Table 5-2. Area enclosed by Levee Alignments A to D.

Levee Alignment Option (A-D)	**Total Area Enclosed** (acres)
Option A	1,101
Option B	2,985
Option C	6,195
Option D	10,150

Levee Options for Reach 4B, Eastside Bypass, and Mariposa Bypass Channel and Structural Improvements Project

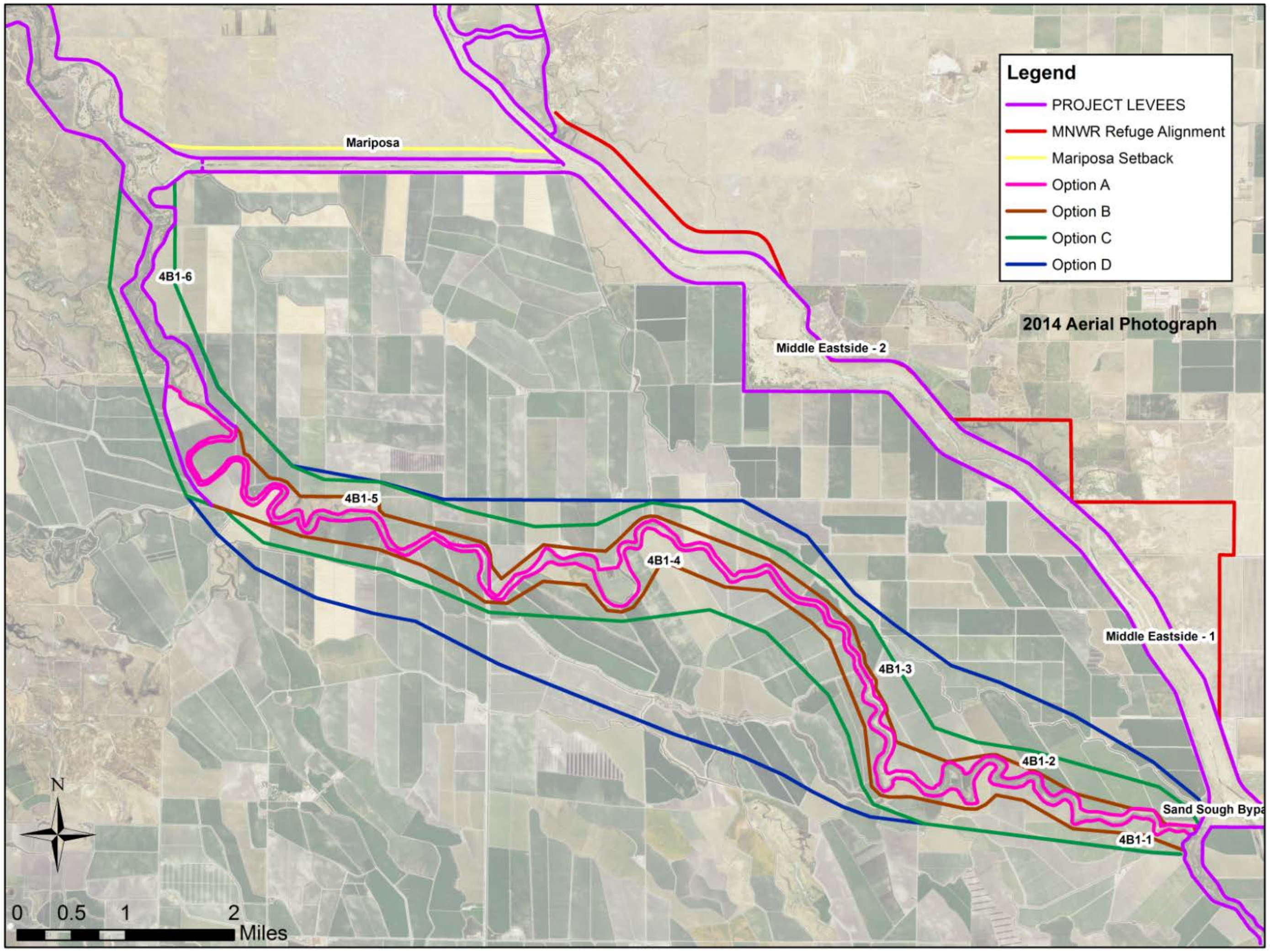


Figure 5-1. Levee Options considered in Reach 4B1 and Bypasses.

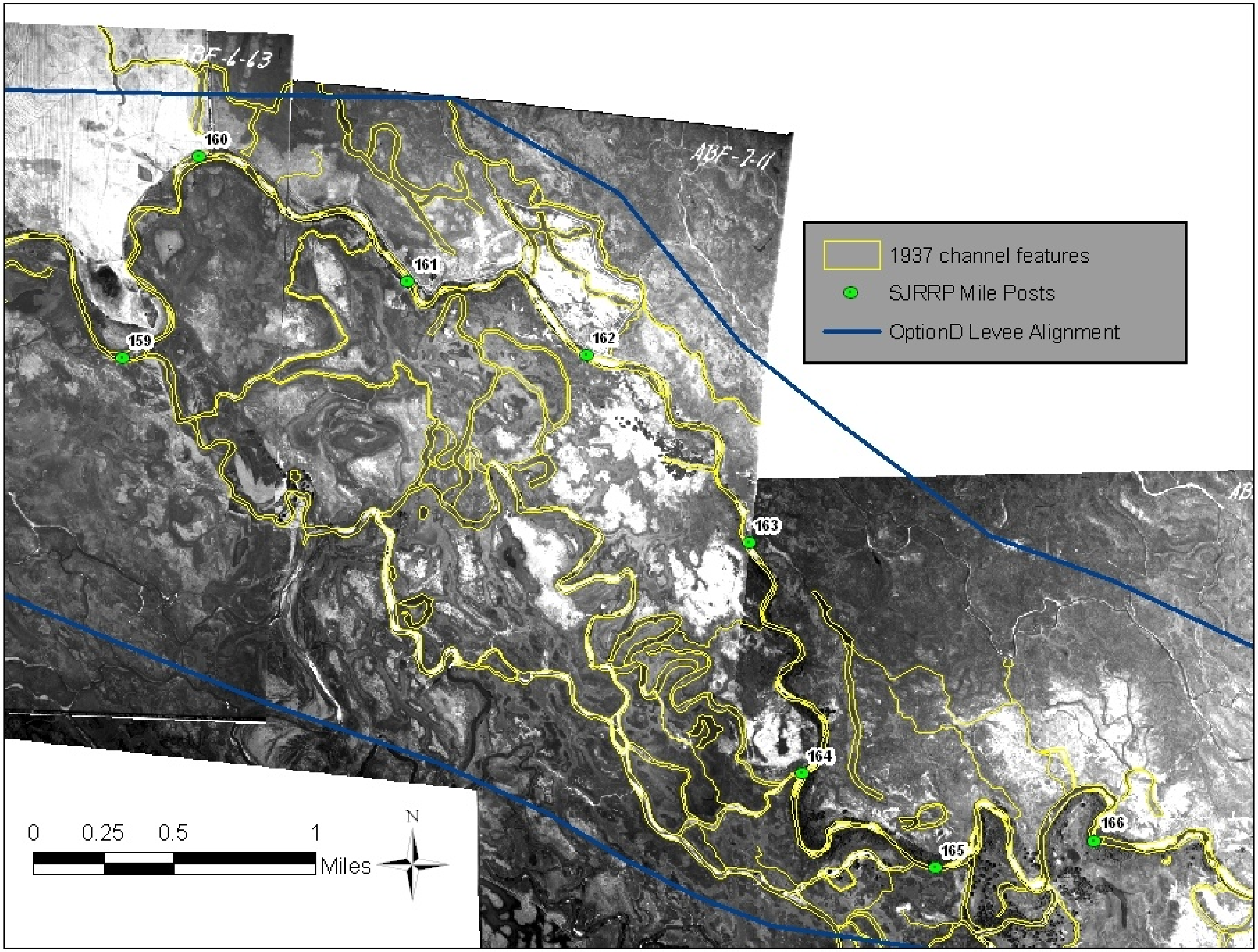


Figure 5-2. Aerial photograph taken in 1937 of the same portion of Reach 4B1 shown in Figure 5-3.

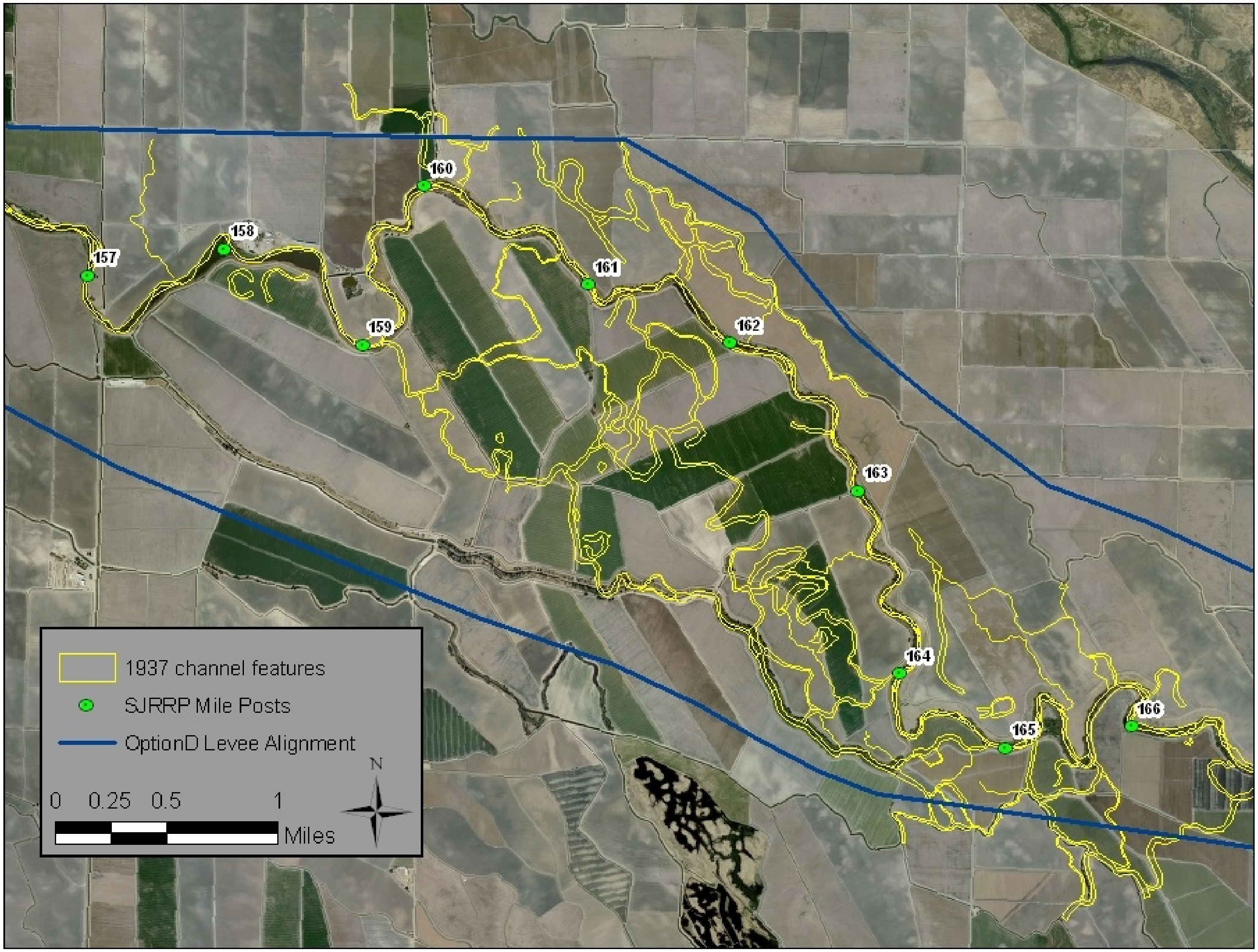


Figure 5-3. Aerial photograph taken in 2004 of a portion of Reach 4B1 shown with 1937 channel features.

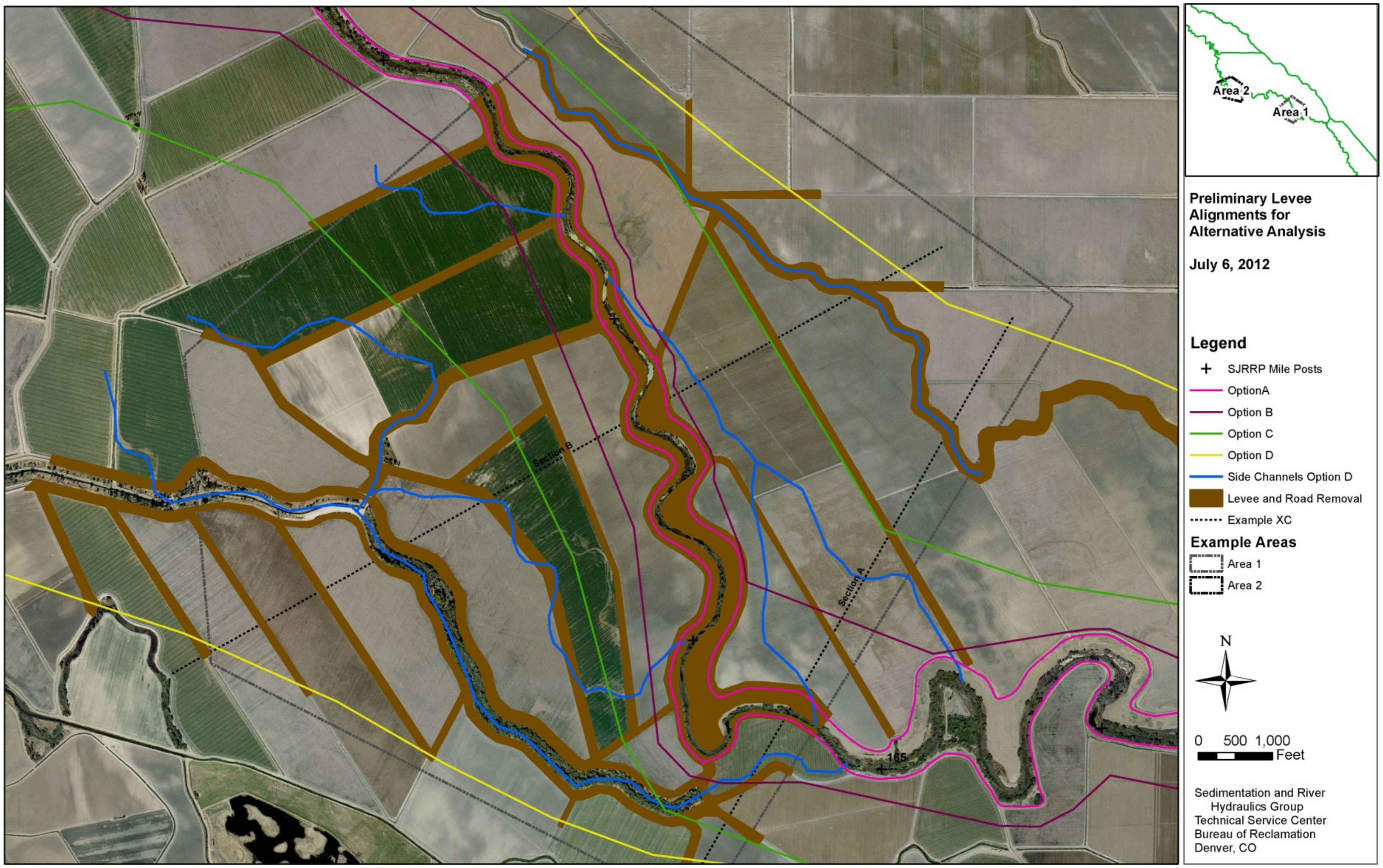


Figure 5-4. Design Features in Example Area 1 in Reach 4B1.

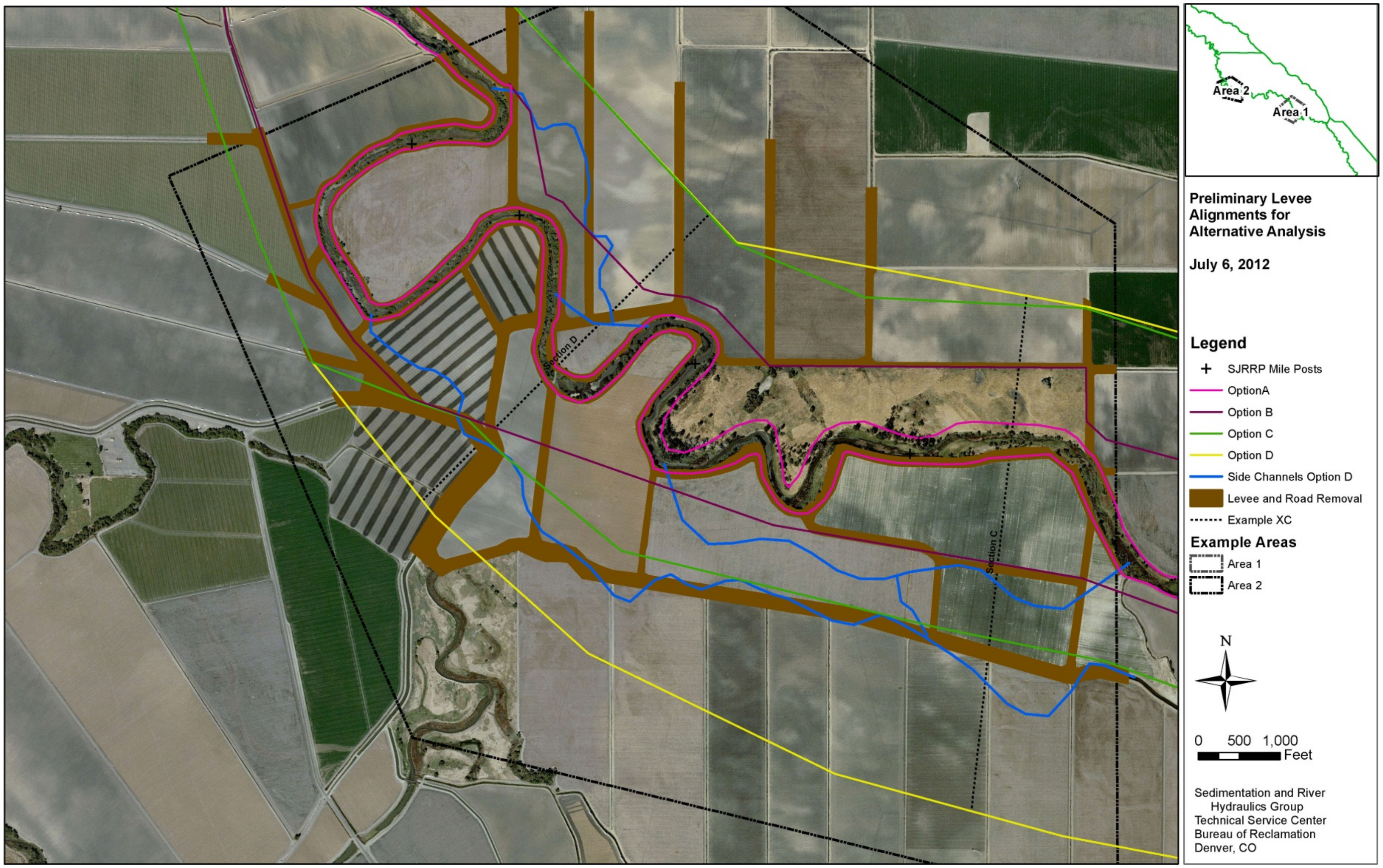
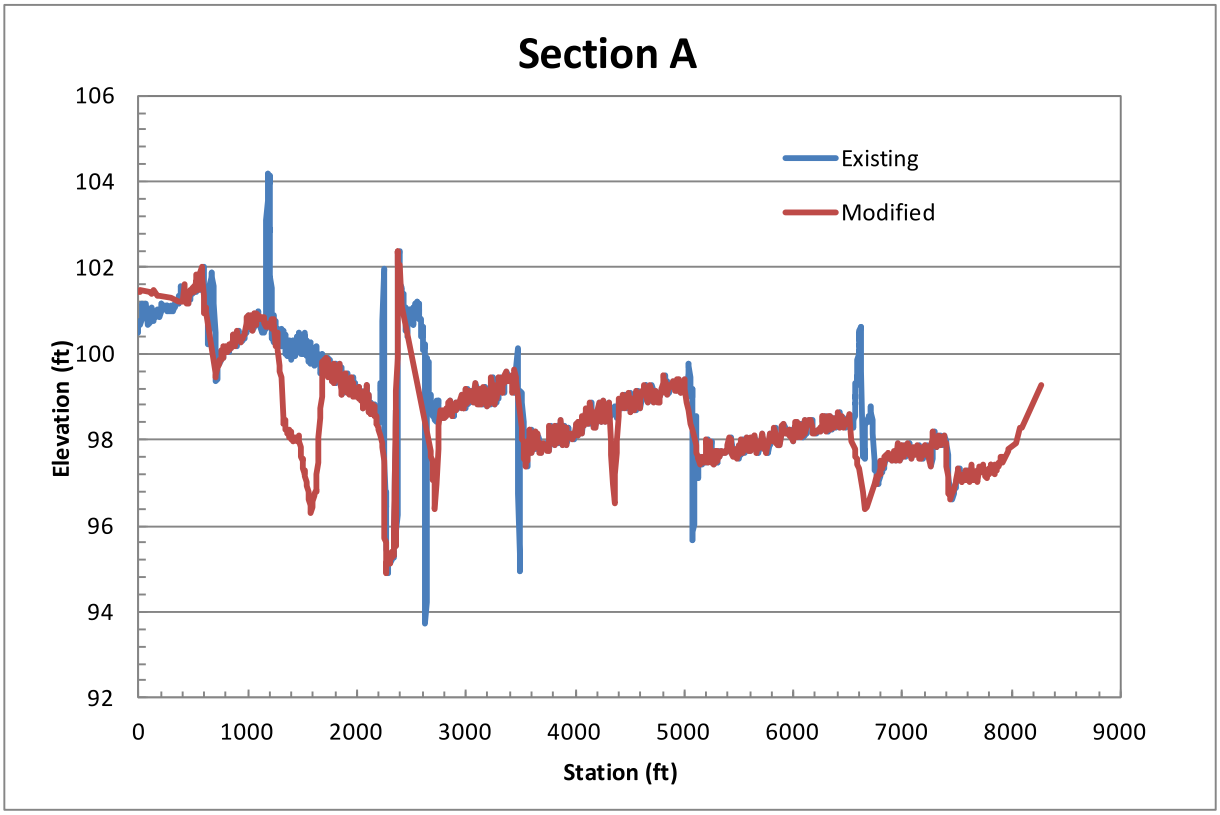


Figure 5-5. Design Features in Example Area 2 in Reach 4B1.



