RECLAMATION
Managing Water in the West

In compliance with the "Management Agency Agreement between the Central Valley Regional Water Quality Control Board and the United States Bureau of Reclamation" executed on December 4, 2014

2017 Annual Report
October 1, 2016 – September 30, 2017

Goodwin Dam on the Stanislaus River, California

Bureau of Reclamation
Mid-Pacific Region

2017

Mission Statements

The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian Tribes and our commitments to island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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Abbreviations and Acronyms

Action Plan	Actions to Address the Salinity and Boron TMDL Issues for the Lower San Joaquin River November 2008
Authority	San Luis & Delta-Mendota Water Authority
Basin Plan	Water Quality Control Plan for the Sacramento and San Joaquin River Basins, 4th Edition
BMP	Best Management Practices
BO	Biological Opinion
CALFED	California Bay-Delta Authority
CCID	Central California Irrigation District
CDEC	California Data Exchange Center
CDFW	California Department of Fish and Wildlife
Corps	U.S. Army Corps of Engineers
CVO	Central Valley Operations
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CV Water Board	Central Valley Regional Water Quality Control Board
CV-SALTS	Central Valley Salinity Alternatives for Long Term Sustainability Stakeholder Group
D-1641	State Water Resources Control Board Decision 1641
DF	Base Design Flow
DMC	Delta-Mendota Canal
DSS	Decision Support System
DWR	California Department of Water Resources
EC	electrical conductivity
GBP	Grassland Bypass Project
GDA	Grassland Drainage Area
GDF	Goodwin Dam Flow
GOES	Geostationary Operational Environmental Satellites
GRCD	Grassland Resource Conservation District
GWD	Grassland Water District
LBNL	Lawrence Berkeley National Laboratory
LSJR	Lower San Joaquin River
MAA	Management Agency Agreement

MOU	Memorandum of Understanding
µS/cm	micro Siemens per centimeter
mg/L	milligram(s) per liter (parts per million)
PTMS	Program to Meet Standards
Reclamation	United States Bureau of Reclamation
RTMP	Real Time Management Program
Service	U.S. Fish and Wildlife Service
SJR	San Joaquin River
SJRIP	San Juan Recovery Implementation Program
SJTSP	San Joaquin Tributary Settlement Process
State Water Board	State Water Resources Control Board
TAF	thousand acre-feet
TDS	total dissolved solids
TMDL	total maximum daily load
VAMP	Vernalis Adaptive Management Plan
WARMF	Watershed Analysis Risk Management Framework
WARMF – SJR	Watershed Analysis Risk Management Framework San Joaquin River
WDR	Waste Discharge Requirement
WQO	water quality objective
WRDP	Westside Regional Drainage Plan
WSI	Water Supply Index
YSI	Yellow Springs Instrument Company

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2017 Reclamation San Joaquin River Salinity TMDL MAA Summary of Activities

Purpose

The Central Valley Regional Water Quality Control Board's (CV Water Board) Control Program for Salt and Boron Discharges into the Lower San Joaquin River (LSJR), also known as the Salt and Boron Total Maximum Daily Load (TMDL), was approved and placed into effect on September 10, 2004. In response to the Salt and Boron TMDL, the United States Bureau of Reclamation (Reclamation) developed the salinity management plan titled *Actions to Address the Salinity and Boron TMDL Issues for the Lower San Joaquin River* (Action Plan) and entered into a Management Agency Agreement (MAA) with the CV Water Board on December 22, 2008. The MAA described Reclamation's actions to meet the obligations allocated to it by the Salt and Boron TMDL for the Lower San Joaquin River. In the MAA, Reclamation agreed to implement the Action Plan.

Reclamation and the CV Water Board revised the MAA on December 4, 2015. The revised MAA does not reference the Action Plan. However, Section 2.3d of the revised MAA states that "Reclamation actions will be detailed in an Annual Work Plan and submitted along with a Status of Activities to Date from the previous year."

This Report summarizes activities conducted by Reclamation in 2017 in conjunction with the related elements outlined in the revised MAA. The original Action Plan described Reclamation's past practices and procedures to mitigate and manage adverse impacts of salt and boron imported into the San Joaquin Basin via the Delta-Mendota Canal (DMC) in order to help achieve compliance with the objectives contained in the CV Water Board's *Water Quality Control Plan for the Sacramento River and the San Joaquin River Basins – 4th Edition* (Basin Plan). Reclamation reported the activities in quarterly reports as agreed to in the 2008 MAA. As agreed to in the revised MAA (referred to as the MAA from here forward), Reclamation activities will now be reported at the end of each calendar year in the Annual Report and activities for the next fiscal year proposed in the Annual Work Plan.

Organization of Annual Report

The Annual Report provides a synopsis of the various activities performed by Reclamation in accordance with the MAA. Action categories include Providing Flows to the System, Salt Load Reductions, and Mitigation. For each action a brief description and list of activities are provided. The annual report includes calculations of salt loads based on DMC deliveries and calculations of assimilative capacity provided through dilution flows. The calculation methods used in this report are provisional and some elements in this report do not include estimations of benefits. The *Compliance Monitoring and Evaluation Plan,* dated May 2010 and submitted in 2010, outlines the criteria and methodology for determining DMC loads and credits.

Providing Flows to the System

In 2000, Reclamation agreed to the provisions in the State Water Resources Control Board's (State Water Board) revised Decision 1641 (D-1641), which requires the release of flows from New Melones Reservoir to meet the Vernalis salinity objectives. Historically, Reclamation has provided both fishery and water quality dilution flows to the San Joaquin River from New Melones Reservoir and through purchases for the Vernalis Adaptive Management Plan (VAMP) or the Central Valley Project Improvement Act (CVPIA). The San Joaquin River Agreement, which included provisions to acquire spring and fall pulse flows for the VAMP, expired on December 31, 2011. Reclamation continued to provide interim spring pulse flows for the San Joaquin River through a 2-year agreement with Merced Irrigation District, which expired on December 31, 2013. During this timeframe, stakeholders within the watershed, including Reclamation, initiated the San Joaquin Tributary Settlement Process to formulate a collaborative solution to present to the State Water Board as an alternative to the State Water Board's new proposed San Joaquin River flow standard.

