RECLAMATION

Managing Water in the West

Grassland Bypass Project
2013 Revised Monitoring Program

Mud Slough near Gustine, California

Revised: 26 March 2013

2013 Revised Monitoring Program for the Continued Operation of the Grassland Bypass Project

January 1, 2013 - December 31, 2019

Revised: 01 March 2013

Monitoring Plan prepared by Members of the Data Collection and Reporting Team for the Grassland Bypass Project

Participating Organizations

U.S. Bureau of Reclamation
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
U.S. Geological Survey
Central Valley Regional Water Quality Control Board
California Department of Fish and Game
San Luis & Delta-Mendota Water Authority

Abbreviations and Acronyms

Participating Organizations

GAF	Grassland Area Farmers
CDFG	California Department of Fish and Game
Regional Board	California Regional Water Quality Control Board, Central Valley Region
NMFS	National Marine Fisheries Service
Authority	San Luis & Delta-Mendota Water Authority
Reclamation	U.S. Bureau of Reclamation
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Grassland Bypass Project Organization

GBP	Grassland Bypass Project
OC	Oversight Committee
TPRT	Technical and Policy Review Team
DCRT	Data Collection and Reporting Team

Contractors

BES	Block Environmental Services, Pleasant Hill, California
SEI	Summers Engineering Inc., Hanford, California
SFEI	San Francisco Estuary Institute, Oakland, California

Features

GDA	Grasslands Drainage Area
SLD	San Luis Drain

Administrative Documents

EIS/EIR	GBP Environmental Impact Statement / Environmental Impact Report
Monitoring Plan	Compliance Monitoring Plan
QAPP	Quality Assurance Project Plan
ROD	Record of Decision
Use Agreement	Agreement for Continued Use of the San Luis Drain for the Periods January 1, 2010 through December 31, 2019. Agreement No. 10-WC-20-3975
2001 WDR	Waste Discharge Requirements No. 5-01-234, issued September 7, 2001; Monitoring and Reporting Program, May 7, 2005

Abbreviations

WY	Water-Year, October 1 through September 30

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2013 Revised Monitoring Program
for Continued Operation of the
Grassland Bypass Project

January 1, 2013 through December 31, 2019

Section 1.0 Introduction

This document describes the program to monitor the progress of the U.S. Bureau of Reclamation (Reclamation) and the San Luis & Delta-Mendota Water Authority (Authority) to meet the environmental commitments agreed upon in the operation of the Grassland Bypass Project (GBP). This program is design to provide data to support the Agreement for Continued Use of the San Luis Drain[1] (Third Use Agreement). It will be amended to conform with the revision of the 2001 Waste Discharge Requirement (WDR)[2], due to be issued by the California Regional Water Quality Control Board, Central Valley Region (Regional Board), in 2013.

The purposes of the GBP are to:

1. Continue the separation of unusable agricultural drainage water discharged from the Grasslands Drainage Area (GDA) from Grassland wetland supply conveyance channels through December 31, 2019, and to

2. Facilitate drainage management that maintains the viability of agriculture in the GDA and promotes improvement in water quality in the San Joaquin River.

Features of the GBP include:

1. Management and consolidation of unusable agricultural drain water from the GDA, which is comprised of Camp 13 Drainage District, Charleston Drainage District, Firebaugh Canal Water District, Panoche Drainage District, Pacheco Water District, Widren Water District, and unincorporated adjacent farmland,

2. Continuation of the Grassland Basin Drainers Activity Agreement, a regional drainage entity,

3. Continued separation of GDA drain water from 93 miles of channels that supply clean water to private wetlands and State and Federal wildlife refuges,

[1] San Luis & Delta-Mendota Water Authority and the United States, Department of the Interior, Bureau of Reclamation, December 22, 2009. Agreement for Continued Use of the San Luis Drain. Agreement No. 10-WC-20-3975.

[2] California Regional Water Quality Control Board, September 21, 2001. Waste Discharge Requirements No. 5-01-234 for the San Luis & Delta-Mendota Water Authority and the United States, Department of the Interior, Bureau of Reclamation, Grassland Bypass Channel Project (Phase II), Fresno and Merced Counties.

4. Use of the Grassland Bypass Channel, a 4-mile-long earthen constructed ditch, to convey drainwater from the GDA to the San Luis Drain,

5. Continued use of approximately 28 miles of the San Luis Drain, to convey unusable agricultural drain water to its terminus,

6. Discharge of unusable agricultural drain water into Mud Slough (North), a tributary of the San Joaquin River,

7. Execution of the *Agreement for Continued Use of the San Luis Drain* from January 1, 2010 through December 31, 2019,

8. Development of the San Joaquin River Water Quality Improvement Project within the GDA, and

9. Implementation of this Monitoring Plan to evaluate the effects of the GBP on the San Luis Drain, Mud Slough (North), Grassland wetland supply channels, and the San Joaquin River.

On September 7, 2001, the Regional Board issued a WDR that specified conditions to allow Reclamation and the Authority to discharge agricultural drainage water into Mud Slough (North), including maximum monthly and annual loads of selenium. The monitoring and reporting program for the WDR was revised in May 2005 to specify contaminant monitoring in the San Luis Drain, Mud Slough, and the San Joaquin River; three-species chronic toxicity monitoring in the Drain and Mud Slough; and storm water monitoring. The latter would occur when all of the surface runoff, storm water flows, and agricultural drainage water exceed the capacity of the Grassland Bypass channel, resulting in releases from the GDA into the Grassland wetland supply channels.

Reclamation and the Authority prepared environmental review documentation on the third phase of the GBP[3] and a Record of Decision[4]. The U.S. Fish and Wildlife Service issued a biological opinion[5] for the GBP with requirements for monitoring biota. The Third Use Agreement, executed on December 18, 2009, establishes the terms and conditions for using the SLD and operation of the GBP through December 31, 2019. The Third Use Agreement includes monthly and annual load objectives, plus significant fines for exceeding these limits.

[3] URS, Corporation. September 29, 2009. Grassland Bypass Project Final Environmental Impact Statement and Environmental Impact Report. Oakland, CA

[4] U.S. Bureau of Reclamation, Mid-Pacific Region. December 18, 2009. Record of Decision for the Grassland Bypass Project 2010/2019. Sacramento, CA

[5] U. S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office. December 18, 2009. Endangered Species Consultation for the Proposed Continuation of the Grassland Bypass Project. Sacramento, CA

The project is located within the Grasslands Sub-area as defined in the Basin Plan for the San Joaquin Valley[6] (**Figure 1**). The Grasslands Sub-area is approximately 370,000 acres and is generally bounded on the north by the alluvial fan of Orestimba Creek and by the Westlands Sub-area to the south. The San Joaquin River forms the eastern boundary and Interstate Highway 5 forms the approximate western boundary.

The Grasslands Sub-area consists primarily of agricultural lands, Federal and State wildlife refuges, and private wetlands. The Grasslands Sub-area soils are derived largely from the erosion of the marine rocks that form the California Coast Ranges and contain abundant salts and other trace elements such as arsenic, boron, mercury, and selenium. Water percolates slowly through these fine-textured soils. Careful management of irrigation water is necessary to prevent saturation of the root zone of agricultural fields.

The area is a highly managed hydrologic system due to the diversion of perennial flows out of the basin. Thus, agricultural irrigation water must be supplied via supply canals. Similarly, drainage water must be managed in the absence of perennial receiving water flows and the accompanying assimilative, or dilution, capacity.

This monitoring program has been developed to provide data necessary for implementation of the Third Use Agreement and to help with annual budget and allocation of staff and supplies.

The Regional Board is preparing a new WDR and Monitoring and Reporting Program that is due in late 2013. This Monitoring Program will be amended to incorporate the monitoring and reporting requirements of the new WDR.

We anticipate that discharge of agricultural drain water from the San Luis Drain to Mud Slough (north) will diminish during 2015, thus ending the purpose of this monitoring program. Based on available funding, Reclamation will continue to monitor Mud Slough (north), between the San Luis Drain and the San Joaquin River, until 31 December 2019, under a new program to be developed by the DCRT.

Section 2.0 Project Management

2.1 Project Organization

Monitoring and reporting efforts for the GBP will be performed by private, State, and Federal agencies whose authority or activities overlap in one or more aspects of the project. These agencies include the Grassland Water District, the Authority, the Regional Board, the California Department of Fish and Wildlife (CDFW), Reclamation, U.S. Fish and Wildlife Service

[6] California Regional Water Quality Control Board, 1998, revised 2011. The Water Quality Control Plan for the Sacramento River and San Joaquin River Basin, Appendix 41.

(USFWS), and U.S. Geological Survey (USGS). Technical guidance is provided by staff of the U.S. Environmental Protection Agency (US EPA) and the National Marine Fisheries Service (NMFS).

2.2 Oversight Committee

The GBP Oversight Committee consists of senior representatives from Reclamation, USFWS, US EPA, CDFW, and the Regional Board. The role of the Committee is to evaluate overall operations of the GBP, to assess monetary charges ("Drainage Incentive Fees") for selenium loads exceeding those specified in the third Use Agreement, and to act on other issues brought to them by the Technical and Policy Review Team (TPRT) and/or the public.

2.3 Technical and Policy Review Team

The Oversight Committee appointed the Technical and Policy Review Team (TPRT) to evaluate technical and policy issues. TPRT members include a representative from the Regional Board, CDFW, Reclamation, USFWS, and US EPA. A representative from USGS serves as an independent technical advisor. The TPRT will be responsible for obtaining and providing the necessary information, options, and recommendations to the Oversight Committee for issues and decisions regarding the project. This includes the review and analysis of analytical data and reports, and obtaining appropriate peer or scientific review as necessary.

2.4 Data Collection and Reporting Team

The Data Collection and Reporting Team (DCRT) consists of the agency representatives and contractors who collect, verify, and report GBP data. The DCRT will meet regularly to coordinate monitoring activities. The team will address issues and concerns regarding data collection, data management, and quality assurance/quality control as the GBP progresses. The DCRT will continue to prepare monthly reports of data and annual reports that analyze the impacts of the GBP on the Grasslands watershed and the San Joaquin River.

2.5 Quality Control Officer (QCO)

A representative from Reclamation has served as the QCO to work with the cooperating agencies to verify, validate, coordinate and update the quality control activities associated with the GBP. Since Reclamation will be collecting and analyzing most of the water samples under this monitoring program, a new QCO from an independent agency will be enlisted.

Section 3.0 Monitoring Plan Approach

3.1 Introduction

The monitoring program is comprised of activities to evaluate the environmental effects of the GBP, and the meet the requirements specified in the Third Use Agreement. **Table 1** lists the sites, **Table 2** lists the general schedule for monitoring, and **Tables 3a, 3b, 3c, and 3d** summarize the Revised Monitoring Program.

Monitoring objectives include the following:

1. To assess environmental conditions in the SLD by measuring contaminants concentrations in water and sediment,

2. To assess environmental conditions in Mud Slough (North) which are related to discharges from the SLD by measuring contaminant concentrations in water, sediment, and biota,

3. To assess environmental conditions in Grasslands wetlands water supply channels, represented by Salt Slough, by measuring contaminant concentrations in water, sediment and biota,

4. To verify that agricultural drainage water from the GDA is removed from wetland water supply channels, and

5. To assess environmental conditions in the San Joaquin River which are related to the GBP by measuring contaminant concentrations in water, sediment, and biota.

3.2 Integration with Research/Investigations Activities

The comprehensive data collection effort undertaken may allow more in-depth, interagency research projects to be performed than might have been otherwise possible. The data collection, reporting, and dissemination process fosters close cooperation and coordination, not only with the agencies and organizations involved in the monitoring program but also within the research community.

3.3 Procedures for Updating this Monitoring Plan

If, at any time during the life of the project, a cooperating agency is unable to complete activities specified under the WDR, Reclamation and the Authority will take over the specified monitoring. If, during the life of the project, budgetary constraints preclude continuing monitoring for other elements of the program, the effected monitoring component will be reevaluated by the DCRT

and alternative recommendations will be forwarded to the TPRT for consideration. If the issue cannot be resolved by the TPRT, then it will be forwarded to the OC for consideration.

This monitoring plan can also be modified periodically based on review of data relative to the project objectives and commitments. Recommendations for modifying the monitoring plan are presented to and discussed before the DCRT. If the DCRT reaches agreement on the suggested changes, then the recommended changes are presented in writing to the TPRT. The TPRT can choose to accept the changes or have the OC make the final decision. If the DCRT cannot agree on the suggested changes, the TPRT can review the request and can accept or deny the request. If the TPRT cannot agree on the changes, a final decision will rest with the Oversight Committee.

3.4 Duration of this Monitoring Program

The Third Use Agreement has incentives for the elimination of discharges of agricultural drain water into the San Luis Drain by January 2015 in the form of Supplemental Mitigation Fees for each pound of selenium discharged into Mud Slough (north) from the San Luis Drain.

Supplemental Mitigation Fees - Cost per pound of selenium discharged.[7]

Water Year Type	2015	2016	2017	2018	2019
Critical	$133.29	$183.52	$393.70	$1,250.00	$1,250.00
Below Normal	$57.78	$80.47	$176.68	$625.00	$625.00
Above Normal	$34.79	$48.79	$108.85	$416.67	$416.67
Wet	$32.05	$44.29	$95.54	$312.50	$312.5
Annual Maximum	$112,500	$112,500	$150,000	$187,500	$187,500

The Westside Regional Drainage Plan is being implemented to manage and control drain water through source control, groundwater management, re-use of drain water, and treatment/salt disposal. Significant funding has been provided by Reclamation and the State of California to construct WRDP facilities, including the Demonstration Treatment Facility being built during 2013 to test methods for removing salts and selenium from drain water. Though this facility will not be large enough to handle the entire amount of drain water produced in the GDA, we anticipate that it will be enlarged to do so by 2015.

Since the discharge of agricultural drain water to Mud Slough (north) will diminish during 2015, so will the purpose of this monitoring program. Based on available funding, Reclamation will continue to monitor Mud Slough (north) between the San Luis Drain and the San Joaquin River until 31 December 2019, under a new program to be developed by the DCRT.

After 2020, it is possible that the Drain may used to convey floodwater on occasion, and a new monitoring program will be developed similar to the current Stormwater Monitoring Program (**Table 4**).

[7] Third Use Agreement, Appendix "L" Mitigation for the Continued Use of Mud Slough, page 49.

K. RECLAMATION anticipates that any long-term use of the Drain beyond the term of this Agreement will be for a program for discharging storm water only. Any such stormwater discharge program will require further specific planning and compliance with all environmental laws, including the National Environmental Policy Act and the Endangered Species Act. Terms of this Agreement have been negotiated by a group of agricultural and environmental stakeholders, and contains three distinct mechanisms to provide incentives to implement an in-valley drainage management solution as soon as possible, such that (i) Load Values decrease over the term of this Agreement; (ii) Incentive Fees increase over the term of this Agreement and (iii) mitigation obligations increase over the term of this Agreement with significant changes applying during Years Six through Ten (2015-2019) in particular; however, such mechanisms do not constitute a model, or form the baseline of requirements for any long-term storm water discharge program, which will be required to meet regulatory requirements for such programs.[8]

Section 4.0 Data Collection, Data Management and Reporting

Each agency will collect, analyze, summarize and report its data in a timely manner to meet the monthly, quarterly, and annual schedules. The ultimate responsibility for collecting and reporting of data required by the WDR rests with the Reclamation and the Authority.

4.1 Data Management

Each agency collecting data will be responsible for their own data reduction (analysis), internal data quality control, data storage, and data retrieval. Each organization will provide its data to an independent organization, currently the San Francisco Estuary Institute (SFEI), for compilation, peer review, and reporting. Reclamation will fund management of GBP data by the independent organization.

4.2 Reporting

The independent data management organization will prepare draft monthly reports, which will be reviewed by the DCRT. The reports will consist of daily flows, available water quality results, and chronic toxicity results. The monthly report will also list the load of selenium discharged from the terminus of the SLD (Station B/B2). If certain data are not available for the current monthly report, values will be marked "Pending" and posted in the next quarterly report. Each monthly report will be posted on the internet and distributed to the public.

A quarterly data report will be compiled by the independent data management organization. This report will list all available data that were collected and analyzed during the 3-month period. The quarterly data report updates and/or revises data that was previously reported in the monthly or quarterly reports, when warranted. After the quarterly data report is reviewed by the DCRT, the report will be posted on the internet and distributed to the public.

[8] Third Use Agreement, page 7.

Schedule for Quarterly Monitoring Reports

Due Date	Type	Reporting Period
01 March	Quarterly monitoring report	01 July – 30 September of previous calendar year
01 June	Quarterly monitoring report	01 October – 31 December of previous calendar year
01 September	Quarterly monitoring report	01 January – 31 March of same calendar year
01 December	Quarterly monitoring report	01 April – 30 June of same calendar year

The contents of the quarterly report are listed in **Appendix 4**.

An annual report will be prepared by the DCRT for the Oversight Committee and Regional Board that reviews all results and trends. The Annual Monitoring Report will be completed by 01 May every year, with the first report due 01 May 2014. The report will cover the monitoring from the previous water year (01 October – 30 September). More information about the contents of the annual report are listed in **Appendix 4**.

Reclamation will incorporate local data collected for other programs in the GBP quarterly and annual reports. For example, flow and water quality data collected by Reclamation for the Delta-Mendota Canal and San Joaquin River Restoration Programs will be relevant to the GBP, as well as data collected by Grasslands Water District for wetlands water supply channels.

Based on available funds, Reclamation will sponsor an annual review of the GBP by an independent organization.

Section 5.0 2013 Revised Monitoring Plan

5.1 Introduction

The 2013 Revised Monitoring Plan is designed to collect data to meet the requirements of the Third Use Agreement and assess the impacts of the GBP on the San Luis Drain, Mud Slough (north), Grasslands wetlands water supply channels, and the San Joaquin River. To this end, flow, water quality, sediment, and biota have been identified as the parameters for assessing the GBP. **Table 1** is a list of monitoring sites, **Table 2** is a general schedule for monitoring, and **Tables 3a, 3b, 3c, and 3d** summarize the monitoring activities.

5.2 Monitoring Station Locations and Purposes

Table 1 is a list of monitoring stations that will be studied to compare changes in pre-project conditions (1985 - 1996) with current conditions. The stations are located within the SLD, Mud

Slough (north), the wetland channels, and the San Joaquin River. **Table 2** lists the schedule for monitoring. **Figure 1** is a map of the Grassland Bypass Project monitoring stations.

Stations in the SLD are located at the drain inlet (A) and drain outlet (B2/B3). Data from these stations are used to assess flows, selenium loads, water quality, and selenium concentrations in the sediment, as well as the amount of sediment in the drain.

The changes in selenium in sediment will be measured at twenty places in the SLD, in Mud Slough (north) below the SLD, and the San Joaquin River below the Mud Slough confluence. Selenium in sediment will also be measured in Salt Slough. These results will be compared with hazardous material criteria established by State and Federal regulations.
The accumulation of sediment along the SLD will be measured annually. Article III.E of the Third Use Agreement directs the Authority to manage, remove, and dispose of all sediment, organic materials and other substances that have accumulated in the SLD as a result of its use of the Drain since October 1996. Article III.G.3 directs Reclamation and the Authority to develop a plan for the removal of sediment from the SLD.

Stations in Mud Slough (north) are located downstream of the discharge from the SLD and in a backwater area. Data from Stations D and I2 will be used to assess flows, contaminant concentrations in water, sediment quality, and tissue concentrations resulting from GBP operations.

The control site will be located in Salt Slough (F/F2). Data from these stations will be used to assess flows, contaminant concentrations, sediment quality, and tissue concentrations. These data will be used to evaluate environmental improvement in the Grassland wetland supply channels.

Water samples will be taken from the Camp 13 Ditch and at the Agatha Canal headwork to confirm that drainage water from the GDA is not discharged into the Grasslands wetlands water supply channels. A special storm monitoring program will be implemented when such releases occur (**Table 4**).

Stations on the San Joaquin River are located at China Island Refuge and Hills Ferry, above the Merced River and downstream of the confluence with Mud Slough, and at Crows Landing, which is downstream of the confluence with the Merced River. Data from these stations will be used to assess flows and contaminant concentrations. Sediment, biota, and toxicity will be measured at the China Island site.

Changes in selenium concentrations have been identified as indicators of the San Joaquin River system resulting from GBP. Tissue concentrations will provide indicators of human health hazard.

Water quality and flow data from the SLD outlet (B2) will be used to compute selenium and salt loads, the metric specified in the Third Use Agreement and WDR.

5.3 Summary of Changes to the Monitoring Program

The tables in Appendix 1 list the proposed differences between the 2011 Interim Monitoring Program and the 2013 Revised Program. The significant changes include:

1. Move the location for collecting water quality samples in the San Luis Drain from Station B to the Gun Club Road crossing (New Station B3). The justification for this change, explained in Appendix 2, is based mainly on the safety of field personnel.
2. Move the location for collecting water quality and biological samples in the San Joaquin River from Hills Ferry upstream to a point within the CDFW China Island Unit. The new site will be called Station R. This reason for this change is to obtain samples from that portion of the river that is most affected by the conveyance of agricultural drain water from the GDA. Field staff have had many problems gaining access to the site because it is located on private property. Furthermore, water in the river at this place was often diluted with Merced River water. This site may be inaccessible during wet weather and when the river is flooding.
3. Increase the parameters for water quality monitoring to include general minerals, trace metals, pesticides, and bacteria.
4. Coordinate with other monitoring programs in the Grasslands watershed to eliminate duplication. For example, Site C (Mud Slough upstream of the San Luis Drain Discharge); Site L2 (CCID San Luis Canal); and Site M2 (Santa Fe Canal) will be dropped from the GBP program,but will continue to be monitored by Grasslands Water District. Reclamation will provide funding to assist with selenium analyses at these sites. The Westside Coalition also monitors selenium and other parameters monthly at Site C under the Irrigated Lands Regulatory Program. These changes will prevent duplicate analyses of waterbodies that are not directly affected by the GBP.
5. Reduce the frequency of sampling nutrients from biweekly during the irrigation season (March – September) to monthly. The reason for this change is save money to pay for the other parameters.
6. Reduce the frequency of measuring boron in the San Luis Drain from daily to monthly, and in the other sites from weekly to monthly. The reason for this change is save money to pay for the other parameters.
7. Monitoring by the GBP will also be discontinued in the San Joaquin River at Fremont Ford (Site G), however, this monitoring will be continued under the San Joaquin River Restoration Program, based on available funding. The Westside Coalition also monitors selenium and other parameters each month at Fremont Ford under the Irrigated Lands Regulatory Program.
8. Reclamation will expand the scope of data reporting by the Independent Data Management Agent to include monitoring data collected by other agencies (Grasslands

WD) and programs (SJRRP). Annual reports shall be completed within six months after the end of each calendar year.

9. Drop monitoring of boron and selenium in seeds.
10. Add quarterly analysis of mercury in fish and invertebrates.

Section 6.0 Flow Monitoring

6.1 Purpose

Flow is a basic parameter in the measurement of contaminant loads in the Grassland Basin. Flow in the San Luis Drain must be managed to prevent erosion of sediments. Flows within the basin can fluctuate quite widely and are especially susceptible to storm events. Flow is typically measured as stage, or depth of water over a reference point. Typical methods include pressure transducer and staff gauge. **Table 5** summarizes the flow monitoring program.

Preliminary, real-time flow measurements will be posted on the California Data Exchange Center[9] for several sites in Mud Slough, Salt Slough, and the river.

6.2 Sampling Locations and Data Uses

Flow data will be collected at the following stations in the San Luis Drain, Mud Slough, Salt Slough, and the San Joaquin River:

Station A	SLD near South Dos Palos, California
Station B2	SLD terminus, near Gustine, California
Station D	Mud Slough (North) downstream of SLD discharge
Station F	Salt Slough at Highway 165
Station H2	San Joaquin River above Merced River (Hills Ferry)
Station N	San Joaquin River at Crows Landing

Daily average flow will be measured in two wetlands water supply channels by Grasslands Water District.

Station J	Camp 13 ditch headworks
Station K2	Agatha Canal headworks

6.3 Frequency of Flow Monitoring

Digital stage recorders will be used at all stations to provide continuous measurements. Additional measurements of stage will be conducted using Steven's recorders and staff gages.

[9] http://cdec.water.ca.gov/

6.4 Field Sampling Techniques

The methods for measuring flow are summarized in **Table 5**. Digital stage recorders will provide continuous measurements of stage (depth). Manual observations of flow will be made of passing over weir boards or across a staff gauge.

6.5 Analytical Techniques

Stage measurements can be converted to discharge values and current shifts in station flow rating curves can be used to correct estimated discharge using standard analytical techniques. These techniques can be found in the USGS Open File Report 96-618 (USGS, 1996).

6.6 Load Calculations

Loads are calculated by multiplying the concentration of the contaminant of concern[10] by the flow (in cubic feet/second) and then multiplying by an appropriate constant to convert the mass flux into pounds or tons, depending on the constituent.

Selenium load (pounds/month) =
Flow (acre-feet/month) x Selenium concentration (µg/L) x 0.00272

Salt load (tons/month) =
Flow (acre-feet/month) x Total Dissolved Solids (mg/L) x 0.00136

Boron load (1000 pounds/month) =
Flow (acre-feet/month) x Boron concentration (mg/L) x 0.00136

6.7 Quality Assurance

Flow measurement quality assurance focuses on verification of the stage discharge relationship at the monitoring station and checking and re-calibration of the sensors deployed at each station.

The relationship of stage to discharge will be rated at Stations A, B2, D, F, H2, and N using USGS protocols (USGS, 1996). The frequency of calibration and station maintenance depends on the characteristics of the station and the flow conditions. Frequent calibration will be performed for stations in unlined earthen channels susceptible to backwater effects and where sedimentation or stream bed erosion is likely.

Tasks to be performed during routine station maintenance include cleaning and re-calibration of sensors, comparing flow data with conventional current meter measurements taken from a bridge, or in stream, and computation of shifts in the stage discharge rating.

[10] expressed in parts per million = milligrams per liter (mg/L) or parts per billion = micrograms per liter (µg/L)

At Stations J and K2, the depth of water passing over the weir boards is related to canal discharge. A standard rating curve has been developed for each station using current meter readings.

Section 7.0 Water Quality Monitoring

Water quality has been closely monitored in the lower San Joaquin River, its tributaries, and the Grassland wetland supply channels since 1985. The historic data[11] have been used to develop regulatory programs for the control of agricultural drainage discharges. This Monitoring Plan will document the environmental effects of the GBP on the watershed.

7.1 Purpose

Water quality monitoring is designed to compare analytical results to the stated water quality objectives and commitments addressed in the WDR. These commitments include meeting monthly and annual selenium loads, not degrading water quality in the San Joaquin River relative to the pre-project condition (including the salinity standard at Vernalis), and ensuring that drain water discharges do not violate applicable State, Federal, and local laws and regulations.

This revised monitoring program will be amended to incorporate requirements in the new WDR due in late 2013. **Table 3a** is a summary of water quality monitoring and **Table 6** is a detailed list of parameters to be measured at the sites listed below.

7.2 Sampling Locations and Data Uses

Water quality sampling locations are depicted in **Figure 1**. The stations include data from the SLD, Mud Slough (North), Salt Slough, San Joaquin River, and the wetland channels.

Station A	SLD near South Dos Palos, California
Station B3	SLD at Gun Club Road (NEW)
Station B2	SLD terminus at Mud Slough
Station D	Mud Slough (North) downstream of SLD discharge
Station I2	Mud Slough (North), about 1 mile downstream of SLD discharge
Station F	Salt Slough at Highway 165
Station F2	Salt Slough in San Luis NWR
Station J	Camp 13 Ditch
Station K2	Agatha Canal at Headwork
Station R	San Joaquin River between Mud Slough and Merced River, in the CDFW China Island Refuge (NEW)
Station H2	San Joaquin River above Merced River (Hills Ferry)

[11] http://www.swrcb.ca.gov/rwqcb5/water_issues/swamp/historic_reports_and_faq_sheets/index.shtml#sjriverwq

Station N San Joaquin River at Crows Landing

Water quality measurements at Station A will be used to assess compliance with salt load objectives specified in the Third Use Agreement, and for measuring changes in the SLD.