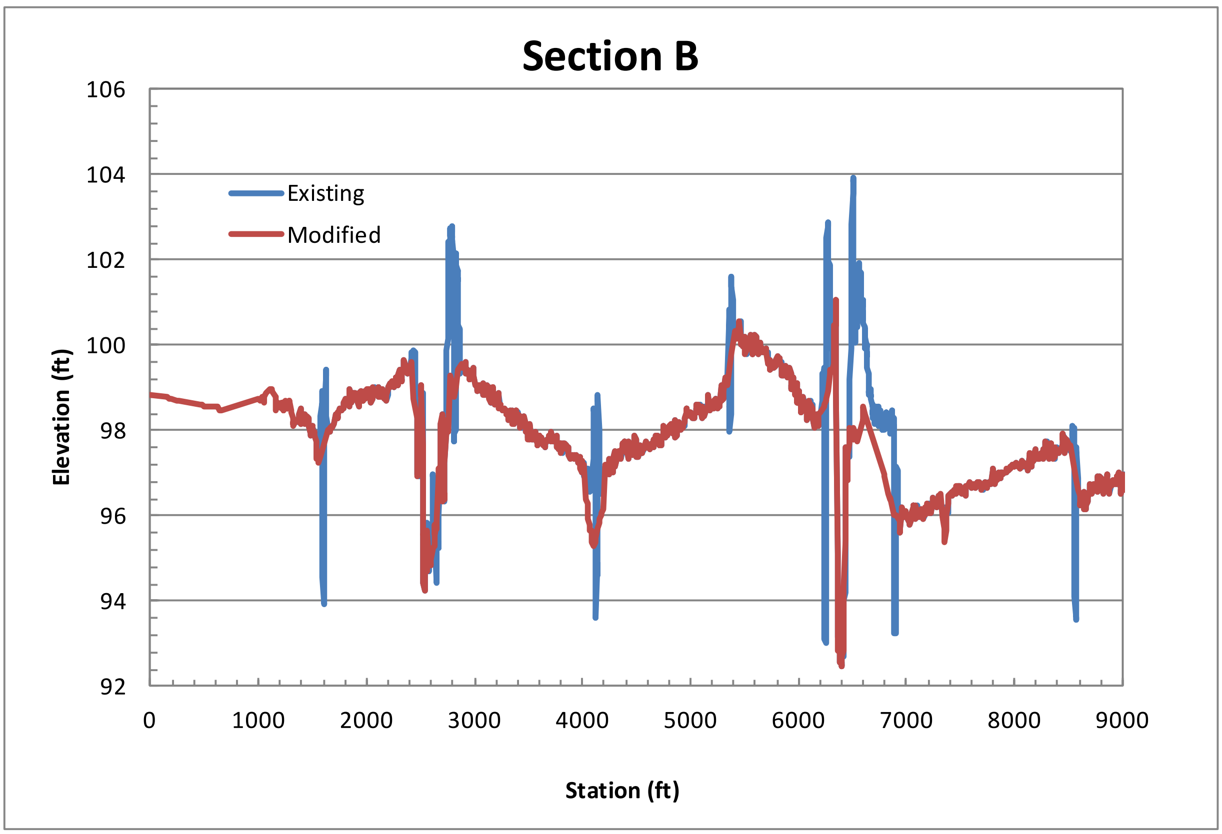
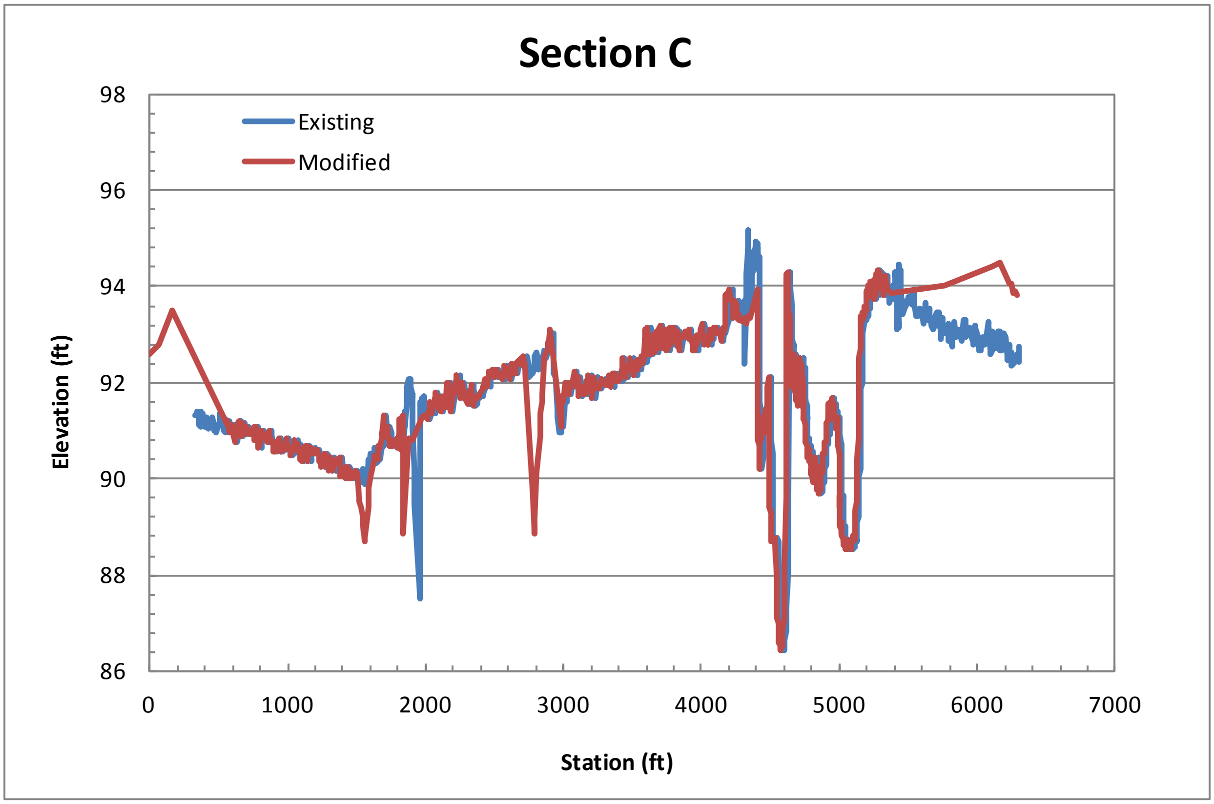


Figure 5-6. Existing and modified Cross sections A and B.



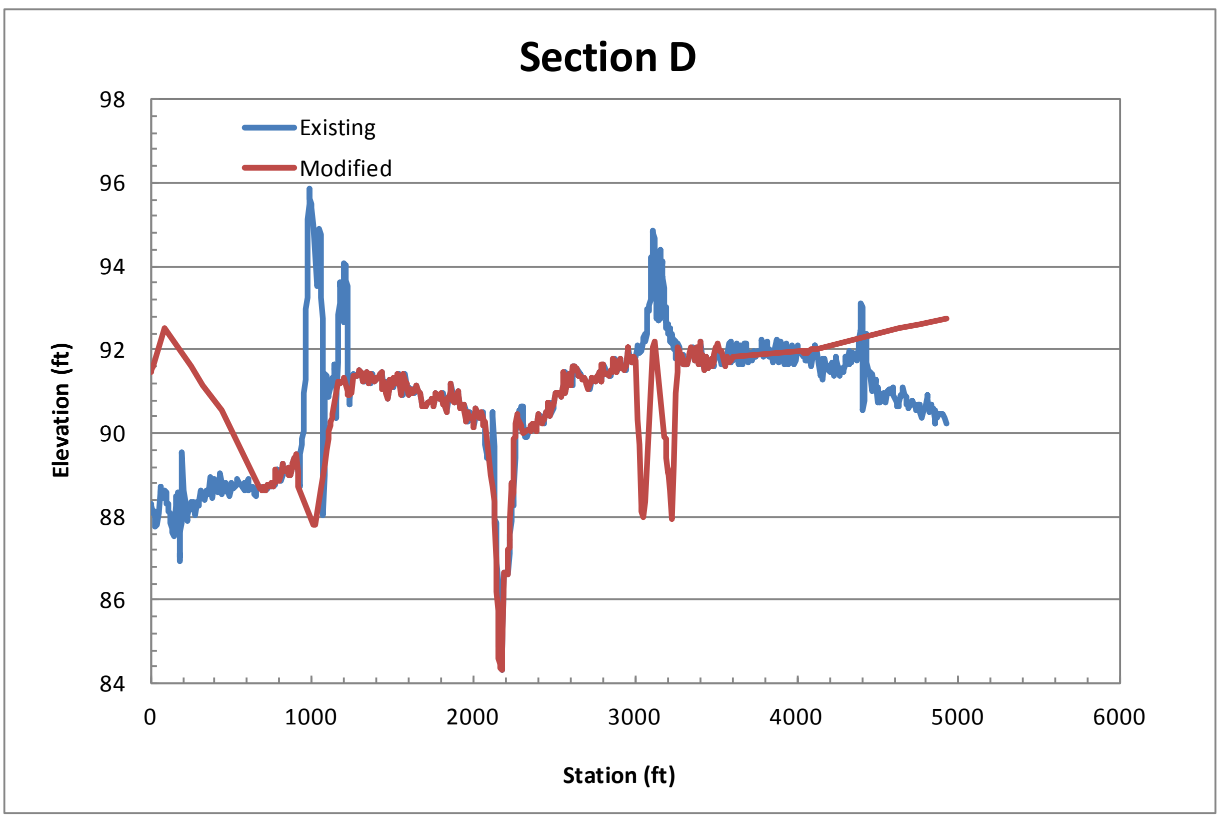


Figure 5-7. Existing and modified Cross sections C and D.

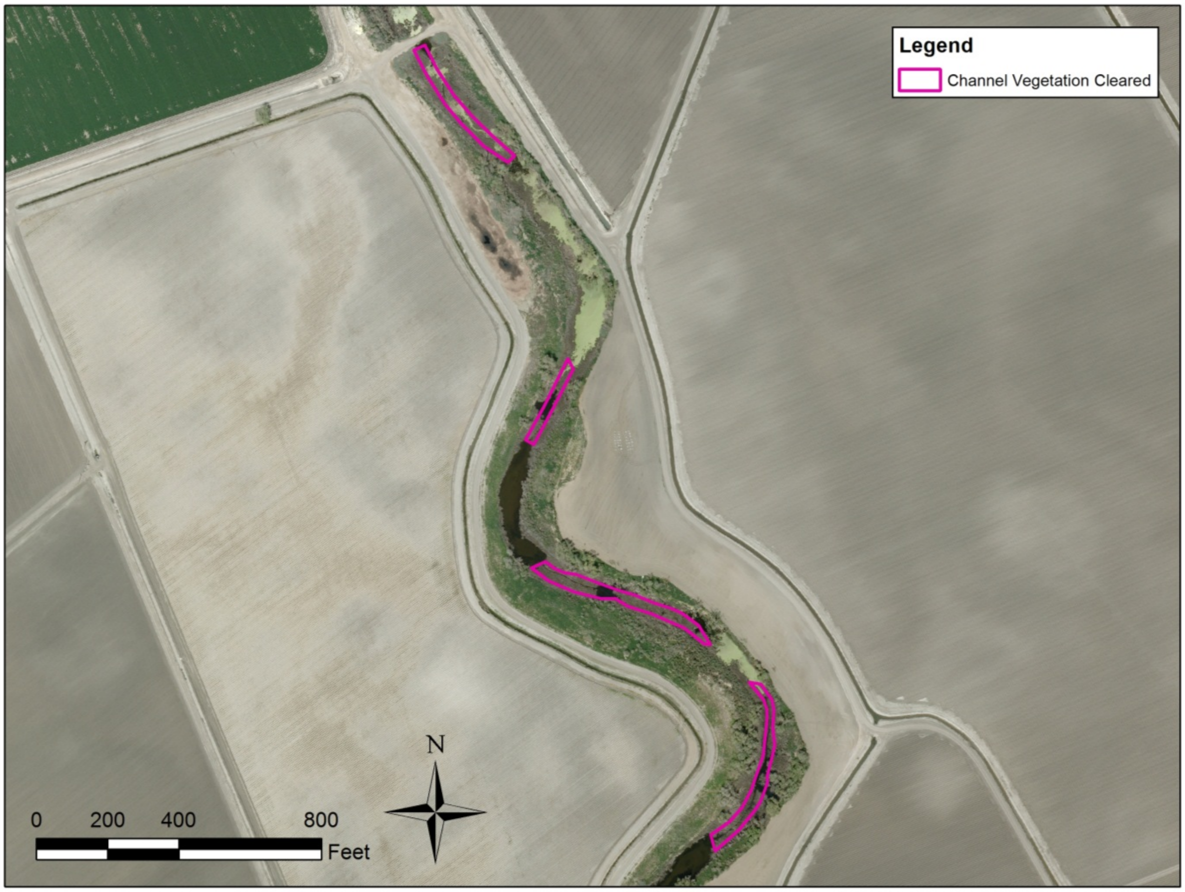


Figure 5-8. Example of channel vegetation clearing in Reach 4B1.

Figure 5-9. Example of type of vegetation that would be removed in channel of Reach 4B1. Photograph is taken from road crossing in Reach 4B1 looking upstream.

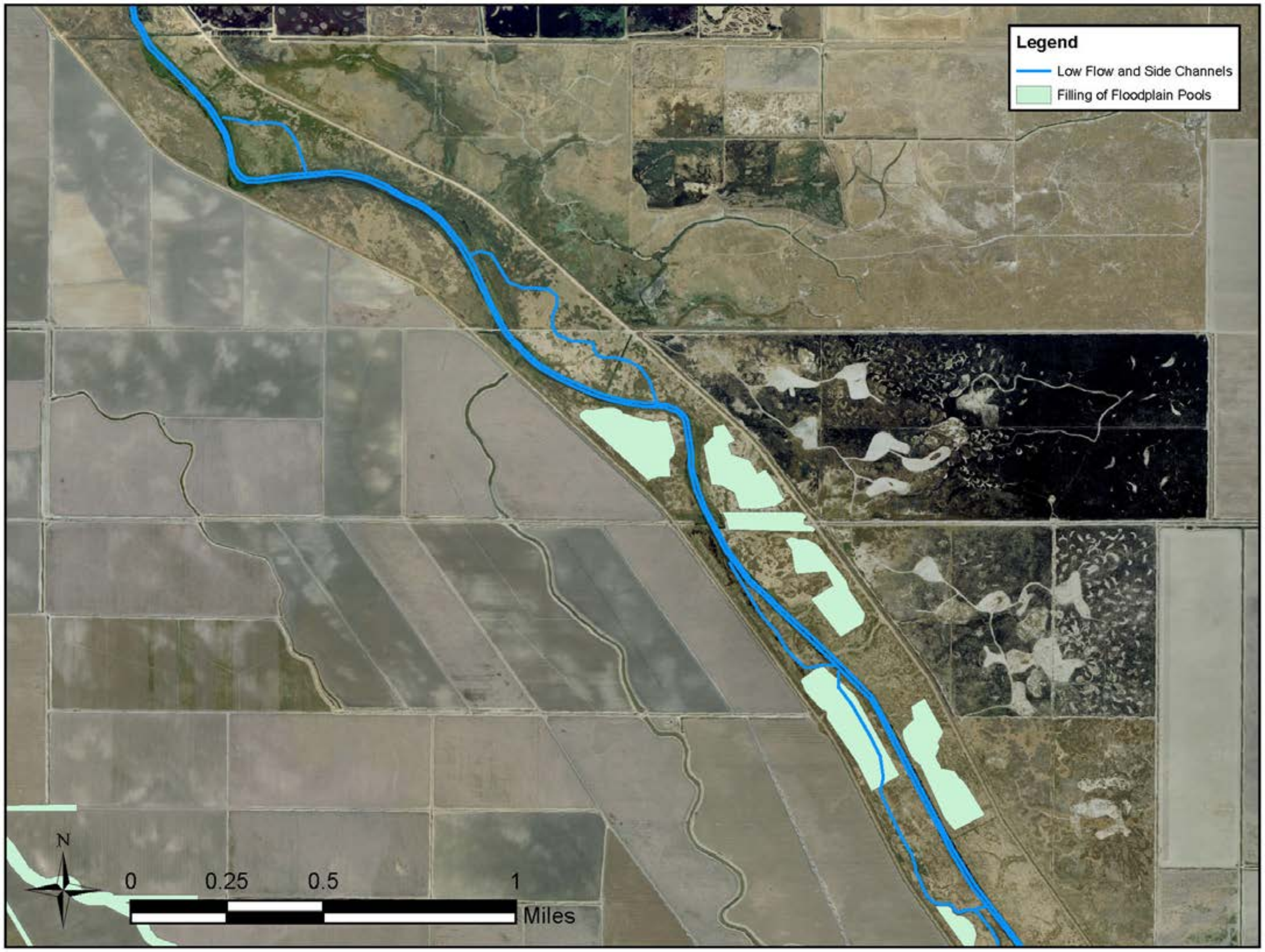


Figure 5-10. Design Features in Eastside Bypass.

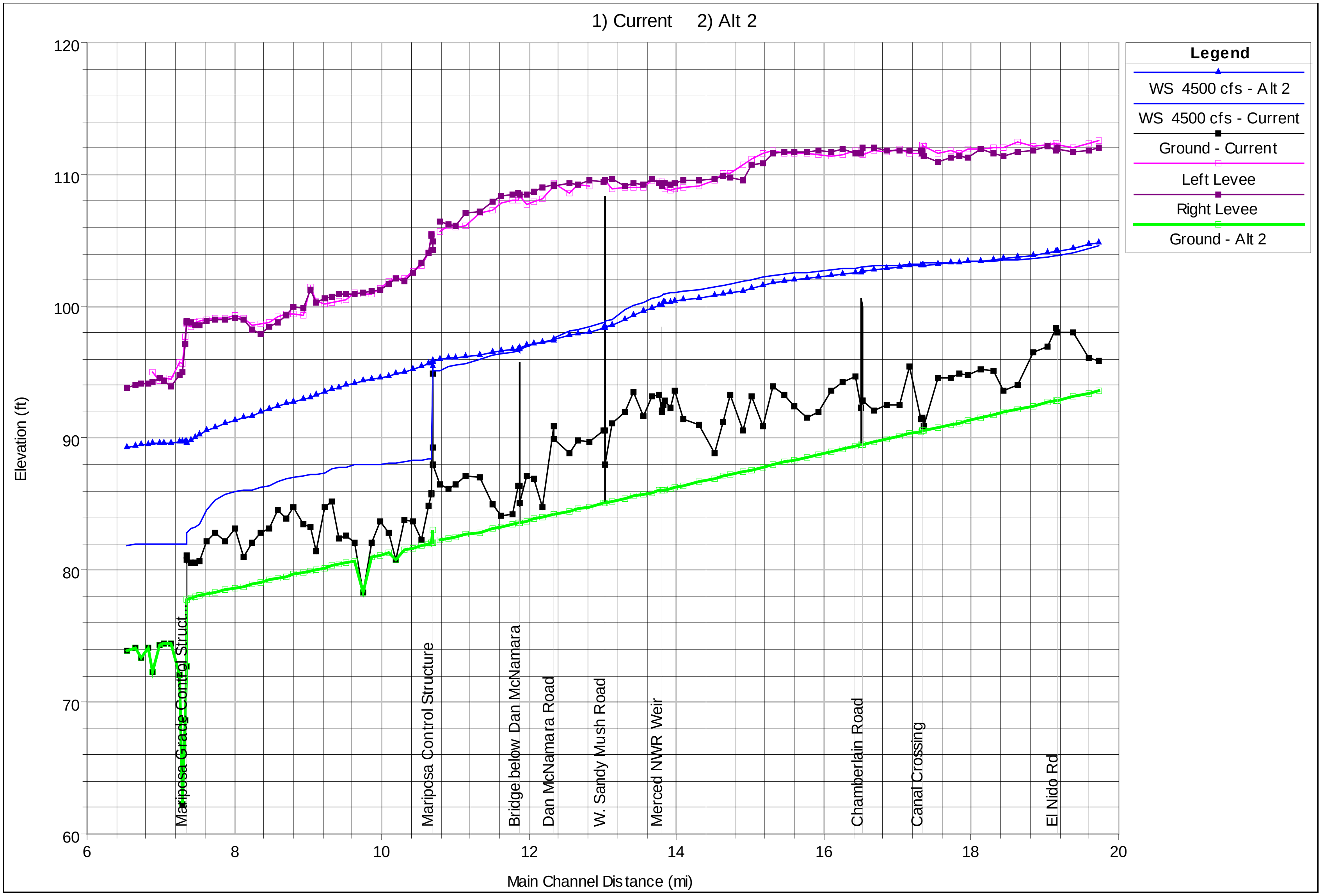
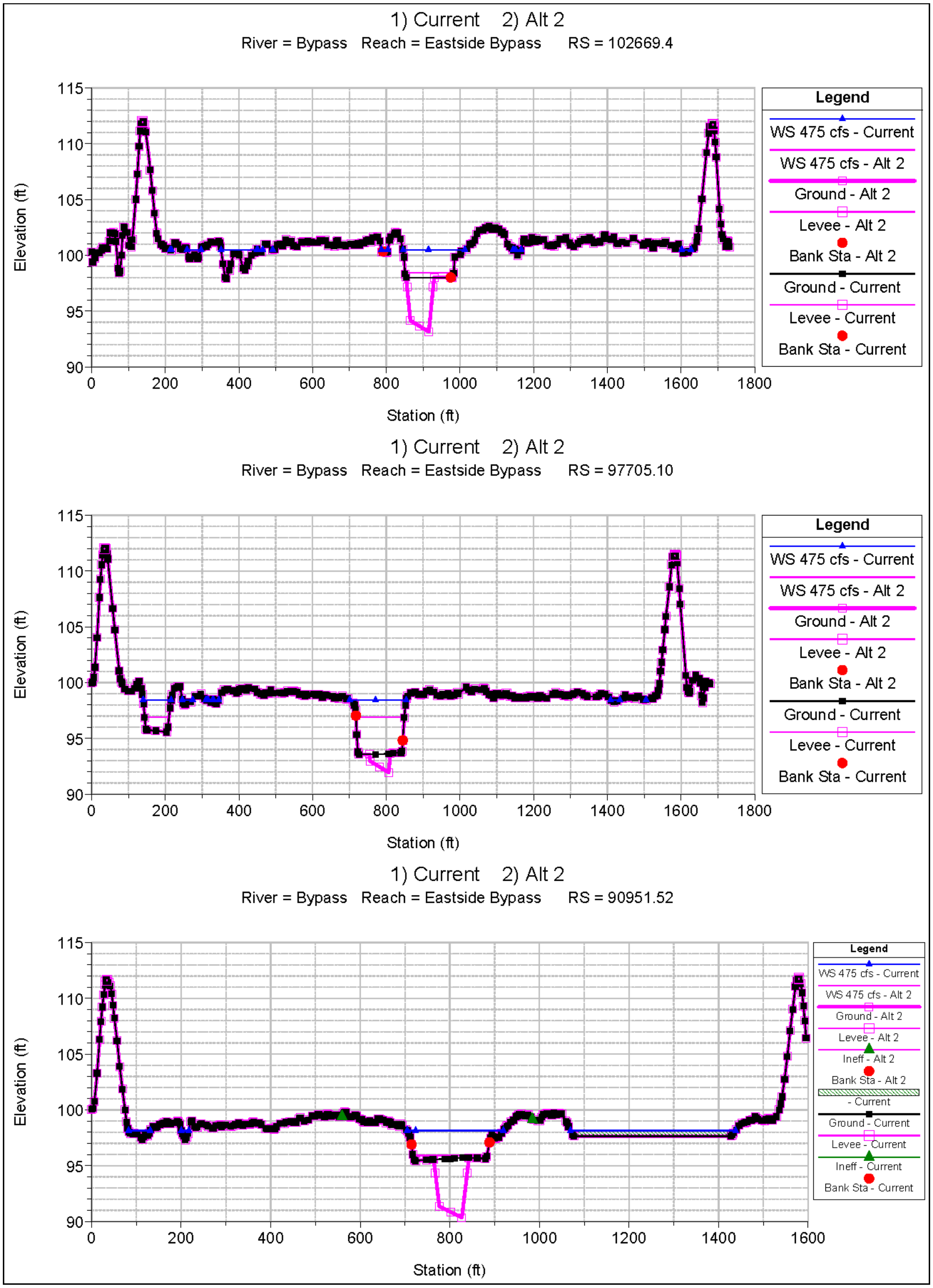
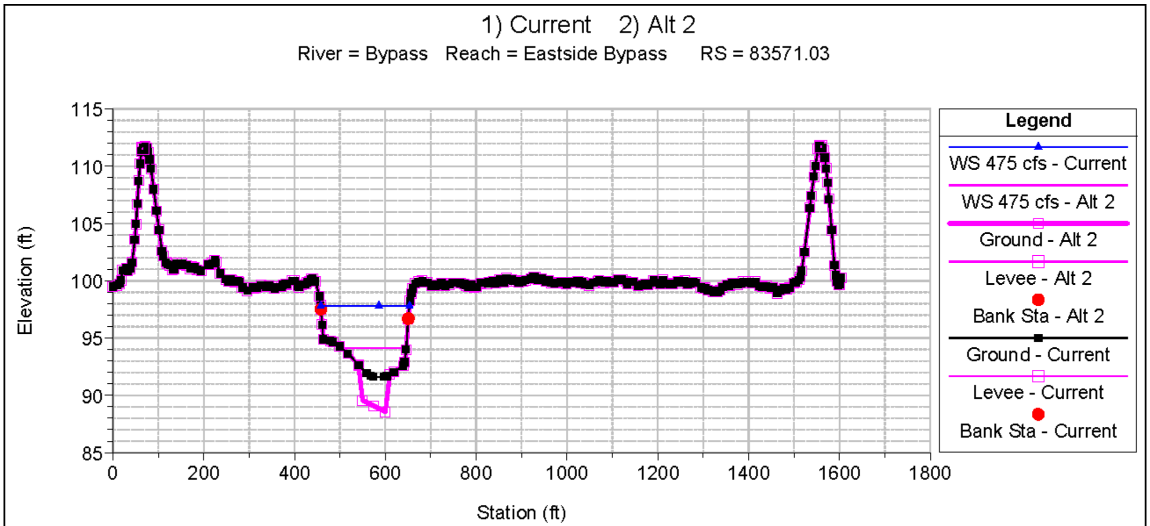
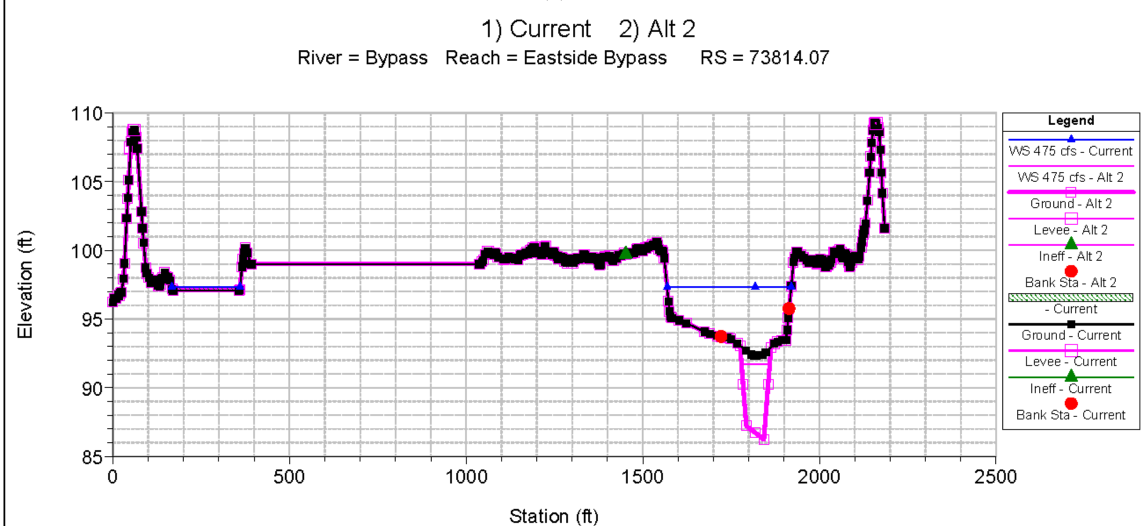
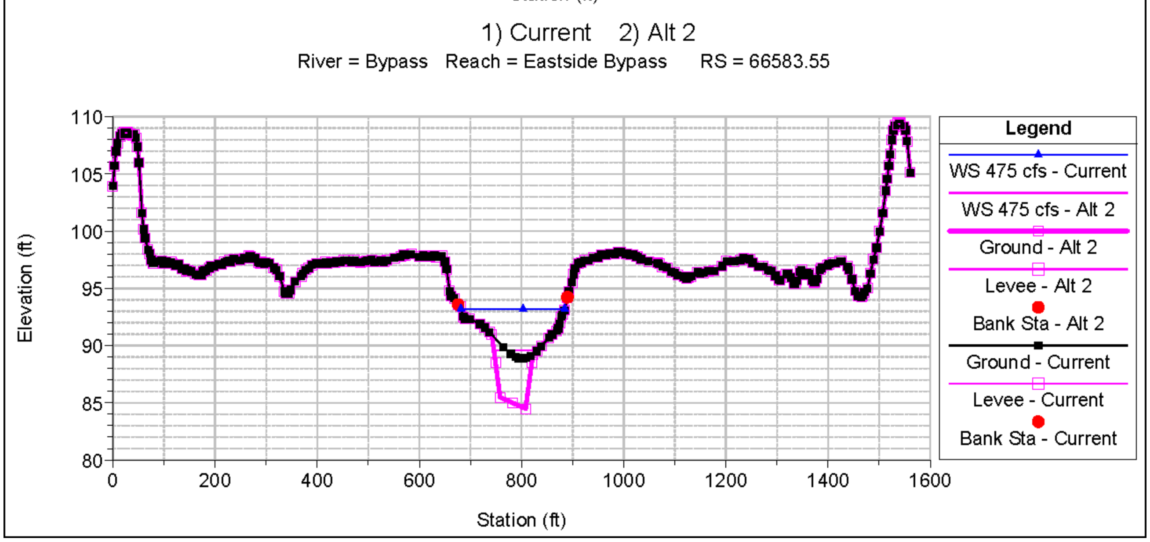


