

# DESIGN HYDRAULIC STUDY

# MANNING AVENUE BRIDGES AT

JAMES BYPASS Bridge Numbers 42C0066 and 42C0067

FRESNO COUNTY, CALIFORNIA



Design Hydraulic Study MANNING AVENUE BRIDGES AT JAMES BYPASS

Fresno County, CALIFORNIA

Bridges #42C0066 and #42C0067

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# PREPARED FOR:

# CORNERSTONE STRUCTURAL ENGINEERING GROUP AND FRESNO COUNTY DEPARTMENT OF PUBLIC WORKS

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#### EXECUTIVE SUMMARY

The Manning Avenue Bridges (bridges) at James Bypass in Fresno County, California are proposed for replacement by the County of Fresno. The proposed west branch bridge (west bridge) will be a 3-span precast prestressed voided slab bridge and will replace an existing 6-span precast reinforced concrete inverted U-girder deck bridge. The proposed east branch bridge (east bridge) will be a single span precast prestressed voided slab bridge and will replace an existing 3-span precast reinforced concrete inverted U-girder deck bridge. The west bridge will be approximately 173 feet long and the east bridge approximately 65 feet long. Both will accommodate two 12-ft travel lanes with two 8-ft 3-in wide shoulders as shown in the attached General Plans (Appendix A). The superstructure of both bridges will be supported by reinforced concrete abutments on 4 feet diameter cast in drilled hole piles and, in the case of the west bridge, cast in place prestressed pier caps on 4 feet diameter cast in drilled hole piles.

James Bypass (also known as the Fresno Slough Bypass) is operated by the James Irrigation District (JID) and was constructed to convey overflow from the Kings River to the San Joaquin River. James Bypass flows northwesterly through the project area and through the central part of Fresno County. James Bypass is made up of two channels; the main channel which runs along the western edge of the bypass (the west branch) and a smaller channel that runs along the eastern edge (the east branch). The discharges and a summary of the hydraulic results used for the bridge hydraulic analysis are shown in Table 1 for the West Bridge and Table 2 for the East Bridge.

	Design	Base	Overtopping		
Frequency (years)	100	>100	>>100		
Discharge (cubic feet per second)	4,750	8,500	>8,500		
Water Surface (elevation in feet at upstream face of Bridge)	173.1	175.3	~182.0		
Freeboard (feet)*	7.1	4.9	n/a		
*Minimum soffit elevation at the upstream face of the bridge is 180.2 feet.					

Table 1: Estimated discharges and water surface elevations for the West Bridge design

Table 2: Estimated	discharges and	water surface of	elevations f	for the East	Bridge design
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	Design	Base	Overtopping		
Frequency (years)	100	>100	>>100		
Discharge (cubic feet per second)	4,750	8,500	>8,500		
Water Surface (elevation in feet at upstream face of Bridge)	176.7	177.3	~182.0		
Freeboard (feet)*	3.6	3.0	n/a		
*Minimum soffit elevation at the upstream face of the bridge is 180.3 feet.					

The US Army Corps of Engineers HEC-RAS<sup>1</sup> Version 5.0.7 model was used to estimate the water surface elevation (WSE) for the existing and proposed bridges. Both of the proposed bridges are shorter than the existing bridges, but due to the combination of higher soffit elevations and reduction

<sup>&</sup>lt;sup>1</sup> US Army Corps of Engineers Hydraulic Engineering Center River Analysis System which backwater hydraulic model designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels.

of piers in the channel, the water surface elevation at the upstream face of the proposed bridges decreased compared to the existing conditions.

This report follows the California Department of Transportation (Caltrans) Final Hydraulic Report Format and has been prepared in accordance with the Caltrans Local Assistance Program Guidelines (Caltrans 2020) and Memos to Designers 16-1<sup>2</sup>.

### GENERAL

This design hydraulic study has been prepared for the sole purpose of meeting the requirements of the Caltrans "Local Assistance Program Guidelines." Although potentially useful for other purposes, this analysis has not been prepared for any other purpose. Reuse of information contained in this report for purposes other than for which Avila and Associates Consulting Engineers, Inc. (Avila and Associates) intended and without their written authorization is not endorsed or encouraged and is at the sole risk of the entity reusing the information.

Avila and Associates was retained to complete the bridge hydrology, hydraulics, and scour analysis for the bridges. The following scope of work has been completed to develop this report.

- 1. Gather information and field review the bridge reach
- 2. Obtain design discharges
- 3. Develop a HEC-RAS model.
- 4. Estimate scour and provide Rock Slope Protection
- 5. Prepare Draft and Final Hydraulic Report
- 6. Complete Location Hydraulic Study and Summary Floodplain Encroachment Report
- 7. Coordinate with the Central Valley Flood Protection Board (CVFPB)

<sup>&</sup>lt;sup>2</sup> Caltrans Memo to Designers 16-1 December 2017 (http://www.dot.ca.gov/des/techpubs/manuals/bridge-memo-to-designer/page/section-16/MTD\_16-1-attach1.pdf)



The existing bridges are located approximately 21 miles southwest from the city of Fresno and 3 miles east of the city of San Joaquin in Fresno County, CA as shown in

Figure 1 and Figure 2. The existing bridges were constructed in 1957. The west bridge is a 6-span precast reinforced concrete inverted U-girder deck bridge supported by reinforced concrete abutments and reinforced concrete 5-column bents all on driven reinforced concrete filled tapered steel shell piles. The east bridge is identical to the west bridge but with only 3 spans. As of 2014, both bridges had a sufficiency rating of 62.2 and are structurally deficient. The County of Fresno proposes to replace the existing bridges with a new bridges crossing James Bypass using Highway Bridge Program (HBP) funding. The datum elevation used for this study is NGVD-29<sup>3</sup>.

<sup>&</sup>lt;sup>3</sup> Electronic Mail from Mark Meyer, PLS, Chief of Surveys, Construction Management Division, Fresno County Public Works, to Edmund Amobi, Design Division, Fresno County Public Works on August 13, 2015.



Figure 2. Detail of Project Vicinity

The proposed west branch bridge (west bridge) will be a 3-span precast prestressed voided slab bridge approximately 173 feet long. The proposed east branch bridge (east bridge) will be identical to the west bridge but with only a single span and approximately 65 feet long. Both will accommodate two travel lanes with two 8-ft 7-in wide shoulders as shown in



Figure 3, Figure 4, and in the attached General Plan (Appendix A).



Figure 3: Proposed west bridge profile view



Figure 4: Proposed east bridge profile view

### HYDROLOGY

The hydrology for the bridge replacements was provided by Steve Stadler, Assistant Manager at the James Irrigation District. According to Mr. Stadler:

Please use 4,750 cfs for the design flow rate of the James Bypass, which is also known as the Fresno Slough Bypass. The 4,750 cfs value can be assumed to be the 100-year number and I can discuss the basis for that assumption tomorrow. Please also evaluate the structure for 6,000 cfs. The floodway can over-perform the design value by a considerable margin and it is important to preserve that capability. Understand that at high flows, there is debris in the channel and the analysis should include an appropriate amount of debris loading.

The discharges used for design are shown in Table 3. The bridge was evaluated for 8,500 cfs to ensure the bridges could pass discharges larger than the design value when bulked with debris.

Table 3: Discharges used for design

	Design	Base
Frequency (Years)	100	
Discharge (Cubic feet per second)	4,750	8,500

Avila and Associates reviewed relevant bridge maintenance records for the two bridges being replaced on the James Bypass (Caltrans, 2014) to discern the typical impacts. The relevant information is summarized in Table 4.

	Manning Avenue (West)	Manning Avenue (East)
Bridge Number	42C0066	42C0067
Bridge Length (ft)	184	74
Span Lengths (ft)	6 @ 30	20/30/20
Bridge Type	6-span PC/RC inverted U-girder	3-span PC/RC inverted U-girder
	on RC abutments on driven piles.	on RC abutments on driven piles.
Debris Challenges	None noted.	None noted.
Cross Sections Available for	1972, 1993, 2005, 2009, 2011,	1972, 1993, 2005, 2011
	20144	
NBIS Item 113 (scour) code	3	5
ELI Flag 361 Condition State	3	1
Pier Type	RC pile extension	RC pile extension
Year Built	1957	1957
Year Widened	N/A	N/A

Table 4: Bridge information from nearby bridges on the reach

<sup>&</sup>lt;sup>4</sup> A channel cross section was taken during this inspection and is included with this report. The cross section was compared with the previous cross section taken on 12/21/2011. Other than the apparent error in the vertical dimension at both abutments in 2011, there have been no significant changes to the channel profile. The vertical dimension recorded in 2011 was 0.0 m, which would mean that the soil along the edge of the channel came up to the top of the outside of the bridge rail. Photos taken during that inspection do not show any material piled up against the bridge rail and flush with the top of the rail.

Scour Challenges	1972 <sup>5</sup> , 1974 <sup>6</sup> , 1976 <sup>7</sup> , 1982 <sup>8</sup> , 1984 <sup>9</sup> ,	1972 <sup>16</sup> , 1974 <sup>17</sup> , 1976 <sup>18</sup> , 1984 <sup>19</sup> ,
	$1997^{10}$ , $1999^{11}$ , $2001^{12}$ , $2010^{13}$ ,	1986 <sup>20</sup> , 1993 <sup>21</sup> , 1994 <sup>22</sup> , 1999 <sup>23</sup> ,
	2011 <sup>14</sup> , 2014 <sup>15</sup>	200124

<sup>16</sup> There is some erosion at Bent 2, but not serious.

<sup>17</sup> There is 1' to 2' of pile shell exposed at Bent #2 and the right side of Bent #3.

18 Same as 1974.

<sup>19</sup> There is a minor erosion in the embankment on the left side of Abutment 4.

<sup>20</sup> The pile shells are exposed 2 feet.

<sup>23</sup> Same as 1994.

<sup>24</sup> Same as 1999.

<sup>&</sup>lt;sup>5</sup> The bank at Abutment 1 is not protected and the right side of the abutment is being undermined. Erosion has also occurred at bents 3-6 but not serious enough to endanger the structure (1' to 3' of corrugated metal pipe shell is exposed). The left side of Abutment 7 is also undermined by erosion, the bottom of the footing being about 1' above the ground line.

<sup>&</sup>lt;sup>6</sup> Erosion continues at the right side of Abutment #1. The footing is eroded 1' below and 1' back under for a length of 4'. Bents #3, #4, and #5 have up to 3' of pile shell exposed and Bent #6 has 5' exposed.

<sup>&</sup>lt;sup>7</sup> There is up to 5' of metal pile shell exposed at Bents 3, 4 & 5, as previously reported.

<sup>&</sup>lt;sup>8</sup> The pile shells are exposed about 6' maximum at Bent 3 to 6. The channel continues to degrade.

<sup>&</sup>lt;sup>9</sup> The channel continues to degrade. The pile shells at Bent 5 are exposed up to 8 feet. The bottom of the diaphragm at Abutment 7 is exposed.

<sup>&</sup>lt;sup>10</sup> The bottom of the diaphragm is exposed over approximately half its length at Abutment 7, and most of the original embankment slope between Bent 6 and Abutment 7 is gone.

<sup>&</sup>lt;sup>11</sup> Abutment 1 is exposed and undermined for about 3m with a void that goes 500mm back and 200mm deep. At bent 6, three of the five piles have exposed steel shells.

<sup>12</sup> Same as 1999.

<sup>&</sup>lt;sup>13</sup> The result of a Structure Hydraulics Branch investigation in October 2009 is described, in part, as such: since construction of the bridge in 1957 there has been significant channel degradation and pile exposure. Additionally, there has been a chronic erosion problem at the abutments, with some undermining of the curtain walls. There is scour protection in Spans 3-6 consisting mostly of concrete rip-rap ranging from fist size up to 1/4 ton. The rip rap is distributed in a haphazard manner with uneven gradation and is mounded up under the bridge, creating a 0.6- to-0.9 m (2 to 3 ft) high obstruction in the channel bed in Spans 3-6. There is little to no scour protection in Spans 1 and 2, and the bank is eroded there. At Bent 2, the pile splice is exposed at column 4 and the corrugated steel pile shell is exposed 0.9 m (3 ft) at column 5. No other pile shells are exposed at this time.

<sup>&</sup>lt;sup>14</sup> There was channel work done to regrade the channel and embankment slopes under and beyond the bridge. There was an effort to rearrange the previously reported haphazard rip-rap placement that created obstructions in the channel bed. The concrete rip-rap was pushed along the bents and under Spans 1 and 2. The previously reported exposed pile shells along Bent 2 were covered.

 $<sup>^{15}</sup>$  Since construction of the bridge in 1957 there has been significant channel degradation and pile exposure. Additionally, there has been a chronic erosion problem at the abutments, with some undermining of the curtain walls. There is scour protection in Spans 3-6 consisting mostly of concrete rip-rap ranging from fist size up to 1/4 ton. Piles are the Raymond step-taper type with steel reinforcement extending 12 ft below the pile-to-column splice. The previously exposed pile shells at the bents have been encased in concrete. But, based on the original ground profile and on 2009 measurements of pile shell encasement heights and channel bed elevations, termination of the reinforcement is estimated to be at elevation 160 ft (+/-) at Bents 2 through 5 and 168 ft at Bent 6, whereas the elevation of the channel is currently 158ft (+/-), 2 feet below the reinforcement. Since calculated scour is below the reinforcement in the piles, all of the bents are potentially unstable.

<sup>&</sup>lt;sup>21</sup> No detrimental scour found, but pile cans exposed at Bents 2 and 3. The exposure ranges to nearly 2 feet for Pile No. 3 of Bent 2.

<sup>&</sup>lt;sup>22</sup> Piles 4 and 5 of Bent 3 and all piles of Bent 2 remain minimally exposed.

### HYDRAULICS

Hydraulic parameters (water surface elevations and velocity) were modeled with the U.S. Army Corps of Engineers HEC-RAS (Hydraulic Engineering Center River Analysis System) version 4.1.0 model<sup>25</sup>, based on: 1) cross-section survey data supplied by Fresno County on May 20, 2015, 2) LiDAR data provided by JID<sup>26</sup> received June 25, 2015, and 3) as-built data provided by CSEG. Cross-sections surveyed for the HEC-RAS model are shown on Figure 5.

The HEC-RAS model was constructed with separate reaches for the west and east branch of the James Bypass. The two reaches combine into one reach at a junction downstream from the bridges as shown in Figure 5. The east branch has hydraulic limitations due to the following:

- smaller channel section compared to the west branch
- an existing access road crosses the channel upstream from the bridge with an 80-inch diameter culvert as shown in Figure 6
- an existing access road crosses the channel downstream from the bridge with no culvert as shown in Figure 7



Figure 5: Plan view of HEC-RAS cross section (downstream sections based on LiDAR data not shown)

<sup>&</sup>lt;sup>25</sup> US Army Corps of Engineers Hydraulic Engineering Center River Analysis System which backwater hydraulic model designed to perform one-dimensional hydraulic calculations for a full network of natural and constructed channels.

<sup>&</sup>lt;sup>26</sup> LiDAR data from JID was in NAD 83, GRS 80, Transverse Mercator Coordinate System, Survey Feet and NAVD 88, feet. This data was first converted to NAD83, California State Plane, Zone 4 and NAVD88 feet and then converted to NGVD-29 (vertical conversion of -2.61 feet per VERTCON, National Geodetic Survey) by Avila and Associates.



Figure 6: East branch looking upstream at existing access road and culvert



Figure 7: East branch looking downstream at existing access road crossing channel



The access road upstream from the east bridge was modeled as a bridge with culvert as shown in Figure 8 and the access road downstream was modeled as an in-line weir structure as shown in Figure 9.

Figure 8: Profile of access road and culvert upstream from east bridge



Figure 9: Profile of existing access road crossing channel downstream from east bridge

The amount of flow that passes through the east bridge is governed by the three hydraulic limitations listed above. Lateral weir structures were modeled along the western edge of the east branch to allow flow in excess of the hydraulic capacity of the system to overtop and join flows in the west branch. The lateral weir structures are equivalent to the top of bank areas shown in Figure 6.

For the 100-yr discharge of 4,750 cfs provided by JID, the initial split of flow between the east and west branch was modeled as 1,000 cfs / 3,750 cfs (east / west). Similarly, for the >100-yr discharge of 8,500 cfs, the initial split modeled was 2,000 cfs / 6,500 cfs (east / west).

## Existing Conditions

Manning's n values of 0.03 for the channel and 0.035 to 0.045 for the overbanks were used in the model.

The starting water surface elevation was determined by examining the water surface elevation at station 6393 (approximately 1.7 miles downstream from the project) that resulted from various starting water surface elevations as shown in Figure 10. When the water surface elevation reaches the maximum levee elevation of 172.5 at station 6393, it will overtop the levee and utilize overland flow as shown in Figure 11.



Figure 10: Starting Water Surface Elevation



Figure 11: Cross Section at Station 6393

Proposed Bridge Model

The HEC-RAS model was re-run by replacing the existing bridges in the model with the proposed bridge alternatives. Profiles of the proposed bridges are shown in Figure 12 and Figure 13.



Figure 12: Profile of proposed bridge – West Branch (42C0066)



Figure 13: Profile of proposed bridge – East Branch (42C0067)

A downstream starting water surface elevation of 172-feet was utilized in each of the models. Each of the proposed bridges was input into the HEC-RAS model to determine the impact to the water surface elevation and velocity. As shown in Figure 14 through Figure 17, the water surface elevation upstream from the bridge for the 8,500 cfs and 4,750 cfs (100-year discharge) is decreased by each of the proposed bridges. The final distribution of flows between the west and east branch, as calculated by HEC-RAS, is shown in Table 5 for both the existing and proposed condition.

For the proposed condition, less flow is diverted from the east branch to the west branch due to the increased hydraulic capacity of the proposed east bridge. This results in a slightly higher water surface elevation profile downstream from the east bridge due to the geometry of the channel, but primarily due to the higher flow overtopping the existing access road downstream. The water surface elevation profile downstream from the west bridge is unchanged for the proposed condition.



