

WATERFRONT FACILITIES INSPECTIONS AND ASSESSMENTS

NORTHERN INDIANA PUBLIC SERVICE COMPANY
MICHIGAN CITY, INDIANA

INSPECTION DATE: JUNE 14, 2018
REPORT DATE: JULY 12, 2018



Professional Certification. I hereby certify that these documents were prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Indiana, License No PE10910730, Expiration Date: July 31, 2018.

Signature: _____



Prepared for:

Northern Indiana Public
Service Company
101 Wabash St.
Michigan City, IN 46360

NIPSCO

Prepared by:

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**MARINE
SOLUTIONS**

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1. INTRODUCTION

Marine Solutions, Inc. conducted a routine inspection of approximately 1,350 linear feet of steel sheet pile bulkhead and 2,500 feet of adjacent shoreline protection for the Northern Indiana Public Service Company (NIPSCO) Michigan City Generation Station for Wood PLC (Wood) in Michigan City, Indiana on June 14th, 2018. The purpose of this inspection was to observe and report the above and below water conditions of the structural components comprising the bulkhead and adjacent shore protection.

The following paragraphs provide a description of the facility, inspection procedures, and results. Summarized results of this inspection are documented on the Structure Inspection Forms which are included in Appendix A. The figures, which illustrates the general configurations and adjacent depths around the bulkhead documented during the inspection, are included in Appendix B. Complete results of the ultrasonic thickness measurements for remaining sheet thicknesses are included in Appendix C.

1.1. Description of the Facility

The generation station is located in Michigan City, Indiana on the southern end of Lake Michigan. The Michigan City Generation Station is a coal and natural-gas fired power plant operated by NIPSCO. The waterfront facility consists of a steel sheet pile bulkhead measuring 1,350 linear feet along the northeast side of the station on Trail Creek and the shoreline protection along Lake Michigan on the west side of the property. Both facilities were stationed from north to south.

1.2. Inspection Procedures

The inspection was conducted utilizing a three-person inspection team led by a professional engineer. The inspection included an above and below water visual and tactile examination of the accessible sheets pile surfaces. The bulkhead and shoreline were stationed from north to south.

The inspected components were observed for signs of distress or deterioration including; damaged sheet pile interlocks, impact damage, cracks, corrosion, scour, loss of backfill material, and debris accumulation. Observed conditions, defects and observations were identified by station location and documented by notes and photographs. Non-destructive testing of sheet piles was performed using an ultrasonic thickness gauge to determine remaining thicknesses of steel. Measurements were taken near the water surface, at mid-depth, and near the mudline every 100 feet on submerged sheeting and at selected locations along the shore protection.

The structural elements were categorized by overall conditions ratings and element level severity ratings. The assigned ratings were based on the American Society of Civil Engineers, *Waterfront Facilities Inspection and Assessment*, Manual and Reports on Engineering Practice No. 130, June 2015. The rating criteria considered are presented in Tables 1-1 and 1-2.

Table 1-1 Overall Condition Assessment Rating Criteria

| ASSESSMENT RATING | DESCRIPTION |
|-------------------|---|
| "Good" | No visible damage or only minor damage noted. Structural elements may show very minor deterioration, but no overstressing observed. |
| "Satisfactory" | Limited Minor to moderate defects or deterioration observed but no overstressing observed. |
| "Fair" | All primary structural elements are sound but minor to moderate defects or deterioration observed. Localized areas of moderate to advanced deterioration may be present but do not significantly reduce the load-bearing capacity of the structure. |
| "Poor" | Advanced deterioration or overstressing observed on widespread portions of the structure but does not significantly reduce the load-bearing capacity of the structure. |
| "Serious" | Advanced deterioration, overstressing, or breakage may have significantly affected the load-bearing capacity of primary structural components. Local failures are possible, and loading restrictions may be necessary. |
| "Critical" | Very advanced deterioration, overstressing, or breakage has resulted in localized failure(s) of primary structural components. More widespread failures are possible or likely to occur, and load restrictions should be implemented as necessary. |