Figure 5-11. Minimum Bed Elevation Profile for Current Bed and under Alternative 2 conditions.


1) Current 2) Alt 2
River = Bypass Reach = Eastside Bypass RS = 102669.4
Elevation (ft)
Station (ft)
Legend
WS 475 cfs - Current
WS 475 cfs - Alt 2
Ground - Alt 2
Levee - Alt 2
Bank Sta - Alt 2
Ground - Current
Levee - Current
Bank Sta - Current
1) Current 2) Alt 2
River = Bypass Reach = Eastside Bypass RS = 97705.10
Elevation (ft)
Station (ft)
Legend
WS 475 cfs - Current
WS 475 cfs - Alt 2
Ground - Alt 2
Levee - Alt 2
Bank Sta - Alt 2
Ground - Current
Levee - Current
Bank Sta - Current
1) Current 2) Alt 2
River = Bypass Reach = Eastside Bypass RS = 90951.52
Elevation (ft)
Station (ft)
Legend
WS 475 cfs - Current
WS 475 cfs - Alt 2
Ground - Alt 2
Levee - Alt 2
Ineff - Alt 2
Bank Sta - Alt 2
- Current
Ground - Current
Levee - Current
Ineff - Current
Bank Sta - Current


1) Current 2) Alt 2
River = Bypass Reach = Eastside Bypass RS = 83571.03
Elevation (ft)
115
110
105
100
95
90
85
0
200
400
600
800
1000
1200
1400
1600
1800
Station (ft)
Legend
WS 475 cfs - Current
WS 475 cfs - Alt 2
Ground - Alt 2
Levee - Alt 2
Bank Sta - Alt 2
Ground - Current
Levee - Current
Bank Sta - Current


1) Current 2) Alt 2
River = Bypass Reach = Eastside Bypass RS = 73814.07
Elevation (ft)
110
105
100
95
90
85
0
500
1000
1500
2000
2500
Station (ft)
Legend
WS 475 cfs - Current
WS 475 cfs - Alt 2
Ground - Alt 2
Levee - Alt 2
Ineff - Alt 2
Bank Sta - Alt 2
- Current
Ground - Current
Levee - Current
Ineff - Current
Bank Sta - Current


1) Current 2) Alt 2
River = Bypass Reach = Eastside Bypass RS = 66583.55
Elevation (ft)
110
105
100
95
90
85
80
0
200
400
600
800
1000
1200
1400
1600
Station (ft)
Legend
WS 475 cfs - Current
WS 475 cfs - Alt 2
Ground - Alt 2
Levee - Alt 2
Bank Sta - Alt 2
Ground - Current
Levee - Current
Bank Sta - Current

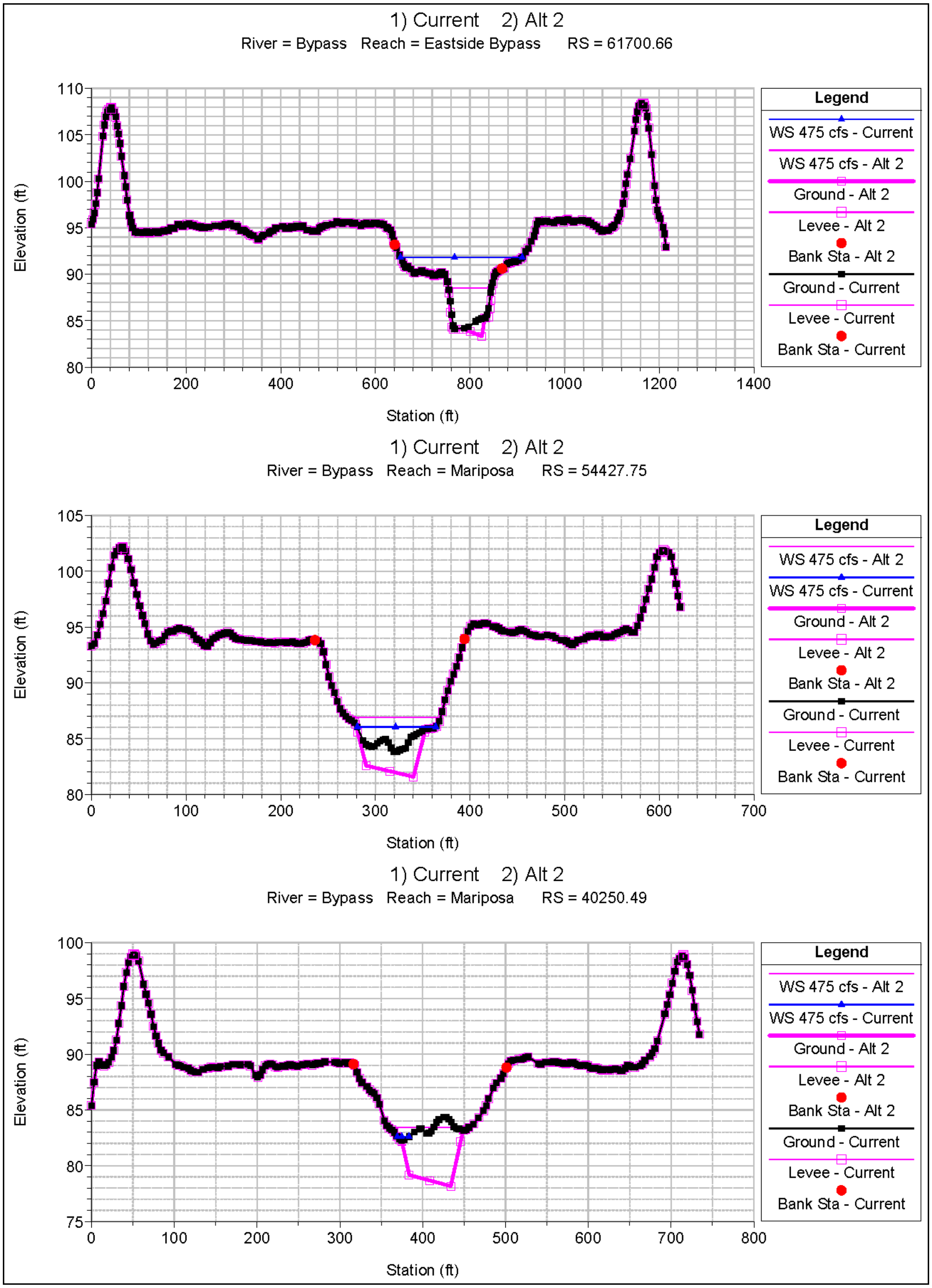


Figure 5-12. Example Cross Sections in Middle Eastside and Mariposa Bypass for Alternative 2.

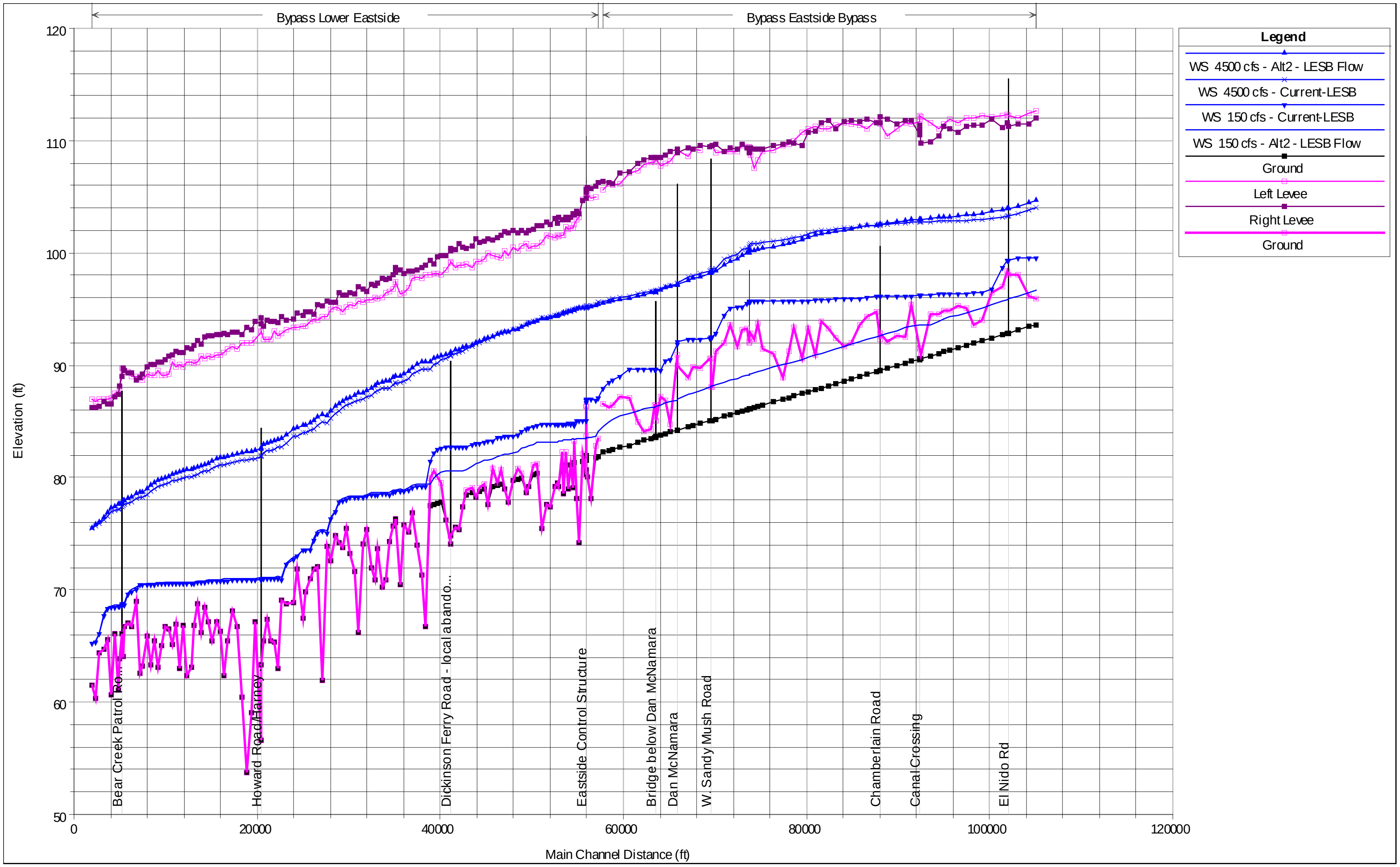


Figure 5-13. Minimum Bed Elevation Profile for Current Bed and under Alternative 2-LESB conditions.

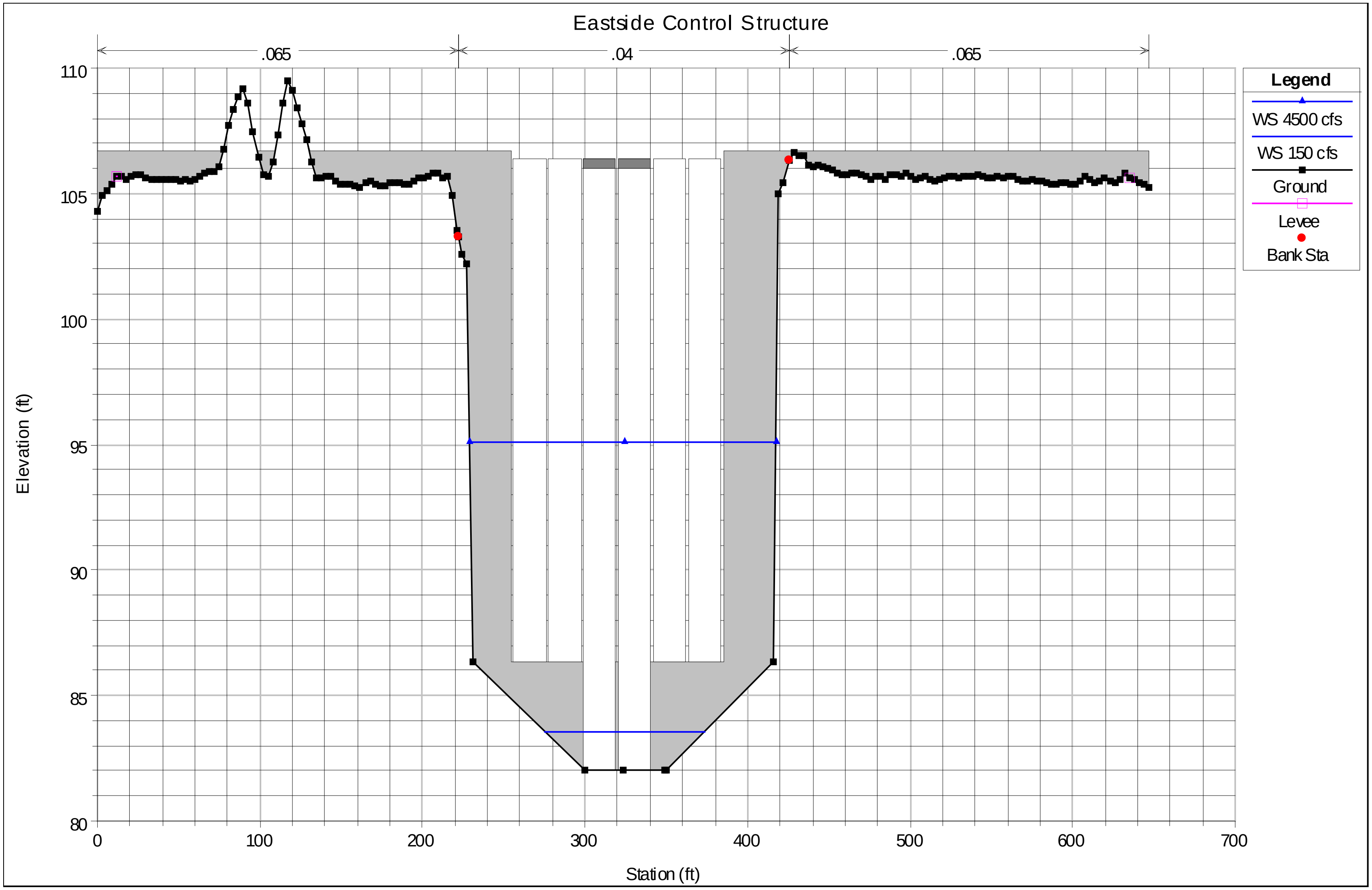


Figure 5-14. Eastside Bypass Control Structure under Alternative 2-LESB conditions.

6 Future Hydrology

The future hydrology in the Project Reach is largely determined by the Settlement and flood flows. The monthly average flows under the Settlement at the upper end of the project reach are given in Figure 6-1 for the various Restoration Year Types. These are the defined “restoration flows,” however, they may not define the actual flows because these restoration flows do not consider the daily operations of the system and the flood releases from Friant Dam and other tributaries to the San Joaquin below Friant.

A daily operations model for the San Joaquin River Restoration Program was developed in RiverWare, a versatile hydrologic modeling software package (Reclamation, 2012). The model simulates hydrology along the San Joaquin restoration reaches from Millerton Lake to the Merced River, and along the Chowchilla and Eastside Bypasses. Daily Friant Dam operations are modeled as well as downstream routing, losses, and operations (bifurcations, diversions, etc.). Daily inflows sum to match monthly CalSim II volumes. Monthly diversions and some downstream inflows are taken from CalSim II results, with monthly to daily flow patterning applied where appropriate. Daily Friant releases are modeled independently from the CalSim II restoration runs used for the PEIS/R, including restoration release flow schedules and flood control releases. The model has the ability to schedule restoration releases in differing patterns, following the constraints defined in the Settlement (NRCD, 2006). The model simulates the operational challenges associated with forecast error and its effects on restoration allocations and scheduling and flood control operations. Model results include Millerton parameters such as storage, pool elevation, and releases, and downstream river flows on a daily timescale.

The daily flow model incorporates both restoration flows and flood operations. It also includes the contributions of tributaries to and diversions from the San Joaquin. The daily flow model uses a historical period of record for Water Years (WY) 1922 to 2003. A water supply forecast is used to define the Restoration Water Year Type within the model and the resulting number of each year type for the 82-yr period of record is shown in Table 6-1.

It is important to recognize that delivery of irrigation water from Friant Dam to the Mendota Pool is not incorporated into the hydrologic simulations. This is because delivery of water to the Mendota Pool is not included into the CALSIM model upon which the model is dependent.

The flow routing assumptions for the various alternatives are described in Section 4. The estimated daily flow exceedances for each alternative and month are given in Appendix C.

Table 6-1. Number of Restoration Year Types within 82-yr Period of Record (1922 to 2003).

