Becher Street, S. 1st Street, and Kinnickinnic Avenue Bridge Scour Analyses

Kinnickinnic River Sediment Remediation Project

Milwaukee County, Wisconsin

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1. Introduction

Representatives of CH2M HILL, the U.S. Environmental Protection Agency (USEPA), the Wisconsin Department of Natural Resources (WDNR), the Port of Milwaukee, and the City of Milwaukee ("City") participated in a meeting on January 21, 2009. There were a variety of topics discussed, but one issue in particular involved the proximity and depth of dredging near the city-owned bridges. The existing plan is to dredge to within 10 feet of bridge abutments and down to a channel elevation of 557.5 feet above mean sea level (amsl) International Great Lakes Datum 1985 (IGLD85). The bottom channel dredge elevation at the downstream part of the project area is currently planned to be 560.5 feet amsl, but might be lowered to 557.5 feet amsl to maintain a consistent channel level.

There are three City-owned bridges in the vicinity of the part of the Kinnickinnic River to be dredged. The Becher Street Bridge is located at the upstream end of the project area. Dredging will not occur beneath this bridge, but will commence approximately 15 feet downstream. The S. 1st Street Bridge is located in the middle of the project area, and the South Kinnickinnic Avenue Bridge is located at the downstream end of the project area. Both the S. 1st Street Bridge and the South Kinnickinnic Avenue Bridge are double-leaf bascule bridges. A rotating railroad bridge owned by Canadian Pacific Railway (CP) is also present in the project area just upstream of the South Kinnickinnic Avenue Bridge.

During discussions with the City, the City questioned how the proposed dredging project might affect the city bridges. It was agreed by all parties present at the meeting that the completion of a scour analysis by CH2M HILL would assist in this evaluation.

1.1 Purpose and Need

This scour report presents the methods used in determining scour potential at the Becher Street Bridge, S. 1st Street Bridge, and Kinnickinnic Avenue Bridge and provides results of each analysis (a site location map of the bridges is included in Appendix A). Each scour analysis determines scour potential for each of the bridges during a 100-year storm event. If an individual analysis reveals scour potential that may affect the integrity of a bridge abutment or pier, scour protection may be warranted.

2. Bridge History

2.1 Becher Street Bridge

The Becher Street Bridge is located in Section 5, Township 6N, Range 22E in the City of Milwaukee, Milwaukee County, Wisconsin. The bridge was built on Becher Street in 1967 and spans approximately 300 feet across the Kinnickinnic River.

2.2 S. 1st Street Bridge

The S. 1st Street Bridge is located in Section 5, Township 6N, Range 22E in the City of Milwaukee, Milwaukee County, Wisconsin. The bridge was built on S. 1st Street in 1955 and spans approximately 300 feet across the Kinnickinnic River.

2.3 Kinnickinnic Avenue Bridge

The Kinnickinnic Avenue Bridge is located in Section 4, Township, 6N, Range 22 in the City of Milwaukee, Milwaukee County, Wisconsin. The bridge was built on Kinnickinnic Avenue in the late 1990s and spans approximately 300 feet across the Kinnickinnic River.

The physical characteristics of the above listed three bridges are presented in Appendix B.

3. Previous Scour Analysis

Previous scour analyses were performed on the Becher Street Bridge and S. 1st Street Bridge in 1997 by Ayers and Associates for the City of Milwaukee (1997 Analysis). The results from these analyses will be compared to the current analyses performed by CH2M HILL (2009 Analysis).

3.1 Becher Street Bridge

A scour analysis and report entitled *Scour Evaluation Report, Bridge No. P-40-794, W. Becher Street Over Kinnickinnic River in Milwaukee, Wisconsin* was completed in 1997 by Ayres Associates for the City of Milwaukee. The Becher Street Bridge scour analysis was run using a 100-storm discharge of 7,000 cubic feet per second (cfs), a D_{50} of 0.085 millimeters (mm) and a D_{90} of 0.40 mm ("D_{50}"refers to a particle size of which 50 percent of the material by weight is finer). Results from this analysis are shown in Table 1.

TABLE 1
Becher Street Scour Analysis Results (1997)

Element	Long Term Scour (ft)	Contraction Scour (ft)	Local Scour (ft)	Total Scour Depth (ft)	Total Scour Width (ft)
Left Abutment	0[1]	12.7[1]	21.2[1]	33.9[1]	85.0[1]
Right Abutment	0[1]	12.7[1]	6.5[1]	19.2[1]	26.0[1]
Pier No. 1	0	12.7	4.3	17.0	17.0
Pier No. 2	0	12.7	4.3	17.0	17.0

3.2 S. 1st Street Bridge

A scour analysis and report entitled *Scour Evaluation Report, Bridge No. P-40-830, S. First Street Over Kinnickinnic River in Milwaukee, Wisconsin* was completed in 1997 by Ayres Associates for the City of Milwaukee. The S. 1st Street Bridge scour analysis was also run using a 100-storm discharge of 7,000 cfs, a D_{50} of 0.085 mm and a D_{90} of 0.40 mm. Results from this analysis are shown in Table 2.

[1] Although scour depths and elevations were calculated in the 1997 and 2009 Hydrologic Engineering Center – River Analysis System (HEC-RAS) models for the Becher Street Bridge abutments, in actuality, they are protected from scour by riprap and the numbers reflect scour potential if the riprap were not present.

TABLE 2
S.1st Street Scour Analysis Results (1997)

Element	Long Term Scour (ft)	Contraction Scour (ft)	Local Scour (ft)	Total Scour Depth (ft)	Total Scour Width (ft)
Left Abutment	0	16.9	0	16.9	146
Right Abutment	0	16.9	0	16.9	146
Pier No. 1	0	16.9	32.1	49.0	167

3.3 Kinnickinnic Avenue Bridge

A previous scour analysis was not available for the Kinnickinnic Avenue Bridge.

4. Methods

The 2009 bridge scour analysis was performed using a Hydrologic Engineering Center – River Analysis System (HEC-RAS) hydraulic model of the Kinnickinnic River, which was obtained from the Southeastern Wisconsin Regional Planning Commission (SEWRPC) to use as a baseline model (SEWRPC Model) for the scour analysis. The SEWRPC Model contained Kinnickinnic River cross-sections and bridge cross-sections within an approximate 8-mile stretch of the Kinnickinnic River. Kinnickinnic River and bridge cross-sections relevant to the project area were used to develop the new bridge scour model (CH2M HILL Model) performed by CH2M HILL. Elevations used for the CH2M HILL model were adjusted from IGLD 85 to the National Geodetic Vertical Datum 1929 used by SEWRPC in the baseline model. All elevations used in this report are in IGLD85.

The 100-year storm discharge value used for the following scour analyses was obtained from the existing SEWRPC model. The soils data was obtained from subsurface investigations performed in 2002 of the Kinnickinnic River. The soils report documenting the results is entitled the *Report of: Subsurface Investigation for Kinnickinnic River, Milwaukee, Wisconsin.* This report was prepared for the U.S. Army Corps of Engineers, Detroit District, by Coleman Engineering. Each bridge location had a separate soil boring in which the D_{50} and D_{95} were determined. The soil particle size used for the analysis of each bridge was based on D_{50} and D_{95} particle sizes at the proposed dredge depth.

5. Scour Analysis Results

5.1 Becher Street Bridge

The Becher Street Bridge scour analysis, Scenario 1, was run using a 100-year storm discharge of 10,500 cfs, a D_{50} of 0.55 mm, and a D_{95} of 3.7 mm for an elevation of 556.5 feet amsl (this includes overdredge) throughout the upper part of the reach, increasing to 559.5 feet amsl (this includes overdredge) just upstream of the Kinnickinnic River Bridge. Table 3 presents the results from this analysis.