Table 1-2 Defect Assessment Rating Criteria (Steel Structures)

| ASSESSMENT RATING | DESCRIPTION |
|-------------------|--|
| "Severe" | Defect Significantly affects the integrity, function or load bearing capacity of the member including bending, buckling, breakage, or displacement. The member has lost critical functionality and load carrying capacity. |
| "Major" | Partial loss of section, visible reduction in thickness, or a loss of nominal thickness between 30 to 50 percent at any location. The member has lost some functionality and load carrying capacity. |
| "Moderate" | Over 50 percent of the surface affected by corrosion at any elevation or section with loss of thickness of 15 to 30 percent at any location. Defect may affect the function or loading bearing capacity of the member. |
| "Minor" | Less than 50 percent of the surface affected by corrosion at any elevation or cross section with loss of thickness up to 15 percent of nominal at any location. The integrity, function or load bearing capacity of the member is not affected at this time. |

2. INSPECTION RESULTS

The following table summarizes the inspection results, overall condition rating of each structure and prioritizes recommended actions and repairs. These priorities are based on the facility operator's perceived needs and should be reviewed against operational concerns and risk tolerances to determine the ultimate need and/or priority to support facility operations. As a guideline, recommendations considered high priority should be performed in the immediate or very near future. Medium priority recommendations should be performed prior to the next recommended inspection period based on criteria set forth in Section No. 3.3. Low priority recommendations should be considered for repair as part of a routine maintenance program with the timeframe decided upon based on need of the facility operator's. For a detailed discussion of conclusions and recommendations refer to Report Section No. 3. Additional details for each structure's configuration and observations are provided in the forms for each structure in Appendix A.

The repair recommendations each include a rough order of magnitude cost estimate to support budgetary planning. These estimates were prepared to consider all recommendations and support long range capital and maintenance budget planning. These estimates are based on assumed design and construction costs necessary to correct the recommended remedial actions. Actual costs are considered to be likely within a margin of 10 to 20 percent of these estimates. Actual labor and equipment rates assumed herein may vary beyond the contingencies considered depending on the location of the contractor, variations in equipment expenses, and means/methods of construction. Additional contingencies may be warranted depending on cost overrun sensitivity of project funding.

Table 2-1 Summary of Waterfront Facility Inspection Results

| STRUCTURE | PRIORITY | RECOMMENDATION |
|-----------------------------------|----------|--|
| Bulkhead Fair Condition | High | None |
| | Medium | Replace backfill in areas of washout Test for microbially induced corrosion (MIC) Replace tiebacks in areas where bulkhead is leaning outward. |
| | Low | Remove vegetation growing through weep holes Continue to monitor damage to the bulkhead as part of a routine inspection program |

Table 2-1 (Continued) Summary of Waterfront Facility Inspection Results

| STRUCTURE | PRIORITY | RECOMMENDATION |
|------------------------|----------|---|
| Shore Protection | High | None |
| | Medium | None |
| Satisfactory Condition | Low | Continue to monitor the shore protection as part of a routine inspection program. |

The above cost estimates consider performance performed concurrently with other repairs and does not include multiple mobilization costs for the equipment necessary to complete each individual task.

3. CONCLUSIONS AND RECOMMENDATIONS

The following sections discuss the conclusions, ratings and recommendations of each structure. Detailed observations and photos can be found within the Structure Inspection Forms in Appendix A.

3.1. Bulkhead

The bulkhead is in Fair condition. The sheet pile surfaces above water exhibit minor corrosion with pitting less than 1/16-inch deep and the surfaces below water typically exhibit minor to moderate corrosion over 100 percent of the surface area consisting of scaling up to 1/4-inch thick and pitting up to 1/16-inch deep. Water seepage is evident through the interlocks. Additionally, isolated areas of Microbial Induced Corrosion (MIC) are present on the sheeting.

