

Appendix D

Seepage Monitoring and Management Plan for Water Year 2010 Interim Flows

**Water Year 2010 Interim Flows Project
Final
Environmental Assessment/Initial Study**



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List of Abbreviations and Acronyms

Act	San Joaquin River Restoration Settlement Act
cfs	cubic feet per second
DWR	California Department of Water Resources
EA/IS	Environmental Assessment/Initial Study
RA	Restoration Administrator
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
Secretary	Secretary of the U.S. Department of the Interior
SJRRP	San Joaquin River Restoration Program
WY	Water Year

1.0 Introduction

This Seepage Monitoring and Management Plan for Water Year (WY) 2010 Interim Flows (Seepage Monitoring and Management Plan) includes groundwater monitoring, levee patrols, landowner feedback, flow monitoring, and potential management responses to address nonattainment with the seepage management objective. The monitoring and management approach described in this plan are included in the Proposed Action for the San Joaquin River Restoration Program (SJRRP) – WY 2010 Interim Flows Environmental Assessment/Initial Study (EA/IS).

1.1 Overview

The seepage management objective is to reduce or avoid adverse third-party impacts resulting from groundwater and levee seepage. The seepage management objective would be attained by achieving the seepage monitoring objective, to identify conditions in real time that could lead to seepage, to support decisions on changing WY 2010 Interim Flow releases. Portions of the Restoration Area have historically experienced groundwater seepage to adjacent lands associated with elevated flows. Groundwater seepage has the potential to cause waterlogging of crops and salt mobilization in the crop root zone. Similarly, some portions of the Restoration Area have experienced levee instability resulting from through-levee and under-levee seepage during periods of elevated flows.

As described in Section 2 of the EA/IS, after initiation in October 2009, the WY 2010 Interim Flows would increase gradually and incrementally from base flows to up to 350 cubic feet per second (cfs). Flows would gradually and incrementally be increased above 350 cfs according to the Exhibit B flows schedules, and consistent with recommendations of the Restoration Administrator (RA). The maximum release for WY 2010 Interim Flows in fall 2009 would be 700 cfs between November 1 and November 11. Flows would not be released between November 20, 2009, and January 31, 2010.

Beginning February 1, 2010, Interim Flows would begin again and flows would be gradually increased from typical releases from Friant Dam. During this spring period, flows would be gradually and incrementally increased based on the information collected on channel capacities and changes in the shallow groundwater elevations during the fall release period and consistent with Exhibit B of the Settlement and the recommendations of the RA.

The maximum release for WY 2010 Interim Flows in spring would occur between 2 weeks to 14 weeks, and would be between 130 cfs to 1,660 cfs, depending on the water year type. Based on assessments of the best available information, including anecdotal information, hydraulic modeling, and records of historical conditions (described in the EA/IS), it is anticipated that the releases of 1,660 cfs, corresponding to a flow of 1,300 cfs downstream from Reach 2A, would not cause groundwater or levee seepage. Additional anecdotal information provided by landowners during review of the public

Draft EA/IS supports 1,300 cfs as the upper limit for WY 2010 Interim Flows in Reach 2B and downstream, and suggests that groundwater and levee seepage effects could occur in Reach 2B and below at flows that correspond to 475 cfs. Based on this additional information, the monitoring frequency would be increased when Friant Dam releases would be expected to result in WY 2010 Interim Flows of 475 cfs or greater in Reaches 2B and 3.

This plan provides direction for seepage monitoring and management, but does not describe in detail the specific design of seepage monitoring activities (e.g., location of groundwater wells, specific timing and frequency of levee patrols); details of these activities will necessarily be dictated by the real-time results during monitoring. Table 1-1 summarizes the components of this plan.

**Table 1-1.
Components of Seepage Monitoring and Management Plan
for WY 2010 Interim Flows**

Monitoring and Management Components	Application of Component to Seepage Monitoring and Management Plan
SJRRP Management Objective for Restoration Flows Within the Restoration Area	Reduce or avoid adverse third-party impacts resulting from groundwater and levee seepage
SJRRP Monitoring Objective for Restoration Flows Within the Restoration Area	Identify conditions in real time that could lead to seepage
Associated Physical Condition Monitoring Within the Restoration Area	Monitor groundwater elevations, patrol and visually inspect levees, and establish and maintain contact with landowners
Conditions Indicating Attainment of SJRRP Management Objectives	Convey WY 2010 Interim Flows without causing third-party seepage effects
Potential Actions to Address Nonattainment of Management Objectives	Reduce Friant Dam releases and/or redirect flows through bypasses

Key:

SJRRP = San Joaquin River Restoration Program

WY= Water Year

1.2 Definition of Key Terms

Key terms defined in the Settlement include the following:

- **Infiltration** – Transition of water from surface to subsurface flows.
- **Program Manager** – Authorized representative for the Secretary of the U.S. Department of the Interior (Secretary) overseeing the SJRRP.
- **Restoration Flows** – Collectively, the base flows, buffer flows, and any additional water acquired by the Secretary from willing sellers to meet the Restoration Goal of the Settlement (see below).

- **Seepage** – Lateral flow of water from the San Joaquin River and flood channel into adjacent lands.
- **Shallow Groundwater Table** – water elevation at or near the surface of surrounding lands.
- **Interim Flows** – Releases of water from Friant Dam consistent with Restoration Flow Schedules specified in the Settlement but subject to channel capacity limitations, and commencing no later than October 1, 2009, for the purpose of collecting relevant data concerning flows, temperatures, fish needs, seepage losses, recirculation, recapture, and reuse.
- **Base Flows** – Releases from Friant Dam made in accordance with Exhibit B of the Settlement. Together, the base flows, buffer flows, and any additional water acquired by the Secretary from willing sellers to meet the Restoration Goal of the Settlement are collectively referred to as the “Restoration Flows.”
- **Buffer Flows** – Releases of up to an additional 10 percent of applicable base flows, as provided in Paragraph 18 and Exhibit B of the Settlement. Together, the base flows, buffer flows, and any additional water acquired by the Secretary from willing sellers to meet the Restoration Goal of the Settlement are collectively referred to as the “Restoration Flows.”
- **Flushing Flows** – A block of water averaging 4,000 cfs from April 16 through 30 in Normal-Wet and Wet years (see below) that could be needed to perform geomorphic functions such as flushing spawning gravels, in accordance with Exhibit B of the Settlement.
- **Restoration Year Type** – Exhibit B of the Settlement identifies six Restoration Year-Types based on October-to-September unimpaired runoff (inflow) at Friant Dam. These are (in order of increasing “wetness”) as follows: Critical-Low, Critical-High, Dry, Normal-Dry, Normal-Wet, and Wet. Except the water year type with the least flow (Critical-Low), water years are defined as falling in a defined range on an exceedence curve of the unimpaired runoff. The Settlement defines water year types based on their occurrence in an 83-year period, from 1922 through 2004, without using a conventional threshold approach. While the associated water year type for each year within the 83-year period is clear, extrapolation of such a Restoration Year Type definition for years outside this period is not. To be consistent with Exhibit B, a threshold was defined using a practical point, near the average of the unimpaired runoff amounts, of 2 years that bracket the transition. Therefore, classification of Restoration Year Types was recommended for the SJRRP based on annual October-through-September unimpaired flow below Friant Dam threshold levels, as shown in Table 1-2.

