Memorandum

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TO: Michael Johnson, LSJRC Manager

COPY TO: Lower San Joaquin River Committee
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SUBJECT: **Development of a Basin Plan Amendment for Salt and Boron in the Lower San Joaquin River (LSJR):**
Task 6 – Long-term Monitoring and Reporting Program

INTRODUCTION

This technical memorandum (TM) is submitted on behalf of the LWA Team[1] to fulfill the requirements of Task 6 in the Scope of Work for the *Development of a Basin Plan Amendment for Salt and Boron in the Lower San Joaquin River* (Workplan). Task 6 includes the following subtasks:

Subtask 6.1 Develop goals for a long-term monitoring and reporting program.

Subtask 6.2 Prepare a monitoring program to evaluate compliance with water quality objectives (WQOs) and the effectiveness of the implementation program.

Information generated in the Task 4 Report, *Implementation Planning for Proposed Salinity Objectives*, April 13, 2015, (Task 4 Report) was used to support the development of this Lower San Joaquin River Salinity Related Long-term Monitoring Program (LSJR Monitoring Program). Due to the extensive network of existing electrical conductivity (EC) and boron monitoring in LSJR (Reach 83[2]), it is anticipated that the LSJR Monitoring Program may be able to rely on these existing programs as the primary source of data.

[1] The LWA Team consists of the following firms: Larry Walker Associates, Carollo Engineers, Kennedy/Jenks Consultants, Systech Water Resources, PlanTierra, Luhdorff and Scalmanini Consulting Engineers, Ascent Environmental, and Dr. Richard Howitt.
[2] From the mouth of the Merced River to Vernalis.

California Water Code (CWC) Section 13242 requires implementation programs designed to achieve WQOs to include a description of the surveillance to be carried out in order to determine compliance with the objectives. The information that will be incorporated into Chapter V of the Central Valley Regional Water Quality Control Board's (Central Valley Water Board) Water Quality Control Plan (Basin Plan) Surveillance and Monitoring section is presented in this TM.

BACKGROUND

Based on the information developed pursuant to the Task 4 Report, the LSJR Committee (LSJRC) is proposing an EC WQOs and recommended Performance Goal for Reach 83 of the LSJR (the Preferred Alternative)[3]. While this TM includes recommendations for a monitoring program based on the Preferred Alternative, the recommendations would also be applicable to the other alternatives evaluated in Task 4. The Preferred Alternative WQO and recommended Performance Goal are protective of the AGR beneficial use and consider agriculture's seasonal demands for water diverted from Reach 83, while at the same time accounting for the fact that ambient water quality conditions are greatly influenced by hydrologic conditions, including the presence of return flows, in the San Joaquin River Basin. Additionally, the Basin Plan already has boron WQOs established for LSJR Reach 83.

Commented [K1]: Note to Reviewer: this information will be updated based on the final direction from the LSJRC regarding the WQOs and Performance Goal.

Electrical Conductivity

Among the four potential project alternatives selected by the LSJRC for consideration in the Basin Planning process, project alternative # 4 (1,550 µmhos/cm EC Objective with a 1,350 µmhos/cm EC Performance Goal for Seasonal and Water Year Considerations) was selected as the Preferred Alternative because it was determined to best meet the six evaluation criteria and provide the greatest operational flexibility to export salts out of the basin while also protecting the AGR (irrigation supply water) beneficial use in Reach 83.

Commented [K2]: Note to Reviewer: this information will be updated based on the final direction from the LSJRC regarding the WQOs and Performance Goal.

Compliance with the proposed EC WQO is based on a 30-day running average that considers the seasonal components of hydrologic conditions and beneficial uses. Alternatives, including monthly averages and annual averages, were also considered; however, a change in averaging period would not likely change the recommended sample collection frequency considering the availability of high frequency (15 minute) EC measurements throughout the LSJR.

Boron

The existing WQOs for boron in Reach 83 are shown in **Table 1**.

