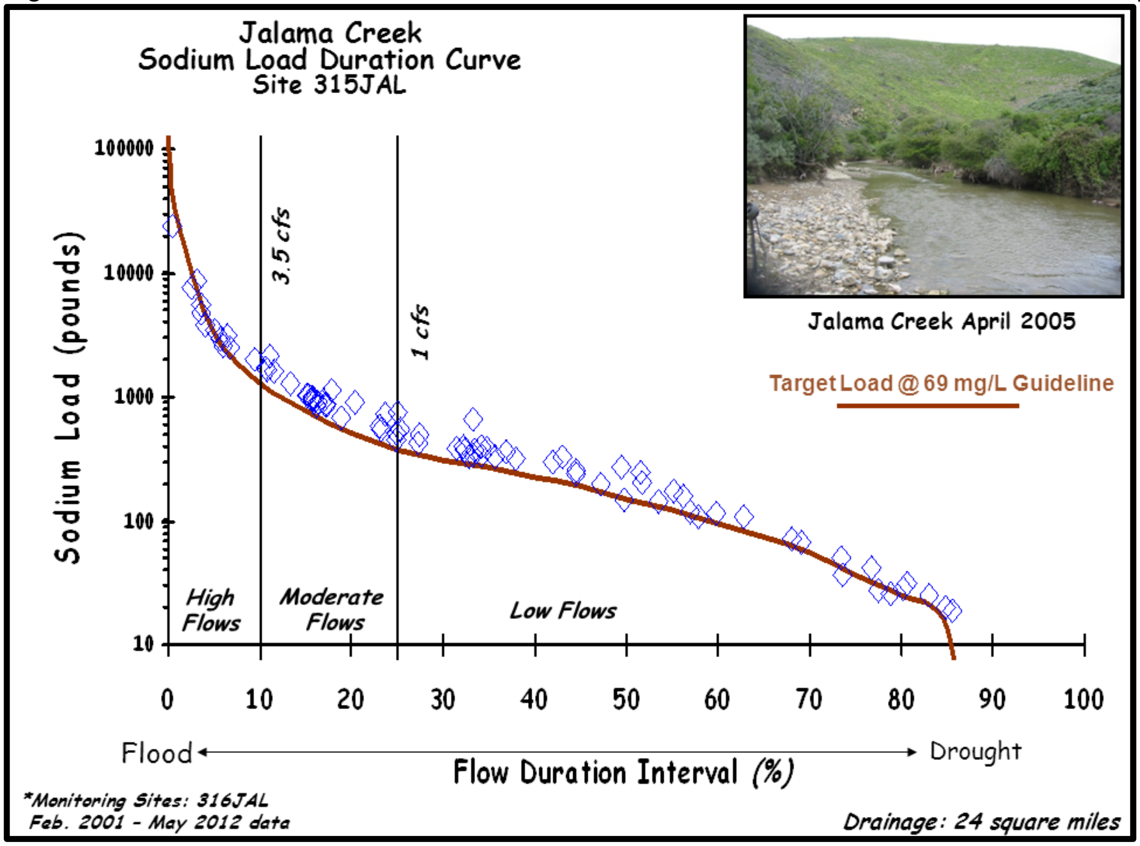
Figure 4-4. Chloride load duration curve, Jalama Creek site 315JAL and tabular summary.



Flow Regime	No. of Samples in Flow Regime	No. Samples Exceeding 106 mg/L guideline value	% Samples Exceeding 106 mg/L guideline value	90th percentile of concentrations observed in flow regime	Median Observed Daily Load (pounds)	Median non-regulatory Guideline Target Load (pounds)	Percent Reduction needed for Median Observed Load to achieve Median Guideline Target Load
High	12	2	17%	117 mg/L	4,237	5,859	0%
Moderate	24	24	100%	157 mg/L	1,386	1.058	20%
Low	47	44	94%	170 mg/L	330	257	22%

[22] Table 3-3 in the Water Quality Control Plan for the Central Coast Basin (Basin Plan) contains guideline values that state severe problems may occur when chloride exceeds 106 mg/L or sodium exceeds 69 mg/L in irrigation supply water. The Basin Plan states these guidelines are flexible and should be modified when warranted by local experience or special conditions of crop, soil, and method of irrigation.

Figure 4-5. Sodium load duration curve, Jalama Creek site 315JAL and tabular summary.



Flow Regime	No. of Samples in Flow Regime	No. Samples Exceeding 69 mg/L guideline value	% Samples Exceeding 69 mg/L guideline value	90th percentile of concentrations observed in flow regime	Median Observed Daily Load (pounds)	Median non-regulatory Guideline Target Load (pounds)	Percent Reduction needed for Median Observed Load to achieve Median Guideline Target Load
High	12	7	58%	91 mg/L	3,588	3.814	0%
Moderate	24	24	100%	120 mg/L	926	689	26%
Low	47	42	89%	104 mg/L	206	167	19%

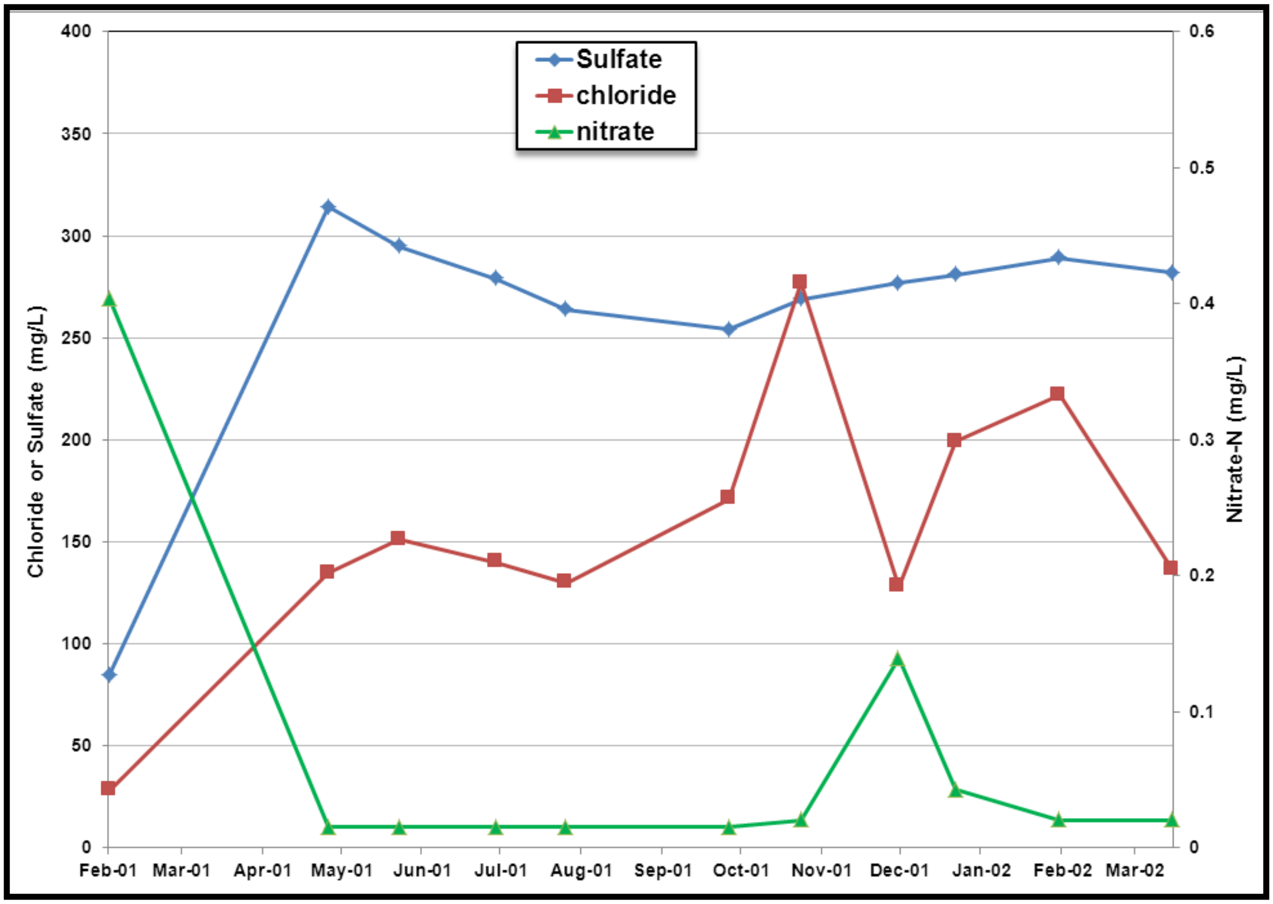
Based on the load duration data, staff determines that there are patterns of flow-based variation in chloride and sodium water quality in Jalama Creek. While exceedances of the non-regulatory, irrigation water supply guideline values are found over all flow conditions, load duration analysis indicates that exceedances are substantially less frequent during high-flow conditions. This is almost undoubtedly because high flow conditions represent a hydrologic regime when meteoric, fresh waters associated with runoff and precipitation make up a much larger contribution to stream flow compared to the relatively more saline water column conditions attributable to natural and geologic conditions which likely prevail at lower flow regimes (refer back to information on geology and subsurface waters in Section 3.4 and Section 3.5).

4.7.5 Water Quality Anion Trends

Researchers have indicated that when anion concentrations in the stream water column are correlated with other major anions, this may suggest that these solutes have the same source (Moran et al., 2011). For example, a point source or wastewater discharge could reasonably be expected to discharge anion concentrations that correlate temporally with each other when measured in the receiving water column.

Consequently, staff performed a Kendall's tau nonparametric correlation tests using R[23] on the time series datasets shown in Figure 4-1. Kendall's tau is a statistical measure of the monotonic association between two variables. The correlation tests indicate that these anion solutes have weakly correlated and their associations are not statistically significant[24]. Practically speaking, this means that there is no strong correlation or statistically significant association between the anion concentrations observed during these monitoring events. Consequently, staff finds there is no evidence of a correlation of anion solute concentrations in Jalama Creek. This suggests that a point source or a wastewater discharge source is not responsible for the observed elevated levels of chloride and sodium in creek waters.

Figure 4-6. Jalama Creek anion trends, for monitoring events where chloride, sulfate, and nitrate were collected.



4.7.6 Summary Water Quality Statistics

Table 4-5 presents summary statistics for the suite of 2001-2012 water quality data for Jalama Creek at monitoring site 315JAL. These water quality data represent the suite of samples that are used in this TMDL to assess water quality status and impairment, consistent with the California 303(d) Listing Policy and the Water Quality Control Plan for the Central Coast Region.

[23] Citation: R Development Core Team (2011). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org/.

[24] Chloride-Sulfate p-value= 0..5423, tau = 0.16363. Chloride-Nitrate p-value = 0.6179, tau = -0.12484. By convention, Kendall's tau correlation coefficients are considered to be statistically significant when probabilities (p-values) are less than 0.05.

Table 4-5. Jalama Creek summary water quality statistics for site 315JAL.

									AGR irrigation supply guidelines		MUN drinking water Secondary MCL		Freshwater aquatic life protection criteria
									Sprinkler Irrigation (foliar absorption)	Surface Irrigation (root absorption)			
Waterbody-Monitoring Site	**Constituent**	**No. of Samples**	**Temporal Representation**		**Min**	**Median**	**Mean**	**Max**	**No. and (%) Exceeding 106 mg/L**	**No. and (%) Exceeding 142 mg/L**	**No. exceeding 250 mg/L**	**% exceeding 250 mg/L**	**No. exceeding 860 mg/L**
Jalama Creek at 315JAL	**Chloride**	83	Feb. 2001	May 2012	28	133	136	277	70 (84%)	22 (27%)	1	1%	0
	Constituent	**No. of Samples**	**Temporal Representation**		**Min**	**Median**	**Mean**	**Max**	**No. and (%) Exceeding 69 mg/L**	**% Exceeding Adjusted SAR = 4.0**	*Sodium does not have secondary MCLs or aquatic habitat criteria*		
	Sodium	83	Feb. 2001	May 2012	32	91	90	160	73 (88%)	66 (80%)	*not applicable*		*not applicable*

4.8 Impairment Assessment

The standards, water quality objectives, and numeric criteria that are being used to assess Jalama Creek chloride and sodium water quality conditions were previously presented in Table 4-2. Summary statistics of water quality parameters and exceedance frequencies as compared to numeric water quality objectives were previously presented in Section 4.7.6. Consequently, these exceedance frequencies are compared to the methodologies promulgated in the California Listing Policy (refer back to Section 4.5) to determine attainment or non-attainment of water quality standards.

