Appendix B

2020 Levee Capacity Update in the Middle Eastside Bypass

August 2021

San Joaquin River Restoration Program

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California Department of Water Resources
Division of Regional Assistance
South Central Region Office

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Acronyms and Abbreviations

cfs	cubic feet per second
DWR	California Department of Water Resources
EBCS	Eastside Bypass Control Structure
ft	foot or feet
GCR	Geotechnical Condition Report
HEC-RAS	Hydrologic Engineering Center's River Analysis System
LiDAR	Light Detection and Ranging
LESB	Lower Eastside Bypass
MESB	Middle Eastside Bypass
Reclamation	U.S. Bureau of Reclamation
SJLE	San Joaquin Levee Evaluation
SJRRP	San Joaquin River Restoration Program
UESB	Upper Eastside Bypass
WSE	water surface elevation

Introduction

The San Joaquin Levee Evaluation (SJLE) Project assists the San Joaquin River Restoration Program (SJRRP) in assessing flood risks associated with the release of Restoration Flows as it relates to levee seepage and stability. The SJLE Project identified a two-mile section of levee in the Middle Eastside Bypass (MESB) that needed improvement for the SJRRP to meet the Stage 1 objective of 2,500 cubic feet per second (cfs) channel capacity to convey Restoration Flows from Friant Dam to the Merced River (SJRRP, 2018). The two-mile section of levee (herein referred to as Reach O) was improved by the Department of Water Resources (DWR) in 2020. This study provides an update to the capacity in the MESB (Figure 1) considering the levee improvement project, subsidence through 2020, and geotechnical data.

Background

In 2015, DWR completed a Geotechnical Condition Report (GCR) that evaluated the MESB levees. The GCR also identified the maximum allowable water surface elevation (WSE) "that can be placed on the waterside levee slopes without exceeding geotechnical criteria for stability and seepage" (URS, 2015). The GCR further split the MESB into reaches based on the levee's geotechnical characteristics (Figure 2). Following the geotechnical results, DWR's consultant, Tetra Tech, prepared *Reaches 3, 4A and Middle Eastside Bypass Subsidence and Capacity Study* that evaluated the levee capacity for each reach using a 1-D Hydrologic Engineering Center's River Analysis System (HEC-RAS) model. The reaches were evaluated by comparing the maximum allowable WSE with water-surface profiles up to a maximum Restoration flow of 4,500 cfs. Since the maximum allowable WSEs in the GCR are based on a 2008 Light Detection and Ranging (LiDAR) dataset, the study evaluated levee capacities considering subsidence that had occurred between 2008 and 2014. The study identified Reach O, as well as four other reaches that had capacities less than 4,500 cfs (Tetra Tech, 2015).

Model Development

This study was conducted using a 1-D HEC-RAS model of the MESB. The model geometry is based on 2015 LiDAR that was further updated to consider subsidence between 2015 and 2020. The model was validated using WSE data collected during a flood event in 2017, which showed that the model was within 0.5 foot (ft) of the observed WSEs (DWR, 2021). The downstream boundary condition for this study assumes that the flash boards on the upstream side of Eastside Bypass Control Structure (EBCS) are removed as part of the fish passage improvements that will be implemented in 2024. Removal of the boards decreases the WSEs from the EBCS to approximately 500 ft upstream of the bridge at Sandy Mush Road.

To update the model geometry for subsidence, the 2015 cross-section elevations were adjusted by the total subsidence that was measured between the 2015 LiDAR and the 2019 top of levee surveys completed by DWR. The model geometry was further modified to reflect subsidence from 2019 to 2020 using U.S. Bureau of Reclamation's (Reclamation's) bi-annual surveys (Figure 3). The top of levee surveys, as well as Reclamation's bi-annual surveys show similar trends in subsidence. However, the top of levee surveys shows slight differences in localized subsidence trends. Each of the model cross sections were adjusted for subsidence based on the average total subsidence within a 300-ft buffer around each cross section on both levees. Data points were removed in areas where the total subsidence was not

consistent with surrounding subsidence trends, such as areas where gravel was added on the levees. These areas consider the average total subsidence from only one levee. The maximum allowable WSEs were also adjusted to reflect elevations in 2020 based on subsidence between the 2008 LiDAR and 2019 top of levee survey and Reclamation's bi-annual surveys between 2019 and 2020. The total subsidence adjustment from 2015 to 2020 ranged from 0.5 ft to 2 ft depending on the location along the MESB. The average subsidence for the reach was 1.0 ft.

Analysis and Results

The hydraulic model was used to compute the WSEs for a range of flows at 50 cfs increments up to 4,500 cfs. The computed water-surface profiles in the MESB were compared to the maximum allowable WSEs for each reach identified in the GCR. The water surface profiles and the maximum allowable WSEs are shown in Figure 4. Table 1 identifies the GCR reach and station, the HEC-RAS cross section, the maximum allowable WSEs, and the corresponding levee capacity.