Figure 14: Water surface elevation for existing and proposed for the West Branch



Figure 15: Water surface elevation for existing and proposed for the West Branch (zoomed in)



Figure 16: Water surface elevation for existing and proposed for the East Branch.



Figure 17: Water surface elevation for existing and proposed for the East Branch (goomed in).

Table 5: Calculated flow distributions

Discharge	Branch	Initial Split	Flow diverted from east branch to west branch	Final Distribution
		(cfs)	(cfs)	(cfs)
>100-yr	East	2,000	880	1,111
	West	6,500	007	7,389
	Total	8,500		8,500
100-yr	East	1,000	185	815
	West	3,750	105	3935
	Total	4,750		4,750

As Figure 14 through Figure 17 illustrate, and as shown by the data in Table 6 and Table 7, both of the proposed bridges will cause a decrease in water surface elevation upstream. Table 8 shows the resulting freeboard available at each of the bridges for both discharges.

	100-yr		>100-yr			
<b>River Station</b>	Exist	Proposed	Diff.	Exist	Proposed	Diff.
15114	173.1	173.1	0.0	175.2	175.2	0.0
15168	173.0	173.0	0.0	175.1	175.1	0.0
U/S Face of Bridge						
15230	173.2	173.1	-0.1	175.4	175.3	-0.1
15304	173.4	173.4	0.0	176.1	175.9	-0.2
15339	173.4	173.4	0.0	176.1	175.9	-0.2
15446	173.5	173.4	-0.1	176.1	176.0	-0.1

Table 6. Water Surface Elevation comparison existing vs. proposed for West Bridge

Table 7. Water Surface Elevation comparison existing vs. proposed for East Bridge

	100-yr				>100-yr	
<b>River Station</b>	Exist	Proposed	Diff.	Exist	Proposed	Diff.
15926	176.4	176.5	0.1	176.8	177.0	0.2
15963	176.3	176.4	0.1	176.7	176.8	0.1
U/S Face of Bridge						
16012	176.9	176.7	-0.2	177.6	177.3	-0.3
16065	177.0	176.9	-0.1	177.7	177.6	-0.1
16144	177.1	177.0	-0.1	177.8	177.7	-0.1
16207	177.2	177.0	-0.2	177.9	177.8	-0.1

Table 8. Resulting freeboard at West and East Bridge

		100-	-yr	> 10	0-yr
Bridge	Minimum Soffit Elevation	<b>WSE</b> (at upstream face)	Freeboard (ft)	<b>WSE</b> (at upstream face)	Freeboard (ft)
West					
Existing	180.6	173.2	7.4	175.4	5.2
Proposed	180.2	173.1	7.1	175.3	4.9
East					
Existing	180.2	176.9	3.3	177.6	2.6
Proposed	180.3	176.7	3.6	177.3	3.0

### HYDRAULIC CRITERIA

Chapter 820 of the Caltrans Highway Design Manual (HDM) delineates the hydraulic design criteria for bridges (Caltrans, 2020). The basic HDM rule for hydraulic design is that bridges should be designed to pass the  $Q_{50}$  with sufficient freeboard and convey the  $Q_{100}$  without freeboard. Exceptions may be granted if the bridge designer can provide sufficient evidence that less freeboard is needed. The HDM notes that 2 feet of freeboard is often assumed to be appropriate for preliminary bridge designs, but leaves the recommendation for freeboard to the judgment of the hydraulic engineer based primarily upon the debris anticipated at the bridge.

Since the minimum soffit elevation under proposed conditions is 180.2 feet for the west bridge and 180.3 feet for East Bridge, 7.1 feet of freeboard will be provided above the 100-year water surface elevation for the West Bridge and 3.6 feet for the east bridge which meets the HDM criteria.

The Central Valley Flood Protection Board (CVFPB), however, has jurisdiction over this river (California Code of Regulations Title 23, Article 8, Section 112) and requires 3 feet of freeboard on the 100-year discharge. The proposed bridges will meet this criterion so no variance will be required.

### DRIFT

Avila and Associates researched the available Bridge Maintenance Reports for the existing bridges to determine if floating debris catches on them. There were no instances of debris being caught on either of the bridges noted.

The proposed bridges will improve the hydraulics by providing more available flow area, due to the raised soffit elevations, and removal of existing piers from the channel which will also reduce the potential for drift accumulation.

### SCOUR

Avila and Associates reviewed the available channel cross-sections between 1972 and 2014. There has been a maximum of 2.5-ft of thalweg change at the west bridge between 1972 and 2009 as shown in Figure 18. There has been no significant change in thalweg elevation between 1972 and 2011 at the east bridge. The 1993 profile (red) that is plotted below appears to be either an anomaly or utilizing a different datum that was not correctly specified on the cross section form. Future degradation is therefore assumed to be minimal for the proposed bridge on the east side and up to 5-ft of degradation should be assumed for bridge design on the west side.



Figure 18: Cross sections taken at the West Branch (42C0066) bridge over time (from Caltrans Maintenance Reports)



Figure 19: Cross sections taken at the East Branch (42C0067) bridge over time (from Caltrans Maintenance Reports)

All scour calculations were completed following the methodology outlined in HEC-18 (Arneson, 2012).

#### **Contraction Scour**

The proposed West bridge does not greatly constrict the channel, however, some of the flow passing in the overbanks upstream passes through the main channel through the bridge reach resulting in approximately 3 feet of contraction scour. The East Bridge constricts the channel from approximately 58 feet upstream to approximately 53 feet through the bridge reach resulting in an estimated contraction scour of 4 feet.

#### Pier Scour

The proposed West Bridge is anticipated to have 4 ft diameter piers, resulting in an estimated 8 feet of local pier scour. The pier scour elevation should be determined from the channel thalweg of 156 ft for the West Bridge and 170 ft for the East Bridge.

#### Abutment Scour

Abutment scour was calculated using the equations from NCHRP 24-20 Condition A where the abutments are located near the main channel, resulting in 6 feet of estimated scour at the West Bridge and 10 ft of abutment scour at the East Bridge. These equations are inclusive of contraction scour, thus additional contraction scour should not be added.

#### **Total Scour**

According to the Foundation Reports (Kleinfleder, 2017 a and b), scour resistant material bedrock is not present at either the West nor the East bridge. The total scour depths and elevations for the West Bridge are provided in Table 9 and the scour summary table is provided in Table 10. The total scour depths and elevations for the East Bridge are provided in Table 11 and the scour summary table is provided in Table 12.

Support	A1	P2	P3	A4
Degradation Depth (ft)	5	5	5	5
Contraction Scour Depth (ft)	3	3	3	3
Pier Scour Depth (ft)	n/a	8	8	n/a
Abutment Scour Depth (ft)	6*	n/a	n/a	6*
Total Scour Depth (ft)	11	16	16	11
Total Scour Elevation (ft)	146	141	141	146
Elevation of Scour Resistant	none	none	none	none
Material (ft)	none	none	none	none
Scour Elevation with				
Geotechnical Considerations	146	141	141	146
(ft)				

Table 9. Total scour depths and elevations for the West Bridge assuming a thalweg elevation of 156 ft.

\*Abutment scour is inclusive of contraction scour.

Table 10. Scour Summary Table for the West Bridge

	Long Term & S	Short-Term Scour Depths	
Support No.	Degradation Scour Depth (ft)	Contraction Scour Depth (ft)	Short Term (Local) Scour Depth (ft)
A1	n/a	n/a	6
P2	5	3	8
P3	5	3	8
A4	n/a	n/a	6

Support	A1	A2
Degradation Depth (ft)	none	none
Contraction Scour Depth (ft)	4	4
Abutment Scour Depth (ft)	10*	10*
Total Scour Depth (ft)	10	10
Total Scour Elevation (ft)	160	160
Elevation of Scour Resistant Material (ft)	none	none
Scour Elevation with Geotechnical Considerations (ft)	160	160

Table 11. Total scour depths and elevations for the East Bridge assuming a thalweg elevation of 170 ft.

\*Abutment scour is inclusive of contraction scour.

Table 12. Scour Summary Table for the East Bridge

	Long Term & S	Short-Term Scour Depths	
Support No.	Degradation Scour Depth (ft)	Contraction Scour Depth (ft)	Short Term (Local) Scour Depth (ft)
A1	None	n/a	10
A2	none	n/a	10

See Appendix D for detailed scour calculations.

### SUMMARY TABLES

The following Hydrologic Summary Table is provided for your use for placement on the Foundation Plan:

# West Bridge:

Drainage Area:	n/a Square mile	es	
	Design	Base	Overtopping
Frequency (Years)	100	>100	>>100
Discharge (Cubic feet per second)	4,750	8,500	>8,500
Water Surface (Elevation at u/s face of Bridge)	173.1	175.3	~182.0
Flood plain data are based upon information avail to meet Federal requirements. The accuracy of and interested or affected parties should make th	lable when the p said information heir own investig	lans were prepa n is not warrant gation.	red and are shown ed by the County

## East Bridge:

Drainage Area:	n/a Square mile	es	
	Design	Base	Overtopping
Frequency (Years)	100	>100	>>100
Discharge (Cubic feet per second)	4,750	8,500	>8,500
Water Surface (Elevation at u/s face of Bridge)	176.7	177.3	~182.0
Flood plain data are based upon information avai to meet Federal requirements. The accuracy of	lable when the p said informatio	lans were prepa n is not warrant	red and are shown red by the County

and interested or affected parties should make their own investigation.

The following Scour Data Table is provided for placement on the West Bridge Foun	dation Plan,
assuming a thalweg elevation of 156 ft:	

Support No.	Long Term (Degradation and Contraction)	Short Term (Local) Scour
	Scour Elevation (ft)	Depth (ft)
A1	n/a	6
P2	148	8
P3	148	8
A4	n/a	6

The following Scour Data Table is provided for placement on the East Bridge Foundation Plan, assuming a thalweg elevation of 170 ft:

Support No.	Long Term (Degradation and Contraction) Scour Elevation (ft)	Short Term (Local) Scour Depth (ft)
A1	n/a	10
A2	n/a	10

### REFERENCES

- Arneson, L.A., Zevenbergen, L.W., Lagasse, P.F., Clopper, P.E., 2012, "Evaluating Scour at Bridges," Hydraulic Engineering Circular 18 Fifth Edition, FHWA NHI-01-001, Washington, D.C.
- California Department of Transportation (Caltrans). 2020. "Local Assistance Procedures Manual, Processing Procedures for Implementing Federal and/or State Funded local Public Transportation Projects." January.
- California Department of Transportation (Caltrans). 2020. "Highway Design Manual Chapter 820." March.
- California Department of Transportation (Caltrans). 2014. Maintenance Records and As-Built Plans for Bridges (Br #42C0066 and 42C0067).
- Kleinfelder, 2017a. "Foundation Report W Manning Avenue over James Bypass East Channel Bridge No. 42C0692 San Joaquin, Fresno County, California." August.
- Kleinfelder, 2017b. "Foundation Report W Manning Avenue over James Bypass West Channel Bridge No. 42C0691 San Joaquin, Fresno County, California." August.

APPENDIX A – GENERAL PLANS



West Bridge



East Bridge



#### Catherine M. C. Avila

From:	sstadler@jamesid.org
Sent:	Tuesday, June 16, 2015 5:12 PM
To:	Catherine M. C. Avila
Cc:	Neil Storey
Subject:	RE: data for James Bypass on Manning Avenue
Attachments:	Kings River Design Flows.pdf; Kings River Below Stinson Weir - 1968-69.pdf

#### Cathy and Neil -

Attached are some reference documents for your project. Please use 4,750 cfs for the design flow rate of the James Bypass, which is also known as the Fresno Slough Bypass. The 4,750 cfs value can be assumed to be the 100-year number and I can discuss the basis for that assumption tomorrow. Please also evaluate the structure for 6,000 cfs. The floodway can over-perform the design value by a considerable margin and it is important to preserve that capability. Understand that at high flows, there is debris in the channel and the analysis should include an appropriate amount of debris loading.

Regarding the LIDAR data, the entire dataset is 121 GB and includes imagery. I am not sure if it will upload in a reasonable time but will try tomorrow. I am not sure if the data set is thumb drive size.

#### Steven Stadler, P.E.

Assistant Manager James Irrigation District 8749 9<sup>th</sup> Street / P.O. Box 757 San Joaquin, California 93660 (559) 693-4356 x110 (phone) (559) 693-4357 (fax) (559) 554-4293 (mobile) <u>sstadler@jamesid.org</u>

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(Ħ)	(ff)	(ff)	(ff)	(ft/ft)	(ft/s)	(sq ft)	(Ħ)	
west branch	14097	8500 cfs WSE 172	Existing	7388.67	155.18	174.70		175.11	0.000319	5.30	1547.22	115.57	0.23
west branch	14097	8500 cfs WSE 172	Proposed Alt 1	7255.90	155.18	174.71		175.11	0.000307	5.20	1548.79	115.64	0.23
west branch	14097	100-year WSE 172	Existing	3935.36	155.18	172.88		173.03	0.000130	3.20	1345.65	106.25	0.15
west branch	14097	100-year WSE 172	Proposed Alt 1	3878.95	155.18	172.88		173.03	0.000126	3.16	1346.05	106.27	0.15
weet hranch	14196	READ of MISE 172	Evicting	7388.67	155 58	17469		17516	0.000418	5 75	1441 GG	115.01	0.07
wood broade	4 4406		Discond Alt 4	7066.00	100.00	00.4.14		476.46	0,000,00	1010	1440 66	146.07	14.0
west branch	14196	100-vear M/SE 172	Froposed Alt 1 Evicting	3035.36	155.58	172.87		173.05	0.000178	3.53	1730 30	10.011	0.17
wood brandt	1 1100	100 mm 100 112		000000	100.00	100 02 1		172.05	0.0000	0.00	1000 10	100.10	1.0
west branch	14196	100-year WSE 172	Proposed Alt 1	CE.8/85	86.661	1/2.88		1/3.05	0.0001 /3	3.48	1239.72	108.14	0.17
west branch	14301	8500 cfs WSE 172	Existing	7388.67	155.43	174.79		175.20	0.000299	5.26	1529.44	126.89	0.23
west branch	14301	8500 cfs WSE 172	Proposed Alt 1	7255.90	155.43	174.80		175.20	0.000288	5.16	1530.68	127.56	0.22
west branch	14301	100-year WSE 172	Existing	3935.36	155.43	172.92		173.07	0.000124	3.17	1324.63	102.01	0.14
west branch	14301	100-year WSE 172	Proposed Alt 1	3878.95	155.43	172.92		173.07	0.000120	3.13	1324.88	102.02	0.14
	1 1001	0100 - 51 1001 - 100				10111		111 00	0000000	LCL	or orus	01 101	000
west pranch	14394	8200 CIS VVSE 1/2	Existing	1300.01	17.001	1/4.64		57.C/L	0.000302	C7.C	N/9/6L	121.43	0.23
west branch	14394	8500 cfs WSE 172	Proposed Alt 1	7255.90	155.27	174.84		175.23	0.000291	5.15	1577.71	127.77	0.23
west branch	14394	100-year WSE 172	Existing	3935.36	155.27	172.94		173.08	0.000126	3.18	1365.30	105.77	0.15
west branch	14394	100-year WSE 172	Proposed Alt 1	3878.95	155.27	172.94		173.08	0.000122	3.13	1365.51	105.78	0.14
west branch	14500	8500 cfs WSE 172	Existing	7388.67	152.74	174.85		175.28	0.000308	5.49	1542.84	122.93	0.23
west branch	14500	8500 cfs WSE 172	Proposed Alt 1	7255.90	152.74	174.85		175.27	0.000297	5.39	1543.77	123.51	0.22
west branch	14500	100-year WSE 172	Existing	3935.36	152.74	172.94		173.10	0.000127	3.32	1340.09	103.68	0.15
west branch	14500	100-year WSE 172	Proposed Alt 1	3878.95	152.74	172.94		173.10	0.000123	3.28	1340.29	103.68	0.14
west branch	14589	8500 cfs WSE 172	Existing	7388.67	154.66	174.85		175.31	0.000353	5.60	1449.35	115.69	0.25
west branch	14589	8500 cfs WSE 172	Proposed Alt 1	7255.90	154.66	174.86		175.30	0.000340	5.49	1450.19	116.03	0.24
west branch	14589	100-year WSE 172	Existing	3935.36	154.66	172.94		173.12	0.000146	3.41	1252.87	99.26	0.16
west branch	14589	100-year WSE 172	Proposed Alt 1	3878.95	154.66	172.94		173.11	0.000142	3.36	1253.05	99.27	0.15
west branch	14694	8500 cfs WSE 172	Existing	7388.67	153.49	174.90		175.35	0.000374	5.66	1481.64	143.29	0.25
west branch	14694	8500 cfs WSE 172	Proposed Alt 1	7255.90	153.49	174.91		175.34	0.000361	5.56	1482.41	143.94	0.25
west branch	14694	100-year WSE 172	Existing	3935.36	153.49	172.96		173.13	0.000157	3.47	1274.46	100.67	0.16
west branch	14694	100-year WSE 172	Proposed Alt 1	3878.95	153.49	172.96		173.13	0.000152	3.42	1274.59	100.68	0.16
though house	1 4000	BEDD of MICE 170	Evicting	7300 67	154 24	176 10		175 40	V CODO V	07.40	1760.69	10 301	000
weet branch	1 1800	BEDD ofe MICE 170	Dronocod Alt 1	7766 00	15.4.24	17510		175.44	0.00016	144	1760 30	176.73	0.00
west branch	14890	100-vear M/SE 172	Evisting	3035 36	15.4.31	173.05		17316		277 0	1512 60	121 31	0.13
	4 4000	400 MIGT 470	A TIN PROVIDE	202000	10.101	10.00		170.40	100000 0	1010	1010	00 101	0.0
west branch	14030	100-year war 172	Proposed Alt 1	00/00	10.401	CD.C / I		01.011	180000	61.2	4C:21CI	00.121	0.13
west branch	14946	8500 cfs WSE 172	Existing	7388.67	154.94	175.11		175.45	0.000260	5.01	1788.81	156.00	0.22
west branch	14946	8500 cfs WSE 172	Proposed Alt 1	7255.90	154.94	175.10		175.44	0.000251	4.92	1788.42	155.99	0.21
west branch	14946	100-year WSE 172	Existing	3935.36	154.94	173.03		173.18	0.000125	3.17	1473.08	149.60	0.15
west branch	14946	100-year WSE 172	Proposed Alt 1	3878.95	154.94	173.03		173.17	0.000121	3.12	1472.94	149.60	0.15
west branch	15005	8500 cfs WSE 172	Existing	7388.67	155.35	175.00		175.52	0.000431	6.02	1401.21	152.22	0.27
west branch	15005	8500 cfs WSE 172	Proposed Alt 1	7255.90	155.35	175.00		175.51	0.000416	5.91	1401.44	152.25	0.27
west branch	15005	100-year WSE 172	Existing	3935.36	155.35	173.00		173.20	0.000200	3.74	1163.25	102.85	0.18