TABLE 3
Becher Street Scour Analysis Results (Scenario 1, 2009)

Element	Long Term Scour (ft)	Contraction Scour (ft)	Local Scour (ft)	Total Scour Depth (ft)	Dredge Elevation (amsl)	Scour Depth Elevation (amsl)	Total Scour Width (ft)
Left Abutment	0[1]	10.1[1]	42.9[1]	53.0[1]	564[2]	511[1]	106[1]
Right Abutment	0[1]	10.1[1]	40.5[1]	50.6[1]	564[2]	513[1]	101[1]
Pier No. 1	0	10.1	3.6	13.7	557[2]	543	54.9
Pier No. 2	0	10.1	3.6	13.7	557[2]	543	54.9

The Becher Street Bridge scour analysis, Scenario 2, was run using a 100-year storm discharge of 10,500 cfs, a D_{50} of 0.55 mm, and a D_{95} of 3.7 mm for an elevation of 556.5 feet amsl (this includes overdredge) throughout the entire reach. Table 4 presents the results from this analysis.

TABLE 4
Becher Street Scour Analysis Results (Scenario 2, 2009)

Element	Long Term Scour (ft)	Contraction Scour (ft)	Local Scour (ft)	Total Scour Depth (ft)	Dredge Elevation (amsl)	Scour Depth Elevation (amsl)	Total Scour Width (ft)
Left Abutment	0[1]	10.5[1]	43.6[1]	54.1[1]	564[2]	510[1]	108[1]
Right Abutment	0[1]	10.5[1]	41.2[1]	51.8[1]	564[2]	512[1]	104[1]
Pier No. 1	0	10.5	3.6	14.1	557[2]	543	56.6
Pier No. 2	0	10.5	3.6	14.1	557[2]	543	56.6

5.2 S. 1st Street Bridge

The S. 1st Street Bridge scour analysis was run using a 100-year storm discharge of 10,500 cfs, a D_{50} of 0.016 mm, and a D_{95} of 0.18 mm for an elevation of 556.5 feet amsl (this includes overdredge) throughout the upper part of the reach, increasing to 559.5 feet amsl (this includes overdredge) just upstream of the Kinnickinnic River Bridge. Table 5 presents the results from this analysis.

[1] Although scour depths and elevations were calculated in the 1997 and 2009 HEC-RAS models for the Becher Street Bridge abutments, in actuality they are protected from scour by riprap and the numbers reflect scour potential if the riprap were not present.

[2] Dredging is not occurring beneath the Becher Street Bridge; however, headcutting has conservatively been assumed to extend upstream underneath the bridge equal to the depth of the maximum dredge cut.

TABLE 5
S. 1st Street Scour Analysis Results (Scenario 1, 2009)

Element	Long Term Scour (ft)	Contraction Scour (ft)	Local Scour (ft)	Total Scour Depth (ft)	Dredge Elevation (amsl)	Scour Depth Elevation (amsl)	Total Scour Width (ft)
Left Abutment	0	11.7	30.5	42.2	570	538	84.3
Right Abutment	0	11.7	24.0	35.7	560[1]	524	71.5
Pier No. 1	0	11.7	28.5	40.2	560[1]	520	161

The S. 1st Street Bridge scour analysis was run using a 100-year storm discharge of 10,500 cfs, a D_{50} of 0.016 mm, and a D_{95} of 0.18 mm for an elevation of 556.5 feet amsl (this includes overdredge) throughout the entire reach. Table 6 presents the results from this analysis.

TABLE 6
S. 1st Street Scour Analysis Results (Scenario 2, 2009)

Element	Long Term Scour (ft)	Contraction Scour (ft)	Local Scour (ft)	Total Scour Depth (ft)	Dredge Elevation (amsl)	Scour Depth Elevation (amsl)	Total Scour Width (ft)
Left Abutment	0	11.6	30.3	41.8	570	538	83.7
Right Abutment	0	11.6	23.8	35.4	560[1]	525	70.8
Pier No. 1	0	11.6	28.6	40.2	560[1]	520	161

5.3 Kinnickinnic Avenue Bridge

The Kinnickinnic Avenue Bridge scour analysis was run using a 100-year storm discharge of 11,300 cfs, a D_{50} of 0.35 mm, and a D_{95} of 17.0 mm for an elevation of 556.5 feet amsl (this includes overdredge) throughout the upper part of the reach, increasing to 559.5 feet amsl (this includes overdredge) just upstream of the Kinnickinnic River Bridge. Table 7 presents the results from this analysis.

TABLE 7
Kinnickinnic Avenue Scour Analysis Results (Scenario 1, 2009)

Element	Long Term Scour (ft)	Contraction Scour (ft)	Local Scour (ft)	Total Scour Depth (ft)	Dredge Elevation (amsl)	Scour Depth Elevation (amsl)	Total Scour Width (ft)
Left Abutment	0	0.0	39.8	39.8	563[1]	523	79.5
Right Abutment	0	0.0	45.5	45.5	563[1]	517	91.1

[1] Dredge elevation is estimated to be approximately 3 feet higher than the channel bottom elevation because dredging will not be done within 10 feet of the piers and abutments, and the long-term slope of the sediment will be approximately 3:1 (H:V).

The Kinnickinnic Avenue Bridge scour analysis was run using a 100-year storm discharge of 11,300 cfs, a D_{50} of 0.35 mm, and a D_{95} of 17.0 mm for an elevation of 556.5 feet amsl (this includes overdredge) throughout the entire reach. Table 8 presents the results from this analysis.

TABLE 8
Kinnickinnic Avenue Scour Analysis Results(Scenario 2, 2009)

Element	Long Term Scour (ft)	Contraction Scour (ft)	Local Scour (ft)	Total Scour Depth (ft)	Dredge Elevation (amsl)	Scour Depth Elevation (amsl)	Total Scour Width (ft)
Left Abutment	0	0.0	41.2	41.2	560[1]	519	82.5
Right Abutment	0	0.0	46.8	46.8	560[1]	513	93.6

Figures showing scour analysis for each of the scenarios are provided in Appendix C.

6. Scour Analysis Comparison

The 1997 analysis for both of the Becher Street and S. 1st Street bridges was compared to the 2009 analysis run using a discharge of 7,000 cfs, a dredge depth of 556.5 feet amsl throughout the channel, and the same sediment particle sizes used in the 1997 analysis. This was done in an attempt to isolate the effects that dredging alone would have on the scour potential for each bridge. Tables 9 and 10 present a side-by-side comparison of these analyses.

6.1 Becher Street Bridge

Table 9 presents the Becher Street Bridge scour analysis comparison.

TABLE 9
Becher Street Bridge Scour Analysis Comparison

	Long Term Scour (ft)		Contraction Scour (ft)		Local Scour (ft)		Total Scour Depth (ft)		Dredge Elevation (amsl)		Scour Depth Elevation (amsl)		Total Scour Width (ft)	
Element	1997	2009	1997	2009	1997	2009	1997	2009	1997	2009	1997	2009	1997	2009
Left Abutment	0[2]	0[2]	12.7[2]	11.4[2]	21.2[2]	40.0[2]	33.9[2]	51.4[2]	572	564[3]	538[2]	513[2]	85.0[2]	103[2]
Right Abutment	0[2]	0[2]	12.7[2]	11.4[2]	6.5[2]	38.1[2]	19.2[2]	49.6[2]	573	564[3]	554[2]	514[2]	26.0[2]	99.1[2]
Pier No. 1	0	0	12.7	11.5	4.3	3.3	17.0	14.8	570	557[3]	553	542	17.0	59.2

[1] Dredge elevation is estimated to be approximately 3 feet higher than the channel bottom elevation because dredging will not be done within 10 feet of the piers and abutments, and the long-term slope of the sediment will be approximately 3:1 (H:V).