New Melones Reservoir Operations – Provision of Dilution Flow

Brief Description: In the Flood Control Act of 1962 (P.L. 87-874), Congress reauthorized and expanded the function of the Melones Reservoir to become a multipurpose reservoir, constructed by the U.S. Army Corps of Engineers and operated by the Secretary of the Interior as part of the Central Valley Project (CVP) – thus creating the New Melones Reservoir. The multipurpose objectives of the reservoir now include flood control, irrigation, municipal and industrial water supply, power generation, fishery enhancement, water quality improvement, and recreation. Since June of 2009, New Melones Reservoir has been operated to meet the National Marine Fisheries Service Biological Opinion (BO) to Reclamation on the effects of the continued operation of the CVP and the California State Water Project on the various runs of Chinook salmon, Central Valley steelhead, and green sturgeon, and their designated critical habitat.

The Sacramento and San Joaquin River Basin Plan was amended in 2004 to include a Control Program for Salt and Boron Discharges into the Lower San Joaquin River. Items 12 and 13 in the Salt and Boron Water Quality Control Program include the following statements:

Figure 1. New Melones Reservoir

Item 12. Salt loads in water discharged into the Lower San Joaquin River (LSJR) or its tributaries for the express purpose of providing dilution flow are not subject to load limits described in this control program if the discharge:

a. complies with salinity water quality objectives for the LSJR at the Airport Way Bridge near Vernalis;
b. is not a discharge from irrigated lands; and
c. is not provided as a water supply to be consumptively used upstream of the San Joaquin River at the Airport Way Bridge near Vernalis.

Item 13. Entities providing dilution flows, as described in item 12, will obtain an allocation equal to the salt load assimilative capacity provided by this flow. This dilution flow allocation can be used to:

1) Offset salt loads discharged by this entity in excess of any allocation or 2) trade, as described in item 10. The additional dilution flow allocation provided by dilution flows will be calculated as described in Table IV-8 (CV Water Board 2004c).

Activities

- Reclamation continues to operate its facilities to comply with State Water Board D-1641, New Melones Interim Plan of Operations, the applicable Biological Opinions, and the Stanislaus River at Ripon monitoring station dissolved oxygen criteria.

Quantification Methodology: Table IV-8 (CV Water Board 2004c) states that dilution flow allocations are calculated as follows:

$$A_{dil} = Q_{dil} * (C_{dil} - WQO) * 0.8293$$

Where:

A_{dil} = dilution flow allocation in thousand tons[1] of salt per month

Q_{dil} = dilution flow volume in thousand acre-feet (TAF) per month – above base flows

C_{dil} = dilution flow electrical conductivity (EC) in micro-Siemens per centimeter (µS/cm)

WQO = salinity water quality objective for the LSJR at Airport Way Bridge near Vernalis in µS/cm

Table 1 lists data and monthly calculations for the past year. Data for flow releases from Goodwin Dam, the Stanislaus River "design flows," and salinity at Orange Blossom Bridge are used to calculate the monthly dilution flow allocations. The water-year type is estimated based

[1] There is a typographical error in the Basin Plan Amendment. The units are actually tons.

on the 75% probability of exceedance found in California Department of Water Resources (DWR) Water Supply Index Forecasts (http://cdec.water.ca.gov/cgi-progs/iodir/WSI) for the San Joaquin Valley. The 75% exceedance forecast for May 1, 2017, is 6.2, which classifies 2017 as a wet year, 192% of the average.

Dilution Flow Allocation: Water Year (WY) 2017 classified as a wet year.

Table 1: Goodwin Dam Monthly Dilution Flow Allocation, WY 2017

	Goodwin Dam Flow (GDF) [a] TAF	Base Design Flow (DF) [b] TAF	Q_{dil} , TAF GDF-DF=Q_{dil}	WQO[c], µS/cm	C_{dil} (monthly average EC at Orange Blossom Bridge) [d], µS/cm	Dilution Flow Allocation, A_{dil}, tons
January 2017	38	18	20	1,000	118	-14,622
February 2017	39	18	21	1,000	143	-14,922
March 2017	51	9	42	1,000	125	-30,470
April 2017	140	28	112	700	146	-51,486
May 2017	292	28	264	700	60	-140,212
June 2017	191	20	171	700	58	-91,105
July 2017	95	5	90	700	57	-47,965
August 2017	92	18	74	700	59	-39,321
September 2017	30	15	15	1,000	65	-11,630
October 2016	46	8	38	1,000	117	-27,820
November 2016	17	12	5	1,000	71	-3,852
December 2016	13	13	0	1,000	89	0
Total						-473,404

Source: Reclamation 2017a

[a] http://www.usbr.gov/mp/cvo/reports.html

[b] Reclamation 2010 Compliance Monitoring and Evaluation Plan

[c] State Water Board Decision 1641

[d] http://cdec.water.ca.gov/cgi-progs/staSearch

[e] In months where Goodwin Dam flow is less than Base Design flow the Base Design flow has been adjusted to match the Goodwin Dam flow. This action eliminates the dilution credit for that month.

Water Acquisitions

Brief Description: The CVPIA signed into law on October 30, 1992, modified priorities for managing water resources of the CVP. The CVPIA altered the management of the CVP to elevate fish and wildlife protection, restoration, and enhancement as a co-equal priority with water supply for agriculture and municipal and industrial purposes while recognizing other associated benefits such as power generation. To meet water acquisition needs under the CVPIA, the U.S. Department of the Interior developed a Water Acquisition Program, a joint effort by Reclamation and the U.S. Fish and Wildlife Service. The program's purpose is to acquire water supplies to meet the habitat restoration and enhancement goals of the CVPIA and to improve Interior's ability to meet regulatory water quality requirements.

