CENTRAL VALLEY SALINITY ALTERNATIVES FOR LONG-TERM SUSTAINABILITY (CV–SALTS)

Strategic Salt Accumulation Land and Transportation Study (SSALTS)

Final Phase 1 Report – Identification and Characterization of Existing Salt Accumulation Areas

December 13,2013

Prepared for
SAN JOAQUIN VALLEY DRAINAGE AUTHORITY

Submitted by
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Abbreviations and Acronyms

ACL	Administrative Civil Liability
ADWF	Average Dry Weather Flow
AF	Acre-feet
bgs	Below ground surface
BLM	Bureau of Land Management
BMP	Best Management Practices
BPA	Basin Plan Amendment
Cal-Water	California Water Service Company
CAO	Cleanup and Abatement Order
CCR	California Code of Regulations
CDFG	California Department of Fish and Game
CDO	Cease and Desist Order
Central Valley RWQCB	Central Valley Regional Water Quality Control Board
CEQA	California Quality Act
CFR	Code of Federal Regulations
CIMIS	California Irrigation Management System
COW	Condensate of Whey
CRA	California Resources Agency
CVHM	Central Valley Hydrologic Model
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CV-SALTS	Central Valley Salinity Alternatives for Long-Term Sustainability
CWA	Clean Water Act
CWC	California Water Code
DAF	Dissolved air floatation
Delta	Sacramento-San Joaquin River Delta
DOI	Department of the Interior
DWR	California Department of Water Resources
DWSA	Dixon Solano Water Authority
EBMUD	East Bay Municipal Utility District

EC	Electrical Conductivity
EIS	Environment Impact Statement
EPA	US Environmental Protect Agency
FDS	Fixed dissolved solids
GAF	Grassland Area Farmers
GDA	Grassland Drainage Area
GEA	Grassland Ecological Area
GEEC	Grassland Environmental Education Center
gpm	Gallons per Minute
GMP	Groundwater Management Plan
GRCD	Grasslands Resouce Conservation District
GWD	Grasslands Water District
HCC	Hilmar Cheese Company
HERO	High efficiency reverse osmosis
IAZ	Initial Analysis Zones
ICM	Initial Conceptual Model
IFDM	Integrated On Farm Drainage Management
I/I	Inflow and Infiltration
ILRP	Irrigate Lands Regulatory Program
IWRP	Integrated Water Resources Plan
IX	Ion exchange
LPRO	Low pressure reverse osmosis
LRP	Land Retirement Program
LSJR	Lower San Joaquin River
MCWD	Merquin County Water District
MGD	million gallons per day
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
O&M	Operation and maintenance
POTWs	Publicly Owned Treatment Works
ppm	Parts Per Million
Reclamation	U.S. Bureau of Reclamation

Regional Water Boards	California Regional Water Quality Control Boards
RO	Reverse Osmosis
RRR	Red Rock Ranch
RSA	Revised Settlement Agreement
RTMP	Real-Time Management Program
RWD	Report of Waste Discharge
NMP	Salt and Nutrient Management Plan
SARI	Santa Ana Regional Interceptor
SAWPA	Santa Ana Watershed Project Authority
SB	Senate Bill
Se	Selenium
SEP	Hilmar Cheese Company's Supplemental Environmental Project
SLDMWA	San Luis Delta-Mendota Water Authority
SJRECWA	San Joaquin River Exchange Contractors Water Authority
SJVDIP	San Joaquin Valley Drainage Implementation Project
SJRIODAY	San Joaquin River Input- Output Daily Model
SRWS	Self Regenerating Water Softeners
SSALTS	Strategic Salts Accumulation Land and Transportation Study
SSJID	South San Joaquin Irrigation District
SWD	Stevinson Water District
SWRCB	State Water Resource Control Board
TAC	Technical Advisory Committee
TDS	Total dissolved solids
TLBWSD	Tulare Lake Basin Water Storage District
TLDD	Tulare Lake Drainage District
TMDL	Total Maximum Daly Load
TSS	Total suspended solids
UF	Ultrafiltration
UIC	Underground Injection Control
USGS	U.S. Geological Survey
VAMP	Vernalis Adaptive Management Plan

WCED	United Nations World Commision on Environment and Development
WDRs	Waste Discharge Requirements
WQO	Water Quality Objectives
WRCD	Westside Resource Conservation District
WTP	Water Treatment Plant
WWTF	Wastewater Treatment Facility
WWTP	Wastewater Treatment Plant
WWQM	Wetland Water Quality Model
WY	Water Years

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Section 1
Introduction

1.1 Project Purpose

The purpose of the Strategic Salt Accumulation Land and Transportation Study (SSALTS) is to identify the range of viable Central Valley alternatives for salt disposal to provide input for consideration during development of the Salt and Nutrient Management Plan (SNMP) for the region under the jurisdiction of the Central Valley Regional Water Quality Control Board (Central Valley RWQCB). The findings will be used to guide discussions regarding establishment of regional salt management policies and the need for changes to the existing Central Valley RWQCB Water Quality Control Plans (Basin Plans) to facilitate salt disposal in a manner that is most beneficial to the region and consistent with the State Water Resource Control Board (SWRCB) Recycled Water Policy.

This work is being conducted under the direction of the Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) initiative, which is developing the SNMP for the Central Valley. The SSALTS project is being conducted in three phases:

- *Phase 1, Identify and Characterize Existing Salt Accumulation Study Areas* – Selection of representative Study Areas to serve as prototype situational examples to facilitate discussions regarding salt accumulation and disposal in the Central Valley. Each of these Study Areas is being characterized to establish baseline information that may be used to support development of salt disposal alternatives in subsequent project phases.

- *Phase 2, Develop Potential Salt Management Strategies* – SSALTS will develop potential long-term salt disposal alternatives in three parts: (1) In-Valley alternatives; (2) Out-of-Valley alternatives; and (3) hybrid alternatives that combine In-Valley and Out-of-Valley salt disposal options.

- *Phase 3, Evaluate Potential Salt Disposal Alternatives to Identify Acceptable Alternatives for Implementation* – Alternatives developed under Phase 2 will be evaluated using selected feasibility criteria (e.g., regulatory, institutional, economic, technological, etc.). The outcome of this evaluation will be the identification and prioritization of acceptable salt disposal alternatives for potential incorporation into Central Valley SNMP as salt management implementation measures.

This draft report represents the findings of Phase 1. Subsequent phases of SSALTS will be implemented following completion of this phase.

1.2 SSALTs Study Areas

Phase 1 work revolves around the concept of a Study Area, whereby a Study Area represents a geographic or situational example that can be used as a basis to develop salt management alternatives for the Central Valley. Phase 1 activities include three key steps: (1) Selection of representative Study Areas consistent with the goals of SSALTS; (2) characterization of the selected Study Areas; and (3) evaluation of the potential for long term sustainable salt management given the characteristics of the Study Area.

1.2.1 Selection of Representative Study Areas

SSALTS Phase 1 called for the selection of up to ten representative Study Areas based on consideration of four general criteria:

- Include areas with existing salinity concerns that can be used as prototypes for strategically developing salt disposal alternatives under the SNMP.
- Represent a range of conditions (e.g., areal extent, sources of salt, disposal constraints, surface water vs. groundwater, etc.) in order to be useful for implementation planning in SSALTS.
- Support evaluation of alternatives to strategically identify the best available or acceptable options to address salt disposal given the set of facts associated with a given Study Area.
- Provide opportunities to evaluate a variety of disposal alternatives and allow the results to be scalable or extrapolated to other Central Valley areas with similar disposal issues.

Based on these criteria, Study Areas could include small or large geographic areas (e.g., representative of regional salt management), consider particular types of land or water use (e.g., source water management), or be representative of specific types of salt disposal alternatives (e.g., brine line disposal). The more diverse the situational examples represented by the selected Study Areas, the broader the baseline of information that can developed for use in subsequent project phases.

Early in Phase 1, CDM Smith developed a preliminary list of recommended Study Areas for consideration by the CV-SALTS Technical Advisory Committee (TAC). Based on comments received, a final draft Study Area list was prepared and submitted to the CV-SALTS Executive Committee for review. This list was approved by the Executive Committee on February 8, 2013 and served as the final list of Study Areas for subsequent Phase 1 analyses as described below (Table 1-1).

Table 1-1. Final List of Study Areas

Section Number	Study Area	Central Valley Basin Planning Area	Representative Sector/Area
2	City of Dixon	Sacramento River Basin	Municipal
3	City of Tracy	San Joaquin River Basin	Municipal
4	Hilmar Cheese	San Joaquin River Basin	Industrial
5	Industrial Food Processing Facilities	Central Valley	Industrial
6	Red Rock Ranch	Tulare Lake Basin	Agriculture
7	Grasslands Water District	San Joaquin River Basin	Agriculture
8	Stevinson Water District	San Joaquin River Basin	Agriculture
9	Tulare Lake Bed	Tulare Lake Basin	Agriculture
10	Westside Regional Drainage Plan	San Joaquin River Basin	Agriculture
11	San Luis Unit Ocean Disposal	San Joaquin River Basin	Agriculture

It is important to note that some Study Areas included in the final list are not "geographic areas" *per se*, but instead are representative of a salt removal process or potential alternative for salt disposal. For example, Table 1-1 includes Study Areas that provide the opportunity to characterize a brine line disposal alternative and existing farming practices that provide viable methods for salt management and disposal. The information developed for these types of Study Areas will be critically important in subsequent phases, where the emphasis will be on developing and evaluating alternatives for salt disposal in the future.

1.2.2 Study Area Characterization

The characterization of each Study Area was completed using readily available information; the study involves no new data collection. Five specific informational areas were originally identified for documentation for each Study Area; however, as will be noted below and elsewhere, given the diverse nature of the Study Areas, some of these informational areas may not apply to a given Study Area:

- *Attributes* - This element includes three types of attributes: (a) physical (e.g., geographic reference, surface and groundwater hydrology, land cover, soils, topography or other relevant physical features); (b) land cover, including relevant agricultural, industrial or residential/commercial land uses; and (c) institutional, economic or regulatory attributes as they pertain to the type of Study Area.

- *Sources of Salt* - For Study Areas where salt accumulation is a concern, this step identifies the primary sources of salt.

- *Salt Accumulation Capacity* - To the extent that a Study Area may have a limited capacity for salt accumulation, this capacity is described. For some Study Areas, the concept of capacity (e.g., within the context of the site being able to accumulate more salt), may not be particularly relevant; instead, the focus may be on the feasibility for salts to be managed by the practices or concepts addressed by the "Study Area".

- *Cost/Benefits of Continued Salt Accumulation* - Where applicable to a Study Area, a relative assessment of the cost and benefits associated with how salt is currently managed is described. In some cases, where the Study Area is a practice or concept (e.g., source water control, farm practices, or brine line disposal), cost/benefit information will be developed more fully under Phase 2 within the context of a potential alternative for consideration.

- *Institutional/Regulatory Barriers* - Given each Study Area's attributes, this step summarizes likely or potential institutional or regulatory barriers that may either impact the potential for long-term accumulation of salt at an existing location or affect how a particular salt management concept may be implemented. In some cases, no barriers may be identified or they no longer exist simply because the practice is functioning as intended, i.e., any potential barriers have already been addressed.

Sections 2 through 11 of this document provide the characterization of each of the ten Study Areas summarized in Table 1-1. To the extent practical, each of these sections follows the same general reporting structure with similar themes. However, where appropriate, deviations were made to accommodate differences in the information content associated with the Study Area.

1.2.3 Long-term Sustainability Evaluation of Study Areas

Following the characterization step, each of the Study Areas was analyzed to assess their longevity and sustainability over a long-term planning horizon. This information is provided in Section 12 of this report. The intent of this analysis is to provide high-level planning information that can be used to support SSALTS Phase 2 and 3 analyses and CV-SALTS discussions regarding likely alternatives for salt disposal to be considered for incorporation into the SNMP.

1.3 Regulatory Background

As noted above, the evaluation of each of the Study Areas includes a summary of relevant regulatory attributes and potential regulatory barriers. Because the salt management activities described for each Study Area occur within an established federal and state regulatory framework, this section describes the general federal and state laws and regulations, state policies, and state and regional programs within which water quality management occurs in the Central Valley. These sections are intended to provide basic information regarding the regulatory requirements that may impact how salt and nitrate are regulated in the Central Valley. It is not intended to be exhaustive; if the reader requires additional information, detailed information may be obtained through many sources, including the Environmental Protection Agency (EPA), State Water Board, and Central Valley RWQCB websites.

1.3.1 Laws and Regulations

Federal

The Federal Water Pollution Control Act (Public Law 92-500, as amended), commonly known as the Clean Water Act (CWA), was promulgated in 1972 following a series of previous legislative efforts to establish water pollution control laws in the United States (e.g., the Water Pollution Control Act of 1948 and 1956 and the Water Quality Act of 1965).

The CWA is applicable to surface "waters of the United States" which are defined in federal regulation (e.g., 40 Code of Federal Regulations [CFR] 122.2). The federal CWA does not apply to groundwater or surface waters that do not meet the definition of a water of the United States. For example, waste treatment systems, such as treatment ponds or lagoons designed to meet the requirements of the CWA, or man-made bodies of water, which were not created within a Water of United States, are not under CWA jurisdiction.

The CWA contains many elements. Key sections (and their implementing regulations) particularly relevant to the management of salt and nitrate include:

- *§301: Effluent Limitations* – §301 authorizes the establishment of effluent limitations in National Pollutant Discharge Elimination System (NPDES) permits to control point source discharges to surface waters under CWA jurisdiction (see 40 CFR 122). This section focuses on technology-based treatment requirements.

- *§302: Water Quality Related Effluent Limitations* – This section authorizes the establishment of water quality-based effluent limitations where it is necessary to ensure that water quality objectives in the receiving water are met after discharge. These effluent limitations are often more stringent than the technology-based limitations required under CWA §301.

- *§303: Water Quality Standards and Implementation Plans* – §303(a) through §303(c) establish state requirements for adoption of beneficial uses and water quality criteria to protect those uses. CWA §303(d) establishes the requirements for states to regularly evaluate whether or not waterbodies are impaired (a situation where technology and water quality based effluent limitations or other required pollution controls, e.g., best management practices (BMPs), are insufficient to ensure compliance with applicable water quality standards).

- *§402: NPDES Permits* – Authorizes the issuance of individual or general permits to control municipal and industrial point source discharges, including those from wastewater and stormwater. The EPA has delegated the implementation of this program to the State of California.

State of California

California's primary statute governing water quality is the Porter-Cologne Water Quality Control Act of 1970 (Porter-Cologne Act; §13000 *et seq.* of the California Water Code [Wat. Code]), as amended. The Porter-Cologne Act grants the State Water Board and nine California Regional Water Quality Control Boards (Regional Water Boards) broad powers to protect water quality and is the primary vehicle for implementation of California's responsibilities under the federal CWA.

State Water Board responsibilities include adoption of various policies that govern water quality control state-wide. This includes policies for the formulation, adoption and implementation by Regional Water Boards of Basin Plans. The State Water Board is also responsible for the adoption and implementation of the California Ocean Plan (Wat. Code, §13170 *et seq.*), which governs water quality in ocean waters of the state, which does not include bays and estuaries.

Each Regional Water Board is required to adopt Basin Plans, which provide the basis for regulatory actions to protect water quality (Wat. Code, §13240 *et seq.*) in inland waters (surface and groundwaters) and bays and estuaries. A Basin Plan designates beneficial uses of water, water quality objectives (WQOs) to protect the uses, a program of implementation to achieve the WQOs, and a monitoring program to ensure the goals of the program are met (Wat. Code, §13050(j)). The Central Valley RWQCB, which is responsible for the area relevant to this Study, has adopted two Basin Plans for the region: *Water Quality Control Plan for the Sacramento and San Joaquin River* and the *Water Quality Control Plan for the Tulare Lake Basin*.

1.3.2 State Water Board Policies

Policies adopted by the State Water Board are implemented through the Basin Plans. Three policies have particular relevance to salt and nitrate management in the Central Valley:

- *State Water Board Resolution 2009-0011 (Recycled Water Policy); as amended by State Water Board Resolution 2013-0003* - The purpose of the Recycled Water Policy is to increase the use of recycled water from municipal wastewater sources in a manner that implements state and federal water quality laws. Policy implementation is intended to encourage the use of recycled water, stormwater, water conservation, conjunctive use of surface and groundwater, and improve the use of local water supplies. Within the Recycled Water Policy is a requirement for the development of an SNMP for each groundwater basin in California.

- *State Water Board Resolution 88-63 (Sources of Drinking Water Policy)* - The Sources of Drinking Water Policy establishes a policy that all waters are considered suitable or potentially suitable to support the Municipal and Domestic Water Supply (MUN) beneficial use, with certain exceptions. The Basin Plans implement this policy by assigning MUN to all surface waters and groundwaters in the Central Valley region unless specifically identified as non-MUN in the Basin Plan and/or exempted through a Basin Plan Amendment that satisfies one or more exception criteria established by the SDWP.

- *State Water Board Resolution 68-16, the Statement of Policy with Respect to Maintaining High Quality of Waters in California (State Anti-Degradation Policy)* - The State Anti-Degradation Policy applies to both surface waters and groundwaters. The State Anti-Degradation Policy generally prohibits the Central Valley RWQCB from authorizing discharges that will degrade "high-quality waters," unless the Board first finds that the degradation is consistent with the maximum benefit to people of the state, that the discharge will be controlled through the use of "best practicable treatment or control" methodologies, and that the discharge will not unreasonably affect present and potential beneficial uses.

1.3.3 Discharge Permits

NPDES Permits and WDRs

NPDES permits are required for discharges of pollutants to waters of the United States, as defined above. NPDES permits are authorized by the federal CWA §402 and issued per regulations at 40 CFR 122. As noted above, the EPA can delegate issuance of NPDES permits to the states. This delegation has occurred for most states, including California.

Porter-Cologne and its implementing regulations (e.g., Basin Plans), provide for the regulation of point and non-point source discharges through the issuance of WDRs. The Central Valley RWQCB is responsible for issuance of WDRs within its region (Wat. Code §13370). For discharges to surface waters under the jurisdiction of the federal CWA, issuance of a WDR is done in a manner consistent with federal requirements for issuance of an NPDES permit. That is, all NPDES permits issued by the Central Valley RWQCB are also WDRs and receive both an NPDES permit number and Board order number. For discharge to waters outside the jurisdiction of the federal CWA or to land, the Central Valley RWQCB may issue WDRs under authorities granted through Porter-Cologne and state regulations. This authority includes issuing WDRs to regulate the discharge of wastes that may impact groundwater quality.

Underground Injection Control Permits

The 1974 federal Safe Drinking Water Act (as amended) authorizes the EPA to regulate underground waste disposal through the use of underground injection wells (§1421 *et seq.*). Federal regulations at 40 CFR 146 provide the basis for implementation of the Underground Injection Control (UIC) program which is responsible for regulating the construction, operation, permitting, and closure of injection wells that place fluids underground for storage or disposal. Underground disposal requires a UIC permit. In California, UIC permits may be issued by the EPA or the State depending on the type of injection well being permitted. Specifically, there are five classes of injection wells to address different types of wastes. California, through the Department of Conservation, Division of Oil, Gas, and Geothermal Resources, is authorized to issue permits for Class II injection wells associated with oil and gas storage and production. EPA is the permitting authority for all other well classes including industrial and municipal waste disposal wells (Class I wells).

1.3.4 State & Regional Programs

Initiated by the State Water Board in 2003, the Irrigated Lands Regulatory Program (ILRP) is implemented by the Regional Water Boards. The purpose of the ILRP is to regulate pollutants (e.g., pesticides, nutrients, sediments, and salt) in agricultural runoff. Under this program, the Central Valley RWQCB instituted a program that granted a Conditional Waiver from a WDR while work continued on establishment of a long term program to manage pollutants from agricultural runoff. Under a Conditional Waiver, the conditions applicable to permittees (e.g., Coalition groups and/or individual dischargers) include: (1) conduct required monitoring and reporting program activities; (2) implementing and evaluating management practices that will result in achieving compliance with applicable water quality standards in surface waters of the State; (3) at the request of the Central Valley RWQCB or after the occurrence of more than one exceedance of a water quality objective within a three-year period, develop and implement Management Plans when discharges are causing or contributing to exceedances of applicable water quality standards; and (4) conduct activities in a manner to prevent nuisance.

Conditional Waivers are currently in the process of being replaced by WDRs. These WDRs are expected to address irrigated agricultural discharges throughout the Central Valley. As of October 2013, three WDRs have been adopted: Eastern San Joaquin Watershed, Individual Growers, and Tulare Lake Basin Area. Additional WDRs are planned for other areas. Currently, the Central Valley RWQCB anticipates that WDRs for all Central Valley regions will be adopted by mid-2014.

1.3.5 Lower San Joaquin River TMDL

Federal CWA §305(b) requires that each state assesses the water quality status of each waterbody under CWA jurisdiction and report these findings to EPA. For this assessment, the state reviews available water quality data, compares these data to water quality objectives, and evaluates whether the beneficial uses of each waterbody are supported. Through this process and pursuant to CWA §303(d) the state is required identify waterbodies not meeting water quality standards even after all required effluent limitations have been implemented (e.g., through a WDR). These waters are often referred to as "303(d) listed" or "impaired" waters. Waterbodies placed on the 303(d) list may require development of a Total Maximum Daily Load (TMDL). A TMDL is a calculation of the maximum amount or load of a pollutant that a waterbody can receive and still meet water quality objectives; this load is allocated among the various sources of the pollutant.

The Central Valley RWQCB adopted a TMDL for salt and boron in the Lower San Joaquin River (LSJR) as a Basin Plan amendment on September 10, 2004. EPA approval occurred in 2006. The approved TMDL establishes a water quality control program for salt and boron to achieve existing salinity and boron WQOs in the San Joaquin River at the Airport Way Bridge near Vernalis ("Vernalis"). The adopted control program requires a second phase TMDL to address salinity and boron concerns in the LSJR upstream of Vernalis. Through CV-SALTS, a LSJR Committee was established to develop recommendations for updated WQOs that support the beneficial uses on the LSJR and an implementation plan to support those objectives. The outcome of this effort will have direct bearing on how salt is managed in the watershed draining to the San Joaquin River.

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Section 2

City of Dixon Study Area

2.1 Introduction and Overview

The City of Dixon (City) is located along the I-80 corridor in northern Solano County, about 19 miles southwest of Sacramento (Figure 2-1). As of 2011, Dixon had a population of approximately 18,000, residing in approximately 6,000 households (U.S. Census Bureau 2011). The City's wastewater collection system includes sewer lines varying in size from 6 to 27 inches in diameter. A 42-inch pipeline conveys wastewater to the City's Wastewater Treatment Facility (WWTF) located approximately 2 miles south of the city (City of Dixon 1993). Wastewater is treated to secondary standards using a conventional treatment facultative pond process (Stantec 2011). The WWTF disposes treated wastewater entirely by application to land using percolation ponds; there is no surface water discharge. Of the approximately 1.3 million gallons per day (MGD) treated by the WWTF, 1.1 MGD originates from residential housing tracts within the City. (Eco:Logic Engineering 2008).

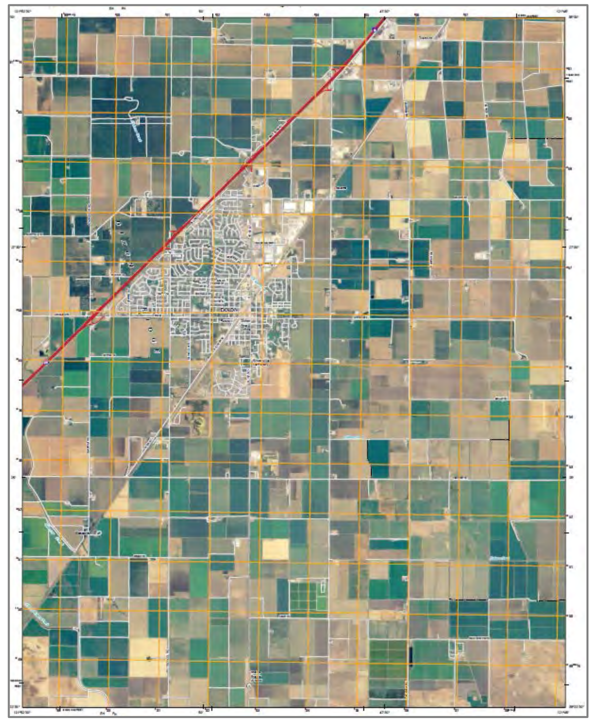

Figure 2-1
GIS Map of Dixon (City of Dixon Date Unknown)

The City provides a prototype SSALTS Study Area describing the salinity-related issues facing a municipal wastewater discharger in complying with Waste Discharge Requirements (WDRs) for salinity. The City has implemented several investigations and programs designed to reduce wastewater salinity discharges including: detailed sewer water quality studies, facilities planning and pilot testing, calibration of salinity models, bringing better quality drinking water wells on line, public education, and buy-back programs for salt discharging water softeners. The City is the first in California to ban existing residential salt discharging water softeners under city ordinances (Ordinance Numbers 09-001, 10-013, 11-04).

2.2 Problem Statement

The Central Valley Regional Water Quality Control Board (Central Valley RWQCB) issued a Cease and Desist Order (CDO), R-2008-0136, (Central Valley RWQCB 2008) in 2008 to address the possible salt pollution of the groundwater under the City's WWTF percolation disposal basins. The City's source water supply has low salinity concentrations and does not contribute significantly to exceedances of the WDR limitations[1]; however it has a high hardness. The high hardness in the water supply drives industrial, residential, and commercial water users to use water softeners. The use of water softening introduces additional loads of chloride and sodium to the sewer system that have contributed to exceedances of the WDR limitations (Eco:Logic Engineering 2008) for sodium and chloride as shown in Table 2-1

Table 2-1. Constituents of Concern (Eco:Logic Engineering 2008)

Constituent	Raw Wastewater[1]	Treated Wastewater[2]	Adopted Limitations[3]
Sodium (mg/L)	150	170	145
Chloride (mg/L)	130	165	106

Notes:
[1] Based on 5-day average flow proportional samples at the WWTF in October 2007
[2] Two year (2006-2007) average taken at existing effluent measurement structure
[3] CDO R5-2008-0136, Item 10, to be calculated as the average over the twelve most recent calendar months.

The City's WWTF[2], as typical of other treatment facilities, neither add nor treat to remove salt from influent wastewater. However, during the City's treatment process, approximately 25% of the wastewater is evaporated, thereby increasing salinity concentrations in the effluent (Eco:Logic Engineering 2008).

In order to comply with effluent quality limits, the City evaluated various alternatives including pollution trading, reverse osmosis (RO) treatment, wastewater/stormwater blending, and nanofiltration of the source water. The City's objective was to determine alternatives that would reduce the salt concentration of discharged wastewater, as opposed to strictly focusing on reducing the total load of salt in the discharged wastewater. The City analyzed these alternatives, with the assumption that the City must reduce chloride concentrations by 30% to comply with regulatory requirements, to determine the impacts to City sewer rates (Personal Communication – Joe DiGiorgio). In this analysis, the City concluded that implementation of many of the alternatives would be costly and/or energy intensive. In addition, many of the alternatives would result in a concentrated brine stream which would also be costly to properly dispose of (Stantec 2011).

Rather than rely solely on new and expensive wastewater treatment processes, the City embarked on a source control approach to salinity management which resulted in reducing salt concentrations (and also salt loadings) in wastewater by a combination of management measures including a public education program, a water softener ban, and switching source water to lower salinity supplies. The City's progress addressing salinity issues is described below and provides a potential prototype for

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[1] WDR Order No. 94-187 states:

The discharge shall not cause underlying groundwater to:

1. Contain waste constituents in concentrations statistically greater than receiving water limits, where specified below, or background groundwater quality where not specified.
2. Contain chemicals, heavy metals, or trace elements in concentrations that adversely affect beneficial uses or exceed maximum contaminant levels specified in 22 CCR, Division 4, Chapter 15.
3. Exceed a most probable number of total coliform organisms of 2.2/ 100 mL over any seven-day period.
4. Exceed concentrations of radionuclides specified in 22 CCR, Division 4, Chapter 15.
5. Contain taste or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses.
6. Contain concentrations of chemical constituents in amounts that adversely affect beneficial uses.(Central Valley RWQCB 1994)

[2] The City's WWTF consists of a headworks, unlined wastewater treatment/storage ponds (both aerated & unaerated), percolation/evaporation ponds & irrigation disposal areas.

other similar cities in the Central Valley facing similar challenges, although the choices of options that would be applicable and the decisions made will vary based on site-specific evaluations.

2.3 Study Area Attributes

2.3.1 Water Resources

The City relies completely on groundwater supplies provided by two water purveyors. The municipal water source is drawn from 13 wells around the Dixon area, pumping groundwater from the Tehama Formation. This formation, which is up to 2,250 feet in thickness, provides a reliable source of good quality water due to the natural filtration through the area's porous soil layers. The water supply is chlorinated to provide residual disinfection through the distribution lines (City of Dixon 1993). The two water agencies that serve the City of Dixon include:

- The Dixon Solano Water Authority (DSWA) serves the Dixon Industrial Park, the Watson Ranch, Pheasant Run, Regency, Connemara, Schooner Ridge, Suffolk Downs, Brookfield, a major portion of the Valley Glen subdivisions, and will also provide water to most newly developing portions of the Dixon Planning Area. DSWA's water supply comes from naturally occurring aquifers pumped to the surface from five different wells ranging in depths from 1,500 to 1,800 feet below ground surface. DSWA produces approximately 1.78 MGD.

- The California Water Service Company (Cal-Water) service area includes the Central Dixon Redevelopment Project and other areas within city limits that are not served by DSWA. Cal-Water averaged 1.4 MGD in 2009, operating nine groundwater wells ranging in depth from 900 to 1,300 feet below ground surface (City of Dixon 1993).

2.3.2 Land Cover Attributes

The City of Dixon is typical of small to mid-sized cities in the Central Valley. The City currently includes a mix of residential, commercial and light industrial land uses. There are approximately 6,000 households in the City. Single family housing comprises 80% of the residential area while multi-family comprises the remaining 20% (U.S. Census Bureau 2011).

The northeastern portions of the City include several large tracts of commercial and light industrial land uses; however, these industrial users do not significantly contribute to the salinity problems (Eco:Logic Engineering 2008). These commercial and industrial uses include businesses such as restaurants, manufacturers, laundry cleaners, mechanical repair shops, hotels, and grocery stores.

2.3.3 Regulatory

The City's WWTF is regulated by state and federal laws including the federal Clean Water Act, the state Porter-Cologne Act, and Title 22 of the California Code of Regulations (CCR). The Central Valley RWCQB, the governing wastewater regulatory agency, regulates the City's effluent discharge through WDR No 94-187, adopted in 1994 and revised in 2008, and Cease and Desist Order No R5-2008-0136, adopted in 2008 (Stantec 2011).

The CDO requires the City to study salinity degradation of groundwater and necessary steps to cease polluting the shallow groundwater (Stantec 2011). Table 2-2 presents the various regulatory standards and limits for the City's effluent.

Table 2-2. Regulatory Standards and Limits (Stantec 2012)

Constituent of Concern	Regulatory Standards & Objectives		Title 27 Groundwater Derived Limits	
	Potable Water SMCL	Agricultural Water Quality Objective[3]	CDO (Item 10) Effluent Limits	Proposed Title 27 Groundwater Limits[1]
Sodium (mg/L)	N/A	69	143	300
Chloride (mg/L)	250	106	106	239
Boron (mg/L)	N/A	0.7	0.7	0.81
TDS (mg/L)	500	450	N/A[2]	1,503
FDS (mg/L)	N/A	N/A	N/A	1,200

SMCL – Secondary Maximum Contaminant Levels (Set by the Department of Health Services)
FDS – Fixed Dissolved Solids
TDS – Total Dissolved Solids

Notes:
[1] Limits Proposed in Groundwater Quality Evaluation Report , January 2012 as CDO, Item 10, limits are reevaluated by the Regional Board.
[2] Calculated TDS value of 808 was omitted from CDO, Item10 Limits.
[3] These numbers are developed from *Water Quality for Agriculture* (Ayers & Westcot 1985)

2.4 Sources of Salt within the City of Dixon

Prior to implementation of the source control program, the primary source of salinity into the City's WWTF was the brine discharge from Self Regenerating Water Softeners (SRWS) installed within residential and commercial/industrial building to reduce nuisance conditions associated with high levels of water hardness (e.g., staining of appliances and poor detergent/soap performance). Salinity compliance issues resulted from both sodium and chloride and approximately 50 % of the chloride load appeared to originate from SRWS (Eco:Logic, 2008).

Other sources contribute to the exceedance issue, albeit not as significantly for the City of Dixon. These additional minor sources include water supply and groundwater inflow and infiltration (I/I), which are described below and shown in Figure 2-2. (Eco:Logic Engineering 2008). These other sources of salt may be important for other municipal agencies in the Central Valley.

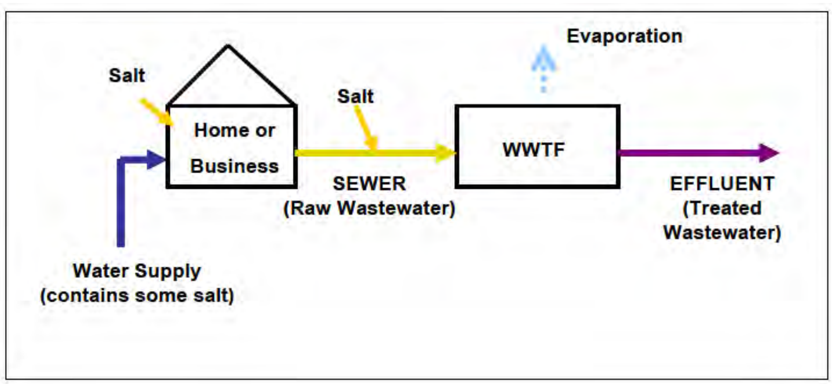

Figure 2-2
Sources/Sinks of Salt in the Municipal Water Cycle (Eco:Logic Engineering 2008)

2.4.1 Source Water Supply

As mentioned above, the City relies on groundwater for their source water supply. Table 2-3 provides the typical water supply quality of the groundwater. As noted previously, chloride and sodium levels are low; however, the high hardness concentrations have instigated widespread use of SRWS to create palatable drinking water. Based on an estimated 1.3 MGD influent into the WWTF at an average concentration of 15 mg/L, it is estimated that the source water supply contributes 163 lb/day of chloride (Eco:Logic Engineering 2008).

Table 2-3. Water Supply Quality (Eco:Logic Engineering 2008)

Constituent of Concern	Water Supply Quality
Sodium (mg/L)	55
Chloride (mg/L)	15
Hardness (as CaCO3)	250
Hardness (Grains/Gallon)	15

2.4.2 Direct Infiltration to Sewers

In recent years, the City has isolated and repaired most of the significant leaks into their collection pipeline system. The repairs have decreased the amount of inflow and infiltration (I/I), such that under average depth to groundwater conditions, total infiltration flow is estimated to be less than 0.1 MGD on a yearly average (Eco:Logic Engineering 2008). The chloride concentration in the shallow groundwater is approximately 22 mg/L, which calculates to a total load of approximately 18.3 lb/day (Eco:Logic Engineering 2008). As with the source water supply described above, it is likely the chloride load from this source does not contribute significantly to exceedances of the WDR limitations (Eco:Logic Engineering 2008).

2.4.3 Self-Regenerating Water Softeners

In 2008, there were an estimated 1,000 residential SRWS in operation throughout the City. In order to estimate chloride influent concentrations due to water softeners, the City sampled the daily fluctuations of chloride loadings at the WWTF headworks. Analyzing the typical daily fluctuations in chloride concentrations and flow compared to the typical brine discharges from SRWS (as a result of late night/early morning recharging), it was determined that approximately 690 lb/day could be attributed to SRWS during peak discharging times and 659 lb/day during non-peak times (Eco:Logic, 2008)

Table 2-4 presents a summary of chloride contributions from various sources throughout the City's collection system.

Table 2-4. Summary of Chloride Loads (lbs/day) (Eco:Logic Engineering 2008)

Source	Load (lbs/day)
Inflow Infiltration	**18**
Water Supply	**163**
Self Regenerating Water Softeners (Peak)	
Residential	580
Commercial/Industrial	110
Self Regenerating Water Softeners (Non-Peak)	
Residential	554
Commercial/Industrial	105
Total	**1,530**

2.5 Reducing the Salinity in the WWTF Influent

As described above, in response to the 2008 CDO, the City conducted several studies to determine the source of the salinity and identify potential solutions to the problem. Outcomes from this effort are discussed below (Stantec 2012).

2.5.1 Public Education

The City held two Water Conditioner Fairs and provided billing flyers to inform the public of the problem and provide alternative solutions to using the SRWS.

2.5.2 Regulatory Ban

The City adopted Ordinance Number 09-001 to modify the City Code to prohibit the installation of brine-discharging water softeners, which is authorized under AB 1366 (City of Dixon 2010). In October 2010, the City adopted Ordinance Number 10-013, which required removal of residential brine discharging water softeners (City of Dixon 2011). The City allowed for the use of water softening/conditioning appliances that do not discharge salt or potassium into the sewer system (i.e., exchange units, descalers, magnets, reverse osmosis, or those devices using carbon filtration).

2.5.3 Water Softener Incentive Program

With the adoption of Ordinance Number 10-013, a financial incentive “buy-back” program began to provide a one-time reimbursement to residents for removing their brine-discharging water softeners. The financial incentive was structured to encourage early removal of the system.

- $1,200 per water softener for the first 200 days.
- $800 per water softener for those removed during the second 200 day period.
- $400 per water softener for those removed during the third 200 day period.

On March 8, 2011, the City amended (through the adoption of Ordinance Number 11-004) the Brine Discharging Water Softening and Conditioning Appliances incentive program to ‘encourage owners of residential brine discharging water softening or conditioning appliances to voluntarily remove and dispose of their [appliances]…without being subject to the enforcement actions.’ The program was in effect for 600 days after effective date of the ordinance (30 days after adoption), resulting in an end-date of November 27, 2012. The incentive specified in Ordinance 11-004, included a $300 cash reimbursement and a $300 credit to an owner's sewer account. Any property owner that had or has a residential brine discharging water softening or conditioning appliances after that date, was or is in violation and subject to fines, penalties, and removal/disposal costs. 'However, the property owner will be compensated $200 as the reasonable value of the violating residential brine discharging water softening or conditioning appliance removed from the property. (City of Dixon 2011)2.5.4 Change in Drinking Water Supply

Both potable water agencies (Cal Water and DSWA) have either installed or plan to install new, deeper wells to either augment or replace old, shallower water supply wells. It is anticipated that the water tapped by these wells would have lower hardness, leading to a reduction in the use of salt in water softeners (Stantec 2012).

2.5.4 Performance

The City conducted a Source Control Effectiveness study in January 2012 to assess the impacts various changes made by the City to comply with the CDO (Stantec 2012). The study expects that there will be significant reductions in both sodium and chloride levels as compared to levels found prior to the CDO (Table 2-5). The reductions can be attributed to reduced softener sales and the change in water supply to deeper groundwater wells. The study found that annual softener salt sales had decreased from 2007 by 50%, which corresponded to a reduction of 15% in chloride. The study also looked at projections for the future water supply quality using the new, deeper wells. As shown in Table 2-6, hardness values are expected to decrease approximately 11.5%.

Table 2-5. Summary of Expected Future and Past Water Quality Constituents (Stantec 2012)

Constituent	2007 Concentration (mg/L)	Expected Raw Wastewater Concentration, 2014 (mg/L)
Sodium	150	120
Chloride	130	110
Boron	N/A	0.67
TDS	650	650
FDS	N/A	480

Table 2-6. Potable Water Supply Quality Projection (Stantec 2012)

Constituent	Flow Weighted Concentration Base on 2007 Production Values	Flow Weighted Concentration Base on Estimated Future Production Values[1]
Sodium, mg/L	52	58[2]
Chloride, mg/L	14	18[2]
Boron, mg/L	0.48	0.49
TDS, mg/L	355	344
Total Hardness, mg CaCO3/L	226	200

Notes:
[1] These values are estimated using data obtained from new wells placed into production through 2011. It is expected that future wells would continue this trend.
[2] According to Stantec 2012, although "sodium and chloride values are somewhat higher, the effect of lower hardness should have a greater influence on wastewater quality to offset that small increase."

2.6 Costs of Implementation

The City of Dixon Study Area involves implementation of source controls to address salinity issues. As such, it does not lend itself to traditional cost/benefit analyses of long-term salt accumulation or disposal approaches. However, the City's program may be useful for other municipal wastewater agencies and could be included as part of an In-Valley Alternative under the CV-SALTS Salt and Nutrient Management Plan (to be developed under Phase 2 of the SSALTS project). This section presents the cost of implementing such a program to provide a tool for other Publicly Owned Treatment Plants to assess their needs in complying with existing WDRs.

Table 2-7 provides estimated costs for the City's implementation of the public education, various city ordinances, financial incentive program for removal of water softeners, and the completed source characterization studies. The majority of the costs for the public education program and the ordinances were the needed staff time to develop and maintain the programs. It is estimated that the incentive program for SRWS cost the City approximately $420,000 in development (including initial outreach and rebates for the first 300 SRWS) and will continue with an annual O&M cost of $160,000. Eliminating sources of salt was determined to be the least costly alternative to meet regulatory requirements. In its analysis of all options, the City estimated that this alternative would cost approximately $3 per household per month and result in a 30 percent reduction in chloride concentration in wastewater discharge (Personal Communication – Joe DiGiorgio). Per unit costs (e.g., dollars per household per month) will be a function of the number of participants in the program..

Table 2-7. Alternative Costs (Stantec 2011; Eco:Logic Engineering 2008)

Project	Costs in Millions[1]		
	Capital	Annual O&M[2]	Total Cost[3]
Public Education, Source Characterization Studies, SRWS Ban, Incentive program	0.42	0.16	2.8

Notes:
[1] Softener exchange program capital costs represent actual incentive program capital costs for the first 300 units removed
[2] O&M costs include changing to canister exchange units at $30/month net cost and costs associated with a large commercial discharger softening cooling water with potassium chloride (KCl) regenerated canister exchange softeners to meet sodium and chloride discharge limits.
[3] Total costs presented as 20 year present worth, assuming 3% net interest rate. Typical residential rates may increase approximately $1/month for each $1 million in total project costs.

2.7 Institutional and Regulatory Barriers

As noted above, instituting source control programs must comply with the federal Clean Water Act, the Porter-Cologne Act, and Title 22 & 27 of the CCR. In addition, the City must be in compliance with the CDO issued by the Central Valley RWCQBInstitutional and regulatory barriers to implementation of source control programs or development of alternative sources of water were identified by the City of Dixon and were overcome through City leadership, proactive planning, and public outreach programs. In some cases of source control measure implementation, the City utilized a combination of incentives and potential penalties when adopting ordinances.

2.8 Salt Capacity

SSALTS is assessing salt capacity to forecast the likelihood of achieving long-term sustainable[3] conditions within a given study area and also as part of a future alternative to be implemented under the SNMP. Currently, salinity issues at the City are primarily being addressed through source controls. Source controls remove or reduce salt loadings and they are the City's primary mechanisms for

[3] With the potential for increasingly stringent effluent limits, it is unknown for certain that the implementation of the source control program will be sustainable in the long-term. As future regulatory conditions cannot be predicted, for the purposes of this project, the phrase "long-term sustainability" is being evaluated within the context of meeting existing limits for salt discharge.

limiting long-term salt accumulation issues. However, TDS concentrations in source water supplies may be an issue for the City in the long term, because of the surrounding irrigated agriculture. The salt in applied irrigation water increases in concentration due to consumptive use and the addition of fertilizers and soil amendments, resulting in increasing TDS concentrations in groundwater. Also, from a salt compliance standpoint, Senate Bill X7-7 mandates the reduction of per capita urban water use by 20 percent by December 31, 2020. While this does not impact salt load, it will reduce water use and thereby increase the TDS concentration in wastewater. The assessment of a city's ability to achieve long-term sustainability must be evaluated both in terms of compliance with existing salinity limits for salt and mass loading. To anticipate the performance of similar salinity control programs to other locations in the Central Valley, factors such as achievable effluent limits, typical flow rates, and average concentrations of constituents can be used to estimate contributions from similar salinity sources.

The City is currently planning for additional actions to further reduce salinity concentrations discharged into the groundwater to be in full compliance with the CDO. The City will develop an activated sludge process to reduce evaporative losses, thereby reducing salt concentrations by 50%. Cost estimates performed by the City estimate that this alternative will cost approximately $40 per household per month (Personal Communication – Joe DiGiorgio).

In addition, Eco:Logic Engineering (2008) developed the following monitoring and public education recommendations to support the City's efforts to achieve compliance over the long term:

- *"Maintain a current business inventory. This can be used to identify businesses in town that have the potential to contribute salinity loading. This is a great tool to identify where to target source identification and source control efforts for any constituent. Once an updated inventory is developed, it can be maintained by reviewing business license applications, and it can be updated every few years.*
- *Periodically check water usage records in order to identify any high water users that have the potential to impact wastewater quality.*
- *Characterize salinity at the headworks and in multiple domestic-only collection system locations (old and new neighborhoods). These samples should be collected at the same time using automated samplers so that residential data can be compared to the headworks. If the results are similar, it is unlikely that there are significant non-domestic salinity sources. Conversely, if headworks concentrations are observed to be higher than domestic, further industrial and commercial investigations may be required.*
- *Research industrial and commercial sources of salinity. Use the business inventory to determine if any industrial processes that generate excessive salinity are present in town. Inspect the likely businesses. Use book values or conduct sampling to determine specific industrial/commercial salinity concentrations.*
- *Assign expected salinity removal percentages (to sources identified above) that can be expected from targeted source control efforts such as outreach, requiring modification of business practices, or assigning discharge limits. Use these removal percentage estimates along with discharge flow estimates, number of businesses and discharge concentrations to estimate an overall load reduction estimate for non-domestic sources and to measure progress."*

2.9 References

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Section 3

City of Tracy Study Area

3.1 Introduction and Overview

The City of Tracy (City) in San Joaquin County has a population of approximately 82,000 (Figure 3-1). The City provides water to customers within the city limits as well as some of the surrounding area over an approximately 44 square mile area. Of the 23,449 service connections that the City provides water to, approximately 95% are residential. The remaining 5% is comprised of commercial (3%), industrial (0.01%), and irrigation (2%) (EKI 2011).

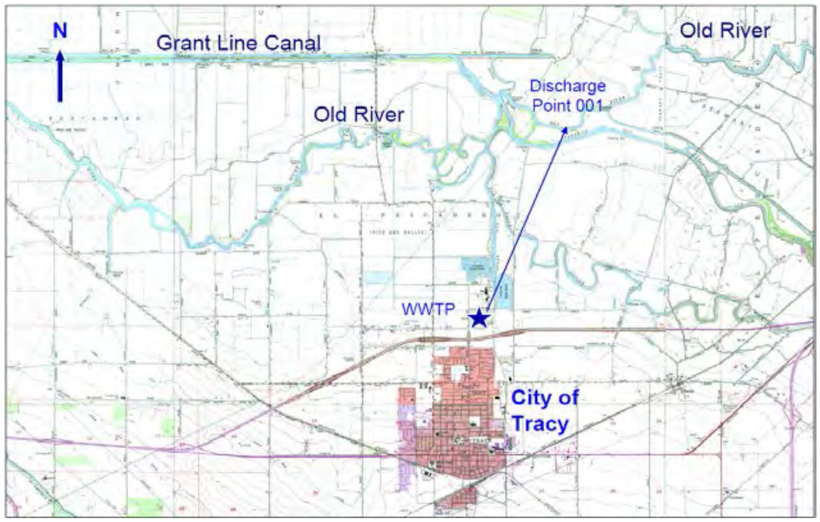

Figure 3-1
Location Map of City of Tracy, Outline of the San Joaquin County with Major Cities and Roadways Labeled. (RWQCB 2012)

Wastewater for the City is treated at the Tracy Wastewater Treatment Plant (WWTP) prior to discharge into the Old River (Figure 3-1). This discharge is currently authorized under Order No. R5-2012-0115 (NPDES No. CA0079154). Currently, the Tracy WWTP receives an average dry weather flow of 7.60 million gallons per day (MGD). The treatment plant, with a capacity of 10.8 MGD, provides tertiary-level treatment to the wastewater generated from the City prior to discharge.