Year Type	Number within 82-yr period of record
Critical Low	1
Critical High	4
Dry	12
Normal-Dry	25
Normal-Wet	24
Wet	16

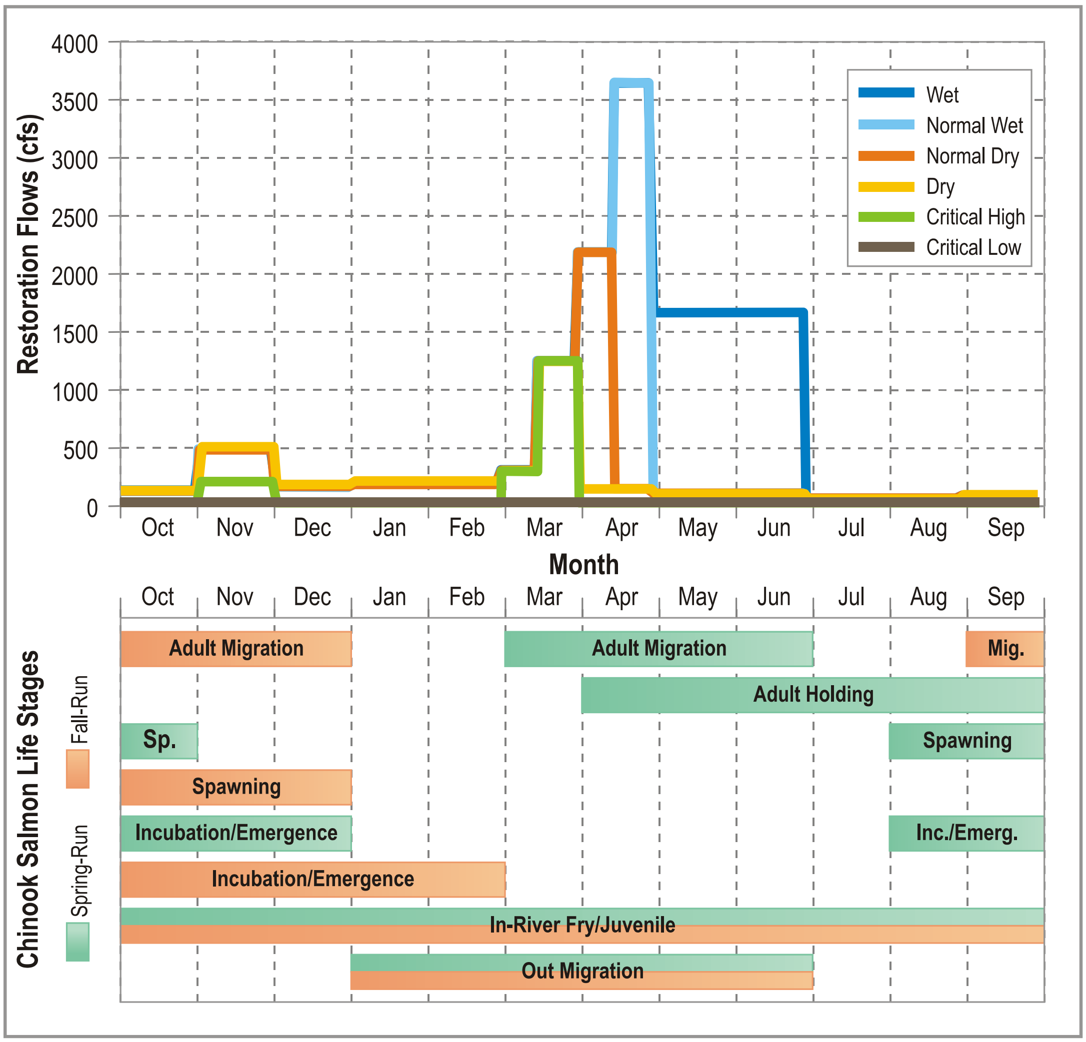


Figure 6-1. Timing of Flow in Reach 4B1 and Chinook Salmon life stages. (SJRRP, 2011).

6.1 No Action

The No Action alternative has Restoration flow passing through the Bypass, but Restoration Flows into the Eastside and Mariposa bypasses are currently limited to avoid channel capacity and seepage concerns. The SJRRP has addressed seepage-related concerns in the Middle Eastside Bypass and Lower Eastside Bypass, but the Restoration Flows into this reach are limited by channel capacity concerns to about 300 cfs. The other projects implemented under the No Action Alternative would provide a capacity of about 2,500 cfs. Flood flows would be routed similar to existing conditions.

6.2 Alternative 1

Two flow conditions were analyzed:

1. All flows less than 4500 cfs routed into Reach 4B1.

2. Only restoration flows routed into Reach 4B1, meaning that flood flows would be routed down the Eastside Bypass.

6.2.1 Flow Condition 1: All flows less than 4500 cfs routed into Reach 4B1

This alternative restores flows of up to 4500 cfs to Reach 4B1.

Figure 6-2 contains the percent exceedance for various flow rates in Reach 4B1 under Flow Condition 1. The median flow in Reach 4B1 would be 155 cfs, the 10% exceedance flow is 1,820 cfs and the 90 % exceedance flow is 45 cfs.

Figure 6-3 contains the flow rates at different exceedance levels for different months for each alternative under Flow Condition 1. The 75 % exceedance flow in the driest month (August) is 45 cfs and in the wettest month (April) is 125 cfs. The 95% exceedance flow in Reach 4B1 is zero, so there would be times during Dry and Critical High years when there is no flow in Reach 4B1.

The capacity of Reach 4A is also 4500 cfs, and therefore most all the flow from the San Joaquin River in Reach 4A enters Reach 4B1 and the Sand Slough Bypass reach connecting Reach 4A to the Eastside Bypass has essentially no flow.

There would be less flow in the Bypass under Alternative 1 than under any of the other alternatives or under existing conditions. Currently, the bypass is estimated to have flow approximately 35 % of the time, whereas under Alternative 1 the bypass would have flow approximately 15 % of the time. There would be many more years where the Bypass is dry under Alternative 1 than under the other alternatives. The Sand Slough Bypass Channel would not have any significant flow and would become essentially standing water separating the moving waters in the Bypass and San Joaquin River.

Flow enters the Eastside Bypass from the Chowchilla Bypass in approximately 20 % of the years, corresponding to wet years. Three example wet water years 1984, 1986, and 1987 are shown in Figure 6-5, Figure 6-6, and Figure 6-7 respectively.

In WY 1984, the James Bypass was contributing water from October to end of January. While the James Bypass was flowing and flows from Friant were sufficient to exceed the capacity of Reach 3, flows from Reach 2a were diverted into the Chowchilla Bypass. During the month of January of that year, most all of the water entering Reach 4B1 was from the James Bypass/Fresno Slough system.

In WY 1986, the flood release occurred during the restoration spring flows and bypass flows were occurring simultaneously with high flows in Reach 4B1. Most of the water in Reach 4B1 originated from James Bypass during the months of March and April. The flows in the Eastside and Chowchilla Bypass were intermittent with high flows in March, no flow in early April, and 2000 cfs in later April.

In WY 1987, there were flood releases in February of approximately 2100 cfs that were routed into Reach 2B and then into 4B because there were no significant flows entering from the James Bypass. The spring restoration flows began in mid-March after the flood flows were reduced.

6.2.2 Flow Condition 2: Only Restoration Flows routed into Reach 4B1

Figure 6-8 contains the percent exceedance for various flow rates in Reach 4B1 under Flow Condition 2. If only restoration flows are routed into Reach 4B1, the bypass would have flow in it approximately 20 % of the time as opposed to 15% of the time under Condition 1. The high flows in Reach 4B1 would be reduced in duration and the 10% exceedance flow in Reach 4B1 would be reduced to 1,225 cfs from 1,820 cfs. There would be flow in the bypass in more years and for longer periods of time.

Example hydrographs are given in Figure 6-11, Figure 6-12, and Figure 6-13 for WY 1984, 1986, and 1987.

In WY 1984, the Bypasses are flowing with several thousand cfs in the winter months while Reach 4B1 has a relatively low flow of 175 cfs. The spring restoration flows are routed down the Reach 4B1 and the bypasses are dry.

In WY 1986, the flows in the Bypass were several thousand cfs from late February until beginning of May, while the flows in Reach 4B1 were keep at low levels until Mid-March.

In WY 1987 when there were flood releases of approximately 2000 cfs during the month of February were routed from Friant Dam through Reach 2b and then into the Eastside Bypass instead of Reach 4B1. The flows in the bypass were ceased in

March and the restoration flows were increased gradually until a peak of approximately 2000 cfs in Reach 4B1 in early April.

6.3 Alternative 2

Under Alternative 2, Reach 4B1 would receive flow only when the capacity of the Eastside Bypass is exceeded, which was simulated to be 0.05 % of the time. This would equate to 17 days of the 82 years of simulation. Therefore, it is possible that Reach 4B1 would never have flowing water except from groundwater flow because it would be difficult to ensure flow capacity if it is rarely utilized. Reach 4B1 would likely become overgrown with vegetation such as it is currently.

The bypass has flow of 45 cfs or more 90% of the time under Alternative 2. The 75% exceedance flow is 65 cfs, the 50% exceedance flow is 175 cfs, the 25% exceedance flow is 355 cfs, and the 10% exceedance flow is 2000 cfs. The bypass would have zero flow less and 10% of the time.

The 75 % exceedance flow in the driest month (August) is 45 cfs and in the wettest month (April) is 120 cfs. Similar to Reach 4B1, there will be period of time during Critical Water Years where the Bypass is dry.

Flow enters the Eastside Bypass from the Chowchilla Bypass in approximately 20% of the years, corresponding to wet years. If the James Bypass is contributing water to the San Joaquin, then flow is limited in Reach 2B because of capacity limitations in Reach 3. Therefore, the water in the Bypass during the spring runoff during a wet year would be a mixture of the San Joaquin and James Bypass/Fresno Slough system.

6.4 Alternative 2-LESB

Alternative 2-LESB (Lower Eastside Bypass) is similar to Alternative 2 except that restoration flows are routed into the Lower Eastside Bypass instead of the Mariposa Bypass. There were no RiverWare model results available for this alternative.

6.5 Alternative 3

Under Alternative 3, Reach 4B1 would receive flows up to 475 cfs. Two flow conditions were analyzed:

1. All flows less than 475 cfs routed into Reach 4B1.

2. Only restoration flows less than 475 cfs routed into Reach 4B1.

6.5.1 Flow Condition 1: All flows less than 475 cfs routed into Reach 4B1

The Bypass would have flow approximately 25% of the time, which is less than under existing conditions. However, the 10% exceedance flow increased from 1,100 cfs under existing conditions to 1,500 cfs under Alternative 3. The 1%

exceedance decreases from 9,200 cfs to 7,800 cfs. Therefore, the midrange spring runoff pulse may increase in magnitude, but the largest flows in the Bypass should decrease in frequency.

In the San Joaquin River, the 75% exceedance flow is 65 cfs, the 50% exceedance flow is 155 cfs, the 25% exceedance flow is 285 cfs, and the 10% exceedance flow is 475 cfs, which is the maximum flow.

6.5.2 Flow Condition 2: Only Restoration Flows less than 475 cfs routed into Reach 4B1

The bypass would have flow approximately 25% of the time. The 10% exceedance flow in the bypass would increase slightly relative to Flow Condition 1 to 1640 cfs.

The 25% exceedance flows in Reach 4B1 would decrease relative to flow condition 2 to 175 cfs, but the 75%, 50%, and 10% exceedance flows would remain the same as Flow Condition 1.

6.6 Alternative 4

Under Alternative 4, Reach 4B1 would receive flows up to 1500 cfs. Two flow conditions were analyzed:

1. All flows less than 1500 cfs routed into Reach 4B1.

2. Only restoration flows less than 1500 cfs routed into Reach 4B1.

6.6.1 Flow Condition 1: All flows less than 1500 cfs routed into Reach 4B1

The Bypass would have flow approximately 20% of the time, which is less than under existing conditions. In addition, the 10% exceedance flow decreases in the Bypass from 1,100 cfs under existing conditions to 670 cfs under Alternative 4. The 1% exceedance decreases from 9,200 cfs to 6,774 cfs.

In the San Joaquin River the 75% exceedance flow is 65 cfs, the 50% exceedance flow is 155 cfs, the 25% exceedance flow is 285 cfs, and the 10% exceedance flow is 1500 cfs, which is the maximum flow in the reach.

6.6.2 Flow Condition 2: Only Restoration Flows less than 1500 cfs routed into Reach 4B1

The Bypass would have flow slightly more often relative to Flow Condition 1, increasing the frequency of flow to approximately 25% of the time. The 10% exceedance flow in the bypass increases to 900 cfs in the bypass.

In Reach 4B1, the 75% exceedance and 50% exceedance flows remain the same as under Flow Condition 1 and the 25% exceedance decreases to 175 cfs and the 10% exceedance decreases to 1225 cfs.

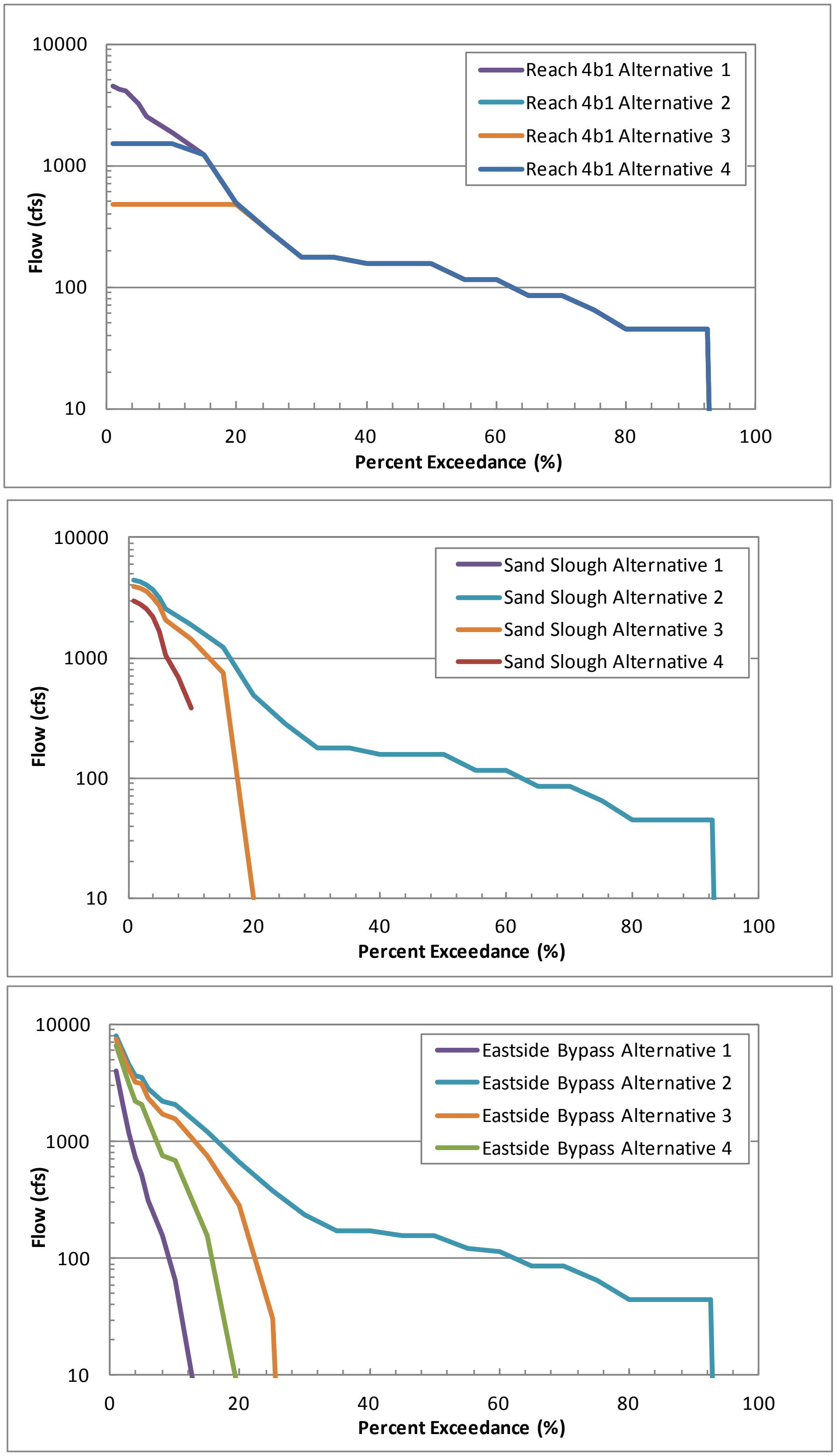


Figure 6-2. Daily flow exceedances for Alternative 1 to 4 when all flow less than capacity of Reach 4B1 is routed into Reach 4B1 (Condition 1).

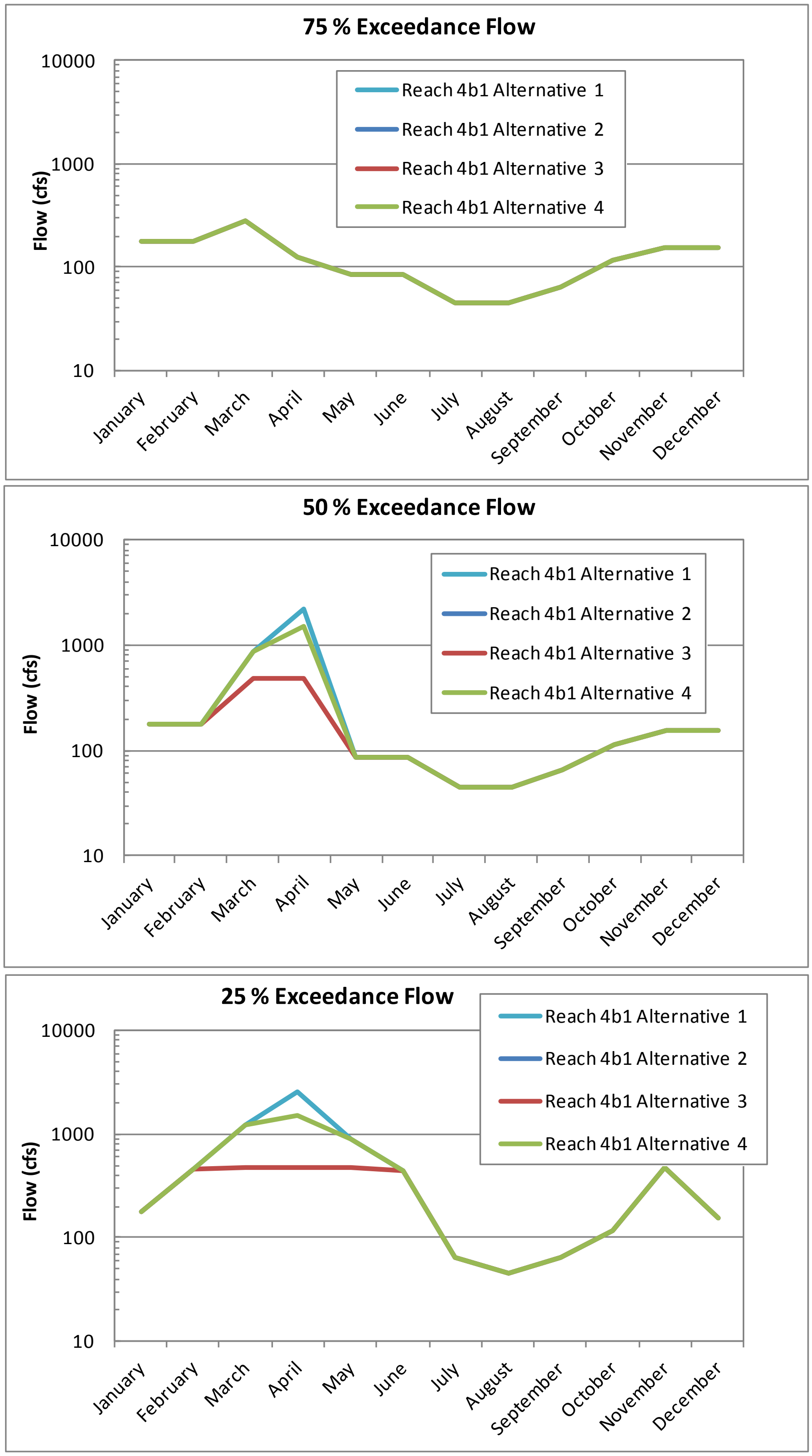


Figure 6-3. Daily flow exceedances in Reach 4B1 for each alternative when all flow less than capacity of Reach 4B1 is routed into Reach 4B1 (Condition 1).

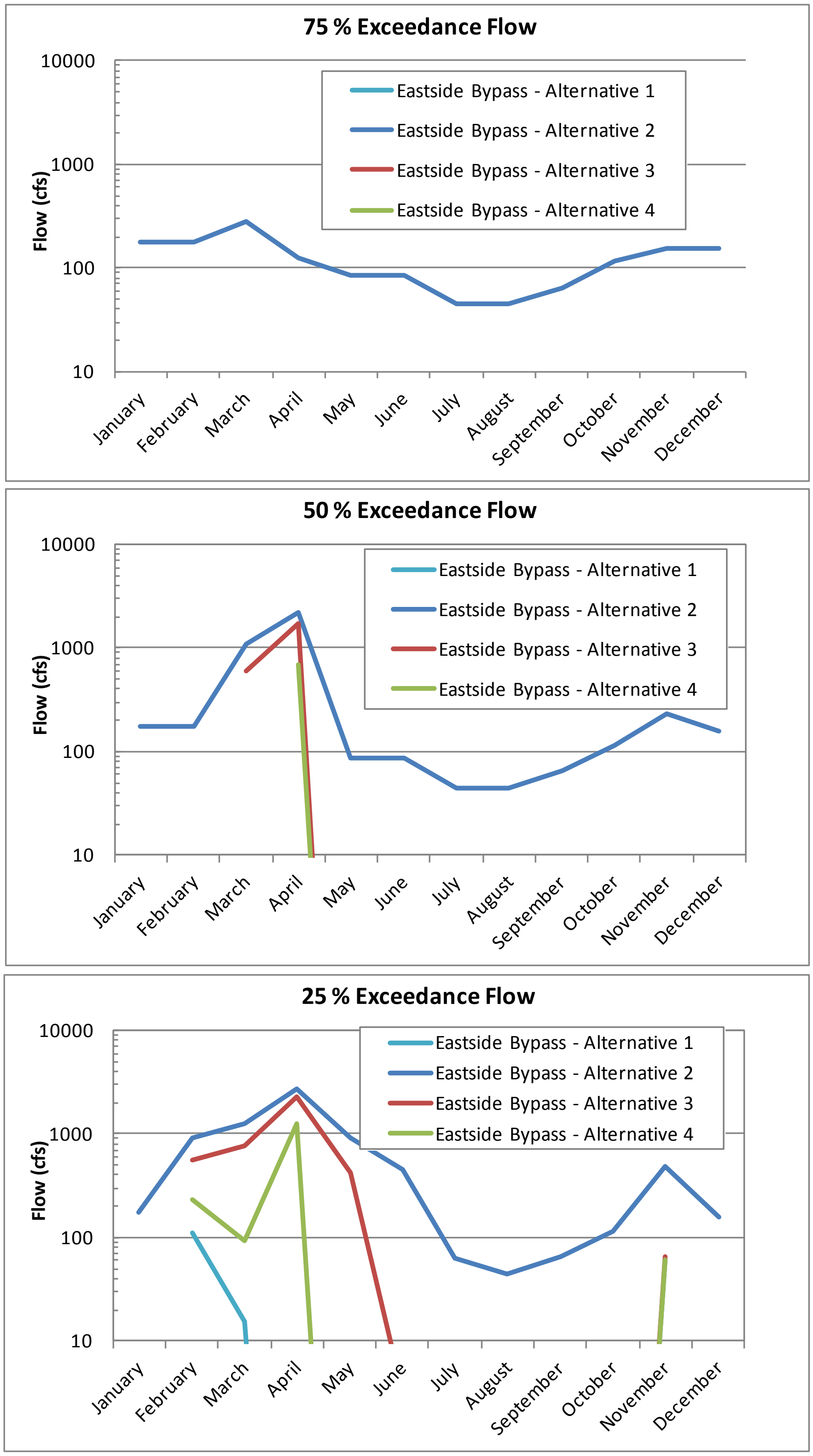


Figure 6-4. Daily flow exceedances in the Eastside Bypass for each alternative when all flow less than capacity of Reach 4B1 is routed into Reach 4B1 (Condition 1).