**Table 1-2.
Water Year Types and Associated Threshold Levels
Based on the Settlement**

Total Annual Inflow to Millerton Lake	Exceedence Level	Restoration Year Type
Equal to or greater than 2,500,000 acre-feet	Wettest 20%	Wet
Equal to or greater than 1,450,000 acre-feet	Next 30% (20 to 50%)	Normal-Wet
Equal to or greater than 930,000 acre-feet	Next 30% (50 to 80%)	Normal-Dry
Equal to or greater than 670,000 acre-feet	Next 15% (80 to 95%)	Dry
Equal to or greater than 400,000 acre-feet	Remaining 5% (95 to 100%)	Critical-High
Less than 400,000 acre-feet		Critical-Low

Key:

Settlement = Stipulation of Settlement

- **Hydrographs** – A chronological graphic record of stream discharge or water level (stage) at a given point on a stream (i.e., a graph of discharge or stage versus time). Hydrographs for various reaches of the San Joaquin River for each water year type are contained in Exhibit B of the Settlement.
- **Settlement** – *NRDC, et al., v. Kirk Rodgers, et al.*
- **Legislation** – San Joaquin River Restoration Settlement Act (Act) (Public Law 111-11)

2.0 Seepage Management

This section describes the seepage management portion of this plan for WY 2010 Interim Flows, including pertinent language from the Act, monitoring information, evaluation of seepage indicators, and potential management actions to attain the seepage management objective.

2.1 Pertinent Language from the Act

Section 10004, Paragraph (h), of the Act describes requirements for developing seepage monitoring. Some subsections are especially relevant to this plan, and are included in the following:

Line 3, Page 943, Paragraph (h) INTERIM FLOWS

(1) STUDY REQUIRED – Prior to releasing any Interim Flows under the Settlement, the Secretary shall prepare an analysis in compliance with the National Environmental Policy Act of 1969 (42 U.S.C 4321 et seq.), including at a minimum –

(A) an analysis of [...] potential for levee or groundwater seepage;

(B) a description of the associated seepage monitoring program;

Line 11, Page 943, Paragraph (h) INTERIM FLOWS

(3) SEEPAGE IMPACTS – The Secretary shall reduce Interim Flows to the extent necessary to address any material adverse impacts to third parties from groundwater seepage caused by such flows that the Secretary identifies based on the monitoring program of the Secretary.

2.2 Seepage Monitoring Information

Information used for the Seepage Monitoring and Management Plan includes the following categories of actions, which would be undertaken on an as-needed basis to implement the plan:

- Groundwater level monitoring
- Flow monitoring
- Patrols for visual observations in collaboration with the Lower San Joaquin Levee District
- Receiving and responding to feedback from local landowners through phone and e-mail

When flows are greater than 475 cfs in Reaches 2B and/or 3, Reclamation would conduct a daily evaluation of all information available, including recent groundwater levels, visual assessments made during levee patrols, flow and stage levels within the river channel, and landowner feedback.

2.3 Attainment of Seepage Management Objective

Historically, groundwater seepage associated with high flow in the San Joaquin River has resulted in several adverse effects to adjacent lands, including waterlogging of crops; salt mobilization into the root zone; and increased levee instability.

During WY 2010 Interim Flows, attainment of the seepage management goal would be achieved if adverse seepage effects to third parties resulting from Interim Flows are either addressed or avoided. Potential conditions that might trigger actions would depend on site-specific concerns, and include the following indicators:

- Groundwater elevations indicating an impending rise of the water table into root zones
- Levee stability problems and lateral seepage, as evidenced by visual observation of boils or piping
- Landowner observations and communication of seepage problems

2.4 Evaluation

An evaluation would be made whenever an indicator is identified. The evaluation would be performed to determine the appropriate actions to address nonattainment of the seepage management objective of avoiding seepage, and criteria would include a determination of the following:

- Type of system response identified
- Immediacy of the system response
- Need for collection of more information, potentially including site visits

2.5 Potential Actions to Address Nonattainment

Following evaluation of system responses, several potential actions may be taken. Potential operational responses to the detection or anticipation of adverse groundwater seepage effects would depend on the evaluation, and could include the following:

- **Restriction on Ramping Rate** – Limits on incremental increases in flow rates would enable the system response to be observed while limiting the volume of WY 2010 Interim Flow releases.

- **Reductions of WY 2010 Interim Flow at Friant Dam** – The Act directs the Secretary to “reduce Interim Flows to the extent necessary to address any material adverse effects to third parties from groundwater seepage caused by such flows that the Secretary identifies based on the monitoring program.”
- **Redirection of WY 2010 Interim Flows at Chowchilla Bypass Bifurcation Structure** – Directing flow into the bypass system at the Chowchilla Bypass Bifurcation Structure would provide a faster response for downstream reaches. This response requires an agreement for operations, and mitigation for levee district actions.
- **Delivery of WY 2010 Interim Flows to Exchange Contractors at Mendota Pool** – Delivery of water to the Mendota Pool would reduce flows in Reach 3. Use of diversions from the Mendota Pool to reduce flows would require coordination with Central California Irrigation District and San Luis & Delta-Mendota Water Authority.
- **Delivery of WY 2010 Interim Flows to Exchange Contractors and/or Refuges at Sack Dam** – When San Luis Canal Company is not fully diverting, additional water diversions can assist with reducing potential seepage effects in Reach 4A and downstream. Use of the Sack Dam response would be consistent with water demands at the Arroyo Canal.
- **Redirection of WY 2010 Interim Flows at Sand Slough Control Structure** – During WY 2010 Interim Flows, water would not be directed into Reach 4B. In subsequent years, water causing seepage effects in Reach 4B could be diverted into the Eastside Bypass.

