Appendix C

Levee Capacity Evaluation of Mariposa Bypass and Reach 4B2 Study Area

January 2020

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January 22, 2020

1. INTRODUCTION

Tetra Tech Inc. performed an analysis to establish a flow capacity along the levees in Reach 4B2 and the Mariposa Bypass (**Figure 1**) based on geotechnical data. This analysis was to support the efforts of the Department of Water Resources (DWR) and the San Joaquin River Restoration Program (SJRRP) to determine then-existing channel capacity within the Restoration Area. The maximum flow capacity in Reach 4B2 and the Mariposa Bypass was based on the maximum allowable water surface elevation (WSE) determined from a geotechnical evaluation of the levees in these reaches. The evaluation identified the point on the levees where underseepage would create significant risk of levee failure based on U.S. Army Corps of Engineers (USACE) criteria for levee seepage and slope stability. The geotechnical evaluation is summarized in a Geotechnical Condition Report (GCR) for these reaches (DWR, 2019). The levees were divided into 33 sub-reaches based on geotechnical characteristics denoted by letters from A to U (**Figures 2 through 5**). Fourteen sub-reaches were identified in Reach 4B2, labeled A through F and I through P. Seven sub-reaches were identified in the Mariposa Bypass, labeled G, H and Q through U. Some sub-reaches could include one or more locations along the reach where seepage or stability issues are most likely to occur. This memorandum summarizes the methods and results of the effort to determine what flow corresponds to the maximum allowable WSE at each location. This work was completed under the River Engineering Services for the San Joaquin River Restoration Program Contract, Task Order 16.

2. METHODOLOGY

The locations in each sub-reach were referenced relative to cross sections in the one-dimensional (1-D) hydraulic (HEC-RAS) model of each particular sub-reach (Tetra Tech, 2014) using ArcGIS. In addition to a letter label, each location is associated with a cross section used for the geotechnical analysis and is identified by a station number. Because a canal is landside and adjacent to a majority of the left bank of Reach 4B2 and the Mariposa Bypass, the maximum allowable WSE was developed for two canal scenarios: no water in the canal and flow depth of two feet in the canal. This assumption is based on observations that the canals are usually wet during flood events and would need to be evaluated prior to applying these results. If there was no canal adjacent to the levee, or if water in the canal did not seem appropriate for the seepage analysis, the capacity was not determined for the second scenario.

HEC-RAS model results were used to estimate maximum allowable flow capacities at each geotechnical cross-section. Because the model cross-sections do not coincide exactly with the geotechnical cross-section, the WSE[1] at the model cross-section immediately upstream of each geotechnical cross section served as the reference for each flow level (**Figure 6**). Model results for a range of discharges between 250 cfs and 4,500 cfs were considered and two discharges that produced WSEs immediately higher and lower than the maximum allowable WSE were

[1] Water-surface elevations result from models that reflect 2008 LiDAR for topography. Regional subsidence within the area range from <0.02 ft to 0.04 per year. So, no adjustments were made to account for subsidence.

identified (**Figure 7** and **Figure 8**). The flow capacity corresponding to the maximum allowable WSE was determined by linearly interpolating between these two discharges. In some cases, the maximum allowable WSE was greater than the modeled WSE at the maximum Restoration Flows of 4,500 cfs. For these instances, a capacity of "> 4,500 cfs" was reported and no further model runs were made.

3. RESULTS

In Reach 4B2, when considering the maximum allowable WSE (assuming no water is in the adjacent canal), 17 of the 22 sub-reaches had a capacity that exceeded the maximum Restoration Flows of 4,500 cfs (Figure 7**;** Table 1).

Table 1. Flow capacities at the CGR cross sections in Reach 4B2

Sub-reach	Levee Station	Model Cross Section	Maximum Allowable WSE Assuming Dry Canal (feet)	Discharge Capacity (cfs)	Maximum Allowable WSE Assuming 2 ft depth in Canal (feet)	Discharge Capacity (cfs)
A	7918+44	994+43	83.2	> 4,500	- -	> 4,500
B1	7975+00	1099+75	82.4	> 4,500	- -	> 4,500
B2	8008+00	1139+89	80.5	2,450	82.5	> 4,500
C1	8068+56	1222+01	84.7	> 4,500	- -	> 4,500
C2	8098+63	1269+30	86.2	> 4,500	- -	> 4,500
D	8168+70	1357+61	83.7	1,950	86.5	> 4,500
E1	8198+55	1404+59	89.8	> 4,500	- -	> 4,500
E2	8218+75	1422+67	89.0	> 4,500	- -	> 4,500
F1	8240+00	1462+79	87.8	4,440	88.4	> 4,500
F2	8268+67	1497+07	87.7	3,370	88.3	4,300
I	7829+50	1010+90	82.1	> 4,500	- -	> 4,500
J	7893+50	1135+26	83.5	> 4,500	- -	> 4,500
K	7912+53	1156+70	84.0	> 4,500	- -	> 4,500
L1	7934+50	1173+70	84.9	> 4,500	- -	> 4,500
L2	7952+51	1198+24	84.2	> 4,500	- -	> 4,500
L3	7977+25	1235+54	84.5	> 4,500	- -	> 4,500
L4	8005+25	1260+91	85.4	> 4,500	- -	> 4,500
L5	8052+55	1345+20	88.0	> 4,500	- -	> 4,500
M	8082+61	1381+94	85.0	2,570	87.0	> 4,500
N	8102+60	1396+07	88.0	> 4,500	- -	> 4,500
O	8145+01	1453+75	89.4	> 4,500	- -	> 4,500
P	8178+00	1512+68	91.1	> 4,500	- -	> 4,500

* '- -' An analysis assuming water in the canal was not completed because there was no adjacent canal or having water in the canal was not appropriate for evaluating levee stability.

