Underwater Bridge Inspection Report

Douglas MacArthur Bridge

Over the Detroit River

April 22, 2009

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SIGNIFICANT FINDINGS SUMMARY

An underwater inspection of the Douglas MacArthur Bridge over the Detroit River was performed on April 22, 2009 through April 24, 2009. At the upstream ends of the piers, particularly around the upstream nose, scour pockets were observed. The scour pockets were typically deep enough to cause footing exposure. The upper tier of the footing was exposed on a total of 14 piers. In addition, the lower tier of the footing was exposed on 9 piers. At Piers 11, 13, and 15, the amount of vertical exposure of the lower tier of the footing was between 3 and 4 feet. This is significant because available plans indicate that the lower tier of the footing is 4 feet thick. However, no undermining of the footings was observed. In general, the channel bottom elevations increased towards the downstream end of the pier and any remaining footing exposure was eliminated. As indicated in the previous report, horizontal timber members protruded from the faces of the piers near the channel bottom. In contrast to the previous report, no localized scour was noted in the channel bottom beneath the horizontal timbers. In addition to the horizontal timbers, occasional timber debris and timber formwork was observed around the piers. The extent of the timber debris and formwork was minimal. Light to moderate scaling, 1/4 inch to 1-1/2 inch deep, was observed from 6 inches to 24 inches below the waterline. The heavier scaling was observed around the upstream nose. Square voids measuring 12 inches by 12 inches were located a few feet below the waterline on the faces of the piers. There were typically four voids per face. The voids exhibited penetrations of 3 feet without stoppage. The faces of the piers also exhibited areas of section loss around and directly above the waterline. The areas were relatively small, typically measuring between 1 and 3 feet in diameter. Penetrations typically ranged from 1 to 6 inches. The heaviest areas of section loss were above the waterline at the upstream and downstream noses. The extent of section loss varied from pier to pier, but penetrations ranged from 1 to 8 inches. In addition, associated

cracking and concrete delaminations were observed. At certain locations, these defects extended to the decorative concrete caps located above the noses.

1.0 INTRODUCTION

1.1 Purpose and Scope

The Douglas MacArthur Bridge carries East Grand Boulevard over the Detroit River in Warren County, Michigan. On April 22, 2009 through April 24, 2009, Collins Engineers, Inc. performed a routine underwater investigation at the bridge to evaluate the condition of Piers 1 through 18, from the high water mark to the channel bottom. At the time of the inspection, the abutments were located on dry portions of the embankments. This report includes a description of the structure and the method of investigation. Existing conditions observed at the time of the inspection are described in Section 2 and included on the Inspection Plans in Appendix C. Section 2 also includes the results of the Scour Analysis. Section 3 contains condition assessments of the bridge components, recommended NBI Condition Ratings, and recommended follow up actions with associated total cost estimates. Appendix A is a location map of the bridge. Photographs of the observed conditions can be found in Appendix B. Depth soundings have been recorded on the Sounding Plans located in Appendix C. A copy of the completed MDOT Bridge Diving Inspection Report (SIA #92-B) can be found in Appendix D. The scour analysis documentation is included in Appendix E. Appendix F includes a breakdown of the cost estimates relating to the recommended follow up actions.

1.2 General Description of the Structure

The Douglas MacArthur Bridge is a nineteen span concrete deck arch bridge which is 2,291.3 feet long and 87.9 feet wide. Photographs 1 and 2 in Appendix B show overall views of the upstream and downstream fascias of the bridge, respectively. Photographs 3 and 4 show views of the upstream and downstream channel, respectively. The structure was built in 1929, but has had reconstruction as recently as 1998. The substructure consists of eighteen concrete piers supported by two tiers of concrete

footings. Both upstream and downstream noses of the piers are rounded with decorative concrete caps. The concrete footings are supported by timber piles. Based on available plans (dated October 9th, 1980), the piers are numbered numerically from north to south. Photographs 5 through 80 show views of each face and nose for Piers 1 through 18, as well as Abutment A and the South Abutment. Please refer to Photographs 81 through 84 for views of each embankment both upstream and downstream of the bridge. Appendix C contains plan and elevations drawings of the structure with sounding depths and inspection findings.

1.3 Method of Investigation

A dive team consisting of engineer-divers, led by a registered Professional Engineer in the State of Michigan, conducted the underwater investigation. The dive team utilized surface supplied air diving equipment with 300 foot long umbilicals and AGA masks. The dive platform was a 19 foot center-counsel, open-bow boat. High current velocities restricted the divers' ability to swim upstream, and therefore the dive vessel was anchored upstream of the bridge while the diver was line-tended around the SSU's. Access to the bridge site was obtained from the public boat launch located approximately 2.0 miles upstream of the bridge.

The underwater investigation generally consisted of a Level I visual inspection of 100 percent of the SSU surfaces from the high-water mark to the channel bottom. A Level II inspection, which included cleaning aquatic growth at the waterline, mid-depth, and channel bottom, was performed at various locations to facilitate an evaluation of the underlying surfaces and provide an overall condition of the structure. Particular attention was given to any observed areas of excessive deterioration or apparent distress, and the condition of any repairs was noted.

A cursory assessment of the waterway and channel bottom conditions in the vicinity of the bridge was also made. The type of channel bottom material was noted, as well as the location and extent of any observed scour, riprap, or debris.

Depth soundings were recorded around each substructure unit, as well as along both fascias of the bridge, along the bridge centerline, and at 100 feet upstream and downstream of the bridge fascias.

The location of the waterline with respect to a fixed reference on the bridge was noted at the time of the inspection.

Low water visibility combined with overcast weather conditions and high stream velocities restricted the use underwater photographs and video.

2.0 EXISTING CONDITIONS

2.1 General Notes

At the time of inspection, the waterline was located 2.7 feet below the top of the webwall at Pier 1. According to Great Lakes water level data provided by the National Oceanic and Atmospheric Administration (NOAA), the waterline elevation during the inspection was approximately 574.4 feet. Depth soundings indicated that the maximum water depth was 31.8 feet and was located near the downstream nose of Pier 3. Refer to the Sounding Plans in Appendix C for a complete list of depth soundings.

The channel bottom material in the vicinity of the piers typically consisted of shells (zebra mussels) over sandy gravel with 3 inches to 6 inches of probe rod penetration. Specific notes are included in Section 2.2 for instances where the channel bottom material varied from this description.

A 1/2 inch to 1-1/2 inch thick layer of zebra mussels was present on the pier surfaces from the channel bottom to 5 feet below the waterline. A 1/4 inch thick layer of aquatic growth was occasionally present from the waterline to 5 feet below the waterline. Refer to Photograph 85 in Appendix B for a view of the zebra mussels. Refer to Photograph 86 in Appendix B for a view of the aquatic growth.

Around the entire perimeter, the concrete of the piers typically exhibited light 1/4 inch to 3/4 inch deep scaling from 6 inches to 24 inches below the waterline. Moderate scaling, 1 inch to 1-1/2 inches deep, was present over the upstream noses of the piers in the same zone. In addition, approximately 5 to 15 small areas of section loss were present on the pier faces between 1 foot below the waterline and 2 feet above the waterline. The small areas of section loss were typically 3 to 6 inches in diameter; however, 9 to 12 inch diameter areas were occasionally observed. These areas of section loss exhibited penetrations ranging from 1.5 to 3 inches in depth. Refer to Photograph 87 in

Appendix B for a view of the small areas of section loss. Refer to Photograph 88 in Appendix B for a view of the typical concrete condition near the waterline.

Square voids measuring 12 inches by 12 inches were typically observed in the north and south faces of the piers. Each face exhibited four voids approximately located at the quarter points and the third points. Penetrations of 3 feet were recorded without stoppage.

As noted in the previous report, horizontal timbers measuring 12 inches by 12 inches typically protruded out from the north and south faces of the piers for 4 to 6 feet. The spacing of the timbers was relatively consistent and was estimated to be approximately 10 feet. At a maximum, a total of eight timbers were observed along one face. The top of the timbers appeared to be located at a consistent depth of approximately 16 feet below the waterline. In many instances, two 12 inch by 12 inch timbers were stacked on top of each other to create a 12 inch wide by 24 inch high timber. The number of timbers exposed at each pier and the extent of their exposure varied with the channel bottom elevation. In general, more timbers were exposed at the upstream end of the piers where the channel bottom elevations were deeper. As the channel bottom depths increased towards the downstream end of the piers, the number of timbers and extent of exposure decreased.

Along both shorelines, concrete riprap was present and ranged in diameter from 1 to 4 feet along with concrete slabs that were 6 to 8 inches thick and up to 6 feet in diameter. Beyond the immediate shoreline, the embankments had little to no slope and were maintained grass/parkland. No erosion or embankment instability was observed. Refer to Photographs 81 through 84 in Appendix B for views of the embankments both upstream and downstream of the bridge.

2.2 Substructure Unit Notes

Pier 1

A 6 to 10 foot diameter mound of silt infilling, approximately 1 to 2 feet higher than the surrounding channel bottom, was observed at the northwest corner of the pier. Based on depth soundings, a scour pocket was present at the upstream nose and was likely 10 feet in diameter and approximately 1 to 3 feet deep. Vertical 12 inch by 12 inch timbers protruded up from the channel bottom 4 feet at the northeast corner of the pier. As described in the general notes, occasional horizontal timber members protruded from faces of the pier near the channel bottom. Located 5 feet downstream of the northeast corner, two areas of section loss measuring 1 to 1.5 feet in diameter were centered at 1 foot above the waterline and at 3.5 feet above the waterline. These areas of section loss had 2 to 3 inches of penetration. Refer to Photograph 89 in Appendix B for a view of the section loss near the northeast corner. A similar area of section loss was also noted at the northwest corner. Refer to Photograph 90 in Appendix B for a view of the section loss at the northwest corner. At the downstream nose an area of section loss extended from 6 inches below the waterline to 2.5 feet above the waterline and was 8 to 10 feet wide, with 4 to 8 inches of penetration. Refer to Photograph 10 in Appendix B for a view of the downstream nose.

Pier 2

The channel bottom material in the vicinity of the pier typically consisted of silt with 6 to 12 inches of probe rod penetration. At the upstream nose, the southern half of the upper tier of the footing had between 6 and 12 inches of vertical exposure. The vertical footing exposure tapered to zero as it approached the southeast corner of the footing. Based on depth soundings and observed footing exposure, a 6 foot to 8 foot deep scour pocket was present at the upstream nose and was approximately 10 to 15 feet in diameter. As described in the general notes, horizontal timbers were noted to protrude

out from the faces of the pier within the upstream quarter of the pier, near the channel bottom. At the downstream nose of the pier a horseshoe shaped scour pocket extended from the nose out 4 feet. The scour pocket was 6 to 10 inches deeper than the adjacent downstream channel bottom elevations and 3 feet deeper than the adjacent upstream channel bottom elevations. Light hairline cracking was observed over the upstream nose, most of which was horizontally oriented. The cracking extended from 1 foot to 3 feet above the waterline for a width of 6 feet. Efflorescence was present at the cracks. Refer to Photograph 13 in Appendix B for a view of the upstream nose. A 2 foot diameter area of section loss was located 15 feet downstream of the southeast corner and was center at 2 feet above the waterline, with 2 to 3 inches of penetration. Refer to Photograph 91 in Appendix B for a view of the section loss. The downstream nose exhibited section loss for a width of 8 feet which extended from 1 foot to 3 feet above the waterline, with penetrations of 3 to 6 inches. In addition, hairline to 1/2 inch wide map cracking was observed over the downstream nose from 6 inches below the waterline to 6 feet above the waterline. The region between 4.5 feet above the waterline and 6 feet above the waterline at both the upstream and downstream noses consisted of a rounded decorative cap. Refer to Photograph 14 in Appendix B for a view of the downstream nose.

Pier 3

Based on depth soundings and observed footing exposure, a 4 to 6 foot deep scour pocket was present at the upstream nose and along both faces to the upstream quarter points. The scour pocket extended out from the nose and faces approximately 10 to 15 feet. The lower tier of the footing was exposed from the mid point on the north face, around and across the upstream nose, to the upstream third point on the south face. The lower tier of the footing had 3 feet of vertical exposure at the northeast and southeast corners and 2 feet of vertical exposure at the center of the upstream face. The upper tier of the footing was exposed from the midpoint on the north face, around

and across the upstream nose, to the downstream quarter point on the south face. As described in the general notes, horizontal timbers protruded from the faces of the pier near the channel bottom. An area of section loss was noted on the south face, 15 feet upstream of the southwest corner. The area was 3 feet long by 1.5 feet high with 2 to 3 inches of penetration and was centered at 3.5 feet above the waterline. Refer to Photograph 92 in Appendix B for a view of the section loss. The downstream nose had section loss over 25 percent of the surface area from 1.5 feet above the waterline to 4.5 feet above the waterline. The section loss extended for a width of 10 feet and had penetrations ranging from 2 to 3 inches. Refer to Photograph 18 in Appendix B for a view of the downstream nose.

Pier 4

Based on depth soundings and observed footing exposure, a 4 foot to 6 foot deep scour pocket was present at the upstream nose and down the south face to the upstream quarter point. The scour pocket extended out from the nose and face approximately 8 to 12 feet. The upper tier of the footing was exposed from the center the upstream face, around the southeast corner, to the upstream quarter point on the south face. The footing was exposed vertically for 1.1 feet at the center of the upstream face and 1.5 feet at the southeast corner. No footing exposure was noted at the northeast corner or along the north face. As described in the general notes, two sets of horizontal timbers were found to protrude from the south face of the pier near the upstream end. No timbers were observed along the north face. Section loss was noted on 75 percent of the surface area of the south half of the upstream nose. The section loss extended from 1 foot above the waterline to 4.5 feet above the waterline, for a length of 8 feet. Penetrations ranged from 2 to 4 inches. Refer to Photograph 21 in Appendix B for a view of the upstream nose. Located 15 feet upstream of the southwest corner, a 3 foot diameter area of section loss was observed at 1 foot above the waterline, with 2 to 3 inches of penetration. Refer to Photograph 93 in Appendix B for a view of the section

loss. The downstream nose exhibited a 15 foot wide area of section loss from 6 inches below the waterline to 3 feet above the waterline, with 3 to 5 inches of probe rod penetration. Refer to Photograph 22 in Appendix B for a view of the downstream nose.

Pier 5

Based on depth soundings and observed footing exposure, a 4 to 6 foot deep scour pocket was present at the upstream nose and downstream along both faces to the upstream quarter points. The scour extended out from the pier nose and faces 10 to 15 feet. As a result, the lower tier of the footing was exposed from the upstream quarter point on the north face, around the northeast corner, to the center of the upstream face. The lower tier of the footing was vertically exposed for 1 foot at the northeast corner and was flush with the channel bottom at the center of the upstream face. The upper tier of the footing was exposed from the upstream quarter point on the north face, around and across the upstream nose, to the upstream quarter point on the south face. At the southeast corner, the upper tier of the footing had 2 feet of vertical exposure. Extending from the upstream nose were two rows of 12 inch by 12 inch horizontal timbers pointing downstream and away from the pier at a 45 degree angle. The timbers were located between 1 foot and 3 feet above the top of the upper tier of the footing. In addition, approximately four rows of horizontal 12 inch by 12 inch timbers were found protruding from pier walls on both the north and south faces, near the channel bottom. Section loss was observed on 75 percent of the surface area of the upstream nose between 1 foot and 4.5 feet above the waterline, for a length of 8 to 10 feet. Penetrations ranged from 3 to 4 inches. Refer to Photograph 25 in Appendix B for a view of the upstream nose. A 1 foot diameter area of section loss was noted at the waterline near the northeast corner of the pier, with 3 to 4 inches of penetration. The downstream nose exhibited section loss from 1.5 feet to 3 feet above the waterline for a length of 10 to 12 feet and had penetrations of 3 to 4 inches. In addition, the decorative cap at the downstream nose had an area of section loss centered at 5.5 feet above the waterline

that measured 5 feet long by 1.5 feet high. The area of section loss had 4 inch deep penetrations and associated 1/2 inch wide cracking. Refer to Photograph 26 in Appendix B for a view of the downstream nose.

Pier 6

Based on depth soundings, a 5 to 6 foot deep scour pocket was present at the upstream nose and was approximately 12 feet in diameter. However, no footing exposure was detected. Channel bottom infilling was noted adjacent to the downstream nose. The channel bottom in this vicinity sloped down and away from the pier nose at an approximate slope of 1:1. Pheumo-fathometer readings indicated that the channel bottom near the downstream nose was 20 feet and that it dropped down and away to a depth of 26 feet. Depth soundings recorded a depth of 26.5 feet in this area. Extending from the northeast corner of the upstream nose were two rows of 12 inch by 12 inch horizontal timbers pointing downstream and away from the pier at a 45 degree angle. As described in the general notes, five sets of horizontal timbers protruded from the north face of the pier near the channel bottom. A 10 inch diameter log was noted on the channel bottom at the northeast corner of the pier and extended downstream and away from the pier at a 45 degree angle. Timber formwork ranging in size from 4 to 12 inches was noted on the channel bottom near the upstream nose and extending south towards Pier 7. Section loss was noted over 50 percent of the surface area of the entire upstream nose from 1.5 feet to 4.5 feet above the waterline. This area exhibited penetrations of 3 to 6 inches. In addition, associated hairline to 1/4 inch wide map cracking and concrete delaminations extended to the decorative cap. Refer to Photograph 29 in Appendix B for a view of the upstream nose. The downstream nose had section loss over 75 of the surface area for a width of 8 to 10 feet. This area extended from 1.5 to 4.5 feet above the waterline and had penetrations ranging from 4 to 6 inches. Refer to Photograph 30 in Appendix B for a view of the downstream nose.

Pier 7

Based on depth soundings and observed footing exposure, a 3 foot to 6 foot deep scour pocket was present at the upstream nose which extended downstream along both faces for approximately 10 to 15 feet. The scour extended out from the nose and faces for a distance of 8 to 12 feet. The upper tier of the footing was exposed from 2 feet downstream of the northeast corner, around and across the upstream face, to 10 feet downstream of the southeast corner. The footing was exposed vertically for 2 feet at the northeast corner at the center of the upstream face, and for 1 foot vertically at the southeast corner. The lower tier of the footing was not detected. As described in the general notes, horizontal timbers were observed near the channel bottom along the north face but became buried in the channel bottom as elevations increased towards the downstream end of the pier. A total of eight horizontal timbers were observed along the south face of the pier near the channel bottom. Between 1.5 feet and 3 feet above the waterline, the south half of the upstream nose exhibiting section loss over 50 percent of the surface area. Penetrations ranged from 3 to 5 inches. Refer to Photograph 33 in Appendix B for a view of the upstream nose. Located 15 feet downstream of the northeast corner, a 1 foot diameter area of section loss with 2 to 3 inches of penetration was center at 1.5 feet above the waterline. A similar area of section loss was also observed 15 feet upstream of the northwest corner. At 15 feet upstream of the northwest corner, center at 3.5 feet above the waterline, there was an area of section loss measuring 2 feet long by 1 foot high with 4 inches of penetration. A vertical 1/16 inch wide crack was observed at 6 feet upstream of the northwest corner and extended from 3.5 feet above the waterline to below the waterline. Refer to Photograph 94 in Appendix B for a view of the vertical crack. A similar vertical crack was observed at 3 feet upstream of the southwest corner. Located 2 feet downstream of the southeast corner, a 1 foot diameter area of section loss with 3 to 4 inches of penetration was observed 1.5 feet above the waterline. Refer to Photograph 95 in Appendix B for a view of the section loss. Section loss, heavier than was typically

observed, was noted over 95% of the surface area of the downstream nose from the waterline to 4.5 feet above the waterline. Penetrations ranged from 6 inches up to 12 inches. The area of section loss had associated hairline to 1/8 inch wide map cracking and concrete delaminations. Refer to Photograph 34 in Appendix B for a view of the downstream nose.

Pier 8

Based on depth soundings and observed footing exposure, a 4 to 8 foot deep scour pocket was observed around the upstream, along the entire south face, and around the downstream nose. The scour extended out from the face and the noses 8 to 12 feet. The upper tier of the footing became exposed 2 feet north of the centerline of the pier at the upstream nose. The footing exposure increased such that there was 1 foot of vertical exposure at the centerline of the pier at the upstream nose. At the southeast corner of the footing there was 1.5 feet of vertical exposure. The vertical exposure continued down the south face to the southwest corner and was 1 foot high. At the centerline of the pier at the downstream nose the footing became buried in the channel bottom. No footing exposure was observed along the north face of the pier nor was any lower tier footing exposure detected. As described in the general notes, along the south face of the pier horizontal timbers were protruding from the face, near the channel bottom. The decorative cap at the downstream nose had a 1 inch wide horizontal crack that was 8 feet long located at 5 feet above the water line. Refer to Photograph 96 in Appendix B for a view of the horizontal crack. The downstream nose had section loss over 75 percent of the surface area from 2.5 feet to 4.5 feet above the waterline with 2 to 6 inches of penetration. Refer to Photograph 38 in Appendix B for a view of the downstream nose.

