Study 41

USGS Seepage Management Plan Support

Final
2015 Monitoring and Analysis Plan

SAN JOAQUIN RIVER
RESTORATION PROGRAM

January 2015

1.0 Seepage Management

The USGS role in the seepage management component of the SJRRP focuses on supporting the continued development of a Seepage Management Plan.

1.1 Water-level Data

Continue water-level database maintenance

1) update with recent data

2) possibly migrate into Access database for improved stability & query capabilities

Deliverable – included in model report and seepage management plan

1.2 Analysis of Water-level Data

1) complete maps of water-table elevation

2) document these maps in Seepage Management Plan

3) continue analysis of hydrographs & maps in support of modeling, monitoring threshold analysis, etc.

Deliverable – included in model report and seepage management plan

1.3 Evaluation of Sand Stringers

In FY12, the USGS and Reclamation evaluated the efficacy of using geophysical methods—frequency-domain electromagnetic induction (FEM) and electrical resistivity tomography (ERT)—to identify abandoned channels, or sand stringers, that may act as conduits for river seepage into fields. The presence of such conduits in a field may substantially increase the susceptibility of crops in that field to seepage impacts from Interim and Restoration Flows. Understanding the geometry and hydrogeologic characteristics of the sand stringers, which may vary greatly, is essential for determining appropriate engineering solutions for seepage mitigation, which may include slurry walls to cut off the sand stringers and/or installing shallow wells or sumps and using the stringers as drains.

Three parcels along reaches 3 and 4 of the river were investigated during FY12. Results from the geophysical work, which were ground-truthed using shallow (5 ft) hand-auger

borings, showed strong correlations between sandy soils, high resistivity in ERT data and low conductivity in FEM data. These methods were very effective for detecting and measuring the geometry of sand stringers, and allow for more detailed subsurface geological exploration than is possible using point borings. The combination of geologic interpretation from point borings and geophysical data has resulted in improved understanding of the subsurface.

During FY13, USGS applied the geophysical methods to fully characterize the Willis parcel. Because of the relative ease of collecting FEM data, this low-cost method was used to cover the entire area; for a subset of the parcel, ERT was used to determine the detailed subsurface geometry.

In FY14, data from Sept. 2013 drilling on the Willis parcel, which provided ground-truth information, will be used to constrain the interpretation (inversion) of the EM data collected on this parcel.

In FY14, a sand stringer on the Willis property will be monitored using pressure transducers and temperature sensors for background data; due to the drought, Restoration flows have not occurred.

In FY15, assuming Restoration flows occur, several methods will be used to quantify seepage rates in these channels, thereby determining the potential effectiveness of engineering solutions. A set of nine shallow wells were installed by Reclamation in September 2013 for the purposes of confirming the channel depth and conducting hydrologic monitoring. Methods for determining seepage rates through these channels include:

- Analysis of distributed temperature data (heat flow simulation using data from temperature sensors deployed at multiple depths in the wells)
- Measured hydraulic gradients (pressure transducers in the wells)
- Groundwater velocity meters (two types of meters will be tested in the wells)
- Salinity and other natural tracers (electrical conductivity will be measured continuously in the wells)

The feasibility and cost effectiveness of these methods will be evaluated using the wells at the Willis site, allowing for consideration of similar monitoring at other sites.

Additional collection of geophysical data will depend on the results of this work. If results from this work show that flow through sand stringers is an important mechanism of the seepage process, and that geophysical data can effectively help to evaluate the relative importance of this process from parcel to parcel, future geophysical data collection will be reconsidered.

Deliverable – On-line USGS Report to document analyses. Results will be included in Seepage Management Plan.

1.4 Local Grid Refinement Tool and Farm Process

The Central Valley Hydrologic Model (CVHM) uses the Farm Process (FMP) to simulate irrigated agriculture within MODFLOW. The modeling efforts described below include refined-scale models within the CVHM model grid. The Local Grid Refinement (LGR) MODFLOW package enables fully embedded "child" models within CVHM. LGR and FMP did not work together; however, this capability was developed as part of this project.

In FY14 the final draft of the code documentation report will be completed.

