SJRRP Flow Bench Evaluation

March 22, 2018

An updated Restoration Administrator (RA) Recommendation was received and approved on March 22, 2018. The RA recommendation calls for an immediate reduction of Friant Dam releases from 300 cfs to 130 cfs in anticipation of tributary flow conditions. This is a result of tributary creeks (Little Dry and Cottonwood) rapidly rising with substantial recent and ongoing rain. Tributary flows take on losses in the system and therefore, the recommendation also includes a target of 130 cfs past Sack Dam as it is anticipated that tributary inflows will exceed all Holding Contract demands and seepage losses between Friant Dam and Gravelly Ford. Any Restoration Flows of more than 130 cfs may be recaptured at Mendota Pool. This Flow Bench Evaluation analyzes this anticipated flow change.

As of March 22, 2018:

1. Channel conveyance: Flow rates are below known conveyance thresholds.

2. Operations Conference Call: An operations call was held on March 21, 2018. No known operational constraints were identified on the call, but the pending tributary inflow was discussed. Abandoned water was expected to be made available to Reach 2B diverters.

3. Seepage Hotline Calls: The seepage hotline has received no calls regarding Restoration Flows in Water Year 2018.

4. Real-time wells: All telemetered groundwater monitoring well levels are below Seepage Management Plan (SMP) thresholds.

5. Priority wells: Weekly groundwater measurements in priority wells, real-time and manually measured, indicate that all wells are below well thresholds with the exception of MW-14-208. The elevated water level in this well is attributed to recent gravity irrigation of the adjacent field.

6. Flow Stabilization: Flows in the system have been stable with a constant release of 300 cfs from Friant Dam; however, flow changes are still subject to occur downstream due to operations at Mendota Pool and Sack Dam, or from tributary inputs – as evaluated here.

7. Projected Groundwater Level Changes: The pulse tributary flows are anticipated to be short in duration and therefore represent unsteady flows. This evaluation assumes steady flows and is therefore conservative in estimating the groundwater response. Under steady conditions, groundwater levels are predicted to remain relatively stable through Reach 3 (within approximately 0.5 ft). Reach 4A, below Sack Dam, is projected to have the largest increase in groundwater levels due to the current recommendation to increase flows past Sack Dam from the Mendota Pool Inflow Credit of 71 cfs as of March 21, 2018 to 130 cfs past Sack Dam. All groundwater well levels are still projected to be below threshold by the Observed Groundwater Level Method or by the Drainage Method (Appendix J of the SMP). The Observed Groundwater Level Method conservatively applies the change in stage observed in the river to the groundwater elevation. The Drainage Method accounts for sufficient drainage from the well to the river channel.

8. Levees: LSJLD has not expressed concerns about this flow increase.

9. Water Districts: The SJRECWA has not identified any operational concerns.

Data

Table 1 shows the groundwater depth in five real-time wells and eight manual measurements from field staff as reported in the weekly groundwater report with a publish date for the week ending March 24, 2018. Reclamation publishes the weekly groundwater report with manual measurements via electronic well sounder and recent flow data on the SJRRP website HERE. To calculate field depths, Reclamation adds ground surface buffers and lateral gradient buffers to measured groundwater depths in the well (Figure 1, Equation 1).

$$Field\ Depth_{Current} = D_{well} - GS_{Buffer} + LG_{Buffer} \quad (1)$$

Where:

$Field\ Depth_{Current}$	Current groundwater level depth in the field
D_{Well}	Current groundwater level depth as measured in the monitoring well
GS_{Buffer}	Ground surface buffer, or the difference in elevation between the well and the field
LG_{Buffer}	Lateral gradient buffer, to account for losing reaches where the groundwater table slopes away from the river (if any)

Table 1. Current Well Data

Well	Reach	1 - Measured Groundwater Depth in Well (feet bgs)	2 - Ground Surface Buffer (feet)	3 - Lateral Gradient Buffer (feet)	4 - Field GW Depth (feet bgs)	5 - Field Threshold (feet bgs)	Comment
FA-9	2A	9.7	2.0	2.5	10.2	6.0	Acceptable
MW-09-47	2A	9.0	2.5	3.3	9.8	6.5	Acceptable
MA-4	2A	11.3	6.1	4.6	9.8	7.0	Acceptable
MW-09-49B	2A	6.3	1.7	2.4	7.0	5.5	Acceptable
MW-09-54B	2B	16.9	7.9	5.5	14.4	7.0	Acceptable
MW-09-55B	2B	9.9	3.7	3.0	9.2	5.5	Acceptable
PZ-09-R3-5	3	10.8	1.2	0.0	9.6	5.7	Acceptable
MW-12-191	3	12.1	1.0	0.0	11.1	6.5	Acceptable
PZ-09-R3-7	3	8.9*	0.7	0.0	8.2	6.5	Acceptable
MW-10-75	3	16.7	0.5	0.2	16.4	8.0	Acceptable
MW-14-208	4A	5.1	1.0	0.0	4.1	5.5	Acceptable†
MW-10-89	4A	11.3	1.0	0.0	10.3	6.5	Acceptable
MW-10-92	4A	7.9	1.0	0.0	6.9	4.8	Acceptable