Pier 9

Based on depth soundings and observed footing exposure, a 6 to 8 foot deep scour depression was present at the upstream nose and extended downstream along both faces for 10 to 15 feet. The scour depression extended out from the nose and faces for 8 to 12 feet. The lower tier of the footing was exposed 10 feet downstream of the northeast corner, around and across the upstream face, to the southeast corner. The lower tier of the footing had 1.5 feet of vertical exposure at the northeast corner and at the center of the upstream face, while the southeast corner was flush with the channel bottom. The upper tier of the footing was exposed from 20 feet downstream of the northeast corner, around and across the upstream nose, to 15 to 20 feet downstream of the southeast corner. Section loss was observed for a length of 8 feet across the upstream nose from 0.5 feet to 2.5 feet above the waterline, with 2 to 4 inches of probe rod penetration. Refer to Photograph 41 in Appendix B for a view of the upstream nose. Section loss was also observed on the downstream nose for a length of 10 feet, and extended from the waterline to 4.5 feet above the waterline. Penetrations ranged from 3 to 8 inches. The decorative cap at the downstream nose had 1/16 inch to 1/4 wide map cracking from 4.5 feet to 7.0 feet above the waterline. Refer to Photograph 42 in Appendix B for a view of the downstream nose and decorative cap.

Pier 10

Based on depth soundings and observed footing exposure, an 8 to 10 foot deep scour pocket was present at the upstream nose and down both faces for a distance of 10 to 15 feet. The scour pocket extended out from the nose and faces for 6 to 10 feet. The lower tier of the footing was exposed from 2 feet downstream of the northeast corner, around and across the upstream nose, to just downstream of the southeast corner. The footing had 1 foot of vertical exposure at the northeast corner, 2 inches at the southeast corner, and between 1 and 2 feet across the upstream face. The upper tier of the footing was exposed from 15 feet downstream of the northeast corner, around and

across the upstream nose, to 10 feet downstream of the southeast corner. The upstream nose had section loss over the south half from 2 feet to 4.5 feet above the waterline with 1 to 2 inches of penetration. Refer to Photograph 45 in Appendix B for a view of the upstream nose. A 5 foot long by 1 foot high area of section loss was noted 15 feet downstream of the northeast corner at 2.5 feet above the waterline. Penetrations were between 2 and 3 inches. Refer to Photograph 97 in Appendix B for a view of the section loss. The downstream nose had hairline to 1/8 inch wide map cracking with efflorescence from the waterline to 4.5 feet above the waterline. Refer to Photograph 46 in Appendix B for a view of the downstream nose.

Pier 11

Based on depth soundings and observed footing exposure, a scour pocket up to 7 to 10 feet deep was observed at the upstream nose and downstream along both faces for 20 to 25 feet. The lower tier of the footing was exposed from 1 foot downstream of the northeast corner, around and across the upstream face, to 10 feet downstream of the southeast corner. The footing had 6 inches of vertical exposure at the northeast corner and 18 inches at the southeast corner. The vertical exposure reached 3.5 feet directly upstream of the upstream nose. The upper tier of the footing was exposed from 20 feet downstream of the northeast corner, around and across the upstream face, to 25 feet downstream of the southeast corner. Timber debris, 8 to 12 inches in diameter was observed on the channel bottom along the north face from the northwest corner to 20 feet upstream of the northwest corner. As described in the general notes, horizontal timber members were protruding from the north pier face near the channel bottom. Section loss was noted over 75 percent of the surface area of the upstream nose for a length of 10 feet, extending from the waterline to 4.5 feet above the waterline. Penetrations ranged from 4 to 5 inches. Refer to Photograph 49 in Appendix B for a view of the upstream nose. Centered at the waterline, a 3 foot diameter area of section loss was located 15 feet downstream of the northeast corner and had up to 5 inches of

penetration. Refer to Photograph 98 in Appendix B for a view of the section loss. A similar area of section loss was noted at 15 feet upstream of the northwest corner. Refer to Photograph 99 in Appendix B for a view of the section loss. Hairline to 1/4 inch wide map cracking with efflorescence was observed over the downstream nose and decorative cap. In addition, two areas of section loss and failing concrete repairs were observed over the downstream nose between 6 and 12 inches above the waterline. The areas were between 2 and 2.5 feet in length and had penetrations ranging from 2 to 3 inches. Refer to Photograph 50 in Appendix B for a view of the downstream nose.

Pier 12

Based on depth soundings and observed footing exposure, an 8 to 10 foot deep scour pocket was present at the upstream nose which extended downstream along both faces for 10 to 15 feet. The lower tier of the footing was exposed from 10 feet downstream of the northeast corner, around and across the upstream face, to 15 feet downstream of the southeast corner. The lower tier of the footing was exposed vertically for 12 inches at the northeast corner and 8 inches at the southeast corner. The vertical exposure reached a maximum height of 2 feet at the center of the upstream face. The upper tier of the footing was exposed from 30 feet downstream of the northeast corner, around and across the upstream nose, to 45 feet downstream of the southeast corner. As described in the general notes, horizontal timbers were protruding from the faces of the pier near the channel bottom. Section loss was observed over the south half of the upstream nose from 3 feet to 4.5 feet above the waterline with 3 to 4 inches of penetration. Refer to Photograph 53 in Appendix B for a view of the upstream nose. An area of section loss measuring 3 feet long by 1 foot high was noted 12 feet downstream of the northeast corner at the waterline. The area exhibited 2 inch to 4 inch deep penetrations. A 2 foot diameter area of section loss was noted at the southeast corner of the pier, centered at the waterline. Penetrations ranged from 4 to 5 inches. Refer to Photograph 100 in Appendix B for a view of the section loss. A 2.5 foot wide area of

abrasion damage was located 20 feet downstream of the southeast corner, between 1 foot and 3 feet above the waterline. The area had penetrations of 1 to 2 inches. Refer to Photograph 101 in Appendix B for a view of the abrasion damage. The downstream nose exhibited section loss, concrete delaminations, and 1 inch wide cracking, extending from the waterline to 4.5 feet above the waterline. The affected area was approximately 12 feet wide and had penetrations ranging from 5 to 7 inches deep. The decorative cap at the downstream nose had 1/4 inch wide map cracking. Refer to Photograph 54 in Appendix B for a view of the downstream nose and decorative cap.

Pier 13

Based on depth soundings and observed footing exposure, a 3 to 6 foot deep scour pocket was present at the upstream nose which extended downstream along both faces for a length of 20 to 25 feet. The scour pocket extended out from the nose of the pier approximately 10 to 15 feet. The lower tier of the footing was exposed from 12 feet downstream of the northeast corner, around and across the upstream face, to 20 to 25 feet downstream of the southeast corner. The lower tier of the footing was exposed vertically for 2 feet at the northeast corner and for 3 feet at the center of the upstream nose and southeast corner. The upper tier of the footing was exposed from 25 feet downstream of the northeast corner, around and across the upstream face, to 20 to 25 feet downstream of the southeast corner. A 6 foot diameter by 2 foot deep scour pocket was center around the downstream nose. As described in the general notes, horizontal timbers were protruding from the faces of the pier, primarily near the midpoints. Near the northwest corner, a vertical timber was protruding up 1 to 2 feet from the channel bottom. Section loss was observed over 75 percent of the surface area of the upstream nose from the waterline to 4 feet above the waterline, with penetrations ranging from 3 to 5 inches. Refer to Photograph 57 in Appendix B for a view of the upstream nose. Located 12 feet upstream of the northwest corner, a 4 foot diameter area of section loss was centered at 1.5 feet above the waterline. The area had penetrations between 6

and 8 inches. Refer to Photograph 102 in Appendix B for a view of the section loss. The downstream nose had section loss and concrete delaminations for a length of 6 feet, extending from 6 inches to 4 feet above the waterline. Penetrations ranged from 2 to 4 inches. Refer to Photograph 58 in Appendix B for a view of the downstream nose.

Pier 14

Based on depth soundings and observed footing exposure, a 4 foot to 6 foot deep scour pocket was present around the upstream nose which extended out from the nose approximately 10 to 15 feet in all directions. A 6 foot diameter scour pocket was centered at the downstream nose and was 1 to 2 feet deep. The lower tier of the footing was exposed from 3 feet downstream of the northeast corner, around the northeast corner and across the upstream face, to just south of the centerline of the pier on the upstream face. The lower tier of the footing was exposed vertically for 1.5 feet at the northeast corner and for 2 feet at the center of the upstream face. The upper footing tier of the footing was exposed across the upstream face and down both faces for approximately 15 feet. As described in the general notes, horizontal timbers protruded from the faces of the pier near the channel bottom. At the upstream nose, 18 inch by 18 inch timbers were found on the channel bottom that extended from the upstream nose 20 to 25 feet downstream. In this vicinity (near the southeast corner of the pier), the timber debris covered the channel bottom and obscured any footing exposure. Section loss was observed over 75 percent of the surface area of the south half of the upstream nose. The section loss was between 6 inches and 3 feet above the waterline and had penetrations between 2 and 4 inches deep. Refer to Photograph 61 in Appendix B for a view of the upstream nose. A 2.5 foot diameter area of section loss with 1 to 2 inches of penetration was observed at the waterline and was located 12 feet downstream of the northeast corner. A 1 foot diameter area of section loss with 1 to 2 inches of penetration was observed at the waterline and was located 12 feet upstream of the northwest corner. The downstream nose exhibited heavy section loss from 6

inches to 4 feet above the waterline. The area extended for a length of 12 to 14 feet and had penetrations of 4 to 6 inches. Refer to Photograph 62 in Appendix B for a view of the downstream nose.

Pier 15

Based on depth soundings and observed footing exposure, a 6 to 8 foot deep scour pocket was present at the upstream nose which extended downstream along both faces to the upstream quarter points. The scour extended out from the faces and the nose for approximately 12 to 15 feet. The lower tier of the footing was exposed from the upstream quarter point on the north face, around and across the upstream face, to the upstream quarter point on the south face. The vertical exposure of the footing was 2 feet at the northeast and southeast corners and 4.5 feet at the center of the upstream face. The upper tier of the footing was exposed from the upstream quarter point on the north face, around and across the upstream face, to the downstream quarter point on the south face. Timber debris measuring 6 to 8 inches in diameter was observed on the channel bottom and extended downstream from the southeast corner for a length of 10 to 15 feet. Section loss was observed on the upstream nose measuring 2.5 feet wide by 1 foot high, centered at 3.5 feet above the waterline. Penetrations of up to 2 inches were noted. Refer to Photograph 65 in Appendix B for a view of the upstream nose. A 2 foot diameter area of section loss was located 15 feet downstream of the northeast corner at 3 feet above the waterline, with penetrations of 3 to 5 inches. Refer to Photograph 103 in Appendix B for a view of the section loss. A 2 foot diameter area of section loss was also located 15 upstream of the northwest corner, with 1.5 inches of penetration. The downstream nose exhibited section loss over 75 percent of the surface area from 6 inches to 4 feet above the waterline and extended across the nose for a length of 6 to 8 feet. The area had penetrations up to 5 inches deep and hairline to 1/16 inch wide map cracking with efflorescence. Refer to Photograph 66 in Appendix B for a view of the downstream nose.

Pier 16

Based on depth soundings and observed footing exposure, a 3 foot to 4 foot deep scour pocket was present at the upstream nose which extended downstream along both faces to the upstream quarter points. The upper tier of the footing was exposed from 10 feet downstream of the northeast corner, around and across the upstream face, to 20 feet downstream of the southeast corner. The upper tier of the footing had 2 feet of vertical exposure across the entire upstream face. As described in the general notes, horizontal timbers protruded from the south face of the pier near the channel bottom. Section loss was observed over 20 percent of the surface area of the upstream nose for a length of 10 feet. The section loss extended from the waterline to 3 feet above the waterline with penetrations of 2 to 4 inches and hairline to 1/16 inch wide map cracking. Refer to Photograph 69 in Appendix B for a view of the upstream nose. Two areas of section loss were noted on the north face of the pier at 10 feet in from noses. The areas were 2 to 3 feet wide and extended from 6 inches to 12 inches above the waterline with 2 to 3 inches of penetration. An area of abrasion damage was found 20 feet downstream of the southeast corner. The area was between 6 inches and 3 feet above the waterline and was 4 feet wide. Penetrations ranged from 3 to 6 inches. Refer to Photograph 140 for a view of the abrasion damage. The downstream nose had section loss from 1 foot below the waterline to 4 feet above the waterline, which extended across the nose for a length of 10 to 12 feet. The penetrations ranged from 3 to 6 inches. In addition, the decorative cap at the downstream end had hairline map cracking. Refer to Photograph 70 in Appendix B for a view of the downstream nose.

Pier 17

Based on depth soundings, a scour pocket up to 2.5 feet deep was present at the upstream nose and was approximately 8 to 10 feet in diameter. No footing exposure was detected at the pier. A 12 inch diameter tree stump was found on the channel bottom, 6 feet downstream of the southeast corner. Around the downstream nose and

along the downstream half of the north face, 4 inch by 4 inch vertical timbers were found protruding up from the channel bottom for 3 feet. The timbers were spaced at approximate 2 foot intervals. The upstream nose exhibited section loss over 25 percent of the surface area for a length of 5 feet. The section loss extended from the waterline to 3 feet above the waterline and had penetrations ranging from 2 to 4 inches. Refer to Photograph 73 in Appendix B for a view of the upstream nose. Two areas of section loss measuring 2 feet in diameter were observed on the north face of the pier, 10 feet in from the noses. The areas had 2 to 4 inches of penetration and were centered 1 foot above the waterline. A 4 foot by 4 foot area of section loss was observed at the southwest corner of the pier. The area was centered at 1 foot above the waterline and had penetrations of 6 to 8 inches. Refer to Photograph 105 in Appendix B for a view of the section loss. The downstream nose and decorative cap exhibited section loss and heavy hairline to 1/8 inch wide map cracking from 6 inches below the waterline to 5 feet above the waterline. The section loss exhibited penetrations of 3 to 6 inches and extended across the nose for a length of 6 to 8 feet. The map cracking was present across the entire nose and decorative cap. Refer to Photograph 106 in Appendix B for a view of the map cracking on the downstream nose. Refer to Photograph 74 in Appendix B for a view of the downstream nose.

Pier 18

No scour or footing exposure was detected at Pier 18. At the upstream quarter point of the north face, an 8 inch diameter section of steel pipe was lying on the channel bottom. A 3 foot long area of section loss was noted on the upstream nose from 2 feet to 3 feet above the waterline, with 3 to 3 inches of penetration. Refer to Photograph 77 in Appendix B for a view of the upstream nose. A 1.5 foot long area of section loss was noted 12 feet upstream of the northwest corner from 6 inches to 12 inches above the waterline, with 3 to 4 inches of penetration. Refer to Photograph 107 in Appendix B for a view of the section loss. Heavy section loss was observed over the downstream nose

for a length of 10 to 12 feet. The section loss extended from 6 inches below the waterline to 3 feet above the waterline, with penetrations ranging from 3 to 6 inches. Areas of the downstream nose not affected by section loss exhibited hairline to 1/16 inch wide map cracking. Refer to Photograph 78 in Appendix B for a view of the downstream nose.

2.3 Scour Analysis

As part of this inspection, a Level I Scour Analysis was performed in accordance with the MDOT Drainage Manual. During the inspection, indicators of active erosion, scour, sediment transportation, and footing exposure were investigated. Arial photographs/images were examined in order to determine any changes in land use, channel location, and channel width. Available structure plans were reviewed in order to determine the substructure configuration. The previous inspection report dated July 2003 and performed by others was reviewed in an effort to provide a historical comparison. MDOT Drainage Manual Worksheets were used to classify the channel type and determine the overall channel stability.

The Level I Scour Analysis of the Douglas MacArthur Bridge revealed several factors indicating historic and active scour. At one bridge length upstream, the channel is approximately 45 percent wider than at the bridge. The previous underwater report (July 2003) revealed footing exposure at numerous piers. As detailed in Section 2.2 – Substructure Unit Notes, the upper and lower tiers of the footing were again exposed. The previous report and observations made during the current underwater inspection indicate that the channel bottom is composed of a transportable material. Refer to Appendix E for completed MDOT Drainage Manual Worksheets and support material pertaining to the Level I Scour Analysis.

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 Evaluation and Assessments

Overall, the submerged components of the bridge SSUs were found to be in fair condition. The most immediate concern is the scour of the channel bottom material near the upstream ends of the piers, particularly at the upstream noses. The upper tier of the footing was exposed on a total of 14 piers and the lower tier was exposed on a total of 9 piers. At the upstream noses of three piers (Piers 11, 13, and 15), there was less than 1 foot of channel bottom material remaining before the bottom of the lower footing becomes undermined. Scour of the channel bottom will continue unless scour countermeasures are installed. It was generally observed that the channel bottom elevations increased towards the downstream ends of the piers. It is possible that the scoured channel bottom material is being deposited alongside the pier walls. The horizontal timber members protruding from the faces of the piers did not appear to be inducing any localized channel bottom scour other defects/deficiencies. The occasional timber debris and timber formwork was minimal and was likely not the cause of any observed scour. The square voids located in the pier walls just below the waterline were likely part of the original and/or the repair construction. No associated defects or deficiencies were found with these voids. The scaling of the concrete surfaces was classified as light to moderate and does not pose a serious threat to the structure. The section loss at the noses and on the pier faces was extensive. However, no exposed reinforcing steel was observed whatsoever. Since there was no exposed reinforcing steel, the section loss does not significantly decrease the capacity of the piers. However, if the section loss continues to increase and allows for reinforcing steel exposure and corrosion, then repairs will need to be made.

A Level I Scour Analysis was preformed to determine the susceptibility of the bridge to scour. The results of the Level I Analysis show a Level II Scour Analysis is required. It is our opinion that the results of the previous Level II Scour Analysis, dated July 2003 and performed by others, are still applicable. We believe this is the case because the factors used to perform a Level II Analysis, such as flow rate, pier shape, channel width, and channel bottom material, have remained unchanged. A review of the previously preformed Level II Scour Analysis indicates that the potential scour exceeds the bottom of footing elevations.

3.2 Recommended NBI Condition Ratings

Substructure Code (Item 60)	Channel and Channel Protection Code (Item 61)	Underwater Inspection Code (Item 92B) (months)	Underwater Inspection Date (Item 93B)	Scour Critical Bridges (Item 113)
5	**8**	**Y60***	**04/21/2014***	**3**

*See Section 3.3 Recommendations.

The code rating of 3 for Scour Critical Bridges (Item 113) was assigned because the Level II Scour Analysis previously performed by others indicates that the calculated scour would expose the timber piles for a length of 8 to 12 feet. A structural analysis for the calculated scour was not performed and is out of the scope of this inspection. As such, the bridge foundations were classified as 'unstable for the calculated scour conditions', indicating a code rating of 3.

3.3 Recommendations

The areas of section loss, both at the upstream and downstream noses as well as along the pier faces, should be monitored during future inspections for any increase in size and to ensure that no reinforcing steel becomes exposed. Proper documentation will help to estimate the rate of deterioration and to schedule any required maintenance.

Also, the importance of bridge aesthetics should be considered in order to determine whether or not concrete repairs are currently necessary.

The horizontal timber members, concrete scaling, square voids, and occasional timber debris and timber formwork, do not require any corrective action at this point.

Based upon completion of the Level I Scour Analysis and review of the previously completed Level II Scour Analysis, it is recommended that scour countermeasures be designed and installed. In addition, observed scour and resulting footing exposure indicate the need for scour countermeasures.

Heavy concrete riprap, measuring between 1 foot and 3 feet in diameter, should be place at the locations where scour and footing exposure was indicated. Care should be taken to ensure that the riprap is not placed at elevations above that of the surrounding channel bottom, as this will reduce the stream cross-section at the bridge. If timber debris is known to be present and may interfere with the placement of the riprap, then it should be removed. If sufficient time has elapsed between the underwater inspection and the commencement of riprap placement, then additional depths soundings and evaluations by a team of engineer-divers may again be required. Additional depth soundings and engineer-diver evaluations will assess any changes in existing conditions; particularly channel bottom elevations, scour, and timber debris.

Once the recommended scour countermeasures are installed, and prior to demobilization of the construction crew and equipment, engineer-divers should evaluate the construction to verify proper riprap placement and document the as-built conditions.

An alternative to using engineer-divers both before and after scour countermeasures are installed would be to conduct localized hydrographic surveys. The hydrographic surveys should be focused on the areas of scour and footing exposure and will help to more accurately determine material costs and placement. A hydrographic survey

should also be conducted after the completion of construction to ensure proper riprap placement and to document the as-built conditions

The estimated cost to have engineer-divers re-assess the existing conditions and take localized depth soundings is $23,500. The estimated cost to install scour countermeasures at the piers is $204,374. The estimate cost to have a team of engineer-divers perform a quality control inspection and document as-built conditions is estimated at $21,500. The estimate cost for conducting localized hydrographic surveys both before and after construction is $44,000. Refer to Appendix F for a cost estimate breakdown of the scour countermeasure construction.