Of the remaining five sub-reaches, sub-reach D has the lowest capacity of 1,950 cfs. Sub-reaches B2 and M, exceed the maximum WSEs at similar discharges of 2,450 cfs and 2,570 cfs,

respectively. The final two sub-reaches, F1 and F2, have capacities of 4,440 cfs and 3,370 cfs, respectively. Assuming a depth of 2 ft in the canal on the landside of the levee resulted in an increase in the maximum WSE in these five sub-reaches. With the assumed canal depth, sub-reaches B2, D, F1 and M have capacities above 4,500 cfs, but the capacity of sub-reach F2 only increases to 4,300 cfs.

In the Mariposa Bypass, only five of the eleven sub-reaches had a capacity that exceeds the maximum flow of 4,500 cfs (Figure 8**;** Table 2) assuming no water in the adjacent canal. Of the remaining six sub-reaches, H1 and H2 exceed the maximum WSE at 335 cfs and 980 cfs, respectively. The maximum WSEs in sub-reaches T1 and T3 were exceeded at 1,800 cfs and 1,920 cfs, respectively. The remaining two sub-reaches, Q and G, exceed the maximum allowable WSEs at 2,170 cfs and 2,940 cfs, respectively. Assuming a depth of 2 ft in the canal on the landside of the levee resulted in an increase in the maximum allowable WSE in four of these five sub-reaches. However, none of the increases resulted in capacities that exceed the 4,500 cfs maximum flow level. The capacity of sub-reach H1 increased to 1,830 cfs, H2 increased to 3,210 cfs, G increased to 4,310 cfs and T3 increased to 2,050 cfs. Many of the remaining reaches were not evaluated under 2 ft of water in the canal because there was either not a canal or it was not an appropriate condition to assume for the stability analysis.

Table 2. Flow capacities at the CGR cross sections in Mariposa Bypass

Sub-reach	Levee Station	Model Cross Section	Maximum Allowable WSE Assuming Dry Canal (feet)	Discharge Capacity (cfs)	Maximum Allowable WSE Assuming 2 ft depth in Canal (feet)	Discharge Capacity (cfs)
G	8288+64	14+43	88.0	2,940	89.0	4,310
H1	1048+09	99+61	86.5	335	90.0	1,830
H2	1137+90	185+13	90.5	980	93.8	3,210
Q	8202+59	3+80	87.0	2,170	- -	2,170
R	1019+40	66+64	91.8	> 4,500	- -	> 4,500
S	1039+46	87+43	93.0	> 4,500	- -	> 4,500
T1	1109+00	156+06	91.5	1,800	- -	1,800
T2	1143+50	191+46	97.8	> 4,500	- -	> 4,500
T3	1157+00	204+36	92.8	1,920	93.0	2,050
T4	1170+00	216+99	98.9	> 4,500	- -	> 4,500
U	8241+41	35+85	90.2	> 4,500	- -	> 4,500

* '- -' An analysis assuming water in the canal was not completed because there was no adjacent canal or having water in the canal was not appropriate for evaluating levee stability.

The analysis indicated that for a maximum Restoration Flow of 4,500 cfs with two feet of water in the adjacent canal, one sub-reach in Reach 4B2 and six sub-reaches in the Mariposa Bypass do not meet the criteria for levee seepage and stability. Assuming that each geotech-location is representative of the entire sub-reach in which it is located, approximately 1 mile of levee in Reach 4B2 and 6 miles of levee in the Mariposa Bypass have a capacity less than 4,500 cfs.

4. REFERENCES

DWR, 2020. Geotechnical Condition Report, San Joaquin River Restoration Program Gravelly Ford (Reach 4B2 and Mariposa Bypass) Study Area. January.

Tetra Tech, 2014. San Joaquin River and Bypass System 1-D Steady State HEC-RAS Model Documentation, Draft technical memorandum prepared for the California Dept. of Water Resources, Fresno, California, March.