bgs = below ground surface; GW = groundwater
*Value from real-time monitoring equipment, not the weekly groundwater monitoring report
† See Analysis for discussion of MW-14-208

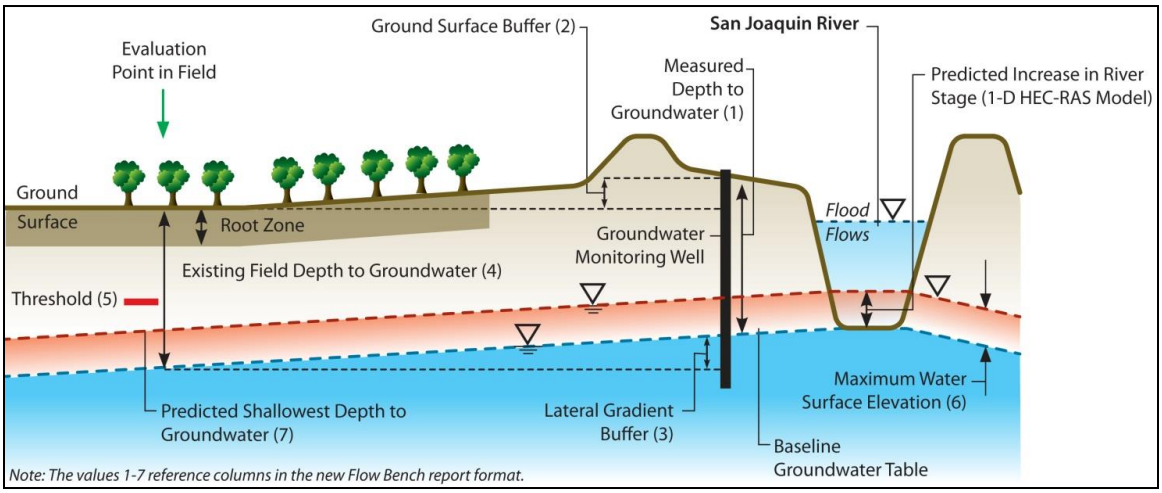

Figure 1. Conceptual Model for Observed Groundwater Level Method

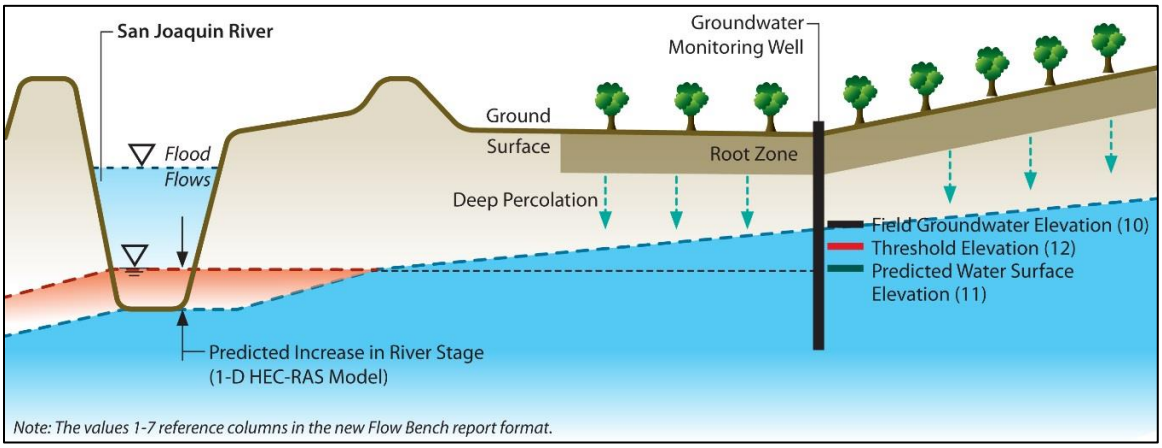

Figure 2. Conceptual Model for Drainage Method

Table 2 shows the anticipated flow rates used to evaluate future groundwater depths. Reclamation assumed that losses will be accounted for from tributary inflows; therefore, Restoration Flow releases from the dam have the potential to be conveyed throughout the Restoration Area (i.e. 130 cfs release from Friant Dam will be released past Sack Dam). San Luis Canal Company demands were also accounted for in Reach 3 flows using the most recent operations report sent March 21, 2018. Pre-condition flows are based on March 20, 2018 data. The comparison of pre-condition and projected flows informs the estimated result of increasing the Sack Dam target to 130 cfs.

Table 2. Anticipated Change in Flows.

	Pre-condition Flows (cfs)	Projected Flows for Evaluation (cfs)
Reach 1	300	130
Reach 2A	175	130
Reach 2B	110	130
Reach 3	243	270
Reach 4A	130	130

Table 3 shows the rise in groundwater based on estimated changes in river stage and the conceptual models shown in Figures 1 – 3. Field depths are calculated by taking the most recent measurements from Table 1, adding the ground surface and the lateral gradient buffers, and subtracting the maximum predicted stage increase (Equation 2).

$$Field\ Depth_{Predicted} = Field\ Depth_{Current} - WSEL_{Max\ Increase} \quad (2)$$

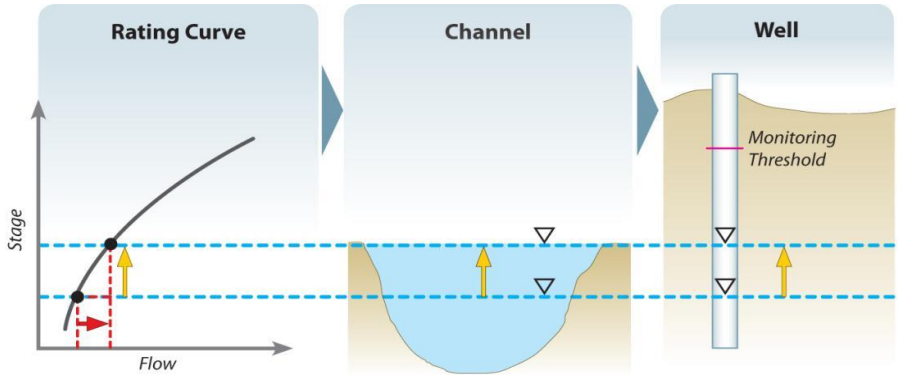

Figure 3. Conceptual Relationship between River Stage and Groundwater Levels

Table 3. Predicted Groundwater Levels for Priority Wells