Assuming the recommended scour countermeasures are installed and quality construction is verified, underwater inspections should continue at an interval of 60 months. If an extreme event occurs (high flow, vessel impact), then an interim underwater inspection may be required.

Originated by:
PDR

APPENDIX A

Location Map

N

CITY OF DETROIT, MICHIGAN **Douglas MacArthur Bridge** **East Grand Boulevard to** **Belle Isle over the Detroit River**	
LOCATION MAP	
COLLINS ENGINEERS INC 12932 168th Avenue Grand Haven, MI 49417	4/22/09 Project 6011 Figure 1

APPENDIX B

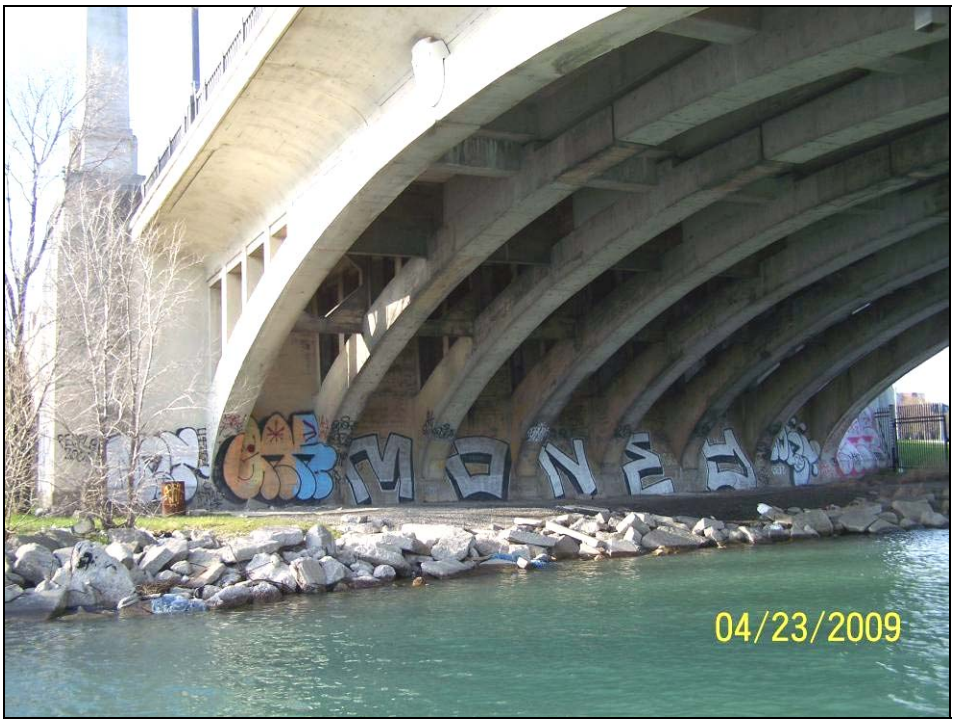
Photographs

Photograph 1. Overall View of the Upstream Fascia.

Photograph 2. Overall View of the Downstream Fascia.

Photograph 3. View of the Upstream Channel.

Photograph 4. View of the Downstream Channel.



Photograph 5. View of Abutment A, South Face and West Face.

Photograph 6. View of Abutment A, South Face and East Face.

Photograph 7. View of Pier 1 North Face.

Photograph 8. View of Pier 1 South Face.

Photograph 9. View of Pier 1 Upstream Nose.

Photograph 10. View of Pier 1 Downstream Nose.

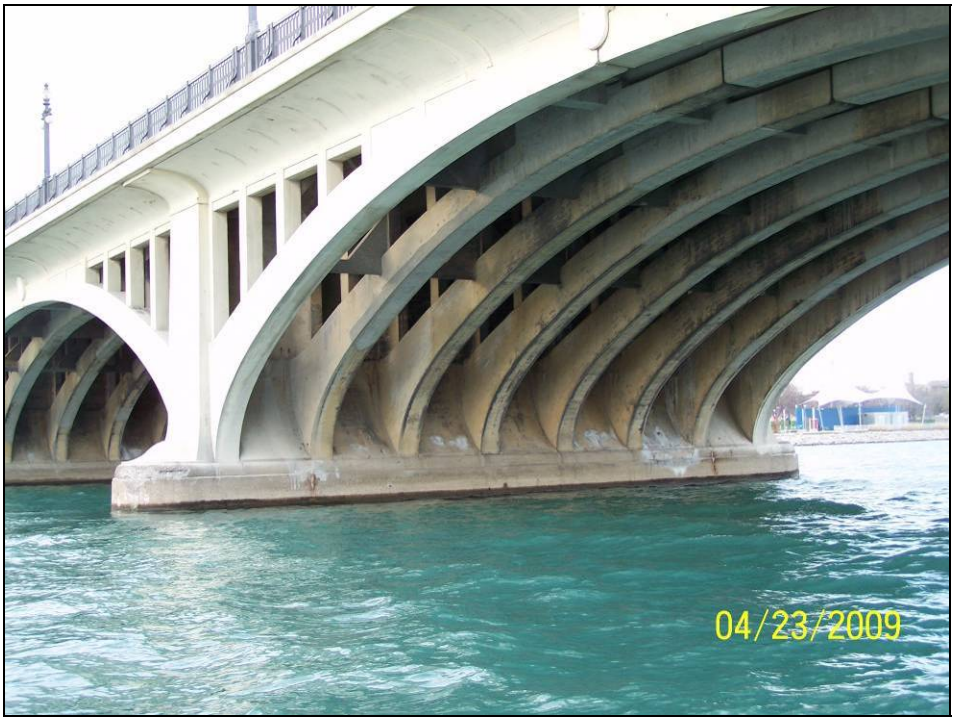
Photograph 11. View of Pier 2 North Face.

Photograph 12. View of Pier 2 South Face.

Photograph 13. View of Pier 2 Upstream Nose.

Photograph 14. View of Pier 2 Downstream Nose.

Photograph 15. View of Pier 3 North Face.

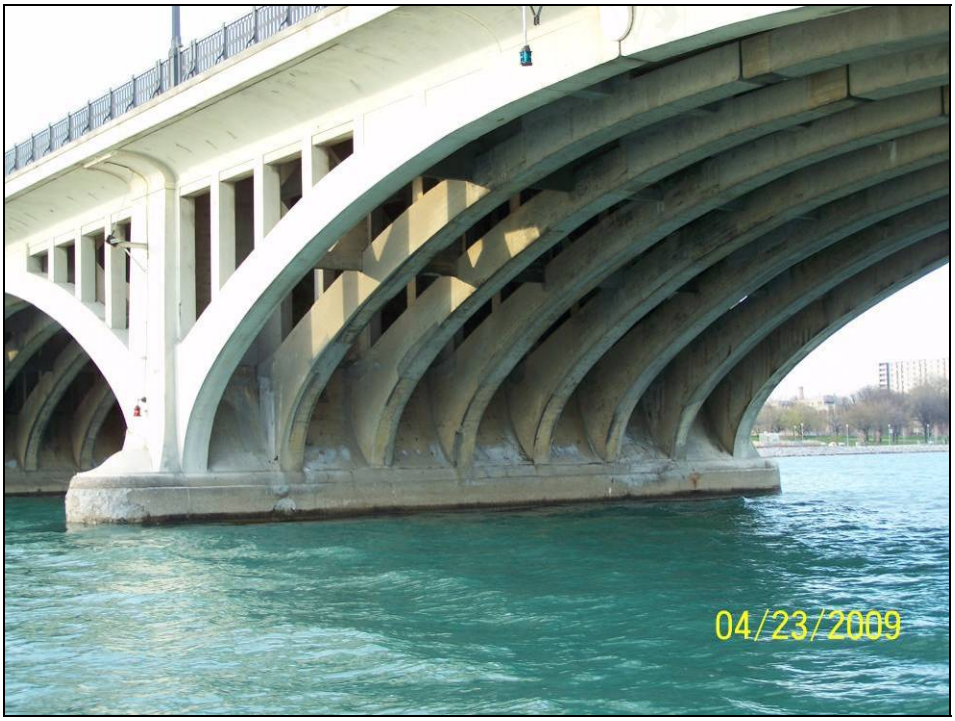


Photograph 16. View of Pier 3 South Face.

Photograph 17. View of Pier 3 Upstream Nose.

Photograph 18. View of Pier 3 Downstream Nose.

Photograph 19. View of Pier 4 North Face.



Photograph 20. View of Pier 4 South Face.

Photograph 21. View of Pier 4 Upstream Nose.

Photograph 22. View of Pier 4 Downstream Nose.

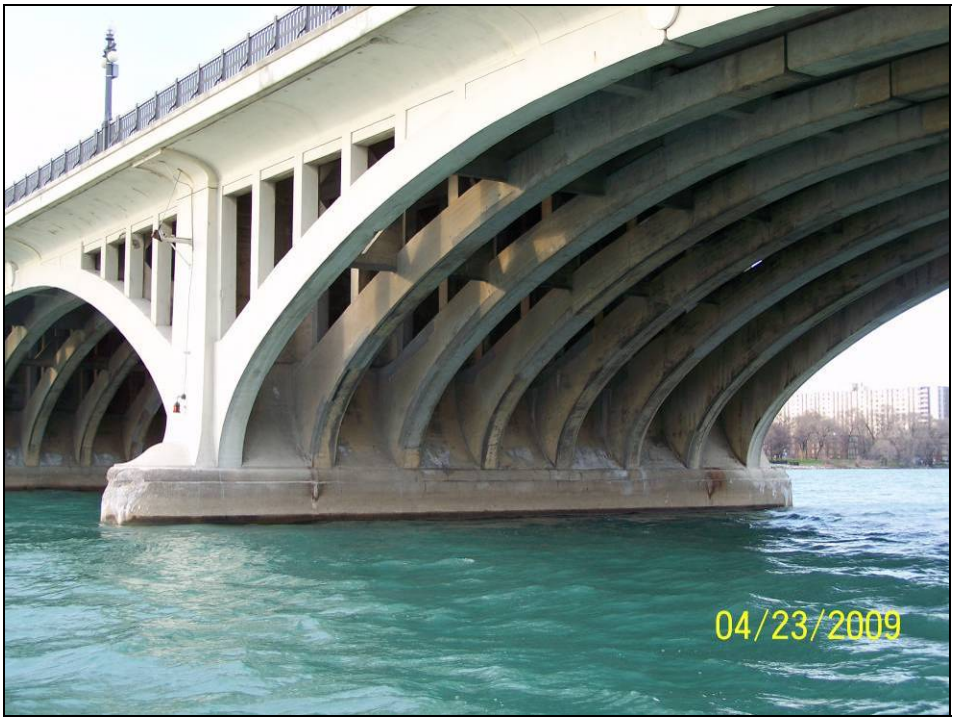
Photograph 23. View of Pier 5 North Face.

Photograph 24. View of Pier 5 South Face.

Photograph 25. View of Pier 5 Upstream Nose.

Photograph 26. View of Pier 5 Downstream Nose.

Photograph 27. View of Pier 6 North Face.



Photograph 28. View of Pier 6 South Face.

Photograph 29. View of Pier 6 Upstream Nose.

Photograph 30. View of Pier 6 Downstream Nose.

Photograph 31. View of Pier 7 North Face.

Photograph 32. View of Pier 7 South Face.

Photograph 33. View of Pier 7 Upstream Nose.

Photograph 34. View of Pier 7 Downstream Nose.

Photograph 35. View of Pier 8 North Face.

Photograph 36. View of Pier 8 South Face.

Photograph 37. View of Pier 8 Upstream Nose.

Photograph 38. View of Pier 8 Downstream Nose.

Photograph 39. View of Pier 9 North Face.

Photograph 40. View of Pier 9 South Face.

Photograph 41. View of Pier 9 Upstream Nose.

Photograph 42. View of Pier 9 Downstream Nose.

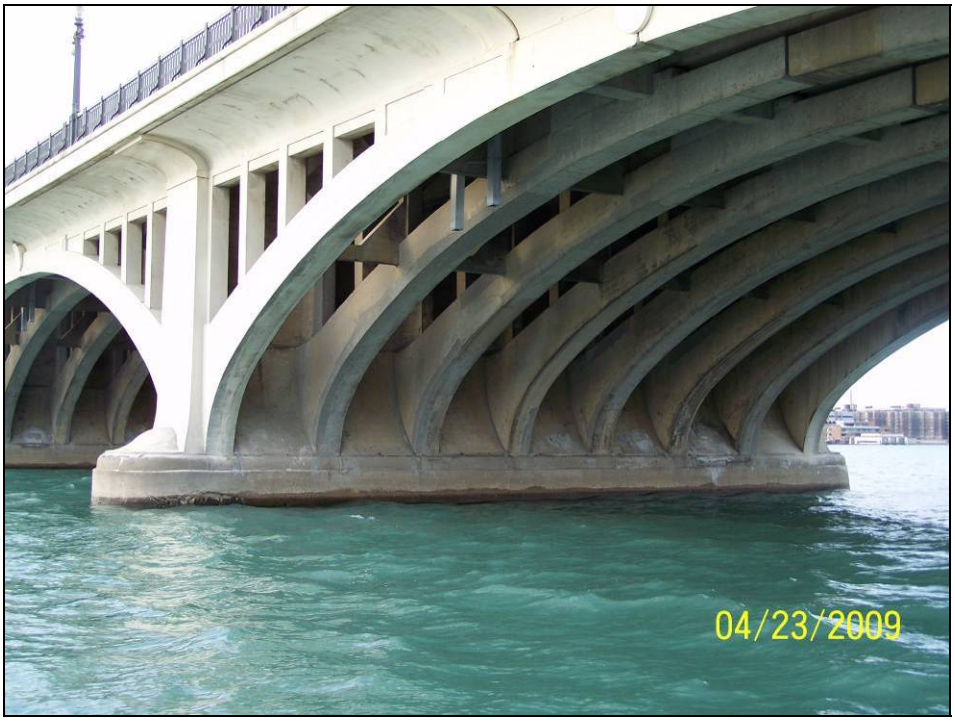
Photograph 43. View of Pier 10 North Face.

Photograph 44. View of Pier 10 South Face.

Photograph 45. View of Pier 10 Upstream Nose.

Photograph 46. View of Pier 10 Downstream Nose.

Photograph 47. View of Pier 11 North Face.



Photograph 48. View of Pier 11 South Face.

Photograph 49. View of Pier 11 Upstream Nose.

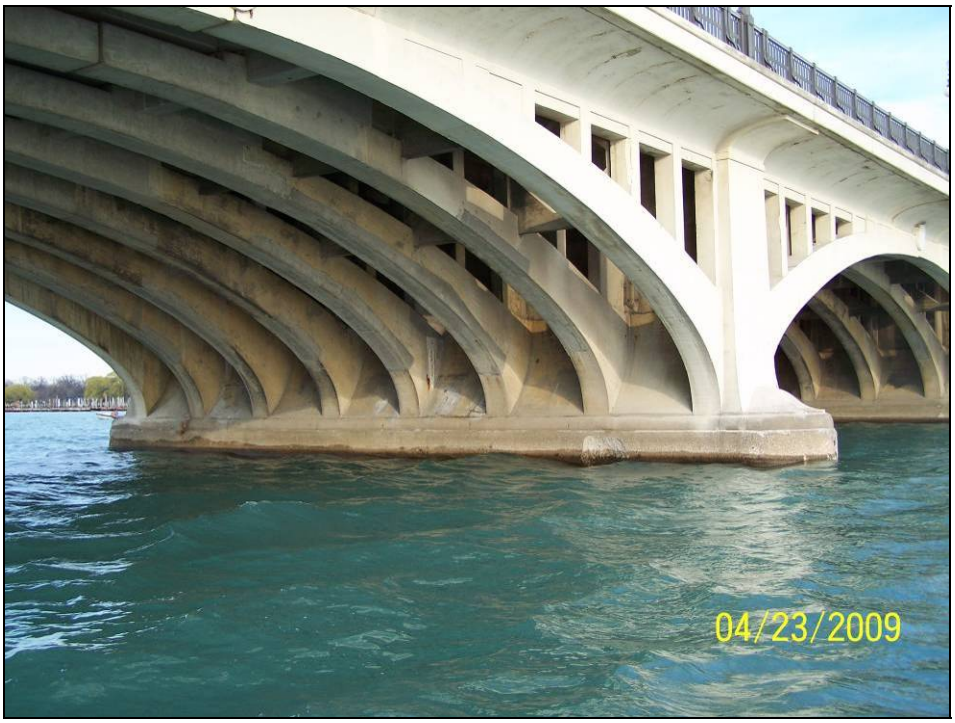
Photograph 50. View of Pier 11 Downstream Nose.

Photograph 51. View of Pier 12 North Face.

Photograph 52. View of Pier 12 South Face.

Photograph 53. View of Pier 12 Upstream Nose.

Photograph 54. View of Pier 12 Downstream Nose.



Photograph 55. View of Pier 13 North Face.

Photograph 56. View of Pier 13 South Face.

Photograph 57. View of Pier 13 Upstream Nose.

Photograph 58. View of Pier 13 Downstream Nose.

Photograph 59. View of Pier 14 North Face.

Photograph 60. View of Pier 14 South Face.

Photograph 61. View of Pier 14 Upstream Nose.

Photograph 62. View of Pier 14 Downstream Nose.

Photograph 63. View of Pier 15 North Face.

Photograph 64. View of Pier 15 South Face.

Photograph 65. View of Pier 15 Upstream Nose.

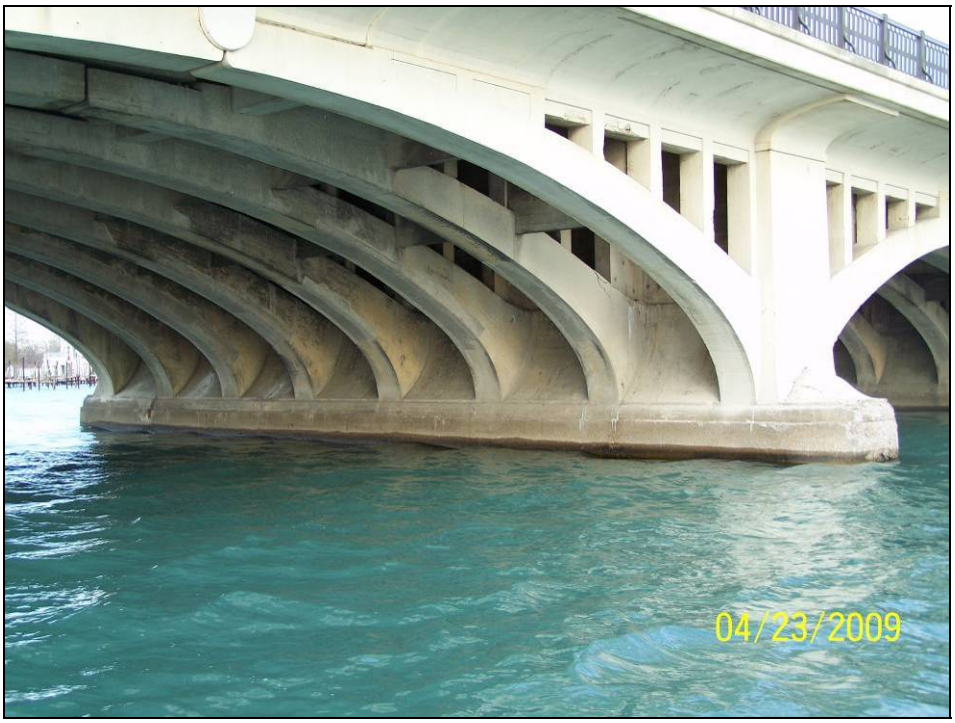
Photograph 66. View of Pier 15 Downstream Nose.

Photograph 67. View of Pier 16 North Face.

Photograph 68. View of Pier 16 South Face.

Photograph 69. View of Pier 16 Upstream Nose.

Photograph 70. View of Pier 16 Downstream Nose.



Photograph 71. View of Pier 17 North Face.

Photograph 72. View of Pier 17 South Face.

Photograph 73. View of Pier 17 Upstream Nose.

Photograph 74. View of Pier 17 Downstream Nose.

Photograph 75. View of Pier 18 North Face.

Photograph 76. View of Pier 18 South Face.

Photograph 77. View of Pier 18 Upstream Nose.

Photograph 78. View of Pier 18 Downstream Nose.