Ultrasonic thickness testing on the bulkhead indicate that the sheet piles exhibit varying degrees of corrosion. Ultrasonic thickness testing indicated that greater than approximately 80 percent of the existing sheet pile section is remaining. Greater than 25 percent loss of section was measured at the mudline on the sheet piles between Sta. 7+00 to 8+75.

The bulkhead is leaning outward and/or out of plumb at sta. 3+95, 5+20 to 6+00 and 12+00 to 13+50. This indicates potential issues with the tiebacks and anchoring systems in these areas, however, this was unable to be confirmed as the anchoring systems are buried in earth behind the bulkhead. Additionally, the backfill is washed out to varying degrees between sta. 6+10 to 13+50.

3.2. Shore Protection

The shore protection is in Satisfactory Condition. The steel sheet pile bulkheads exhibited minor to moderate corrosion with evidence of water seepage between the interlocks on the inner bulkhead. Above the inner bulkhead, the backfill consists of gravel roads with containment ponds beyond the roads. The area between the bulkheads consists of sand with light vegetation and concrete rubble. Additionally, large stone rip rap has been placed along the outside of the outer bulkhead to provide additional protection from Lake Michigan. Three low areas with minimal scour protection were noted along the entire length between bulkheads. The shore protection should continue to be monitored and no repairs are recommended at this time.

3.3. Global Facility Recommendations

The bulkhead and shoreline protection mooring should be periodically inspected as part of a routine inspection program or following significant events such as severe impacts. Routine inspections are generally recommended not to exceed 5 years in periodicity for similar structures in Good Condition per guidelines presented in the American Society of Civil Engineers, *Waterfront Facilities Inspection and Assessment*, Manual and Reports on Engineering Practice No. 130, June 2015.