Table 1. 2020 Levee Capacities at the GCR Cross Sections

GCR Reach	GCR Station	HEC-RAS Model Cross Section	Maximum Allowable WSE (ft)	Levee Capacity (cfs)
A	102000	60106	97.7	>4,500
B	106500	64035	103.8	>4,500
C	111000	69622	97.1	4,000[2]
D	116400	73247	99.1	4,500
E	136100	93015	102.0	>4,500
F	144600	101445	101.0	4,250
J	106000	61699	94.4	3,700[3]
K	111830	67946	99.1	>4,500
L1	116800	72501	98.0	2,600
L2	124500	80459	99.7	4,050
M	126500	82690	103.8	>4,500
N	134500	90952	100.9	>4,500
O	140500	96995	N/A[1]	>4,500

[1] Not applicable: The Reach O levee improvement project did not evaluate a maximum water surface elevation, only evaluated the stability of the reach at 4,500 cfs after 25-years of subsidence.
[2] Capacity at Reach C decreases to 3,950 cfs with the EBCS flash boards in place.
[3] Capacity at Reach J decreases to 3,550 cfs with the EBCS flash boards in place.

Prior to the improvement in Reach O, the SJRRP levee capacity of the reach was 1,070 cfs (Tetra Tech, 2015). The recent MESB improvements increased Reach O capacity to greater than 4,500 cfs; however, the limiting capacity is now 2,600 cfs for Reach L1, the downstream mile or so of Reach L. However, further analysis is necessary to determine the boundary of capacities between 2,600 cfs and 4050 cfs. In total, there are about 6.5 miles of remaining levee within the Middle Eastside Bypass with a levee capacity of less than 4,500 cfs.

Conclusion

The results of this hydraulic analysis show that capacities through the MESB are equal to or greater than 2,600 cfs. However, because subsidence continues, the capacity will continue to be reduced over time. The SJRRP will need to determine if additional reaches will need improvement over the next several years to maintain capacity for the Stage 1 objective of 2,500 cfs by 2024. Reach L, as well as other reaches, will be evaluated periodically to determine if improvements will be needed over the next five to ten years.