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3.0 Seepage Monitoring

This section describes monitoring pertaining to groundwater and levee seepage for WY 2010 Interim Flows. This includes monitoring flow and groundwater levels. This section provides a framework for the SJRRP Monitoring Program, attached to this document.

Seepage monitoring tools include monitoring flow and groundwater elevations, conducting levee patrols, contacting landowners, and establishing procedures for landowners to report potential or observed seepage. Implementation would require a number of site-specific efforts to identify final monitoring locations, and install groundwater monitoring wells. Coordination with local landowners will provide information to improve the effectiveness of the monitoring program. Data collected as part of SJRRP monitoring efforts will be made available to the public in the form of annual technical reports.

3.1 Flow Monitoring

Flow monitoring will obtain flow and stage data in the San Joaquin River. Paragraph 13 and Exhibit B of the Settlement specify Interim Flow measurement on the San Joaquin River at the first six locations listed below. In addition to the six gages identified by the Settlement, a seventh gage is scheduled for installation to monitor potential Interim Flows to the Eastside Bypass. If surface water stage corresponding to known or observed levee stability problems and lateral seepage are observed, WY 2010 Interim Flows would be reduced or diverted. Flow data will also be used to identify potential infiltration losses between gage stations on the San Joaquin River.

The following is a complete list of intended flow monitoring locations for WY 2010 Interim Flows:

- Below Friant Dam
- At Gravelly Ford
- Below Chowchilla Bypass Bifurcation Structure
- Below Sack Dam
- At the head of Reach 4B1
- Above the Merced River confluence
- At the head of the Sand Slough Bypass

3.2 Groundwater Monitoring

Currently, 33 wells are permitted for installation on public lands within the Restoration Area, as described in a Categorical Exclusion (CEC-09-36, March 2009). Additional wells on private property could be installed, pending access agreements currently under negotiation with landowners. Access limitations and information from monitoring, analysis, and trouble spots identified by local landowners would determine the final location of groundwater transects and wells developed with the specific intent of monitoring potential groundwater seepage. Information collected as part of the initial phases of monitoring may require changing locations or adding or decommissioning wells in the future.

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation) and California Department of Water Resources (DWR) would monitor groundwater levels in installed wells. Observed groundwater levels would be used by the Secretary to determine when to reduce flow releases from Friant Dam, as required by the Act. Following installation of each monitoring well, groundwater elevation thresholds would be developed in consideration of nearby land uses, known groundwater and subsurface conditions, and other information available or provided by landowners.

In general, groundwater depth thresholds would be classified in three ranges, as illustrated in Figure 3-1. These include an acceptable level at which groundwater levels are not expected to affect agricultural production, a potential buffer zone indicating an increased likelihood that seepage could affect agricultural production without flow modification, and a threat zone representing groundwater levels that affect agricultural production. The threat zone would be determined based in part on the rooting depth associated with any crops located near the monitoring well. Maximum rooting depths of crops commonly found in the Restoration Area are shown in Table 3-1. The Proposed Action includes flow reductions in response to groundwater levels observed in the buffer or threat zones. If groundwater levels at a monitoring well exceed an identified threshold, WY 2010 Interim Flows would be reduced or diverted.

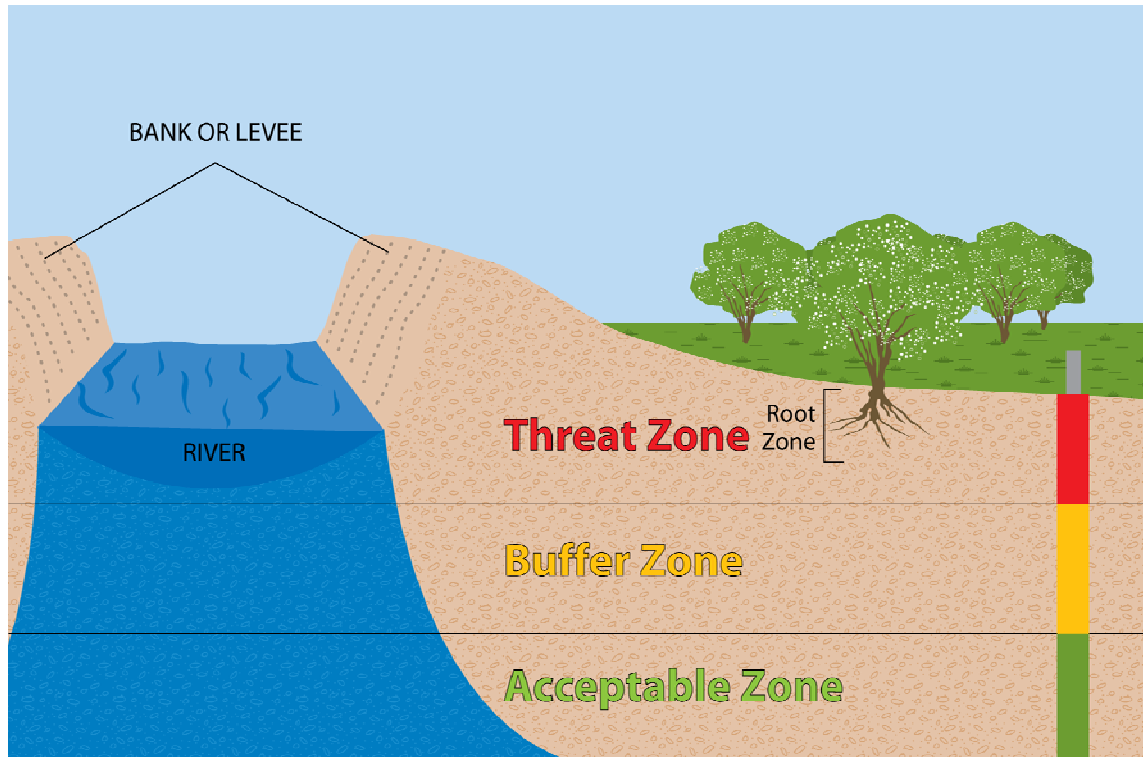


Figure 3-1.
Potential Groundwater Seepage Threshold Zones

Table 3-1.
Maximum Rooting Depth of Crops Commonly Found
in the Restoration Area

Crop	Maximum Root Depth (feet)
Alfalfa ¹	6
Almonds ¹	6-9
Grape ²	3-6
Pistachio ²	3-5
Tomato ¹	5-6
Melon ¹	5-6
Cotton ¹	5-6

Notes:

¹ Westlands Water District, 2009.