Activities

- Reclamation did not acquire any additional water for water quality purposes this year.

Salt Load Reductions

Reclamation is under a court order to provide drainage to the San Luis Unit, on the west side of the Lower San Joaquin Valley. As part of this effort, Reclamation historically supported the WRDP through grants and in-kind services. Salt Load Reduction Actions include the Grassland Bypass Project (GBP), implementation of the Westside Regional Drainage Plan (WRDP), and the following conservation programs: Water Conservation Field Services Program, WaterSMART Water and Energy Efficiency Grants (formerly Water 2025 Grants Program), and the California Bay Delta Authority (CALFED) Bay-Delta Water Use Efficiency Program.

Grassland Bypass Project

Brief Description: The GBP is a multi-agency stakeholder project currently based upon the 2009 Use Agreement[2] between Reclamation and the San Luis and Delta-Mendota Water Authority (Authority) to manage and reduce the volume of agricultural drainage water produced within the Grassland Drainage Area (GDA), and to use a 28-mile section of the San Luis Drain to convey this drainage water to Mud Slough, a tributary of the San Joaquin River. The GBP removed agricultural drainage water from most wetland water supply conveyance channels, facilitated drainage management that maintains the viability of agriculture in the GDA, and promoted continuous improvement in water quality in the San Joaquin River. The GBP is scheduled to attain zero discharge of pollutants to the San Joaquin River by the end of 2019. The progress and feasibility of attaining this goal is assessed by the Interagency Data Collection and Review Team that implements the GBP environmental monitoring program.

Activities

- The load of salts and boron discharged from the GDA to the lower San Joaquin River has been significantly reduced through the implementation of the GBP in 1996 and the development of the San Joaquin River Improvement Project (SJRIP) in 2002.
- Prior to WY 1996, more than 191,000 tons of salts and 357 tons of boron were discharged annually from the GDA to the Lower San Joaquin River.
- During WY 2017, approximately 42,000 tons of salts and 150 tons of boron were discharged from the GDA to the San Luis Drain.
- These significant reductions are the result of activities conducted by the Grassland Area Farmers to develop and operate the SJRIP reuse area.
- During WY 2017, approximately 182,000 tons of salts and 493 tons of boron were displaced to the SJRIP. Absent the efforts of the Grassland Area Farmers, these loads would have been discharged to the Lower San Joaquin River.

[2] U.S. Bureau of Reclamation and the San Luis and Delta-Mendota Water Authority, December 22, 2009. Agreement for Continued Use of the San Luis Drain for the Period January 1, 2010, through December 31, 2019. Agreement No. 10-WC-20-3975

- Figure 2 shows the progressive reduction of salts discharged from the GDA[3] displacement to the SJRIP.

- Figure 3 shows the progressive reduction of boron discharged from the GDA. For WY 2017, 150 tons of boron were discharged to the Lower San Joaquin River and approximately 470 tons were displaced to the SJRIP.

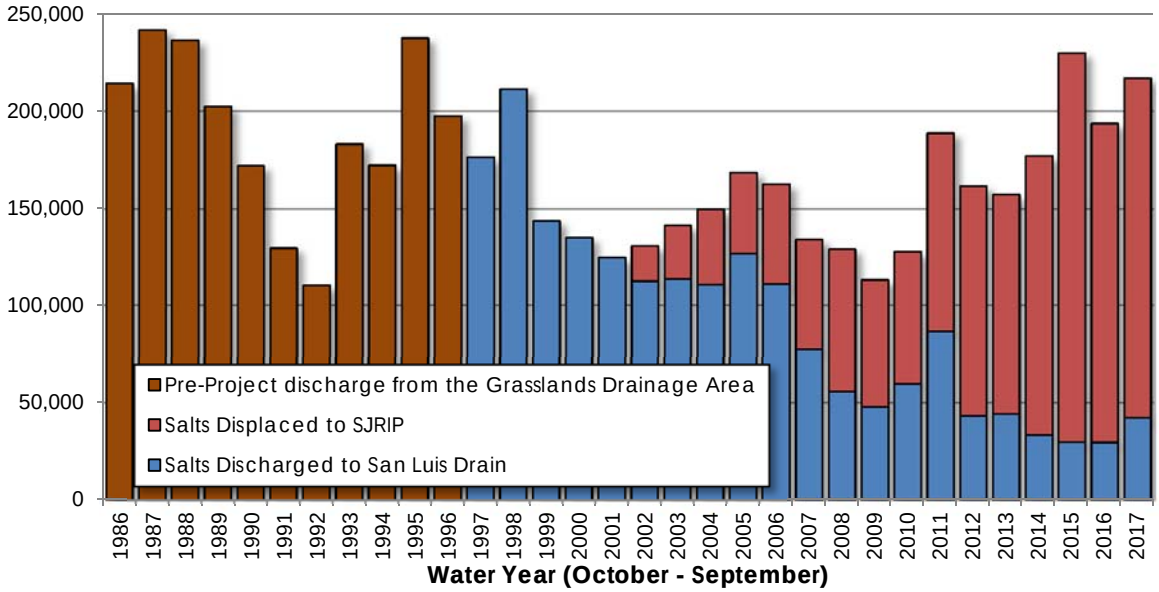

Figure 2. Salts Discharged from the Grasslands Drainage Area (tons)

[3] Data Sources: Regional Board (pre-project), Reclamation, and Summers Engineering