The City provides a prototype SSALTS Study Area describing the salinity issues facing a municipal wastewater discharger required to comply with salinity objectives in the Delta.

3.2 Problem Statement

The City of Tracy discharges treated wastewater into the Old River, which is part of the southern Sacramento-San Joaquin River Delta (Delta). Salinity problems have plagued the Delta and the State Water Resource Control Board (SWRCB) has made efforts to regulate salinity since the 1960s. In 1991, the SWRCB adopted the Water Quality Control Plan for Salinity for the San Francisco

Bay/Sacramento-San Joaquin Delta Estuary (commonly known as the "Bay-Delta Plan"). This plan instituted water quality objectives (WQO) for electrical conductivity (EC) for locations in the Delta (Table 3-1). The 1991 Bay-Delta Plan was amended in 1995 to delay implementation of these EC WQOs until December 31, 1997 (City of Tracy v SWRCB 2011). The Bay-Delta Plan was amended again in 2006; however, the Table 3-1 WQOs were not changed (SWRCB 2006).

Table 3-1. 1991 Bay-Delta Plan EC WQOs for Vernalis, Ca (City of Tracy v SWRCB 2011)

Time Frame	EC WQO (µmhos/cm)
Summer Irrigation Season (April 1 – August 31)	700
Winter Irrigation Season (September 1 – March 31)	1,000

The background EC for the Old River waters around the Tracy WWTP outfall has an average of 640 µmhos/cm. This indicates that there is very little summertime assimilative capacity for additional EC discharged from the wastewater facility. Monitoring reports from 1998 through 2004 indicate that the effluent from the Tracy WWTP had an EC range from 1,008 µmhos/cm to 2,410 µmhos/cm, averaging 1,753 µmhos/cm (City of Tracy v SWRCB 2011).

The high salinity was a result of the source water, which had an average EC of 739 µmhos/cm, and the industrial wastewater discharger, Leprino Foods. This discharger had an average EC of 3,113 µmhos/cm. Under the City's pretreatment program, Leprino Foods treats their wastewater to reduce organic loading, but does not specifically target reduction in salinity. Prior to discharging to the City's collection system, Leprino Foods pre-treats the wastewater in an oxidation pond which evaporates some of the wastewater, thus concentrating the salts (City of Tracy v SWRCB 2011).

3.3 Study Area Attributes

3.3.1 Water Resources

The City of Tracy uses both groundwater and surface supplies to meet their service area's water demand, treating the water at the John Jones Water Treatment Plant (WTP). Although water demands fluctuate both seasonally and annually, the City's average annual demand is just over 16,000 acre-feet per year (AF/yr). Accounting for population growth, the City expects that future water demand is expected to be 33,600 AF/yr in 2035 (EKI 2011).

3.3.2 Land Cover Attributes

The City is typical of small to mid-sized cities in the Central Valley. The City currently includes a mix of residential, commercial and light industrial land uses.

The area surrounding the City is comprised of agricultural land. Water is supplied to this agricultural area through several irrigation districts including Byron-Bethany Irrigation District, Banta-Carbona Irrigation District, West Side Irrigation District, and Naglee-Burk Irrigation District (San Joaquin County 2011).

3.3.3 Regulatory

The Tracy WWTP is regulated by state and federal laws including the federal Clean Water Act, the Porter-Cologne Act, and Title 22 of the California Code of Regulations (CCR).

2006 Bay-Delta Plan. In 2006, SWRCB adopted amendments to the 1995 Bay-Delta Plan, revising the program of implementation to achieve the salinity objectives; however, as noted above, it did not amend the objectives themselves. The updated Plan instituted required regulation of 'in-Delta' discharges of salt by municipal dischargers where previously there was no specific regulation. However, enforcement of south Delta salinity objectives for municipal discharges has been challenged. The Central Valley RWQCB Order R5-2012-0115 states, "The Bay-Delta Plan includes water quality objectives for Electrical Conductivity (EC) for the South Delta in the vicinity of the discharge. On 1 June 2011, the Superior Court for Sacramento County entered a judgment and peremptory writ of mandate in the matter of City of Tracy v. State Water Resources Control Board (Case No; 34-2009-8000-392-CU-WM-GDS), ruling that the South Delta salinity objectives shall not apply to the City of Tracy and other municipal dischargers in the South Delta area pending reconsideration of the South Delta salinity objectives under Water Code §13241 and adoption of a proper program of implementation under Water Code §13242 that includes municipal dischargers. The State Water Board is currently considering new salinity and flow objectives in the South Delta that will address the Court Order. Therefore, at the time this Order was adopted the South Delta salinity objectives were not applicable to the Discharger.

Wastewater Discharges. The City's WWTP effluent discharge is permitted by WDR No. R5-2012-0115 (NPDES permit No. CA0079154) which was adopted in December 2012. Prior to this, discharges to Old River were regulated under WDR No. R5-2007-0036.

Groundwater. The Tracy Sub-Regional Groundwater Management Plan (GMP) was originally developed in 1996 to address a decline in the quality of the groundwater. The GMP discusses groundwater monitoring, saline water intrusion, well construction, well abandonment and deconstruction, contaminants in groundwater, and potential for groundwater contamination due to future land use.

3.4 Sources of Salt in the City of Tracy

Prior to the agreement with the South San Joaquin Irrigation District (SSJID) for surface water in the Stanislaus River, the sources of salinity for the water supply of the City of Tracy included groundwater and treated surface water.

3.4.1 Groundwater

The City pumps groundwater primarily from the Tulare Formation through nine groundwater wells ranging in depth between 300 to 700 feet below ground surface (bgs). Four of the wells located near the John Jones WTP pump groundwater into the plant, which blends the groundwater with surface water and treats both prior to entering the distribution system. The remaining five wells pump groundwater directly into the distribution system, after chloramination (EKI 2011). Table 3-2 provides the average quality of the groundwater in the vicinity of the City.

Table 3-2. Average Groundwater Quality

Constituent	Average Quality
Calcium (mg/L)	51
Sodium (mg/L)	103
Total Hardness ($CaCO_3$) (mg/L)	222
TDS (mg/L)	590
EC (umhos/cm)	917

3.4.2 Central Valley Project Surface Water

The City has a contractual entitlement to 10,000 AF annually of Central Valley Project (CVP) water, diverted from the Delta-Mendota Canal. The City entered into the contract with the Bureau of Reclamation (Reclamation) in 1974. The 40-year contract for supply expires in 2014, and the City is currently negotiating its renewal (EKI 2011).

The water supplied from this source is treated by the John Jones WTP, which has a treatment capacity of 30 MGD. Table 3-3 provides the typical drinking water quality of the effluent from the John Jones WTP.

Table 3-3. Average Treated Surface Water Quality from the John Jones WTP.

Constituent	Effluent from John Jones Water Treatment Plant
Calcium (mg/L)	13
Sodium (mg/L)	20
Total Hardness ($CaCO_3$) (mg/L)	61
TDS (mg/L)	140
EC (umhos/cm)	230

3.4.3 Leprino Foods Company

Leprino Foods is a cheese manufacturer located in the City of Tracy. Leprino Foods discharges industrial food processing wastewater to pretreatment ponds at the Tracy WWTP. From there, the wastewater is sent to the plant's industrial holding ponds prior to treatment at the plant. After treatment, the wastewater is discharged to the Old River.

According to Leprino Foods industrial user permit, the facility is allowed to discharge up to 850,000 gallons per day of pretreated wastewater to the City's treatment plant. Leprino Foods' pretreatment program was established to reduce the organic loading entering into the Tracy WWTP. The program does not reduce the salinity in the waste stream, which typically has an average EC of 3,113 µmhos/cm (City of Tracy v SWRCB 2011).

Because both the pretreatment ponds (operated by Leprino Foods) and the industrial holding ponds (owned and operated by the City) are located at the same site, impacts of these ponds on local groundwater cannot be distinguished between the two operators. As a result, the Central Valley RWQCB established WDR No R5-2007-0038 to regulate the ponds.

3.5 Alternative Water Supply Sources

As a result of salinity regulations in the Delta, the City initiated a project in conjunction with the Cities of Manteca, Escalon, and Lathrop to purchase water from the SSJID, whose source is the Stanislaus River. Initiated first in 1995, the project's purpose was to reduce the salinity of the City's water source. For the City, the project required the construction of 40 miles pipeline to bring an allocated 10,000 AF/yr of treated water[1] to the City. Water deliveries from SSJID began in 2005, and in 2008 the City completed construction of a second pipeline that delivered SSJID water to the City (Central Valley RWQCB 2012). Table 3-4 provides the average quality of this treated water.

[1] Prior to being delivered to the City, the water is treated at the Nick C. DeGroot Water Treatment Plant.

Table 3-4. Average Treated Surface Water Quality of SSJID Delivered Water

Constituent	Effluent from SSJID
Calcium (mg/L)	15
Sodium (mg/L)	5
Total Hardness ($CaCO_3$) (mg/L)	58
TDS (mg/L)	110
EC (umhos/cm)	149

In order to reduce the volume of saline groundwater used, the City also entered into a long-term agreement with Reclamation to purchase additional surface water, in the amount of 10,000 AF/yr of agricultural reliable water from the CVP (see Table 3-3 for water quality characteristics). This additional volume became available in 2004.

Table 3-5 presents the City's past and anticipated future volumes of each type of source water. As the table shows, the City expects to eliminate their high saline groundwater source in the future, relying completely on surface water from the CVP and the Stanislaus River.

Table 3-5. Past and Expected Future Supply Volume of Source Water (EKI 2011)

Source	2010 Volume (AF/Year)	2035 Expected Volume (AF/Year)
Groundwater (9 wells)	498	2,500
CVP	10,850	34,000
SSJID	5,303	13,000

3.5.1 Performance

With the changes to the water supply and implementation of industrial source control practices, the City has reduced its salt load by approximately 5,000 tons per year (Figure 3-2) (Central Valley RWQCB 2012). The City has also achieved a 25% reduction in Tracy WWTP effluent EC, from average monthly levels of 1,580 µmhos/cm prior to 2007, to 1,191 µmhos/cm in more recent years (March 2009 – April 2011) (LWA 2012).

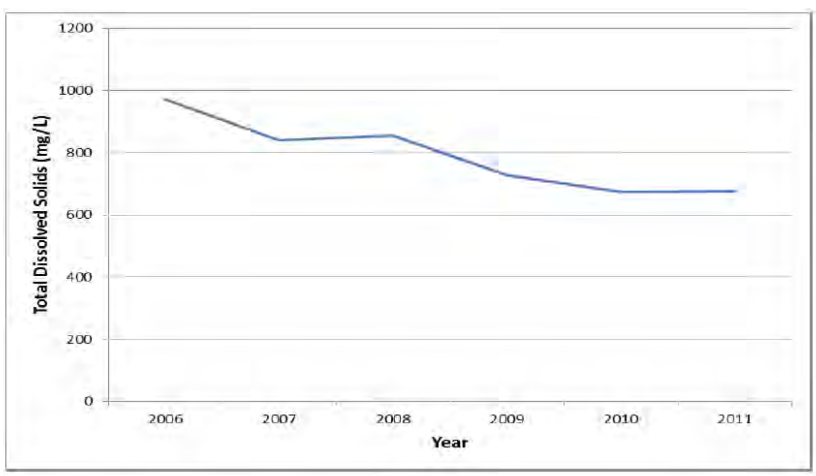

Figure 3-2
Average TDS of Tracy WWTP Effluent after Modifications to Water Supply Source (Central Valley RWQCB 2012)

3.6 Cost of Implementation

The Tracy Study Area involves implementation of source controls to address salinity issues. As such, it does not lend itself to traditional cost/benefit analyses of long-term salt accumulation or disposal approaches. However, the City's approach may be useful for other municipal wastewater agencies and could be included as part of an In-Valley alternative under the CV-SALTS Salt and Nutrient Management Plan (to be developed under Phase 2 of the SSALTS project). Table 3-6 presents the cost of implementing such a program to provide a tool for other Publicly Owned Treatment Plants to assess their needs in complying with existing WDRs.

Table 3-6. Estimated Implementation Costs of Purchasing Water from SSJID (LWA 2012)

	Installation Cost	2012 Annual Operation and Maintenance Cost[2]
Total Cost[1]	$150 Million	$6.6 Million
City of Tracy's Share of Total Cost	$50 Million	

[1] Total cost of the project was shared between the Cities of Tracy, Manteca, Lathrop, and Escalon.

[2] It is assumed that the annual operation & maintenance cost is shared between all participating Cities.

3.7 Institutional and Regulatory Barriers

Modifications of source water require compliance with various federal and state regulations such as the Clean Water Act, the Porter-Cologne Act, and Title 22 of the CCR. In addition, the City must be in compliance with its WDR/NPDES permits. Although there were no institutional or regulatory barriers identified, obtaining the needed permits, funding, and approvals and constructing the needed infrastructure took many years. For example, for the City of Tracy, it took approximately 10 years from the initiation of the project to receipt of the first water delivery from SSJID. Note also that the project proponents were able to identify a water supply source, which may not always be the case.

3.8 Salt Capacity

SSALTS is assessing salt capacity to forecast the likelihood of achieving long-term sustainable[2] conditions within a given Study Area and also as part of a future alternative to be implemented under the SNMP. Although future regulations cannot be accurately predicted, it can be expected that future regulations will be more stringent as a result of water quality regulations in the Delta.

Currently, salinity issues at the City are primarily being addressed through modifications to the City's water sources and implementing industrial source control management practices. Source controls remove or reduce the salt loadings; therefore, evaluating the long-term capacity for accumulation and disposal of salt loads in this Study Area is not an issue of concern. Instead, the City's ability to achieve long-term sustainability is best measured in terms of compliance with existing limits for salt. Through modifications of the source water, the City has reduced its effluent EC from an average 1,580 µmhos/cm to 1,191 µmhos/cm in recent years (March 2009 through April 2011) (LWA 2012). Although this equates to a 32% reduction in EC, the discharging wastewater still has a high salinity that exceeds the WQOs of the 2006 Bay-Delta Plan. Ancillary effects of surface water diversions can include decreased flows and increased salinity for downstream uses and decreased flows for in-

[2] With the potential for increasingly stringent effluent limits, it is unknown for certain that the implementation of the source control program will be sustainable in the long-term. Thus, for the purposes of this project, the phrase "long-term sustainability" is being evaluated within the context of meeting existing limits for salt discharge.

stream uses. Water rights issues and the sustainability of surface water diversions would need to be determined on a case-by-case basis.

Looking into the future with potentially increasing salinity requirements, the City has studied the potential use of membrane technology, agricultural reuse, and further regulations/actions on source controls (i.e., self-regenerating water softeners, infiltration of groundwater into pipelines, industrial dischargers) (CH2MHill 2012). The City has evaluated the construction and operation of a 1.2 MGD desalination plant to treat the effluent generated by the Tracy WWTP powered by a biomass cogeneration plant. At this time, it is unknown how the City might dispose of the resultant brine stream. In addition, the City has commenced two pilot projects to study the potential for storage of surface water. The storage would provide an increase in the reliability of low saline water supplies (Central Valley RWQCB 2012).

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Section 4

Hilmar Cheese Study Area

4.1 Introduction and Overview

The Hilmar Cheese Company (HCC), founded in 1984[1] and located in Hilmar, CA[2] (Figure 4-1), is the largest integrated cheese production facility in the world (HCC 2013a). The Hilmar facility receives over 11 million pounds of milk per day to produce over 1 million pounds of a variety of cheeses on a daily basis. Additional commodities include various whey products and lactose powder (Central Valley Regional Water Quality Control Board [Central Valley RWQCB] 2010). Through their manufacturing processes, Hilmar typically generates over 2 million gallons per day (MGD) of wastewater (Central Valley RWQCB 2010, Environmental Protection Agency [EPA] 2011). This wastewater is treated and then discharged for land application/reuse (under Waste Discharge Requirement [WDR] R5-2010-0008). Concentrated minerals from the wastewater treatment process are injected into deep wells (under Class I Nonhazardous Waste Injection Permit No. CA10500001), or transported to East Bay Municipal Utility District (EBMUD).

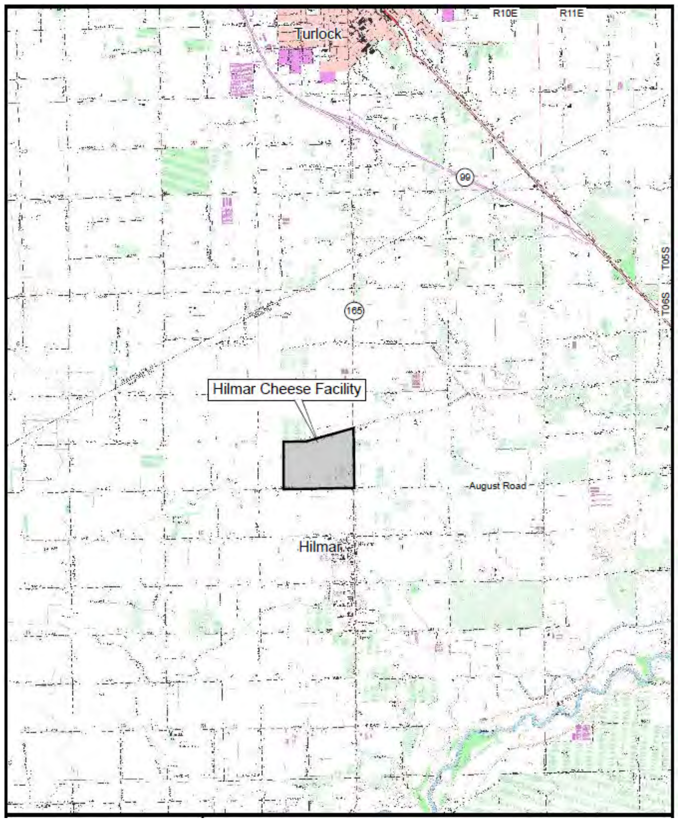

Figure 4-1
Location/Site Map of Hilmar Cheese Company (RWQCB 2010)

HCC serves as a prototype SSALTS Study Area by describing discharge issues facing industrial plants whose processes require treatment of saline wastewater. The need to comply with state regulations that require reductions in salinity concentrations in the facility's effluent necessitated HCC to evaluate, design, and implement a series of treatment processes. These treatment processes (identified collectively as the Water Reclamation facility) include equalization, dissolved air flotation (DAF), anaerobic digestion, aerobic digestion (sequential batch reactors), ultrafiltration (UF) membrane system, ion exchange (IX), two-stage reverse osmosis (RO) system, and evaporation. The Water Reclamation facility produces fully treated wastewater that is transported to storage ponds prior to use for crop irrigation; and

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[1] The Company began production in 1985.

[2] Hilmar Cheese Company also has a production facility in Dalhart, Texas.

concentrate (or brine) that is either injected through deep well injection or transported by truck to EBMUD (Figure 4-2).

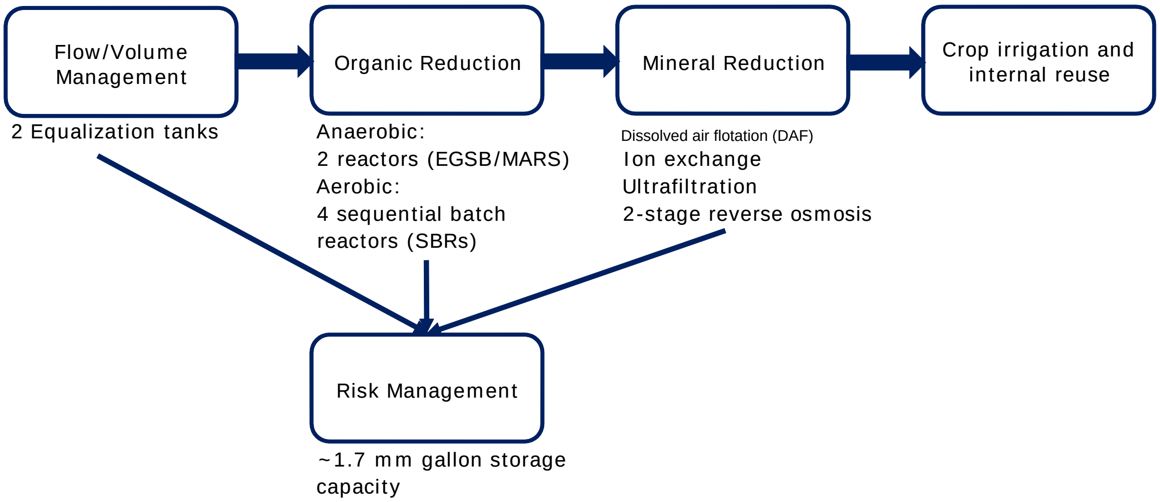

Figure 4-2
HCC Water Reclamation Facility Simplified Flow Diagram (HCC 2013b)

4.2 Problem Statement

Due to the nature and complexity of the wastewater generated at HCC, the treatment of this wastewater to reduce the salinity to concentrations acceptable for land application has proved to be challenging. Table 4-1 provides the typical quality of the HCC wastewater from the facility.

Table 4-1. Quality of Raw Wastewater from Hilmar Cheese Company (HCC WDR, April 2010 – December 2012)

Constituent	Value
EC at 25°C (µmhos/cm)	2750 - 5640
5-day BOD (mg/L)	1900 - 4900
pH (s.u.)	5.1 – 6.7

HCC originally operated under WDR No. 97-206. Although the wastewater was treated prior to being discharged for land application, the salinity often exceeded WDR limits. A Cleanup and Abatement Order (CAO) was issued in December 2004 by the Central Valley RWQCB to HCC for nuisance conditions and groundwater impacts from discharges to land (Central Valley RWQCB 2010) (Table 4-2).

Table 4-2. Comparison Between Water Quality Objectives (WQO) Incorporated into HCC 1997 WDR and Waste Stream Quality (RWQCB 2004)

Constituent	WQO	Hilmar Cheese Discharge to Primary Lands[1] Waste Stream Characterization
EC at 25°C (µmhos/cm)	900[2]	1,900 – 4,300[3]
TDS (mg/L)	500[2]	2,000 – 12,000[4]
Chloride (mg/L)	106-175[5,6]	160-510[4]
Sodium (mg/L)	69-115[5,6]	160-490[4]

EC = Electrical Conductivity
TDS = Total Dissolved Solids
WQO = Water Quality Objective

Notes:
[1] Primary Lands are those lands that received partially treated wastewater.
[2] Numeric WQOs specified by the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) (RWQCB 2011)
[3] As reported in self-monitoring reports for the years of 1999 through 2004.
[4] As reported in self-monitoring reports for the three months between June through August 2004.
[5] Based on a translation of narrative WQOs specified in the Basin Plan.
[6] Lower limit reflects sensitivity of certain crops as reported in Ayers et. al. (1985). Upper limit reflects sensitivity of certain crops as reported in the Agriculture Salinity Assessment and Management. American Society of Civil Engineers Manuals and Reports on Engineering Practice No. 71, New York (1996).

Following the issuance of the CAO, the Central Valley RWQCB issued an Administrative Civil Liability (ACL) Complaint (R5-2005-0501) in January 2005 for exceedances of the electrical conductivity (EC) effluent limit. Specifically, EC exceedances occurred for 1,039 days between January 27, 2002 and November 30, 2004, averaging approximately 2,750 µmhos/cm. It was estimated that during this same period, HCC discharged an estimated 821 million gallons of wastewater to the land (Central Valley RWQCB 2005a).

In 2006, the Central Valley RWQCB issued a Revised Settlement Agreement (RSA) (Order No R5-2006-0025) that prescribed Interim Operating Limits for discharge flow and the EC of the effluent (Table 4-3) in response to HCC's claims that the 900 µmhos/cm limit, as required by the Basin Plan, was unreasonable and unachievable for the following reasons (Central Valley RWQCB 2006):

- Both incoming potable water supply and community drinking water have a higher salinity;
- There was no proven, reliable, treatment technology to treat wastewater similar to HCC's to less than 900 µmhos/cm EC;
- The wastewater is not toxic to the groundwater nor is the groundwater significantly impacted by the HCC discharge;
- There is no threat to public health; and
- There was no economic benefit to HCC for not complying with the 900 µmhos/cm limit.

Table 4-3. Interim Operating Limits[1] as Specified by the RSA (Central Valley RWQCB 2006)

Water Quality Standard	Effluent Limitation
Maximum Monthly Average Total Non-RO Discharge to Primary Fields	1.2 MGD
Maximum Monthly Average EC to Primary Fields	3,700 µmhos/cm[2]
Maximum Monthly Average RO Permeate Discharge	0.6 MGD[3]
Maximum Monthly Average of RO Permeate	900 µmhos/cm[2,4]
Maximum Monthly Average Total Discharge to Land	1.9 MGD

MGD = Million Gallons Per Day
RO = Reverse Osmosis
1 Interim Operating Limits based on HCC's existing discharge; the RSA did not allow an increase in either the volume of discharge applied to the primary fields or an increase in the EC of the discharge.
2 Based upon 24-hour composite samples collected at least weekly and analyzed by a certified third-party laboratory.
3 This minimum does not require any land discharge, but applies if the total discharge to land exceeds 0.6 MGD.
4 This limit applies to the entire discharge to land if the total land discharge is 0.6 MGD or less.

In addition to the Interim Operating Limits, HCC was also required to conduct a "Supplemental Environmental Project" (SEP) to study salinity wastewater management for the food processing industry in California. HCC finalized this study in 2007 (HCC 2007). The SEP, as a general finding, concluded "that there is not a single inventory of salt in the San Joaquin Valley. Rather, the problem of salt management is a local one, particularly for point sources such as food processing facilities".

In 2010, the Central Valley RWQCB issued a new WDR (No. R5-2010-0008) with revised effluent limitations (Table 4-4). To meet the new discharge requirements, HCC implemented the following:

- Installed additional dissolved air flotation units;
- Installed an IX system;
- Modified the reverse osmosis system to enhance performance;
- Added additional tank capacity to address potential "emergency" situations;
- Optimized the treatment system configuration; and
- Continued on-going pilot testing/evaluation of advanced treatment technologies.

The remaining concentrated salt brine would then either be discharged through the deep well injection system or transported to EBMUD for disposal.

Table 4-4. Effluent limitations applicable to discharges to storage ponds or reuse areas (Central Valley RWQCB 2010)

Constituent	Monthly Average Limitation	12-Month Rolling Average Limits
EC (µmhos/cm)	1,000	900
TDS (mg/L)	600	500
5-day BOD (mg/L)	50	N/A
Chloride (mg/L)	85	N/A
Total Nitrogen (mg/L)	20	N/A

EC = Electrical Conductivity
TDS = Total Dissolved Solids
BOD = Biochemical Oxygen Demand

4.3 Study Area Attributes

4.3.1 Land Cover and Uses

Land use surrounding the HCC is agricultural; the unincorporated town of Hilmar is located approximately 0.5 miles south of the facility. Soils consist of Dehli sands and Hilmar loamy sands (Central Valley RWQCB 2010). Central Valley RWQCB (2010) notes that the Hilmar loamy sands are poorly drained with a fluctuating groundwater table.

4.3.2 Groundwater

Groundwater flows from east/northeast to the southwest; however, groundwater flow is influenced by local groundwater pumping. The lands surrounding HCC have poor drainage due to a shallow water table, which can range in depth from 5 to 15 feet below grade surface. Table 4-5 summarizes groundwater quality upgradient of HCC (Central Valley RWQCB 2010).

In addition to groundwater as a supply water, HCC uses condensate of whey ("COW") as a source of supply water. COW is the water recovered from milk that has been processed internally by HCC through reverse osmosis units. The salinity contribution from COW is minimal.

Table 4-5. Upgradient Groundwater Quality (Central Valley RWQCB 2010)

Constituent	Average Value
EC (µmhos/cm)	847
TDS (mg/L)	570
Nitrate (as N) (mg/L)	18
Chloride (mg/L)	54
Sodium (mg/L)	76

EC = Electrical Conductivity
TDS = Total Dissolved Solids

4.3.3 Precipitation

Annual precipitation averages 12 inches in Hilmar, CA. All stormwater runoff from the Hilmar facility is collected in the facility drain system and routed to the Water Reclamation facility.

4.3.4 Regulatory

Wastewater discharge from HCC to land is currently regulated through WDR No. R5-2010-0008. HCC also has a permit issued by the EPA, No. CA10500001, under the underground injection control (UIC) program.

4.4 Sources of Salt for HCC

Sources of salinity in the HCC waste stream are from the addition of salt to the cheese manufacturing process, chemicals used for the sanitation and cleaning of process areas and equipment, and from chemicals used for treatment of wastewater in the Water Reclamation facility. In addition, groundwater used as one of HCC's water supplies and milk used to make the cheese are also sources of salinity.

4.4.1 Groundwater

HCC's groundwater water supply source comes from two operational groundwater wells (#4 and #5). Table 4-6 provides the average quality of the source water based on data collected from April 2010 through 2012.

Table 4-6. Average Source Water Quality (HCC WDR, April 2010 – December 2012)

Constituent	Average Concentration for Well #4	Average Concentration for Well #5
TDS (mg/L)	770 – 800	510
EC (µmhos/cm)	1,220 – 1,370	778 - 836
Chloride (mg/L)	320	180 - 190
Sodium (mg/L)	170 - 180	140 - 15

EC = Electrical Conductivity
TDS = Total Dissolved Solids

4.4.2 Dairy Milk

The Hilmar facility receives milk from local dairies on a daily basis. As stated above, the site receives over 11 million pounds of milk a day from more than 260 dairies (Central Valley RWQCB 2010). Table 4-7 presents the approximate salt composition of milk (Pieter Walstra, Jan T. M. Wouters and Tom J. Geurts, *Dairy Science and Technology Second Edition* – CRC Press 2006).

Table 4-7. Approximate Salt Composition in Milk (Pieter Walstra, Jan T. M. Wouters and Tom J. Geurts, *Dairy Science and Technology Second Edition* – CRC Press 2006)

Constituent	Concentration Range (mg/1000 g)
Sodium (mg/1000 g)	450
Chloride (mg/1000 g)	1,100

4.4.3 Cheese Production Process

HCC produces several varieties of cheeses including cheddar, monterey jack, pepper jack, mozzarella, colby, and colby-jack. Cheese is produced through a multi-step process in vats where pasteurized milk is combined with other ingredients and allowed to coagulate. The resulting mass is cut into curds (small pieces of cheese). The result is a mixture of both solids (curds) and liquids (wheys), which are then cooked. The whey is drained off, while the curds are washed with water and salted.

Although each variety of cheese produced requires varying amounts of salt, on average the Hilmar facility uses approximately 15 tons of salt per day to produce all cheese products.

4.5 Reducing the Salinity in the WWTF Influent

Wastewater generated from HCC typically consists of water and residual chemicals from the cleaning and sanitation of process equipment, cooling tower, and boiler blowdown. Because the daily composition of the waste stream is dependent on the number of cleanings that occur in the plant, it is highly variable.

The wastewater is collected and transported into equalization tanks to equalize flows to the remainder of the treatment system. The wastewater is routed through anaerobic and aerobic digesters to remove or reduce concentrations of constituents, such as ammonia, and biochemical oxygen demand.

The remainder of the wastewater is then treated to reduce the mineral (salt) content through the use of a UF and RO systems. Permeate from the RO system is collected in storage ponds and then used to irrigate more than 1,500 acres of nearby properties. The concentrate (or brine) is either injected via deep well injection or trucked to EBMUD (Central Valley RWQCB 2010).

4.5.1 Ultrafiltration

The HCC UF system is comprised of three units – Zenon 1, Zenon 2 and Zenon 3. Zenon 1 permeate flow is up to 1,200 gallons per minute (gpm); Zenon 2 permeate flow is up to 600 gpm. Zenon 3 has four trains that are operated separately; each train can run up to 320 gpm. Permeate is collected and stored in the Permeate Tanks that feed the RO units.

4.5.2 Reverse Osmosis

The RO system at HCC has a two stage process whereby permeate from the UF system is first treated through three high-pressure primary units followed by two additional high-pressure secondary units (Central Valley RWQCB 2010). The resulting permeate from the RO system is discharged for crop irrigation. Table 4-8 provides information on the quality of the discharge.

Table 4-8. Average Permeate Effluent Quality Discharged (HCC WDR, April 2010 – December 2012)

Constituent	Value
Flow (MGD)	1.47 – 1.85
EC (µmhos/cm)	420 - 797
Total Nitrogen (mg/L)	3.4 – 19.7
Chloride (mg/L)	43.3 – 81.0
TDS (mg/L)	208 - 453
BOD (mg/L)	ND – 14.5

BOD = Biochemical Oxygen Demand
EC = Electrical Conductivity
MGD = Million Gallons per Day
TDS = Total Dissolved Solids

4.5.3 Deep Well Injection

Discharging brine through a deep well injection system requires a permit issued under EPA's UIC Program. Through this program, EPA regulates subsurface discharges to prevent contamination of underground water resources. Regulation under the UIC Program is dependent on the type of fluid injected and the depth of the injection well, as described in Section 1.

HCC operates under a Class 1 Nonhazardous Waste Injection permit which was issued in 2006. The permit allows for HCC to construct and operate up to 4 separate injection wells: WD-1, WD-2, WD-3, and WD-4. Currently, three of the wells have been built: WD-1P (in a different location from where WD-1 was planned), WD-2 and WD-3 (Table 4-9) (EPA 2011). HCC is permitted to discharge brine from their RO system at a maximum of 916 pounds per square inch gage (psig) and a rate of 23 million gallons per month (or 768,000 gallons per day) (EPA 2011). This rate is equivalent to approximately 70.6 acre-feet (AF) per month or 2.4 AF per day. Although built, at the time of this report, the injection wells are not actively discharging concentrate due to technical issues. Currently injecting the concentrate is not compatible with the formation zone, creating precipitate and clogging the injecting wells. HCC is currently working on a solution to this problem.

Table 4-9. Depth of HCC Completed Injection Wells (EPA 2011, Central Valley RWQCB 2010)

Deep Well ID	Date Installed	Total Depth (feet bgs)
WD-1P	January 2009	4,125
WD-2	June 2006	4,100
WD-3	December 2010[1]	4,115

bgs = below grade surface
[1] This is the date on the location drawings in the UIC Permit.

4.5.4 Trucking Brine to EBMUD

The excess brine that cannot be discharged through the deep well injection system is transported to EBMUD's Main Wastewater Treatment Plant in Oakland, CA, an approximate distance of 100 miles. In 2012, HCC discharged in excess of 37 million gallons of concentrate to EBMUD (HCC 2012).

4.6 Cost of Implementation

As shown in Table 4-10, HCC invested over $70 million in capital costs for wastewater treatment technologies and over $170 million in operating costs, between 1998 and 2012. Most recently, HCC installed an ion exchange system, additional ultrafiltration units, deep wells and a second anaerobic reactor.

Table 4-10. Hilmar Wastewater Operating and Capital Costs (HCC 2013)

Years	Operating Expenditures[1,2]	Capital Expenditures[2]	Total discharge flow (1,000 gallons)	Operating costs $/1,000 total gallons
1998 - 2000	$3,800,000	$8,400,000	1,040,361	3.65
2001 - 2005	$40,500,000	$32,300,00	2,574,936[3]	15.72
2006 - 2012	$120,000,000	$30,000,000	4,421,894	27.14
Total	**$174,300,000**	**$70,700,000**		

[1] Excludes depreciation
[2] Estimated values
[3] 2005 discharge flow based on average discharge flow for January and February 2005.

4.6.1 Disposal Costs

Disposal of the concentrated brine stream occurs either through deep well injection (Table 4-11) or it is transported to EBMUD for disposal. Total cost for disposition of brine at EBMUC is $0.11 - $0.12 per gallon (HCC 2013).

Deep well injection has relatively lower capital costs. The lower capital costs are typically offset by high energy costs due to the costs for pumping large amounts of brine into pressurized wells. Long-term annual operation and maintenance costs for deep well injection are dependent on the pressure needed to inject the brine into the receiving aquifer. The costs can also vary significantly based on the geological conditions at each location.

Table 4-11. Typical Costs for Deep Well Injection at HCC

Expenditure	Cost ($)
Capital Costs	2,500,000
Annual Costs	250,000

4.7 Salt Capacity

Salt capacity is an estimate of the limiting capacity of each Study Area to assess the likelihood of achieving sustainable conditions. In this Study Area, salinity in the wastewater is a result of the source water, milk, chemicals or salt added to the production processes and Water Reclamation facility. The generated wastewater from the production processes undergoes treatment, including both UF and RO systems, to reduce salinity and other nutrients. The resulting concentrated brine stream is discharged through either deep well injection or is transported to EBMUD for discharge.

Although trucking brine is an "Out-of-Valley" disposal option and thus not subject to accumulation capacity limits, deep well injection will result in salt accumulation in the deeper aquifers beneath the Study Area. However, the salinity concentrations in the formation receiving the brine from HCC is significantly higher than the salinity concentration of the brine being injected. The salt accumulation capacity of deep well injection is subject to the limitations in the EPA UIC permit.

4.8 Institutional and Regulatory Barriers

Deep well injection requires a UIC permit as described above. A Class I well must not impact any potential Underground Source of Drinking Water that contains less than 10,000 part per million TDS as defined in 40 CFR § 144.3. UIC permits also limit the capacity of deep well injection in response to the anticipated aquifer pressure created by the injection activities. Aquifer pressure generally increases as the volume of injection fluid increases. HCC conducts ongoing monitoring and reporting. The EPA UIC permit for HCC requires an annual Fall Off (pressure) Testreport to calculate the Zone of Endangering Influence.

As described above, the injection wells are not, at the time of this report, actively discharging concentrate into the aquifer. HCC is currently working through technical issues regarding the compatibility of their brine concentrate and the formation zone that they are injecting into. Currently, injection activities are creating a precipitate that causes plugging of the injection equipment. As a result, all brine concentrate is being trucked to EBMUD until this technical issues is resolved (Personal Communication – Burt Fleischer).

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Section 5

Industrial Food Processing Study Area

5.1 Introduction and Overview

Industrial food processing is an important economic activity in California; in 2009, Central Valley food processors generated over $26 billion in rever California Center of Excellence (COE) 2010). I the Central Valley there are over 640 facilities in industries such as tomato processing, dairy processing, meat processing, wineries, grain milling, and confectionary manufacturing (Figure 5-1) (Central Valley Regional Water Quality Control Board (RWQCB) 2006). Of these, 212 facilities discharge wastewater und individual WDRs. According to the 2008 stud by Howitt, et al, food processors account for a relatively small portion of the annual salt load in the Central Valley. The 2005 annual salt loading estimate for food processors accounte for 2.08% in the Sacramento Basin, 4.01% in the San Joaquin Basin, and 3.17% in the Tular Basin.

in the Central Valley (HCC 2007)

Wastewater generated from these industries may contain relatively high levels of organic matter and salts and slightly lower levels of nutrients, which must be managed carefully t avoid odors, nuisance and the potential to impact water supplies (surface or groundwater). Sometimes the wastewater generated from these industries is treated pric discharge. Food processors in the Central Valley discharge their wastes either directly to publicly owned treatment works (POTWs) or to land under various permit requirements.

Industrial food processing serves as a prototype SSALTS Study Area that addresses salinity issues for large industry adjusting to increased regulatory focus due to observed salt impacts to groundwater at selected sites. Past regulation of food processing discharges focused on preventing nuisance conditions (e.g., odor problems or vector promotion), while encouraging beneficial reuse through land application. However, more recent implementation of existing regulations has focused on minimizing

[1] This number includes all food processing facilities, both large and small and does not indicate the number of facilities that have Wastewater Discharge Requirements (WDRs) or who discharge to POTWs.

the risk of salt impacts to groundwater. The food processing industry groups have developed comprehensive guidelines for process water management addressing all constituents, including salt. The guidance documents include: *Comprehensive Guide to Sustainable Management of Winery Water and Associated Energy* developed for the Wine Institute and American Vineyard Foundation (Kennedy/Jenks, 2008) and the *Manual of Good Practice for Land Application of Food Processing/Rinse Water* prepared for the California League of Food Processors (Brown and Caldwell & Kennedy/Jenks 2007). In addition, Stanislaus County received a waiver from the Central Valley RWQCB to implement a Food Processing By-Products Use Program (Resolution No. R5-2008-0182).

5.2 Problem Statement

According to the Central Valley RWQCB, the 643 food processors operating in the Central Valley dispose of their waste waters in the following manner: 119 discharge to POTWs, which are regulated by federal National Pollutant Discharge Elimination System (NPDES) permits or the Central Valley RWQCB issued Waste Discharge Requirements (WDRs) depending on whether or not they discharge effluent to waters of the United States; 212 discharge to land under individual WDRs; 62 are classified as small wineries or food processors and discharge to land under the coverage of a general waiver (Order No. R5-2009-0097); 250 discharge to land without having submitted a Report of Waste Discharge (RWD) for Regional Board review, as required by the California Water Code (CWC) (Central Valley RWQCB 2006).

In 2005, the Central Valley RWQCB released a staff report titled *Regulation of Food Processing Waste Discharges to Land* (Central Valley RWQCB 2005). In it, the Central Valley RWQCB expressed concerns that significant groundwater impacts had occurred due to land application of food processing wastewater, and that changes in regulatory strategy were needed to prevent future impacts. A review of monitoring well data from 105 Central Valley food processing facilities found that 90% of these sites had suspected or confirmed groundwater impacts from waste discharges to land (Central Valley RWQCB 2006).

Table 5-1 provides the quality of winery wastewater, other food processing wastewater, and domestic wastewater. The maximum TDS concentration in food processing waste can be more than double the maximum concentration in domestic wastewater (greater than 2,300 mg/L and 1,000 mg/L respectively).

Table 5-1. Comparison of Raw Wastewater Quality from Wineries and other Food Processors to Untreated Domestic Wastewater Quality

Constituent	Value		
	Wineries[1]	Other Food Processors[2]	Domestic[1]
TDS (mg/L)	80 – 7,000	400 – 2,300	250 – 1,000

[1]Source: Central Valley RWQCB 2006
[2]Source: Central Valley RWQCB 2009a

There are no region-wide numeric salinity limits for effluent applied to land. Instead, the Central Valley RWQCB relies on the Antidegradation Policy[2] to determine whether a specific discharge will degrade surface water or groundwater quality. The Antidegradation Policy states that high quality water must be maintained, unless a change in water quality is of maximum benefit to the people of the State and there is no negative effect to current or future beneficial use. Regulation is therefore specific to the effluent water quality, groundwater quality, geology, and other attributes of each discharger and discharge location. Table 5-2 provides the secondary drinking water standards for salinity, as well as the existing salinity limits above which sensitive crops may experience a reduced yield. These numerical limits guide the Central Valley RWQCB in their decision to investigate potential degradation; however, a Certification by the Executive Officer of the Central Valley RWQCB, executed on September 28, 2009, emphasized that permitting decisions are case-specific and they will not rely on 'rules of general applicability' (Central Valley RWQCB 2009b).

Table 5-2. California State Standards for Salinity (Central Valley RWQCB 2005)

Standard	Recommended Numerical Limit	
	EC (µmhos/cm)	TDS (mg/L)
California Secondary MCL (Recommended Limit)	900	500
California Secondary MCL (Upper Limit)	1,600	1,000
Threshold for reduced yield for sensitive crops[1]	700	450

Notes:
[1]More salt-tolerant crops can utilize irrigation waters with ECs greater than 1000 umhos/cm with no loss of yield (UC Davis 2002.)

5.3 Study Area Attributes

5.3.1 Land Cover and Uses

The Central Valley can be broadly divided into the San Joaquin and Sacramento River Basins to the north and the Tulare Lake Basin to the south. Together, these regions encompass 40% of the land area in California. Major cities include Fresno, Sacramento, Bakersfield, Stockton, and Modesto (Central Valley RWQCB 2004 and 2011). The San Joaquin and Sacramento River Basins are largely agricultural and encompass a third of the state's irrigable land. The Tulare Lake Basin also relies heavily on agriculture; nearly one third of the land is federally owned.

Industrial food processing occurs throughout the Central Valley, though it is concentrated on the east side of the valley. Stanislaus and Fresno counties each have over 150 food manufacturing establishments; Sacramento, San Joaquin, Merced, and Tulare counties each have over 75 food manufacturers, and the remainder of the counties in the Central Valley have fewer than 75 each (COE 2010).

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[2] The State Antidegradation Policy (Resolution No. 68-16) requires that high quality water be maintained unless the following conditions are met:

a. A change in water quality is consistent with maximum benefit to the people of the State
b. There will be no unreasonable effect to present or future beneficial use
c. Water quality will not be lower than prescribed standards

Any activity that produces waste discharging to high quality waters must meet waste discharge requirements resulting in best practicable treatment or control to ensure no pollution or nuisance will occur and the maximum benefit to the people is maintained.

5.3.2 Water Resources

Industrial food processors use both surface water and groundwater to support operations. In the San Joaquin and Tulare Lake Basins, native surface water supplies cannot solely support the levels of agricultural and industrial activity, and the Basin relies heavily on imported water and groundwater (Central Valley RWQCB, 2004). There are 63 and 39 groundwater basins underlying the Sacramento and San Joaquin watersheds, respectively (Central Valley RWQCB 2011).

5.3.3 Regulatory

Food processing wastewater discharged to POTWs is regulated under a POTW federal NPDES permit, if discharging effluent to waters of the United States, or a RWQCB issued WDR if discharging to other waters or to land. Discharge to land is not generally regulated by federal permits. If a wastewater discharge to land is found to unreasonably degrade or pollute groundwater, it is regulated by the RWQCB, who requires dischargers to submit a Report of Waste Discharge (RWD) and may be issued a WDR or a waiver.

5.4 Sources of Salt for Industrial Food Processing

A 2005 survey by Hilmar Cheese Company (HCC) found that Central Valley food processors annually discharged approximately 60,000 metric tons of fixed dissolved solids (FDS) with their wastewater (HCC 2007). FDS rather than total dissolved solids (TDS) is reported because it better represents the inorganic fraction of salts that would not be degraded through soil attenuation before reaching the groundwater. Table 5-3 shows the FDS load contribution from each industry in the food processing sector during 2003, 2004, and 2005.

Table 5-3. Food Processing FDS Loads for the Central Valley (HCC 2007)

Industry[1]	FDS Loads (metric ton)[2]		
	2003	2004	2005
Animal slaughtering & processing	560	570	540
Beet sugar manufacturing	0	0	0
Dairy product manufacturing	3,230	5,110	4,540
Dried & dehydrated food manufacturing	190	160	130
Fat and oils refining and blending	112	92	57
Frozen food manufacturing	1,510	1,630	1,820
Fruit and vegetable canning	30,900	28,400	28,200
Fruit and vegetable canning, pickling, and drying	11,100	10,100	9,900
Rendering and meat byproduct processing	0	0	0
Roasted nuts and peanut butter manufacturing	820	4,390	6,300
Waste and miscellaneous	3,440	3,820	4,050
Wineries	4,950	3,990	4,080
Total	**56,700**	**58,300**	**59,700**

FDS = Fixed Dissolved Solids

Notes:

[1] Data derived from surveys of 160 Central Valley food-processing facilities.

[2] Calculations of FDS loads utilized gap filling to estimate loads when processors reported an effluent volume but not an FDS value. Gap filling utilized a volume-weighted average salinity concentration for those months when salinity data was provided.

[3] The 2005 annual salt loading estimate for food processors accounted for 2.08% in the Sacramento Basin, 4.01% in the San Joaquin Basin, and 3.17% in the Tulare Basin (Howitt *et al.*, 2008).

As seen in Figure 5-2, fruit and vegetable canning contributed between 54 and 47 percent of the annual FDS load between 2003 and 2005. Other industries with notable contributions include pickling, and drying, roasted nuts and peanut butter manufacturing, dairy product manufacturing, and wineries.