² Allen, R.G., et al.

3.3 Levee Patrols for Seepage Effects

Levee patrols would be conducted in coordination with the Lower San Joaquin Levee District to assist with identifying adverse effects to third parties from groundwater seepage. These patrols would be used to identify the formation of boils, piping, and surface water, which would indicate a realization or potential realization of damages.

3.4 Landowner Contact for Seepage Effects

Outreach to landowners adjacent to the San Joaquin River would be conducted to assist in identifying potential adverse effects to third parties from groundwater seepage. Landowners would be able to report observed conditions through the SJRRP Web site or through a toll-free number.

4.0 References

- Allen, R.G., L.S. Pereira, D. Raes, and M. Smith. 1998. Crop evapotranspiration – Guidelines for computing crop water requirements. FAO Irrig. And Drain. Paper 56, Food and Agric. Organ. United Nations, Rome, Italy.
- Westlands Water District. 2009. Crop Characteristics. Available at <http://www.westlandswater.org/wtrcon/handbook/crops/crops.htm>. Accessed August 7, 2009.

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Attachment 1

Monitoring Program for Water Year 2010 Interim Flows

Seepage Management and Monitoring Plan



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List of Abbreviations and Acronyms

Act	San Joaquin River Restoration Settlement Act
cfs	cubic feet per second
Secretary	Secretary of the U.S. Department of the Interior
SJRRP	San Joaquin River Restoration Program
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
WY	Water Year

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1.0 Introduction

An initial set of river transects has been identified for the locations of Water Year (WY) Interim Flows flow gages and groundwater level monitoring wells. These locations are summarized by reach in Figures 3-1 through 3-6. This initial set of monitoring locations was selected from a much larger monitoring program, currently under development by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation). The monitoring program will be designed to collect data for several physical parameters, including flow, water quality, groundwater levels, and sediment transport.

The locations in Figures 3-1 through 3-6 were selected from the larger monitoring program based on ease of access and location on public lands.

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2.0 Flow Monitoring Locations

This section describes locations selected for flow monitoring for WY 2010 Interim Flows.

In addition to the six gages identified by the Settlement, a seventh gage is scheduled for installation to monitor potential WY 2010 Interim Flows to the Eastside Bypass. This gage will be located at the head of the Sand Slough Bypass. Flow monitoring locations are summarized in Table 2-1 and shown in Figure 2-1. WY 2010 Interim Flows will be measured using these seven stream gages.

**Table 2-1.
Interim Restoration Flow Monitoring Locations
Specified in the Settlement**

Location	Station Identifier(s) ¹	Responsible Agency	Remarks
Below Friant Dam	MIL	Reclamation	Flows will be measured at Friant Dam outlets and spillway
Gravelly Ford	GRF	Reclamation	Existing gage adequate to measure Interim and Restoration flows
Below Chowchilla Bypass Bifurcation Structure	CBP, SJB	Reclamation	Existing gages will be retrofitted to measure Interim and Restoration flows
Below Sack Dam	To be determined	DWR	Gage to be installed, pending landowner agreements
Head of Reach 4B1	To be determined	DWR	Gage to be installed, pending landowner agreements
Head of Sand Slough Bypass	To be determined	DWR	Gage to be installed, pending landowner agreements
Above the Merced River Confluence	To be determined	USGS	Gage to be installed, pending landowner agreements

Note:

¹ California Data Exchange Center identifiers

Key:

CBP = Chowchilla Bypass below Bifurcation Structure

DWR = California Department of Water Resources

GRF = San Joaquin River at Gravelly Ford

MIL = Millerton Lake

Reclamation = U.S. Department of the Interior, Bureau of Reclamation

Settlement = Stipulation of Settlement

SJB = San Joaquin River below Bifurcation Structure

USGS = U.S. Geological Survey

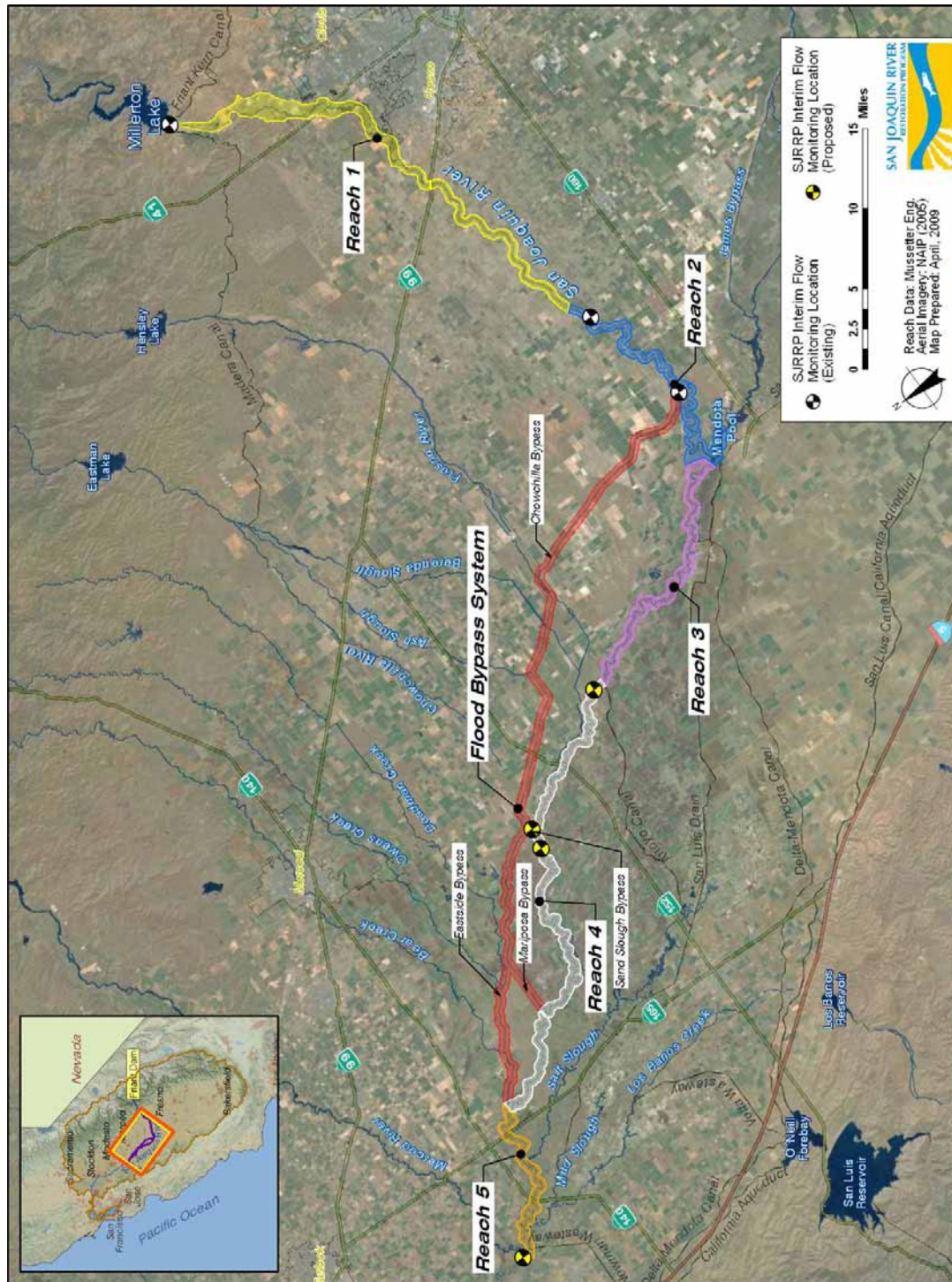


Figure 2-1.
Streamflow Gages Used for Interim and Restoration Flow Monitoring

3.0 Groundwater Level Monitoring Locations

This section describes the locations selected for groundwater monitoring for WY 2010 Interim Flows.

For WY 2010 Interim Flows, the groundwater wells used during the pilot program will be made available for monitoring groundwater. Additionally, desirable groundwater transects have been identified on public accessible lands. These existing wells and identified transects are presented in Figures 3-1 through 3-6.

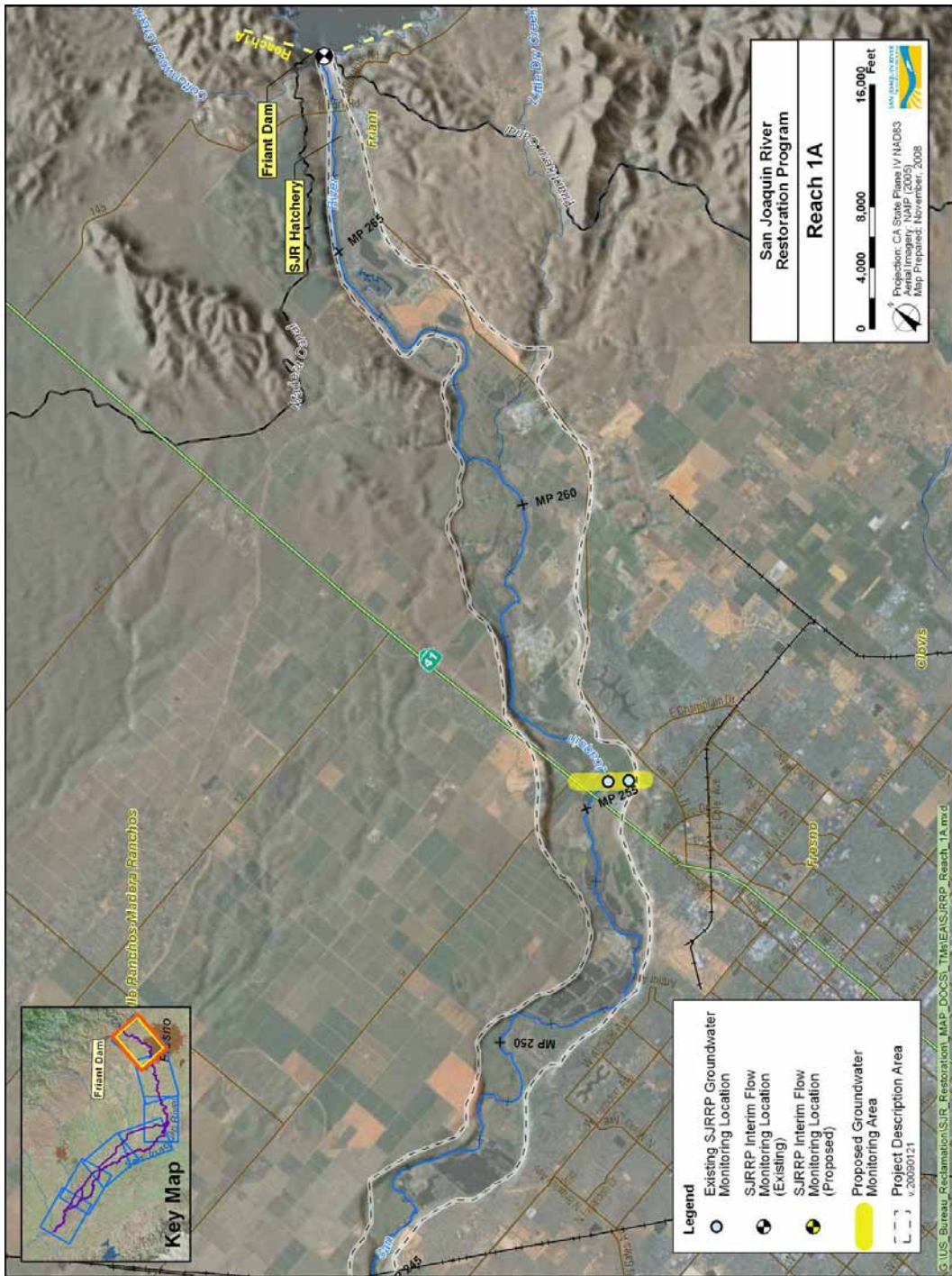


Figure 3-1
Reach 1A – Existing Gages for Flow and Groundwater, and Potential Transects for
WY 2010 Interim Flow Groundwater Monitoring