Station B3 will be used to assess compliance with selenium load objectives specified in the Third Use Agreement and the WDR. Water quality data is evaluated along with flow to assess selenium loads. For the 2013 Revised Monitoring Plan, the site for measuring water quality will be Station B3, located upstream of the siphon under Gun Club Road. Note that flow will continue to be measured at the terminus of the SLD (Station B2). See **Appendix 2** for more information about monitoring at this location.

Data collected at Site D will be used to assess water quality in Mud Slough (north) with the GDA drainage water. Site I2 will assess water quality in a backwater area.

Data collected at the new China Island site (Station R) will be used to assess water quality in the river containing the GDA drainage water. Flow, salinity, and temperature will be measured in the river above the confluence with the Merced River at Station H2. Station N is a compliance point specified in the WDR.

Station F will be the control site to assess the environmental changes that are occurring with the removal of GDA discharges from the wetlands water supply channels. Sites J and K will be used to confirm the Project goal to prevent drainage water is being discharged from the GDA into adjacent wetlands.

7.3 Water Quality Parameters

Table 6 summarizes the parameters to be sampled at each station.

Physical measurements will be made with handheld meters for these parameters: Dissolved oxygen, pH, specific conductivity, and turbidity. Depending on the delay between sampling and testing, temperature will be measured as well.

General mineral analyses will include Calcium, Magnesium, Potassium, Sodium, Chloride, Sulfate, and total organic carbon. Hardness will be calculated. Total suspended sediments will be measured monthly in the SLD at Stations A and B.

Analyses of metals will include Arsenic, Boron, Cadmium, Copper, Lead, Mercury, Molybdenum, Nickel, Selenium, and Zinc. Total concentrations will be measured in monthly grab samples, and dissolved concentrations of Cadmium, Copper, Lead, Molybdenum, Nickel, and Zinc will be measured twice each year.

Dissolved selenium and selenium in suspended particulates in will be measured in samples to be collected quarterly, coinciding with each biological monitoring field trip at Stations B3, D, F, and China Island.

Nutrients will be measured monthly at four places; the analyses will include Nitrates as N, Total Ammonia, Total Phosphate, and Ortho Phosphate.

Pesticides, to be measured twice a year at four places, include Carbamates, Pyrethroid scan, Organochlorine scan, and Organophosphate scan.

Biannual analyses will measure bacteria: total coliform, fecal coliform, and E coli.

7.4 Frequency of Sampling

Tables 2, 3a, and 6 summarize the frequency of water quality sampling at each station.

San Luis Drain

Daily grab samples will be collected at Station A to measure the concentration of total selenium. Daily average flow and specific conductivity will be measured with a sonde. Total suspended solids will be measured weekly at this site.

Daily composite samples will be collected at Station B3 using an autosampler to measure total selenium. Daily monitoring of selenium loads is required to determine compliance with loads specified in the Third Use Agreement and WDR. Physical measurements will be made weekly. Total suspended solids will be measured weekly at Station B3. Monthly samples will be taken to measure general minerals, total metals, and nutrients. Quarterly samples will be taken to measure dissolved selenium and selenium in suspended particulates. Water samples will be collected twice per year to be analyzed for dissolved metals, pesticides, and bacteria.

Mud Slough (North)

Water quality samples will be collected weekly at Station D, a bridge across the slough located about a quarter mile below the SLD discharge. The water here will be monitored continuously for flow, EC, and temperature[12]. Physical measurements will be made weekly. Monthly samples will be taken to measure general minerals, TSS, total metals, and nutrients. Quarterly samples will be taken to measure dissolved selenium and selenium in suspended particulates. Water samples collected twice per year will be analyzed for dissolved metals, pesticides, and bacteria.

Water samples will also be collected at the Station I2, a seasonal backwater. This site is typically

[12] Real-time monitoring of flow, EC, and temperature are currently conducted by the US Geological Survey at Station D. Reclamation is negotiating with Grasslands WD to take over monitoring at this site in FY 2014.

flooded in the winter and spring. Weekly samples will be measured for physicals and total selenium when water is present. Site I2 is intended to be a better representation of the adverse effects of bioaccumulative drainwater contaminants than Site D, because it consists of a backwater. Stagnant conditions and evapoconcentration in such backwaters increase selenium assimilation into aquatic food chains.

The 2013 Revised Monitoring Plan will not continue to monitor Station C, Mud Slough (north) upstream of the SLD discharge, because this site is not directly affected by the operation of the GBP. Grasslands Water District will continue to measure flow, salinity, selenium and boron in Mud Slough (north) at the Gun Club Road crossing, about one mile upstream of Station C. Reclamation will provide funding and technical assistance for selenium monitoring. The Westside Coalition also monitors water quality at Site C under the Irrigated lands Regulatory Program.

Wetland Channels and Salt Slough

Stations J (Camp 13), Station K2 (Agatha Canal Headworks), and Station F (Salt Slough) will be sampled weekly. A real-time station will continue to measure flow, EC, and temperature at Station F. Sites J and K2 are visually inspected each week to survey potential drainage diversions. No discharges may occur from the GDA into these channels. However, such diversions may occur following large rain events. A storm water monitoring program is specified in the WDR and summarized on **Table 4**.

The 2013 Revised Monitoring Plan will not continue to monitor Stations L2 (CCID San Luis Canal) and Station M2 (Santa Fe Canal), because these sites are not directly affected by the operation of the GBP. Both sites will be monitored by Grasslands Water District. Both sites will be monitored during emergency storm water situations when agricultural drain water is discharged from the GDA (**Table 4**).

San Joaquin River

The new Station R is located in the China Island Unit of the Los Banos Wildlife Management Area. Weekly grab samples will be tested for total selenium and physical parameters. Monthly grab samples will be analyzed for general minerals, total metals, and nutrients. Twice a year, the water will be tested for dissolved metals, pesticides, and bacteria. Recent vandalism on the adjacent refuge will prevent the deployment of an autosampler at this site.

Reclamation will continue to fund the operation and maintenance of real-time monitoring sites along the river by the US Geological Survey (USGS) at Sites H2 and N along the river.

The 2013 Revised Monitoring Plan will not continue to monitor Station G, San Joaquin River at Fremont Ford, because this site is not directly affected by the operation of the GBP. Based on

available funds, the SJRRP may fund the operation of a real-time station at this site. The Westside Coalition also monitors water quality at Fremont under the Irrigated lands Regulatory Program.

7.5 Sampling Methods

Several sampling techniques are used to collect water quality samples, including grab and time composite. The techniques used at each location are summarized on **Table 6**. Because of the remoteness of the region and staffing limitations, auto-samplers will be used to collect time-composite samples at Stations B3 and N. Vandalism will prevent the deployment of an autosampler at China Island at this time.

Grab samples are collected using a stainless steel sampling device. This device is attached to a pole with a cage at one end which holds the sampling bottle, or an HDPE container with a rope. Grab samples will be collected from the stream bank or bridge. This technique will be used for grab samples.

Time composite samples are collected using autosamplers at Stations B3 and N. The autosamplers will be operated and maintained by Reclamation. Daily (2 to 8 sub-samples per day) composite samples will be collected to determine daily average concentrations of selenium for comparison with current and proposed water quality objectives for the Grasslands wetlands water supply channels, Mud Slough (north), and the San Joaquin River.

Continuous SC and temperature are recorded at Stations D, F, G, H2, and N with sondes connected to digital data-loggers equipped to send data via satellite to the California Data Exchange Center to be posted on the Internet.

Real-time measurements of flow, conductivity, and pH will be made by Grasslands Water District at Stations J and K2. These data will be reported as daily averages by the district.

7.6 Storm Water Monitoring

The WDR contains specifications for notification and monitoring should storm water from the GDA be discharged into the wetlands water supply channels. The storm water monitoring program is conducted at five sites immediately prior to diversion of storm water into the Camp 13 Ditch and/or Agatha Canal; daily during the diversion, and one week after the diversion ceases. The five sites, listed in **Table 4**, are:

Station F	Salt Slough at Highway 165
Station J	Camp 13 Ditch headworks
Station K2	Agatha Canal headworks
Station L2	San Luis Canal at Upstream of the Splits

Station M2 Santa Fe Canal at Weir

The daily grab samples are analyzed for pH, EC, temperature, total selenium, and boron. Daily average flow is also measured at each site.

Section 8.0 Biological Monitoring

8.1 Purpose

The purposes for tissue sampling in biological specimens are to assess the potential for adverse biological impacts to fish and wildlife resources and to assess public health risks. For the GBP monitoring plan, food chain (invertebrates and whole body fish) samples will be analyzed for contaminant residues to assess impacts to fish and wildlife resources, while game fish fillet samples are analyzed for contaminant residues to assess human health risks.

For the 2013 Revised Monitoring Plan, the concentration of dissolved selenium in water and in suspended particulates will be measured in samples to be collected quarterly, coinciding with the collection of biological samples. These measurements are needed to assess selenium contamination in this trophic level. Also, the concentration of mercury will be measured in whole body fish and invertebrates.

Bird embryo malformation and mortality are among the more ecologically important consequences of elevated selenium in the environment. To assess selenium hazard to birds, bird eggs will be collected in the Grassland area during the bird breeding season (spring and early summer) each year.

Recommended ecological risk guidelines for selenium and boron are used to interpret selenium body burdens in assessing impacts to fish and wildlife resources. **Table 3b** summarizes and **Table 7** provides detailed information about the biological monitoring activities for this monitoring plan.

Collecting food chain samples for analysis is important since contaminant levels along the Mud Slough (North) corridor may reach the recommended ecological risk guidelines toxicity thresholds for selenium in represented biota. Biota contaminant residues in food chain compartments can be used to evaluate ecosystem health. For example, since selenium bioaccumulates, elevated concentrations at lower trophic levels can be an indicator of elevated concentrations at higher trophic levels. Effects of elevated selenium at higher trophic levels are well documented, such as teratogenic effects on avian embryos. Collecting edible portions (fillets) of game fish to evaluate the potential for adverse public health risks is important, since recreational and subsistence fishing are known to occur in Mud Slough (North) and the San Joaquin River.

8.2 Sampling Locations

Biological monitoring will be performed at the following stations:

Station D	Mud Slough (north) downstream of SLD discharge
Station I2	Mud Slough (north) backwater located about 1 mile downstream of SLD discharge (when water is present)
Station F2	Salt Slough in the San Luis National Wildlife Refuge (NWR)
Station R	San Joaquin River between Mud Slough and the Merced River in the CDFW China Island Refuge

Mud Slough (north):

Biological monitoring will occur at two sites in Mud Slough (north) below the discharge from the SLD. The main site, Station D, has a channel with flowing water.

Station I2 is a seasonal backwater with low flow depositional habitat; biological samples will be collected there when water is present. Site I2 is intended to be a better representation of the adverse effects of bioaccumulative drainwater contaminants than Site D, because it consists of a backwater. Stagnant conditions and evapoconcentration in such backwaters increase selenium assimilation into aquatic food chains.

Station F2:

This site represents conditions within the Grassland Wetlands water supply channels without drain water from the GDA.

Station R:

This point shows the full influence of the GBP on the river. This is a new site located in the CDFW Los Banos Wildlife Management Area between the confluences of Mud Slough and the Merced River.

8.3 Frequency of Sampling

Fish and invertebrate samples will be collected from all stations four times a year; suggested dates are March, June, September, and November[13]. Because aquatic insects are a major source of food for certain avian species during the breeding season, insect samples will be collected in the spring and autumn[14]. Egg samples will be collected in the spring along the Mud Slough and Salt Slough for analysis and inclusion for the Lemly Index.

For the 2013 Revised Monitoring Plan, biological samples will not be collected from Mud

[13] CDFW recommends sampling in March and September only.
[14] CDFW recommends sampling in June and September due to the greater availability of insects in warmer water.

Slough (north) upstream of the SLD discharge (formerly Site C) nor from the San Joaquin River at Fremont Ford (formerly GBP Site G) because neither site is directly affected by current GBP operations. Biological monitoring will continue at Fremont Ford under the San Joaquin River Restoration Program.

Seeds will no longer be collected because prior data indicate that the concentration of selenium has been consistently below the 3 µg/g level of concern as diet for waterfowl at all sites. Furthermore, the concentrations of boron in vegetation has been above the 30 µg/g level of concern at all sites, and the cause of this regional problem is not the Grassland Bypass Project.

Instead, we will measure mercury in whole body fish and invertebrates to be collected quarterly at Sites D, I2, F, and R.

8.4 Field Sampling Techniques

Procedures and protocol for biota sampling to determine contaminant body burdens in fish and invertebrates is standardized to complement recent or current studies conducted by USFWS and CDFW.

Non-game fish

Monitoring of non-game fish is essential for the program because of their importance in wildlife food chains. Mosquitofish (*Gambusia affinis*) has been selected for monitoring, as it represents the most prevalent fish inhabiting both sloughs. Mosquitofish may not be sufficiently abundant for sampling at the San Joaquin River stations, in which case another small species such as fathead minnows (*Pimephales promelas*), red shiners (*Cyprinella lutrensis*), or inland silversides (*Menidia beryllina*) will be sampled. All of these species are important as forage for piscivorous fish and birds inhabiting the areas adjacent to Mud and Salt Sloughs.

Changes in fish species can be made in the monitoring program if it is ascertained that other species are found more consistently at certain sites. Selection of fish species to be sent for trace element analysis is dependent on numbers and species collected at each sampling location during each sampling quarter.

Fish specimens are collected at all biological monitoring stations by dip netting, seining or electro-fishing. To conserve analytical resources, five or more individuals (whole body) of approximately similar size and of the same or closely related species may be composited in each sample. To the extent practicable at least two replicate samples of each species from each sampling site are analyzed. Samples include sufficient tissue mass to enable selenium and mercury analysis. Currently minimum mass for selenium wet weight analysis is about two grams. Minimum mass for selenium dry weight analysis (including percent moisture determination) is about five grams.

Game fish

Game fish species are expected to vary among project stations and time periods, but the most common species of larger fish and those most sought for human consumption is selected for analysis (at each collection location and time). Species likely to be collected include channel catfish (*Ictalurus punctatus*), white catfish (*Ameiurus catus*), bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), and common carp (*Cyprinus carpio*). Selection of fish species sent for selenium analysis is dependent on numbers and species collected at each sampling location during each sampling quarter. Game fish will be collected at all biological monitoring stations where they are available by dip netting, seining or electro-fishing. Samples consist of skinless fillets to best represent tissue likely to be consumed by humans. To conserve analytical resources, fillets of approximately the same mass from five or more individuals of the same or closely related species are composited in each sample. To the extent practicable, at least two replicate samples of each species from each sampling site are analyzed. Samples include sufficient tissue mass to enable both selenium and mercury analysis on a wet weight basis (minimum two grams, preferably five or more grams).

Invertebrates

Crayfish (*Procambarus sp*.), which represent an omnivorous epibenthic foraging species, will be collected at all biological monitoring stations where they are available by dip netting, seining or electro-fishing. Crayfish samples will consist of whole bodies, including carapace, to best represent exposure to wildlife. To conserve analytical resources, five or more individuals of approximately the same mass will be composited in each sample. To the extent practicable at least two replicate samples from each sampling site will be analyzed. Samples will include sufficient tissue mass to enable selenium and mercury analysis (see Non-game Fish above).

Aquatic insects

Aquatic insects such as water boatman (Corixidae), dragonflies (Odonata), damselflies (Odonata), and back swimmers (Notonectidae), which represent important food items for breeding waterfowl, will be collected from all biological monitoring stations; insects will be collected opportunistically using dip nets, kick nets, and seines. Aquatic insect samples will comprise enough individuals, composited by species, to enable both selenium and mercury analysis (see "Non-game Fish" above). To the extent practicable, at least two replicate samples of each species from each sampling site will be analyzed.

Bird Egg Monitoring

Bird embryo malformation and mortality are among the more ecologically important consequences of elevated selenium in the environment. For this reason, selenium concentrations

in bird eggs are included as one of the five components of the Lemly Index, which measures the biological hazard of selenium. To assess selenium hazard to birds, a maximum of 36 bird eggs will be collected in the Grassland area during the bird breeding season (spring and early summer) each year.

Each nest will be assessed for bird species. Each egg will be analyzed for total selenium. Each egg will be opened to determine its fertility, stage of development, viability, the position of the embryo, and whether pipping has occurred. Gross embryonic abnormalities will also be noted when observed.

Disturbance of nests and parent birds will be minimized during egg collection. Only one egg will be randomly selected for collection from among the several eggs in each nest. Eggs will be collected both from the area potentially affected by seleniferous agricultural drainwater (the vicinity of the San Luis Drain and Mud Slough) and from the area from which agricultural drainwater has been removed (the vicinity of Salt Slough). Priority will be given to collection of eggs from the nests of species of birds that are potentially at risk of elevated selenium exposure, especially bird species that are to a large degree dependent (directly or indirectly) on aquatic life.

8.5 Analytical Techniques

Biological specimens will be analyzed for body burden concentrations of selenium and mercury. Because larger fish and waterfowl would consume the entire organism, chemical analyses will be performed on whole body composite food chain samples for fish and wildlife effects assessment. However, for public health risk assessment purposes, fillets from the more common game fish species will be analyzed. Concentrations of selenium and mercury will be reported on dry weight basis in all samples, and they also will be reported on wet weight basis in game fish.

Section 9.0 Toxicity Testing (Water and Sediment)

9.1 Objectives

The objectives of the laboratory toxicity testing program are to evaluate the potential toxicity of the SLD discharge and the receiving waters after discharge. Tests will be conducted using standardized bioassay protocols under controlled environmental conditions. The toxicity testing program will evaluate potential toxicity of agriculture drain water as it is conveyed through the SLD to Mud Slough (North). **Table 3c** summarizes and **Table 8** provides detailed information about toxicity testing for this monitoring plan.

The only change to toxicity monitoring in 2013 is to reduce the frequency from monthly to quarterly to conform with the 2001 WDR.

The Westside Coalition also monitors toxicity at Station F under the Irrigated Lands Regulatory

Program.

9.2 Sampling Locations – Toxicity in Water

Water samples will be collected at the following stations for use in laboratory bioassays:

Station B3	SLD at Gun Club Road
Station D	Mud Slough (North) downstream of SLD discharge
Station I2	Backwater below SLD Discharge
Station R	San Joaquin River between Mud Slough and above Merced River in the CDFW China Island refuge
Station F	Salt Slough at Highway 165
Control	Delta-Mendota Canal near Santa Nella, California

The Delta-Mendota Canal station will be the control site because it is the freshwater source to the entire project area. This water is considered to be of good quality which can be used as dilution water in the event that definitive bioassays are required.

Mid-channel samples can be collected from Sites B3, D, F, and the DMC. Samples will be collected from the riverbank at Station R.

9.3 Frequency of Sampling – Toxicity in Water

Toxicity monitoring will occur four times per year: March, June, September, and November.

9.4 Field Sampling – Toxicity in Water

Field sampling techniques will follow the protocol described in Short-Term Methods for Estimating the Chronic Toxicity for Effluents and Receiving Water to Fresh Water Organisms 3rd Ed (EPA-600-4-91-022) for fathead minnows and algae. The *Daphnia magna* 7-D test protocol is found in EPA-600-D87-080. The protocol is included in the QAPP.

Water from each station is collected in a one-gallon bucket. The sample is transferred to a 2.5 gallon cubitainer, stored in a cooler and transported back to the laboratory. Before sampling, the bucket and sample containers are rinsed with station water. Samples for chemical analysis are transferred directly from the bucket to the appropriate sample container. Nitric acid is added to the 500 mL container for selenium analysis.

Water for the laboratory study is collected 3 times during the 7-day testing period; on test days 0, 2, and 4. The first sample is used for test initiation and for test solution renewal on day 2. The second sample is used for test solution renewal on days 3 and 4. The third sample is used for test solution renewal on days 5, 6, and 7.

9.5 Species Selection – Toxicity in Water

Test species include the larval fathead minnow, *Pimephales promelas* (less than 24 hours old), the cladoceran, *Daphnia magna* (10-day old) and the alga *Selenastrum capricornutum* (4-7 days old). The day to day species were selected for their sensitivity to selenium, diazinon and chlorpyrifos and their tolerance to usual water quality of the study area. Fathead minnows are sensitive to selenium; *Daphnia magna* is sensitive to pesticides.

9.6 Laboratory Techniques – Toxicity in Water

Laboratory techniques selected for toxicity testing include US EPA methods using the short term chronic bioassay protocol. These methods are generally used to evaluate the toxicity of an effluent to receiving water. Specific methods for culturing and conducting toxicity tests using fathead minnows and *Selenastrum* may be found in (EPA 600/4-91-022). All tests have chronic end points, either growth or reproduction. In addition, fathead minnows and *Daphnia* are scored for survival (acute end point). All testing is conducted at the screening level, comparing the control against 100 percent test water.

Culturing and testing protocols for *Daphnia* will follow those found in "Short-Term Chronic Toxicity Test Using *Daphnia magna@* (EPA 600-D87-080). This test exposes ten-day-old females to the effluent for seven days. Three broods are expected during this period.

9.7 Chemical Analysis – Toxicity in Water

Water quality analyses will be performed on each water sample collected. Analyses include pH, specific conductivity, dissolved oxygen, alkalinity, and hardness (as calcium carbonate). Total selenium will be analyzed by Reclamation.

9.8 Sediment Toxicity

Hyalella azteca is an epibenthic detritovore reported to also digest bacteria and algae from ingested sediment particles. This amphipod burrows into the sediment surface and inhabits lakes, ponds, and streams throughout North and South America. *H. azteca* is a sensitive benchmark, i.e. established, test species that can be cultured in the laboratory with relative ease.

Test Method: The toxicity tests are conducted for 10 days in 300-mL chambers containing 100 mL of sediment and 175 mL of overlying water. Overlying water is renewed daily and test organisms are fed during the toxicity tests. The endpoint in the toxicity test with *H. azteca* is survival. (EPA 1994)

Frequency: Annual (September)
Sample sites:

Station B3	SLD at Gun Club Road
Station D	Mud Slough (North) downstream of SLD discharge
Station I2	Mud Slough (North) backwater below SLD discharge
Station R	San Joaquin River between Mud Slough and above Merced River in the CDFW China Island refuge
Station F	Salt Slough at Highway 165

9.9 Changes from 2011 Interim Monitoring Program

The 2013 Revised Monitoring Program will reduce the frequency of toxicity testing from monthly to quarterly, to conform with the 2001 Waste Discharge Requirement. Toxicity testing in water will occur at the new site in the San Joaquin River.

The 2013 revision adds annual toxicity testing in sediment.

The 2013 revision will discontinue toxicity testing in Mud Slough, upstream of the SLD discharge, and in the San Joaquin River at Fremont Ford. The Westside Coalition monitors chronic toxicity at both sites twice a year under the Irrigated lands Regulatory Program. The Coalition also monitors toxicity at Salt Slough (GBP Station F).

Section 10.0 Sediment Monitoring (Quality)

10.1 Purpose

The purpose of sediment monitoring is to measure selenium and organic carbon in the SLD, Mud Slough, Salt Slough, and San Joaquin River. The measurements within the SLD provide selenium concentration estimates for comparison with California Department of Health Services' hazardous waste criterion of 100 mg Se/kg (wet weight). The measurements in Mud and Salt Sloughs and the river will provide selenium concentrations for comparison with USFWS thresholds for ecological risk. **Table 3d** summarizes and **Tables 9a and 9b** provide detailed information about the sediment monitoring plan in the sloughs and the SLD.

10.2 Sampling Locations

SLD[15]	Ten places along the San Luis Drain
Station D	Mud Slough (North) downstream of SLD discharge
Station I2	Mud Slough (North) backwater
Station F	Salt Slough at Highway 165
Station R	San Joaquin River between Mud Slough and Merced River (CDFW China Island Refuge)

Selenium in sediment will be measured in the San Luis Drain, based on the accumulation measurements (Section 11). The methodology for selecting these places is described in the annual reports.

10.3 Frequency of Sampling

The measurement of selenium in sediment will occur once per year, usually in September.

10.4 Field Sampling Techniques

Sediment samples will be collected with an acrylic coring device (42 cm diameter, 38 cm internal length). After collecting the up to 15 cm (6 inches) of sediment, sections of the core are slowly extruded using a non-metallic internal pushing device and placed in a stainless steel bowl. The process will be continued until three samples are collected along a transect across the Drain or slough. Material from the 2nd and 3rd samples is placed in the mixing bowl containing the 1st samples. The samples are then mixed well in their mixing bowls in a manner similar to kneading bread. The mixing objective is to get one homogeneous sample in each of the bowls. Composited samples are then placed in a wide-mouth polyethylene container and stored in an ice chest at 4°C.

10.5 Chemical Analysis

Laboratory analysis of sediment samples collected from Mud Slough, Salt Slough, and the river will be tested for total selenium, total and methyl mercury, Total organic carbon, percent moisture, grain size, pesticides, and toxicity (*Hyalella azteca*).

Laboratory analysis of samples collected from the San Luis Drain will include total selenium concentrations (wet weight), total organic carbon, and per cent moisture.

Section 11.0 Sediment Accumulation in the San Luis Drain

[15] SLD includes sampling at Site A and Site B3

11.1 Purpose

The purpose of this aspect of the GBP Monitoring Program is to determine the changes in quantity and movement of sediment in the SLD. This is accomplished by conducting an annual survey measuring the sediment and using total suspended solids measurements at the inlet and outlet of the SLD to determine sediment volumes. **Table 10** summarizes the new sediment quantity monitoring plan.

The Third Use Agreement contains provisions for the removal of sediment from the SLD. The concentration of selenium and other parameters in sediment (Section 10) and accumulation data will be determine if the sediments can be spread locally or must be treated as hazardous waste.

11.2 Sampling Locations

The sediment is not uniformly deposited along the length of the SLD. In general, sediment tends to build up near the check structures. To obtain an accurate determination of sediment deposition, it is necessary to take additional readings near these structures. Sediment thickness measurements are taken at the locations that were used in the Summers Engineering survey (March 1987). The distances from the structures and locations at which measurements were taken are documented, and the sites can reliably be re-sampled. Chapter 10 of the GBP Annual Reports have historic sediment accumulation data.

11.3 Frequency of Sampling

The sediment volume survey is done annually, typically in September at the end of the irrigation season.

11.4 Field Sampling Techniques

Cross-sections of the SLD from Check 18 (west of Russell Ave) to the terminus will be used for volume estimates. There will be water flowing in the SLD during the sediment surveys. In order to obtain an accurate thickness measurement at any given location, a measurement will be taken along the length of the slope of the lining from the top of the lining to the water surface on each side of the drain, and then, a probe be used to take the measurement from the water surface to the sediment at the intersection of the sediment and the canal lining on each side of the SLD. This cross-sectioning method should help account for variations in the sediment thickness across the width of the SLD. The thickness of sediment is measured and determined arithmetically.

11.5 Volume Estimation

a. Water Level Calculations

The level of the water is determined by measuring along the lining above the water level on the left (X_{lt}) and right bank (X_{rt}) of the SLD. The actual water level (h) is determined by subtracting the average of the X_{lt} and X_{rt} (X_{avg}) from the total length of lining (X1) and converting it into a vertical distance, $h = 0.55 * (X1 - X_{avg})$.

b. Depth of Sediment

The depth of sediment (d) is determined by taking the average of the difference between the two readings (y_1 and y_2) obtained from the sediment probe and the water level (h), $d = h - y_{avg}$.

c. Cross-Sectional Area of Sediment

The cross-sectional area of the sediment is determined by assuming that the upper surface of the sediment is flat and that it occupies a trapezoidal area. The formula for finding the area of sediment is as follows: Area = 2 * (8 + (8 + 2 * d * 1.5)) * d.

d. Volume of Sediment

The volume of sediment in the SLD is calculated by averaging the cross sectional area between readings and multiplying by the length. The formula for the sediment volume is as follows:

Volume = (Average Area) * Length * 0.037,

where length is the distance between probe readings and 0.037 is the factor by which cubic feet are converted to cubic yards.