4.8.1 Chloride

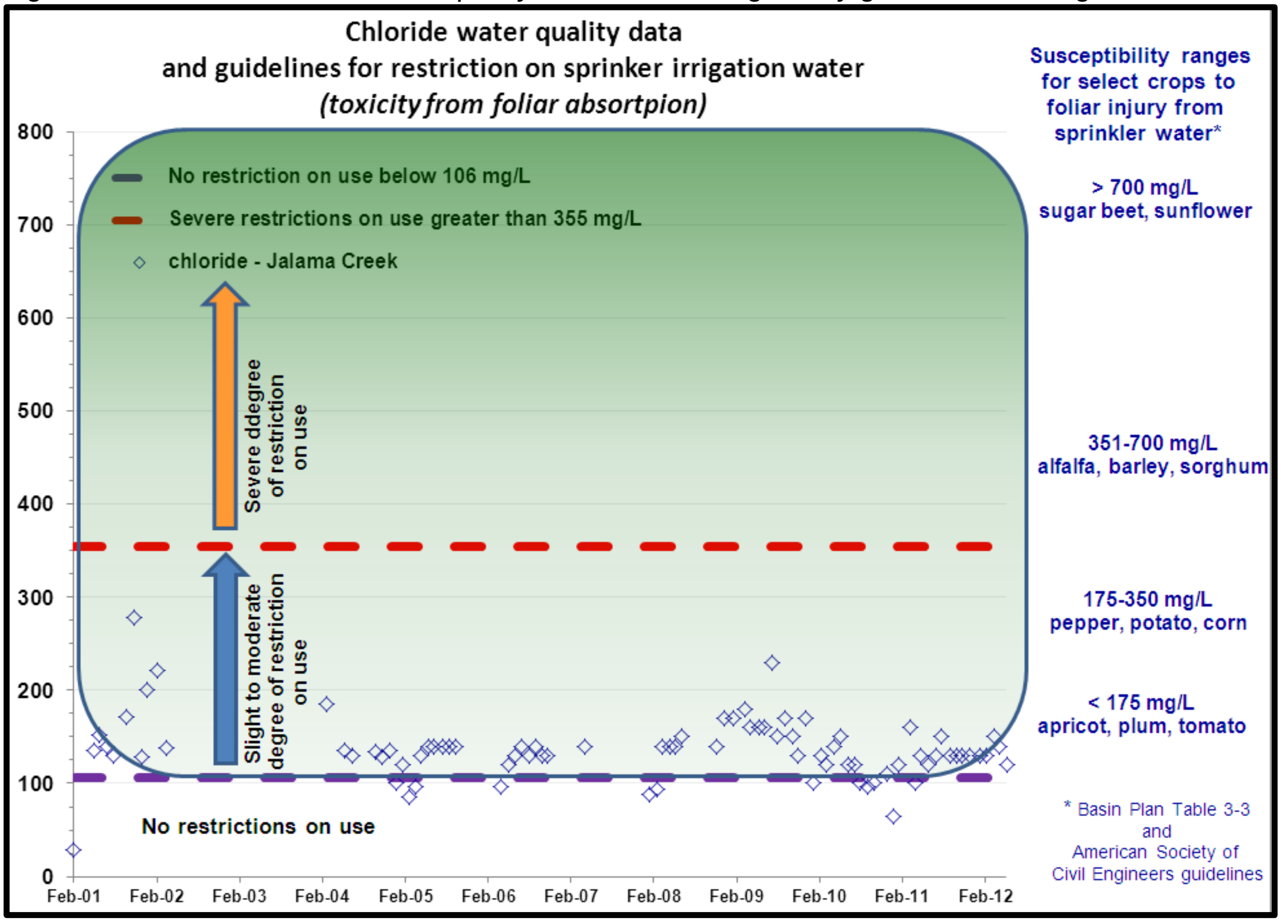
Designated drinking water supply (MUN) and aquatic habitat (WARM, SPWN) beneficial uses are currently being supported on the basis of chloride concentrations in Jalama Creek and identified water quality criteria.

Chloride concentrations in Jalama Creek exceed non-regulatory agricultural irrigation supply (AGR) guidelines for some sensitive crop types (see Figure 4-7). This indicates impairment of potential or future uses of irrigation supply (AGR) beneficial uses for crops with low chloride tolerance, depending on situation-specific conditions of crop, soil, and method of irrigation.

Also, it should be noted that AGR beneficial uses are currently being supported for most agricultural supply uses including existing uses; for example stock watering, support of vegetation for range grazing, as well as for potential irrigation of many crop types that are relatively chloride-tolerant.

Finally, it should be noted that under high flow conditions, when fresh metoric waters and runoff dilute the chloride concentrations in the creek, it appears that even the most stringent guideline value (106 mg/L) for chloride in irrigation water is achieved (refer back to Figure 4-4). Therefore, pending the acquisition of additional water quality data (see Section 8.6) it may be possible to conclude that site specific water quality objectives for chloride are only necessary at low flow conditions.

Figure 4-7. Chloride stream water quality data and non-regulatory guidelines for irrigation water.



4.8.2 Sodium

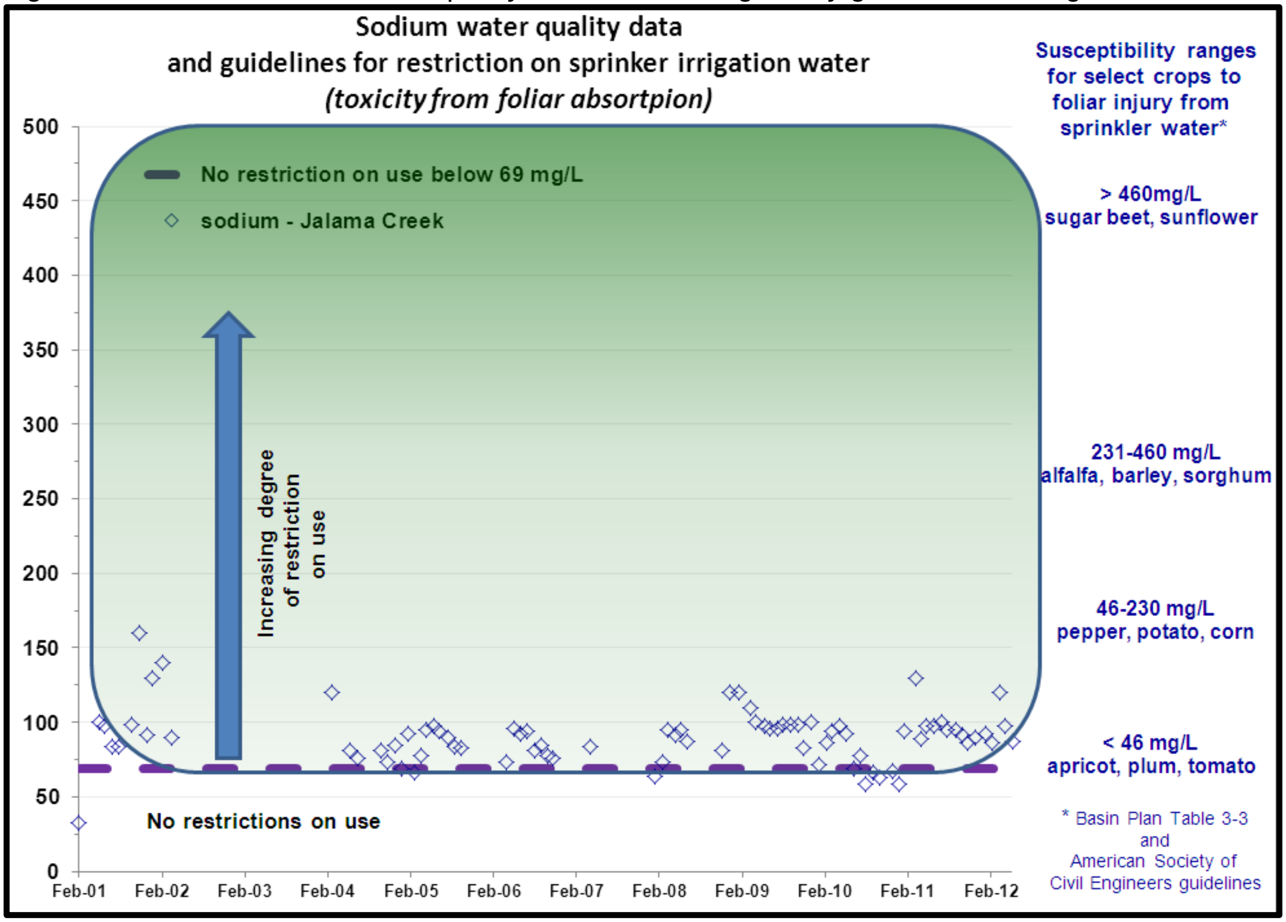
There are no secondary MCLs, regulatory thresholds, or numeric criteria for sodium that apply to drinking water beneficial uses (MUN) or to aquatic habitat beneficial uses (WARM, SPWN). Therefore, these beneficial uses are not affected by sodium.

Sodium concentrations in Jalama Creek exceed non-regulatory agricultural irrigation supply (AGR) guidelines for some sensitive crop types (see Figure 4-8).

Also, it should be noted that AGR beneficial uses are currently being supported for most agricultural supply uses including existing uses; for example stock watering, support of vegetation for range grazing, as well as for potential irrigation of many crop types that are relatively sodium-tolerant.

Finally, it should be noted that under high flow conditions, when fresh metoric waters and runoff dilute the sodium concentrations in the creek, it appears that even the most stringent guideline value (69 mg/L) for sodium in irrigation water is frequently achieved (refer back to Figure 4-4). Therefore, pending the acquisition of additional water quality data (see Section 8.6) it may be possible to conclude that site specific water quality objectives for sodium are only necessary at low flow conditions.

Figure 4-8. Sodium stream water quality data and non-regulatory guidelines for irrigation water.



4.8.3 Impairment Assessment Findings

Table 4-6 presents a status summary of potential impairments of designated beneficial uses of surface waters in the TMDL project area.

Table 4-6. Status summary of Jalama Creek designated beneficial uses that could potentially be impacted by chloride or sodium.

Designated Beneficial Use	**Water Quality Objective, or Recommended Numeric Level** [A] (refer to Table 4-2)	**Exceeding Water Quality Criteria or Non-regulatory Recommended Level?** [B]	**Is Beneficial Use Being Supported?**
MUN & GWR *(drinking water supply & groundwater recharge)*	Taste and Odor Narrative Objective 250 mg/L Chloride	No	Yes
AGR *(irrigation sprinkler water supply for chloride and sodium sensitive crops)*	<106 mg/L Chloride = "no problem" <69 mg/L Sodium = "no problem"	Yes[A] *depending on situation specific condition of crop, soils, and method of irrigation (refer back to Figure 4-7 and Figure 4-8)*	No[B] *on the basis of the University of California Agricultural Extension Service guideline value*
AGR *(irrigation water supply for chloride and sodium tolerant crops)*	106 to 700 mg/L Chloride 69 to 460 mg/L Sodium 4.0 to 10.0 Adjusted SAR Sodium[C]	No	Yes
AGR *(stock watering, support of vegetation for range grazing)*	None	No	Yes

Designated Beneficial Use	Water Quality Objective, or Recommended Numeric Level [A] (refer to Table 4-2)	Exceeding Water Quality Criteria or Non-regulatory Recommended Level?[B]	Is Beneficial Use Being Supported?
WARM, SPWN *(aquatic habitat)*	Toxicity Narrative Objective 860 mg/L Chloride	No	Yes

[A] It should be noted that the University of California Agricultural Extension Service guideline values for chloride and sodium are flexible, and may not necessarily be appropriate due to local conditions or special conditions of crop, soil, and method of irrigation. In cases where local natural conditions are causing the non-attainment of the University of California Agricultural Extension Service guideline values, it may be necessary to develop site specific water quality objectives for these constituents.

[B] This determination is made on the basis of the University of California Agricultural Extension Service guideline values published in the Basin Plan. It is important to note that these guidelines have limitations in actual practice; in many instances a water may be wholly unsuitable for irrigation under certain conditions of use and yet be completely satisfactory under other conditions depending on soil permeability, temperature, humidity, rainfall, and other contributing factors. As such, the designated AGR beneficial use of Jalama Creek may in fact be supportable on the basis of site specific conditions and site specific water quality objectives which may be developed for chloride and sodium pursuant to this TMDL.

[C] SAR can be reduced if necessary by adding gypsum.

5 SOURCE ANALYSIS

In any given watershed, plausible sources that could cause or contribute to elevated concentrations of chloride and salts in surface waters can potentially include the following:

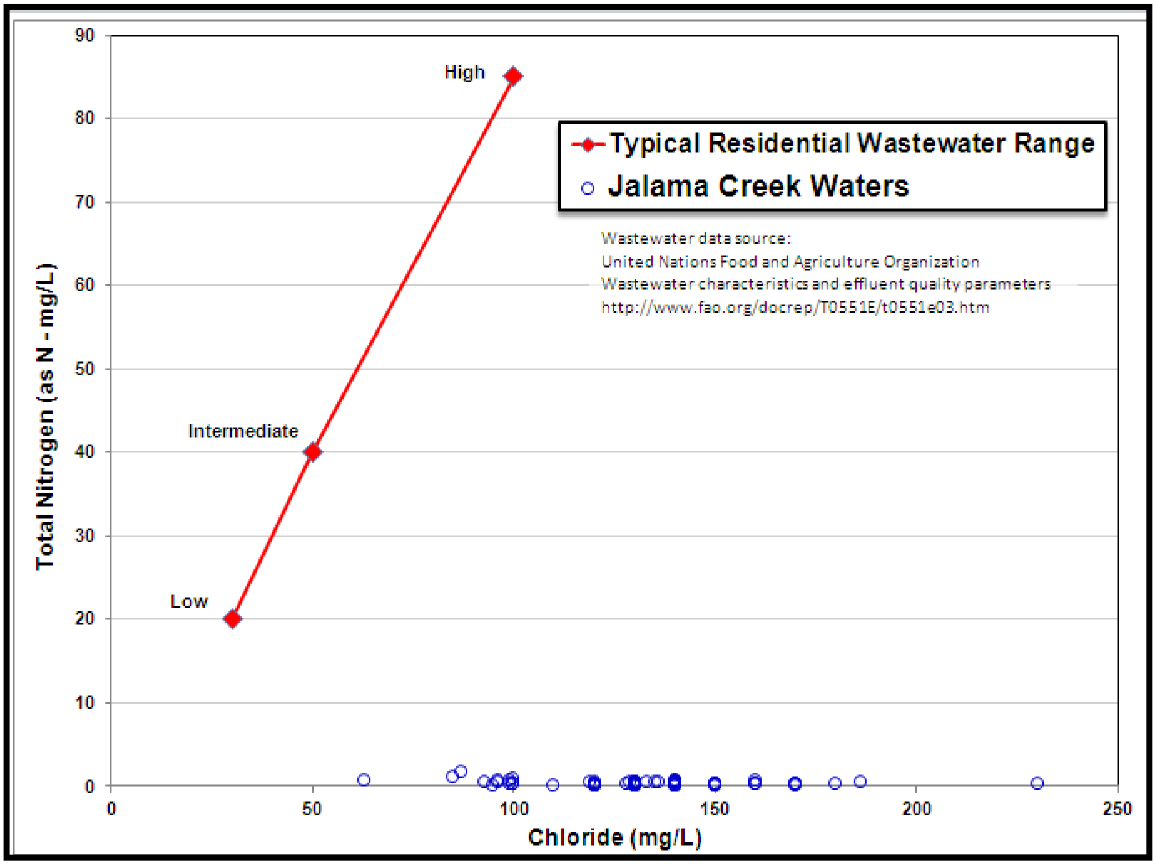
- Wastewater effluent from urban areas, industrial facilities, and wastewater treatment plants.
- Agricultural fertilizer runoff
- Septic systems
- Produced water from oil, gas or geothermal wells
- Landfill leakage
- Land disturbance
- Natural sources, such as rocks, soils, springs, and groundwaters.