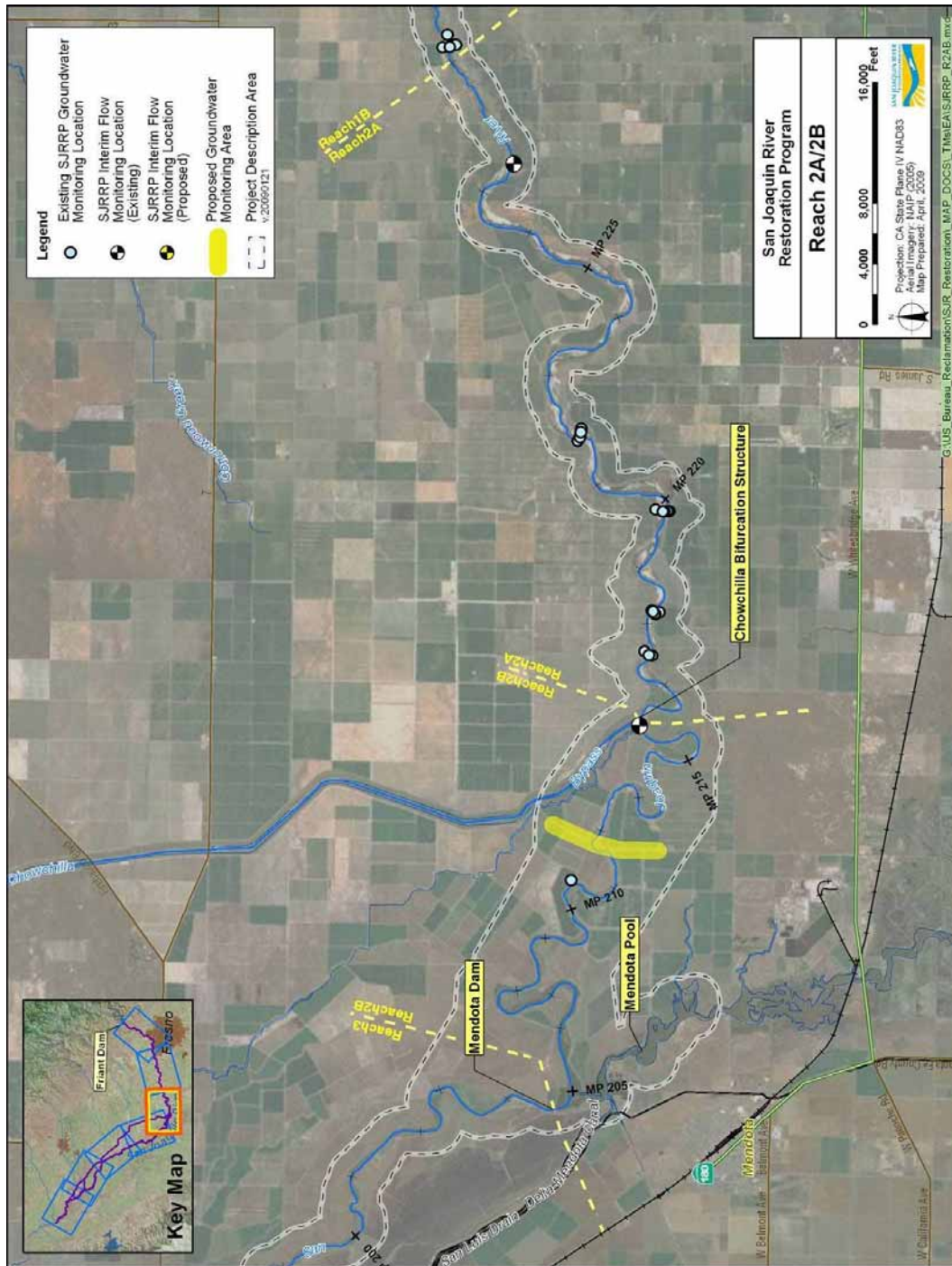


Figure 3-2.
Reaches 2A/2B – Existing Gages for Flow and Groundwater, and Potential Transects for
WY 2010 Interim Flow Groundwater Monitoring

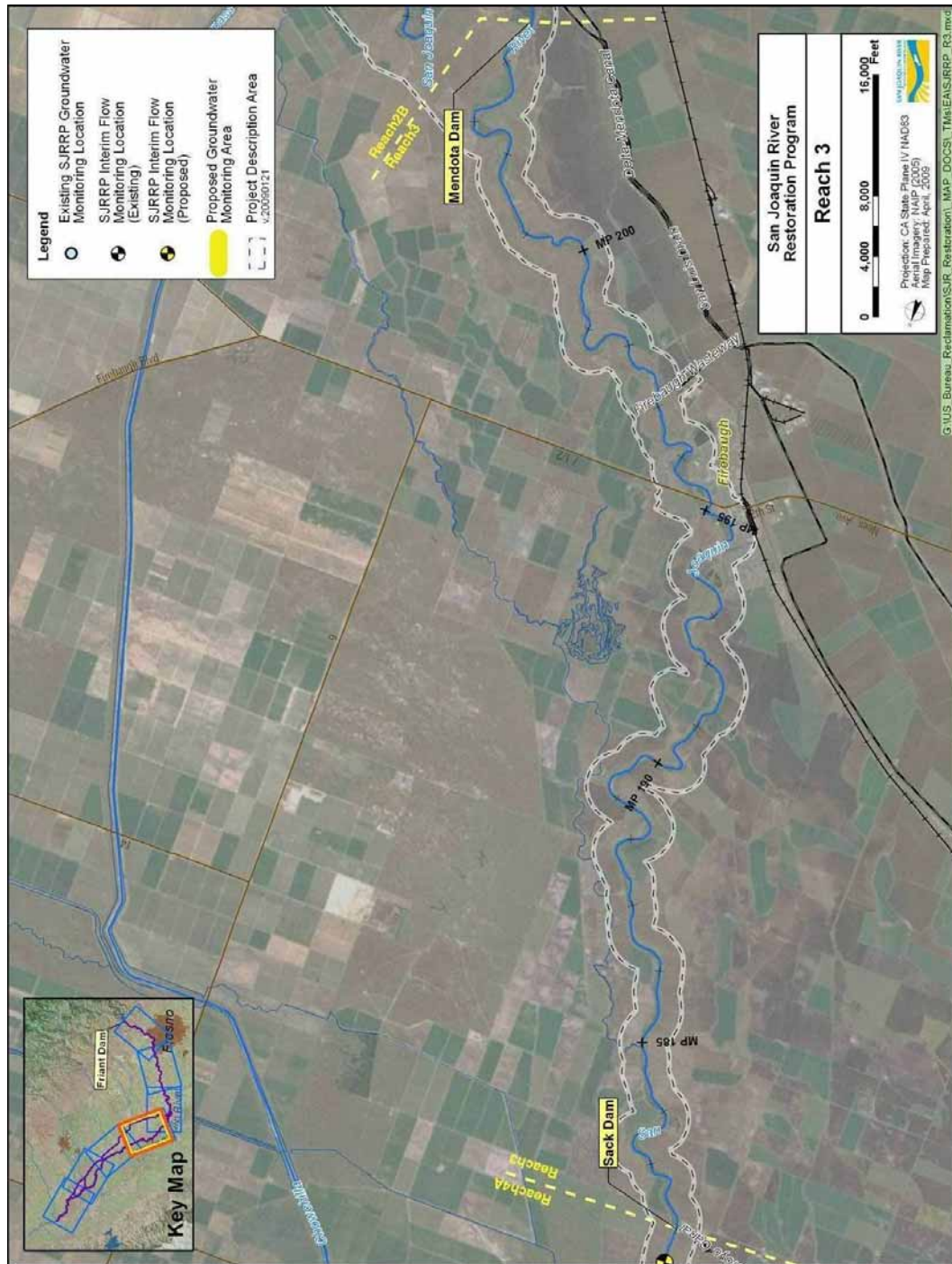


Figure 3-3.
Reach 3 – Existing Gages for Flow and Groundwater, and Potential Transects for
WY 2010 Interim Flow Groundwater Monitoring