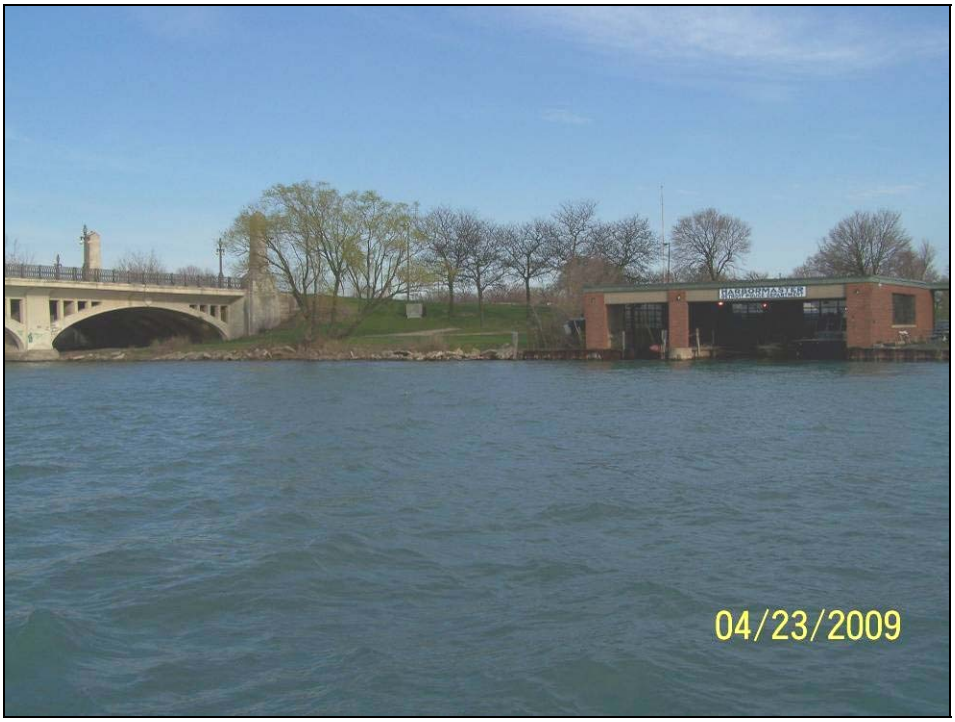
Photograph 79: View of South Abutment, North Face and East Face.

Photograph 80: View of South Abutment, North Face and West Face.

Photograph 81: View of the Northwest Embankment.

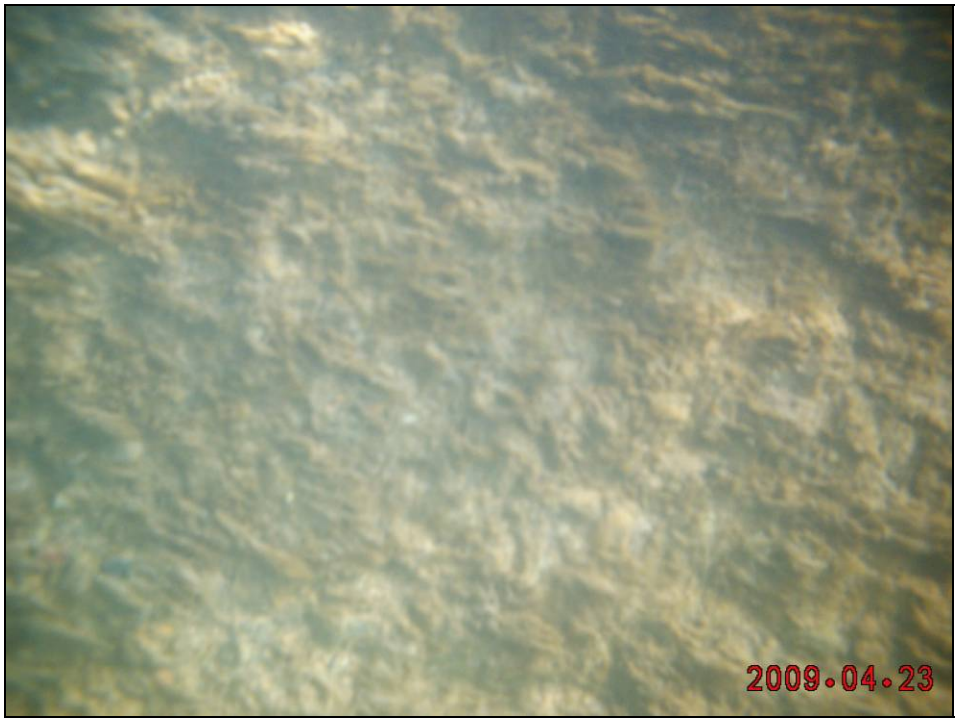
Photograph 82: View of the Northeast Embankment.

Photograph 83: View of the Southeast Embankment.



Photograph 84: View of the Southwest Embankment.

Photograph 85: View of Zebra Mussels Below the Waterline.



Photograph 86: View of Aquatic Growth Below the Waterline.

Photograph 87: View of Small Areas of Section Loss Near the Waterline.

Photograph 88: View of Typical Concrete Condition Near the Waterline.

Photograph 89: View of Pier 1 Section Loss Near Northeast Corner.

Photograph 90: View of Pier 1 Section Loss Near Northwest Corner.

Photograph 91: View of Pier 2 Section Loss on South Face.

Photograph 92: View of Pier 3 Section Loss on South Face.

Photograph 93: View of Pier 4 Section Loss on South Face.

Photograph 94: View of Pier 7 Vertical Crack Near Northwest Corner.

Photograph 95: View of Pier 7 Section Loss on South Face.

Photograph 96: View of Pier 8 Horizontal Crack on Downstream Decorative Cap.

Photograph 97: View of Pier 10 Section Loss on North Face.

Photograph 98: View of Pier 11 Section Loss 15 Downstream of Northeast Corner.

Photograph 99: View of Pier 11 Section Loss 15 Feet Upstream of Northwest Corner.

Photograph 100: View of Pier 12 Section Loss on North Face.

Photograph 101: View of Pier 12 Abrasion Damage on South Face.

Photograph 102: View of Pier 13 Section Loss on North Face.

Photograph 103: View of Pier 15 Section Loss on North Face.

Photograph 104: View of Pier 16 Abrasion Damage on South Face.

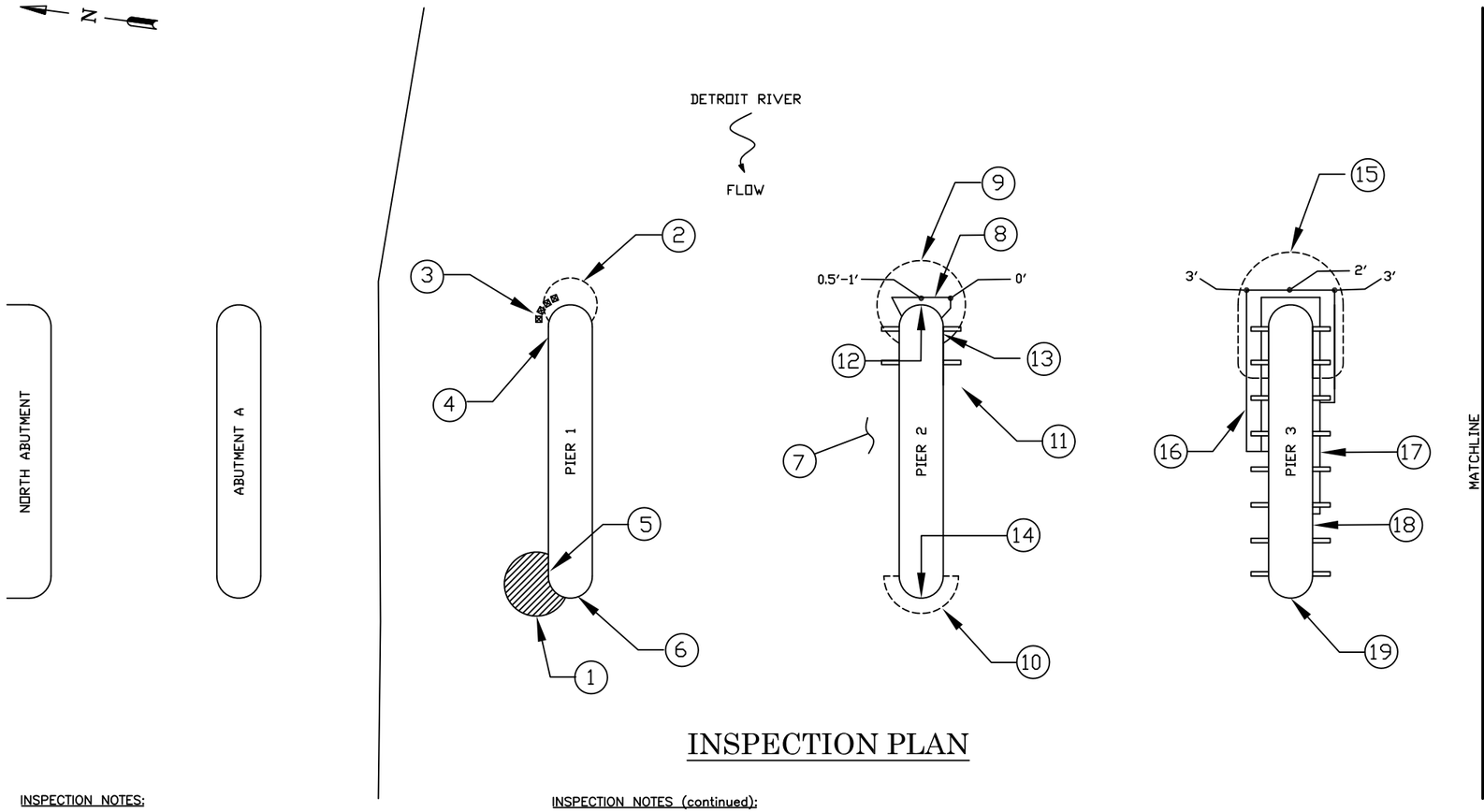
Photograph 105: View of Pier 17 Section Loss on South Face.

Photograph 106: View of Pier 17 Map Cracking on Downstream Nose.

Photograph 107: View of Pier 18 Section Loss on North Face.

APPENDIX C

Sounding and Inspection Plans



INSPECTION PLAN

INSPECTION NOTES:

1. Pier 1 – A 6 to 10 foot diameter mound of silt infilling, approximately 1 to 2 feet higher than surrounding channel bottom, at the northwest corner.
2. Pier 1 – Scour pocket at the upstream nose, 10 feet in diameter, 1 to 3 feet deep.
3. Pier 1 – Vertical 12 inch by 12 inch timbers protruded up from the channel bottom 4 feet at the northeast corner.
4. Pier 1 – 5 feet downstream of the northeast corner, two areas of section loss measuring 1 to 1.5 feet in diameter centered at 1 foot above the waterline and at 3.5 feet above the waterline, with 2 to 3 inches of penetration.
5. Pier 1 – 1.5 foot diameter area of section loss centered at 1 foot above the waterline located at the northwest corner.
6. Pier 1 – At the downstream nose, section loss extended from 6 inches below the waterline to 2.5 feet above the waterline and was 8 to 10 feet wide, with 4 to 8 inches of penetration.
7. Pier 2 – The channel bottom material typically consisted of silt with 6 to 12 inches of probe rod penetration.
8. Pier 2 – At the upstream nose, the southern half of the upper tier of the footing had between 6 and 12 inches of vertical exposure. The vertical footing exposure tapered to zero as it approached the southeast corner of the footing.
9. Pier 2 – A 6 to 8 foot deep scour pocket was present at the upstream nose and was approximately 10 to 15 feet in diameter.
10. Pier 2 – At the downstream nose of the pier a horseshoe shaped scour pocket extended from the nose out 4 feet. The scour pocket was 6 to 10 inches deeper than the adjacent downstream channel bottom elevations and 3 feet deeper than the adjacent upstream channel bottom elevations.
11. Pier 2 – As described in the general notes, horizontal timbers protruded out from the faces of the pier within the upstream quarter of the pier, near the channel bottom.
12. Pier 2 – Light hairline cracking was observed over the upstream nose, most of which was horizontally oriented. The cracking extended from 1 foot to 3 feet above the waterline for a width of 6 feet. Efflorescence was present at the cracks.

INSPECTION NOTES (continued):

13. Pier 2 – A 2 foot diameter area of section loss was located 15 feet downstream of the southeast corner and was center at 2 feet above the waterline, with 2 to 3 inches of penetration.
14. Pier 2 – The downstream nose exhibited section loss for a width of 8 feet which extended from 1 foot to 3 feet above the waterline, with penetrations of 3 to 6 inches. In addition, hairline to 1/2 inch wide map cracking was observed over the downstream nose from 6 inches below the waterline to 6 feet above the waterline.
15. Pier 3 – 4 to 6 foot deep scour pocket at the upstream nose and down both faces to the upstream quarter points. The scour pocket extended out from the nose and faces approximately 10 to 15 feet.
16. Pier 3 – The lower tier of the footing was exposed from the mid point on the north face, around and across the upstream nose, to the upstream third point on the south face. The lower tier of the footing had 3 feet of vertical exposure at the northeast and southeast corners and 2 feet of vertical exposure at the center of the upstream face.
17. Pier 3 – The upper tier of the footing was exposed from the midpoint on the north face, around and across the upstream nose, to the downstream quarter point on the south face.
18. Pier 3 – An area of section loss was noted on the south face, 15 feet upstream of the southwest corner. The area was 3 feet long by 1.5 feet high with 2 to 3 inches of penetration and was centered at 3.5 feet above the waterline.
19. Pier 3 – The downstream nose had section loss over 25 percent of the surface area from 1.5 feet above the waterline to 4.5 feet above the waterline. The section loss extended for a width of 10 feet and had penetrations ranging from 2 to 3 inches.

GENERAL NOTES:

1. The channel bottom material in the vicinity of the piers typically consisted of shells (zebra mussels) over sandy gravel with 3 inches to 6 inches of probe rod penetration.

2. A 1/2 inch to 1–1/2 inch thick layer of zebra mussels was present on the pier surfaces from the channel bottom to 5 feet below the waterline. A 1/4 inch thick layer of aquatic growth was occasionally present from the waterline to 5 feet below the waterline

3. Around the entire perimeter, the concrete of the piers typically exhibited light 1/4 inch to 3/4 inch deep scaling from 6 inches to 24 inches below the waterline. Moderate scaling, 1 inch to 1–1/2 inches deep, was present over the upstream noses of the piers in the same zone. In addition, approximately 5 to 15 small areas of section loss were present on the pier faces between 1 foot below the waterline and 2 feet above the waterline. The small areas of section loss were typically 3 to 6 inches in diameter; however, 9 to 12 inch diameter areas were occasionally observed. These areas of section loss exhibited penetrations ranging from 1.5 to 3 inches in depth.

4. Square voids measuring 12 inches by 12 inches were typically observed in the north and south faces of the piers. Each face exhibited four voids approximately located at the quarter points and the third points. Penetrations of 3 feet were recorded without stoppage.

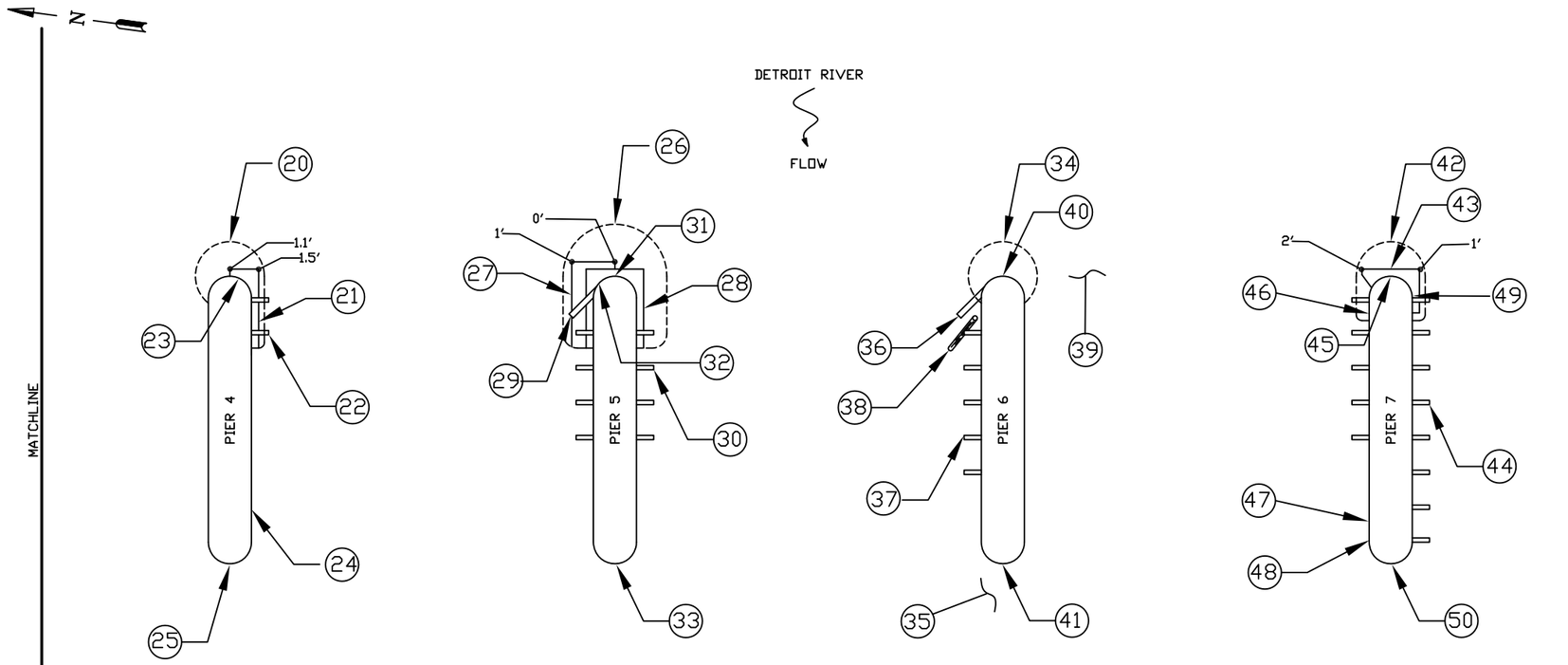
5. As noted in the previous report, horizontal timbers measuring 12 inches by 12 inches typically protruded out from the north and south faces of the piers for 4 to 6 feet. The spacing of the timbers was relatively consistent and was estimated to be approximately 10 feet. At a maximum, a total of eight timbers were observed along one face. The top of the timbers appeared to be located at a consistent depth of approximately 16 feet below the waterline. In many instances, two 12 inch by 12 inch timbers were stacked on top of each other to create a 12 inch wide by 24 inch high timber. The number of timbers exposed at each pier and the extent of their exposure varied with the channel bottom elevation. In general, more timbers were exposed at the upstream end of the piers where the channel bottom elevations were deeper. As the channel bottom depths increased towards the downstream end of the piers, the number of timbers and extent of exposure decreased.

6. Along both shorelines, concrete riprap was present and ranged in diameter from 1 to 4 feet along with concrete slabs that were 6 to 8 inches thick and up to 6 feet in diameter. Beyond the immediate shoreline, the embankments had little to no slope and were maintained grass/parkland. No erosion or embankment instability was observed.

CITY OF DETROIT

DOUGLAS A. MACARTHUR BRIDGE OVER THE DETROIT RIVER INSPECTION PLAN

DRAWN BY: GMS	COLLINS ENGINEERS PC	12932 168TH AVENUE	DATE: 04–22–09
CHECKED BY: PDR		GRAND HAVEN, MI 49417	SCALE: NTS
JOB NO.: 6011		(616)-844-9096	SHEET NO.: 1



INSPECTION PLAN

INSPECTION NOTES:

20. Pier 4 – A 4 to 6 foot deep scour pocket at the upstream nose and down the south face to the upstream quarter point, extending out from the nose and face approximately 8 to 12 feet.
21. Pier 4 – The upper tier of the footing was exposed from the center the upstream face, around the southeast corner, to the upstream quarter point on the south face. The footing was exposed vertically for 1.1 feet at the center of the upstream face and 1.5 feet at the southeast corner.
22. Pier 4 – As described in the general notes, two sets of horizontal timbers were found to protrude from the south face of the pier near the upstream end. No timbers were observed along the north face.
23. Pier 4 – Section loss was noted on 75 percent of the surface area of the south half of the upstream nose. The section loss extended from 1 foot above the waterline to 4.5 feet above the waterline, for a length of 8 feet. Penetrations ranged from 2 to 4 inches.
24. Pier 4 – Located 15 feet upstream of the southwest corner, a 3 foot diameter area of section loss was observed at 1 foot above the waterline, with 2 to 3 inches of penetration.
25. Pier 4 – The downstream nose exhibited a 15 foot wide area of section loss from 6 inches below the waterline to 3 feet above the waterline, with 3 to 5 inches of probe rod penetration.
26. Pier 5 – A 4 to 6 foot deep scour pocket was present at the upstream nose and downstream along both faces to the upstream quarter points. The scour extended out from the pier nose and faces 10 to 15 feet.
27. Pier 5 – The lower tier of the footing was exposed from the upstream quarter point on the north face, around the northeast corner, to the center of the upstream face. The lower tier of the footing was vertically exposed for 1 foot at the northeast corner and was flush with the channel bottom at the center of the upstream face.
28. Pier 5 – The upper tier of the footing was exposed from the upstream quarter point on the north face, around and across the upstream nose, to the upstream quarter point on the south face. At the southeast corner, the upper tier of the footing had 2 feet of vertical exposure.