The Jalama Creek subwatershed is a sparsely-populated rural drainage, and substantial anthropomorphic impacts are often not expected in areas with limited human activities. However, as a matter of practicing due diligence, staff compiled and assessed available data for each potential source category shown above in order to confirm or refute these sources as probable causes/contributors to elevated chloride and sodium in Jalama Creek waters.

5.1 Point Sources

The Jalama Creek subwatershed is a sparsely populated, rural drainage catchment. There are no NPDES point source discharges in the TMDL project area, nor are there any census-designated urban areas which would be subject to NPDES municipal separate stormwater sewer system permit requirements. Further, Jalama Creek waters do not appear to exhibit the typical characteristics and chemical signature of residential wastewater (see Figure 5-1). Based on this information, it is implausible that point sources cause or contribute to elevated chloride and sodium in creek waters. Therefore, the chloride and sodium waste load allocations for NPDES point sources are zero.

Figure 5-1. Typical residential wastewater characteristics (nitrogen and chloride) compared to Jalama Creek waters.



5.2 Nonpoint Sources

5.2.1 Livestock Grazing

In any given watershed, livestock operations could potentially cause excessive land disturbance and thereby contribute to elevated sedimentation and dissolved solids (e.g, dissolved minerals, salts) in a stream. However, based on available data there is no evidence of excessive land disturbance by livestock in the Jalama Creek watershed that would conceivably contribute to elevated salts in the creek. Water quality data indicate that the median turbidity value in Jalama Creek is 1.1 NTU; the 75th percentile is 5 NTU. These are low turbidity values which comport reasonably well with a relatively undisturbed or reference background condition for levels of turbidity in California streams[25].

Additionally, Cojo-Jalama Ranch personnel report that the primary source of water for livestock is from wells (personal communication, Mark Chachones Cojo-Jalama Ranch, Oct. 24, 2012); this indicates that off-creek watering is a management strategy of the ranch. Note that resource professionals consider off-creek watering to be a livestock management strategy than can help minimize livestock impacts to creeks and riparian areas. As such, based on available information, ranching and grazing operations in the Jalama Creek subwatershed do not appear to be causing or contributing to excessive land disturbance which could lead to the routinely elevated levels of chloride and sodium observed in creek waters. Furthermore, available water quality data and geologic data

[25] USEPA has estimated that reference or relatively undisturbed turbidity conditions in California streams range from 1.1 NTU to 5.5 NTU (*USEPA, 2000. Ambient Water Quality Criteria Recommendations – Rivers and Streams in Nutrient Ecoregion III. EPA 822-B-00-016*)

indicate the inorganic chemical composition of creek waters are consistent with a signature that would be expected from mixing of meteoric waters and mineral-rich subsurface connate waters and springs, likely causing or contributing to elevated sodium-chloride in creek waters (refer back to Section 3.4 and Section 3.5.

Collectively, the aforementioned information constitutes multiple lines of evidence indicating that it is implausible that the livestock-land distrubance source category causes or contributes to elevated chloride and sodium in Jalama Creek water. Therefore, a load allocation for this source category is not warranted.

5.2.2 Septic Systems

There are no septic systems upstream of monitoring site 315JAL that could plausibly cause or contribute to elevated chloride and sodium in creek waters. U.S. Census bureau data indicate there are only a few persons, and a few housing units located in the Jalama Creek subwatershed upstream of monitoring site 315JAL. These structures are associated with the Cojo-Jalama Ranch headquarters; the ranch manager informs staff that the septic system associated with the ranch headquarters is located at least one-quarter mile from the creek (personal communication, Cojo-Jalama Ranch Manager to Water Board staff, October 17, 2012). Furthermore, Jalama Creek waters do not appear to have the typical chemical characteristics and signature of residential wastewater (refer back to Figure 5-1). Therefore, a load allocation for this source category is not warranted.

5.2.3 Agricultural Fertilizer

According to land cover spatial datasets staff evaluated, there is virtually no irrigated cropland in the Jalama Creek watershed which might be a potential source of chloride. An additional line of supporting evidence was provided to staff by the manager of the Cojo-Jalama Ranch. The ranch manager informed staff that the only cultivated crop in the Jalama Creek subwatershed is about a hundred acres of bean crop which is dryland farmed (personal communication, Cojo-Jalama ranch manager, Oct. 17, 2012). Additionally, the only fertilizing material that is likely to be associated with elevated chloride levels in receiving waters is muriate of potash (potassium chloride) which is the most commonly used potassium fertilizer. However, according to the California Department of Food and Agriculture, between January 2010 and Decenmber 2010 only 159 tons of muriate of potash was sold in *all* of Santa Barbara County (CDFA, 2010). This is only a tiny fraction of all fertilizer sold in Santa Barbara County during this time period[26], as such muriate of potash is not a widely and frequently used fertilizer in Santa Barbara County. Furthermore, water column nitrogen and phosphorus in Jalama Creek are at low levels[27], providing another line of evidence that the creek is not being impacted by fertilizing materials.

Collectively, the aforementioned information constitutes multiple lines of evidence indicating that it is implausible that this source category causes or contributes to elevated chloride in Jalama Creek water. Therefore, a load allocation for this source category is not warranted.

5.2.4 Oil, Gas and Geothermal Production

In any given watershed, improperly-managed produced water from oil, gas, and geothermal wells can potentially contribute to elevated chloride and sodium in surface waters. This is because these produced waters come from hydrocarbon or geothermal subsurface reservoirs typically containing brackish or saline connate pore water fluids. However, there are no oil or gas fields in the Jalama

[26] 128,633 tons of fertilizing material was sold in Santa Barbara County during this time, making muriate of potash equivialent to 0.1% of all fertilizer sales in the county.

[27] Average water column nitrate as N in Jalama Creek is 0.07 mg/L; average total phosphorus as P is 0.14 mg/L. These concentrations comport reasonably well with an undisturbed, ambient conditions for the California central coast region.

Creek subwatershed. According to public well records from the California Division of Oil, Gas and Geothermal Resources (DOGGR), historically, three petroleum wells were drilled within the Jalama Creek subwatershed (see Table 5-1). These wells evidently were either exploratory boreholes or outpost wells, and available data indicate they never resulted in oil or gas field production. Further, well records indicate that these wells were properly plugged which should prevent the boreholes from acting as hydraulic conduits for discharge of subsurface waters to land or to creek waters. Additionally, according to spatial information available from DOGGR there are no geothermal production fields anywhere in Santa Barbara or Ventura counties.

Based on the aforementioned information, it is implausible that the oil, gas, and geothermal production source category causes or contributes to elevated chloride and sodium in Jalama Creek water, therefore, an allocation for this source category is not warranted.

Figure 5-2. Oil fields, and location of historic petroleum wells drilled in Jalama Creek subwatershed.

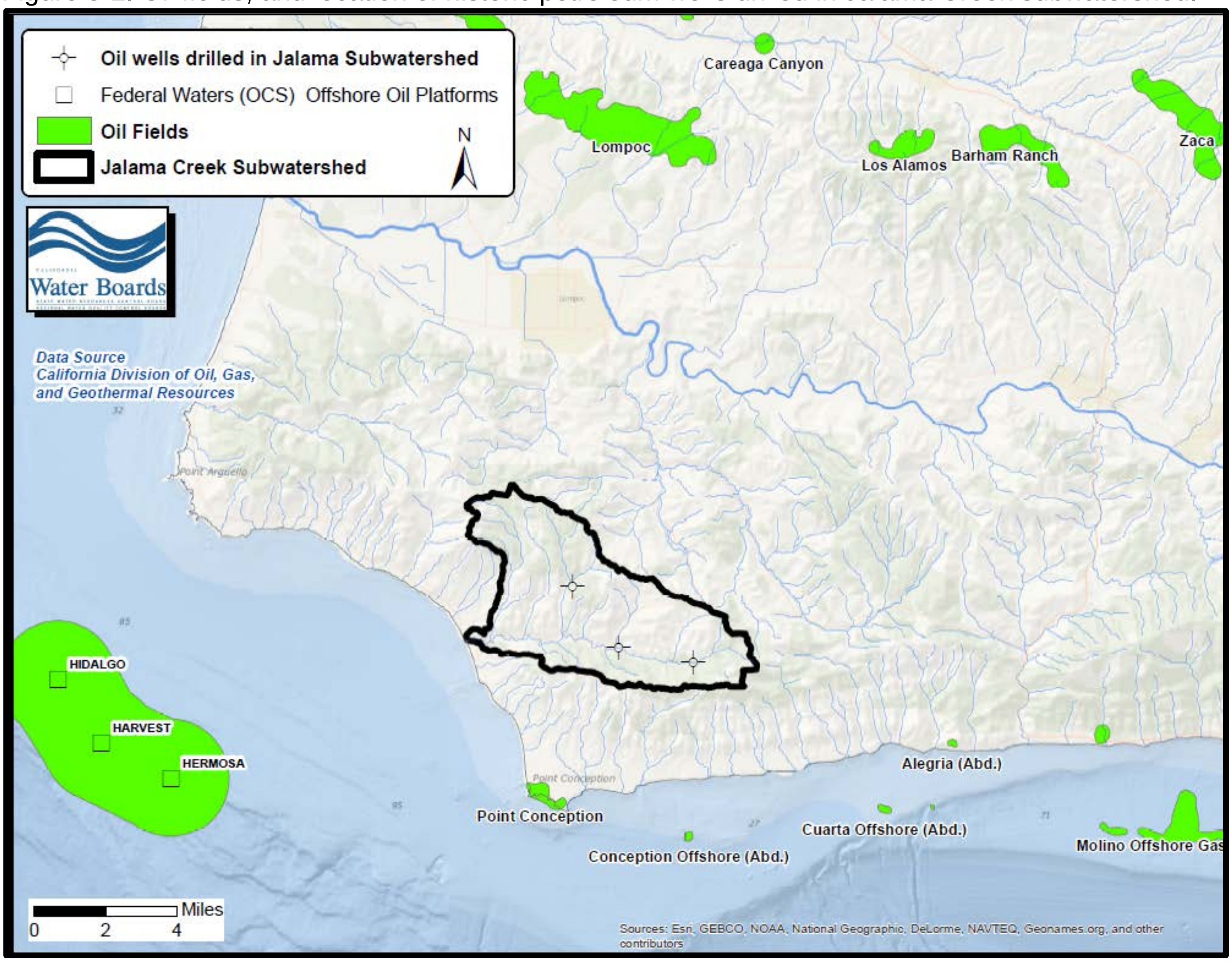


Table 5-1. Historic petroleum wells drilled in Jalama Creek subwatershed.

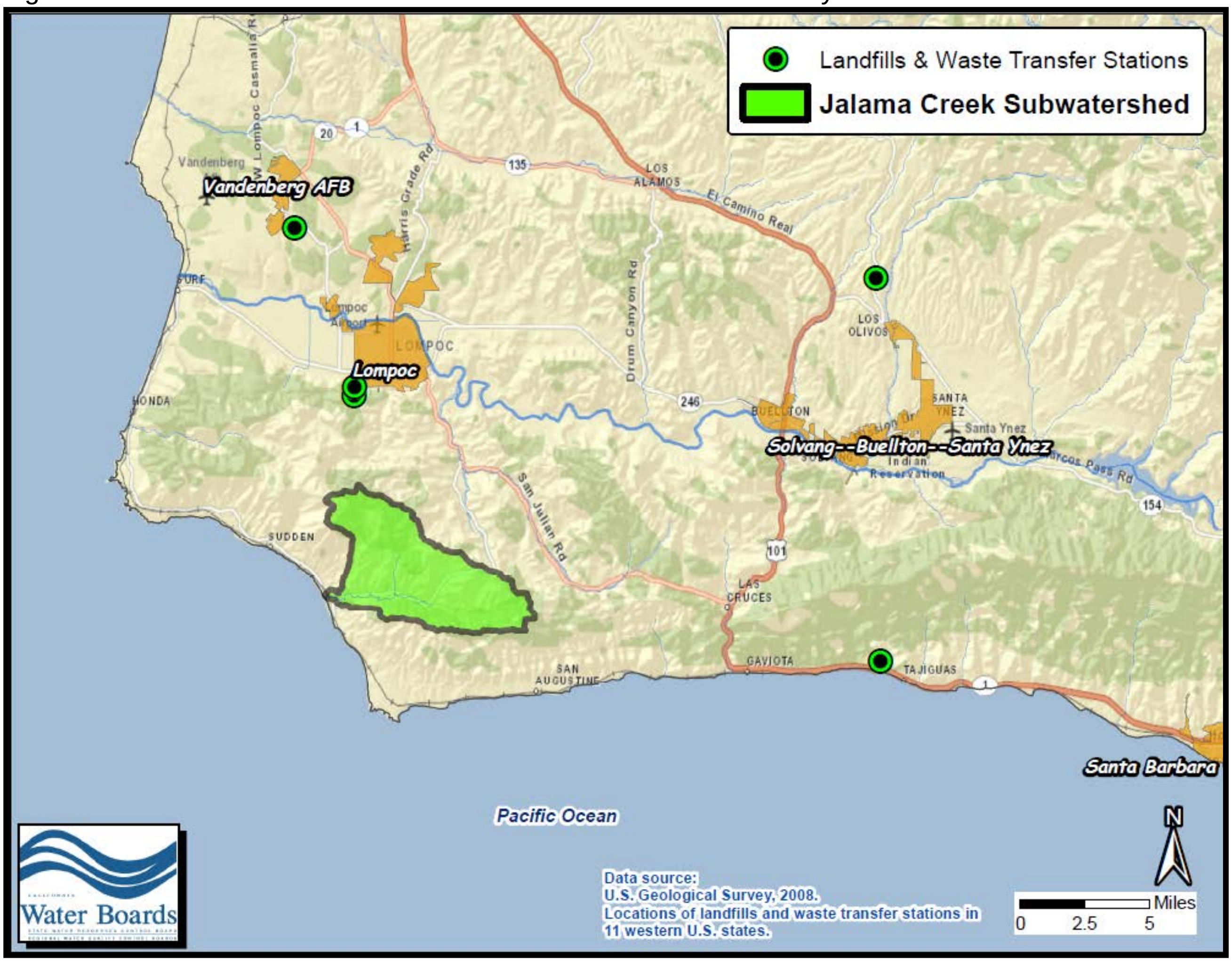
Operator	Well Number	Well Status	Latitude	Longitude	Lease Name	Operator Status
Volvo Petro. Inc.	1	Plugged	34.509607	-120.428157	Bixby Ranch	Inactive
Volvo Petro. Inc.	2	Plugged	34.503450	-120.391361	Bixby Ranch	Inactive
Volvo Petro. Inc.	3	Plugged	34.534423	-120.451062	Bixby Ranch	Inactive

Data source: California Division of Oil, Gas, and Geothermal Resources public online well record database.