Condition 1: All flow less than Reach 4B1 capacity are routed into Reach 4B1

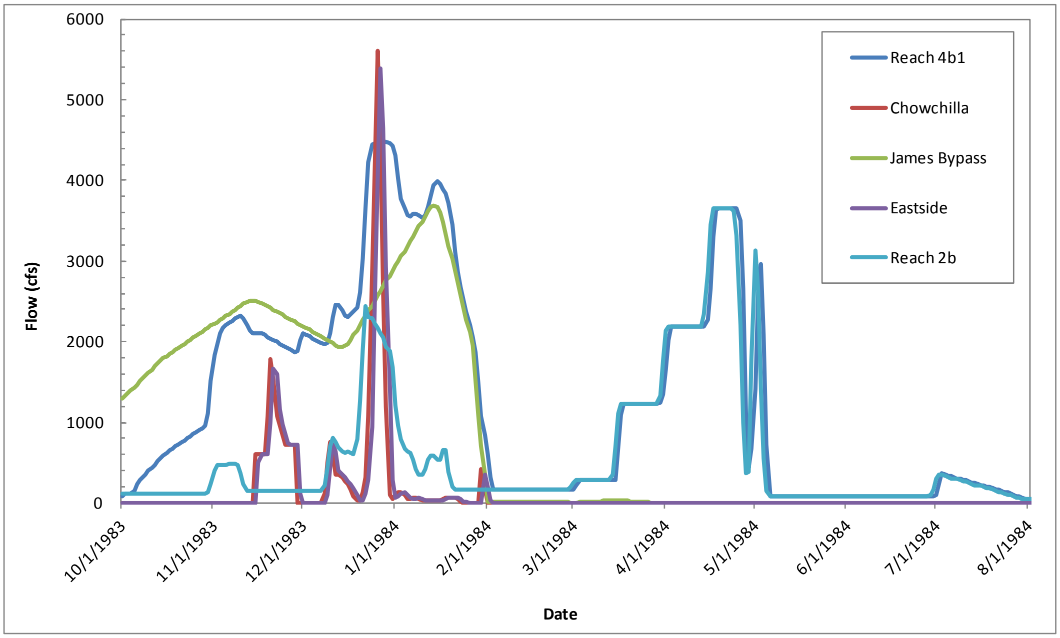


Figure 6-5. Example of water year 1984 for Alternative 1 when all flow less than Reach 4B1 capacity are routed into Reach 4B1.

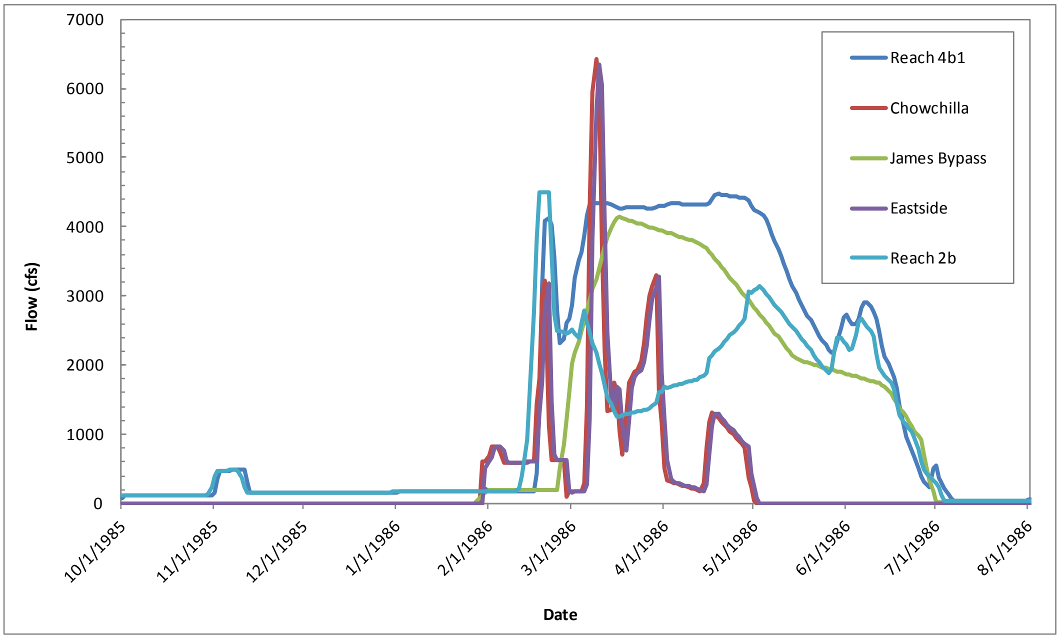


Figure 6-6. Example of water year 1986 for Alternative 1 when all flow less than Reach 4B1 capacity are routed into Reach 4B1.

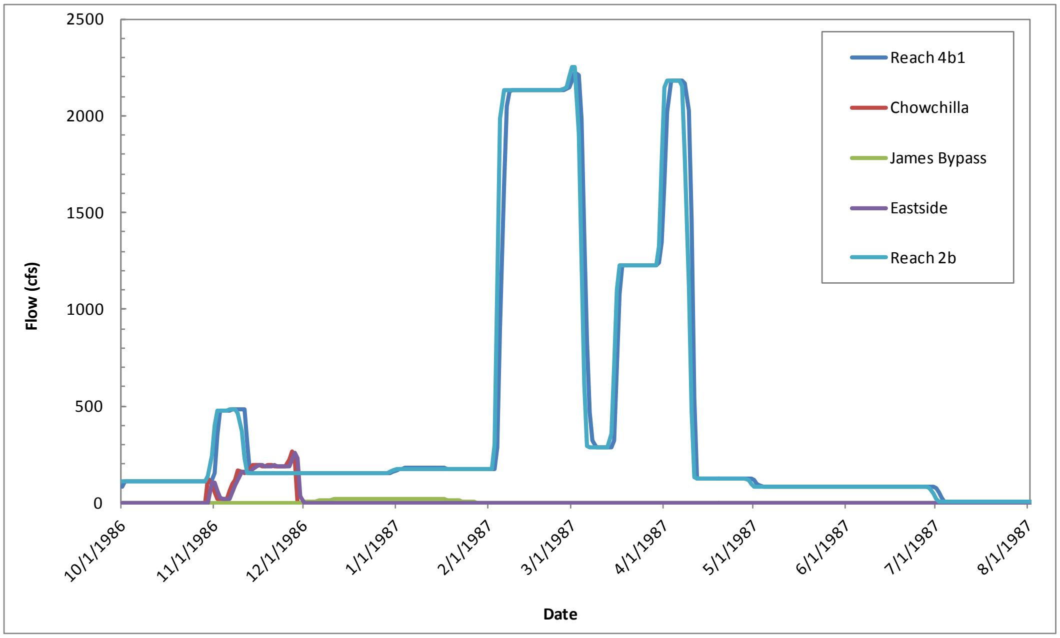


Figure 6-7. Example of water year 1987 for Alternative 1 when all flow less than Reach 4B1 capacity are routed into Reach 4B1.

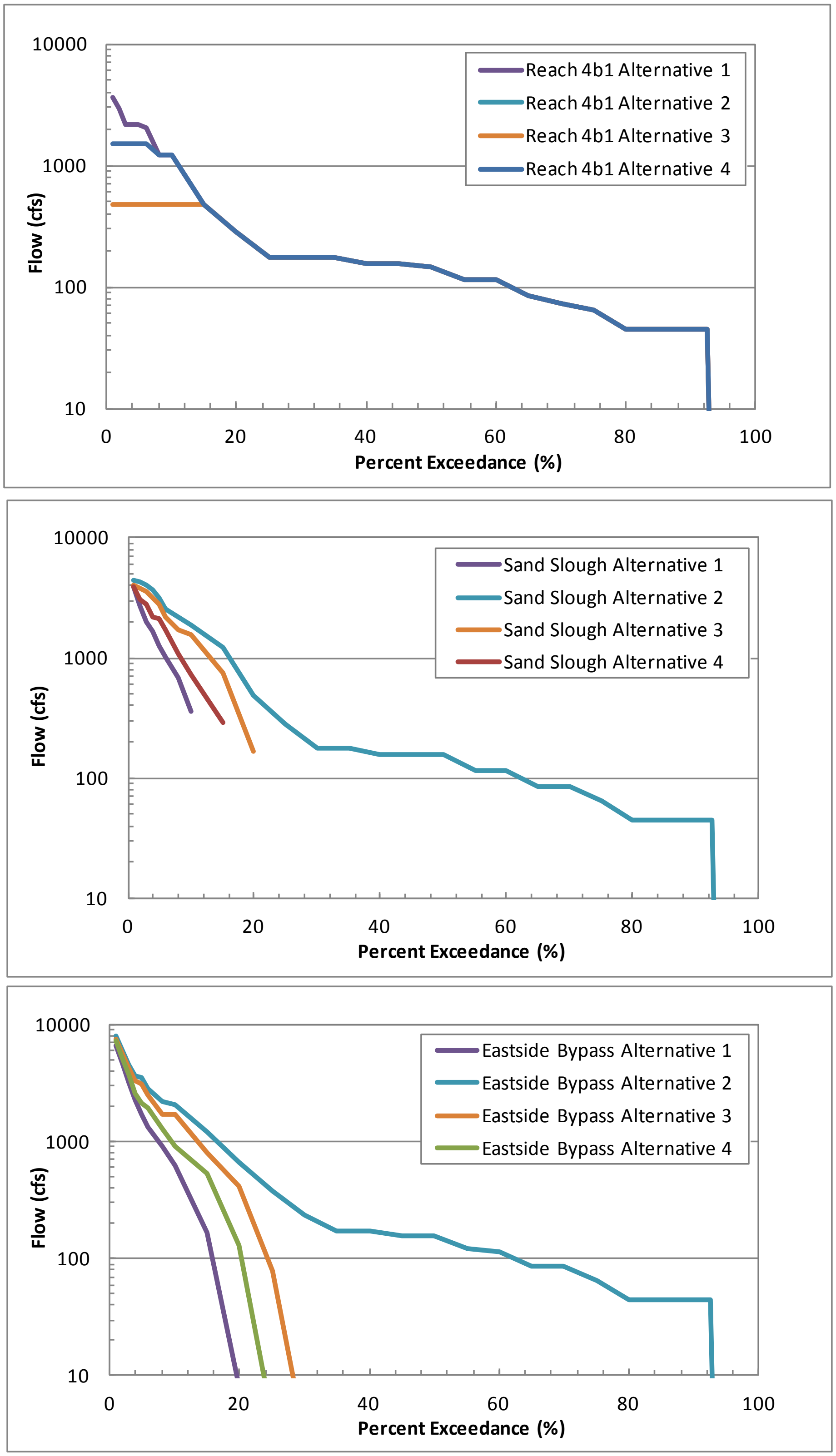


Figure 6-8. Daily flow exceedances for Alternatives 1 to 4 when flood flows are routed into the bypass system (Condition 2).

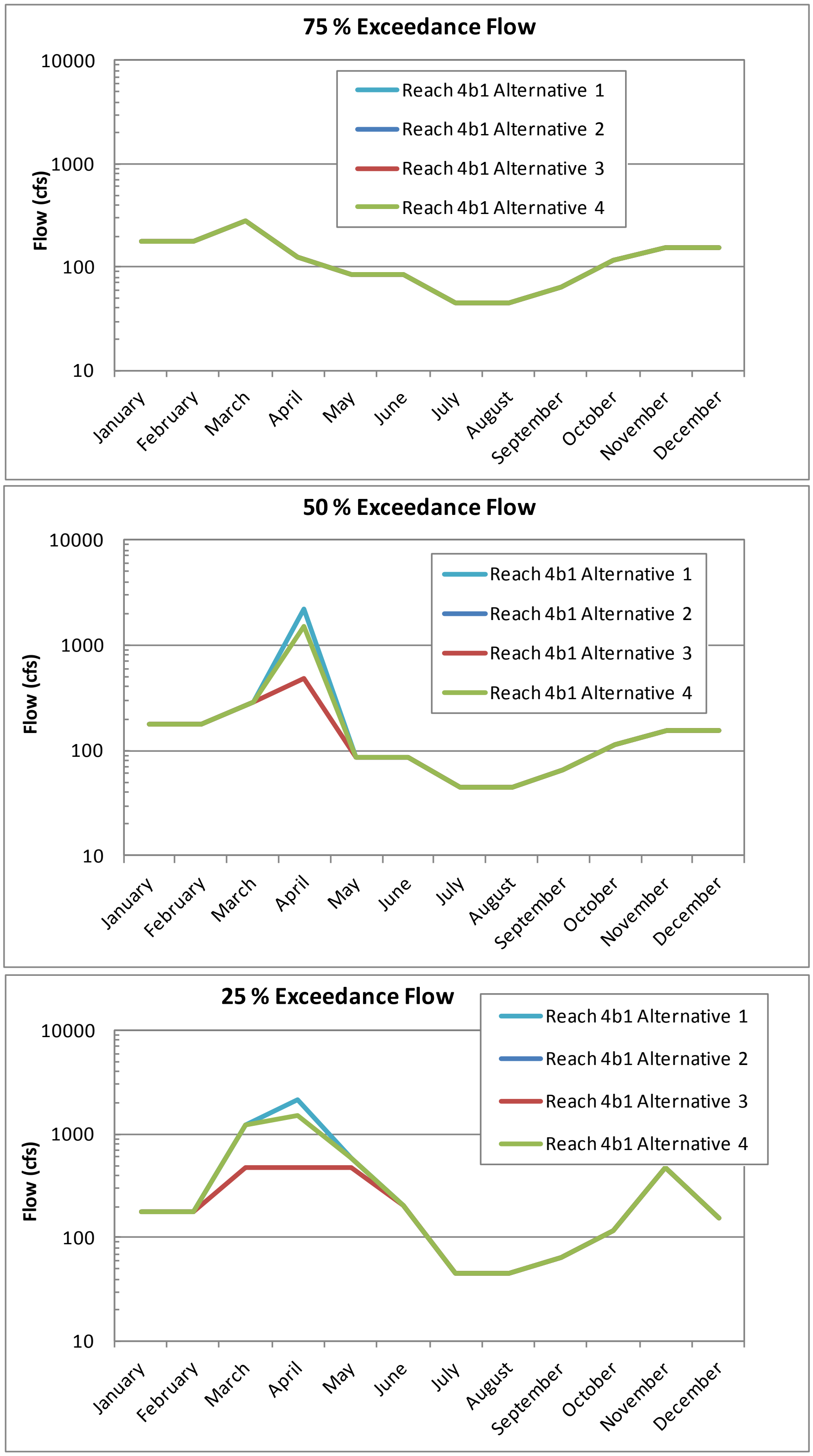


Figure 6-9. Daily flow exceedances in Reach 4B1 for each alternative when flood flows are routed into bypass system (Condition 2).

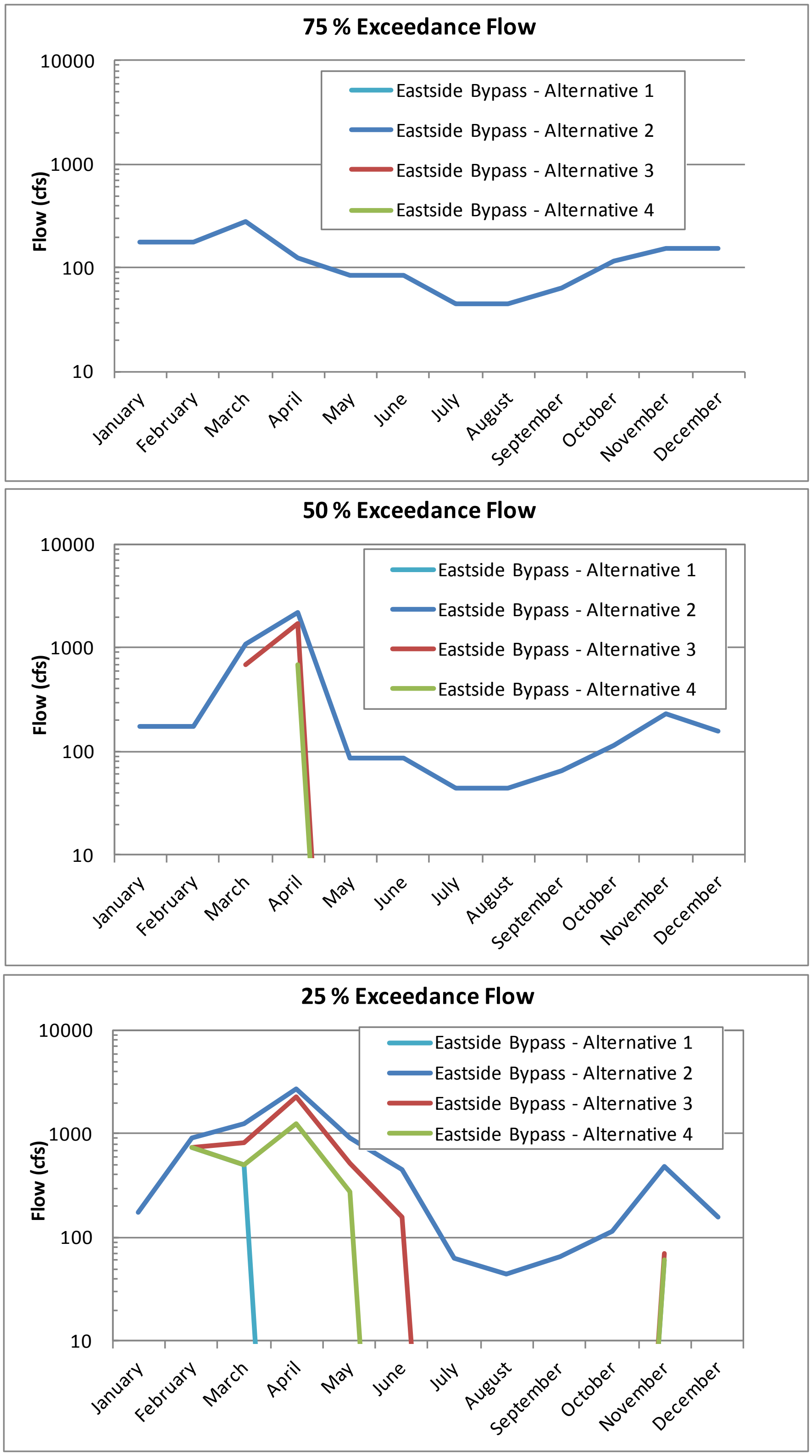


Figure 6-10. Flows at various excedance levels in Eastside Bypass for each alternative when flood flows are routed into bypass system (Condition 2).

Condition 2: Flood Flows Routed in Bypass

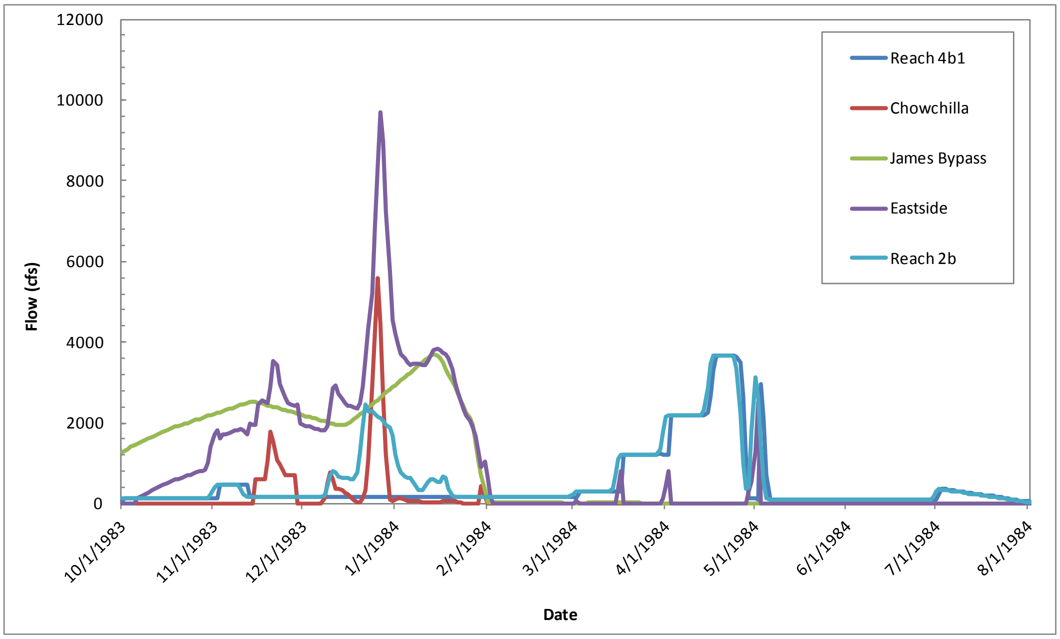


Figure 6-11. Example of water year 1984 for Alternative 1 when flood flows are routed down bypass system. Early flood flows are routed down the bypass and restoration flows are routed down Reach 4B1.

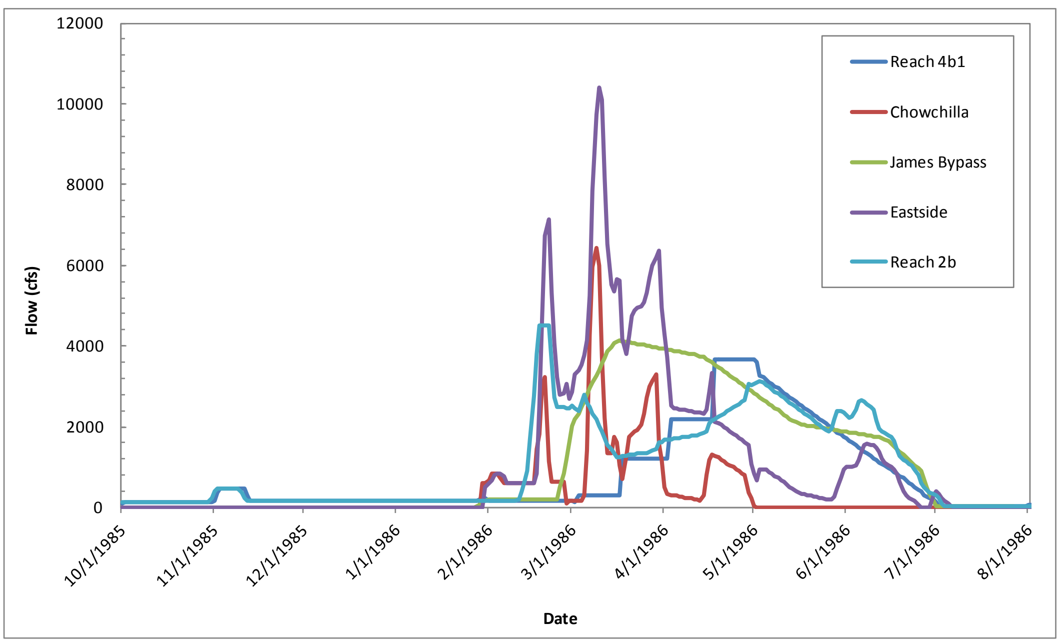


Figure 6-12. Example of water year 1986 for Alternative 1 when flood flows are routed down bypass system. Early flood flows are routed down the bypass and restoration flows are routed down Reach 4B1.