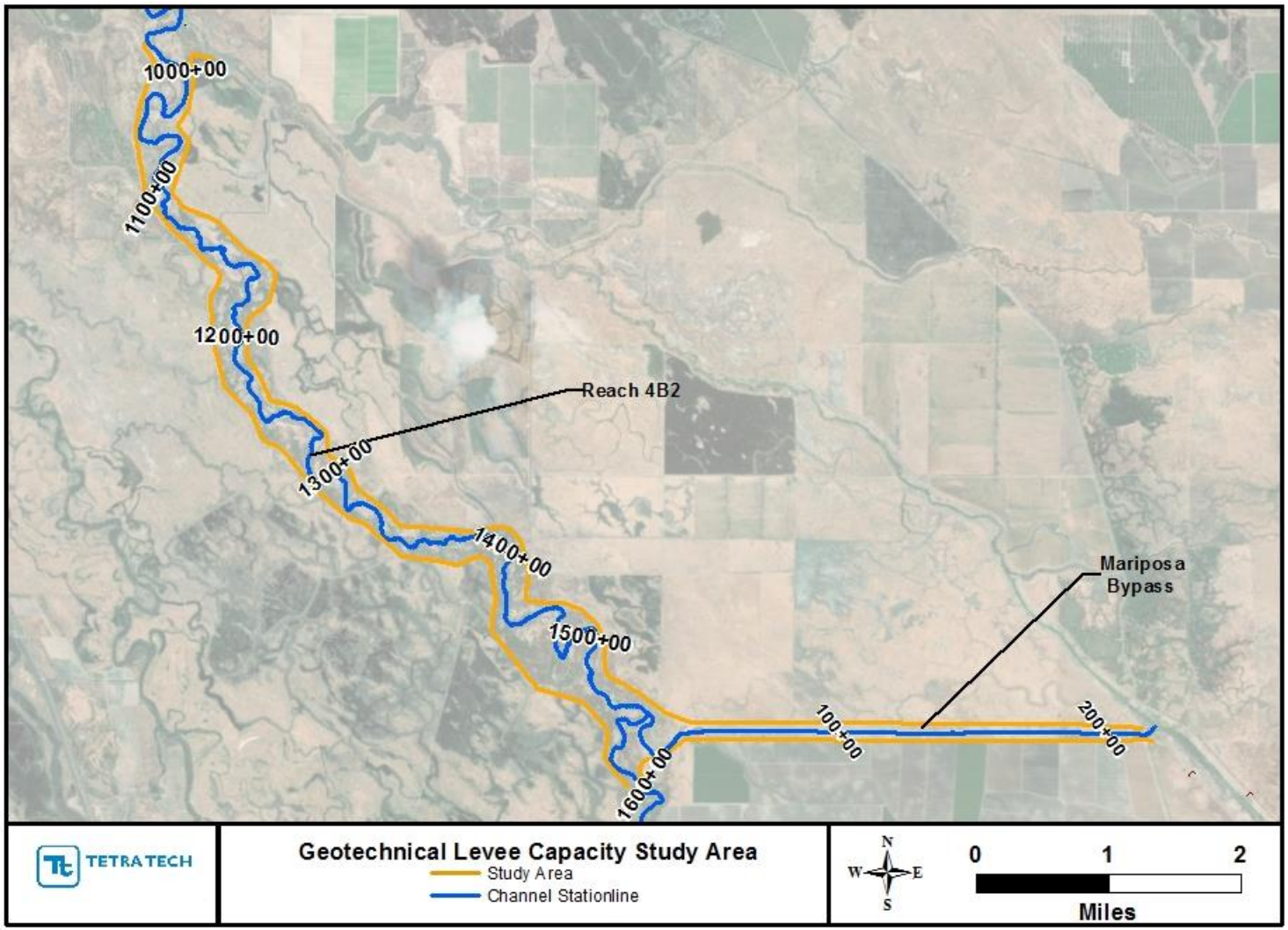

Figure 1. Site map of study area.