Section 12.0 References

12.1 Technical Documents

California Regional Water Quality Control Board, Central Valley Region. *Water Quality of the Lower San Joaquin River: Lander Ave to Vernalis*. Water Years 1985 through 1999. Sacramento, CA.[16]

California Regional Water Quality Control Board, Central Valley Region. *Agricultural Drainage Contribution to Water Quality in the Grassland Watershed of Western Merced County, California.* Water Years 1985 through 1999. Sacramento, CA.

[16] http://www.swrcb.ca.gov/rwqcb5/water_issues/swamp/historic_reports_and_faq_sheets/index.shtml#sjriverwq

San Francisco Estuary Institute (SFEI). Grassland Bypass Project, Monthly Reports October 1996 – July 2012. Richmond, CA.

San Francisco Estuary Institute (SFEI). Grassland Bypass Project, Annual Reports. Richmond, CA.

U. S. Department of Interior. *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley.* Final Report of the San Joaquin Valley Drainage Program. September 1990. Sacramento, CA.

U. S. Geological Survey. *Surface-Water Quality Assurance Plan for the California District of the U. S. Geological Survey*, Open-File Report 96-618. 1996. Sacramento, CA.

12.2 Administrative Documents

California Regional Water Quality Control Board, Central Valley Region. September 7, 2001. Waste Discharge Requirements for San Luis & Delta-Mendota Water Authority and United States Department of the Interior Bureau of Reclamation Grassland Bypass Channel Project (Phase II) - Fresno and Merced Counties. Sacramento, CA.

California Regional Water Quality Control Board, Central Valley Region. May 2005. Revised Monitoring and Reporting Program No. 5-01-234 for San Luis & Delta-Mendota Water Authority and United States Department of the Interior Bureau of Reclamation Grassland Bypass Channel Project (Phase II) - Fresno and Merced Counties.

U.S. Bureau of Reclamation and San Luis & Delta-Mendota Water Authority, November 1995. Agreement for the Use of the San Luis Drain. Sacramento, CA.

U.S. Bureau of Reclamation. September 1996. Compliance Monitoring Program for Use and Operation of the Grassland Bypass Project. Sacramento, CA.

U.S. Bureau of Reclamation and San Luis & Delta-Mendota Water Authority. May 25, 2001. Grassland Bypass Project Final Environmental Impact Statement/Environmental Impact Report. Volume 1, Main Text, Appendices A & I; Volume 2 - Technical Appendices. Sacramento, CA.

U.S. Bureau of Reclamation and San Luis & Delta-Mendota Water Authority, September 2001. Agreement for the Use of the San Luis Drain. Sacramento, CA.

U.S. Bureau of Reclamation. September 28, 2001. Record of Decision - Grassland Bypass Project. Sacramento, CA.

U.S. Bureau of Reclamation, et. al. September 2001. Quality Assurance Project Plan for the

Monitoring Plan of the Grassland Bypass Project (Phase II). Sacramento, CA.

U. S. Bureau of Reclamation, September 29, 2009. Final Environmental Impact Statement – Impact Report, Continuation of the Grassland Bypass Project, 2010-2019. Sacramento, CA.

U. S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office. December 18, 2009. Endangered Species Consultation on the Proposed Continuation of the Grassland Bypass Project. Sacramento, CA.

U.S. Bureau of Reclamation. December 21, 2009. Record of Decision, Grassland Bypass Project, 2010-2019. Sacramento, CA.

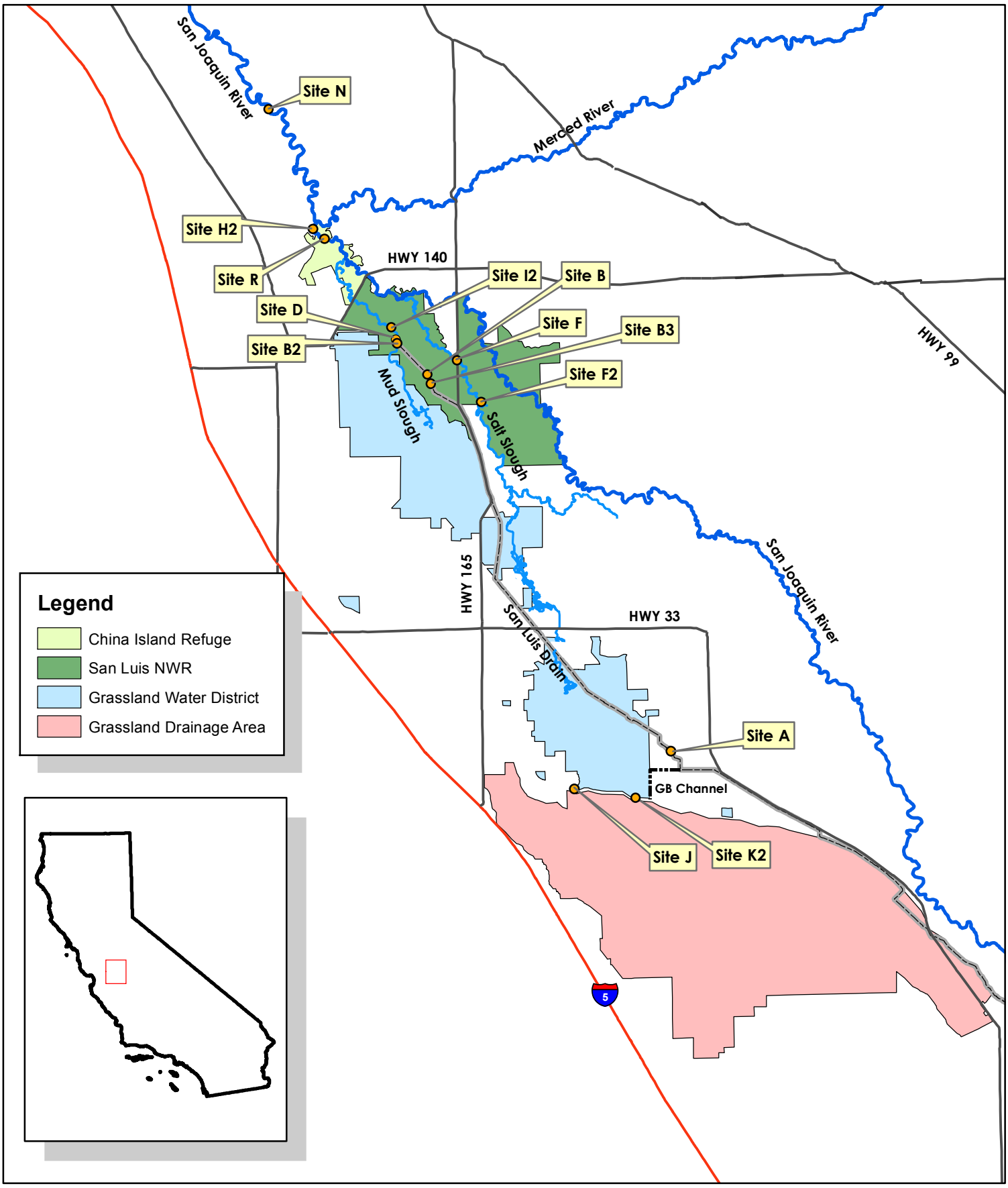
U.S. Bureau of Reclamation and the San Luis & Delta-Mendota Water Authority. December 22, 2009. Agreement for Continued Use of the San Luis Drain for the Period January 1, 2010 through December 31, 2019. Agreement No. 10-WC-20-3975.

U. S. Bureau of Reclamation. May 23, 2011. Grassland Bypass Project 2011 Interim Water Quality Monitoring Program.

Analytical Reference Documents

U.S. Environmental Protection Agency, Office of Research and Development , June 1994. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates. EPA 600/R-94/024. Duluth, Minnesota

Figure 1: Map of the Grasslands Bypass Project



Grasslands Bypass Project

2013 Monitoring Plan Sites

0 2.5 5 10 Miles

N W E S

Grasslands Bypass Project
NAD 1983 California Zone 10
U.S. Bureau of Reclamation

Grassland Bypass Project
2013 Revised Monitoring Program
Table 1: Monitoring Stations

Feature	Station	Location	Latitude	Longitude	Purpose
San Luis Drain	A	Check 17	36 57'59.69"	120 40'14.26"	Flow and water quality of GDA discharge
		Checks 1 - 18 (10 places)	various		Selenium in sediment and accumulation
	B3	Gun Club Road siphon	37 13'53.71"	120 52'33.55"	New water quality site (Spring 2013)
	B	footbridge north of Gun Club Road	37 14'26.54"	120 52'54.08"	Water quality of GBP water to be discharged into Mud Slough; compliance point for WDR and Use Agreement (to be replaced by Station B3)
	B2	Terminus at Mud Slough	37 15'39.53"	120 54'18.79"	Volume of GBP water discharged to Mud Slough
Mud Slough (north)	D	downstream of SLD	37 15'49.47"	120 54'22.57"	Mud Slough with GBP water
	I2**	backwater below SLD	37 16'20.69"	120 54'35.11"	Water quality in backwater area with GBP (SEASONAL)
Wetlands channels	F	Salt Slough at Hwy 165	37 14'51.52"	120 51'07.29"	Control site; represents recovery of wetlands channels with removal of GDA discharge
	F2	Salt Slough in San Luis NWR	37 13'03.54"	120 49'53.29"	Biological monitoring site
	J*	Camp 13 ditch, headworks	36 56'28.21"	120 45'24.66"	Confirm prohibition of GDA discharge to Grasslands wetlands water supply channels (SEASONAL)
	K2*	Agatha Canal, headworks	36 56'02.35"	120 42'09.27"	
San Joaquin River	R	China Island Unit	37 20'10.40"	120 58'03.47"	Water quality in San Joaquin River with GBP water
	H2	above Merced River (Hills Ferry)	37 20'49.69"	120 59'33.96"	Flow of San Joaquin River with GBP water
	N	Crows Landing	37 25'53.37"	121 00'48.23"	Flow and water quality of San Joaquin River with GBP water; WDR compliance point

* = Samples will be collected when water is passing site

** = Samples will be collected when this site is flooded by Mud Slough and GDA water

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Table 2: Schedule for Monitoring

Frequency	Stations	Parameters	Media	Agency	Notes
Real-time	D, F, H2, N	Flow, specific conductivity, temperature	W	USGS	preliminary data on CDEC
	J*, K2*	Flow, specific conductivity, temperature	W	Grasslands WD	
Daily	A, B2	Flow, specific conductivity, temperature	W	Panoche DD	
	A	Selenium (total)	W	Panoche DD	grab
	B3, N	Selenium (total), boron	W	MP-157	autosamplers
Weekly	B3, D, F, R, I2**	Physicals	W	SCCAO	
	B3, D, F, R, J*, K2*, I2**	Selenium (total)	W	SCCAO	
Monthly	B3, D, F, R	General minerals	W	SCCAO	
	B3, D, F, R	Metals (total)	W	SCCAO	
	A, B3	Total suspended solids	W	Panoche DD	
	B3, D, F, R	Nutrients	W	SCCAO	
Quarterly (March, June, September, November)	B3, D, F, R	Three-species chronic toxicity	W	Contractor	
	D, F, R, I2**	Biological	B	Contractor	
	B3, D, F, R, I2**	Particulate selenium	W	SCCAO	
	B3, D, F, R, I2**	Selenium (dissolved)	W	SCCAO	
Biannual (March, September)	B3, D, F, R	Metals (dissolved)	W	MP-157	
	B3, D, F, R	Pesticides	W	SCCAO	
	B3, D, F, R	Bacteria	W	SCCAO	
	B3, D, F, R, I2	Sediment toxicity	S	MP-157	
Seasonal (April-June)	SLD and refuges	bird eggs	B	US FWS	
Annual (September)	San Luis Drain	Accumulation of sediment	S	Panoche DD	
	SLD, D, F, R, I2	Sediment (mercury, selenium, TOC, pesticides,etc.)	S	MP-157	

* = samples will be collected when water is passing site
** = samples will be collected when this site is flooded

SCCAO - Reclamation. Fresno Office
MP-157 - Reclamation Sacramento Office

B - biota fish, invertebrates
S - sediment

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Table 3a: Summary of Surface Water Quality Monitoring Stations, Parameters, and Frequencies[1]

			Surface Water																
Feature	**Station**	**Location**	**Flow**	**Specific Conductivity**	**Temperature**	**Physicals**	**General minerals**	**Total suspended solids**	**Metals, total**	**Metals, dissolved**	**Boron**	**Selenium, total**	**Selenium, dissolved**	**Selenium in particulates**	**Nutrients**	**Pesticides**	**Bacteria**	**Toxicity**
San Luis Drain	A	Check 17	Da	Da				M				D						
	B3	Gun Club Road siphon				W	M	M	M	B	Dc	Dc	Q	Q	M	B	B	Q
	B2	terminus at Mud Slough	Da	Da	Da													
Mud Slough (north)	D	downstream of SLD	C	C	C	W	M		M	B		W	Q	Q	M	B	B	Q
	I2	backwater below SLD**				W**						W**						
Wetlands channels	F	Salt Slough at Hwy 165	C	C	C	W	M		M	B		W	Q	Q	M	B	B	Q
	J	Camp 13 ditch headworks*	Da	Da	Da							W*						
	K2	Agatha Canal headworks*	Da	Da	Da							W*						
San Joaquin River	R	China Island Unit				W	M		M	B		W	Q	Q	M	B	B	Q
	H2	above Merced River (Hills Ferry)	C	C	C													
	N	Crows Landing	C	C	C	W					W	Dc						

1) See Table 6 for detailed information on surface water quality monitoring

Key

B = Biannual (March, September)
C = Daily average based on continuous measurements
Da = Daily average
Dc = Daily composite (autosampler)
D = Daily grab
E = Estimate
M = Monthly grab
Q = Seasonal (March, June, September, November)
W = Weekly grab

Physicals: Field measurements of DO, pH, specific conductivity, temperature, turbidity
General minerals: Ca, Mg, K, Na, Cl, SO4, TOC, hardness
Metals, total: As, B, Cd, Cu, Pb, Hg, Mo, Ni, Se, Zn
Metals, dissolved: Cd, Cu, Pb, Mo, Ni, Se, Zn
Nutrients: Nitrates as N, Total Ammonia, Total Kjeldahl Nitrogen, Total Phosphorous, and Soluble Ortho Phosphate.
Pesticides: EPA 531.2 Carbamates, SM 8081BM Pyrethroid scan and Organochlorine scan, SM 8141AM Organophospl
Bacteria: Total coliform, fecal coliform, E. Coli
Toxicity in water: survival in *C.dubia* and *P. promelas*, growth in *S. capricornutum*

* = samples will be collected when water is passing site
** = samples will be collected when this site is flooded

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Table 3b: Summary of Biological Monitoring Stations, Parameters, and Frequencies[1]

			Biota						
Feature	**Station**	**Location**	**Selenium in wholebody fish**	**Mercury in wholebody fish**	**Selenium in fish muscle tissue**	**Community assessment**	**Selenium in bird eggs**	**Selenium in invertebrates**	**Selenium in aquatic insects**
Mud Slough (north)	D	downstream of SLD	Q	Q			S	Q	S
	I2	backwater below SLD **	S	S				S	S
Wetlands Channels	F2	Salt Slough in San Luis NWR	Q	Q			S	Q	S
San Joaquin River	R	China Island Unit	Q	Q	Q	Q		Q	SA

1) See Table 7 for detailed information on biological monitoring

Key

Q = Seasonal (March, June, September, November)

S = Spring - Early summer (March, June)

SA= Spring/Autumn (June, September)

** = Samples will be collected when this site is flooded

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Table 3c: Summary of Toxicity Monitoring Stations, Parameters, and Frequencies[1]

			Toxicity							
Feature	**Station**	**Location**	**C.dubia survival**	***Pimephales promelas* (fathead minnow) survival**	***Selenastrum capricornatum* growth**	**Selenium in site water**	**TSS in site water**	**Conductivity, DO, pH, alkalinity, hardness in site water**	**Total chlorine in site water**	**Ammonia in site water**
San Luis Drain	B3	Gun Club Road siphon	Q	Q	Q	Q	Q	Q	Q	Q
Mud Slough (north)	D	downstream of SLD	Q	Q	Q	Q	Q	Q	Q	Q
Wetlands Channels	F	Salt Slough in San Luis NWR	Q	Q	Q	Q	Q	Q	Q	Q
San Joaquin River	R	China Island Unit	Q	Q	Q	Q	Q	Q	Q	Q

1) See table 8 for detailed information on toxicity monitoring

Key

Q = Seasonal (March, June, September, November)

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Table 3d: Summary of Sediment Monitoring Stations, Parameters, and Frequencies[1]

			Sediment							
Feature	**Station**	**Location**	**Selenium**	**Mercury, total and methyl**	**Total organic carbon**	**Percent moisture**	**Grain size**	**Pesticides**	**Toxicity**	**Accumulation**
San Luis Drain	A	Check 17	A		A	A				
		Checks 1 - 18 (10 places)	A		A	A				A
	B3	Gun Club Road	A	A	A	A	A	A*	B	
Mud Slough (north)	D	downstream of SLD discharge	A	A	A	A	A	A*	B	
	I2	backwater below SLD discharge	A	A	A	A	A	A*	B	
Wetlands channels	F	Salt Slough at Hwy 165	A	A	A	A	A	A*	B	
San Joaquin River	R	China Island Unit	A	A	A	A	A	A*	B	

1) See tables 9a, 9b, and 10 for detailed information on sediment monitoring

Key

A = Annual (September)

B = Biannual (March and September)

* Additional pesticide analysis required if significant toxicity (≥20 reduction in survival)

Pesticides: Pyrethroid scan (8081BM) and OP scan (8141AM).

Toxicity - *Hyalella azteca* survival

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Table 4: Storm Water Monitoring

Feature	Station	Location	Flow	Physicals	Boron	Molybdenum	Selenium
Wetland Channels	F	Salt Slough at Hwy 165	C	Df	Dg	Dg	Dg
	J	Camp 13 ditch headworks	Da	Df	Dg	Dg	Dg
	K2	Agatha Canal headworks	Da	Df	Dg	Dg	Dg
	L2	San Luis Canal above splits	Da	Df	Dg	Dg	Dg
	M2	Santa Fe Canal above splits	Da	Df	Dg	Dg	Dg

Key

C = Daily total based on continuous measurements, real-time

Da = Daily total (estimate)

Df = Daily field measurement

Dg = Daily grab sample

Physicals: Field measurements of DO, pH, specific conductivity, turbidity

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Table 5: Flow Monitoring Specifications

Feature	Station	Location	Method	Frequency	Agency
San Luis Drain	A	Check 17	Stage over sharp-crested weir	Daily	SLDMWA
	B2	San Luis Drain terminus	Stage over sharp-crested weir	Daily	SLDMWA
Mud Slough	D	downstream of SLD	Pressure transducer	Continuous	USGS 1126900
Wetlands Channels	F	Salt Slough at Hwy 165	Pressure transducer	Continuous	USGS 1126100
	J	Camp 13 Ditch	Pressure transducer	Daily	Grasslands WD
	K2	Agatha Canal	Pressure transducer	Daily	Grasslands WD
San Joaquin River	H2	above Merced River (Hills Ferry)	Pressure transducer	Continuous	USGS 11273900
	N	Crows Landing	Pressure transducer	Continuous	USGS 11274550
Panoche Creek		Highway I-5 *	Pressure transducer	Continuous	USGS

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Table 6: Surface Water Quality Monitoring[1]

Feature	Station	Location	Parameters	Method	Frequency	Sample collection	Funding
San Luis Drain	A	Check 17	Specific conductivity, temperature	Sonde	Daily	SLDMWA	SLDMWA
			Selenium, total	Grab	Daily		Reclamation
			Total suspended solids	Grab	Monthly		SLDMWA
	B3	Gun Club Road	Boron	Autosampler	Daily composite	Reclamation	Reclamation
			Selenium, total	Autosampler	Daily composite		
				Grab	Weekly		
			Physicals	Field	Weekly		
			General minerals	Grab	Monthly		
			Metals, total	Grab	Monthly		
			Nutrients	Grab	Monthly		
			Total suspended solids	Grab	Monthly	SLDMWA	SLDMWA
			Selenium, dissolved	Grab	Quarterly	Reclamation	Reclamation
			Selenium, particulates	Grab	Quarterly		
			Bacteria	Grab	Biannual		
			Metals, dissolved	Grab	Biannual		
			Pesticides	Grab	Biannual		
	B2	terminus at Mud Slough	Specific conductivity, temperature	Sonde	Daily	SLDMWA	SLDMWA
Mud Slough (north)	D	downstream of SLD discharge	Specific conductivity, temperature	Sonde	Continuous	USGS	Reclamation
			Physicals	Grab	Weekly	Reclamation	
			Selenium, total	Grab	Weekly		
			General minerals	Grab	Monthly		
			Metals, total	Grab	Monthly		
			Nutrients	Grab	Monthly		
			Selenium, dissolved	Grab	Quarterly		
			Selenium, particulates	Grab	Quarterly		
			Bacteria	Grab	Biannual		
			Metals, dissolved	Grab	Biannual		
			Pesticides	Grab	Biannual		
	I2	backwater below SLD	Physicals	Grab	Weekly*	Reclamation	Reclamation
			Selenium, total	Grab	Weekly*		

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Table 6: Surface Water Quality Monitoring[1]

Feature	Station	Location	Parameters	Method	Frequency	Sample collection	Funding
Wetlands Channels	**F**	Salt Slough at Hwy 165	Specific conductivity, temperature	Sonde	Continuous	USGS	Reclamation
			Physicals	Grab	Weekly	Reclamation	
			Selenium, total	Grab	Weekly		
			General minerals	Grab	Monthly		
			Metals, total	Grab	Monthly		
			Nutrients	Grab	Monthly		
			Selenium, dissolved	Grab	Quarterly		
			Selenium, particulates	Grab	Quarterly		
			Bacteria	Grab	Biannual	Reclamation	
			Metals, dissolved	Grab	Biannual		
			Pesticides	Grab	Biannual		
	J	Camp 13 Ditch headworks	Selenium, total	Grab	Weekly*	Grasslands WD	Reclamation
			Physicals	Field	Weekly*		
	K2	Agatha Canal headworks	Selenium, total	Grab	Weekly*	Grasslands WD	Reclamation
			Physicals	Field	Weekly*		
San Joaquin River	**R**	China Island Unit	Selenium, total	Grab	Weekly	SLDMWA	Reclamation
			Physicals	Grab	Weekly	Reclamation	
			General minerals	Grab	Monthly		
			Metals, total	Grab	Monthly		
			Nutrients	Grab	Monthly		
			Selenium, dissolved	Grab	Quarterly		
			Selenium, particulates	Grab	Quarterly		
			Bacteria	Grab	Biannual	Reclamation	
			Metals, dissolved	Grab	Biannual		
			Pesticides	Grab	Biannual		
	H2	above Merced River (Hills Ferry)	Specific conductivity, temperature	Sonde	Continuous	USGS	Reclamation
	N	Crows Landing	Specific conductivity, temperature	Sonde	Continuous	USGS	Reclamation
			Selenium, total	Autosampler	Daily composite	Reclamation	
				Grab	Weekly		
			Boron	Grab	Weekly		
			Physicals	Grab	Weekly		

1) See Table 3a for a summary of surface water quality monitoring

Physicals: Field measurements of DO, pH, specific conductivity, temperature, turbidity

* = Samples will be collected when water is passing this site

General minerals: Ca, Mg, K, Na, Cl, SO4, TOC, TSS, hardness

Metals, total: As, B, Cd, Cu, Pb, Hg, Mo, Ni, Se, Zn

Metals, dissolved: Cd, Cu, Pb, Mo, Ni, Se, Zn

Nutrients: Nitrates as N, Ammonia, Total Kjeldahl Nitrogen, Total Phosphate, and Ortho Phosphate.

Pesticides: EPA 531.2 Carbamates, SM 8081BM Pyrethroid scan and Organochlorine scan, SM 8141AM Organophosphate scan

Bacteria: Total coliform, fecal coliform, E. Coli

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Table 7: Biological Monitoring[1]

Feature	Station	Location	Parameters	Frequency	Agency
Mud Slough (north)	D	downstream of SLD discharge	Physicals	March, June, September, November	US FWS or contractor
			Selenium in wholebody fish and invertebrates		
			Mercury in wholebody fish and invertebrates		
			Other (3)		
			Selenium in bird eggs (2)	March, June	
			Selenium in aquatic insects		
	I2**	backwater below SLD	Same as Site D		
Wetlands Channels	F2	Salt Slough	Same as Site D		
San Joaquin River	R	China Island	Physicals	March, June, September, November	CDFG or contractor
			Selenium in wholebody fish and invertebrates		
			Mercury in wholebody fish and invertebrates		
			Fish community assessment		
			Selenium in fish muscle tissue		
			Other (3)		
			Selenium in aquatic insects	June, September	

(1) See Table 3b for a summary of biological monitoring

(2) Each egg will be opened to determine its fertility, stage of development, viability, the position of the embryo, and whether pipping has occurred. Gross embryonic abnormalities will also be noted when observed.

(3) Water samples will be collected at each site to be tested for dissolved selenium and particulate selenium

** Samples will be collected when water is present at this site

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Table 8: Toxicity Monitoring Specifications[1]

Feature	Station	Location	Parameters	Frequency	Agency
San Luis Drain	B3	Gun Club Road	larval survival for *Pimephales promelas* larval survival for *Ceriodaphnia dubia* *Selenastrum capricornutum* growth *Water quality(2)*	March, June, September, November	Contractor
			Hyalella azteca survival(3)	March, September	Contractor
Mud Slough (north)	D	downstream of SLD discharge		Same as Station B	
	I2	Backwater below SLD discharge	*Hyalella azteca* survival (3)	March, September	Contractor
Wetlands Channels	F	Salt Slough at Hwy 165		Same as Station B3	
San Joaquin River	R	China Island Unit		Same as Station B3	
Control	DMC	near Check 13		Same as Station B3	

(1) See Table 3c for a summary of the toxicity monitoring

(2) Water samples will be tested for selenium, TSS, Cl, Ammonia as N, temperature, hardness, alkalinity, DO, pH.

(3) The toxicity tests are conducted for 10 days in 300-mL chambers containing 100 mL of sediment and 175 mL of overlying water.