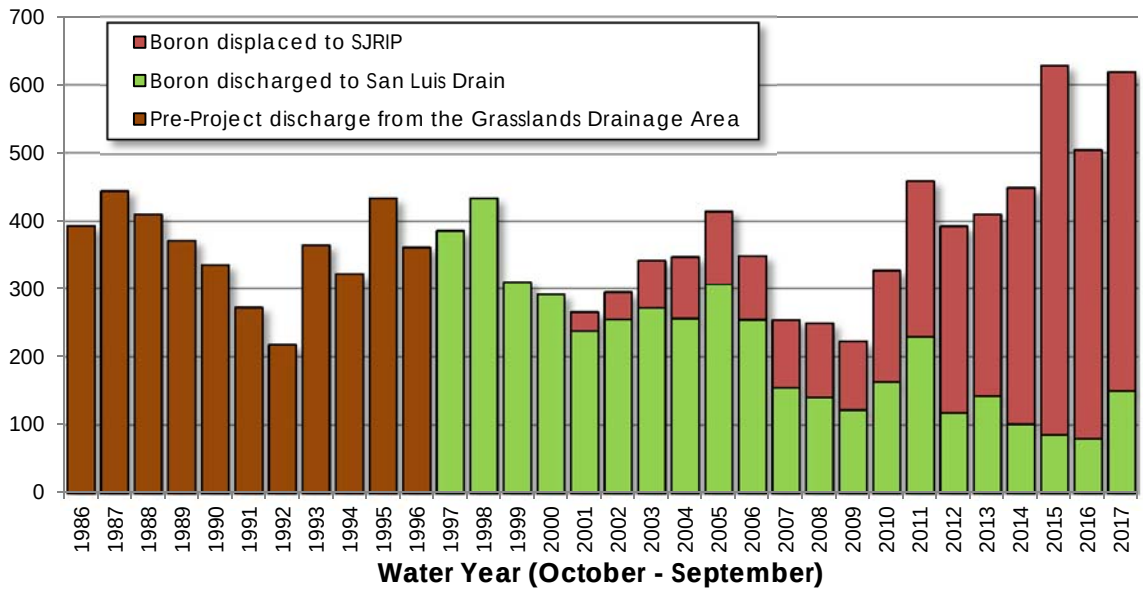

Figure 3. Boron Discharged from the Grasslands Drainage Area (tons)

- A small amount of seepage from adjacent wetlands in the Grassland Water District (GWD) is flowing from the San Luis Drain into Mud Slough, which is closely monitored by Reclamation.
- Runoff from winter rainstorms on the GDA has been conveyed through the San Luis Drain. In 2018, Reclamation and the Authority will negotiate a new agreement for the continued use the San Luis Drain to convey stormwater and seepage after the end of the GBP agreement in December 2019.
- Reclamation staff continues to collect and analyze water samples from nine sites for selenium, boron, salts, nutrients, and molybdenum and continues to operate auto-samplers in the San Luis Drain and in the river at Crows Landing.
- All data and reports associated with the GBP are posted on the GBP website that is maintained by the San Francisco Estuary Institute: http://www.sfei.org/gbp.

Westside Regional Drainage Plan

Brief Description: The WRDP is a local stakeholder program developed by integrating all consistent elements of drainage management developed by government and local agencies and private partnerships. The original efforts of the WRDP focused on reducing selenium discharges to the San Joaquin River. Success of the original effort prompted a proposal to expand the WRDP to go beyond regulatory requirements and eliminate selenium, boron, and salt discharges to the San Joaquin River, while maintaining productivity of agricultural lands in the San Joaquin valley and enhancing water supplies for the region.

Reclamation provided $45 million in grant funding to implement the WRDP since 2002.

Activities

- Reclamation continues to administer four grants with Panoche Drainage District to implement the WRDP for source control activities, groundwater management, reuse of drain water and salt treatment/disposal. Negotiations have begun on a 2017 implementation grant worth $3.8 million.

Panoche Drainage District has invested Reclamation grant funds in the development of drainage conveyance infrastructure, planting salt-tolerant crops, and environmental mitigation within the SJRIP project area. Panoche Drainage District has been a cooperator on two State-sponsored grant projects to provide decision support for salt management on the alfalfa and Jose tall wheatgrass fields within the SJRIP through use of remote sensing and continuous flow and water quality measurement. For WY 2017, the district reports that it has displaced 26,500 acre-feet of agricultural drainage water, containing 164,000 tons of salts and 424 tons of boron. Absent the SJRIP, these salt and boron loads would have been discharged into the Lower San Joaquin River.

Conservation Efforts

Brief Description: The water use efficiency program includes several grant programs which fund actions to assure efficient use of existing and new water supplies. Efficiency actions can alter the pattern of water diversions and reduce the magnitude of diversions, providing additional benefits. Efficiency actions can also result in reduced discharge of pollutant-laden effluent or drainage and therefore improve water quality. Although Reclamation is unable to quantify the benefits of the various funded projects as related to salinity reduction, the following information is provided to depict the agency's water conservation efforts in the basin. Through WaterSMART, the Reclamation/Natural Resources Conservation Service partnership and the CALFED Bay-Delta Restoration program Reclamation awarded over 90 projects in the San Joaquin Valley that required performance measures since 2006. As information is collected from these projects, quantifiable benefits may be determined in the future.

Activities

The 2017 WaterSMART Water and Energy Efficiency Program grants have been announced; Reclamation was awarded two projects within the San Joaquin basin in 2017.

- **Del Puerto Water District, Remote Flow Monitoring Program (Phase I) (Stanislaus County)**
  Reclamation Funding: $106,399; Total Project Cost: $217,140

  The Del Puerto Water District in Patterson, California, will update its irrigation monitoring system to allow for real-time, accurate flow tracking of individual growers' water use throughout the district. The project includes installation of a radio tower, telemetry equipment, establishment of a sensor network and user interface for collecting and displaying flow data, as well as upgrading meters at two high-priority turnouts. The project is expected to result in annual water savings of 455 acre-feet, which will help reduce reliance on pumped groundwater. Since the EC of groundwater pumpage exceeds that of surface water, the project helps to reduce salt loads discharged to the San Joaquin River.