# APPENDIX C - HEC-RAS RESULTS

## West Branch

10		Ligit	Q lotal	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
U-yea	OLT LOUT		(cfs)	(ft)	(ff)	(ll)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
	ar WSE 172	Proposed Alt 1	38/8.95	155.35	1/3.00		1/3.20	0.000194	3.69	1163.26	102.85	0.18
8	fs WSE 172	Existing	7388.67	156.05	175.05		175.55	0.000491	6.18	1462.82	153.95	0.29
00	fs WSE 172	Proposed Alt 1	7255.90	156.05	175.05		175.53	0.000474	6.07	1462.75	153.95	0.28
5	ear WSE 172	Existing	3935.36	156.05	173.01		173.22	0.000241	3.90	1179.28	116.46	0.20
5	ear WSE 172	Proposed Alt 1	3878.95	156.05	173.01		173.21	0.000234	3.85	1179.24	116.46	0.20
8	cfs WSE 172	Existing	7388.67	156.45	175.19		175.59	0.000374	5.43	1626.62	159.61	0.25
18	cfs WSE 172	Proposed Alt 1	7255.90	156.45	175.19		175.57	0.000361	5.33	1625.67	159.59	0.25
6	year WSE 172	Existing	3935.36	156.45	173.07		173.23	0.000185	3.43	1323.60	118.84	0.17
Ó	-year WSE 172	Proposed Alt 1	3878.95	156.45	173.07		173.23	0.000180	3.39	1323.35	118.83	0.17
10	0 cfs WSE 172	Existing	7388.67	158.90	175.11		175.73	0.000626	6.68	1260.64	104.99	0.32
10	00 cfs WSE 172	Proposed Alt 1	7255.90	158.90	175.10		175.71	0.000604	6.61	1253.99	102.95	0.32
	D-year WSE 172	Existing	3935.36	158.90	173.04		173.29	0.000299	4.24	1049.73	99.72	0.22
	D-year WSE 172	Proposed Alt 1	3878.95	158.90	173.04		173.28	0.000289	4.19	1047.18	98.38	0.21
			Bridge									
117	O ofe MICE 170	Evicting	7388.67	158 84	175 30	168 07	176 JR	0.000876	7 76	1070.68	QA 17	0.38
110	00 cfs WSF 172	Proposed Alt 1	7255.90	158.84	175.29	168.82	17613	0.000862	7.66	1066.09	94.61	0.37
	D-vear WSE 172	Existina	3935.36	158.84	173.15	166.14	173.52	0.000449	5.04	865.94	88.05	0.27
0	D-year WSE 172	Proposed Alt 1	3878.95	158.84	173.10	166.11	173.46	0.000440	4.98	865.75	88.54	0.26
	8											
١Ω	00 cfs WSE 172	Existing	7388.67	156.40	176.07		176.34	0.000205	4.44	1951.42	158.01	0.19
S	00 cfs WSE 172	Proposed Alt 1	7255.90	156.40	175.94		176.21	0.000203	4.40	1931.82	157.76	0.19
2	D-year WSE 172	Existing	3935.36	156.40	173.43		173.55	0.000110	2.90	1545.23	151.70	0.14
0	)-year WSE 172	Proposed Alt 1	3878.95	156.40	173.38		173.50	0.000109	2.87	1537.10	151.54	0.14
10	00 cfs WSE 172	Existing	7388.67	156.87	176.07		176.35	0.000225	4.66	1977.36	173.40	0.20
5	00 cfs WSE 172	Proposed Alt 1	7255.90	156.87	175.94		176.22	0.000223	4.62	1955.75	173.26	0.20
0	D-year WSE 172	Existing	3935.36	156.87	173.43		173.56	0.000129	3.14	1523.77	170.30	0.15
0	D-year WSE 172	Proposed Alt 1	3878.95	156.87	173.37		173.51	0.000127	3.11	1514.63	170.19	0.15
10	00 cfs WSE 172	Existing	7388.67	157.22	176.10		176.38	0.000204	4.34	1916.20	163.07	0.19
5	00 cfs WSE 172	Proposed Alt 1	7255.90	157.22	175.98		176.25	0.000202	4.30	1895.97	162.87	0.19
0	D-year WSE 172	Existing	3935.36	157.22	173.46		173.58	0.000105	2.82	1514.76	123.07	0.13
	)-year WSE 172	Proposed Alt 1	3878.95	157.22	173.41		173.52	0.000103	2.79	1508.14	122.82	0.13
10	00 cfs WSE 172	Existing	7388.67	156 73	17614		176.40	0.000191	4 29	1993 70	176.10	0.19
10	00 cfs WSE 172	Proposed Alt 1	7255.90	156.73	176.01		176.27	0.000190	4.25	1971.70	175.90	0.19
0	D-year WSE 172	Existing	3935.36	156.73	173.48		173.59	0.000102	2.80	1562.74	132.79	0.13
	D-year WSE 172	Proposed Alt 1	3878.95	156.73	173.42		173.53	0.000100	2.77	1555.55	132.65	0.13
		:										
101	00 cfs WSE 172	Existing	7388.67	156.97	176.11		176.44	0.000295	4.92	1776.55	168.73	0.23
S I	00 cfs WSE 172	Proposed Alt 1	7255.90	156.97	175.98		176.31	0.000294	4.88	1755.50	168.54	0.22
0	D-year WSE 172	Existing	3935.36	156.97	173.46		173.61	0.000172	3.30	1349.32	129.71	0.17

HEC-RAS RIVI	er: James Bypa	ass Reach: west branc	ch (Continued)										
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ff)	(ft)	(ft/ft)	(ft/s)	(ad ft)	(ft)	
west branch	15746	8500 cfs WSE 172	Existing	7388.67	157.19	176.14		176.47	0.000310	4.82	1758.87	177.75	0.23
west branch	15746	8500 cfs WSE 172	Proposed Alt 1	7255.90	157.19	176.02		176.34	0.000309	4.78	1736.62	177.51	0.23
west branch	15746	100-year WSE 172	Existing	3935.36	157.19	173.48		173.63	0.000182	3.24	1332.44	131.06	0.17
west branch	15746	100-year WSE 172	Proposed Alt 1	3878.95	157.19	173.42		173.57	0.000180	3.21	1325.34	130.90	0.17
west branch	15843	8500 cfs WSE 172	Existing	7388.67	156.81	176.22		176.50	0.000225	4.61	1953.27	169.17	0.20
west branch	15843	8500 cfs WSE 172	Proposed Alt 1	7255.90	156.81	176.09		176.37	0.000223	4.57	1932.11	168.83	0.20
west branch	15843	100-year WSE 172	Existing	3935.36	156.81	173.52		173.65	0.000126	3.05	1505.41	150.20	0.15
west branch	15843	100-year WSE 172	Proposed Alt 1	3878.95	156.81	173.46		173.59	0.000124	3.02	1497.23	148.68	0.15
west branch	15944	8500 cfs WSE 172	Existing	7388.67	155.95	176.22		176.54	0.000266	4.75	1774.86	154.44	0.21
west branch	15944	8500 cfs WSE 172	Proposed Alt 1	7255.90	155.95	176.09		176.41	0.000264	4.71	1755.63	153.88	0.21
west branch	15944	100-year WSE 172	Existing	3935.36	155.95	173.52		173.67	0.000144	3.13	1386.53	122.12	0.15
west branch	15944	100-year WSE 172	Proposed Alt 1	3878.95	155.95	173.47		173.61	0.000142	3.10	1379.84	121.88	0.15
west branch	16041	8500 cfs WSE 172	Existing	7388.67	154.95	176.22		176.57	0.000276	4.98	1709.79	148.91	0.22
west branch	16041	8500 cfs WSE 172	Proposed Alt 1	7255.90	154.95	176.10		176.44	0.000273	4.93	1691.29	148.37	0.22
west branch	16041	100-year WSE 172	Existing	3935.36	154.95	173.53		173.68	0.000146	3.24	1344.27	112.41	0.16
west branch	16041	100-year WSE 172	Proposed Alt 1	3878.95	154.95	173.48		173.62	0.000144	3.21	1338.10	112.24	0.16
west branch	16145	8500 cfs WSE 172	Existing	6500.00	155.96	176.24		176.61	0.000282	5.06	1492.92	144.39	0.22
west branch	16145	8500 cfs WSE 172	Proposed Alt 1	6500.00	155.96	176.11		176.48	0.000291	5.11	1473.60	144.08	0.23
west branch	16145	100-year WSE 172	Existing	3750.00	155.96	173.53		173.71	0.000169	3.55	1175.51	94.30	0.17
west branch	16145	100-year WSE 172	Proposed Alt 1	3750.00	155.96	173.47		173.65	0.000172	3.57	1170.03	94.15	0.17