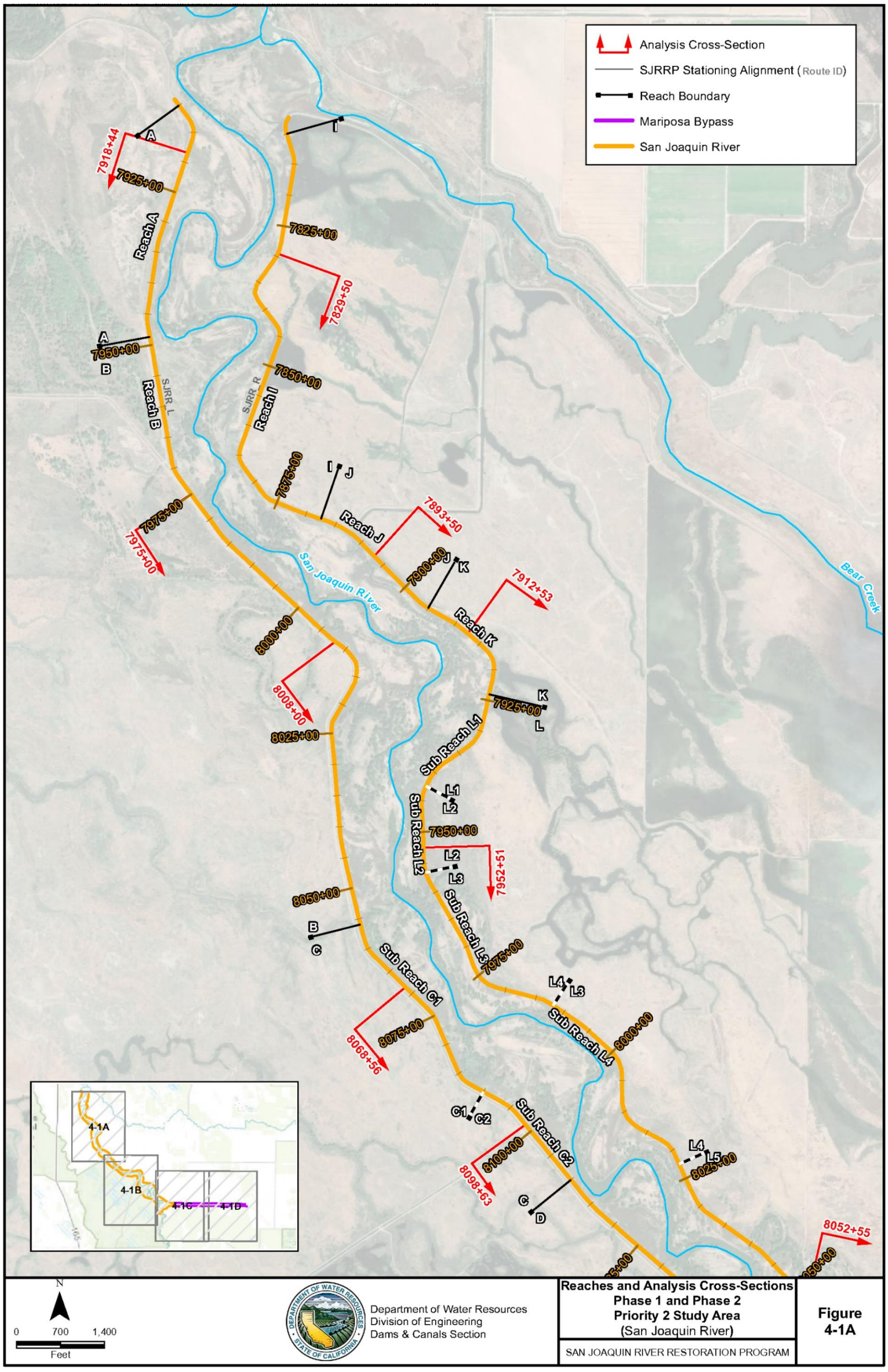

Figure 2. GCR analysis reaches and cross sections in the lower portion of Reach 4B2 (Figure 4-1a from Kleinfelder, 2015).

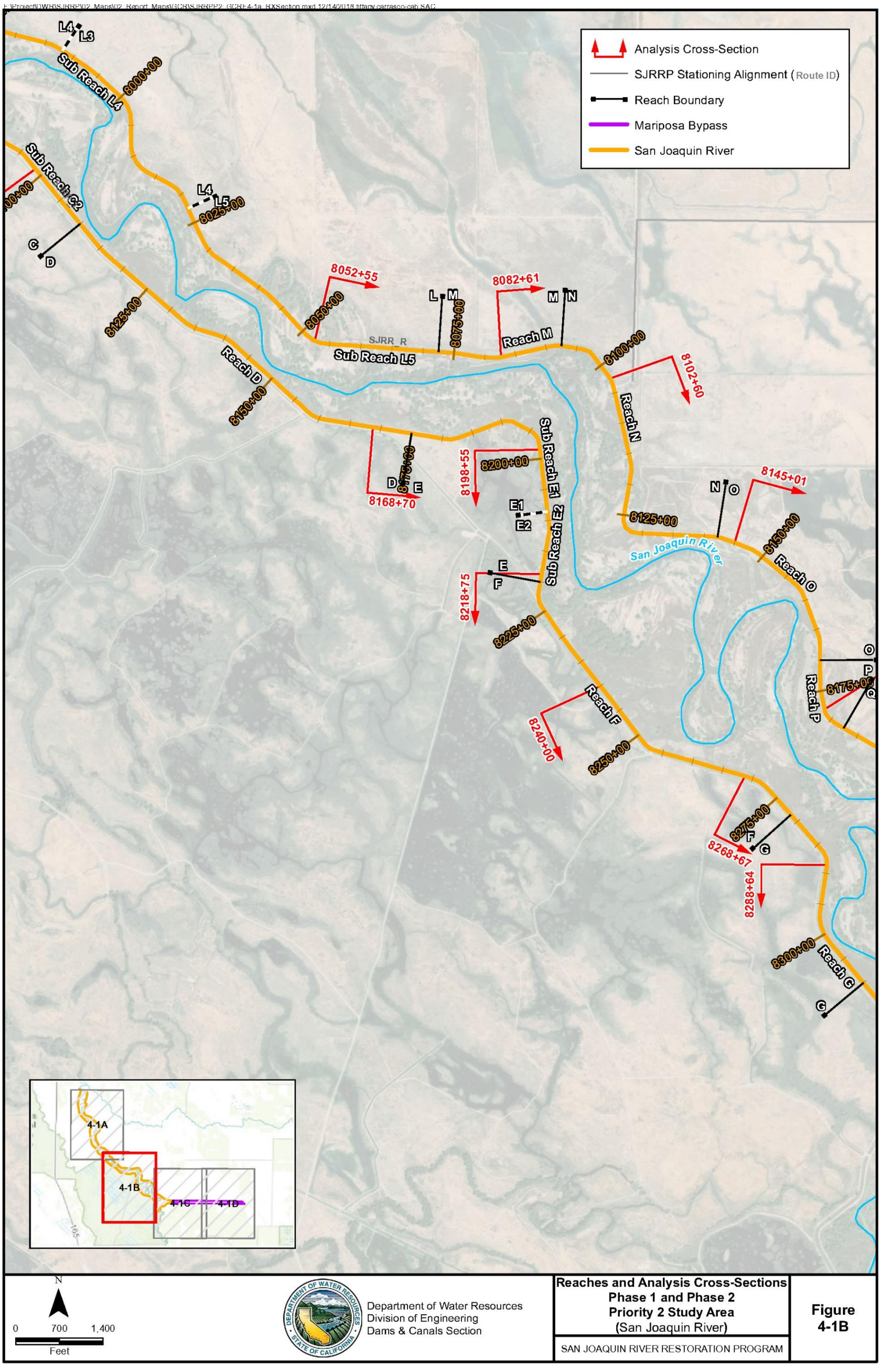

Figure 3. GCR analysis reaches and cross sections in the middle portion of Reach 4B2 (Figure 4-1b from Kleinfelder, 2015).

