LOWER MINNESOTA RIVER
WATERSHED DISTRICT

Executive Summary for Action

Lower Minnesota River Watershed District Board of Managers Meeting
Wednesday April 17, 2019

Agenda Item
Item 6. B. - Dredge Management

Prepared By
Linda Loomis, Administrator

Summary

i. **Funding for dredge material management**
The LMRWD is included in the BWSR budget for $480,000 for the biennium. We were surprised (as was BWSR) to find this in the House omnibus bill from the Environment and Natural Resource Finance Committee. Apparently, when the appropriation for the LMRWD was included in 2017 legislation it did not specify that funding was a one time appropriation.

ii. **Vernon Avenue Dredge Material Management site**
The no-rise evaluation and the 60% design plan has been provided to the City of Savage. Staff is meeting with the city staff on Friday, April 12 to discuss the proposed reconfiguration of the site.

I visited the site on Tuesday, April 9 and was not able to get in as Vernon Avenue and the access road into the site were flooded. The river elevation that day was just above 708 feet; flood stage is 702 feet. The berm containing the private dredge material exhibited some minor erosion; however, it appears the flood water did not overtop the berm.

iii. **Private Dredge Material Placement**
Private terminals are in the process of getting DNR permits to dredge this spring. They will have to wait until the flood waters recede in order to remove material currently on site. New material cannot be placed until the prior year's material has been removed.

Attachments
No-rise evaluation
60% design plan set

Recommended Action
No recommended action

resourceful. naturally.
engineering and environmental consultants

BARR

Technical Memorandum

To: Della Schall Young, Young Environmental Consulting Group
From: Jeff Weiss, Barr Engineering Co.
Subject: Minnesota River No-Rise Certification Evaluation - DRAFT
Date: March 8, 2019
Project: 23701082

The purpose of this memorandum is to provide a summary of the evaluation of potential impacts of the proposed modifications to the Cargill East River Dredge Material Site (Dredge Site) on the modeled water surface elevations for 1% Annual Exceedance Probability Flood, commonly referred to as the 100-year flood, on the Minnesota River. The Dredge Site Project will require information that supports a Minnesota "No-Rise" Certification, which certifies the project will have not result in a modification of the flood plain by more than 0.00 feet. The memorandum summarizes the analysis completed to determine the conditions for which a "No-Rise" Certification can be achieved.

Project Overview and Study Area

The purpose of the Dredge Site Project is to establish permanent berms and facilities to store and dewater dredge material generated from the Minnesota River and nearby commercial facilities. Dredge material is current stored at the site on a temporary basis; however, the Dredge Site Project will establish a permanent configuration for stored materials. Background information on the Dredge Site Project is included in a technical memorandum from Burns & McDonnell and Young Environmental Consulting Group, dated February 15, 2017, and the Cargill East River (MN – 14.2 RMP) Dredge Material Site Management Plan (Lower Minnesota River Watershed District, 2013).

The study area is on the floodplain of the Minnesota River, near the Soo Line Railroad Bridge in Savage, MN (Figure 1). The main study area was concentrated between rivers stations 35 and 39; however, as discussed in the hydraulic analysis section below, the analysis reviewed modeling results further upstream of River Station 39.

Hydraulic Analysis

The hydraulic analysis utilized the HEC-RAS model (version 5.0.6) used by the U.S. Army Corps of Engineers (USACE) to develop the effective floodplain for the Minnesota River within the study area. The USACE developed the base model in 2004 (see Attachment A). The original model configuration was preserved as a reference, and to be consistent with other FEMA floodplain analyses the original configuration is referred to as the Duplicate Effective Model.

Barr Engineering Co. (Barr) modified the Duplicate Effective Model to more accurately model existing conditions at and near the Dredge Material Site. The modified model is referred to as the Corrected Effective Model and is used as a basis of comparison for the Proposed Conditions Model. The focused area of study is shown in Figure 1.

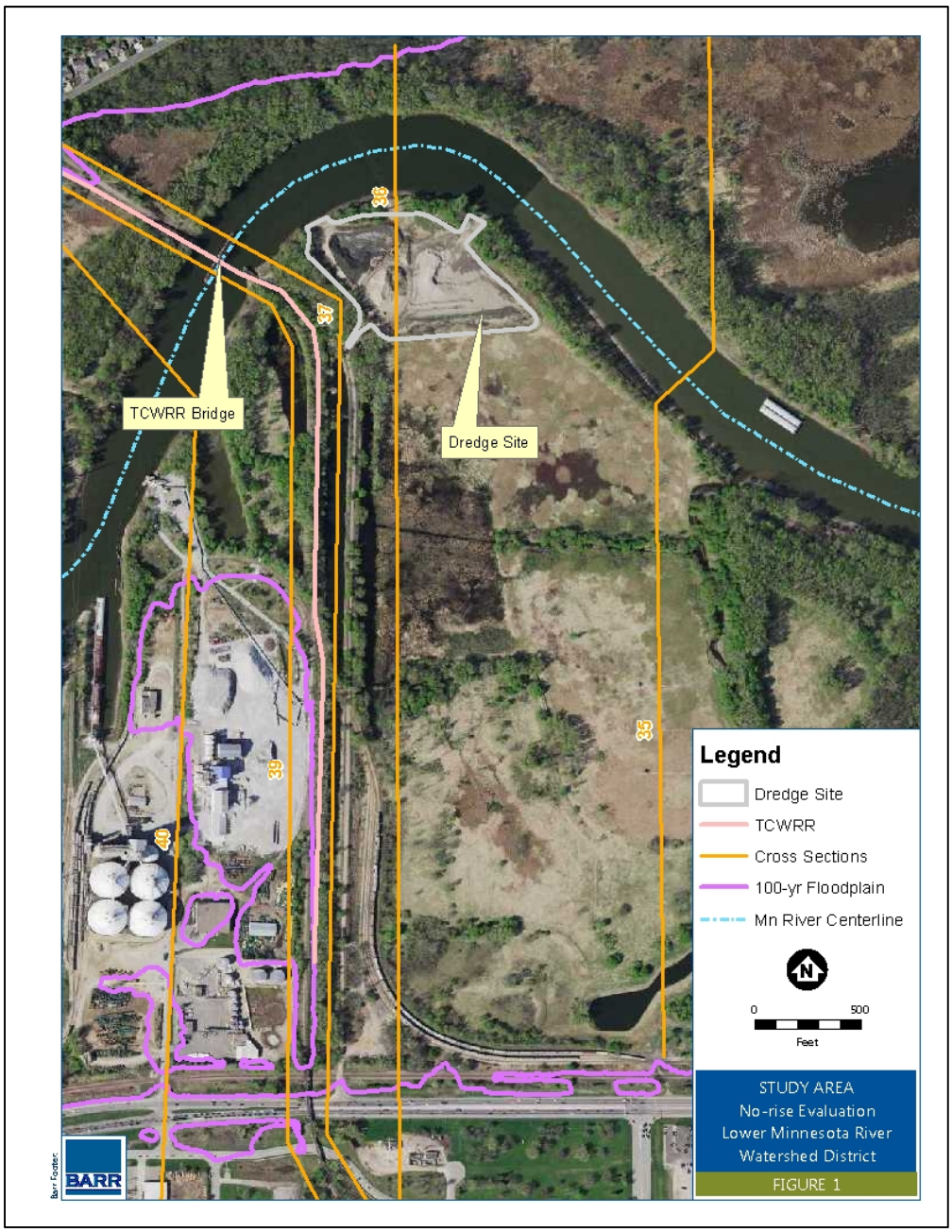

Figure 1 – Dredge site study area between cross sections 35 and 39.

The following bullet points highlight key modifications to create the Corrected Effective Model:

- Ineffective flow areas upstream and downstream of the TCWRR Bridge were modified to more accurately model the flow at the bridge
- Manning's n roughness values were adjusted in some areas to reflect existing vegetation cover.
- Additional cross sections were added in the study area to more accurately model transitions between different topographic features.

All other aspects of the model (e.g. flows, boundary conditions, modeling parameters, etc.) were left unchanged between the duplicate effective and corrected effective models. However, one feature that should be noted is that neither the Duplicate Effective Model nor the Corrected Effective Model include the temporary berms and dredge material that is often on site.

Ineffective flow areas

The modifications to the ineffective flow areas were the most significant change made to the Corrected Effective Model and warrant additional discussion. The ineffective flow areas were initially adjusted by using guidelines in the Bridge Hydraulic Analysis with HEC-RAS (USACE, 1996). The ineffective flow areas were further modified to more accurately account for the specific flow characteristics regarding depth of overtopping flow and the height of the railroad in relation to the floodplain. The top of the railroad is significantly higher (~16 feet) than much of the adjacent floodplain. If flood flows remain below the top of the railroad, then the railroad creates a significant "shadow" where most of the water adjacent to the railroad is effectively backwater and not actively flowing. A portion of the railroad and bridge is overtopped by a relatively small depth (~2.5 feet on average) during the 100-year flood; however the depth of overtopping the railroad is significantly smaller than the elevation difference between the top of the railroad and the adjacent floodplain. To accurately account for the effective flow area upstream and downstream of the bridge, the effective flow and ineffective flow areas were modeled in the following ways:

- The expansion and contraction of the effective flow areas were modeled using guidelines in Bridge Hydraulic Analysis with HEC-RAS (USACE, 1996)
- The area of effective flow above the top of the bridge due to overtopping flows was preserved in upstream and downstream cross sections
- Areas of ineffective flow were preserved if they were too far from the bridge opening to be effective flow or too far below the elevation of the overtopping railroad and bridge to be effective flow.