Image         Image <th< th=""><th>Reach</th><th>River Sta</th><th>Profile</th><th>Plan</th><th>Q Total</th><th>Min Ch El</th><th>W.S. Elev</th><th>Crit W.S.</th><th>E.G. Elev</th><th>E.G. Slope</th><th>Vel Chnl</th><th>Flow Area</th><th>Top Width</th><th>Froude # Chl</th></th<>	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
eest branch         1471         8500 da WEE 172         Exating         113410         17510         17510           eest branch         14871         100-year WEE 172         Exating         113410         173410         173410         173410           eest branch         14871         100-year WEE 172         Exating         113410         173410         173410         173410           eest branch         15143         100-year WEE 172         Evaleng         11133         167.57         17540         17341           eest branch         15143         100-year WEE 172         Evaleng         11133         167.57         17340         17342           eest branch         15143         100-year WEE 172         Evaleng         11133         169.61         17346         17347           eest branch         15343         100-year WEE 172         Evaleng         11133         169.61         17346         17347           eest branch         15345         100-year WEE 172         Evaleng         111413         11341         11341         11341           eest branch         15546         100-year WEE 172         Evaleng         111413         11441         11341         11341           eest branch         15556<					(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
east branch         (447)         (500 ds WGE 172         Proposed Mt1         (17.3)           east branch         (487)         (10.9ert WGE 172         Existry         (17.3)         (17.3)           east branch         (471)         (10.9ert WGE 172         Existry         (17.3)         (17.3)           east branch         (51.4)         (500 ds WE 172         Existry         (17.3)         (17.3)           east branch         (51.4)         (500 ds WE 172         Existry         (17.3)         (17.3)           east branch         (51.4)         (500 ds WE 172         Existry         (11.1.3)         (17.5)         (17.5)           east branch         (55.4)         (10.9ert WE 172         Existry         (11.1.3)         (17.5)         (17.5)           east branch         (55.6)         (10.9ert WE 172         Existry         (11.1.3)         (17.5)         (17.5)           east branch         (55.6)         (10.9ert WE 172         Existry         (11.1.3)         (17.5)         (17.5)           east branch         (55.6)         (10.9ert WE 172         Existry         (11.1.3)         (17.5)         (17.5)           east branch         (55.6)         (10.9ert WE 172         Existry         (11.1.3) <td< td=""><td>st branch</td><td>14871</td><td>8500 cfs WSE 172</td><td>Existing</td><td>1111.33</td><td>167.04</td><td>175.19</td><td></td><td>175.19</td><td>0.00000</td><td>0.56</td><td>2181.39</td><td>490.44</td><td>0.04</td></td<>	st branch	14871	8500 cfs WSE 172	Existing	1111.33	167.04	175.19		175.19	0.00000	0.56	2181.39	490.44	0.04
east branch         14371         100-year WSE 172         Example         151.13         175.14         175.14         175.14           east branch         154.13         100-year WSE 172         Proposed Att         171.13         175.15         175.16         175.16           east branch         151.43         1600-year WSE 172         Proposed Att         171.13         175.16         175.16         175.16           east branch         151.43         100-year WSE 172         Proposed Att         171.13         165.17         175.16         175.36           east branch         151.43         100-year WSE 172         Proposed Att         171.13         166.01         175.16         175.36           east branch         155.36         100-year WSE 172         Proposed Att         171.13         166.01         175.41         175.41           east branch         155.36         100-year WSE 172         Proposed Att         171.13         166.01         175.41         175.41           east branch         155.36         100-year WSE 172         Proposed Att         171.13         166.01         175.41         175.41           east branch         155.36         100-year WSE 172         Proposed Att         171.13         166.01         175.41<	st branch	14871	8500 cfs WSE 172	Proposed Alt 1	1244.10	167.04	175.19		175.20	0.000011	0.63	2183.79	490.46	0.04
east branch         1471         100-year WSE 172         Propreed M11         871 05         175 12         173 12           east branch         151 43         800 c6 WSE 172         Ending         111 1.33         167 57         173 16         173 16           east branch         151 43         800 c6 WSE 172         Ending         111 1.33         167 57         173 06         173 16           east branch         151 43         000-year WSE 172         Ending         111 1.33         168 01         175 16         173 17           east branch         15259         8600 c6 WSE 172         Ending         111 1.33         168 01         175 16         175 28           east branch         15269         8600 c6 WSE 172         Ending         111 1.33         168 01         175 16         175 28           east branch         15360         00-year WSE 172         Ending         111 1.33         168 01         175 16         175 36           east branch         15360         000-year WSE 172         Ending         111 1.33         168 01         175 16         175 36           east branch         15560         000-year WSE 172         Ending         111 1.33         168 06         175 48         174 48           east	st branch	14871	100-year WSE 172	Existing	814.64	167.04	173.11		173.12	0.000015	0.59	1387.75	325.29	0.05
est branch         15143         6500 ch WSE 172         Existing         111133         167 57         175 16         175 15           est branch         15143         100-year WSE 172         Existing         817 16         175 17         173 16           est branch         15143         100-year WSE 172         Existing         817 16         175 17         173 16           est branch         15143         100-year WSE 172         Existing         817 16         173 15         173 16         173 15           est branch         15256         800 ch WSE 172         Existing         814 44         168 01         173 36         173 36         174 36           est branch         15256         800 ch WSE 172         Proposed Att         124 410         168 01         173 36         173 36         174 36           est branch         15366         800 ch WSE 172         Proposed Att         124 410         168 01         173 36         174 36         174 36           est branch         15366         800 ch WSE 172         Proposed Att         124 410         168 01         173 36         173 36         174 36         174 36         174 36         174 36         174 36         174 36         174 36         174 36         174 36	st branch	14871	100-year WSE 172	Proposed Alt 1	871.05	167.04	173.12		173.12	0.000018	0.64	1388.49	325.59	0.05
Beart branch         15143         660 c6 WGE 172         Fixing         1175.17         175.16         175.27           eest branch         15143         600 c6 WGE 172         Existing         1114.130         167.57         173.06         173.17           eest branch         15143         000-year WGE 172         Existing         814.64         167.57         173.07         173.07           eest branch         15256         6500 c6 WGE 172         Existing         814.64         167.57         173.07         173.05           eest branch         15256         100-year WGE 172         Existing         814.64         167.07         173.67         173.97         173.67           eest branch         15366         6500 c6 WGE 172         Existing         814.64         167.05         173.97         174.67         175.64           eest branch         15366         6500 c6 WGE 172         Existing         811.64         173.07         173.97         174.64           eest branch         15366         100-year WGE 172         Existing         871.06         173.67         174.66           eest branch         15366         100-year WGE 172         Existing         871.06         174.66         174.66         174.66 <t< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>														
Nick         Biologe         Nick         Biologe         Nick	st branch	15143	8500 cfs WSE 172	Existing	1111.33	167.57	175.18		175.20	0.000091	1.31	1088.57	351.89	0.11
east branch         (51.43)         (100-year WSE 172)         Existing         (61.75)         (73.06)         (73.15)           east branch         (57.33)         (50.45)         (70.36)         (67.77)         (73.07)         (73.07)           east branch         (52.39)         8500 ds WSE 172         Proposed Att         (111.13)         (68.01)         (73.51)         (73.07)         (73.07)           east branch         (52.39)         8500 ds WSE 172         Proposed Att         (111.13)         (68.01)         (73.97)         (73.97)         (73.65)           east branch         (52.39)         (00-year WSE 172         Proposed Att         (74.44)         (68.01)         (73.97)         (73.67)         (73.67)           east branch         (53.36)         8500 ds WSE 172         Proposed Att         (74.44)         (68.66)         (74.75)         (73.67)         (73.67)         (73.67)           east branch         (55.56)         8500 ds WSE 172         Proposed Att         (74.41)         (68.66)         (74.76)         (75.67)         (73.66)         (74.76)           east branch         (5551         8500 ds WSE 172         Proposed Att         (24.41)         (68.66)         (75.66)         (77.56)         (75.67) <t< td=""><td>st branch</td><td>15143</td><td>8500 cfs WSE 172</td><td>Proposed Alt 1</td><td>1244.10</td><td>167.57</td><td>175.18</td><td></td><td>175.21</td><td>0.000114</td><td>1.46</td><td>1089.83</td><td>351.93</td><td>0.12</td></t<>	st branch	15143	8500 cfs WSE 172	Proposed Alt 1	1244.10	167.57	175.18		175.21	0.000114	1.46	1089.83	351.93	0.12
east branch         [51-30]         100/year WGE 17.2         Proposed At1         97.105         17.3.10         17.3.10           east branch         152-39         8600 c6 WGE 17.2         Existing         1111.1.33         168.01         17.5.15         17.5.23           east branch         152-39         8600 c6 WGE 17.2         Existing         1111.1.33         168.01         17.5.36         17.5.36           east branch         152-36         8500 c6 WGE 172         Existing         1111.1.33         168.60         17.5.36         17.5.36           east branch         153-36         100/year WGE 172         Proposed At1         12.44.10         168.61         17.5.37         17.3.47           east branch         153-36         100/year WGE 172         Proposed At1         12.44.10         168.66         17.5.32           east branch         155-51         100/year WGE 172         Proposed At1         12.44.10         168.66         17.4.53           east branch         15551         100/year WGE 172         Proposed At1         12.44.10         168.66         17.4.53           east branch         15551         100/year WGE 172         Proposed At1         12.44.10         168.66         17.4.56           east branch         15551<	st branch	15143	100-year WSE 172	Existing	814.64	167.57	173.08		173.15	0.000603	2.34	408.32	241.40	0.25
east branch         1529         5500 cls WSE 172         Existing         1111.33         166.01         175.14         175.295         173.957         173.957         173.957         173.957         173.957         173.957         173.957         173.957         173.957         173.957         173.957         173.956	st branch	15143	100-year WSE 172	Proposed Alt 1	871.05	167.57	173.07		173.16	0.000692	2.51	407.51	241.05	0.27
east branch         15:259         660 or SWSE 172         Existing         1111.13         166 01         175.16         175.17           east branch         15:259         100-year WSE 172         Existing         814.64         166 01         175.41         175.34         175.34           east branch         15:259         100-year WSE 172         Existing         814.64         166 01         175.41         175.34           east branch         15:366         100-year WSE 172         Existing         814.64         166 01         175.36         174.76           east branch         15:366         100-year WSE 172         Existing         814.64         166 05         175.36         174.76           east branch         15:366         100-year WSE 172         Existing         814.64         166 06         175.36         174.76           east branch         15:551         800 of wSE 172         Existing         814.64         166 08         174.76         174.76           east branch         15:551         800 of wSE 172         Existing         814.64         166 08         174.86         174.76           east branch         15:551         800 of wSE 172         Existing         814.64         106.94         175.76														
east branch         12259         B600 cls MUE 172         Proposed Alt         124.410         166.01         173.35         173.35         173.35           east branch         152.56         100-year WUE 172         Proposed Alt         81.44.41         166.01         173.35         173.35         173.35           east branch         152.56         100-year WUE 172         Proposed Alt         12.44.10         166.01         173.35         173.35           east branch         153.66         500 cls WUE 172         Evising         811.46         166.06         173.57         173.45           east branch         153.66         100-year WUE 172         Evising         811.46         166.68         175.45         174.46           east branch         155.61         100-year WUE 172         Evising         811.46         166.68         175.45         175.61           east branch         155.61         100-year WUE 172         Evising         811.44         166.68         175.61         175.61           east branch         155.61         100-year WUE 172         Evising         811.44         166.68         175.61         175.61           east branch         155.61         100-year WE 172         Evising         811.44         166.68	st branch	15259	8500 cfs WSE 172	Existing	1111.33	168.01	175.15		175.25	0.001263	4.01	475.36	266.73	0.31
Bit March         15259         100-year WSE 172         Existing         91464         168.01         173.95         173.95         173.95           east branch         15556         100-year WSE 172         Proposed Att         871.05         168.08         175.39         173.97           east branch         15556         100-year WSE 172         Proposed Att         871.05         168.08         175.39         173.47           east branch         15556         100-year WSE 172         Proposed Att         871.05         168.08         173.47         173.97         173.47           east branch         15551         8500 c6 WSE 172         Proposed Att         1111.33         169.46         175.39         177.56           east branch         15551         100-year WSE 172         Proposed Att         124.410         169.46         175.67         177.56           east branch         15551         100-year WSE 172         Proposed Att         124.410         169.46         175.67         175.67           east branch         15555         100-year WSE 172         Proposed Att         171.133         168.68         175.64         175.75           east branch         15565         100-year WSE 172         Proposed Att         171.16	st branch	15259	8500 cfs WSE 172	Proposed Alt 1	1244.10	168.01	175.14		175.28	0.001597	4.51	473.92	266.54	0.35
east branch         173.56         100-year WSE 172         Proposed Att 1         871.05         168.68         175.32         173.97         173.97           east branch         15396         8600 c6 WSE 172         Exsting         1111.133         168.68         175.32         175.43           east branch         15396         8600 c6 WSE 172         Proposed Att 1         244.10         168.68         175.43           east branch         15556         100-year WSE 172         Proposed Att 1         871.05         169.46         175.43           east branch         15551         100-year WSE 172         Proposed Att 1         871.05         169.46         175.46         175.17           east branch         15551         100-year WSE 172         Proposed Att 1         1111.33         169.46         175.61         175.16           east branch         15555         100-year WSE 172         Proposed Att 1         124.410         168.68         175.61         175.61           east branch         15565         8500 c6 WSE 172         Proposed Att 1         124.410         168.68         175.61         175.61           east branch         15565         100-year WSE 172         Proposed Att 1         124.410         168.68         175.61	st branch	15259	100-year WSE 172	Existing	814.64	168.01	173.95	173.95	174.43	0.006750	7.79	189.95	183.09	0.69
east branch         1536         6500 cfs WSE 172         Existing         111.13         168 66         175.22         175.46           east branch         1536         100-year WSE 172         Proposed Alt 1         244.10         168 68         175.32         173.63           east branch         1536         100-year WSE 172         Proposed Alt 1         871.05         168 68         173.76         173.64           east branch         15551         5500 cfs WSE 172         Proposed Alt 1         871.05         169.46         173.69         173.76           east branch         15551         100-year WSE 172         Proposed Alt 1         871.05         169.46         173.69         175.71           east branch         15565         5500 cfs WSE 172         Proposed Alt 1         871.05         169.46         173.69         175.71           east branch         15565         5500 cfs WSE 172         Proposed Alt 1         244.10         168.68         175.76         175.61           east branch         15565         5500 cfs WSE 172         Proposed Alt 1         244.10         168.68         175.76         175.61           east branch         15565         5500 cfs WSE 172         Proposed Alt 1         244.10         168.68         17	st branch	15259	100-year WSE 172	Proposed Alt 1	871.05	168.01	173.97	173.97	174.50	0.007355	8.16	194.32	186.13	0.72
east branch         1536         6800 cis WSE 172         Existing         111.133         168.68         175.23         175.47           east branch         15396         5000 cis WSE 172         Proposed Alt 1         814.64         168.68         174.76         174.86           east branch         15396         100-year WSE 172         Proposed Alt 1         814.64         168.68         175.32         175.66           east branch         15551         8500 cis WSE 172         Proposed Alt 1         244.10         169.46         175.61         177.61           east branch         15551         8500 cis WSE 172         Proposed Alt 1         1244.10         169.46         175.61         175.61           east branch         15565         8500 cis WSE 172         Proposed Alt 1         871.05         169.46         175.61         175.61           east branch         15565         8500 cis WSE 172         Proposed Alt 1         871.05         169.46         175.61         175.61           east branch         15565         100-year WSE 172         Proposed Alt 1         871.05         169.46         175.61         175.61           east branch         15567         100-year WSE 172         Existing         871.05         169.46         175.														
east branch         15366         B500 cts WSE 172         Proposed Alt 1         124,10         166.68         175,22         175,42           east branch         15366         100-year WSE 172         Existing         811,64         168.68         174,67         174.87           east branch         15551         8500 cts WSE 172         Existing         811,64         168.68         177,53         174.87           east branch         15551         100-year WSE 172         Proposed Alt 1         871,05         168.68         177,53         175.17           east branch         15551         100-year WSE 172         Proposed Alt 1         871,05         168.68         175.17           east branch         15556         8500 cts WSE 172         Proposed Alt 1         124,410         168.68         175.16           east branch         15556         8500 cts WSE 172         Proposed Alt 1         124,410         168.68         175.16           east branch         15565         100-year WSE 172         Proposed Alt 1         124,410         168.68         175.16         175.17           east branch         15565         100-year WSE 172         Proposed Alt 1         111.1.33         166.68         175.16         175.16           east	st branch	15396	8500 cfs WSE 172	Existing	1111.33	168.68	175.29		175.43	0.001144	4.08	408.44	176.00	0.32
east branch         15366         100-year WSE 172         Existing         81.464         166.68         174.86         174.86           east branch         15551         8500 cls WSE 172         Proposed Alt 1         871.05         169.46         175.39         175.57           east branch         15551         8500 cls WSE 172         Proposed Alt 1         12.44.10         169.46         175.56         175.57           east branch         15551         100-year WSE 172         Proposed Alt 1         12.44.10         169.46         175.56         175.57           east branch         15557         100-yaar WSE 172         Proposed Alt 1         12.44.10         168.68         175.56         175.57           east branch         15556         100-yaar WSE 172         Proposed Alt 1         12.44.10         168.68         175.56         175.57           east branch         15567         100-yaar WSE 172         Proposed Alt 1         12.44.10         168.68         175.56         175.57           east branch         15567         100-yaar WSE 172         Proposed Alt 1         12.44.10         166.68         175.56         175.56           east branch         15567         100-yaar WSE 172         Proposed Alt 1         174.46         175.56	st branch	15396	8500 cfs WSE 172	Proposed Alt 1	1244.10	168.68	175.32		175.49	0.001382	4.50	414.06	176.50	0.36
action         1336         100-year WSE 172         Proposed All 1         871.05         168.06         175.33         175.67           action         15551         8500 cfs WSE 172         Existing         1111.33         169.46         175.45         175.17           action         15551         8500 cfs WSE 172         Existing         814.64         169.46         175.45         175.17           action         15551         100-year WSE 172         Existing         814.64         169.46         175.61         175.61           action         15565         8500 cfs WSE 172         Existing         814.64         168.68         175.61         175.65           action         15565         100-year WSE 172         Existing         814.64         168.68         175.70         175.16           action         15565         100-year WSE 172         Existing         814.64         168.68         175.65         175.65           action         15565         100-year WSE 172         Proposed All 1         871.05         166.81         175.65         175.16           action         15507         100-year WSE 172         Proposed All 1         871.05         175.65         175.16           actisting         814.	st branch	15396	100-year WSE 172	Existing	814.64	168.68	174.68		174.82	0.001332	4.04	304.16	166.35	0.34
ast branch         1551         6500 ds WSE 172         Existing         111.33         169.46         175.45         175.17           east branch         15551         100-year WSE 172         Proposed Alt         12.44.10         169.46         175.45         175.17           east branch         15551         100-year WSE 172         Proposed Alt         81.4.64         169.46         175.45         175.17           east branch         15551         100-year WSE 172         Proposed Alt         81.4.64         169.46         175.16         175.17           east branch         15565         100-year WSE 172         Proposed Alt         81.4.64         168.68         175.16         175.16           east branch         15565         100-year WSE 172         Proposed Alt         81.4.64         168.68         175.16         175.17           east branch         15565         100-year WSE 172         Proposed Alt         81.4.64         168.68         175.16         175.17           east branch         15597         6500 cis WSE 172         Proposed Alt         81.4.64         166.81         175.16         175.16           east branch         15597         6500 cis WSE 172         Proposed Alt         81.4.64         166.81         175.16 <td>st branch</td> <td>15396</td> <td>100-year WSE 172</td> <td>Proposed Alt 1</td> <td>871.05</td> <td>168.68</td> <td>174.76</td> <td></td> <td>174.91</td> <td>0.001366</td> <td>4.14</td> <td>317.53</td> <td>167.61</td> <td>0.35</td>	st branch	15396	100-year WSE 172	Proposed Alt 1	871.05	168.68	174.76		174.91	0.001366	4.14	317.53	167.61	0.35
east branch         15551         8500 ck WSE 172         Existing         1111.33         169.46         175.45         175.17           east branch         15551         100-year WSE 172         Proposed Alt 1         71.44.10         169.46         175.45         175.16           east branch         15551         100-year WSE 172         Proposed Alt 1         871.05         169.46         175.16         175.16           east branch         15565         100-year WSE 172         Existing         111.133         168.68         175.16         175.16           east branch         15565         100-year WSE 172         Proposed Alt 1         871.05         168.68         175.16         175.16           east branch         15565         100-year WSE 172         Proposed Alt 1         871.05         168.68         175.16         175.12           east branch         15567         100-year WSE 172         Proposed Alt 1         871.05         175.17         175.12           east branch         15597         100-year WSE 172         Proposed Alt 1         871.05         175.16         175.17           east branch         15597         100-year WSE 172         Proposed Alt 1         871.05         175.16         175.12           east br														
east branch         1551         8500 cls WSE 172         Evising         814.44.10         169.46         174.81         175.07           east branch         15551         100-year WSE 172         Evising         814.64         169.46         174.81         175.07           east branch         15551         100-year WSE 172         Evising         814.64         169.46         174.81         175.61           east branch         15565         8500 cls WSE 172         Evising         814.64         168.68         175.61         175.63           east branch         15565         8500 cls WSE 172         Evising         814.64         168.68         175.16         175.66           east branch         15567         100-year WSE 172         Evising         814.64         168.68         175.16         175.76           east branch         15597         8500 cls WSE 172         Proposed Alt 1         871.05         168.81         175.16         175.76           east branch         15597         8500 cls WSE 172         Proposed Alt 1         814.64         166.81         175.16         175.76           east branch         15597         100-year WSE 172         Proposed Alt 1         814.64         166.81         175.17	st branch	15551	8500 cfs WSE 172	Existing	1111.33	169.46	175.39		175.67	0.001420	5.34	323.20	130.57	0.42