[2] Although scour depths and elevations were calculated in the 1997 and 2009 HEC-RAS models for the Becher Street Bridge abutments, in actuality they are protected from scour by riprap and the numbers reflect scour potential if the riprap were not present.

[3] Dredging is not occurring beneath the Becher Street Bridge; however, headcutting has conservatively been assumed to extend upstream underneath the bridge equal to the depth of the maximum dredge cut.

TABLE 9
Becher Street Bridge Scour Analysis Comparison

	Long Term Scour (ft)		Contraction Scour (ft)		Local Scour (ft)		Total Scour Depth (ft)		Dredge Elevation (amsl)		Scour Depth Elevation (amsl)		Total Scour Width (ft)	
Element	1997	2009	1997	2009	1997	2009	1997	2009	1997	2009	1997	2009	1997	2009
Pier No. 2	0	0	12.7	11.5	4.3	3.3	17.0	14.8	574	557[3]	557	542	17.0	59.2

6.2 S. 1st Street Bridge

The results of the scour analysis comparison for the S. 1st Street Bridge are shown in Table 10.

TABLE 10
S. 1st Street Scour Analysis Comparison

	Long Term Scour (ft)		Contraction Scour (ft)		Local Scour (ft)		Total Scour Depth (ft)		Dredge Elevation (amsl)		Scour Depth Elevation (amsl)		Total Scour Width (ft)	
Element	1997	2009	1997	2009	1997	2009	1997	2009	1997	2009	1997	2009	1997	2009
Left Abutment	0	0	16.9	11.0	0	27.6	16.9	38.6	570	570[1]	553	531	146	77.2
Right Abutment	0	0	16.9	11.0	0	22.6	16.9	33.5	567	560[1]	550	527	146	67.1
Pier No. 1	0	0	16.9	11.0	32.1	24.2	49.0	35.2	560	560[1]	511	525	167	141

6.3 Kinnickinnic Avenue Bridge

No previous scour analysis for the Kinnickinnic Avenue Bridge has been made available to CH2M HILL; therefore, no comparison to previous analyses can be made.

7. Discussion

Scour potential for the 2009 analyses are based on D_{50} and D_{95} of sediment samples taken at the approximate dredge elevation in borings closest to each bridge. In reality, the D_{50} and D_{95} will not remain constant throughout the entire scour depth.

The 2009 Becher Street Bridge scour analysis predicted a scour potential of up to 54 feet at the abutments; however, the Becher Street Bridge has riprap serving as scour protection along both abutments. Thus, scour is not anticipated around the abutments.

The 2009 S. 1st Street Bridge scour analysis predicted potential scour down to an elevation of 520 feet; however, based on the boring logs, there is a stiff clay soil at elevation 545.3 feet amsl. From the dredge elevation of 556.5 feet used in the model, there is approximately 11.2 feet of soft sediment that may be scoured away before the clay is encountered. It is

[1] Dredge elevation is estimated to be approximately 3 feet higher than the channel bottom elevation because dredging will not be done within 10 feet of the piers and abutments, and the long-term slope of the sediment will be approximately 3:1 (H:V).

anticipated that the maximum scour potential would not occur as the clay layer would act as a scour barrier.

The 2009 Kinnickinnic Avenue Bridge scour analysis predicted potential scour down to an elevation of 513 feet. Soil boring logs indicate primarily organic silt and sandy sediment down to an elevation of 531.3 feet amsl, where glacial tills comprised of stiff clay and silt were encountered. the soil boring stopped. It is anticipated that the maximum scour potential would not occur as the clay and silt layer would act as a scour barrier.

8. Conclusions

The 2009 scour analyses were perform to determine to what extent the planned dredging of the Kinnickinnic River will impact the scour potential near the City-owned bridges. Secondarily, the impact to scour potential due to a change in dredge elevation from 560.5 to 557.5 feet amsl at the downstream end of the project was evaluated. A bridge-by-bridge evaluation follows.

8.1 Becher Street Bridge

Although no dredging will occur beneath the Becher Street Bridge, it has been conservatively assumed that headcutting will occur and the post-dredge sediment elevations will extend upstream beneath the bridge. In actuality, if headcutting does occur, it will likely diminish somewhat before the bridge is reached. Also, both abutments of the bridge have been protected by riprap already, and potential scour calculated for these structures do not take this fact into account. Therefore, scour is unlikely to occur at all around the abutments.

Maximum potential scour depth at the piers was calculated to be 17 feet in 1997 and 15 feet in 2009 (using the 1997 flowrate and sediment particle sizes). Using the larger 100-year flowrate and location specific sediment particle size, maximum potential scour depth was determined to be 14 feet (the downstream dredge elevation made little difference). While the potential scour elevation was lower than the 1997 elevation due to headcutting (553 feet amsl versus 542 feet amsl), the lack of change in magnitude of scour potential suggests that additional scour protection measures are unnecessary at the Becher Street Bridge.

8.2 S. 1st Street Bridge

Post-dredge elevations at the S. 1st Street Bridge will be 570 at the left abutment and 560 at the right abutment and pier. Maximum potential scour depths at these three structures as calculated in 1997 were 17, 17, and 49 feet, respectively, and in 2009 (using the 1997 flowrate and sediment particle sizes) were 39, 34, and 35 feet, respectively. Potential scour elevations at these three structures as calculated in 1997 were 553, 550, and 511 feet amsl, respectively, and in 2009 (using the 1997 flowrate and sediment particle sizes) were 531, 527, and 525 feet amsl, respectively. While the potential scour elevations for the abutments are significantly lower due to the dredging work, the potential scour elevation for the pier is actually 14 feet higher. Using the larger 100-year flowrate and location specific sediment particle size, the potential scour elevations were somewhat lower than using the 1997 parameters (538, 525, and 520 feet amsl, respectively), but the most critical potential scour at the pier was still less in magnitude than the 1997 calculation (2009 elevation of 520 feet amsl versus 1997 elevation of 511 feet amsl). Therefore, it appears that the dredging project will not increase the most critical potential scour at the S. 1st Street Bridge.

