



# **Hydrogeology Monitoring for the CDFW R-4 Wildlife Areas Water Development Project**

## **Groundwater Level and Subsidence Monitoring Plan**

**U.S. Bureau of Reclamation, Mid-Pacific Region**

**August 14, 2015**



U.S. Department of the Interior  
Bureau of Reclamation  
Mid-Pacific Region

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## **A.1 PROJECT BACKGROUND**

The Bureau of Reclamation (Reclamation) proposes entering into the “*Agreement for the Reimbursement of Pumping Costs for Refuge Water Supplies at Department of Fish and Wildlife Region 4 Wildlife Areas between the United States and the State of California*” (Agreement). Through the Agreement, the State of California Department of Fish and Wildlife (CDFW) proposes operating groundwater wells and the Ruth Lake Water Conservation Project (WCP) located on CDFW wildlife areas in the San Joaquin Valley to develop another source of Incremental Level 4 (IL4) water supplies to benefit south-of-Delta Refuges for reimbursement by Reclamation of CDFW’s operational costs.

Pursuant to the Agreement, a “Hydrogeology Monitoring Plan” is to be implemented, resulting in this “*Hydrogeology Monitoring for the CDFW R-4 Wildlife Areas Water Development Project – Groundwater Level and Subsidence Monitoring Plan*” (Plan). In accordance with one of the responsibilities outlined in the Agreement, CDFW will monitor groundwater levels at each of the groundwater wells identified under the Agreement. These groundwater wells are located on the Los Banos Wildlife Area (WA), and the China Island, Gadwall and Salt Slough Units of the North Grasslands WA Complex. CDFW will perform groundwater level monitoring in accordance with the provisions of the Plan. And in accordance with one of Reclamation’s responsibilities under the Agreement, Reclamation will collect and analyze land subsidence data in the vicinity of the Proposed Action (Project) in concert with the provisions of the Plan.

For further description of the Project and background please refer to Reclamation’s Environmental Assessment – Agreement for the Reimbursement of Pumping Costs Between the United States and the State of California for Refuge Water Supplies at Wildlife Areas (EA Number 14-34-MP).

### **A.1.1 Groundwater Levels**

Groundwater levels will be monitored from Los Banos WA Deep Wells 1 and 2, Gadwall Unit Deep Well 1, Salt Slough Unit Deep Well 1, and China Island Unit Deep Wells 1 and 4 to determine if these water supplies are pumped in a sustainable manner that does not lead to long-term adverse groundwater conditions or third party impacts.

### **A.1.2 Land Subsidence**

Information and data collected for analysis of land subsidence will include land surface elevations data and related information acquired from Reclamation’s San Joaquin River Restoration Program (SJRRP) and from United States Geological Survey (USGS) studies in the area around the Project area to ensure that the Project’s groundwater pumping does not lead to long-term adverse subsidence impacts that could adversely impact critical infrastructure.

## **A.2 MONITORING AND REPORTING PLAN**

### **A.2.1 Groundwater Level Measurements**

Measure water levels in all wells listed in Table 1 of Appendix C on the following schedule:

Static water level measurements will be made (i.e after the well pump is turned off) in the wells on a quarterly basis during the months of January, April, July and October. Water levels will be measured with an electric well sounder or steel tape no sooner than 72 hours after the well pump is shut off. The date, time and depth to water from the reference point shall be recorded and entered into an EXCEL spreadsheet.

Measure water levels from a reference point clearly marked on the well by CDFW. Measure water levels from the reference point to the water surface in the well to the nearest tenth of a foot (0.1 feet).

If available, download data collected monthly by the State of California Department of Resources (DWR) as part of the regional groundwater level monitoring network and incorporate and archive that data with the Project's collected data. DWR's data is available online through the California Statewide Groundwater Elevation Monitoring (CASGEM) database (<http://www.water.ca.gov/groundwater/casgem/>).