The difference in the modeled ineffective flow areas for the Duplicate Effective Model and the Corrected Effective Model are illustrated in Figures 2 and 3.

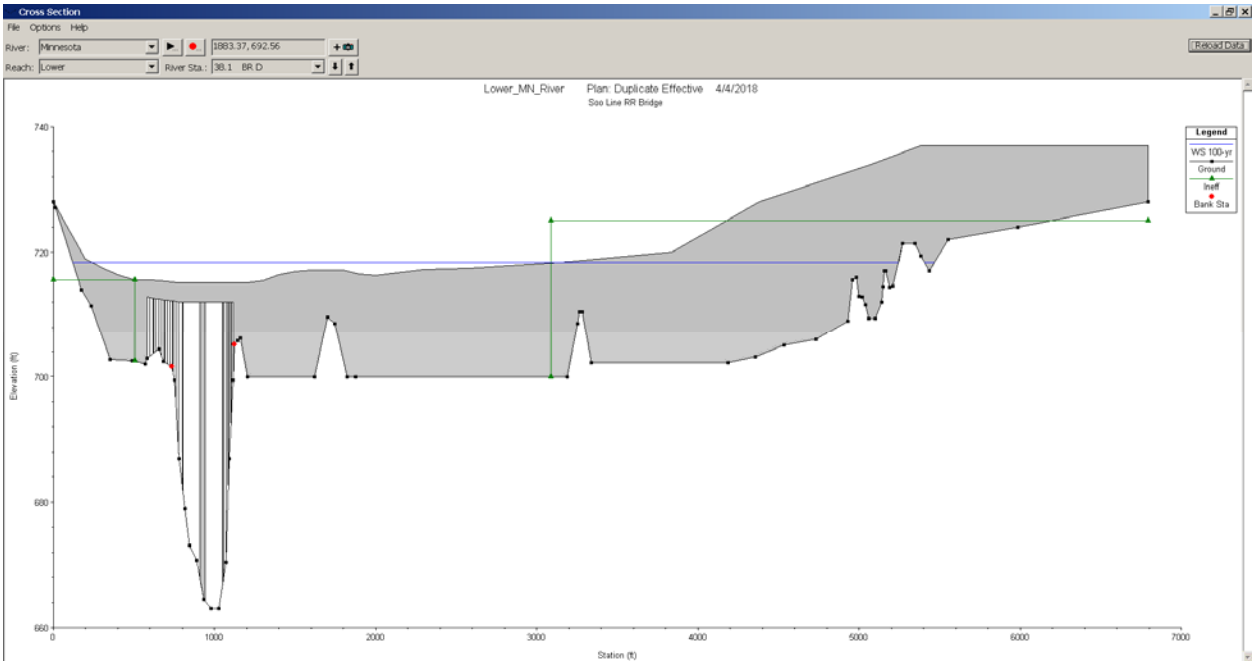

Figure 2 – Cross Section at Railroad Bridge in Duplicate Effective Model. Note little ineffective flow area (inside green outline) below the top of the railroad

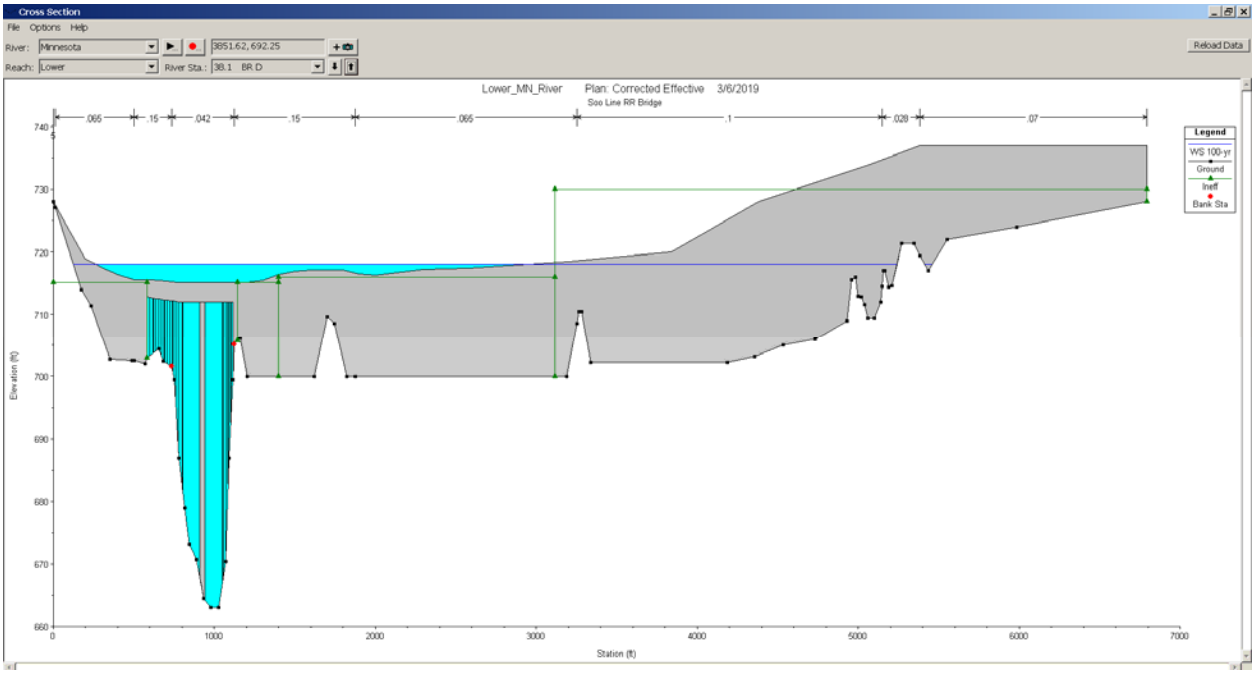

Figure 3 – Cross Section at Railroad Bridge in Corrected Effective Model. Note added ineffective flow area (green outlines) below the top of the railroad

Proposed Conditions Model

The modifications made to create the Corrected Effective Model were carried forward to the Proposed Conditions Model such that the only changes made to the proposed conditions model was to add the proposed permanent storage and dewatering areas for dredge materials. The comparison of existing and proposed cross sections is shown in Figures 4 and 5 on the following page.

Table 1 includes the comparison of modeled water surface elevations for the Corrected Effective and Proposed conditions models. The no-rise certification requires a change of no more than 0.00 for any modeled water surface elevation. The proposed berm elevations are 715.0 for the northtwo western storage areas and 706.0 feet for the eastern storage area. These initial berm elevations were found to create changes to the modeled 100-year floodplain, so the berm elevations were modified iteratively until the maximum elevations were found that would also comply with the criteria to complete a No-Rise Certification. Table 1 shows the modeling results for the project area.

Table 1 HEC-RAS model results for water surface elevations within the study area

	River Station	35	35.5[a]	35.75[a]	36	36.5[a]	37	TCWRR Bridge	39	40
1% AEP Event	Corrected Effective	717.36	717.41	717.45	717.53	717.67	717.75		718.00	718.61
	Proposed	717.36	717.41	717.45	717.53	717.67	717.75		718.00	718.61
	Difference	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00
Floodway	Corrected Effective	717.58	717.62	717.67	717.73	717.91	717.98		718.18	718.78
	Proposed	717.58	717.62	717.66	717.73	717.91	717.98		718.18	718.78
	Difference	0.00	0.00	-0.01	0.00	0.00	0.00		0.00	0.00

a – Cross section added to more accurately model the project area

The no-rise certification requires no more than a 0.00 change in the water surface elevation for any modeled cross section for both the 1% AEP Event and the Floodway. As can be seen in Table 1, this criteria is met for all cross sections except for cross section 35.75, where the proposed conditions model results have a decrease of 0.01 feet for the Floodway model. When the model results are expanded to more decimal places, the modeled water surface elevations for the corrected effective and proposed conditions for the Floodway model are 717.6660 and 717.6649, respectively. Therefore, the difference in the modeled water surface elevation is only 0.0011 feet and the difference shown in Table 1 is attributed to rounding. The HEC-RAS model results are both the 1% AEP Event and the Floodway model are included as attachments A and B to this memorandum.