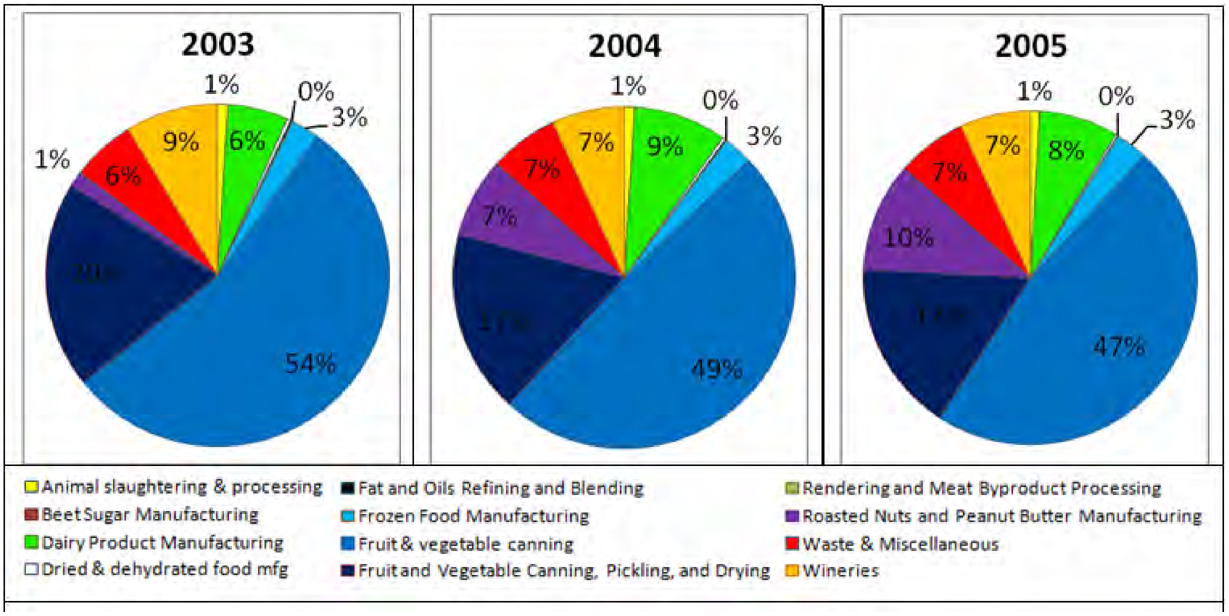

Figure 5-2
Percent of total FDS loads (metric tons) for the Central Valley by industry (HCC 2007)

The following are some general sources of salt in food process wastewater:

- Supply Water—Supply water can contribute a large salt load, particularly in areas with high-salinity groundwater or reliance on imported water. In the Tulare Lake Basin, nearly half of the basin's salt load comes from imported water (Central Valley RWQCB 2004). In a study of 10 Central Valley food processors located from Ripon south to Lemoore, supply water's EC was found to range from 340 to 1,750 µS/cm (HCC 2007).

- Boiler Feed Water Treatment—To prevent calcification, boiler feed water is generally softened using ion exchange. This process removes calcium and magnesium ions from the feed water, exchanging them for sodium ions. The salts within the boiler concentrate as water evaporates, and this concentrate is regularly discharged as boiler blow-down.

- Food Product Loss—Product losses in food processing facilities contribute to the salt content of the waste stream. Typical TSS loads range from 128 lb TSS/ton for white potatoes to 2.0 lb TSS/ton for cherries (Brown and Caldwell & Kennedy/Jenks 2007).

- Cleaning and Process Chemicals—Salt-containing chemicals can be added to foods during processing for both flavor and preservation. Sodium hydroxide is sometimes used for fruit and vegetable peeling prior to canning, and can also be utilized as a cleaning agent. Potassium hydroxide may also be used for peeling as well.

In general, there is a lack of information on the various types of industries throughout the Central Valley. Both the winery and the tomato processing industries are described below primarily because more information was readily available for these industries.

5.4.1 Winery Salt Sources

Typically, the largest contributor to salt load was supply water (HCC 2007). Additionally, ion exchange regeneration, if used, and cleaning are major process sources of salt in wineries. As described in the HCC (2007), stabilization of wines following clarification can be accomplished through an ion exchange process. After use, the ion exchange resin is regenerated, often using sulfuric acid. Sulfuric acid and chemicals utilized to neutralize the sulfuric acid can be major sources of salt. Potassium hydroxide and sodium hypochlorite are chemicals commonly used to clean and sanitize winery equipment. Both can contribute to salt load. However, in an analysis of FDS load from four wineries, cleaning chemicals were found to only contribute between 2 and 5 percent of the FDS load (see Table 5-4).

Salt loading is somewhat seasonal, with peak loads typically corresponding to the fall grape harvest. Figure 5-3 shows the monthly FDS loads from five Central Valley wineries. Peak monthly loading approaches 400 metric tons for a single winery. In a study of three Central Valley wineries, EC in wastewater was measured up to 38,400 µS/cm (HCC 2007).

Table 5-4. Sources of FDS in winery waste (HCC 2007)

Source of FDS	Percent Contribution (%)			
	Winery 1	Winery 2	Winery 3	Winery 4
Supply	51	66	35	61
Product loss	15	11	10	22
Cleaning Chemicals	4	2	4	5
Unknown	31	20	51	11

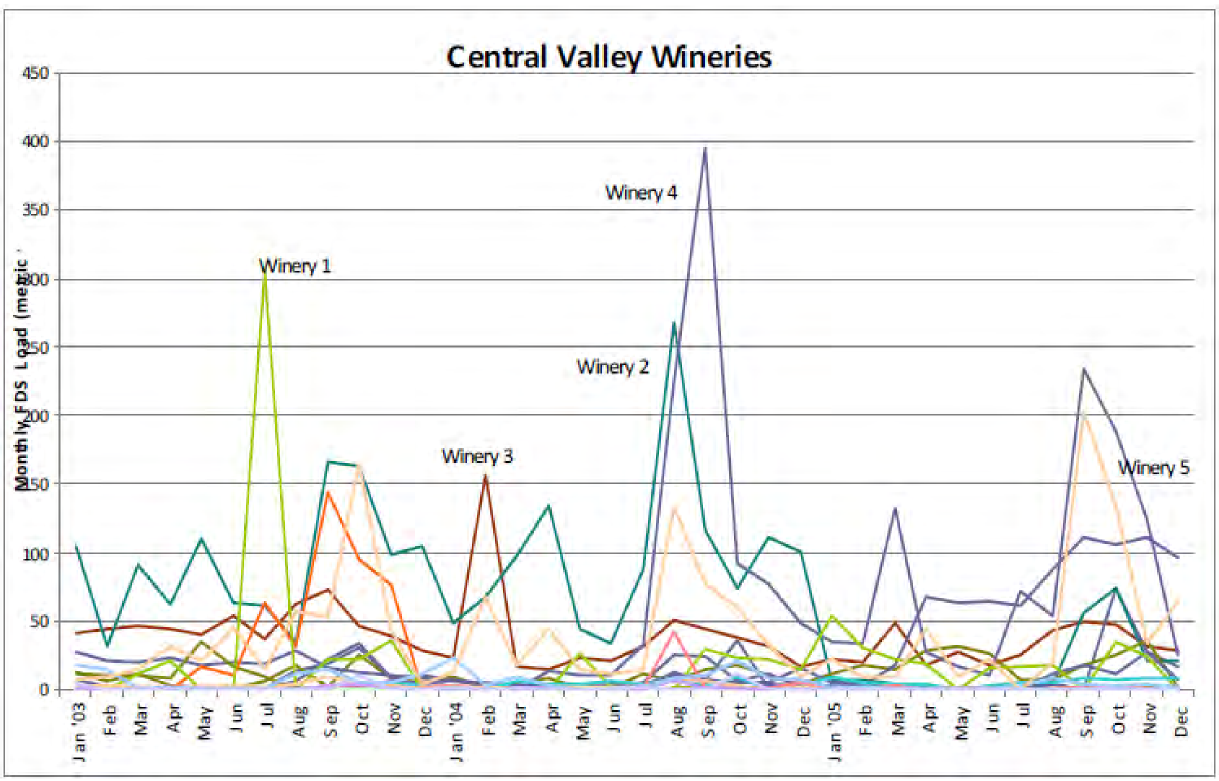

Figure 5-3
Monthly FDS loading (metric tons) for five Central Valley wineries (HCC 2007)

5.4.2 Tomato Processing Sources

Major sources of salt in tomato processing include source supply water, product loss, softener regeneration and boiler blowdown, cleaning chemicals, and process chemicals. An analysis of FDS load from a selected tomato processing plant is provided in Table 5-5. Supply water contributes the highest percentage of the FDS load (55 percent), and the largest process consumer of supply water is the use of water to transport tomatoes from the truck to the processing facility. Product loss is the second greatest source of FDS; the two main avenues for product loss are spillage from the flume and loss during peeling (HCC 2007).

Table 5-5. Sources of FDS in tomato processing waste (HCC 2007)

Source of FDS	Percent Contribution (%)
Supply	55
Product Loss	27
Softener Regeneration	9
Boiler Blowdown	3
Cleaning Chemicals	4
Process Chemicals	1

Tomato processing operates seasonally in conjunction with the tomato harvest during the months of July to August. As seen in Figure 5-4, salt load is also highly seasonal. The majority of the load occurs as fresh tomatoes are processed during the harvesting season into canned products and tomato paste; paste can be stored and manufactured into other products in the off-season. In a study of three Central Valley tomato processing plants, EC in wastewater was measured up to 15,200 µS/cm (HCC 2007).

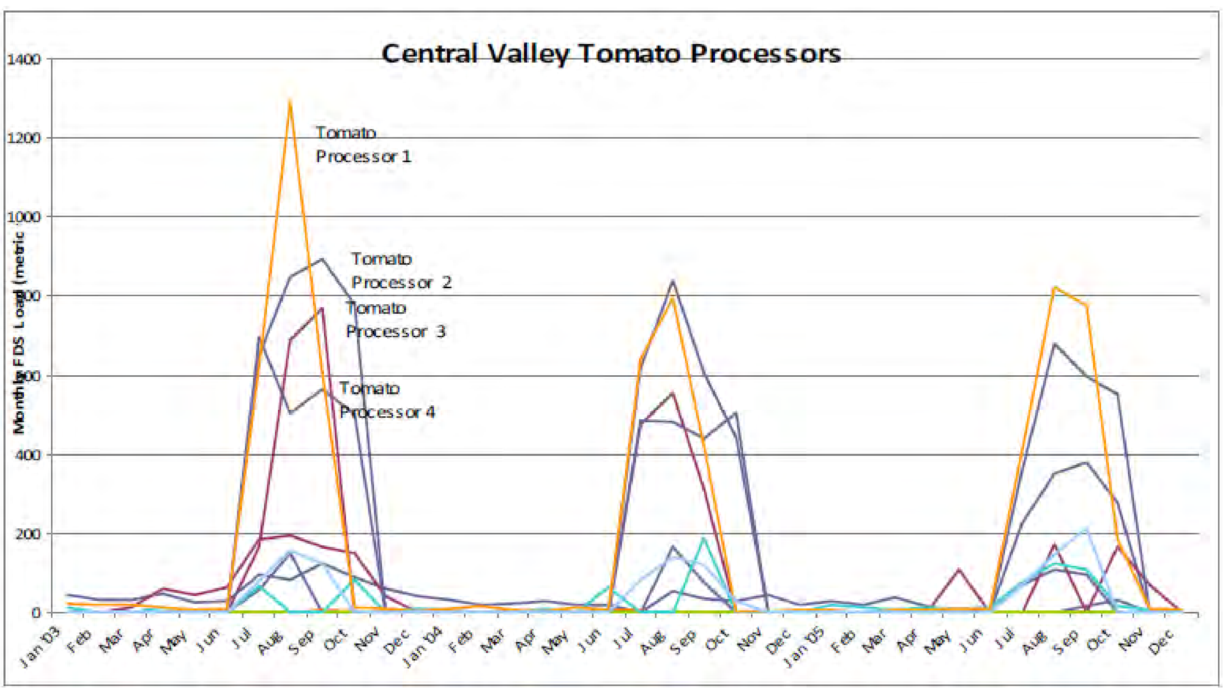

Figure 5-4
Monthly FDS loading (metric tons) for four Central Valley tomato processors (HCC 2007)

5.5 Reducing the Salinity in Food Processing Wastewater

The following are some general strategies for reducing salinity in food processing wastewater. The strategies used by a given food processor would be process-specific, and would necessitate a study of existing conditions at each specific processing and disposal site.

5.5.1 General Salt Reduction Strategies

- Boiler Feed Water Treatment—Treatment of boiler water with a reverse osmosis system can reduce salts and boiler blow-down water volume.
- Product Loss Reduction—Product loss reduction strategies vary by industry. However, good housekeeping practices can yield some reduction in losses. For example, dry sweeping solids prior to hosing down work areas can save water and prevent salt additions.
- Cleaning and Process Chemical Treatment and Reduction—Utilizing potassium hydroxide rather than sodium hydroxide to clean processing equipment can result in a reduction of FDS. Although potassium hydroxide does contribute potassium salts, these salts are more likely to be utilized as nutrients when applied to soil than are sodium salts. If salinity-adding chemicals are needed in the food processing train, spent chemical evaporation can be utilized to reduce the volume of chemicals for disposal.
- Supply Water Treatment—Supply water treatment occurs before food processing activities take place. The three main technologies available for salinity removal are Low Pressure Reverse Osmosis (LPRO), High Efficiency Reverse Osmosis (HERO), and electrodialysis. LPRO alone has limited applicability when supply water has high levels of hardness. Utilizing LPRO followed by HERO, with an intermediate water softening step, can result in a highly concentrated waste stream and low salinity product water. The waste stream then must be disposed of through alternate means. All of these technologies are costly to implement and operate and may have secondary environmental impacts such as green house gas emissions. Options for waste stream disposal typically include evaporation ponds, seeded evaporation, crystallization, spray drying, and POTW disposal. Seeded evaporation involves introducing a crystalline "seed" to encourage formation of salt precipitate. This technique reduces fouling of heat exchanger equipment, as precipitation is more likely to occur on existing crystals than on new surfaces. Crystallization is the circulation of the waste stream through a heat exchanger and mechanical crystallizer; making multiple passes through the crystallizer increases the salt content of the effluent, as additional water evaporates in each pass. Spray drying involves spraying brine with an atomizer into a gas-fired drying chamber; dry salts can then be separated from vapor in a bag filter (HCC 2007). All of these technologies are costly to implement and operate.
- Effluent Treatment—When supply water and process strategies cannot meet discharge requirements, end-of-pipe or effluent treatment strategies can be utilized. Techniques for end-of-pipe treatment generally include a mix of biological treatment, chemical clarification, and membrane separation such as reverse osmosis.

5.5.2 Winery Salt Reduction Strategies

Wineries can utilize alternate methods of stabilization in order to reduce reliance on ion exchange systems. Typically a winery will evaluate its overall winemaking process, identify potential salt reduction strategies, perform a feasibility study to determine the efficacy of employing the strategies, implement the strategies, and monitor performance. A limited list of alternative stabilization methods include cold storage or electrodialysis followed by reverse osmosis. Fetzer Vineyards in Mendocino County has been successfully utilizing electrodialysis to stabilize a portion of their wines since 2007 (Kennedy/Jenks 2008). Wineries can also reduce salinity by using ozone for equipment sanitization, rather than sodium hypochlorite. J Vineyards and Winery in Sonoma County switched to ozone disinfection of equipment in order to prevent the alteration to flavor that chlorine can bring about; however, this action also has the side effect of reducing salinity (Kennedy/Jenks 2008).

5.5.3 Tomato Canning Salt Reduction Strategies

Two salt-reduction strategies specific to tomato canning facilities are product loss reduction and chemical substitution. To combat salinity addition through product loss, tomato processors can run process water through an evaporator. This results in the creation of tomato paste, which can have added product value, as well as a reduction in salinity. Salinity can also be reduced by changing out lye peelers in favor or steam peelers. In an analysis of seven Central Valley tomato processors, those using steam peeling had a lower added FDS concentration in their waste stream (range 140 to 600 mg/L added FDS) compared to those using lye peeling (range 950 to 1700 mg/L added FDS) (HCC 2007). Steam peelers may result in additional product loss or impact product quality; however, if an evaporator is already in place, then product can be salvaged before wastewater is discharged.

5.6 Cost of Implementation

In a modeling analysis of the Lower San Joaquin River Basin, HCC found that the annual losses resulting from land application of food processing wastes are estimated at $400,000 through 2025. This value is based on the additional cost to agricultural and urban water consumers for blending high quality surface water with impacted groundwater. If consumers are assumed to rely wholly on groundwater, the losses associated with land application approach $1.5 million (HCC 2007). The costs of various treatment approaches are listed in Table 5-6. The value of salt reduction in decreased impacts to groundwater would need to be balanced against the reductions in profit that would be experienced by the food processors immediately upon implementation. There may also be secondary economic impacts including job losses and a decreased tax base.

Table 5-6. Unit cost of various treatment options (HCC 2007)

Treatment Options	Unit Cost ($/kgal)
Supply Water Treatment	1.40 – 145.30
Boiler Feed Water Treatment	4.19
Product Loss Reduction	Varies by industry
Spent Chemical Evaporation	24.80
End of Pipe Treatment	9.87

5.7 Salt Capacity

Salt capacity is the mass of salt that can be accumulated or removed on a sustainable basis for each archetype Study Area, such that there are not deleterious effects on the designated beneficial uses for the water bodies (surface water and groundwater) in question. Source control is the primary strategy for reducing salinity in food processing discharges. As such, the capacity is dependent on the site-specific technologies utilized, underlying groundwater quality, groundwater migration, and soil conditions at each disposal site.

A component of every salt mitigation plan is to minimize, to the extent possible, the mass of salt discharged to wastewater treatment plants, discharge ponds, or land application. Information in each discharger's RWD can be utilized to determine the source water quality and discharge water quality for food processors throughout the Central Valley; however, additional research would be needed to compile these data into a salt balance model. Each salt balance model would need to incorporate site specific details.

5.8 Institutional and Regulatory Barriers

5.8.1 Regulatory Barriers

The Porter-Cologne Act allows the Regional Board to regulate discharges to land through issuance of either WDRs or conditional waivers of WDRs. CWC Section 13269, amended in 1999, caused all Regional Board waivers to expire on January 1, 2003; entities wishing to renew their waivers had to submit to a case-by-case evaluation process by the Board and, if granted a waiver, were required to demonstrate compliance with the State's Antidegradation Policy through continued monitoring and reporting. At the same time, the Regional Board instituted a Consistency Policy which called for an appraisal of the WDR program to check for consistency with the State's Title 27 regulations governing disposal of solid waste to land (27 CCR § 20005, *et seq*.).

Current regulation of food processors discharging to land is based on interim standards as more permanent policy setting takes place (HCC 2007). The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) program will lead to future action, but until such policies are in place dischargers may be reluctant to institute potentially costly salt reduction methods.

5.8.2 Institutional Barriers

The technologies utilized by each food processor would depend upon site-specific conditions and goals. Because there is no basin-wide salinity standard for discharge to land, the relative impact of discharge concentrations on groundwater quality would also need to be considered.

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Section 6

Red Rock Ranch Study Area

6.1 Introduction and Overview

Red Rock Ranch (RRR), located near Five Points, CA southwest of Fresno (Figure 6-1), has been owned and operated by John Diener and his family since 1980. The entire ranch consists of approximately 7,000 acres of various fruit and vegetable crops (Kresge and Mamen 2009). Section 9, a 640-acre portion of the farm (Figure 6-2), has been the focus of a number of innovative pilot projects to address the salinity and drainage issues which are prevalent within the Westside of the San Joaquin Valley. The Integrated On-Farm Drainage Management (IFDM) system is one of those pilot projects. IFDM systems help to reduce drainage runoff, rehabilitate agricultural land for use in high-value production, and create a potential marketable produce in recovered salt.

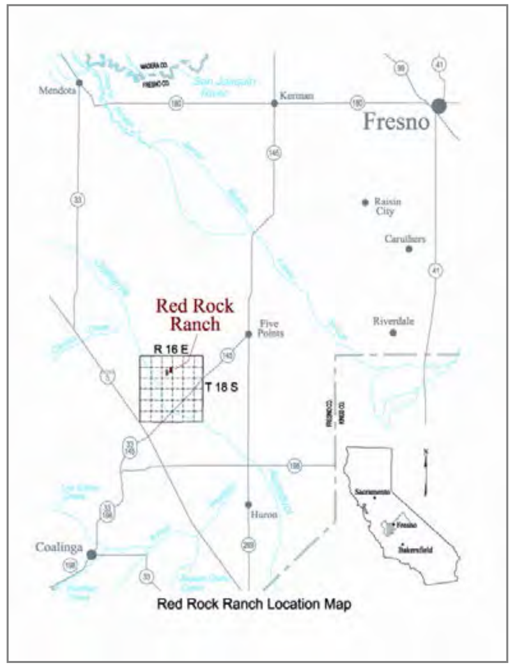

Figure 6-1
Location of Map of Red Rock Ranch
(DWR Date Unknown)

IFDM is a zero discharge farming system that manages drainage water by sequentially reusing it to grow increasingly salt-tolerant crops and evaporating the final effluent in a solar evaporator. RRR, along with the cooperation of the California Department of Water Resources (DWR), developed a farm-scale IFDM system, including a solar evaporator, to serve Section 9. The RRR pilot project provides a good example of an IFDM system that may be considered for other locations in the Central Valley to address salinity concerns.

6.2 Problem Statement

RRR, located on the westside of the San Joaquin Valley, has faced chronic problems with the build-up of salts, as well as, selenium, boron and other naturally occurring elements. The combination of continuous irrigation, poor drainage, and naturally saline soils resulted in concentrated levels of salinity and selenium in the soil and drainage water. Poor drainage on the Westside is often created by an impermeable layer of clay that prevents the irrigation water from infiltrating into deeper groundwater aquifers. The trapped irrigation water forms a shallow, or perched, water table. Without an outlet, the highly saline waters accumulate in the root zone close to the ground surface and reduce crop productivity. Drainage water may also have elevated levels of selenium that can be toxic to wildlife and impede safe off-farm drainage and disposal of the water. RRR has implemented an IFDM system to address the accumulation of highly saline drainage water and declining productivity of croplands.

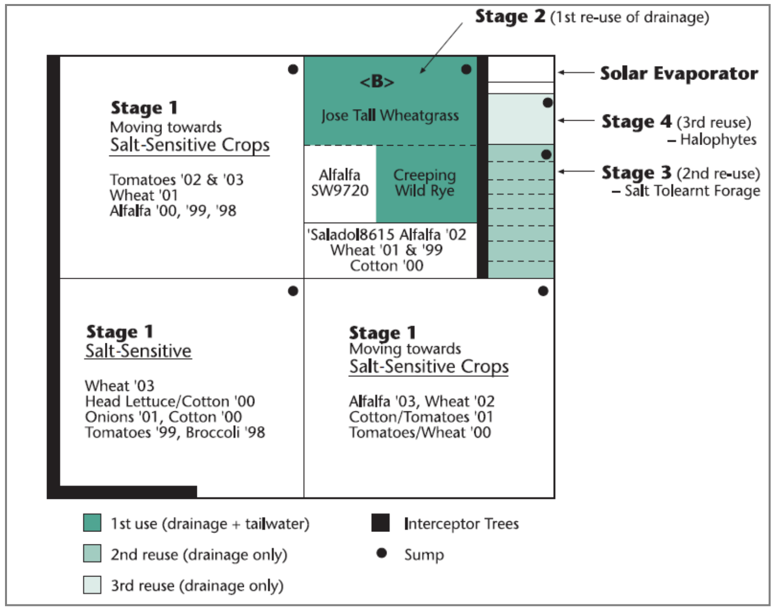

Figure 6-2
Map of 640 acre IFDM system at RRR (WRCD 2004)

6.3 Physical Attributes

6.3.1 Hydrology and Drainage Patterns

On average, the RRR area receives about 11.23 inches of precipitation per year (National Oceanic and Atmospheric Administration [NOAA] 2013). Rainfall is seasonal with the majority of precipitation occurring between November and April.

Drainage within the RRR is provided by a subsurface drain tile system. Typically, the drainage flows include surface drainage from applied irrigation, shallow groundwater and losses to deep percolation. On the westside of the San Joaquin Valley, the groundwater generally flows down from the Coastal Range and northeast towards the trough of the Valley (Water Resource Conservation District [WRCD] 2004).

6.3.2 Land Cover Attributes

RRR is fairly typical of irrigated agricultural operations in the area. The surrounding area is characterized by gradually sloping topography. Land cover varies throughout the year based on cropping patterns. Soils in RRR, as is throughout the westside of the San Joaquin Valley, are primarily composed of alluvium (Reclamation 2006).

6.3.3 Institutional, Economic & Regulatory Attributes

Irrigated agricultural lands in the Central Valley are subject to many economic and regulatory pressures as described below.

Institutional Attributes. RRR falls within the Westlands Water District, which provides water supply services to more than 600,000 acres in Fresno and Kings counties. Water districts, including Westlands Water District, provide expertise and education/outreach to land owners and agricultural water users. RRR also lies within the WRCD. The WRCD provided expertise for the development of the RRR IFDM pilot study and developed a Landowner's Manual for developing IFDM systems as part of an educational and outreach program to educate landowners on the advantages, disadvantages, costs, environmental regulations and other issues involving an IFDM system (WRCD 2004).

Economic Attributes. Irrigated agriculture in an area with salinity issues, such as the Central Valley, is driven by economic factors such as application of improved technology, availability of labor and other resources, demand for commodities, and production. Improved efficiency in irrigation and drainage reuse are examples of technological innovations that have improved crop yields in recent years (Howitt et al 2009). Future production of irrigated agriculture operations will be impacted by the reliability of high quality water supplies, potential climate change impacts, future policies impacting the agricultural sector, and increasing crop production in other countries (Howitt et al 2009).

Regulatory Attributes. Irrigated agriculture is regulated by the ILRP (see Section 1). In July 2013, the RWQCB adopted the WDR for individual growers (R5-2013-0100). Under this WDR, it is specified that discharges to either surface water or groundwater "*shall not cause or contribute to an exceedances of applicable water quality objectives*" (Central Valley RWQCB 2013). Under the MRP, dischargers are required to develop a Groundwater Assessment Report which describes groundwater areas as "high vulnerability" or "low vulnerability" areas. Those areas assessed as a high vulnerability area will have more stringent requirements including enforced water quality objectives and maximum contaminant levels for discharges to protect beneficial uses of the groundwater.

6.4 Sources of Salt Accumulation

At the RRR, the primary source of salt accumulation is drainage water which mobilizes and concentrates the large mass of salt present in the subsoil profile (WRCD 2005) (see Figure 3). Continuous application of irrigation waters can result in concentrated levels of salinity and selenium in the soil and drainage water.

6.5 IFDM System Description

The following section is primarily derived from A Landowner's Manual Managing Agricultural Irrigation Drainage Water: A guide for developing Integrated On-Farm Drainage Management Systems (WRCD 2004).

Although, there is no standard design for IFDM, typically the system includes:

- Separate production areas for salt sensitive crops and increasingly salt-tolerant crops (including forages and halophytes);
- Subsurface drainage system; and
- Solar evaporator (WRCD 2005)

In addition to these primary components described above, the RRR system also includes a border strip of trees to intercept shallow regional groundwater flow (WRCD 2004). The following sections provide additional details regarding the RRR IFDM system.

6.5.1 Crop Production Areas

IFDM Systems are subdivided into sequential crop production areas, each of which has a subsurface tile system that intercepts subsurface drainage water and transports it, using pumps and piping, to the next area of the process (WRCD 2004). Figure 6-3 presents a conceptual graphic of the components of an IFDM system.

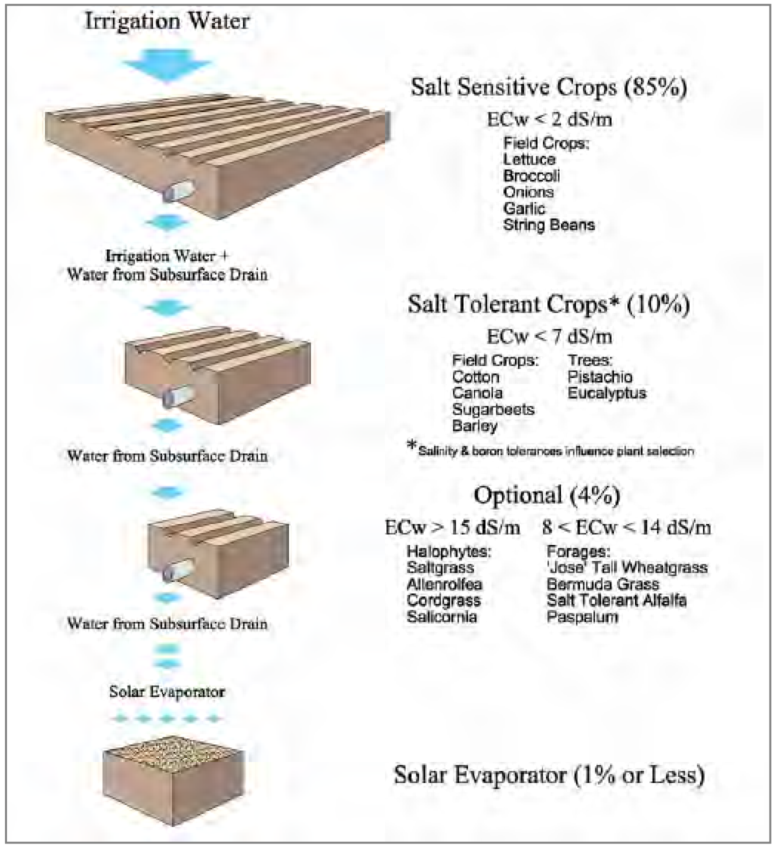

Figure 6-3
Process Flow Diagram (Source Unknown[1])

The first production area is generally the largest. In this area high quality irrigation waters are applied to grow salt-sensitive crops such as lettuce, broccoli, and garlic.

The second production area uses drainage waters collected from the first production area, to grow salt-tolerant crops such as cotton or wheat. In some cases, the drainage water is used directly or it is blended with fresh water to reduce salinity as necessary.

The third production area is optional. This area is cropped with halophytes or forage grasses and is irrigated with drainage water collected from the second production area.

Drainage water from the final production area is collected and discharged to a solar evaporator which is the final stage of an IFDM system. The solar evaporator is typically a small area dedicated to evaporating the final drainage effluent and harvesting the salt. Typically the area contains either just a solar evaporator or both a solar evaporator and water catchment basin (Figure 6-4). The requirements for construction of a solar evaporator are described in (and regulated by) Title 27 of the CCR.

[1] This figure is an example figure, as the specific source for this could not be found.

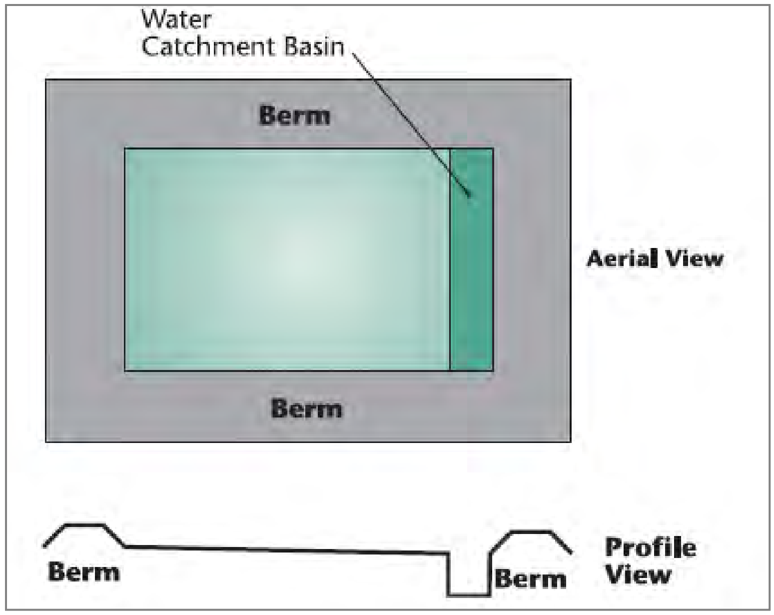

Figure 6-4
Solar Evaporator and Water Catchment Basin

As described above, all crop production areas in the IFDM system would have subsurface drainage and pumping systems, and as such there is some flexibility in moving production areas around within the system. The amount of flexibility primarily depends on the salinity of the soils in each of the production areas (WRCD 2005).

Specifically, the RRR IFDM consists of sequential crop production areas for salt-sensitive[2] crops, salt-tolerant[3] crops, and halophytes[4] and forage[5] grasses.

6.5.2 Efficient Irrigation Methods

In general, IFDM irrigation systems must be highly controllable and efficient in their ability to uniformly apply water in a controlled manner that minimizes deep percolation. The IFDM crop production areas function primarily for the purpose of generating crop revenue; however, an important "secondary purpose is to reduce the volume of water through evaporation and evapotranspiration thereby minimizing the volume of water and salt discharged to the solar evaporator" (WRCD 2005).

The use of low-pressure, center pivot sprinklers by the RRR IFDM system allows for precise irrigation scheduling and reduced water losses due to evapotranspiration. IFDM systems carefully schedule irrigation based upon moisture levels in the soil root zone. RRR monitors soil moisture levels to

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[2] Crops that cannot tolerate salinity levels higher than 2 dS/m (WRCD 2004)

[3] Crops that cannot tolerate salinity levels higher than 8 dS/m (WRCD 2004)

[4] Crops that can tolerate salinity levels higher than 15 dS/m (WRCD 2004)

[5] Crops that can tolerate salinity levels between 8 to 15 dS/m (WRCD 2004)

calibrate their California Irrigation Management System[6] (CIMIS) irrigation scheduling system (Kresge and Mamen 2009).

6.5.3 Performance

The IFDM system is a zero-liquid discharging agricultural practice. As such, performance cannot be described as a reduction in the salinity between an influent and the effluent. However, it can be described through the impacts on the soil salinity and land value. Table 6-1 provides data that was associated with another IFDM project for AndrewsAg in Kern County. This farm has an approximate 1,200 acres of agricultural land dedicated to the IFDM process which was started in the 1990 (Unknown).

Table 6-1. IFDM Performance for AndrewsAg in Kern County (Unknown)

	Prior to IFDM Implementation	After IFMD Implementation
Crop Mixture	Cotton Alfalfa	Salt Sensitive Crops: Asparagus, Garlic, Onions, Carrots, Cantaloupe, Honeydew melons, alfalfa Salt Tolerant Crops: *Allenrolfea*, Saltgrass NyPa, Native saltgrass
Soil Salinity (EC in dS/m)	4.1-11.6	2.1-2.7
Land Value	Appraised value 10 times higher in 2010 than in 2002.	
Revenues	Considered taking farm out of production because mitigation cost for evaporation pond was too high	Annual revenues of about $6 million

In addition, other improvements in agricultural methods are briefly described, as documented by Kresge and Mamen (2009):

- Using the innovative irrigation practices described, the RRR IFDM system reduces irrigation water use by about 20%.
- As a collateral benefit, reduced tillage of crop areas reduces tractor work by approximately 80 percent thereby reducing the associated labor costs, while improving water infiltration.
- Production of high value crops may improve farm profitability.
- The production of salt and selenium as an end product of the solar evaporator may provide another potential marketable commodity.

The IFDM system at RRR is currently still operational. At the time of this report, the system is on stand-by waiting for a wet year. Currently, the Westland Water District is not supplying sufficient irrigation water to RRR and therefore a significant amount of land is being fallowed. The fallowing has resulted in a drop in the shallow groundwater table below the tile drains; therefore, there is no water available for reuse (Personal Communication – Jose Faria).

6.6 Cost of Implementation

The costs for individual IFDM systems can vary depending on a number of factors including: the amount of land allocated to low-value salt tolerant plants or to the solar evaporator, any rental or

[6] A program of the Office of Water Use Efficiency (OWUE), DWR that manages a network of over 120 automated weather stations in the state of California. CIMIS was developed in 1982 by DWR and the University of California, Davis to assist irrigators in managing their water resources efficiently.

opportunity costs associated with the land, plant selection, and monitoring requirements. As the amount of land allocated to either salt tolerant crops or to the solar evaporator increases, the average costs of an IFDM system per acre of marketable crop production increases significantly. For those farms which have a sub-surface drainage system already installed, the costs associated with the IFDM system decreases (WRCD 2004). Although initially the capital cost for installing such a system may be high, RRR estimated that they could be "offset by the increase in value of the reclaimed land by approximately $1,600/acre and a net return on high-value crops of $150 to $375/acre/year" (Kresge and Mamen 2009).

Table 6-2 provides information on various components of installing an IFDM system.

Table 6-2. Estimated Costs of installing an IFDM System

Component	Estimated Cost Per Acre
Capital Cost	--
Drain Tiles	$600[1]
Central Pivot Irrigation System	$500[1]
Drip Irrigation System	$1,200-1,4001
Solar Evaporator	$1,000[2]
Annual Costs	$100-$120[3]

Source:
[1] Kresge and Mamen 2009
[2] WRCD 2005
[3] WRCD 2004

6.7 Salt Capacity

The salt capacity is intended to be an estimate of the limiting capacity of each salt accumulation Study Area to assess the likelihood of achieving sustainable conditions. Ideally, an IFDM system like the one at RRR would perform a salt balance calculation to quantify, for example on an annual basis, the mass of salts imported with the irrigation water and the amount produced in the solar evaporator. Achieving a salt balance would help to ensure the long-term sustainability of irrigated agriculture on RRR. The San Joaquin Drainage Implementation Program estimated the total salt production at RRR to be about 80 tons per year (San Joaquin Valley Drainage Implementation Project [SJVDIP] 1999).

As a theoretical concept, a salt balance for an IFDM system, would prevent soil salinization and improve long-term sustainability because the salt mass entering the irrigated area would be equal to the mass moved through the system and discharged to the solar evaporator (e.g., $Salt_{out}=Salt_{in}$). A salt balance might be achievable for IFDM systems that do not have large stores of native salt in the soil profile below the crop root zone.

However, this is not the case at the RRR, nor in many areas along the westside of the San Joaquin Valley. A salt balance comparison between the input to all the fields and the output to the solar evaporator will not be an accurate representation of the salt accumulation within the RRR IFDM because more salt routinely leaves the system than is applied by irrigation water. In essence, salt is being mined from the soil profile. In order for an IFDM system to be sustainable there must be active management and integration of both the irrigation and drainage systems that comprise the IFDM system, as described below.

6.7.1 Irrigation Water Management

Salt capacity and long-term sustainability at RRR are dependent on careful irrigation water management and operation. The IFDM system must be operated and managed to achieve optimum salt levels in the root zone of each crop production area. The goal is to reduce the total volume of water being collected and reused by sequential, more salt tolerant production areas. Careful irrigation water management will minimize the amount of water that is collected and ultimately discharged to the solar evaporator. The irrigation must be scheduled and the irrigation schedule must include the impact of the drainage system operation on crop water use from shallow groundwater. The irrigation system design has to be strictly followed. Poor implementation will result in poor distribution uniformity, excess deep percolation losses and potential yield loss.

6.7.2 Drainage Water Management

Active drainage system management also is required. Typically drainage systems operate continuously to draw the soil water levels down. The IFDM approach manages irrigation and drainage systems as an integrated system. As the crop develops, there is a potential for significant crop water use from shallow groundwater that must be considered when making irrigation decisions. In-situ crop water use may result in less irrigation over the season and may reduce drainage water. Managing irrigation water to limit standing water and tailwater will be required. If the surface water contains selenium, there is the potential for impacts on wildlife that may have regulatory consequences.

6.8 Institutional and Regulatory Barriers

It is important to understand the institutional and regulatory attributes that influence the IFDM system at RRR in order to assess the opportunities and constraints and the potential for long-term sustainable operations.

6.8.1 Institutional

Institutional barriers to implementation of IFDM are related to deployment and acceptance of this relatively new technology by landowners and farm operators. RRR in one of several pilot studies commissioned to demonstrate IFDM's efficacy at managing drainage and its potential commercial viability. Marketing or disposal of the salt end products has presented another institutional challenge. The WRCD has developed guidance manuals that address developing standard IFDM design practices that can be readily applied by other landowners (WRCD 2004, 2005). Institutional barriers to IFDM can be further addressed by providing appropriate training and information to landowners who may be interested in implementing IFDM.

Applications for grant funding to implement IFDM pilot projects are often sponsored by water districts and RCDs. The RRR pilot study included cost-share funds from a Bureau of Reclamation challenge grant and staff expertise provided by the WRCD, as well as, DWR, and the U.S. Natural Resource Conservation Service.

Currently, implementation of a version of IFDM, known as regional reuse, is being looked at on a more regional use as opposed to individual farms. Implementation of regional reuse (as described further in Westside Regional Study Area, Section 10) may help water and drainage districts meet discharge goals (Personal Communication – Jose Faria).

6.8.2 Regulatory

The RRR IFDM has also provided a good test case of the laws and regulations which govern water quality, wildlife protections, and hazardous materials control during design and implementation of these systems. The primary permitting and regulatory hurdles facing IFDM systems appears to be related to the wildlife protection and the potential for the solar evaporator system to concentrate pollutants such as selenium. These challenges resulted in a potential barrier to implementation of IFDM at RRR. However, as described below, this barrier was removed through the combined action of legislation and revised regulations.

At RRR, the Central Valley Regional Water Quality Control Board (RWQCB) established Waste Discharge Requirements (WDRs) for the operation of the solar evaporator. However, the discharges to the solar evaporator were high in selenium derived from natural background concentrations in the drainage water. Based on the selenium concentrations, the RWQCB invoked regulatory provisions of the Toxic Pits Cleanup Act and issued WDRs for the solar evaporator. RRR experienced difficulties in efficiently operating the solar evaporator while meeting the WDR's and was served with Notices of Violation (SWRCB 2003).

The selenium problems were related to standing water within the solar evaporator. These 'ponded' waters supported growth of invertebrates (primarily brine flies) and introduced selenium into the food chain that biomagnified and impacted nesting shorebirds. These problems resulted in the shut-down of the original solar evaporator at RRR (SWRCB 2003).

Recognizing the importance of solar evaporators as the essential final component of the IFDM system, the legislature introduced Senate Bill (SB) 1372, which directed the State Water Resources Control Board (SWRCB) to adopt emergency regulations to address the selenium concerns (SWRCB 2003). These emergency regulations were replaced with the adoption of SB 1347 in September 2006. This new regulation provides the framework for the construction and permitting of a new solar evaporator, as well as continuous monitoring requirements. In addition, Title 27 of the California Code of Regulations now includes minimum requirements for the design, construction, operation, and closure of solar evaporators as components of IFDM systems (CCR Title 27).

6.9 References

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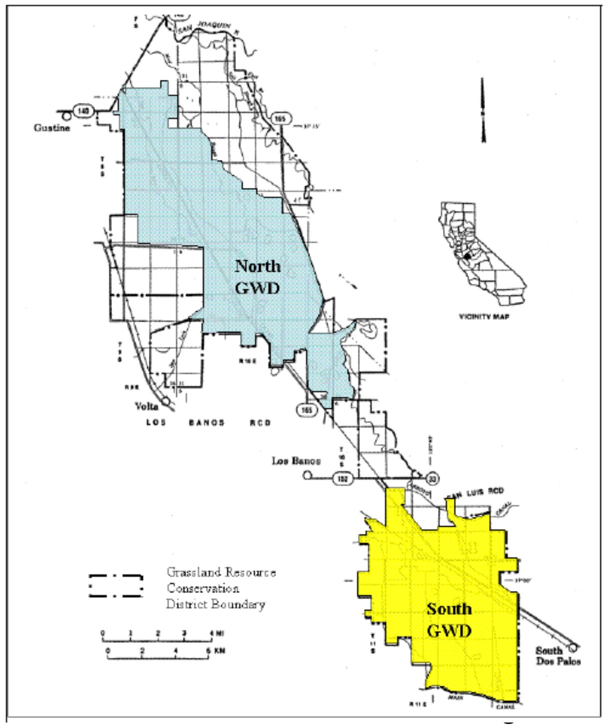
Section 7

Grasslands Water District – Real Time Water Quality Management Study Area

7.1 Introduction and Overview

The Grasslands Water District (GWD) is located in the San Joaquin Valley, near Los Banos (Figure 7-1). GWD encompasses approximately 51,537 acres with the majority of this land in wetland habitat. GWD operates and maintains a canal system approximately 110 miles long to deliver water to the landowners in the GWD.



Location of Grassland's Water District (Quinn *et al.* 2004)

Similar to the surrounding region (see Westside Regional Drainage Plan Study Area, Section 10), the GWD experiences high salinity and drainage issues. It is estimated that approximately 10 percent of the San Joaquin River's annual flow, and 30 percent of its annual salt load, passes through wetlands within the Grasslands Basin, which includes the GWD (Quinn *et al.* 1997, Rahilly *et al.* 2010).

In 2004, the *Real Time Water Quality Management in the Grasslands Water District Study* (Quinn *et al.* 2004) was completed. This research study was supported by CALFED and the Bureau of Reclamation (Reclamation) and furthered the conceptual development of a Real-Time Management Program (RTMP). The goal of the RTMP is to collaboratively manage water quality in the river by coordinating the timing of higher salinity discharges from wetlands and agricultural areas with the lower salinity releases from the east-side reservoirs. The RTMP would maximize saline discharges during periods when the river has high assimilative capacity and thereby minimize exceedances of salinity water quality objectives at Vernalis.

The RTMP would rely on an extensive network of water quality monitoring stations along the river, tributaries, and at discharge locations. These monitoring stations are equipped with probes that continuously measure flow and water quality parameters at targeted locations. The monitoring stations utilize telemetry systems to disseminate the water quality conditions on a "real-time" basis. Operation of the RTMP would require ongoing cooperation between the water quality monitoring system operators, a forecasting/modeling team, water system operators, and dischargers to plan and coordinate discharges and reservoir releases in order to maximize use of the assimilative capacity of the San Joaquin River. This Study Area provides an opportunity for the SSALTS project to understand real-time management of water as a method for regional salt management.

7.2 Problem Statement

The GWD RTMP Study Area specifically addresses issues related to drainage from managed seasonal wetlands under a RTMP. Wetlands management generally involves manipulation of water levels to control the extent and depth of inundation and the soil moisture content. The wetlands are flooded in the fall to provide over-wintering habitat for waterfowl and other wildlife. In the spring, wetlands are drawn down to promote germination of seeds and other food sources for waterfowl migration. The fall flood-up occurs during the months of September and October, and the spring drawdown occurs during the months of February, March, and April (Quinn *et al.* 2004).

GWD primarily uses Central Valley Project (CVP) water diverted from the Delta-Mendota Canal to flood wetland areas. While the salinity levels of the water supplies to the GWD are fairly low, during the periods of wetlands flooding, these salinity levels typically increase due to evaporation and evapotranspiration by wetland vegetation, dissolution of soil residues and inputs from saline groundwater. The GWD wetlands drawdown in the spring is discharged into tributaries of the Lower San Joaquin River and is timed to meet wetland management objectives (*e.g.*, habitat conditions, soil moisture for seed germination). The timing of the GWD wetlands drawdown discharges in the spring may not coincide with higher assimilative capacity in the San Joaquin River which typically occurs between January and April.

The late-season wetland releases of high salt loads can impact the salinity in the San Joaquin River by: (1) increasing salinity for downstream riparian irrigators potentially resulting in reduced crop yields; and (2) impacting salmon during their annual migration due to the high flows in the river (Quinn, *et al.* 2004). The GWD RTMP research study examined how coordination among stakeholders could potentially reduce these negative impacts. The GWD research included development of a real-time water quality monitoring network and wetland forecasting modeling tool, analysis of adaptive wetland drawdown schedules to better coordinate with assimilative capacity in the San Joaquin River, and remote sensing techniques to measure impacts of seasonal wetland drawdown on habitat and soil moisture conditions.

7.3 Study Area Attributes

7.3.1 Hydrology and Drainage Patterns

Hydrologic conditions within GWD are highly controlled as described above. Wetlands water levels are manipulated to maintain standing water from mid-September through mid-to late-April (Quinn *et al.* 2004). The wetlands are managed to mimic the historical seasonal hydrology of the San Joaquin River Basin. Stream flows vary by season. Higher flows in the San Joaquin River Basin occur during wet winters, spring snowmelt, February and March when water levels in managed wetland refuges are drawn down, and April and May as a result of pulse flows required under the Vernalis Adaptive Management Plan (VAMP)[1]. Lower stream flows also tend to occur during hot dry summer and fall conditions and non-irrigation periods when return flows are reduced. Stream flows may also vary on

[1] VAMP, implemented in 2000, requires regulated releases from reservoirs located on the eastside of the San Joaquin Valley to provide adequate river flows to protect juvenile salmon migrating from the San Joaquin River through the Sacramento-San Joaquin Delta.

an annual basis, *e.g.*, stream flows will be higher during wet years when substantial precipitation has occurred and lower during dry years with below normal precipitation.

