SJRRP Flow Bench Evaluation

July 15, 2019

Introduction

This Flow Bench Evaluation evaluates the transition from flood flows to Restoration Flows, which became effective instantaneously throughout the Restoration Area on July 11, 2019. Flood control releases from Friant Dam are not subject to the Seepage Management Plan (SMP), but any Restoration Flows will be operated to the SMP.

The Restoration Administrator (RA), as of July 11, 2019, recommends Restoration Flow releases of 300 cfs past Gravelly Ford. Mendota Dam releases are to be adjusted to result in 200 cfs target passing below Sack Dam. Any difference between Mendota Pool inflow credit and releases below Sack Dam would be creditable as Mendota Pool recapture for the San Joaquin River Restoration Program (SJRRP).

Reclamation resumed Restoration Flow releases from Friant Dam on Thursday, July 11th at 750 cfs. Releases were briefly increased to 1000 cfs to assist in evacuating the reservoir prior to the end of uncontrolled season.

As of July 15, 2019:

1. Channel conveyance: Flow rates are below known conveyance thresholds in all reaches.

2. Operations Conference Call: An operations call was held on July 10, 2019. The anticipation of Restoration Flow releases was discussed on this call. Subsequent coordination calls were held on July 13, July 14, and July 15th.

3. Seepage Hotline Calls: The seepage hotline received one call regarding elevated groundwater levels in Water Year 2019 on March 30, 2019; however, the elevated groundwater conditions were due to flood flows. Although the conditions were due to flood flows and not Restoration Flows, the SJRRP recorded this report for further investigation to inform the response at this site for higher flow rates.

4. Real-time wells: Telemetered groundwater monitoring equipment was removed from MW-09-49B due to flood flows, but other real-time equipment remains intact. Real-time equipment was installed at MW-17-225 this spring. Telemetered groundwater monitoring well levels were below SMP thresholds at MW-10-75, MW-10-89, and MW-17-225. Telemetered measurements at PZ-09-R3-7 were above well threshold during flood control operations. In lieu of telemetered equipment at MW-09-49B, manual measurements were recorded and indicated levels above threshold from flood control operations as well.

5. Priority wells: As indicated in the Weekly Groundwater Report dated July 13, 2019, wells throughout the Restoration Area are mostly below SMP well thresholds, with some exceptions due to flood control operations. Additional critical wells have been identified for targeted monitoring during recent monitoring efforts. Therefore, this FBE includes more wells than the Weekly Groundwater Report contains and focuses on field threshold rather than well thresholds since field conditions inform impacts.

6. Projected Groundwater Level Changes: Reclamation has evaluated the change in flows using the Groundwater Level Method as described in Appendix J of the SMP. Groundwater levels are projected to decrease in all reaches with the transition to Restoration Flows, with the caveat that Reach 3 flows are subject to demands at Arroyo Canal. As agricultural demands vary, flows in Reach 3 will vary as well.

7. Levees: LSJLD has not expressed concerns about this transition to Restoration Flows.

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

Data

The following Data section considers the most recent monitoring measurements collected in July around the transition to Restoration Flows on July 11th. These values are referred to as "pre-condition" and are intended to represent the groundwater levels at the transition to Restoration Flows. The "projected" values indicate the modeled results from this FBE model-based analysis with the current releases as of July 15th to inform the response to Restoration Flows. Projected values are discussed further in the Analysis section.

Table 2 shows groundwater depths in three active real-time wells and 15 manual measurements from field staff in response to flood flows. Measurements are reported from the field between July 10, 2019 and July 12, 2019. Values for priority wells are published by Reclamation in the Weekly Groundwater Report on the SJRRP website HERE, and are taken with manual measurements via electronic well sounder. To calculate field depths, Reclamation adds ground surface buffers and lateral gradient buffers to measured groundwater depths in the well (Equation 1, Figure 1). Several soil borings were also initiated and measured to verify groundwater levels directly in fields. Soil boring values are documented with footnotes in the table.