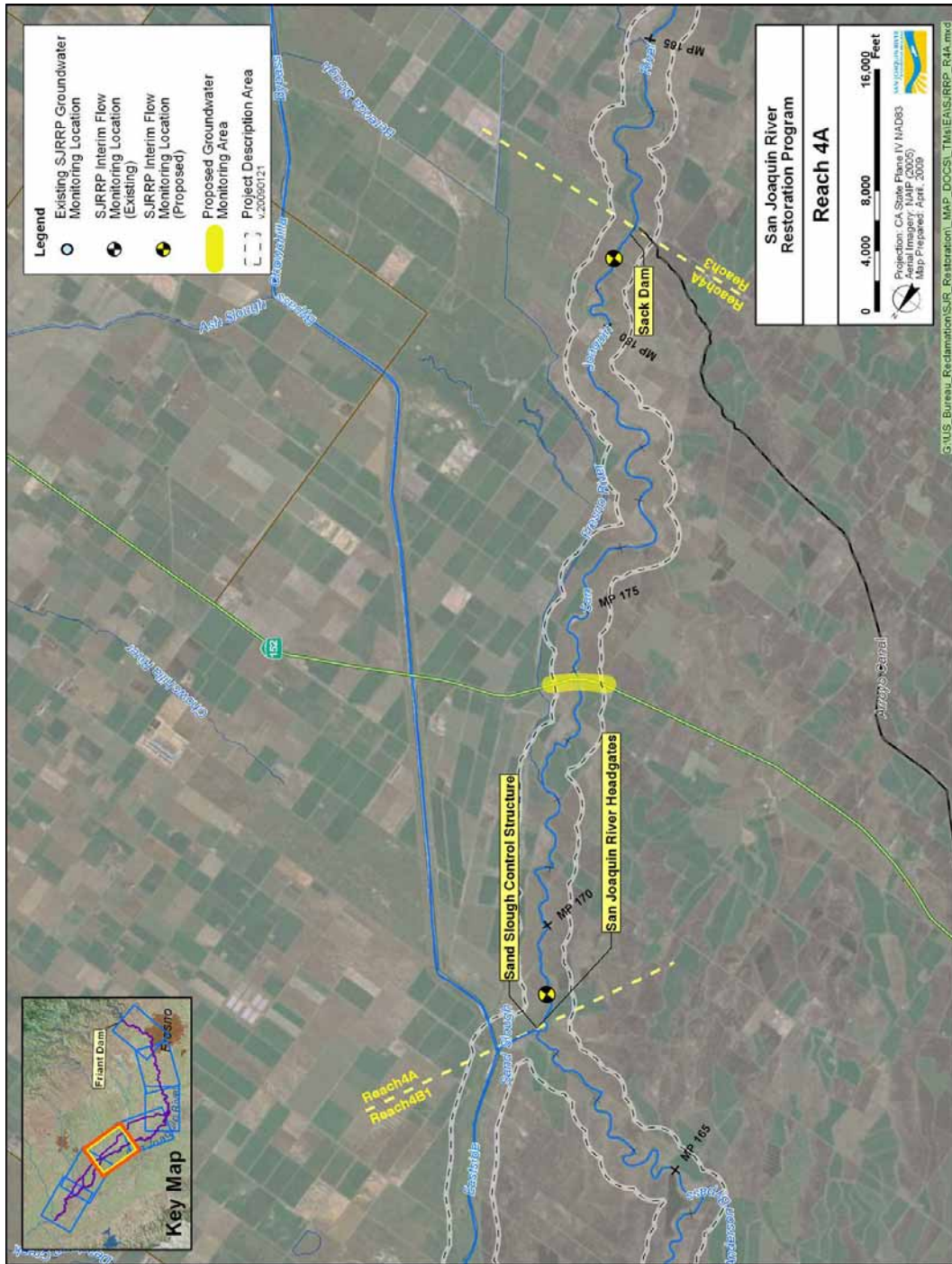


Figure 3-4.
Reach 4A – Existing Gages for Flow and Groundwater, and Potential Transects for
WY 2010 Interim Flow Groundwater Monitoring