east branch         1551         100-year WSE 172         Existing         811.05         169.46         174.89         175.10           east branch         15555         100-year WSE 172         Proposed Alt 1         871.05         169.46         175.61         175.16           east branch         15555         8500 cfs WSE 172         Existing         1111.33         165.68         175.16         175.66           east branch         15565         100-year WSE 172         Existing         814.84         168.68         175.14         175.65           east branch         15565         100-year WSE 172         Proposed Alt 1         124.410         168.68         175.14         175.65           east branch         15597         8500 cfs WSE 172         Proposed Alt 1         124.410         166.81         175.65         175.61           east branch         15597         8500 cfs WSE 172         Proposed Alt 1         124.410         166.81         175.61         175.61           east branch         15597         100-year WSE 172         Proposed Alt 1         124.410         166.81         175.61         175.61           east branch         15597         100-year WSE 172         Proposed Alt 1         124.410         167.60         175.62	st branch	15551	8500 cfs WSE 172	Proposed Alt 1	1244.10	169.46	175.45		175.77	0.001677	5.84	330.31	131.14	0.46
east branch         1551         100-year WSE 172         Proposed Alt 1         871.05         168.68         175.61         175.66           east branch         15565         8500 c6s WSE 172         Existing         111.13         168.68         175.77         175.17           east branch         15565         100-year WSE 172         Existing         814.44         168.68         175.77         175.17           east branch         15565         100-year WSE 172         Existing         814.44         168.68         175.15         175.15           east branch         15567         100-year WSE 172         Proposed Alt 1         871.05         168.68         175.15         175.15           east branch         15597         8500 c5s WSE 172         Proposed Alt 1         871.05         166.81         175.75         175.17           east branch         15597         8500 c5s WSE 172         Proposed Alt 1         871.05         166.81         175.16         175.17           east branch         15597         8500 c5s WSE 172         Proposed Alt 1         871.05         166.81         175.16         175.16           east branch         15707         100-year WSE 172         Proposed Alt 1         174.410         167.66         175.16	st branch	15551	100-year WSE 172	Existing	814.64	169.46	174.81		175.08	0.001518	5.08	249.23	124.44	0.42
at branch         15565         8500 cfs WSE 172         Existing         1111.33         168.68         175.61         175.66           east branch         15565         8500 cfs WSE 172         Existing         1244.10         168.68         175.70         175.05           east branch         15565         100-year WSE 172         Existing         814.64         168.68         175.16         175.16           east branch         15565         100-year WSE 172         Existing         811.05         168.68         175.14         175.57           east branch         15597         8500 cfs WSE 172         Existing         1111.33         166.81         175.75         175.77           east branch         15597         100-year WSE 172         Proposed Alt 1         871.05         166.81         175.75         175.77           east branch         15597         100-year WSE 172         Proposed Alt 1         871.05         166.81         175.75         175.77           east branch         15710         8500 cfs WSE 172         Proposed Alt 1         1244.10         167.80         175.17         175.17           east branch         15710         8500 cfs WSE 172         Proposed Alt 1         1244.10         167.80         175.16	st branch	15551	100-year WSE 172	Proposed Alt 1	871.05	169.46	174.89		175.17	0.001562	5.22	259.54	125.31	0.43
east branch         15565         8500 cis WSE 172         Existing         1111.33         166.68         175.61         175.63           east branch         15565         100-year WSE 172         Proposed Alt 1         12.44.10         168.68         175.05         175.05           east branch         15565         100-year WSE 172         Proposed Alt 1         871.05         168.68         175.05         175.05           east branch         15567         8500 cis WSE 172         Proposed Alt 1         871.05         168.68         175.05         175.75           east branch         15597         8500 cis WSE 172         Proposed Alt 1         1744.10         166.81         175.75         175.75           east branch         15597         8500 cis WSE 172         Proposed Alt 1         1744.10         166.81         175.75         175.75           east branch         15707         100-year WSE 172         Proposed Alt 1         174.410         167.17         175.05         175.17           east branch         15710         8500 cis WSE 172         Proposed Alt 1         174.410         167.80         175.07         175.17           east branch         15710         8500 cis WSE 172         Proposed Alt 1         871.05         175.07														
east branch         15565         8500 cfs WSE 172         Proposed Alt 1         1244.10         165.68         175.70         175.35           east branch         15565         100-year WSE 172         Existing         814.64         168.68         175.15         175.05         175.15           east branch         15567         100-year WSE 172         Existing         811.65         166.68         175.15         175.05           east branch         15597         8500 cfs WSE 172         Existing         814.64         166.68         175.15         175.17           east branch         15597         100-year WSE 172         Existing         814.64         166.81         175.75         175.17           east branch         15597         100-year WSE 172         Proposed Alt 1         871.05         166.81         175.16         175.17           east branch         15710         8500 cfs WSE 172         Proposed Alt 1         871.05         166.81         175.17         175.17           east branch         15710         8500 cfs WSE 172         Proposed Alt 1         871.05         175.17         175.16           east branch         15710         8500 cfs WSE 172         Proposed Alt 1         174.410         167.80         175.16	st branch	15565	8500 cfs WSE 172	Existing	1111.33	168.68	175.61		175.69	0.000234	2.35	513.94	132.99	0.18
east branch         15565         100-year WSE 172         Existing         814.64         165.68         175.14         175.17           east branch         15597         8500 cfs WSE 172         Proposed Alt 1         871.05         166.88         175.14         175.55           east branch         15597         8500 cfs WSE 172         Existing         1111.33         166.81         175.65         175.55           east branch         15597         8500 cfs WSE 172         Proposed Alt 1         1244.10         166.81         175.63         175.51           east branch         15597         100-year WSE 172         Proposed Alt 1         871.05         166.81         175.16         175.51           east branch         15710         8500 cfs WSE 172         Proposed Alt 1         871.05         167.80         175.51         175.51           east branch         15710         8500 cfs WSE 172         Proposed Alt 1         1244.10         167.80         175.56         175.56           east branch         15710         8500 cfs WSE 172         Proposed Alt 1         1244.10         167.80         175.56           east branch         15710         8500 cfs WSE 172         Proposed Alt 1         1244.10         167.80         175.56	st branch	15565	8500 cfs WSE 172	Proposed Alt 1	1244.10	168.68	175.70		175.80	0.000275	2.58	526.68	133.98	0.19
east branch         15565         100-year WSE 172         Proposed Alt 1         871.05         166.16         175.16         175.12           east branch         15597         8500 cfs WSE 172         Existing         1111.33         166.81         175.75         175.75           east branch         15597         8500 cfs WSE 172         Existing         814.46         166.81         175.75         175.15           east branch         15597         100-year WSE 172         Existing         814.46         166.81         175.75         175.15           east branch         15597         100-year WSE 172         Existing         814.46         166.81         175.17         175.52           east branch         15710         8500 cfs WSE 172         Proposed Alt         171.13         167.80         175.67         175.52           east branch         15710         8500 cfs WSE 172         Proposed Alt         174.410         167.80         175.74         175.57           east branch         15710         100-year WSE 172         Proposed Alt         871.05         167.80         175.67         175.67           east branch         15710         100-year WSE 172         Proposed Alt         174.410         167.80         175.67 <t< td=""><td>st branch</td><td>15565</td><td>100-year WSE 172</td><td>Existing</td><td>814.64</td><td>168.68</td><td>175.05</td><td></td><td>175.11</td><td>0.000187</td><td>1.96</td><td>440.78</td><td>127.14</td><td>0.15</td></t<>	st branch	15565	100-year WSE 172	Existing	814.64	168.68	175.05		175.11	0.000187	1.96	440.78	127.14	0.15
at branch         15597         8500 cfs WSE 172         Existing         1111.33         166.81         175.65         175.15           east branch         15597         8500 cfs WSE 172         Existing         134.41         166.81         175.65         175.15           east branch         15597         100-year WSE 172         Existing         814.64         166.81         175.16         175.11           east branch         15597         100-year WSE 172         Existing         811.05         166.81         175.06         175.16           east branch         15710         8500 cfs WSE 172         Existing         1111.33         167.80         175.17         175.57           east branch         15710         8500 cfs WSE 172         Existing         871.05         167.80         175.64         175.17           east branch         15710         8500 cfs WSE 172         Existing         871.05         167.80         175.67         175.63           east branch         15710         100-year WSE 172         Existing         871.05         167.80         175.67         175.63           east branch         15710         100-year WSE 172         Proposed Alt         174.410         167.80         175.66         175.63 </td <td>st branch</td> <td>15565</td> <td>100-year WSE 172</td> <td>Proposed Alt 1</td> <td>871.05</td> <td>168.68</td> <td>175.14</td> <td></td> <td>175.20</td> <td>0.000200</td> <td>2.05</td> <td>452.19</td> <td>128.07</td> <td>0.16</td>	st branch	15565	100-year WSE 172	Proposed Alt 1	871.05	168.68	175.14		175.20	0.000200	2.05	452.19	128.07	0.16
east branch         15507         8500 cis WSE 172         Existing         111.33         166.81         175.15         175.15           east branch         15597         8500 cis WSE 172         Proposed Alt 1         1244.10         166.81         175.15         175.16         175.17           east branch         15597         100-year WSE 172         Proposed Alt 1         871.05         166.81         175.17         175.17           east branch         15597         100-year WSE 172         Proposed Alt 1         871.05         167.80         175.17         175.17           east branch         15710         8500 cis WSE 172         Proposed Alt 1         1244.10         167.80         175.64         175.17           east branch         15710         8500 cis WSE 172         Proposed Alt 1         871.05         167.80         175.07         175.17           east branch         15710         100-year WSE 172         Proposed Alt 1         871.05         167.80         175.07         175.16           east branch         15710         100-year WSE 172         Proposed Alt 1         871.05         175.07         175.07           east branch         15762         8500 cis WSE 172         Proposed Alt 1         174.410         175.07														
east branch         15507         8500 cis WSE 172         Proposed Alt 1         1244.10         166.81         175.75         175.13           east branch         15597         100-year WSE 172         Existing         814.64         166.81         175.16         175.13           east branch         15597         100-year WSE 172         Proposed Alt 1         871.05         166.81         175.17         175.13           east branch         15710         8500 cis WSE 172         Proposed Alt 1         171.13         167.80         175.74         175.75           east branch         15710         8500 cis WSE 172         Proposed Alt 1         1244.10         167.80         175.74         175.75           east branch         15710         100-year WSE 172         Proposed Alt 1         871.05         167.80         175.76         175.75           east branch         15710         100-year WSE 172         Proposed Alt 1         171.13         168.48         175.67         175.76           east branch         15722         8500 cis WSE 172         Proposed Alt 1         1244.10         168.48         175.67         175.56           east branch         15722         8500 cis WSE 172         Proposed Alt 1         1244.10         168.48	st branch	15597	8500 cfs WSE 172	Existing	1111.33	166.81	175.65		175.70	0.000101	1.81	672.13	139.92	0.12
east branch         15507         100-year WSE 172         Existing         814.84         166.81         175.06         175.17           east branch         15597         100-year WSE 172         Proposed Alt 1         871.05         166.81         175.17         175.27           east branch         15710         8500 cfs WSE 172         Proposed Alt 1         174.410         175.64         175.73           east branch         15710         8500 cfs WSE 172         Proposed Alt 1         124.410         167.80         175.67         175.67           east branch         15710         100-year WSE 172         Proposed Alt 1         124.410         167.80         175.67         175.67           east branch         15710         100-year WSE 172         Proposed Alt 1         124.410         167.80         175.67         175.67           east branch         15720         8500 cfs WSE 172         Proposed Alt 1         124.410         167.80         175.67         175.56           east branch         15722         8500 cfs WSE 172         Proposed Alt 1         124.410         167.80         175.56         175.56           east branch         15722         8500 cfs WSE 172         Proposed Alt 1         124.410         167.80         175.56	st branch	15597	8500 cfs WSE 172	Proposed Alt 1	1244.10	166.81	175.75		175.81	0.000120	1.99	686.62	140.47	0.13
east branch         155/7         100-year WSE 172         Proposed Alt 1         871.05         166.81         175.17         175.72           east branch         15710         8500 cis WSE 172         Existing         11411.33         167.80         175.74         175.75           east branch         15710         8500 cis WSE 172         Existing         814.44         167.80         175.74         175.75           east branch         15710         100-year WSE 172         Proposed Alt 1         871.05         167.80         175.07         175.55           east branch         15710         100-year WSE 172         Proposed Alt 1         871.05         167.80         175.67         175.55           east branch         15702         8500 cis WSE 172         Proposed Alt 1         111.33         168.48         175.67         175.55           east branch         15722         8500 cis WSE 172         Proposed Alt 1         111.33         168.48         175.56         175.55           east branch         15722         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.56         175.56           east branch         15762         8500 cis WSE 172         Proposed Alt 1         871.05         168.48         175	st branch	15597	100-year WSE 172	Existing	814.64	166.81	175.08		175.11	0.000075	1.47	592.88	136.85	0.10
at branch         15710         8500 cfs WSE 172         Existing         111.33         167.80         175.64         175.75           east branch         15710         8500 cfs WSE 172         Existing         111.33         167.80         175.64         175.63           east branch         15710         100-year WSE 172         Existing         814.64         175.07         175.07           east branch         15710         100-year WSE 172         Existing         814.64         167.80         175.07         175.53           east branch         15710         100-year WSE 172         Proposed Alt 1         871.05         167.80         175.65         175.53           east branch         15762         8500 cfs WSE 172         Proposed Alt 1         1244.10         168.48         175.65         175.53           east branch         15762         8500 cfs WSE 172         Proposed Alt 1         871.05         168.48         175.54         175.53           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.54         175.53           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.00 <td< td=""><td>st branch</td><td>15597</td><td>100-year WSE 172</td><td>Proposed Alt 1</td><td>871.05</td><td>166.81</td><td>175.17</td><td></td><td>175.21</td><td>0.000081</td><td>1.55</td><td>605.48</td><td>137.35</td><td>0.11</td></td<>	st branch	15597	100-year WSE 172	Proposed Alt 1	871.05	166.81	175.17		175.21	0.000081	1.55	605.48	137.35	0.11
east branch         15710         8500 cis WSE 172         Existing         1111.33         167.80         175.64         175.73           east branch         15710         8500 cis WSE 172         Proposed Alt 1         1244.10         167.80         175.07         175.07           east branch         15710         100-year WSE 172         Proposed Alt 1         1244.10         167.80         175.07         175.07           east branch         15710         100-year WSE 172         Proposed Alt 1         871.05         167.80         175.16         175.52           east branch         15762         8500 cis WSE 172         Proposed Alt 1         871.05         167.80         175.16         175.53           east branch         15762         8500 cis WSE 172         Proposed Alt 1         1244.10         168.48         175.56         175.56           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.57         175.56           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.50         175.56           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         175.00														
east branch         15710         8500 cfs WSE 172         Proposed Alt 1         1244.10         167.80         175.74         175.86           east branch         15710         100-year WSE 172         Existing         814.64         167.90         175.07         175.07         175.07           east branch         15710         100-year WSE 172         Existing         814.64         167.90         175.16         175.07         175.32           east branch         15722         8500 cfs WSE 172         Proposed Alt 1         871.05         168.48         175.45         175.53           east branch         15762         8500 cfs WSE 172         Proposed Alt 1         1244.10         168.48         175.51         175.55           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.50         175.55           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.00         175.55           east branch         15812         8500 cfs WSE 172         Proposed Alt 1         871.05         167.43         175.50         175.55           east branch         15812         8500 cfs WSE 172         Proposed Alt 1         871	st branch	15710	8500 cfs WSE 172	Existing	1111.33	167.80	175.64		175.73	0.000220	2.47	533.34	137.68	0.17
east branch         15710         100-year WSE 172         Existing         814.84         167.80         175.07         175.13           east branch         15710         100-year WSE 172         Proposed Alt 1         871.05         167.80         175.16         175.25           east branch         1572         8500 cfs WSE 172         Proposed Alt 1         111.133         168.48         175.56         175.56           east branch         1572         8500 cfs WSE 172         Proposed Alt 1         1244.10         168.48         175.56         175.56           east branch         1572         100-year WSE 172         Proposed Alt 1         1244.10         168.48         175.57         175.56           east branch         15722         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.50         175.56           east branch         15612         8500 cfs WSE 172         Proposed Alt 1         871.05         167.32         175.00         175.56           east branch         15812         8500 cfs WSE 172         Proposed Alt 1         124.10         167.32         175.50         175.56           east branch         15812         8500 cfs WSE 172         Proposed Alt 1         124.10         167.32 <td< td=""><td>st branch</td><td>15710</td><td>8500 cfs WSE 172</td><td>Proposed Alt 1</td><td>1244.10</td><td>167.80</td><td>175.74</td><td></td><td>175.85</td><td>0.000258</td><td>2.70</td><td>547.39</td><td>138.15</td><td>0.19</td></td<>	st branch	15710	8500 cfs WSE 172	Proposed Alt 1	1244.10	167.80	175.74		175.85	0.000258	2.70	547.39	138.15	0.19
east branch         15710         100-year WSE 172         Proposed Alt 1         871.05         175.10         175.15           east branch         15762         8500 cfs WSE 172         Existing         1111.33         168.48         175.45         175.85           east branch         15762         8500 cfs WSE 172         Proposed Alt 1         1244.10         168.48         175.51         175.85           east branch         15762         8500 cfs WSE 172         Proposed Alt 1         1244.10         168.48         175.61         175.52           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.00         175.52           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.00         175.52           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         167.32         175.00         175.53           east branch         15812         8500 cfs WSE 172         Proposed Alt 1         1244.10         167.32         175.00         175.53           east branch         15812         8500 cfs WSE 172         Proposed Alt 1         1244.10         167.32         175.00	st branch	15710	100-year WSE 172	Existing	814.64	167.80	175.07		175.13	0.000176	2.08	455.40	135.07	0.15
east branch         15762         8500 cis WSE 172         Existing         1111.33         168.48         175.45         175.58           east branch         15722         8500 cis WSE 172         Proposed Alt 1         1244.10         168.48         175.51         175.58           east branch         15762         100-year WSE 172         Proposed Alt 1         1244.10         168.48         174.92         175.52           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.00         175.52           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.00         175.50           east branch         15812         8500 cis WSE 172         Proposed Alt 1         171.33         167.32         175.00         175.50           east branch         15812         8500 cis WSE 172         Proposed Alt 1         1244.10         167.32         175.00         175.50	st branch	15710	100-year WSE 172	Proposed Alt 1	871.05	167.80	175.16		175.23	0.000188	2.17	467.78	135.49	0.16
east branch         15782         8500 cis WSE 172         Existing         1111.33         168.48         175.45         175.68           east branch         15782         8500 cis WSE 172         Proposed Alt 1         1244.10         168.48         175.51         175.52           east branch         15762         100-year WSE 172         Proposed Alt 1         1244.10         168.48         175.07         175.52           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.00         175.52           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.00         175.53           east branch         15762         8500 cis WSE 172         Proposed Alt 1         871.05         167.32         175.00         175.53           east branch         15812         8500 cis WSE 172         Proposed Alt 1         1244.10         167.32         175.70         175.53           east branch         15812         8500 cis WSE 172         Proposed Alt 1         1244.10         167.32         175.70         175.53														
east branch         15762         8500 cis WSE 172         Proposed Alt 1         1244.10         168.48         175.51         175.92           east branch         15782         100-year WSE 172         Existing         814.64         168.48         174.32         175.52           east branch         15782         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.00         175.20           east branch         15782         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.00         175.32           east branch         15812         8500 cis WSE 172         Existing         1111.33         167.32         175.70         175.59           east branch         15812         8500 cis WSE 172         Proposed Alt 1         1244.10         167.32         175.70         175.59	st branch	15762	8500 cfs WSE 172	Existing	1111.33	168.48	175.45		175.85	0.001499	5.26	247.63	134.70	0.42
east branch         15762         100-year WSE 172         Existing         814.64         168.48         174.92         175.22           east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.00         175.30           east branch         15812         8500 cis WSE 172         Existing         1111.33         167.32         175.00         175.31           east branch         15812         8500 cis WSE 172         Existing         1111.33         167.32         175.70         175.99           east branch         15812         8500 cis WSE 172         Proposed Alt 1         1.244.10         167.32         175.82         175.69	st branch	15762	8500 cfs WSE 172	Proposed Alt 1	1244.10	168.48	175.51		175.99	0.001774	5.77	256.04	134.88	0.46
east branch         15762         100-year WSE 172         Proposed Alt 1         871.05         168.48         175.00         175.33           east branch         15812         8500 cls WSE 172         Existing         1111.33         167.32         175.70         175.51           east branch         15812         8500 cls WSE 172         Existing         1111.33         167.32         175.70         175.51           east branch         15812         8500 cls WSE 172         Proposed Alt 1         1244.10         167.32         175.82         176.00	st branch	15762	100-year WSE 172	Existing	814.64	168.48	174.92		175.22	0.001242	4.47	197.13	59.88	0.38
east branch         15612         8500 cfs WSE 172         Existing         111.33         167.32         175.70         175.91           east branch         15812         8500 cfs WSE 172         Proposed Alt 1         1244.10         167.32         175.82         176.04	st branch	15762	100-year WSE 172	Proposed Alt 1	871.05	168.48	175.00		175.33	0.001337	4.68	201.78	60.28	0.39
east branch         15812         8500 c/s WSE 172         Existing         1111.33         167.32         175.70         175.91           east branch         15812         8500 c/s WSE 172         Proposed Alt 1         1244.10         167.32         175.82         176.04														
east branch 15812 8500 cfs WSE 172 Proposed Alt 1 1244.10 167.32 175.82 176.06	st branch	15812	8500 cfs WSE 172	Existing	1111.33	167.32	175.70		175.91	0.000607	3.87	346.22	102.14	0.28
	st branch	15812	8500 cfs WSE 172	Proposed Alt 1	1244.10	167.32	175.82		176.06	0.000699	4.21	358.19	102.64	0.30
east branch 15812 100-year WSE 172 Existing 814.64 167.32 175.11 175.21	st branch	15812	100-year WSE 172	Existing	814.64	167.32	175.11		175.27	0.000509	3.31	287.07	99.65	0.25