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

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)

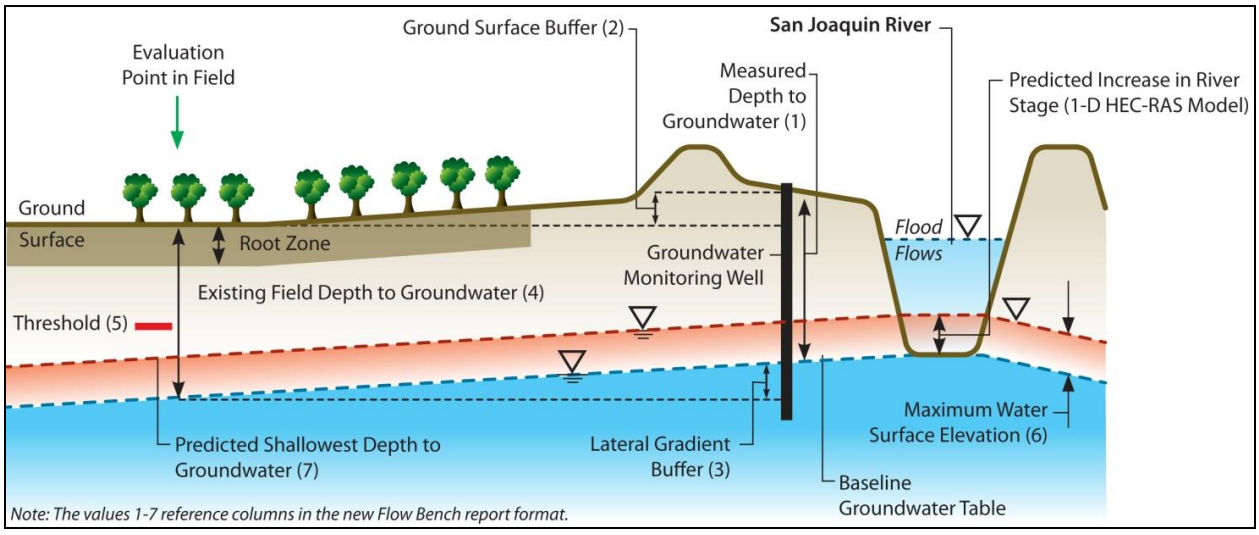

Figure 1. Conceptual Model for Observed Groundwater Level Method

Pre-Condition

The pre-condition well data in Table 2 shows some groundwater levels above threshold during flood control operations. Table 2 focuses on field values and field thresholds rather than well thresholds since field conditions inform impacts. The measured groundwater depth in the well, such as those reported in the Weekly Groundwater Reports, is converted to field data using Equation 1. Flood flows primarily impacted Reach 2A and Reach 2B; however, groundwater levels were also elevated at some Reach 3 and Reach 4A wells from various influences such as irrigation demand and flood flows from the Kings River system. From Table 2, note that the land adjacent to PZ-09-R3-5 and MW-12-190 is currently fallow and therefore these wells do not have thresholds assigned. MW-09-49B and MW-09-55B have calculated groundwater levels that are above threshold at the time of transition to Restoration Flows. The projected conditions indicate groundwater levels at these locations will decline.

Analysis

Under the current RA recommendation, all wells except MW-09-49B are projected to be below threshold given the conceptual model for the Observed Groundwater Level Method (Figure 1 and depicted further in Figure 2). All sites will have reduced groundwater elevations with the predicted stage decreases. For MW-09-49B, an early 2019 flow bench exercise in the river indicated this site is not impacted until flows in excess of 800 cfs at the Gravelly Ford (GRF) gauge. With the RA Recommendation below this flow rate, the groundwater levels at MW-09-49B are projected to drain to below threshold and will be monitored both in the well and in the field with a soil boring to confirm. Monitoring will continue throughout the network with the operation of Restoration Flows to record changes in groundwater elevation. Once below projected thresholds, subsequent FBEs may be completed to inform any potential flow changes.