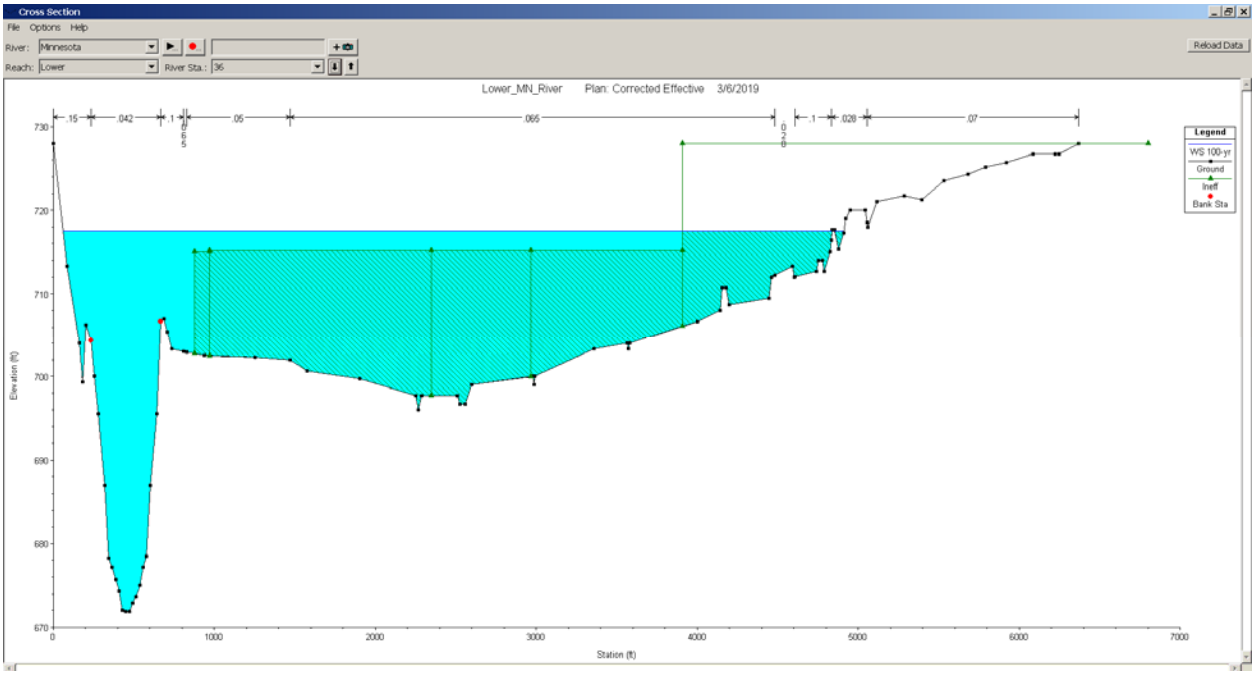

Figure 4 – Cross Section at River Station 36 in Corrected Effective Model. Green hatch areas are ineffective flow areas.

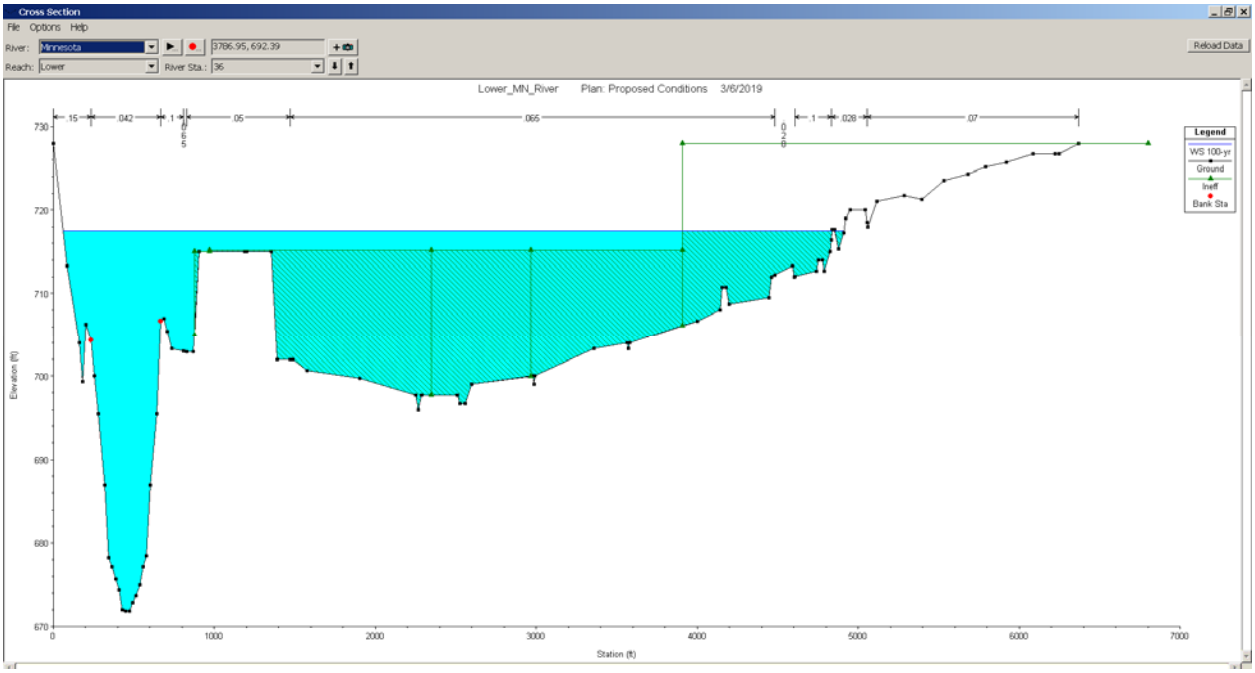

Figure 5 - Cross Section at River Station 36 in Proposed Conditions Model. Green hatch areas are ineffective flow areas. Ground was modified to show proposed berms and storage areas

Conclusion

The proposed project to construct permanent berms within the project area will not cause an increase in modeled flood elevations, and a no-rise certification is justified.

References

Burns & McDonnell, Technical Memorandum, February 15, 2017

LMRWD. January 2013. "Cargill East River (MN – 14.2 RMP) Dredge Material Site Management Plan" Lower Minnesota River Watershed District.

USACE. April 1996. "Bridge Hydraulic Analysis with HEC-RAS" TP – 151. US Army Corps of Engineers Institute for Water Resources, Hydrologic engineering Center, Davis, CA

Attachments:

Attachment A: HEC-RAS model results for the 1% AEP Event
Attachment B: HEC-RAS model results for the Floodway model
Attachment C: Minnesota "No-Rise" Certification