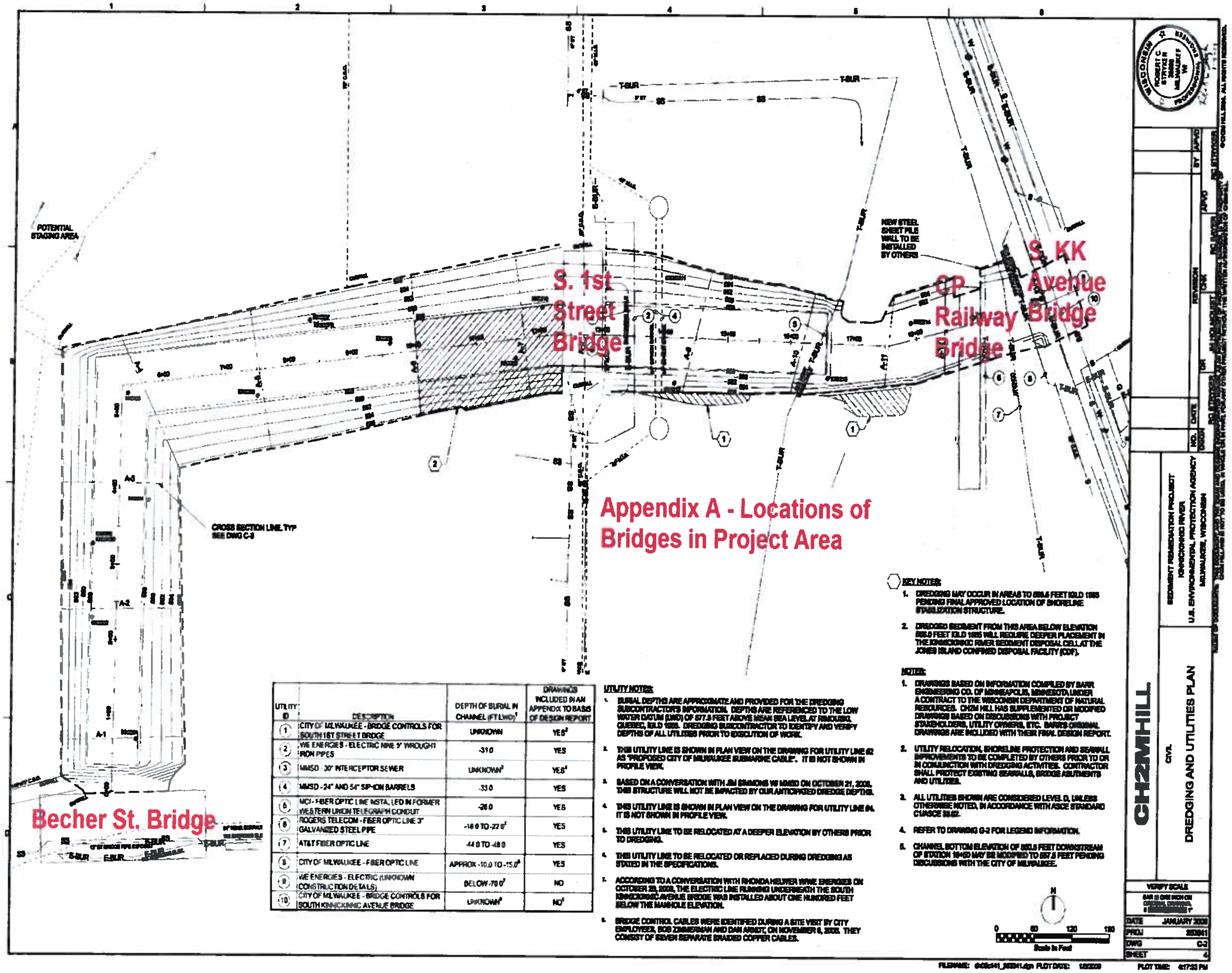
8.3 Kinnickinnic Avenue Bridge

Post-dredge elevations at the Kinnickinnic Avenue Bridge will be 563 feet amsl at the abutments with the 560 feet amsl dredge elevation scenario and 560 feet amsl with the 557 feet amsl dredge elevation scenario. No previous scour analysis was provided to CH2M HILL for this bridge.

Maximum potential scour depths at the left and right abutments were calculated to be 40 and 46 feet, respectively, with the 560 feet amsl dredge elevation scenario and 41 and 47 feet, respectively, with the 557 feet amsl dredge elevation scenario. The potential scour elevations for the left and right abutments were calculated to be 523 and 517 feet amsl, respectively, with the 560 feet amsl dredge scenario and 519 and 513 feet amsl, respectively, with the 557 feet amsl dredge scenario. Although no previous scour analysis was available, the bridge itself had not been deemed scour critical according to a conversation with Jeff Dellemann with the City of Milwaukee. At these potential scour depths, it likely is scour critical.

It appears that the dredging project will impact the scour potential at the Kinnickinnic Avenue bridge significantly, regardless of the downstream dredge depth. Therefore, the 557 feet amsl dredge depth scenario can be used, and implementation of scour protection measures after dredging, most likely in the form of riprap armoring, appears justified.

Appendix A
Site Location Map



UTILITY ID	DESCRIPTION	DEPTH OF BURIAL IN CHANNEL (FT LWD)[1]	DRAWINGS INCLUDED IN AN APPENDIX TO BASIS OF DESIGN REPORT
1	CITY OF MILWAUKEE - BRIDGE CONTROLS FOR SOUTH 1ST STREET BRIDGE	UNKNOWN	YES[8]
2	WE ENERGIES - ELECTRIC NINE 5" WROUGHT IRON PIPES	-31.0	YES
3	MMSD - 30" INTERCEPTOR SEWER	UNKNOWN[3]	YES[4]
4	MMSD - 24" AND 54" SIPHON BARRELS	-33.0	YES
5	MCI - FIBER OPTIC LINE INSTALLED IN FORMER WESTERN UNION TELEGRAPH CONDUIT	-26.0	YES
6	ROGERS TELECOM - FIBER OPTIC LINE 3" GALVANIZED STEEL PIPE	-18.0 TO -22.0[5]	YES
7	AT&T FIBER OPTIC LINE	-44.0 TO -48.0	YES
8	CITY OF MILWAUKEE - FIBER OPTIC LINE	APPROX -10.0 TO -15.0[6]	YES
9	WE ENERGIES - ELECTRIC (UNKNOWN CONSTRUCTION DETAILS)	BELOW -70.0[7]	NO
10	CITY OF MILWAUKEE - BRIDGE CONTROLS FOR SOUTH KINNICKINNIC AVENUE BRIDGE	UNKNOWN[8]	NO[8]

UTILITY NOTES:

1. BURIAL DEPTHS ARE APPROXIMATE AND PROVIDED FOR THE DREDGING SUBCONTRACTOR'S INFORMATION. DEPTHS ARE REFERENCED TO THE LOW WATER DATUM (LWD) OF 577.5 FEET ABOVE MEAN SEA LEVEL AT RIMOUSKI, QUEBEC, IGLD 1985. DREDGING SUBCONTRACTOR TO IDENTIFY AND VERIFY DEPTHS OF ALL UTILITIES PRIOR TO EXECUTION OF WORK.
2. THIS UTILITY LINE IS SHOWN IN PLAN VIEW ON THE DRAWING FOR UTILITY LINE #2 AS "PROPOSED CITY OF MILWAUKEE SUBMARINE CABLE". IT IS NOT SHOWN IN PROFILE VIEW.
3. BASED ON A CONVERSATION WITH JIM SIMMONS W/ MMSD ON OCTOBER 21, 2008, THIS STRUCTURE WILL NOT BE IMPACTED BY OUR ANTICIPATED DREDGE DEPTHS.
4. THIS UTILITY LINE IS SHOWN IN PLAN VIEW ON THE DRAWING FOR UTILITY LINE #4. IT IS NOT SHOWN IN PROFILE VIEW.
5. THIS UTILITY LINE TO BE RELOCATED AT A DEEPER ELEVATION BY OTHERS PRIOR TO DREDGING.
6. THIS UTILITY LINE TO BE RELOCATED OR REPLACED DURING DREDGING AS STATED IN THE SPECIFICATIONS.
7. ACCORDING TO A CONVERSATION WITH RHONDA HELWER W/WE ENERGIES ON OCTOBER 23, 2008, THE ELECTRIC LINE RUNNING UNDERNEATH THE SOUTH KINNICKINNIC AVENUE BRIDGE WAS INSTALLED ABOUT ONE HUNDRED FEET BELOW THE MANHOLE ELEVATION.
8. BRIDGE CONTROL CABLES WERE IDENTIFIED DURING A SITE VISIT BY CITY EMPLOYEES, BOB ZIMMERMAN AND DAN ARNDT, ON NOVEMBER 6, 2008. THEY CONSIST OF SEVEN SEPARATE BRAIDED COPPER CABLES.

KEY NOTES:

1. DREDGING MAY OCCUR IN AREAS TO 569.5 FEET IGLD 1985 PENDING FINAL APPROVED LOCATION OF SHORELINE STABILIZATION STRUCTURE.
2. DREDGED SEDIMENT FROM THIS AREA BELOW ELEVATION 569.0 FEET IGLD 1985 WILL REQUIRE DEEPER PLACEMENT IN THE KINNICKINNIC RIVER SEDIMENT DISPOSAL CELL AT THE JONES ISLAND CONFINED DISPOSAL FACILITY (CDF).