INSPECTION NOTES (continued):

29. Pier 5 – Extending from the upstream nose were two rows of 12 inch by 12 inch horizontal timbers pointing downstream and away from the pier at a 45 degree angle. The timbers were located between 1 foot and 3 feet above the top of the upper tier of the footing.
30. Pier 5 – As described in the general notes, approximately four rows of horizontal 12 inch by 12 inch timbers were found protruding from pier walls on both the north and south faces, near the channel bottom.
31. Pier 5 – Section loss was observed on 75 percent of the surface area of the upstream nose between 1 foot and 4.5 feet above the waterline, for a length of 8 to 10 feet. Penetrations ranged from 3 to 4 inches.
32. Pier 5 – A 1 foot diameter area of section loss was noted at the waterline near the northeast corner of the pier, with 3 to 4 inches of penetration.
33. Pier 5 – The downstream nose exhibited section loss from 1.5 feet to 3 feet above the waterline for a length of 10 to 12 feet and had penetrations of 3 to 4 inches. In addition, the decorative cap at the downstream nose had an area of section loss centered at 5.5 feet above the waterline that measured 5 feet long by 1.5 feet high. The area of section loss had 4 inch deep penetrations and associated 1/2 inch wide cracking.
34. Pier 6 – A 5 to 6 foot deep scour pocket was present at the upstream nose and was approximately 12 feet in diameter. However, no footing exposure was detected.
35. Pier 6 – Channel bottom infilling was noted adjacent to the downstream nose. The channel bottom in this vicinity sloped down and away from the pier nose at an approximate slope of 1:1. Pheumo–fathometer readings indicated that the channel bottom near the downstream nose was 20 feet and that it dropped down and away to a depth of 26 feet.
36. Pier 6 – Extending from the northeast corner of the upstream nose were two rows of 12 inch by 12 inch horizontal timbers pointing downstream and away from the pier at a 45 degree angle.
37. Pier 6 – As described in the general notes, five sets of horizontal timbers protruded from the north face of the pier near the channel bottom.

INSPECTION NOTES (continued):

38. Pier 6 – A 10 inch diameter log was noted on the channel bottom at the northeast corner of the pier and extended downstream and away from the pier at a 45 degree angle.
39. Pier 6 – Timber formwork ranging in size from 4 to 12 inches was noted on the channel bottom near the upstream nose and extending south towards Pier 7.
40. Pier 6 – Section loss was noted over 50 percent of the surface area of the entire upstream nose from 1.5 feet to 4.5 feet above the waterline. This area exhibited penetrations of 3 to 6 inches. In addition, associated hairline to 1/4 inch wide map cracking and concrete delaminations extended to the decorative cap.
41. Pier 6 – The downstream nose had section loss over 75 of the surface area for a width of 8 to 10 feet. This area extended from 1.5 to 4.5 feet above the waterline and had penetrations ranging from 4 to 6 inches.
42. Pier 7 – A 3 foot to 6 foot deep scour pocket was present at the upstream nose which extended downstream along both faces for approximately 10 to 15 feet. The scour extended out from the faces and nose for 8 to 12 feet.
43. Pier 7 – The upper tier of the footing was exposed from 2 feet downstream of the northeast corner, around and across the upstream face, to 10 feet downstream of the southeast corner. The footing was exposed vertically for 2 feet at the northeast corner at the center of the upstream face, and for 1 foot vertically at the southeast corner. The lower tier of the footing was not detected.
44. Pier 7 – As described in the general notes, horizontal timbers were observed near the channel bottom along the north face but became buried in the channel bottom as elevations increased towards the downstream end of the pier. A total of eight horizontal timbers were observed along the south face of the pier near the channel bottom.
45. Pier 7 – Between 1.5 feet and 3 feet above the waterline, the south half of the upstream nose exhibiting section loss over 50 percent of the surface area. Penetrations ranged from 3 to 5 inches.
46. Pier 7 – Located 15 feet downstream of the northeast corner, a 1 foot diameter area of section loss with 2 to 3 inches of penetration was center at 1.5 feet above the waterline. A similar area of section loss was also observed 15 feet upstream of the northwest corner.

INSPECTION NOTES (continued):

47. Pier 7 – At 15 feet upstream of the northwest corner, center at 3.5 feet above the waterline, there was an area of section loss measuring 2 feet long by 1 foot high with 4 inches of penetration.
48. Pier 7 – A vertical 1/16 inch wide crack was observed at 6 feet upstream of the northwest corner and extended from 3.5 feet above the waterline to below the waterline. A similar vertical crack was observed at 3 feet upstream of the southwest corner.
49. Pier 7 – Located 2 feet downstream of the southeast corner, a 1 foot diameter area of section loss with 3 to 4 inches of penetration was observed 1.5 feet above the waterline.
50. Pier 7 – Section loss, heavier than was typically observed, was noted over 95 % of the surface area of the downstream nose from the waterline to 4.5 feet above the waterline. Penetrations ranged from 6 inches up to 12 inches. The area of section loss had associated hairline to 1/8 inch wide map cracking and concrete delaminations.

GENERAL NOTES:

1. The channel bottom material in the vicinity of the piers typically consisted of shells (zebra mussels) over sandy gravel with 3 inches to 6 inches of probe rod penetration.

2. A 1/2 inch to 1–1/2 inch thick layer of zebra mussels was present on the pier surfaces from the channel bottom to 5 feet below the waterline. A 1/4 inch thick layer of aquatic growth was occasionally present from the waterline to 5 feet below the waterline

3. Around the entire perimeter, the concrete of the piers typically exhibited light 1/4 inch to 3/4 inch deep scaling from 6 inches to 24 inches below the waterline. Moderate scaling, 1 inch to 1–1/2 inches deep, was present over the upstream noses of the piers in the same zone. In addition, approximately 5 to 15 small areas of section loss were present on the pier faces between 1 foot below the waterline and 2 feet above the waterline. The small areas of section loss were typically 3 to 6 inches in diameter; however, 9 to 12 inch diameter areas were occasionally observed. These areas of section loss exhibited penetrations ranging from 1.5 to 3 inches in depth.

4. Square voids measuring 12 inches by 12 inches were typically observed in the north and south faces of the piers. Each face exhibited four voids approximately located at the quarter points and the third points. Penetrations of 3 feet were recorded without stoppage.

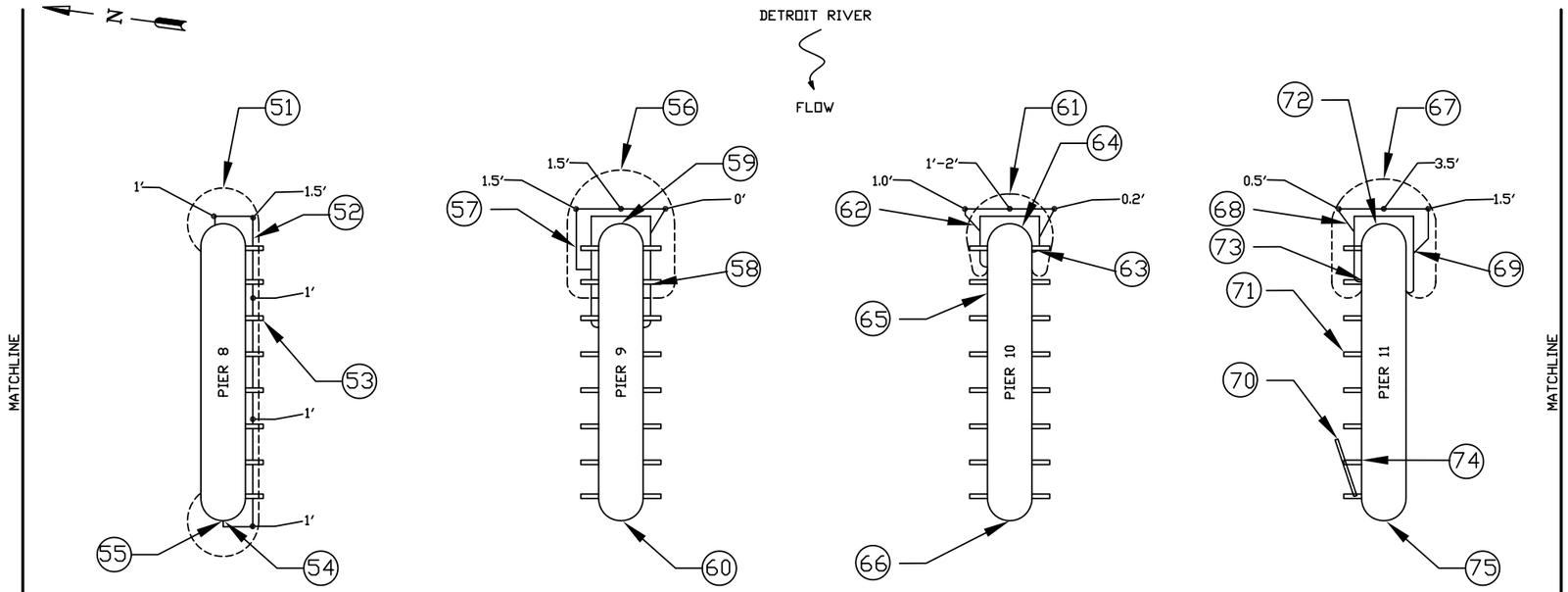
5. As noted in the previous report, horizontal timbers measuring 12 inches by 12 inches typically protruded out from the north and south faces of the piers for 4 to 6 feet. The spacing of the timbers was relatively consistent and was estimated to be approximately 10 feet. At a maximum, a total of eight timbers were observed along one face. The top of the timbers appeared to be located at a consistent depth of approximately 16 feet below the waterline. In many instances, two 12 inch by 12 inch timbers were stacked on top of each other to create a 12 inch wide by 24 inch high timber. The number of timbers exposed at each pier and the extent of their exposure varied with the channel bottom elevation. In general, more timbers were exposed at the upstream end of the piers where the channel bottom elevations were deeper. As the channel bottom depths increased towards the downstream end of the piers, the number of timbers and extent of exposure decreased.

6. Along both shorelines, concrete riprap was present and ranged in diameter from 1 to 4 feet along with concrete slabs that were 6 to 8 inches thick and up to 6 feet in diameter. Beyond the immediate shoreline, the embankments had little to no slope and were maintained grass/parkland. No erosion or embankment instability was observed.

CITY OF DETROIT

DOUGLAS A. MACARTHUR BRIDGE
OVER THE DETROIT RIVER
INSPECTION PLAN

DRAWN BY: GMS	COLLINS ENGINEERS INC	12932 168TH AVENUE	DATE: 04–22–09
CHECKED BY: PDR		GRAND HAVEN, MI 49417	SCALE: NTS
JOB NO.: 6011		(616)-844-9096	SHEET NO.: 2



INSPECTION PLAN

INSPECTION NOTES:

51. Pier 8 – A 4 to 8 foot deep scour pocket was observed around the upstream, along the entire south face, and around the downstream nose. The scour extended out from the face and the noses 8 to 12 feet.
52. Pier 8 – The upper tier of the footing became exposed 2 feet north of the centerline of the pier at the upstream nose. The footing exposure increased such that there was 1 foot of vertical exposure at the centerline of the pier at the upstream nose. At the southeast corner of the footing there was 1.5 feet of vertical exposure. The vertical exposure continued down the south face to the southwest corner and was 1 foot high. At the centerline of the pier at the downstream nose the footing became buried in the channel bottom. No footing exposure was observed along the north face of the pier nor was any lower tier footing exposure detected.
53. Pier 8 – As described in the general notes, along the south face of the pier horizontal timbers were protruding from the face, near the channel bottom.
54. Pier 8 – The decorative cap at the downstream nose had a 1 inch wide horizontal crack that was 8 feet long located at 5 feet above the water line.
55. Pier 8 – The downstream nose had section loss over 75 percent of the surface area from 2.5 feet to 4.5 feet above the waterline with 2 to 6 inches of penetration.
56. Pier 9 – A 6 to 8 foot deep scour depression was present at the upstream nose and extended downstream along both faces for 10 to 15 feet. The scour depression extended out from the nose and faces for 8 to 12 feet.
57. Pier 9 – The lower tier of the footing was exposed 10 feet downstream of the northeast corner, around and across the upstream face, to the southeast corner. The lower tier of the footing had 1.5 feet of vertical exposure at the northeast corner and at the center of the upstream face, while the southeast corner was flush with the channel bottom.
58. Pier 9 – The upper tier of the footing was exposed from 20 feet downstream of the northeast corner, around and across the upstream nose, to 15 to 20 feet downstream of the southeast corner.

INSPECTION NOTES (continued):

59. Pier 9 – Section loss was observed for a length of 8 feet across the upstream nose from 0.5 feet to 2.5 feet above the waterline, with 2 to 4 inches of probe rod penetration.
60. Pier 9 – Section loss was observed on the downstream nose for a length of 10 feet, and extended from the waterline to 4.5 feet above the waterline. Penetrations ranged from 3 to 8 inches. The decorative cap at the downstream nose had 1/16 inch to 1/4 wide map cracking from 4.5 feet to 7.0 feet above the waterline.
61. Pier 10 – An 8 to 10 foot deep scour pocket was present at the upstream nose and down both faces for a distance of 10 to 15 feet. The scour pocket extended out from the nose and faces for 6 to 10 feet.
62. Pier 10 – The lower tier of the footing was exposed from 2 feet downstream of the northeast corner, around and across the upstream nose, to just downstream of the southeast corner. The footing had 1 foot of vertical exposure at the northeast corner, 2 inches at the southeast corner, and between 1 and 2 feet across the upstream face.
63. Pier 10 – The upper tier of the footing was exposed from 15 feet downstream of the northeast corner, around and across the upstream nose, to 10 feet downstream of the southeast corner.
64. Pier 10 – The upstream nose had section loss over the south half from 2 feet to 4.5 feet above the waterline with 1 to 2 inches of penetration.
65. Pier 10 – A 5 foot long by 1 foot high area of section loss was noted 15 feet downstream of the northeast corner at 2.5 feet above the waterline. Penetrations were between 2 and 3 inches.
66. Pier 10 – The downstream nose had hairline to 1/8 inch wide map cracking with efflorescence from the waterline to 4.5 feet above the waterline.
67. Pier 11 – A scour pocket up to 7 to 10 feet deep was observed at the upstream nose and downstream along both faces for 20 to 25 feet.
68. Pier 11 – The lower tier of the footing was exposed from 1 foot downstream of the northeast corner, around and across the upstream face, to 10 feet downstream of the southeast corner. The footing had 6 inches of vertical exposure at the northeast corner and 18 inches at the southeast corner. The vertical exposure reached 3.5 feet directly upstream of the upstream nose.

INSPECTION NOTES (continued):

69. Pier 11 – The upper tier of the footing was exposed from 20 feet downstream of the northeast corner, around and across the upstream face, to 25 feet downstream of the southeast corner.
70. Pier 11 – Timber debris, 8 to 12 inches in diameter was observed on the channel bottom along the north face from the northwest corner to 20 feet upstream of the northwest corner.
71. Pier 11 – As described in the general notes, horizontal timber members were protruding from the north pier face near the channel bottom.
72. Pier 11 – Section loss was noted over 75 percent of the surface area of the upstream nose for a length of 10 feet, extending from the waterline to 4.5 feet above the waterline. Penetrations ranged from 4 to 5 inches.
73. Pier 11 – Centered at the waterline, a 3 foot diameter area of section loss was located 15 feet downstream of the northeast corner and had up to 5 inches of penetration.
74. Pier 11 – A similar area of section loss was noted at 15 feet upstream of the northwest corner.
75. Pier 11 – Hairline to 1/4 inch wide map cracking with efflorescence was observed over the downstream nose and decorative cap. In addition, two areas of section loss and failing concrete repairs were observed over the downstream nose between 6 and 12 inches above the waterline. The areas were between 2 and 2.5 feet in length and had penetrations ranging from 2 to 3 inches.

GENERAL NOTES:

1. The channel bottom material in the vicinity of the piers typically consisted of shells (zebra mussels) over sandy gravel with 3 inches to 6 inches of probe rod penetration.

2. A 1/2 inch to 1–1/2 inch thick layer of zebra mussels was present on the pier surfaces from the channel bottom to 5 feet below the waterline. A 1/4 inch thick layer of aquatic growth was occasionally present from the waterline to 5 feet below the waterline

3. Around the entire perimeter, the concrete of the piers typically exhibited light 1/4 inch to 3/4 inch deep scaling from 6 inches to 24 inches below the waterline. Moderate scaling, 1 inch to 1–1/2 inches deep, was present over the upstream noses of the piers in the same zone. In addition, approximately 5 to 15 small areas of section loss were present on the pier faces between 1 foot below the waterline and 2 feet above the waterline. The small areas of section loss were typically 3 to 6 inches in diameter; however, 9 to 12 inch diameter areas were occasionally observed. These areas of section loss exhibited penetrations ranging from 1.5 to 3 inches in depth.

4. Square voids measuring 12 inches by 12 inches were typically observed in the north and south faces of the piers. Each face exhibited four voids approximately located at the quarter points and the third points. Penetrations of 3 feet were recorded without stoppage.

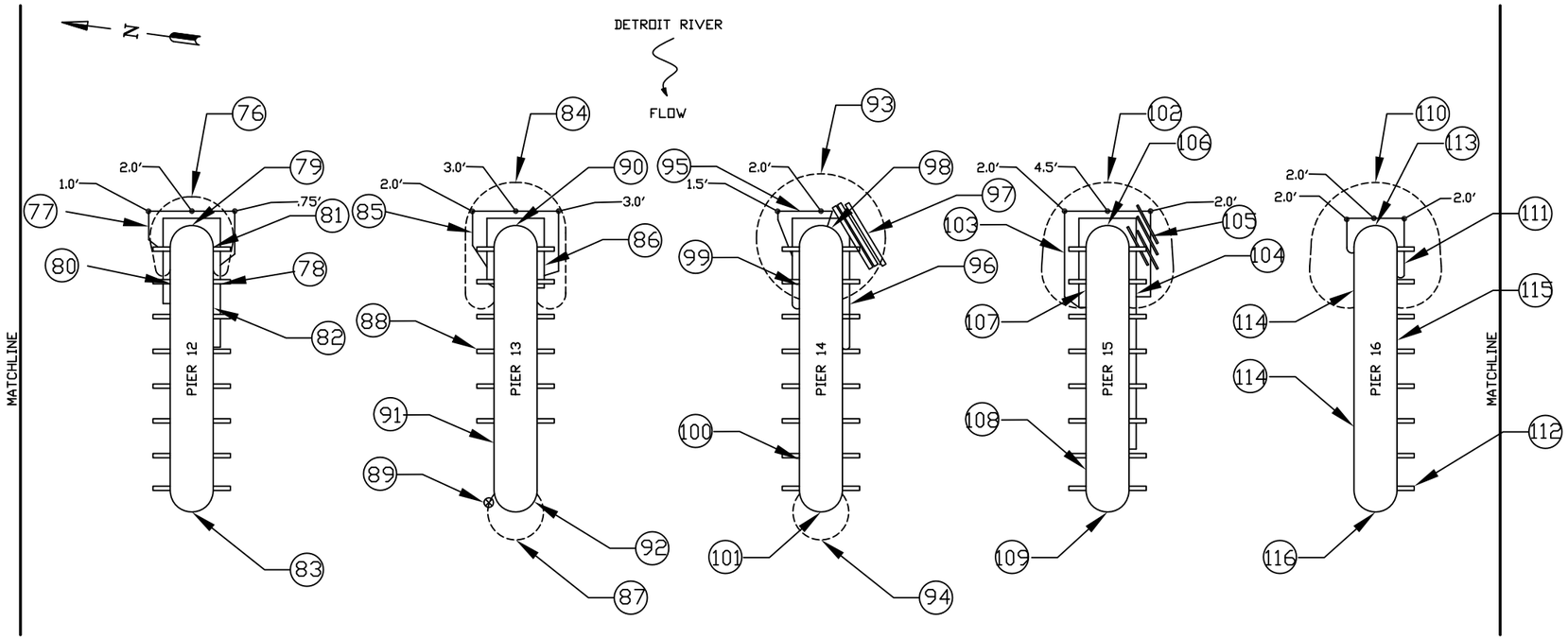
5. As noted in the previous report, horizontal timbers measuring 12 inches by 12 inches typically protruded out from the north and south faces of the piers for 4 to 6 feet. The spacing of the timbers was relatively consistent and was estimated to be approximately 10 feet. At a maximum, a total of eight timbers were observed along one face. The top of the timbers appeared to be located at a consistent depth of approximately 16 feet below the waterline. In many instances, two 12 inch by 12 inch timbers were stacked on top of each other to create a 12 inch wide by 24 inch high timber. The number of timbers exposed at each pier and the extent of their exposure varied with the channel bottom elevation. In general, more timbers were exposed at the upstream end of the piers where the channel bottom elevations were deeper. As the channel bottom depths increased towards the downstream end of the piers, the number of timbers and extent of exposure decreased.