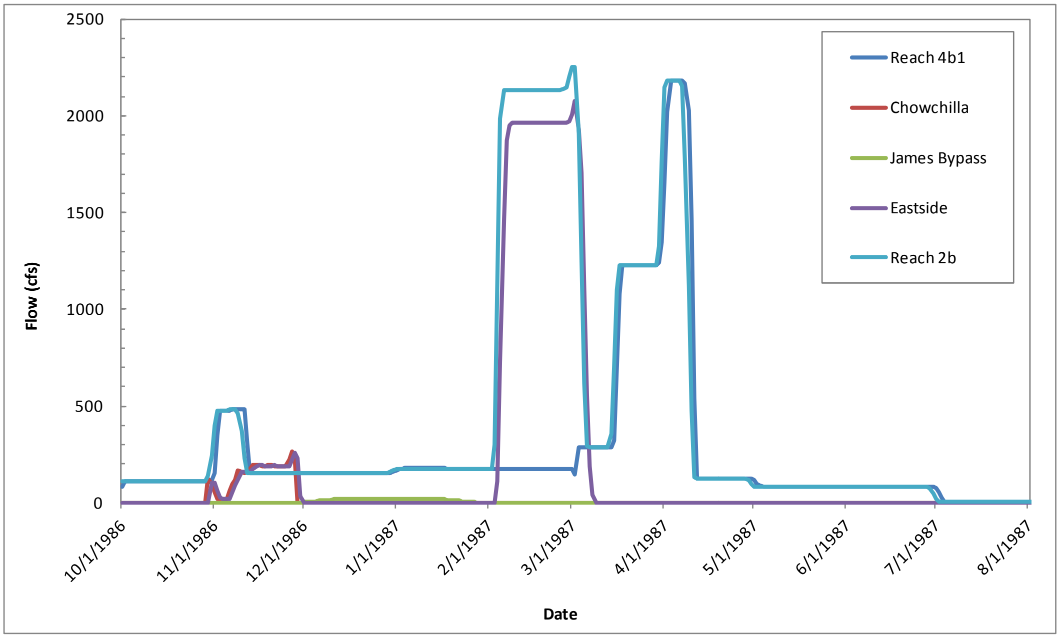


Figure 6-13. Example of water year 1987 for Alternative 1 when flood flows are routed down bypass system. Early flood flows are routed down the bypass and restoration flows are routed down Reach 4B1.

7 Future Hydraulics

The impact of each alternative is described as it relates to the hydraulic conditions in the Bypass and Reach 4B1.

7.1 No Action

Under the No Action alternative, the flood capacity in the Middle Eastside Bypass remains the same as existing conditions defined in Section 4. However, active subsidence is occurring in this region and the flood capacity in the upper portion of the Middle Eastside Bypass will continue to decrease. The extent of this decrease is discussed in Section 9.2.

7.2 Alternative 1

7.2.1 1D Simulation

HEC-RAS was used to simulate Reach 4B1 under Levee Options B through D. The Manning roughness was assigned a value of 0.12 in the floodplain and a value of 0.045 in the main channel. There is significant uncertainty on these values because there are no observed flows in this reach and there is uncertainty in the channel and vegetation response after restoration of the reach.

Under Alternative 1, the overall flood capacity of the San Joaquin system including the Bypass and San Joaquin River in the Project Reach is increased by 4500 cfs because of the addition of Reach 4B1 to the flood conveyance. The flood capacity of the Eastside Bypass itself would not be significantly altered because no significant additional vegetation growth is expected in the Bypass under this alternative.

The water surface elevation profiles (WSE) in Reach 4B1 for the levee set back options B to D are given in Figure 7-1 for a flow of 4500 cfs. The WSE profiles for flows of 1500 cfs and 150 cfs are shown in Figure 7-2 and Figure 7-3. In these figures, the results for Alternative 4 are shown because that alternative uses the Option A levee alignment. Option A is not considered feasible for Alternative 1 because the water depth is over 15 feet for a flow of 4500 cfs and the levees would become unreasonably high and at high risk of erosion because of the relative high velocities against the levees.

The average channel velocity at 4500 cfs for Options B to D is shown in Figure 7-4. The average channel velocity is generally largest for Option B and decreases for Option D. However, the channel velocities are generally very low due to the low slope of the channel. The spikes in the channel velocities are generally at the bridge constrictions and road crossings. However, the velocities are all less than 6 ft/s for options B to D.

The maximum channel depth at a flow of 50 cfs is shown in Figure 7-5. The depths are generally above 1 foot the entire length of the channel. The one exception is the control structure at the head of the channel, however, this is because the 1D hydraulic model was not sufficiently refined in the vicinity of this structure and does not include the fish passage facilities that would be constructed there.

The hydraulic residence time under steady state conditions for various Levee Options and Alternatives is given in Table 7-1. The total residence time was calculated by dividing the distance between cross sections by the average channel velocity at each cross section and summing the residence time between all the cross sections within the reach. The total residence time at a flow of 2200 cfs for Alternative 1 Option C is 4.8 times greater than the total residence time for Alternative 2 with existing levees.

The residence times in the table assume steady state conditions and the actual residence times could be substantially different under the unsteady flow conditions that would occur under actual conditions. The effective residence time for a specific flow would be increased under unsteady conditions because of the storage effects of the floodplains.

Table 7-1. Channel and Total Hydraulic Residence Time for steady flows.

Total Residence Time (Days)						
	Reach 4B1				Bypass	
flow (cfs)	Alt 3, 4 Opt A	Alt 1 Opt B	Alt 1 Opt C	Alt 1 Opt D	Alt 2 Existing Levees	Alt 2 Setback Levees
150	2.26	2.33	2.44	2.59	1.21	1.21
475	1.52	2.17	2.87	2.83	0.83	0.83
700	1.40	2.32	3.27	3.30	1.21	1.21
1200	1.36	2.54	3.62	3.87	0.69	0.69
2200	1.42	2.53	3.62	3.99	0.71	0.74
4500	1.60	2.26	3.22	3.61	0.78	0.94
Channel Residence Time (Days)						
	Reach 4B1				Bypass	
flow (cfs)	Alt 3, 4 Opt A	Alt 1 Opt B	Alt 1 Opt C	Alt 1 Opt D	Alt 2 Existing Levees	Alt 2 Setback Levees
150	2.27	2.26	2.27	2.11	1.20	1.20
475	1.47	1.51	1.56	1.45	0.78	0.78
700	1.27	1.33	1.41	1.31	0.71	0.71
1200	1.04	1.13	1.23	1.17	0.60	0.60
2200	0.98	0.96	1.08	1.04	0.49	0.50
4500	1.05	0.80	0.93	0.90	0.40	0.41

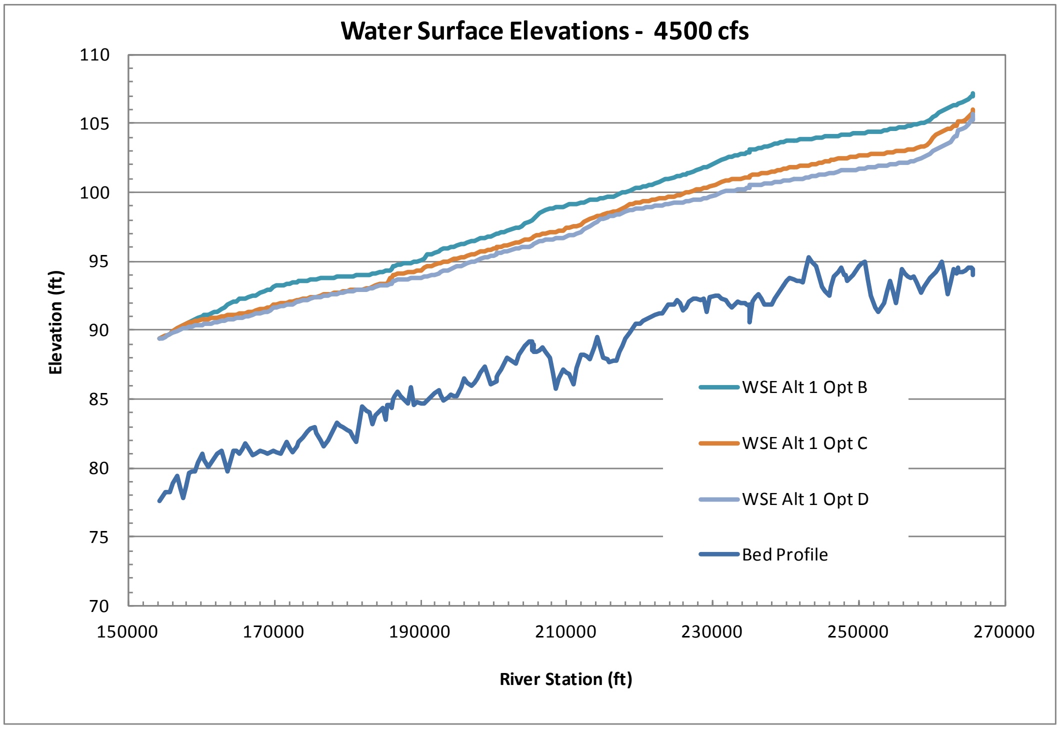


Figure 7-1. Reach 4B1 water surface profiles for 4500 cfs for levee setback Options B to D.

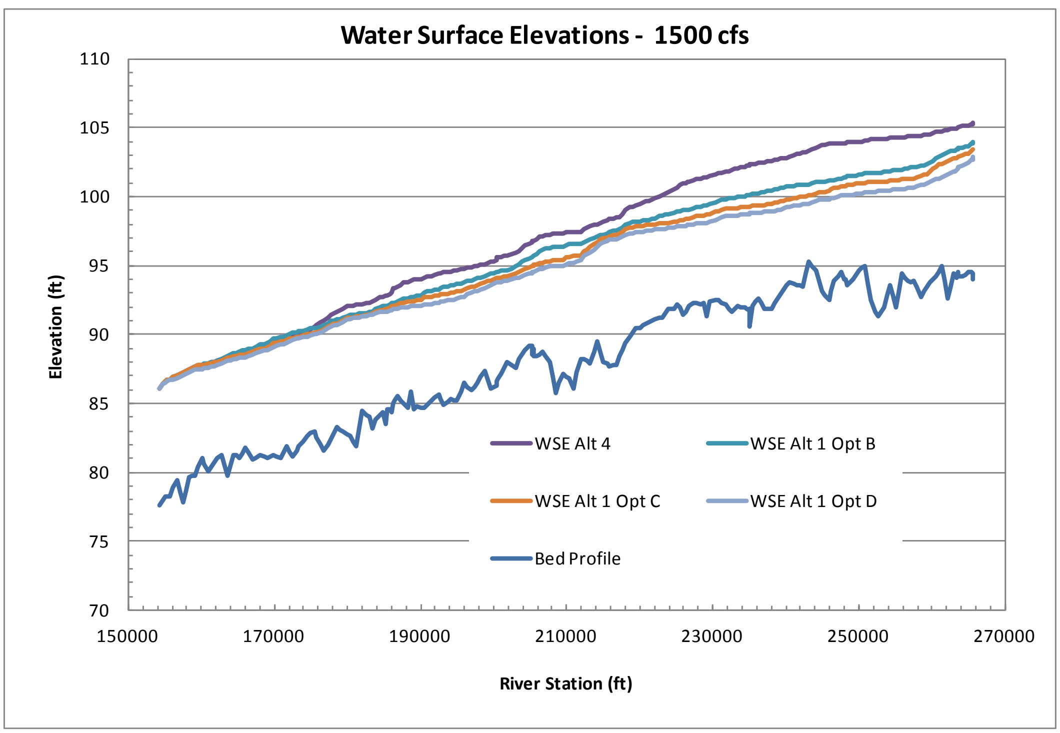


Figure 7-2. Reach 4B1 water surface profiles for 1500 cfs for levee setback Options A to D. Option A is labeled Alt 4 because it uses the Option A levee alignment.

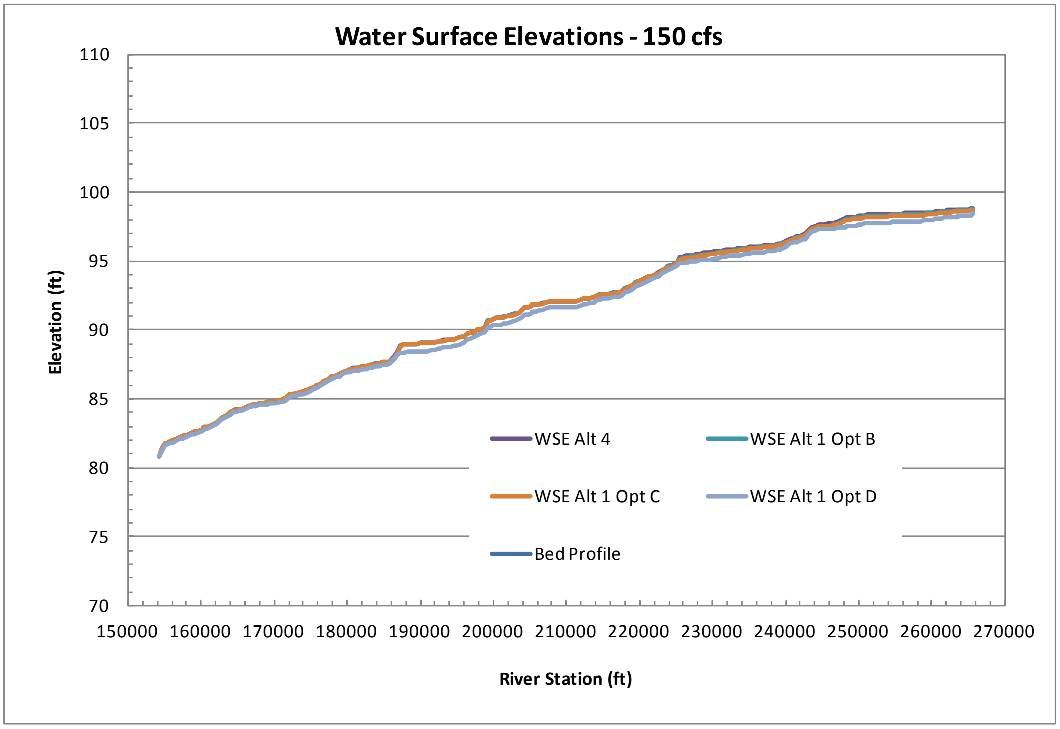


Figure 7-3. Reach 4B1 water surface profiles for 150 cfs for levee setback Options B to D. Alt 4 is shown here for comparison purposes because it uses the Option A levee alignment.

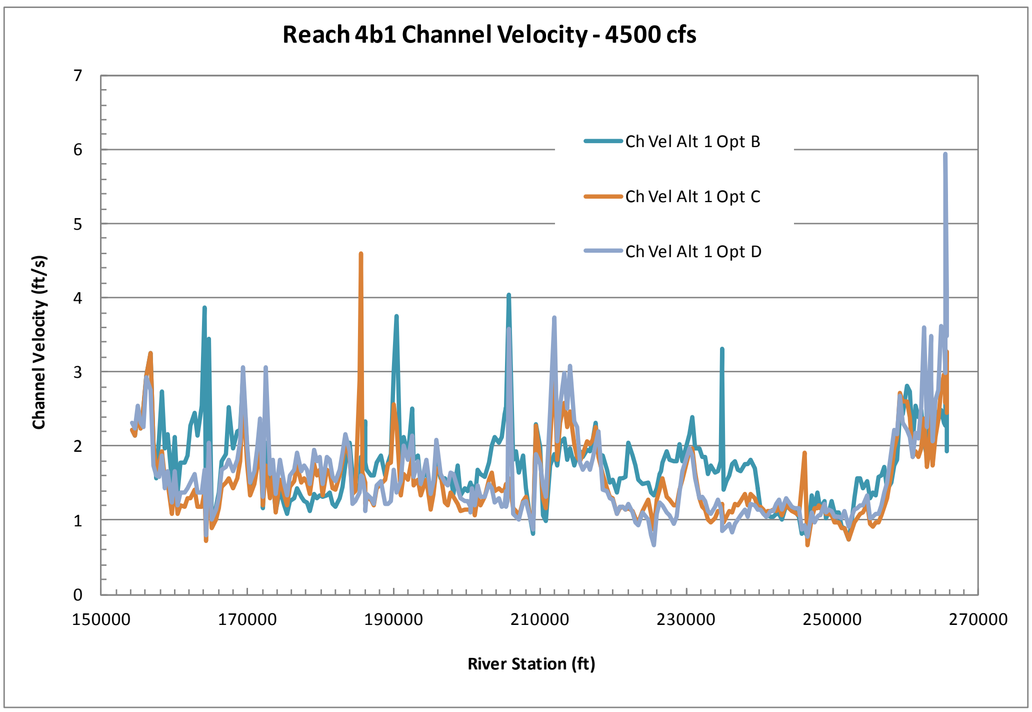


Figure 7-4. Reach 4B1 Channel Velocity at 4500 cfs for Alternative 1 Options B to D.

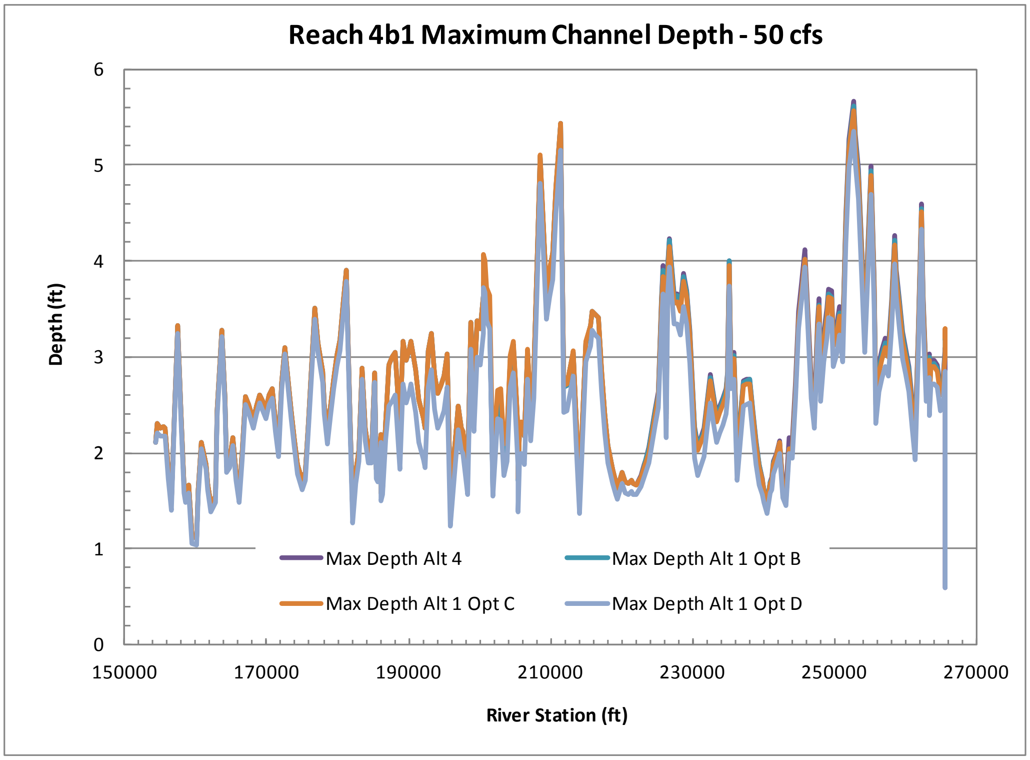


Figure 7-5. Maximum channel depth at 50 cfs. Alt 4 is shown here for comparison purposes because it uses the Option A levee alignment.

7.2.2 2D Simulation

SRH-2D version 2.1 (Lai, 2008) was used to simulate the flow in Reach 4B1 and the Eastside Bypass. The same river and flood plain geometry and the same hydraulic roughness was used as in the HEC-RAS model. Only the two example areas described in Section 5 were simulated. In these two areas, the existing levees were removed, side channels constructed, and floodplain was modified.

An example mesh for Levee Option D is shown in Figure 7-6. Quadrilateral elements with 15 to 20 ft sides were used in the main channel and triangular elements 25 to 100 ft on a side were used in the floodplain. This is considered a relatively coarse mesh, but appropriate for the alternative analysis being undertaken.

The simulations show that flow of 150 cfs is generally contained within the main channel, however, the topography used in the simulations may not be sufficiently accurate at the entrance to the side channels to simulate the lowest flows and more activation of the side channels is expected than what was simulated. For flows of 475 cfs and greater, the banks of the main channel are exceeded at a few location and there are spills of flow onto the floodplain. It is likely that the upper part of Reach 4B1 experiences more out of bank flow because of the lower slope.

The 2D simulation of Reach 4B1 was used to support the fish habitat assessment and the floodplain production assessment in Section 8.

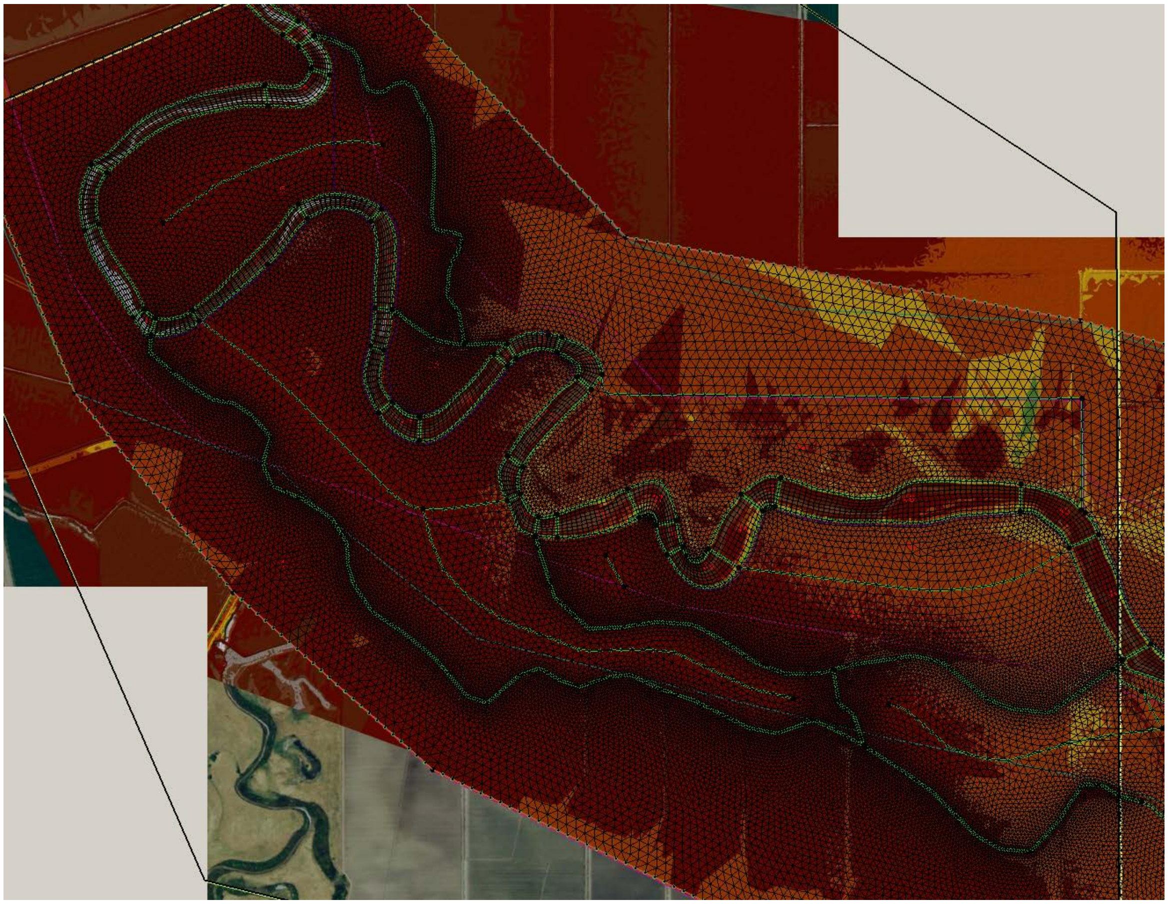


Figure 7-6. Mesh for Reach 4B1 Option D for the example area 2.

7.3 Alternative 2

An approximately 50-ft wide channel would be excavated within the existing 150-ft wide low flow channel of the Middle Eastside Bypass as shown in Figure 5-11 and Figure 5-12. The MNWR weir would be removed and the road crossings would be elevated to pass at least 4500 cfs. Several bays of the Mariposa Control structure would also be lowered so that the structure does not impede fish passage and sediment could be sluiced through the structure.