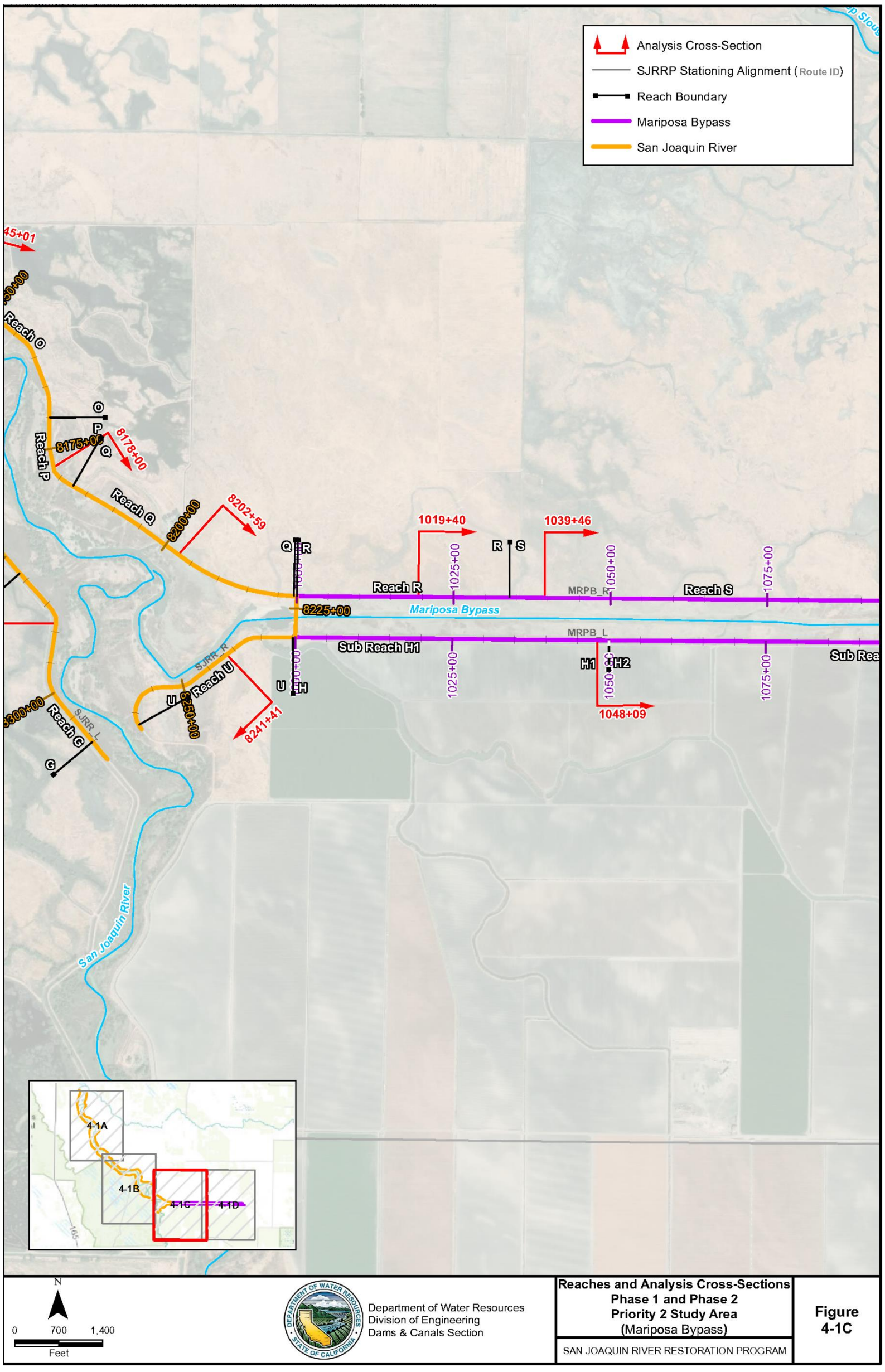

Figure 4. GCR analysis reaches and cross sections in the upper portion of Reach 4B2 and the lower portion of the Mariposa Bypass (Figure 4-1c from Kleinfelder, 2015).