Table 1. Lower San Joaquin River Boron Water Quality Objectives.

Period of Applicability	Maximum (mg/L)	Monthly Mean (mg/L)	Critical[a] WY Monthly Mean (mg/L)
March 15th through September 15th	2.0	0.8	1.3
September 16th through March 14th	2.6	1.0	1.3

[a] – Table IV-3, Basin Plan

[3] Section 6.1, Task 4 Report

Implementation Program

The program of implementation to meet the proposed EC WQO primarily includes the following, already initiated, actions within the San Joaquin River:[4]

- Full Implementation of the Real Time Management Program (RTMP) – RTMP facilitates the control and timing of wetland and/or agricultural drainage to the LSJR to coincide with periods when the LSJR has capacity to assimilate additional salt up to the EC WQO. It is anticipated that the RTMP will be fully implemented by 2020.
- Full Implementation of the Grassland Bypass Project – The Grassland Bypass Project prevents discharge of subsurface agricultural drainage water into wildlife refuges and wetlands in central California. The Grassland Bypass Project is scheduled for completion in 2019.

MONITORING PROGRAM GOALS

The primary goals of the LSJR Monitoring Program are to evaluate:

1) Compliance with the salinity-related WQOs and Performance Goal in Reach 83 of the LSJR[5]; and
2) The effectiveness of the implementation program.[6]

Based on the information developed in Task 4, these LSJR Monitoring Program goals were expanded into the following, more specific, assessment goals:

- Assess compliance with the EC and boron WQOs in Reach 83 of the LSJR[7] (primary goal No. 1);
- Characterize long-term changes/trends in the ambient EC and boron concentrations within Reach 83 of the LSJR (primary goals No. 1 and No. 2);
- Assess the effectiveness of the implementation program management actions in controlling salt and boron in Reach 83 (primary goal No. 2); and
- Use the LSJR Monitoring Program results to identify potential revisions to the WQOs, Performance Goal, and/or implementation program (primary goals No. 1 and No. 2).

These assessment goals may be modified in the future based on additional information and/or the adaptive management of the implementation program.

EXISTING MONITORING PROGRAMS

Existing monitoring efforts in the LSJR are significant and include continuous (typically 15 minute interval) sensors and sample collection at numerous locations within Reach 83 and immediately upstream in the San Joaquin River, Stanislaus River, Tuolumne River, Merced River, Orestimba Creek, Mud Slough, and Salt Slough. The Central Valley Water Board, the United States Geological Survey (USGS), the California Department of Water Resources (DWR), and the United States Bureau of Reclamation (USBR) all conduct routine flow and EC

[4] Section 6.2, Task 4 Report
[5] Primarily electrical conductivity (EC) and boron
[6] Section 6.2, Task 4 Report
[7] Compliance with the EC WQOs will be based on a 30-day running average

and/or boron monitoring that can be used to augment the LSJR Monitoring Program. Upstream tributary sites and diversions were not considered in this evaluation because they do not immediately address the assessment goals. If additional management actions within the upstream tributary drainage areas are identified, these sites may be further considered at that time.

The following monitoring programs are or have collected samples that may be used to address the LSJR Monitoring Program assessment questions:

- The Central Valley Water Board previously collected boron and EC samples through the Surface Water Ambient Monitoring Program (SWAMP); however, this monitoring work was completed in 2011.
- The San Joaquin River Real-time Water Quality Management Program (RTMP) uses telemetered stream stage and salinity data and computer models to simulate and forecast water quality conditions along the LSJR. Its primary goal is to increase the frequency of meeting San Joaquin River salinity WQOs to optimize high quality releases made specifically for meeting San Joaquin River salinity objectives.[8] DWR, USGS, and USBR are all cooperating agencies in this program, which has established an extensive network of flow and salinity (EC) continuous (15 minute interval) sensors in the San Joaquin River and all major upstream tributaries. These continuously measured data are reported through the California Data Exchange Center (CDEC).
- Self monitoring by the United States Bureau of Reclamation and the San Luis & Delta-Mendota Water Authority for the Grassland Drainage discharge to the San Luis Drain is part of the 2010 use agreement (Agreement No. 10-WC-20-2975) that refers to the 2001 Waste Discharge Requirements (Grassland WDR, Order No. 5-01-234) monitoring program. The 2001 WDR requires weekly EC and boron sampling on the San Joaquin River and other upstream tributaries. This WDR monitoring characterizes the effects of the Grassland Bypass Project to reduce selenium and boron loading to surrounding wetlands and refuges, as well as the San Joaquin River.
- The Irrigated Lands Regulatory Program (ILRP) requires monitoring through a WDR for agricultural non-point discharges. The Westside San Joaquin River Coalition 2014 WDR includes boron and EC monitoring on the San Joaquin River upstream of Reach 83. Other ILRP WDRs includes upstream tributary monitoring.
- The City of Turlock and City of Modesto publically owned treatment works (POTWs) monitor EC at locations above and below their discharges between Crows Landing and Maze Road.

Table 2 and **Table 3** summarize the best available data in the mainstem of Reach 83 and the immediate proximity. The data are of high quality and are readily available through the CDEC or the California Environmental Data Exchange Network (CEDEN). **Figure 1** identifies the locations of each of these San Joaquin River mainstem sites.

[8] http://www.water.ca.gov/waterquality/sjr_realtime/map/index.cfm

Table 2. Electrical Conductivity and Boron Monitoring in the Lower San Joaquin River.

	Source	CEDEN	CEDEN	CDEC	CDEC	CDEC	CEDEN
	Program	SWAMP	Grasslands		Real-Time Program		ILRP
	Agency	CVRWQCB	USBR	DWR	USBR	USGS	WSJRC
	Frequency	Weekly	Weekly	Continuous	Continuous	Continuous	Monthly
	EC	Yes	Yes	Yes	Yes	Yes	Yes
Location	**Boron**	Yes	Yes	No	No	No	Yes
	Site ID	541SJC501		SJR	VER	VNS	
Vernalis	Begin Date	1995		2005	1999	1999	
	End Date	2011		Present	Present	Present	
	Site ID	541STC510		MRB			
Maze Road	Begin Date	1995		2007			
	End Date	2011		Present			
	Site ID	541STC507		SJP			
Patterson	Begin Date	1995		2000			
	End Date	2011		Present			
	Site ID	535STC504	535STC504			SCL	
Crows Landing Bridge	Begin Date	1995	2011			2004	
	End Date	2011	Present			Present	
	Site ID					NEW [flow]	
Newman [Flow Only]	Begin Date					1995	
	End Date					Present	

Note: POTW river monitoring comprise weekly EC grab samples upstream and downstream of the effluent outfalls. Both effluent outfalls are between the Merced and Tuolumne rivers.

Table 3. Electrical Conductivity and Boron Monitoring in the San Joaquin River Upstream of Reach 83.

	Source	CEDEN	CEDEN	CDEC	CDEC	CDEC	CEDEN
	Program	SWAMP	Grasslands	Real-Time Program			ILRP
	Agency	CVRWQCB	USBR	DWR	USBR	USGS	WSJRC
	Frequency	Weekly	Weekly	Continuous	Continuous	Continuous	Monthly
	EC	Yes	Yes	Yes	Yes	Yes	Yes
Location	**Boron**	Yes	Yes	No	No	No	Yes
Hills Ferry	Site ID	541STC512					
	Begin Date	1985					
	End Date	2007					
	Site ID	541MER538	541MER538			FFB	
Fremont Ford	Begin Date	1995	2011			2004	
	End Date	2011	Present			Present	
Stevenson/Lander Ave.	Site ID	541MER522		SJS			541MER522
	Begin Date	1995		2000			2011
	End Date	2011		Present			Present

Note: POTW river monitoring comprise weekly EC grab samples upstream and downstream of the effluent outfalls. Both effluent outfalls are between the Merced and Tuolumne rivers.