HEC-RAS River: Minnesota Reach: Lower Profile: 100-yr

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)	(ft)	
Lower	41	100-yr	Corrected Eff	103000.00	670.20	718.94	689.97	719.01	0.000060	3.15	73948.68	4531.93	0.09
Lower	41	100-yr	Ppsd cond	103000.00	670.20	718.94	689.97	719.01	0.000060	3.15	73951.13	4531.95	0.09
Lower	40	100-yr	Corrected Eff	103000.00	672.10	718.61	692.10	718.85	0.000143	4.88	43016.01	4050.11	0.13
Lower	40	100-yr	Ppsd cond	103000.00	672.10	718.61	692.10	718.85	0.000143	4.88	43017.60	4050.15	0.13
Lower	39	100-yr	Corrected Eff	103000.00	663.80	718.00	687.05	718.65	0.000239	6.60	24190.55	3527.52	0.18
Lower	39	100-yr	Ppsd cond	103000.00	663.80	718.00	687.05	718.65	0.000239	6.60	24192.51	3527.60	0.18
Lower	38.1			Bridge									
Lower	37	100-yr	Corrected Eff	103000.00	663.00	717.75		718.29	0.000207	6.03	23791.95	5143.71	0.16
Lower	37	100-yr	Ppsd cond	103000.00	663.00	717.75		718.29	0.000207	6.03	23794.50	5143.76	0.16
Lower	36.500*	100-yr	Corrected Eff	103000.00	667.45	717.67		718.17	0.000225	5.95	26979.89	4943.44	0.17
Lower	36.500*	100-yr	Ppsd cond	103000.00	667.45	717.67		718.17	0.000225	5.94	26982.93	4943.45	0.17
Lower	36	100-yr	Corrected Eff	103000.00	671.90	717.53	692.40	718.06	0.000270	6.13	26797.74	4837.54	0.18
Lower	36	100-yr	Ppsd cond	103000.00	671.90	717.53	692.40	718.06	0.000270	6.13	26788.50	4837.55	0.18
Lower	35.75	100-yr	Corrected Eff	103000.00	671.51	717.45	692.54	717.86	0.000241	5.80	35151.00	4810.16	0.17
Lower	35.75	100-yr	Ppsd cond	103000.00	671.51	717.45	692.54	717.86	0.000241	5.81	33959.60	4810.13	0.17
Lower	35.5	100-yr	Corrected Eff	103000.00	671.33	717.41	692.52	717.68	0.000186	5.09	42580.00	4996.97	0.15
Lower	35.5	100-yr	Ppsd cond	103000.00	671.33	717.41	692.52	717.68	0.000186	5.09	42580.00	4996.97	0.15
Lower	35	100-yr	Corrected Eff	103000.00	671.10	717.36	692.51	717.52	0.000133	4.29	52487.17	5189.26	0.13
Lower	35	100-yr	Ppsd cond	103000.00	671.10	717.36	692.51	717.52	0.000133	4.29	52487.17	5189.26	0.13
Lower	34	100-yr	Corrected Eff	103000.00	672.80	717.27		717.35	0.000077	3.16	67286.31	4056.92	0.10
Lower	34	100-yr	Ppsd cond	103000.00	672.80	717.27		717.35	0.000077	3.16	67286.31	4056.92	0.10
Lower	33	100-yr	Corrected Eff	103000.00	671.20	717.14	697.73	717.25	0.000099	3.63	54708.24	2893.41	0.11
Lower	33	100-yr	Ppsd cond	103000.00	671.20	717.14	697.73	717.25	0.000099	3.63	54708.24	2893.41	0.11
Lower	32	100-yr	Corrected Eff	103000.00	661.10	717.04		717.17	0.000093	3.77	48587.19	2354.22	0.11
Lower	32	100-yr	Ppsd cond	103000.00	661.10	717.04		717.17	0.000093	3.77	48587.19	2354.22	0.11
Lower	31	100-yr	Corrected Eff	103000.00	671.60	716.83	691.62	717.00	0.000122	4.06	53328.17	5752.21	0.12
Lower	31	100-yr	Ppsd cond	103000.00	671.60	716.83	691.62	717.00	0.000122	4.06	53328.17	5752.21	0.12
Lower	30	100-yr	Corrected Eff	103000.00	675.00	716.63	695.59	716.79	0.000132	4.35	60893.74	6500.88	0.13
Lower	30	100-yr	Ppsd cond	103000.00	675.00	716.63	695.59	716.79	0.000132	4.35	60893.74	6500.88	0.13
Lower	29	100-yr	Corrected Eff	103000.00	674.20	716.47	693.35	716.58	0.000091	3.53	56719.04	6860.31	0.11
Lower	29	100-yr	Ppsd cond	103000.00	674.20	716.47	693.35	716.58	0.000091	3.53	56719.04	6860.31	0.11
Lower	28	100-yr	Corrected Eff	103000.00	675.00	716.35	697.48	716.44	0.000089	3.38	66195.98	5448.78	0.10
Lower	28	100-yr	Ppsd cond	103000.00	675.00	716.35	697.48	716.44	0.000089	3.38	66195.98	5448.78	0.10
Lower	27	100-yr	Corrected Eff	103000.00	670.40	716.21	691.90	716.31	0.000083	3.44	57433.64	5465.55	0.10
Lower	27	100-yr	Ppsd cond	103000.00	670.40	716.21	691.90	716.31	0.000083	3.44	57433.64	5465.55	0.10
Lower	26	100-yr	Corrected Eff	103000.00	671.70	715.94	691.50	716.12	0.000130	4.33	45451.97	2437.52	0.13
Lower	26	100-yr	Ppsd cond	103000.00	671.70	715.94	691.50	716.12	0.000130	4.33	45451.97	2437.52	0.13
Lower	25	100-yr	Corrected Eff	103000.00	673.70	715.37	691.59	715.74	0.000226	5.54	35690.85	6438.40	0.17
Lower	25	100-yr	Ppsd cond	103000.00	673.70	715.37	691.59	715.74	0.000226	5.54	35690.85	6438.40	0.17
Lower	23.7	100-yr	Corrected Eff	103000.00	670.40	715.22	691.01	715.65	0.000256	5.68	25785.78	6041.83	0.17
Lower	23.7	100-yr	Ppsd cond	103000.00	670.40	715.22	691.01	715.65	0.000256	5.68	25785.78	6041.83	0.17
Lower	23.6			Bridge									
Lower	23.5	100-yr	Corrected Eff	103000.00	670.40	715.09	691.01	715.52	0.000259	5.69	25807.77	6023.82	0.18
Lower	23.5	100-yr	Ppsd cond	103000.00	670.40	715.09	691.01	715.52	0.000259	5.69	25807.77	6023.82	0.18
Lower	23	100-yr	Corrected Eff	103000.00	671.00	715.04	691.01	715.47	0.000247	5.80	30255.32	4955.19	0.17
Lower	23	100-yr	Ppsd cond	103000.00	671.00	715.04	691.01	715.47	0.000247	5.80	30255.32	4955.19	0.17
Lower	22.5	100-yr	Corrected Eff	103000.00	667.70	715.10	690.11	715.19	0.000077	3.27	58602.93	6984.06	0.10
Lower	22.5	100-yr	Ppsd cond	103000.00	667.70	715.10	690.11	715.19	0.000077	3.27	58602.93	6984.06	0.10
Lower	22	100-yr	Corrected Eff	103000.00	667.10	715.07	691.19	715.09	0.000027	1.96	103498.50	6214.75	0.06
Lower	22	100-yr	Ppsd cond	103000.00	667.10	715.07	691.19	715.09	0.000027	1.96	103498.50	6214.75	0.06
Lower	21	100-yr	Corrected Eff	103000.00	666.00	715.01	692.25	715.04	0.000026	1.96	106168.60	5842.16	0.06
Lower	21	100-yr	Ppsd cond	103000.00	666.00	715.01	692.25	715.04	0.000026	1.96	106168.60	5842.16	0.06
Lower	20	100-yr	Corrected Eff	103000.00	674.30	714.93	693.30	714.96	0.000030	2.04	100034.40	5458.79	0.06
Lower	20	100-yr	Ppsd cond	103000.00	674.30	714.93	693.30	714.96	0.000030	2.04	100034.40	5458.79	0.06
Lower	19	100-yr	Corrected Eff	103000.00	675.40	714.83	694.86	714.87	0.000044	2.41	73574.34	4882.91	0.07
Lower	19	100-yr	Ppsd cond	103000.00	675.40	714.83	694.86	714.87	0.000044	2.41	73574.34	4882.91	0.07
Lower	18.4	100-yr	Corrected Eff	103000.00	670.20	714.74	690.54	714.82	0.000067	3.14	60514.66	4410.26	0.09
Lower	18.4	100-yr	Ppsd cond	103000.00	670.20	714.74	690.54	714.82	0.000067	3.14	60514.66	4410.26	0.09

HEC-RAS River: Minnesota Reach: Lower Profile: 100-yr (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)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Lower	18	100-yr	Corrected Eff	103000.00	668.80	714.73	689.61	714.81	0.000062	3.03	61698.26	5155.64	0.09
Lower	18	100-yr	Ppsd cond	103000.00	668.80	714.73	689.61	714.81	0.000062	3.03	61698.26	5155.64	0.09
Lower	17	100-yr	Corrected Eff	103000.00	668.50	714.67	691.09	714.74	0.000070	3.16	59891.38	5116.47	0.09
Lower	17	100-yr	Ppsd cond	103000.00	668.50	714.67	691.09	714.74	0.000070	3.16	59891.38	5116.47	0.09
Lower	16	100-yr	Corrected Eff	103000.00	671.30	714.61	690.42	714.66	0.000050	2.65	71164.64	5622.31	0.08
Lower	16	100-yr	Ppsd cond	103000.00	671.30	714.61	690.42	714.66	0.000050	2.65	71164.64	5622.31	0.08
Lower	15	100-yr	Corrected Eff	103000.00	674.50	714.58	695.17	714.59	0.000017	1.46	123899.00	6712.99	0.05
Lower	15	100-yr	Ppsd cond	103000.00	674.50	714.58	695.17	714.59	0.000017	1.46	123899.00	6712.99	0.05
Lower	14	100-yr	Corrected Eff	103000.00	672.90	714.55	696.28	714.56	0.000015	1.43	130247.20	7047.24	0.04
Lower	14	100-yr	Ppsd cond	103000.00	672.90	714.55	696.28	714.56	0.000015	1.43	130247.20	7047.24	0.04
Lower	13.4	100-yr	Corrected Eff	103000.00	668.40	714.45	692.37	714.52	0.000067	2.97	71865.44	7111.87	0.09
Lower	13.4	100-yr	Ppsd cond	103000.00	668.40	714.45	692.37	714.52	0.000067	2.97	71865.44	7111.87	0.09
Lower	13.3			Bridge									
Lower	13.2	100-yr	Corrected Eff	103000.00	668.40	714.41	692.37	714.48	0.000066	2.94	68411.14	7165.72	0.09
Lower	13.2	100-yr	Ppsd cond	103000.00	668.40	714.41	692.37	714.48	0.000066	2.94	68411.14	7165.72	0.09
Lower	12.7	100-yr	Corrected Eff	103000.00	674.00	714.42	697.06	714.44	0.000027	1.85	98992.77	7263.38	0.06
Lower	12.7	100-yr	Ppsd cond	103000.00	674.00	714.42	697.06	714.44	0.000027	1.85	98992.77	7263.38	0.06
Lower	12.5			Bridge									
Lower	12.3	100-yr	Corrected Eff	103000.00	674.00	714.41	696.96	714.43	0.000029	1.94	100027.40	7046.76	0.06
Lower	12.3	100-yr	Ppsd cond	103000.00	674.00	714.41	696.96	714.43	0.000029	1.94	100027.40	7046.76	0.06
Lower	12	100-yr	Corrected Eff	103000.00	671.90	714.40	694.40	714.42	0.000023	1.77	108192.60	7121.24	0.05
Lower	12	100-yr	Ppsd cond	103000.00	671.90	714.40	694.40	714.42	0.000023	1.77	108192.60	7121.24	0.05
Lower	11	100-yr	Corrected Eff	103000.00	669.70	714.37	689.08	714.38	0.000017	1.58	127035.60	7312.78	0.05
Lower	11	100-yr	Ppsd cond	103000.00	669.70	714.37	689.08	714.38	0.000017	1.58	127035.60	7312.78	0.05
Lower	10	100-yr	Corrected Eff	103000.00	673.00	714.32	695.61	714.34	0.000017	1.56	147946.80	8891.12	0.05
Lower	10	100-yr	Ppsd cond	103000.00	673.00	714.32	695.61	714.34	0.000017	1.56	147946.80	8891.12	0.05
Lower	9	100-yr	Corrected Eff	103000.00	671.40	714.27		714.28	0.000013	1.35	149712.40	8740.81	0.04
Lower	9	100-yr	Ppsd cond	103000.00	671.40	714.27		714.28	0.000013	1.35	149712.40	8740.81	0.04
Lower	8	100-yr	Corrected Eff	103000.00	675.90	714.19		714.21	0.000029	1.89	129059.90	8034.65	0.06
Lower	8	100-yr	Ppsd cond	103000.00	675.90	714.19		714.21	0.000029	1.89	129059.90	8034.65	0.06
Lower	7.1	100-yr	Corrected Eff	103000.00	671.20	714.10	689.70	714.12	0.000023	1.83	111312.10	6739.34	0.05
Lower	7.1	100-yr	Ppsd cond	103000.00	671.20	714.10	689.70	714.12	0.000023	1.83	111312.10	6739.34	0.05
Lower	6.7	100-yr	Corrected Eff	103000.00	674.00	714.05	689.78	714.09	0.000053	2.68	70937.00	6893.22	0.08
Lower	6.7	100-yr	Ppsd cond	103000.00	674.00	714.05	689.78	714.09	0.000053	2.68	70937.00	6893.22	0.08
Lower	6.6			Bridge									
Lower	6.5	100-yr	Corrected Eff	103000.00	670.30	714.03	688.67	714.08	0.000049	2.67	72018.45	7007.20	0.08
Lower	6.5	100-yr	Ppsd cond	103000.00	670.30	714.03	688.67	714.08	0.000049	2.67	72018.45	7007.20	0.08
Lower	6.1	100-yr	Corrected Eff	103000.00	672.20	713.98	692.27	714.03	0.000057	2.69	74014.85	6104.78	0.08
Lower	6.1	100-yr	Ppsd cond	103000.00	672.20	713.98	692.27	714.03	0.000057	2.69	74014.85	6104.78	0.08
Lower	5	100-yr	Corrected Eff	103000.00	670.00	713.87	690.14	713.92	0.000043	2.44	76349.61	5516.05	0.07
Lower	5	100-yr	Ppsd cond	103000.00	670.00	713.87	690.14	713.92	0.000043	2.44	76349.61	5516.05	0.07
Lower	4	100-yr	Corrected Eff	103000.00	669.70	713.77		713.81	0.000044	2.52	79582.76	4466.99	0.07
Lower	4	100-yr	Ppsd cond	103000.00	669.70	713.77		713.81	0.000044	2.52	79582.76	4466.99	0.07
Lower	3	100-yr	Corrected Eff	103000.00	668.30	713.62		713.69	0.000057	2.93	71361.66	4071.40	0.08
Lower	3	100-yr	Ppsd cond	103000.00	668.30	713.62		713.69	0.000057	2.93	71361.66	4071.40	0.08
Lower	2	100-yr	Corrected Eff	103000.00	670.10	713.48		713.56	0.000078	3.40	60877.46	3785.07	0.10
Lower	2	100-yr	Ppsd cond	103000.00	670.10	713.48		713.56	0.000078	3.40	60877.46	3785.07	0.10
Lower	1	100-yr	Corrected Eff	103000.00	665.20	713.32	690.87	713.43	0.000097	3.84	60465.26	3275.95	0.11
Lower	1	100-yr	Ppsd cond	103000.00	665.20	713.32	690.87	713.43	0.000097	3.84	60465.26	3275.95	0.11