Well	Reach	1 - Measured Groundwater Depth in Well (feet bgs)	2 - Ground Surface Buffer (feet)	3 - Lateral Gradient Buffer (feet)	4 - Field GW Depth (feet bgs)	6 - Maximum Predicted WSEL Increase (feet)	7 - Predicted Shallowest GW Depth (feet bgs)	5 - Field Threshold (feet bgs)	Comment
FA-9	2A	9.7	2.0	2.5	9.6	-0.3	10.4	6.0	Acceptable
MW-09-47	2A	9.0	2.5	3.3	9.3	-0.3	10.0	6.5	Acceptable
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bgs = below ground surface; GW = groundwater; WSEL = water surface elevation

*Value from real-time monitoring equipment, not the weekly groundwater monitoring report

† See Analysis for discussion of MW-14-208

Analysis

All thirteen priority groundwater monitoring wells are predicted to remain below seepage thresholds with flows of 130 cfs from Friant Dam, with the exception of MW-14-208, located past Sack Dam.

Groundwater levels at MW-14-208 were analyzed, and found to remain below the thresholds identified in the Seepage Management Plan for flows up to 129 cfs, with potential seepage constraints occurring at 130 cfs by the Drainage Method. The Drainage Method uses the same type of relationships (i.e., rating curves) as in the Groundwater Level Method (Figure 1) to estimate the predicted water surface elevation in the river from the 1-D HEC-RAS model (Tetra Tech 2009). The Drainage Method (Figure 2) then uses the predicted water surface elevation and compares this to the elevation of the threshold. If the predicted water surface elevation is more than 0.3 feet below the threshold elevation it is assumed that drainage from the field to the river will still be able to occur given the change in flow in the river. If the predicted water surface elevation is above the threshold elevation or within 0.3 feet of the threshold elevation, then drainage cannot occur with certainty and the proposed Restoration Flows would need to be monitored closely and/or re-evaluated.