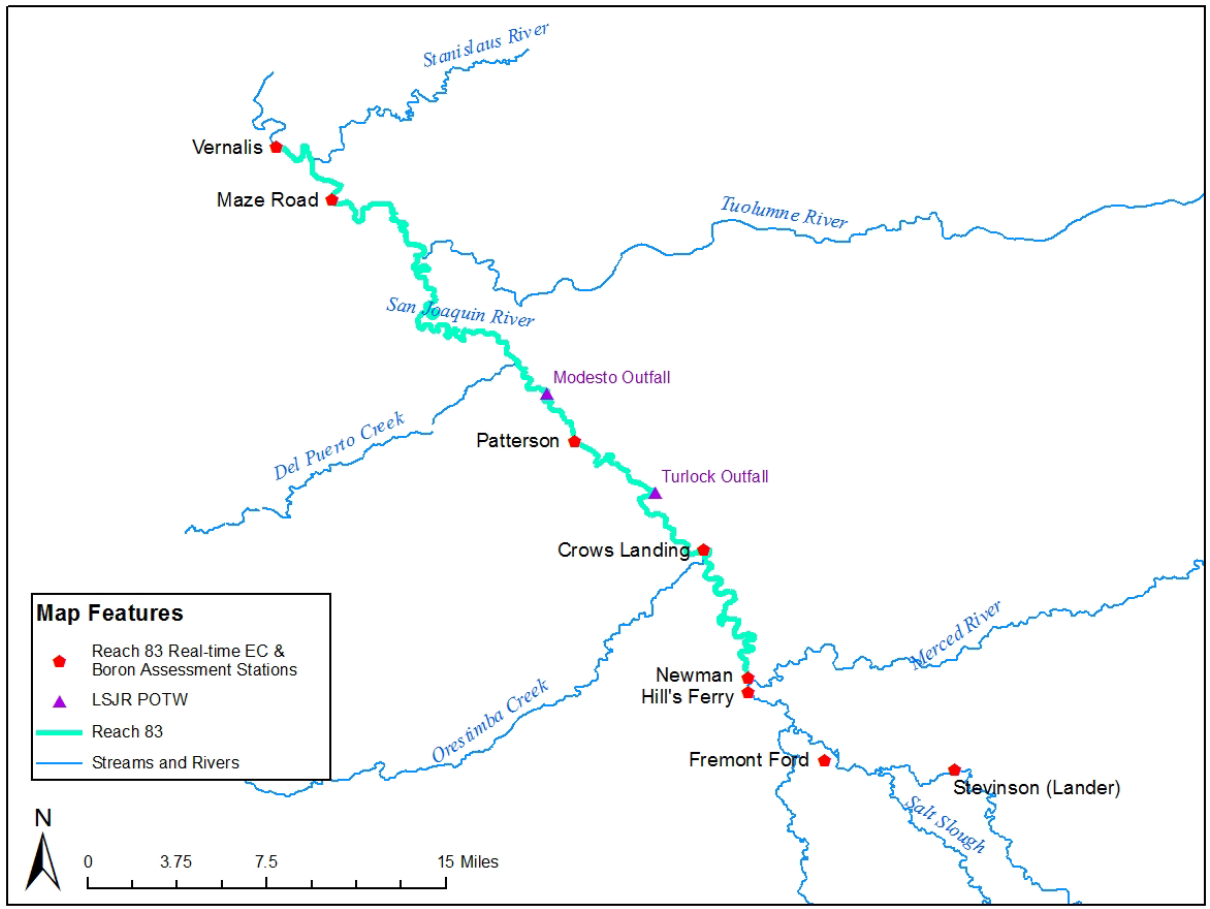

Figure 1. Project Location, Management Action Areas, and Sampling Locations.