NOTES:

1. DRAWINGS BASED ON INFORMATION COMPILED BY BARR ENGINEERING CO. OF MINNEAPOLIS, MINNESOTA UNDER A CONTRACT TO THE WISCONSIN DEPARTMENT OF NATURAL RESOURCES. CH2M HILL HAS SUPPLEMENTED OR MODIFIED DRAWINGS BASED ON DISCUSSIONS WITH PROJECT STAKEHOLDERS, UTILITY OWNERS, ETC. BARR'S ORIGINAL DRAWINGS ARE INCLUDED WITH THEIR FINAL DESIGN REPORT.
2. UTILITY RELOCATION, SHORELINE PROTECTION AND SEAWALL IMPROVEMENTS TO BE COMPLETED BY OTHERS PRIOR TO OR IN CONJUNCTION WITH DREDGING ACTIVITIES. CONTRACTOR SHALL PROTECT EXISTING SEAWALLS, BRIDGE ABUTMENTS AND UTILITIES.
3. ALL UTILITIES SHOWN ARE CONSIDERED LEVEL D, UNLESS OTHERWISE NOTED, IN ACCORDANCE WITH ASCE STANDARD CI/ASCE 38-02.
4. REFER TO DRAWING G-2 FOR LEGEND INFORMATION.
5. CHANNEL BOTTOM ELEVATION OF 560.5 FEET DOWNSTREAM OF STATION 16+50 MAY BE MODIFIED TO 557.5 FEET PENDING DISCUSSIONS WITH THE CITY OF MILWAUKEE.