GWD includes three natural drainages. These drainages are Mud Slough and Los Baños Creek in the northern region and Salt Slough in the southern region. In addition to these historic drainages, there are numerous constructed channels, ditches, drains, culverts, gates, and siphons throughout the GWD (Quinn *et al.* 2004).

7.3.2 Land Cover

The GWD is primarily comprised of wildlife refuges which are part of the Grasslands Ecological Area (GEA) in Merced County. Land uses include seasonally flooded wetlands, moist soil impoundments, permanent wetland, irrigated pasture, and croplands (GWD website). The GEA includes about 178,000 acres which includes two federal wildlife refuges, three state wildlife areas (23,000 acres), 150 private duck clubs, and 33,400 acres of state parks and recreation areas (Thomas Reid Associates 2001).

7.3.3 Institutional, Economic & Regulatory

Grasslands Water District. GWD supplies irrigation water to about 51,000 acres of public and private lands within the GEA. GWD operates 160 structures for water deliveries including concrete weirs, metal box weirs, concrete pipe and gates and performs structural repairs and replacements, silt removal and channel repair, aquatic weed control and herbicide application (Thomas Reid Associates 2001). GWD also includes the Grasslands Environmental Education Center (GEEC) which promotes public education and awareness of wetlands.

Grasslands Resource Conservation District (GRCD). GRCD covers approximately 75,000 acres including most of GWD. GRCD lands are also primarily managed for waterfowl habitat. GRCD has submitted a Water Management Plan to Reclamation as required under the Central Valley Project Improvement Act (CVPIA). The Water Management Plan outlines GRCD's management goals and objectives and policies and procedures. It also provides an inventory of facilities and environmental characteristics.

Central Valley Project Improvement Act (CVPIA). The CVPIA, promulgated by the U.S. Congress in October 1992, mandates that 800,000 acre-feet of water be dedicated for fish and wildlife purposes. This increased water supply for wetlands has improved wildlife habitat, but it has also increased seasonal wetland drainage, producing more flow and salt loading to the San Joaquin River.

San Joaquin River Basin Total Maximum Daily Load (TMDL). In September 2004, the Central Valley Regional Water Quality Control Board (Central Valley RWQCB) established a boron and salt TMDL for the Lower San Joaquin River that included regulation of wetlands. The Central Valley RWQCB divided the Lower San Joaquin River Basin into 7 sub-area's; the GWD is a part of the Grasslands Sub-Area.

Central Valley RWQCB. As the RTMP is still in the pilot phase, the Central Valley RWQCB has not permitted this project. If the GWD RTMP were to be fully implemented, the Central Valley RWQCB would need to review and approve this project.

7.4 Sources of Salt in the GWD

Wetlands. The wetlands of the GWD are typically flooded in the fall with water from the Delta-Mendota Canal, containing electrical conductivity (EC) values in the range of 500 to 1,000 µS/cm. As the flood season progresses, the ponded water increases in salinity due to evapotranspiration from wetland vegetation, as well as through the mineralization of salt from other saline sources (*e.g.*, soil, groundwater) and from contact with aquatic bird species. The spring drawdown (between the months of February and April) of the wetlands typically coincides with high salt concentrations in that reach of the San Joaquin River (Figure 7-2).

Groundwater. The San Joaquin River Basin contains 26 groundwater basins, with 9 of those basins being classified as significant sources of groundwater (Reclamation 2006). The total dissolved solids (TDS) of the groundwater averages about 500 parts per million (ppm), but ranges from 64 to 10,700 ppm. Calcium, magnesium, sodium, bicarbonates, sulfates, and chlorides are all significant components of TDS. The highest groundwater salinity concentrations occur in areas of the highest native soil salinity (Reclamation 2006).

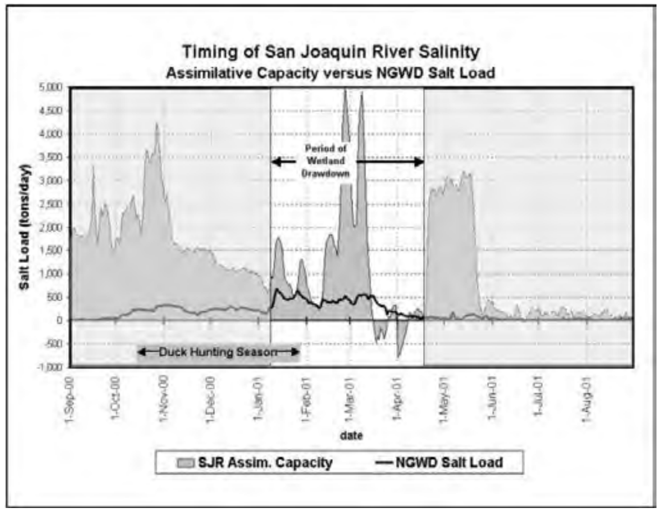


Figure 7-2
Chart Depicting the Typical Annual Flux of Salt Loading in the San Joaquin River
(Quinn *et al.* 2004)

Soils. The coastal ranges on the westside of the San Joaquin Valley are composed of sandstones and shales of marine origin. Because the leeward (east) side of the coastal ranges receives little precipitation, these soils tend to be poorly-sorted with low permeability. The marine soils also have a high concentration of salt and relatively high concentrations of naturally-occurring Se. In addition, the Corcoran clay, a Pleistocene lacustrine deposit, underlies the westside limiting drainage leading to higher salinity in shallow groundwater. Hence, while the westside includes some of the most productive agricultural lands in California, the underlying soils contribute to and are impacted by increasingly severe problems associated with poor drainage and increased salinity, Se concentrations, and sodicity[2].

Surface Water. The major sources of surface water in the area include imported water from the Central Valley Project and the San Joaquin River and its tributaries. The water quality of the San Joaquin River is degraded downstream of Bear Creek because of upstream diversions of high quality water for irrigation on the eastern side of the San Joaquin Valley and because of agricultural drainage into the river and its tributaries, especially Salt Slough and Mud Slough. The water quality of the San Joaquin River improves further downstream with water entering the San Joaquin River from east side tributaries, including the Merced River, the Tuolumne River, and the Stanislaus River.

In 2010, the Central Valley RWQCB published its Final Staff Report for *Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Salt and Boron Discharges into the Lower San Joaquin River* (Central Valley RWQCB 2004). This report established the TMDL that could enter the Lower San Joaquin River from sources without causing exceedances in water quality standards at Vernalis.

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[2] Sodic soils are soils with a disproportionately high makeup of sodium in caution exchange sites on the mineral surfaces. High sodicity leads to poor physical characteristics of the soil (soil structure), as well as low water permeability.

7.5 Real Time Salinity Management

As mentioned above, the RTMP Study Area provides the opportunity to look at a managing salinity through the management of wetland water releases, specifically to facilitate the control and timing of wetland and agricultural drainage, to coincide with periods when the San Joaquin River has high assimilative capacity.

7.5.1 Monitoring

The development of a water quality monitoring network is a primary component of a RTMP. For GWD, the monitoring network had the following primary objectives (Quinn *et al.* 2004):

- Measure the flow and salinity of the inflow and outflow of wetland water. This information provides the basis for the salt load entering and exiting the system.
- Through the use of the Internet, provide these data on a real-time basis, which allows advanced wetland monitoring and decision support for operations of the wetlands.

Monitoring stations were constructed at all the major inlets and outlets throughout the Study Area, with both flow (or velocity) transducers and EC sensors installed and calibrated to take measurements every 15 minutes. These data were transmitted from six monitoring stations through a telemetry system to a database, and eventually to the Internet. The data are used to assist wetland managers in their daily operations as well as calibrating the real-time wetland water quality model. The real-time data allow for more accurate model predictions and a better understanding of the salt mass balance in the GWD (Quinn *et al.* 2004).

7.5.2 Models

The RTMP uses the San Joaquin River Input-Output Daily Model (SJRIODAY) to predict flow and TDS concentrations for the reach of the San Joaquin River between Lander Avenue and Vernalis. This mass balance model is used to estimate the assimilative capacity of the San Joaquin River up to two weeks in the future (Figure 7-3).

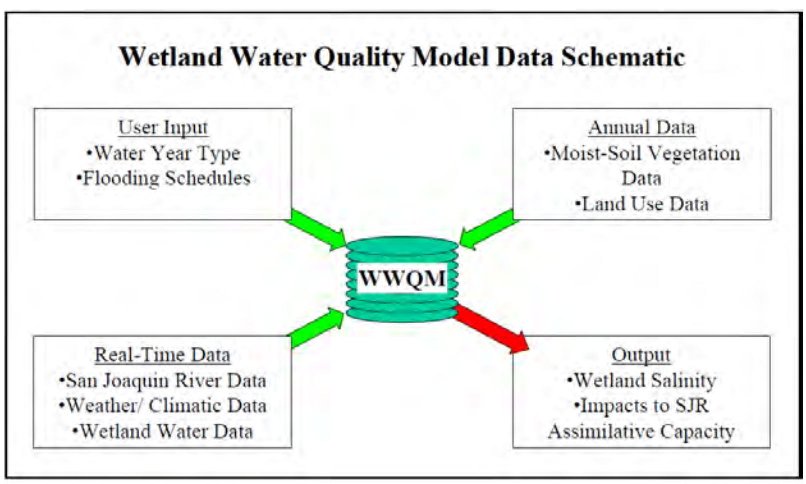

Figure 7-3
Wetland Water Quality Model (Quinn *et al.* 2004)

RTMP developers created the Wetland Water Quality Model (WWQM) to interact with the SJRIODAY by predicting flows and salt loads for wetland releases from the GWD. This mass balance model calculates projected salinity through a weighted contribution of all inputs and outputs. Using real time data from monitoring stations located throughout the area, the model can be calibrated daily. Besides salinity and flow inputs, the model accounts for seasonal or permanent wetlands, depth of water, precipitation, groundwater inflow/outflow, evaporation, and evapotranspiration.

The WWQM can also be used to simulate various wetland management strategies to predict impacts to the San Joaquin River, providing wetland managers with a decision tool for the timing of wetland drawdowns.

7.6 Cost of Implementation

RTMP is still in the research and development phase and detailed cost information has not been yet been developed. The Salt and Boron TMDL Staff Report did include an initial cost assessment of the components of a typical real time system based on professional judgment. The estimated "per system" cost for RTMP included $350K for installation and $100K per year for operation and maintenance, including discharge coordination (Central Valley RWQCB 2002). The TMDL Staff Report assumed that eleven systems would cover most of the major irrigation districts and the wetland operations in the Lower San Joaquin River (Central Valley RWQCB 2002).

7.7 Salt Capacity

Salt capacity is intended to be an estimate of the limiting capacity of each salt accumulation Study Area to assess the likelihood of achieving sustainable conditions for salt accumulation within the Central Valley. As an "Out of Valley" alternative, the GWD RTMP would provide long-term sustainable capacity for exporting salt loads since salt accumulations are exported into the Delta using the available assimilative capacity in the San Joaquin River. The actual capacity of the RTMP would be limited by the wetlands areas served and the volume and salt concentration discharged during draw down periods. Operation of the RTMP would rely on extensive monitoring network and forecasting tools. Sufficient storage capacity must be provided, either in the wetlands or in a dedicated storage facility, to withhold discharges during periods when insufficient assimilative capacity is available in the river. The capacity of the RTMP to export salt loads will be limited by the available storage capacity and the accuracy of the monitoring and forecasting tools required to operate the system.

The GWD RTMP study did not provide estimates of the salt load export potentially achievable under the RTMP. The Salt and Boron TMDL Staff Report estimated the total salt load attributable to 160,000 acres of managed wetland/refuge areas in the GEA. The TMDL analysis assumed a mean net discharge from wetlands of 193,000 af/yr at a salinity (TDS) of 380 mg/L resulting in a net salt discharge of 101,000 tons (Central Valley RWQCB 2002). The TMDL Staff Report noted that wetlands represented approximately 9 percent of the Lower San Joaquin River's total annual salt load. This analysis is considered a minimum estimate of salt loading to the Lower San Joaquin River from the managed wetlands because it does not account for salt leaching from wetland soils or wetland derived groundwater accretions to surface drainages (Central Valley RWQCB 2002). Depending on the efficacy of the RTMP, a portion of this salt loading would be discharged during periods of higher assimilative capacity.

7.8 Institutional and Regulatory Barriers

One of the primary institutional barriers to the GWD RTMP development is that the objectives of the wetland refuge managers do not coincide with the objectives of the RTMP. The wetlands are managed primarily to provide habitat benefits while the RTMP would be operated primarily to provide water quality benefits. The GWD Real Time Water Quality Management study researched decision support tools to allow wetland managers to adaptively respond to San Joaquin River salt discharge opportunities while maximizing long-term wetland function and habitat benefits (Quinn *et al.* 2004).

Implementation of the RTMP will require a centralized organizational structure where real time monitoring data is analyzed and forecasting tools are utilized to direct the actions of dischargers. The South Central Region Office of the California Department of Water Resources has initiated a website (http://www.water.ca.gov/waterquality/sjr_realtime) under the San Joaquin River Real-time Water Quality Management Program that is intended to fulfill some of these organizational needs. The website currently provides access to 'real time' data derived from the telemetered stream stage and salinity stations within the watershed. It also provides access to the results of computer models that simulate and forecast water quality conditions along the Lower San Joaquin River.

7.9 References

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Section 8

Stevinson Water District Study Area

8.1 Introduction and Overview

The Stevinson Water District (SWD) is located in Merced County, near the confluence of the Merced and San Joaquin Rivers (Figure 8-1). SWD provides irrigation water to 7,560 acres of land within the district boundaries and to 1,340 acres of land outside of the boundaries. In addition, SWD also delivers surface water to the neigboring Merquin County Water District (MCWD) to irrigate 6,000 acres of land (SWD 2005). To augment the water deliveries from SWD, MCWD uses groundwater from private wells (SWD 2006). Water conveyance is achieved through 66,900 feet of earthen ditches throughout the district, which is a significant source of seepage to groundwater.

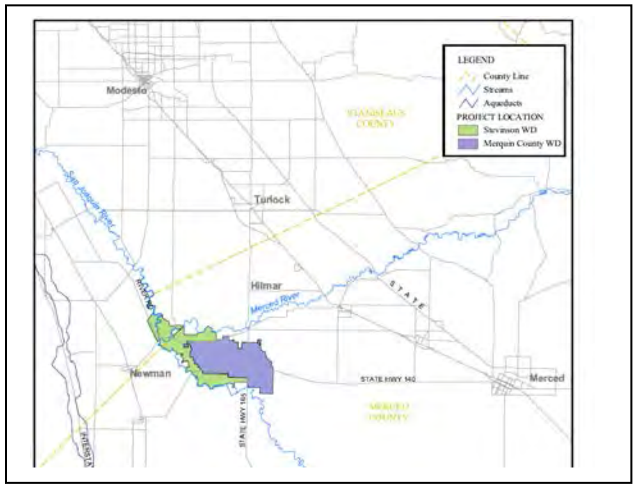

Figure 8-1
Stevinson Water District & the Merquin County Water District (SWD 2005)

The salinity in this region is a result of saline groundwater and marine soils. Both SWD and MCWD are downslope from the adjacent Merced Irrigation District, and inflows from the adjacent rivers, deep percolation from irrigated lands, and a shallow clay layer results in a high groundwater table (at depths between 3 to 22 feet below ground surface and with TDS concentrations ranging from 500 to 2,000 mg/L [SWD 2004 and 2005]). To address the salinity problems, SWD and MCWD developed an Integrated Water Resources Plan (IWRP), which identifies actions to manage and conserve agricultural water. Developed in 2003 and submitted in 2005 to the California Department of Water Resources (DWR), the IWRP's measures include "lateral piping [a pipeline], drainage management, agricultural water conservation, groundwater monitoring, and conjunctive management programs" (SWD 2006).

8.2 Problem Statement

Poor drainage throughout SWD combined with high seepage from earthen ditches has resulted in significant agricultural water losses, a high groundwater table, and limited available cropping options for farmers. In addition, the saline soils in the area cause concentrated salt levels in the groundwater, reducing crop yields as a result. The Stevinson Study Area targets conserving water supplies and addressing agricultural drainage related salinity issues by reducing seepage, managing drainage through a series of artificial wetlands, and implementing other ancillary facilities as well as other water management actions included in the IWRP.

This Study Area was included into the SSALTS project at the recommendation of the CV-SALTS TAC. As it is currently understood, this project is primarily a water management project with a minor salt source control component. There is not significant information to draw any conclusions for future salt management methods.

8.3 Study Area Attributes

8.3.1 Hydrology Attributes

On average, the region receives an average of 11.23 inches of precipitation per year (National Oceanic and Atmospheric Administration [NOAA] 2013). Rainfall is seasonal with the majority of precipitation occurring between November and April.

Water for SWD is diverted from the Merced River and delivered to agricultural land through the East Side Canal (Figure 8-1). Irrigation return flows from the Study Area are discharged into the San Joaquin River.

8.3.2 Land Cover Attributes

Located in Merced County, the SWD and MCWD are primarily comprised of agricultural lands and the unincorporated town of Stevinson. The primary industry in the area is dairy while the primary crops include alfalfa and corn, which support the dairies (SWD 2006).

8.3.3 Institutional, Economic & Regulatory Attributes

The regional economy of the SWD is predominantly agricultural. As is similar throughout the Central Valley, the impacts of salinity on irrigated agriculture production are primarily related to the availability of drainage services, soil salinity, and groundwater conditions. Irrigated agriculture in an area with salinity issues, such as the Central Valley, is driven by economic factors such as application of improved technology, availability of labor and other resources, demand for commodities, and production. Improved efficiency in irrigation and drainage reuse are examples of technological innovations that have improved crop yields in recent years (Howitt et al 2009). Future production of irrigated agriculture operations will be impacted by the reliability of high quality water supplies, potential climate change impacts, future policies impacting the agricultural sector, and increasing crop production in other countries (Howitt et al 2009).

Irrigated Lands Regulatory Program (ILRP). In July 2013, the RWQCB adopted the WDR for individual growers (R5-2013-0100). Under this WDR, it is specified that discharges to either surface water or groundwater "shall not cause or contribute to an exceedances of applicable water quality objectives" (Central Valley RWQCB 2013). Under the MRP, dischargers are required to develop a Groundwater Assessment Report which describes groundwater areas as "high vulnerability" or "low vulnerability" areas. Those areas assessed as a high vulnerability area will have more stringent requirements including enforced water quality objectives and maximum contaminant levels for discharges to protect beneficial uses of the groundwater.

8.4 Sources of Salt in the Stevinson Water District

The main sources of salt entering the Study Area are from water supplies for irrigation, which is obtained from both deep groundwater wells and surface water.

8.4.1 Groundwater

Groundwater, which is produced from aquifers between 30 to 210 feet below ground, has typical total dissolved solids (TDS) concentrations ranging from 300 to 1,300 mg/L.

8.4.2 Surface Water

Both the Merced River and the East Side Canal, which is used to deliver Merced River water to agricultural land, have low salinity. Salinity in the Merced River has an average TDS of 44.8 mg/L while the East Side Canal has a TDS of 64 mg/L.

8.5 Integrated Water Resources Plan

The IWRP was designed with the primary goals of conserving water and thereby improving water supply reliability and reducing water quality impacts of agricultural drainage water discharges to the San Joaquin River. The IWRP consists of several projects aimed at achieving these goals including installation of pipelines in unlined ditches and artificial wetland management. These projects are discussed below in more detail.

8.5.1 Pipelines

The original water conveyance system for SWD and MCWD primarily consists of earthen ditches that move water via gravity. Both districts have flat topography with an average slope of 0.1% generally towards the southwest. The earthen ditches are a significant source of seepage into an already shallow perched groundwater table, which, in turn, increases the soil salinity and reduces crop production. It is estimated that seepage associated with these earthen ditches is approximately 2,940 acre-feet/year (AF/yr) (SWD 2006). Water lost to seepage leaches salt from the saline soils that ultimately mixes with the shallow, saline groundwater further degrading its quality. The shallow groundwater flows towards the San Joaquin River and most likely contributes to the base flow in the river. SWD estimated that 60 to 70% of the seepage in the area will eventually discharge to the San Joaquin River (SWD 2005).

To reduce seepage losses, the IWRP proposed the Lateral Canal Pipelining Project which converts approximately 20,000 linear feet out of a total 66,900 linear feet of open earthen canals to pipelines ranging in diameters from 30 to 36 inches (SWD 2005). By installing the pipelines, the SWD and MCWD reduce water losses from evaporation and evapotranspiration (through vegetation along the bank) as well as seepage losses. The conserved water would be used to supply regional uses and would substitute for diverted water from tributaries to the San Joaquin River. The reduction in seepage is expected to "increase" flows of good quality water in the San Joaquin River and reduce the salt load entering the San Joaquin River and ultimately the Delta.

Performance

Table 8-1 summarizes the estimated reduction in water losses and corresponding salt loads expected from implementation of the *Lateral Canal Pipelining Project* (SWD 2005).

Table 8-1. Reduction in Water Losses and Corresponding Salt Load Decreases as a Result of Lateral Canal Pipelining Project (SWD 2005)

Description	Volume (AF/yr)	Resulting Decrease in Salt Loads (tons/year)
Reduced Groundwater Return Flows into the San Joaquin River	705	75[1]
Reduced Withdrawals from the San Joaquin River System	1,130	21[2]
Net Increase in Flow and Reduced Salt Load in the Delta (Mostly Occurring in the Summer)	425	54

Notes:
[1] Assumes an average groundwater TDS of 600 mg/L.
[2] Assumes an average surface water TDS of 100 mg/L.

8.5.2 Artificial Wetlands

As of 2006, SWD retained agricultural runoff in a 20 acre shallow, artificial wetland called Big Bottom Lake located between Highway 140 and the San Joaquin River. Water levels are controlled by a weir located at Turner Slough. During the summer, water levels in the wetland are typically raised, retaining agricultural drainage, and are lowered during the fall. Wetland water is discharged into the slough and ultimately carried to the San Joaquin River via a 48-inch pipe.

The IWRP proposed the Agricultural Drainage Control Project to enhance the existing wetland at Big Bottom Lake and construct a new wetland to improve the SWD's capacity to store drainage and storm water. This project would connect the wetlands through pipelines and control structures. The new wetlands would be converted from 34 acres of existing upland habitat (Figure 8-2). The new wetland would add capacity to store existing agricultural drainage water, with estimated TDS concentrations averaging 600 mg/L, and allow the flexibility of releasing this water to the San Joaquin River at times of high flow when there is typically greater capacity for salt (SWD 2006 & 2010).

Performance

Some of the salinity goals for the Agricultural Drainage Control Project include:

- Reduce loadings of TDS, boron, nitrogen, phosphorous, and sediment associated with agricultural drainage to the San Joaquin River.
- Control the timing of agricultural drainage discharges so that the loadings coincide with periods of high flow.
- Create a groundwater mound to obstruct intrusion of saline groundwater from the Westside of the San Joaquin Valley (SWD 2010).

Through a monitoring system implemented throughout both wetlands, SWD determined that nitrogen and phosphorus were reduced through vegetation uptake, and sediment loading was reduced through deposition in the wetlands. As a result of evaporation in the system, TDS increased in concentration; however, the total salt loading (tons per year) remained similar throughout the system. Through installed control structures, wetland releases have occurred during high flows in the San Joaquin River. The monitoring results did not provide any conclusive evidence that the project impacted local groundwater elevations (SWD 2010).

8.6 Cost of Implementation

As described in Table 8-2, the cost of implementation for both projects was documented by SWD (2005 & 2010).

Table 8-2. Estimated Project Costs (SWD 2005 & 2010)

Project	Capital Cost	Annual Operation & Maintenance Cost (O&M)
Lateral Canal Pipelines Project	$1,003,200[1]	$13,700[1]
Agricultural Drainage Control Project	$497,553[2]	Unknown[3]

Notes:
[1] In 2005 Dollars
[2] In 2010 Dollars. This is the money that has been spent as of June 2010 for the Agricultural Drainage Control Project.
[3] SWD 2010 did not indicate that there were any O&M costs associated with the project.

In 2007, the State Water Resources Control Board, under Proposition 50, provided $603,300 in grant money for the Agricultural Drainage Control Project (CALFED Bay-Delta Program 2007). As shown in Table 8-2, as of 2010, $497,553 of that grant money had been spent. The costs for the pipeline were shared between SWD ($107,200) and DWR through a grant ($896,000).

8.7 Salt Capacity

Salt capacity is intended to be an estimate of the limiting capacity of each salt Study Area to assess the likelihood of achieving long-term sustainable conditions within the Central Valley. The salinity issues addressed by the SWD are primarily source control solutions. These solutions either prevent or reduce the volume of saline groundwater from entering the San Joaquin River (through the Lateral Canal Pipelining Project), or by release of stored saline agricultural drainage water during times of high flow in the river (through the Agricultural Drainage Control Project). However, this Study Area does not remove salt, but improves the management of salt entering into the water district by conserving water supplies. Salt is still entering into the district and infiltrating (through agricultural drainage) into the shallow groundwater. As described above, this groundwater will eventually migrate downslope towards to the San Joaquin River, providing a source of the river's base flow. As such, an evaluation of the long-term capacity for accumulation and disposal of salt loads in this Study Area will be required.

8.8 Institutional and Regulatory Barriers

The programs described in the IWRP would need to adhere to the various applicable federal and state regulations. Compliance with regulations, such as WDRs and TMDLs issued by the Central Valley RWQCB, could potentially become a barrier to implementation. The future regulatory climate will likely become a barrier in implementation of such a project as regulations against salinity impacts to groundwater and surface water become more stringent.

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Section 9

Tulare Lakebed Study Area

9.1 Introduction and Overview

The Tulare Lakebed is located within the Tulare Lake Basin within the southern portion of the San Joaquin Valley (Figure 9-1). The Tulare Lake Basin, comprising approximately 10.5 million acres, is a mixture of federally owned National Parks, agricultural land, and municipalities. The Basin is essentially a closed system, draining only into the San Joaquin River in extreme wet years (Central Valley Regional Water Quality Control Board [RWQCB] 2004).

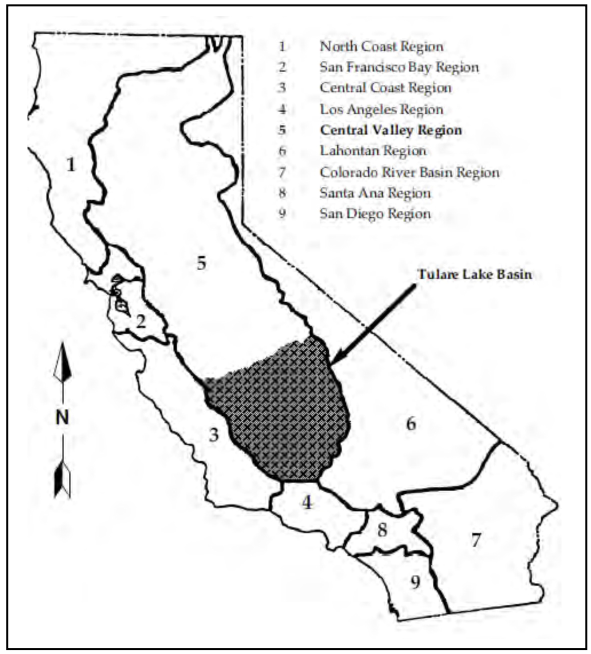

Figure 9-1
Tulare Lake Basin (Central Valley RWQCB 2004).

The historic Tulare Lakebed is a subarea of the Tulare Lake Basin located just southwest of the town of Corcoran (Figure 9-2). Prior to the twentieth century, lake levels and boundaries would flucuate as a result of variations of inflow from the major tributaries, with a maximum area of approximately 800 square miles in 1868. The lakebed became dry in 1898 and 1899. Subsequently, the lakebed was developed for irrigated agriculture and, combined with upstream dam construction, the portion of the lakebed which can experience flooding in wet years has shrunk to less than 200,000 acres (Tulare Lake Basin Water Storage District [TLBWSD] 2012).

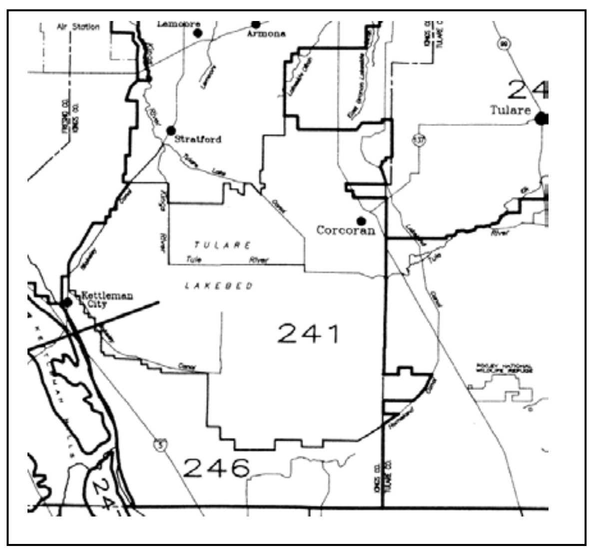

Figure 9-2
The Tulare Lakebed (Central Valley RWQCB 2004).

Underlying the majority of western and southern Tulare Lake Basin is the impermeable Corcoran Clay, the primary of several clay layers, which separates the groundwater into a perched groundwater table and a deeper groundwater table. The perched groundwater table can be encountered as soon as 5 feet below ground surface. It is estimated that the electrical conductivity (EC) of this shallow groundwater is in the range of 5,000 to more than 35,000 µS/cm (TLBWSD 2012)[1].

[1] In another CV-SALTS-related project, the Tulare Lake Basin Water Storage District is currently developing information regarding the typical EC values in a portion of the Tulare Lake bed area.

The sources of the salinity in the groundwater are a result of the closed basin and resulting saline soils from application of surface waters for irrigation. With no drainage out of the Tulare Lake Basin, agricultural operations in the lakebed have constructed a drainage collection system with evaporation basins for the accumulation of salts rather than allowing the salts to continue to increase in the groundwater.

Under the existing *Water Quality Control Plan for the Tulare Lake Basin (Second Edition)* (Central Valley RWQCB 2004), the groundwater basin under the lakebed has MUN, AGR, and IND[2] beneficial uses. And as a result of its beneficial use designation as MUN, the groundwater underneath the Tulare Lakebed is currently protected by water quality objectives and criteria established to protect a drinking water supply. More stringent regulations related to selenium levels and potential impacts to waterfowl have caused many evaporation basins to close. With their closure, stakeholders are searching for a solution to their drainage problems.

9.2 Problem Statement

The Tulare Lake Basin is a closed system, and there is currently no drain outlet. Salt is imported from surface water supplies, which are primarily used to irrigate the majority of the 3 million acres of agricultural land (Sholes 2006). Water that is not used by crops will eventually percolate into the ground, taking the imported salt from water supplies and leaching additional salt from areas with saline soils into the shallow groundwater. Within the closed Tulare Lakebed, groundwater is not able to drain out, and this increases the concentration of salt in groundwater. These high salt concentrations (ranging from 5,000 to 35,000 µS/cm [TLBWSD 2012]) reduce crop yields throughout the lakebed and make the shallow perched groundwater unusable for agriculture or municipal purposes.

Currently the groundwater source under the Tulare Lakebed is designated as having MUN and AGR beneficial uses. According to the Basin Plan, the water quality objectives for salinity are:

- *All ground water shall be maintained as close to natural concentrations of dissolved matter as is reasonable considering careful use and management of water resources.*
- *The maximum annual increase in EC for Tulare Lake is 3 umhos/cm (calculated using monitoring data for a cummulative average annual increase over a 5 year period).*

The Basin Plan also stipulates that, "*At a minimum, water designated MUN shall not contain concentrations of chemical consituents in excess of the maximum contaminant levels (MCLs) specifed in the following Provisions of Title 22 of the California Code of Regulations [CCR]"* (Central Valley RWQCB 2004). The requirements from Title 22 of the CCR are provided in Table 9-1.

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[2] According to the Central Valley RWQCB (2004):

- MUN (Municipal & Domestic Supply): uses of water for community, military, or individual water supply systems, including, but not limited to drinking water supply.
- AGR (Agricultural Supply): uses of water for farming, horticulture, or ranching, including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.
- IND (Industrial Service Supply): uses of water for industrial activities that do not depend primarily on water quality, including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.

Table 9-1. Title 22 Regulations (Taken from Table 64449-B)

Constituent	Maximum Contaminant Level (MCL) Ranges[1]		
	Recommended	Upper	Short Term
Total Dissolved Solids (mg/L)	500	1,000	1,500
Specific Conductance (µS/cm)	900	1,600	2,200

Notes:
[1] The MCL ranges are considered "Consumer Acceptance Contaminant Level Ranges"

With no drain outlet readily available for the lakebed, stakeholders (through the Tulare Lake Drainage District [TLDD]) have constructed and operated drainage system with three evaporation basins (North Evaporation Basin, Hacienda Evaporation Basin, and the South Evaporation Basin, see Figure 9-3) to accumulate salts and maintain agricultural productivity. Agricultural drainage water is conveyed to the evaporation basins through a series of sub-surface pipelines and open ditches. The water storage capacity of these three interconnected basins is approximately 17,000 acre-feet (AF). In recent years, the TLDD has filled their evaporation ponds to capacity as a result of increased demand of sub-surface drainage water disposal. It is estimated that the annual average evaporation capacity of the three basins is approximately 17,000 AF (TLDD 2012).

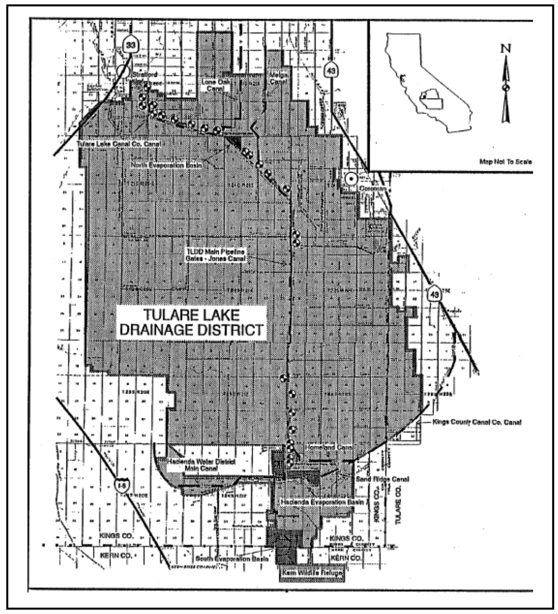

Figure 9-3
TLDD's Evaporation Ponds (Central Valley RWQCB 1993).

The use of these evaporation basins, however, has the potential to impact local and migrating wildlife that use the ponds as wetlands. In addition to the accumulation of salt in the evaporation basins, selinium is also present in the drainage water, although at lower levels than experienced in other areas. Potential impacts to waterfowl have caused a reduction in the use of evaporation basins throughout the Tulare Lake Basin hydrologic area. Table 9-2 provides the typical concentrations found in each of the three existing evaporation basins.

Table 9-2. Water Quality at the TLDD Evaporation Basins (Central Valley RWQCB 1993)

Constituent	North Basin		Hacienda Basin		South Basin	
	Range	Geometric Mean[1]	Range	Geometric Mean[1]	Range	Geometric Mean[1]
Chloride (mg/L)	580-5,900	1,336	80-35,000	4,523	1,400-72,000	5,790
Sodium (mg/L)	1,000-12,000	2,365	120-49,000	6,866	2,400-67,000	8,370
EC (µmhos/cm)	4,730-31,000	9,561	1,560-105,000	26,191	1-,600-153,600	29,586
Selenium (µg/L)	0.90-5.22	1.77	1-41	14	3-29	13
TDS (mg/L)	3,000-33,000	6,818	530-150,000	22,125	8,200-170,000	11,927

Notes:
[1] The geometric mean is defined as the *n*th root (where *n* is the count of numbers) of the product of the numbers.

Although the groundwater underlying the lakebed has beneficial use designations, the high salinity likely makes this water unuseable for either municpalities or agriculture uses. As a result, stakeholders in the basin are looking to de-designate a portion of the historic lakebed in this area from the MUN beneficial use (see footnote 1). The de-designation of the MUN beneficial use would simplify regulatory requirements of the Basin Plan related to the construction of evaporation ponds in the lakebed.

9.3 Study Area Attributes

9.3.1 Hydrology Attributes

The average annual precipitation in the valley portion of the Tulare Lake Basin is less than 10 inches per year. As mentioned above, the lakebed is considered a closed system and drains into the San Joaquin River by means of a diversion of the North Fork of the Kings River into the Fresno Slough only in extreme wet years. The main rivers that enter the Basin are the Kings, Kaweah, Tule, and Kern Rivers which flow generally west from the Sierra Nevada Mountains. In addition, water is imported into the Basin from manmade waterways including the Friant-Kern Canal and the California Aqueduct. The groundwater in the Basin is also considered a closed aquifer, due to the "*nature of the Tulare Lake Basin*" which prevents little groundwater outflow (Central Valley RWQCB 2004).

9.3.2 Soil Attributes

The Tulare Lakebed is relatively flat with a general slope of about 1 foot for every mile away from the historical boundaries of the lake. The soils in the area are generally made up of alluvial fan and basin soils underlain by an impermeable clay layer (typically referred to as Corcoran Clay or "E" Clay) (TLBWSD 2012). The majority of these soils were deposited when the Central Valley was an inland sea. The deposition of these sediments in a marine environment is a primary reason for saline soils today.

9.3.3 Land Cover Attributes

The primary land use in the Tulare Lakebed Study Area is agriculture. The area produces cotton, wheat, safflower, alfalfa hay, processing tomatoes, and other field crops (TLBWSD 2012). There is no urban development within the Study Area delineated for the MUN de-designation. The towns of Corcoran and Alpaugh are located along the eastern border and Kettleman City is on the western border. Stratford is located to the north.

9.3.4 Institutional, Economic & Regulatory Attributes

The economy of the Tulare Lake Basin is predominantly agricultural. The impacts of salinity on irrigated agriculture production are primarily related to the availability of drainage services, soil salinity, and groundwater conditions.

Irrigated agriculture in an area with salinity issues, such as the Central Valley, is driven by economic factors such as application of improved technology, availability of labor and other resources, demand for commodities, and production. Improved efficiency in irrigation and drainage reuse are examples of technological innovations that have improved crop yields in recent years (Howitt et al 2009). Future production of irrigated agriculture operations will be impacted by the reliability of high quality water supplies, potential climate change impacts, future policies impacting the agricultural sector, and increasing crop production in other countries (Howitt et al 2009).

Evaporation Basins. The three evaporation basins for the TLDD are currently regulated by the Central Valley RWQCB under Order No. 93-136, which was adopted in August 1993. As part of this order it is stated that: "The discharge [into these evaporation basins] shall not cause or contribute to degradation of any useable water supply" (Central Valley RWQCB 1993). In addition, TLDD must develop "a program of management actions to reduce, avoid, and mitigate for adverse environmental impacts to wildlife" (TLDD 2012). Protocols established to mitigate for the adverse environmental impacts have been implemented for all three basins.

Irrigated Lands Regulatory Program (ILRP). In March 2013, the Central Valley RWQCB published the tentative WDR and MRP for the Tulare Lake Basin area. Under this WDR, it is specified that discharges to either surface water or groundwater "*shall not cause or contribute to an exceedance of applicable water quality objectives*" (Central Valley RWQCB 2013). Under the MRP, dischargers are required to develop a Groundwater Quality Assessment report which describes groundwater areas as "high vulnerability"[3] or "low vulnerability"[4] areas. Those areas assessed as a high vulnerability area will have more stringent requirements including enforced water quality objectives and maximum contaminant levels for discharges to protect beneficial uses of the groundwater.

9.4 Sources of Salt in the Tulare Lake Basin

Sources of salt for the lakebed are similar to the sources of salt for the Basin. The main out-of-basin sources of salts are imported surface waters for irrigation. It is estimated that the natural river system in the Basin imports approximately 145,000 tons of salt annually. The manmade water ways of the Friant-Kern Canal and the California Aqueduct import 63,000 and 336,000 tons of salt annually, respectively (Central Valley RWQCB 2004). The majority of this water is used for agricultural irrigation. The water not absorbed by crops will typically percolate into the soils, leaching out salt in the soils, and concentrating salts in the shallow groundwater.

9.5 De-designation of the Groundwater MUN Beneficial Use

The delisting or designation of the MUN beneficial use is allowed by the State Water Resources Control Board (SWRCB) under Resolution No. 88-63. Per this order, all surface or groundwater in the State is designated, by default, to have an MUN beneficial use with a few exceptions. The exceptions for both surface and groundwater include waters where:

- *The TDS exceeds 3,000 mg/L (an EC of 5,000 µS/cm) and it is not reasonably expected by Regional Boards to supply a public water system, or*
- *There is contamination, either by natural processes or by human activity (unrelated to a specific pollution incident), that cannot reasonably be treated for domestic use by using either Best Management Practices or best economically achievable treatment practices.*

9.5.1 CV-SALTS

CV-SALTS, in collaboration with the TLDD and TLBWSD, is currently supporting a project intended to de-designate MUN from a portion of the Tulare Lakebed because it can serve as an appropriate archetype or template for studies in which the purpose is to evaluate the appropriateness of the MUN

[3] High vulnerability areas for groundwater "meet any of the following requirements: (1) there is a confirmed exceedance of a water quality objective or applicable water quality trigger in a groundwater well and irrigated agriculture may cause or contribute to the exceedances; (2) the Basin Plan requires development of a groundwater quality management plan for a constituent or constituents discharged by irrigated agriculture; or (3) the Executive Officer determines that irrigated agriculture *may be causing or contributing to a trend of degradation of groundwater that may threaten applicable Basin Plan beneficial uses.*" (Central Valley RWQCB 2013)

[4] Low vulnerability areas for groundwater are those areas that do not qualify as a high vulnerability area.

beneficial use on a designated groundwater body. Moreover, the outcome of the de-designation effort can help advance the purpose and requirements associated with the development of the SNMP for the Central Valley region in that it may provide a template that can be utilized to identify areas that may serve as salt sinks until alternate treatment, disposal and/or export alternatives are developed.

The CV-SALTS Technical Advisory and Executive Committees approved a workplan (CDM Smith 2012) to complete the following technical tasks within the framework of the requirements associated with a Basin Plan Amendment (BPA), the mechanism by which the MUN use may be de-designated from a water body:

1. Define the regulated area targeted for MUN de-designation ("Target Area") and the area around the periphery of the Target Area that is included in the technical analyses. Combined, the Target Area and peripheral area around the Target Area comprise the "Project Area";

2. Complete the technical tasks within the Target or Project Areas to demonstrate that the exemption criteria in SWRCB Resolution 88-63 apply and characterize the past, present and probable future uses of the area;

3. Identify if any additional data collection is necessary to support a BPA; and, if so, complete the required data collection;

4. Prepare the regulatory documentation required to support a BPA to remove the MUN beneficial use in the targeted area in coordination with the CV-SALTS processes;

5. Coordinate with the ongoing CV-SALTS process so that the findings and procedures from this effort are closely linked with the larger purposes of CV-SALTS; and

6. Complete stakeholder participation and other regulatory activities to support and complete a BPA process.

Implementation of the CV-SALTS workplan for the Tulare Lake MUN de-listing is currently underway. In 2012, the TLBWSD prepared a proposed delineation of the Project Area that was approved by the Regional Board. Currently, TLDD and TLBWSD are completing a comprehensive hydrogeologic analysis of the MUN de-designation target area.

9.5.2 Additional Evaporation Basin

As mentioned above, in recent years the TLDD's evaporation basins have been filled to capacity as a result of increased demand for sub-surface drainage water disposal. The TLDD has proposed to expand their existing drainage disposal system with the addition of a new 1,800 acre evaporation basin (which would be located north of the existing Hacienda Evaporation Basin).

9.6 Cost of Implementation

As the de-designation of the MUN beneficial use is still an ongoing process, it is not known how it would impact costs for implementing future salt management projects. If the de-designation were to occur, it could reduce the regulatory compliance costs for expanding and operating evaporation ponds as well as related costs for other salt management options. The specific cost implications are unknown at this time.

In addition, the costs associated with the construction of a new evaporation basin are also unknown at this time. It is assumed that the costs would be associated with the labor and equipment needed to excavate the soil, construct the needed conveyance pipeline, and construct any other needed ancillary facilities.

9.7 Salt Capacity

The Tulare Lake Basin is considered a closed basin and therefore does not have a drainage outlet. With the inflow of salt from surface waters, the basin is currently accumulating salt. As such, an evaluation of the long-term capacity for accumulation and disposal of salt loads in this Study Area will be required. In the Tulare Lake Basin Plan, the Central Valley RWQCB specifically states that, "*a valleywide drain to carry salts out of the valley remains the best technical solution to the water quality problems of the Tulare Lake Basin*" (Central Valley RWQCB 2004). While an "Out-of-Valley" drain would provide the best long-term solution to salt accumulation in the Tulare Lake Basin, it would present many regulatory, technical, and financial obstacles as well. Agricultural operators in the Tulare Lake Basin are considering numerous other salinity management alternatives (e.g., drainage management, regional re-use, drain water treatment and expanded evaporation ponds) that would provide near- and mid-term salt capacity.

9.8 Institutional and Regulatory Barriers

The de-designation of the MUN beneficial use for a portion of the historic Tulare Lakebed requires completion of all required documentation to amend the Tulare Lake Basin Plan and approval by the Central Valley RWQCB and SWRCB. Completion of these steps is a public process requiring workshops and hearings. As this process is currently being undertaken, it is not fully known where potential barriers to completion of the BPA may occur.

As mentioned, the primary regulatory barrier for salt management projects in the historic Tulare Lakebed is the MUN beneficial use designation for groundwater. The delisting of this beneficial use would facilitate the implementation of other salinity management projects, including construction of additional evaporation ponds, by removing some of the current regulatory requirements. The implementability of these projects would be highly dependent on future regulations.

9.9 References

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Section 10

Westside Regional Study Area

10.1 Introduction and Overview

The westside region of the San Joaquin Valley is located primarily in Fresno County, but also includes a small portion of Merced and Kings Counties (Figure 10-1). The area encompasses San Luis, Westlands, Broadview, Firebaugh Canal, Panoche, and Pacheco water districts. This region also includes the Camp 13 Drainage District and a portion of the Central California Irrigation District (San Joaquin River Exchange Contractors Water Authority [SJRECWA] 2003). The northwestern portion of the Study Area, with the exception of the Westland Water District, is known as the Grassland Drainage Area (GDA).

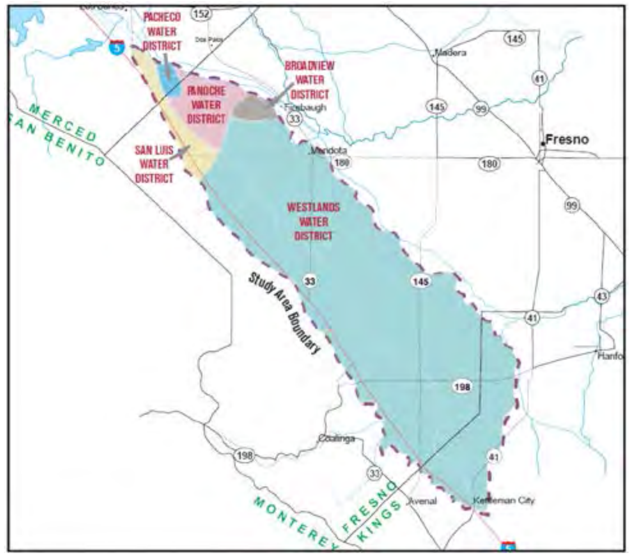

Figure 10-1
Location of Westside of San Joaquin Valley
[http://www.swrcb.ca.gov/rwqcb5/water_issues/salinity/salt_management_efforts/index.shtml]

Much of the area has been plagued with drainage problems since the 1950s (Reclamation 2006), although salt accumulation in the shallow groundwater zones can be traced back to the 1890s and early 1900s (Johnston *et al.*, 2012). The San Luis Act of 1960 (Public Law 86-488) authorized the San Luis Unit, which is part of both the federal CVP and the California State Water Project. The San Luis Unit is operated jointly by Reclamation and DWR and its principal purpose was to supply irrigation water to farmlands on the westside. A number of jointly constructed and operated conveyance facilities were developed to deliver water to the westside area. Public Law 86-488 also mandated a joint (with the state) master drain or a federal-only interceptor drain for irrigation drainage waters from the federal San Luis Unit service area with ultimate disposal in the Bay-Delta. The state did not participate in the drain and the federal government began construction of the drain in 1968. Only 87 miles of the planned 188 miles were constructed and all construction was halted in 1975 because of rising costs and environmental concerns about discharges in the Bay-Delta. The San Luis Drain ultimately ended near Gustine, CA.