# East Branch

International         Internat	the state of the s	100-year WSE 172 8500 cls WSE 172 8500 cls WSE 172 100-year WSE 172 100-year WSE 172	Proposed Alt 1	(cfs)	(ft)	(ft)	(ff)	(¥)	(ft/ft)	(ft/s)	(sq ft)	(ft)		
Interner         19812         Cloyene WisE 172         Personal Att         971/3         175/3         1	branch         15812           thranch         15845           thranch         15895           thranch         15895           thranch         15895           thranch         15895           thranch         15895           thranch         15895	100-year WSE 172 8500 cfs WSE 172 8500 cfs WSE 172 100-year WSE 172 100-year WSE 172	Proposed Alt 1		Physics and the second se	and a second second			11000000000000000000000000000000000000				2010 CONTRACTOR (CONTRACTOR)	
Entrol         1556         500 ch MGE T2         Full Mark         175 ch MGB         175 ch MGB         175 ch MGB         171 ch MGB	branch         15845           branch         15895           branch         15895           branch         15895           branch         15895           branch         15895           branch         15895	8500 cfs WSE 172 8500 cfs WSE 172 100-year WSE 172 100-year WSE 172		CU.178	167.32	175.21		175.38	0.000539	3.45	296.73	100.06	0.26	
Image         Tissa         Comono         Sia	Ibranch         15845           Ibranch         15845           Ibranch         15845           Ibranch         15845           Ibranch         15895	8500 cfs WSE 172 100-year WSE 172 100-year WSE 172	Existing	1111.33	167.55	175.67		175.96	0.000880	4.71	311.73	112.35	0.33	
Housen         19646         100/aeu WGE 172         Bolading         614.44         175.34         175.34         0.000722         4.08         2.46.8         2.67.54         0.75.34         0.00033           Breinen         19646         100/aeu WGE 172         PropadedA11         1141.33         106.4         175.34         0.00033         3.4.36         2.55.96         175.46         0.00033           Breinen         19666         9600 de WEE 172         PropadedA11         1141.33         106.44         175.34         175.34         0.00033         3.4.3         2.55.96         115.6         0.02           Breinen         19666         9600 de WEE 172         PropadeA11         1141.13         114.4         114.4         114.4         114.4         114.4         117.2         117	branch 15845 branch 15845 branch 15878 branch 15895 branch 15895 branch 15895 branch 15895 branch 15895 branch 15895	100-year WSE 172 100-year WSE 172	Proposed Alt 1	1244.10	167.55	175.78		176.12	0.001007	5.10	324.52	113.19	0.36	
Under Inder Neurol Ne	branch 15845 branch 15878 branch 15895 branch 15895 branch 15895 branch 15895 branch 15895 branch 15905	100-year WSE 172	Existing	814.64	167.55	175.08		175.32	0.000752	4.08	248.63	97.83	0:30	
tument         5573         m         m         Stude         m         Stude         T/7.2M         T/7.2M         COORDAM         4.42         365.80         111.15         Court         Court<	branch 15878 branch 15895 branch 15895 branch 15895 branch 15895 branch 15895 branch 15895		Proposed Alt 1	871.05	167.55	175.18		175.43	0.000802	4.26	257.96	102.87	0.31	
Diment         1666         600 d-M06E 172         Exeminal         111         133         1666         177.24         177.24         0000000         4.12         36.66         111 f.15         0.00000         4.11         36.66         111 f.15         0.00000         4.11         36.66         111 f.15         0.00000         4.11         36.66         111 f.15	branch         15895			Inl Struct										
Dument         15566         6500 de WKE 172         Pondeed/1         111.13         117.33         177.34	branch         15895													
Demon         1556         6500 AWE TZ         Failing         17.44         0.000000         4.73         27.30         17.74         0.000000         4.73         27.40         17.74         0.000000         4.73         27.40         17.74         0.000000         4.73         27.40         0.000000         4.71         27.40         0.000000         4.73         27.40         0.000000         4.73         27.40         0.000000         4.73         27.40         0.000000         4.73         27.40         0.000000         4.74         27.40         0.000000         4.74         27.40         0.000000         4.74         27.40         0.000000         4.74         27.40         0.000000         4.74         27.40         0.000000         4.74         27.40         0.000000         4.74         27.40         0.000000         4.74         27.40         0.000000         4.75         27.40         0.000000         4.75         27.40         0.000000         4.75         27.40         0.000000         4.75         27.40         0.000000         4.75         27.40         0.000000         4.75         27.40         0.000000         4.75         27.40         0.000000         4.75         27.40         0.0000000         0.75         27.41 <td>branch 15895 branch 15895 branch 15895 branch 15926 branch 15926</td> <td>8500 cfs WSE 172</td> <td>Existing</td> <td>1111.33</td> <td>168.64</td> <td>176.76</td> <td>173.48</td> <td>177.04</td> <td>0.000834</td> <td>4.42</td> <td>305.99</td> <td>111.51</td> <td>0.32</td>	branch 15895 branch 15895 branch 15895 branch 15926 branch 15926	8500 cfs WSE 172	Existing	1111.33	168.64	176.76	173.48	177.04	0.000834	4.42	305.99	111.51	0.32	
Image         1566         100-year WGE 172         Periode         176 33         172 44         176 35         0000663         344         200 35         96 35         000         96 35         000         96 35         000         96 35         000         96 35         000         96 35         000         96 35         000         96 35         96 10         96 35         <	branch 15895 branch 15895 branch 15926 branch 15926	8500 cfs WSE 172	Proposed Alt 1	1244.10	168.64	176.93	173.78	177.24	0.000920	4.73	324.99	115.16	0.34	
bmm         1566         100-year WGE 172         Proposed Alt1         671 (6)         1664         176.42         172.93         177.01         0000690         3.61         3.601 (1)         9.62         0.02           bmm         15906         800 c4 WKE 172         Proposed Alt1         1.411.13         166.63         176.81         177.24         177.07         0.0007-30         4.12         230.53         96.64         0.00           bmm         15963         600 c4 WKE 172         Ensing         111.133         175.41         175.64         177.26         177.26         0.0007-30         3.41         25.77         165.64         0.00           bmm         15963         600 c4 WKE 172         Ensing         111.133         177.34         176.64         177.26         177.61         0.0007-00         3.41         25.77         165.40         0.64           bmm         15963         600 c4 WKE 172         Ensing         111.13         177.36         174.61         177.61         0.000170         3.41         25.77         165.40         0.64           bmm         16012         6600 c4 WKE 172         Ensing         111.13         177.61         177.61         177.61         177.61         0.000150 <t< td=""><td>branch 15895 branch 15926 homoth 15026</td><td>100-year WSE 172</td><td>Existing</td><td>814.64</td><td>168.64</td><td>176.33</td><td>172.74</td><td>176.53</td><td>0.000626</td><td>3.64</td><td>260.86</td><td>95.26</td><td>0.27</td></t<>	branch 15895 branch 15926 homoth 15026	100-year WSE 172	Existing	814.64	168.64	176.33	172.74	176.53	0.000626	3.64	260.86	95.26	0.27	
Perment         FSAS         BSOD dis VASE F12         Existing Existing         TTT III         ITT IIII         ITT III         ITT III         ITT III         ITT III         ITT III         ITT IIII         ITT III         ITT IIII         ITT IIIII         ITT IIIII         ITT IIIII         ITT IIIIIIII         ITT IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	branch 15926	100-year WSE 172	Proposed Alt 1	871.05	168.64	176.42	172.89	176.63	0.000669	3.81	269.11	99.21	0.28	
Instant         Isso         Instant         I	hmach 15076	8500 cfs WSE 172	Existing	1111.33	168.63	176.81	172.97	177.07	0.000740	4.12	293.52	95.66	0.30	
bunch         1556         100-yert WEE 172         Centing         8146         16863         176.34         177.26         177.54         177.26         000570         3.48         257.57         83.51         0.02           bunch         15863         100-yert WEE 172         Proposed Att         87.163         177.41         177.54         177.72         0.000774         6.00         184.41         54.30         0.05           bunch         15863         100-yert WEE 172         Proposed Att         87.163         177.24         177.52         0.000734         6.01         184.41         51.83         0.00           bunch         15863         100-yert WEE 172         Proposed Att         87.163         177.43         177.82         0.000736         43.71         51.83         0.00           bunch         1607         Bunck         177.21         177.82         0.000710         6.01         184.41         51.83         0.00	DIGITCI 13220	8500 cfs WSE 172	Proposed Alt 1	1244.10	168.63	176.97	173.24	177.27	0.000829	4.45	309.47	96.77	0.32	
Index         Index <th< td=""><td>branch 15926</td><td>100-year WSE 172</td><td>Existing</td><td>814.64</td><td>168.63</td><td>176.38</td><td>172.26</td><td>176.55</td><td>0.000524</td><td>3.32</td><td>252.35</td><td>77.67</td><td>0.25</td></th<>	branch 15926	100-year WSE 172	Existing	814.64	168.63	176.38	172.26	176.55	0.000524	3.32	252.35	77.67	0.25	
Damel         15863         8600 ck WSE 172         Existing         1111.33         171.24         175.64         177.27         0.0003044         6.00         144.81         53.40         0.000           Damel         15863         000-year WSE 172         Proposed Alt         1.14.10         171.24         175.64         177.26         177.27         0.000317         6.00         188.47         54.00         0.06           Damel         15863         00-year WSE 172         Proposed Alt         1.11.31         177.36         177.36         177.36         177.36         177.36         177.36         0.000316         4.27         166.47         16.00         16.01         16.01         16.01         16.01         16.01         16.01         16.01         16.01         17.01         177.36         177.36         177.36         177.36         177.31	branch 15926	100-year WSE 172	Proposed Alt 1	871.05	168.63	176.46	172.41	176.65	0.000570	3.49	257.57	83.51	0.26	
Insert         Second Second Second Sector         Territy in trans		or of the the	l			TOT.						0.01		
memment         reactor         reactor <t< td=""><td>branch 15063</td><td>8500 cls VVSE 1/2</td><td>Existing Pronoced Alt 1</td><td>1244.10</td><td>171 24</td><td>176.84</td><td>175.64</td><td>177 50</td><td>0.002944</td><td>6.60</td><td>104.01</td><td>54.00</td><td>0.00</td></t<>	branch 15063	8500 cls VVSE 1/2	Existing Pronoced Alt 1	1244.10	171 24	176.84	175.64	177 50	0.002944	6.60	104.01	54.00	0.00	
Image         Image <th< td=""><td>branch 15963</td><td>100-vear WSF 172</td><td>Fxisting</td><td>814.64</td><td>171 24</td><td>176.30</td><td>174 79</td><td>176.69</td><td>0.00256</td><td>4.97</td><td>163 77</td><td>51.63</td><td>0.49</td></th<>	branch 15963	100-vear WSF 172	Fxisting	814.64	171 24	176.30	174 79	176.69	0.00256	4.97	163 77	51.63	0.49	
Index         Index <th< td=""><td>branch 15963</td><td>100-year WSE 172</td><td>Proposed Alt 1</td><td>871.05</td><td>171.24</td><td>176.38</td><td>174.92</td><td>176.81</td><td>0.002321</td><td>5.27</td><td>165.43</td><td>51.95</td><td>0.51</td></th<>	branch 15963	100-year WSE 172	Proposed Alt 1	871.05	171.24	176.38	174.92	176.81	0.002321	5.27	165.43	51.95	0.51	
Indication         Indication         Bindge         Intert         Inter         Intert         Inter         I														
Indext         16012         6500 c6 wSE 172         Evaluadi         111.33         170.36         177.53         174.97         177.83         0.001100         4.27         256.97         60.06         0.001           bench         16012         6500 c6 wSE 172         Proposed Att         111.33         170.38         177.58         177.170         0.001524         5.18         240.34         56.63         0.033           bench         16012         100-year WSE 172         Proposed Att         157.13         167.68         177.44         177.69         0.001524         5.18         240.34         56.63         0.03           bench         16012         100-year WSE 172         Proposed Att         157.51         177.26         177.54         177.61         177.69         0.000123         420.34         56.63         0.03           bench         16065         8500 c6 wSE 172         Proposed Att         127.13         167.83         177.61         177.76         0.000269         321         240.34         56.63         0.01           bench         16065         8500 c6 wSE 172         Proposed Att         127.13         167.84         177.64         177.76         0.000269         257.333.47         72.80         0.01	branch 16007			Bridge										
Index         Index <th< td=""><td>branch 16012</td><td>8500 cfs WSE 172</td><td>Existing</td><td>1111.33</td><td>170.88</td><td>177.55</td><td>174.97</td><td>177.83</td><td>0.001109</td><td>4.27</td><td>259.97</td><td>60.09</td><td>0.36</td></th<>	branch 16012	8500 cfs WSE 172	Existing	1111.33	170.88	177.55	174.97	177.83	0.001109	4.27	259.97	60.09	0.36	
Indext         Indext<	branch 16012	8500 cfs WSE 172	Proposed Alt 1	1244.10	170.88	177.28	175.19	177.70	0.001524	5.18	240.34	58.76	0.43	
Indication         Indicat	branch 16012	100-year WSE 172	Existing	814.64	170.88	176.86	174.43	177.07	0.000961	3.71	219.73	56.63	0.33	
Instruct         16065         8500 cis WSE 172         Existing         1157.33         167.83         177.76         177.78         0.000370         3.21         385.62         74.03         0.025           Instruct         16065         8500 cis WSE 172         Proposed Alt         127.133         167.83         177.16         177.76         0.000483         353         373.97         73.76         0.02           Instruct         16065         100-year WSE 172         Proposed Alt         121.33         167.83         177.16         177.16         0.000483         353         373.97         73.76         0.02           Instruct         16065         100-year WSE 172         Proposed Alt         121.33         167.83         177.16         171.17         176.96         0.000326         2.57         333.17         72.80         0.018           Instruct         16065         100-year WSE 172         Proposed Alt         1.27.12         177.14         177.69         177.14         177.82         0.000326         2.82         33.317         72.65         0.018           Instruct         16144         8500 cis WSE 172         Proposed Alt         1353.20         166.22         177.01         177.82         0.000194         2.82	branch 16012	100-year WSE 172	Proposed Alt 1	871.05	170.88	176.66	174.54	176.93	0.001223	4.20	207.20	55.63	0.38	
Indef         16055         5500 cfs WSE 172         Proposed At1         1271.33         167.33         177.66         177.76         0.00433         36.33         37.397         73.76         0.02           oranch         16065         100-year WSE 172         Existing         816.49         167.83         177.01         171.62         177.11         0.000266         2.57         333.17         72.80         0.018           oranch         16065         100-year WSE 172         Existing         871.29         167.83         177.01         171.62         177.11         0.000266         2.57         333.17         72.80         0.018           oranch         16055         100-year WSE 172         Existing         871.29         167.83         177.01         177.92         0.00038         2.87         37.37         72.80         0.16           oranch         161.44         8500 cfs WSE 172         Existing         1268.51         166.22         177.72         174.01         177.92         0.000194         2.62         67.180         155.16         0.13           oranch         161.44         8500 cfs WSE 172         Existing         255.61         155.16         0.16         0.17.02         0.000194         2.62 <t< td=""><td>branch 16065</td><td>8500 cfs WSE 172</td><td>Existing</td><td>1157.33</td><td>167.83</td><td>177.72</td><td>172.37</td><td>177.88</td><td>0.000370</td><td>3.21</td><td>385.62</td><td>74.03</td><td>0.22</td></t<>	branch 16065	8500 cfs WSE 172	Existing	1157.33	167.83	177.72	172.37	177.88	0.000370	3.21	385.62	74.03	0.22	
oranch         16065         100-year WSE 172         Existing         167.13         177.01         171.62         177.11         0.000266         2.57         333.17         72.80         0.01           oranch         16055         100-year WSE 172         Proposed Alt1         871.29         167.83         177.61         171.74         176.96         2.67         333.17         72.96         0.01           oranch         16055         100-year WSE 172         Proposed Alt1         871.29         167.83         177.64         177.92         0.00038         2.82         32.36         0.55         0.01           oranch         16144         8500 cfs WSE 172         Existing         1268.51         166.22         177.72         174.01         177.92         0.00194         2.62         671.80         155.16         0.13           oranch         16144         8500 cfs WSE 172         Existing         1265.21         166.22         177.02         177.02         0.000194         2.62         671.80         155.16         0.13           oranch         16144         100-year WSE 172         Existing         825.56         166.22         177.02         0.00194         2.62         57.16         0.13           oranch	branch 16065	8500 cfs WSE 172	Proposed Alt 1	1271.33	167.83	177.56	172.60	177.76	0.000483	3.63	373.97	73.76	0.25	
Dranch         1605         100-ger/WSE 172         Proposed Alt 1         871.20         167.83         171.74         176.96         0.00028         2.82         322.36         72.55         0.02           Dranch         16143.99         Lat Struct         Lat Struct         Lat Struct         1.66.82         177.74         176.96         0.000194         2.62         671.80         155.59         0.01           Dranch         16144         8500 cfs WSE 172         Existing         1268.51         166.22         177.72         174.01         177.92         0.000194         2.62         671.80         155.16         0.01           Dranch         16144         8500 cfs WSE 172         Existing         1265.56         166.22         177.70         174.00         177.72         2.04         555.61         155.56         0.01           Dranch         16144         100-year WSE 172         Existing         825.56         166.22         177.02         177.02         0.00156         2.24         55.61         155.16         0.13           Dranch         16144         100-year WSE 172         Existing         825.56         166.22         177.09         177.12         0.00156         2.24         55.16         0.13	branch 16065	100-year WSE 172	Existing	816.49	167.83	177.01	171.62	177.11	0.000266	2.57	333.17	72.80	0.18	
Initiation         Initiation         Lat Struct         Lat Struct         Lat Struct         Lat Struct         Lat Struct         Lat Struct         Struct <th< td=""><td>branch 16065</td><td>100-year WSE 172</td><td>Proposed Alt 1</td><td>871.29</td><td>167.83</td><td>176.86</td><td>171.74</td><td>176.98</td><td>0.000328</td><td>2.82</td><td>322.36</td><td>72.55</td><td>0.20</td></th<>	branch 16065	100-year WSE 172	Proposed Alt 1	871.29	167.83	176.86	171.74	176.98	0.000328	2.82	322.36	72.55	0.20	
Instruct         16144         8500 cfs WSE 172         Existing         1268.51         166.22         177.84         174.01         177.82         0.000194         2.62         677.80         155.56         0.18           bennch         16144         8500 cfs WSE 172         Existing         1353.20         166.22         177.72         174.01         177.82         0.000134         2.62         677.86         155.16         0.18           branch         16144         100-year WSE 172         Existing         825.56         166.22         177.09         174.00         177.14         0.000134         2.04         555.60         152.81         0.13           branch         16144         100-year WSE 172         Existing         875.16         166.22         176.05         177.02         0.000134         2.04         555.60         152.81         0.13           branch         16124         100-year WSE 172         Evisting         875.16         166.22         177.05         174.00         177.02         0.000165         2.24         555.30         152.32         0.14           branch         16122         166.22         177.09         177.02         0.000165         2.24         555.30         152.32         0.14 <td>branch 16143.99</td> <td></td> <td></td> <td>Lat Struct</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	branch 16143.99			Lat Struct										
Instanct         16144         B500 cts WSE 172         Proposed At1         1353.20         166.22         177.72         174.01         177.82         0.000238         2.87         653.54         155.16         0.18           branch         16144         100-year WSE 172         Existing         825.56         166.22         177.09         174.00         177.14         0.000134         2.04         555.60         152.81         0.13           branch         16144         100-year WSE 172         Proposed At1         875.16         166.22         177.09         174.00         177.02         0.000134         2.04         555.60         152.81         0.13           branch         16144         100-year WSE 172         Proposed At1         875.16         166.22         177.09         174.00         177.02         0.000156         2.24         555.60         152.32         0.01           branch         1612         Culvert         875.16         166.52         177.09         174.00         177.02         0.000156         2.24         555.39         152.32         0.01           branch         16122         Existing         166.52         177.81         177.02         0.000156         2.24         555.39         152.32<	branch 16144	8500 cfs WSE 172	Existing	1268.51	166.22	177.84	174.01	177.92	0.000194	2.62	671.80	155.59	0.16	
branch         1614         100-year WSE 172         Existing         825.56         166.22         177.09         177.16         0.00134         2.04         555.60         152.81         0.13           branch         16144         100-year WSE 172         Proposed Alt 1         875.16         166.22         176.95         174.00         177.02         0.000156         2.24         555.39         152.32         0.14           branch         1612         Proposed Alt 1         875.16         166.22         176.85         174.00         177.02         0.000165         2.24         555.39         152.32         0.14           branch         1612         Culwert         20         166.51         177.05         177.02         0.000165         2.24         555.39         152.32         0.14           branch         1612         Culwert         20         165.51         177.81         177.40         277.02         0.000174         2.57         711.42         154.24         0.15           branch         16207         8500 cls WSE 172         Proposed Alt 1         1353.20         165.51         177.78         0.000208         2.79         667.57         154.24         0.15	branch 16144	8500 cfs WSE 172	Proposed Alt 1	1353.20	166.22	177.72	174.01	177.82	0.000238	2.87	653.54	155.16	0.18	
Index         Index <th< td=""><td>branch 16144</td><td>100-year WSE 172</td><td>Existing</td><td>825.56</td><td>166.22</td><td>177.09</td><td>174.00</td><td>177.14</td><td>0.000134</td><td>2.04</td><td>555.60</td><td>152.81</td><td>0.13</td></th<>	branch 16144	100-year WSE 172	Existing	825.56	166.22	177.09	174.00	177.14	0.000134	2.04	555.60	152.81	0.13	
branch         16192         Culvert         Culvert         Culvert         Figure         Culvert         Figure         Figure <th figu<="" td=""><td>branch 16144</td><td>100-year WSE 172</td><td>Proposed Alt 1</td><td>875.16</td><td>166.22</td><td>176.95</td><td>174.00</td><td>177.02</td><td>0.000165</td><td>2.24</td><td>535.39</td><td>152.32</td><td>0.14</td></th>	<td>branch 16144</td> <td>100-year WSE 172</td> <td>Proposed Alt 1</td> <td>875.16</td> <td>166.22</td> <td>176.95</td> <td>174.00</td> <td>177.02</td> <td>0.000165</td> <td>2.24</td> <td>535.39</td> <td>152.32</td> <td>0.14</td>	branch 16144	100-year WSE 172	Proposed Alt 1	875.16	166.22	176.95	174.00	177.02	0.000165	2.24	535.39	152.32	0.14
Dranch         16207         8500 cls WSE 172         Existing         165.51         177.87         174.40         177.94         0.000174         2.57         711.42         154.24         0.15           branch         16207         8500 cls WSE 172         Existing         165.51         177.87         177.44         177.94         0.000174         2.57         711.42         154.24         0.15           branch         162.51         177.78         177.44         177.86         0.000208         2.79         667.57         153.87         0.16	hranch 16102			Cultvert										
branch         16207         8600 cls WSE 172         Existing         1268.51         167.51         177.87         174.40         177.94         0.000174         2.57         711.42         154.24         0.15           branch         16207         8500 cls WSE 172         Proposed Att         1353.20         165.51         177.78         174.41         177.86         0.0000208         2.79         687.57         153.87         0.16														
branch 16207 8500 cfs WSE 172 Proposed Alt 1 1353.20 165.51 177.78 174.41 177.86 0.000208 2.79 687.57 153.87 0.16	branch 16207	8500 cfs WSE 172	Existing	1268.51	165.51	177.87	174.40	177.94	0.000174	2.57	711.42	154.24	0.15	
	branch 16207	8500 cfs WSE 172	Proposed Alt 1	1353.20	165.51	177.78	174.41	177.86	0.000208	2.79	697.57	153.87	0.16	