5.2.5 Landfills

It is well known that landfill leachate typically contains elevated dissolved salts which may impact groundwater or surface water quality if the leachate is not properly managed. Available information indicates there are no landfills or waste transfer stations in the Jalama Creek subwatershed that could cause or contribute to elevated chloride and sodium in creek waters (see Figure 5-3. Therefore, an allocation for this source is not warranted.

Figure 5-3. Location of landfills and waste transfer stations in vicinity of Jalama Creek subwatershed.



5.2.6 Natural Sources

Information and data developed previously in this project report in Section 3.4 and Section 3.4 constitute multiple lines of evidence that geology, tectonics, structural features, saline springs, groundwater chemistry, geothermal activity, and credible evidence of hydrologic communication between meteoric waters, and deeper, saline connate fluids (paleo-seawater) cause or contribute to elevated chloride and sodium levels observed in Jalama Creek.

5.3 Summary of Sources

There is no plausible evidence of human impacts and activities that could cause or contribute to observed elevated chloride and sodium levels in Jalama Creek. Indeed, multiple lines of evidence are developed in this report that credibly demonstrates non-controllable natural sources are the cause of elevated levels of chloride and sodium in Jalama Creek at site 315JAL.

Best available information indicates there are no identifiable controllable sources of chloride and sodium in the subwatershed. Further, there is credible evidence that localized natural and geologic conditions causes or contributes to elevated chloride and sodium concentrations in Jalama Creek. Consequently, staff finds that the 303(d)-identified water quality impairments caused by chloride and sodium in Jalama Creek at monitoring site 315JAL are attributable to non-controllable natural and geologic sources.

6 NUMERIC TARGETS

According to USEPA (1999), the “primary goals of target analysis are (1) to clarify whether the ultimate goal of the TMDL is to comply with a numeric water quality criterion, comply with an interpretation of a narrative water quality criterion, or attain a desired condition that supports meeting a specified designated use; (2) to identify the waterbody’s critical conditions; (3) to identify appropriate ways to measure (track) progress toward achieving stated goals; and (4) to tie the measures to pollutant loading.”

6.1 Chloride Criteria for Protection of MUN and GWR

The purpose of this target is to implement the Basin Plan’s narrative taste and odor general water quality objective for drinking water supply. The U.S. Environmental Protection Agency and the California Department of Public Health have established a recommended secondary maximum contaminant level (secondary MCL) for chloride in drinking water as 250 mg/L.

Therefore, the numeric target for chloride which demonstrates whether or not the MUN (drinking water supply) and GWR (groundwater recharge) designated beneficial uses are being supported is as follows:

- *The controllable discharge of wastes shall not cause concentrations of chloride to exceed 250 mg/l in receiving waters.*

Based on available water quality data, chloride concentrations in Jalama Creek are easily achieving this numeric target under all flow and seasonal conditions and therefore MUN and GWR designated beneficial uses of the creek are being supported. It should be noted that State and Federal anti-degradation policies require that existing chloride water quality which is currently supporting MUN and GWR be maintained, and that future lowering of existing water quality is not allowed unless consistent with provisions of the State and Federal anti-degradation policies[28].

6.2 Chloride Criteria for Protection of Aquatic Habitat (WARM, SPWN)

The purpose of this target is to implement the Basin Plan’s narrative toxicity general water quality objective and to ensure support of designated aquatic habitat beneficial uses in Jalama Creek. The U.S. Environmental Protection Agency (USEPA) has established a national recommended acute toxicity threshold for chloride in ambient waters as 860 mg/L, which is protective of freshwater aquatic organisms (USEPA, 1988).

[28] The State Water Resources Control Board and appellate court decisions indicate that water can be considered high quality for purposes of the anti-degradation policy on a constituent by constituent basis. Therefore, water can be of high quality under the anti-degradation policy for some constituents or beneficial uses, but not for others (see Court of Appeal of the State of California, Third Appellate District, Appeal Case C066410, Acociacion de Gente Unida, etc. et al. v. Central Valley Regional Water Quality Control Board).

Therefore, the proposed numeric target for chloride, which demonstrates whether or not the WARM and SPWN designated beneficial uses are being supported, is as follows:

- *The controllable discharge of wastes shall not cause concentrations of chloride to exceed 860 mg/l in receiving waters.*

Based on available water quality data, chloride concentrations in Jalama Creek are easily achieving this numeric target under all flow and seasonal conditions and therefore aquatic habitat designated beneficial uses of the creek are being supported. It should be noted that State and Federal anti-degradation policies require that existing chloride water quality which is currently supporting aquatic habitat be maintained, and that future lowering of existing water quality is not allowed unless consistent with provisions of the State and Federal anti-degradation policies[29,30].

6.3 Chloride Criteria for Protection of Agricultural Supply (AGR)

The Basin Plan numeric water quality guideline used in the 2010 303(d) assessment for chloride in irrigation water is 106 mg/L chloride. This value is based on University of California Agricultural Extension Service general guideline value for chloride in irrigation water, and it should be noted that this value may not necessarily be appropriate due to local conditions or special conditions of crop, soil, and method of irrigation (refer back to Section 4.3). According to USEPA, the TMDL for Jalama Creek should be calculated on the basis of this 303(d) assessment criteria = 106 mg/L, pending the approval of revised water quality guidelines or site specific objectives. This is because TMDLs must be consistent with current water quality criteria found in the Central Coast Basin Plan.

Therefore, the TMDL numeric target for chloride, which demonstrates whether or not the AGR designated beneficial use for irrigation supply is being supported, is as follows:

- *The controllable discharge of wastes shall not cause concentrations of chloride to exceed 106 mg/l in receiving waters.*

6.3.1 Interim Numeric Target for Chloride

The desired goal for this TMDL is to attain state water quality standards in Jalama Creek by identifying a strategy to correct inappropriate criteria used in the 303(d) assessment, in recognition that natural conditions cause elevated chloride levels in the creek. Due to non-anthropogenic natural background conditions − which frequently cause chloride in Jalama Creek to exceed 106 mg/L − a representative water quality endpoint is needed to account for the natural, existing background loading capacity of the water body and to support development of site specific water quality objective for chloride. Further, an estimate of existing natural loading is needed to implement state and federal anti-degradation requirements. Jalama Creek is currently supporting designated aquatic habitat, drinking water supply, and existing agricultural supply uses – as such, existing water quality must be protected and further degradation of the water resource above and beyond the natural chloride loads present is not allowed, unless warranted pursuant to provisions in federal and state anti-degradation policies.

Chloride loads in Jalama Creek are attributable to natural background, and the chloride numeric criteria used in the 303(d) listing is not adequate to take natural background loading into account. The selected interim numeric endpoint identified in this TMDL is derived from taking the 95th percentile of historic (2001-2012) chloride water quality data and represents the maximum measured chloride concentration resulting from background conditions, and also reserves a 5%

[29] *Ibid*
[30] Refer to Section 4.4

margin of error to account for uncertainties in the response of the waterbody to chloride loading. The 95th percentile of historic chloride water quality data is 185 mg/L.

Therefore the interim chloride numeric target is as follows:

- *The controllable discharge of wastes shall not cause concentrations of chloride to exceed 185 mg/l in receiving waters.*

Accordingly, this target is consistent with anti-degradation policies and the protection of existing water quality. **Note that the interim numeric target for chloride is already being achieved on the basis of natural background loading to the waterbody**. Further information on interim water quality targets and recommendations to revise chloride water quality guidelines or establish site specific water quality objectives are outlined in Section 8 of this report.

6.4 Sodium Criteria for Protection of Agricultural Supply (AGR)

The Basin Plan numeric water quality guideline used in the 2010 303(d) assessment for sodium in irrigation water is 69 mg/L sodium. This value is based on University of California Agricultural Extension Service general guideline value for sodium in irrigation water, and it should be noted that this value may not necessarily be appropriate due to local conditions or special conditions of crop, soil, and method of irrigation (refer back to Section 4.3). According to USEPA, the TMDL for Jalama Creek should be calculated on the basis of this 303(d) assessment criteria = 69 mg/L, pending the approval of revised water quality guidelines or site specific objectives. This is because TMDLs must be consistent with current water quality criteria found in the Central Coast Basin Plan.

Therefore, the TMDL numeric target for sodium, which demonstrates whether or not the AGR designated beneficial use for irrigation supply is being supported, is as follows:

- *The controllable discharge of wastes shall not cause concentrations of sodium to exceed 69 mg/l in receiving waters.*

6.4.1 Interim Numeric Target for Sodium

The desired goal for this TMDL is to attain state water quality standards in Jalama Creek by identifying a strategy to correct inappropriate criteria used in the 303(d) assessment, in recognition that natural conditions cause elevated sodium levels in the creek. Due to non-anthropogenic natural background conditions − which frequently cause sodium in Jalama Creek to exceed 69 mg/L − a representative water quality endpoint is needed to account for the natural, existing background loading capacity of the water body and to support development of site specific water quality objective for sodium. Further, an estimate of existing natural loading is needed to implement state and federal anti-degradation requirements. Jalama Creek is currently supporting existing agricultural supply uses subwatershed – as such, existing water quality must be protected and further degradation of the water resource above and beyond the natural sodium loads present is not allowed, unless warranted pursuant to provisions in federal and state anti-degradation policies[31].

Sodium loads in Jalama Creek are attributable to natural background, and the sodium numeric criteria used in the 303(d) listing is not adequate to take natural background loading into account. The selected interim numeric target identified in this TMDL is derived from taking the 95th percentile of historic (2001-2012) sodium water quality data and represents the maximum measured sodium concentration resulting from background conditions, and also reserves a 5% margin of error to

[31] *Ibid*

account for uncertainties in the response of the waterbody to sodium loading. The 95th percentile of historic sodium water quality data is 120 mg/L.

Therefore the interim sodium numeric target is as follows:

- *The controllable discharge of wastes shall not cause concentrations of sodium to exceed 120 mg/l in receiving waters.*

Accordingly, this target is consistent with anti-degradation policies and the protection of existing water quality. **Note that the interim numeric target for sodium is already being achieved on the basis of natural background loading to the waterbody**. Further information on interim water quality targets and recommendations to revise sodium water quality guidelines or establish site specific water quality objectives are outlined in Section 8 of this report.

7 LOADING CAPACITIES AND ALLOCATIONS

7.1 Introduction

The TMDL represents the loading capacity of a waterbody—the amount of a pollutant that the waterbody can assimilate and still support beneficial uses. Chloride and sodium loads in Jalama Creek are attributable to natural background conditions. Designated MUN, aquatic habitat, and existing AGR beneficial uses (livestock watering) are being supported in the subwatershed

7.2 Existing Loading Capacities

7.2.1 Chloride Total Maximum Daily Load (TMDL)

USEPA expects that TMDLS be set at levels necessary to attain and maintain applicable water quality standards. Note that while numeric water quality concentrations for chloride in irrigation water are recommended general guidelines (refer back to Section 4.3), because they are published in the Basin Plan as guidelines, USEPA considers these values to be appropriate for the purposes of TMDL calculation[32]. Therefore, the numeric endpoint used for calculating the loading capacity (TMDL) for chloride in receiving waters of Jalama Creek is 106 mg/L (refer back to Section 6.3). The loading capacity is derived by multiplying the flow by the numeric target (106 mg/L) and a conversion factor. Flow-based allowable loads and the TMDL for chloride in Jalama Creek are presented in Table 7-1.

Table 7-1. Flow-based allowable loading capacity for chloride at 106 mg/L guideline.

Flow Regime (period of record 1965-2012)	Flow (cfs)	Flow Exceedance Percentile	Daily Loading Capacity (pounds)
High	9	5%	5,159
Moderate	1.4	20%	800
Low	0.26	60%	149
Median flow for days with observable stream flow *(period of record 1965-2012)*	0.53	45%	**303**

Loading capacities and flow data are derived from flow duration and load duration target records which are presented in Appendix C of this project report.

[32] Letter from USEPA Region 9 to Central Coast Water Board staff dated March 18, 2013.