Kesterson Reservoir was originally designed as a flow-regulating reservoir, but due to the aforementioned cost and environmental concerns, it became a terminal reservoir. By the early 1980s, Reclamation began accepting drainage water from growers in the WWD who were part of the drainage collector system in the northern portion of WWD. Within 18 months, Kesterson Reservoir had reached capacity and it was determined that the evaporation rate was not sufficient to handle the drainage water inflow Kesterson Reservoir is located in what became the Kesterson National Wildlife Refuge which was jointly operated by Reclamation and USFWS. Soon after the reservoir reached capacity, the USFWS notified Reclamation of abnormally high selenium (Se) concentrations in mosquitofish and by 1983 USFWS noted deformities and deaths in aquatic birds.

As a result of selenium impacts to migratory birds at Kesterson Reservoir, Reclamation ceased discharges through the San Luis Drain in 1986, thereby removing the drainage option for the westside region. In October 2002, Reclamation published the *San Luis Drainage Feature Re-Evaluation Plan Formulation Report*, which identified potential alternatives to address drainage issues throughout the westside region. The alternatives would then be re-evaluated in the *San Luis Drainage Feature Re-evaluation Feasibility Report* and the *Final Environmental Impact Statement* (FEIS) (Reclamation 2006). Reclamation signed the Record of Decision (ROD) in March 2007, selecting the *"In-Valley/Water Needs/Land Retirement Alternative"* as the preferred alternative. The Westside Regional Drainage Plan (Plan) was created by stakeholders in the drainage area to identify actions that could be developed on an accelerated timeframe to meet increasingly stringent discharge standards (SJRECWA 2003). All elements of the Plan were created to be consistent with the *San Luis Drainage Feature Re-Evaluation Plan Formulation Report* (Reclamation 2002). WWD is developing a drainage service for a subunit of its district and Reclamation has awarded a contract for a demonstration treatment plant within the Panoche Water District's boundaries.

The westside region of the San Joaquin Valley provides a prototype SSALTS Study Area describing salinity-related issues on a regional scale. The westside, however, also faces another serious challenge in the presence of naturally-occurring Se in native soils. The Plan and its recommended actions provide an opportunity to study a combination of salt management strategies developed to address the drainage impaired area, but the strategies must also ensure that Se-exposure pathways are limited to a degree in which acute and chronic effects are not observed in sensitive species. Within the westside region, such actions include land retirement, regional reuse, groundwater management, source control, treatment of drainage water for both salinity and selenium, and the use of a portion of the San Luis Drain to eliminate the historic use of Grassland area channels which historically discharged to the San Joaquin River.

10.2 Problem Statement

The westside region is composed primarily of agricultural land, which has poor drainage and relatively high concentration of salts, selenium, boron, and other naturally-occurring constituents. The poor drainage is a result of the presence of impermeable shallow clay layers (including the Corcoran Clay) that prevent irrigation water from infiltrating into the deeper groundwater aquifers, resulting in trapped irrigation water forming a shallow, or perched, water table. Without an outlet, the highly saline waters accumulate in the root zone close to the ground surface and reduce crop productivity. The high selenium levels in the drainage water are toxic to wildlife and create challenges for safe off-farm drainage and disposal of the water. The stakeholders of the drainage area have begun to implement activities, as identified in the Plan, to increase the crop productivity in the region and to manage subsurface drainage water.

10.3 Physical Attributes

10.3.1 Hydrology and Drainage Patterns

Most of the westside is semi-arid with highly seasonal precipitation typically occurring from November through April. The average precipitation for the area is approximately 8.6 inches per year, but can range from 2.4 inches along the valley floor to almost 21 inches in the upland areas of the coastal range (Reclamation 2006).

Stream flows vary by season. Higher flows for the San Joaquin River Basin occur during wet winters, spring snowmelt, and in February and March when water levels in managed wetland refuges are drawn down. Lower river flows tend to occur during hot dry summers and falls and non-irrigation periods when return flows are reduced. River flows may also vary on an annual basis (*e.g.*, stream flows will be higher during wet years when substantial precipitation has occurred and lower during dry years with below normal precipitation). In addition to the San Joaquin River, variation in the flows of the Panoche and Silver Creek flows impact the hydrology of the westside region (Personal Communication – Joe McGahan & Dave Cory, October 23, 2013).

Salt Slough and Mud Slough are the major westside tributaries to the San Joaquin River, contributing not only flow, but salinity and Se – if the flows are not managed. Flows in Mud Slough downstream of the San Luis Drain are composed mainly of seasonal runoff in the winter, managed wetlands discharges in the spring and GDA discharges in the summer. The primary sources of water used for irrigation in the westside are the Delta-Mendota and San Luis Canals and local groundwater, which have low to moderate levels of salinity (Central Valley Regional Water Quality Control Board [RWQCB] 2004). The applied irrigation waters percolate through saline soils and leach salts from the soil. The agricultural return flows in the westside region increase salinity levels during periods of low flow and are a major portion of the total salt load to the San Joaquin River.

10.3.2 Land Cover

The westside is predominately an agricultural region characterized by a very flat topography. The soils are fairly uniform throughout, primarily composed of alluvium. As of 2003, irrigated crop acreage in the WWD alone could range up to 560,000 acres depending on the availability of water and market conditions (SJRECWA 2003). None of the agricultural lands within WWD currently discharge into the San Joaquin River. The cropping patterns vary throughout the districts (Table 10-1) (Reclamation 2006).

Table 10-1. Cropping Patterns in the Unit (Personal Communication – John Dickey)

Major Crop Type	Number of Acres	Percent of Irrigated Area
Forage	70,393	11%
Cotton	227,672	36%
Grain	7,256	1%
Sugar Beets	8,982	1%
Other Field	64,959	10%
Tomatoes	110,268	17%
Truck	70,848	11%
Orchard/Vineyard	74,452	12%
Total	**634,830**	**100%**

10.3.3 Institutional, Economic & Regulatory Attributes

The economy of the westside is predominantly agriculturally-based. The impacts of salinity on irrigated agriculture production are primarily related to the availability of drainage services, soil salinity, and groundwater conditions.

Irrigated agriculture in an area with salinity issues, such as the Central Valley, is driven by economic factors such as application of improved technology, availability of labor and other resources, demand for commodities, and production. Improved efficiency in irrigation and drainage reuse are examples of technological innovations that have improved crop yields in recent years (Howitt, *et al.* 2009). Future production of irrigated agriculture operations will be impacted by the reliability of high quality water supplies, potential climate change impacts, future policies impacting the agricultural sector, and increasing crop production in other countries (Howitt et al 2009).

Water Quality Control Plan (Basin Plan). The Basin Plan regulates drainage areas in the Sacramento and San Joaquin River Basins, covering an approximate 43,090 square miles. The 3rd Edition of the Basin Plan was originally adopted by the Central Valley RWQCB in 1994. In subsequent years, the Basin Plan has been amended. In 1996, the Basin Plan (Resolution 96-147) was amended to address subsurface drainage discharges. The 4th Edition of the Basin Plan states:

- "The control of toxic trace elements in agriculture subsurface drainage, especially selenium, is the first priority.
- The control of agricultural subsurface drainage will be pursued on a regional basis.
- The reuse of agricultural subsurface drainage will be encouraged, and actions that would limit or prohibit reuse discouraged.
- Of the two major options for disposal of salts produced by agricultural irrigation, export out of the basin has less potential for environmental impacts and, therefore, is the favored option. The San Joaquin River may continue to be used to remove salt from the basin so long as water quality objectives are met.
- The valley-wide drain to carry the salts generated by agricultural irrigation out of the valley remains the best technical solution to the water quality problems of the San Joaquin River and Tulare Lake Basin. The Regional Water Board, at this time, feels that a valley-wide drain will be the only feasible, long-range solution for achieving a salt balance in the Central Valley. The Regional Water Board favors the construction of a valley-wide drain under the following conditions:
  - All toxicants would be reduced to a level which would not harm beneficial uses of receiving waters.
  - The discharge would be governed by specific discharge and receiving water limits in an NPDES permit.
  - Long-term, continuous biological monitoring would be required.
- Optimizing protection of the beneficial uses on a watershed basis will guide the development of actions to regulate agricultural subsurface drainage discharges.
- For regulation of selenium discharges, actions need to be focused on selenium load reductions" (Central Valley RWQCB 2011).

Irrigated Lands Regulatory Program (ILRP). This program, initiated in 2003 by the Central Valley RWQCB, is used to regulate pollutants in agricultural runoff. Through this program, the Central Valley RWQCB instituted Conditional Waiver of Waste Discharge Requirements that included regulations that, in cases where impairment of the water quality is found, required monitoring of receiving waters and other, as needed, corrective actions. These Conditional Waivers are now being replaced by WDRs for applicable areas (Central Valley RWQCB 2013). The GDA is not currently in the ILRP because GDA has a permit to discharge from the Grassland Bypass Project. As their permit is renewed, issues related to the ILRP will be added.

10.4 Sources of Salt in the Westside of the San Joaquin Valley

There are several sources of salinity in the Valley, including groundwater, soils, and surface water. This section describes each in greater detail.

10.4.1 Groundwater

The San Joaquin River Basin contains 26 groundwater basins, with 9 of those basins being classified as significant sources of groundwater (Reclamation 2006). The total dissolved solids (TDS) of the groundwater averages about 500 mg/L, but ranges from 64 to 10,700 mg/L (Figure 10-2). Calcium, magnesium, sodium, bicarbonates, sulfates, and chlorides are all significant components of TDS. The highest groundwater salinity occurs in areas of the highest native soil salinity (Reclamation 2006).

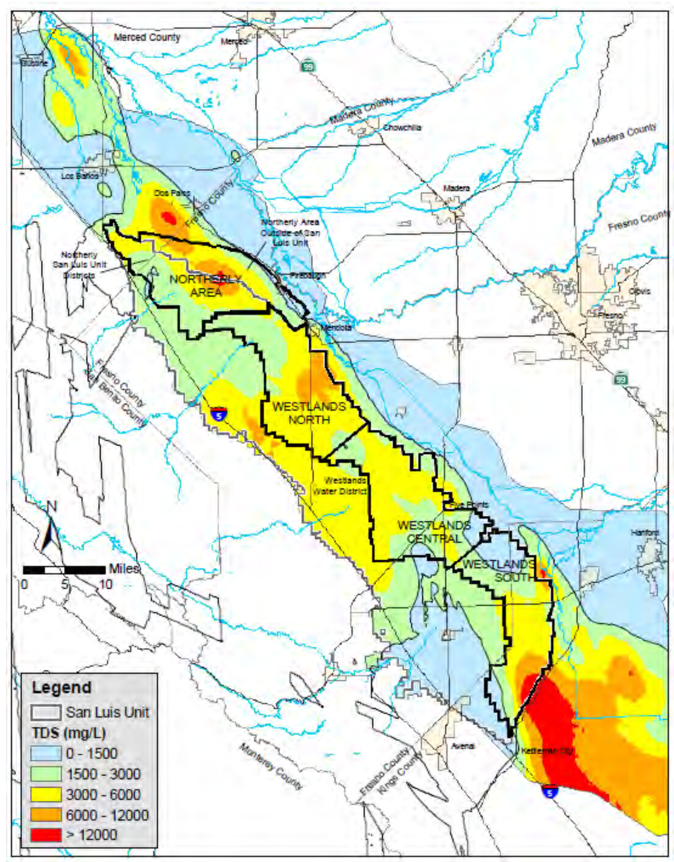

Figure 10-2
TDS in Shallow Groundwater
(Reclamation 2006)

10.4.2 Soils

The coastal ranges on the westside of the San Joaquin Valley are composed of sandstones and shales of marine origin. Because the leeward (east) side of the coastal ranges receives little precipitation, these soils tend to be poorly-sorted with low permeability. The marine soils also have a high concentration of salt and relatively high concentrations of naturally-occurring Se. In addition, shallow clay layers and the Corcoran clay, a Pleistocene lacustrine deposit, underly the westside limiting drainage leading to higher salinity in shallow groundwater. Hence, while the westside includes some of the most productive agricultural lands in California, the underlying soils contribute to and are impacted by increasingly severe problems associated with poor drainage and increased salinity, Se concentrations, and sodicity[1].

10.4.3 Surface Water

The major sources of surface water in the area include imported water from the Central Valley Project and the San Joaquin River and its tributaries. The water quality of the San Joaquin River is degraded because of upstream diversions of high quality water for irrigation on the eastern side of the San Joaquin Valley and because of agricultural drainage into the river and its tributaries, especially Salt Slough and Mud Slough. The water quality of the San Joaquin River improves further downstream with water entering the San Joaquin River from east side tributaries, including the Merced River, the Tuolumne River, and the Stanislaus River.

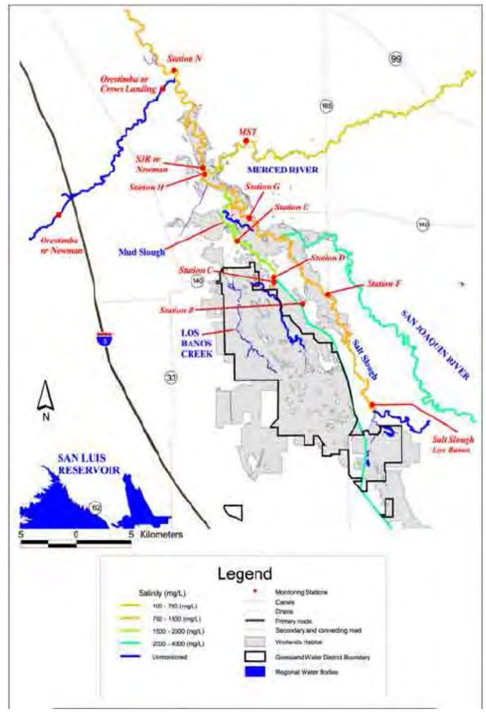

Figure 10-3
Existing Conditions for Salinity (WY 1999) (Reclamation 2006)

In 2010, the Central Valley RWQCB published its Final Staff Report for *Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Salt and Boron Discharges into the Lower San Joaquin River* (Central Valley RWQCB 2004). This report established the TMDL that could enter the Lower San Joaquin River from sources without causing exceedances in water quality standards at Vernalis.

10.5 Drainage in the Westside Region

As a result of the closure of the San Luis Drain and Kesterson Reservoir, growers in the Westlands Water District were left without an agricultural drainage solution. With the increasing need for drainage, the GDA and the Westlands Water District developed solutions to meet their drainage needs. The following sections describe the specific program components implemented by the GDA and the Westlands Water District in more detail.

10.5.1 Westlands Water District

The Westlands Water District is considered a “closed system” as there is no discharge out of the district. Agricultural drainage water is currently allowed to seep into the shallow groundwater table. The following section describes the actions that the Westlands Water District is implementing to decrease the impacts of the accumulating agricultural drainage in the shallow groundwater table.

[1] Sodic soils are soils with a disproportionately high makeup of sodium in caution exchange sites on the mineral surfaces. High sodicity leads to poor physical characteristics of the soil (soil structure), as well as low water permeability.

10.5.1.1 Land Retirement

The Westlands Water District includes more than 560,000 irrigated acres of various crops, of which approximately 200,000 acres are affected by salinity and drainage issues (SJRECWA, *et al.* 2003). As a potential solution to the problem, Reclamation (in coordination with the [USFWS] and the Bureau of Land Management [BLM]) undertook the Land Retirement Demonstration Project to determine the impacts of land retirement. Under this program, 1,443 acres of irrigated lands, characterized by low productivity, poor drainage, and groundwater with high selenium concentrations, were retired. The goals of this program were to reduce drainage, enhance fish and wildlife resources, and make water available for other purposes (DOI 2005).

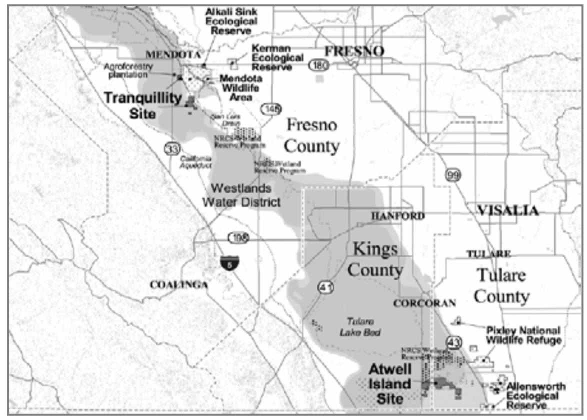

Figure 10-4
Map of Tranquility and Atwell Sites (DOI 2005)

The Project identified two study sites, the Tranquility site (located in western Fresno County) and the Atwell Island site (located in Kings and Tulare counties) (Figure 10-4). The lands purchased were previously used to grow crops such as cotton, tomatoes, grain, and sugar beets. The retired land would no longer be irrigated, which will both reduce impacts from deep percolation from these lands and reduce agricultural drainage water. As described in the Westside Regional Drainage Plan, it is anticipated that up to 200,000 acres of drainage-impacted land would be purchased for land retirement. The potential use of these retired lands is discussed below, under Regional Reuse.

Performance

During a five-year study to evaluate the impacts from land retirement, both study sites were monitored for changes in soil, groundwater, and surface water conditions. Findings included: (1) shallow groundwater declined (Figure 10-5), indicating that irrigation water was the primary source of groundwater recharge; and (2) salinity in the soils decreased (Table 10-2) (DOI 2005).

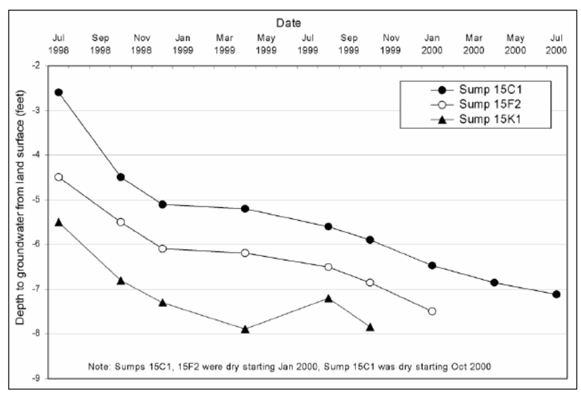

Figure 10-5
Impacts of land retirement on depth to groundwater (DOI 2005)

Table 10-2. Salinity in Soils at Tranquility Site (DOI 2005)

Depth (feet)	Median Salinity 1999 (µg/kg)	Median Salinity 2004 (µg/kg)	Sites Decreasing	Sites Increasing
0-1	3.66	1.53	102	8
2-3	6.67	4.99	24	22
4-5	7.35	5.88	22	4

Institutional and Regulatory Attributes

Land retirement programs have been voluntary and have involved willing sellers in areas impacted by shallow groundwater. Land retirement programs have been implemented by Westlands Water District and state and federal agencies; Westlands Water District alone has retired approximately 100,000 acres from irrigated agriculture. The Westlands Regional Drainage Plan includes the following framework for land retirement:

- The plan must provide balanced benefits for all affected parties.
- The plan must provide farmers a fair and reasonable price for their land, with values determined as if those lands had drainage services provided.
- The program must be voluntary, involving only willing sellers.
- No harm or loss of water should occur to any other Central Valley Project (CVP) water user.
- Third-party impacts must be identified and addressed. (SJRECWA 2003)

Title to these lands remains with Westlands Water District or a nonprofit entity. Under the program, the land retirement may be temporary or permanent, water rights remain with the region and the retired lands must be managed to be compatible with continuing agriculture on remaining farmlands.

Reclamation has authority under the Central Valley Project Improvement Act (CVPIA) Section 3408(h), to purchase land and water rights from willing sellers who receive CVP water. Under Section 3408(h), the Land Retirement Program (LRP) was developed cooperatively by an interagency DOI team with representatives from Reclamation, USFWS, and the BLM. Under the LRP, drainage impaired farmland is acquired from willing sellers and converted to restored upland wildlife habitat. Land retirement helps achieve the CVPIA goals to reduce drainage, enhance fish and wildlife resources and make water available for other CVPIA purposes. DOI developed interim guidelines for the LRP including the application, review and selection process (DOI 1997).

Regulatory. Land retirement programs are not subject to Clean Water Act requirements since they do not result in discharges to surface waters. However, land retirement programs are subject to other environmental review and regulations. For example, to satisfy Endangered Species Act requirements, the LRP included preparation of a USFWS Biological Opinion (BO) that identified concerns about the potential impacts of the program on groundwater levels, groundwater and surface water quality, soil chemistry, and biota. The BO established performance standards for monitoring selenium and mercury concentrations in surface water and groundwater at land retirement sites.

10.5.2 Grasslands Drainage Area

The GDA is considered an “open system” as the GDA exports saline drainage water out of the valley through the implementation of several projects. The GDA is working towards becoming a “zero-discharger” and essentially becoming a “closed system” through the use of regional reuse techniques. As the GDA works towards this goal, they have implemented the Grasslands Bypass Project to allow discharge out of the GDA.

10.5.2.1 Grasslands Bypass Project

In 1996, Grassland Area Farmers (GAF)[2] formed to develop a program to improve water quality in drainage channels in the GDA (approximately 97,000 acres) (Figure 10-6). The program consolidates subsurface agricultural drainage flows[3] regionally and conveys the flows around the habitat areas to the San Joaquin River downstream of the Merced River confluence at Mud Slough. Eventually the drainage water enters the San Joaquin River and is ultimately discharged through the Delta. The land within the Grasslands Bypass Project never discharged into the Kesterson Reservoir but discharged to the San Joaquin River using channels within the grassland wetland area..

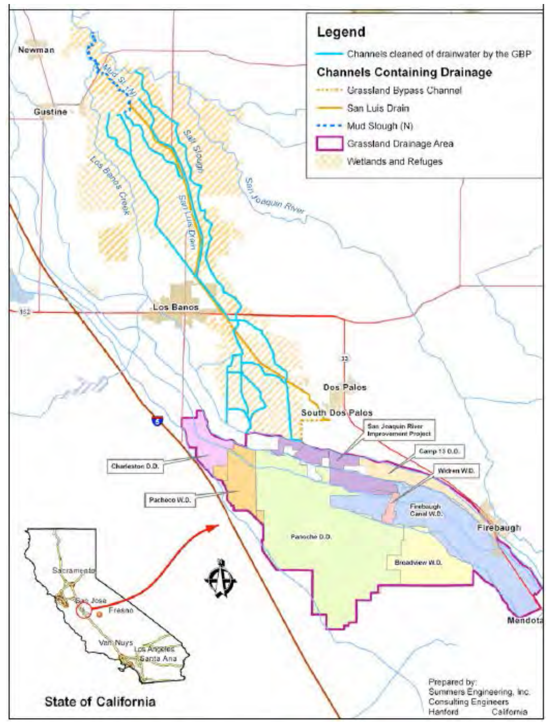

Figure 10-6
Location Map of Grassland Drainage Area (Reclamation 2010)

The Grasslands Bypass Project (Project), which began on September 27, 1996 and will continue through December 31, 2019, is based on an agreement between Reclamation and the San Luis and Delta-Mendota Water Authority (SLDMWA) to use a 28-mile segment of the San Luis Drain to convey agricultural subsurface drainage water from the GDA to Mud Slough.

The purpose of the Project is to separate unusable agricultural drainage water from the wetland water supply and also to facilitate drainage management to maintain the viability of agriculture in the area (Reclamation 2010a). By re-routing saline agricultural water to the San Luis Drain, the Project has effectively removed this high saline drainage water from water channels that supply water to more than 160,000 acres of wetlands and wildlife area in the GDA (Reclamation 2010a).

Performance

The performance of the Project has been documented in both monthly and annual reports. Monitoring stations are located throughout the area to provide information such as volume, flow, and water quality in various locations (Figure 10-7). The report data provide an in-depth look at the impacts of the Project.

Table 10-3 summarizes drainage volume and constituent load reductions for water years (WY) 1996 through 2008. During this period, average annual drainage volume reduction has been 47%, selenium load reduction has been 56%, and salt load reduction has been 37%, as compared to the pre-project conditions in WY 1996 (San Francisco Estuary Institute [SFEI] 2009).

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[2] At the time of formation, the GAF included the Broadview Water District, Charleston Drainage District, Firebaugh Canal Water District, Pacheco Water District, Panoche Drainage District, Widren Water District, and the Camp 13 Drainage District.
[3] In the northern portion of the westside of the San Joaquin Valley, over 30,000 acres of the agricultural land have subsurface drains installed; these drains discharge via the Grasslands Bypass (SJRECWA 2003).

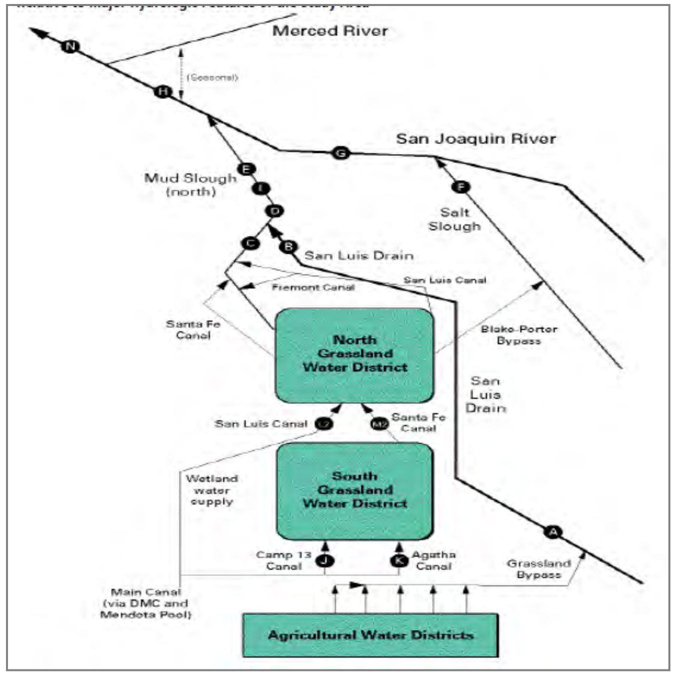

Figure 10-7
Schematic of Grassland Bypass Project
(Reclamation 2010)
Letters in the figure indicate the location of various water quality monitoring stations throughout the area.

Table 10-3. Grassland Drainage Area – Volume and Loads (SFEI 2009)

Water Year	Discharge (AF)	Selenium Load (lbs)	Salt Load (tons)
1996	53,000	10,036	197,500
1997	39,860	7,096	172,600
1998	49,244	9,118	213,500
1999	32,310	5,124	149,100
2000	31,260	4,603	135,000
2001	28,254	4,377	120,000
2002	28,391	3,939	116,100
2003	27,290	4,029	118,152
2004	27,700	3,871	120,200
2005	29,960	4,288	138,900
2006	25,995	3,563	79,094
2007	18,531	2,554	79,094
2008	15,695	1,737	66,459
2009	13,166	1,264	56,223
2010	14,529	1,577	67,661
2011	18,513	2,067	87,537
2012	10,486	741	38,400
% Reduction 96-12	80%	93%	81%

Note: WY 97, 98, and 2005 include discharges through Grasslands Water District

Institutional and Regulatory Attributes

Institutional. The institutional framework for the Project was initiated in 1996 when several irrigation and drainage districts formed the GAF, a regional drainage entity under the umbrella of the SLDMWA. The SLDMWA negotiated Use Agreements with Reclamation in order to use a portion of the San Luis Drain. The first Use Agreement was signed in 1995 and allowed the SLDMWA to convey water in the San Luis Drain from 1996 through 2001. A second Use Agreement was executed in 2001 and extended through 2009. An Environmental Impact Statement/Environmental Impact Report (EIS/EIR) was prepared in 2009 to extend the San Luis Drain Use Agreement through 2019. The current Use Agreement facilitates continued drainage management to maintain the economic viability of agriculture and improve water quality in the San Joaquin River (Reclamation and SLDMWA 2009). The Use Agreement identifies "draining parties" including the Broadview Water District, the Firebaugh Canal District, the Pacheco Water District, the Panoche Water District, the Charleston Water District, and the Widren Water District. In addition to load reduction assurances for salt and selenium, the Use Agreement commits the draining parties to implementing water conservation programs and developing long-term management plans.

A "Drainage Oversight Committee" is convened as necessary to monitor the progress and operation of the Project and makes recommendations to Reclamation, the Central Valley RWQCB and the draining parties. The committee members include managers from Reclamation, EPA, USFWS, CDFW, and the Central Valley RWQCB.

The Use Agreement includes "Drainage Incentive Fees" to be imposed when monthly or annual selenium or salt loads are exceeded. The fees can be waived for uncontrollable or unforeseeable events. Credits can be awarded toward future incentive fees if monthly or annual selenium or salinity discharges are less than 90% of the required load target values.

The monthly and annual fees are set as an annually variable flat price per pound for selenium and per ton for salt. The fees have annual caps which increase from a total of $600,000 during year 1 to $1,200,000 during year 10. The incentive fees must be used for programs or actions that will assist in meeting selenium load values, salinity load values and discharge goals, water quality objectives in the drainage area, and/or will enhance wildlife values in the drainage area or adjacent areas (Reclamation and SLDMWA 2009).

Regulatory. With the adoption of the 1996 Basin Plan Amendment, the Central Valley RWQCB allowed the use of the San Joaquin River for subsurface agricultural discharges. In addition, the Central Valley RWQCB initially issued WDRs for Project discharges from the San Luis Drain in 1998 (Central Valley RWQCB 1998a). The WDRs were revised in 2001. The WDRs established selenium discharge load values (selenium pounds, monthly and annually). In 2010, the Central Valley RWQCB issued a Basin Plan Amendment for selenium control in the Lower San Joaquin River (Resolution No, R5-2010-0046).

An EIS/EIR was completed to extend the Project through 2019. The Central Valley RWQCB will update the Project WDRs to require compliance with water quality-related mitigation measures identified in the EIR/EIS prepared for the project. The WDRs may incorporate requirements for other constituents, similar to the program requirements for the ILRP and/or implementation of TMDLs for salt, boron, dissolved oxygen, and/or pesticides (Entrix 2009).

10.5.2.2 Drainage Water Treatment

The Westside Regional Drainage Plan describes regional drainage water treatment components. As part of the overall plan, the GDA would treat subsurface agricultural drainage water, which contains selenium and other constituents, to improve the water quality of discharges. Subsurface agricultural drainage would be collected and treated to remove these constituents as well as reduce water volumes which would increase the cost-effectiveness of disposal (SJRECWA 2003). Drainage treatment technology includes reverse osmosis (RO), solar arrays, membrane systems, biological treatment to remove selenium, and deep well injection (Personal Communication – Joe McGahan & Dave Cory, October 23, 2013).

Currently there are several pilot projects being conducted to determine the effectiveness of various treatment technologies on the drainage water in the GDA.

In 2013 Reclamation began construction of a pilot plant study, located in the Panoche Drainage District. The plant will treat drainage water using membrane technology as well as a biological treatment system to remove selenium. The pilot plant would pretreat influent drainage water using either a microfiltration or ultrafiltration membrane prior to a RO treatment system. The concentrated RO waste stream would then be treated to remove selenium using bioreactor tanks (Reclamation 2012).

In addition to this pilot plant, the Panoche Drainage District has also constructed a separate treatment facility to desalinate drainage water. The pilot study is looking at the viability of solar arrays to heat and condensate drainage water.

Figure 10-8
Location Maps of the Panoche WD and RRR Pilot Plant Locations (Reclamation 2008)
(Revised figure being developed)

Institutional and Regulatory Attributes

Thus far, regional drainage treatment systems have only been pilot tested under demonstration studies. The potential institutional and regulatory attributes of regional drainage treatment systems have been analyzed in environmental studies prepared for the GAF and San Luis Drainage Feature Re-evaluation projects. These projects reviewed alternatives such as RO and biotreatment to remove salinity and selenium. Specific alternatives include treatment and disposal facilities funded by federal or non-federal entities. The institutional attributes for these facilities have not been determined but may follow examples from other locations such as the Santa Ana Watershed Project Authority.

Regional drainage treatment systems will face significant regulatory and environmental review requirements. One of the primary regulatory issues will be brine disposal. Implementing a complex treatment system using RO will require a method to dispose of the concentrated salt byproduct. The desalination pilot study being undertaken in the Panoche Drainage District using the solar array would produce solid salts, which could be disposed of in a landfill.

10.5.2.3 Land Retirement

Irrigation water is no longer applied to lands in the Broadview Water District, as well as approximately 1,000 acres of the Widren Water District (Personal Communication – Joe McGahan &

David Cory, October 23, 2013). The GAF also continues to consider additional areas to retire (Nitta 2012).

10.5.2.4 Regional Reuse

Regional reuse involves large-scale collection and reapplication of saline drainage water at a dedicated facility. The facility consists of crops that naturally retain and concentrate salts and selenium from water. These plants generally have limited commercial value but are used mainly for remediation of drainage water.

Although the GAF is the primarily implementer of regional reuse in the westside, the Westlands Water District investigated potential use of the retired lands as a reuse facilities. Such uses included:

- Use of retired lands for drainage, treatment, and/or disposal of agricultural drainage water from adjacent lands that are still in production.
- Retired land along the proposed Highway 180 alignment, from Mendota to I-5, would be made available to local communities for either commercial or industrial activities.
- Construction of a detention basin on retired land to collect and attenuate flood flows from the Panoche/Silver Creek to prevent potential flooding in the City of Mendota.
- Construction of a detention basin on retired land to collect and attenuate flood flows from the Arroyo Pasajero to prevent potential flooding in the City of Huron.
- Construction of storage basins on retired lands to retain 40,000 to 50,000 acre-feet (AF) of rescheduled water, surplus water, and water from other sources to be used for future purposes.
- Retired land could be leased for dry land farming, to plant a winter or spring grain or be used for livestock grazing.
- Retired land could be used for wildlife purposes to allow species to migrate to different areas. In addition, retired land could be restored for upland habitat purposes (SJRECWA, *et al.* 2003).

Performance

The GAF long-term in-valley drainage management plan includes a regional reuse facility known as the San Joaquin River Water Quality Improvement Project (SJRIP). The SJRIP was originally constructed in 2001 and currently has 4,280 acres in production and plans to eventually expand up to 6,900 acres. The SJRIP applies saline drainage water to salt tolerant crops. Drainage water can be blended in varying concentrations to conform to the salt tolerance of crops. At completion, the facility is planned to have capacity for all the drainage produced in the GDA (up to 29,500 AF annually) (Entrix 2009).

The SJRIP greatly reduces the volume of drainage water; however, the remaining water has high concentrations of salt and selenium. The GAF long-range plan will augment the regional reuse system with drainage water treatment and salt disposal in order to eliminate the remaining drainage water. The GAF has implemented pilot programs to treat this remaining water as described above in Section 10.5.2.2.

10.6 Costs of Implementation

As of 2008, it is estimated that Reclamation has spent over $21 million in federal funding to support the reduction of salinity in the Study Area. Within the GDA over $100 million including – $66 million in Federal and State grants, $23 million in local district funding and $15 million funded by farmers (Personal Communication - Roger Reynolds, March 21, 2013) – has been spent to date. Costs associated with the construction and operation of the two pilot plant studies to treat drainage water is still unknown as the studies are currently ongoing. These projects have eliminated discharges from agricultural drainage water into wetlands and refuges.

10.7 Salt Capacity

Salt capacity is intended to be an estimate of the limiting capacity of each salt accumulation Study Area to assess the likelihood of achieving long-term[4] sustainable conditions within the Central Valley. The salinity issues addressed by the westside region are primarily source control solutions, preventing or reducing the volume of saline agricultural drainage water from entering into the San Joaquin River. Long term, in accordance with the requirements of the 2009 Use Agreement, the discharge to the San Joaquin River will be phased out and for all practical purposes stopped by 2019 (Personal Communication - Roger Reynolds, March 21, 2013). As such, an evaluation of the long-term capacity for accumulation and disposal of salt loads in this Study Area is addressed in Section 12.

The Westside Regional Drainage Plan provides for an adaptive management program to allow flexibility to meet existing or future water quality limits. For this program, local irrigation and water districts will coordinate activities with Reclamation and other State and Federal agencies. This group will analyze and refine management activities to meet both regulatory and agricultural issues, for both the present and potentially the future.

10.8 Institutional and Regulatory Barriers

As noted above for various programs within the Plan, there are many federal and state regulations that must be adhered to for implementation of the Plan. Compliance with regulations such as the WDRs and TMDLs issued by the Central Valley RWQCB, BOs issued by the USFWS, and various environmental reviews could potentially become a challenge to implementation.

10.9 References

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[4] With the potential for increasingly stringent effluent limits, it is unknown for certain that the implementation of the Plan will be sustainable in the long-term. As future regulatory conditions cannot be predicted, for the purposes of this project, the phrase "long-term sustainability" is being evaluated within the context of meeting existing salinity limits.

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Section 11

San Luis Unit Ocean Disposal Study Area

The San Luis Unit Study Area serves as an example of where the potential construction of a brine line to transport salt from the Central Valley to the ocean has been studied as a salt disposal method. This proposed project, which was analyzed in the Bureau of Reclamation's (Reclamation) San Luis Drainage Feature Re-Evaluation Environmental Impact Statement (EIS), was controversial and ultimately not accepted (and therefore has not been constructed). Regardless, for the purposes of SSALTS, this project provides information regarding issues associated with a brine line disposal project. This information will be characterized here and then used to inform development of future alternatives for Out-of-Valley salt disposal in subsequent SSALTS phases.

11.1 Introduction and Overview

The 730,000 acre area known as the San Luis Unit is located in the westside of the San Joaquin Valley, and includes the water districts of Westlands, Broadview, Panoche, and Pacheco (Figure 11-1). Also included in this area are the Grasslands Drainage Area and the southern portion of the San Luis Water District (Reclamation 2006). The San Luis Unit began to receive Central Valley Project (CVP) water deliveries in the 1960s.

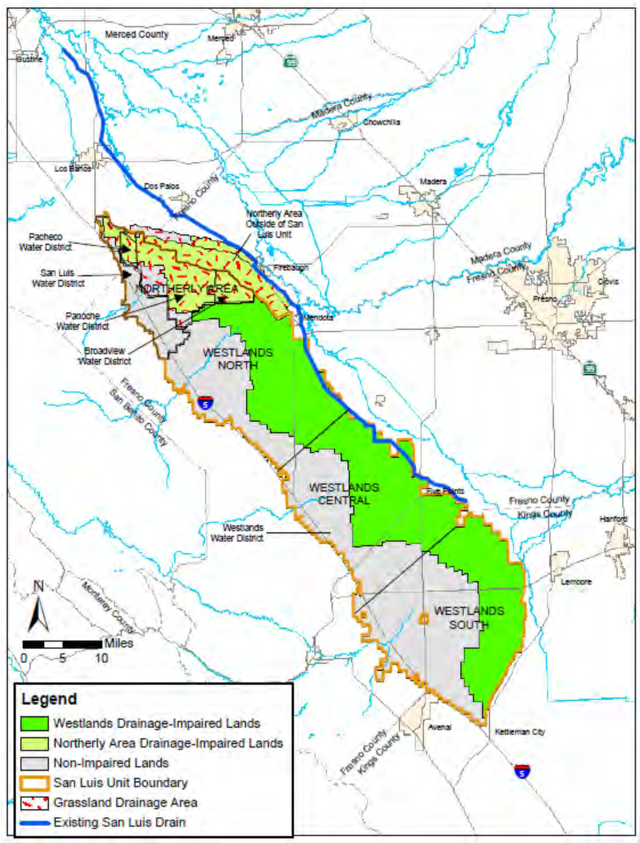

Figure 11-1
Map of the San Luis Unit in the San Joaquin Valley (Reclamation 2006)

Much of the area has been plagued with drainage problems since the 1950s (Reclamation 2006), although salt accumulation in the shallow groundwater zones can be traced back to the 1890s and early 1900s (Johnston *et al.*, 2012). The San Luis Act of 1960 (Public Law 86-488) authorized the San Luis Unit, which is part of both the federal CVP and the California State Water Project. The San Luis Unit is operated jointly by Reclamation and DWR and its principal purpose was to supply irrigation water to farmlands on the westside. A number of jointly constructed and operated conveyance facilities were developed to deliver water to the westside area. Public Law 86-488 also mandated a joint (with the state) master drain or a federal-only interceptor drain for irrigation drainage waters from the federal San Luis Unit service area with ultimate disposal in the Bay-Delta. The state did not participate in the drain and the federal government began construction of the drain in 1968. Only 87 miles of the planned 188 miles were constructed and all construction was halted in 1975 because of rising costs and environmental concerns about discharges in the Bay-Delta. The San Luis Drain ultimately ended near Gustine, CA.

Kesterson Reservoir was originally designed as a flow-regulating reservoir, but due to the aforementioned cost and environmental concerns, it became a terminal reservoir. By the early 1980s, Reclamation began accepting drainage water from growers in the WWD who were part of the drainage collector system in the northern portion of WWD. Within 18 months, Kesterson Reservoir had reached capacity and it was determined that the evaporation rate was not sufficient to handle the drainage water the subsystem of collector drains. Kesterson Reservoir is located in what became the Kesterson National Wildlife Refuge which was jointly operated by Reclamation and USFWS. Soon after the reservoir reached capacity, the USFWS notified Reclamation of abnormally high selenium (Se) concentrations in mosquitofish and by 1983 USFWS noted deformities and deaths in aquatic birds.

The drainage problems in the San Luis Unit and corresponding build-up of salts result from a combination of shallow groundwater tables, saline soils, and application of irrigation water. In 2001, Reclamation developed a report, Plan of Action, to address the lack of drainage service in the Unit, as required by a U.S. Court of Appeals' ruling (Reclamation 2001). Through the process initiated by this report, Reclamation developed various In-Valley and Out-of-Valley alternatives for providing drainage service[1] to the area. In 2006, Reclamation published its Final EIS looking at eight separate action alternatives, three of which include various alignments for concentrated salt export out of the valley (Reclamation 2006).

Although the Record of Decision (Reclamation 2007) indicated that the environmentally preferable alternative was the "In-Valley/Water Needs Land Retirement[2]" alternative rather than an "Out of Valley/Ocean Disposal" alternative, this SSALTS prototype Study Area provides an opportunity to look again at the latter concept which involves transporting salt out of the valley using a brine line.

11.2 Problem Statement

In order to achieve a long-term, sustainable salt and water balance in the root zone of irrigated lands in the San Luis Unit and adjacent areas, drainage service must be provided. Poor drainage is a result of an impermeable layer of clay that prevents the irrigation water from infiltrating into the deeper groundwater aquifers. The trapped irrigation water forms a shallow, or perched, water table. Without an outlet, the highly saline waters accumulate in the root zone close to the ground surface, significantly impacting agricultural production. The selenium levels in the drainage water are toxic to wildlife and impede safe off-farm drainage and disposal of the water. Of the approximate 730,000 acres in the Unit, it is estimated that 379,000 acres are considered to be drainage-impaired, requiring drainage service (Reclamation 2006). The construction of a pipeline to transport a concentrated salt stream to the ocean would be a long-term solution for removing salt and other pollutants such as selenium from the area.

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[1] Drainage service, as defined by Reclamation (2006), is "managing the regional shallow groundwater table by collecting and disposing of shallow groundwater from the root zone and/or reducing contributions of water to the shallow groundwater table through land retirement."

[2] This alternative considered land retirement as a solution to increase the availability of water from Central Valley Project contractors and groundwater.

11.3 Study Area Attributes

11.3.1 Hydrology and Drainage Patterns

Most of the westside is semi arid with highly seasonal precipitation typically occurring from November through April. The average precipitation for the area is approximately 8.6 inches per year, but can range from 2.4 inches along the valley floor to almost 21 inches in the upland areas of the coastal range (Reclamation 2006).

Stream flows vary by season. Higher flows in the San Joaquin River Basin occur during wet winters, spring snowmelt, February and March when water levels in managed wetland refuges are drawn down, and April and May as a result of pulse flows required under the Vernalis Adaptive Management Plan (VAMP)[3]. Lower stream flows also tend to occur during hot dry summers and falls and non-irrigation periods when return flows are reduced. Stream flows may also vary on an annual basis, *e.g.*, stream flows will be higher during wet years when substantial precipitation has occurred and lower during dry years with below normal precipitation.

Flows in the San Joaquin River are controlled by dams on eastside tributaries and on the mainstem upstream from Fresno. In addition, water supply developments on the major eastside tributaries have reduced the flow of the mainstem San Joaquin River (U.S. Department of the Interior [DOI] and California Resources Agency [CRA] 1990). The headwaters of the San Joaquin River are stored in Millerton Reservoir, located on the San Joaquin River upstream of Fresno. Water is diverted from the Reservoir into the Friant- Kern and Madera Canals. Releases from Millerton Reservoir into the San Joaquin River infiltrate into the river bottom. The river channel was often dry much of the year in a stretch below Gravelly Ford west of Fresno prior to implementation of the San Joaquin River Restoration Program.

Salt Slough and Mud Slough are the major westside tributaries to the San Joaquin River, contributing not only flow, but salinity and Se – if the flows are not managed. Flows in Mud Slough downstream of the San Luis Drain are composed mainly of seasonal runoff in the winter and discharges from the Grassland Drainage Area (GDA) in the summer. The primary sources of water used for irrigation in the westside are the Delta-Mendota and San Luis Canals and local groundwater, which are relatively saline (Central Valley Regional Water Quality Control Board [Central Valley RWQCB] 2004). The water then comes in contact with soils that have a high salt content. The agricultural return flows in the westside region increase salinity levels during periods of low flow and are a major portion of the total salt load to the San Joaquin River.

11.3.2 Land Cover

The westside is predominately an agricultural region characterized by a very flat topography. The soils are fairly uniform throughout, primarily composed of alluvium. Irrigated crop acreage in the Westlands Water District alone can range up to 560,000 acres depending on the availability of water and market conditions (SJRECWA 2003). The cropping patterns vary throughout the districts (Table 11-1) (Reclamation 2006).

[3] VAMP, implemented in 2000, requires regulated releases from reservoirs located on the eastside of the San Joaquin Valley.

Table 11-1. Cropping Patterns in the Unit (Reclamation 2006)

Major Crop Type	Percent of Irrigated Area, Average from 1995-1999	
	Westlands	Northerly Area Districts
Forage	3	10
Cotton	45	48
Grain	6	3
Sugar Beets	1	1
Other Field	1	2
Tomatoes	17	12
Truck	19	22
Orchard/Vineyard	7	2
Total	100	100

11.3.3 Institutional, Economic & Regulatory Attributes

The economy of the westside is predominantly agricultural. The impacts of salinity on irrigated agriculture production are primarily related to the availability of drainage services, soil salinity, and groundwater conditions. Irrigated agriculture in an area with salinity issues, such as the Central Valley, is driven by economic factors such as application of improved technology, availability of labor and other resources, demand for commodities, and production. Improved efficiency in irrigation and drainage reuse are examples of technological innovations that have improved crop yields in recent years (Howitt *et al.* 2009). Future production of irrigated agriculture operations will be impacted by the reliability of high quality water supplies, potential climate change impacts, future policies impacting the agricultural sector, and increasing crop production in other countries (Howitt *et al.* 2009).

Irrigated Lands Regulatory Program (ILRP). In July 2013, the RWQCB adopted the WDR for individual growers (R5-2013-0100). Under this WDR, it is specified that discharges to either surface water or groundwater "*shall not cause or contribute to an exceedance of applicable water quality objectives*" (Central Valley RWQCB 2013). Under the MRP, dischargers are required to develop a Groundwater Assessment Report which describes groundwater areas as "high vulnerability" or "low vulnerability" areas. Those areas assessed as a high vulnerability area will have more stringent requirements including enforced water quality objectives and maximum contaminant levels for discharges to protect beneficial uses of the groundwater.