6. Along both shorelines, concrete riprap was present and ranged in diameter from 1 to 4 feet along with concrete slabs that were 6 to 8 inches thick and up to 6 feet in diameter. Beyond the immediate shoreline, the embankments had little to no slope and were maintained grass/parkland. No erosion or embankment instability was observed.

CITY OF DETROIT

DOUGLAS A. MACARTHUR BRIDGE
OVER THE DETROIT RIVER
INSPECTION PLAN

DRAWN BY: GMS	COLLINS ENGINEERS INC	12932 168TH AVENUE	DATE: 04–22–09
CHECKED BY: PDR		GRAND HAVEN, MI 49417	SCALE: NTS
JOB NO.: 6011		(616)-844-9096	SHEET NO.: 3



INSPECTION PLAN

INSPECTION NOTES:

76. Pier 12 – An 8 to 10 foot deep scour pocket was present at the upstream nose which extended downstream along both faces for 10 to 15 feet.
77. Pier 12 – The lower tier of the footing was exposed from 10 feet downstream of the northeast corner, around and across the upstream face, to 15 feet downstream of the southeast corner. The lower tier of the footing was exposed vertically for 12 inches at the northeast corner and 8 inches at the southeast corner. The vertical exposure reached a maximum height of 2 feet at the center of the upstream face.
78. Pier 12 – The upper tier of the footing was exposed from 30 feet downstream of the northeast corner, around and across the upstream nose, to 45 feet downstream of the southeast corner.
79. Pier 12 – Section loss was observed over the south half of the upstream nose from 3 feet to 4.5 feet above the waterline with 3 to 4 inches of penetration.
80. Pier 12 – An area of section loss measuring 3 feet long by 1 foot high was noted 12 feet downstream of the northeast corner at the waterline. The area exhibited 2 inch to 4 inch deep penetrations.
81. Pier 12 – A 2 foot diameter area of section loss was noted at the southeast corner of the pier, centered at the waterline. Penetrations ranged from 4 to 5 inches.
82. Pier 12 – A 2.5 foot wide area of abrasion damage was located 20 feet downstream of the southeast corner, between 1 foot and 3 feet above the waterline. The area had penetrations of 1 to 2 inches.
83. Pier 12 – The downstream nose exhibited section loss, concrete delaminations, and 1 inch wide cracking, extending from the waterline to 4.5 feet above the waterline. The affected area was approximately 12 feet wide and had penetrations ranging from 5 to 7 inches deep. The decorative cap at the downstream nose had 1/4 inch wide map cracking.
84. Pier 13 – A 3 to 6 foot deep scour pocket was present at the upstream nose which extended downstream along both faces for a length of 20 to 25 feet. The scour pocket extended out from the nose of the pier approximately 10 to 15 feet.

INSPECTION NOTES (continued):

85. Pier 13 – The lower tier of the footing was exposed from 12 feet downstream of the northeast corner, around and across the upstream face, to 20 to 25 feet downstream of the southeast corner. The lower tier of the footing was exposed vertically for 2 feet at the northeast corner and for 3 feet at the center of the upstream nose and southeast corner.
86. Pier 13 – The upper tier of the footing was exposed from 25 feet downstream of the northeast corner, around and across the upstream face, to 20 to 25 feet downstream of the southeast corner.
87. Pier 13 – A 6 foot diameter by 2 foot deep scour pocket was center around the downstream nose.
88. Pier 13 – As described in the general notes, horizontal timbers were protruding from the faces of the pier, primarily near the midpoints.
89. Pier 13 – Near the northwest corner, a vertical timber was protruding up 1 to 2 feet from the channel bottom.
90. Pier 13 – Section loss was observed over 75 percent of the surface area of the upstream nose from the waterline to 4 feet above the waterline, with penetrations ranging from 3 to 5 inches.
91. Pier 13 – Located 12 feet upstream of the northwest corner, a 4 foot diameter area of section loss was centered at 1.5 feet above the waterline. The area had penetrations between 6 and 8 inches.
92. Pier 13 – The downstream nose had section loss and concrete delaminations for a length of 6 feet, extending from 6 inches to 4 feet above the waterline. Penetrations ranged from 2 to 4 inches.
93. Pier 14 – A 4 foot to 6 foot deep scour pocket was present around the upstream nose which extended out from the nose approximately 10 to 15 feet in all directions.
94. Pier 14 – A 6 foot diameter scour pocket was centered at the downstream nose and was 1 to 2 feet deep.
95. Pier 14 – The lower tier of the footing was exposed from 3 feet downstream of the northeast corner, around the northeast corner and across the upstream face, to just south of the centerline of the pier on the upstream face. The lower tier of the footing was exposed vertically for 1.5 feet at the northeast corner and for 2 feet at the center of the upstream face.

INSPECTION NOTES (continued):

96. Pier 14 – The upper footing tier of the footing was exposed across the upstream face and down both faces for approximately 15 feet.
97. Pier 14 – At the upstream nose, 18 inch by 18 inch timbers were found on the channel bottom that extended from the upstream nose 20 to 25 feet downstream. In this vicinity (near the southeast corner of the pier), the timber debris covered the channel bottom and obscured any footing exposure.
98. Pier 14 – Section loss was observed over 75 percent of the surface area of the south half of the upstream nose. The section loss was between 6 inches and 3 feet above the waterline and had penetrations between 2 and 4 inches deep.
99. Pier 14 – A 2.5 foot diameter area of section loss with 1 to 2 inches of penetration was observed at the waterline and was located 12 feet downstream of the northeast corner.
100. Pier 14 – A 1 foot diameter area of section loss with 1 to 2 inches of penetration was observed at the waterline and was located 12 feet upstream of the northwest corner.
101. Pier 14 – The downstream nose exhibited heavy section loss from 6 inches to 4 feet above the waterline. The area extended for a length of 12 to 14 feet and had penetrations of 4 to 6 inches.
102. Pier 15 – A 6 to 8 foot deep scour pocket was present at the upstream nose which extended downstream along both faces to the upstream quarter points. The scour extended out from the faces and the nose for approximately 12 to 15 feet.
103. Pier 15 – The lower tier of the footing was exposed from the upstream quarter point on the north face, around and across the upstream face, to the upstream quarter point on the south face. The vertical exposure of the footing was 2 feet at the northeast and southeast corners and 4.5 feet at the center of the upstream face.
104. Pier 15 – The upper tier of the footing was exposed from the upstream quarter point on the north face, around and across the upstream face, to the downstream quarter point on the south face.
105. Pier 15 – Timber debris measuring 6 to 8 inches in diameter was observed on the channel bottom and extended downstream from the southeast corner for a length of 10 to 15 feet.
106. Pier 15 – Section loss was observed on the upstream nose measuring 2.5 feet wide by 1 foot high, centered at 3.5 feet above the waterline. Penetrations of up to 2 inches were noted.

GENERAL NOTES:

1. The channel bottom material in the vicinity of the piers typically consisted of shells (zebra mussels) over sandy gravel with 3 inches to 6 inches of probe rod penetration.

2. A 1/2 inch to 1–1/2 inch thick layer of zebra mussels was present on the pier surfaces from the channel bottom to 5 feet below the waterline. A 1/4 inch thick layer of aquatic growth was occasionally present from the waterline to 5 feet below the waterline

3. Around the entire perimeter, the concrete of the piers typically exhibited light 1/4 inch to 3/4 inch deep scaling from 6 inches to 24 inches below the waterline. Moderate scaling, 1 inch to 1–1/2 inches deep, was present over the upstream noses of the piers in the same zone. In addition, approximately 5 to 15 small areas of section loss were present on the pier faces between 1 foot below the waterline and 2 feet above the waterline. The small areas of section loss were typically 3 to 6 inches in diameter; however, 9 to 12 inch diameter areas were occasionally observed. These areas of section loss exhibited penetrations ranging from 1.5 to 3 inches in depth.

4. Square voids measuring 12 inches by 12 inches were typically observed in the north and south faces of the piers. Each face exhibited four voids approximately located at the quarter points and the third points. Penetrations of 3 feet were recorded without stoppage.

5. As noted in the previous report, horizontal timbers measuring 12 inches by 12 inches typically protruded out from the north and south faces of the piers for 4 to 6 feet. The spacing of the timbers was relatively consistent and was estimated to be approximately 10 feet. At a maximum, a total of eight timbers were observed along one face. The top of the timbers appeared to be located at a consistent depth of approximately 16 feet below the waterline. In many instances, two 12 inch by 12 inch timbers were stacked on top of each other to create a 12 inch wide by 24 inch high timber. The number of timbers exposed at each pier and the extent of their exposure varied with the channel bottom elevation. In general, more timbers were exposed at the upstream end of the piers where the channel bottom elevations were deeper. As the channel bottom depths increased towards the downstream end of the piers, the number of timbers and extent of exposure decreased.

6. Along both shorelines, concrete riprap was present and ranged in diameter from 1 to 4 feet along with concrete slabs that were 6 to 8 inches thick and up to 6 feet in diameter. Beyond the immediate shoreline, the embankments had little to no slope and were maintained grass/parkland. No erosion or embankment instability was observed.

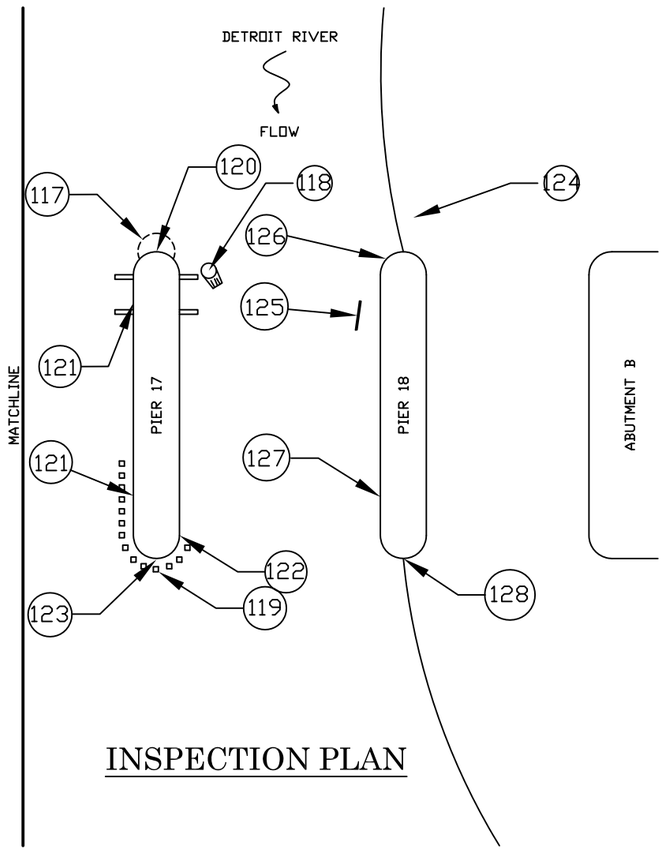
INSPECTION NOTES (continued):

107. Pier 15 – A 2 foot diameter area of section loss was located 15 feet downstream of the northeast corner at 3 feet above the waterline, with penetrations of 3 to 5 inches.
108. Pier 15 – A 2 foot diameter area of section loss was also located 15 upstream of the northwest corner, with 1.5 inches of penetration.
109. Pier 15 – The downstream nose exhibited section loss over 75 percent of the surface area from 6 inches to 4 feet above the waterline and extended across the nose for a length of 6 to 8 feet. The area had penetrations up to 5 inches deep and hairline to 1/16 inch wide map cracking with efflorescence.
110. Pier 16 – A 3 foot to 4 foot deep scour pocket was present at the upstream nose which extended downstream along both faces to the upstream quarter points.
111. Pier 16 – The upper tier of the footing was exposed from 10 feet downstream of the northeast corner, around and across the upstream face, to 20 feet downstream of the southeast corner. The upper tier of the footing had 2 feet of vertical exposure across the entire upstream face.
112. Pier 16 – As described in the general notes, horizontal timbers protruded from the south face of the pier near the channel bottom.
113. Pier 16 – Section loss was observed over 20 percent of the surface area of the upstream nose for a length of 10 feet. The section loss extended from the waterline to 3 feet above the waterline with penetrations of 2 to 4 inches and hairline to 1/16 inch wide map cracking.
114. Pier 16 – Two areas of section loss were noted on the north face of the pier at 10 feet in from noses. The areas were 2 to 3 feet wide and extended from 6 inches to 12 inches above the waterline with 2 to 3 inches of penetration.
115. Pier 16 – An area of abrasion damage was found 20 feet downstream of the southeast corner. The area was between 6 inches and 3 feet above the waterline and was 4 feet wide. Penetrations ranged from 3 to 6 inches.
116. Pier 16 – The downstream nose had section loss from 1 foot below the waterline to 4 feet above the waterline, which extended across the nose for a length of 10 to 12 feet. The penetrations ranged from 3 to 6 inches. In addition, the decorative cap at the downstream end had hairline map cracking.

CITY OF DETROIT

DOUGLAS A. MACARTHUR BRIDGE
OVER THE DETROIT RIVER
INSPECTION PLAN

DRAWN BY: GMS	COLLINS ENGINEERS PC	12932 168TH AVENUE	DATE: 04–22–09
CHECKED BY: PDR		GRAND HAVEN, MI 49417	SCALE: NTS
JOB NO.: 6011		(616)-844-9096	SHEET NO.: 4



INSPECTION PLAN

INSPECTION NOTES:

117. Pier 17 – A scour pocket up to 2.5 feet deep was present at the upstream nose and was approximately 8 to 10 feet in diameter.
118. Pier 17 – A 12 inch diameter tree stump was found on the channel bottom, 6 feet downstream of the southeast corner.
119. Pier 17 – Around the downstream nose and along the downstream half of the north face, 4 inch by 4 inch vertical timbers were found protruding up from the channel bottom for 3 feet. The timbers were spaced at approximate 2 foot intervals.
120. Pier 17 – The upstream nose exhibited section loss over 25 percent of the surface area for a length of 5 feet. The section loss extended from the waterline to 3 feet above the waterline and had penetrations ranging from 2 to 4 inches.
121. Pier 17 – Two areas of section loss measuring 2 feet in diameter were observed on the north face of the pier, 10 feet in from the noses. The areas had 2 to 4 inches of penetration and were centered 1 foot above the waterline.
122. Pier 17 – A 4 foot by 4 foot area of section loss was observed at the southwest corner of the pier. The area was centered at 1 foot above the waterline and had penetrations of 6 to 8 inches.
123. Pier 17 – The downstream nose and decorative cap exhibited section loss and heavy hairline to 1/8 inch wide map cracking from 6 inches below the waterline to 5 feet above the waterline. The section loss exhibited penetrations of 3 to 6 inches and extended across the nose for a length of 6 to 8 feet. The map cracking was present across the entire nose and decorative cap.
124. Pier 18 – No scour or footing exposure was detected at Pier 18.
125. Pier 18 – At the upstream quarter point of the north face, an 8 inch diameter section of steel pipe was lying on the channel bottom.
126. Pier 18 – A 3 foot long area of section loss was noted on the upstream nose from 2 feet to 3 feet above the waterline, with 3 to 3 inches of penetration.
127. Pier 18 – A 1.5 foot long area of section loss was noted 12 feet upstream of the northwest corner from 6 inches to 12 inches above the waterline, with 3 to 4 inches of penetration.
128. Pier 18 – Heavy section loss was observed over the downstream nose for a length of 10 to 12 feet. The section loss extended from 6 inches below the waterline to 3 feet above the waterline, with penetrations ranging from 3 to 6 inches. Areas of the downstream nose not affected by section loss exhibited hairline to 1/16 inch wide map cracking.

GENERAL NOTES:

1. The channel bottom material in the vicinity of the piers typically consisted of shells (zebra mussels) over sandy gravel with 3 inches to 6 inches of probe rod penetration.

2. A 1/2 inch to 1–1/2 inch thick layer of zebra mussels was present on the pier surfaces from the channel bottom to 5 feet below the waterline. A 1/4 inch thick layer of aquatic growth was occasionally present from the waterline to 5 feet below the waterline

3. Around the entire perimeter, the concrete of the piers typically exhibited light 1/4 inch to 3/4 inch deep scaling from 6 inches to 24 inches below the waterline. Moderate scaling, 1 inch to 1–1/2 inches deep, was present over the upstream noses of the piers in the same zone. In addition, approximately 5 to 15 small areas of section loss were present on the pier faces between 1 foot below the waterline and 2 feet above the waterline. The small areas of section loss were typically 3 to 6 inches in diameter; however, 9 to 12 inch diameter areas were occasionally observed. These areas of section loss exhibited penetrations ranging from 1.5 to 3 inches in depth.

4. Square voids measuring 12 inches by 12 inches were typically observed in the north and south faces of the piers. Each face exhibited four voids approximately located at the quarter points and the third points. Penetrations of 3 feet were recorded without stoppage.

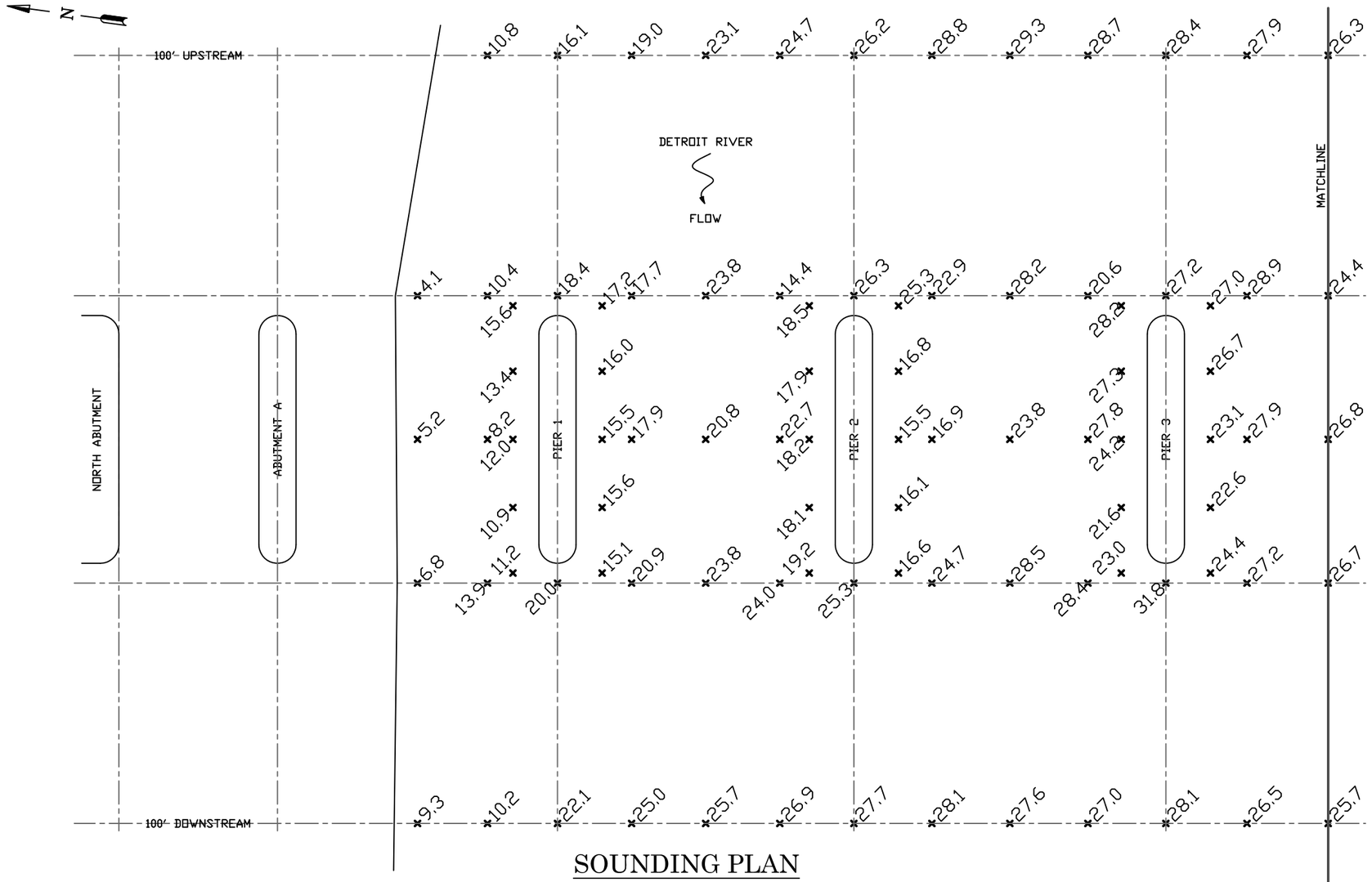
5. As noted in the previous report, horizontal timbers measuring 12 inches by 12 inches typically protruded out from the north and south faces of the piers for 4 to 6 feet. The spacing of the timbers was relatively consistent and was estimated to be approximately 10 feet. At a maximum, a total of eight timbers were observed along one face. The top of the timbers appeared to be located at a consistent depth of approximately 16 feet below the waterline. In many instances, two 12 inch by 12 inch timbers were stacked on top of each other to create a 12 inch wide by 24 inch high timber. The number of timbers exposed at each pier and the extent of their exposure varied with the channel bottom elevation. In general, more timbers were exposed at the upstream end of the piers where the channel bottom elevations were deeper. As the channel bottom depths increased towards the downstream end of the piers, the number of timbers and extent of exposure decreased.