HEC-RAS River: Minnesota Reach: Lower Profile: 100-yr Fldwy

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)	(ft)	
Lower	41	100-yr Fldwy	Corrected Eff	103000.00	670.20	719.02	689.96	719.19	0.000109	4.27	52655.25	2541.47	0.12
Lower	41	100-yr Fldwy	Ppsd cond	103000.00	670.20	719.02	689.96	719.19	0.000109	4.27	52656.80	2541.47	0.12
Lower	40	100-yr Fldwy	Corrected Eff	103000.00	672.10	718.78	692.10	719.01	0.000139	4.82	43326.02	2330.05	0.13
Lower	40	100-yr Fldwy	Ppsd cond	103000.00	672.10	718.78	692.10	719.01	0.000139	4.82	43327.44	2330.05	0.13
Lower	39	100-yr Fldwy	Corrected Eff	103000.00	663.80	718.18	687.04	718.82	0.000234	6.55	24465.88	2778.22	0.17
Lower	39	100-yr Fldwy	Ppsd cond	103000.00	663.80	718.18	687.04	718.82	0.000234	6.55	24467.75	2778.22	0.17
Lower	38.1			Bridge									
Lower	37	100-yr Fldwy	Corrected Eff	103000.00	663.00	717.98		718.52	0.000203	5.99	24035.63	2761.69	0.16
Lower	37	100-yr Fldwy	Ppsd cond	103000.00	663.00	717.98		718.52	0.000203	5.99	24038.33	2761.71	0.16
Lower	36.500*	100-yr Fldwy	Corrected Eff	103000.00	667.45	717.91		718.40	0.000218	5.87	27774.36	4947.33	0.17
Lower	36.500*	100-yr Fldwy	Ppsd cond	103000.00	667.45	717.91		718.40	0.000218	5.87	27777.59	4947.35	0.17
Lower	36	100-yr Fldwy	Corrected Eff	103000.00	671.90	717.73	692.40	718.27	0.000273	6.18	24327.51	2574.83	0.18
Lower	36	100-yr Fldwy	Ppsd cond	103000.00	671.90	717.73	692.40	718.27	0.000273	6.18	24317.88	2574.83	0.18
Lower	35.75	100-yr Fldwy	Corrected Eff	103000.00	671.51	717.67	692.54	718.06	0.000232	5.71	35980.51	4817.43	0.17
Lower	35.75	100-yr Fldwy	Ppsd cond	103000.00	671.51	717.66	692.54	718.06	0.000232	5.72	34788.41	4817.39	0.17
Lower	35.5	100-yr Fldwy	Corrected Eff	103000.00	671.33	717.62	692.52	717.89	0.000179	5.01	43428.58	5052.12	0.15
Lower	35.5	100-yr Fldwy	Ppsd cond	103000.00	671.33	717.62	692.52	717.89	0.000179	5.01	43428.58	5052.12	0.15
Lower	35	100-yr Fldwy	Corrected Eff	103000.00	671.10	717.58	692.51	717.74	0.000129	4.24	51229.02	3412.15	0.12
Lower	35	100-yr Fldwy	Ppsd cond	103000.00	671.10	717.58	692.51	717.74	0.000129	4.24	51229.02	3412.15	0.12
Lower	34	100-yr Fldwy	Corrected Eff	103000.00	672.80	717.48		717.57	0.000077	3.18	64534.80	3556.97	0.10
Lower	34	100-yr Fldwy	Ppsd cond	103000.00	672.80	717.48		717.57	0.000077	3.18	64534.80	3556.97	0.10
Lower	33	100-yr Fldwy	Corrected Eff	103000.00	671.20	717.36	697.73	717.47	0.000096	3.59	55358.89	2897.26	0.11
Lower	33	100-yr Fldwy	Ppsd cond	103000.00	671.20	717.36	697.73	717.47	0.000096	3.59	55358.89	2897.26	0.11
Lower	32	100-yr Fldwy	Corrected Eff	103000.00	661.10	717.27		717.40	0.000090	3.73	49122.60	2355.75	0.11
Lower	32	100-yr Fldwy	Ppsd cond	103000.00	661.10	717.27		717.40	0.000090	3.73	49122.60	2355.75	0.11
Lower	31	100-yr Fldwy	Corrected Eff	103000.00	671.60	717.02	691.62	717.22	0.000134	4.27	45016.23	2309.19	0.13
Lower	31	100-yr Fldwy	Ppsd cond	103000.00	671.60	717.02	691.62	717.22	0.000134	4.27	45016.23	2309.19	0.13
Lower	30	100-yr Fldwy	Corrected Eff	103000.00	675.00	716.80	695.59	716.98	0.000148	4.61	52974.34	2745.01	0.14
Lower	30	100-yr Fldwy	Ppsd cond	103000.00	675.00	716.80	695.59	716.98	0.000148	4.61	52974.34	2745.01	0.14
Lower	29	100-yr Fldwy	Corrected Eff	103000.00	674.20	716.65	693.35	716.76	0.000089	3.50	57230.14	2860.23	0.10
Lower	29	100-yr Fldwy	Ppsd cond	103000.00	674.20	716.65	693.35	716.76	0.000089	3.50	57230.14	2860.23	0.10
Lower	28	100-yr Fldwy	Corrected Eff	103000.00	675.00	716.53	697.48	716.62	0.000087	3.35	66795.66	3379.69	0.10
Lower	28	100-yr Fldwy	Ppsd cond	103000.00	675.00	716.53	697.48	716.62	0.000087	3.35	66795.66	3379.69	0.10
Lower	27	100-yr Fldwy	Corrected Eff	103000.00	670.40	716.40	691.90	716.49	0.000081	3.40	58017.46	3932.42	0.10
Lower	27	100-yr Fldwy	Ppsd cond	103000.00	670.40	716.40	691.90	716.49	0.000081	3.40	58017.46	3932.42	0.10
Lower	26	100-yr Fldwy	Corrected Eff	103000.00	671.70	716.13	691.49	716.31	0.000127	4.28	45919.02	2434.25	0.13
Lower	26	100-yr Fldwy	Ppsd cond	103000.00	671.70	716.13	691.49	716.31	0.000127	4.28	45919.02	2434.25	0.13
Lower	25	100-yr Fldwy	Corrected Eff	103000.00	673.70	715.57	691.59	715.93	0.000220	5.48	36053.77	2141.00	0.16
Lower	25	100-yr Fldwy	Ppsd cond	103000.00	673.70	715.57	691.59	715.93	0.000220	5.48	36053.77	2141.00	0.16
Lower	23.7	100-yr Fldwy	Corrected Eff	103000.00	670.40	715.44	691.01	715.85	0.000246	5.60	26032.03	1280.25	0.17
Lower	23.7	100-yr Fldwy	Ppsd cond	103000.00	670.40	715.44	691.01	715.85	0.000246	5.60	26032.03	1280.25	0.17
Lower	23.6			Bridge									
Lower	23.5	100-yr Fldwy	Corrected Eff	103000.00	670.40	715.31	691.01	715.72	0.000248	5.60	26007.74	2361.22	0.17
Lower	23.5	100-yr Fldwy	Ppsd cond	103000.00	670.40	715.31	691.01	715.72	0.000248	5.60	26007.74	2361.22	0.17
Lower	23	100-yr Fldwy	Corrected Eff	103000.00	671.00	715.25	691.01	715.67	0.000240	5.74	30620.96	3060.83	0.17
Lower	23	100-yr Fldwy	Ppsd cond	103000.00	671.00	715.25	691.01	715.67	0.000240	5.74	30620.96	3060.83	0.17
Lower	22.5	100-yr Fldwy	Corrected Eff	103000.00	667.70	715.31	690.11	715.40	0.000075	3.24	59220.81	4663.42	0.10
Lower	22.5	100-yr Fldwy	Ppsd cond	103000.00	667.70	715.31	690.11	715.40	0.000075	3.24	59220.81	4663.42	0.10
Lower	22	100-yr Fldwy	Corrected Eff	103000.00	667.10	715.28	691.19	715.30	0.000026	1.94	103351.70	5566.90	0.06
Lower	22	100-yr Fldwy	Ppsd cond	103000.00	667.10	715.28	691.19	715.30	0.000026	1.94	103351.70	5566.90	0.06
Lower	21	100-yr Fldwy	Corrected Eff	103000.00	666.00	715.23	692.26	715.25	0.000025	1.93	107403.90	5828.60	0.06
Lower	21	100-yr Fldwy	Ppsd cond	103000.00	666.00	715.23	692.26	715.25	0.000025	1.93	107403.90	5828.60	0.06
Lower	20	100-yr Fldwy	Corrected Eff	103000.00	674.30	715.15	693.30	715.18	0.000029	2.01	101210.10	5450.00	0.06
Lower	20	100-yr Fldwy	Ppsd cond	103000.00	674.30	715.15	693.30	715.18	0.000029	2.01	101210.10	5450.00	0.06
Lower	19	100-yr Fldwy	Corrected Eff	103000.00	675.40	715.05	694.86	715.09	0.000043	2.38	74372.60	4880.74	0.07
Lower	19	100-yr Fldwy	Ppsd cond	103000.00	675.40	715.05	694.86	715.09	0.000043	2.38	74372.60	4880.74	0.07