In addition to the adopted WDR for individual growers, the RWQCB has drafted tentative WDRs for the Westside San Joaquin River Watershed Coalition.

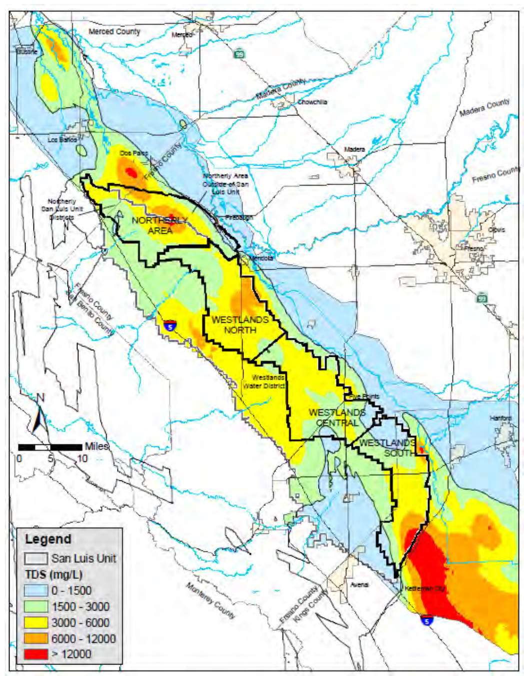

Figure 11-3
TDS in Shallow Groundwater
(Reclamation 2006)

11.4 Sources of Salt within the Unit

There are several sources of salinity in the Valley, including groundwater and soils, and surface water (Figure 11-3). This section describes each in greater detail.

11.4.1 Groundwater

The San Joaquin River Basin contains 26 groundwater basins, with 9 of those basins being classified as significant sources of groundwater (Reclamation 2006). The total dissolved solids (TDS) of the groundwater averages about 500 parts per million (ppm), but ranges from 64 to 10,700 ppm (Figure 11-3). Calcium, magnesium, sodium, bicarbonates, sulfates, and chlorides are all significant components of TDS. The highest groundwater salinity concentrations occur in areas of the highest native soil salinity (Reclamation 2006).

11.4.2 Soils

Soils. The coastal ranges on the westside of the San Joaquin Valley are composed of sandstones and shales of marine origin. Because the leeward (east) side of the coastal ranges receives little precipitation, these soils tend to be poorly-sorted with low permeability. The marine soils also have a high concentration of salt and relatively high concentrations of naturally-occurring Se. In addition, the Corcoran clay, a Pleistocene lacustrine deposit, underlies the westside limiting drainage leading to higher salinity in shallow groundwater. Hence, while the westside includes some of the most productive agricultural lands in California, the underlying soils contribute to and are impacted by increasingly severe problems associated with poor drainage and increased salinity, Se concentrations, and sodicity[4].

11.4.3 Surface Water

The major sources of surface water in the area include imported water from the Central Valley Project and the San Joaquin River and its tributaries. The water quality of the San Joaquin River is degraded downstream of Bear Creek because of upstream diversions of high quality water for irrigation on the eastern side of the San Joaquin Valley and because of agricultural drainage into the river and its tributaries, especially Salt Slough and Mud Slough. The water quality of the San Joaquin River improves further downstream with water entering the San Joaquin River from east side tributaries, including the Merced River, the Tuolumne River, and the Stanislaus River. In 2010, the Central Valley RWQCB published its Final Staff Report for *Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Salt and Boron Discharges into the Lower San Joaquin River* (Central

Figure 11-4
Existing Conditions for Salinity (WY 1999) (Reclamation 2006)

[4] Sodic soils are soils with a disproportionately high makeup of sodium in caution exchange sites on the mineral surfaces. High sodicity leads to poor physical characteristics of the soil (soil structure), as well as low water permeability.

Valley RWQCB 2004). This report established the TMDL that could enter the Lower San Joaquin River from sources without causing exceedances in water quality standards at Vernalis.

11.5 Ocean Disposal Brine Line Alternative

The "Ocean Disposal" alternative considered in the San Luis Drainage Feature Re-evaluation Study included construction of 211 miles of 36-inch diameter, high pressure buried pipeline and tunnels to transport drainage water from the San Joaquin Valley to an offshore location south of the Monterey Bay National Marine Sanctuary, known as Point Estero (Figure 11-5). Implementation of this alternative would have required construction of 3 tunnels (7-foot diameter) through the coastal range, 23 pumping plants, drainwater collection systems, regional reuse facilities, and sumps (Reclamation 2006). The "Ocean Disposal" alternative also included construction of a closed sub-surface drainage system to collect agricultural runoff and convey it to new regional reuse facilities[5] or to the newly constructed brine line.

In addition to the construction of reuse facilities, pipeline, and drainage collection system, the "Ocean Disposal" alternative also included significant land retirement and on-farm drainage reduction activities. It was assumed that a minimum of 44,106 acres of drainage impaired agricultural lands throughout the San Luis Unit would be retired to reduce the volume of drainage runoff that would need to either be reused or transported through the brine line (Reclamation 2006). Drainage water reduction activities were assumed to be implemented throughout the Unit (Table 11-2).

[5] The regional reuse facilities would be used to recycle agricultural runoff to irrigate salt-tolerant crops. Drainage from these crops would then be collected and transported via the brine pipeline for ocean disposal.

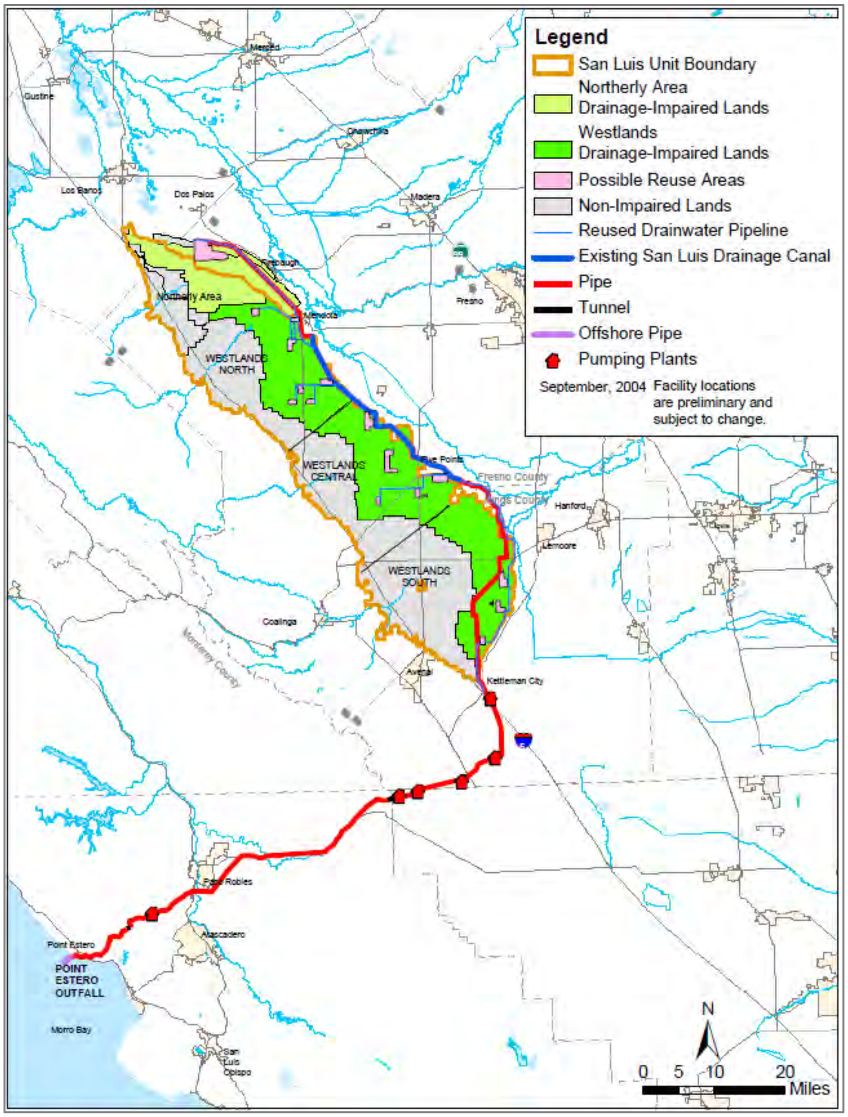

Figure 11-5
Ocean Disposal Brine Line Alignment
(Reclamation 2006)

Table 11-2. List of possible on-farm drainage reduction activities (Reclamation 2006)

Activity	Description
Drainage Re-use	A total of 48,000 acres of installed drains would continue to be used.
Irrigation Practice Improvements	Efficiency in irrigation practices would be expected in response to economic conditions
Irrigation System Improvements	In the absence of drainage, the management of perched water would occur.
Reallocated Irrigation Water	Available water as a result of fallowing would be reallocated to unaffected areas.

Per the original analysis, it was estimated that the volume of salt concentrate would be reduced from 97,023 acre-feet (AF)/year to 69,957 AF/year through implementation of the various drainwater reduction methods described above. This reduced volume would then either be transported to regional reuse facilities and then to the brine pipeline, or be directly discharged to the pipeline for disposal in the ocean. It was estimated that the final (after regional reuse) drainage volume transported through the pipeline would be 20,988 AF/year at an average flow rate of 29.1 cubic feet/second (Reclamation 2006). The Ocean Disposal Alternative was estimated to provide a net reduction of over 500,000 tons/year of salt from the root zone and shallow groundwater (Reclamation 2006).

11.6 Costs of Implementation

In their development of the FEIS, Reclamation conducted an analysis to determine expected costs for the various components of the ocean disposal alternative. Table 11-3 presents the summarized results from that analysis.

Table 11-3. Estimated Costs (Reclamation 2006)

Feature	Present Value[1] ($1,000,000)	Annual Equivalent ($1,000,000)
Conveyance System	289.8	17.4
Land Retirement	10.2	0.6
Drainage Collection System	184.1	11.1
Regional Reuse Facilities	77.0	4.6

[1] Present Value in 2006, 50-year planning period.

Subsequent to the publication of the Reclamation FEIS, the Hilmar Supplemental Environmental Project (Rubin *et al.* 2007) conducted its own cost analysis of ocean disposal based on a brine line constructed for Calleguas Regional Salinity Management in Ventura County. This project estimated that the cost of the pipeline would be approximately $4.4 million per mile, not including the outfall (which would cost approximately $8 million). This pipeline had an alignment of approximately 30 miles and varied in diameter from 18 to 48 inches, with a capacity of 19 MGD (Rubin *et al.* 2007). Operation and Maintenance (O&M) costs were estimated using information from the operation of the Inland Empire Brine Line (IEBL, formerly the Santa Ana Regional Interceptor [SARI]) in southern California. The annual O&M budget for the IEBL was $73 million in Fiscal Year 2008-09. Given that the IEBL is 73 miles long, the estimated annual O&M cost is $0.11 million/mile.

11.7 Institutional and Regulatory Barriers

The construction of a brine line to transport drainage from the Unit to the Pacific Ocean would require extensive permitting. Many Federal, State, and local agencies must be involved including, but not limited to, U.S. Army Corp of Engineers, U.S. Department of Interior, National Marine Fisheries Service, California State Historic Preservation Office, California State Lands Commission, California Coastal Commission, San Francisco Bay Conservation and Development Commission, and the California Department of Fish and Game.

The FEIS identified several potentially harmful impacts and potential barriers to implementing the ocean disposal alternative. These include:

- Permitting: Reclamation (2006) determined that the ocean disposal alternative would be the third most complex and difficult alternative to permit, falling directly behind the two brine disposal alternatives that released the salt concentrate into the Delta.

- Coastal Impacts: The FEIS determined that there would be water quality degradation in the vicinity of the outfall, although water quality objectives would be met outside this zone. In addition, there have not been any long-term studies to determine impacts from discharging into the ocean.

- Impacts to Wildlife: the ocean disposal alternative is expected to significantly impact federal and state listed special-status species through construction and operation of the pipeline. In construction of this alternative, it is expected that 2,000 acres of natural and native habitats will be modified. In addition, high selenium levels in reuse facilities would impact sensitive habitat for aquatic or wetland-depended species.

- Power use: out of all the alternatives considered in the FEIS, the ocean disposal alternative would require over 3 times more power than the next highest power consumption alternative. The needed conveyance system, including pumps, is expected to consume 81,400,000 kilowatt-hours/year.

In 2008, Reclamation published the *San Luis Drainage Feature Re-Evaluation Feasibility Report* (Reclamation 2008). In this report, Reclamation provides the following reason for not completing feasibility level designs and cost estimates:

1. It would be difficult to provide sufficient analysis to demonstrate that this alternative is consistent with the California Coastal Management Program[6] and that this alternative is the least environmentally damaging feasible alternative considering long-term effects to the marine environment;

2. It is not one of the two alternatives with the greatest National Economic Development (NED) benefit[7];

3. Implementing this alternative would result in significant public concerns;

4. It is doubtful that a consistency determination, acceptable to the Environmental Protection Agency (EPA) and the State of California, could be developed establishing that the ocean disposal alternative is the least environmentally damaging feasible alternative; and

5. This alternative would not be completed until 2014 and, therefore, could not begin providing drainage service within the time required to meet the revised TMDLs for drainage into the San Joaquin River (Reclamation 2008).

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[6] The goals of the California Coastal Management Program (administered by the California Coastal Commission and the San Francisco Bay Conservation and Development Commission) are as follows:

1. *Protect, maintain, and where feasible enhance and restore the overall quality of the coastal environment and its natural and manmade resources.*
2. *Assure orderly, balanced use, and conservation of coastal resources taking into account the social and economic needs of the people of the State.*
3. *Maximize public access to and along the coast and maximize public recreational opportunities in the coastal zone consistent with sound resource conservation principles and constitutionally protected rights of private property owners.*
4. *Assure priority for coastal-dependent development over other development on the coast.*
5. *Encourage State-local initiatives and cooperation in preparing procedures to implement coordinated planning and development for mutually beneficial uses, including educational uses, in the coastal zone* (California Coastal Commission 1997).

[7] Reclamation (2008) determined that the ocean disposal alternative had a **net** NED benefit of ($12,471,000).

11.7.1 California Ocean Plan (2009)

The California Ocean Plan (Ocean Plan) was amended by the SWRCB in September 2009, and became effective in March 2010. The purpose of Ocean Plan is to protect the quality of the Pacific Ocean waters by controlling waste discharges into it (SWRCB 2009). The Ocean Plan establishes water quality objectives (WQOs) and applicable to dischargers (Table 11-4).

Table 11-4. WQO for Discharges into the Pacific Ocean (SWRCB 2009)

Constituent	6-Month Median	Daily Maximum	Instantaneous Maximum
Selenium (µg/L)	15	60	150
Acute Toxicity (TUa)[1]	N/A	0.3	N/A
Chronic Toxicity (TUc)[2]	N/A	0.1	N/A

Notes:
[1] Acute Toxicity is expressed in Toxic Units Acute (TUa) = 100/(96 hour LC 50[3])
[2] Chronic Toxicity is expressed in Toxic Units Chronic (TUc) = 100/NOEL[4]
[3] 96 hour LC50 = 96 Hour Lethal Concentration 50%
[4] NOEL = No Observed Effect Level

11.7.2 California Coastal Commission

The California Coastal Commission (Commission) is the agency that implements the Federal Coastal Zone Management Act for California. The Commission regulates activities that could potentially impact coastal resources including development activities, oil and gas exploration and development, material disposal in the ocean, and CWA Section 404 permits. The Commission regulates Federal, State and local agency activities with the goals to:

1. Improve the protection of coastal and ocean resources;
2. Improve assessment and management of impacts of development in the coastal zone;
3. Improve shoreline access opportunities for the public;
4. Enhance staff capabilities and expertise on technical and other subjects;
5. Enhance the Coastal Commission's leadership role in coastal zone management and in the provision of information regarding coastal and ocean resources;
6. Strive to make the Commission's regulatory and planning processes more effective, efficient, and user-friendly; and
7. Develop innovative approaches to carrying out the Commission's programs, including inter-agency, inter-disciplinary, and volunteer approaches (California Coastal Commission 1997).

11.8 Salt Capacity

Salt capacity is intended to be an estimate of the limiting capacity of each salt accumulation Study Area to assess the likelihood of achieving sustainable conditions within the Central Valley. As an "Out of Valley" alternative, ocean disposal provides unlimited potential capacity since the ocean is the ultimate salt sink. The actual capacity of the ocean disposal alternative is limited by the area provided with drainage service and the volume of drainage water produced after drainwater reduction measures are implemented. Because ocean disposal relies on an extensive collection and conveyance system serving regional reuse systems, ultimately an ocean disposal alternative is limited by the capacity of the brine line and associated pumping plants.

Implementation of the Ocean Disposal Alternative, as described in the San Luis Drainage Feature Re-Evaluation Study, would result in a net reduction of salt accumulation of approximately 500,000 tons per year (Reclamation 2006).

11.9 References

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Section 12

Long-Term Sustainability

"Salt problems are particularly insidious. They do not come charging at you with trumpets blowing and battle flags flying, a sight to set stirring the hearts of activists in any century. Rather, they slip in almost unnoticed. Time is of no concern, for they are supremely confident of their ultimate victory. History is on their side, as are the laws of physics, chemistry and biology. They have quietly destroyed, without fuss of fanfare, more civilizations than all the mighty armies of the world."

Warren A. Hall
Acting Director, Department of Interior's Water Resources Institute (1973)

12.1 Introduction

As discussed in the archetype Study Area descriptions in Sections 2 through 11, there are a variety of salt sources impacting the Central Valley, and each Study Area has unique sources and (potential) sinks for salt and different management solutions – or combinations of management solutions – will be needed to address salinity issues in various areas of the Central Valley. The Central Valley stakeholders are seeking sustainable – over a 50 to 200 year timeframe – mitigation measures to control, treat, and dispose of salt that is accumulating throughout the Valley. The objective of Section 12 is to evaluate the long-term sustainability of the salt disposal methods that are currently being utilized at the 10 archetype Study Areas, which will help to provide the perspective for developing salt disposal alternatives in Phase 2.

12.1.1 Salt Mitigation Components of the Representative Study Areas

Each Study Area has components or strategies for the mitigation of salt accumulation that fall into three broad categories: source control, treatment for salts, and disposal. For the purposes of this report, these categories are defined below:

- **Source Control**. Source control includes the active management or best management practices that minimize salt addition or accumulation in a Study Area. Examples include: improvements in source water total dissolved solids (TDS), IFDM, water softener incentive programs, land retirement, industrial source controls, salt reduction practices in food processing, etc.

- **Treatment for Salt Removal.** Treatment includes technologies employed at the Study Areas that separate salt from the waste stream. Examples include: evaporators (including solar evaporators), reverse osmosis (RO), microfiltration (MF), etc.

- **Disposal**. Disposal means either the accumulation on-site or removal from the site of the waste stream containing salt (or the salt that has been separated from the waste stream). Examples include: on-site accumulation and storage, salt accumulation at regional sites, hauling brine to wastewater treatment plans (WWTPs), hauling salt to a land fill, deep well injection, discharges to land, discharges to a surface water body, disposal in a brine line, etc.

Section 12 is an evaluation of the long-term sustainability of salt disposal methods – source control and treatment mitigation measures are only discussed explicitly in this section if needed to provide the context for salt disposal for a given Study Area.

In Phase 2, potential salt management strategies for each Study Area will be further analyzed and developed. The disposal strategies will include disposal within the Central Valley ("In-Valley"), transporting or exporting salt to areas outside the Central Valley ("Out-of-Valley") or a hybrid. Again, the salt disposal methods employed at the 10 archetype Study Areas are evaluated for sustainability in this report to provide the framework for Phase 2. Potential general disposal strategies that will be evaluated in Task 2 and where such strategies are currently in use include[1]:

- Discharge ponds (to groundwater): ***City of Dixon, Industrial Food Processing Facilities***
- Discharge to surface water conveyances or streams (to Bay-Delta): ***City of Tracy, Grasslands Water District, Westside Regional Drainage Plan***
- Evaporation and accumulation on the land surface (this includes site-specific and regional salt accumulation areas): ***Red Rock Ranch***
- Evaporation and trucking to landfill
- Regional accumulation of salt on the land surface and in shallow groundwater (MUN de-designation; institutional controls; shallow groundwater management): ***Tulare Lake Bed***
- Deep injection: ***Hilmar Cheese***
- Trucking to an ocean (or San Francisco Bay)-disposal WWTP: ***Hilmar Cheese***
- Regional brine line to an ocean (or San Francisco Bay)-disposal WWTP: ***San Luis Unit***
- Regional brine line to a Delta-disposal WWTP

12.1.2 Factors in the Consideration of Sustainability

Sustainable: able to be maintained at a certain rate or level.[2]

For the SSALT evaluation of the archetype Study Areas, this simple definition of sustainability was broken down into the following components to facilitate a more objective and meaningful analysis of which disposal methods and projects would be able to be maintained at a certain level into the future.[3]

- ***Implementability*** *of the salt disposal method*. This factor reviews the technical feasibility and efficacy of a given salt disposal method. In other words, given today's technology, how feasible or implementable is the given method? **Implementability** was rated from a high score of 4 (utilizes proven technologies and is readily implementable) to a low score of 1 (salt disposal method is not working or utilizes unproven technologies).

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[1] Disposal options used by the 10 archetype Study Areas are shown. Stevinson Water District does not have a disposal option as its current salt mitigation strategy.

[2] http://oxforddictionaries.com/us/definition/american_english/sustainable?q=sustainability#sustainable__7

[3] Section 12.1.3 discusses the evaluation timeframes.

- *Salt **capacity** of the disposal method*. This factor looks at the mass or concentration of salt that can be disposed by the method in question. For a given salt disposal method, the controlling might be a component part of the disposal method. For example, when analyzing a brine line with an ocean outfall, the mass discharged into the ocean can be virtually limitless, because the ocean is the ultimate global salt sink (and source). The salt capacity of an ocean outfall brine line is limited by the pipe diameter and flow capacity. For deep well injection it might be the injection capacity of the well field, the hydrogeology of the aquifer system, receiving water quality, formation pressures, or the governing permit. The capacity of a surface water discharge might be the ability of the project to meet the EC (or salt concentration) discharge limits. **Capacity** was rated from a high score of 4 (the project's salt disposal load was not limited by the disposal method) to a low score of 1 (salt disposal method has a capacity less than the salt disposal load).

- ***Regulatory** challenges*. This factor reviewed pertinent regulatory challenges including Basin Plan water quality objectives, WWTP discharge limits, WWTP Resource Recovery permits, WDRs, UIC permits, proposed Basin Plan amendments, NEPA/CEQA, etc. **Regulatory** was rated from a high score of 4 (the project is readily permitable and is able to meet current regulatory requirements) to a low score of 1 (the project faces considerable regulatory challenges now or in the 50-year planning horizon).

- ***Institutional** requirements*. Institutional requirements speaks to successfully bringing the project on-line, not from a technology standpoint (which is addressed by Implementability), but from a context of governance or management. What agency, group of agencies, coalition, joint powers authority, company or consortium of companies is responsible for the development and operation of the project? **Institutional** was rated from a high score of 4 (bias toward fewer entities involved – unless they are part a group with a strong governance structure; bias also given toward, in some cases, public sector project proponents with known or secure funding sources) to a low score of 1 (group of small, underfunded individual stakeholders).

- *Capital and operation and maintenance **costs***. An objective evaluation of salt disposal cost is difficult because much of the cost information is not present, not separable from costs associated with the entire project (disposal vs. source control and/or treatment), and not able to be placed on the same cost basis (for example, dollars per ton of salt removed). Some SSALTS Study Area projects are underway and some are still in the planning stages, so the costs will need to be reconciled to a common starting point in time. These are all issues that will be addressed in developing alternatives under Phase 2 of SSALTS. In the meantime, the **cost** factor was rated from a high score of 4 (projects with lower anticipated costs) to a low score of 1 (projects with higher anticipated costs).

- *Potential **environmental issues***. Aside from salinity, there are other constituents of potential concern that are evaluated in this section as well as other possible environmental concerns. For example, selenium accumulation in standing water in evaporation ponds or discharge ponds provides a potential exposure pathway and ecological risk to certain species. Trucking waste as a disposal option – when expanded in scope and scale (*e.g.*, valley-wide) – may have air quality and carbon footprint issues. **Environmental issues** were rated from a high score of 4 (little to no anticipated environmental issues) to a low score of 1 (reasonable potential for significant environmental issues to arise).

- ***Public acceptance***. This factor takes into account public awareness and acceptance of the disposal method utilized by the project. **Public acceptance** was rated from a high score of 4 (little to no public awareness and reasonable public acceptance) to a low score of 1 (high level of public awareness and little to no public acceptance).

12.1.3 Sustainability Timeframes and Planning Horizons

In 1987, the United Nations World Commission on Environment and Development (WCED) published a report[4], which stated, "Sustainable development is development that meets the needs of the present without compromising the ability of future *generations* to meet their own needs." (emphasis added). Part of the intent of the WCED report was to take a longer view across multiple generations. In SSALTS, salt disposal methods that are sustainable over a 50-year planning horizon may not be in 100 or 200 years. In developing the work plan for SSALTS, the stakeholders echoed the sentiments of the WCED in looking at longer than typical engineering planning horizons. The SSALTS work plan (CDM Smith 2012) states that, "each of the salt accumulation Study Areas characterized in Task 1.3 will be analyzed to assess their longevity and sustainability over an initial 50-year planning horizon. To the extent practicable, this analysis will also evaluate long-term sustainability beyond this period at 50-year increments, but no more than a total of 200 years. This assessment beyond 50 years will be accompanied by caveats and assumptions regarding the uncertainty associated with extrapolations beyond the initial 50-year planning period."

A 2011 report from the World Economic Forum[5] lists the global trends that we face today:

- Climate change, environment, and sustainability
- Rapidly growing demand for energy
- Limited resources
- Shifting centers of economic activity
- Growing demand for food, nutrition, and health
- Increasing scarcity and unequal distribution of water
- Demographics, including shifting populations and mobility

To the extent possible, these global trends – as well as regional, sub-regional, and local trends – will be interwoven into the long-term sustainability analyses. Based on the information available in Task 1.4, the analysis of sustainability for each of the ten archetype Study Areas in Section 12.2 will focus on a 50-year planning horizon. However, where certain trends may affect sustainability for these projects beyond 50 years, a qualitative statement as to that effect is made, accompanied by caveats and assumptions regarding the uncertainty associated with extrapolations beyond the initial 50-year planning period, as stated in the work plan. The goal in Phase 2 of SSALTS is to develop more information to allow a more definitive assessment of sustainability to discern general differences between the 50- and 200-year planning horizons recognizing the high levels of uncertainty. Stratifying

[4] United Nations. 1987. Report of the World Commission on Environment and Development: Our Common Future.

[5] World Economic Forum Global Agenda Council. 2011. Building a Sustainable Future: Rethinking the Role of Technology Innovation in an Increasingly Interdependent, Complex and Resource-constrained World. A report from the World Economic Forum Global Agenda Council on Emerging Technologies.

the long-term sustainability analyses at additional 50-year increments (e.g., 100 years and 150 years) is proving to be incompatible with the planning information and tools currently available.

12.2 Long-Term Sustainability of the Study Areas

The following section will consider the above factors in the analysis of the long-term sustainability of each of the archetype Study Areas. The discussion for each Study Area will focus on current disposal technologies and practices, but will also look at other potential salt disposal methods, as warranted. To the extent that data are available, tons of salt disposed per year and costs will be estimated. Potential changes in regulatory issues and permits will also be discussed.

12.2.1 City of Dixon

The City of Dixon is an archetype Study Area for the disposal of salt in municipal discharge ponds and ultimately to groundwater. As described in Section 2, the City of Dixon currently discharges its tertiary-treated wastewater into discharge ponds. The TDS of the wastewater is about 650 mg/L (Stantec 2012) and the flow-weighted TDS of the groundwater supply is about 355 mg/L; therefore, the current waste increment is about 295 mg/L. The tertiary-treated wastewater has a higher TDS concentration than groundwater and, thus, will act to increase the TDS concentration of the groundwater supply. Of greater concern, however, is the impact of irrigated agriculture on regional and sub-regional groundwater quality. As shown in Figure 2-1, the City of Dixon is surrounded by irrigated farmlands. Depending on the irrigation efficiency, percolating water in the vadose zone may have TDS concentrations as high as 1,400 mg/L. Over time, the TDS of the groundwater supply – for both irrigated agriculture and the City of Dixon – will increase significantly. The City of Dixon has observed increasing TDS and nitrate concentrations in its shallower potable supply wells (DiGiorgio, pers. comm. 2013) and is contemplating drilling deeper wells and augmenting their potable supply with surface water.

Results from the Task 7 and 8 Initial Conceptual Model (ICM) Technical Services Final Report (LWA 2013) were reviewed in order to provide a *regional* groundwater quality perspective. The Initial Analysis Zones (IAZs) in the ICM were based on the 2009 US Geological Survey (USGS) Central Valley Hydrologic Model (CVHM)[6]. With the exceptions of the Westside Region, and the Tulare Lake Bed, there are considerable disparities between the area of each of the archetype Study Areas and its associated IAZ. The IAZs that contain any of the archetype Study Areas range in size from 345,790 acres to 1,055,743 acres, while the archetype Study Areas range from 1,200 acres to 879,053 acres[7]. The Westside Drainage Area and the San Luis Unit extend beyond the boundaries of IAZ 14; the Tulare Lake Bed covers about 30 percent of IAZ 15 and the Grasslands Water District covers about 10 percent of IAZ 22. All of the other archetype Study Areas cover less than 2 percent of the IAZ they are in. The linkage in this technical memorandum to the IAZs in the ICM is to understand the regional groundwater quality from a regional context – whenever possible, site-specific groundwater quality was reviewed and used in the analyses.

The City of Dixon is in IAZ 6 (Cache-Putah area) of the ICM. The percentage of CVHM grid cells in IAZ 6 containing at least one well with TDS concentrations greater than 500 mg/L[8] were 59, 59, 58, and 57

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[6] At the request of the CV-SALTS Technical Advisory Committee Co-Chair, Nigel Quinn, the Delta-Mendota Basin was subdivided, resulting in 22 IAZs versus 21 hydrologic subareas in the CVHM.

[7] Not including the Westside Region and the Tulare Lake Bed.

[8] The Basin Plan states that, "at a minimum, ground waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels (MCLs) specified in the

percent for the following time periods: pre-1960, 1960 – 1979, 1980 – 1999, and 2000 – 2012, respectively. The median TDS concentration in the shallow groundwater was 1,060 mg/L[9], while the estimated TDS concentration in the deep aquifer was 461 mg/L[10]. The ICM further suggests that the mass of salts in shallow groundwater in IAZ 6 increased by about 121 tons in the fourth quarter of 2002 alone.[11] ICM model simulations show IAZ 6 exceeding the secondary MCL of 500 mg/L for 100 and 200 percent of projected salt loading. A threshold of 1,000 mg/L was exceeded when simulated salt loads were at 200 percent. IAZ 6 is a priority 4 basin[12] when using a 500 mg/L threshold and a priority 2 basin when using a 1,000 mg/L threshold. There is virtually no assimilative capacity in IAZ 6 when using the 500 mg/L threshold.

Table 12-1 presents an analysis of the sustainability of the municipal discharge ponds salt disposal archetype, based on the preceding discussion.

Table 12-1. Sustainability Analyses for the City of Dixon Salt Disposal Archetype

Factor	Score[1]	Discussion
Implementability	4	The construction, operation, and maintenance of municipal discharge ponds utilizes proven technologies and is implementable in those subareas of the Central Valley with recharge capacity. This salt disposal method would not be implementable in the west side of the San Joaquin Basin where soils are poorly draining.
Capacity	1	The influent flow to the WWTP is about 1.25 million gallons per day (MGD). Assuming a 25 percent evaporation loss, the WWTP discharges about 0.94 MGD at an average concentration of 650 mg/L, hence, the City is disposing of about 930 tons of salt per year to the discharge ponds. The ICM suggests that there is little to no assimilative capacity in IAZ 6 and that salt continues to accumulate. Although most of the salt accumulation in the City of Dixon Study Area is due to irrigated agriculture and not the City's discharge, there is still no additional salt capacity in the Basin.
Regulatory	2	The ICM suggests that there is little to no assimilative capacity in IAZ 6 and the concentration of TDS in the wastewater effluent exceeds the Basin Plan objective. The Central Valley RWQCB cannot permit discharges without raising the basin plan objectives through a Basin Plan amendment process13. There also may be additional regulatory concerns about contaminants of emerging concern (CECs) in the wastewater effluent, including pharmaceuticals and personal care products (PPCPs). The California Department of Public Health (CDPH) may also have concerns about retention times in the soil and groundwater and the recycled water contribution (RWC) in potable supply wells.
Institutional	4	The project is managed by a single public agency.
Costs	1	The initial costs for the construction, operation, and maintenance of the discharge ponds is relatively low. However, as groundwater concentrations continue to increase, the City and/or DSWA and Cal-Water may need to pursue other sources of potable supply in order to serve water that meets the MUN beneficial use threshold, and to be able to meet their discharge limit (i.e., after the waste increment is added). This may include deeper wells, well-head treatment, and surface water sources.

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following provisions of Title 22 of the California Code of Regulations, which are incorporated by reference into this plan." The Title 22 secondary MCL for TDS is 500 mg/L.

[9] 2003 to 2012

[10] 1980 to 2012

[11] Figure 7-3

[12] Out of five categories: 0 through 4, with 4 being the highest priority.

[13] Which will likely include certain commitments from the project proponent including salt mitigation and alternative compliance strategies.

Table 12-1. Sustainability Analyses for the City of Dixon Salt Disposal Archetype

Factor	Score[1]	Discussion
Environmental Issues	3	Because the discharge is to groundwater, other environmental issues should be minor.
Public Acceptance	3	The public would not generally be aware of this project or they would have a neutral opinion.

[1] On a scale of 1 to 4, with 4 being high, or best in terms of sustainability.

12.2.2 City of Tracy

The City of Tracy is an archetype Study Area describing the salinity issues facing a municipal wastewater discharger required to comply with salinity objectives in the Delta. As described in Section 3, the City of Tracy currently discharges its tertiary-treated water from the Tracy WWTP to Discharge Point 001 on the Old River. The City's population generates an average dry weather flow (ADWF) of 7.6 MGD, while the Tracy WWTP has an ADWF design capacity of 10.8 MGD (CH2MHill 2012). The City is permitted to discharge up to 16 MGD of ADWF.[14] The effluent from the Tracy WWTP has an EC range from 1,008 to 2,410 µmhos/cm, with an average of 1,753 µmhos/cm. In 1991, the Central Valley RWQCB instituted a WQO for EC for Vernalis of 700 µmhos/cm for the summer irrigation season[15] and 1,000 µmhos/cm for the winter irrigation season.[16] The background EC for the Old River waters around the Tracy WWTP outfall has an average of 640 µmhos/cm and there is little assimilative capacity in the summer for additional wastewater discharged from the Tracy WWTP.

CH2M-Hill (2012) stated, "Because, in the opinion of the Water Board, there is a potential impact to groundwater at the facility, the Tracy WWTP's industrial pretreatment ponds, industrial holding ponds, sludge drying beds, and biosolids storage areas of the facility are regulated by separate waste discharge requirements as defined in Order No. R5-2007-0038."

The City of Tracy is in IAZ 9 (Delta area) of the ICM. The percentage of CVHM grid cells in IAZ 9 containing at least one well with TDS concentrations greater than 500 mg/L were 78, 84, 69, and 80 percent for the following time periods: pre-1960, 1960 – 1979, 1980 – 1999, and 2000 – 2012. The median TDS concentration in the shallow groundwater was 961 mg/L[17], while the estimated TDS concentration in the deep aquifer was 560 mg/L[18]. ICM model simulations show IAZ 9 exceeding the secondary MCL of 500 mg/L for 50, 100 and 200 percent of projected salt loading. A threshold of 1,000 mg/L was exceeded when simulated salt loads were at 100 and 200 percent. IAZ 9 is a priority 4 basin[19] when using a 500 mg/L threshold and a priority 2 basin when using a 1,000 mg/L threshold. There is no assimilative capacity using the 500 mg/L threshold.

TDS in IAZ 9 exceeds the Basin Plan WQO and is projected to increase. However, the City of Tracy "is planning to scale back its groundwater extraction in future years to increase the overall quality of its water supply" and they will "continue to rely on groundwater for peaking and drought and emergency supplies…" (EKI 2011):

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[14] California Regional Water Quality Control Board, Central Valley Region. 2007. Order No. R5-2011-0012 Amending Waste Discharge Requirements, Order R5-2007-0036 (NPDES Permit No. CA0079154), City of Tracy, Tracy Wastewater Treatment Plant, San Joaquin County.

[15] April 1st to August 31st

[16] September 1st to March 31st

[17] 2003 to 2012

[18] 1980 to 2012

[19] Out of five categories: 0 through 4, with 4 being the highest priority.

Table 12-2 presents an analysis of the sustainability of the municipal discharge to surface water archetype, based on the preceding discussion.

Table 12-2. Sustainability Analyses for the City of Tracy Salt Disposal Archetype

Factor	Score[1]	Discussion
Implementability	4	The construction, operation, and maintenance of a municipal outfall to a surface water discharge point utilizes proven technologies and is implementable.
Capacity	1	The State Board is considering new salinity objectives for the South Delta and currently the South Delta salinity objectives do not apply to the City of Tracy[20]. When new South Delta salinity objectives are promulgated, compliance and salt capacity for this disposal method will be difficult to determine. The Old River is tidally–influenced and there are reversals of flow direction twice daily. Flow conditions in the Old River are also affected by flow conditions in the San Joaquin River, the operations of multiple barriers and gates, and pumping by the SWP and CVP at Clifton Court. The receiving water in the Old River at DP-001 may experience multiple "dosing" of effluent and the entire complex hydrodynamic system must be considered when evaluating assimilative capacity in Old River and in determining compliance.
Regulatory	1	The discharge to DP-001 is regulated by Central Valley RWQCB Order R5-2012-0115. While this order states that the South Delta salinity objectives do not apply to the City of Tracy, the State Board is considering new salinity objectives, so there is regulatory uncertainty. Central Valley RWQCB Order R5-2012-0115 also includes the following effluent limitation, "The effluent total calendar annual mass loading of total dissolved solids shall not exceed 13,688 tons." At an ADWF of 7.6 MGD, this would convert to an annual average TDS of 1,182 mg/L. At the current and expanded ADWF design capacities of 10.8 and 16 MGD, the mass loading limitation would be equivalent to annual TDS concentrations of 881 and 561 mg/L. The mass loading limitation may be difficult to achieve in the future.
Institutional	4	The project is managed by a single public agency.
Costs	1	The initial costs for the construction, operation, and maintenance of the surface water discharge point is relatively low. However, as groundwater concentrations have continued to increase, the City has invested, along with the Cities of Manteca, Escalon, and Lathrop in a 40-mile pipeline to bring in an allocated 10,000 AFY of treated water from the SSJID. The degradation of the groundwater in IAZ 9 is, therefore, increasing water supply costs to the City. This cost may be considered a de facto disposal cost, because the City needs an improved water supply – at least in part – in order to meet the future WQOs.
Environmental Issues	2	Because the discharge is to a surface water body, other environmental issues may surface.
Public Acceptance	2	The public may become aware of this project and have neutral to slightly negative opinions.

[1] On a scale of 1 to 4, with 4 being high, or best in terms of sustainability.

[20] From Central Valley RWQCB Order R5-2012-0115, "The Bay-Delta Plan includes water quality objectives for Electrical Conductivity (EC) for the South Delta in the vicinity of the discharge. On 1 June 2011, the Superior Court for Sacramento County entered a judgment and peremptory writ of mandate in the matter of City of Tracy v. State Water Resources Control Board (Case No; 34-2009-8000-392-CU-WM-GDS), ruling that the South Delta salinity objectives shall not apply to the City of Tracy and other municipal dischargers in the South Delta area pending reconsideration of the South Delta salinity objectives under Water Code §13241 and adoption of a proper program of implementation under Water Code §13242 that includes municipal dischargers. The State Water Board is currently considering new salinity and flow objectives in the South Delta that will address the Court Order. Therefore, at the time this Order was adopted the South Delta salinity objectives were not applicable to the Discharger."

12.2.3 Hilmar Cheese Company

The Hilmar Cheese Company (HCC) is an archetype Study Area for industrial plants in the Central Valley whose processes require the treatment of saline water and disposal of salt by trucking the brine to a WWTP with an ocean disposal and/or disposal of salt by deep well injection. As described in Section 4, HCC has two principal sources of water supply: groundwater and condensate of whey (COW). Based on data from April 2010 to December 2012, the TDS in Well #4 ranged from 770 and 800 mg/L and the TDS in Well #5 was 510 mg/L. In addition to groundwater, HCC also uses COW – COW is water recovered from milk that has been processed internally by HCC using RO. The TDS of COW is low.

HCC is in IAZ 12 (Turlock Basin) of the ICM. The percentage of CVHM grid cells in IAZ 12 containing at least one well with TDS concentrations greater than 500 mg/L were 30, 31, 27, and 29 percent for the following time periods: pre-1960, 1960 – 1979, 1980 – 1999, and 2000 – 2012, respectively. The median TDS concentration in the shallow groundwater was 825 mg/L[21], while the estimated TDS concentration in the deep aquifer was 273 mg/L[22]. ICM model simulations show IAZ 12 exceeding the secondary MCL of 500 mg/L for 50, 100, and 200 percent of projected salt loading. A threshold of 1,000 mg/L was exceeded when simulated salt loads were at 200 percent. IAZ 12 is a priority 4 basin[23] when using a 500 mg/L threshold and a priority 1 basin when using a 1,000 mg/L threshold. There is no assimilative capacity using the 500 mg/L threshold.

In addition to salt from water supply sources, salt is introduced into HCC from the 11 million pounds of milk processed daily. The concentration of sodium chloride in milk is about 1,500 mg/L. About 15 tons of salt a day are also used in the production of various cheese products. The wastewater stream from processing and cleaning is treated with microfiltration and RO and the permeate – with a TDS concentration range of 208 to 453 mg/L – is used in the irrigation of nearby fields. The brine is disposed of either using deep injection wells or by trucking to a WWTP operated by EBMUD.

HCC operates under a Class 1 Nonhazardous Waste Injection permit issued through the EPA's UIC Program. Three of the four permitted injection wells have been constructed to date. The capital costs for well drilling, construction, and equipping was $250 million and the annual operations and maintenance costs are $250,000. However, the injection wells are not operating currently due to mineral precipitation on the injection well screens and perhaps in the gravel pack and aquifer formation. HCC is exploring options for well rehabilitation. HCC may also need to look at chemical additions in order to prevent precipitation after well rehabilitation. The equivalent annual cost for HCC's deep well injection is $427,000, not including well rehabilitation or additional future operating costs.[24] Knowledge of the average brine concentration would allow for the calculation of the disposal costs for deep well injection on a per ton basis.

Excess brine that cannot be injected is transported to EBMUD's Main WWTP in Oakland, a distance of 100 miles. When the deep well injection system is not operational, all of the brine would be trucked to EBMUD, which is the case currently. In 2012, EBMUD transported 37 million gallons of brine to EBMUD's Main WWTP, which charged a fee that ranged from $0.11 to $0.12 per gallon or $4.26 million

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[21] 2003 to 2012

[22] 1980 to 2012

[23] Out of five categories: 0 through 4, with 4 being the highest priority.

[24] This assumes a service life of 25 years for the injection wells.

for 2012. In addition, the trucking costs ranges between $1 million to $2 million annually[25]. Knowledge of the average brine concentration and using average values for trucking and discharge at EBMUD, the disposal costs can be calculated on a per ton basis.

Table 12-3 presents an analysis of the sustainability of the archetype for industrial plants in the Central Valley whose processes require the treatment of saline water and disposal of salt by trucking brine to a WWTP with an ocean disposal and/or by deep well injection, based on the preceding discussion. The first table analyzes the deep well injection disposal method, while the second table evaluates the trucking disposal method.

Table 12-3. Sustainability Analyses for the Hilmar Cheese Salt Disposal Archetype: Deep Well Injection

Factor	Score[1]	Discussion
Implementability	1	Deep well injection utilizes proven technologies; however, direct experience at HCC demonstrates that there can be technological challenges to be met. The implementability of deep well injection to other areas in the Central Valley is dependent on a deep aquifer of degraded water quality to inject into, capacity of the aquifer to accept the requisite volume of brine, permitting, compatibility of the water chemistries of the brine and the groundwater, and on-going maintenance to keep the injection wells operational.
Capacity	4	According to their UIC permit, HCC is permitted to inject at a rate of 23 million gallons per month – they produced brine at a rate of about 3.1 million gallons per month in 2012, so in this case, there does not appear to be a capacity issue. Every facility would require a site-specific analysis, including the development of a hydrogeological conceptual model, development of a numerical simulation model, and pilot testing.
Regulatory	3	HCC operates under a Class 1 Nonhazardous Waste Injection permit issued through the EPA's UIC Program.
Institutional	4	The project is managed by a single private company.
Costs	3	The initial costs for the construction, operation, and maintenance of the injection wells is relatively low. Current O&M costs are also relatively minor, despite the amount of energy required to operate the wells. The equivalent annual cost for HCC's deep well injection is $427,000. The determination of whether deep well injection is feasible at this site and the costs of well rehabilitation and on-going O&M are uncertain.
Environmental Issues	3	Because the discharge is to deep groundwater that is of lower quality than the injected water, other environmental issues should be minor.
Public Acceptance	1	The public may confuse deep well injection into a non-potable aquifer for waste disposal with injection into a potable aquifer and/or fracking.

[1] On a scale of 1 to 4, with 4 being high, or best in terms of sustainability.

[25] Fuel costs are likely to rise in the future, which may be partially – but not completely – off-set by gains in fuel efficiency.

Table 12-4. Sustainability Analyses for the Hilmar Cheese Salt Disposal Archetype: Trucking Brine to EBMUD's Main WWTP

Factor	Score[1]	Discussion
Implementability	3	Trucking the brine to EBMUD utilizes proven technologies; its implementability for other sites in the Central Valley depend, in part, on the distance, rising fuel costs, the volume of brine, and on-site brine minimization technologies to reduce the brine volume prior to transportation.
Capacity	3	Currently, treatment capacity at EBMUD's main WWTP is not completely utilized. Proponents of projects in other similar industrial Study Areas that would consider this disposal method should perform an engineering and economic forecast to determine the sustainability and the future costs of disposal at EBMUD or other WWTPs.
Regulatory	3	HCC has a Resource Recovery/Trucked Waste permit with EBMUD. It is anticipated that other projects in the Central Valley will need similar permits, but that these would not present any regulatory challenges.
Institutional	4	The project is managed by a single private company.
Costs	1	In 2012, EBMUD transported 37 million gallons of brine to EBMUD where there is a fee of $0.11 to $0.12 per gallon or $4.26 million for 2012. In addition, the trucking costs range between $1 million to $2 million annually. These costs are relatively high and projected to get higher based on rising fuel costs and potential increases in EBMUD fees.
Environmental Issues	3	Because the discharge is to a WWTP, other environmental issues should be minor. If this archetype were expanded to a Valley-wide scale, there may be issues with Air Quality Management District and the collective projects' carbon footprint.
Public Acceptance	3	The public would not generally be aware of this project or would likely have a neutral opinion.

[1] On a scale of 1 to 4, with 4 being high, or best in terms of sustainability.

12.2.4 Industrial Food Processing Facilities

Industrial food processing serves as archetype Study Area that addresses salinity issues facing large industries adjusting to increased regulatory focus due to observed salt impacts to groundwater. Wastewater generated from these industries contains high levels organic matter, salts, and nutrients that must be treated prior to discharge. Food processors in the Central Valley discharge their wastes either directly to publicly owned treatment works (POTWs) or to land under various permit requirements. RWQCB has expressed concerns that significant groundwater impacts have occurred due to land application of food processing wastewater[26], and that changes in regulatory strategy are needed to prevent future impacts. In response, food processing industry groups have developed new guidelines for source control and process water management.