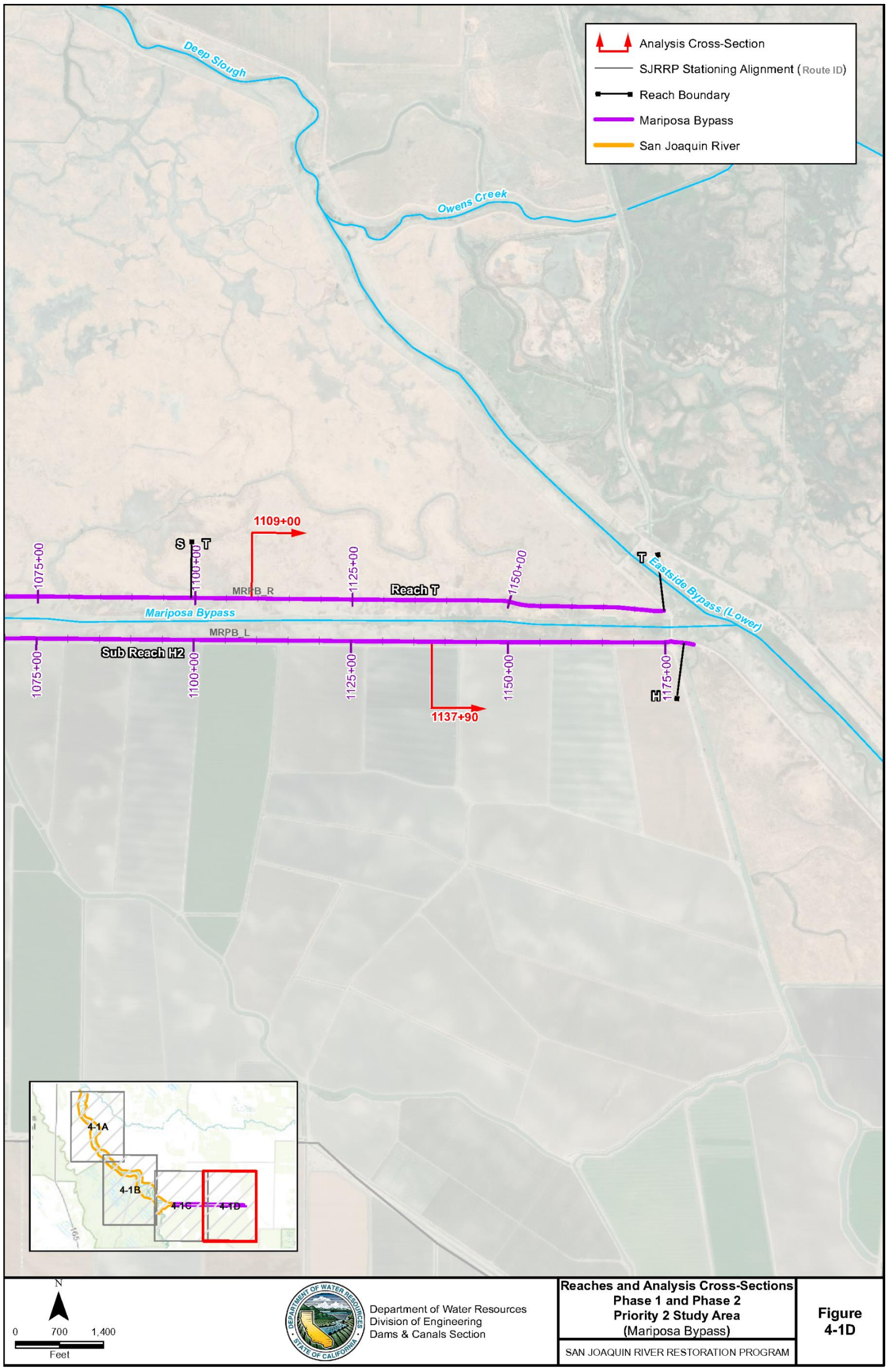

Figure 5. GCR analysis reaches and cross sections in the upper portion of Reach Mariposa Bypass (Figure 4-1d from Kleinfelder, 2015).