- **City of Fresno, Public Landscape Water Conservation Project (Fresno County) Reclamation Funding: $300,000 Total Project Cost: $600,000**

  The City of Fresno will replace manually operated irrigation systems covering approximately 120 acres of turf and landscape areas with new automated high efficiency sprinkler systems with smart controllers. The new centrally controlled irrigation systems will allow for daily evapotranspiration adjustments and provide system alerts for breaks and leaks. The project is expected to result in annual water savings of 40 acre-feet, which will reduce the City's reliance on pumped groundwater. This project implements adaptation strategies that were identified in the completed WaterSMART Sacramento-San Joaquin River Basin Study.

Salt Load Management

The MAA lists several actions that are intended to improve management of salt and boron loads in the San Joaquin River. Reclamation has actively supported the development of the San Joaquin River Salinity Forecasting Model which utilizes the Watershed Analysis Risk Management Framework (WARMF) model code to estimate daily river salt assimilative capacity and to provide decision support for real-time salinity management at the watershed level. The model provides a framework for analysis of flow and salinity data from tributaries to the River and for water district diversions from the river. Salt assimilative capacity forecasts require both the provision of real-time flow and salinity data and anticipated actions impacting flow and salinity in the river over a 2-week forecast period. The accuracy of these forecasts is a function of the level of stakeholder involvement and the sharing of information.

RTMP – Development of Stakeholder-Driven Program

Brief Description: The RTMP is described in the TMDL as a stakeholder driven effort to use real-time water quality and flow monitoring data to support water salinity management decisions in order to maximize the use of assimilative capacity in the San Joaquin River. Reclamation has been working with San Joaquin River stakeholders and participants in the CV-SALTS initiative to support the development of a stakeholder-driven RTMP.

Activities

- Reclamation continues work to increase stakeholder involvement opportunities in developing a RTMP. During 2017 a meeting was held on August 3, 2017, targeting participation by the major irrigation districts on the eastside of the San Joaquin River, Turlock Irrigation District and Modesto Irrigation District. Turlock Irrigation District (Debbie Liebersbach and Alex Buenrostro) has been supplying continuous flow data from its five monitoring sites that measure mostly operational spill from the district into the river since late 2016. Monitoring of the EC sondes installed during 2006/2007 was discontinued after the conclusion of the Stockton Dissolved Oxygen TMDL Project and the district has been in the process of rehabilitating these sondes and reinstating continuous EC monitoring at these stations. Because of the high discharge sometimes associated with return flows from TID and MID, accurate EC is important to improve the accuracy of salt assimilative capacity forecasts at Vernalis. The August 3, 2017, meeting

was the first time Modesto Irrigation District had been included in planning activities related to real-time salinity management. Gordon Enas and Carrie Loschke represented the district. After being briefed on the data resources being requested by the Program, the district staff present agreed to present the Committee request to their Board. MID has continued to collect EC and flow data – hence making the data available to the WARMF-Online server would require involvement by district IT staff to either upload daily flow and EC data to an external FTP site or server made available by 34 North or provide access to an external FTP or server site, maintained by the district, from which daily flow and EC data could be downloaded. The consent of the MID Board had still not been obtained by November 15, 2017.

- Regarding west-side exchange contractors, Alejandro Paolini, Water Conservation Manager and Water Master for Henry Miller Reclamation District and San Luis Canal Water District, was approached to help identify any existing or potential monitoring stations that would improve water and salt load accounting for the San Joaquin River and improve the accuracy of forecasts being made by the WARMF-SJR model. From the discussions it appears that there are no direct discharges from the Exchange Contractors service area into the San Joaquin River and those discharges that occur are covered by existing monitoring of return flows entering the GWD from the East and those that enter Salt Slough upstream of the Wolfsen Road Bridge. The Wolfsen Road Bridge was location of a flow and EC monitoring site for approximately 4 years under a real-time salinity monitoring program centered around the Federal San Luis National Wildlife Refuge from around 2003–2006. Having real-time access to the Exchange Contractor return flow sites would allow refinement of flow and salt load forecasts since the Exchange Contractors could report their estimates of % changes to their drainage production at each site if given current conditions. This would be especially useful if and when these individual entities that collectively drain to the San Joaquin River needed to account for their separate contributions.
- The RTMP Framework document continues to be refined as stakeholder outreach gathers momentum and stakeholders develop greater awareness of the long-term economic and resource benefits of adopting real-time salinity management practices. This refinement also helps to identify future potential funding sources for installation of new sensor networks, on both east and west sides of the San Joaquin Basin, as well as the enhancement of existing sensor networks. These activities help to improve communication of essential San Joaquin River salt load information between stakeholders, including both discharge to the river and removal through irrigation diversions and identify opportunities to optimize use of San Joaquin River salt assimilative capacity. Ultimately stakeholders benefit by exporting salt load to the limit of San Joaquin River assimilative capacity. The closer stakeholders can operate to the 30-day running average concentration objective the greater the potential allowable salt export. The Framework document stakeholder workgroup (including Reclamation) plans to conduct quarterly meetings to coordinate their efforts.

RTMP – Technical Support

Brief Description: A successful RTMP will require telemetered networks of flow and salinity sensors along the main stem of the San Joaquin River and within watersheds draining to the San Joaquin River that allow easy access to data and data sharing. Real-time quality assurance of this data is essential to encourage data sharing so that an entity avoids liability-related issues if erroneous data is posted to the web. Towards this end Reclamation and technical consultant Lawrence Berkeley National Laboratory have been working with KISTERS International Inc. to develop an easy-to-use, semi-automated data QA solution. The RTMP pilot study in the GWD developed an application of the WISKI software, which has allowed data from the 50 stations in the district to be quality checked before being archived in their database.