Appendix B
Physical Characteristics of Bridges

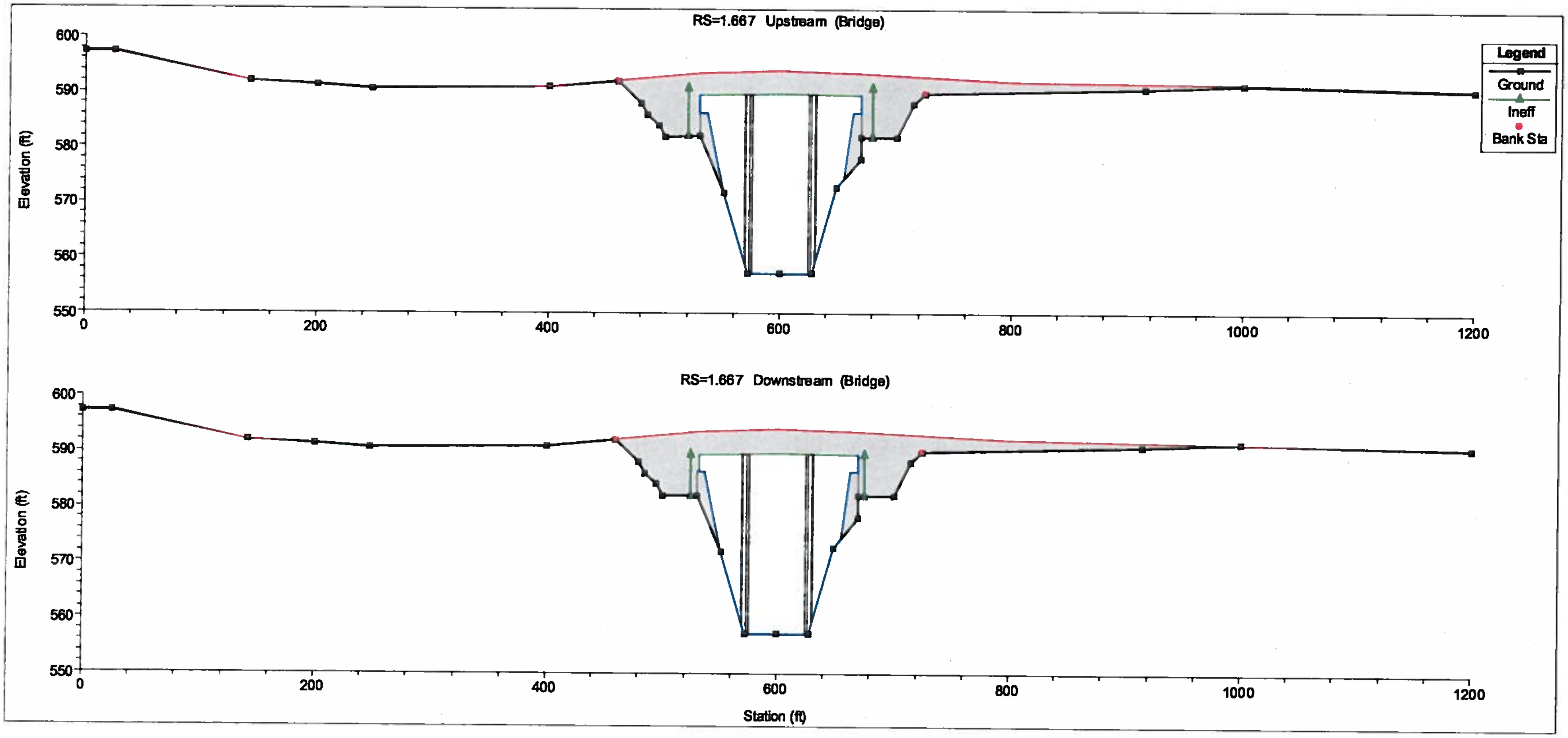


FIGURE B-1
Becher Street Bridge Physical Characteristics

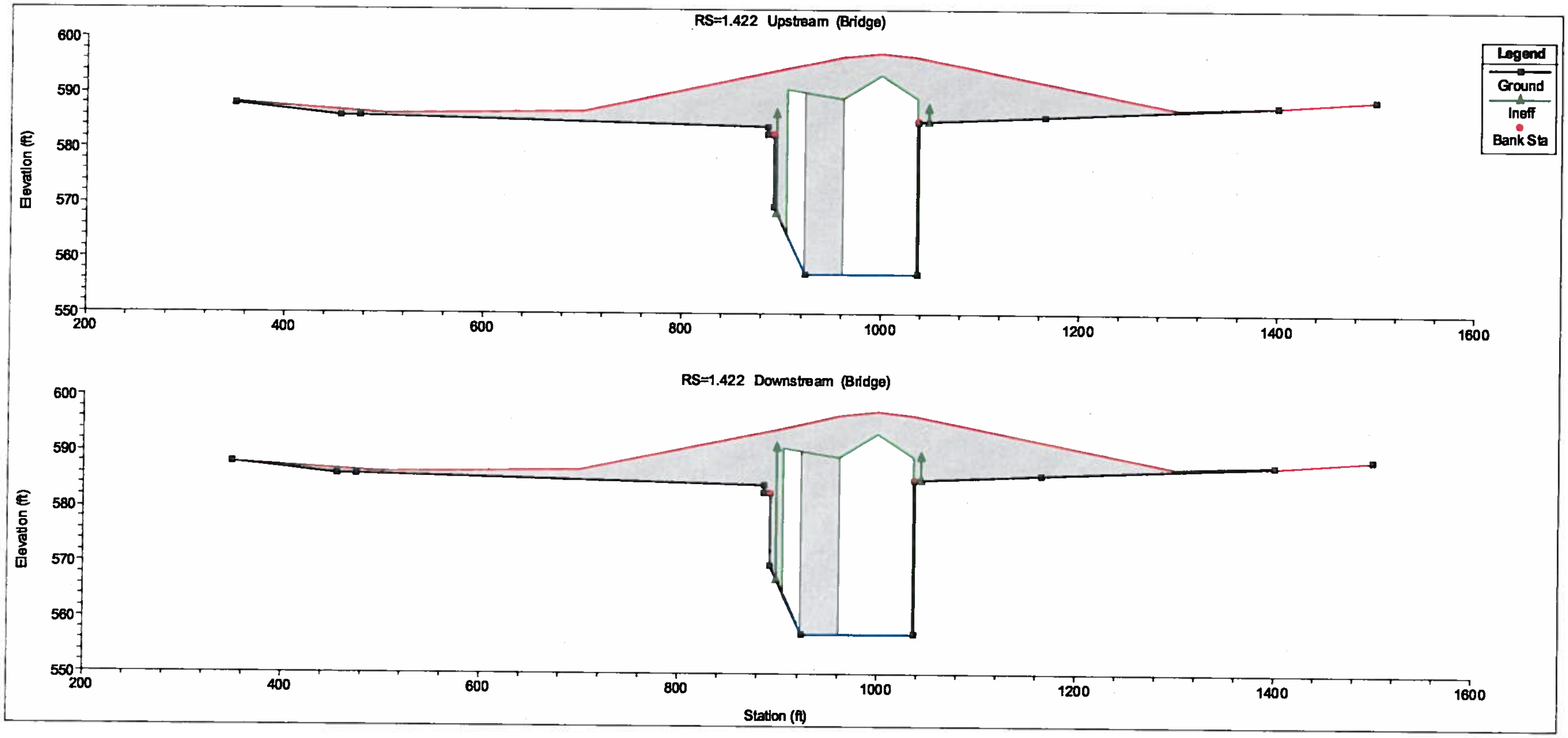


FIGURE B-2
S. 1st Street Bridge Physical Characteristics

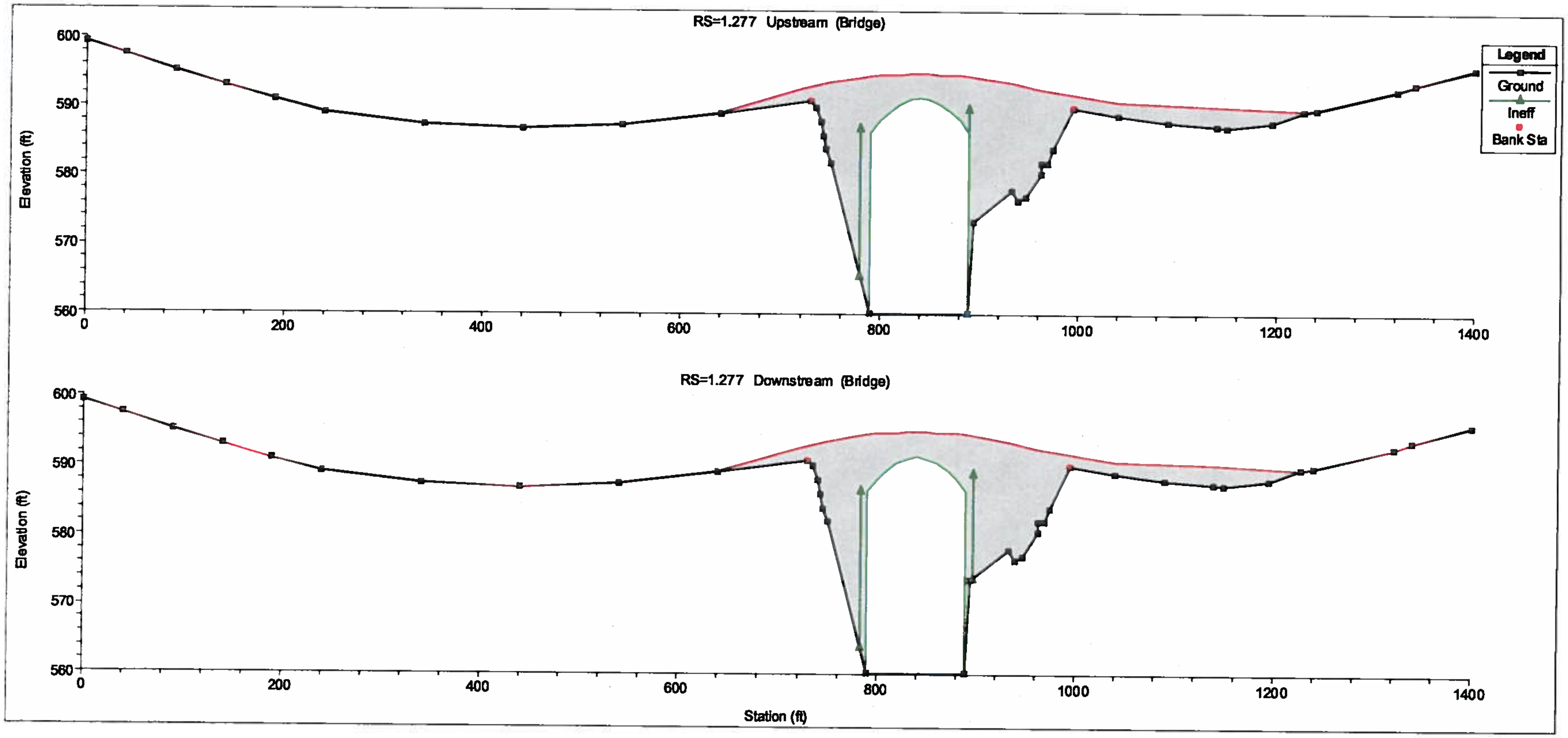


FIGURE B-3
Kinnickinnic Avenue Bridge Physical Characteristics.