Effectiveness Assessment of Management Actions by Other Groups

The Grassland Bypass Project and the RTMP are the most significant implementation actions that will affect EC and boron concentrations upstream and within Reach 83. The effectiveness of the Grassland Bypass Project will be characterized through the WDR monitoring performed by USBR in the San Joaquin River, Mud Slough, and the San Luis Drain. These WDR data are sufficient to characterize loads of salinity and boron from most significant management action areas, thus, no further monitoring is necessary.

The RTMP effectiveness will be assessed through RTMP sensors and ongoing assessments at Vernalis and other locations. Additionally, changes in discharges to Reach 83 will also be assessed through salinity compliance reporting by POTWs and other regulated entities.

PROPOSED LONG-TERM MONITORING AND REPORTING PROGRAM

The availability of existing monitoring program data and the ability to answer the four assessment goals comprised the criteria considered to develop the proposed monitoring program.

Availability of Existing Monitoring Data

The previous section summarized readily available data (**Table 2** and **Table 3**) in and adjacent to LSJR Reach 83 (**Figure 1**). The eight San Joaquin River locations and the two POTW data sources were considered for inclusion in the monitoring program. There are other active and inactive monitoring locations that could be included, especially for assessment of the management actions. However, the identified locations consist of established sites with a historic record of monitoring and readily available data through CEDEN, CDEC, and Central Valley Water Board reporting. The location, type, and frequency of sample collection are further developed through consideration of the four assessment goals.

Assessment Goal Consideration

The proposed monitoring program should address all four of the assessment goals, which support the two primary goals.

Assess Compliance with the EC and Boron Water Quality Objectives

The first LSJR Monitoring Program primary goal is to assess compliance with the proposed EC and existing boron WQOs. The goal will also facilitate the assessment of compliance with the recommended EC Performance Goal. The Preferred Alternative WQO and Performance Goal for EC will require either the use of continuous sensors or daily sample collection to obtain the data necessary to calculate accurate 30-day running averages or monthly averages for EC if an alternate to the Preferred Alternative is ultimately selected. To evaluate the existing boron WQOs would require sample collection on a weekly basis for comparison to the monthly average.

Characterize Long-term Changes/Trends in the Ambient EC and Boron Concentrations within Reach 83 of the LSJR

Trends are best assessed with higher frequency data collection, especially if the system experiences changing flow conditions and has a large number of factors that could contribute to the concentration and loading of salinity and boron. Trends in the data collected can be assessed

through statistical comparisons that determine if differences over time are random in nature or systematic. Less frequent quarterly or annual sample collection would not adequately characterize the effects of management actions, dam releases, or climate change over time relative to the rate of change and overall variability of flow, weather conditions, and water resource management. While more frequent data collection improves statistical power to identify changes in complex systems, the assessment duration, data variability, and the magnitude of the change in conditions are also considerations when designing sample collection plans. Without specified assessment periods or allowable condition changes, the existing LSJR sensor data collection programs provide reasonable statistical power for future assessments.

Assess the Effectiveness of the Implementation Program Management Actions in Controlling Salt and Boron

The management actions could be considered factors in the system affecting the downstream water quality. In this way assessment of the WQOs attainment measures the effectiveness of these programs, especially if other factors in the system (e.g. stream conditions, groundwater contributions) are well known. Because the existing management actions are expected to have significant benefits to downstream salt loads, attainment of the proposed and existing WQOs and recommended Performance Goal can indicate successful management action implementation. In cases where management actions make only small changes, it may not be possible to statistically identify changes in these downstream "integrator" sites. Future smaller scale studies at the management action locations could provide direct measurement of load reductions and effectiveness of the individual management action. Management actions should be evaluated both on the downstream water quality changes as well as the downstream load changes.