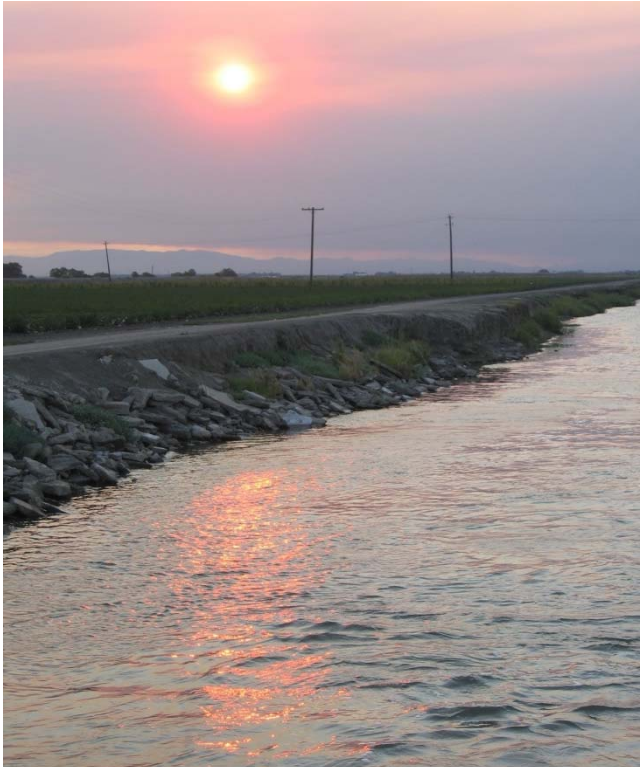
Figure 4. Newman Wasteway

A major impediment to the continued success of the real-time sensor network in the GWD was avoided in 2017 through a concerted effort to develop a new vendor relationship with the company In-Situ Inc. and fortunate timing when In-Situ Inc. resolved to acquire the company MACE (USA). The MACE (USA) acquisition allowed the district to utilize the acoustic Doppler sensors at more than 18 of the monitoring sites as dataloggers and, with the acquisition of modem cards, enable telemetry of data to In-Situ's Data-Vu web portal. The In-Situ Data-Vu web portal is accessible at no cost except for data telemetry charges, making it a lower cost option than the mothballed YSI-ECONET web portal. The GWD was able to recover archived data before the YSI-ECONET system shutdown in May 2017 and these data were migrated to the WISKI server. In October 2017, the Data-Vu server protocols were worked out to allow simultaneous web posting of data and transmission to the GWD's WISKI server. The WISKI software not only provides procedures for real-time data QA but also allows the creation of forms for data reporting and the summary of data in annual reports.

The current system in place at the GWD offers a low-cost and robust exemplar real-time water quality data management and reporting system that can be emulated in other water districts and in the Federal and State refuges where environmental data management practices are not well-evolved.

The WARMF-Online web portal is a unique data resource developed by 34 North Inc. that allows access to raw flow and EC data within the watershed – specifically those data that are used as inputs to the WARMF salt assimilative capacity forecasting model. The web portal was

developed using 34 North's Open-NRM software development platform that has been used for other projects in California such as Bay-Delta Live and an EPA-sponsored educational and discrete data resource for the east side of the San Joaquin Basin. Hence the WARMF-Online web portal shares data navigation and display tools across these platforms. The eventual goal is to fuse features of all three web portals to create a go-to web application for all things San Joaquin.

The WARMF-Online web portal provides real-time access to continuous and discrete flow and EC data throughout the Basin as well as the means of visualizing flow, EC and salt load assimilative capacity forecasts. Significant improvements to the WARMF-Online website were made in 2017, making the site more robust and changing the formatting of certain graph types for consistency. Additional dashboards are under development for west-side stakeholders those entities that may be interested in assessing the performance of the WARMF-SJR forecasting model. Now that the data are migrated to the WISKI server in the GWD, the data for the five drainage outlets maintained by the district will appear on WARMF-Online before the end of 2017. Discussions with the new district manager of Patterson Irrigation District and general managers of West Stanislaus Irrigation District and El Solyo Irrigation District will continue in the New Year to allow real-time flow and EC data of river diversions to be made available to the WARMF forecasting model. WARMF model diversion assumptions can lead to significant errors in flow and EC forecast at the Vernalis compliance monitoring station. A Proposition 84 grant proposal that was selected for funding may finally be awarded in early 2018 after a lapse of 12 months. This proposal would supply environmental sensors and telemetered logging equipment for these major diversion sites and improve the likelihood of having this data made available for salt assimilative capacity forecasting purposes.

Reclamation continues to support the development and maintenance of existing sensor networks into ungauged or poorly gauged watersheds and will provide ongoing technical support to water districts willing to develop real-time salinity management capability. Other activities during 2017 were focused on improving the reliability and efficiency of automated data uploads into the WARMF-SJR model.

Activities

- Performance testing of new capabilities of the WARMF model continued in 2017 with the help of Berkeley National Laboratory interns. This work focused on wetland drainage water quality simulation and the accuracy of the EC signal compared to the EC data collected at the five drainage outlets. We attempted to look at wind velocity as a possible explanatory parameter to increase the amplitude of EC variations and more closely match the summed flows, average EC and total salt loads form the five drainage outlets. Simulation of wetland drainage EC was found to improve. However, we are still not able to match wetland drainage EC as well as wetland drainage flow.
- To improve coordination between the WARMF Technical Review Team and the west-side stakeholder group (Westside Drainage Coalition) led by Joe McGahan, it was resolved to hold combined meetings when advantageous to both groups. A TRT objective of these meetings is to involve and receive feedback from interested parties regarding the improvements to the WARMF-SJR forecast model and model interface and to guide ongoing development of WARMF-Online. The improved WARMF-SJR