Pre-condition measurements at MW-14-208 indicate that the well is above its well threshold of 6.5 ft; however, this is attributed to recent gravity irrigation (Figure 4). Recent field monitoring has also indicated that water levels were continuing to fall at this site at a rate of approximately 0.1 ft per day after the most recent manual measurement on March 20, 2018 due to the completion of pre-irrigation activities. Furthermore, monitoring indicates that current river stage and groundwater levels in the basin allow drainage in both directions (i.e. to the San Joaquin River and to the groundwater basin to the east). To confirm whether or not an increase to 130 cfs past Sack Dam would impact this site, field monitoring will be required with the proposed flow change.

Assuming flows are managed so as to avoid impeding drainage at MW-14-208, an additional flow bench evaluation was conducted to determine the next seepage constraint. That analysis suggests that groundwater levels will not exceed SMP thresholds until 200 cfs below Sack Dam.

The SJRRP will continue weekly monitoring of groundwater wells to track the influence of Restoration Flows, and will update this analysis if any changes to Restoration Flows are recommended. Follow-up monitoring is specifically scheduled at MW-14-208 to closely track the response of the proposed 130 cfs past Sack Dam.

Figure 4. Gravity Irrigation Observed near MW-14-208 on February 27, 2018

Summary

This analysis in combination with recent field measurements, indicates acceptable conditions for the target of 130 cfs past Sack Dam, with the condition that groundwater levels are closely monitored at MW-14-208 so as not to impede drainage. The maximum allowable flow below Sack Dam is currently limited by conditions at this well.

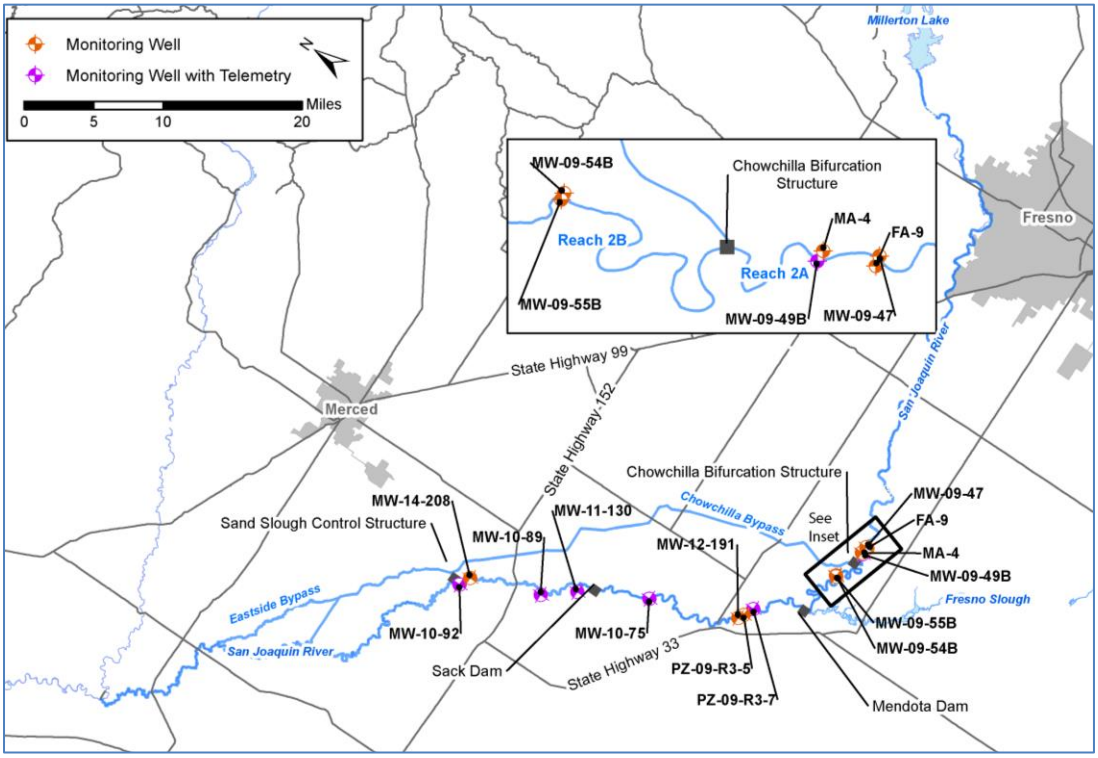

Figure 5. Priority Monitoring Well Location