Table 12-5 presents an analysis of the sustainability of industrial food processing archetype, based on the preceding discussion.

[26] A review of monitoring well data from 105 Central Valley food processing facilities found that 90 percent of these sites had suspected or confirmed groundwater impacts from waste discharges to land.

Table 12-5. Sustainability Analyses for the Industrial Food Processing Salt Disposal Archetype

Factor	Score[1]	Discussion
Implementability	4	The two primary disposal methods for salt (in industrial wastewater) are disposal to a WWTP and discharge to the land surface. The construction, operation, and maintenance of a service connection to a municipal WWTP utilizes proven technologies and is implementable. Likewise, the construction, operation, and maintenance of land discharge methods (application directly to land, discharge ponds, etc.) utilized proven technologies and is implementable.
Capacity	2	Capacity would be evaluated on a site-specific basis and would depend on the capacity of the WWTP and/or the capacity of wastewater discharge ponds. The capacity of the discharge ponds may depend on soil and aquifer characteristics (drainage, depth to groundwater, etc.), requisite land for additional ponds, as necessary, and changes in land use (encroachment of urban land uses).
Regulatory	1	The Porter-Cologne Act allows the Central Valley RWQCB to regulate discharges to land through issuance of either WDRs or conditional waivers of WDRs. CWC Section 13269, amended in 1999, caused all Central Valley RWQCB waivers to expire on January 1, 2003; entities wishing to renew their waivers had to submit to a case-by-case evaluation process by the Board and, if granted a waiver, were required to demonstrate compliance with the State's Antidegradation Policy through continued monitoring and reporting. At the same time, the Central Valley RWQCB instituted a Consistency Policy which called for an appraisal of the WDR program to check for consistency with the State's Title 27 regulations governing disposal of solid waste to land (27 CCR § 20005, et seq.). Current regulation of food processors discharging to land is based on interim standards as more permanent policy setting takes place (HCC, 2007). The Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) program will lead to future action, but until such policies are in place dischargers may be reluctant to institute potentially costly salt reduction methods. It is anticipated that the future regulatory paradigm will be more restrictive and that projects under current permits will receive new permits with more stringent requirements.
Institutional	2	The technologies utilized by each food processor would depend upon site-specific conditions and goals. Because there is no valley-wide salinity standard for discharging industrial wastewater to land, the relative impact of discharge concentrations on groundwater quality would also need to be considered.
Costs	1	Future regulations may require substantive pre-treatment for industrial processors for both discharges to a WWTP and to the land surface.
Environmental Issues	2	Depending on the trace constituents in the wastewater discharged to the land surface, there is a potential for other environmental issues.
Public Acceptance	3	The public would not generally be aware of this project or would have a neutral opinion.

[1] On a scale of 1 to 4, with 4 being high, or best in terms of sustainability.

12.2.5 Red Rock Ranch

The Red Rock Ranch (RRR) is an archetype Study Area for zero-discharge IFDMs in the Central Valley whose processes include managing drainage water by sequentially reusing it to grow increasingly salt-tolerant crops and then using a solar evaporator to reduce the last of the tail water to dry salt. The goal would be to develop an alternate market for the recovered salt.

RRR is located on the Westside of the San Joaquin Valley where drainage is problematic due to alluvium of marine-origin. The Corcoran Clay, which ranges in thickness from about 20 to 40 feet under RRR, limits infiltration to deeper aquifer systems, leading to drainage issues and the accumulation of salt and trace constituents, e.g., selenium and boron in soil and shallow groundwater. In developing a conceptual salt balance model on a site-specific area for RRR, one must consider salts leached from the soil, in addition to salt added with irrigation water, concentrated by consumptive use, harvested and removed with commercial crops, and salt ultimately accumulated at the solar evaporator.

The San Joaquin Drainage Implementation Program estimated that the total annual production of salt at RRR would be about 80 tons (SJVDIP 1999). The particle density of sodium chloride is 2.165 grams per cubic centimeter or 135 pounds per cubic feet (lbs/ft^3). The bulk density of de-icing salt ranges between 72 and 80 lbs/ft^3. The bulk density of sodium sulfate is about 85 lbs/ft^3. The salt accumulation area at RRR is about 10,000 square feet. Using the range of salt densities, the height of the salt accumulation, after 50 years, would be between 6 and 10 feet.[27]

Table 12-6 presents an analysis of the sustainability of the archetype for IFDMs in the Central Valley, characterized by zero-discharge, marketing the salt as a commercially-viable product – or sequestering the salt at the site, and potential ancillary environmental issues.

Table 12-6. Sustainability Analyses for the Red Rock Ranch Salt Disposal Archetype

Factor	Score[1]	Discussion
Implementability	2	In terms of disposal, the salt is produced by evaporation using a solar evaporator and then transported to an accumulation area for storage. The dry-salt is then either sold and transported off-site to be used for commercial purposes or would be sequestered on-site indefinitely. Salts derived from IFDM drainage water are mixtures, but typically are largely sodium sulfate and sodium chloride and technologies exist to separate purified salt products for commercial markets (Jenkins et al., 2003)28. One of the keys for a commercially-viable salt product is the fractional crystallization of sodium-sulfate decahydrate from the drainage water, due to its distinctive solubility characteristics. Sodium sulfate is not a "major commodity chemical" and sodium sulfate recovery at RRR would net "roughly $12,000 additional revenue if sulfate were marketed at average unit value" (Jenkins et al., 2003). Jenkins et al. further state, "Full capital and operating costs are not yet known for these systems meeting environmental compliance and economic feasibility remains uncertain. The actual market value for agricultural drainage derived salt also remains uncertain until routine purities and marketing options can be established." Other commercial markets for agricultural drainage-derived salts are being explored. The technologies to sequester and manage salt on-site are proven and implementable. Long-term capacity and environmental concerns are issues described below in this table.
Capacity	1	In terms of marketing the salt as a commercially-viable product, the capacity relates to the mass that can be produced, separated, purified and sold. The roughly $12,000 additional revenue for sodium sulfate recovery at RRR cited above was assuming a recovery of 129 million grams per year. In addition to the implementability issues, one must consider the capacity of the IFDM to produce enough marketable salt products or if this needs to be evaluated at a regional scale to take advantage of economies of scale. In terms of the site's capacity to sequester salt, the height of the salt accumulation would be between 6 and 10 feet after 50 years – and much higher if the salt were merely stored as a series of piles.

[27] This assumes vertical sides. Without retaining walls, one would need to take into account the angle of repose of the salt and a "pile" of salt would be much higher.

[28] Jenkins, B. M., G. Sun, V. Cervinka, J. Faria, P. Thy, T. R. Runsey, and M. W. Yore. 2003. Salt separation and purification concepts in integrated farm drainage management systems. 2003 ASAE Annual International Meeting. Las Vegas, Nevada, 27-30 July 2003.

Table 12-6. Sustainability Analyses for the Red Rock Ranch Salt Disposal Archetype

Factor	Score[1]	Discussion
Regulatory	2	The RWQCB established WDRs for the operation of the solar evaporator. However, because the discharges to the solar evaporator were high in selenium, the RWQCB invoked regulatory provisions of the Toxic Pits Cleanup Act and issued WDRs for the solar evaporator. RRR experienced difficulties in efficiently operating the solar evaporator while meeting the WDR's and was served with Notices of Violation (SWRCB 2003). The selenium problems were related to standing water within the solar evaporator, which introduced selenium into the food chain that biomagnified and impacted nesting shorebirds. Recognizing the importance of solar evaporators as the essential final component of the IFDM system, the legislature introduced Senate Bill (SB) 1372 which directed the State Water Resources Control Board (SWRCB) to adopt emergency regulations to address the selenium concerns (SWRCB 2003). The regulations were primarily designed to account for the no standing water provision included in SB 1372. Title 27 of the California Code of Regulations now includes minimum requirements for the design, construction, operation, and closure of solar evaporators as components of IFDM systems (CCR Title 27).
Institutional	2	Institutional barriers to implementation of IFDM are related to deployment and acceptance of this relatively new technology by landowners and farm operators. The WRCD has developed guidance manuals that address developing standard IFDM design practices that can be readily applied by other landowners (WRCD 2004, 2005).
Costs	1	In terms of marketability of sodium sulfate as a product, the costs may be relatively high, as Jenkins et al. (2003) describe a process flow diagram wherein the salt separation by fractional crystallization occurs on-site. Disposal costs for salt accumulation are low to start, but will increase as the mass and volume of salt increase. The salt must be kept on-site and erosion controls – for both wind and water – must be implemented.
Environmental Issues	1	Major rain events can result in ponded water and the rapid formation of an aquatic food chain. Standing water with relatively high selenium concentrations has the potential of impacting sensitive species.
Public Acceptance	2	A proliferation of salt accumulation areas throughout the valley may have a low public acceptance.

[1] On a scale of 1 to 4, with 4 being high, or best in terms of sustainability.

12.2.6 Grassland Water District Real Time Management

The Real-Time Management Program (RTMP) is an archetype Study Area for the release of salt loads into a surface water body using real-time management and sophisticated modeling to utilize assimilative capacity in the water body. In 2004, the Real Time Water Quality Management in the Grasslands Water District Study (Quinn *et al.*, 2004) was completed. This research study was supported by CALFED and the Reclamation and furthered the development of an RTMP. The goal of the RTMP is to collaboratively manage water quality in the river by coordinating the timing of higher salinity discharges from wetlands and agricultural areas with the releases of lower salinity water from the east-side reservoirs. The RTMP would maximize saline discharges during periods when the river has high assimilative capacity and thereby minimize exceedances of salinity water quality objectives at Vernalis.

The RTMP would rely on an extensive network of water quality monitoring stations along the river, tributaries, and at discharge locations. These monitoring stations are equipped with probes that continuously measure flow and water quality parameters at targeted locations. The monitoring stations utilize telemetry systems to disseminate the water quality conditions on a "real-time" basis. Operation of the RTMP would require ongoing cooperation between the water quality monitoring system operators, a forecasting/modeling team, water system operators, and dischargers to plan and coordinate discharges and reservoir releases in order to maximize use of the assimilative capacity of the San Joaquin River.

In terms of water releases, the goals of the RTMP and the wetlands management by the GWD are not in complete alignment: the GWD wetlands drawdown in the spring is discharged into tributaries of the Lower San Joaquin River and is timed to meet wetland management objectives. The GWD wetlands drawdown in the spring does not coincide with higher assimilative capacity in the San Joaquin River (between January and April) which is the primary management goal of the RTMP.

Table 12-7 presents an analysis of the sustainability of RTMP salt disposal archetype, based on the preceding discussion.

Table 12-7. Sustainability Analyses for the Grassland Water District RTMP Salt Disposal Archetype

Factor	Score[1]	Discussion
Implementability	3	The construction, operation, and maintenance of the infrastructure (weirs, pipes, gates, monitoring equipment, SCADA, etc.) to accomplish the RTMP relies on proven individual technologies; however, very high levels of integration between the system operations and the monitoring and modeling (forecasting) are required.
Capacity	3	As an "Out of Valley" alternative, the GWD RTMP would provide long-term sustainable capacity for exporting salt loads since salt accumulations are exported into the Delta using the available assimilative capacity in the San Joaquin River. The actual capacity of the RTMP would be limited by the area of wetlands areas served and the volume and salt concentration discharged during draw down periods. The salt capacity for RTMP is also dependent on the periodically-available assimilative capacity (both duration and magnitude) of the San Joaquin River, and whether and how much of the assimilative capacity would be allocated to the RTMP.
Regulatory	2	The LSJR is listed on CWA's 303(d) list as impaired for salinity and boron. In September 2004, the Central Valley RWQCB established a boron and salt TMDL for the Lower San Joaquin River that included regulation of wetlands. The RTMP project proponents will need to work with the Central Valley RWQCB to be allocated assimilative capacity in the San Joaquin River.
Institutional	2	The RTMP would rely on an extensive network of water quality monitoring stations along the river, tributaries, and at discharge locations. Operation of the RTMP would require ongoing cooperation between the water quality monitoring system operators, a forecasting/modeling team, water system operators, and dischargers to plan and coordinate discharges and reservoir releases in order to maximize use of the assimilative capacity of the San Joaquin River. In terms of water releases, the goals of the RTMP and the wetlands management by the GWD are not in complete alignment.
Costs	2	The Salt and Boron TMDL did include an initial cost assessment of the components of a typical real time system based on professional judgment. The estimated "per system" cost for RTMP included $350,000 for installation and $100,000 per year for operation and maintenance, including discharge coordination (Central Valley RWQCB 2002). The TMDL Staff report assumed that eleven systems would cover most of the major irrigation districts and the wetland operations in the lower SJR (Central Valley RWQCB 2002). Over a 50 year service life, and with a discount rate of 5 percent, the equivalent annual cost is $1.3M.
Environmental Issues	2	Environmental issues are expected to be minor.
Public Acceptance	3	The public would generally approve of this project.

[1] On a scale of 1 to 4, with 4 being high, or best in terms of sustainability.

12.2.7 Stevinson Water District

Poor drainage throughout Stevinson Water District (SWD) combined with high seepage from earthen ditches has resulted in significant agricultural water losses, a high groundwater table, and limited available cropping options for farmers. In addition, the highly saline soils in the area cause concentrated salt levels in the groundwater, reducing crop yields as a result. The Stevinson Study Area specifically looked at conserving water supplies and addressing agricultural drainage related salinity issues by reducing seepage, managing drainage through a series of artificial wetlands, and implementing other ancillary facilities as well as other water management actions included in the Integrated Water Resources Plan (IWRP). The IWRP was designed with the primary goals of conserving water and thereby improving water supply reliability and reducing water quality impacts of agricultural drainage water discharges to the San Joaquin River.

In terms of salinity in source water supply, TDS concentrations in groundwater typically range from 300 to 3000 mg/L, while water from the Merced River has an average TDS of 44.8 mg/L and the East Side Canal has an average TDS of 64 mg/L. Salt is added or increased in concentration from dairies (the primary industry in the area), consumptive use by field crops, leaching of shallow, highly-saline soils.

SWD is in IAZ 13 (Merced, Chowchilla, and Madera Basins) of the ICM. The percentage of CVHM grid cells in IAZ 13 containing at least one well with TDS concentrations greater than 500 mg/L were 12, 18, 11, and 20 percent for the following time periods: pre-1960, 1960 – 1979, 1980 – 1999, and 2000 – 2012, respectively. The median TDS concentration in the shallow groundwater was 648 mg/L[29], while the estimated TDS concentration in the deep aquifer was 236 mg/L[30]. ICM model simulations show IAZ 13 exceeding the secondary MCL of 500 mg/L only for 200 percent of projected salt loading. A threshold of 1000 mg/L was not exceeded for any of the simulated salt loads. IAZ 13 is a priority 1 basin[31] when using a 500 mg/L threshold and a priority 0 basin when using a 1000 mg/L threshold. There is no assimilative capacity using the 500 mg/L threshold.

Salt is entering into the SWD area and infiltrating (through agricultural drainage) into the groundwater below. SWD addresses these salinity issues primarily through source controls. These solutions either prevent or reduce the volume of saline groundwater from entering the San Joaquin River (through the Lateral Canal Pipelining Project) or release saline agricultural drainage water during times of high assimilative capacity in the river (through the Agricultural Drainage Control Project). As described above, this groundwater will eventually migrate downgradient towards the San Joaquin River, providing a source for the river's base flow. The SWD project does not have a salt disposal method and therefore cannot be evaluated herein.

12.2.8 Tulare Lake Bed

The Tulare Lake Bed is an archetype Study Area for salt disposal, regionally sequestering salt on the land surface and in shallow groundwater. The Tulare Lake Basin is a closed system, and there is currently no drainage outlet. Salt is imported from surface water supplies, which are primarily used to irrigate the majority of the 3 million acres of agricultural land. The salt in applied irrigation water increases in concentration due to consumptive use, the addition of fertilizers and soil amendments

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[29] 2003 to 2012

[30] 1980 to 2012

[31] Out of five categories: 0 through 4, with 4 being the highest priority.

and the leaching of naturally-occurring salt from areas with saline soils into the shallow groundwater. Virtually no water infiltrates vertically through the Corcoran Clay. Within the closed Tulare Lake Bed, groundwater is not able to drain out, thereby further increasing the concentration of salt in groundwater. These high salt concentrations (ranging from 5,000 to 35,000 µmhos/cm [TLBWSD 2012]) throughout the lake bed make the groundwater unusable for municipal (MUN) beneficial uses and limits agricultural (AGR) beneficial uses due to reduced crop yields and limiting the crops grown to only salt tolerant species.

With no feasible drainage outlet readily available for the lake bed, stakeholders constructed and are operating a drainage system with evaporation basins to accumulate salts and maintain agricultural productivity. However, the use of these evaporation basins has the potential to impact local and migrating wildlife that use the ponds as wetlands, due to naturally-occurring selenium in the drainage water.

The majority of the Tulare Lake Bed Study Area is in IAZ 15 (Tulare Lake and Western Kings Basin) of the ICM. The percentage of CVHM grid cells in IAZ 15 containing at least one well with TDS concentrations greater than 500 mg/L were 53, 46, 61, and 48 percent for the following time periods: pre-1960, 1960 – 1979, 1980 – 1999, and 2000 – 2012, respectively. The median TDS concentration in the shallow groundwater was 1000 mg/L[32], while the estimated TDS concentration in the deep aquifer was 337 mg/L[33]. ICM model simulations show IAZ 15 exceeding the secondary MCL of 500 mg/L for 50, 100, and 200 percent of projected salt loading. A threshold of 1000 mg/L was not exceeded for any of the simulated salt loads. IAZ 15 is a priority 4 basin[34] when using a 500 mg/L threshold and a priority 2 basin when using a 1000 mg/L threshold. There is no assimilative capacity using the 500 mg/L threshold.

High salinity makes groundwater underlying the Tulare Lake Bed unusable in terms of the MUN beneficial use; as a result, stakeholders in the basin are working with the Central Valley RWQCB through CV-SALTS to delist a portion of the historical lakebed in this area from the MUN beneficial use. Designation of the MUN beneficial use is required under State Resolution No. 88-63. Per this order, all surface or groundwater in the State is designated, by default, to have an MUN beneficial use with a few exceptions. The exceptions for both surface and groundwater include waters where: (i) the TDS exceeds 3,000 mg/L and it is not reasonably expected by the Central Valley RWQCB to supply a public water system, or (ii) there is contamination, either by natural processes or by human activity (unrelated to a specific-pollution incident), that cannot reasonably be treated for domestic use by using either Best Management Practices or best economically achievable treatment practices. Tulare Lake Bed is unique in that it is the ultimate salt sink in the Tulare Basin.

Table 12-8 presents an analysis of the sustainability of for the Tulare Lake Bed salt disposal archetype, based on the preceding discussion.

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[32] 2003 to 2012

[33] 1980 to 2012

[34] Out of five categories: 0 through 4, with 4 being the highest priority.

Table 12-8. Sustainability Analyses for the Tulare Lake Bed Salt Disposal Archetype

Factor	Score[1]	Discussion
Implementability	4	The construction, operation, and maintenance of the infrastructure for the evaporation ponds utilizes proven technologies and is implementable for the Tulare Lake Bed.
Capacity	3	An in-depth evaluation of the long-term capacity for accumulation and disposal of salt loads in the Tulare Lake Bed will be required. In the Tulare Lake Basin Plan, the RWQCB specifically states that, "a valley-wide drain to carry salts out of the valley remains the best technical solution to the water quality problems of the Tulare Lake Basin" (Central Valley RWQCB 2004). While an "out-of-valley" drain would provide the best long-term solution to salt accumulation in the Tulare Lake Basin, it will present many regulatory, technical, and financial obstacles as well. Agricultural operators in the Tulare Lake basin are considering numerous other salinity management alternatives (e.g., drainage management, regional re-use, drain water treatment and expanded evaporation ponds) that would provide near- and mid-term salt capacity.
Regulatory	3	The delisting of the MUN beneficial use for a portion of the historical Tulare Lake Bed requires completion of all required documentation to amend the Tulare Lake Basin Plan and approval by the Central Valley RWQCB and SWRCB. Completion of these steps occurs under a public process requiring workshops and hearings. As this process is currently being undertaken, it is not fully known where potential barriers to completion of the Basin Plan Amendment may occur, but the working group feels there is a high probability of success.
Institutional	3	Stakeholders in the Tulare Lake Bed area will need to coordinate efforts to manage salt on the land surface and in shallow groundwater, manage groundwater elevations in the perched system, and manage the evaporation basins to minimize their use by wildlife as wetlands or as waterways for migrating avian species.
Costs	3	The costs associated with this archetype Study Area are the management of salt on the land surface from evaporation ponds, the management of groundwater elevations in the perched system, and manage the evaporation basins.
Environmental Issues	3	There are potential environmental concerns about salt disposal at the Tulare Lake Bed including the control of salt at the evaporators (leaching, water and wind erosion). As with other archetype study areas in the western portion of the San Joaquin Valley, there are inherent challenges with naturally-occurring trace metals, most notably selenium. Tertiary marine sedimentary deposits – especially the Monterey Miocene Formation – and Quaternary marine sedimentary rocks are the principal sources of selenium in the Tulare Lake Bed area (Seiler *et al.*, 1999). The presence of selenium leads to potential concern about the formation of ponds of standing water which may lead to the bioaccumulation of certain trace constituents in the food chain. While naturally-occurring selenium must be managed, the Tulare Lake Bed is a viable salt disposal alternative. A number of the evaporation ponds have been in operation for over 25 years at the Tulare Lake Bed and environmental issues have been encountered and addressed previously.
Public Acceptance	3	The public will be neutral to sensitive to the potential environmental issues associated with this project.

[1] On a scale of 1 to 4, with 4 being high, or best in terms of sustainability.

12.2.9 Westside Regional Drainage Plan

The Westside Regional Drainage Plan (WRDP) is the archetype Study Area that describes source control, treatment, and salt disposal on a regional scale on the west side of the San Joaquin Valley where there are wide-scale drainage issues. As noted in Section 10, the WRDP was prepared by the primary stakeholders on the westside: the San Joaquin River Exchange Contractors Water Authority, the Broadview Water District, the Panoche Water District, and the Westlands Water District. The WRDP is fully consistent with Reclamation's San Luis Drain Feature Re-Evaluation Plan Formulation Report, and indeed borrows the main technical components from that effort. These components, which were originally developed as part of *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley, Final Report* for the San Joaquin Valley Drainage Program ("Rainbow Report"), and includes land retirement, groundwater management, source control, regional re-use, treatment and salt disposal. The WRDP does include an accelerated schedule for providing drainage.

WRDP is in IAZ 14 (Westside and Northern Pleasant Valley Basins) of the ICM. The percentage of CVHM grid cells in IAZ 14 containing at least one well with TDS concentrations greater than 500 mg/L were 100, 99, 95, and 95 percent for the following time periods: pre-1960, 1960 – 1979, 1980 – 1999, and 2000 – 2012, respectively. The median TDS concentration in the shallow groundwater was 3375 mg/L[35], while the estimated TDS concentration in the deep aquifer was 966 mg/L[36]. ICM model simulations show IAZ 14 exceeding the secondary MCL of 500 mg/L at 50, 100, and 200 percent of projected salt loading. A threshold of 1000 mg/L was exceeded at 50, 100, and 200 percent of simulated salt loads. IAZ 14 is a priority 4 basin[37] when using a 500 mg/L threshold and a priority 3 basin when using a 1000 mg/L threshold. There is no assimilative capacity using the 500 mg/L threshold.

Table 12-9 presents an analysis of the sustainability of regional salt disposal archetype, based on the preceding discussion.

Table 12-9. Sustainability Analyses for the Westside Drainage Regional Plan Salt Disposal Archetype

Factor	Score[1]	Discussion
Implementability	2	In terms of salt disposal options, the WRDP lists the following alternatives (SJRECWA, 2003): "Initially, the brine solution could be stored in waste containment facilities, including evaporation ponds, built on retired land." This option is similar in concept to the RRR on-site disposal option. "Ultimately, it may be possible to market some of this product for [commercial] uses." This option is similar in concept to the RRR market disposal option. "If a viable market for reclaimed salt is not developed then, as an alternative, salts could be collected in waste containment facilities and stored indefinitely. Evaporation ponds and solar evaporators will be used to concentrate the brine into sludge or dry crystals for ultimate utilization and disposal." "Final disposal also could be into permitted disposal sites." Developing a viable commercial market will have the same challenges as RRR. However, because the WRDP is a regional project and there are economies of scale, WRDP may have a better chance at developing this commercial market. The technologies to sequester and manage salt on-site are proven and implementable. Long-term capacity and environmental concerns are issues described below in this table.
Capacity	1	One of the WRDP's salt disposal option is to collect the salt in waste containment facilities and store them indefinitely. The same capacity issues that faces RRR would be of concern at WRDP, just at an expanded scale.

[35] 2003 to 2012

[36] 1980 to 2012

[37] Out of five categories: 0 through 4, with 4 being the highest priority.

Table 12-9. Sustainability Analyses for the Westside Drainage Regional Plan Salt Disposal Archetype

Factor	Score[1]	Discussion
Regulatory	2	The waste containment facilities will be regulated, including the states Title 27: "Where necessary to protect water quality, the Regional Water Quality Control Board (RWQCB) can implement, in coordination with the enforcement agency (EA) or, as appropriate, the California Integrated Waste Management Board (CIWMB), appropriate standards promulgated by the CIWMB." Depending on the nature of the containment facilities there may be air quality and erosion issues, as well as percolation to groundwater concerns.
Institutional	3	The management of the salt – whether it is sold as a commercial product, stored indefinitely in waste containment facilities, or ultimately removed to permitted disposal sites – should be coordinated under one stakeholder group, e.g., the authors of the WRDP.
Costs	1	Disposal costs for salt accumulation are low to start, but will increase as the mass and volume of salt increase. The salt must be kept on-site and erosion controls – for both wind and water – must be implemented. If the salt is removed to permitted disposal sites, there will also be trucking costs.
Environmental Issues	1	Major rain events can result in ponded water and the rapid formation of an aquatic food chain. Standing water with relatively high selenium concentrations has the potential of impacting sensitive species. Possible AQMD concerns if the salt is ultimately removed to permitted disposal sites.
Public Acceptance	2	A proliferation of salt accumulation areas throughout the valley may have a low public acceptance.

1 On a scale of 1 to 4, with 4 being high, or best in terms of sustainability.

12.2.10 San Luis Unit Ocean Disposal

The San Luis Unit provides an archetype Study Area describing salinity-related issues on a regional scale. Reclamation's 2002 San Luis Drainage Feature Re-Evaluation Plan Formulation Report identified potential alternatives to address drainage issues throughout the westside region. The alternatives were then re-evaluated in the *San Luis Drainage Feature Re-evaluation Feasibility Report* and the *Final Environmental Impact Statement* (Final EIS) (Reclamation 2006). Based on input from the Technical Advisory Committee (TAC), SSALTS evaluated salt disposal for only the ocean disposal alternative from the Final EIS.

The Final EIS (Reclamation, 2006) analyzed seven action alternatives for salt mitigation and disposal. There are a number of common elements for both On-Farm/In-District Actions and Federal Facilities:

On-Farm/In-District Actions Common to All Action Alternatives	Federal Facilities Common to All Action Alternatives
Irrigation System Improvements	Drainwater Collection System and Delta Mendota Canal Drain
Shallow Groundwater Management	Regional Reuse Facilities
Seepage Reduction	Treatment and Disposal Alternatives
Drainwater Recycling	

In addition to the common elements, the seven action alternatives include:

- **In Valley.** The drainwater from the 16 proposed regional reuse facilities would undergo RO for salt reduction and biotreatment to reduce selenium concentrations. The disposal method would be regional evaporation basins located in-valley.

- **In Valley/Groundwater Quality Land Retirement**. There are 44,106 acres that would be retired under each of the action alternatives. This alternative would include retiring that acreage as well as all lands with underlying selenium concentrations greater than 50 µg/L – 92,592 acres in all. As with the In-Valley alternative, there would be RO, selenium biotreatment and disposal at evaporation basins.
- **In-Valley/Water Needs**. This alternative would include the retirement of enough agricultural lands to balance demand and expected supply with the San Luis Unit – 193,956 acres in total. As with the In-Valley alternative, there would be RO, selenium biotreatment and disposal at evaporation basins.
- **In Valley/Drainage-Impaired Area**. This alternative would include the retirement of all drainage impaired lands in the Wetlands and Broadview Water Districts – 298,000 acres. Lands that would remain in production in the northerly drainage-impaired area would be eligible for drainage services and there would be RO, selenium biotreatment and disposal at evaporation basins.
- **Delta-Chipps**. This alternative includes land retirement, selenium biotreatment and a new conveyance facility from the current terminus of the San Luis Drain at Mud Slough to the western end of the Delta at Chipps Island. The Delta-Chipps alternative includes 160 miles of new pipeline and canals. There is no RO included in this alternative.
- **Delta-Carquinez**. This alternative is similar to the Delta-Chipps alternative, except that the conveyance system would be extended west to the Carquinez Strait, immediately upstream of the Carquinez Bridge. Because this potential discharge point is further downstream in the Bay-Delta system, there is more extensive tidal mixing. The Delta- Carquinez alternative includes 177 miles of new pipeline and canals. There is no RO included in this alternative.
- **Ocean**. This alternative includes land retirement, and a new conveyance facility from the San Joaquin Valley to the Pacific Ocean to an outfall about 1.4 miles offshore near Point Estero and about 10 miles south of the southern boundary of the Monterey Bay National Marine Sanctuary. There is no RO or selenium biotreatment included in this alternative.

The estimated costs for the seven alternatives evaluated in the FEIS are presented below (Reclamation, 2006):

Table 12-10. Federal Project Costs ($ millions, 2002 dollars)

Alternative	Construction	Annual OM&R	Present Worth	Annual Equivalent
In Valley	607	19.8	562	33.8
In Valley/Groundwater Quality	676	18.1	626	37.6
In-Valley/Water Needs	828	15.1	773	46.5
In Valley/Drainage-Impaired Area	918	10.9	857	51.6
Delta-Chipps	630	12.5	562	33.8
Delta-Carquinez	673	12.5	598	36.0
Ocean	589	11.6	563	33.8

Federal Cost: Cost for facilities that would be part of the Federal drainage service plan and would be Federally funded.
Construction: All capital costs for lands, rights-of-way. Construction, mitigation, and interest during construction.
Annual OM&R: All annual costs to operate, maintain, and replace project facilities.
Present Worth: The combined construction and annual OM&R costs presented as a one-time cost.
Annual Equivalent: The present worth cost presented as a series of equal annual payments over 50 years.

The San Luis Unit is in IAZ 14 (Westside and Northern Pleasant Valley Basins) of the ICM. The percentage of CVHM grid cells in IAZ 14 containing at least one well with TDS concentrations greater than 500 mg/L were 100, 99, 95, and 95 percent for the following time periods: pre-1960, 1960 – 1979, 1980 – 1999, and 2000 – 2012, respectively. The median TDS concentration in the shallow groundwater was 3375 mg/L[38], while the estimated TDS concentration in the deep aquifer was 966 mg/L[39]. ICM model simulations show IAZ 14 exceeding the secondary MCL of 500 mg/L at 50, 100, and 200 percent of projected salt loading. A threshold of 1000 mg/L was exceeded at 50, 100, and 200 percent of simulated salt loads. IAZ 14 is a priority 4 basin[40] when using a 500 mg/L threshold and a priority 3 basin when using a 1000 mg/L threshold. There is no assimilative capacity using the 500 mg/L threshold.

Table 12-11 presents an analysis of the sustainability of ocean outfall salt disposal archetype, based on the preceding discussion.

Table 12-11. Sustainability Analyses for the San Luis Unit Ocean Outfall Salt Disposal Archetype

Factor	Score[1]	Discussion
Implementability	4	The construction, operation, maintenance, and replacement of a conveyance system for ocean disposal – including pipelines, tunnels, lift, stations – utilizes proven technologies and is implementable.
Capacity	4	The pipeline capacity is sized to accommodate the anticipated drainage water, taking into account land retirement and regional reuse facilities. It was estimated that the final (after regional reuse) drainage volume transported through the pipeline would be 20,988 acre-feet/year at an average flow rate of 29.1 cubic feet/second (Reclamation 2006).
Regulatory	1	The construction of a brine line to transport drainage from the San Luis Unit to the Pacific Ocean would require extensive permitting. Many Federal, State, and local agencies must be involved including, but not limited to, US Army Corp of Engineers, US Department of Interior, National Marine Fishery Service, California State Historic Preservation Office, California State Lands Commission, California Coastal Commission, San Francisco Bay Conservation and Development Commission, and the California Department of Fish and Game. Reclamation (2006) determined that the ocean disposal alternative would be the third (out of the seven action alternatives) most complex and difficult alternative to permit, after the two brine disposal alternatives that would discharge the drainwater into the Delta. It would be difficult to provide sufficient analysis to demonstrate that this alternative is consistent with the California Coastal Management Program41 and that this alternative is the least environmentally damaging feasible alternative considering long-term effects to the marine environment. It is doubtful that a consistency determination, acceptable to the USEPA and the State of California, could be developed establishing that the ocean disposal alternative is the least environmentally damaging feasible alternative
Institutional	2	The Ocean Outfall pipeline would be managed by a single agency (Reclamation), but would require extensive coordination with other agencies (state and federal regulatory agencies, regional water agencies, and local municipal agencies).

[38] 2003 to 2012

[39] 1980 to 2012

[40] Out of five categories: 0 through 4, with 4 being the highest priority.

[41] Encourage State-local initiatives and cooperation in preparing procedures to implement coordinated planning and development for mutually beneficial uses, including educational uses, in the coastal zone (California Coastal Commission, 1997).

Table 12-11. Sustainability Analyses for the San Luis Unit Ocean Outfall Salt Disposal Archetype

Factor	Score[1]	Discussion
Costs	1	The present worth cost for the ocean outfall pipeline are $563 million and the annual equivalent costs are $33.8 million. The Ocean Disposal Alternative was estimated to provide a net reduction of over 500,000 tons per year of salt from the root zone and shallow groundwater (Reclamation, 2006), yielding a cost of $67.60 per ton of salt. However, Reclamation did not provide an estimate of the tons of salt removed permanently from the valley; the reduction of 500,000 tons per year also includes the benefits of irrigation efficiencies, regional reuse facilities, and land retirement.
Environmental Issues	1	Through the analysis, the FEIS determined that there would be water quality degradation in the vicinity of the outfall, although water quality objectives would be met outside this zone. In addition, there have not been any long-term studies to determine impacts from discharging into the ocean. The ocean disposal alternative is expected to significantly impact federal and state listed special-status species through construction and operation of the pipeline. In construction of this alternative, it is expected that 2,000 acres of natural and native habitats will be modified. In addition, high selenium levels in reuse facilities would impact sensitive habitat for aquatic or wetland-dependent species. Out of all the alternatives considered in the FEIS, the ocean disposal alternative would require over 3 times more power than the next highest power consumption alternative. The needed conveyance system, including pumps, is expected to consume 81,400,000 kilowatt hours/ year.
Public Acceptance	1	Implementing this alternative would result in significant public concerns.

[1] On a scale of 1 to 4, with 4 being high, or best in terms of sustainability.

12.3 Summary of Study Areas and their Long-Term Sustainability

The sustainability scoring for the archetype Study Areas is shown in Table 12-12.[42] The scores ranged from a high of 2.9 (out of 4) to a low of 1.6. These scores are straight averages of the seven individual factors for long-term sustainability. For the assessment level analysis in Task 1, it was decided not to apply a weighting scheme to the sustainability factors. Developing and applying weighting factors for more fully-developed alternatives may be a more appropriate activity in Phase 2 of SSALTS. It is anticipated that the weighting factors would be developed based on a consensus of the stakeholders.

Table 12-12. Summary of the Sustainability Analyses for the Salt Disposal Archetypes

Factor	City of Dixon	City of Tracy	Hilmar Cheese – Deep Well injection	Hilmar Cheese – Trucking to WWTP	Industrial Food Processing	Red Rock Ranch	Grassland Water District – Real Time Management	Stevinson Water District	Tulare Lake Bed	Westside Regional Drainage Plan	San Luis Unit Ocean Disposal
Implementability	4	4	1	3	4	2	3	N/A	4	2	4

[42] The numbers in parenthesis in the discussion following Table 12-13 are the scores for the factors being discussed.

Table 12-12. Summary of the Sustainability Analyses for the Salt Disposal Archetypes

Factor	City of Dixon	City of Tracy	Hilmar Cheese – Deep Well injection	Hilmar Cheese – Trucking to WWTP	Industrial Food Processing	Red Rock Ranch	Grassland Water District – Real Time Management	Stevinson Water District	Tulare Lake Bed	Westside Regional Drainage Plan	San Luis Unit Ocean Disposal
Capacity	1	1	4	3	2	1	3	N/A	3	1	4
Regulatory	1	1	3	3	1	2	2	N/A	3	2	1
Institutional	4	4	4	4	2	2	2	N/A	3	3	2
Costs	1	1	3	1	1	1	2	N/A	3	1	1
Environmental Issues	3	2	3	3	2	1	2	N/A	2	1	1
Public Acceptance	3	2	1	3	3	2	3	N/A	2	2	1

The archetype Study Areas are ranked from highest estimated sustainability to lowest in the following list.

Tulare Lake Bed. The Tulare Lake Bed is the salt sink/salt sequestering disposal archetype. This Study Area scored very well (4) for implementability - the construction, operation, and maintenance of the infrastructure for the evaporation ponds utilizes proven technologies and is implementable for the Tulare Lake Bed. The Study Area scored well (3) for capacity, regulatory issues, institutional issues, and costs. There are potential environmental concerns about salt disposal at the Tulare Lake Bed including the control of salt at the evaporators (leaching, water and wind erosion). There is also potential concern about the formation of ponds of standing water which may lead to the bioaccumulation of certain trace constituents in the food chain. However, a number of the evaporation ponds have been in operation for over 25 years at the Tulare Lake Bed and several environmental issues have been encountered and addressed previously, ameliorating some of the environmental concerns and leading to a score of 2. The public will be somewhat sensitive to the potential environmental issues associated with this project (2).

Hilmar Cheese Company– Trucking to WWTP. HCC – Trucking to WWTP is the archetype for industrial plants in the Central Valley whose processes require the treatment of saline water and disposal of salt by trucking brine to a WWTP with an ocean disposal. This Study Area scored very well (4) for institutional issues because it is managed and operated by a single company. Trucking scored well (3) for implementability, capacity, regulatory, environmental issues, and public acceptance. The cost factor score was poor (1) because the 2012 fees paid to EBMUD were about $4.26M, with an additional $1 million to $2 million in hauling costs.

Hilmar Cheese Company – Deep Well Injection. HCC – Deep Well Injection is the archetype for industrial plants in the Central Valley whose processes require the treatment of saline water and disposal of salt by disposal by deep well injection. This Study Area scored very well (4) for institutional issues because it is managed and operated by a single company. Deep well injection also scored very well (4) for capacity; HCC is permitted to inject at a rate of 23 million gallons per month, which is more than 7 times the volume of brine HCC produces. However, every Study Area would require analyses, including the development of a hydrogeological conceptual model, development of a numerical simulation model, and pilot testing to determine site- and project-specific salt capacities. Deep well injection scored well (3) for regulatory, costs, and environmental issues. Deep well injection scored poorly for implementability and public acceptance. Deep well injection utilizes proven technologies; however, direct experience at HCC demonstrates that there can be technological challenges to be met. The implementability of deep well injection to other areas in the Central Valley is dependent on a deep aquifer of degraded water quality to inject into, capacity of the aquifer to accept the requisite volume of brine, permitting, compatibility of the water chemistries of the brine and the groundwater, and on-going maintenance to keep the injection wells operational. In terms of public acceptance, there may be confusion that wastes are being disposed of by injection into a potable aquifer. There also may be concerns about hydraulic fracturing (fracking) among the general public.

City of Dixon. The City of Dixon is an archetype Study Area for the disposal of salt in municipal discharge ponds and ultimately to groundwater. This Study Area scored very well (4) for implementability and institutional issues. The construction, operation, and maintenance of municipal discharge ponds utilizes proven technologies and the project is implemented by a single agency. This Study Area scored poorly (1) to fair (2) in terms of capacity, regulatory issues, and costs. These three factors are all related to the finding that shallow groundwater continues to degrade in terms of TDS and nitrate due mostly to consumptive use by the surrounding irrigated agriculture. Depending on the water quality objectives developed by the Central Valley RWQCB, there may not be assimilative capacity for TDS in groundwater. Permitting a waste discharge to groundwater where the waste's TDS is greater than the objective (there is no assimilative capacity) – even though it is less than the receiving water's TDS concentration – calls to mind the Rancho Caballero decision and does not comply with State Resolution 68-16[43]. However, the basin plan water quality objective can be raised through a Basin Plan amendment process. Developing a new, higher quality source of water will be costly, whether deeper wells or surface water becomes a more dominant component of the supply mix.

Grassland Water District – Real Time Management. The GWD-RTMP is the archetype Study Area for the disposal of salt to a surface water body through the use of sophisticated modeling and operations to utilize assimilative capacity in the water body. The GWD-RTMP scored well (3) for implementability, capacity, and public acceptance and fair (2) for regulatory issues, institutional issues, costs, and environmental issues. Perhaps the most critical challenge of this archetype Study Area is aligning the goals of the RTMP and the goals wetlands management by the GWD. The GWD wetlands drawdown in the spring is discharged into tributaries of the Lower San Joaquin River and is timed to meet wetland management objectives. The GWD wetlands drawdown in the spring does not coincide with higher assimilative capacity in the San Joaquin River (between January and April) which is the primary management goal of the RTMP.

City of Tracy. The City of Tracy is the municipal discharge to surface water archetype Study Area. Tracy scored very well (4) for implementability since the construction, operation, and maintenance of a municipal outfall to a surface water discharge point utilizes proven technologies. Tracy scored poorly (1) for salt capacity, regulatory issues and costs. The court entered a judgment and peremptory writ of mandate ruling that the South Delta salinity objectives do not apply to Tracy or other municipal discharges. However, the State Board is in the process of considering new flow and water quality objectives meaning that there is regulatory uncertainty. There is also a mass loading limitation

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[43] Note that the receiving water TDS was not better than necessary to protect the MUN beneficial use.

in Central Valley RWQCB Order R5-2012-0115 that may lead to compliance issues in the WWTP expansion (the mass or salt load does not increase with increasing permitted discharge volumes). Tracy is in the process of converting its water supply sources to surface water to improve source water quality, in part to meet the potential WQOs at DP001.

Industrial Food Processing. The Industrial Food Processors are the archetype for industries that produce high salinity waste water in the valley. The two primary disposal methods for salt (in industrial wastewater) are disposal to a WWTP and discharge to the land surface. The construction, operation, and maintenance of a service connection to a municipal WWTP utilizes proven technologies and is implementable. Likewise, the construction, operation, and maintenance of land discharge methods (application directly to land, discharge ponds, etc.) utilized proven technologies and is implementable, hence this archetype Study Area scored very well (4) for implementability. Industrial food processing scored well (3) for public acceptance and fair (2) for capacity, institutional issues, and environmental issues. This archetype Study Area scored poorly (1) for regulatory issues and costs. It is anticipated that the future regulatory paradigm will be more restrictive and that projects under current permits will receive new permits with more stringent requirements. These future regulations may require substantive pre-treatment for industrial processors for both discharges to a WWTP and to the land surface.

San Luis Unit Ocean Disposal. The San Luis Unit Ocean Outfall is the archetype Study Area for salt disposal through an ocean outfall. The Study Area scored very well (4) for implementability and capacity. The construction, operation, maintenance, and replacement of a conveyance system for ocean disposal – including pipelines, tunnels, lift, stations – utilizes proven technologies and is implementable. The pipeline capacity is sized to accommodate the anticipated drainage water, taking into account land retirement and regional reuse facilities. The San Luis Unit Ocean Outfall scored poorly (1) for regulatory issues, costs, environmental issues, and public acceptance. This project would be extremely difficult to permit and to demonstrate that it is consistent with the California Coastal Management Program. The FEIS determined that there would be water quality degradation in the vicinity of the outfall. The project is expected to significantly impact federal and state listed special-status species through construction and operation of the pipeline. High selenium levels in reuse facilities could impact sensitive habitat for aquatic or wetland-dependent species. The ocean outfall project is also very energy intensive because of the elevation differences between the San Joaquin Valley and the Coastal Ranges.

Westside Regional Drainage Plan. The WRDP is the archetype Study Area for regional salt disposal. WRDP scored well (3) for institutional issues because the management of the salt should be coordinated under one stakeholder group. Implementability, regulatory issues, and public acceptance all scored fair (2). In terms of implementability, the salt disposal options range for (i) initial and indefinite storage at regional evaporation facilities, (ii) attempt to find or develop a commercial market, and (iii) ultimately remove the salt to a permitted disposal facility. The containment facilities would be regulated under Title 27. Depending on the nature of the containment facilities there may be air quality and erosion issues, as well as percolation to groundwater concerns. Capacity, costs, and environmental issues all scored poor (1) and are all related. One of the pillars of the salt disposal portion of both WRDP and RRR is for the development of a commercially-viable market for the salt produced from their operations. Absent this market, the salt disposal options for both become either on- or off-site storage. The lack of a viable market has a negative impact on capacity, costs, and environmental issues.

Red Rock Ranch. RRR is the archetype Study Area for IFDMs in the Central Valley, characterized by zero-discharge, attempting to market the salt as a commercially-viable product or sequestering the salt at the site. RRR scored the same as WRDP for all factors save institutional – the assumption being that a regional coordinated program would function better than disconnected, individual IFDMs. There might also be economies of scale in developing future salt markets or pricing ultimate landfill-disposal options.

Stevinson Water District. The salinity issues addressed by the SWD are primarily source control solutions. These solutions either prevent or reduce the volume of saline groundwater from entering the San Joaquin River (through the Lateral Canal Pipelining Project), or release saline agricultural drainage water during times of high assimilative capacity in the river (through the Agricultural Drainage Control Project). However, this project does not remove salt, although it does reduce salt entering into the water district by conserving water supplies. Hence, an evaluation of the sustainability of salt disposal methods could not be performed.

12.4 Potential Alternative Disposal Options and Next Steps

The purpose of SSALTS is to identify the range of viable Central Valley alternatives for salt disposal (taking into account regulatory, institutional, economic, and technological issues) in order to inform the development of the SNMP for the Central Valley.

The Phase 1 information developed for the representative Study Areas in this report provides a foundation for the Phase 2 analyses. For example, if the capacity for continued salt disposal within a particular Study Area is limited, then under Phase 2, other alternatives for addressing that limitation through in-valley or out-of-valley disposal strategies (or some combination of both) will be identified and characterized.

Phase 2 will focus on the development of potential salt management strategies that may include salt disposal within the Central Valley (“in-valley”), transporting or exporting salt to areas outside of the Central Valley (“out-of-valley”), or some combination of both. Under Phase 2, alternatives that support these potential strategies for salt disposal will be identified (through review of literature and reports and information obtained from regional experts) and characterized. Analysis of the alternatives to determine the best implementation options will occur under Phase 3.

Phase 2 will characterize the various in-valley salt management alternatives that may be deployed in the Central Valley. The analysis will evaluate potential management practices (MPs), *e.g.*, combinations of various source and treatment controls, as well as disposal/storage practices and technologies relevant to agricultural, municipal, and industrial salt sources.

Phase 3 builds upon the work completed under previous phases by evaluating the range of in-valley, out-of-valley, and hybrid salt management alternatives developed under Phase 2. Under this phase, SSALTS will develop feasibility criteria (*e.g.*, regulatory, institutional, economic, technological, *etc*.) to provide a basis for evaluating each alternative and completing the feasibility analysis. The outcome of this evaluation will be the identification and prioritization of acceptable salt disposal alternatives (*i.e.*, implementation measures) for incorporation into the developing SNMP for the Central Valley.

12.5 References

Seiler, R. L., J. P. Skorupa, and L. A. Peltz. 1999. Areas Susceptible to Irrigation-Induced Selenium Contamination of Water and Biota in the Western United States. US Geological Survey Circular 1180. Carson City, Nevada.