Therefore, based on the median daily stream flow for the period of record (1965-2012) when there was observable stream flow (see Table 7-1), the TMDL for chloride for Jalama Creek is as follows:

Chloride TMDL: 303 pounds per day,
and,
The controllable discharge of wastes shall not cause concentrations of chloride to exceed 106 mg/l in receiving waters.

It should be noted that this loading capacity and numeric target (106 mg/L) **are unachievable due to non-controllable local natural and geologic conditions**, as documented in this project report. Therefore note that the proposed implementation actions contemplate development of site-specific numeric water quality objectives appropriate for natural background conditions (refer to Section 8.3). Additionally, this project report proposes interim numeric targets for chloride on the basis of natural, background loading to Jalama Creek (refer back to Section 6.3.1). Note that the **interim numeric target for chloride is already being achieved on the basis of natural background loading to the waterbody**.

7.2.2 Sodium Total Maximum Daily Load (TMDL)

USEPA expects that TMDLS be set at levels necessary to attain and maintain applicable water quality standards. Note that while numeric water quality concentrations for sodium in irrigation water are recommend general guidelines (refer back to Section 4.3), because they are published in the Basin Plan as guidelines, USEPA considers these values to be appropriate for the purposes of TMDL calculation[33]. Therefore, the numeric endpoint used for calculating the loading capacity (TMDL) for chloride in receiving waters of Jalama Creek is 69 mg/L (refer back to Section 6.4). The loading capacity is derived by multiplying the flow by the numeric target (69 mg/L) and a conversion factor. Flow-based allowable loads and the TMDL for chloride in Jalama Creek are presented in Table 7-2

Table 7-2. Flow-based allowable loading capacity for sodium at 69 mg/L guideline.

Flow Regime (period of record 1965-2012)	Flow (cfs)	Flow Exceedance Percentile	Daily Loading Capacity (pounds)
High	9	5%	3.358
Moderate	1.4	20%	521
Low	0.26	60%	97
Median flow for days with observable stream flow	0.53	45%	**197**

Loading capacities and flow data are derived from flow duration and load duration target records which are presented in Appendix C of this project report.

Therefore, based on the median daily stream flow for the period of record (1965-2012) when there was observable stream flow (see Table 7-2), the TMDL for sodium for Jalama Creek is as follows:

Sodium TMDL: 197 pounds per day,
and,
The controllable discharge of wastes shall not cause concentrations of sodium to exceed 69 mg/l in receiving waters.

It should be noted that this loading capacity and numeric target (69 mg/L) **are unachievable due to non-controllable local natural and geologic conditions**, as documented in this project report. Therefore note that the proposed implementation actions contemplate development of site-specific

[33] *Ibid*

numeric water quality objective appropriate for natural background conditions (refer to Section 8.3). Additionally, this project report proposes interim numeric targets for sodium on the basis of natural, background loading to Jalama Creek (refer back to Section 6.4.1). Note that the **interim numeric target for chloride is already being achieved on the basis of natural background loading to the waterbody**.

7.3 Allocations

7.3.1 Waste Load Allocations

The waste load allocations for the chloride and sodium component of the TMDL is set at zero, because there are no point sources of chloride and sodium in the Jalama Creek subwatershed.

7.3.2 Load Allocations (Natural Background Allocations)

The single load allocation for chloride and sodium is assigned to natural sources, because the single identified source of elevated chloride and sodium in Jalama Creek is naturally occurring and non-controllable. Therefore, the existing loading capacity (TMDL) for chloride and sodium is set equal to the load allocation.

7.3.3 Tabular Summaries of Allocations

Table 7-3 and Table 7-4 present tabular summaries of the chloride and sodium TMDL allocations.

Table 7-3. Chloride allocations.

CHLORIDE WASTE LOAD ALLOCATIONS [A]			
Waterbody	**WBID**	**Party Responsible (Source)**	**Receiving Water Allocation for Chloride (pounds per day)**
Jalama Creek[a]	CAR3151005119990304115034	NONE	0
CHLORIDE LOAD ALLOCATIONS [A]			
Waterbody	**WBID**	**Responsible Party (Source)**	**Receiving Water Allocation for Chloride (pounds per day)**
Jalama Creek[a]	CAR3151005119990304115034	Natural Sources (no responsible parties - not subject to regulation)	303

[A] federal and state anti-degradation requirements apply to all waste load and load allocations.

Table 7-4. Sodium allocations.

SODIUM WASTE LOAD ALLOCATIONS [A]			
Waterbody	**WBID**	**Party Responsible (Source)**	**Receiving Water Allocation for Sodium (pounds per day)**
Jalama Creek[a]	CAR3151005119990304115034	NONE	0
SODIUM LOAD ALLOCATIONS [A]			
Waterbody	**WBID**	**Responsible Party (Source)**	**Receiving Water Allocation for Sodium (pounds per day)**
Jalama Creek[a]	CAR3151005119990304115034	Natural Sources (no responsible parties - not subject to regulation)	197

[A] federal and state anti-degradation requirements apply to all waste load and load allocations.

7.3.4 Achievement of Interim Water Quality Targets

It should be noted that the allocations presented above, and which are based on numeric targets of 106 and 69 mg/L for chloride and sodium respectively, **are unachievable due to non-controllable local natural and geologic conditions**, as documented in this project report.

Therefore note that the proposed implementation actions contemplate development of site-specific numeric water quality objective appropriate for natural background conditions (refer to Section 8.3).

In order to address the interim discrepancy between the proposed TMDL allocations (refer back to Table 7-3 and Table 7-4) and what appear to be natural conditions in Jalama Creek, USEPA recommends setting interim numeric water quality targets that are reflective of local natural conditions in Jalama Creek[34]. These interim water quality targets were previously presented in Sections 6.3.1 and 6.4.1, and are 185 mg/L and 120 mg/L for chloride and sodium respectively. **It is important to reiterate that these proposed interim numeric targets for chloride and sodium are already being achieved on the basis of natural background loading to Jalama Creek**.

Therefore, current attainment of these interim numeric targets serves as an interim water quality benchmark and establishes estimated natural baseline conditions, pending future development of site specific numeric water quality criteria appropriate for local natural background.

7.4 Margin of Safety

The Clean Water Act and federal regulations require that TMDLs provide a margin of safety to account for uncertainty concerning the relationship between pollution controls and water quality responses (see 40 CFR 130.7(c)(1)). The recommendation of this report is to develop site specific water quality objectives for chloride and sodium appropriate to account for natural background conditions. This is based on the conclusion that there are no controllable human-induced sources of chloride and sodium in this stream reach. Note that an explicit percent margin of safety is incorporated in the TMDLs by using conservative assumptions in the development of numeric endpoints (refer back to Section 6.3 and 6.4). The explicit margin of safety is five percent.

7.5 Critical Conditions and Seasonal Variation

Staff determined that there is no seasonal variation in chloride and sodium concentrations in Jalama Creek. Based on staff's load duration analyses, chloride and sodium concentrations are generally lower during high flow conditions, likely due to increase inputs of fresh, meteoric water from runoff and precipitation. Data during high flow conditions are relatively limited at present. Flow-related variability should be further evaluated and considered in any final proposed site specific water quality objectives.

7.6 Linkage Analysis

The goal of the linkage analysis is to establish a link between the identified pollutant loads (e.g. the wasteload and load allocations) and the desired water quality condition. For this TMDL, the desired water quality condition for chloride and sodium levels in Jalama Creek is already achieved, because the current levels are naturally occurring. Therefore, the link is established.

[34] Letter from USEPA Region 9 TMDL liason to Central Coast Water Board staff, dated March 18, 2013.

8 PROPOSED ACTIONS TO ADDRESS 303(d)-LISTED IMPAIRMENT

8.1 Introduction

The purpose of a TMDL implementation strategy is to describe the steps necessary to correct or address a water quality impairment and to provide a strategy to attain water quality standards.

Staff finds that non-attainment of the agricultural irrigation supply guidelines that were used in the 2010 303(d) assessment for chloride and sodium in Jalama Creek are due to non-controllable, local natural conditions. Given the natural, non-controllable nature of chloride and sodium load in Jalama Creek, staff concludes that the irrigation supply water quality guidelines used in the 2010 303(d) assessment for Jalama Creek may not be reliable indicators of water quality impairment for Jalama Creek. It should be noted that the Central Coast Basin Plan explicitly states that the University of California Agricultural Extension guideline values for chloride and sodium in irrigation water are flexible and depend to a significant extent on local conditions of soil, crop type, climate, and method of irrigation.

Therefore, staff proposes an implementation strategy to address the impairment that includes development and implementation of site specific water quality objectives for these constituents based on the assessment that exceedances are naturally occurring and that designated agricultural (AGR) beneficial use is an existing and/or potential beneficial use of this creek. Staff recommends development of a basin plan amendment to promulgate site specific objectives (SSOs) for these constituents at a future Central Coast Water Board public hearing. Note that the approval of SSOs require Regional and State Water Board approval, as well as approval from USEPA. Also note that SSOs or refinements in the water quality criterion may be considered when a numeric criterion is in question (e.g., chloride and sodium guideline values for salinity in irrigation water) and not the beneficial use itself[35] consistent with State of California guidance on TMDL development:

> *"SSOs or refinements in the water quality objective are often considered when a numeric objective is in question (e.g., copper or chloride standard) and not the use itself."*
>
> State of California S.B. 469 TMDL Guidance: A Process for Addressing Impaired Waters in California (June 2005, approved by State Water Resources Control Board Resolution 2005-0050.

8.2 Options under the Impaired Waters Policy

In accordance with the California Impaired Waters Policy, the Water Board may pursue one of the following actions in addressing impaired waters.

A. If the water body is neither impaired nor threatened, the appropriate regulatory response is to delist the water body.

B. If the failure to attain standards is due to the fact that the applicable standards are not appropriate due to natural conditions, an appropriate regulatory response is to correct the standards.

C. A TMDL must be calculated for impairments caused by certain EPA designated pollutants. The two other common causes or categories of impairment are related to anthropogenic factors. They include waters impaired by pollution and waters impaired by certain EPA designated pollutants. The Porter-Cologne Water Quality Control Act charges the State Board and

[35] As documented in this report, the potential impact of chloride and sodium water concentrations on the suitability for use as irrigation supply depends on many site specific factors, including special conditions of crop, soil, and method of irrigation.

Regional Boards with the responsibility of protecting the beneficial uses and quality of all waters of the state, irrespective of the cause of the impairment. Thus, if possible, the impairment should be corrected in either event. Presently, the EPA has designated all pollutants as suitable for TMDL calculation under proper technical conditions.

Based on the analyses presented in this TMDL, the most appropriate action based on the three options listed above is bullet "B," a correction of the standards. Note that AGR (agricultural supply) is an existing beneficial use (livestock watering, support of rangeland vegetation) in the Jalama Creek watershed. Further, sodium and chloride concentrations in the creek could in fact support potential or future irrigation supply for many crop types, depending on site specific condtions of crop, soil, and irrigation method (refer back to Table 4-2). Therefore, de-designation of the AGR beneficial use is not an appropriate regulatory response. Consequently, staff concludes that a modification of the chloride and sodium numeric water quality guidelines applicable to Jalama Creek – which may include development of site specific objectives (SSOs) − is the appropriate water quality standards response to address the 303(d)-listed impairments for chloride and sodium in Jalama Creek.

8.3 Recommendation to Develop and Implement Site-Specific Water Quality Criteria

SSOs or refinements in the water quality objective are often considered when a numeric objective is in question and not the use itself. In the case of Jalama Creek, non-attainment of agricultural irrigation supply non-regulatory guidelines for chloride and sodium used in the 2010 303(d) assessment are due to non-controllable, local natural conditions and staff propose that a modification of the chloride and sodium numeric water quality guidelines applicable to Jalama Creek – which may include development of site specific objectives (SSOs) − is the appropriate water quality standards response to address the 303(d)-listed impairments for chloride and sodium in Jalama Creek

Based on current information and data, staff developed interim site specific chloride and sodium water quality end points that may be reviewed, revised, or incorporated in a future basin plan amendment (see Sections 8.3.1 and 8.3.2). Additionally, data collected in the future during high flows may be helpful in SSO development; it appears there is flow variation in sodium and chloride concentrations (refer back to Section 7.5). As such, it may be necessary to have SSOs that apply to high flow conditions, and separate SSOs that apply to low flow conditions.

8.3.1 Interim Numeric Target for Chloride

In order to address the interim discepency between the proposed TMDL allocations (refer back to Table 7-3 and Table 7-4) and what appear to be natural conditions in Jalama Creek, USEPA recommends setting interim numeric water quality targets that are reflective of local natural conditions in Jalama Creek[36]. On the basis of information presented previously in Section 6.3.1, the interim numeric target for chloride is as follows:

- *The controllable discharge of wastes shall not cause concentrations of chloride to exceed 185 mg/l in receiving waters.*

It is important to reiterate that this proposed interim numeric target for chloride is already being achieved on the basis of natural background loading to Jalama Creek. Therefore, current attainment of the interim chloride numeric target serves as an interim benchmark and establishes estimated natural baseline conditions, pending future development of site specific numeric water quality criteria appropriate for local natural background.

[36] Letter from USEPA Region 9 TMDL liason to Central Coast Water Board staff, dated March 18, 2013.

8.3.2 Interim Numeric Target for Sodium

In order to address the interim discepency between the proposed TMDL allocations (refer back to Table 7-3 and Table 7-4) and what appear to be natural conditions in Jalama Creek, USEPA recommends setting interim numeric targets that are reflective of local natural conditions in Jalama Creek[37]. On the basis of information presented previously in Section 6.4.1, the interim numeric target for sodium is as follows:

- *The controllable discharge of wastes shall not cause concentrations of sodium to exceed 120 mg/l in receiving waters.*

It is important to reiterate that this proposed interim numeric target for sodium is already being achieved on the basis of natural background loading to Jalama Creek. Therefore, current attainment of the interim sodium numeric target serves as an interim benchmark and establishes estimated natural baseline conditions, pending future development of site specific numeric water quality criteria appropriate for local natural background.