Table 2. Pre-Condition Well Data

Well	Reach	1 - Measured Groundwater Depth in Well (feet bgs)	Date Measured	2 - Ground Surface Buffer (feet)	3 - Lateral Gradient Buffer (feet)	4 – Calculated Field GW Depth (feet bgs)	5 - Field Threshold (feet bgs)	Comparison of Calculated Field GW and Field Threshold
FA-9	2A	7.6	7/11/2019	2.0	2.5	**8.1**	**6.0**	**Acceptable**
MW-09-47	2A	6.5	7/11/2019	2.5	3.3	**7.3**	**6.5**	**Acceptable**
MA-4	2A	9.7	7/11/2019	6.1	4.6	**8.2**	**7.0**	**Acceptable**
MW-09-49B	2A	2.7	7/11/2019	1.7	2.4	**3.5**	**5.5**	**Above Threshold[4]**
MW-09-54B	2B	9.4	7/11/2019	7.9	5.5	**7.0**	**7.0**	**Acceptable**
MW-09-55B	2B	5.4	7/12/2019	3.7	3.0	**4.7**	**5.5**	**Above Threshold[4]**
PZ-09-R3-5	3	8.8	7/10/2019	1.2	-	**7.6**	-	**Acceptable[3]**
MW-12-191	3	10.5	7/10/2019	1.0	-	**9.5**	**6.5**	**Acceptable**
PZ-09-R3-7	3	6.7	7/11/2019	0.7	-	**7.2[2]**	**6.5**	**Acceptable**
MW-10-75	3	17.4	7/12/2019	0.5	0.2	**17.1**	**8.0**	**Acceptable**
MW-10-78	3	6.8	7/10/2019	3.0	-	**4.1[2]**	**3.9**	**Acceptable**
MW-13-201	3	11.1	7/10/2019	2.9	-	**8.2**	**8.0**	**Acceptable**
MW-12-190	3	7.4	7/10/2019	2.4	-	**5.0**	-	**Acceptable[3]**
PZ-09-R3-3	3	11.4	7/10/2019	2.3[5]	-	**9.0**	**7.4**	**Acceptable**
MW-10-89	4A	10.6	7/11/2019	1.0	-	**9.6**	**6.5**	**Acceptable**
MW-18-80B	4A	10.4	7/10/2019	4.1	-	**7.9[2]**	**6.7[1]**	**Acceptable**
MW-17-225	4A	9.0	7/11/2019	2.1[5]	-	**7.1[2]**	**6.5[1]**	**Acceptable**
MW-10-188	4A	9.4	7/11/2019	2.1	-	**7.3**	**6.5**	**Acceptable**

bgs = below ground surface; GW = groundwater; Header numbers refer to Figure 1

[1] Field thresholds are estimated.

[2] Soil boring measurements were taken in field.

[3] Field is currently fallow and therefore no threshold is assigned.

[4] Groundwater in field is above threshold due to flood flows but projected to drain with decreased Restoration Flows.

[5] Values from 2019 elevation survey.

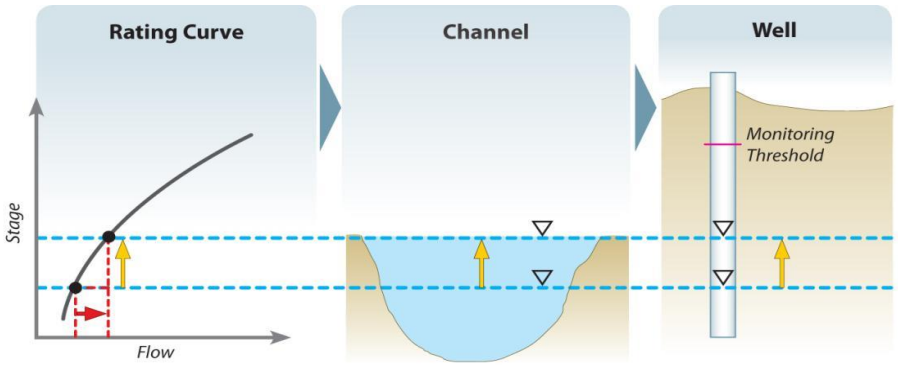

Figure 2. Conceptual Relationship between River Stage and Groundwater Levels

Projected Conditions

Table 3 shows the pre-condition flows from gauges throughout the Reaches and projected flow rates used to evaluate projected groundwater depths. Reclamation calculated projected losses based on the values assumed in Exhibit B. Henry Miller Reclamation District demands were also accounted for in Reach 3 using the SJRRP Operations Report sent July 15. Pre-condition flows are based on the flood control releases from Friant Dam until July 11. The comparison of pre-condition and projected flows informs the estimated result of decreasing flows from flood operations. Acceptable Restoration Flows may be refined further through future FBEs following groundwater monitoring.

Table 3. Anticipated Change in Flows.