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Table 9a: Sediment Monitoring Specifications (Quality and Toxicity)[1]

Feature	Station	Location	Parameters	Frequency	Agency
San Luis Drain	**B3**	Gun Club Road	Selenium	September	Reclamation
			Mercury, total and methyl		
			Total organic carbon		
			Percent moisture		
			Pesticides (Pyrethroid scan)		
			Pesticides (OP scan)		
			Toxicity (1)	March and September	Contractor
Mud Slough (north)	**D**	below SLD discharge		Same as Site B3	
	I2	backwater below SLD discharge		Same as Site B3	
Wetlands Channels	**F**	Salt Slough		Same as Site B3	
San Joaquin River	**R**	China Island		Same as Site B3	

(1) See Table 3c for a summary of the sediment monitoring

(1) *Hyalella azteca* survival (see Table 8)

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Table 9b: San Luis Drain Sediment Monitoring Specifications (Quality)[1]

Feature	Station	Location	Parameters	Frequency	Agency
San Luis Drain	Between Stations A and B	Ten places where sediment has accumulated	Selenium	September	Reclamation
			Total organic carbon		
			Percent moisture		

(1) See Table 3c for a summary of the sediment monitoring

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Table 10: San Luis Drain Sediment Accumulation Monitoring Specifications[1]

Feature	Station	Location	Parameters	Frequency	Agency
San Luis Drain	Between Stations A and B	Ten places where sediment has accumulated	Volume of sediment	September	SLDMWA

(1) See Table 3c for a summary of the sediment monitoring

Appendices

Appendix 1. Summary of Revisions

Appendix 2. Station B

Appendix 3. Data Summaries

Appendix 4. Reporting Requirements

Grassland Bypass Project
2013 Revised Monitoring Plan
Appendix 1. Summary of Revisions

Table 1: Proposed Changes to Flow Monitoring Specifications

				2005 MRP	2011 Interim Monitoring Plan		2013 Revised Monitoring Plan	
Feature	**Station**	**Location**	**Method**	**Frequency**	**Frequency**	**Agency**	**Frequency**	**Agency**
San Luis Drain	A	Check 17	Stage over sharp-crested weir		Daily average	SLDMWA	Daily average	SLDMWA
	B2	San Luis Drain terminus	Stage over sharp-crested weir	Daily	Daily average	SLDMWA	Daily average	SLDMWA
Mud Slough (north)	C	upstream of SLD	Estimate		Estimate	Reclamation	(1)	Grasslands WD
	D	downstream of SLD	Pressure transducer	Daily	Continuous	USGS	Continuous	USGS
Wetlands Channels	F	Salt Slough at Hwy 165	Pressure transducer		Continuous	USGS	Continuous	USGS
	J	Camp 13 Ditch	Staff gage		Daily average	Grasslands WD	Daily average	Grasslands WD
	K	Agatha Canal	Staff gage		Daily average	Grasslands WD	Daily average	Grasslands WD
	L2	San Luis Canal (CCID)	Staff gage		Daily average	Grasslands WD	(2)	Grasslands WD
	M2	Santa Fe Canal	Staff gage		Daily average	Grasslands WD	(3)	Grasslands WD
San Joaquin River	G	Fremont Ford	Pressure transducer	Daily	Continuous	USGS	(4)	SJRRP
	H2	above Merced River (Hills Ferry)	Pressure transducer		Continuous	USGS	Continuous	USGS
	N	Crows Landing	Pressure transducer	Daily	Continuous	USGS	Continuous	USGS

Notes: Discontinued for 2013 Revised Monitoring Plan

(1) Real-time flow will be measured by Grasslands WD at Mud Slough at Gun Club Road.

(2) Real-time flow will be measured by Grasslands WD in the CCID San Luis Canal upstream of the splits

(3) Real-time flow will be measured by Grasslands WD in the Santa Fe Canal at Mud Slough (north)

(4) Continuous flow will be continued under the San Joaquin River Restoration Program

Revised: 11/27/2012

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Appendix 1. Summary of Revisions

Table 2: Proposed Changes to Surface Water Quality Monitoring Specifications

Feature	Station	Location	Parameters	2005 Monitoring & Reporting Program	2011 Interim Monitoring Plan				2013 Revised Monitoring Plan				
					Method	Frequency	Sampler	Analysis	Change	Method	Frequency	Collecting Agency	Analytical Agency
	A	Check 17	Flow		Sonde	Daily average	SLDMWA	SLDMWA		Sonde	Daily average	SLDMWA	SLDMWA
			Temperature		Sonde	Daily average	SLDMWA	SLDMWA		Sonde	Daily average	SLDMWA	Reclamation
			Specific conductivity		Sonde	Daily average	SLDMWA	SLDMWA		Sonde	Daily average	SLDMWA	Reclamation
					Autosampler	7-day composite	SLDMWA	Reclamation	(1)(2)				
			Selenium, total		Autosampler	7-day composite	SLDMWA	Reclamation	(1)	Grab	Daily	SLDMWA	Reclamation
			Boron		Autosampler	7-day composite	SLDMWA	Reclamation	(X)				
			Total suspended solids		Grab	Weekly	SLDMWA	APPL		Grab	Weekly	Panoche DD	Contractor
	B	footbridge near Gun Club Road	pH	Weekly	Field	Weekly	SCCAO	Reclamation	Water quality monitoring moved to Site B3				
				Weekly	Field	Weekly	SCCAO	Reclamation					
			Specific conductivity	24 hour composite	Autosampler	Daily composite	MP-157	Reclamation					
			Temperature	Weekly	Field	Weekly	SCCAO	Reclamation					
				Weekly	Grab	Weekly	SCCAO	Reclamation					
			Boron	24 hour composite	Autosampler	Daily composite	SCCAO	Reclamation					
			Molybdenum	Monthly	Grab	Monthly	SCCAO	Reclamation					
			Nutrient series	Monthly(1)	Grab	Monthly (1)	SCCAO	Reclamation					
			Selenium, total	24 hour composite	Autosampler	Daily composite	SCCAO	Reclamation					
					Grab	Weekly	SCCAO	Reclamation					
			Total suspended solids	Weekly(2)	Grab	Weekly(2)	Panoche DD	Contractor					
			Three species chronic toxicity	Quarterly	Grab	Monthly	Panoche DD	Block Env.					
			Physicals		Field	Weekly	SCCAO	Reclamation					
	B2	terminus at Mud Slough (north)	Flow	Daily average	Sonde	Daily average	SLDMWA	SLDMWA		Sonde	Daily	SLDMWA	SLDMWA
			Specific conductivity	Daily average	Sonde	Daily average	SLDMWA	SLDMWA		Sonde	Daily	SLDMWA	SLDMWA
			Temperature	Daily average	Sonde	Daily average	SLDMWA	SLDMWA		Sonde	Daily	SLDMWA	SLDMWA

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Table 2: Proposed Changes to Surface Water Quality Monitoring Specifications

				2005 Monitoring & Reporting Program	2011 Interim Monitoring Plan				2013 Revised Monitoring Plan				
Feature	Station	Location	Parameters		Method	Frequency	Sampler	Analysis	Change	Method	Frequency	Collecting Agency	Analytical Agency
San Luis Drain	B3	footbridge near Gun Club Road	pH						(4)	Field	Weekly	SCCAO	Reclamation
			Specific conductivity						(4)	Field	Weekly	SCCAO	Reclamation
										Autosampler	Daily composite	MP-157	Reclamation
			Temperature						(4)	Field	Weekly	SCCAO	Reclamation
			Total suspended solids							Grab	Weekly (2)	Panoche DD	Contractor
			Boron						(2)(5)				
										Autosampler	Daily composite	MP-157	Reclamation
			Molybdenum						(5)	Grab	Monthly	SCCAO	Reclamation
			Nutrient series						(7)	Grab	Monthly	SCCAO	Reclamation
			Selenium, total							Autosampler	Daily composite	MP-157	Reclamation
										Grab	Weekly	SCCAO	Reclamation
			Selenium, dissolved						(8)	Grab	Quarterly	MP-157	Reclamation
			Selenium, particulate						(8)	Grab	Quarterly	MP-157	Reclamation
			Three species chronic toxicity						(9)	Grab	Quarterly	SLDMWA	Contractor
			Physicals							Field	Weekly	SCCAO	Reclamation
			General minerals						(8)	Grab	Monthly	SCCAO	Reclamation
			Metals, total						(8)	Grab	Monthly	SCCAO	Reclamation
			Metals, dissolved						(8)	Grab	Biannual	SCCAO	Reclamation
			Pesticides						(8)	Grab	Biannual	SCCAO	Reclamation
			Bacteria						(8)	Grab	Biannual	SCCAO	Reclamation

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Table 2: Proposed Changes to Surface Water Quality Monitoring Specifications

Feature	Station	Location	Parameters	2005 Monitoring & Reporting Program	2011 Interim Monitoring Plan				2013 Revised Monitoring Plan				
					Method	Frequency	Sampler	Analysis	Change	Method	Frequency	Collecting Agency	Analytical Agency
Mud Slough (north)	C	upstream of San Luis Drain	Flow		calculated	Daily	SCCAO	Reclamation	(10)	Sonde	Daily	Grasslands WD	Grasslands WD
			pH	Weekly	Field	Weekly	SCCAO	Reclamation	(10)	Sonde	Daily	Grasslands WD	Grasslands WD
			Specific conductivity	Weekly	Field	Weekly	SCCAO	Reclamation	(10)	Sonde	Daily	Grasslands WD	Grasslands WD
			Physicals		Field	Weekly	SCCAO	Reclamation	(10)(11)(18)	Field	Monthly	Grasslands WD	Grasslands WD
			Temperature	Weekly	Field	Weekly	SCCAO	Reclamation	(10)	Sonde	Daily	Grasslands WD	Grasslands WD
			Selenium, total	Monthly	Grab	Weekly	SCCAO	Reclamation	(10)(11)(18)	Grab	Monthly	Westside Coalition	Westside Coalition
			Boron	Monthly	Grab	Weekly	SCCAO	Reclamation	(12)(18)	Grab	Monthly	Westside Coalition	Westside Coalition
			Molybdenum	Monthly	Grab	Monthly	SCCAO	Reclamation	(18)	Grab	Monthly	Westside Coalition	Westside Coalition
			Nutrient series	Monthly(1)	Grab	Monthly(1)	SCCAO	Reclamation	(18)	Grab	Monthly	Westside Coalition	Westside Coalition
			Three species chronic toxicity	Quarterly	Grab	Monthly	Panoche DD	Block Env.	(18)	Grab	Biannual	Westside Coalition	Westside Coalition
	D	downstream of San Luis Drain	Flow	Daily average	Sonde	Continuous	USGS	USGS		Sonde	Daily	USGS	USGS
			pH	Weekly	Field	Weekly	SCCAO	Reclamation	(4)	Field	Weekly	SCCAO	Reclamation
			Specific conductivity	Weekly	Field	Weekly	SCCAO	Reclamation	(4)	Field	Weekly	SCCAO	Reclamation
					Sonde	Continuous	USGS	USGS		Sonde	Daily	USGS	USGS
			Temperature	Weekly	Field	Weekly	SCCAO	Reclamation	(4)	Field	Weekly	SCCAO	Reclamation
					Sonde	Continuous	USGS	USGS		Sonde	Daily	USGS	USGS
			Selenium, total	Weekly	Grab	Weekly	SCCAO	Reclamation		Grab	Weekly	SCCAO	Reclamation
			Selenium, dissolved						(8)	Grab	Quarterly	MP-157	Reclamation
			Selenium, particulate						(8)	Grab	Quarterly	MP-157	Reclamation
			Boron	Weekly	Grab	Weekly	SCCAO	Reclamation	(3)(5)	Grab	Monthly	SCCAO	Reclamation
			Molybdenum	Monthly	Grab	Monthly	SCCAO	Reclamation	(5)	Grab	Monthly	SCCAO	Reclamation
			Nutrient series	Monthly(1)	Grab	Monthly(1)	SCCAO	Reclamation	(7)	Grab	Monthly	SCCAO	Reclamation
			Three species chronic toxicity	Quarterly	Grab	Monthly	Panoche DD	Block Env.	(9)	Grab	Quarterly	SLDMWA	Contractor
			Turbidity		Field	Weekly	SCCAO	Reclamation	(4)	Field	Weekly	SCCAO	Reclamation
			Physicals		Field	Weekly	SCCAO	Reclamation		Field	Weekly	SCCAO	Reclamation
			General minerals						(8)	Grab	Monthly	SCCAO	Reclamation
			Metals, total						(8)	Grab	Monthly	SCCAO	Reclamation
			Metals, dissolved						(8)	Grab	Biannual	SCCAO	Reclamation
			Pesticides						(8)	Grab	Biannual	SCCAO	Reclamation
			Bacteria						(8)	Grab	Biannual	SCCAO	Reclamation
	I2	backwater below San Luis Drain	Temperature		Field	Weekly (3)	SCCAO	Reclamation	(4)(13)	Field	Weekly*	SCCAO	Reclamation
			Turbidity		Grab	Weekly (3)	SCCAO	Reclamation	(4)(13)	Field	Weekly*	SCCAO	Reclamation
			pH		Field	Weekly (3)	SCCAO	Reclamation	(4)(13)	Field	Weekly*	SCCAO	Reclamation
			Specific conductivity		Field	Weekly (3)	SCCAO	Reclamation	(4)(13)	Field	Weekly*	SCCAO	Reclamation
			Physicals		Field	Weekly (3)	SCCAO	Reclamation	(13)	Field	Weekly*	SCCAO	Reclamation
			Selenium, total		Grab	Weekly (3)	SCCAO	Reclamation	(13)	Grab	Weekly*	SCCAO	Reclamation
			Boron		Grab	Weekly (3)	SCCAO	Reclamation	(X)				

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Table 2: Proposed Changes to Surface Water Quality Monitoring Specifications

				2005 Monitoring & Reporting Program	2011 Interim Monitoring Plan				2013 Revised Monitoring Plan				
Feature	Station	Location	Parameters		Method	Frequency	Sampler	Analysis	Change	Method	Frequency	Collecting Agency	Analytical Agency
Wetlands Channels	F	Salt Slough	Flow		Sonde	Continuous	USGS	USGS		Sonde	Daily	USGS	USGS
			Specific conductivity		Sonde	Continuous	USGS	USGS		Sonde	Daily	USGS	USGS
					Field	Weekly	SCCAO	Reclamation	(4)	Field	Weekly	SCCAO	Reclamation
			Temperature		Sonde	Continuous	USGS	USGS		Sonde	Daily	USGS	USGS
					Field	Weekly	SCCAO	Reclamation	(4)	Field	Weekly	SCCAO	Reclamation
			pH		Field	Weekly	SCCAO	Reclamation	(4)	Field	Weekly	SCCAO	Reclamation
			Selenium, total		Grab	Weekly	SCCAO	Reclamation		Grab	Weekly	SCCAO	Reclamation
			Selenium, dissolved						(8)	Grab	Quarterly	MP-157	Reclamation
			Selenium, particulate						(8)	Grab	Quarterly	MP-157	Reclamation
			Boron		Grab	Weekly	SCCAO	Reclamation	(5)	Grab	Monthly	SCCAO	Reclamation
			Molybdenum		Grab	Monthly	SCCAO	Reclamation	(5)	Grab	Monthly	SCCAO	Reclamation
			Nutrient series		Grab	Monthly(1)	SCCAO	Reclamation	(7)	Grab	Monthly	SCCAO	Reclamation
			Three species chronic toxicity		Grab	Monthly	Panoche DD	Block Env.	(9)	Grab	Quarterly	SLDMWA	Contractor
			Storm water monitoring	Event + 7 days	Grab	Daily + 7	SLDMWA	SLDMWA		Grab	daily + 7	SLDMWA	Reclamation
			Physicals		Field	Weekly	SCCAO	Reclamation		Field	Weekly	SCCAO	
			General minerals						(8)	Grab	Monthly	SCCAO	Reclamation
			Metals, total						(8)	Grab	Monthly	SCCAO	Reclamation
			Metals, dissolved						(8)	Grab	Biannual	SCCAO	Reclamation
			Pesticides						(8)	Grab	Biannual	SCCAO	Reclamation
			Bacteria						(8)	Grab	Biannual	SCCAO	Reclamation
	J	Camp 13 Ditch	Flow		Estimate	Weekly	Grassland WD	Grasslands WD	(14)	Sonde	Daily	Grasslands WD	Grasslands WD
			Specific conductivity		Field	Weekly	SLDMWA	Reclamation	(4)(15)	Field	Weekly	SLDMWA	Reclamation
			Selenium, total		Grab	Weekly	SLDMWA	Reclamation	(15)	Grab	Weekly	SLDMWA	Reclamation
			Boron		Grab	Weekly	SLDMWA	Reclamation	(X)				
			Stormwater monitoring	Event + 7 days	Grab	Daily + 7	SLDMWA	SLDMWA		Grab	daily + 7	SLDMWA	Reclamation
	K	Agatha Canal	Flow		Estimate	Weekly	Grassland WD	Grasslands WD	(14)	Sonde	Daily	Grasslands WD	Grasslands WD
			Specific conductivity		Field	Weekly	SLDMWA	Reclamation	(4),(15)	Field	Weekly(3)	SLDMWA	Reclamation
			Selenium, total		Grab	Weekly	SLDMWA	Reclamation	(15)	Grab	Weekly(3)	SLDMWA	Reclamation
			Boron		Grab	Weekly	SLDMWA	Reclamation	(X)				
			Stormwater monitoring	Event + 7 days	Grab	Daily + 7	SLDMWA	SLDMWA		Grab	daily + 7	SLDMWA	Reclamation
	L/L2	San Luis Canal (CCID)	Flow		Estimate	Weekly	Grassland WD	Grasslands WD	(12)	Sonde	Daily	Grasslands WD	Grasslands WD
			Specific conductivity		Field	Weekly	SLDMWA	Reclamation	(12)	Sonde	Daily	Grasslands WD	Grasslands WD
			Selenium, total		Grab	Weekly	SLDMWA	Reclamation	(12)	Grab	Monthly	Grasslands WD	Grasslands WD
			Boron		Grab	Weekly	SLDMWA	Reclamation	(12)	Grab	Monthly	Grasslands WD	Grasslands WD

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Table 2: Proposed Changes to Surface Water Quality Monitoring Specifications

					2011 Interim Monitoring Plan					2013 Revised Monitoring Plan			
Feature	Station	Location	Parameters	2005 Monitoring & Reporting Program	Method	Frequency	Sampler	Analysis	Change	Method	Frequency	Collecting Agency	Analytical Agency
			Stormwater monitoring	Event + 7 days	Grab	Daily + 7	SLDMWA	SLDMWA		Grab	daily + 7	SLDMWA	Reclamation
			Flow		Estimate	Weekly	Grassland WD	Grasslands WD	(12)	Sonde	Daily	Grasslands WD	Grasslands WD
			Specific conductivity		Field	Weekly	SLDMWA	Reclamation	(12)	Sonde	Daily	Grasslands WD	Grasslands WD
	M/M2	Santa Fe Canal	Selenium, total		Grab	Weekly	SLDMWA	Reclamation	(12)	Grab	Monthly	Grasslands WD	Grasslands WD
			Boron		Grab	Weekly	SLDMWA	Reclamation	(12)	Grab	Monthly	Grasslands WD	Grasslands WD
			Stormwater monitoring	Event + 7 days	Grab	Daily + 7	SLDMWA	SLDMWA		Grab	daily + 7	SLDMWA	Reclamation

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Table 2: Proposed Changes to Surface Water Quality Monitoring Specifications

				2005 Monitoring & Reporting Program	2011 Interim Monitoring Plan				2013 Revised Monitoring Plan				
Feature	Station	Location	Parameters		Method	Frequency	Sampler	Analysis	Change	Method	Frequency	Collecting Agency	Analytical Agency
San Joaquin River	G	Fremont Ford	Flow	Daily average	Sonde	Continuous	USGS	USGS	(16)	Sonde	Continuous	USGS	USGS
			pH	Weekly	Field	Weekly	SCCAO	Reclamation	(4)(16)	Field	Monthly	SJRRP	Reclamation
			Specific conductivity	Weekly	Field	Weekly	SCCAO	Reclamation	(4)(16)	Field	Monthly	SJRRP	Reclamation
					Sonde	Continuous	USGS	USGS	(16)	Sonde	Continuous	USGS	USGS
			Temperature	Weekly	Field	Weekly	SCCAO	Reclamation	(4)(16)	Field	Monthly	SJRRP	Reclamation
					Sonde	Continuous	USGS	USGS	(16)	Sonde	Continuous	USGS	USGS
			Physicals		Field	Weekly	SCCAO	Reclamation	(16)	Field	Monthly	SJRRP	Reclamation
			Selenium, total	Weekly	Grab	Weekly	SCCAO	Reclamation	(16)	Grab	Monthly	SJRRP	Reclamation
			Boron	Weekly	Grab	Weekly	SCCAO	Reclamation	(16)	Grab	Monthly	SJRRP	Reclamation
			Molybdenum	Monthly	Grab	Monthly	SCCAO	Reclamation	(16)	Grab	Monthly	SJRRP	Reclamation
			Nutrient series	Monthly(1)	Grab	Monthly(1)	SCCAO	Reclamation	(16)	Grab	Monthly	SJRRP	Reclamation
			Pesticides						(18)	Grab	Monthly	Westside Coalition	Westside Coalition
			Miscellaneous (19)						(18)	Grab	Monthly	Westside Coalition	Westside Coalition
	R	China Island Unit	Physicals						(8)	Field	Weekly	SCCAO	Reclamation
			General minerals						(8)	Grab	Monthly	SCCAO	Reclamation
			Metals, total						(8)	Grab	Monthly	SCCAO	Reclamation
			Metals, dissolved						(8)	Grab	Biannual	SCCAO	Reclamation
			Selenium, total						(8)	Grab	Weekly	SCCAO	Reclamation
			Selenium, dissolved						(8)	Grab	Quarterly	MP-157	Reclamation
			Selenium, particulate						(8)	Grab	Quarterly	MP-157	Reclamation
			Pesticides						(8)	Grab	Biannual	SCCAO	Reclamation
			Bacteria						(8)	Grab	Biannual	SCCAO	Reclamation
	H1	Above Newman WW	Specific conductivity		Grab	Weekly	Panoche DD	SLDMWA	(X)				
			Selenium, total		Grab	Weekly	Panoche DD	SLDMWA	(X)				
			Boron		Grab	Weekly	Panoche DD	SLDMWA	(X)				
	H2	above Merced River (Hills Ferry)	Flow		Sonde	Continuous	USGS	USGS		Sonde	Continuous	USGS	USGS
			Specific conductivity		Grab	Weekly	Panoche DD	SLDMWA	(X)				
					Sonde	Continuous	USGS	USGS		Sonde	Continuous	USGS	USGS
			Temperature		Sonde	Continuous	USGS	USGS		Sonde	Continuous	USGS	USGS
			Selenium, total		Grab	Weekly	Panoche DD	SLDMWA	(17)				
			Boron		Grab	Weekly	Panoche DD	SLDMWA	(X)				
	N	Crows Landing	Flow	Daily average	Sonde	Continuous	USGS	USGS		Sonde	Continuous	USGS	USGS
			pH	Weekly	Field	Weekly	SCCAO	Reclamation	(4)	Field	Weekly	SCCAO	Reclamation
			Specific conductivity	Weekly	Field	Weekly	SCCAO	Reclamation	(4)	Field	Weekly	SCCAO	Reclamation
				24 hour composite	Sonde	Continuous	USGS	USGS		Sonde	Continuous	USGS	USGS
			Temperature	Weekly	Field	Weekly	SCCAO	Reclamation	(4)	Field	Weekly	SCCAO	Reclamation
				24 hour composite	Sonde	Continuous	USGS	USGS		Sonde	Continuous	USGS	USGS
			Selenium, total	Weekly	Grab	Weekly	SCCAO	Reclamation		Grab	Weekly	SCCAO	Reclamation
				24 hour composite	Autosampler	Daily composite	MP-157	Reclamation		Autosampler	Daily composite	MP-157	Reclamation

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Table 2: Proposed Changes to Surface Water Quality Monitoring Specifications

Feature	Station	Location	Parameters	2005 Monitoring & Reporting Program	2011 Interim Monitoring Plan				2013 Revised Monitoring Plan				
					Method	Frequency	Sampler	Analysis	Change	Method	Frequency	Collecting Agency	Analytical Agency
				Weekly	Grab	Weekly	SCCAO	Reclamation		Grab	Weekly	SCCAO	Reclamation
			Boron	24 hour composite	Autosampler	Daily composite	MP-157	Reclamation	(X)				
			Molybdenum	Monthly	Field	Monthly	SCCAO	Reclamation	(X)				
			Nutrient series	Monthly(1)	Field	Monthly(1)	SCCAO	Reclamation	(X)				
			Physicals		Field	Weekly	SCCAO	Reclamation		Field	Weekly	SCCAO	

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Table 2: Proposed Changes to Surface Water Quality Monitoring Specifications

Feature	Station	Location	Parameters	2005 Monitoring & Reporting Program	2011 Interim Monitoring Plan				2013 Revised Monitoring Plan				
					Method	Frequency	Sampler	Analysis	Change	Method	Frequency	Collecting Agency	Analytical Agency
2001 WDR and 2005 M&RP													
(1) Sampling frequency increases to twice monthly during the irrigation season (March through August)									(X) Discontinued for GBP				
(2) Daily during storm events									(1) Change from weekly composite to daily grab.				
									(2) Discontinued because more frequent samples will be collected				
									(3) Reduced frequency from weekly to monthly				
2013 Revised Monitoring Plan list of Parameters:									(4) Included with physical parameters				
Physicals: Field measurements of DO, pH, specific conductivity, temperature, turbidity									(5) Included with trace metals, total				
General minerals: Ca, Mg, K, Na, Cl, SO4, TOC, hardness									(6) Reduced frequency from daily to monthly				
Metals: As, B, Cd, Cu, Pb, Hg, Mo, Ni, Se, Zn									(7) Reduced frequency to monthly during irrigation season				
Nutrients: Nitrates as N, Total Ammonia, Total Kjeldahl Nitrogen, Total Phosphorous, and Soluble Ortho Phosphate.									(8) New parameter in 2013 Monitoring Program				
Pesticides: EPA 531.2 Carbamates, SM 8081BM Pyrethroid scan and Organochlorine scan, SM 8141AM Organophosphate scan									(9) Reduced frequency from monthly to quarterly per 2001 WDR				
Bacteria: Total coliform, fecal coliform, E. Coli									(10) Real-time monitoring will be conducted in Mud Slough at Gun Club Road.				
Toxicity in water: 3 species chronic and acute tests									(11) Grab samples will be collected from Mud Slough at Gun Club Road.				
									(12) Grab samples will be collected and analyzed by Grasslands WD				
									(13) Samples will be collected when backwater area is flooded				
									(14) Increased frequency from weekly estimate to daily average				
									(15) Samples will be collected when water is flowing past this site				
									(16) Monitoring will be funded by San Joaquin River Restoration Program				
Revised: 28 Nov 2012									(17) Sampling location changed to Site R SJR at China Island				
									(18) Grab sample will be collected and analyzed under the Irrigated lands Regulatory Program				
									(19) TDS, Bromide, nitrate, DOC, TOC				

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Table 3: Proposed Changes to Biological Monitoring Specifications

		2011 Interim Monitoring Program				2013 Revised Monitoring Plan		
Feature	Station	Location	Parameters	Frequency	Agency	Parameters	Frequency	Agency
Mud Slough (north)	C	Upstream of SLD discharge	Selenium in wholebody fish and invertebrates	April, June, August, November	US FWS	(X)		
			Selenium and Boron in plant seeds	August				
	D	Downstream of SLD discharge	Same as Site C			Physicals		US FWS or contractor
						Selenium in wholebody fish and invertebrates	March, June, August, November	
						Mercury in wholebody fish and invertebrates		
						Selenium in aquatic insects	March, June	
						Other (1)	March, June, August, November	
	E	Downstream of SLD discharge, Highway 140	Selenium in wholebody fish and invertebrates	April, June, August, November	CDFG	(X)		
			Fish community assessment					
			Selenium in fish muscle tissue					
			Selenium and Boron in plant seeds	August				
	I2	Seasonal backwater downstream of SLD discharge	Same as Site C			Physicals	When flooded (typically March, June and November)	US FWS or contractor
						Selenium in whole body fish and invertebrates		
						Mercury in wholebody fish and invertebrates		
						Selenium in aquatic insects		
						Other (1)		
Wetlands Channels	F	Salt Slough	Same as Site C			Same as Site D		
San Joaquin River	G	Fremont Ford	Same as E			(X)		
	H2	Hills Ferry	Same as E			Monitoring location moved upstream to Site R China Island		
	R	China Island Unit				Physicals	March, June, August, November	CDFG or contractor
						Selenium in wholebody fish and invertebrates		
						Mercury in wholebody fish and invertebrates		
						Fish community assessment		
						Selenium in fish muscle tissue		
						Selenium in aquatic insects	March, June	
						Other (1)	March, June, August, November	

Revised: 1/14/2013

(1) Water samples will be collected at each site to be tested for dissolved selenium and particulate selenium

(X) Discontinued under 2013 Grassland Bypass Project monitoring plan.