Forecast Model interface and linkage to WARMF-Online has made it easier to assemble the data sets and model inputs to make forecasts of SJR salt assimilative capacity. Continued development and refinement of stakeholder user dashboards is still being pursued as a means of improving use of the WARMF-Online web portal. Additional dashboards will be completed for potential stakeholder groups such as Grassland Water District and the State and Federal refuges and the eastside irrigation districts, MID and TID. Two combined meetings were held in 2017 during the scheduled quarterly meetings of the Westside Drainage Coalition. One successful example of this approach was the discussion provoked by a WARMF model presentation made by Joel Herr (Systech Water Resources) that showed increasing stream-aquifer losses along the main stem of the San Joaquin River, which suggested that the river had moved from a gaining to a losing river along most of its length. The presentation led to further analysis by Reclamation and the local stakeholders and a realization that model assumptions of river diversions significantly underestimated the total flow removed from the river. The important lesson learned was that the model is as good as the data that goes into it and that provision of accurate real-time diversion data can have a significant impact on the accuracy of model flow and EC forecasts.

- The United States Geological Survey plan to release the WESTSIM-HM model to Reclamation continues to be stalled, most likely because of the potential use of the model by SGMA GSAs in the Central Valley and uncertainty related to canal diversions within the San Joaquin Valley. The Central Valley Operations canal diversion data (also used in the WARMF model) has been shown by the developers of the CVHM model to be higher than that from raw data received by the San Luis and Delta-Mendota Water Authority. Initial estimates of the discrepancy were as high as 40%. Current estimates of the discrepancy are closer to 15%. Once released, this model can serve as a resource for improving WARMF model groundwater accretion and depletion estimates, and provide a better tool for estimating long-term trends in surface-groundwater interactions. The WARMF model simulation of groundwater is crude and the availability of a more rigorous tool such as WESTSIM-HM will help to improve stakeholder confidence in model simulation results and weekly forecast of river assimilative capacity.
- West-side tributary return flow data from eight real-time flow and salinity monitoring stations will be upgraded using a state-of-the-art telemetry and the web reporting system Data-Vu developed by In-Situ Inc. and currently deployed in the GWD. This is contingent on release of Proposition 84 grant funds from the California Department of Water Resources which have been delayed, as previously described. The Data-Vu web portal is more readily accessible than CDEC and will be easier to use by Irrigation District personnel within PID, WSID, and ESID. The recently completed data export capability from the Data-Vu server will allow these data to be accessed by the WARMF-Online web portal.

Assistance to Federal Refuges and Other Wetland Areas

The California Department of Fish and Wildlife and the GRCD operate under Best Management Practices (BMP) to reduce the salt loads in discharges from managed wetlands into the San Joaquin River. Reclamation has provided resources to support the development of a real-time monitoring network and other potential BMPs within Federal, State, and private managed

wetlands. We anticipate greater involvement from the State and Federal refuges during 2018 through our ongoing funding of real-time water quality management activities within the GWD.

Activities

- Reclamation continues to support the network of real-time flow and water quality monitoring stations that provide flow and EC data at major GWD inlets and outlets as well as along the water distribution network.
- The previously discussed issues related to the sunset of the YSI-EcoNET web-based data reporting system have been successfully addressed and most previous functionality restored through use of the In-Situ Data-Vu site. With a relatively low-cost investment in additional data modems, almost half of the YSI-EcoNET stations were brought back online owing to the fortuitous acquisition of MACE (USA) Inc. by In-Situ Inc. This has saved approximately $80,000 in hardware costs. Reclamation funding for FY 2018 will allow the District to restore the real-time water quality monitoring system to full functionality in early 2018.

Participation in CV-SALTS Program

Brief Description: The CV Water Board and State Water Board initiated a comprehensive effort to address salinity problems in California's Central Valley and adopt long-term solutions that will lead to enhanced water quality and economic sustainability. The CV-SALTS stakeholder group has been a collaborative basin planning effort aimed at developing and implementing a comprehensive salinity management program. The goal of CV-SALTS is to maintain a healthy environment and a good quality of life for all Californians by protecting the state's most essential and vulnerable resource – water.

Activities

Reclamation has participated in the following subcommittees of the CVSALTS program including Executive, Technical Advisory, and Lower San Joaquin River Committees. Reclamation co-chaired the CVSALTS Technical Committee (through a contract with Berkeley National Laboratory). The Lower San Joaquin River Committee (LSJRC) has not met for the past 4 months of 2017 with the completion of the analysis in support of the adoption of upstream salinity objectives at Crows landing. The LSJRC has been a useful forum for interfacing with local stakeholders and discussing options for a salinity management implementation program to meet existing and newly promulgated salinity objectives. The activities of the LSJRC have been continued to some degree by the TRT and the Westside Drainage Coalition.

Central Valley Project Deliveries Load Calculation

Brief Description: The CVP delivers water to both the Grassland and Northwest subareas (as described in the Basin Plan) through the DMC, the San Luis Canal, and the San Joaquin River/Mendota Pool. Most CVP water is pumped from the Delta into the DMC through the C.W. "Bill" Jones Pumping Plant located near Tracy, California. CVP water is conveyed south to DMC Check 13 near Santa Nella, California, where water is either mixed with the State Water Project in O'Neill Forebay and then either pumped into San Luis Reservoir for later delivery

through the DMC or San Luis Canal, or conveyed further south to the DMC terminus at the Mendota Pool. During periods of drought, groundwater and river water are pumped into the DMC at several locations. The calculation methods used in this report are provisional and some elements in this report do not include estimations of benefits at this time. Reclamation submitted the *Compliance Monitoring and Evaluation Plan* to the CV Water Board (Reclamation 2010) which outlines the criteria and methodology for determining DMC loads and credits.