HEC-RAS River: Minnesota Reach: Lower Profile: 100-yr Fldwy (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)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Lower	18.4	100-yr Fldwy	Corrected Eff	103000.00	670.20	714.97	690.54	715.04	0.000065	3.11	61220.41	4483.86	0.09
Lower	18.4	100-yr Fldwy	Ppsd cond	103000.00	670.20	714.97	690.54	715.04	0.000065	3.11	61220.41	4483.86	0.09
Lower	18	100-yr Fldwy	Corrected Eff	103000.00	668.80	714.96	689.61	715.03	0.000060	3.00	62410.70	4945.31	0.09
Lower	18	100-yr Fldwy	Ppsd cond	103000.00	668.80	714.96	689.61	715.03	0.000060	3.00	62410.70	4945.31	0.09
Lower	17	100-yr Fldwy	Corrected Eff	103000.00	668.50	714.89	691.08	714.97	0.000068	3.13	60602.98	5118.86	0.09
Lower	17	100-yr Fldwy	Ppsd cond	103000.00	668.50	714.89	691.08	714.97	0.000068	3.13	60602.98	5118.86	0.09
Lower	16	100-yr Fldwy	Corrected Eff	103000.00	671.30	714.84	690.41	714.89	0.000049	2.81	72070.45	5553.08	0.08
Lower	16	100-yr Fldwy	Ppsd cond	103000.00	671.30	714.84	690.41	714.89	0.000049	2.81	72070.45	5553.08	0.08
Lower	15	100-yr Fldwy	Corrected Eff	103000.00	674.50	714.80	695.17	714.82	0.000016	1.44	123251.80	6165.95	0.04
Lower	15	100-yr Fldwy	Ppsd cond	103000.00	674.50	714.80	695.17	714.82	0.000016	1.44	123251.80	6165.95	0.04
Lower	14	100-yr Fldwy	Corrected Eff	103000.00	672.90	714.78	696.28	714.79	0.000015	1.41	131745.90	6984.97	0.04
Lower	14	100-yr Fldwy	Ppsd cond	103000.00	672.90	714.78	696.28	714.79	0.000015	1.41	131745.90	6984.97	0.04
Lower	13.4	100-yr Fldwy	Corrected Eff	103000.00	668.40	714.66	692.36	714.74	0.000079	3.25	65478.77	5168.94	0.10
Lower	13.4	100-yr Fldwy	Ppsd cond	103000.00	668.40	714.66	692.36	714.74	0.000079	3.25	65478.77	5168.94	0.10
Lower	13.3			Bridge									
Lower	13.2	100-yr Fldwy	Corrected Eff	103000.00	668.40	714.61	692.36	714.68	0.000071	3.08	64939.44	5115.78	0.09
Lower	13.2	100-yr Fldwy	Ppsd cond	103000.00	668.40	714.61	692.36	714.68	0.000071	3.08	64939.44	5115.78	0.09
Lower	12.7	100-yr Fldwy	Corrected Eff	103000.00	674.00	714.62	697.06	714.64	0.000026	1.83	100008.90	5137.12	0.06
Lower	12.7	100-yr Fldwy	Ppsd cond	103000.00	674.00	714.62	697.06	714.64	0.000026	1.83	100008.90	5137.12	0.06
Lower	12.5			Bridge									
Lower	12.3	100-yr Fldwy	Corrected Eff	103000.00	674.00	714.61	696.96	714.63	0.000029	1.92	101053.70	5180.72	0.06
Lower	12.3	100-yr Fldwy	Ppsd cond	103000.00	674.00	714.61	696.96	714.63	0.000029	1.92	101053.70	5180.72	0.06
Lower	12	100-yr Fldwy	Corrected Eff	103000.00	671.90	714.60	694.40	714.62	0.000023	1.75	109303.40	6841.88	0.05
Lower	12	100-yr Fldwy	Ppsd cond	103000.00	671.90	714.60	694.40	714.62	0.000023	1.75	109303.40	6841.88	0.05
Lower	11	100-yr Fldwy	Corrected Eff	103000.00	669.70	714.58	689.08	714.58	0.000017	1.58	128387.10	7313.63	0.05
Lower	11	100-yr Fldwy	Ppsd cond	103000.00	669.70	714.58	689.08	714.58	0.000017	1.58	128387.10	7313.63	0.05
Lower	10	100-yr Fldwy	Corrected Eff	103000.00	673.00	714.52	695.61	714.54	0.000017	1.58	141601.50	8068.57	0.05
Lower	10	100-yr Fldwy	Ppsd cond	103000.00	673.00	714.52	695.61	714.54	0.000017	1.58	141601.50	8068.57	0.05
Lower	9	100-yr Fldwy	Corrected Eff	103000.00	671.40	714.47		714.48	0.000013	1.34	151450.20	8718.11	0.04
Lower	9	100-yr Fldwy	Ppsd cond	103000.00	671.40	714.47		714.48	0.000013	1.34	151450.20	8718.11	0.04
Lower	8	100-yr Fldwy	Corrected Eff	103000.00	675.90	714.39		714.41	0.000028	1.86	130676.10	8012.80	0.06
Lower	8	100-yr Fldwy	Ppsd cond	103000.00	675.90	714.39		714.41	0.000028	1.86	130676.10	8012.80	0.06
Lower	7.1	100-yr Fldwy	Corrected Eff	103000.00	671.20	714.31	689.70	714.33	0.000023	1.81	112590.60	6731.56	0.05
Lower	7.1	100-yr Fldwy	Ppsd cond	103000.00	671.20	714.31	689.70	714.33	0.000023	1.81	112590.60	6731.56	0.05
Lower	6.7	100-yr Fldwy	Corrected Eff	103000.00	674.00	714.25	689.78	714.30	0.000052	2.66	71808.13	4198.63	0.08
Lower	6.7	100-yr Fldwy	Ppsd cond	103000.00	674.00	714.25	689.78	714.30	0.000052	2.66	71808.13	4198.63	0.08
Lower	6.6			Bridge									
Lower	6.5	100-yr Fldwy	Corrected Eff	103000.00	670.30	714.24	688.67	714.28	0.000048	2.65	72891.29	4196.93	0.08
Lower	6.5	100-yr Fldwy	Ppsd cond	103000.00	670.30	714.24	688.67	714.28	0.000048	2.65	72891.29	4196.93	0.08
Lower	6.1	100-yr Fldwy	Corrected Eff	103000.00	672.20	714.19	692.27	714.24	0.000055	2.66	74808.56	5591.74	0.08
Lower	6.1	100-yr Fldwy	Ppsd cond	103000.00	672.20	714.19	692.27	714.24	0.000055	2.66	74808.56	5591.74	0.08
Lower	5	100-yr Fldwy	Corrected Eff	103000.00	670.00	714.09	690.14	714.13	0.000041	2.41	77169.77	5514.32	0.07
Lower	5	100-yr Fldwy	Ppsd cond	103000.00	670.00	714.09	690.14	714.13	0.000041	2.41	77169.77	5514.32	0.07
Lower	4	100-yr Fldwy	Corrected Eff	103000.00	669.70	713.98		714.02	0.000042	2.49	80549.72	4468.60	0.07
Lower	4	100-yr Fldwy	Ppsd cond	103000.00	669.70	713.98		714.02	0.000042	2.49	80549.72	4468.60	0.07
Lower	3	100-yr Fldwy	Corrected Eff	103000.00	668.30	713.84		713.91	0.000055	2.89	72196.19	4052.74	0.08
Lower	3	100-yr Fldwy	Ppsd cond	103000.00	668.30	713.84		713.91	0.000055	2.89	72196.19	4052.74	0.08
Lower	2	100-yr Fldwy	Corrected Eff	103000.00	670.10	713.70		713.78	0.000075	3.37	61721.76	3779.46	0.10
Lower	2	100-yr Fldwy	Ppsd cond	103000.00	670.10	713.70		713.78	0.000075	3.37	61721.76	3779.46	0.10
Lower	1	100-yr Fldwy	Corrected Eff	103000.00	665.20	713.55	690.80	713.65	0.000094	3.80	61163.47	3247.61	0.11
Lower	1	100-yr Fldwy	Ppsd cond	103000.00	665.20	713.55	690.80	713.65	0.000094	3.80	61163.47	3247.61	0.11