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(Ħ)	
east branch	16207	100-year WSE 172	Proposed Alt 1	875.16	165.51	177.03	173.66	177.08	0.000140	2.16	583.34	150.80	0.13
east branch	16256	8500 cfs WSE 172	Existing	1460.92	168.08	177.87	172.49	177.96	0.000236	2.69	688.67	153.79	0.18
east branch	16256	8500 cfs WSE 172	Proposed Alt 1	1532.81	168.08	177.78	172.62	177.88	0.000275	2.87	675.13	153.47	0.19
east branch	16256	100-year WSE 172	Existing	924.57	168.08	177.16	171.45	177.21	0.000150	2.00	581.15	151.25	0.14
east branch	16256	100-year WSE 172	Proposed Alt 1	954.23	168.08	177.02	171.52	177.10	0.000215	2.36	458.48	149.49	0.17
			;										
east branch	16298	8500 cfs WSE 1 /2	Existing	1547.29	167.57	1//.89	1/2.29	111.91	0.000200	2.57	/82.86	1 / 2.89	0.17
east branch	16298	8500 cfs WSE 172	Proposed Alt 1	1610.34	167.57	177.80	172.39	177.89	0.000228	2.73	768.45	172.72	0.18
east branch	16298	100-year WSE 172	Existing	940.44	167.57	177.18	171.15	177.22	0.000117	1.84	660.72	171.38	0.12
east branch	16298	100-year WSE 172	Proposed Alt 1	963.12	167.57	177.06	171.19	177.11	0.000133	1.94	641.11	171.14	0.13
east branch	16404	8500 cfs WSE 172	Existing	1773.79	167.93	177.88	173.07	178.01	0.000330	3.24	722.73	184.78	0.21
east branch	16404	8500 cfs WSE 172	Proposed Alt 1	1815.20	167.93	177.80	173.13	177.94	0.000365	3.39	707.65	184.62	0.22
east branch	16404	100-year WSE 172	Existing	988.24	167.93	177.18	171.71	177.24	0.000167	2.16	594.03	183.40	0.15
east branch	16404	100-year WSE 172	Proposed Alt 1	992.73	167.93	177.07	171.72	177.13	0.000184	2.24	573.35	183.17	0.16
east branch	16498	8500 cfs WSE 172	Existing	1848.51	167.38	177.85	173.02	178.08	0.000504	3.90	520.93	162.05	0.26
east branch	16498	8500 cfs WSE 172	Proposed Alt 1	1880.87	167.38	177.77	173.07	178.01	0.000543	4.02	513.03	161.54	0.27
east branch	16498	100-year WSE 172	Existing	1000.00	167.38	177.18	171.61	177.26	0.000209	2.39	455.14	157.71	0.17
east branch	16498	100-year WSE 172	Proposed Alt 1	1000.00	167.38	177.07	171.61	177.16	0.000222	2.44	444.52	157.00	0.17
east branch	16601	8500 cfs WSE 172	Existing	1849.55	167.56	177.97	172.92	178.13	0.000378	3.38	679.12	173.72	0.23
east branch	16601	8500 cfs WSE 172	Proposed Alt 1	1881.10	167.56	177.81	172.97	178.07	0.000573	4.10	462.41	166.83	0.28
east branch	16601	100-year WSE 172	Existing	1000.00	167.56	177.20	171.54	177.29	0.000215	2.40	417.47	132.73	0.17
east branch	16601	100-year WSE 172	Proposed Alt 1	1000.00	167.56	177.09	171.54	177.18	0.000226	2.44	410.33	131.51	0.17
east hranch	16706	8500 cfs WSE 172	Evicting	1885 33	168.05	177 98	173 44	178.10	0.000519	3 84	575 03	155 79	0.76
east branch	16706	8500 cfs WSE 172	Proposed Alt 1	1906.99	168.05	177.92	173.46	178.14	0.000552	3.93	567.81	154.48	0.27
east branch	16706	100-vear WSE 172	Existing	1000.00	168.05	177.21	171.96	177.32	0.000273	2.61	382.42	132.91	0.19
east branch	16706	100-year WSE 172	Proposed Alt 1	1000.00	168.05	177.10	171.96	177.21	0.000287	2.66	375.60	130.44	0.19
		•	•										
east branch	16810	8500 cfs WSE 172	Existing	1894.58	167.10	177.98	173.10	178.27	0.000658	4.34	436.07	121.71	0.29
east branch	16810	8500 cfs WSE 172	Proposed Alt 1	1913.67	167.10	177.92	173.12	178.23	0.000687	4.43	432.37	121.05	0.30
east branch	16810	100-year WSE 172	Existing	1000.00	167.10	177.24	171.51	177.35	0.000249	2.57	389.56	113.18	0.18
east branch	16810	100-year WSE 172	Proposed Alt 1	1000.00	167.10	177.14	171.51	177.24	0.000261	2.61	383.04	111.95	0.18
			:										
east branch	10913	8500 CTS WSE 1/2	Existing	1901.20	101./3	1/8.08	1/3.68	1/8.35	0.000643	4.30	86.126	140.33	0.29
east branch	16913	8500 cfs WSE 172	Proposed Alt 1	1923.48	167.73	178.03	173.69	178.30	0.000675	4.38	514.89	139.94	0.30
east branch	16913	100-year WSE 172	Existing	1000.00	167.73	177.25	172.09	177.38	0.000322	2.86	349.37	109.63	0.20
east branch	16913	100-year WSE 172	Proposed Alt 1	1000.00	167.73	177.15	172.09	177.28	0.000338	2.91	343.46	108.29	0.21
east branch	17022	8500 cfs WSE 172	Existing	1974.25	167.26	178.20	173.47	178.41	0.000528	3.96	616.39	160.09	0.26
east branch	17022	8500 cfs WSE 172	Proposed Alt 1	1980.23	167.26	178.15	173.48	178.37	0.000548	4.01	608.94	159.99	0.27
east branch	17022	100-year WSE 172	Existing	1000.00	167.26	177.31	171.77	177.42	0.000272	2.66	375.54	118.26	0.19
east branch	17022	100-year WSE 172	Proposed Alt 1	1000.00	167.26	177.20	171.77	177.32	0.000284	2.71	369.40	116.96	0.19
east prancn	1/122.99			Lat Struct				_		_	_		

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ff)	(ft/ft)	(ft/s)	(sq ft)	(ff)	
st branch	17123	8500 cfs WSE 172	Existing	2000.00	168.33	178.22	173.81	178.49	0.000649	4.31	536.85	120.77	0.25
st branch	17123	8500 cfs WSE 172	Proposed Alt 1	2000.00	168.33	178.18	173.81	178.45	0.000666	4.35	531.56	120.69	0.30
st branch	17123	100-year WSE 172	Existing	1000.00	168.33	177.33	172.18	177.45	0.000293	2.74	365.13	94.29	0.19
st branch	17123	100-year WSE 172	Proposed Alt 1	1000.00	168.33	177.23	172.18	177.35	0.000307	2.78	359.14	93.58	0.20

# APPENDIX D - SCOUR CALCULATIONS

West Bridge



# HEC-18 5th Edition - Scour Calculation Spreadsheet (1D)

## Live Bed Contraction Scour

<u>Live Bed Contraction Scour</u>: Scour at a contraction when the bed material in the channel upstream of the bridge is moving at the flow causing bridge scour.

	Modified Laursen's Equation (1): $y_2 = \begin{pmatrix} y_2 \\ y_1 \end{pmatrix}$	$\left(\frac{Q_2}{Q_1}\right)^{6/7} \left(\frac{W}{W}\right)^{6/7}$	$\left(\frac{I_1}{I_2}\right)^{k_1}$	Average (	Contractio	$y_s = y_2 - y_0$
Parameter	Description	Metric	: Units	USU	Inits	Notes
y <sub>o</sub>	Existing Depth in the Contracted Section Before Scour	3.90	(m)	12.80	(ft)	Flow area of bridge l'W 2
<b>y</b> 1	Average Depth in the Upstream Channel	4.88	(m)	16.02	(ft)	Data from Chosen Upstream XS
y <sub>2</sub>	Average Depth in the Contraction Section	4.90	(m)	16.07	(ft)	Nodified Laursen's Equation
Q <sub>1</sub>	Flow in the Upstream Channel Transporting Sediment	189.78	(m <sup>3</sup> /s)	6701.86	(cfs)	Flow in the main channel upstream of the bridge, not including overbank flow.
Q <sub>2</sub>	Flow in the Contracted Channel	205.56	(m³/s)	7259.46	(cfs)	Flow at the bridge section (through the bridge opening)
W <sub>1</sub>	Bottom Width of the Upstream Main Channel that is Transporting Bed Material	29.65	(m)	97.29	(ft)	Can be estimated by Upstream Channel Top Width. Data from Chosen Upstream XS
W <sub>2</sub>	Bottom width of the Contracted Section Minus Pier and Debris Width	32.61	(m)	107.00	(ft)	Effective Bridge Width Calculated Given Bridge, Pier, and Debris Width
S <sub>1</sub>	Slope of EGL of Upstream Channel	0.00	(m/m)	0.00	(ft/ft)	Data hom Chosen Upstream XS
V*	Shear Velocity in the Upstream Main Channel	0.10	(m/s)	0.32	(ft/s)	Calculated from data from Chosen Upstream XSIst. [ V = (gy <sub>1</sub> , S <sub>1</sub> ) <sup>6,8</sup> ]
ω	Fall Velocity of Bed Material based on D50	0.04	(m/s)	0.12	(ft/s)	See Fall Velocity Tab
V*/ω	Ratio of Shear Velocity to Fall Velocity	2.697	-	2.697	-	Determines Mode of Bed Transport and k-
k <sub>1</sub>	Modified Laursen's Equation Exponent	0.69	-	0.69	-	See Table 2 to the right.

Average Live Bed Contraction	3.3	(ft)
Scour Depth (y <sub>s</sub> )	1.0	(m)





**Pier Scour** 

Pier Scour is a function of bed material characteristics, bed configuration, flow characteristics, fluid properties, and the geometry of the pier and footing.

### 1). HEC-18 5th Edition Pier Scour Equation (based on the CSU Equation)

	HEC-18 Equation: $\frac{y_s}{y_1} = 2.0 \text{ K}_1 \text{ K}_2 \text{ K}_3 \left( -\frac{y_1}{y_1} + \frac{y_2}{y_1} + \frac{y_2}{y_1} \right)$	$\frac{a}{y_1}\right)^{0.65} Fr_1^0$	1,43	In terms	of y₅/a:	$\frac{y_{s}}{a} = 2.0 \text{ K}_{1} \text{ K}_{2} \text{ K}_{3} \left(\frac{y_{1}}{a}\right)^{0.35} \text{ Fr}_{1}^{0.43}$
Parameter	Description	Metric	: Units	USU	Jnits	Notes
<b>у</b> 1	Flow depth directly upstream of the pier	3.90	(m)	12.81	(ft)	Obtained from (BR U) Flow Distribution Table; Bridge Information Macro
θ	Angle of attack of the flow (skew)	0	(deg)	0	(deg)	Bridge Skew
K <sub>1</sub>	Correction factor for Pier nose shape	1.0	-	1.0	-	Use Figure 7.3 and Table 7.1 If θ > 5 degrees, K <sub>1</sub> = 1.0
K <sub>2</sub>	Correction factor for angle of attack of flow	1.0	-	1.0		$K_2 = [(\cos(\theta) + \sin(\theta) * L/A)^{0.05}]$ $(where L/A_{max} = 12)$
K <sub>3</sub>	Correction factor for bed condition	1.0	-	1.0	-	Use Table 7.3
а	Pier Width (including bottom width)	1.2	(m)	4.00	(ft)	Bottom Pier Width; no floating debris included
L	Length of Pier	0.0	(m)	0.0	(ft)	See Figure 7.3 for Guidance
V <sub>1</sub>	Velocity of flow directly upstream of the pier	2.66	(m/s)	8.73	(ft/s)	Obtained from (BR U) Flow Distribution Table; Bridge Information Macro
Fr <sub>1</sub>	Froude Number directly upstream of the pier	0.43	-	0.43	-	$Fr_{1} = [V_{1} / (gy_{1})^{1/2}]$

HEC-18 Equation Maximum	8.4	(ft)
Pier Scour Depth (y <sub>s</sub> )	2.5	(m)

\*Note for Round Nose Piers:

Maximum Scour Depth ( $y_s$ ) is typically  $\leq$  (2.4 \* a) for Fr  $\leq$  0.8  $\rightarrow$ 2.4 \* a = 9.60 Maximum Scour Depth (y<sub>s</sub>) is typically  $\leq$  (3.0 \* a) for Fr > 0.8  $\rightarrow$ 3.0 \* a = 12.00

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Figure 7.3. Common pier shapes.