In FY15 80 hours are included for resolving review and editorial comments, and seeing it through the remaining publication process.

Deliverable - Completion of the code documentation and applications will occur during FY14.

1.5 Modeling

Completion and publication of the preliminary ¼-mile-scale model (SJRRPGW) was the primary focus during FY14; the report is currently in editorial review, having passed successfully through peer and Center specialist review. It is expected to be published within FY14.

In FY15, modeling priorities will be to support applications of the current version of SJRRPGW and associated sub-models, and to develop the updated version of SJRRPGW. SJRRPGW is currently linked via head and flux-based boundaries to the CVHM, and ends in 2003. A high priority in FY15 is the temporal extension of the model from 2003 to present and other enhancements, described below, to support longer-term efforts. The key driving purpose for temporal extension is to allow for better calibration of the model using data collected during interim restoration flows starting in 2009, and to provide realistic initial conditions for evaluations of future hydrologic responses to alternative management actions.

Enhancements will be made to SJRRPGW during FY15 in order to (1) improve its ability to accurately simulate river flows and seepage, other stresses, and aquifer-system response to management actions.

These enhancements include:

- temporal extension from 2003 (end of CVHM) to current, allowing for calibration to Interim Restoration Flows, and thus more accurate simulation of Restoration flows and associated responses [ongoing extension of CVHM by another project will allow for updated boundary conditions]

- Incorporation of lithologic data collected during recent years into the previously-developed sediment texture database, and updating of the TPROGS-generated sediment texture models

- consideration of multiple equally probable TPROGS-generated sediment texture models to determine sensitivity of SJRRPGW results to the texture distribution, and to seek the best fit

- embed the SJRRPGW within CVHM using MODFLOW FMP-LGR, as described above, thereby providing improved boundary conditions and simultaneous run capabilities, which are important for scenario development

- incorporate climate variability and change into future scenarios, which is important for evaluating the robustness of monitoring thresholds and various response actions

- land subsidence, which is an important issue for the SJRRP with respect to construction design, exacerbation of drainage issues, and effects on river stage, is addressed as a separate component of USGS involvement in the SJRRP [Task 3.6].

In FY15-16, the updated SJRRPGW will be documented in a USGS report and used for future analyses. It will also be used to provide boundary conditions for **finer-scale models** to be used for closer examination of near-river processes/issues. CDM will be the primary developer of fine-scaled models, with USGS support.

Applications of the SJRRPGW and associated finer-scale models may include:

- evaluation of the monitoring corridor – how far away from the river should water-level monitoring occur?

- support of Reach-specific studies, including Reaches 2 & 4

- areal & temporal evaluation of monitoring thresholds

    - simulate range of hydrologic conditions over long periods

    - evaluate overall effectiveness of monitoring thresholds

    - evaluate those conditions for which exceedance of monitoring thresholds should be ignored (unrelated to Restoration activities)

    - consider temporal adjustments in thresholds for more robust performance, perhaps based on climatic factors and antecedent conditions

- comparison of alternative physical SJRRP response actions, including:

    - projects – slurry walls, drains, wells, etc.

- flow management – adjust releases, flow routing, etc.

- other Seepage Management Plan support

Deliverable - The USGS Scientific Investigation Report "Documentation of a Groundwater Flow Model (SJRRPGW) for the San Joaquin River Restoration Program Study Area, California," will be published in FY14 and an updated report will be published in FY16.

1.6 Seepage Management Plan support

FY14, this task will include:

1) incorporate modeling and other analyses into the Plan

2) stakeholder meeting attendance and support

3) continue to support SJRRP staff on groundwater matters, reviews, etc.

4) Technical support on local seepage issues – USGS has provided technical support to Reclamation in several forms, including:

   - evaluating site conditions

   - suggesting locations for additional monitoring

   - analytical modeling to estimate potential effects of increased river stage on water table at various distances from the river

   - technical review of related documents

FY15, this task will include support roles in the development of:

- small-scale models for the purpose of simulating parcel-scale phenomena, such as the potential that small near-surface paleochannels extend the lateral influence of seepage effects, and evaluation of various seepage management actions (continuing along the lines of such work in FY13-14)

- highly refined embedded models for similar purposes

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