	Pre-condition Flows (cfs)	Projected Flows from Evaluation (cfs)
Reach 2A	1063	525
Reach 2B	1150	425
Reach 3	745	770[1]
Reach 4A	222	200

[1] Assumes 570 cfs demand for Arroyo Canal

Table 4 shows the change in groundwater based on estimated changes in river stage and the conceptual models shown in Figures 1 – 2. Field depths are calculated by taking the most recent measurements from Table 2, adding the ground surface and the lateral gradient buffers, and subtracting the maximum predicted stage increase (Equation 2).

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

Table 4. Predicted Groundwater Levels for Priority Wells with Projected Flows

Well	Reach	1 - Measured GW Depth in Well (feet bgs)	Date Measured	2-Ground Surface Buffer (feet)	3 - Lateral Gradient Buffer (feet)	4 - Field GW Depth (feet bgs)	6 - Predicted WSEL Change (feet)	7 - Predicted Shallowest GW Depth (ft bgs_field)	5 - Field Threshold (feet bgs)	Comparison of Predicted Field GW and Field Threshold
FA-9	2A	7.6	7/11/2019	2.0	2.5	8.1	-1.2	**9.3**	**6.0**	**Acceptable**
MW-09-47	2A	6.5	7/11/2019	2.5	3.3	7.3	-1.2	**8.5**	**6.5**	**Acceptable**
MA-4	2A	9.7	7/11/2019	6.1	4.6	8.2	-1.4	**9.6**	**7.0**	**Acceptable**
MW-09-49B	2A	2.7	7/11/2019	1.7	2.4	3.5	-1.4	**4.8**	**5.5**	**Acceptable**[4]
MW-09-54B	2B	9.4	7/11/2019	7.9	5.5	7.0	-2.2	**9.1**	**7.0**	**Acceptable**
MW-09-55B	2B	5.4	7/12/2019	3.7	3.0	4.7	-2.2	**6.9**	**5.5**	**Acceptable**
PZ-09-R3-5	3	8.8	7/10/2019	1.2	-	7.6	0.1	**7.5**	**-**	**Acceptable**[3]
MW-12-191	3	10.5	7/10/2019	1.0	-	9.5	0.1	**9.4**	**6.5**	**Acceptable**
PZ-09-R3-7	3	6.7	7/11/2019	0.7	-	7.2[2]	0.1	**7.1**	**6.5**	**Acceptable**
MW-10-75	3	17.4	7/12/2019	0.5	0.2	17.1	0.1	**17.1**	**8.0**	**Acceptable**
MW-10-78	3	6.8	7/10/2019	3.0	-	4.1[2]	0.1	**4.1**	**3.9**	**Acceptable**
MW-13-201	3	11.1	7/10/2019	2.9	-	8.2	0.1	**8.1**	**8.0**	**Acceptable**
MW-12-190	3	7.4	7/10/2019	2.4	-	5.0	0.1	**4.9**	**-**	**Acceptable**[3]
PZ-09-R3-3	3	11.4	7/10/2019	2.3[5]	-	9.0	0.1	**9.0**	**7.4**	**Acceptable**
MW-10-89	4A	10.6	7/11/2019	1.0	-	9.6	-0.7	**10.3**	**6.5**	**Acceptable**
MW-18-80B	4A	10.4	7/10/2019	4.1	-	7.9[2]	-0.3	**8.1**	**6.7**[1]	**Acceptable**
MW-17-225	4A	9.0	7/11/2019	2.1[5]	-	7.1[2]	-0.3	**7.4**	**6.5**[1]	**Acceptable**
MW-10-188	4A	9.4	7/11/2019	2.1	-	7.3	-0.5	**7.8**	**6.5**	**Acceptable**

bgs = below ground surface; GW = groundwater; WSEL = water surface elevation; Header numbers refer to Figure 1

[1] Field thresholds are estimated.

[2] Soil boring measurements were taken in field.

[3] Field is currently fallow and therefore no threshold is assigned.

[4] Calculated groundwater in field is above threshold due to flood flows; 2019 flow bench exercise indicates will drain with decreased Restoration Flows at GRF.

[5] Values from 2019 elevation survey.