END OF REPORT

**Appendix A –
Structure
Inspection Forms**

| | | | | |
|---|---|---|--|-------------|
| STRUCTURE: | Bulkhead | | | |
| INSPECTION TYPE: | <input type="checkbox"/> Baseline <input checked="" type="checkbox"/> Routine <input type="checkbox"/> Special <input type="checkbox"/> Design | | | |
| LOCATION: | Trail Creek, northeast side of property | | | |
| WATER SURFACE ELEVATION: | 580.7 feet IGLD 1985 | | | |
| CONFIGURATION: | PILE SECTION: PDA32, PDA27 LENGTH: 1350 feet STATIONING: North to South TOP OF BULKHEAD ELEV.: 586 feet IGLD 1985 PILE TIP ELEV.: Unknown CAP: Steel Channel/None DECK: Gravel 0 to 6+10/Grass 6+10 to 13+50 BACKFILL: Unknown MOORING FITTINGS: None | | | |
| GENERAL CONDITIONS: | <input type="checkbox"/> Good <input type="checkbox"/> Satisfactory <input checked="" type="checkbox"/> Fair <input type="checkbox"/> Poor <input type="checkbox"/> Serious <input type="checkbox"/> Critical CORROSION: <input type="checkbox"/> Severe <input type="checkbox"/> Major <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Minor <input type="checkbox"/> N/A | | | |
| SPLIT INTERLOCKS: | <input type="checkbox"/> Yes/ <input checked="" type="checkbox"/> No | IMPACT DAMAGE: | <input checked="" type="checkbox"/> Yes/ <input type="checkbox"/> No | |
| HOLES: | <input checked="" type="checkbox"/> Yes/ <input type="checkbox"/> No | BROKEN MOORINGS: | <input type="checkbox"/> Yes/ <input checked="" type="checkbox"/> No | |
| LOSS OF BACKFILL: | <input checked="" type="checkbox"/> Yes/ <input type="checkbox"/> No | | | |
| LADDER DAMAGE: | <input type="checkbox"/> Yes/ <input checked="" type="checkbox"/> No | | | |
| PREVIOUS REPAIRS: None | | | | |
| OBSERVATIONS: | | SHEET PILE WEB THICKNESS READINGS: | | |
| Configuration: <ol style="list-style-type: none"> The bulkhead cap consists of a steel channel from Sta. 0+00 to 9+75. No cap was observed from Sta. 9+75 to the end at Sta. 13+50. Intake in the bulkhead from Sta. 8+82 to 9+10. Intake/outfall in the bulkhead from Sta. 9+90 to 10+05. Evidence of tiebacks was observed at 577.5 feet IGLD 1985 from Sta. 0+00 to 10+05. Wales consisting of two angles at 580.5 feet IGLD 1985 from sta. 10+05 to 13+50. Conditions: <ol style="list-style-type: none"> The channel bottom around the bulkhead consists of sand and silt. A moderate layer of aquatic growth consisting of zebra/quagga mussels typically measuring up to 1 inch thick was noted on submerged surfaces. The sheet pile surfaces above water exhibit minor corrosion with pitting less than 1/16-inch deep. The exposed steel surfaces below water typically exhibit minor to moderate corrosion over 100 percent of the surface area consisting of scaling up to 1/4-inch thick and pitting up to 1/16-inch deep. | | NOMINAL: 2 Sections (IN/% Nominal) | | |
| | | Flange (PDA32) Sta. 0+00 to 7+60 | Surface | 0.470/97.2% |
| | | | Mid-Depth | 0.433/89.5% |
| | | | Bottom | 0.447/92.4% |
| | | Web (PDA32) Sta. 0+00 to 7+60 | Surface | 0.355/94.6% |
| | | | Mid-Depth | 0.328/87.5% |
| | | | Bottom | 0.330/88.2% |
| | | Flange/Web (PDA27) Sta. 7+60 to 13+50 | Surface | 0.336/89.5% |
| | | | Mid-Depth | 0.314/83.9% |
| | | | Bottom | 0.317/84.4% |



PROJECT NO: 01-18-071
 CLIENT: NIPSCO
 SITE: Michigan City
 CREW: J. Guthrie, R. O'Keefe

PAGE: 2 of 5
 DATE: 06/14/2018

LEAD INSPECTOR:
 J. Loftus, P.E.

STRUCTURE: Bulkhead

ADDITIONAL OBSERVATIONS:

5. The steel sheet piles exhibit isolated areas of microbially induced corrosion (MIC).
6. The steel sheet piles exhibit minor impact damage of up to 2 inches of deflection throughout the bulkhead.
7. Evidence of water seepage through the sheet piles at interlocks was observed throughout.
8. Weep holes in the sheeting from Sta. 1+00 to Sta. 3+00 at 583.5 feet IGLD 1985 exhibit heavy corrosion with water seepage.
9. Roots growing through weep holes in the sheeting between Sta. 2+70 to Sta. 3+00.
10. Bulkhead leaning outward, up to 6 inches out of plumb, at Sta. 3+95 with a separation in the cap.
11. Area of impact damage 1.5 feet below the top of the cap at Sta. 4+90 measuring 1 foot by 1 foot with 4 inches of penetration.
12. Area of impact damage and a tear in the sheeting 3 feet below the top of the cap at Sta. 5+00 measuring 1 foot by 4 inches with 4 inches of penetration.
13. Bulkhead cap deflected upwards up to 5 inches between Sta. 5+20 to Sta. 6+00.
14. Area of impact damage 1.5 feet below the top of the cap at Sta. 7+00 measuring 2.5 feet by 2 feet with 6 inches of penetration.
15. Area of impact damage 2 feet below the top of the cap at Sta. 7+40 measuring 1 foot by 1 foot with 6 inches of penetration.
16. The wale is detached from the sheeting at Sta. 12+00.
17. Bulkhead leaning outward between Sta. 12+00 to 13+50.
18. The backfill is typically washed out between Sta. 6+10 to 13+50, measuring 6 inches to 1.5 feet below the top of the bulkhead.
19. The backfill is washed out between Sta. 8+50 to 8+75 measuring up to 2 feet below the top of the bulkhead.
20. The backfill is washed out between Sta. 11+50 to 12+50 measuring up to 4 feet below the top of the bulkhead.