Task 1.3 - SSALTS - Comments on Phase 1 Characterization

Task	Comment No.	Date Received	Comment Source	Deliverable	Comment	Response
1.3	1	04/03/13	Jeanne Chilcott & Rudy Schnagl (CVRWQCB)	Study Area Characterization	The case studies presented in the report represent projects in several stages of development. Some are conceptual while others are in operation. The status of each should be made clear.	Changes were made to appropriate Study Area Sections to describe their current status as follows: • **City of Dixon**: The described methods in the study have been implemented. No major changes were made to address this comment. • **City of Tracy**: The change in source water has been implemented and is already indicated in the Section. • **Hilmar Cheese Company**: Clarification was added that at the time of writing, technical issues regarding the deep well injection were still being worked out. Currently HCC is trucking all brine to EBMUD. • **Industrial Food Processing**: This unique section talks about all industrial food processing in general. • **Red Rock Ranch**: Text was added to Section 6.5.3 to indicate the current operational status of RRR (currently they are on stand-by waiting for sufficient irrigation water from Westland's Water District). • **Grasslands RTMP**: Text was added at the beginning of the Section to describe that the RTMP is a pilot program. • **Stevinson Water District**: The described projects and water management activities have been implemented (and are currently ongoing) and is already indicated in the Section. • **Tulare Lakebed**: Minor edits were made throughout the section to clarify the current status of the MUN de-designation. • **Westside Region**: Any needed clarification was added to the various projects in the Westside Region to clearly state their current stage of development. • **San Luis Ocean Disposal**: In the opening paragraph, it was indicated that this project was a proposed project that was never accepted. The phrase "(and therefore not yet constructed) was added to the paragraph to clearly state that this project has not been implemented.
1.3	2	04/03/13	Jeanne Chilcott & Rudy Schnagl (CVRWQCB)	Study Area Characterization	Some of these projects have been reviewed by the Regional Board while others have not (e.g. the Westside). This means that even the existing projects may not comply with requirements in our Basin Plan. Recently-developed WDRs adopted by the Board have focused on salinity impacts to receiving waters more than in the past, so if a project's WDRs are over 5 years old they may not reflect the current regulatory approach to dealing with salt. Hopefully the report will be able to indicate whether the technical approaches discussed are likely to stand the test of time.	Section 12 of the Phase 1 report analyzes and describes the relative sustainability of each Study Area.
1.3	3	04/03/13	Jeanne Chilcott & Rudy Schnagl (CVRWQCB)	Study Area Characterization	These case studies range from individual facilities to regional management operations. The key questions are (1) does the project comply with current Basin Plan requirements and other regulations and will it continue to do so over the long term (200 years)? A subset of this issue is the question of what changes to the Basin Plan are needed to allow continued operation of superior salt management approaches. (2) If the local management of salt does not provide a complete solution, what additional steps have to eventually be taken? And (3) where does the salt end up? For example, Red Rock Ranch concentrates salt, but is not designated as a disposal site. Where will the salt go?	(1) Current compliance with the Basin Plan are described in the sections. Any clarification needed will be addressed (as described for each section in other comment responses). The future long-term compliance (50 years) is described in Section 12 of the Phase 1 SSALTS report. (2) Phase 2 of the SSALTS project will look at any additional steps that may need to be taken to create a "complete" alternative. (3) Several of the study areas do not address "where the salt goes" (i.e., Red Rock Ranch and Industrial Food Processors). Any necessary clarification will be added to each Study Area section to address what happens to the salt. In addition Section 12 of the Phase 1 report will summarize the salt disposal methods for each of the study areas. In addition, the long-term sustainability of these salt disposal methods is analyzed in Section 12.

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Task	Comment No.	Date Received	Comment Source	Deliverable	Comment	Response
1.3	4	04/03/13	Jeanne Chilcott & Rudy Schnagl (CVRWQCB)	Study Area Characterization	The impact of the projects on groundwater quality is often not discussed. This is understandable given the available information, but this is a key element in evaluating the feasibility (and sustainability) of these operations.	Current impacts on groundwater quality were addressed when information when information was readily available for the particular Study Area. Future potential impact on groundwater quality will be described in Section 12 of the Phase 1 report.
1.3	5	04/03/13	Jeanne Chilcott & Rudy Schnagl (CVRWQCB) - Meeting Notes	Study Area Characterization	The RWQCB would like CDM Smith to look at both short-term and long-term impacts of the current projects, asking the questions of "what are we going to do with the salt in the long-term?" They requested that we remind our readers of the overall picture and where salt is going in each study area.	Section 12 of the Phase 1 report will describe short-term and long-term impacts of each of the Study Areas.
1.3	6	04/03/13	Jeanne Chilcott & Rudy Schnagl (CVRWQCB) - Meeting Notes	Study Area Characterization	The RWQCB would like the report to acknowledge that just because a study area has a WDR that is over 8 years older, is not reflective of how the RWQCB would issue a WDR now, under the current regulatory climate. If the case study wasn't regulated by RWQCB, it does not mean that the project would be approved by the RWQCB. Any renewal or new permits issued would probably be more stringent in how salt is dealt with. The current regulatory status of each of the projects should be made clear in the report.	Potential future regulatory changes in regards to the sustainability of these Study Areas will be described in Section 12. Changes were made to appropriate Study Area Sections to describe their current regulatory status as follows: • **City of Dixon**: No changes were made - currently under R5-2008-0136 as described in the section. • **City of Tracy:** No changes were made - currently under R5-2012-0115 as described in the section. • **Hilmar Cheese Company**: No changes were made - currently under R5-2010-0008 as described in the section. • **Industrial Food Processing**: Current regulatory status would depend on individual food processors. • **Red Rock Ranch**: Information in the IRLP was added to Section 8.3.3. • **Grasslands RTMP**: Clarity as to the regulatory status was added in the last paragraph of Section 7.3.3. • **Stevinson Water District**: Information in the IRLP was added to Section 8.3.3. It is unknown in agricultural growers in the Stevinson Water District are part of a coalition or obtaining a WDR as an individual grower, or a mixture of the two. • **Tulare Lakebed**: Language was added in regards to the current regulatory requirements for the evaporation basins. • **Westside Region**: Any needed clarification for the various projects in the Westside Region are described was added to clarify their current regulatory status. • **San Luis Ocean Disposal**: As this is a concept there is no regulatory status for this project because it has not been implemented. Additional information about the IRLP has been added in Section 11.3.3.
1.3	7	04/03/13	Jeanne Chilcott & Rudy Schnagl (CVRWQCB) - Meeting Notes	Study Area Characterization	Real-Time Management: This project is more of a concept than a current project. It is not in place and the RWQCB would need to review and approve the project if it were to happen.	This was clarified in last paragraph of Section 7.3.3.
1.3	8	04/03/13	Jeanne Chilcott & Rudy Schnagl (CVRWQCB) - Meeting Notes	Study Area Characterization	Westside: Many elements of this Plan would not be approved by the Board (including pumping saline groundwater for use in irrigation. This Plan has not been reviewed or adopted by the Board.	The Study Area Section (10.5) has been revised so that the discussion does not revolve around the Plan necessarily but more about what is currently being done or planned.
1.3	9	04/03/13	Jeanne Chilcott & Rudy Schnagl (CVRWQCB) - Meeting Notes	Study Area Characterization	Westside: Westland's Drainage District never drained to the San Joaquin River, although initially using the San Luis Drain, the district became a closed system in the end. Currently the salt is accumulating in the groundwater.	Thank you for this information. The text in the Study Area Section was clarified.
1.3	10	04/03/13	Jeanne Chilcott & Rudy Schnagl (CVRWQCB) - Meeting Notes	Study Area Characterization	Westside: Grasslands had historically discharged through wetlands to the San Joaquin River.	Thank you for this information. The text in the Study Area Section was clarified.

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Task	Comment No.	Date Received	Comment Source	Deliverable	Comment	Response
1.3	11	04/03/13	Jeanne Chilcott & Rudy Schnagl (CVRWQCB) - Meeting Notes	Study Area Characterization	Westside: Add discussion on the 1996 Basin Plan amendment	Language was added in Section 10.3.3
1.3	12	04/03/13	Jeanne Chilcott & Rudy Schnagl (CVRWQCB) - Meeting Notes	Study Area Characterization	Westside: Break the section into Westside (a closed system) and Grasslands (an open system which releases to the River downstream of the Merced River. The District is looking at becoming a closed system).	This comment was incorporated in Section 10.5
1.3	13	04/03/13	Jeanne Chilcott & Rudy Schnagl (CVRWQCB) - Meeting Notes	Study Area Characterization	RRR: Currently there are 2 or 3 IFDM operators (including Rainbow Ranch). The IFDM concept has never really taken off and the SSALTS TM should describe why this concept has not taken off and what a new WDR for the project might look like (including impacts of selenium to wildlife).	Potential regulatory requirements for the implementation of an IFDM system will be discussed in Section 12 of the Phase 1 report. Language about how IFDM is transitioning into to more of a Regional Reuse process has been added to Section 6.8.1.
1.3	14	04/03/13	Jeanne Chilcott & Rudy Schnagl (CVRWQCB) - Meeting Notes	Study Area Characterization	Tulare Lake: The use of evaporation basins has decreased as a result of RWQCB regulations to prevent the degradation of groundwater. Also any attempts to increase the volume of existing basins are having a difficult time	Thank you for this information. This comment was made prior to the release of the Tulare Lakebed Study Area Section. This was taken into consideration throughout the writing of the Study Area.
1.3	15	05/24/13	Burt Fleischer (Hilmar Cheese Company)	Study Area Characterization	HCC would prefer the section not focus on past regulatory and enforcement issues that the company has faced. HCC would prefer the section focus on current operations and what the company has been doing since the permit was issued in 2010. These regulatory issues are sensitive to the company.	Although CDM Smith kept many changes to the HCC Section made by Mr. Fleischer, large deletions of text regarding past regulatory and enforcement issues were not incorporated. CDM Smith felt that this information was important to provide the regulatory context under which HCC made specific changes. It also provides other industrial food processors with information as to potential future regulatory issues that may occur.
1.3	16	05/24/13	Burt Fleischer (Hilmar Cheese Company)	Study Area Characterization	Currently the HCC section has generic information, which is not representative of the HCC. Burt F will provide specific information to include in revisions for the section.	Thank you for this information. CDM Smith has incorporated HCC specific information as provided by Mr. Fleischer throughout the section.
1.3	17	05/24/13	Burt Fleischer (Hilmar Cheese Company)	Study Area Characterization	The main regulatory barrier has been the Basin Plan, which requires an discharge EC of 900 uS/cm.	This information will be discussed in Section 12 and subsequent phase of the SSALTS project.
1.3	18	05/24/13	Burt Fleischer (Hilmar Cheese Company)	Study Area Characterization	Another barrier has been disposal of wastewater using deep well injection. The compatibility of the injected concentrate and the formation zone has created precipitates that are currently plugging the well. There is ongoing efforts to resolve this problem. Currently HCC's wastewater is not injected into the ground. All wastewater is being trucked to EBMUD.	This information was added to Section 4.5.3 and 4.8.
1.3	19	05/24/13	Burt Fleischer (Hilmar Cheese Company)	Study Area Characterization	HCC would like the section to clarify that the aquifer that the concentrate would be injected into has a higher salinity than the concentrate.	This information was added in Section 4.7.
1.3	20	05/24/13	Burt Fleischer (Hilmar Cheese Company)	Study Area Characterization	The ancillary effects of trucking the concentrate to EBMUD are the fuel costs and air quality effects. HCC generates approximately 125 to 130 thousand gallons of concentrate per day that is currently being trucked to EBMUD. HCC reports their shipments to EBMUD to the RWQCB through their monthly WDRs	Thank you for this information. CDM Smith considered these environmental impacts in Section 12.
1.3	21	05/24/13	Burt Fleischer (Hilmar Cheese Company)	Study Area Characterization	The long-term sustainability of the treatment system is what concerns HCC. Currently the treatment system needs to be operated 24 hours/day, 7 days/week, 365 days/year to meet the WDR requirements. Potential hiccups could cause violations with the permit.	Thank you for this information. CDM Smith incorporated these sustainability concerns in Section 12.
1.3	22	05/24/13	Burt Fleischer (Hilmar Cheese Company)	Study Area Characterization	The composition of HCC's wastewater changes daily, and is highly dependent on the number of cleaning in places (CIPs) that occur in a day from the three plants (Cheese, Lactose, and Protein).	This information was added in Section 4.5.
1.3	23	05/24/13	Burt Fleischer (Hilmar Cheese Company)	Study Area Characterization	The Basin Plan is currently based on "old science" from 1996, and the RWQCB has not considered whether or not it is still appropriate and accurate. Revisions to the Basin Plan should look at crops individually by area basins. Some crops can handle higher EC's. In addition, the future Basin Plan should look at each entity individually, not just falling back to an EC of 900 for everyone. No one can control the volume of salt entering into the basin, which is greater than the volume leaving the basin; and therefore salt is accumulating. The RWQCB seems to be more focused on regulating industries, which are a small contribution to the salt in the valley (<1%). However the regulations are set up as a one-size fits all.	Thank you for this information. CDM Smith will use this information in subsequent Phases of the SSALTS project.
1.3	24	05/23/13	Jose Faria (DWR)	Study Area Characterization	Jose F will provide more detailed comments at a later date.	Thank you for your revisions.
1.3	25	05/23/13	Jose Faria (DWR)	Study Area Characterization	The costs of implementation of IFDM at RRR are slightly off. Jose F will update these numbers. Particularly there are updated cost estimates on the solar evaporator. Jose F will send a copy of the report by Shwabe from UC Riverside that updates these costs.	Thank you for the information you provided.

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Task	Comment No.	Date Received	Comment Source	Deliverable	Comment	Response
1.3	26	05/23/13	Jose Faria (DWR)	Study Area Characterization	IFDM is being looked at more as more of a regional project rather than at individual farms. IFDM helps regions meet discharge goals. For example Grasslands is looking to implement this next year. Westland's is also looking into regional IFDM.	Thank you for this information. CDM Smith will use this information in Phase 2 "Develop Potential Salt Management Strategies" of the SSALTS project. During this phase, CDM Smith will be looking at alternative salt management strategies for the Study Areas.
1.3	27	05/23/13	Jose Faria (DWR)	Study Area Characterization	An updated SB 1372 allows the solar evaporator to be built and used for regional use.	Thank you for the information you provided. It has been added to Section 6.8.2
1.3	28	05/23/13	Jose Faria (DWR)	Study Area Characterization	It is expected that future regulatory changes will reduce water supply by 20% and there is not enough water to farm land. In response, crops are changing to permanent (almonds, citrus, pistachios)	Thank you for this information. CDM Smith will use this information in Phase 2 "Develop Potential Salt Management Strategies" of the SSALTS project. During this phase, CDM Smith will be looking at alternative salt management strategies for the Study Areas.
1.3	29	05/23/13	Jose Faria (DWR)	Study Area Characterization	A report about Rainbow Ranch from the 2000's took a look at mass loading into the project.	Thank you for this information. It was incorporated into Section 6.5.3 and will be considered in the development of Section 12.
1.3	30	05/23/13	Jose Faria (DWR)	Study Area Characterization	Salt accumulation is continuing to be an issue. Even with Regional IFDM, you must look at ways to recycle the salts which could be used to offset costs of the project. Approximately 40% of solar evaporator salts is actually gypsum. Using technology (an example company is New Sky), the salt from solar evaporators could be converted to Sulfuric Acid and Caustic Soda (from the sodium sulfate), gypsum, and table salt (from the sodium chloride). Sulfuric acid is used in industrial processes, while caustic soda could be used in glass bottle productions. A small pilot plant is anticipated in Tulare Lake to research further if this is possible. Costs are still being worked out	Thank you for this information. CDM Smith will use this information in Phase 2 "Develop Potential Salt Management Strategies" of the SSALTS project. During this phase, CDM Smith will be looking at alternative salt management strategies for the Study Areas.
1.3	31	05/23/13	Jose Faria (DWR)	Study Area Characterization	In the next 5 years, regional IFDM is expected to occur in Grasslands. For Westland's it could be in 10 to 20 years.	Thank you for this information. We will use this to develop Section 12 as well as for future use in Phase 2 "Develop Potential Salt Management Strategies" of the SSALTS project. During this phase, CDM Smith will be looking at alternative salt management strategies for the Study Areas.
1.3	32	05/23/13	Jose Faria (DWR)	Study Area Characterization	Jose F still believes that the brine line is the ultimate solution, however there is no recycling.	Thank you for this information. CDM Smith will use this information in Phase 2 "Develop Potential Salt Management Strategies" of the SSALTS project. During this phase, CDM Smith will be looking at alternative salt management strategies for the Study Areas.
1.3	33	05/23/13	Jose Faria (DWR)	Study Area Characterization	Yoram Cohnen from UCLA is researching how to desalt brackish water on the Westside using RO. There are issues with membrane fouling as a result of varied salinity. A SMART system would monitory the salinity in the incoming water and make needed adjustments.	Thank you for this information. CDM Smith will use this information in Phase 2 "Develop Potential Salt Management Strategies" of the SSALTS project. During this phase, CDM Smith will be looking at alternative salt management strategies for the Study Areas.
1.3	34	05/17/13	Joe DiGiorgio (Stantec for City of Dixon)	Study Area Characterization	The City of Dixon SSALTS section should include a discussion that the City looked at all options to meet regulatory requirements. Such options included pollution trading, RO treatment on the effluent, blending with stormwater, and nanofiltration of the well head. These options were analyzed and potential impacts on city sewer rates were looked at. It was assumed that 30% of the chloride would need to be removed based on the estimate from the CDO.	Additional information on the options looked at by the City was included in Section 2.2.
1.3	35	05/17/13	Joe DiGiorgio (Stantec for City of Dixon)	Study Area Characterization	Eliminating sources of salt is the cheapest alternative, however it only removes so much salt. Eliminating salt was estimated to cost approximately $3 per household per month for a 30 % reduction.	Thank you for this information. CDM Smith added this to Section 2.6.
1.3	36	05/17/13	Joe DiGiorgio (Stantec for City of Dixon)	Study Area Characterization	The second phase after eliminating sources of salt would be to then dilute effluent with stormwater or high quality surface water which is estimated to cost approximately $10 per household.	Thank you for this information. CDM Smith will use this information in Phase 2 "Develop Potential Salt Management Strategies" of the SSALTS project. During this phase, CDM Smith will be looking at alternative salt management strategies for the Study Areas.
1.3	37	05/17/13	Joe DiGiorgio (Stantec for City of Dixon)	Study Area Characterization	The City of Dixon is planning to develop activated sludge which is planned to reduce salt concentrations by 50% by reducing evaporative losses (which is essentially dilution). With this action, the City is expected to be in full compliance with the CDO. This is a midrange (in terms of cost) solution with an estimated cost of $40 per household per month.	Thank you for this information. CDM Smith added this to Section 2.8.

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1.3	38	05/17/13	Joe DiGiorgio (Stantec for City of Dixon)	Study Area Characterization	The potential alternative of bringing in a new source of water (surface water) or treating water at the well head are very expensive alternatives. Treating water at the well head was estimated to cost $70 to $80 per household per month.	Thank you for this information. CDM Smith will use this information in Phase 2 "Develop Potential Salt Management Strategies" of the SSALTS project. During this phase, CDM Smith will be looking at alternative salt management strategies for the Study Areas.
1.3	39	05/17/13	Joe DiGiorgio (Stantec for City of Dixon)	Study Area Characterization	For a medium size Central Valley city it was determined that the cost for the range of alternatives varied from: <Reduce Source Salt $> < Dilution $$> <Limit Evaporative Loses $$$><Salt Removal/Treatment $$$$><New Source or Treatment of Water Source $$$$$>	Thank you for this information. CDM Smith will use this information in Phase 2 "Develop Potential Salt Management Strategies" of the SSALTS project. During this phase, CDM Smith will be looking at alternative salt management strategies for the Study Areas.
1.3	40	05/17/13	Joe DiGiorgio (Stantec for City of Dixon)	Study Area Characterization	The 20% decrease in water use as described in the CA Water Plan would correlate to an approximate increase of 25% in salinity.	Thank you for this information. CDM Smith will use this information in Phase 2 "Develop Potential Salt Management Strategies" of the SSALTS project. During this phase, CDM Smith will be looking at alternative salt management strategies for the Study Areas.
1.3	41	05/17/13	Joe DiGiorgio (Stantec for City of Dixon)	Study Area Characterization	The water softener band got about 15% reduction in Chloride (~50% of water softeners = ~15% reduction in chloride)	Thank you for this clarification CDM Smith added this to Section 2.5.5.
1.3	42	05/17/13	Joe DiGiorgio (Stantec for City of Dixon)	Study Area Characterization	$1 million dollars in 20 year present worth = $1 per household per month	Thank you for this information. CDM Smith may use this information in Phase 2 "Develop Potential Salt Management Strategies" of the SSALTS project. During this phase, CDM Smith will be looking at alternative salt management strategies for the Study Areas.
1.3	43	05/17/13	Joe DiGiorgio (Stantec for City of Dixon)	Study Area Characterization	The biggest sources of salinity is the Sac River (from Shasta) and the Merced River (from Yosemite) which equate to almost 70% of the total load.	Thank you for this information. CDM Smith may use this information in Phase 2 "Develop Potential Salt Management Strategies" of the SSALTS project. During this phase, CDM Smith will be looking at alternative salt management strategies for the Study Areas.
1.3	44	06/03/13	Roger Reynolds	Study Area Characterization	Stevinson Water District: Is the problem addressed here really a salt problem or a water management problem?	This study area was added at the recommendation of the CV-SATLS TAC. CDM Smith agrees that this study area does not seem to provide a solution for salt management, and is primarily a water management solution. This clarification was added to Section 8.2.
1.3	45	06/14/13	Rob Neenan (CLFP)	Study Area Characterization	CLFP's main comment is that this report does not put food processing discharges into context. According to the 2008 study by Howitt, et al, food processors account for a very small portion of the annual salt load in the Central Valley. They estimated that food processors accounted for 2.08% in the Sacramento Basin, 4.01% in the San Joaquin Basin, and 3.17% in the Tulare Basin. Wineries made an additional very small contribution. Howitt's modeling forecasts indicated little changes in these percentages by 2030.	The following text has been added, "According to the 2008 study by Howitt, et al., food processors account for a relatively small portion of the annual salt load in the Central Valley. The 2005 annual salt loading estimate for food processors accounted for 2.08% in the Sacramento Basin, 4.01% in the San Joaquin Basin, and 3.17% in the Tulare Basin." The 2008 report was a final draft; the cited table, Table 3.1.9, does not appear in the Final report published in March 2009.
1.3	46	06/14/13	Rob Neenan (CLFP)	Study Area Characterization	Industrial Food Processing: Incorporate editorial comments throughout the Study Area Section	The editorial comments provided by the CLFP were incorporated throughout the Study Area.
1.3	47	06/14/13	Rob Neenan (CLFP)	Study Area Characterization	Regarding Table 5-1: This table should also show fixed dissolved solids (FDS; minerals) because the organic dissolved solids are not relevant to residual salinity in groundwater.	The scope of this SSALTS technical memorandum was to review readily available information and reports. Absent additional information, the text has not been changed.
1.3	48	06/14/13	Rob Neenan (CLFP)	Study Area Characterization	Regarding Table 5-2: This is too restrictive for most crops, 1,000 – 1,100 may be more reasonable for most crops in most areas.	The information was cited from a Regional Board publication and addresses sensitive crops. A footnote has been added, "More salt-tolerant crops can utilize irrigation waters with ECs greater than 1000 □m Irrigation Water Salinity and Crop Production. Agriculture and Natural Resources Publication 8066)."
1.3	49	06/14/13	Rob Neenan (CLFP)	Study Area Characterization	Regarding Table 5-3: How does this compare to the total annual salt load for the Valley? It is important to put this into context.	The following footnote was added to Table 5-3, "The 2005 annual salt loading estimate for food processors accounted for 2.08% in the Sacramento Basin, 4.01% in the San Joaquin Basin, and 3.17% in the Tulare Basin (Howitt et al., 2008)."

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Task	Comment No.	Date Received	Comment Source	Deliverable	Comment	Response
1.3	50	06/14/13	Rob Neenan (CLFP)	Study Area Characterization	Why single out wineries and tomato processing for detailed discussion? What about nuts, dairy, meat and other large contributors as mentioned in Section 5.4?	Fruit and vegetable canning was the largest discharger of salt in the Central Valley based on the survey conducted by HCC (2007) of 160 Central Valley food-processing facilities. Wineries are an industrial sector that has been proactive regarding salt management. These two industrial sectors were chosen to be proxies for the food processing industry, in reviewing source control measures, treatment and disposal options.
1.3	51	06/14/13	Rob Neenan (CLFP)	Study Area Characterization	Regarding the sentence "“Stabilization of wines following clarification can be accomplished through an ion exchange process.”: Very few wineries even do this. It makes it sound like all wineries. Maybe, Wine Institute has data on how frequent. Our clients don’t seem to do much. Wine ion exchange is a focus of this paragraph without any data to support the discussion.	The text has been revised to cite the source of this information as follows: “As described in the HCC (2007), stabilization of wines following clarification can be accomplished through an ion exchange process.”
1.3	52	06/14/13	Rob Neenan (CLFP)	Study Area Characterization	Providing data from only one plant is not very helpful and could be misleading.	The scope of this SSALTS technical memorandum was to review readily available information and reports. Absent additional information, the text has not been changed.
1.3	53	06/14/13	Rob Neenan (CLFP)	Study Area Characterization	Regarding Table 5-6: Where are the benefits? Should be compared with losses in $/kgal.	The scope of this SSALTS technical memorandum was to review readily available information and reports. Absent additional information, the text has not been changed
1.3	54	06/14/13	Rob Neenan (CLFP)	Study Area Characterization	Regarding "Regulatory Barriers": Might be good to note the limited regulatory resources to timely review regulatory submittals and applications to help dischargers manage salt loads.	Commented noted. At this time, there was no revision to this text as there is no source to cite regarding timely reviews by the Regional Board.
1.3	55	06/14/13	Rob Neenan (CLFP)	Study Area Characterization	All in all, this document seems to be out of date – the significant references data [sic] from 2007 and earlier.	The scope of this SSALTS technical memorandum was to review readily available information and reports. Absent additional information, the text has not been changed.
1.3	48	04/26/13	Jeanne Chilcott (CVRWQCB)	Study Area Characterization	General: We’ve been struggling with all the case studies to try to understand how they will provide a basis for determining “where to put the salt”. It may be that we’re jumping ahead in the project, so we went back to the original scope (attached) and looked at Task 1.3. The Task (paraphrased) is to take a “study area” and identify current salt issues, practices dealing with the issue, regulatory activities and overall sustainability(sustainability is Task 1.4). Many of the case studies seem to have narrowed that focus (e.g. Tulare Lake Bed). Some of the chosen study areas are actually specific discharges (e.g. Hilmar Cheese) so the narrow focus is understandable. However, we’re concerned that overall, none of the reviews really leave the reader understanding the magnitude of the issue. In the long run, we would hope that there will be a process that can screen the studies and categorize them as follows with specific reasons cited. • helps with local salt problems, but has secondary adverse impacts to receiving waters • just making the water quality problem worse and changes are needed asap • suitable for short-term management pending development of additional regional storage/disposal/offset methods. • expected to be sustainable over the long term (200+ years).	This comment was taken into consideration throughout development and revisions of the Study Areas Sections as well as the development of Section 12 which looks at the long-term sustainability of the study areas.

Task 1.3 - SSALTS - Comments on Phase 1 Characterization

Task	Comment No.	Date Received	Comment Source	Deliverable	Comment	Response
1.3	49	04/26/13	Jeanne Chilcott (CVRWQCB)	Study Area Characterization	Stevinson Water District: The discussion focuses on the piping of supply lines for agriculture and development of expanded holding facilities to reduce seepage to groundwater and time releases of flow to the San Joaquin River, respectively. But, none of those activities are controlling salt load to the area. Plus, although dairies are mentioned as the primary industry, there is no mention of the additional loading from that industry. The reality is that the district will continue to utilize its water rights for Merced River water and reduce groundwater pumping that had augmented the supply water. (Why pay to pump poorer quality water?) So, I'm not seeing where the ultimate salt load to poor quality perched groundwater is decreasing—unless you're assuming that the pumping was redistributing salt from the confined aquifer to the perched aquifer and now better quality water is being utilized. Surface flow loading is also not decreasing—just being retimed (unless the above assumption about the confined aquifer higher salinity loads being assumed removed hold true). They are removing salt from the area by releasing loads to the river—but as the report notes, it is unclear whether their system release as much as it gains. (By the way, please do not use the phrase that they are utilizing "assimilative capacity" within the river when it appears that they are just holding the water until there are flows in the LSJR. At this time, there is no management program in place on the river to coordinate releases from water agencies that have the capacity to time their discharges.) While the district clearly has salt issues, it is unclear what CV-SALTS has to learn from this case study. Has the piping of the supply lines produced any noticeable improvements of any kind? Have the expanded holding facilities had the anticipated impact on the movement of groundwater from the west, as expected? Again, we may be jumping ahead in the project, but these are overarching questions that must be addressed.	CDM Smith agrees with this comment. This study area was added at the recommendation of the CV-SALTS TAC. Clarification was added in Section 8.2 stating that the study area is primarily a water management program with a small component of salt source control (replacement of earthen ditches with pipeline to reduce seepage to the groundwater).
1.3	50	04/26/13	Jeanne Chilcott (CVRWQCB)	Study Area Characterization	Industrial Food Processing: Industrial Food Processing: This section was very difficult to review and I would strongly suggest that Rob Neenan look at the document. The document touches on a huge issue with a very broad brush, and does not fully flesh out the significant problem: these are very site specific issues and 90% of the evaluated processing facilities appear to have groundwater impacts. These are end of pipe discharges. In theory, these type of discharges are controllable—but at what cost? There is almost certainty that if the facilities were required to go to the extent that Hilmar had to, industries would move out of state and large sectors of agriculture would be stranded and unsustainable. Salt Capacity notes that the sites need individual review, but then lumps them together to talk about potential for a 50% reduction. Since these are site specific issues, that type of lumping (reducing by 30,000 metric tons annually) really has no context on whether that reduction really means anything. The sustainability review will be critical, but will be difficult to conduct with such diverse issues over a broad scale. You may want to focus on one area with a diversity of processors for the more detailed review. 11.3.4: Potential groundwater pollution is regulated by the Regional Boards. > > 11.4: Is the ICM using FDS and if not should it be? > > Table 11-3: Did the report state the number of each of the types of facilities (for perspective)? > > 11.5.4: The process described appears to be moving salt, not reducing it. > > 11.7: Specific site conditions need to include groundwater quality and rate of lateral movement. > > 11.8: This is the section that should be expanded to include the increasingly stringent regulatory requirements as more and more of the facilities are demonstrating impacts to local groundwater (or do you cover that in sustainability?)	**General:** Rob Neenan has taken a look at the Section and has provided his comments. **11.3.4**: (Now 5.3.4) This was corrected **11.4**: (Now 5.4) CDM Smith is unsure what exactly the ICM is using **Table 11-3**: (Now Table 5-3) Unfortunately no, the HCC SEP did not provide this information **11.5.4**: This section has been removed **11.7**: (Now 5.7) This has been added. **11.8**: (Now 5.8) This discussion will be described in Section 12 of the Phase 1 report.

Task 1.3 - SSALTS - Comments on Phase 1 Characterization

Task	Comment No.	Date Received	Comment Source	Deliverable	Comment	Response
1.3	51	04/26/13	Jeanne Chilcott (CVRWQCB)	Study Area Characterization	Tulare Lake: As stated above, this section highlights where the report appears to veer away from original scope of reviewing the activities within an area to focusing on one component. The Tulare Lakebed is intensively farmed. In order to maintain the high production agriculture, freshwater is imported and tile lines lower the shallow groundwater. The tile water must be moved offsite and has a myriad of issues including excess salt. To maintain ag, the tile water is moved to evaporation basins. There has been significant regulatory oversight of those basin's since the 1980's—none of which is discussed in the current report. It is the need for expansion of those facilities and the required update of existing WDRs that spurred TLDD to initiate the process to dedesignate (not de-list) MUN. The ILRP regulations came later. The focus of the study appears to be on the MUN dedesignation as the solution which does not address potential construction/management of evaporation ponds as a viable salt storage option. Specific comments: > 1) Overall comment – section 9.8 first sentence replace "delisting" with "dedesignation" here and anywhere else it appears after the first reference in section 9.5. > 2) Page 3 table 9-1—note that MCL is for consumer acceptance levels. > 3) Page 3 paragraph 1 seems to imply evaporation basins should not be utilized. However, one of the reasons TLDD is pursuing MUN dedesignation is to construct additional evap ponds. > 4) Page 3 paragraph 2 sentence one, recommend saying that the salinity "likely" makes this water unusable for ag. We're evaluating whether it should be dedesignated now. > 5) Section 9.3.4 This section does not appear to have done the evaluation described in Step 3 starting on page 2-6 of the Workplan (see attached). Particularly not reviewing TLDD WDRs for existing ponds. > Section 9.8: The section leaves the impression that regulation of salt is the regulatory barrier. This comment relates back to the fact that this whole write-up appears focused on the MUN dedesignation as the project--no evaporation ponds or other management alternatives.	**General**: An additional Section (9.5.2) was added to the Study Area describing the construction of additional evaporation basins that would occur if the de-designation were to be completed. **1)** This substitution was made. **2)** The change was made. **3)** A sentence was added to the last paragraph of Section 9.2 to address this comment. **4)** This change was made. **5)** Information on Order 93-136 for the TLDD's three Evaporation Basins was added to Section 9.3.4. **Section 9.8**: Minor changes were made to indicate that the MUN beneficial use is the regulatory barrier to the ultimate goal of the construction of additional evaporation ponds.

Task 1.4/1.5 - SSALTS- Comments on Draft Phase 1 Report

Task	Comment No.	Date Received	Comment Source	Deliverable	Comment	Response
1.4/1.5	1	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 1.3.2 (Pg 1-5), Second Bullet: I would rewrite this paragraph. This is a new interpretation of the Basin Plan by the RWB. Suggest keeping language more nuetral.	The text has been modified from: “The Sources of Drinking Water Policy establishes a policy that all waters are considered suitable or potentially suitable to support the Municipal and Domestic Water Supply (MUN) beneficial use, with certain exceptions. The Basin Plans implement this policy by generally assigning the MUN beneficial use to all surface waters and groundwaters in the Central Valley unless those waters have already been identified as not supporting the MUN use in the Basin Plans. Under existing regulations, exemptions to the MUN beneficial use can only be made in the Basin Plans themselves.” to: “The Sources of Drinking Water Policy establishes a policy that all waters are considered suitable or potentially suitable to support the Municipal and Domestic Water Supply (MUN) beneficial use, with certain exceptions. The Basin Plans implement this policy by assigning MUN to all surface waters and groundwaters in the Central Valley region unless specifically identified as non-MUN in the Basin Plan and/or exempted through a Basin Plan Amendment that satisfies one or more exception criteria established by the SDWP.”
1.4/1.5	2	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 2.2 (Pg 2-2), Paragraph after Table 2-1: It probably would be helpful to describe the process.	The following text has been added as a footnote to his paragraph: "The City's WWTF consists of a headworks, unlined wastewater treatment/storage ponds (both aerated & unaerated), percolation/evaporation ponds & irrigation disposal areas."
1.4/1.5	3	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 2.2 (Pg 2-2), Last paragraph: Although the choices of options and the decisions may vary based on site specific evaluations. Can this be stated?	The text has been modified from: “The City’s progress addressing salinity issues is described below and provides a potential prototype for other similar cities in the Central Valley facing similar challenges.” to: “The City’s progress addressing salinity issues is described below and provides a potential prototype for other similar cities in the Central Valley facing similar challenges, although the choices of options that would be applicable and the decisions made will vary based on site-specific evaluations.”

Task 1.4/1.5 - SSALTS- Comments on Draft Phase 1 Report

Task	Comment No.	Date Received	Comment Source	Deliverable	Comment	Response
1.4/1.5	4	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 2.4 (Pg 2-4), second paragraph on GW infiltration: In some areas, this may be significant.	The text has been modified from: “Other sources contribute to the exceedance issue, albeit insignificantly. These additional minor sources include the water supply and groundwater infiltration (Figure 2-2), which are described below.” to: “Other sources contribute to the exceedance issue, albeit not as significantly for the City of Dixon. These additional minor sources include water supply and groundwater inflow and infiltration (I/I), which are described below and shown in Figure 2-2. These other sources of salt may be important for other municipal agencies in the Central Valley.”
1.4/1.5	5	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 2.4.2 (Pg 2-5): Note this type of improvement will vary based on groundwater quality. For those with low saline shallow groundwater, these improvments will increase overall concentrations. The opposite is true when high saline groundwater is present.	Comment noted. In general, it’s best to repair I/I leaks; in some cases a relatively high flow of groundwater – with a low organic content – can result in a disruption of the biological treatment processes in a WWTP.
1.4/1.5	6	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 2.5.3 (Pg 2-6), last paragaph: This is a little unclear to me. Did they replace the program or add to it, what was the motivation. This will help others lerar.	The text has been modified from: “In March 2011, the City modified (through the adoption of Ordinance Number 11-04) the incentive program and extended the program to offer those residents removing water softeners prior to July 7, 2012, a $300 check and a $300 credit on their sewer bill (City of Dixon 2011). Those owners who remove their water softeners after the expiration date would be compensated $200 for the removal costs.” to: “On March 8, 2011, the City amended (through the adoption of Ordinance Number 11-004) the Brine Discharging Water Softening and Conditioning Appliances incentive program to ‘encourage owners of residential brine discharging water softening or conditioning appliances to voluntarily remove and dispose of their [appliances]…without being subject to the enforcement actions.’ The program was in effect for 600 days after effective date of the ordinance (30 days after adoption), resulting in an end-date of November 27, 2012. The incentive specified in Ordinance 11-004, included a $300 cash reimbursement and a $300 credit to an owner’s sewer account. Any property owner that had or has a residential brine discharging water softening or conditioning appliances after that date, was or is in violation and subject to fines, penalties, and removal/disposal costs. ‘However, the property owner will be compensated $200 as the reasonable value of the violating residential brine discharging water softening or conditioning appliance removed from the property.’” (City of Dixon 2011)
1.4/1.5	7	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 2.5. (Pg 2-6): Note: To make this really happen usually requires a public outreach campaign showing both the detriments of continued use ($, environmental harm) and the benefits ($ saved, env benefit, etc).	Comment noted.

Task 1.4/1.5 - SSALTS- Comments on Draft Phase 1 Report

Task	Comment No.	Date Received	Comment Source	Deliverable	Comment	Response
1.4/1.5	8	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 2.6 (Pg 2-7): of ????? (Choride, EC?)	Text was revised to clearly indicate that it was a reduction of chloride.
1.4/1.5	9	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 2.6 (Pg 2-7): Somewhere, we need to recognize that factors change. Cost per household is very dependent on # of households.	The text has been modified from: "In its analysis of all options, the City estimated that this alternative would cost approximately $3 per household per month for a 30% reduction in wastewater discharge concentration (Personal Communication – Joe DiGiorgio)." to: "In its analysis of all options, the City estimated that this alternative would cost approximately $3 per household per month and result in a 30 percent reduction in chloride concentration in wastewater discharge (Personal Communication – Joe DiGiorgio). Per unit costs (e.g., dollars per household per month) will be a function of the number of participants in the program."
1.4/1.5	10	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 2.7 (Pg 2-8): This reads like it was a piece of cake to implement. In most cases it is not true. (See CVCWA BMP manual). Also note that it took a lot of effort to get the community and the leadership behind this.	The text has been modified from: "No institutional or regulatory barriers to implementation of source control programs or development of alternative sources of water have been identified. Where such barriers may have existed, (e.g., need for City authority to implement controls on use of SRWS), the City removed existing barriers through the adoption of ordinances." to: "Institutional and regulatory barriers to implementation of source control programs or development of alternative sources of water were identified by the City of Dixon and were overcome through City leadership, proactive planning, and public outreach programs. In some cases of source control measure implementation, the City utilized a combination of incentives and potential penalties when adopting ordinances."

Task 1.4/1.5 - SSALTS- Comments on Draft Phase 1 Report

Task	Comment No.	Date Received	Comment Source	Deliverable	Comment	Response
1.4/1.5	11	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 2.8 (Pg 2-8), first paragraph: Although this may be true, there should be some assessment of the long term reduction in salts so these types of BMPs can be compared. Another thing to be considered is the impacts of conservation. If Dixon's compliance is based on load, this is probably going to be okay. However, if it is based on concentration, there is a concern that current and future mandates will lead to higher concentrations even with lower loads. Dixon has faced this.	The text has been modified from: "Source controls remove or reduce the salt loadings; therefore, evaluating the long-term capacity for accumulation and disposal of salt loads in this Study Area is not an issue of concern. Instead, the City's ability to achieve long-term sustainability is best measured in terms of compliance with existing limits for salt. To anticipate the performance of similar salinity control programs to other locations in the Central Valley, factors such as achievable effluent limits, typical flow rates, and average concentrations of constituents can be used to estimate contributions from similar salinity sources." to: "Source controls remove or reduce salt loadings and they are the City's primary mechanisms for limiting long-term salt accumulation issues. However, TDS concentrations in source water supplies may be an issue for the City in the long term, because of the surrounding irrigated agriculture. The salt in applied irrigation water increases in concentration due to consumptive use and the addition of fertilizers and soil amendments, resulting in increasing TDS concentrations in groundwater. Also, from a salt compliance standpoint, Senate Bill X7-7 mandates the reduction of per capita urban water use by 20 percent by December 31, 2020. While this does not impact salt load, it will reduce water use and thereby increase the TDS concentration in wastewater. The assessment of a city's ability to achieve long-term sustainability must be evaluated both in terms of compliance with existing salinity limits for salt and mass loading. To anticipate the performance of similar salinity control programs to other locations in the Central Valley, factors such as achievable effluent limits, typical flow rates, and average concentrations of constituents can be used to estimate contributions from similar salinity sources."

Task 1.4/1.5 - SSALTS- Comments on Draft Phase 1 Report

Task	Comment No.	Date Received	Comment Source	Deliverable	Comment	Response
1.4/1.5	12	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 3.3.3 (Pg 3-3), WDR: Please note, this was challenged sucessfully and these objectives cannot be applied at end of pipe without the proper public process.	The text has been modified from: "In 2006, SWRCB adopted amendments to the 1995 Bay-Delta Plan, revising the program of implementation to achieve the salinity objectives; however, as noted above, it did not amend the objectives themselves. The updated Plan instituted required regulation of 'in-Delta' discharges of salt by municipal dischargers where previously there was no specific regulation." to "In 2006, SWRCB adopted amendments to the 1995 Bay-Delta Plan, revising the program of implementation to achieve the salinity objectives; however, as noted above, it did not amend the objectives themselves. The updated Plan instituted required regulation of 'in-Delta' discharges of salt by municipal dischargers where previously there was no specific regulation. However, enforcement of south Delta salinity objectives for municipal discharges has been challenged. The Central Valley RWQCB Order R5-2012-0115 states, "The Bay-Delta Plan includes water quality objectives for Electrical Conductivity (EC) for the South Delta in the vicinity of the discharge. On 1 June 2011, the Superior Court for Sacramento County entered a judgment and peremptory writ of mandate in the matter of City of Tracy v. State Water Resources Control Board (Case No; 34-2009-8000-392-CU-WM-GDS), ruling that the South Delta salinity objectives shall not apply to the City of Tracy and other municipal dischargers in the South Delta area pending reconsideration of the South Delta salinity objectives under Water Code §13241 and adoption of a proper program of implementation under Water Code §13242 that includes municipal dischargers. The State Water Board is currently considering new salinity and flow objectives in the South Delta that will address the Court Order. Therefore, at the time this Order was adopted the South Delta salinity objectives were not applicable to the Discharger."
1.4/1.5	13	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 3.4.2 (Pg 3-3), last paragraph: specify that this is the water treatment plant or is the drinking water quality.	The text has been modified from: "Table 3-3 provides the typical water quality of the effluent from the plant." to: "Table 3-3 provides the typical drinking water quality of the effluent from the John Jones WTP." The Table Title has been modified from: "Table 3-3. Average Treated Surface Water Quality" to: "Table 3-3. Average Treated Surface Water Quality from the John Jones WTP."
1.4/1.5	14	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Table 3-6 (Pg 3-6): It may make sense to also break this down into customer cost.	Further information would be needed in order to develop the customer cost. Primarily Tracy's share of the O&M costs are unknown from existing documents.

Task 1.4/1.5 - SSALTS- Comments on Draft Phase 1 Report

Task	Comment No.	Date Received	Comment Source	Deliverable	Comment	Response
1.4/1.5	15	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 3.7 (Pg 3-6): It is important to recognize that Tracy had a willing seller. Not all areas will have this.	The text has been modified from: "For example, for the City of Tracy, it took approximately 10 years from the initiation of the project to receipt of the first water delivery from SSJID." to: ""For example, for the City of Tracy, it took approximately 10 years from the initiation of the project to receipt of the first water delivery from SSJID. Note also that the project proponents were able to identify a water supply source, which may not always be the case."
1.4/1.5	16	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 3.8 (Pg 3-6): One issue with changing water supplies that is not discussed is that you basically are diverting more upstream. This can increase the concentration of salt in the waterbody downstream of the diversion (assuming constant salt sources, i.e. less dilution). It also has reduces water for instream uses. Wheterhether it is sustainable as on overall practice depend on a lot of different factors such as would that water be diverted anyway	The following text has been added to the paragraph: "Ancillary effects of surface water diversions can include decreased flows and increased salinity for downstream uses and decreased flows for in-stream uses. Water rights issues and the sustainability of surface water diversions would need to be determined on a case-by-case basis."
1.4/1.5	17	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 12.1 (Pg 12-1): or management solutions	The text has been modified from: "As discussed in the archetype Study Area descriptions in Sections 2 through 11, there are a variety of salt sources impacting the Central Valley, and each Study Area has unique sources and (potential) sinks for salt." to: The text has been modified from: "As discussed in the archetype Study Area descriptions in Sections 2 through 11, there are a variety of salt sources impacting the Central Valley, and each Study Area has unique sources and (potential) sinks for salt and different management solutions – or combinations of management solutions – will be needed to address salinity issues in various areas of the Central Valley."
1.4/1.5	18	11/13/13	Debbie Webster (CVCWA)	Draft Phase 1 Report	Regarding Section 12.1.1 (Pg 12-2), 8th Bullet: This could be really hard - do you mean bay-area. That is a saline condition where much of the delta is tidal or fresh water standards will apply.	The text has been modified from: "Evaporation and trucking to a Delta-disposal WWTP." to: "Evaporation and trucking to a San Francisco Bay/Ocean-disposal WWTP."
1.4/1.5	19	11/22/13	Joe McGahan (Summers Engineering)	Draft Phase 1 Report	Regarding Section 10.1 (Internal Edits): You should check with Westlands on this. You can call Jose Gutierrez at 559-241-6215	Jose Gutierrez was contacted and the project was confirmed to be awarded.

Task 1.4/1.5 - SSALTS- Comments on Draft Phase 1 Report

Task	Comment No.	Date Received	Comment Source	Deliverable	Comment	Response
1.4/1.5	20	11/22/13	Joe McGahan (Summers Engineering)	Draft Phase 1 Report	Regarding Section 10.1 (Internal Edits): Need to say Grassland area historically discharged to the SJR and use of the San Luis Drainwas to ellimnate the historic use of grassland channels.	Text has been revised to read as follows: "Within the westside region, such actions include land retirement, regional reuse, groundwater management, source control, treatment of drainage water for both salinity and selenium, and the use of a portion of the San Luis Drain to eliminate the historic use of Grassland area channels which historically discharged to the San Joaquin River."
1.4/1.5	21	11/22/13	Joe McGahan (Summers Engineering)	Draft Phase 1 Report	Regarding Section 10.3.1, Last Paragraph: Bypass Project has reduced salinity discharges.	Commented noted. The text was not changed in this location, however the Section does discuss the reduction in salinity discharges as a result of the Bypass Project in Section 10.5.2.1
1.4/1.5	22	11/22/13	Joe McGahan (Summers Engineering)	Draft Phase 1 Report	Regarding Section 10.4.3, First Paragraph (Internal Edits): Is correct location reference? Joe McGahan suggests deleting.	This has been deleted