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Table 4: Proposed Changes to Toxicity Monitoring Specifications

			2011 Interim Monitoring Program			2013 Revised Monitoring Plan		
Feature	Station	**Location**	**Parameters**	**Frequency**	**Agency**	**Parameters**	**Frequency**	**Agency**
San Luis Drain	B	near Gun Club Road	larval survival for fathead minnows larval growth for fathead minnows larval survival for *Daphnia magna* larval reproduction for *Daphnia magna* *Selenastrum capricornutum* *water quality (1)*	Monthly	Block Environmental Service	larval survival for *Pimephales promelas* (X) larval survival for Ceriod*aphnia dubia* (X) *Selenastrum capricornutum* growth *water quality (1)*	March, June, September, November	Contractor
						Hyalella azteca survival in sediment (2)	March, September	Contractor
Mud Slough	D	Downstream of SLD discharge	Same as Station B			Same as Station B		
	I2	Backwater below SLD discharge				*Hyalella azteca* survival in sediment(2)	March, September	Contractor
Wetlands Channels	F	Salt Slough	Same as Station B			Same as Station B		
San Joaquin River	R	China Island Refuge				Same as Station B		
Control	DMC	near Check 13	Same as Station B			Same as Station B		

(1) Water samples will be tested for selenium, TSS, Cl, Ammonia as N, temperature, hardness, alkalinity, DO, pH.

(2) The toxicity tests are conducted for 10 days in 300-mL chambers containing 100 mL of sediment and 175 mL of c ed ing ater

revised: 1/15/2013

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Table 5: Proposed changes to Sediment Monitoring Specifications (Quality)

			2011 Interim Monitoring Program			2013 Revised Monitoring Program		
Feature	**Station**	**Location**	**Parameters**	**Frequency**	**Agency**	**Parameters**	**Frequency**	**Agency**
San Luis Drain	**B3**	San Luis Drain at Gun Club Road				Selenium Methyl mercury Total organic carbon percent moisture *Hyalella azteca* survival	Annual (September)	Reclamation
Mud Slough (north)	**C**	upstream of San Luis Drain	Selenium Total organic carbon percent moisture	March, June, August, November	Reclamation	(X)		
	D	downstream of SLD discharge	Same as Station C			Same as B3		
	E	downstream of SLD discharge	Same as Station C			(X)		
	I2	upstream of San Luis Drain	Same as Station C			Same as B3		
Wetlands Channels	**F**	Salt Slough	Same as Station C			Same as B3		
San Joaquin River	**H**	above Merced River				Same as B3		

(X) Discontinued monitoring at this site

Table 6: Proposed Changes to San Luis Drain Sediment Monitoring Specifications (Quality)

			2011 Interim Monitoring Program			2013 Revised Monitoring Plan			
Feature	**Station**	**Location**	**Parameters**	**Frequency**	**Agency**	**Location**	**Parameters**	**Frequency**	**Agency**
San Luis Drain	Between Stations A and B	Twenty places based on sediment accumulation	Selenium Total organic carbon percent moisture	Annual	Reclamation	Ten places based on sediment accumulation	Selenium Total organic carbon percent moisture	Annual	Reclamation

Table 7: Proposed Changes to San Luis Drain Sediment Monitoring Specifications (Quantity)

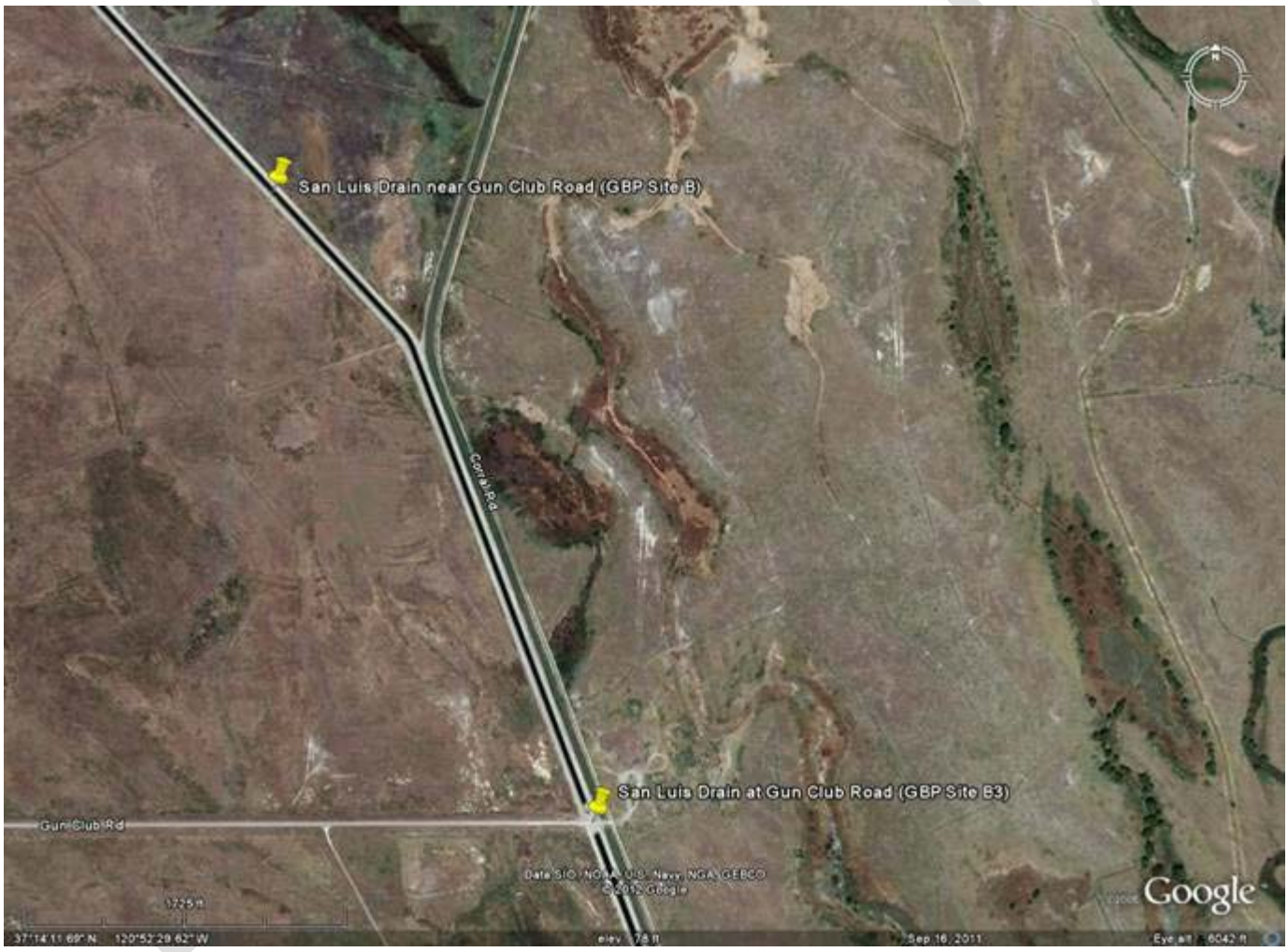
			2011 Interim Monitoring Program			2013 Revised Monitoring Plan		
Feature	**Station**	**Location**	**Parameters**	**Frequency**	**Agency**	**Parameters**	**Frequency**	**Agency**
San Luis Drain	Between Stations A and B	Between Checks 1 to 2	Volume of sediment	Annual	SLDMWA	Volume of sediment	Annual	SLDMWA
		Between Checks 10 to 11	Same			Same		
		Between Checks 14 to 15	Same			Same		
		Between Checks 17 to 18	Same			Same		

revised: 12/28/2012

Appendix 2. Station B

Grassland Bypass Project - 2013 Revised Monitoring Plan –
Proposal to Move Site B to Gun Club Road

On November 7, 2012, Reclamation made a proposal to the Data Collection and Review Team to change the water quality monitoring site in the San Luis Drain from the original Site B to the Gun Club Road siphon. The main reason is for this change is the safety of Reclamation staff.



Site B is located 0.7 miles northwest of Gun Club Road (GCR) on the service road of the San Luis Drain. This dirt road is a narrow levee that is wide enough for one vehicle. It is difficult for another vehicle to pass when we are there. Also, it is impossible to turn around, and it is difficult and dangerous to back up along the levee road. The end of Drain is 1.9 miles away. This situation is worsened in winter with fog and rain that makes the service road muddy and rutted. The road is also used to access the adjacent refuges.

Site B is where water quality is measured to ensure compliance with the 2001 WDR and 2009 Use Agreement. The autosampler is used to collect daily composite samples for measuring selenium, boron, and salinity. We also collect weekly grab samples here. The autosamplers are located on a pier in the SLD.

Here is a picture taken November 2, 2012 morning of stinging insects inside the autosampler located at Site B.

As you can imagine, spraying a pesticide here is not good for the sampler and the equipment. Getting stung out there could be fatal.

At the 25 Sep 2012 DCRT meeting, Reclamation suggested moving the location of Site B from the footbridge/pier back to the siphon under Gun Club Road. Reclamation presented data comparing selenium in samples collected at both sites. The DCRT recommended the continued use Site B, and to use the GCR site as an alternate in bad weather.

We have been collecting grab samples from both sites for eight months and find that there is no difference in the concentration of selenium and salinity. The attached table compares the RPD for these measurements.

The 2013 revised monitoring program will increase the number of parameters to be measured at Site B, increasing the duration spent at this site.

For the safety of our staff, we recommend moving the sampling location from the Site B pier to the upstream side of the siphon at Gun Club Road. The new site would be called Site B3.

We would begin sampling at B3 in January 2013. We plan to install a kiosk there to securely contain the autosampler and various supplies. We will connect power to the kiosk, or use solar panels.

Comparison of Site B and B3			
Date	Selenium Results (µg/L)		RPD
	Site B	Site B3	
1/12/2012	27	25	7.7%
1/17/2012	14	13	7.4%
1/24/2012	22	22	0.0%
1/31/2012	17	17	0.0%
2/7/2012	15	14	6.9%
2/17/2012	11	10	9.5%
2/21/2012	26	25	3.9%
2/28/2012	23	24	4.3%
3/6/2012	29	28	3.5%
3/13/2012	27	25	7.7%
3/21/2012	34	35	2.9%
3/28/2012	29	29	0.0%
4/3/2012	31	30	3.3%
4/10/2012	26	27	3.8%
4/17/2012	23	23	0.0%
4/24/2012	24	23	4.3%
5/1/2012	20	24	18.2%
5/7/2012	35	37	5.6%
5/15/2012	38	37	2.7%
5/22/2012	42	44	4.7%
5/29/2012	47	48	2.1%
6/5/2012	41	43	4.8%
6/13/2012	35	37	5.6%
6/19/2012	42	39	7.4%
6/25/2012	32	32	0.0%
7/2/2012	22	22	0.0%

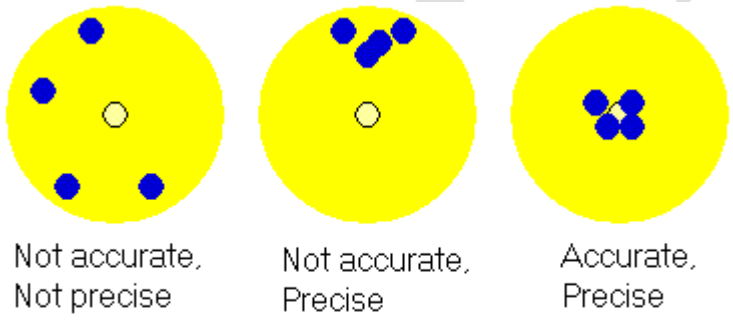
7/10/2012	30	30	0.0%
7/18/2012	33	34	3.0%
7/24/2012	32	32	0.0%
8/1/2012	34	30	12.5%
8/9/2012	21	23	9.1%
8/14/2012	26	27	3.8%
8/28/2012	35	35	0.0%

Average relative percent difference = 4.4%

RPD is the **relative percent difference** between two values. That is the absolute difference between two numbers divided by their average.

$$RPD = \frac{|Result_A - Result_B|}{(Result_A + Result_B)/2}$$

RPD is indicative of precision, but not accuracy.



When we collect a sample in duplicate, we compare the results. In theory, the two results should have a RPD of 0%. If the RPD is greater than 20%, we ask for reanalysis since the two results are significantly different, possibly indicating some sort of error.

Keep in mind though that when the results are near the reporting limit, RPD may not be an acceptable tool to determine precision. The relative uncertainty is greater as the value gets closer to the reporting limit.

For example…

Reporting Limit = 0.4 ppb
Result A = 1.2 ppb
Result B = 1.6 ppb
RPD = 28.6%

Even though the RPD is outside the 20% acceptance limit, Result A is within the reporting limit of result B. Thus, we would accept the results.

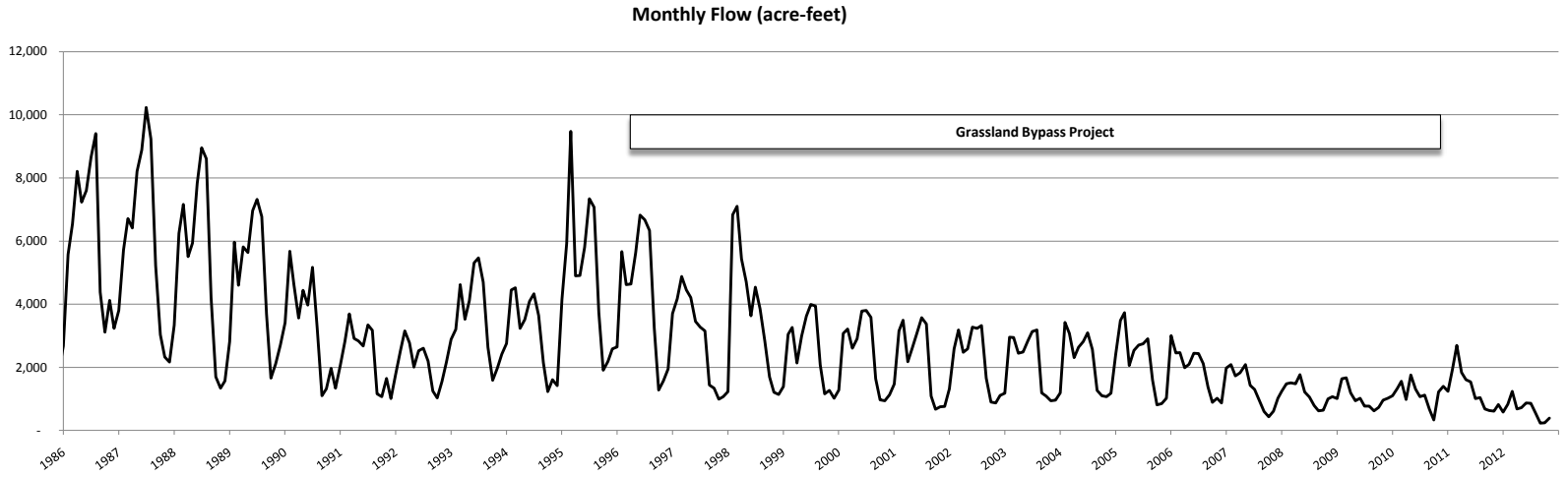
Once the results exceed 5 x Reporting Limit (2.0 ppb), then the uncertainty is small relative to the result, and RPD is solely used to determine precision.

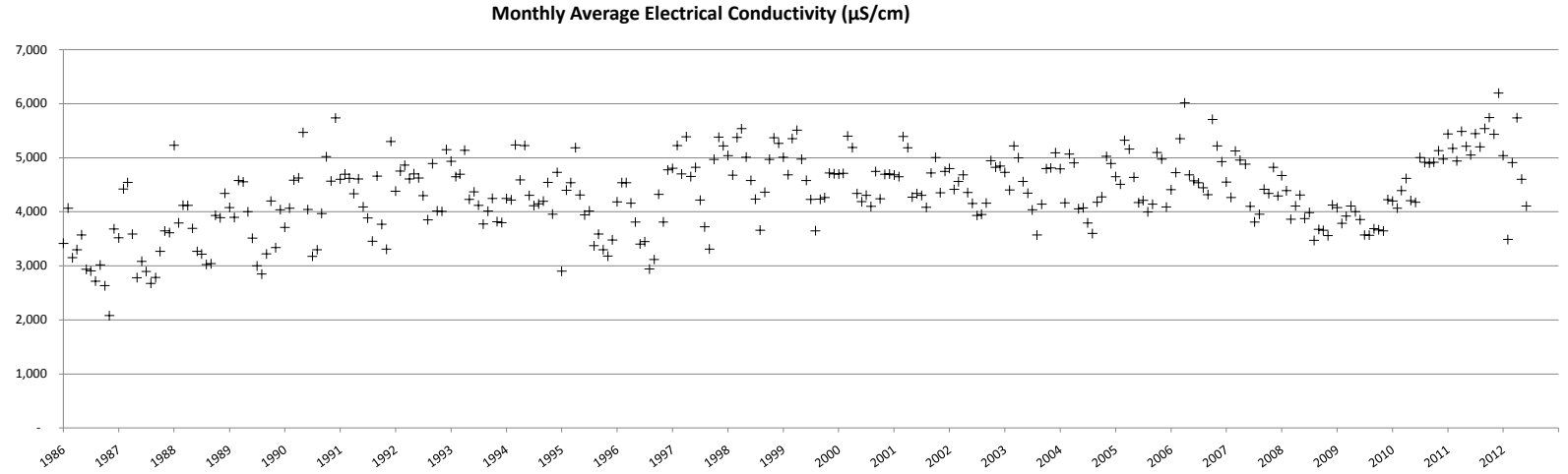
Averaging the RPDs is a quick and dirty way to determine if two data sets are similar. We are essentially saying if the two sites were just duplicates, this is how we would compare them, and here is the average of those comparisons. The wide range of variance is probably because the results are close to the reporting limit.

There are other methods that will give you a clearly picture (much more statistically justified).

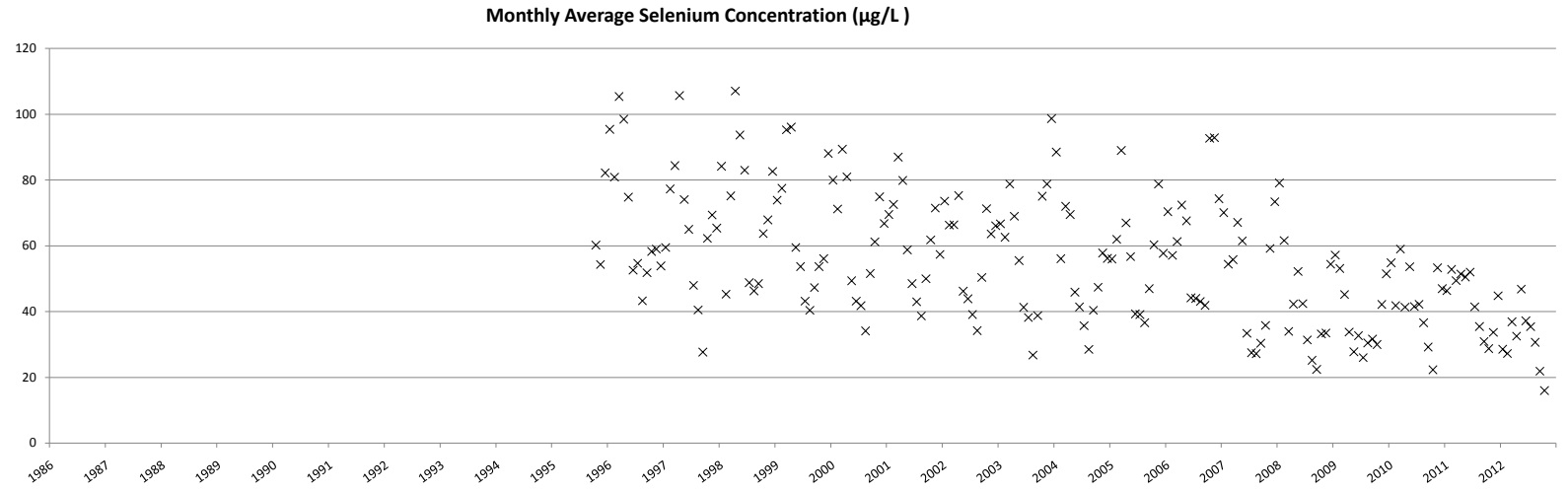
Student's T-Test & F-Test http://www.fao.org/docrep/W7295E/w7295e08.htm#6.4.2 f test for precision

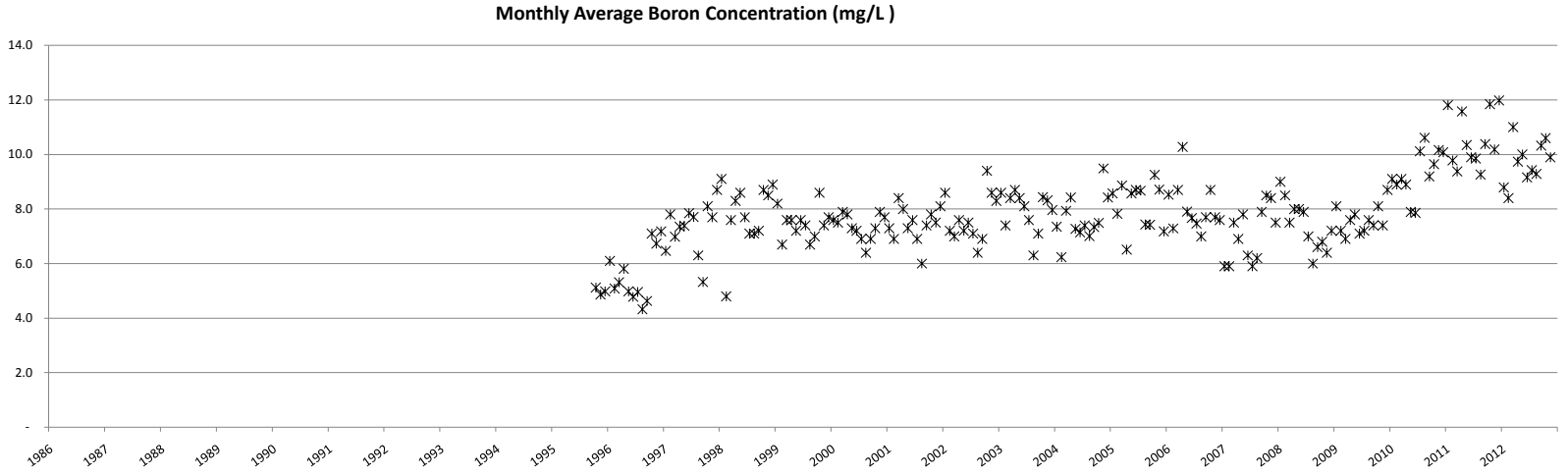
Grassland Bypass Project
San Luis Drain near South Dos Palos
Site A



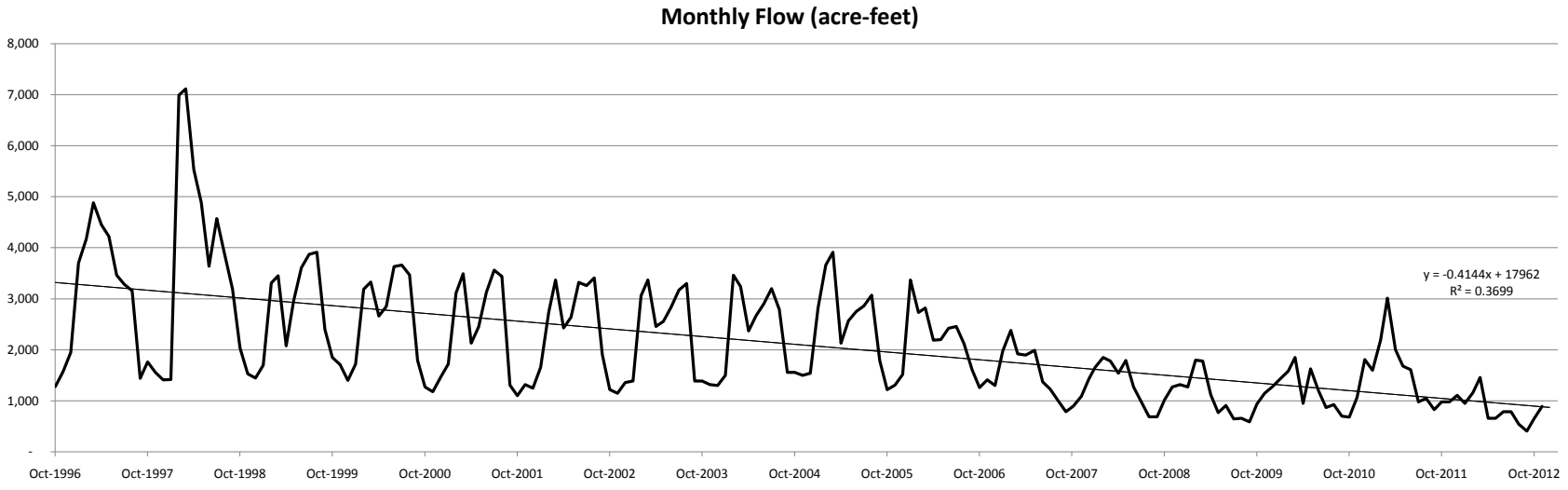


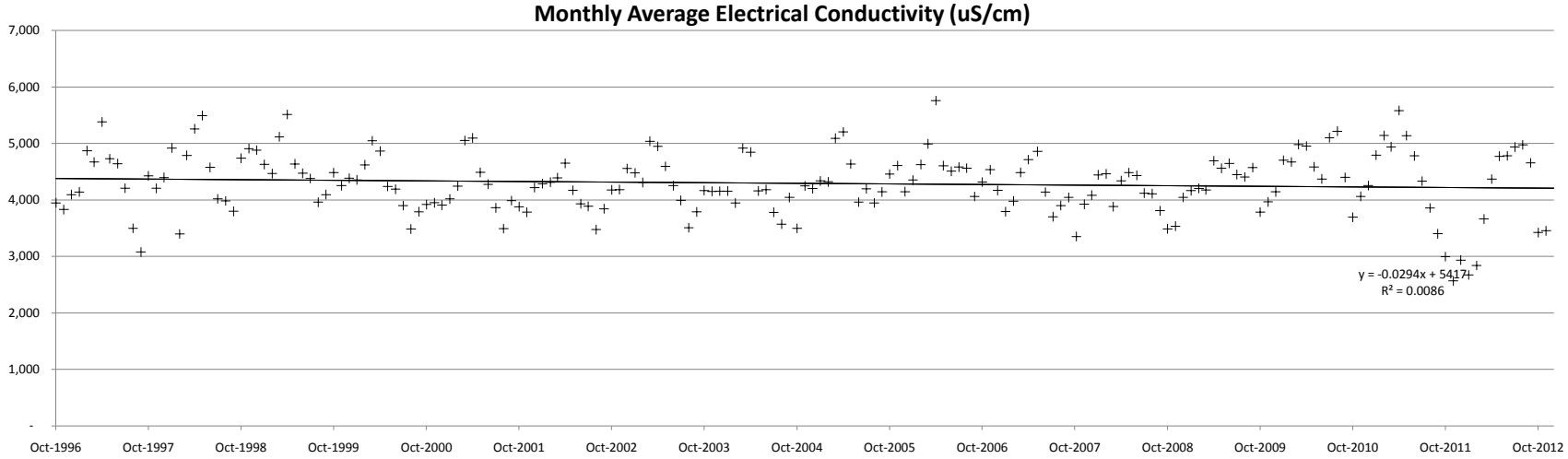
Grassland Bypass Project
San Luis Drain near South Dos Palos
Site A