Typical sheeting condition



Typical sheeting below water



Typical sheeting condition below water, growth removed

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CLIENT: NIPSCO
SITE: Michigan City
CREW: J. Guthrie, R. O'Keefe

PAGE: 3 of 5
DATE: 06/14/2018

LEAD INSPECTOR:
J. Loftus, P.E.

STRUCTURE: Bulkhead

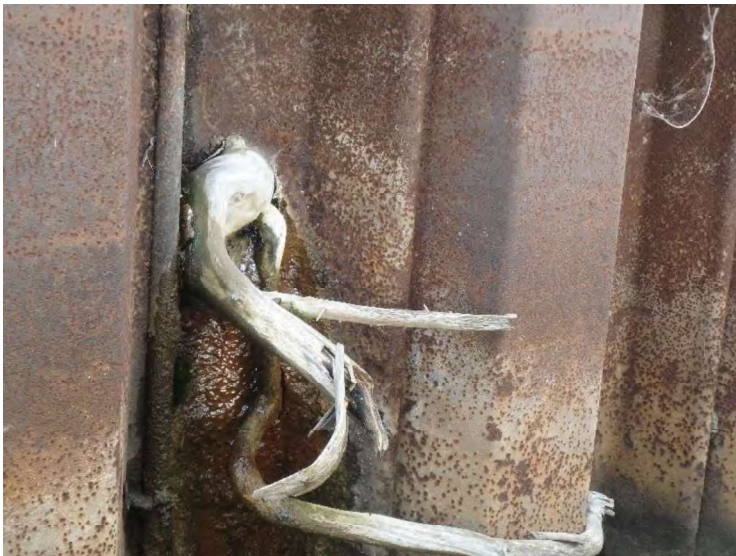
ADDITIONAL PHOTOS:



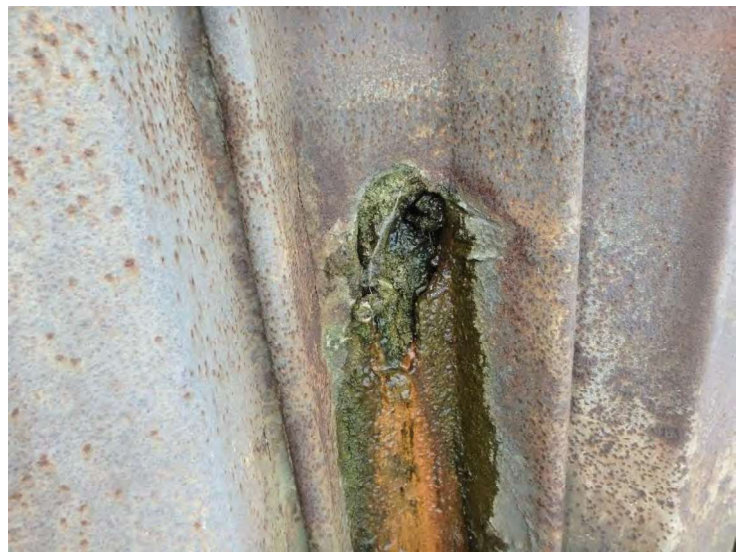
Tieback below water



Area of MIC on sheeting below water



Root growing in weep hole at Sta. 2+75



Corrosion at weep hole at Sta. 1+10

STRUCTURE: Bulkhead**ADDITIONAL PHOTOS:**

Bulkhead leaning outward and separation in the cap at Sta. 3+95



Area of impact damage at Sta. 4+90



Cap deflected upward at Sta. 6+00



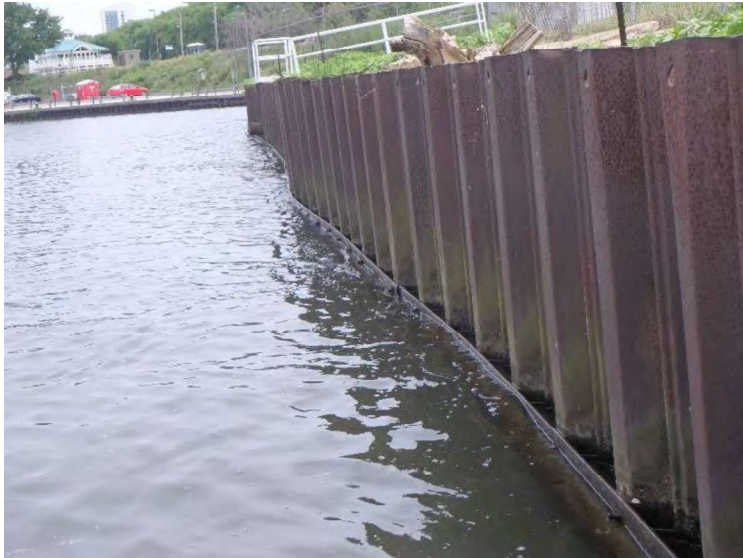
Area of impact damage at Sta. 7+00

STRUCTURE: Bulkhead**ADDITIONAL PHOTOS:**

Detached wale at Sta. 12+00



Detached wale at Sta. 12+00



Bulkhead leaning outward between Sta. 12+00 to 13+50




Washed out backfill at Sta. 12+00

MOORING CELL INSPECTION REPORT FORM

PROJECT NO: 01-18-071
 CLIENT: NIPSCO
 SITE: Michigan City
 CREW: J. Guthrie, R. O'Keefe

PAGE: 1 of 4
 DATE: 06/14/2018

LEAD INSPECTOR:
 J. Loftus, P.E.