HEC-RAS River: Minnesota Reach: Lower Profile: 100-yr Fldwy

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)	(ft)	
Lower	41	100-yr Fldwy	Corrected Eff	103000.00	670.20	719.0162	689.96	719.19	0.000109	4.27	52655.25	2541.47	0.12
Lower	41	100-yr Fldwy	Ppsd cond	103000.00	670.20	719.0168	689.96	719.19	0.000109	4.27	52656.80	2541.47	0.12
Lower	40	100-yr Fldwy	Corrected Eff	103000.00	672.10	718.7837	692.10	719.01	0.000139	4.82	43326.02	2330.05	0.13
Lower	40	100-yr Fldwy	Ppsd cond	103000.00	672.10	718.7843	692.10	719.01	0.000139	4.82	43327.44	2330.05	0.13
Lower	39	100-yr Fldwy	Corrected Eff	103000.00	663.80	718.1833	687.04	718.82	0.000234	6.55	24465.88	2778.22	0.17
Lower	39	100-yr Fldwy	Ppsd cond	103000.00	663.80	718.1840	687.04	718.82	0.000234	6.55	24467.75	2778.22	0.17
Lower	38.1			Bridge									
Lower	37	100-yr Fldwy	Corrected Eff	103000.00	663.00	717.9800		718.52	0.000203	5.99	24035.63	2761.69	0.16
Lower	37	100-yr Fldwy	Ppsd cond	103000.00	663.00	717.9810		718.52	0.000203	5.99	24038.33	2761.71	0.16
Lower	36.500*	100-yr Fldwy	Corrected Eff	103000.00	667.45	717.9122		718.40	0.000218	5.87	27774.36	4947.33	0.17
Lower	36.500*	100-yr Fldwy	Ppsd cond	103000.00	667.45	717.9132		718.40	0.000218	5.87	27777.59	4947.35	0.17
Lower	36	100-yr Fldwy	Corrected Eff	103000.00	671.90	717.7318	692.40	718.27	0.000273	6.18	24327.51	2574.83	0.18
Lower	36	100-yr Fldwy	Ppsd cond	103000.00	671.90	717.7321	692.40	718.27	0.000273	6.18	24317.88	2574.83	0.18
Lower	35.75	100-yr Fldwy	Corrected Eff	103000.00	671.51	717.6660	692.54	718.06	0.000232	5.71	35980.51	4817.43	0.17
Lower	35.75	100-yr Fldwy	Ppsd cond	103000.00	671.51	717.6649	692.54	718.06	0.000232	5.72	34788.41	4817.39	0.17
Lower	35.5	100-yr Fldwy	Corrected Eff	103000.00	671.33	717.6241	692.52	717.89	0.000179	5.01	43428.58	5052.12	0.15
Lower	35.5	100-yr Fldwy	Ppsd cond	103000.00	671.33	717.6241	692.52	717.89	0.000179	5.01	43428.58	5052.12	0.15
Lower	35	100-yr Fldwy	Corrected Eff	103000.00	671.10	717.5794	692.51	717.74	0.000129	4.24	51229.02	3412.15	0.12
Lower	35	100-yr Fldwy	Ppsd cond	103000.00	671.10	717.5794	692.51	717.74	0.000129	4.24	51229.02	3412.15	0.12
Lower	34	100-yr Fldwy	Corrected Eff	103000.00	672.80	717.4839		717.57	0.000077	3.18	64534.80	3556.97	0.10
Lower	34	100-yr Fldwy	Ppsd cond	103000.00	672.80	717.4839		717.57	0.000077	3.18	64534.80	3556.97	0.10
Lower	33	100-yr Fldwy	Corrected Eff	103000.00	671.20	717.3616	697.73	717.47	0.000096	3.59	55358.89	2897.26	0.11
Lower	33	100-yr Fldwy	Ppsd cond	103000.00	671.20	717.3616	697.73	717.47	0.000096	3.59	55358.89	2897.26	0.11
Lower	32	100-yr Fldwy	Corrected Eff	103000.00	661.10	717.2680		717.40	0.000090	3.73	49122.60	2355.75	0.11
Lower	32	100-yr Fldwy	Ppsd cond	103000.00	661.10	717.2680		717.40	0.000090	3.73	49122.60	2355.75	0.11
Lower	31	100-yr Fldwy	Corrected Eff	103000.00	671.60	717.0158	691.62	717.22	0.000134	4.27	45016.23	2309.19	0.13
Lower	31	100-yr Fldwy	Ppsd cond	103000.00	671.60	717.0158	691.62	717.22	0.000134	4.27	45016.23	2309.19	0.13
Lower	30	100-yr Fldwy	Corrected Eff	103000.00	675.00	716.7966	695.59	716.98	0.000148	4.61	52974.34	2745.01	0.14
Lower	30	100-yr Fldwy	Ppsd cond	103000.00	675.00	716.7966	695.59	716.98	0.000148	4.61	52974.34	2745.01	0.14
Lower	29	100-yr Fldwy	Corrected Eff	103000.00	674.20	716.6533	693.35	716.76	0.000089	3.50	57230.14	2860.23	0.10
Lower	29	100-yr Fldwy	Ppsd cond	103000.00	674.20	716.6533	693.35	716.76	0.000089	3.50	57230.14	2860.23	0.10
Lower	28	100-yr Fldwy	Corrected Eff	103000.00	675.00	716.5294	697.48	716.62	0.000087	3.35	66795.66	3379.69	0.10
Lower	28	100-yr Fldwy	Ppsd cond	103000.00	675.00	716.5294	697.48	716.62	0.000087	3.35	66795.66	3379.69	0.10
Lower	27	100-yr Fldwy	Corrected Eff	103000.00	670.40	716.3952	691.90	716.49	0.000081	3.40	58017.46	3932.42	0.10
Lower	27	100-yr Fldwy	Ppsd cond	103000.00	670.40	716.3952	691.90	716.49	0.000081	3.40	58017.46	3932.42	0.10
Lower	26	100-yr Fldwy	Corrected Eff	103000.00	671.70	716.1349	691.49	716.31	0.000127	4.28	45919.02	2434.25	0.13
Lower	26	100-yr Fldwy	Ppsd cond	103000.00	671.70	716.1349	691.49	716.31	0.000127	4.28	45919.02	2434.25	0.13
Lower	25	100-yr Fldwy	Corrected Eff	103000.00	673.70	715.5724	691.59	715.93	0.000220	5.48	36053.77	2141.00	0.16
Lower	25	100-yr Fldwy	Ppsd cond	103000.00	673.70	715.5724	691.59	715.93	0.000220	5.48	36053.77	2141.00	0.16
Lower	23.7	100-yr Fldwy	Corrected Eff	103000.00	670.40	715.4418	691.01	715.85	0.000246	5.60	28032.03	1280.25	0.17
Lower	23.7	100-yr Fldwy	Ppsd cond	103000.00	670.40	715.4418	691.01	715.85	0.000246	5.60	28032.03	1280.25	0.17
Lower	23.6			Bridge									
Lower	23.5	100-yr Fldwy	Corrected Eff	103000.00	670.40	715.3146	691.01	715.72	0.000248	5.60	28007.74	2361.22	0.17
Lower	23.5	100-yr Fldwy	Ppsd cond	103000.00	670.40	715.3146	691.01	715.72	0.000248	5.60	28007.74	2361.22	0.17
Lower	23	100-yr Fldwy	Corrected Eff	103000.00	671.00	715.2489	691.01	715.67	0.000240	5.74	30620.96	3060.83	0.17
Lower	23	100-yr Fldwy	Ppsd cond	103000.00	671.00	715.2489	691.01	715.67	0.000240	5.74	30620.96	3060.83	0.17
Lower	22.5	100-yr Fldwy	Corrected Eff	103000.00	667.70	715.3104	690.11	715.40	0.000075	3.24	59220.81	4663.42	0.10
Lower	22.5	100-yr Fldwy	Ppsd cond	103000.00	667.70	715.3104	690.11	715.40	0.000075	3.24	59220.81	4663.42	0.10
Lower	22	100-yr Fldwy	Corrected Eff	103000.00	667.10	715.2792	691.19	715.30	0.000026	1.94	103351.70	5566.90	0.06
Lower	22	100-yr Fldwy	Ppsd cond	103000.00	667.10	715.2792	691.19	715.30	0.000026	1.94	103351.70	5566.90	0.06
Lower	21	100-yr Fldwy	Corrected Eff	103000.00	666.00	715.2257	692.26	715.25	0.000025	1.93	107403.90	5828.60	0.06
Lower	21	100-yr Fldwy	Ppsd cond	103000.00	666.00	715.2257	692.26	715.25	0.000025	1.93	107403.90	5828.60	0.06
Lower	20	100-yr Fldwy	Corrected Eff	103000.00	674.30	715.1508	693.30	715.18	0.000029	2.01	101210.10	5450.00	0.06
Lower	20	100-yr Fldwy	Ppsd cond	103000.00	674.30	715.1508	693.30	715.18	0.000029	2.01	101210.10	5450.00	0.06
Lower	19	100-yr Fldwy	Corrected Eff	103000.00	675.40	715.0464	694.86	715.09	0.000043	2.38	74372.60	4880.74	0.07
Lower	19	100-yr Fldwy	Ppsd cond	103000.00	675.40	715.0464	694.86	715.09	0.000043	2.38	74372.60	4880.74	0.07