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Figure 1 **Study Area**

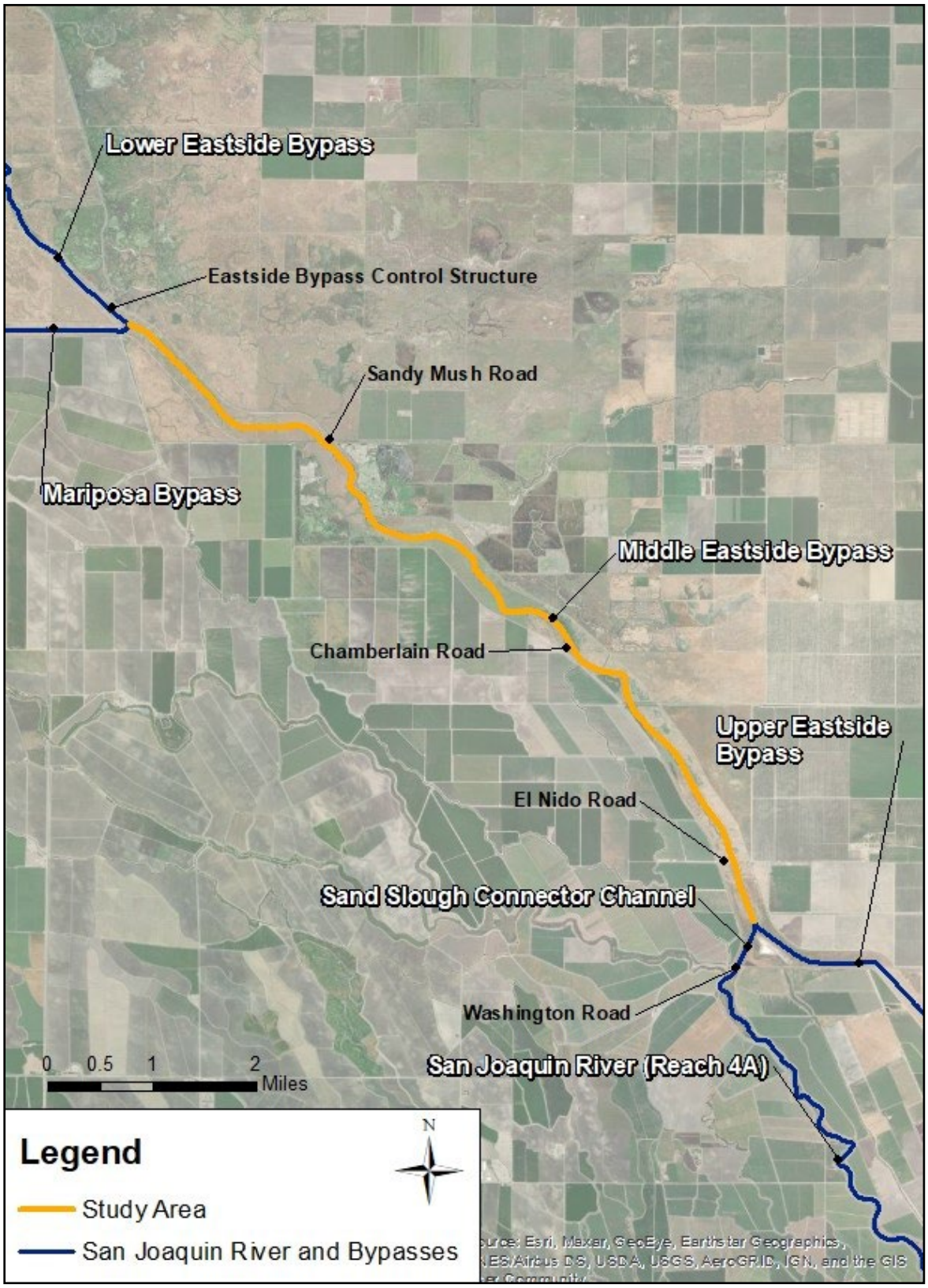


Figure 2 GCR Reaches and Cross Sections in the Middle Eastside Bypass (URS, 2015)