Provide the combined data (e.g., groundwater level data collected on-site and from DWR) in quarterly monitoring reports and in the final annual report as part of the groundwater monitoring program for the Project wells as identified on Table 1.

Measure or estimate pumping volumes from each well and include these data in the quarterly monitoring reports. Measurements shall be made with flow meters or other approved methods. Alternatively, pumping estimates can be made using the methods described in the Water Measurement Manual (USDOI, BOR, 1997). The date and time that the well pumps are turned on and off shall be recorded and reported in the quarterly monitoring reports.

Use the DWR form Excel spreadsheet file named "Groundwater Data Collection Form v1 4-22-15\_Generic.xlsx" (See Appendix D) for recording groundwater level measurements in the field.

### **A.2.2 Land Subsidence**

Annually, collect land subsidence information and data available for the vicinity of the Project area, including surface level elevations, from various sources including Reclamation's SJRRP, USGS, San Luis & Delta-Mendota Water Authority (SLDMWA), and Central California Irrigation District (CCID).

Annually, analyze the results of the land subsidence data collection and document in a report along with conclusions. Upon completion the annual report will be distributed to all Project parties.

The wells are located within or near the study area of ongoing land subsidence monitoring being conducted by the USGS and the SLDMWA as a continuation of the land subsidence monitoring conducted from 2003 – 2010 that is summarized in USGS Scientific Investigations Report 2013-5142(Sneed, 2013). The SLDMWA is the Monitoring Agency for the Delta-Mendota Subbasin. Groundwater pumping from below the Corcoran Clay has been identified as the primary cause of aquifer-system compaction and resultant land subsidence in the study area. Although significant land subsidence has been measured within the Delta-Mendota Subbasin, most of it has occurred south and east of the Project area and has been associated with pumping from the lower zone, beneath the Corcoran Clay. The area in the vicinity of the wells has not been identified as a critical land subsidence area. In addition, all the wells pump from the unconfined aquifer above the Corcoran Clay and therefore should not contribute to any land subsidence associated with pumping from the confined aquifer below the Corcoran Clay. Both the SLDMWA and CCID maintain land subsidence monitoring programs. Reclamation and CDFW will review the results of those monitoring programs annually, along with the annual analysis of land subsidence data, and collaborate with those agencies to the extent practical to address problems associated with land subsidence and the Project.

Additionally, the SJRRP is monitoring the subsidence GPS (global positioning system) stations depicted on Map 1 in Appendix E. Acquire and review all of the annual data collected by the SJRRP. This information will be summarized in the annual monitoring report.

## **B.1 ADAPTIVE MANAGEMENT**

An adaptive management process will be utilized to ensure that the monitoring for the Project achieves the Project objectives and pumping can continue annually without causing cumulative adverse impacts to the local aquifer or land surface elevation. The process should follow the guidance provided in “Adaptive Management: The U.S. Department of Interior Technical Guide” (Williams, 2009). This document can be found at <http://www.doi.gov/initiatives/AdaptiveManagement/documents.html>.

By May 30 after the first Contract Water Year (beginning March 1 and continuing through the last day of February of the following year) of groundwater pumping, CDFW and Reclamation shall complete a project management plan to clarify and formalize the monitoring/reporting tasks and schedule. The plan will include explicit and measurable management objectives for future years. The plan may also address any issues related to flow meter calibration certification updates, and any issues related to collecting flow meter values. Each year, Reclamation and CDFW will review the previous year’s

monitoring data to determine if water level or subsidence problems have occurred or may occur if pumping continues.

If it is determined that continued pumping in some or all of the wells will lead to adverse irreversible impacts or third party impacts, CDFW will cease under the Proposed Action and both parties to the agreement shall identify and agree on an appropriate course of action.