Summary

This analysis indicates acceptable conditions for the current RA Recommendation. Groundwater levels will continue to be closely monitored at MW-09-49B, which is currently elevated due to flood flows, so as not to impede drainage. Monitoring will also continue at other critical wells (Figure 4) and the remainder of the network. The maximum allowable flow below Sack Dam is currently limited to 250 cfs. Arroyo Canal demands will also be monitored to determine if the capacity for Restoration Flows in Reach 3 becomes limited. Reclamation retains the right to recapture Restoration Flows in Mendota Pool to adjust for Arroyo Canal demands when constrained by seepage in Reach 3. Subsequent FBEs will be performed to inform any flow changes with the potential to impact seepage.

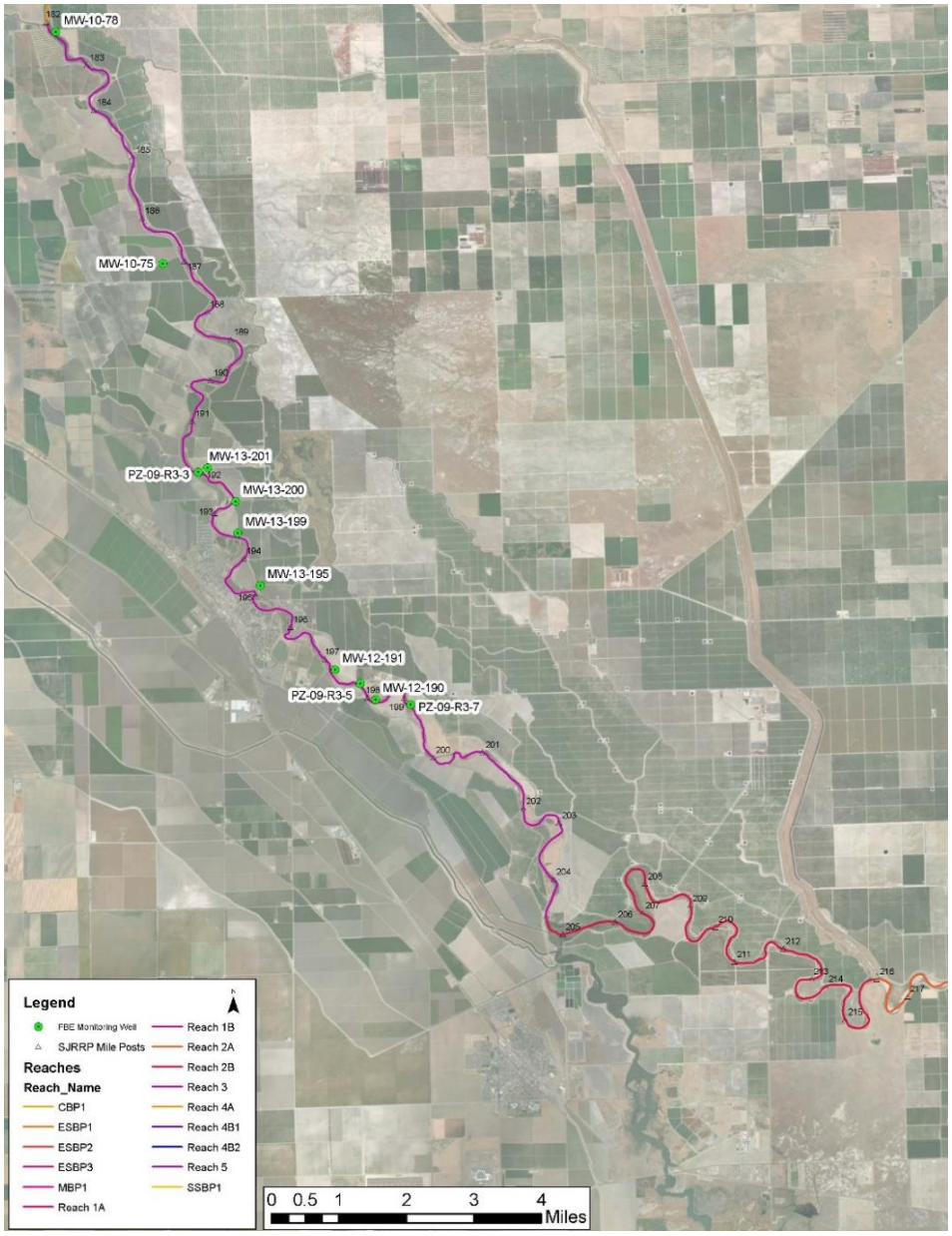

Figure 4a. Critical Monitoring Well Locations in Reach 3

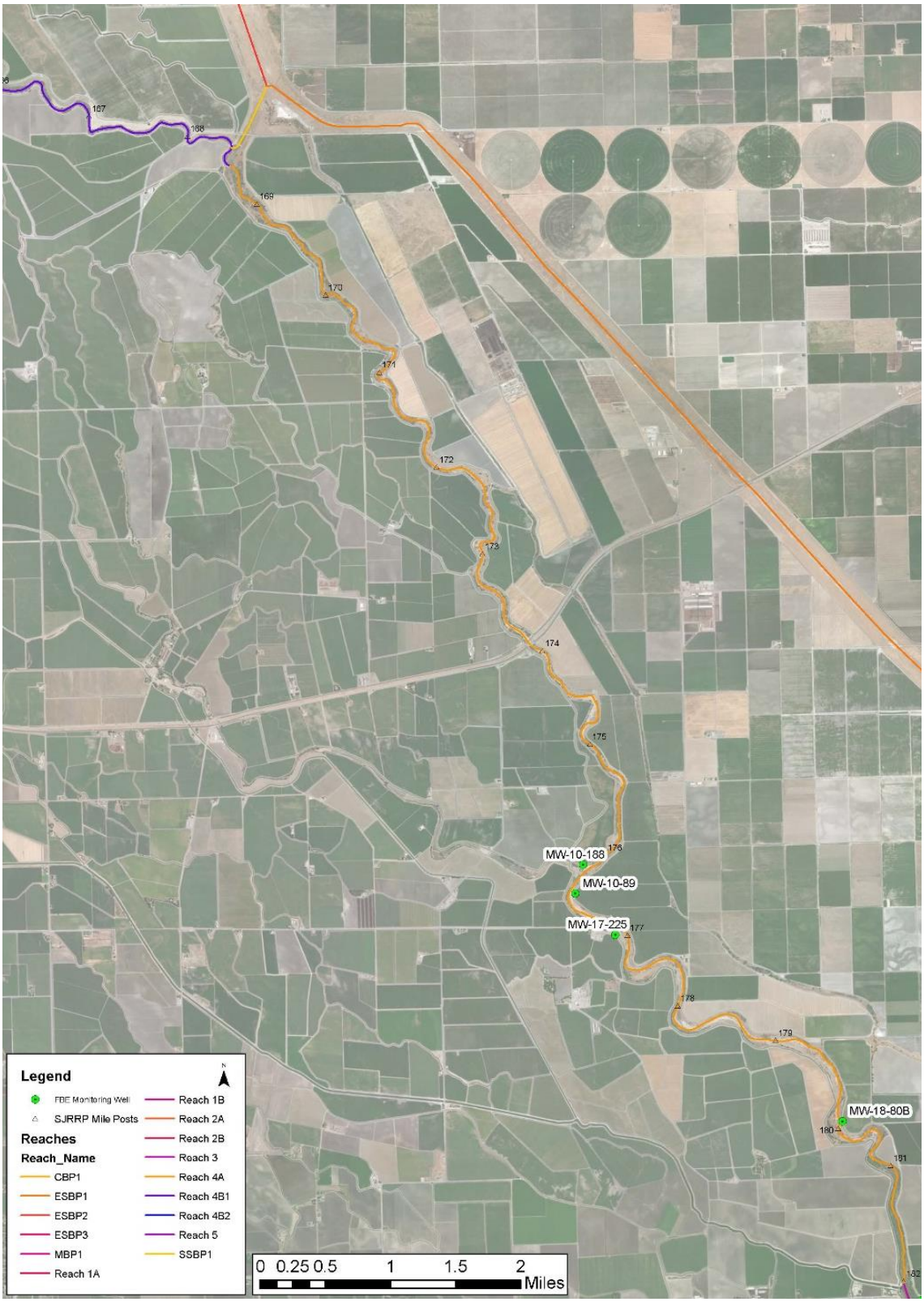

Figure 4b. Critical Monitoring Well Locations in Reach 4A