Shape of Pier Nose	K <sub>1</sub>
(a) Square nose	1.1
(b) Round nose	1.0
(c) Circular cylinder	1.0
(d) Group of cylinders	1.0
(e) Sharp nose	0.9

Table 7.3. Increase in Equilibrium Pier Scour Depths, K <sub>3</sub> , for Bed Condition.							
Bed Condition	Dune Height ft	K <sub>3</sub>					
Clear-Water Scour	N/A	1.1					
Plane bed and Antidune flow	N/A	1.1					
Small Dunes	10 > H ≥ 2	1.1					
Medium Dunes	30 > H ≥ 10	1.2 to 1.1					
Large Dunes	H ≥ 30	1.3					



2a) Scour occurring when the abutment is in or close to the main channel (Live Bed)

$(a)^{6/7}$		
$ \mathbf{y}_{c} = \mathbf{y}_{1}   \frac{\mathbf{q}_{2c}}{c}$	$y_{max} = \alpha_A y_c$	$y_s = y_{max} - y_0$
$(\mathbf{q}_1)$		

Parameter	Description	Metri	c Units	US Units		Notes
<b>y</b> 1	Upstream flow depth	4.88	(m)	16.02	(ft)	Flow area of bridge l'M $_{z}$
y <sub>o</sub>	Flow depth prior to scour	3.90	(m)	12.80	(ft)	Data from chosen upstream XS
αa	Amplification factor for live-bed conditions		-	1.20	-	For spill through abutments: Use Figure 8.9 For wingwall abutments: Use Figure 8.10
W1	Width of the upstream channel	29.65	(m)	97.29	(ft)	Width of Flow upstream of the bridge section
Q <sub>1</sub>	Flow in the upstream channel	189.78	(m <sup>3</sup> /s)	6701.9	(ft <sup>3</sup> /s)	Flow upstream of the bridge section
q <sub>zc</sub>	Unit discharge in the constricted opening accounting for non-uniform flow distribution	6.30	(m²/s)	67.85	(ft²/s)	Estimated as the total discharge in the bridge opening divided by the width of the bridge opening: $Q \ge 1/M_{\odot}$
q <sub>1</sub>	Upstream unit discharge	6.40	(m <sup>2</sup> /s)	68.89	(ft <sup>2</sup> /s)	Q,1W,
q <sub>2</sub> /q <sub>1</sub>	Ratio of unit discharge	0.98	(m)	0.98	(ft)	Value used in Figure 8.9 and Figure 8.10 to determine amplification factor
y <sub>c</sub>	Flow depth including live-bed contraction scour	4.82	(m)	15.81	(ft)	Equation Above
<b>y</b> <sub>max</sub>	Max flow depth resulting from abutment scour	5.78	(m)	18.97	(ft)	Equation Above

6.2

1.9

(ft)

(m)

Live Bed Abutment Scour Depth (v <sub>s</sub> )	

East Bridge



HEC-18 5th Edition - Scour Calculation Spreadsheet (1D)

# Live Bed Contraction Scour

<u>Live Bed Contraction Scour</u> : Scour at a contraction when the bed material in the channel upstream of the bridge is moving at the flow causing bridge scour.

	$\frac{y_2}{y_1} = \left(\frac{y_2}{y_1}\right)$	$\left(\frac{Q_2}{Q_1}\right)^{6/7} \left(\frac{W}{W}\right)^{6/7}$	$\left(\frac{V_1}{V_2}\right)^{k_1}$	Average	Contractio	$y_s = y_2 - y_0$
Parameter	Description	Metri	c Units	USU	Inits	Notes
Уо	Existing Depth in the Contracted Section Before Scour	1.37	(m)	4.50	(ft)	Flow area of bridge I'w <sub>2</sub>
<b>y</b> 1	Average Depth in the Upstream Channel	2.26	(m)	7.42	(ft)	Data from Chosen Upstream XS
y <sub>2</sub>	Average Depth in the Contraction Section	2.50	(m)	8.20	(ft)	Modified Laursen's Equation
Q <sub>1</sub>	Flow in the Upstream Channel Transporting Sediment	33.80	(m <sup>3</sup> /s)	1193.77	(cfs)	Flow in the main channel upstream of the bridge, not including overbank flow.
Q <sub>2</sub>	Flow in the Contracted Channel	35.13	(m <sup>3</sup> /s)	1240.54	(cfs)	Flow at the bridge section (through the bridge opening)
W <sub>1</sub>	Bottom Width of the Upstream Main Channel that is Transporting Bed Material	17.93	(m)	58.83	(ft)	Can be estimated by Upstream Channel Top Width, Data from Chosen Upstream XS
W <sub>2</sub>	Bottom width of the Contracted Section Minus Pier and Debris Width	16.27	(m)	53.39	(ft)	Effective Bridge Width Calculated Given Bridge, Pier, and Debris Width
S <sub>1</sub>	Slope of EGL of Upstream Channel	0.00	(m/m)	0.00	(ft/ft)	Data from Chosen Upstream XS
V*	Shear Velocity in the Upstream Main Channel	0.07	(m/s)	0.23	(ft/s)	Calculated from data from Chosen Upstream XSIst. [ V = (gy + S + ) <sup>ks</sup> ]
ω	Fall Velocity of Bed Material based on D50	0.02	(m/s)	0.07	(ft/s)	See Fall Velocity Tab
V*/ω	Ratio of Shear Velocity to Fall Velocity	3.302	-	3.302	-	Determines Mode of Bed Transport and k-,
k <sub>1</sub>	Modified Laursen's Equation Exponent	0.69	-	0.69	-	See Table 2 to the right.

Average Live Bed Contraction	3.7	(ft)	
Scour Depth (y <sub>s</sub> )	1.1	(m)	



2a) Scour occurring when the abutment is in or close to the main channel (Live Bed)

(	a ) <sup>6/7</sup>		
$\mathbf{y}_{c} = \mathbf{y}_{1}$		$y_{max} = \alpha_A y_c$	$y_s = y_{max} - y_0$
	<b>(Y</b> <sub>1</sub> <b>)</b>		

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Parameter	Description	Metrie	c Units	US Units		US Units		US Units		Notes
<b>y</b> 1	Upstream flow depth	2.26	(m)	7.42	(ft)	Flow area of bridge I W $_{2}$				
y <sub>o</sub>	Flow depth prior to scour	1.37	(m)	4.50	(ft)	Data from chosen upstream XS				
αa	Amplification factor for live-bed conditions	1.70	-	1.70	-	For spill through abutments: Use Figure 8.9 For wingwall abutments: Use Figure 8.10				
W <sub>1</sub>	Width of the upstream channel	17.93	(m)	58.83	(ft)	Width of Flow upstream of the bridge section				
Q <sub>1</sub>	Flow in the upstream channel	33.80	(m <sup>3</sup> /s)	1193.8	(ft <sup>3</sup> /s)	Flow upstream of the bridge section				
q <sub>2c</sub>	Unit discharge in the constricted opening accounting for non-uniform flow distribution	2.16	(m²/s)	23.24	(ft²/s)	Estimated as the total discharge in the bridge opening divided by the width of the bridge opening: $Q_2 : / M_2$				
q <sub>1</sub>	Upstream unit discharge	1.89	(m <sup>2</sup> /s)	20.29	(ft²/s)	$Q_{j}/N_{j}$				
q <sub>2</sub> /q <sub>1</sub>	Ratio of unit discharge	1.15	(m)	1.15	(ft)	Value used in Figure 8.9 and Figure 8.10 to determine amplification factor				
Уc	Flow depth including live-bed contraction scour	2.54	(m)	8.33	(ft)	Equation Above				
<b>y</b> <sub>max</sub>	Max flow depth resulting from abutment scour 4.32 (m) 14.17				(ft)	Equation Above				
	Live Red Abutment	9.7	(ft)							

(m)

Live Bed Abutment Scour Depth (y <sub>s</sub> )	9.7
1 (23)	2.9

APPENDIX E – LOCATION HYDRAULIC STUDY

# LOCATION HYDRAULIC STUDY FORM

District:	6	Co.	Fresno	Rte.	Manning Av	<u>ve</u> P.M.
Adv No.		Fed Aid	d No. <u>BRLS-</u>	<u>5942(233)</u>	Bridge Nos.	42C0066 and 42C0067

Floodplain Description:

Are NFIP maps and studies available?

Within the project area, James Bypass runs northwesterly through the central part of Fresno County. James Bypass is operated by the James Irrigation District (JID) and was constructed as an overflow channel from Kings River to San Joaquin River. Within the project area, there are two channels within the bypass; one along the western edge and the other along the eastern edge. The western branch is approximately 140 feet from top of bank to top of bank with an approximate depth of 14 feet from top of bank to toe. The eastern branch is approximately 85 feet from top of bank to top of bank to top of bank with an approximate depth of 12.5 feet from top of bank to toe. Bridge #42C0066 crosses the west branch and bridge # 42C0067 crosses the east branch. Within the project area, James Bypass is bounded by levees on each side. The area surrounding the project site is agricultural. The banks are sparsely vegetated and the channel bed is composed of clayey sand to poorly graded sand (at 42C0066) and silty sand (at 42C0067).

1. Description of Proposal (include any physical barriers i.e. concrete barriers, soundwalls etc. and design elements to minimize floodplain impacts)

Fresno County is proposing to replace two County owned bridges (No. 42C0066 & No. 42C0067) along the Manning Avenue corridor over the James Bypass Overflow. The purpose of the proposed project is to replace these bridges which were revealed to be structurally deficient with a 2011 sufficiency rating of 62.2 for both bridges. Due to the relatively close proximity of the two bridges, they have been programmed for concurrent replacement in order to maximize efficiencies during design and construction. Replacement funding will be provided through the FHWA Highway Bridge Program (HBP).

2.	ADT:Current <u>1,600 (2013)</u> Project	ed <u>2,530</u>	(2036)				
3.	Hydraulic Data: Base Flood $>Q_{100} = 7$ .	389 cfs at west	t bridge_	WSE <sub>&gt;100</sub> = <u>175</u>	.3 ft upstream fa	ce of west bridge	<u>2</u>
	= <u>1</u>	,111 cfs at east	t bridge	WSE <sub>&gt;100</sub> = <u>177</u>	.3 ft upstream fa	ce of east bridge	
	= 8	500 cfs Total					
	The flood of record, if greater than $Q_{100}$	Q= <u>n/a</u>	CFS	WSE= <u>n/a</u>			
	Overtopping flood Q=	<u>&gt;&gt;Q100</u> CFS	WSE=	approx.182.0 (	existing roadway	y elevation east o	<u>f site)</u>
		For flows branch ov of the pro	much hi vertops fin ject. The	gher than the b rst and will eve project bridge	ase flood, the le entually overtop s do not overtop	vee along the eas Manning Avenue in this scenario.	t east

YES 🖂

NO 🗌



Figure 1: Water Surface Profile through the west bridge reach (comparison of existing to proposed)



Figure 2. Water Surface Profile through the east bridge reach (comparison of existing to proposed)

District:6Co.FresnoRte.Manning AveP.M.Adv No.Fed Aid No.BRLS-5942(233)Bridge Nos.42C0066 and 42C0067

### 4. Is the highway location alternative within a regulatory floodway? YES NO

The reach is in a Zone A FEMA floodplain without Base Flood Elevations determined as shown in Figure 3 and Figure 4.



Figure 3. FEMA FIS FIRM Panel 2550 of 3525 dated February 18, 2009

District:6Co.FresnoRte.Manning AveP.M.Adv No.\_\_\_\_\_\_Fed Aid No.BRLS-5942(233)Bridge Nos.42C0066 and 42C0067



Figure 4. FEMA FIS FIRM Panel 2575 of 3525 dated February 18, 2009

5. Attach map with flood limits outlined showing all buildings or other improvements within the base floodplain. Potential Q100 backwater damages: The water surface elevation within the floodplain upstream from the bridges is slightly lowered as a result of the proposed bridges as shown in Figure 1 and Figure 2. Even though the water surface profiles change slightly (approximately 0.2 ft at most), the limits of the floodplain are unchanged as shown in Figure 5.

District: Adv No.	<u>    6                                </u>	Co. <u>Fresno</u> Fed Aid No. <u>BRLS</u>	Rte. -5942(233)	<u>Manning</u> Bridge Nos	<u>Ave_</u> . <u>42C0066 a</u>	P.M. nd 42C0067		
							EAST E	BRIDGE
MANN	ING AVE	4						
	WEST BRIDGE							
相關語题		國際局部非計劃的電影。	被服服 影響。	1 CM		100-yr	WSE	Evicting
	Figure 5. 100-year	water surface elevation	n delineated on	Plan View fo	or Existing and	and d Proposed Co	WSE Proposi onditions	sed
A.	Residences? There are no reside	ences in the vicinity oj	NO 🛛	YES bridges as s	Shown in Figu	ure 5.		
В.	Other Bldgs? There are no build	ings in the vicinity of t	NO 🖾	YES bridge as she	Down in Figure	5.		
C.	Crops? There are crops ad Figure 5. The crop will have no impac	ljacent to the floodpla os are on the "dry side t on the crops.	NO in upstream a e" of the levee	YES nd downstre e and the floo	(X) am from the p odplain is und	proposed bri changed, the	dges as s proposed	hown in l bridges

D. Natural and beneficial Floodplain values? NO YES Since the floodplain is unchanged, the proposed bridges will have no impact on the floodplain values.

"Natural and beneficial flood-plain values" shall include but are not limited to fish, wildlife, plants, open space, natural beauty, scientific study, outdoor recreation, agriculture, aquaculture, forestry, natural moderation of floods, water quality maintenance and groundwater recharge.

District: Adv No.		<u>    6                                </u>	Co. <u>F</u> Fed Aid	<u>resno</u> No. <u>BRLS-</u> :	R 5942(23	te. <u>33)</u>	<u>Manning</u> Bridge No	<u>Ave</u> s. <u>42C0066</u>	P.M. and 42C0067
6.	Туре	of Traffic:							
	А.	Emergency supply or evacuation route?			NO		YES	$\boxtimes$	
	B.	Emergency vehicle access? Practicable detour available? School bus or mail route?			NO		YES	$\boxtimes$	
	C.				NO		YES	$\boxtimes$	
	D.				NO		YES	$\boxtimes$	
7.	Estin	nated duration of traf	0-year o	event	(hours):	0	_		
8.	Estin	nated value of Q100 flood damages (if any) – moderate risk level.							
	А.	Roadway	\$ <u> </u>	0					
	В	Property	\$	0					
		Total	\$	0					
9.	Asses	ssment of Level of R	isk Lo <sup>.</sup> Mo Hig	w oderate gh					

For High Risk projects, during design phase, additional Design Study Risk Analysis may be necessary to determine design alternative.

Rte. District: Co. Fresho 6 Adv No. Fed Aid No. BRLS-5942(233)

Manning Ave P.M. Bridge Nos. 42C0066 and 42C0067

# PREPARED BY:

(Item numbers 3, 4, 5, 7, 9)



Signature – Hydraulic Engineer 64 Catherine M.C. Avila, P.E.

Date May 31, 2014

Is there any longitudinal encroachment, significant encroachment, or any support of incompatible Floodplain development? No X Yes

If yes, provide evaluation and discussion of practicability of alternatives in accordance with 23 CFR 650.113

Information developed to comply with the Federal requirement for the Location Hydraulic Study shall be retained in the project files.

Signature - Project Engineer Mark a. Gran Date May 31, 2016. (Item numbers 1, 2, 6, 8)

APPENDIX F – SUMMARY FLOODPLAIN ENCROACHMENT REPORT

# SUMMARY FLOODPLAIN ENCROACHMENT REPORT\*

District:	6	Co.	Fresno	Rte.	Manning Ave	P.M. <u>0.XX</u>
Adv No.		Fed A	id No	Bridge	Nos. <u>42C0066 and</u>	d 42C0067

### Limits:

Fresno County is proposing to replace two County owned bridges (No. 42C0066 & No. 42C0067) along the Manning Avenue corridor over the James Bypass Overflow. The purpose of the proposed project is to replace these bridges which were revealed to be structurally deficient with a 2011 sufficiency rating of 62.2 for both bridges. Due to the relatively close proximity of the two bridges, they have been programmed for concurrent replacement in order to maximize efficiencies during design and construction. The proposed bridges will improve the hydraulics by eliminating some of the existing piers in the channel and maintaining the existing soffit elevation.

### Floodplain Description:

The proposed bridge is within an existing FEMA Zone A floodplain without Base Flood Elevations determined.

1.	Is the proposed action a longitudinal encroachment of the base floodplain? The proposed bridges are not a longitudinal encroachment.	No ⊠	Yes	
2.	Are the risks associated with the implementation of the proposed action significant? <i>The level of risk to the floodplain of the project site is low.</i>	$\boxtimes$		
3.	Will the proposed action support probable incompatible floodplain development? <i>The proposed bridge replacement will not support incompatible floodplain development.</i>	$\boxtimes$		
4.	Are there any significant impacts on natural and beneficial floodplain values? The proposed construction will have only minor impact to the existing riparian habitat in the creek at the bridge site.	$\boxtimes$		
5.	Routine construction procedures are required to minimize impacts on the floodplain. Are there any special mitigation measures necessary to minimize impacts or restore and preserve natural and beneficial floodplain values? If yes, explain. <i>Best management practices for erosion control measures should be used for proposed</i> <i>construction to minimize temporary impacts to the floodplain during construction.</i>			
6.	Does the proposed action constitute a significant floodplain encroachment as defined in 23 CFR, Section 650.105(q).			
7.	Are Location Hydraulic Studies that document the above answers on file? If not explain.		$\boxtimes$	

<sup>\*</sup> Same as Figure 804.7B Floodplain Evaluation Report Summary located in Chapter 804 of the *Highway Design Manual* 

PREPARED BY:

May 31, 2016 Date

gnature - Hydraulic Engineer

I Concur:

Signature District Hydraulic Engineer

61 Date

Signature - District Environmental Branch Chief

0

6/3/2016 Date 3/14

2016

Date

Signature - District Local Assistance Engineer