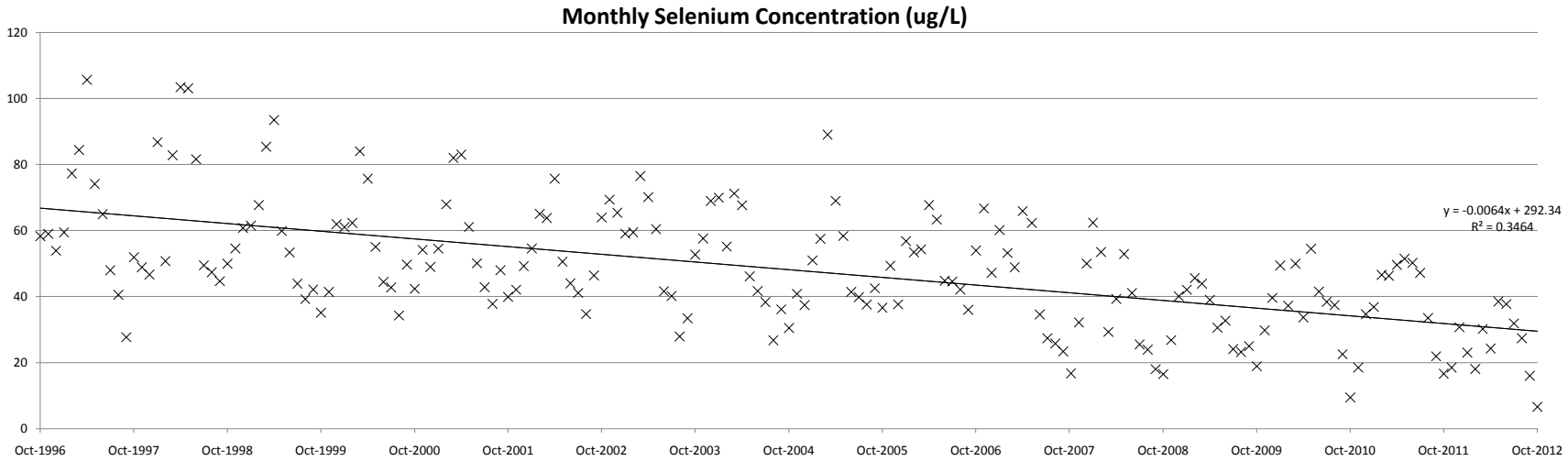


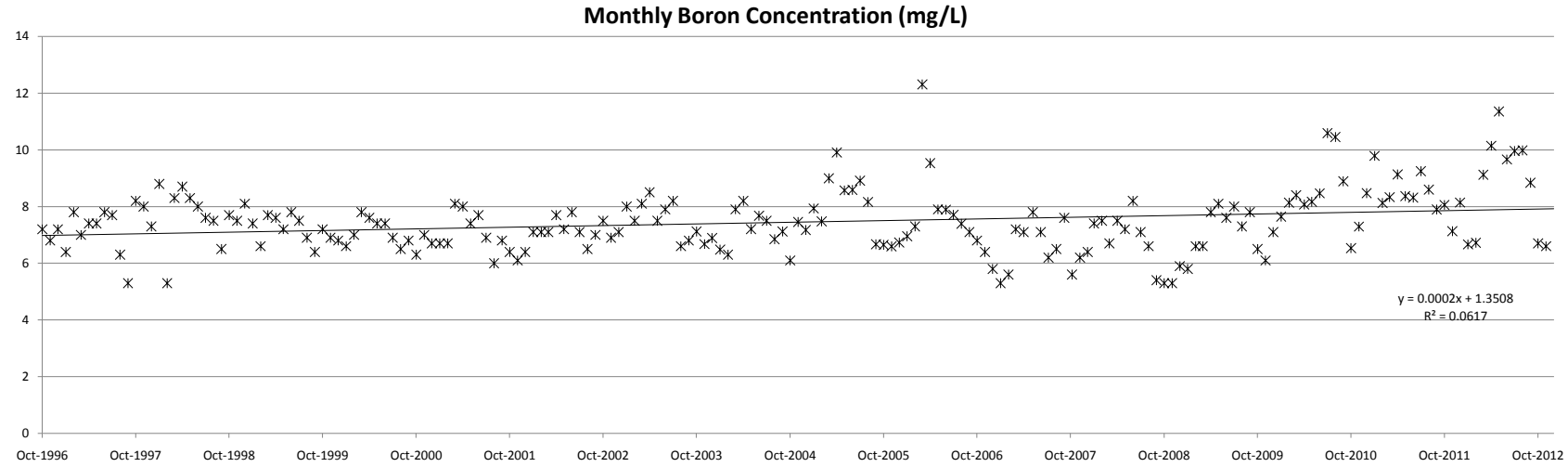
Grassland Bypass Project
San Luis Drain near terminus at Mud Slough (north)
Site B



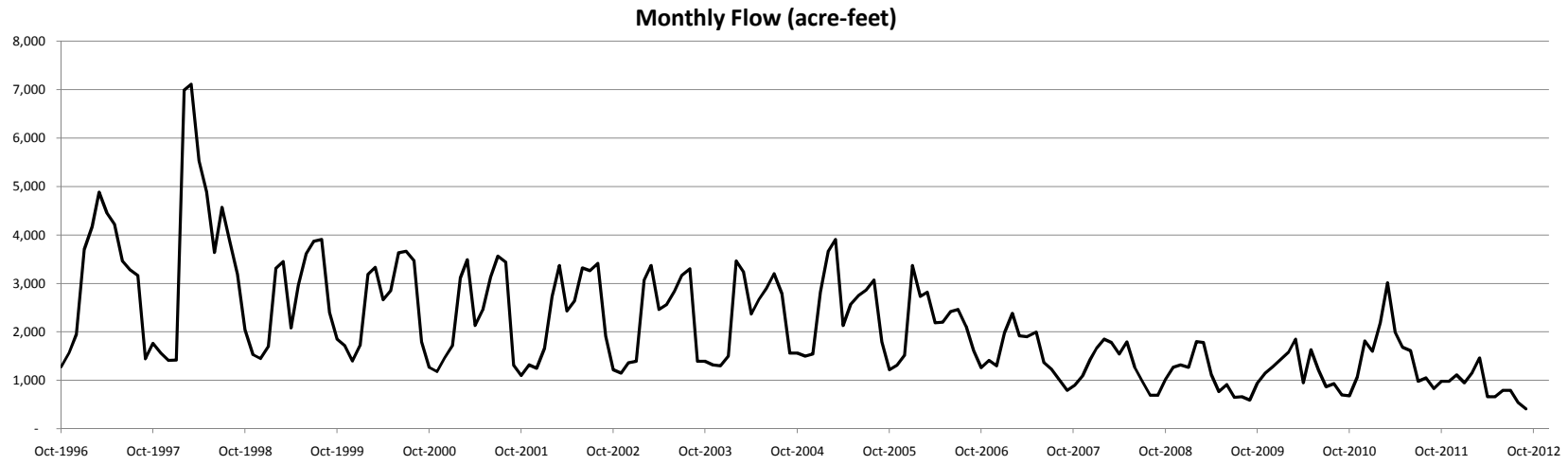


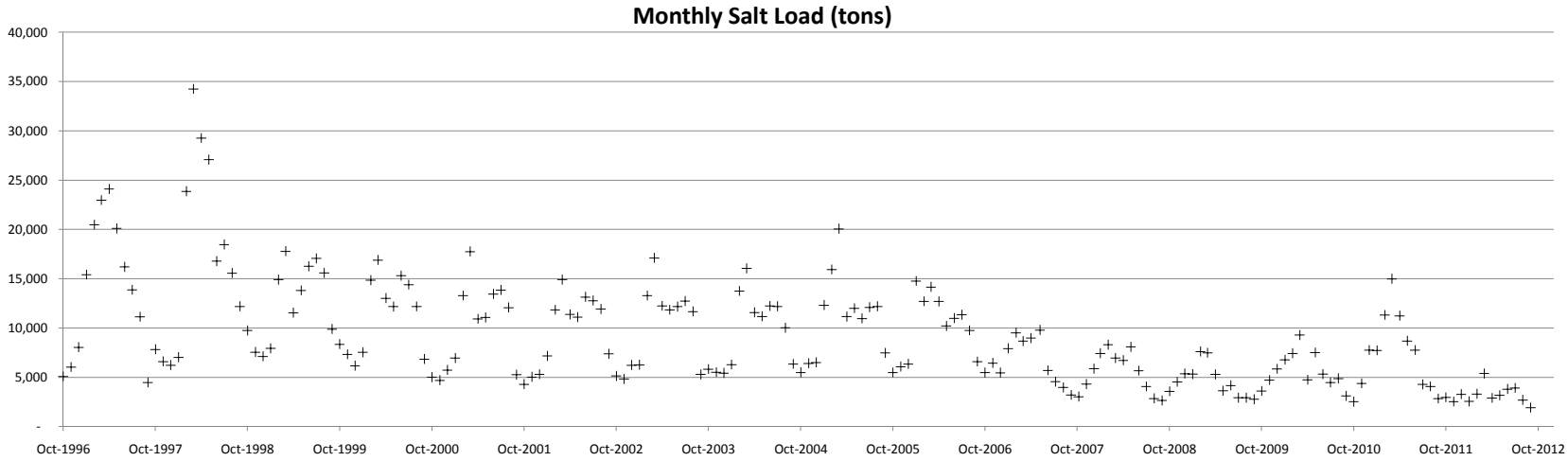
Grassland Bypass Project
San Luis Drain near terminus at Mud Slough (north)
Site B



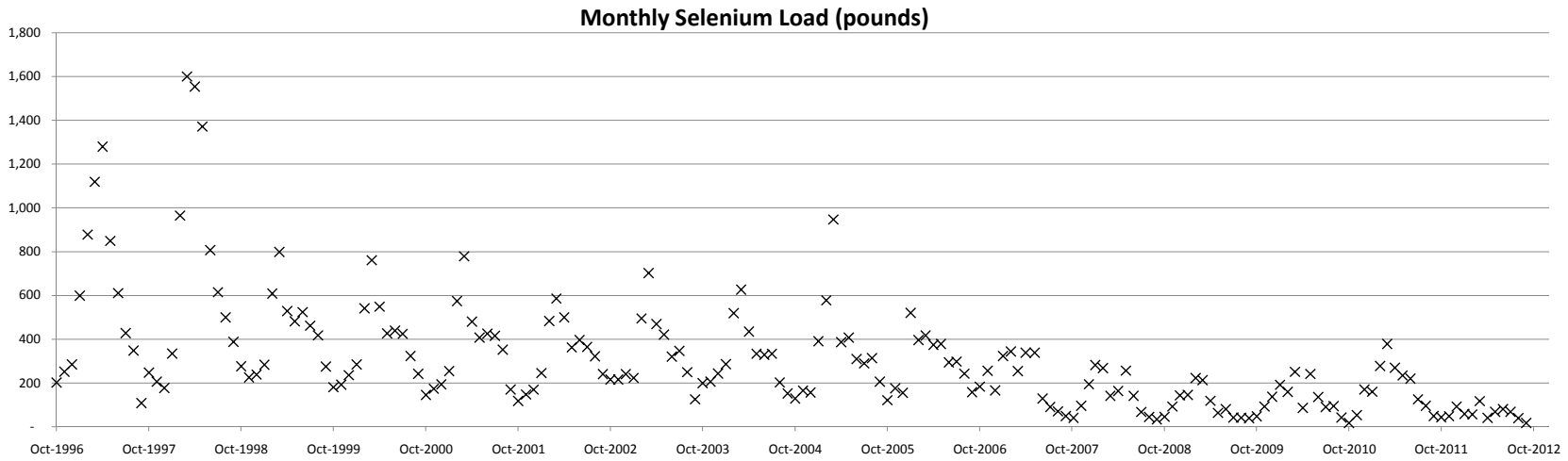


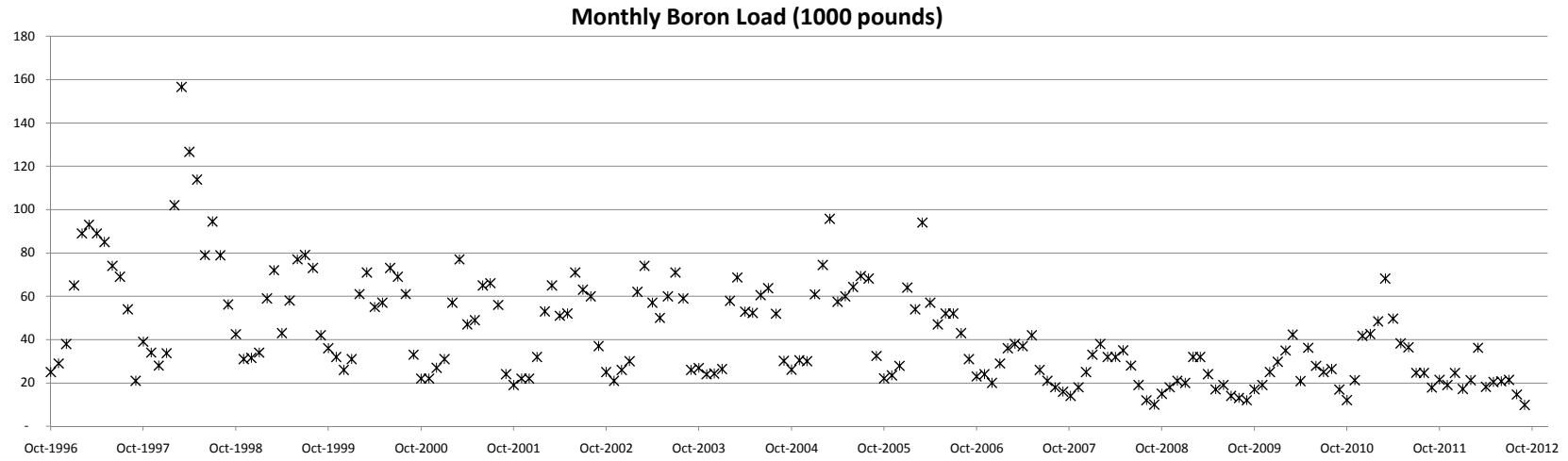
Grassland Bypass Project
San Luis Drain near terminus at Mud Slough (north)
Site B, continued



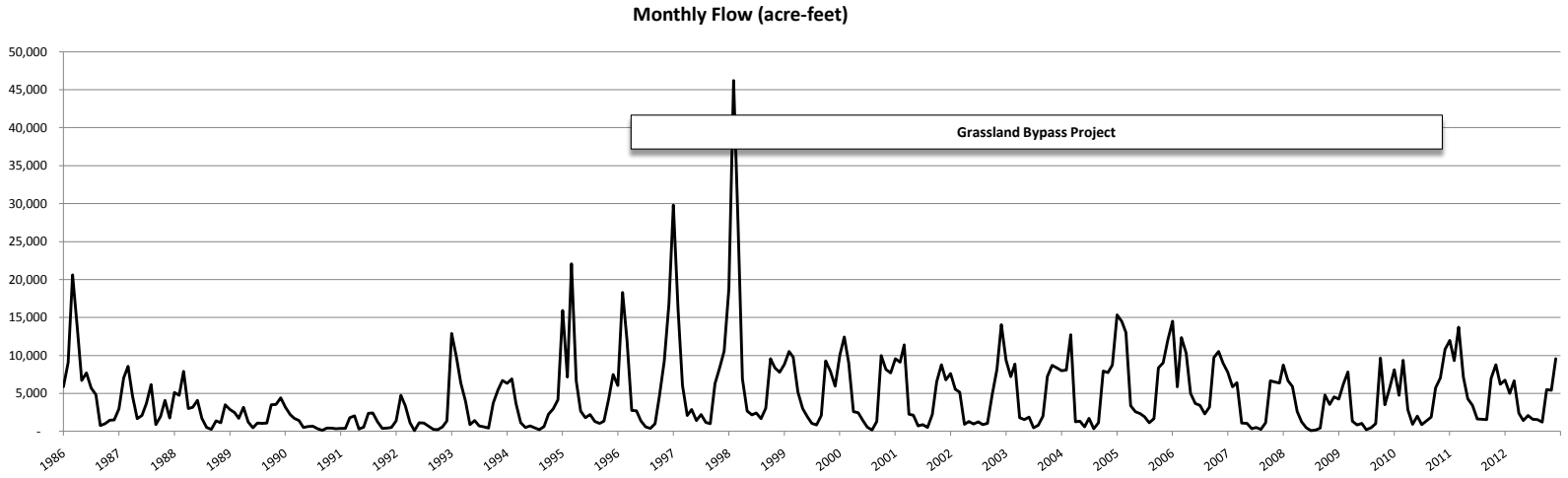


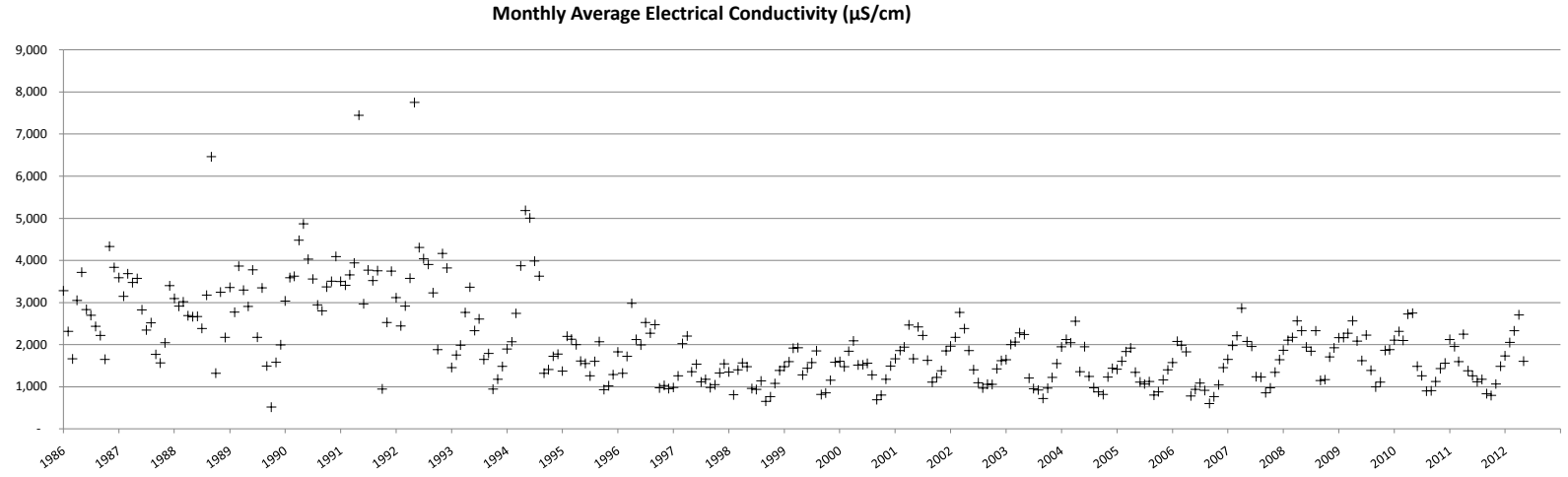
Grassland Bypass Project
San Luis Drain near terminus at Mud Slough (north)
Site B, continued





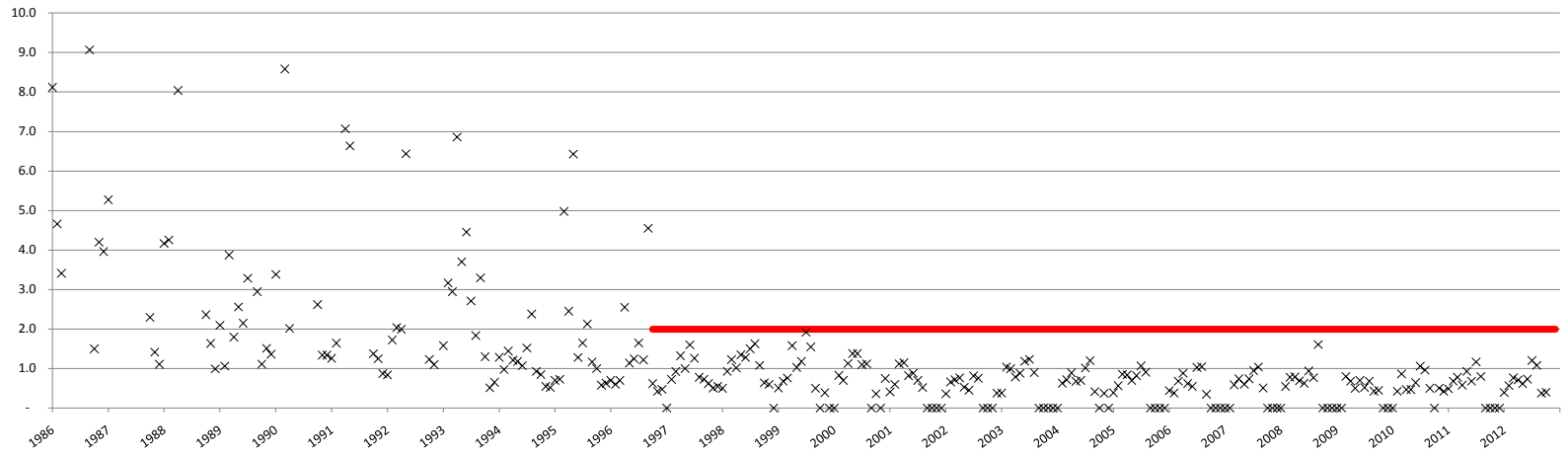
Grassland Bypass Project
Mud Slough (north), upstream of San Luis Drain Discharge
Site C



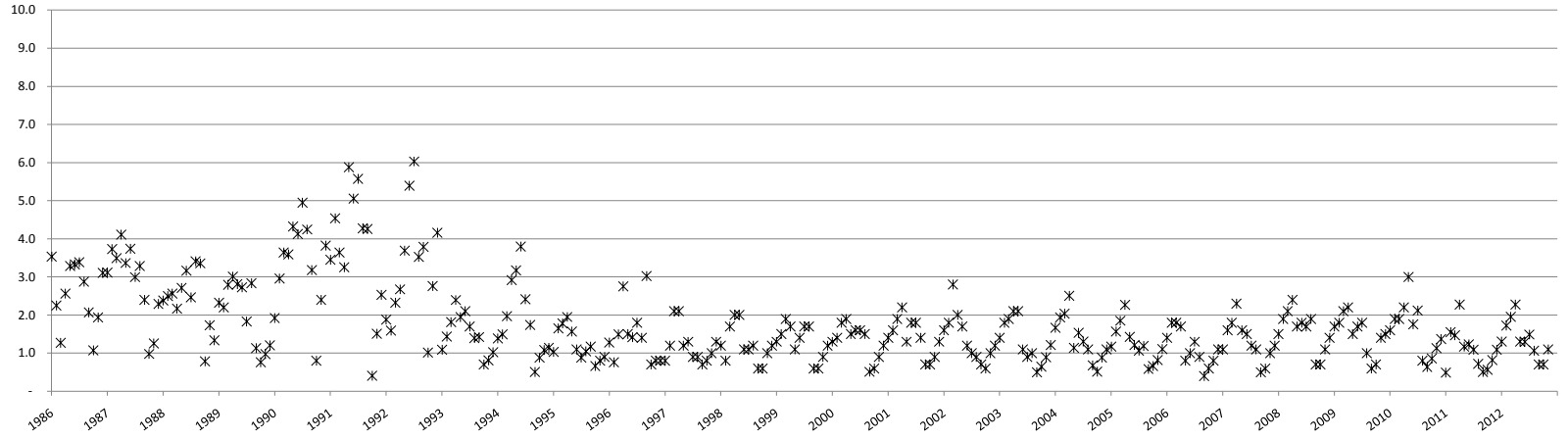


Grassland Bypass Project
Mud Slough (north), upstream of San Luis Drain Discharge
Site C

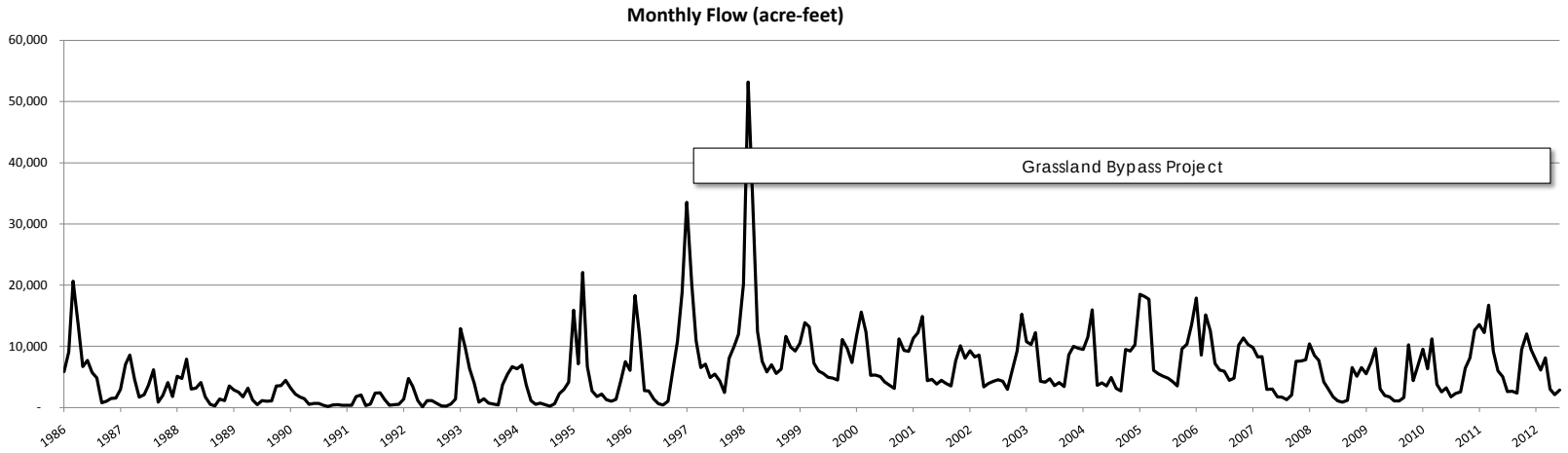
Monthly Average Selenium Concentration (µg/L)

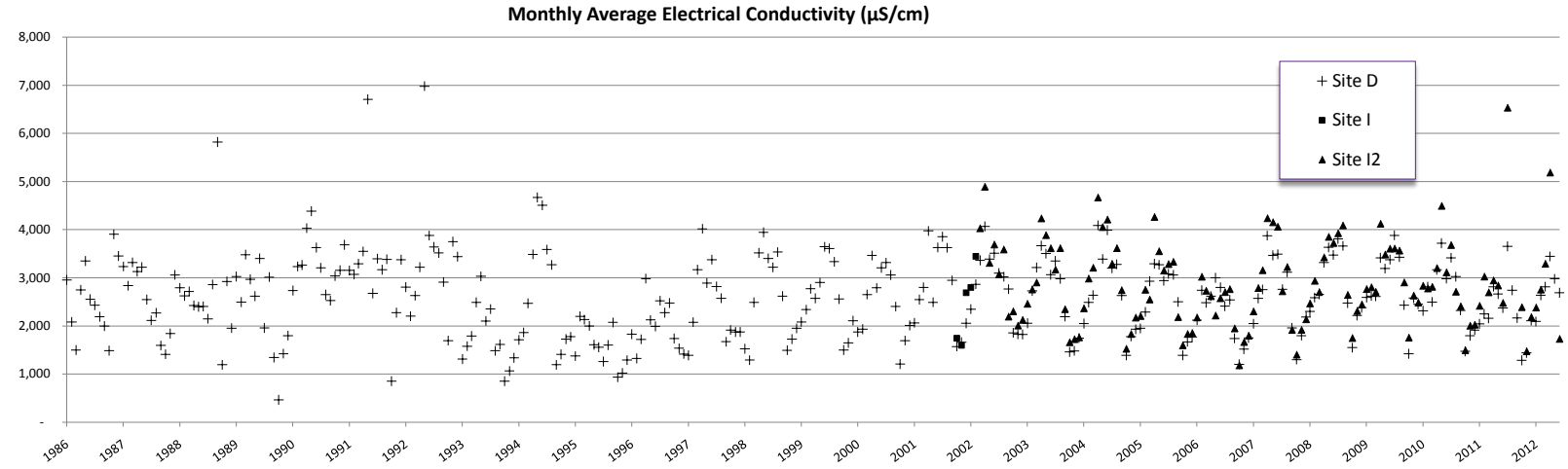


Monthly Average Boron Concentration (mg/L)