Quantification Methodology: The monthly amount of CVP water supply delivered to each district is prorated according to the area of each district within either the Grassland subarea, Northwest subarea, or outside of these subareas. The monthly mean salinity of CVP water is calculated from average daily measurements taken at three locations along the DMC. The salinity of CVP water delivered to each district is associated with the salinity monitoring site closest to the District's turnout along the DMC.

The Basin Plan allocates a salt load to Reclamation for water delivered to the Grassland and Northwest Subareas. This background load allocation is calculated according to Table IV-8

Summary of Allocations and Credits (CV Water Board 2004c):

$$LA_{DMC} = Q_{DMC} * 52 \text{ mg/L} * 0.00136$$

Where:

LA_{DMC} = Load Allocation of salts, in tons

Q_{DMC} = monthly amount of CVP water delivered to Grassland and Northwest Subareas, in acre-feet

52 mg/L = "background" salinity of water in the San Joaquin River released at Friant Dam (per the Basin Plan) measured as total dissolved solids (TDS)

0.00136 = factor for converting units into tons

Actual DMC salt loads are calculated by the following equation:

$$L_{DMC} = Q_{DMC} * C_{DMC} * 0.00136$$

Where:

L_{DMC} = Actual DMC Load, in tons

Q_{DMC} = monthly amount of water delivered to Grassland and Northwest Subareas, in acre-feet

C_{DMC} = monthly average of salinity of the water delivered to Grassland and Northwest Subareas, in mg/L TDS

0.00136 = factor for converting units into tons

Each Subarea's Q_{DMC} is calculated and then paired with the associated monthly average TDS for that reach, so the equation becomes:

$$L_{DMC} = 0.00136 * \Sigma(Q_{DMC} * C_{DMC})_{\text{Subareas}}$$

This equation is then broken into calculations for each subarea based on the source of CVP water. Table 2 lists the monthly volumes of CVP water and salts delivered to the Grassland and Northwest subareas and an estimate of the salts delivered in excess of the Monthly Load Allocation.

Table 2. Calculation of DMC Allocations and Loads

Water Year	Water Year Type	Grassland Subarea						Northwest Subarea					Total
		San Joaquin River and Mendota Pool Deliveries from CVP, load in thousand tons	Delta- Mendota Canal Deliveries from CVP, load in thousand tons	San Luis and Cross Valley Canal Deliveries from CVP, load in thousand tons	Total Flow, thousand acre-feet	Load Allocation, thousand tons	Actual Load - Load Allocation, thousand tons	San Joaquin River and Mendota Pool Deliveries from CVP, load in thousand tons	Delta- Mendota Canal Deliveries from CVP, load in thousand tons	Total Flow, thousand acre-feet	Load Allocation, thousand tons	Actual Load - Load Allocation, thousand tons	Total Excess Load from CVP Deliveries, thousand tons
2013	Critical	355.1	97.2	51.3	1060.1	74.9	428.6	27.1	25.6	121.4	8.6	44.1	472.7
2014	Critical	302.1	55.3	49.1	674.8	47.7	358.9	22.5	23.5	80.8	5.7	40.3	399.2
2015	Critical	285.7	56.9	46.7	611.8	43.2	346.2	22.0	32.5	84.0	5.9	48.5	394.7
2016	Dry	275.4	89.9	36.2	873.4	61.7	339.8	50.5	15.5	92.8	6.6	29.5	369.2
2017	Wet	147.5	57.8	20.1	1,032	72.9	152.4	9.3	11.0	122.7	8.7	11.6	164.0

Source: Reclamation 2017

Report of Annual Work Plan Activity Performance

Reclamation has met schedule milestones for the MAA and performance of actions that assist San Joaquin River Stakeholders in managing salt loads and offsetting the DMC salt load into the San Joaquin River. New Melones Reservoir has been operating in accordance with D-1641 water quality requirements.

The San Joaquin River salt assimilative capacity forecasting tool and decision support systems is based on the WARMF-SJR model. The WARMF-SJR model has been used for studies worth several million dollars since it was first developed for the San Joaquin River dissolved oxygen TMDL in 2005. This work continues in FY2018 as Reclamation and its contractors Systech Water Resources Inc. and Berkeley National Laboratory improve the performance of the model and the datasets available for model calibration and validation. Reclamation has also provided funding and a contractor, 34 North, to create and maintain a website for San Joaquin River real-time management activities that include having access to timely flow, and EC data and the ability to estimate salt loading and salt loading assimilative capacity from these monitoring station data sources. The website WARMF-Online is unique in its ability to combine access to real-time

environmental data and model-based simulation and forecasting projections of future conditions. Stakeholder involvement is critical to the success of the real-time water quality management program, to improve not only the collective understanding of the river itself but also stakeholder projections of their own operations over the 2-week forecast period. Data uploading automation is important to bring the simulation model up-to-date. However, stakeholder estimates of salt loading to the river and their ability to manage these return flows will be important for forecast accuracy and reliability. Our belief is that once we are able to satisfy the data and analytical needs of a small number of key stakeholders, the use and adoption of the WARMF-Online web portal will expand. We would like WARMF-Online to become the one-stop shop for relevant environmental monitoring and model-based information in the Basin and be relied upon just as the weather app is relied upon on a person's iPhone.

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CV Water Board 2004c	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 Final Staff Report. Table IV-8 Summary of Allocations and Credits, Dilution Flow Allocations, Regional Water Quality Control Board Central Valley Region, September 10, 2004.
Keller, C. 2014	Forecasting and assessment of the WARMF model for real-time salinity management in the San Joaquin River. US Dept. of Energy Office and Science, Science Undergraduate Laboratory Internship (SULI), Summer 2014.
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New Publications, Lectures, Posters

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4. Quinn, N.W.T. 2017. Real-time salinity management. Guest lecture, Department of Plant Science, California State University, Fresno, CA. Apr 19, 2017.
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