8.4 Anti-degradation Requirements

Staff has developed this TMDL, in part, to be consistent with state anti-degradation policy. This policy requires, in part that when the existing quality of water is better than the quality of water established as objectives, such existing water quality shall be maintained unless otherwise provided for by the provisions of State Water Resources Control Board Resolution No. 68-16. High quality waters are determined on a "pollutant-by-pollutant"/"parameter-by-parameter" basis, by determining whether water quality is better than the criterion for each parameter using chemical or biological data[38].

The State Water Resourced Control Board has explained that high quality waters are determined based on specific properties or characteristics[39]. Therefore, waters can be of high quality for some constituents or beneficial uses, but not for others. In Jalama Creek designated drinking water supply (MUN), aquatic habitat (WARM, SPWN), and existing AGR (livestock watering, support of rangeland vegetation) beneficial uses are being supported on the basis of sodium and chloride data. Consequently, future lowering of existing chloride and sodium water quality is not allowed unless consistent with provisions of the state and federal anti-degradation policies.

Non-compliance with anti-degradation requirements may be determined on the basis of trends in declining water quality consistent with the methodologies provided in Section 3.10 of the California 303(d) Listing Policy (SWRCB, 2004).

8.5 California Water Code Considerations

Development of site specific water quality objectives (SSO) requires the Central Coast Water Board to consider various factors in accordance with CWC §13241. According to the State Water Resources Control Board[40], for an SSO the supporting documentation should also include:

- Past, present, and probable future beneficial uses
- Environmental characteristics, including quality of water

[37] *Ibid*

[38] See: State Water Resources Control Board (2008), *Water Quality Standards Academy, Basic Course, Module 14*. Presented by U.S. Environmental Protection Agency, Region 9 – Office of Science and Technology (May 12, 2008).

[39] Court of Appeal of the State of California Third Appellate District, Asocacion De Gente Unida Por El Agua et al. v. Central Valley Regional Water Quality Control Board (Super. Ct. No. 34-2008-00003604CU-WM-GDS)

[40] State of California S.B. 469 TMDL Guidance – A Proces for Addressing Impaired Waters in California. California State Water Resources Control Board, June 2005.

- Water quality conditions that could be reasonably achieved through coordinated control of all factors affecting water quality
- Economic considerations
- The need for developing housing in the region
- The need to develop and reuse recycled water

8.6 Additional Data to Support Water Quality Objectives Development

Additional data collected in the future, including during high flow events, may be helpful in development of revised chloride and sodium numeric water quality guidelines or SSO development for Jalama Creek. Based on available data it appears there is flow variation in sodium and chloride concentrations (refer back to Section 7.5). Note that under high flow conditions, when fresh metoric waters and runoff dilute the chloride and sodium concentrations in the creek, it appears that even the most stringent guideline values for chloride (106 mg/L) and for sodium (69 mg/L) in irrigation water are frequently achieved (refer back to Section Figure 4-4). Currently, there is relatively limited water quality data for high flow regimes. Therefore, pending the acquisition of additional water quality data it may be possible to conclude that SSOs for chloride and/or sodium are only necessary at low flow conditions.

8.7 Timeline

Amending chloride and sodium numeric water quality guidelines applicable to Jalama Creek will require development of a basin plan amendment, with Central Coast Water Board, State Board, USEPA approvals, and considerable expenditure of staff resources. There are no permit effluent limitations for chloride or sodium based on the existing irrigation water quality guidelines regulating discharges in the Jalama Creek subwatershed, and existing chloride and sodium water quality is not negatively impacting current beneficial uses of surface waters in the watershed. Therefore, there is not an immediate urgency to develop site specific objectives or revised guidelines for chloride and sodium for the Jalama Creek subwatershed. Staff does, however, recommend a future basin plan amendment to address the issue. Staff will prioritize this future effort against competing threats to water quality. Staff anticipates a basin plan amendment to address the issue could be proposed within ten years, or 2023. This date also provides for the opportunity to collect more water quality data that can be used to support development of the SSOs (refer back to Section 8.6).

9 PUBLIC PARTICIPATION

9.1 Public Meetings & Stakeholder Engagement

Staff conducted stakeholder outreach efforts during TMDL development. Staff conducted a public workshop in Gaviota on November 16, 2012 and staff engaged with stakeholders during the development of the TMDL through informal contacts such as email and telephone. Individuals and entities staff engaged during the public workshop or during TMDL development included representatives of the following:

- Cojo-Jalama Ranch
- Butterbean Studios Farm
- Vandenberg Air Force Base – Water Resources Program
- University of California Cooperative Extension
- Santa Barbara County Parks
- Cachuma Resource Conservation District
- Santa Barbara County Cattlemen's Association
- Gaviota Coast Conservancy

Information provided by landowners and land operators in the Jalama Creek watershed comported with staff's source analysis: namely, that there are very limited anthropogenic impacts in the subwatershed; human activities are mostly limited to rangeland grazing of cattle and very small amounts of dryland farming.

Stakeholders confirmed that there are virtually no residences or septic systems in the subwatershed upstream of monitoring site 315JAL, and that off-creek watering is provided for cattle which is considered a good management practice to limit riparian land disturbance by cattle. Stakeholders familiar with the subwatershed also confirmed the presence of sulfur springs, which provides visual confirmation of staff's source assessment pertaining to natural conditions, saline springs, and saline geothermal waters which likely cause or contribute elevated levels of chloride and sodium in surface waters of Jalama Creek.

Collectively, staff's data assessment in conjunction with reporting from stakeholders familiar with the subwatershed provide independent lines of evidence, and provided for a weight-of-evidence approach confirming that natural sources are responsible for non-attainment of the 303(d) listing water quality criteria used in the 2010 303(d) assessment.

The staff report, resolution, and technical project reports were made available for a 35-day public comment commencing on February 22, 2013. Water Board staff solicited public comment from a range of stakeholders including local land owners and land operators, agricultural representatives, environmental representatives, resource professionals, and public agencies.

One public comment letter was received from:

1. Ms. Janet Parrish, TMDL Liaison, U.S. Environmental Protection Agency (USEPA), Region IX, San Francisco, in a letter dated March 18, 2013.

The comment letter from USEPA recommended minor administrative changes to the TMDL project. Staff made the administrative changes as recommended by USEPA. USEPA also stated their support for the proposed TMDL implementation strategy as well as for the goal of identifying and protecting existing water quality conditions, consistent with Clean Water Act anti-degradation requirements.

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Appendix A − Chloride and Sodium Tolerance of Selected Crops

The purpose of this appendix is to provide supplemental information regarding the ion-specific toxicity information and the relative chloride and sodium tolerance of various crops.

The information provided below is a direct transcription from *Ayers, R.S. and D.W. Westcot, 1989. Water Quality for Agriculture, Food and Agriculture Organization of the United Nations, Irrigation and Drainage Paper, 29 Rev. 1*.

Chloride

The most common toxicity is from chloride in the irrigation water. Chloride is not adsorbed or held back by soils, therefore it moves readily with the soil-water, is taken up by the crop, moves in the transpiration stream, and accumulates in the leaves. If the chloride concentration in the leaves exceeds the tolerance of the crop, injury symptoms develop such as leaf burn or drying of leaf tissue. Normally, plant injury occurs first at the leaf tips (which is common for chloride toxicity), and progresses from the tip back along the edges as severity increases. Excessive necrosis (dead tissue) is often accompanied by early leaf drop or defoliation. With sensitive crops, these symptoms occur when leaves accumulate from 0.3 to 1.0 percent chloride on a dry weight basis, but sensitivity varies among these crops. Many tree crops, for example, begin to show injury above 0.3 percent chloride (dry weight).

Chemical analysis of plant tissue is commonly used to confirm a chloride toxicity. The part of the plant generally used for analysis varies with the crop, depending upon which of the available interpretative values is being followed. Leaf blades are most often used, but the petioles of some crops (grapes) are sometimes used rather than leaves. For irrigated areas, the chloride uptake depends not only on the water quality but also on the soil chloride, controlled by the amount of leaching that has taken place and the ability of the crop to exclude chloride. Crop tolerances to chloride are not nearly so well documented as crop tolerances to salinity. Table 14 gives the known tolerances of several crops to chloride in the saturation extract or in the applied water. These values may need to be changed where local experience indicates that different levels cause damage. For example, tobacco, although tolerant to chloride, acquires progressively more undesirable burning characteristics of the leaf as well as reduced storage life if chloride levels in irrigation water increase above a few milliequivalents per litre. This greatly affects its market value.

Table 14 CHLORIDE TOLERANCE OF SOME FRUIT CROP CULTIVARS AND ROOTSTOCKS[1]

Crop	Rootstock or Cultivar	Maximum Permissible Cl^- without Leaf Injury[2]	
		Root Zone (Cl_e) (me/l)	Irrigation Water (Cl_w)[3] [4] (me/l)
	Rootstocks		
Avocado *(Persea americana)*	West Indian	7.5	5.0
	Guatemalan	6.0	4.0
	Mexican	5.0	3.3
Citrus *(Citrus spp.)*	Sunki Mandarin	25.0	16.6
	Grapefruit		

	Cleopatra mandarin		
	Rangpur lime		
	Sampson tangelo	15.0	10.0
	Rough lemon		
	Sour orange		
	Ponkan mandarin		
	Citrumelo 4475	10.0	6.7
	Trifoliate orange		
	Cuban shaddock		
	Calamondin		
	Sweet orange		
	Savage citrange		
	Rusk citrange		
	Troyer citrange		
Grape *(Vitis spp.)*	Salt Creek, 1613-3	40.0	27.0
	Dog Ridge	30.0	20.0
Stone Fruits *(Prunus spp.)*	Marianna	25.0	17.0
	Lovell, Shalil	10.0	6.7
	Yunnan	7.5	5.0
	Cultivars		
Berries *(Rubus spp.)*	Boysenberry	10.0	6.7
	Olallie blackberry	10.0	6.7
	Indian Summer Raspberry	5.0	3.3
Grape *(Vitis spp.)*	Thompson seedless	20.0	13.3
	Perlette	20.0	13.3
	Cardinal	10.0	6.7
	Black Rose	10.0	6.7
Strawberry *(Fragaria spp.)*	Lassen	7.5	5.0
	Shasta	5.0	3.3

[1] Adapted from Maas (1984).
[2] For some crops, the concentration given may exceed the overall salinity tolerance of that crop and cause some reduction in yield in addition to that caused by chloride ion toxicities.
[3] Values given are for the maximum concentration in the irrigation water. The values were derived from saturation extract data (EC_e) assuming a 15–20 percent leaching fraction and $EC_e = 1.5\ EC_w$.
[4] The maximum permissible values apply only to surface irrigated crops. Sprinkler irrigation may cause excessive leaf burn at values far below these (see Section 4.3).

A chloride toxicity can occur by direct leaf absorption through leaves wet during overhead sprinkler irrigation. This occurs most frequently with the rotating type sprinkler heads.

Sodium

Sodium toxicity is not as easily diagnosed as chloride toxicity, but clear cases of the former have been recorded as a result of relatively high sodium concentrations in the water (high Na or SAR). Typical toxicity symptoms are leaf burn, scorch and dead tissue along the outside edges of leaves in contrast to symptoms of chloride toxicity which normally occur initially at the extreme leaf tip. An extended period of time (many days or weeks) is normally required before accumulation reaches toxic concentrations. Symptoms appear first on the older leaves, starting at the outer edges and, as the severity increases, move progressively inward between the veins toward the leaf centre. Sensitive crops include deciduous fruits, nuts, citrus, avocados and beans, but there are many others. For tree crops, sodium in the leaf tissue in excess of 0.25 to 0.50 percent (dry weight basis) is often associated with sodium toxicity.

Leaf tissue analysis is commonly used to confirm or monitor sodium toxicity but a combination of soil, water and plant tissue analyses greatly increases the probability of a correct diagnosis. When using only leaf blade analysis to diagnose sodium toxicity, it is advisable to include analyses of leaf blades from damaged trees as well as separate analyses from nearby undamaged ones for comparative purposes.

Sodium toxicity is often modified or reduced if sufficient calcium is available in the soil. Whether an indicated sodium toxicity is a simple one or is more complicated involving a possible calcium deficiency or other interaction is presently being researched. Preliminary results indicate that for at least a few annual crops, calcium deficiency rather than sodium toxicity may be occurring. If confirmed, these crops should respond to calcium fertilization using material such as gypsum or calcium nitrate. For a discussion of possible calcium deficiency, see Section 5.6 on Nutrition and Water Quality.

Many crops do show sodium toxicity. The toxicity guidelines of Table 1 use SAR as the indicator of the potential for a sodium toxicity problem which is expected to develop following surface irrigation with a particular quality of water. Table 15 gives the relative sodium tolerance of several representative crops. The data in the table are given not in terms of SAR but of soil exchangeable sodium (ESP). Estimates of soil ESP that are expected to result from long-term (several years) use of water of given SAR can be made using the nomogram in Figure 1. (Refer to Section 3.2.1 for a discussion of the impact of erroneous interpretations of SAR-ESP relationships in presence of gypsum.)