Appendix C
Scour Analysis Figures

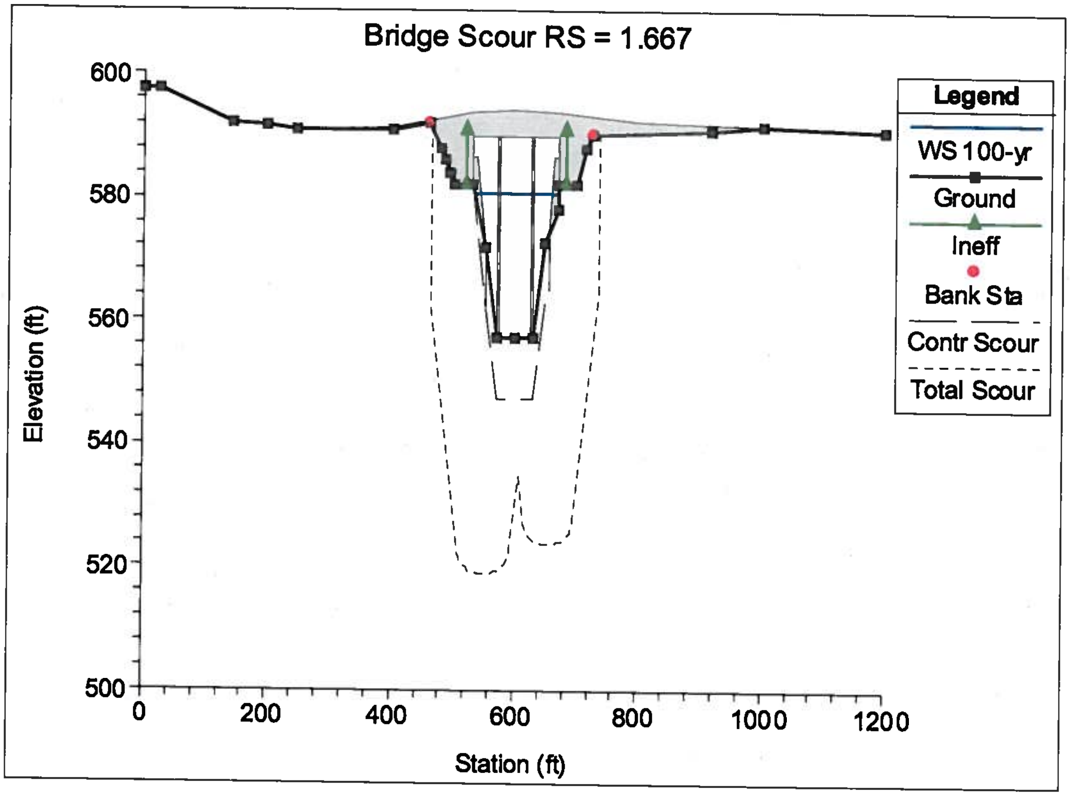


FIGURE C-1.
Becher Street Bridge Scour Analysis Scenario 1

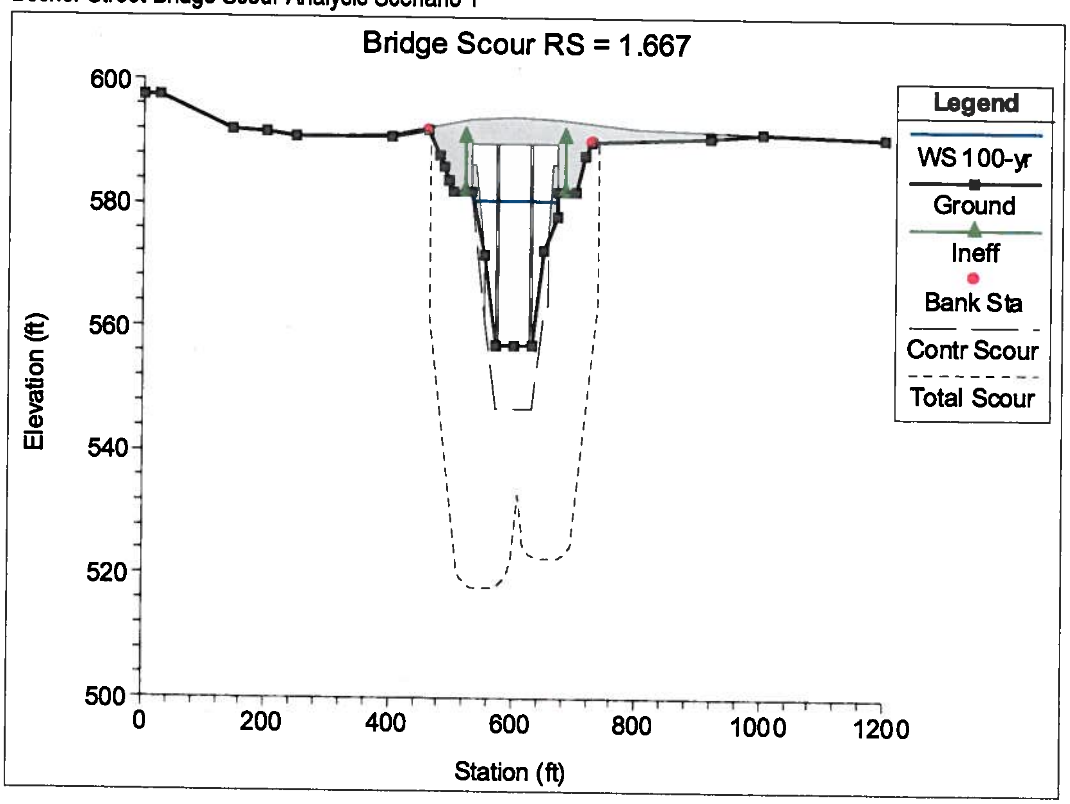


FIGURE C-2.
Becher Street Bridge Scour Analysis Scenario 2

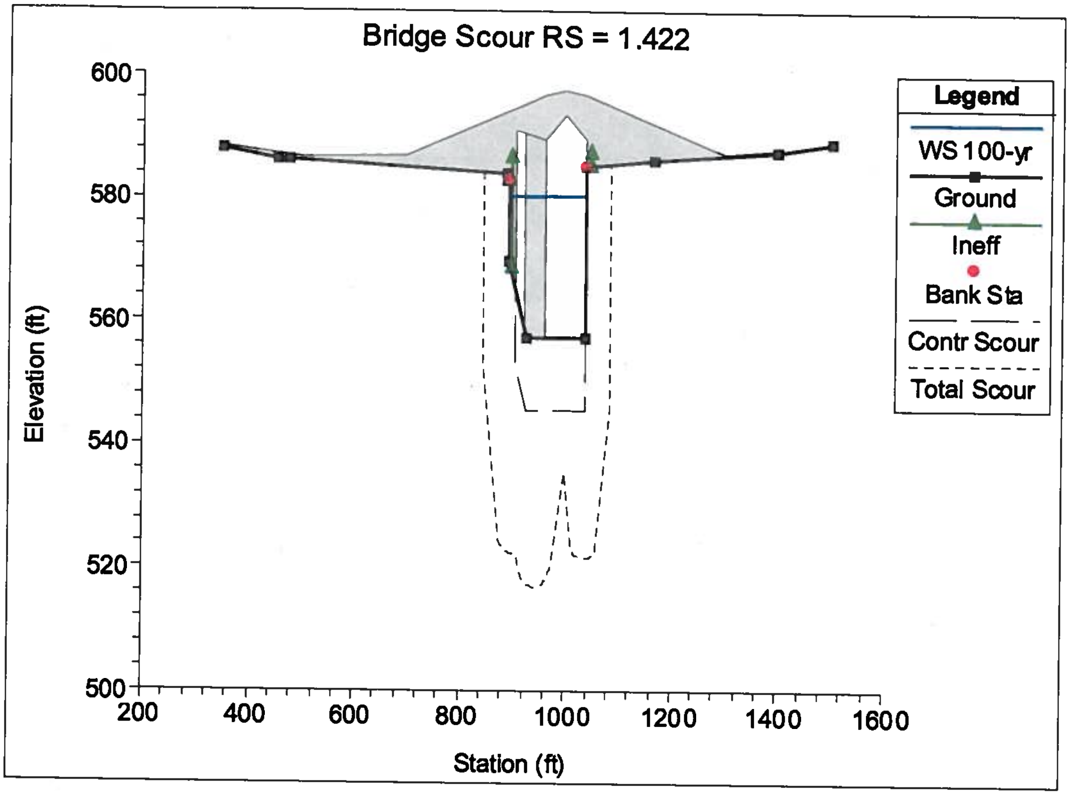


FIGURE C-3.
S. 1st Street Bridge Scour Analysis Scenario 1