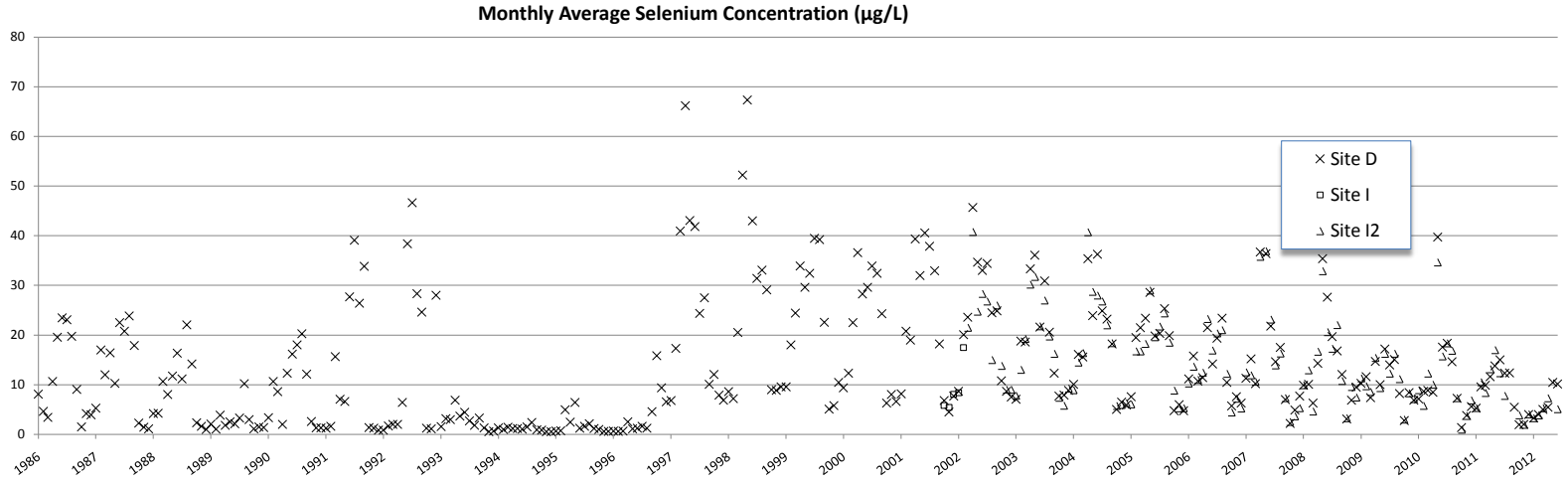


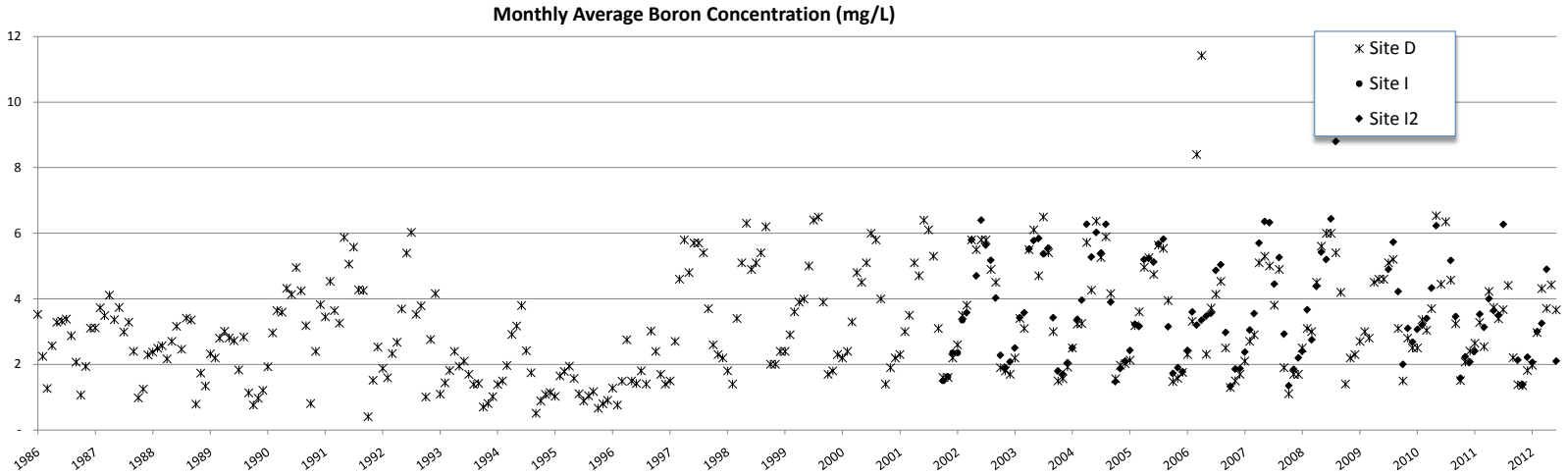
Grassland Bypass Project
Mud Slough (north), downstream of San Luis Drain Discharge
Sites D, I and I2



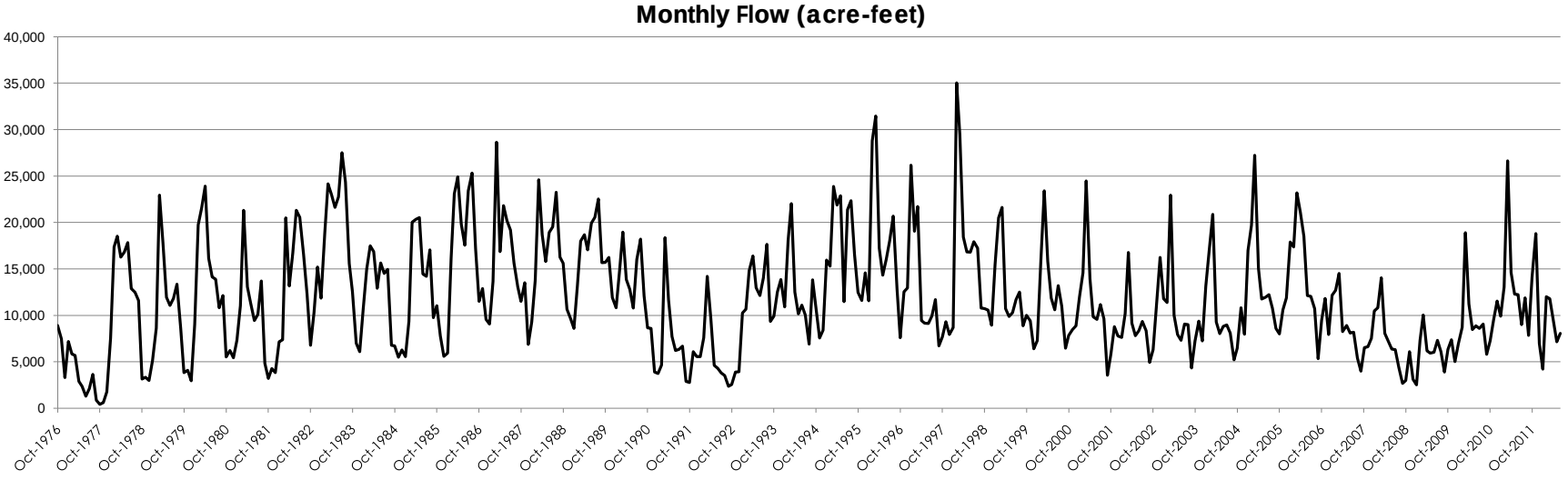


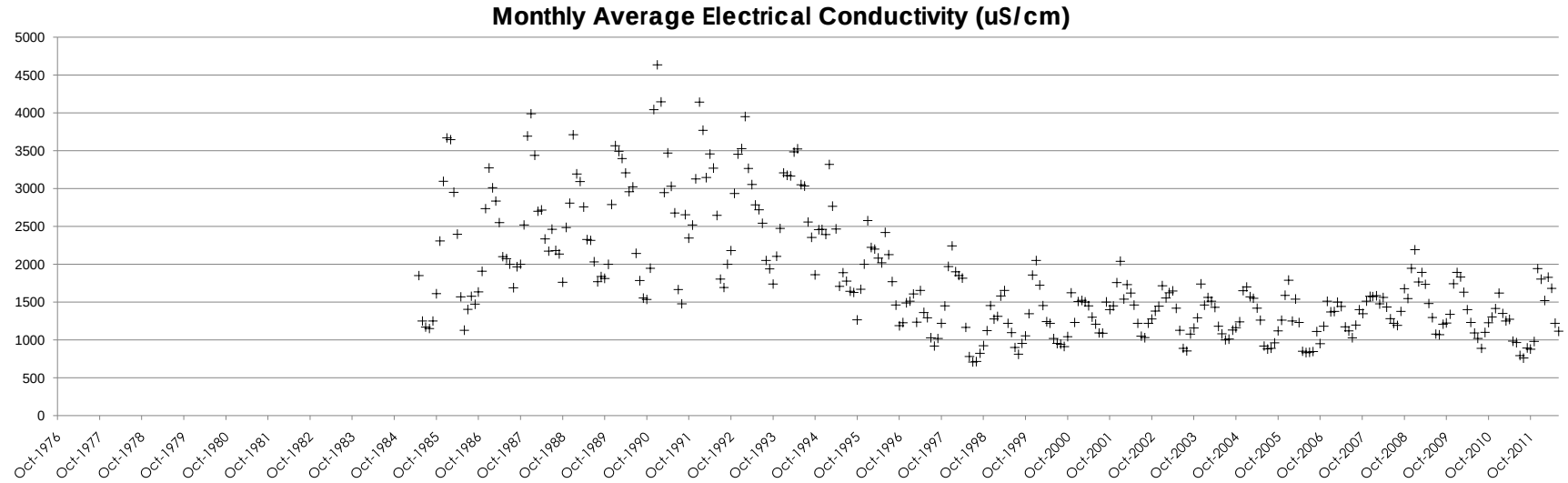
Grassland Bypass Project
Mud Slough (north), downstream of San Luis Drain Discharge
Sites D, I and I2



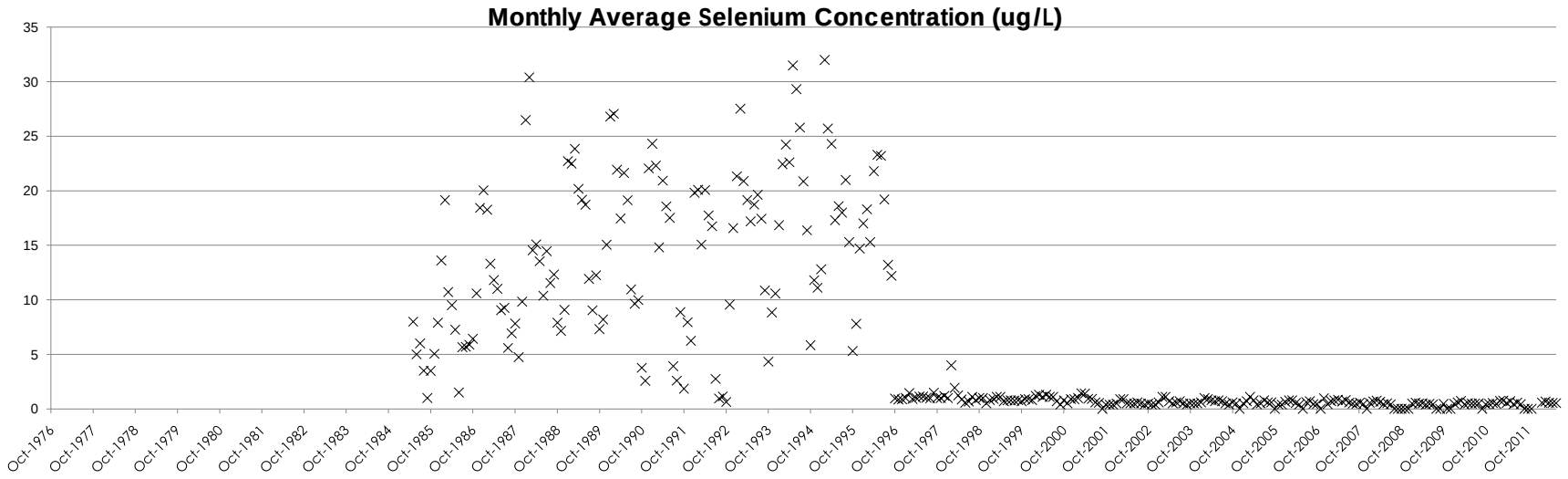


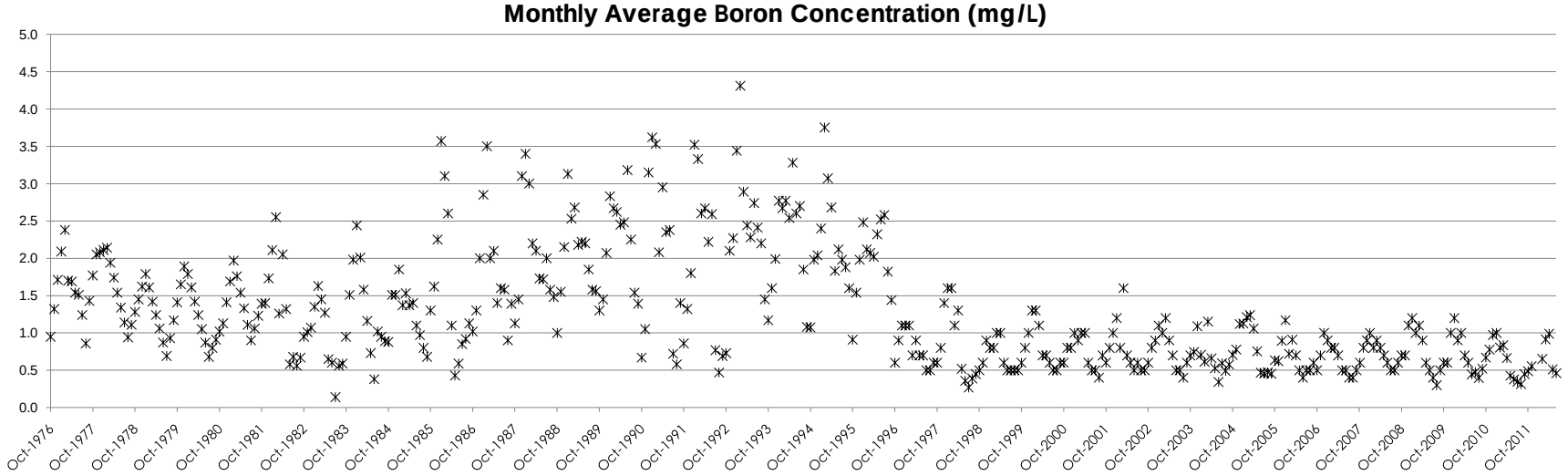
Grassland Bypass Project
Salt Slough
Site F



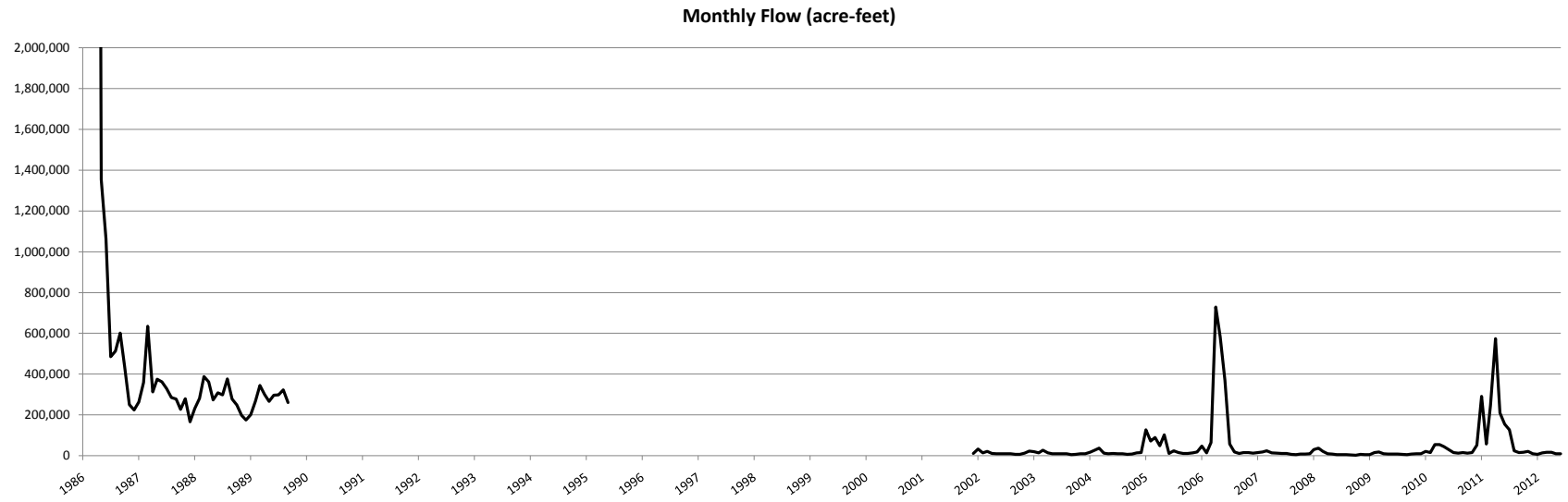


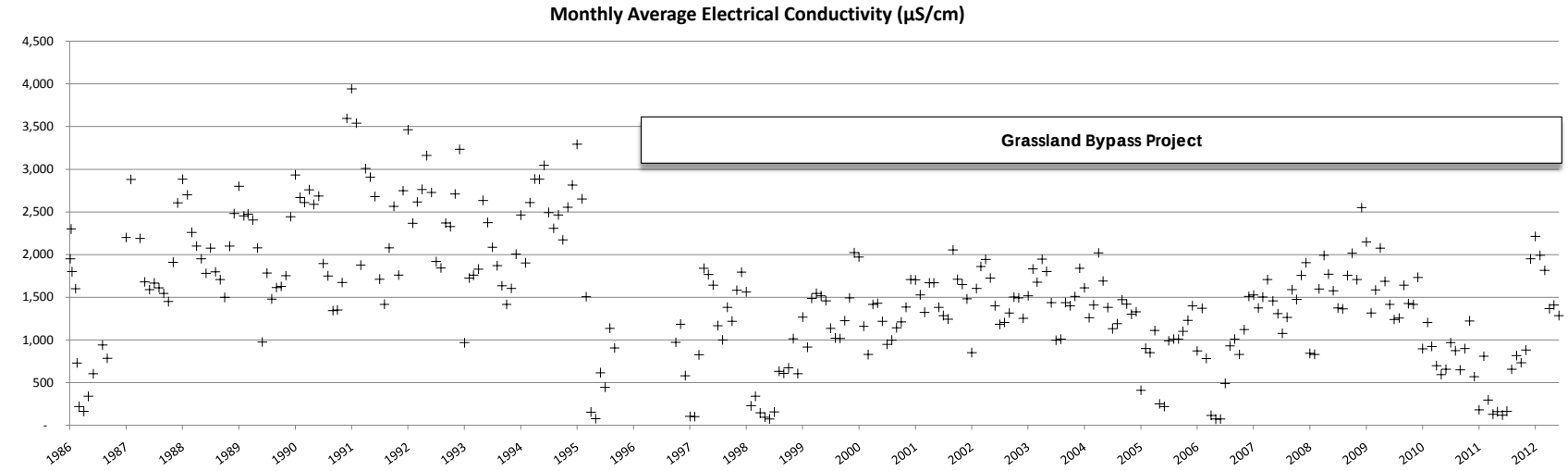
Grassland Bypass Project
Salt Slough
Site F



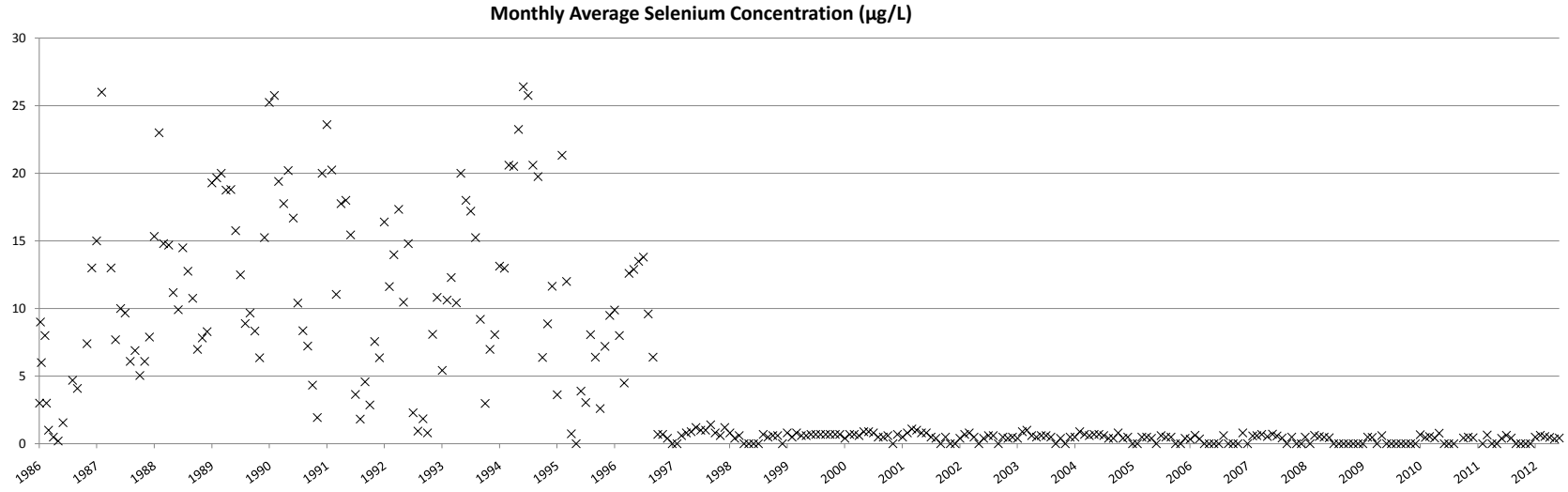


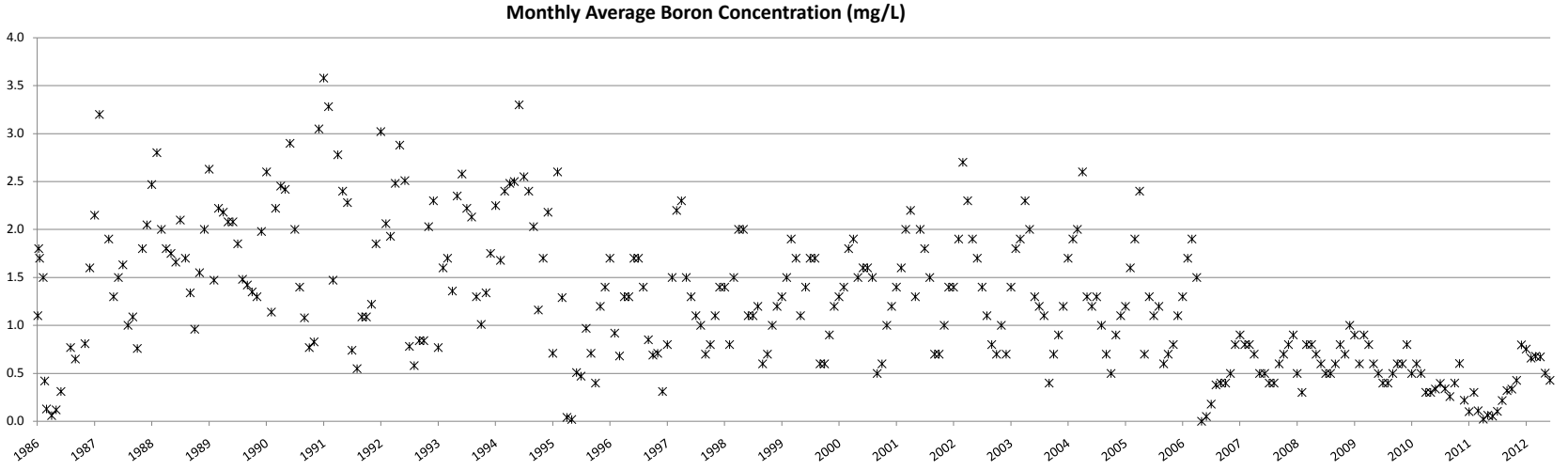
Grassland Bypass Project
San Joaquin River at Fremont Ford, upstream of Mud Slough (north)
Site G



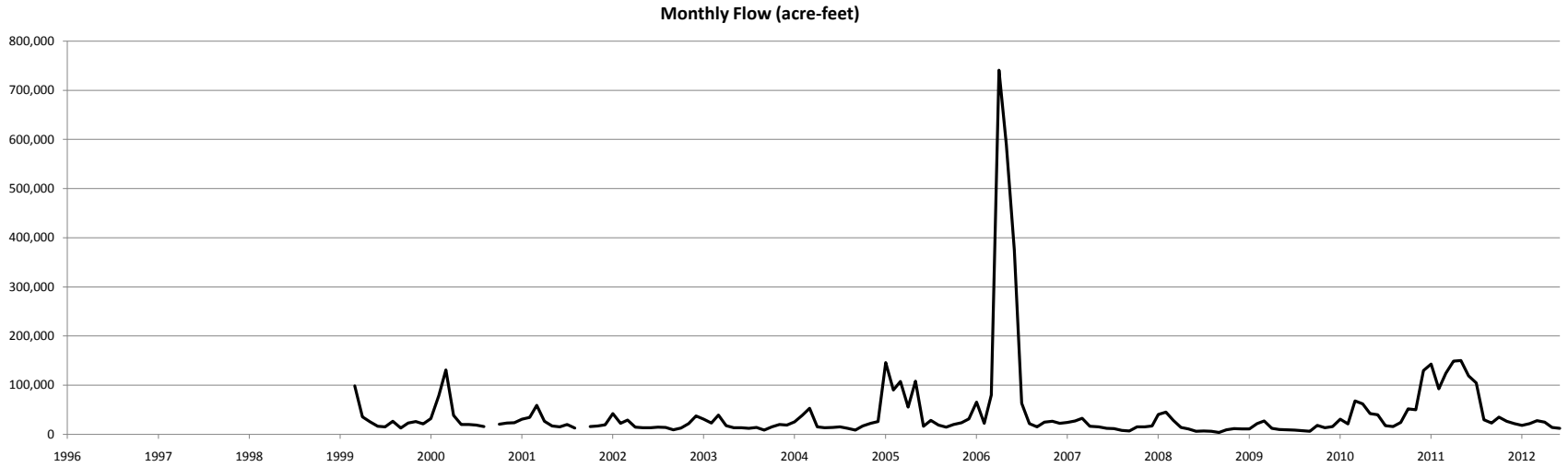


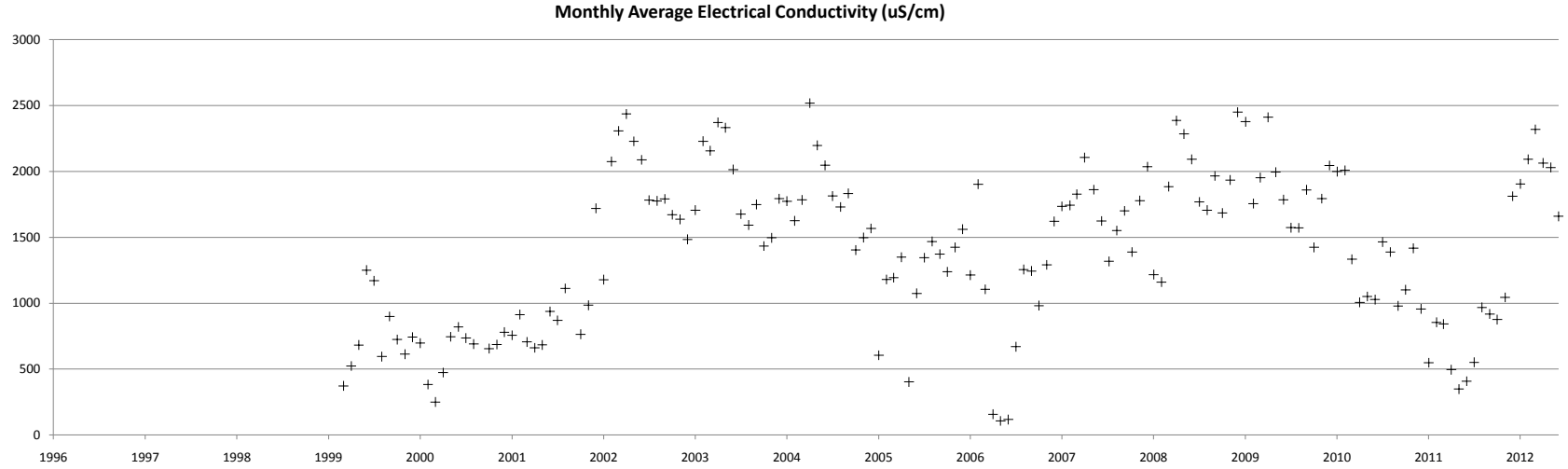
Grassland Bypass Project
San Joaquin River at Fremont Ford, upstream of Mud Slough (north)
Site G