Table 15 RELATIVE TOLERANCE OF SELECTED CROPS TO EXCHANGEABLE SODIUM[1]

Sensitive[2]	**Semi-tolerant[2]**	**Tolerant[2]**
Avocado	**Carrot**	**Alfalfa**
(Persea americana)	*(Daucus carota)*	*(Medicago sativa)*
Deciduous Fruits	**Clover, Ladino**	**Barley**
Nuts	*(Trifolium repens)*	*(Hordeum vulgare)*
Bean, green	**Dallisgrass**	**Beet, garden**
(Phaseolus vulgaris)	*(Paspalum dilatatum)*	*(Beta vulgaris)*
Cotton (at germination)	**Fescue, tall**	**Beet, sugar**
(Gossypium hirsutum)	*(Festuca arundinacea)*	*(Beta vulgaris)*
Maize	**Lettuce**	**Bermuda grass**
(Zea mays)	*(Lactuca sativa)*	*(Cynodon dactylon)*
Peas	**Bajara**	**Cotton**
(Pisum sativum)	*(Pennisetum typhoides)*	*(Gossypium hirsutum)*
Grapefruit	**Sugarcane**	**Paragrass**
(Citrus paradisi)	*(Saccharum officinarum)*	*(Brachiaria mutica)*
Orange	**Berseem**	**Rhodes grass**
(Citrus sinensis)	*(Trifolium alexandrinum)*	*(Chloris gayana)*

Peach	**Benji**	**Wheatgrass, crested**
(Prunus persica)	*(Melilotus parviflora)*	*(Agropyron cristatum)*
Tangerine	**Raya**	**Wheatgrass, fairway**
(Citrus reticulata)	*(Brassica juncea)*	*(Agropyron cristatum)*
Mung	**Oat**	**Wheatgrass, tall**
(Phaseolus aurus)	*(Avena sativa)*	*(Agropyron elongatum)*
Mash	**Onion**	**Karnal grass**
(Phaseolus mungo)	*(Allium cepa)*	*(Diplachna fusca)*
Lentil	**Radish**	
(Lens culinaris)	*(Raphanus sativus)*	
Groundnut (peanut)	**Rice**	
(Arachis hypogaea)	*(Oryza sativus)*	
Gram	**Rye**	
(Cicer arietinum)	*(Secale cereale)*	
Cowpeas	**Ryegrass, Italian**	
(Vigna sinensis)	*(Lolium multiflorum)*	
	Sorghum	
	(Sorghum vulgare)	
	Spinach	
	(Spinacia oleracea)	
	Tomato	
	(Lycopersicon esculentum)	
	Vetch	
	(Vicia sativa)	
	Wheat	
	(Triticum vulgare)	

Adapted from data of FAO-Unesco (1973); Pearson (1960); and Abrol (1982).

The approximate levels of exchangeable sodium percentage (ESP) corresponding to the three categories of tolerance are: sensitive less than 15 ESP; semi-tolerant 15–40 ESP; tolerant more than 40 ESP. Tolerance decreases in each column from top to bottom. The tolerances listed are relative because, usually, nutritional factors and adverse soil conditions stunt growth before reaching these levels. Soil with an ESP above 30 will usually have too poor physical structure for good crop production. Tolerance in most instances were established by first stabilizing soil structure.

Particular care in assessment of a potential toxicity due to SAR or sodium is needed with high SAR water because apparent toxic effects of sodium may be due to or complicated by poor water infiltration. As shown in Table 15, only the more sensitive perennial crops have yield losses due to sodium if the physical condition of the soil remains good enough to allow adequate infiltration. Several of the crops listed as more tolerant do show fair growth when soil structure is maintained and, in general, these crops can withstand higher ESP levels if the soil structure and aeration can be maintained, as in coarse textured soils.

Appendix B − Water Quality Data

This appendix contains TMDL project area monitoring site location information and water quality data.

SiteTag	Latitude	Longitude	SampleDate	AnalyteName	Result	ResultUnit
315JAL	34.51217	-120.498	2/13/2001	Chloride	28	mg/L
315JAL	34.51217	-120.498	5/8/2001	Chloride	135	mg/L
315JAL	34.51217	-120.498	6/4/2001	Chloride	151	mg/L
315JAL	34.51217	-120.498	7/11/2001	Chloride	140	mg/L
315JAL	34.51217	-120.498	8/7/2001	Chloride	130	mg/L
315JAL	34.51217	-120.498	10/8/2001	Chloride	171	mg/L
315JAL	34.51217	-120.498	11/5/2001	Chloride	277	mg/L
315JAL	34.51217	-120.498	12/12/2001	Chloride	128	mg/L
315JAL	34.51217	-120.498	1/3/2002	Chloride	199	mg/L
315JAL	34.51217	-120.498	2/12/2002	Chloride	222	mg/L
315JAL	34.51217	-120.498	3/27/2002	Chloride	137	mg/L
315JAL	34.51217	-120.498	3/4/2004	Chloride	186	mg/L
315JAL	34.51217	-120.498	5/19/2004	Chloride	136	mg/L
315JAL	34.51217	-120.498	6/23/2004	Chloride	129	mg/L
315JAL	34.51217	-120.498	10/7/2004	Chloride	133	mg/L
315JAL	34.51217	-120.498	11/4/2004	Chloride	128	mg/L
315JAL	34.51217	-120.498	12/8/2004	Chloride	135	mg/L
315JAL	34.51217	-120.498	1/5/2005	Chloride	99	mg/L
315JAL	34.51217	-120.498	2/3/2005	Chloride	119	mg/L
315JAL	34.51217	-120.498	3/2/2005	Chloride	85	mg/L
315JAL	34.51217	-120.498	3/29/2005	Chloride	96	mg/L
315JAL	34.51217	-120.498	4/27/2005	Chloride	130	mg/L
315JAL	34.51217	-120.498	5/25/2005	Chloride	140	mg/L
315JAL	34.51217	-120.498	6/22/2005	Chloride	140	mg/L
315JAL	34.51217	-120.498	7/27/2005	Chloride	140	mg/L
315JAL	34.51217	-120.498	8/24/2005	Chloride	140	mg/L
315JAL	34.51217	-120.498	9/22/2005	Chloride	140	mg/L
315JAL	34.51217	-120.498	4/11/2006	Chloride	96	mg/L
315JAL	34.51217	-120.498	5/16/2006	Chloride	120	mg/L
315JAL	34.51217	-120.498	6/13/2006	Chloride	130	mg/L
315JAL	34.51217	-120.498	7/10/2006	Chloride	140	mg/L
315JAL	34.51217	-120.498	8/10/2006	Chloride	130	mg/L
315JAL	34.51217	-120.498	9/14/2006	Chloride	140	mg/L
315JAL	34.51217	-120.498	10/12/2006	Chloride	130	mg/L
315JAL	34.51217	-120.498	11/1/2006	Chloride	130	mg/L
315JAL	34.51217	-120.498	4/16/2007	Chloride	140	mg/L
315JAL	34.51217	-120.498	1/30/2008	Chloride	87	mg/L
315JAL	34.51217	-120.498	2/28/2008	Chloride	93	mg/L
315JAL	34.51217	-120.498	3/27/2008	Chloride	140	mg/L
315JAL	34.51217	-120.498	4/24/2008	Chloride	140	mg/L
315JAL	34.51217	-120.498	5/19/2008	Chloride	140	mg/L
315JAL	34.51217	-120.498	6/17/2008	Chloride	150	mg/L
315JAL	34.51217	-120.498	11/17/2008	Chloride	140	mg/L
315JAL	34.51217	-120.498	12/16/2008	Chloride	170	mg/L
315JAL	34.51217	-120.498	1/29/2009	Chloride	170	mg/L

SiteTag	Latitude	Longitude	SampleDate	AnalyteName	Result	ResultUnit
315JAL	34.51217	-120.498	3/19/2009	Chloride	180	mg/L
315JAL	34.51217	-120.498	4/16/2009	Chloride	160	mg/L
315JAL	34.51217	-120.498	5/21/2009	Chloride	160	mg/L
315JAL	34.51217	-120.498	6/18/2009	Chloride	160	mg/L
315JAL	34.51217	-120.498	7/23/2009	Chloride	230	mg/L
315JAL	34.51217	-120.498	8/18/2009	Chloride	150	mg/L
315JAL	34.51217	-120.498	9/17/2009	Chloride	170	mg/L
315JAL	34.51217	-120.498	10/21/2009	Chloride	150	mg/L
315JAL	34.51217	-120.498	11/16/2009	Chloride	130	mg/L
315JAL	34.51217	-120.498	12/15/2009	Chloride	170	mg/L
315JAL	34.51217	-120.498	1/19/2010	Chloride	100	mg/L
315JAL	34.51217	-120.498	2/16/2010	Chloride	130	mg/L
315JAL	34.51217	-120.498	3/17/2010	Chloride	120	mg/L
315JAL	34.51217	-120.498	4/19/2010	Chloride	140	mg/L
315JAL	34.51217	-120.498	5/18/2010	Chloride	150	mg/L
315JAL	34.51217	-120.498	6/23/2010	Chloride	120	mg/L
315JAL	34.51217	-120.498	7/15/2010	Chloride	120	mg/L
315JAL	34.51217	-120.498	8/11/2010	Chloride	100	mg/L
315JAL	34.51217	-120.498	9/9/2010	Chloride	95	mg/L
315JAL	34.51217	-120.498	10/12/2010	Chloride	99	mg/L
315JAL	34.51217	-120.498	12/14/2010	Chloride	110	mg/L
315JAL	34.51217	-120.498	1/4/2011	Chloride	63	mg/L
315JAL	34.51217	-120.498	2/2/2011	Chloride	120	mg/L
315JAL	34.51217	-120.498	3/17/2011	Chloride	160	mg/L
315JAL	34.51217	-120.498	4/12/2011	Chloride	100	mg/L
315JAL	34.51217	-120.498	5/9/2011	Chloride	130	mg/L
315JAL	34.51217	-120.498	6/13/2011	Chloride	120	mg/L
315JAL	34.51217	-120.498	7/12/2011	Chloride	130	mg/L
315JAL	34.51217	-120.498	8/9/2011	Chloride	150	mg/L
315JAL	34.51217	-120.498	9/13/2011	Chloride	130	mg/L
315JAL	34.51217	-120.498	10/12/2011	Chloride	130	mg/L
315JAL	34.51217	-120.498	11/1/2011	Chloride	130	mg/L
315JAL	34.51217	-120.498	12/8/2011	Chloride	130	mg/L
315JAL	34.51217	-120.498	1/25/2012	Chloride	130	mg/L
315JAL	34.51217	-120.498	2/21/2012	Chloride	130	mg/L
315JAL	34.51217	-120.498	3/27/2012	Chloride	150	mg/L
315JAL	34.51217	-120.498	4/17/2012	Chloride	140	mg/L
315JAL	34.51217	-120.498	5/16/2012	Chloride	120	mg/L

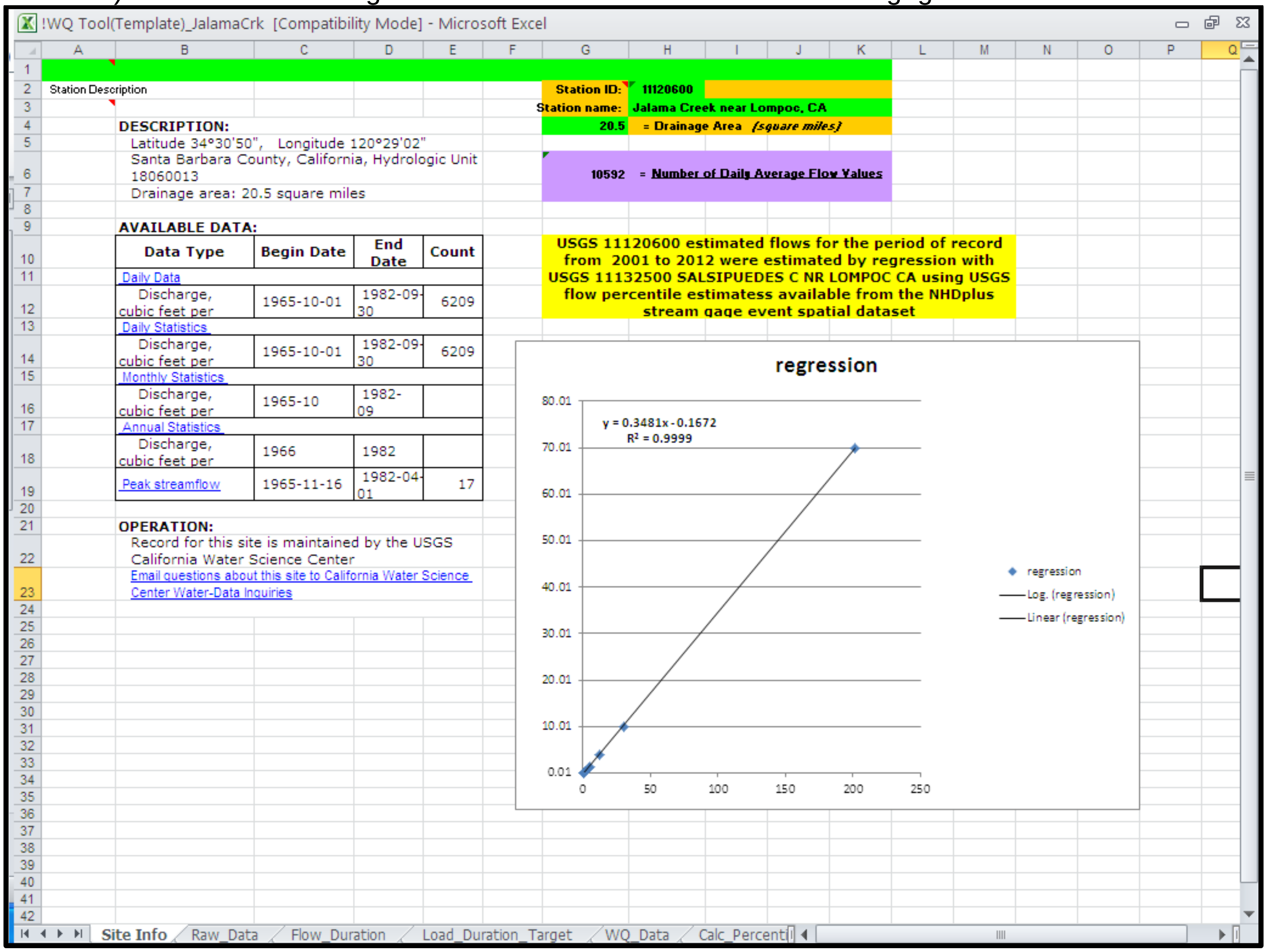
SiteTag	Latitude	Longitude	SampleDate	AnalyteName	Result	ResultUnit
315JAL	34.51217198	120.498226	7/15/2010	Sodium	77	mg/L
315JAL	34.51217198	120.498226	8/11/2010	Sodium	59	mg/L
315JAL	34.51217198	120.498226	9/9/2010	Sodium	66	mg/L
315JAL	34.51217198	120.498226	10/12/2010	Sodium	62	mg/L
315JAL	34.51217198	120.498226	12/14/2010	Sodium	67	mg/L
315JAL	34.51217198	120.498226	2/13/2001	Sodium	32	mg/L
315JAL	34.51217198	120.498226	5/8/2001	Sodium	100	mg/L
315JAL	34.51217198	120.498226	6/4/2001	Sodium	97	mg/L
315JAL	34.51217198	120.498226	7/11/2001	Sodium	83	mg/L
315JAL	34.51217198	120.498226	8/7/2001	Sodium	83	mg/L
315JAL	34.51217198	120.498226	10/8/2001	Sodium	98	mg/L