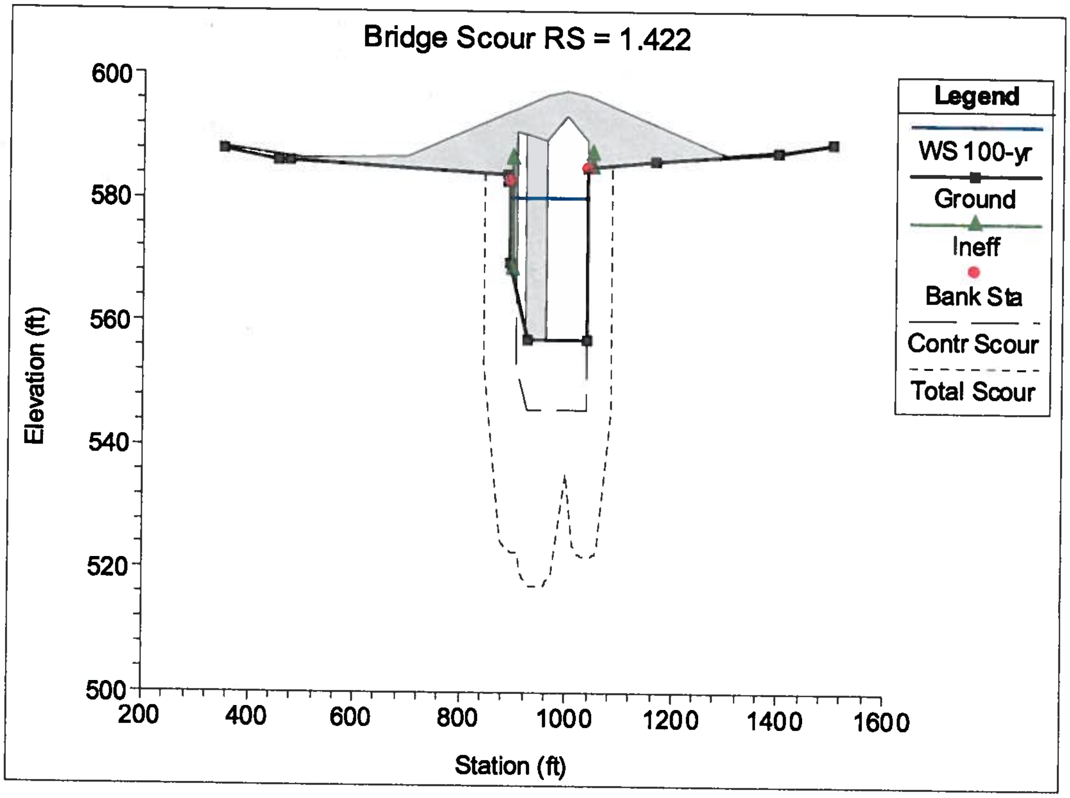


FIGURE C-4.
S. 1st Street Bridge Scour Analysis Scenario 2

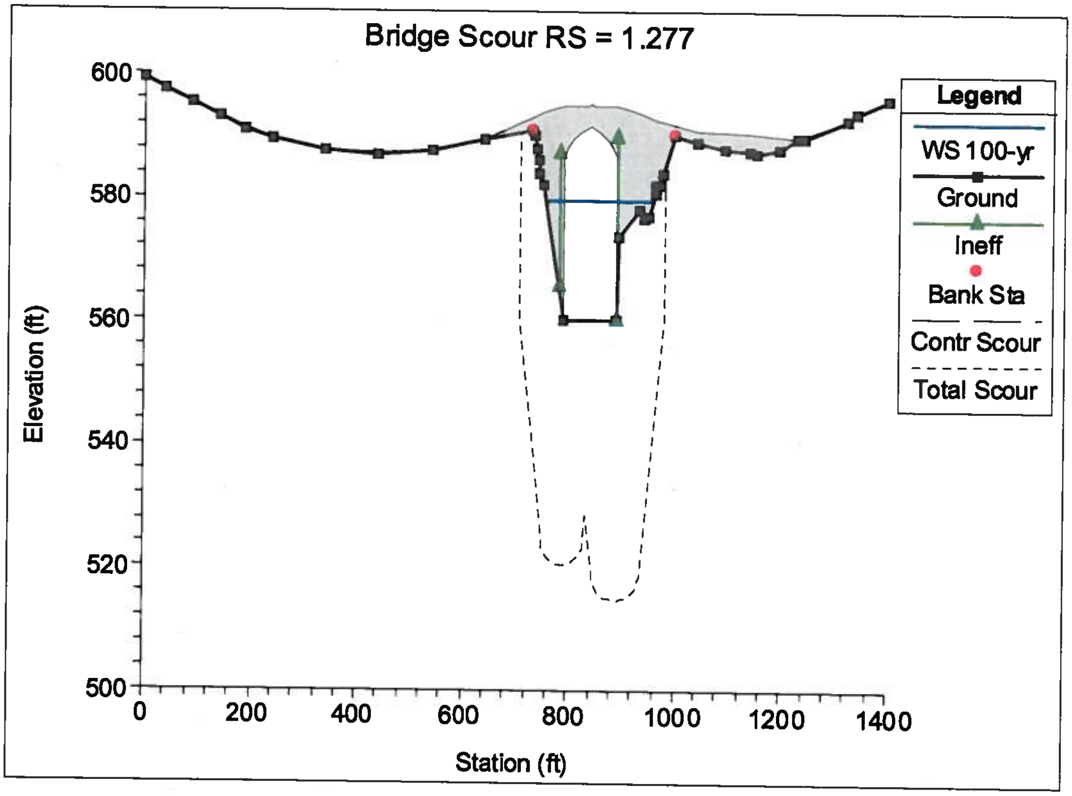


FIGURE C-5
Kinnickinnic Avenue Bridge Scour Analysis Scenario 1

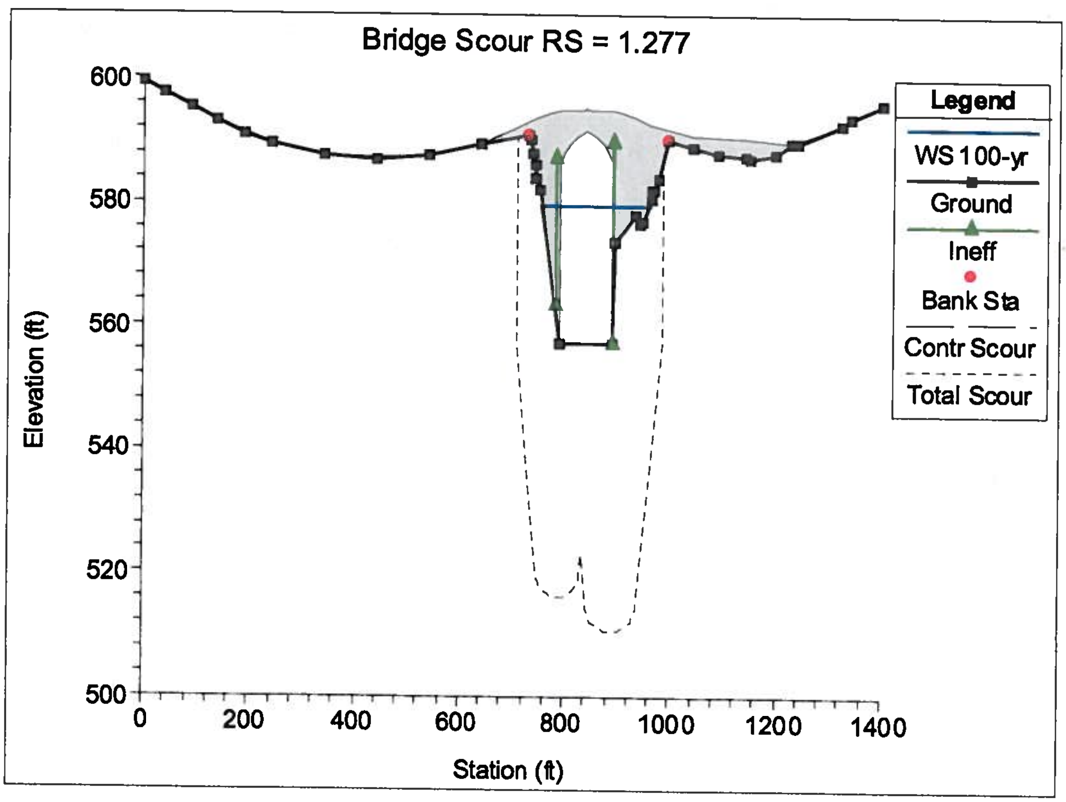


FIGURE C-6.
Kinnickinnic Avenue Bridge Scour Analysis Scenario 2