Figure 3 U.S. Bureau of Reclamation Subsidence Rates from 2019 to 2020

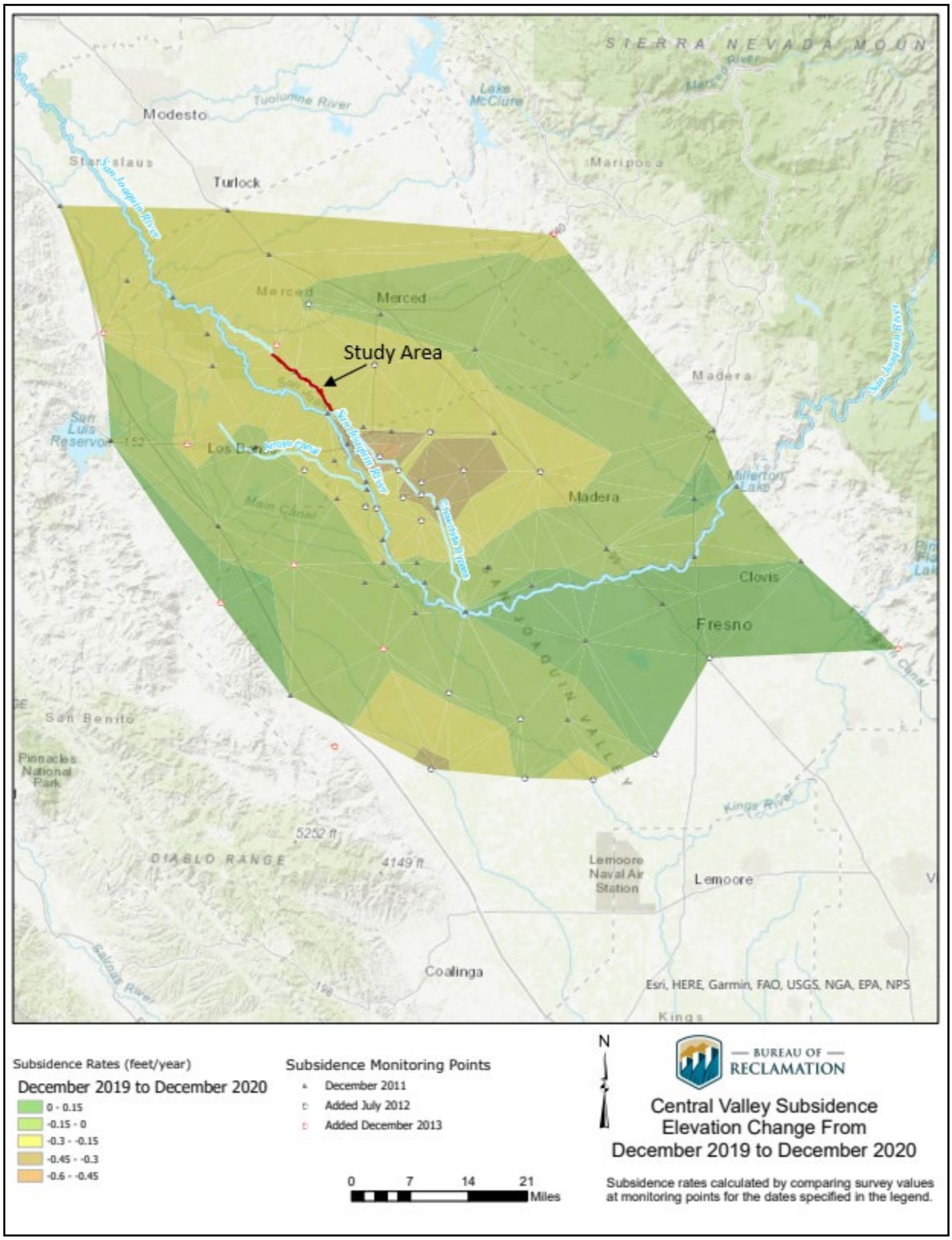
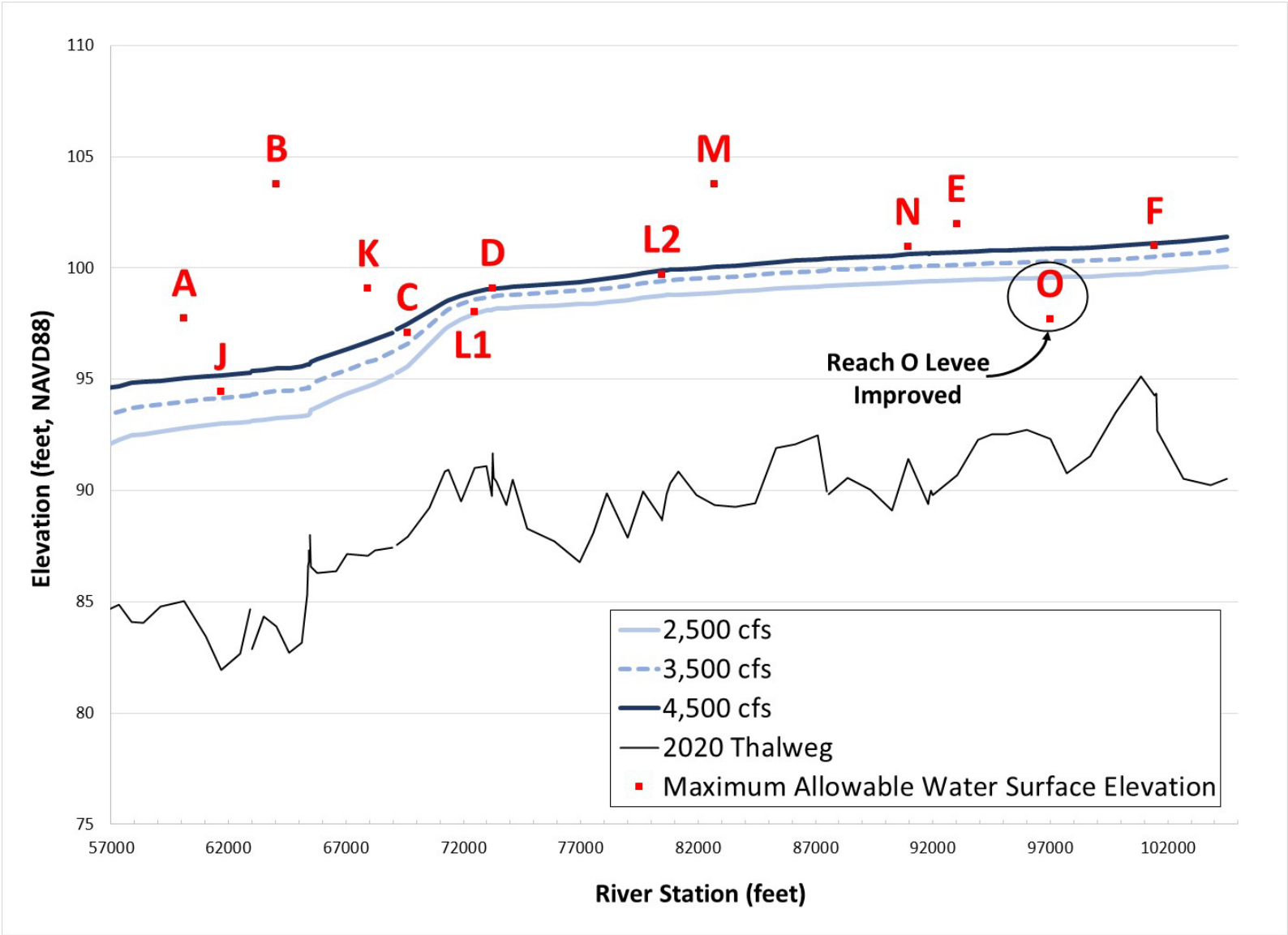


Figure 4 2020 Maximum Allowable WSE and WSE up to 4,500 cfs in the Middle Eastside Bypass

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