## Reference Citations

Sneed, Michelle, Brandt, Justin, and Solt, Mike, 2013, Land Subsidence along the Delta-Mendota Canal in the Northern Part of the San Joaquin Valley, California, 2003–10: U.S. Geological Survey Scientific Investigations Report 2013–5142, 87 p., <http://dx.doi.org/10.3133/sir20135142>

Williams, B.K.R.C. Szaro, and C.D. Shapiro. 2009, Adaptive Management: The U.S. Department of the Interior Technical Guide. Adaptive Management Working Group, U.S. Department of the Interior, Washington, DC. <http://www.doi.gov/initiatives/AdaptiveManagement/documents.html>

US Department of Interior, Bureau of Reclamation, 1997. Water Measurement Manual – A Water Resource Technical Publication, U.S. Government Printing Office, Denver CO.

## **Appendix A: Project Management Plan**

**To be developed after the first year of pumping.**



## Appendix B: Acronyms

BOR	Bureau of Reclamation
CCID	Central California Irrigation District
CDFW	California Department of Fish and Wildlife
CDWR	California Department of Water Resources
CVPIA	Central Valley Project Improvement Act
GPS	Global Positioning System
GRCD	Grassland Resource Conservation District
Reclamation	United States Bureau of Reclamation
SJRRP	San Joaquin River Restoration Program
SLDMDWA	San Luis Delta Mendota Water Authority
SOP	Standard Operating Procedure
USGS	United States Geological Survey
WA	Wildlife Area

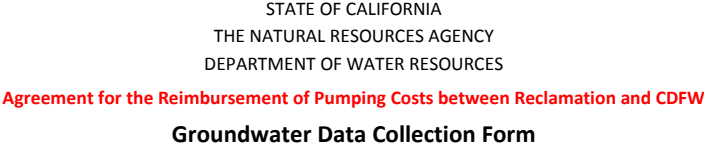
## APPENDIX C: Table 1 – Proposed Action Details for Groundwater Wells and Lift Pumps

**Table 1 Proposed Action Details for Groundwater Wells and Lift Pumps**

Wildlife Area	Pump	Depth (Feet)	Discharge Point	Estimated Maximum Production		Used Only in Critical Dry Years
				Acre-Feet Average/Normal Hydrologic Year	Acre-Feet Dry/Critical Dry Hydrologic Year	
Los Banos (Ruth Lake WCP)	Los Banos WA Low Lift (LL) Pump 12 1/	NA	Internal	4,000	2,000	No
	Los Banos WA LL Pump 12 and Los Banos WA LL Pump 13 1/	NA	San Luis Canal			
Los Banos	Los Banos WA Deep Well (DW) 1	572	San Luis Canal or Internal	1,200	2,160	No
Los Banos	Los Banos WA DW 2	480	Internal	1,200	2,280	No
North Grasslands - Salt Slough Unit	Salt Slough Unit DW 1	510	Internal	0	2,160	Yes
North Grasslands - China Island Unit	China Island Unit DW 1	Unknown	Internal/J Lateral	3,600	3,600	No
North Grasslands - China Island Unit	China Island Unit DW 4	260	Internal/J Lateral	2,160	2,160	No
North Grasslands - Gadwall Unit	Gadwall Unit DW 1	275	San Luis Canal or Internal	2,160	2,160	No
Total				14,320	16,520	

1/ Los Banos WA Low Lift (LL) Pumps 12 and 13 are both required to move the same water. Los Banos WA LL Pump 12 moves water internally from the Boundary Drain into Ruth Lake WCP. Los Banos WA LL Pump 13 will pump water from Ruth Lake WCP and discharge into the San Luis Canal.