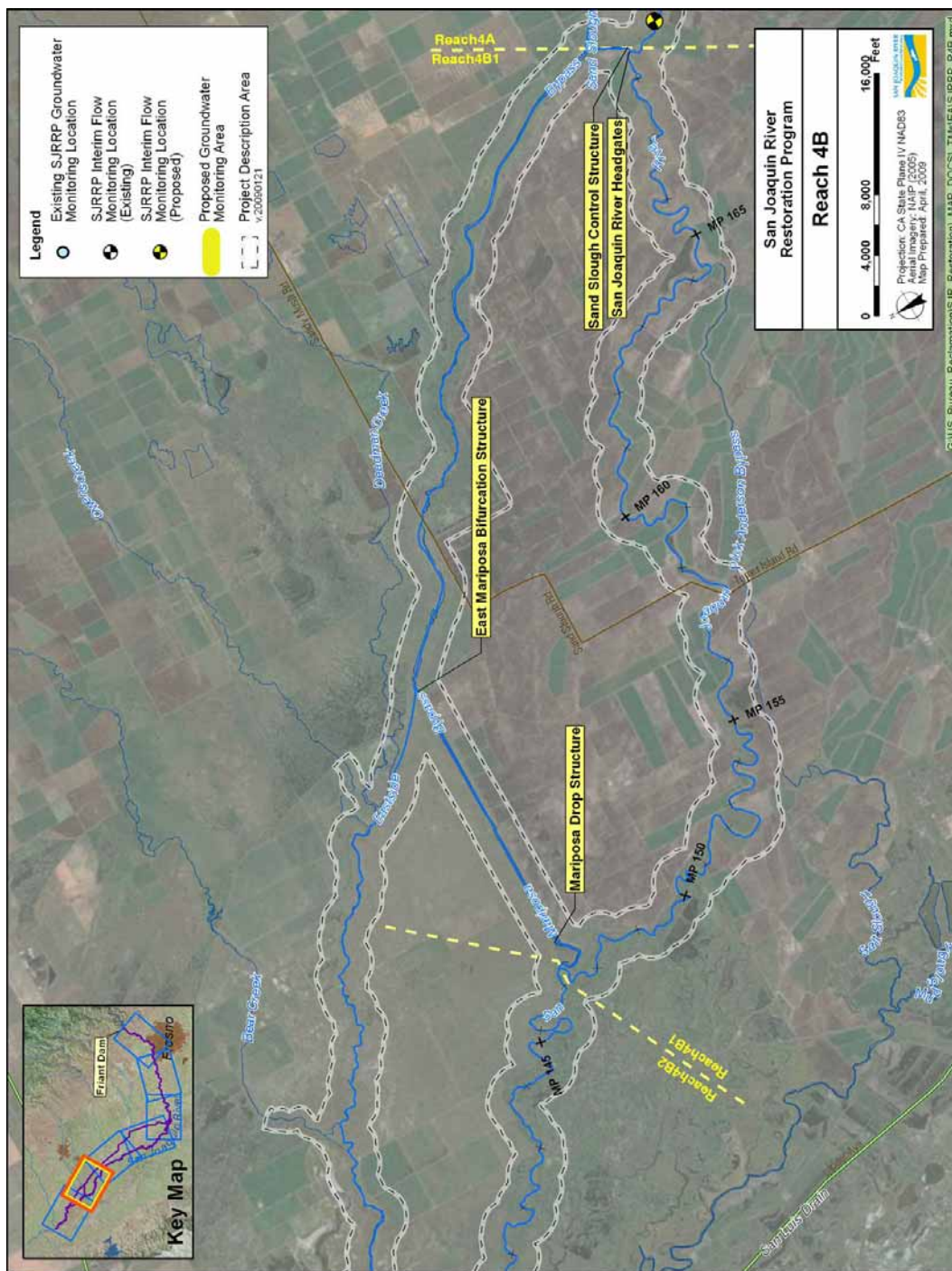


Figure 3-5.
Reach 4B – Existing Gages for Flow and Groundwater, and Potential Transects for
WY 2010 Interim Flow Groundwater Monitoring

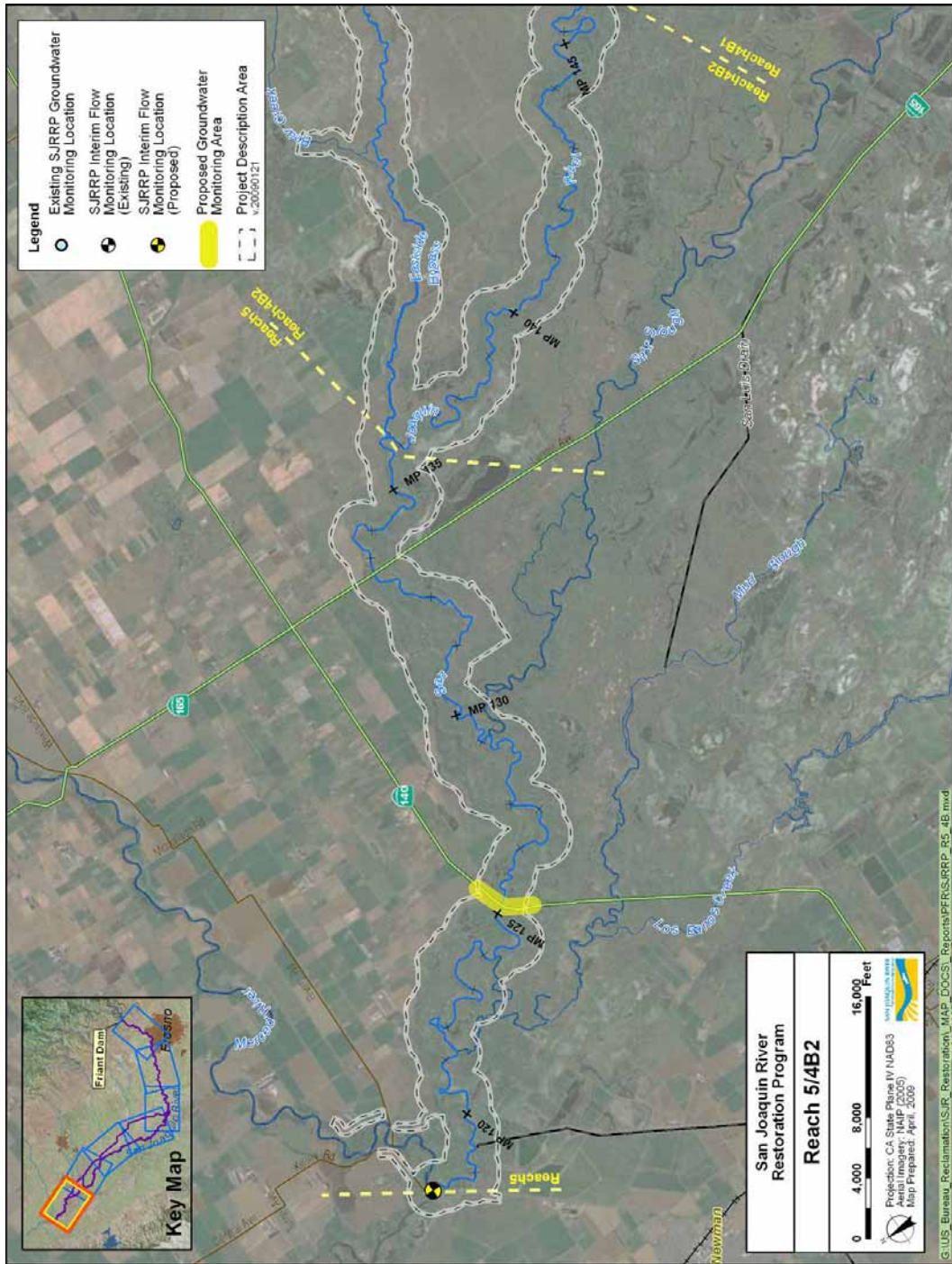


Figure 3-6.
Reaches 5/4B 2 – Existing Gages for Flow and Groundwater, and Potential Transects for
WY 2010 Interim Flow Groundwater Monitoring

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