With baseflow established in the bypass under Alternative 2, a significant amount of riparian vegetation would establish. Vegetation growth may be limited because of soil conditions, but the intention of the revegetation plan is to establish a band of woody riparian species adjacent the low flow channel and spaced throughout the floodplain (Figure 7-7). To estimate the future roughness conditions in the bypass, the values of roughness were taken from those calibrated in Reach 4B2 as shown in Table 7-2 (Reclamation, 2012b).

It is assumed the channel Manning's roughness coefficient increases to 0.04 and the floodplain value increases to between 0.065 and 0.1 (Table 7-2). This is considered the likely range of future Manning's roughness in the floodplain after the vegetation in the bypass fully develops. It is intended to cover the range of possibility from scattered trees and light brush covering the floodplain to a floodplain that is covered in medium density trees and brush. It was not considered possible that the entire floodplain would be covered in dense trees and brush (which would have resulted in a floodplain roughness of 0.125).

Because restoration flows can inundate the majority of the Middle Eastside and Mariposa Bypass, there could be active recruitment of vegetation. It is recommended that the roughness coefficient assumed in the hydraulic capacity calculations for the Middle Eastside Bypass and Mariposa is the high roughness value of 0.1.

Table 7-2. Hydraulic roughness values calibrated in Reach 4B2 (Reclamation 2012b) used as guidance in selecting the range of roughness in Bypass under Alternative 2.

Description	Initial n Values	Calibrated n Values
Channel	0.035	0.044
Bare soil	0.045	0.056
Scattered Trees and Light Brush	0.060	0.075
Medium Density Trees and Brush	0.080	0.100
Dense Trees and Brush	0.100	0.125

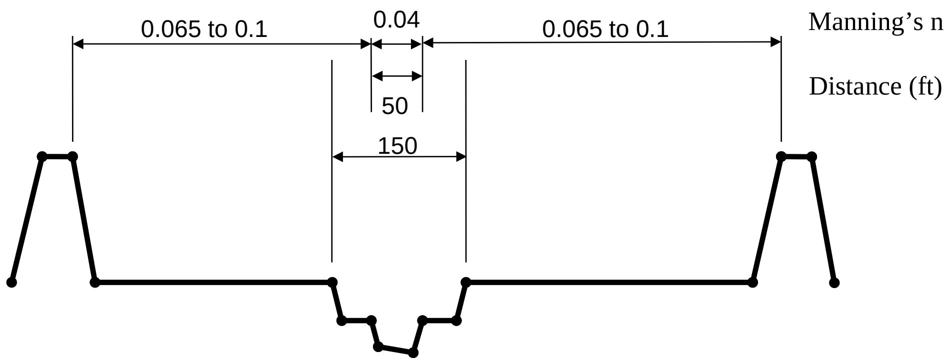


Figure 7-7. Hydraulic roughness values assumed for Alternative 2 with future vegetation growth.

7.3.1 Restoration Flow analysis

The removal of structures and excavation of the low flow channel would significantly lower the low-flow water surface elevations. This would create a more focused low flow channel with greater depths at low flow as shown in Figure 7-8. The current maximum channel depths at a flow of 50 cfs are less than 1 foot at several locations along the bypass. However, with the constructed low flow channel in Alternative 2, the channel depth is generally over 1.5 feet at 50 cfs. After the establishment of flows and sediment transport, the low flow channel geometry is expected to change and the channel depths would become more variable. However, it is unlikely that the low flow channel would become substantially wider than constructed. There may some bed variability included in the initial channel in later channel design phases to promote a more diverse habitat. However, diversity of habitat would occur naturally if sediment transport continuity was allowed in this reach.

Lowering of the low flow water surface would also decrease the potential for seepage problems outside the levee (Figure 7-9). Even with the increase of vegetation roughness, the water surface elevations would decrease for the majority of the Middle Eastside Bypass for flows less than 4500 cfs because of the construction of the low flow channel and associated changes to the structures within the reach (Figure 7-10).

The average channel velocity as computed in HEC-RAS at a flow of 4500 cfs is shown in Figure 7-11. All channel velocities are less than 6 ft/s throughout the bypass including at structures. In fact, a channel velocity of 6 ft/s is not exceeded at any flow throughout the bypass for Alternative 2.

7.3.2 Flood Capacity Analysis

The design capacity of the bypass system is given in Figure 3-2. The design flow in the Middle Eastside Bypass was assumed to be 16,500 cfs and the design flow in the Mariposa Bypass was 8500 cfs. SRH-2D was used to evaluate the water surface elevations at the design capacity of the Bypass system for Alternative 2 under various roughness conditions, with and without levee setbacks.

The water surfaces in the Middle Eastside and Mariposa Bypasses under the design flow conditions are given in Figure 7-12 and Figure 7-13, respectively. The differences between the estimate current condition SRH-2D and the various conditions are given in Figure 7-14 and Figure 7-15.

In the Middle Eastside Bypass, if the vegetation approaches the high roughness values, the water surface increases more than 2.5 ft upstream of El Nido Road. If the Middle Eastside Bypass levee along the North side is setback according to the NMWR alignment, then the water surface at the design flow is increased less than 0.5 ft even for the high roughness case except for upstream of El Nido Road, where there is no levee setback.

In the Mariposa Bypass, the high roughness increases the water surface elevations for the design flow by less than 1 ft because the Alternative 2 design calls for the removal of the grade control structure on the downstream end of the reach. If there is a setback of the Mariposa Bypass levee, then the water surface elevation under the high roughness is less than the current condition.

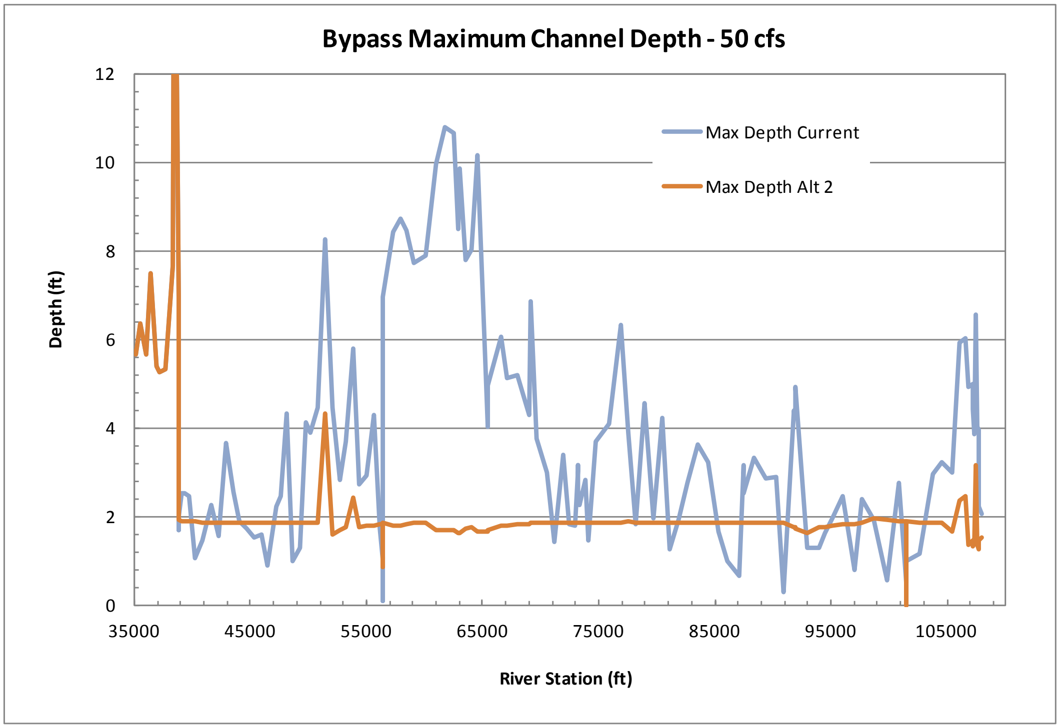


Figure 7-8. Comparison between current maximum channel depth and maximum channel depth under Alternative 2 at 50 cfs in Middle Eastside and Mariposa Bypass.

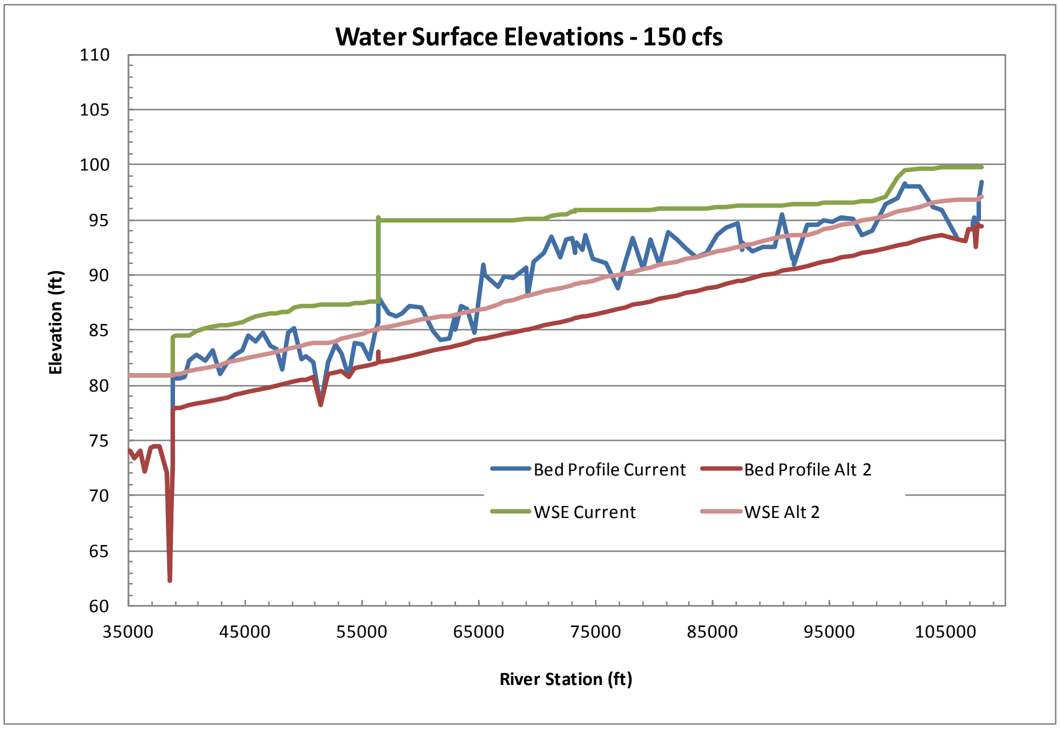


Figure 7-9. Comparison between current WSE profile for Current Conditions and under Alternative 2 at 150 cfs in Middle Eastside and Mariposa Bypass.

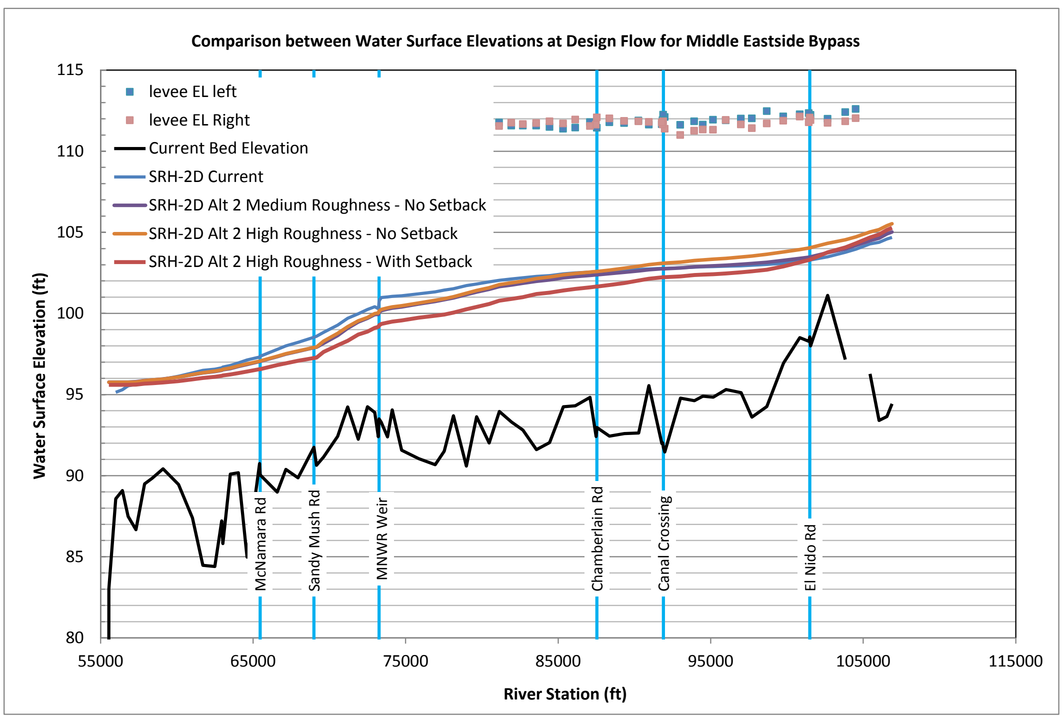


Figure 7-10. Comparison between current WSE profile for Current Conditions and under Alternative 2 at 4500 cfs in Middle Eastside Bypass.

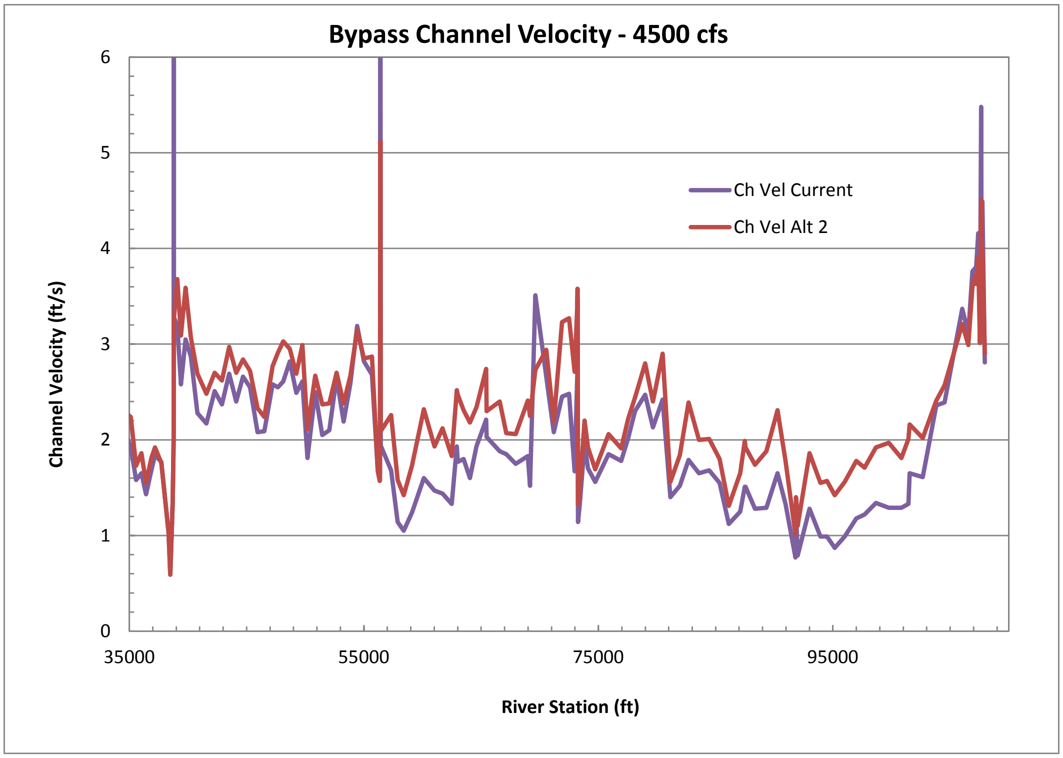


Figure 7-11. Comparison between current average channel velocity and average channel velocity under Alternative 2 at 4500 cfs in Mariposa and Middle Eastside Bypass.

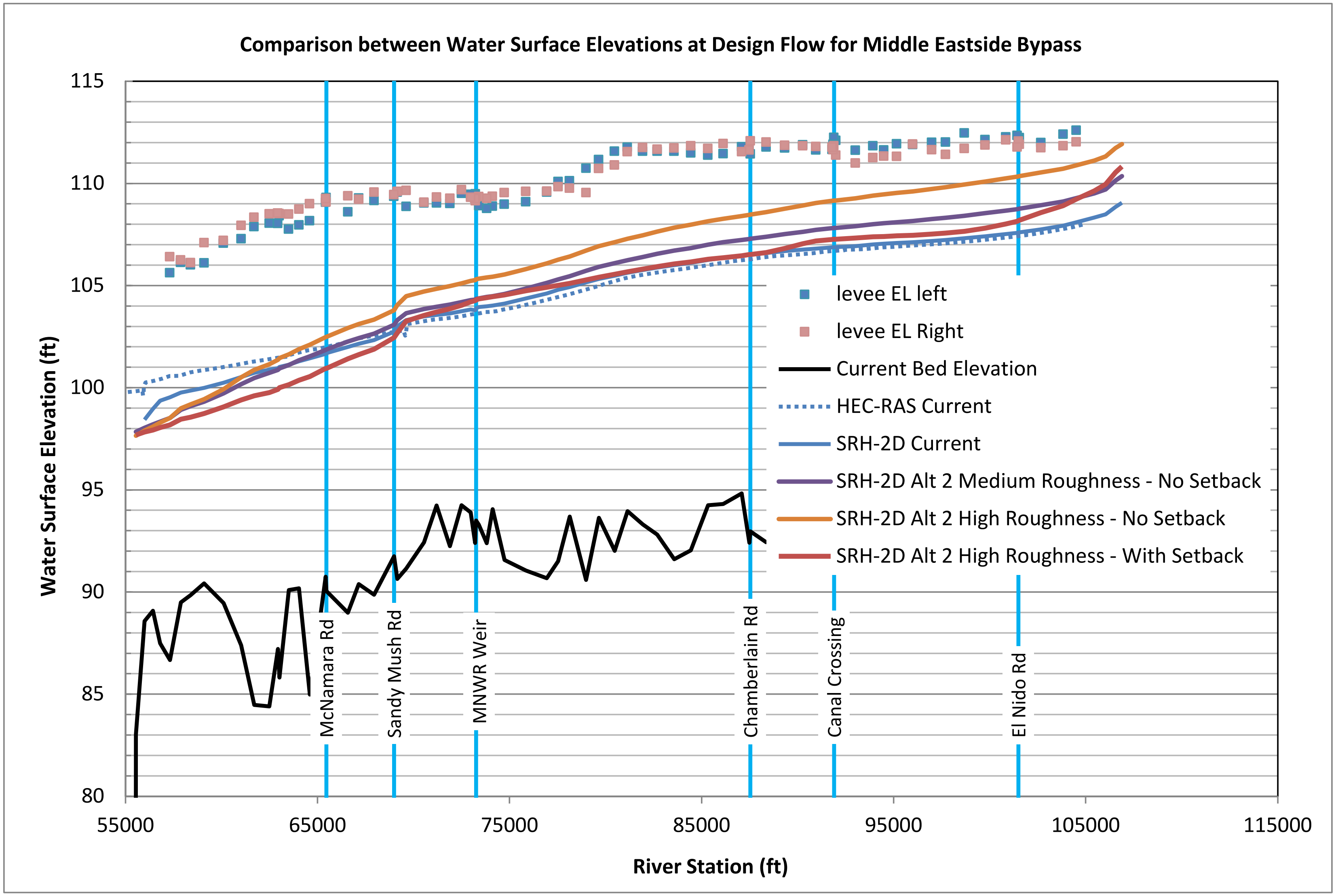


Figure 7-12. Middle Eastside Bypass WSE estimated by SRH-2D for a flow of 16500 cfs under Current Conditions and Alternative 2 Conditions with and without Levee Setbacks in Middle Eastside Bypass.

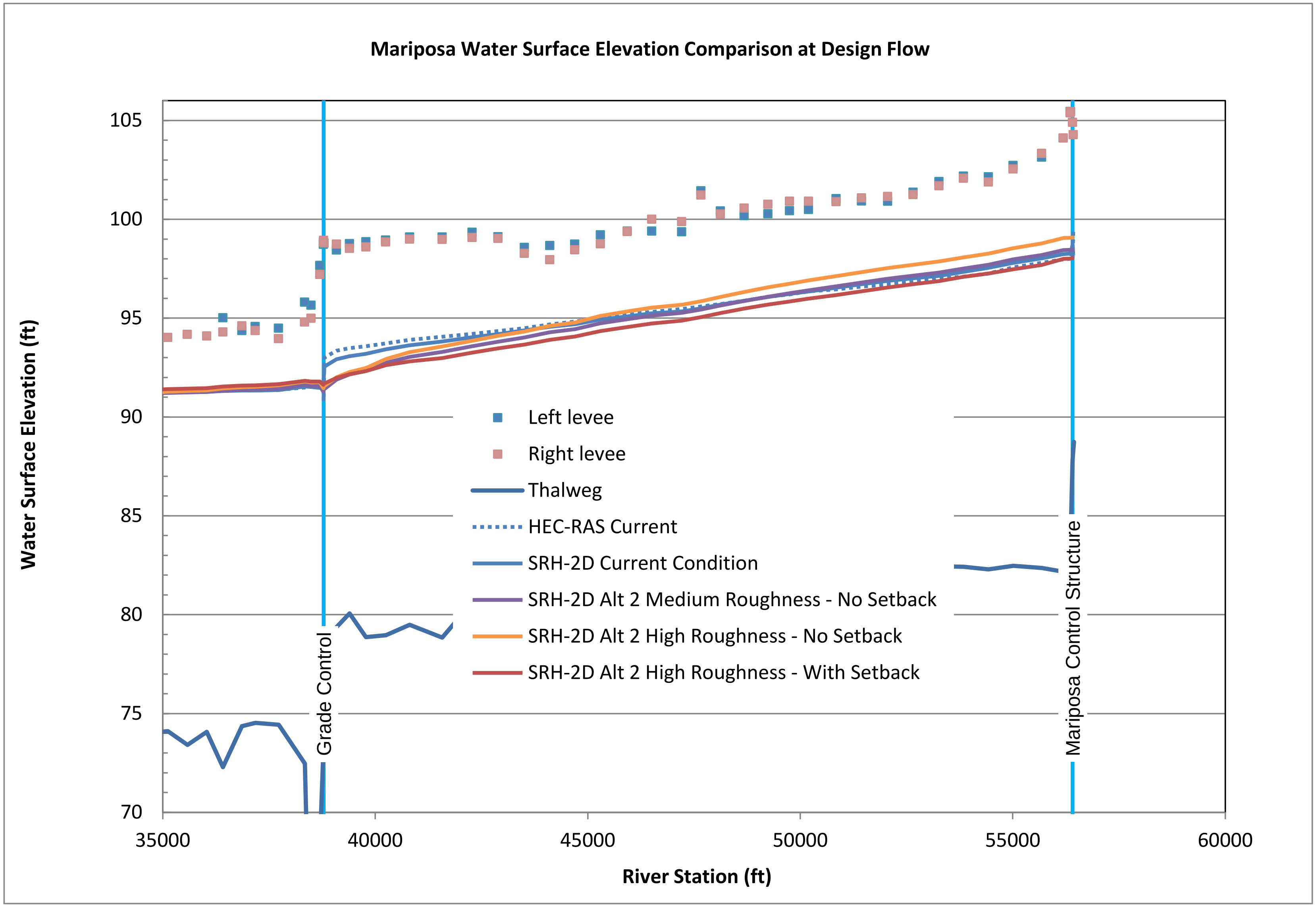


Figure 7-13. Mariposa Bypass WSE estimated by SRH-2D for a flow of 8500 cfs under Current Conditions and Alternative 2 Conditions with and without Levee Setbacks in Mariposa Bypass.