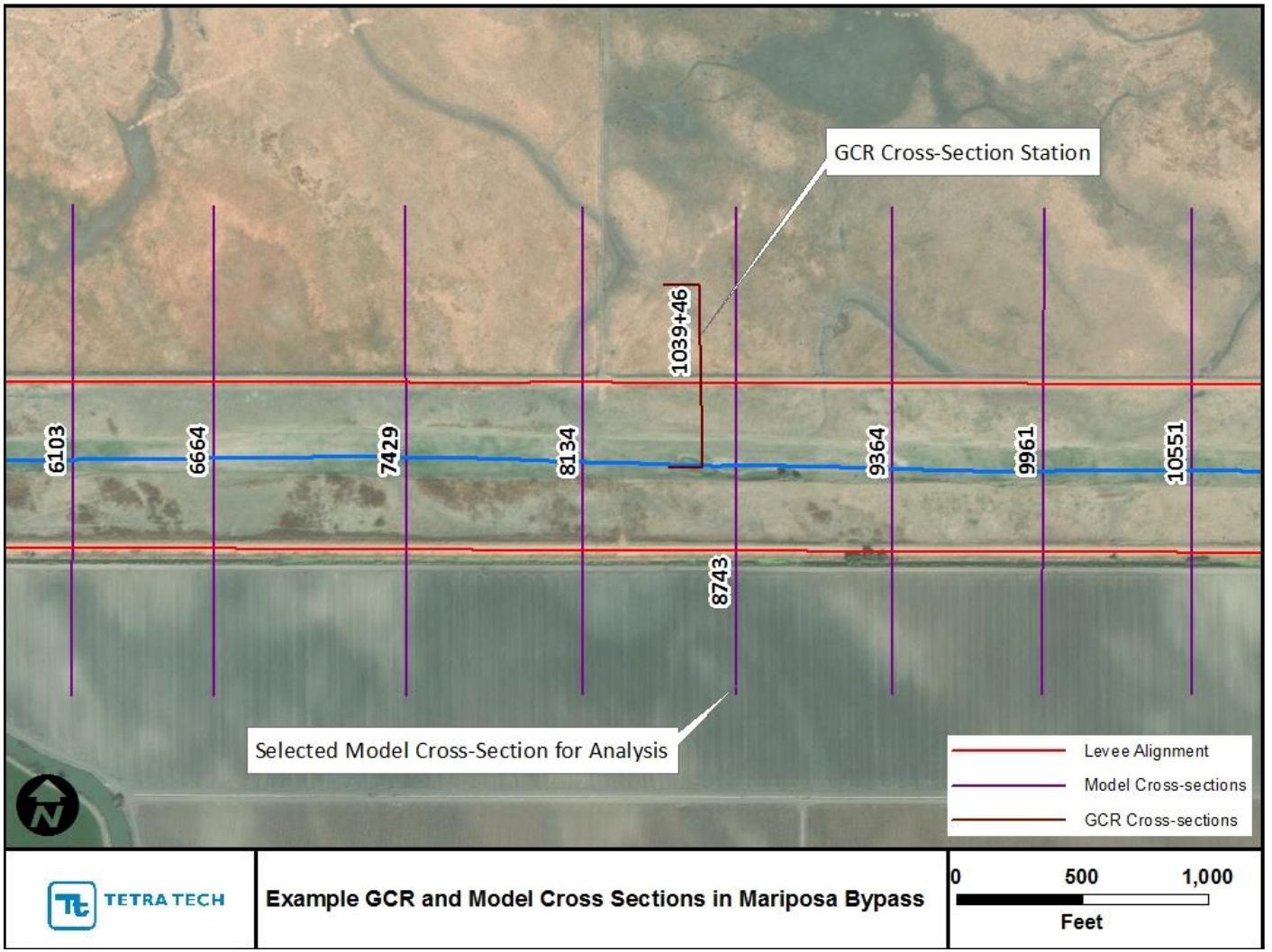

Figure 6. Planview of example GCR cross section and HEC-RAS model cross section selected for capacity calculations.