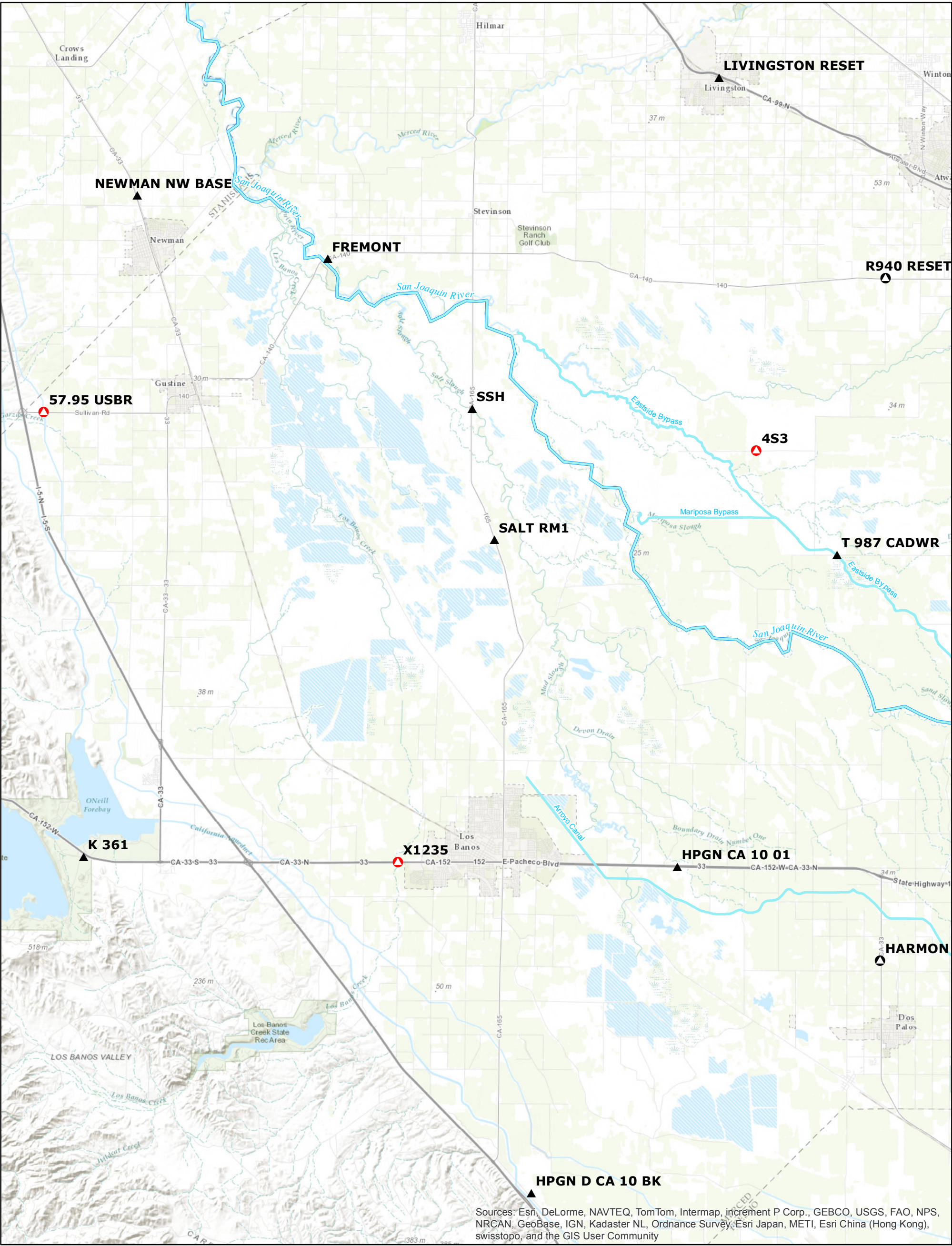
**APPENDIX D: Groundwater Data Collection Form v1 4-22-15\_Generic.xlsx**

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## **APPENDIX E: San Joaquin River Restoration Program Subsidence Monitoring Locations**





**RECLAMATION**  
*Managing Water in the West*

## Legend

### GPS Coordinates

- ▲ GPS Point-December 2011
- ◉ GPS Point-added July 2012
- ◉ GPS Point-added December 2013



### Reclamation Subsidence GPS Stations