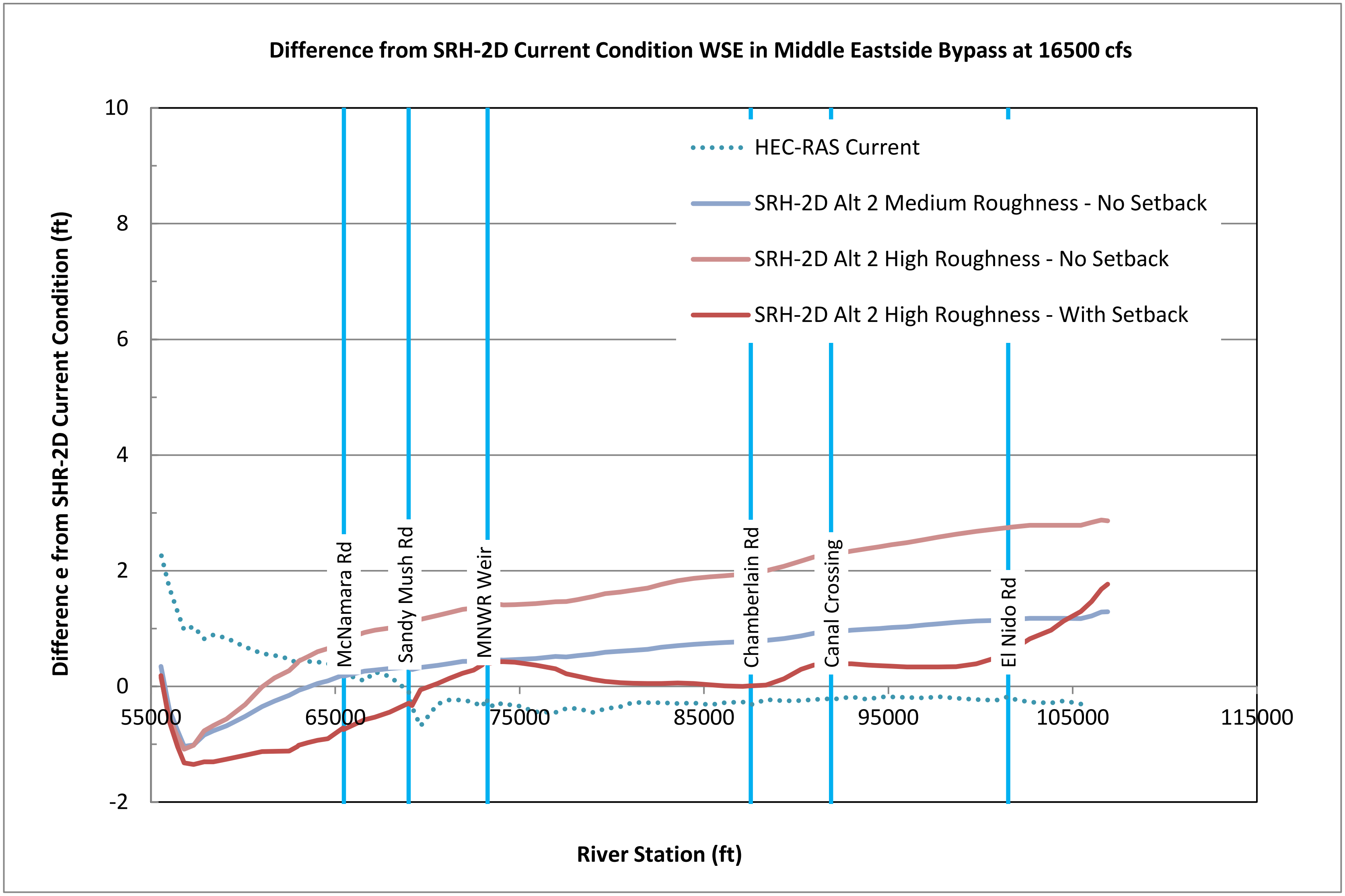


Figure 7-14. Difference in WSE from SRH-2D current condition for a flow of 16500 cfs in Middle Eastside Bypass.

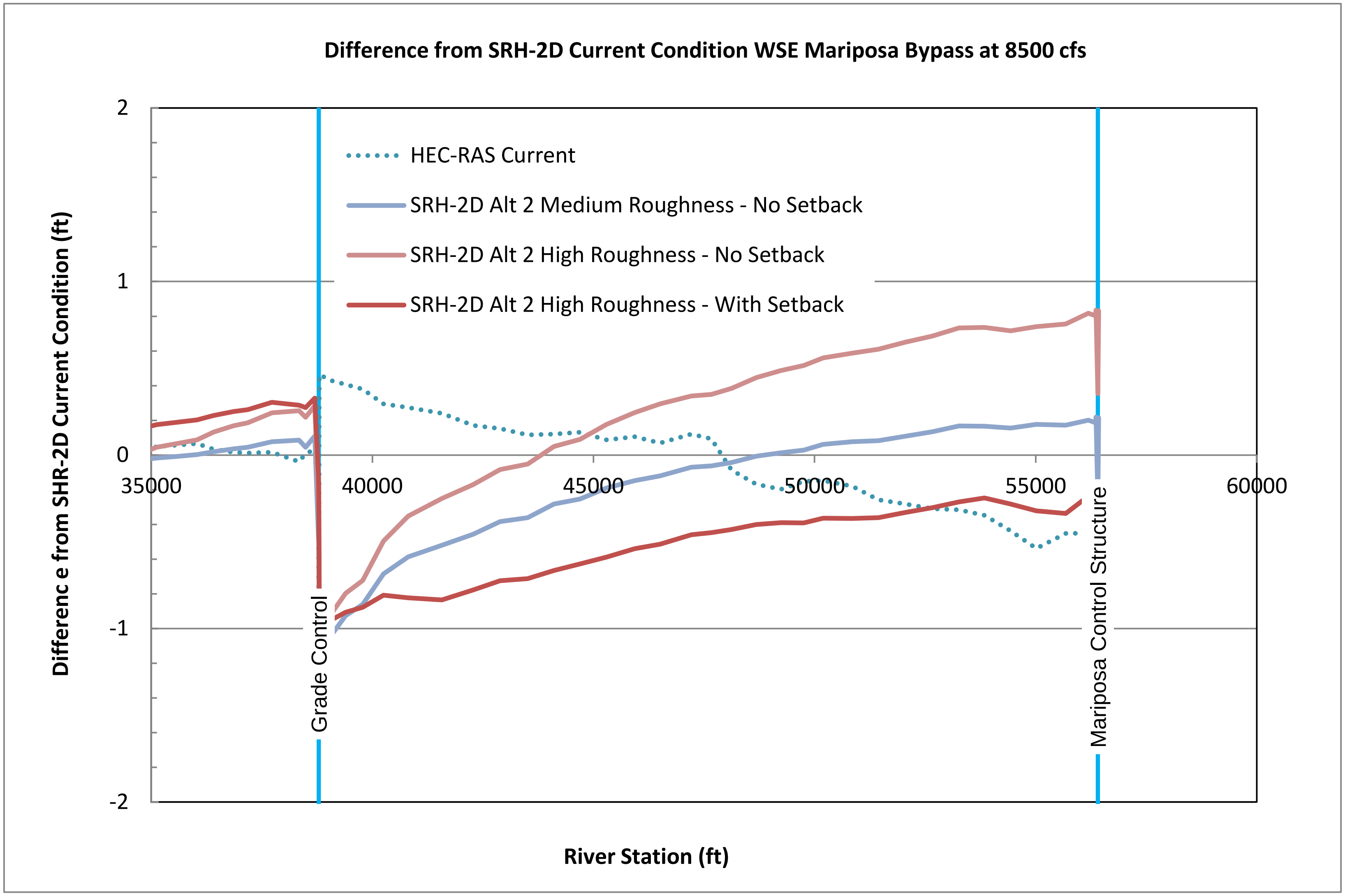


Figure 7-15. Difference in WSE from SRH-2D current condition for a flow of 8500 cfs in Mariposa Bypass.

7.4 Alternative 2-LESB

It is assumed that the future hydraulics in the Middle Eastside Bypass under Alternative 2 and Alternative 2-LESB are equivalent because the same grading plan and flow operations will be used in the Middle Eastside Bypass for both Alternative 2 and Alternative 2-LESB. Therefore, this section will focus on the hydraulic results in the Lower Eastside Bypass.

Only a minor amount of channel grading is required in the Lower Eastside Bypass and only in the upper section of the reach. The water surface elevations within the cross sections throughout the Lower Eastside Bypass are shown in Figure 7-16. Restoration flows will generally be below 3650 cfs and will be entirely contained within the incised channel. The base flow (approximately 50 cfs) will generally be more than 10 ft below the floodplain elevation. Flood flows above 4500 cfs just barely inundate the floodplain, but these will likely be infrequent. Because of these factors, the floodplain in the Lower Eastside Bypass is unlikely to support a dense riparian corridor and the floodplain will more likely be characterized by “Scattered Trees and Light Brush”, which is assumed to have a roughness of 0.065. Currently, the floodplain of the Lower Bypass is almost entirely devoid of woody vegetation outside of the incised channel. The lack of woody vegetation is likely due to the low elevation of base flows relative to the floodplain and because most of the Lower Eastside Bypass appears to be heavily grazed by cows.

7.4.1 Restoration Flow Analysis

The computed maximum channel depths at the low flows of 150 and 475 cfs is given in Figure 7-17. The maximum channel depths at a flow of 150 cfs vary between less than 0.5 ft to near 5 ft. There are sections in the Lower Eastside that will act as control points at low flow that spread out the low flows and create shallow areas.

The channel velocity at higher flows of 1200 and 4500 cfs is given in Figure 7-18. The velocity in the Lower Eastside Bypass is typically higher than in the Middle Eastside because the channel is more incised and the incised channel contains a greater portion of the flow.

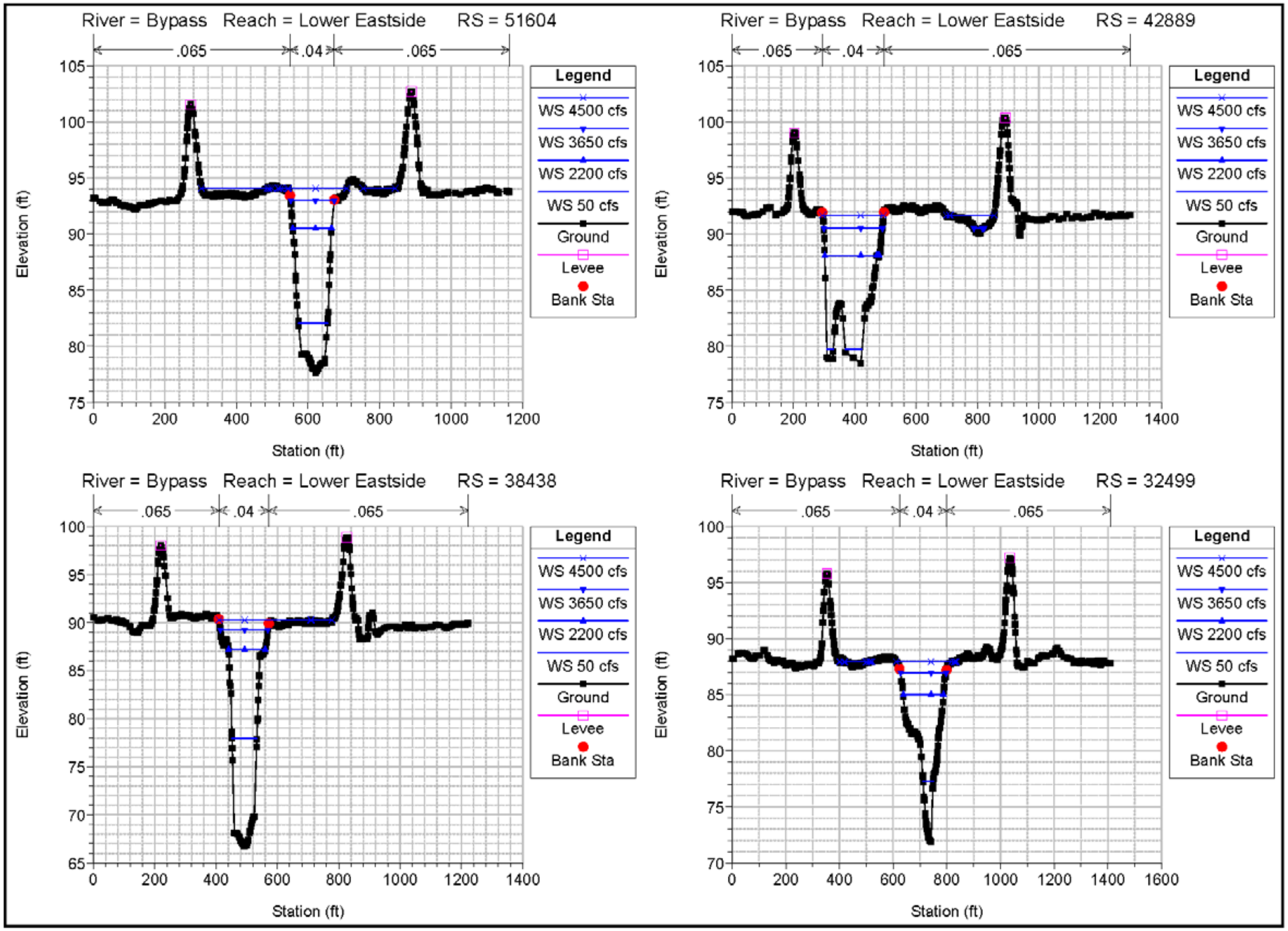
In the upper section of the Lower Eastside Bypass, the velocities are typically between 2 to 3 ft/s at a flow of 4500 cfs. However, in the section between River Station 22000 and about 30000 (just upstream of Howard Road Bridge to about 2 miles upstream of the bridge), the velocities increase because the bed slope of the Eastside Bypass is highest in this section. The velocity increases to between 3 and 4 ft/s in this area at a flow of 4500 cfs. This is considered to be substantially higher than in other parts of the San Joaquin River, where the velocities are typically less than 3 ft/s at a flow of 4500 cfs.

7.4.2 Flood Capacity Analysis

The designed flood capacity of the Lower Eastside Bypass increases from 12,000 cfs downstream of the control structure to 13,500 cfs downstream of Owens

Creek, to 18,500 cfs downstream of Bear Creek. The computed water surface elevation at the design flow is shown in Figure 7-19 for the current condition roughness condition and with a medium roughness assumption and with a high roughness assumption. The results from HEC-RAS under current conditions are also shown for comparison purposes.

Under the medium roughness assumption, the water surface increases approximately 1.25 ft at the design flow and under the high roughness assumption, the water surface increases approximately 2.5 ft (Figure 7-20). As mentioned in the previous section, a medium roughness assumption is believed to be most appropriate for the Lower Eastside Bypass under Alternative 2-LESB conditions.


River = Bypass Reach = Lower Eastside RS = 51604
.065
.04
.065
Elevation (ft)
Station (ft)
Legend
WS 4500 cfs
WS 3650 cfs
WS 2200 cfs
WS 50 cfs
Ground
Levee
Bank Sta
River = Bypass Reach = Lower Eastside RS = 42889
.065
.04
.065
Elevation (ft)
Station (ft)
Legend
WS 4500 cfs
WS 3650 cfs
WS 2200 cfs
WS 50 cfs
Ground
Levee
Bank Sta
River = Bypass Reach = Lower Eastside RS = 38438
.065
.04
.065
Elevation (ft)
Station (ft)
Legend
WS 4500 cfs
WS 3650 cfs
WS 2200 cfs
WS 50 cfs
Ground
Levee
Bank Sta
River = Bypass Reach = Lower Eastside RS = 32499
.065
.04
.065
Elevation (ft)
Station (ft)
Legend
WS 4500 cfs
WS 3650 cfs
WS 2200 cfs
WS 50 cfs
Ground
Levee
Bank Sta

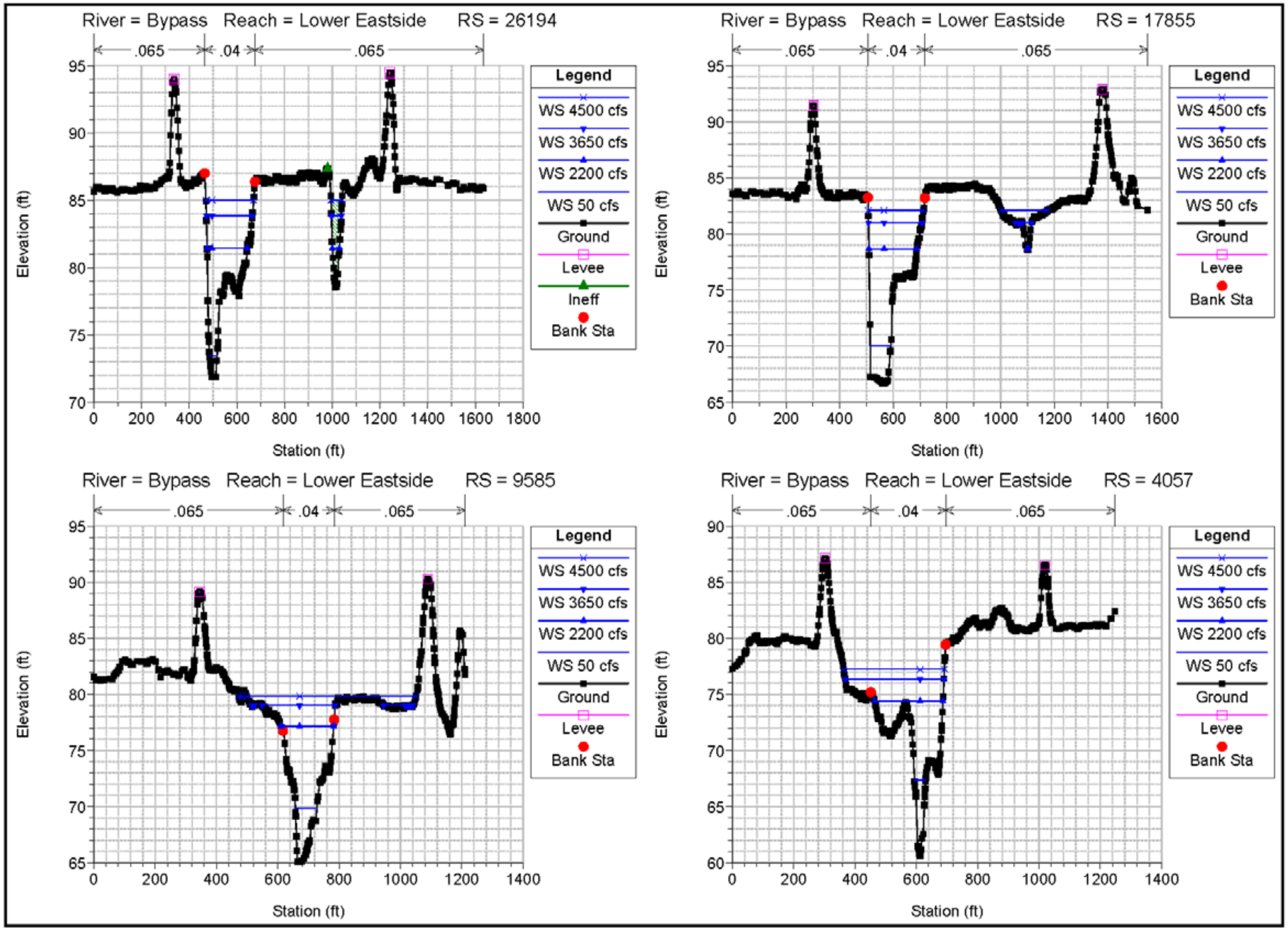


Figure 7-16. Cross section and water surface elevations in the Lower Eastside Bypass.

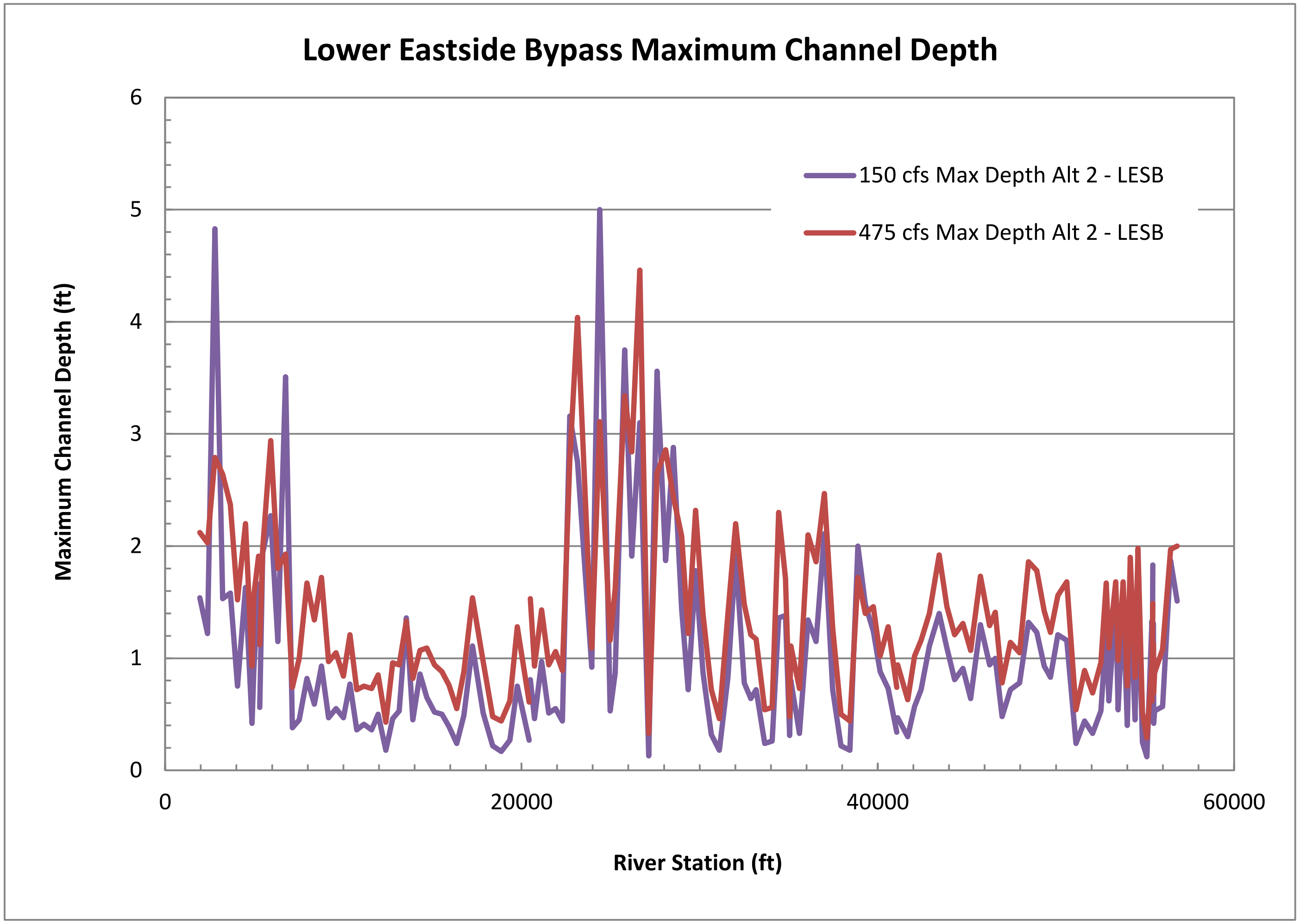


Figure 7-17. Maximum channel depth in Lower Eastside Bypass under Alternative 2 – LESB for a flow of 475 and 150 cfs.