Use the LSJR Monitoring Program Results to Identify Potential Revisions to the WQOs and/or implementation Program

Revisions to WQOs and the implementation program would be based on a number of sources including data collected under the LSJR Monitoring Program. The LSJR monitoring program should provide data sufficient to characterize WQO and Performance Goal attainment, including the duration and magnitude of WQO and Performance Goal exceedances, if any. Data collection should support existing and expected modeling efforts that are used to characterize water flow and quality conditions and evaluate implemented, planned, and proposed management actions.

Based on the aforementioned information in this report, it was determined that the recommended LSJR Monitoring Program goals can be met through existing monitoring locations, constituents, and sample collection frequency. Future management actions should include sufficient assessment monitoring to characterize their benefit to both water quality and salt load reductions. The recommended approach is shown in Table 4 and **Table 5** and described below.

Electrical Conductivity

The Preferred Alternative EC WQO and Performance Goal would, at a minimum, require daily sample collection on LSJR at Maze Road and Crows Landing. While daily sample collection would be sufficient to calculate a 30-day running average, daily average values capture time-of-day bias and changes that may occur during a day. Daily average values at these locations should be calculated by existing programs based on sensor values that are field calibrated and supplemented with calibration measurements as is done as part of the RTMP. Existing stations at the proposed locations can provide these data. Thus, no additional sample collection would be

necessary. **Table 4** summarizes the recommended monitoring locations, collection entity, type, and frequency.

Table 4. Recommended Electrical Conductivity Monitoring Locations, Collection Approach, and Frequency.

San Joaquin River Location	Sample Collection Entity	EC WQO Assessment	Sample Collection Type	Sample Collection Frequency
Maze Road	DWR	30 day running average	continuous sensor	15 minute data to calculate daily average
Crows Landing Bridge	USGS			

Locations

The existing USGS and DWR continuous EC sensors within LSJR Reach 83 can be used to characterize compliance at the proposed locations:

- Maze Road - characterizes water quality between the Tuolumne and Stanislaus Rivers, and
- Crows Landing - characterizes water quality between the Merced and Tuolumne Rivers.

Selection of these two sites sufficiently characterizes Reach 83 with respect to the location of major tributaries and point sources, and includes the WQO compliance point for the proposed action (Crows Landing) and a location upstream (Maze Road) of the Vernalis compliance point (see **Figure 1**). The downstream boundary of the LSJR, Vernalis, could also be used to characterize the portion of Reach 83 downstream of the Stanislaus River. This location may be used to characterize the overall condition of the LSJR.

Frequency

The RTMP sensors report values every 15 minutes that can be used to calculate a daily average value and the resultant 30-day rolling average or another WQO compliance period that may be identified. Until the variability in the data is determined, the "continuous" data are recommended because of their availability, use within the RTMP, and higher resolution to better characterize variability and trends or the effects of management actions.

Boron

Compliance with the existing Basin Plan WQOs for maximum and monthly average boron concentrations can be assessed at Crows Landing Bridge using the weekly Grassland's sample collection. Apart from Crows Landing Bridge, there are no other active monitoring locations where weekly boron samples are collected within the LSJR Reach 83. **Table 5** summarizes the recommended monitoring locations, collection entity, type, and frequency.

Table 5. Recommended Boron Monitoring Locations, Collection Approach, and Water Quality Objective Assessment.

San Joaquin River Location	Sample Collection Entity`	EC WQO Assessment	Sample Collection Type	Sample Collection Frequency
Maze Road	None	TBD	None	None
Crows Landing Bridge	Grasslands Project	Calculation of monthly average based on available weekly samples WQO and single sample comparisons to maximum WQO	Discrete grab samples	Weekly

Locations

The boron WQO applies to the entirety of Reach 83 and does not specifically identify one compliance point. An assessment program would then ideally consider the three sections above and below the Stanislaus and Tuolumne River as was proposed for EC. However, sample collection at the Crows Landing Bridge can be used to assess beneficial use protection, as it would be expected to have the highest boron concentration. Attainment of the boron objective at this location suggests downstream attainment, where the influence of the Stanislaus River would improve water quality. Upstream management actions include those upstream of Reach 83, and resultant changes would be adequately characterized by upstream monitoring in coordination with Crows Landing Bridge monitoring. If results exceed the boron Basin Plan WQOs at Crows Landing Bridge, then additional locations at Maze Road and Vernalis may be considered to further characterize LSJR Reach 83.