6. Along both shorelines, concrete riprap was present and ranged in diameter from 1 to 4 feet along with concrete slabs that were 6 to 8 inches thick and up to 6 feet in diameter. Beyond the immediate shoreline, the embankments had little to no slope and were maintained grass/parkland. No erosion or embankment instability was observed.

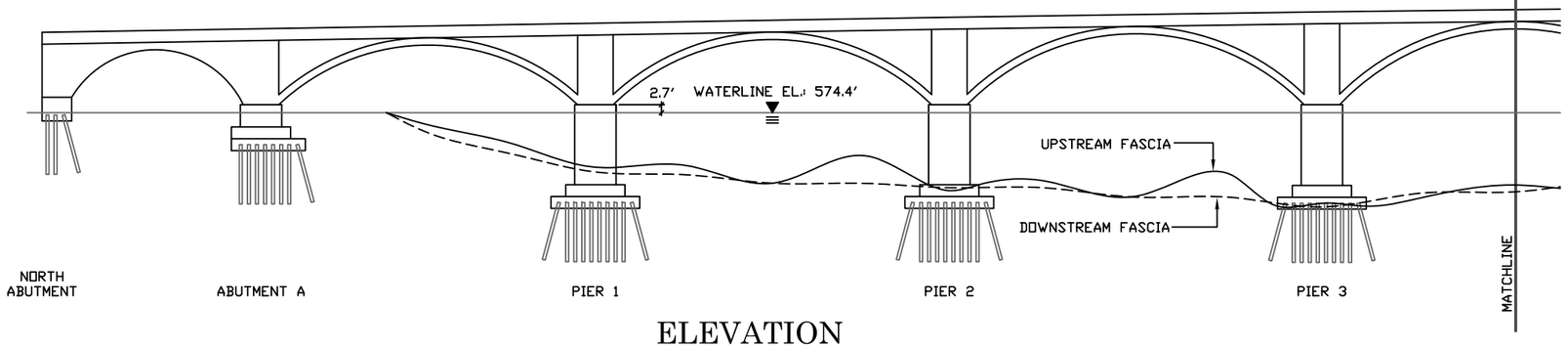
CITY OF DETROIT

DOUGLAS A. MACARTHUR BRIDGE
OVER THE DETROIT RIVER
INSPECTION PLAN

DRAWN BY: GMS	COLLINS ENGINEERS INC	12932 168TH AVENUE	DATE: 04–22–09
CHECKED BY: PDR		GRAND HAVEN, MI 49417	SCALE: NTS
JOB NO.: 6011		(616)-844-9096	SHEET NO.: 5



SOUNDING PLAN



ELEVATION

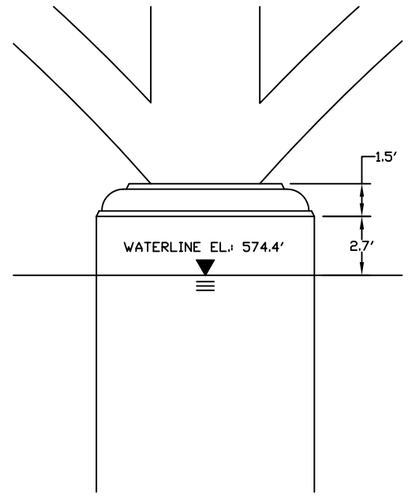
GENERAL NOTES:

1. Drawings were generated according to inspection notes and available plans dated October 9, 1980.

2. All soundings are recorded in feet.

3. At the time of inspection, the waterline was located 2.7 feet below the top of the webwall at Pier 1. According to Great Lakes water level data provided by the National Oceanic and Atmospheric Administration (NOAA), the waterline elevation during the inspection was approximately 574.4 feet.

4. Sounding depth locations are approximate. As a result, the channel bottom profiles should not be used to identify footing exposure. Refer to the inspection notes for the footing exposure limits.



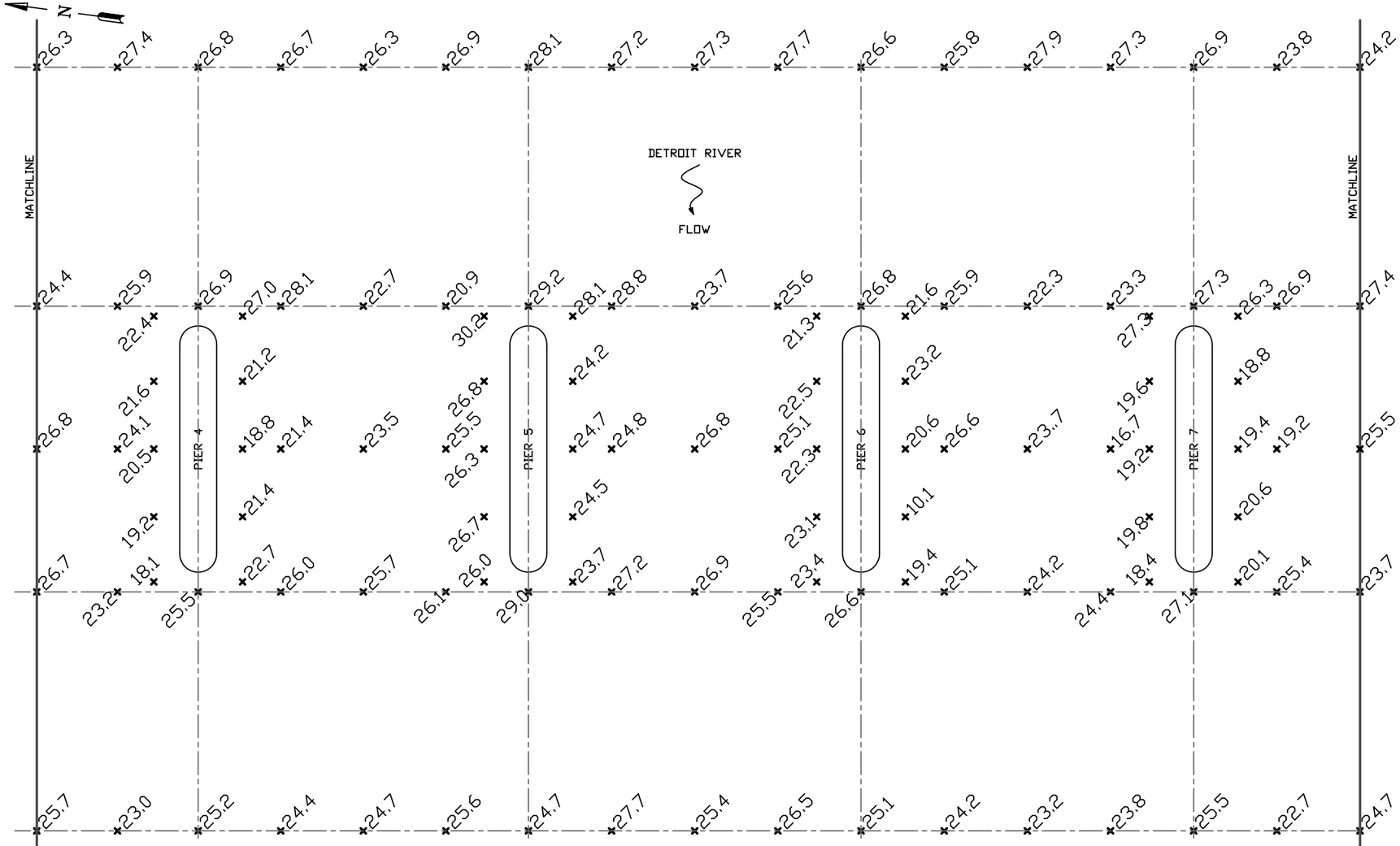
WATERLINE REFERENCE

PIER 1 CROSS-SECTION

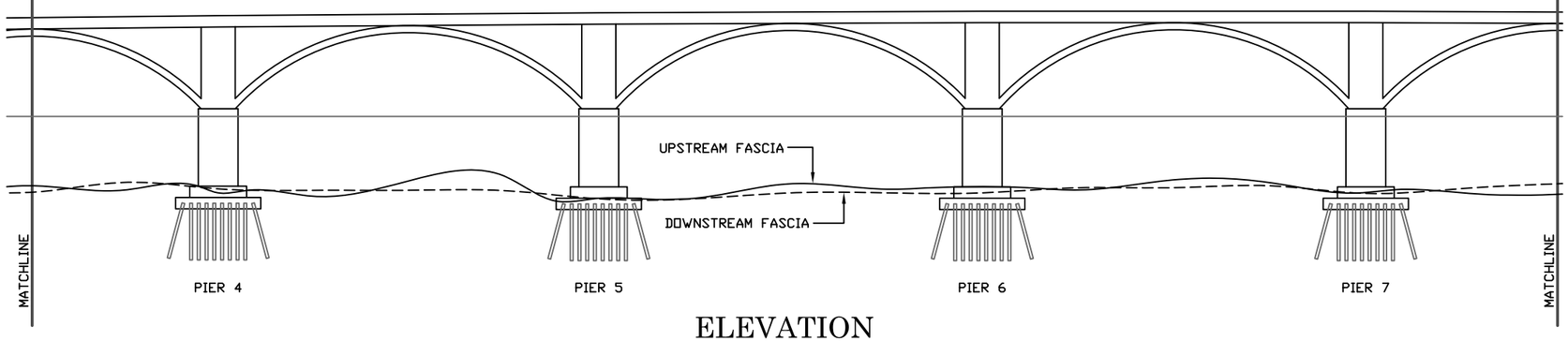
CITY OF DETROIT

DOUGLAS A. MACARTHUR BRIDGE OVER THE DETROIT RIVER SOUNDING PLAN AND ELEVATION

DRAWN BY: GMS	COLLINS ENGINEERS INC	12932 168TH AVENUE GRAND HAVEN, MI 49417 (616)-844-9096	DATE: 04-22-09
CHECKED BY: PDR			SCALE: NTS
JOB NO.: 6011			SHEET NO.: 6



SOUNDING PLAN



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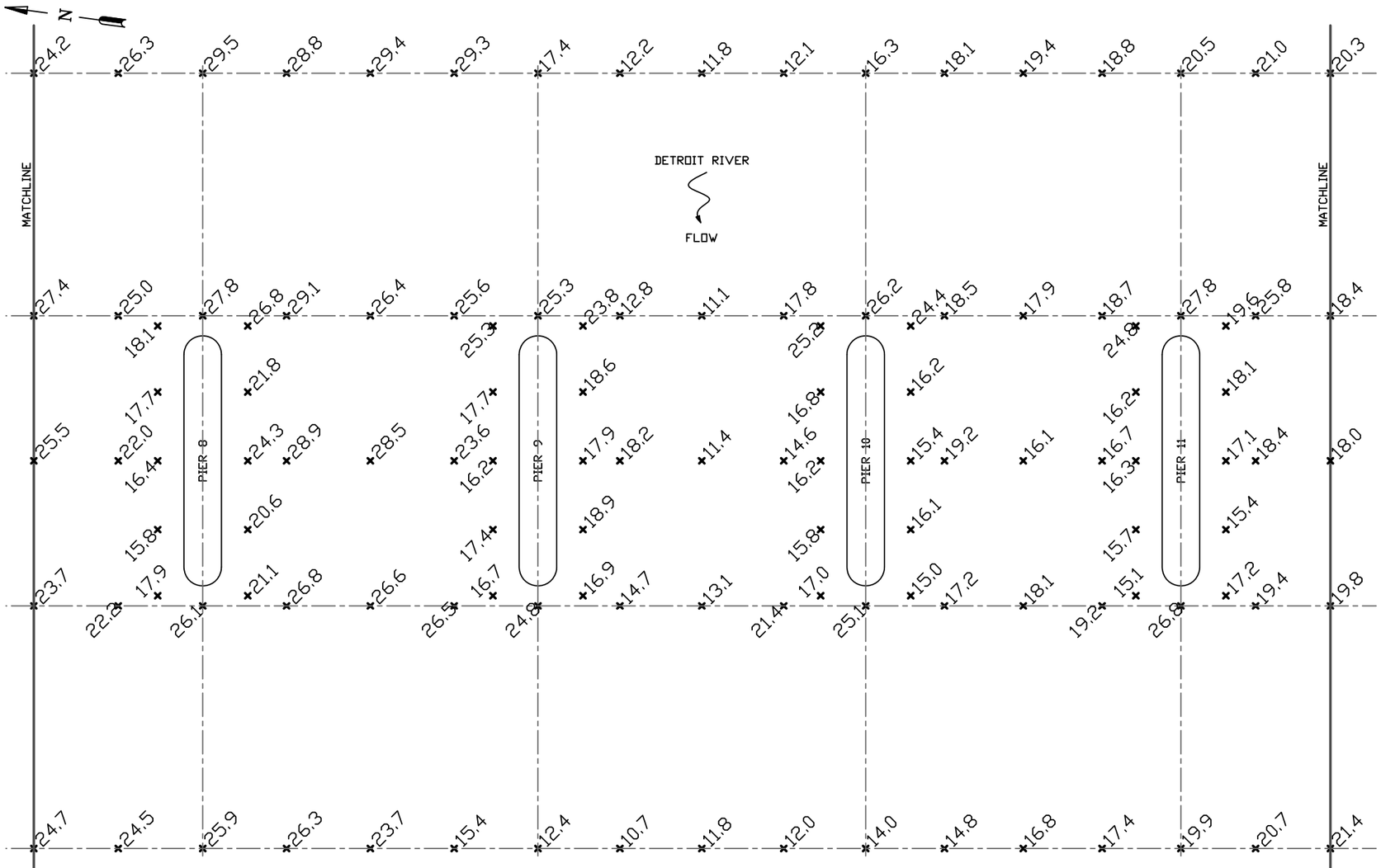
4. Sounding depth locations are approximate. As a result, the channel bottom profiles should not be used to identify footing exposure. Refer to the inspection notes for the footing exposure limits.

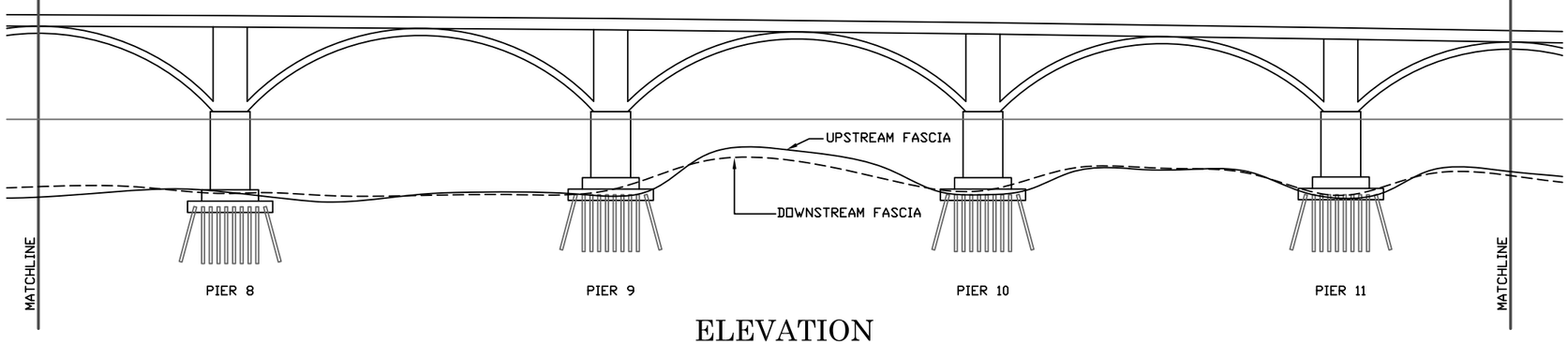
CITY OF DETROIT

DOUGLAS A. MACARTHUR BRIDGE OVER THE DETROIT RIVER SOUNDING PLAN AND ELEVATION

DRAWN BY: GMS	COLLINS ENGINEERS INC	12932 168TH AVENUE GRAND HAVEN, MI 49417 (616)-844-9096	DATE: 04-22-09
CHECKED BY: PDR			SCALE: NTS
JOB NO.: 6011			SHEET NO.: 7



SOUNDING PLAN



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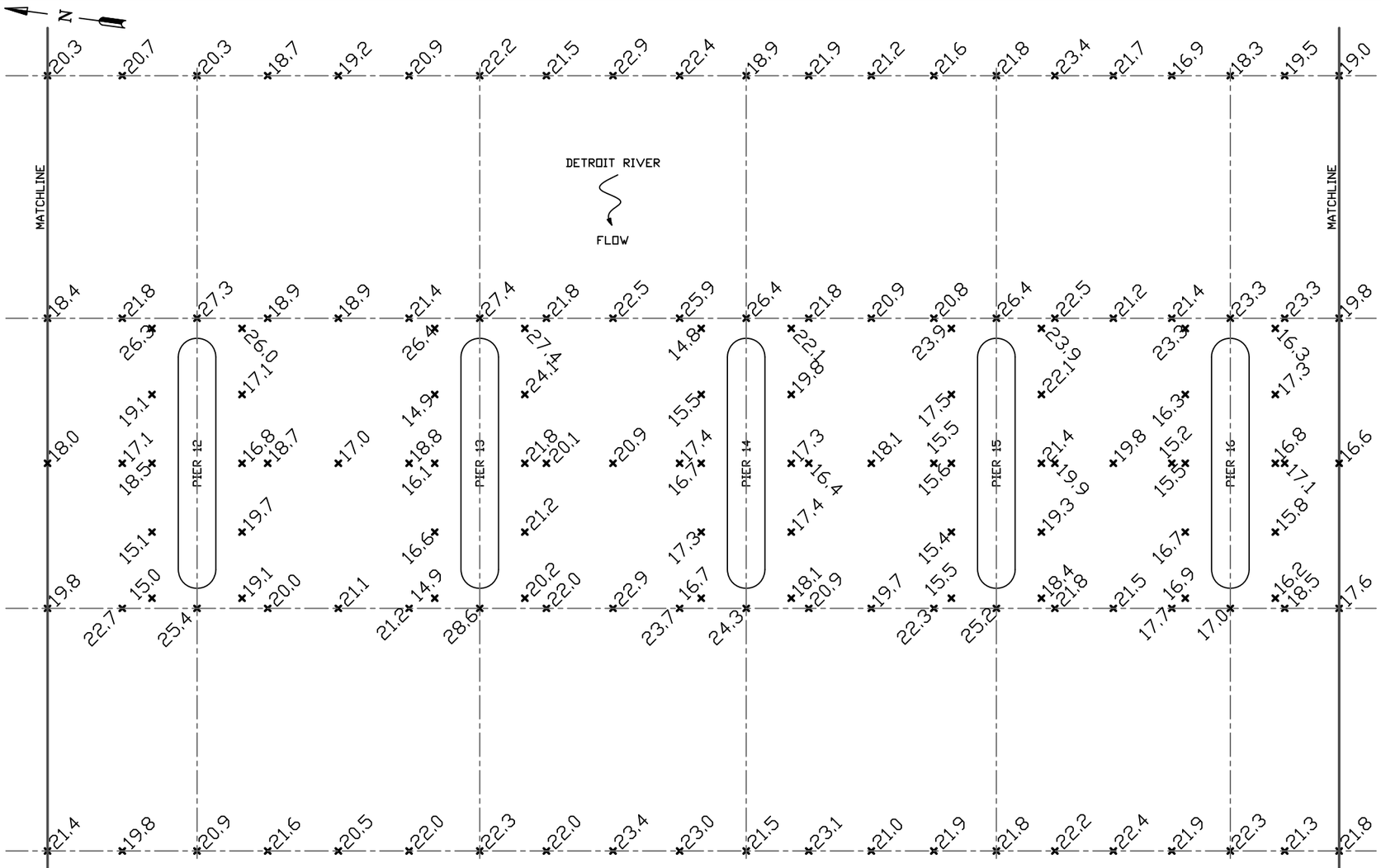
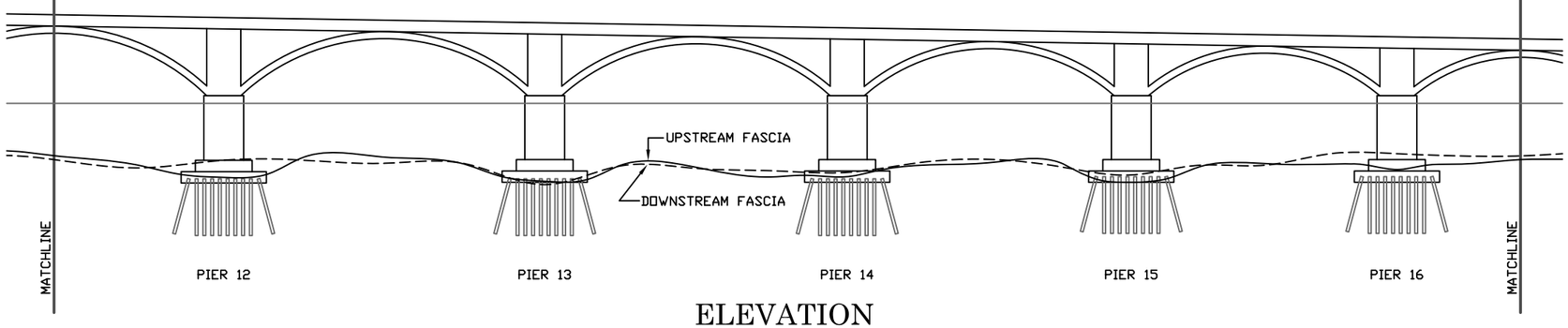
CITY OF DETROIT