HEC-RAS River: Minnesota Reach: Lower Profile: 100-yr Fldwy (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)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Lower	18.4	100-yr Fldwy	Corrected Eff	103000.00	670.20	714.9663	690.54	715.04	0.000065	3.11	61220.41	4483.86	0.09
Lower	18.4	100-yr Fldwy	Ppsd cond	103000.00	670.20	714.9663	690.54	715.04	0.000065	3.11	61220.41	4483.86	0.09
Lower	18	100-yr Fldwy	Corrected Eff	103000.00	668.80	714.9559	689.61	715.03	0.000060	3.00	62410.70	4945.31	0.09
Lower	18	100-yr Fldwy	Ppsd cond	103000.00	668.80	714.9559	689.61	715.03	0.000060	3.00	62410.70	4945.31	0.09
Lower	17	100-yr Fldwy	Corrected Eff	103000.00	668.50	714.8942	691.08	714.97	0.000068	3.13	60602.98	5118.86	0.09
Lower	17	100-yr Fldwy	Ppsd cond	103000.00	668.50	714.8942	691.08	714.97	0.000068	3.13	60602.98	5118.86	0.09
Lower	16	100-yr Fldwy	Corrected Eff	103000.00	671.30	714.8358	690.41	714.89	0.000049	2.61	72070.45	5553.08	0.08
Lower	16	100-yr Fldwy	Ppsd cond	103000.00	671.30	714.8358	690.41	714.89	0.000049	2.61	72070.45	5553.08	0.08
Lower	15	100-yr Fldwy	Corrected Eff	103000.00	674.50	714.8033	695.17	714.82	0.000016	1.44	123251.80	6165.95	0.04
Lower	15	100-yr Fldwy	Ppsd cond	103000.00	674.50	714.8033	695.17	714.82	0.000016	1.44	123251.80	6165.95	0.04
Lower	14	100-yr Fldwy	Corrected Eff	103000.00	672.90	714.7791	696.28	714.79	0.000015	1.41	131745.90	6984.97	0.04
Lower	14	100-yr Fldwy	Ppsd cond	103000.00	672.90	714.7791	696.28	714.79	0.000015	1.41	131745.90	6984.97	0.04
Lower	13.4	100-yr Fldwy	Corrected Eff	103000.00	668.40	714.6569	692.36	714.74	0.000079	3.25	65478.77	5168.94	0.10
Lower	13.4	100-yr Fldwy	Ppsd cond	103000.00	668.40	714.6569	692.36	714.74	0.000079	3.25	65478.77	5168.94	0.10
Lower	13.3			Bridge									
Lower	13.2	100-yr Fldwy	Corrected Eff	103000.00	668.40	714.6064	692.36	714.68	0.000071	3.08	64939.44	5115.78	0.09
Lower	13.2	100-yr Fldwy	Ppsd cond	103000.00	668.40	714.6064	692.36	714.68	0.000071	3.08	64939.44	5115.78	0.09
Lower	12.7	100-yr Fldwy	Corrected Eff	103000.00	674.00	714.6180	697.06	714.64	0.000026	1.83	100008.90	5137.12	0.06
Lower	12.7	100-yr Fldwy	Ppsd cond	103000.00	674.00	714.6180	697.06	714.64	0.000026	1.83	100008.90	5137.12	0.06
Lower	12.5			Bridge									
Lower	12.3	100-yr Fldwy	Corrected Eff	103000.00	674.00	714.6067	696.96	714.63	0.000029	1.92	101053.70	5180.72	0.06
Lower	12.3	100-yr Fldwy	Ppsd cond	103000.00	674.00	714.6067	696.96	714.63	0.000029	1.92	101053.70	5180.72	0.06
Lower	12	100-yr Fldwy	Corrected Eff	103000.00	671.90	714.5950	694.40	714.62	0.000023	1.75	109303.40	6841.88	0.05
Lower	12	100-yr Fldwy	Ppsd cond	103000.00	671.90	714.5950	694.40	714.62	0.000023	1.75	109303.40	6841.88	0.05
Lower	11	100-yr Fldwy	Corrected Eff	103000.00	669.70	714.5646	689.08	714.58	0.000017	1.56	128387.10	7313.63	0.05
Lower	11	100-yr Fldwy	Ppsd cond	103000.00	669.70	714.5646	689.08	714.58	0.000017	1.56	128387.10	7313.63	0.05
Lower	10	100-yr Fldwy	Corrected Eff	103000.00	673.00	714.5234	695.61	714.54	0.000017	1.58	141601.50	8068.57	0.05
Lower	10	100-yr Fldwy	Ppsd cond	103000.00	673.00	714.5234	695.61	714.54	0.000017	1.58	141601.50	8068.57	0.05
Lower	9	100-yr Fldwy	Corrected Eff	103000.00	671.40	714.4683		714.48	0.000013	1.34	151450.20	8718.11	0.04
Lower	9	100-yr Fldwy	Ppsd cond	103000.00	671.40	714.4683		714.48	0.000013	1.34	151450.20	8718.11	0.04
Lower	8	100-yr Fldwy	Corrected Eff	103000.00	675.90	714.3905		714.41	0.000028	1.86	130676.10	8012.80	0.06
Lower	8	100-yr Fldwy	Ppsd cond	103000.00	675.90	714.3905		714.41	0.000028	1.86	130676.10	8012.80	0.06
Lower	7.1	100-yr Fldwy	Corrected Eff	103000.00	671.20	714.3109	689.70	714.33	0.000023	1.81	112590.60	6731.56	0.05
Lower	7.1	100-yr Fldwy	Ppsd cond	103000.00	671.20	714.3109	689.70	714.33	0.000023	1.81	112590.60	6731.56	0.05
Lower	6.7	100-yr Fldwy	Corrected Eff	103000.00	674.00	714.2526	689.78	714.30	0.000052	2.66	71808.13	4198.63	0.08
Lower	6.7	100-yr Fldwy	Ppsd cond	103000.00	674.00	714.2526	689.78	714.30	0.000052	2.66	71808.13	4198.63	0.08
Lower	6.6			Bridge									
Lower	6.5	100-yr Fldwy	Corrected Eff	103000.00	670.30	714.2350	688.67	714.28	0.000048	2.65	72891.29	4196.93	0.08
Lower	6.5	100-yr Fldwy	Ppsd cond	103000.00	670.30	714.2350	688.67	714.28	0.000048	2.65	72891.29	4196.93	0.08
Lower	6.1	100-yr Fldwy	Corrected Eff	103000.00	672.20	714.1860	692.27	714.24	0.000055	2.66	74808.56	5591.74	0.08
Lower	6.1	100-yr Fldwy	Ppsd cond	103000.00	672.20	714.1860	692.27	714.24	0.000055	2.66	74808.56	5591.74	0.08
Lower	5	100-yr Fldwy	Corrected Eff	103000.00	670.00	714.0867	690.14	714.13	0.000041	2.41	77169.77	5514.32	0.07
Lower	5	100-yr Fldwy	Ppsd cond	103000.00	670.00	714.0867	690.14	714.13	0.000041	2.41	77169.77	5514.32	0.07
Lower	4	100-yr Fldwy	Corrected Eff	103000.00	669.70	713.9819		714.02	0.000042	2.49	80549.72	4468.60	0.07
Lower	4	100-yr Fldwy	Ppsd cond	103000.00	669.70	713.9819		714.02	0.000042	2.49	80549.72	4468.60	0.07
Lower	3	100-yr Fldwy	Corrected Eff	103000.00	668.30	713.8400		713.91	0.000055	2.89	72196.19	4052.74	0.08
Lower	3	100-yr Fldwy	Ppsd cond	103000.00	668.30	713.8400		713.91	0.000055	2.89	72196.19	4052.74	0.08
Lower	2	100-yr Fldwy	Corrected Eff	103000.00	670.10	713.7009		713.78	0.000075	3.37	61721.76	3779.48	0.10
Lower	2	100-yr Fldwy	Ppsd cond	103000.00	670.10	713.7009		713.78	0.000075	3.37	61721.76	3779.48	0.10
Lower	1	100-yr Fldwy	Corrected Eff	103000.00	665.20	713.5500	690.80	713.65	0.000094	3.80	61163.47	3247.61	0.11
Lower	1	100-yr Fldwy	Ppsd cond	103000.00	665.20	713.5500	690.80	713.65	0.000094	3.80	61163.47	3247.61	0.11

MINNESOTA "NO-RISE" CERTIFICATION

This is to certify that I am a duly qualified professional engineer licensed to practice in the State of Minnesota.

It is further to certify that the attached technical data supports the fact that the proposal

to construct a permanent dredge material management site

(*development name / short project description*)

will not impact the floodway width or 100-year flood elevation (will not raise or lower by more than 0.00 feet) on the Minnesota River (*Name of stream*) at published sections in the Flood Insurance Study for Savage (*Name of Community*) dated _____ (*Study Date*) and will not impact the 100-year flood elevation (will not raise or lower by more than 0.00 feet) at unpublished cross-sections in the vicinity of the proposed development / project.

Attached are the following documents that support my findings:

HEC-RAS output tables

summary memorandum

Date: 3/8/19

Signature: _____ PE 48031 **{SEAL}**

Title: Sr. Water Resources Engineer