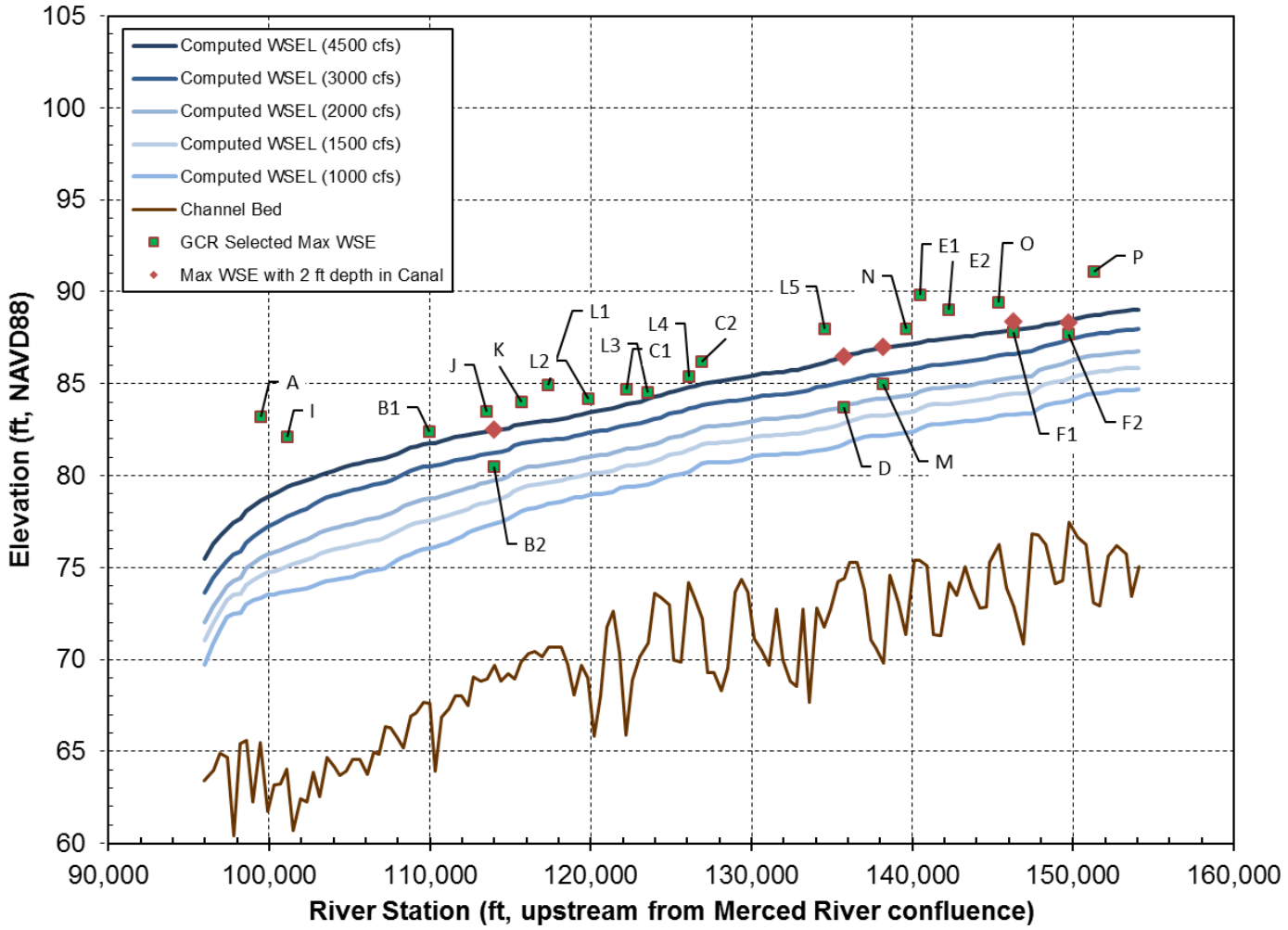

Figure 7. Computed water-surface profiles along Reach 4B2. Also shown are the reference points for each of the GCR cross sections in this reach.

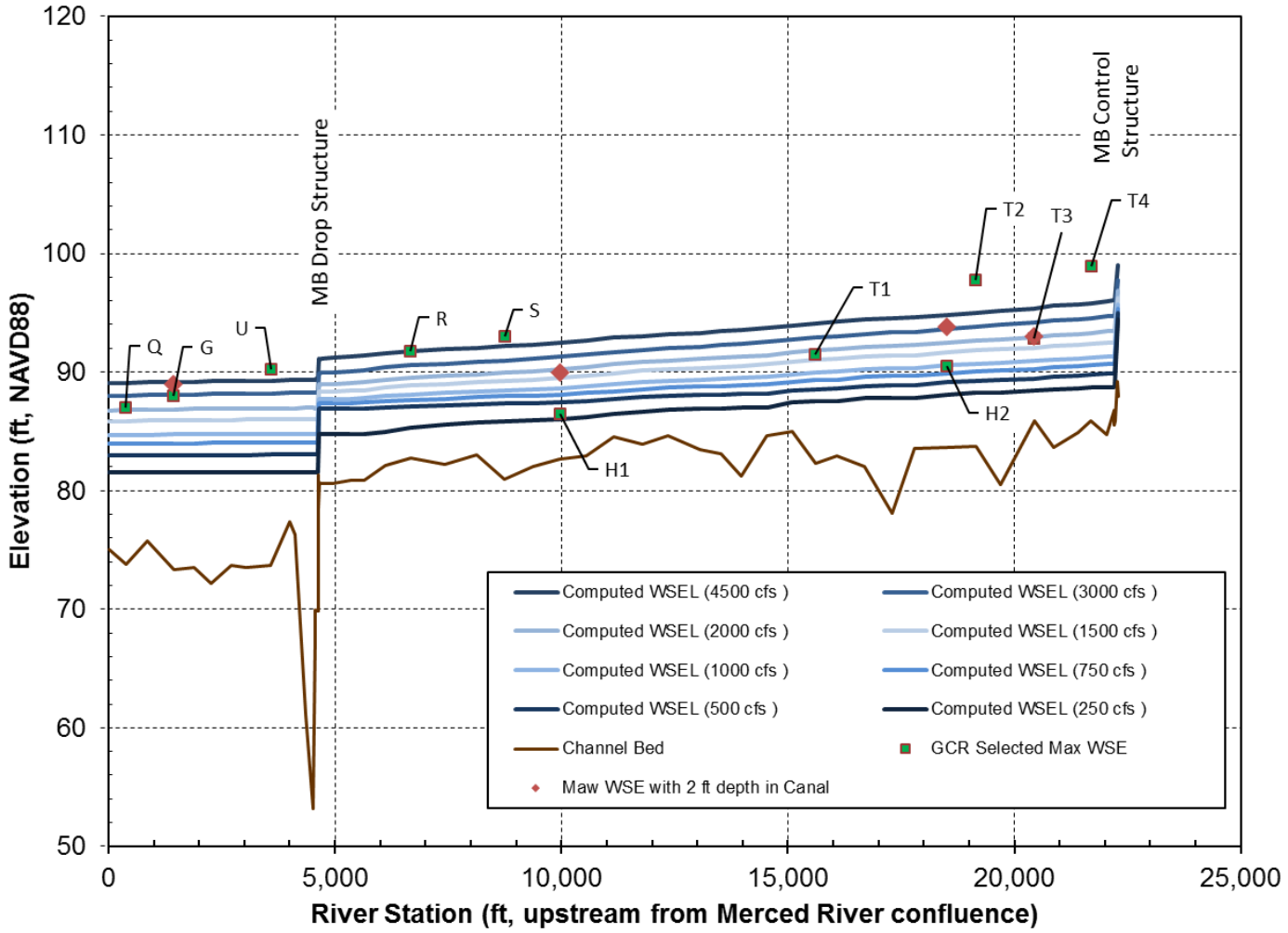

Figure 8. Computed water-surface profiles along Mariposa Bypass. Also shown are the reference points and for each of the GCR cross sections in this reach.