SiteTag	Latitude	Longitude	SampleDate	AnalyteName	Result	ResultUnit
315JAL	34.51217198	120.498226	11/5/2001	Sodium	160	mg/L
315JAL	34.51217198	120.498226	12/12/2001	Sodium	91	mg/L
315JAL	34.51217198	120.498226	1/3/2002	Sodium	130	mg/L
315JAL	34.51217198	120.498226	2/12/2002	Sodium	140	mg/L
315JAL	34.51217198	120.498226	3/27/2002	Sodium	90	mg/L
315JAL	34.51217198	120.498226	3/4/2004	Sodium	120	mg/L
315JAL	34.51217198	120.498226	5/19/2004	Sodium	81	mg/L
315JAL	34.51217198	120.498226	6/23/2004	Sodium	76	mg/L
315JAL	34.51217198	120.498226	10/7/2004	Sodium	81	mg/L
315JAL	34.51217198	120.498226	11/4/2004	Sodium	74	mg/L
315JAL	34.51217198	120.498226	12/8/2004	Sodium	85	mg/L
315JAL	34.51217198	120.498226	1/5/2005	Sodium	68	mg/L
315JAL	34.51217198	120.498226	2/3/2005	Sodium	92	mg/L
315JAL	34.51217198	120.498226	3/2/2005	Sodium	66	mg/L
315JAL	34.51217198	120.498226	3/29/2005	Sodium	77	mg/L
315JAL	34.51217198	120.498226	4/27/2005	Sodium	95	mg/L
315JAL	34.51217198	120.498226	5/25/2005	Sodium	97	mg/L
315JAL	34.51217198	120.498226	6/22/2005	Sodium	94	mg/L
315JAL	34.51217198	120.498226	7/27/2005	Sodium	90	mg/L
315JAL	34.51217198	120.498226	8/24/2005	Sodium	83	mg/L
315JAL	34.51217198	120.498226	9/22/2005	Sodium	82	mg/L
315JAL	34.51217198	120.498226	4/11/2006	Sodium	74	mg/L
315JAL	34.51217198	120.498226	5/16/2006	Sodium	96	mg/L
315JAL	34.51217198	120.498226	6/13/2006	Sodium	92	mg/L
315JAL	34.51217198	120.498226	7/10/2006	Sodium	94	mg/L
315JAL	34.51217198	120.498226	8/10/2006	Sodium	81	mg/L
315JAL	34.51217198	120.498226	9/14/2006	Sodium	85	mg/L
315JAL	34.51217198	120.498226	10/12/2006	Sodium	77	mg/L
315JAL	34.51217198	120.498226	11/1/2006	Sodium	76	mg/L
315JAL	34.51217198	120.498226	4/16/2007	Sodium	83	mg/L
315JAL	34.51217198	120.498226	1/30/2008	Sodium	64	mg/L
315JAL	34.51217198	120.498226	2/28/2008	Sodium	73	mg/L
315JAL	34.51217198	120.498226	3/27/2008	Sodium	95	mg/L
315JAL	34.51217198	120.498226	4/24/2008	Sodium	91	mg/L
315JAL	34.51217198	120.498226	5/19/2008	Sodium	95	mg/L
315JAL	34.51217198	120.498226	6/17/2008	Sodium	87	mg/L
315JAL	34.51217198	120.498226	11/17/2008	Sodium	81	mg/L
315JAL	34.51217198	120.498226	12/16/2008	Sodium	120	mg/L
315JAL	34.51217198	120.498226	1/29/2009	Sodium	120	mg/L
315JAL	34.51217198	120.498226	3/19/2009	Sodium	110	mg/L
315JAL	34.51217198	120.498226	4/16/2009	Sodium	100	mg/L
315JAL	34.51217198	120.498226	5/21/2009	Sodium	97	mg/L
315JAL	34.51217198	120.498226	6/18/2009	Sodium	96	mg/L
315JAL	34.51217198	120.498226	7/23/2009	Sodium	96	mg/L
315JAL	34.51217198	120.498226	8/18/2009	Sodium	99	mg/L
315JAL	34.51217198	120.498226	9/17/2009	Sodium	99	mg/L
315JAL	34.51217198	120.498226	10/21/2009	Sodium	98	mg/L
315JAL	34.51217198	120.498226	11/16/2009	Sodium	82	mg/L
315JAL	34.51217198	120.498226	12/15/2009	Sodium	100	mg/L
315JAL	34.51217198	120.498226	1/19/2010	Sodium	71	mg/L

SiteTag	Latitude	Longitude	SampleDate	AnalyteName	Result	ResultUnit
315JAL	34.51217198	120.498226	2/16/2010	Sodium	86	mg/L
315JAL	34.51217198	120.498226	3/17/2010	Sodium	94	mg/L
315JAL	34.51217198	120.498226	4/19/2010	Sodium	97	mg/L
315JAL	34.51217198	120.498226	5/18/2010	Sodium	92	mg/L
315JAL	34.51217198	120.498226	6/23/2010	Sodium	69	mg/L
315JAL	34.51217198	120.498226	4/12/2011	Sodium	89	mg/L
315JAL	34.51217198	120.498226	2/2/2011	Sodium	93	mg/L
315JAL	34.51217198	120.498226	1/4/2011	Sodium	59	mg/L
315JAL	34.51217198	120.498226	3/17/2011	Sodium	130	mg/L
315JAL	34.51217198	120.498226	7/12/2011	Sodium	100	mg/L
315JAL	34.51217198	120.498226	6/13/2011	Sodium	97	mg/L
315JAL	34.51217198	120.498226	5/9/2011	Sodium	97	mg/L
315JAL	34.51217198	120.498226	8/9/2011	Sodium	95	mg/L
315JAL	34.51217198	120.498226	10/12/2011	Sodium	91	mg/L
315JAL	34.51217198	120.498226	12/8/2011	Sodium	90	mg/L
315JAL	34.51217198	-120.498226	11/1/2011	Sodium	86	mg/L
315JAL	34.51217198	120.498226	9/13/2011	Sodium	95	mg/L
315JAL	34.51217198	120.498226	1/25/2012	Sodium	92	mg/L
315JAL	34.51217198	120.498226	2/21/2012	Sodium	86	mg/L
315JAL	34.51217198	120.498226	4/17/2012	Sodium	97	mg/L
315JAL	34.51217198	120.498226	3/27/2012	Sodium	120	mg/L
315JAL	34.51217198	120.498226	5/16/2012	Sodium	87	mg/L

Appendix C – Flow Duration and Load Duration Records

Flow regression between USGS 11120600 (Jalama Creek) and USGS 11132500 (Salsipuedes Creek) used to infill missing flow records for Jalama Creek historical gage.



Data Type	Begin Date	End Date	Count
Daily Data			
Discharge, cubic feet per	1965-10-01	1982-09-30	6209
Daily Statistics			
Discharge, cubic feet per	1965-10-01	1982-09-30	6209
Monthly Statistics			
Discharge, cubic feet per	1965-10	1982-09	
Annual Statistics			
Discharge, cubic feet per	1966	1982	
Peak streamflow	1965-11-16	1982-04-01	17

Flow duration record summary for Jalama Creek at USGS 11120600.

!WQ Tool(Template)_JalamaCrk [Compatibility Mode] - Microsoft Excel

	A	B	C	D	E	F	G	H	I	J
1	FLOW DURATION SUMMARY				Station ID:	11120600				
2		Peak to Low			Station name:	Jalama Creek near Lompoc, CA				
3		cfs	mm		1-day	High	Moist	Mid	Dry	Low
4	0.009%	1040.00	47.92	Peak	231	9	1	0	0	0
5	0.01%	686.17	31.62		10.640	0.416	0.047	0.018	0.005	0.000
6	0.27%	230.90	10.64	1-day						
7	1%	70.00	3.23		Average					
8	5%	9.02	0.42		4					
9	10%	3.50	0.16		0.173	9.8%	2.5	inches		
10	15%	2.10	0.10							
11	20%	1.40	0.06							
12	25%	1.01	0.05							
13	30%	0.84	0.04							
14	35%	0.73	0.03							
15	40%	0.61	0.03							
16	45%	0.52	0.02							
17	50%	0.40	0.018							
18	55%	0.33	0.02							
19	60%	0.26	0.01							
20	65%	0.20	0.01							
21	70%	0.15	0.01							
22	75%	0.10	0.00							
23	80%	0.07	0.00							
24	85%	0.04	0.00							
25	90%	0.00	0.00							
26	95%	0.00	0.00							
27	99%	0.00	0.00							
28	100%	0.00	0.000	Low						
29										
30	9.8%	4	0.17	Average						

Load duration target for chloride at 106 mg/L guideline.

	A	B	C	D	E	F	G	H	I	J
1	LOAD DURATION SUMMARY				Station ID:	11120600				
2		Peak to Low			Station name:	Jalama Creek near Lompoc, CA				
3		cfs	mm	Load	20.5	= Drainage Area (square miles)				
4	0.004%	1040.00	47.923	594689.7	High	Moist	Mid	Dry	Low	
5	0.01%	686.17	31.618	392361.1	9	1	0.4	0.1	0.0	
6	0.10%	230.90	10.640	132032.8	0.416	0.047	0.018	0.005	0.000	
7	1%	70.00	3.226	40027.2	5158.70	577.08	228.73	57.18	0.00	
8	5%	9.02	0.416	5158.7						
9	10%	3.50	0.161	2001.4						
10	15%	2.10	0.097	1200.8		106	WQ Criteria			
11	20%	1.40	0.065	800.5						
12	25%	1.01	0.047	577.1		Key Loading Equations				
13	30%	0.84	0.039	480.3						
14	35%	0.73	0.034	417.9		Load (lb/day) = Criteria * Flow * (5.3945)				
15	40%	0.61	0.028	348.8						
16	45%	0.52	0.024	297.3		TSS Load (tons/day)				
17	50%	0.40	0.018	228.7		= Criteria * Flow * (5.3945/2000)				
18	55%	0.33	0.015	187.0						
19	60%	0.26	0.012	148.7						
20	65%	0.20	0.009	115.4		Bacteria Load (counts/day)				
21	70%	0.15	0.007	85.8		= Criteria * Flow * ((28317/100)*60*60*24)				
22	75%	0.10	0.005	57.2		Note : 1 ft^3 = 28,317 mL				
23	80%	0.07	0.003	38.9						
24	85%	0.04	0.002	20.8						
25	90%	0.00	0.000	0.0						
26	95%	0.00	0.000	0.0						
27	99%	0.00	0.000	0.0						
28	100%	0.00	0.000	0.0						

Site Info / Raw_Data / Flow_Duration / Load_Duration_Target / WQ_Data / Calc_Percenti

Ready

Load duration target for sodium at 69 mg/L guideline.

	A	B	C	D	E	F	G	H	I	J
1	LOAD DURATION SUMMARY				Station ID:	11120600				
2		Peak to Low			Station name:	Jalama Creek near Lompoc, CA				
3		cfs	mm	Load	20.5	= Drainage Area (square miles)				
4	0.004%	1040.00	47.923	387109.3	High	Moist	Mid	Dry	Low	
5	0.01%	686.17	31.618	255404.9	9	1	0.4	0.1	0.0	
6	0.10%	230.90	10.640	85945.9	0.416	0.047	0.018	0.005	0.000	
7	1%	70.00	3.226	26055.4	3358.02	375.64	148.89	37.22	0.00	
8	5%	9.02	0.416	3358.0						
9	10%	3.50	0.161	1302.8						
10	15%	2.10	0.097	781.7		69	WQ Criteria			
11	20%	1.40	0.065	521.1						
12	25%	1.01	0.047	375.6		Key Loading Equations				
13	30%	0.84	0.039	312.7						
14	35%	0.73	0.034	272.0		Load (lb/day) = Criteria * Flow * (5.3945)				
15	40%	0.61	0.028	227.1						
16	45%	0.52	0.024	193.6		TSS Load (tons/day)				
17	50%	0.40	0.018	148.9		= Criteria * Flow * (5.3945/2000)				
18	55%	0.33	0.015	121.7						
19	60%	0.26	0.012	96.8						
20	65%	0.20	0.009	75.1		Bacteria Load (counts/day)				
21	70%	0.15	0.007	55.8		= Criteria * Flow * ((28317/100)*60*60*24)				
22	75%	0.10	0.005	37.2		Note : 1 ft^3 = 28,317 mL				
23	80%	0.07	0.003	25.3						
24	85%	0.04	0.002	13.5						
25	90%	0.00	0.000	0.0						
26	95%	0.00	0.000	0.0						
27	99%	0.00	0.000	0.0						
28	100%	0.00	0.000	0.0						

Site Info / Raw_Data / Flow_Duration / Load_Duration_Target / WQ_Data / Calc_Percenti

Ready