DOUGLAS A. MACARTHUR BRIDGE OVER THE DETROIT RIVER SOUNDING PLAN AND ELEVATION

DRAWN BY: GMS	COLLINS ENGINEERS INC	12932 168TH AVENUE	DATE: 04-22-09
CHECKED BY: PDR		GRAND HAVEN, MI 49417	SCALE: NTS
JOB NO.: 6011		(616)-844-9096	SHEET NO.: 8



SOUNDING PLAN



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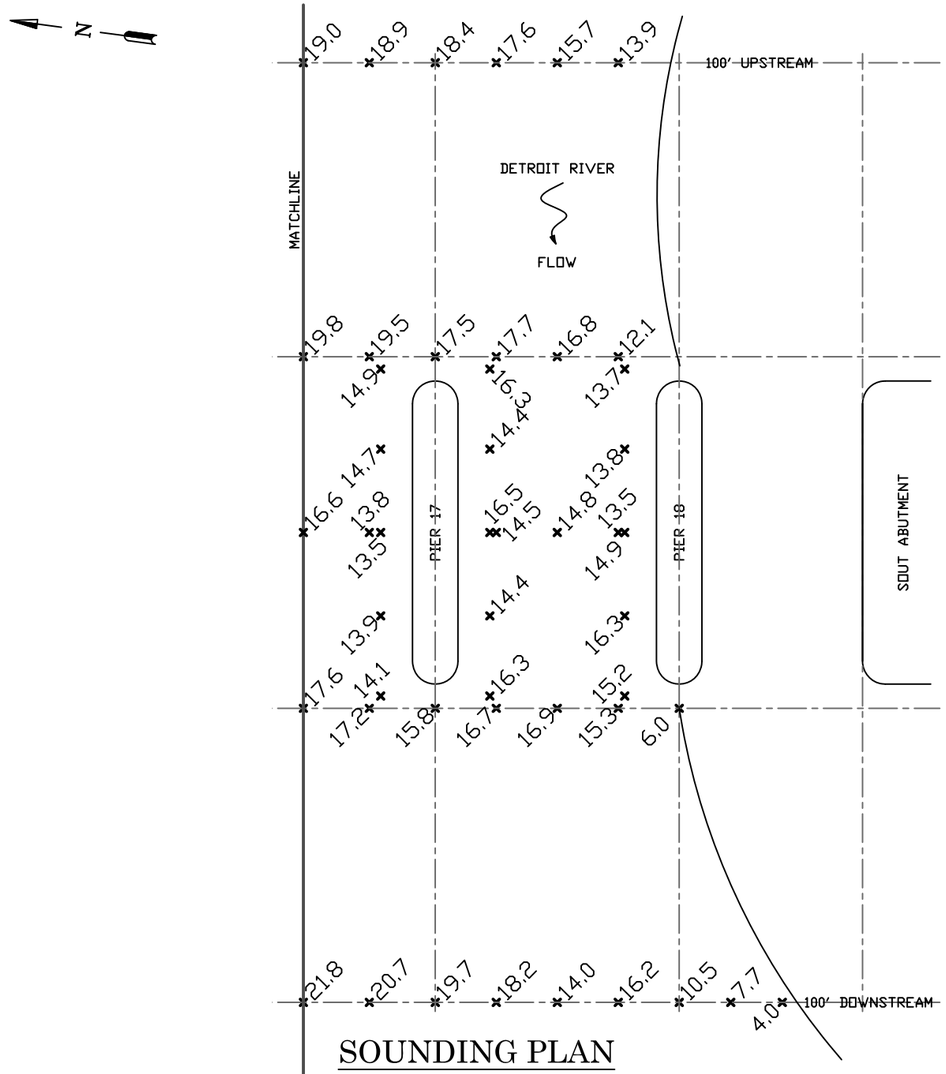
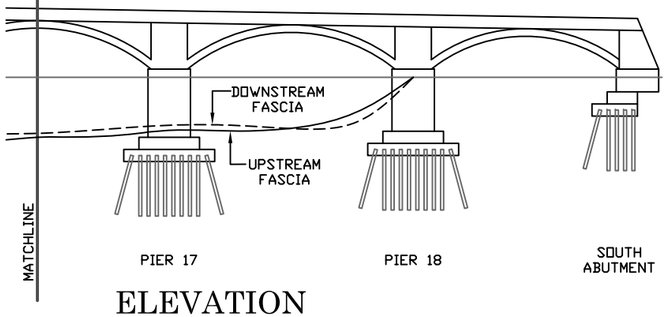
CITY OF DETROIT

DOUGLAS A. MACARTHUR BRIDGE OVER THE DETROIT RIVER SOUNDING PLAN AND ELEVATION

DRAWN BY: GMS	COLLINS ENGINEERS INC	12932 168TH AVENUE	DATE: 04-22-09
CHECKED BY: PDR		GRAND HAVEN, MI 49417	SCALE: NTS
JOB NO.: 6011		(616)-844-9096	SHEET NO.: 9



SOUNDING PLAN



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4. Sounding depth locations are approximate. As a result, the channel bottom profiles should not be used to identify footing exposure. Refer to the inspection notes for the footing exposure limits.

CITY OF DETROIT

DOUGLAS A. MACARTHUR BRIDGE OVER THE DETROIT RIVER SOUNDING PLAN AND ELEVATION

DRAWN BY: GMS	COLLINS ENGINEERS INC	12932 168TH AVENUE GRAND HAVEN, MI 49417 (616)-844-9096	DATE: 04-22-09
CHECKED BY: PDR			SCALE: NTS
JOB NO.: 6011			SHEET NO.: 10

APPENDIX D

MDOT Bridge Diving Inspection Report (SIA #92-B)

MICHIGAN DEPARTMENT OF TRANSPORTATION

BRIDGE DIVING INSPECTION REPORT [SIA #92-B]

MDOT Bridge ID	Structure Number	Control Section
8218084 0051200B01	12392	

Facility	Federal Struc ID	Inspector Name	Agency Name	Inspection Date
BELLE ISLE TRAFFIC	824180800512B01	Peter Rusche	Collins Engineers, inc.	04/22/2009

Feature	Location	Latitude	Longitude	Insp Freq	Insp Key
DETROIT RIVER	DETROIT RIVER AT BELLE IS	422024.28	825947.98	60	BXXL

Length	Width	Year Built	Yr Recon	Br	Type	Scour Eval	# of Pins
2291.3	87.93	1929	1998	1	00	4 Stable, needs action	0

-

BRIDGE INFORMATION

NUMBER OF SUBSTRUCTURE ELEMENTS IN WATERWAY 18

SCOUR COUNTER MEASURES

INSPECTION COMMENTS

None

SCOUR CRITICAL ACTION PLAN AVAILABLE? N

SCOUR CRITICAL ACTION PLAN LOCATION

NAVIGATION PROTECTION SYSTEMS

PROTECTION SYSTEMS

INSPECTION COMMENTS

None

INSPECTION STAFF & EQUIPMENT

ENGINEER Mark Gibson
DIVER Peter Rusche
TENDER Frank Lasch

DIVE EQUIPMENT(S) Surface Supplied Air, Boat

NEAREST BOAT LAUNCH SITE

Access to the bridge site was obtained from the public boat launch located approximately 2.0 miles upstream of the bridge.

SAFETY CONCERNS

High flow velocities, low visibility, weather/waves, marine traffic, diver entanglement.

WATERWAY & WEATHER CONDITIONS

CURRENT SPEED	3	**TURBIDITY**	3	**WATER TEMPERATURE**	50
STREAM BED MATERIAL	Sand	**MAXIMUM DEPTH**	32	**AIR TEMPERATURE**	55

MARINE GROWTH ON STRUCTURE

A 1/2 inch to 1-1/2 inch thick layer of zebra mussels was present on the pier surfaces from the channel bottom to 5 feet below the waterline. A 1/4 inch thick layer of aquatic growth was occasionally present from the waterline to 5 feet below the waterline.

WEATHER CONDITIONS ON DAY OF DIVE

This inspection was conducted over multiple days. The weather conditions varied from overcast with high winds to partially sunny with no winds. Temperatures ranged from approximately 55 to 75 degrees.

INSPECTION DETAILS

MICHIGAN DEPARTMENT OF TRANSPORTATION

BRIDGE DIVING INSPECTION REPORT [SIA #92-B]

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Length	Width	Year Built	Yr Recon	Br	Type	Scour Eval	# of Pins
2291.3	87.93	1929	1998	1	00	4 Stable, needs action	0

-

WATERWAY AND BANK OBSERVATIONS

Along both shorelines, concrete riprap was present and ranged in diameter from 1 to 4 feet along with concrete slabs that were 6 to 8 inches thick and up to 6 feet in diameter. Beyond the immediate shoreline, the embankments had little to no slope and were maintained grass/parkland. No erosion or embankment instability was observed.

SUBSTRUCTURE OBSERVATIONS (Above the waterline)

The faces of the piers exhibited areas of section loss around and directly above the waterline. The areas were relatively small, typically measuring between 1 and 3 feet in diameter. Penetrations typically ranged from 1 to 6 inches. The heaviest areas of section loss were above the waterline at the upstream and downstream noses. The extent of section loss varied from pier to pier, but penetrations ranged from 1 to 8 inches. In addition, associated cracking and concrete delaminations were observed. At certain locations, these defects extended to the decorative concrete caps located above the noses.

SUBSTRUCTURE OBSERVATIONS (Below the waterline)

At the upstream ends of the piers, particularly around the upstream nose, scour pockets were observed. The scour pockets were typically deep enough to cause footing exposure. The upper tier of the footing was exposed on a total of 14 piers. In addition, the lower tier of the footing was exposed on 9 piers. At Piers 11, 13, and 15, the amount of vertical exposure of the lower tier of the footing was between 3 and 4 feet. This is significant because available plans indicate that the lower tier of the footing is 4 feet thick. However, no undermining of the footings was observed. In general, the channel bottom elevations increased towards the downstream end of the pier and any remaining footing exposure was eliminated. As indicated in the previous report, horizontal timber members protruded from the faces of the piers near the channel bottom. In contrast to the previous report, no localized scour was noted in the channel bottom beneath the horizontal timbers. In addition to the horizontal timbers, occasional timber debris and timber formwork was observed around the piers. The extent of the timber debris and formwork was minimal.

DEBRIS IN WATERWAY

As described in 'Substructure Observations (Below the waterline)'.

RECOMMENDATIONS

The areas of section loss, both at the upstream and downstream noses as well as along the pier faces, should be monitored during future inspections for any increase in size and to ensure that no reinforcing steel becomes exposed.

Heavy concrete riprap, measuring between 1 foot and 3 feet in diameter, should be place at the locations where scour and footing exposure was indicated. Once the recommended scour countermeasures are installed, and prior to demobilization of the construction crew and equipment, engineer-divers should evaluate the construction to verify proper riprap placement and document the as-built conditions.

Assuming the recommended scour countermeasures are installed and quality construction is verified, underwater inspections should continue at an interval of 60 months. If an extreme event occurs (high flow, vessel impact), then an interim underwater inspection may be required.

UNDERWATER VIDEO AVAILABLE?	N
UNDERWATER VIDEO DESCRIPTION	
UNDERWATER VIDEO LOCATION	
STREAM BED PROFILE COMPLETED?	N
SITE PLAN COMPLETED?	N
PHOTOGRAPHS?	Y

GENERAL NOTES

MICHIGAN DEPARTMENT OF TRANSPORTATION

BRIDGE DIVING INSPECTION REPORT [SIA #92-B]

MDOT Bridge ID	Structure Number	Control Section
8218084 0051200B01	12392	

Facility	Federal Struc ID	Inspector Name	Agency Name	Inspection Date
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Length	Width	Year Built	Yr Recon	Br	Type	Scour Eval	# of Pins
2291.3	87.93	1929	1998	1	00	4 Stable, needs action	0

-

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The channel bottom material in the vicinity of the piers typically consisted of shells (zebra mussels) over sandy gravel with 3 inches to 6 inches of probe rod penetration.

Around the entire perimeter, the concrete of the piers typically exhibited light 1/4 inch to 3/4 inch deep scaling from 6 inches to 24 inches below the waterline. Moderate scaling, 1 inch to 1-1/2 inches deep, was present over the upstream noses of the piers in the same zone. In addition, approximately 5 to 15 small areas of section loss were present on the pier faces between 1 foot below the waterline and 2 feet above the waterline. The small areas of section loss were typically 3 to 6 inches in diameter; however, 9 to 12 inch diameter areas were occasionally observed. These areas of section loss exhibited penetrations ranging from 1.5 to 3 inches in depth.

Square voids measuring 12 inches by 12 inches were typically observed in the north and south faces of the piers. Each face exhibited four voids approximately located at the quarter points and the third points. Penetrations of 3 feet were recorded without stoppage.

APPENDIX E

Level I Scour Analysis

Revised 5 06 02

MICHIGAN DEPARTMENT OF TRANSPORTATION
LEVEL ONE SCOUR ANALYSIS WORKSHEET

Date: 5/7/2009 By: COLLINS Structure No: _____ Control Section: _____

Job No. 6011 Route: MAC ARTHUR Watercourse: DETROIT RIVER

All references are to HEC-20, 3rd Edition.

Data Collection

✓ Plans
✓ Bridge Inspection Reports (Maintenance Division)
✓ Underwater Inspection Reports (Maintenance Division)
✓ Review existing items 60, 61, 71, 92, 93, and 113 of the NBIS
✓ Review available construction, design, and maintenance files for repair and maintenance work done on structure

Field Investigation Date: 4/21/2009

✓ Channel bottom width approximately one bridge span upstream = 2400 feet wider than bridge.
✓ Overbank and channel Manning's roughness coefficients

.04 Left .03 Channel .04 Right

✓ Is there sufficient riprap? Abutments Yes Piers NO
✓ Photographs
✓ Cross sections at upstream and downstream faces of bridge

Comments:

Stream Characteristics

✓ Complete the attached Figure 2.6 from HEC-20.

Comments:

Land Use: Identify the existing and past land use of the upstream watershed:

Urban Area	Yes ✓ No	Comments:
Sand and Gravel Mining	Yes No ✓	Comments:
Undeveloped Land	Yes No ✓	Comments:

1 of 2

Lateral Stability: Refer to HEC-20, Section 2.3.9 on Channel Boundaries and Vegetation for channel bank stability. Comment:

Vertical Stability:

- streambed elevation change from as-built plans? Yes ✓ No ____
- exposed pier footings (degradation)? Yes ✓ No ____
- exposed abutment footings (degradation)? Yes ____ No ✓
- channel bank caving in (degradation)? Yes ____ No ✓
- eroding floodplain (aggradation)? Yes ____ No ✓
- crossing at confluence or tributaries? Yes ____ No ✓
- bridge sites upstream and downstream? Yes ____ No X Not in Vicinity
- grade or hydraulic controls, i.e. dams, weirs, diversions? Yes ____ No ✓
- foundation on rock Yes ____ No ✓
- channel armoring potential Yes ____ No ✓

Comments:

Stream Stability: Make a qualitative assessment of the overall stream stability by referring to the above information and Figure 2.6 and Table 3.2 from HEC-20 (attach copies of figures).

Stable ✓ Unstable ____ Degrading ____ Aggrading ____

Comments: Previous inspection unclear on soundings of footing exposure up to 2 feet (½ of height) of lower tier of footing exposed

RECOMMENDED NBIS ITEM 113 CODE: ____

LEVEL TWO ANALYSIS NEEDED: YES X NO ____

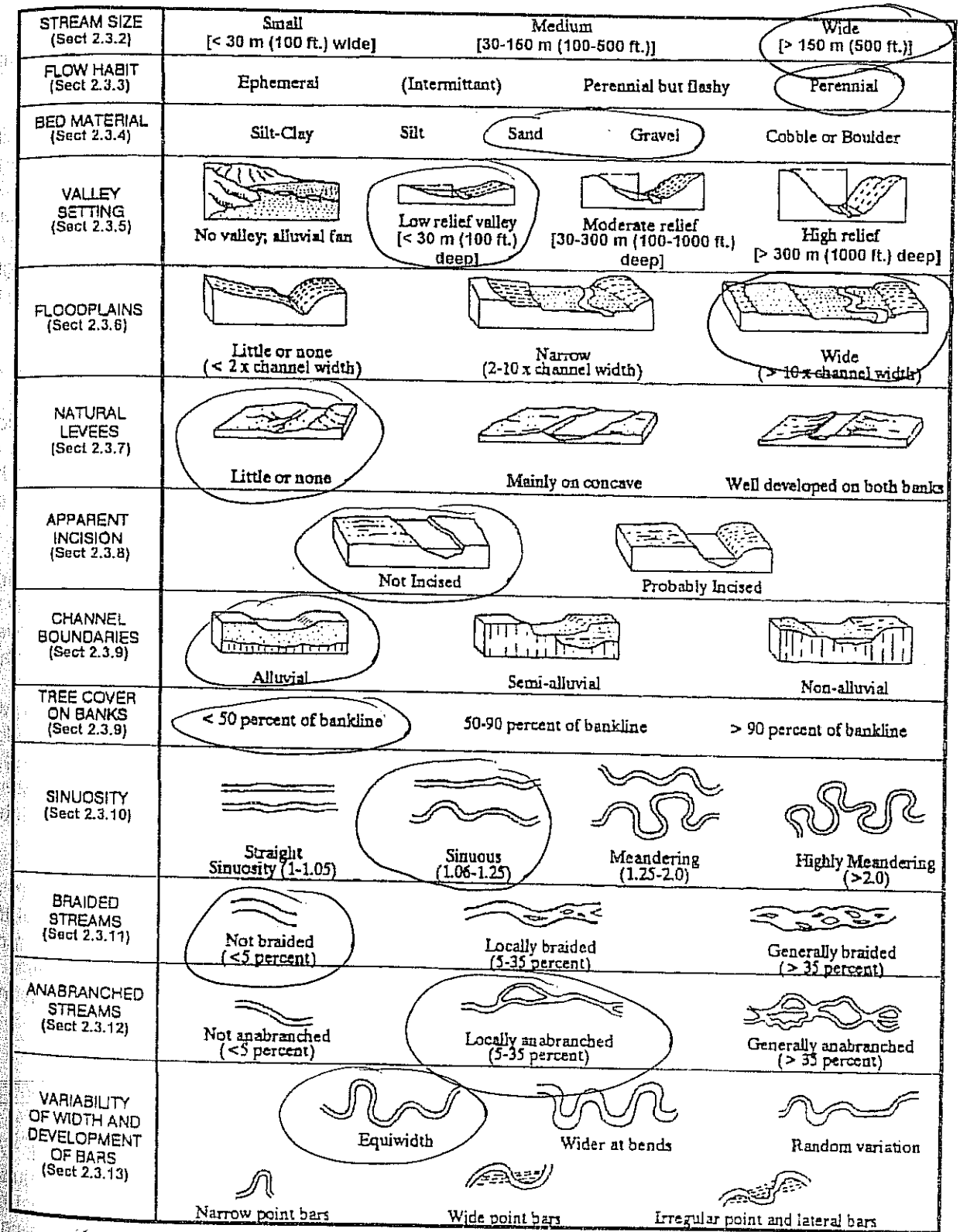

Figure 2.6. Geomorphic factors that affect stream stability (adapted from Brice and Blodgett).[10]

A: Detroit, MI

APPENDIX F

Cost Estimate Breakdown

ENGINEER'S COST ESIMATE BREAKDOWN

Item	Description	Quantity	Units	Unit Cost	Cost
1	Concrete Riprap (1ft-3ft Dia.)	1105	YD	75	$82,875.00
2	Labor & Equipment	-	-	-	$121,500.00
			Total Cost:		**$204,375.00**

Notes:

Item 1 - Approx. 65 Yards Per Pier x 17 Piers.
Item 2 - 2 Barges and 2 Crews. Includes Mob/Demob Costs.