Frequency

Until the Grassland Bypass Project is completed and sufficient time has elapsed to demonstrate continuous compliance, weekly sample collection is recommended for the purpose of calculating a monthly average. Reliable boron continuous sensors are not currently available; however, surrogate relationships between parameters such as EC and boron may be further evaluated to better understand trends and the effect of implementation programs.

Changes to the monitoring program could be made as part of the WQO assessment process and should be targeted to address specific trend changes, characterize specific segments, or better evaluate specific sources or management actions. Design of this additional monitoring would be based on existing data, modeling information, and best professional judgment to meet the monitoring objectives. For example, if an episodic exceedance of boron occurred for unknown reasons at Crows Landing Bridge during the same month in multiple years, additional sample collection of upstream tributaries could be scheduled for that month in the following year(s). Also, additional sample collection in that month at Maze Road and Vernalis would further characterize Reach 83 WQO objective compliance. In many cases data collected by others would be sufficient and additional sample collection might not be necessary.

Finally, the proposed LSJR Monitoring Program and other existing efforts as described above will provide a robust data set that can be used to measure the cumulative effect of all salinity management actions. As a result, no new monitoring to assess the effectiveness of a specific management action is recommended at this time. However, because the monitoring program relies on other external programs, it is important that those efforts are supported and tracked, especially where improvements or changes are proposed.

REPORTING

Data for the RTMP sensors (USBR, USGS and DWR) are reported and archived through CDEC. There is currently no specific SWAMP guidance for continuous sensors; however, the continuous sensor programs used by these agencies follow the intent of the SWAMP Quality Assurance Project Plan (QAPP) approach. Without implementation of continuous data QA computer software, continuous sensor data should be reviewed to identify out-of-range results in the 15 minute interval dataset and the performance of calibration samples should be considered. Boron and EC grab samples reported through CEDEN by the Grassland Bypass Project are

collected according to their QAPP requirements and are consistent with SWAMP guidance as approved by the Central Valley Water Board in support of the Grassland WDR.[9]

To meet requirements of the Federal Clean Water Act and section 303(c) and Water Code section 13240, the Central Valley Water Board reviews the water quality standards contained in the Basin Plans every three years. However, the Basin Plan section IV LSJR Salt and Boron implementation specifies "The Regional Water Board will review and update the load allocations and waste load allocations by 28 July 2012 and every 6 years thereafter." While this is specific to the TMDL allocations, it is a more feasible review cycle to observe trends in ambient water quality and the protection of beneficial uses for both the proposed EC WQO and the existing boron WQO. Thus, the six year review cycle tied to TMDL assessment is recommended unless stakeholders initiate or request a more frequent assessment or the Regional Water Board identifies another schedule or process to perform this assessment.

Adaptive management of the monitoring and assessment program may be necessary based on the Regional Water Board's review of WQO attainment. Recommended monitoring or assessment actions from this review may be performed by other stakeholders or regulated parties. Actions initiated by other regulatory programs (e.g., Grassland Bypass Project, NPDES permits, etc.) should be evaluated in light of the goals and proposed components of this program.

REFERENCES

Larry Walker Associates (LWA). 2015. *Task 4 – Implementation Planning for Proposed Salinity Objectives.* Final Report. Prepared for San Joaquin Valley Drainage Authority. Submitted by Larry Walker Associates, in association with Systech Water Resources, Carollo Engineers, and PlanTierra. July.

[9] http://www.usbr.gov/mp/grassland/documents/gbp_2013_rev_mon_plan.pdf