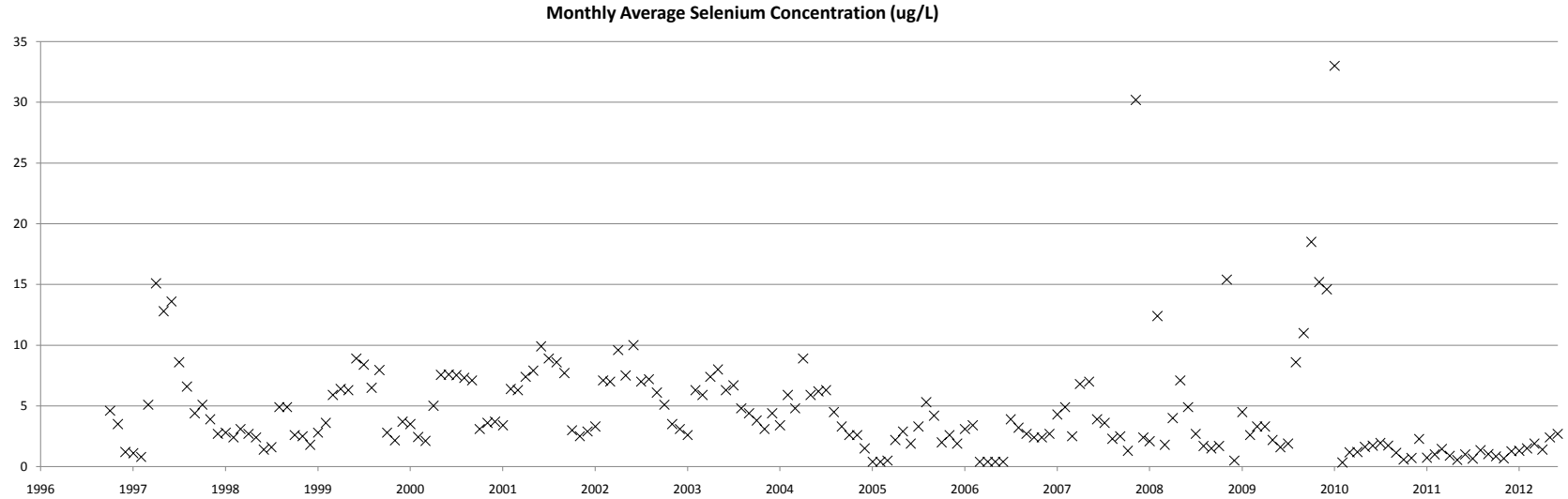


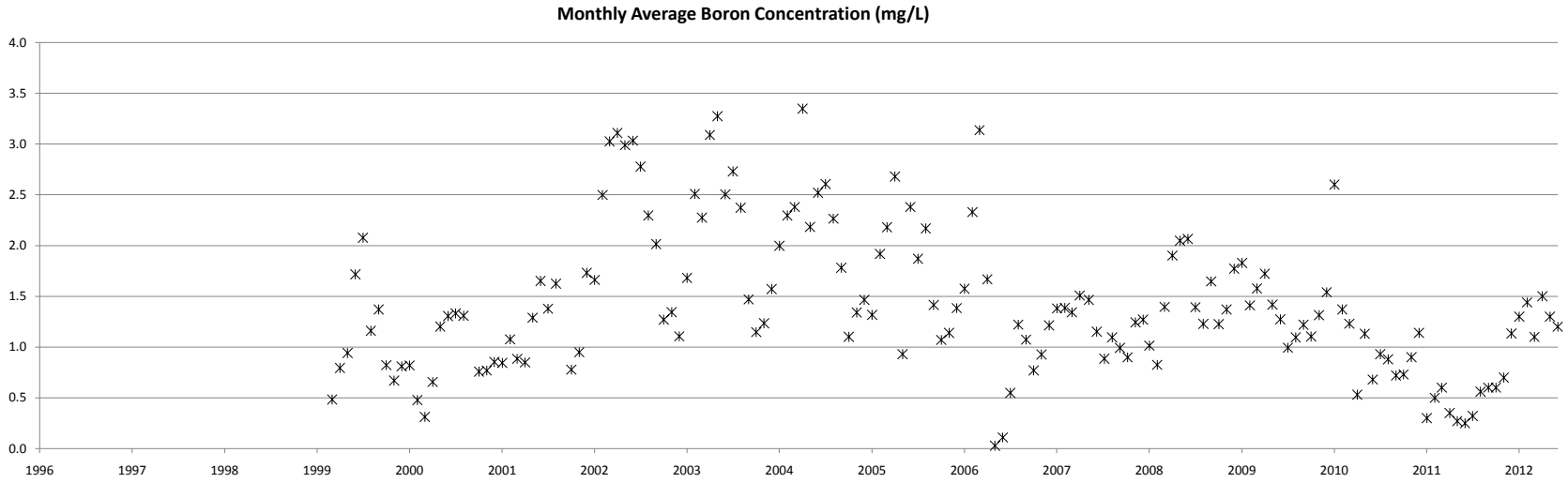
Grassland Bypass Project
San Joaquin River above Merced River (Hills Ferry)
Site H, 1996 - 2012



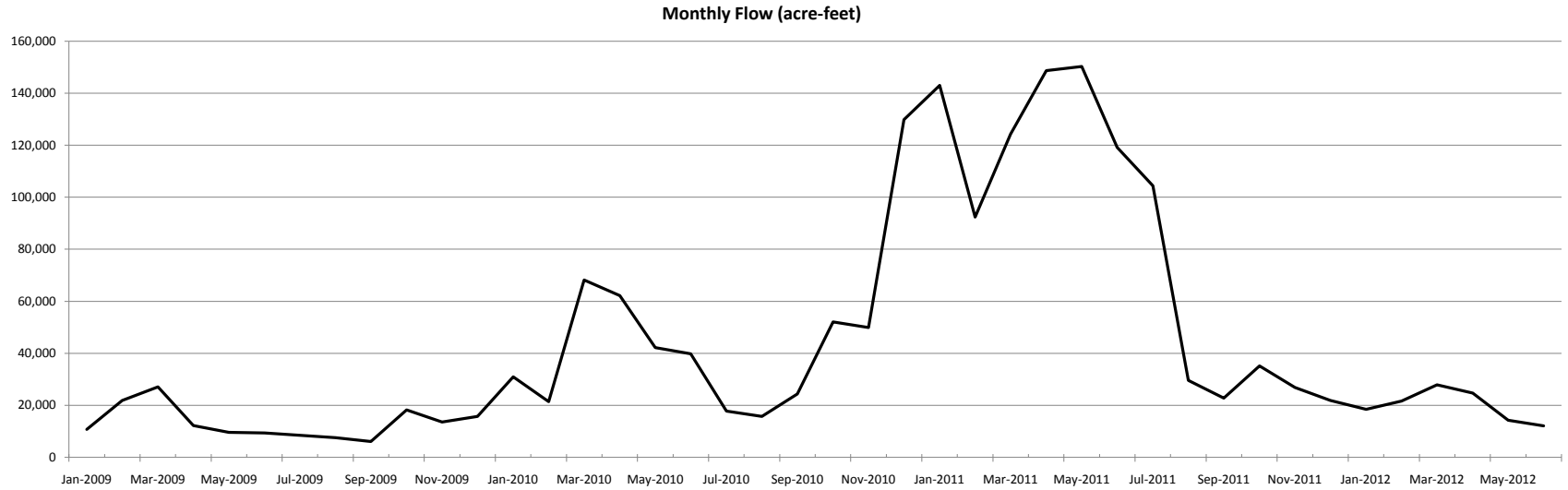


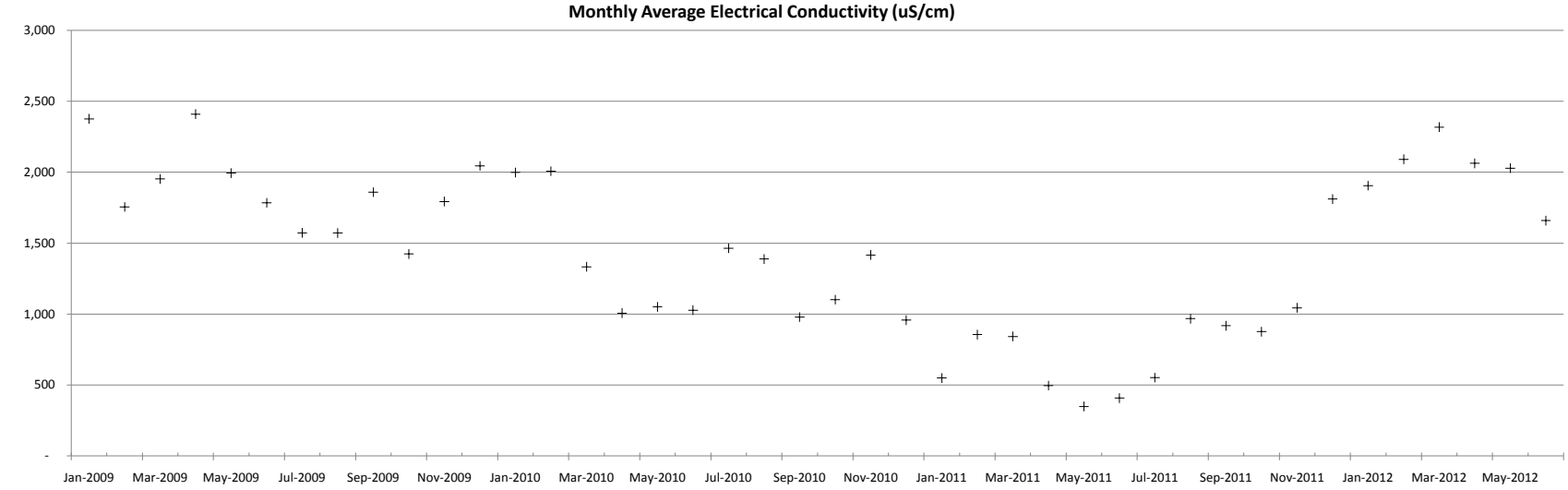
Grassland Bypass Project
San Joaquin River above Merced River (Hills Ferry)
Site H, 1996 - 2012



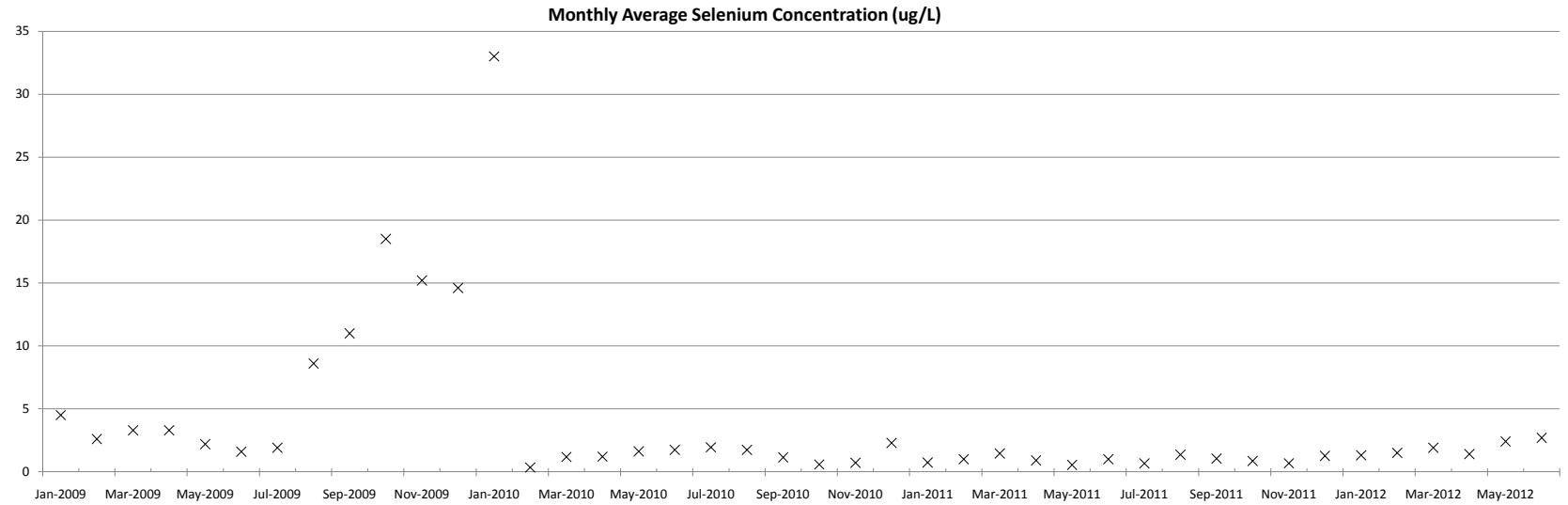


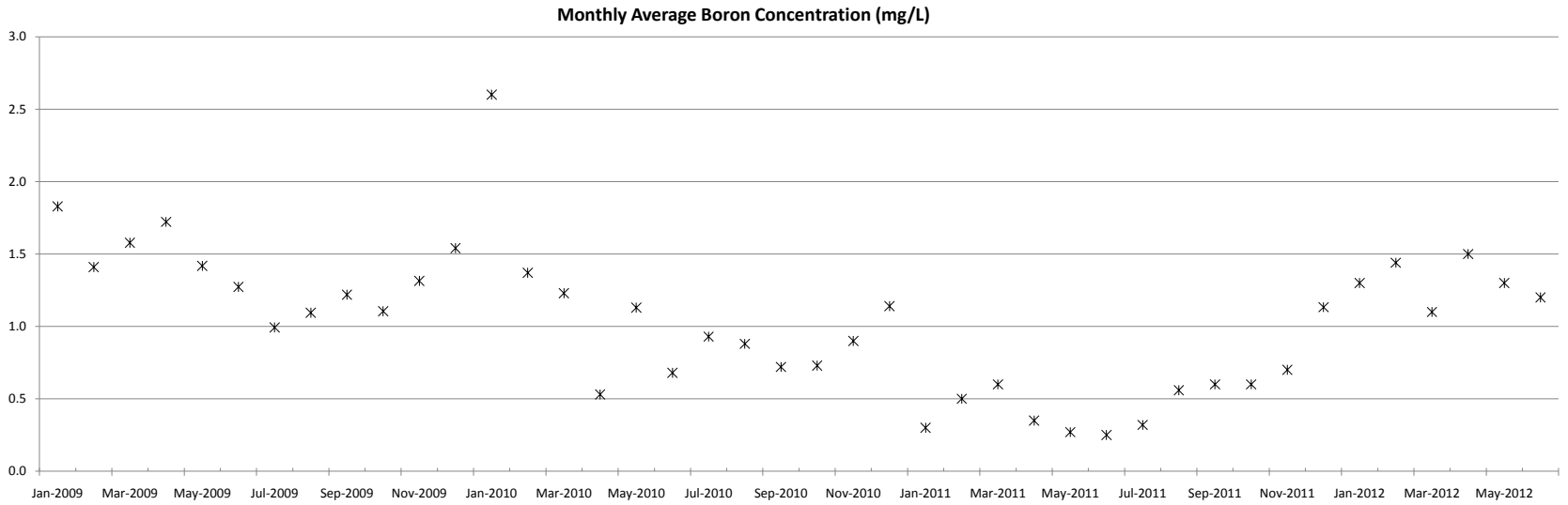
Grassland Bypass Project
San Joaquin River above Merced River (Hills Ferry)
Site H, 2009 - 2012



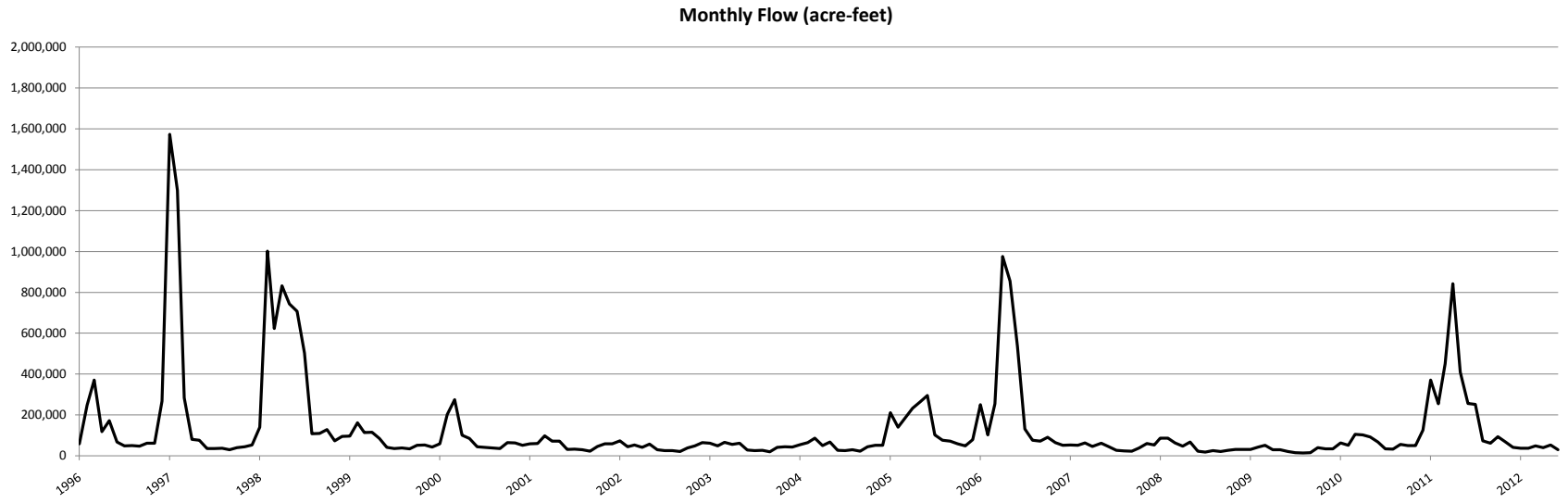


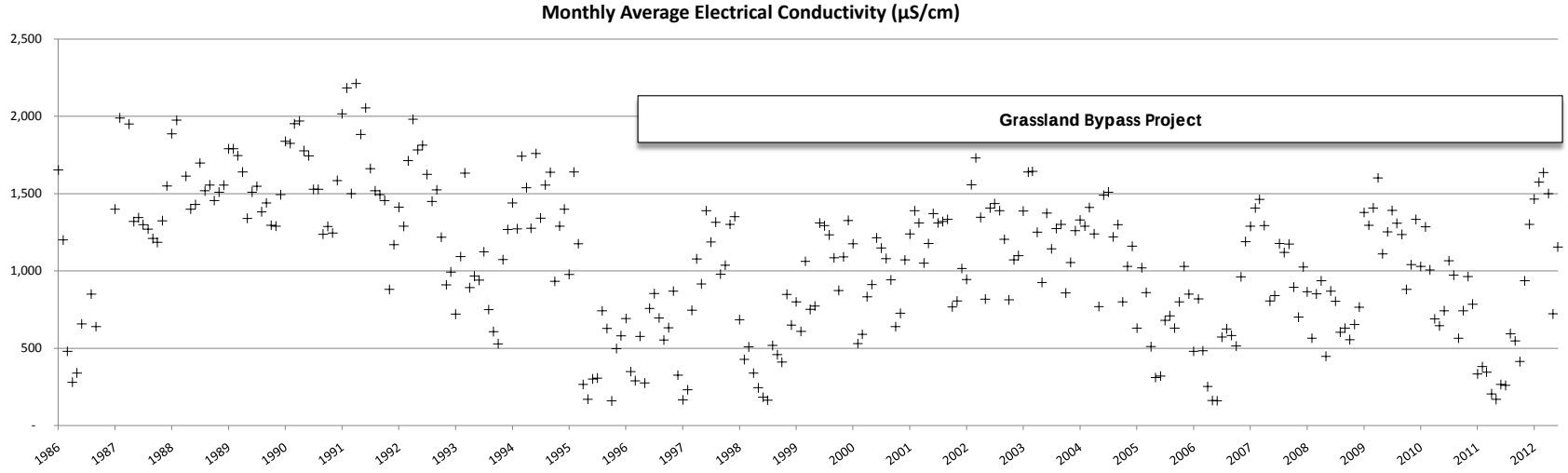
Grassland Bypass Project
San Joaquin River above Merced River (Hills Ferry)
Site H, 2009 - 2012



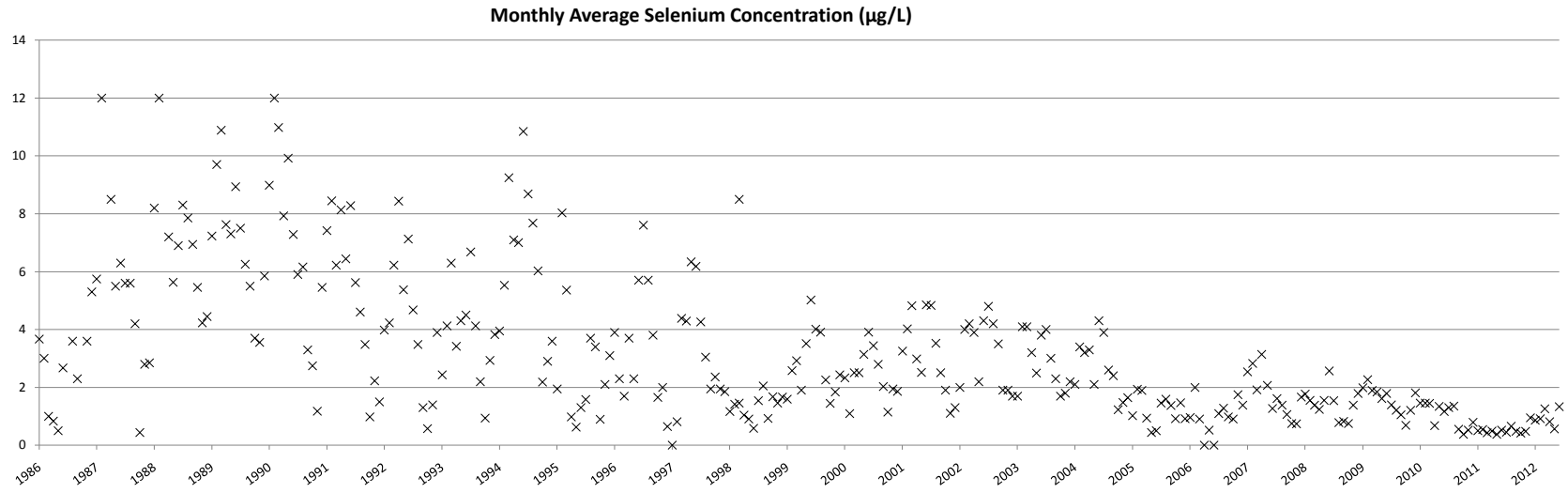


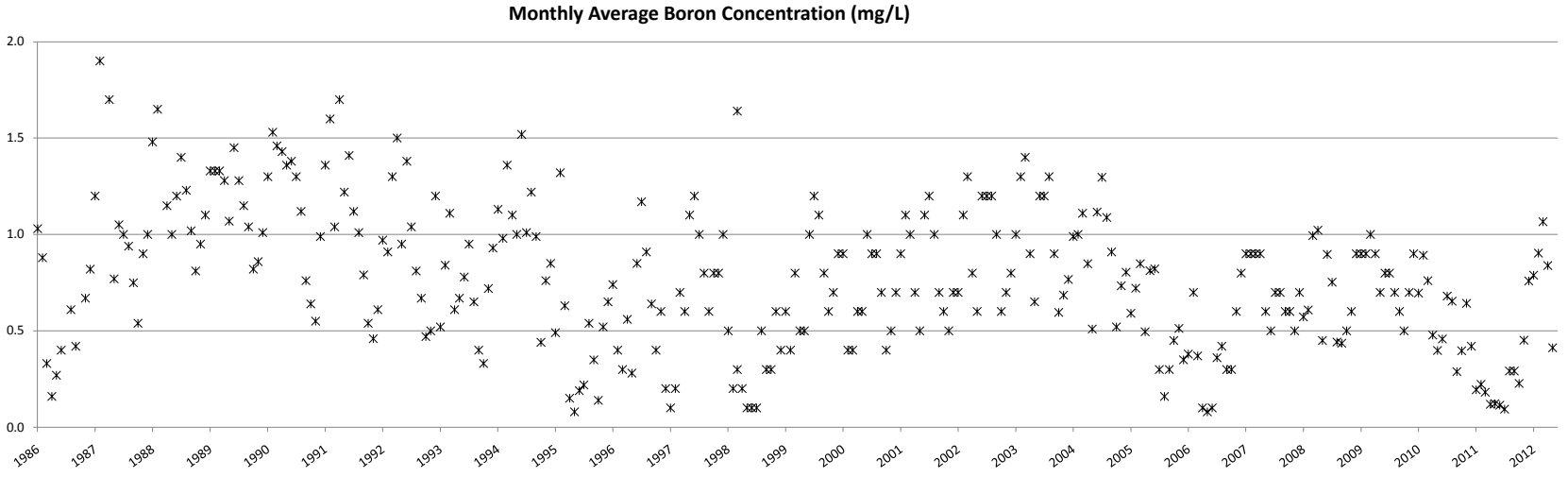
Grassland Bypass Project
San Joaquin River at Crows Landing
Site N





Grassland Bypass Project
San Joaquin River at Crows Landing
Site N





Appendix 4. Reporting Requirements

Quarterly Monitoring Data Reports

1. Excel workbook with all data records in CEDEN format (surface water)
2. Electronic copies of photos from all surface water monitoring sites, labeled with CEDEN station code and date.
3. Electronic copies of all applicable laboratory analytical reports
4. For toxicity reports, all laboratory raw data must be included, including data for failed tests, as well as copies of original bench sheets showing results of individual replicates, such that all calculations and statistics can be reconstructed. The toxicity analyses data must include individual sample results, negative control summary results, and replicate results. The minimum in-test water quality measurements reported must include minimum and maximum measured values for specific conductivity, pH, ammonia, temperature, and dissolved oxygen.
5. For chemistry data, analytical reports must include the following:
    a. A lab narrative describing QC failures
    b. Analytical problems and anomalous occurrences
    c. Chain of custody and sample receipt documentation
    d. All sample results for contract and subcontract laboratories with units, reporting limits, and minimum detection levels.
    e. Sample collection, preparation, extraction, and analysis dates.
    f. Results for all quality control samples including all field and laboratory blanks, lab control spikes, matrix spikes, filed and laboratory duplicates, and surrogate recoveries.

Annual Report

1. Signed transmittal letter
2. Title page
3. Table of contents
4. Executive summary
5. Description of Project geographical area
6. Monitoring objectives and design
7. Location maps showing sampling sites, crop and land uses within the project area (updated annually)
8. Rainfall records
9. Tabulated results of all analyses arranged in tabular form
10. Discussion of data relative to water quality objectives
11. Sampling and analytical methods used
12. Summary of Quality Assurance Evaluation results for precision, accuracy, and completeness
13. Specification of the methods used to obtain estimated flow at each site
14. Summary of exceedances of water quality objectives occurring during the reporting

period

15. Actions taken to address water quality exceedances that have occurred, including but not limited to, revised or additional management practices implemented.
16. Evaluation of monitoring data to identify spatial and temporal trends and patterns
17. Summary of annual Nitrogen budget
18. Summary of management practice information
19. Summary of mitigation monitoring
20. Summary of education and outreach activities
21. Conclusions and recommendations