| | | | | |
|--|--|--|--------|-------------|
| STRUCTURE: Shore Protection | |  | | |
| INSPECTION TYPE: <input type="checkbox"/> Baseline <input checked="" type="checkbox"/> Routine <input type="checkbox"/> Special <input type="checkbox"/> Design | | | | |
| LOCATION: Lake Michigan west side of property | | | | |
| WATER SURFACE ELEVATION: 580.7 feet IGLD 1985 | | | | |
| CONFIGURATION: | | | | |
| PILE SECTION: PDA27, PZ27, PZ38 LENGTH: 2500 feet STATIONING: North to South TOP OF BULKHEAD ELEV.: Outer Wall 585 feet IGLD 1984 PILE TIP ELEV.: Unknown CAP: None BACKFILL: Sand, Gravel, Concrete Rubble MOORING FITTINGS: None | | | | |
| GENERAL CONDITIONS: | | | | |
| <input type="checkbox"/> Good <input checked="" type="checkbox"/> Satisfactory <input type="checkbox"/> Fair <input type="checkbox"/> Poor <input type="checkbox"/> Serious <input type="checkbox"/> Critical | | CORROSION: <input type="checkbox"/> Severe <input type="checkbox"/> Major <input checked="" type="checkbox"/> Moderate <input type="checkbox"/> Minor <input type="checkbox"/> N/A | | |
| SPLIT INTERLOCKS: <input type="checkbox"/> Yes/ <input checked="" type="checkbox"/> No | | IMPACT DAMAGE: <input checked="" type="checkbox"/> Yes/ <input type="checkbox"/> No | | |
| HOLES: <input type="checkbox"/> Yes/ <input checked="" type="checkbox"/> No | | LOSS OF BACKFILL: <input checked="" type="checkbox"/> Yes/ <input type="checkbox"/> No | | |
| | | LADDER DAMAGE: <input type="checkbox"/> Yes/ <input checked="" type="checkbox"/> No | | |
| PREVIOUS REPAIRS: None | | | | |
| OBSERVATIONS: | | SHEET PILE WEB THICKNESS READINGS: | | |
| Configuration: | | NOMINAL: 3 Sections (IN/% Nominal) | | |
| <ol style="list-style-type: none"> The outer bulkhead consists of PDA27 steel sheet piles from Sta. 0+00 to 25+00 driven in the 1930-40's. The exterior, lakeside, of the outer bulkhead consists of large rip rap 5 to 6 feet in diameter along the entire length. The interior, shoreside, outer bulkhead has steel wales and tiebacks exposed along a majority of the bulkhead, typically at the ground line. The inner bulkhead consists of PZ27 steel sheet piles from Sta. 0+00 to 15+00 and PZ38 steel sheet piles from Sta. 15+00 to 25+00 driven in the 1970's. | | PDA27 Outer Bulkhead | Flange | 0.372/99.2% |
| | | | Web | 0.383/102% |
| | | PZ27 0+00 to 15+00 Inner Bulkhead | Flange | 0.364/97.1% |
| | | | Web | 0.374/99.7% |
| | | Flange (PZ38) 15+00 to 25+00 | Flange | 0.535/107% |
| | | | Web | 0.375/100% |
| Conditions: | | | | |
| <ol style="list-style-type: none"> The outer bulkhead sheet pile surfaces above water exhibit minor corrosion with no measurable pitting. The outer bulkhead sheet pile surfaces at the waterline typically exhibit minor to moderate corrosion over 100 percent of the surface area consisting of scaling up to 1/4-inch thick and pitting up to 1/16-inch deep. | | | | |
| | | | | |

STRUCTURE: Shore Protection

ADDITIONAL OBSERVATIONS:

3. The inner bulkhead sheet pile surfaces typically exhibit minor to moderate corrosion over 100 percent of the surface area consisting of pitting 1/32 to 1/16-inch deep.
4. The outer bulkhead sheet piles upper 6 inches exhibited impact damage of up to 2 inches of deflection due to driving.
5. The outer bulkhead tiebacks and wales are broken in several areas. This is not a structural issue since rip rap has been placed on the exterior of the bulkhead.
6. Several section of the upper 4 feet of sheets on the outer bulkhead have been removed in areas throughout the bulkhead to assist with drainage.
7. Evidence of water seepage through the inner bulkhead sheet piles at the interlocks was observed throughout.
8. A low area with no significant ground protection was observed between the bulkheads from Sta. 6+50 to 9+25.
9. A low area with no significant ground protection was observed between the bulkheads from Sta. 10+25 to 12+00.
10. A low area with no significant ground protection was observed between the bulkheads from Sta. 16+00 to 21+00.



Overview looking north



Overview of the inner bulkhead looking south



Typical outer bulkhead sheet pile condition above water

PROJECT NO: 01-18-071
 CLIENT: NIPSCO
 SITE: Michigan City
 CREW: J. Guthrie, R. O'Keefe

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 DATE: 06/14/2018

LEAD INSPECTOR:
 J. Loftus, P.E.

STRUCTURE: Shore Protection

ADDITIONAL PHOTOS:



Typical impact damage due to driving on the outer bulkhead



Typical condition of tiebacks and wales on the outer bulkhead



Removed sheet piles on the outer bulkhead for drainage



Typical inner bulkhead sheet pile condition

PROJECT NO: 01-18-071
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LEAD INSPECTOR:
 J. Loftus, P.E.

STRUCTURE: Shore Protection

ADDITIONAL PHOTOS:



Typical seepage through the sheet piles on the inner bulkhead



Low area between bulkheads from Sta. 6+50 to 9+25

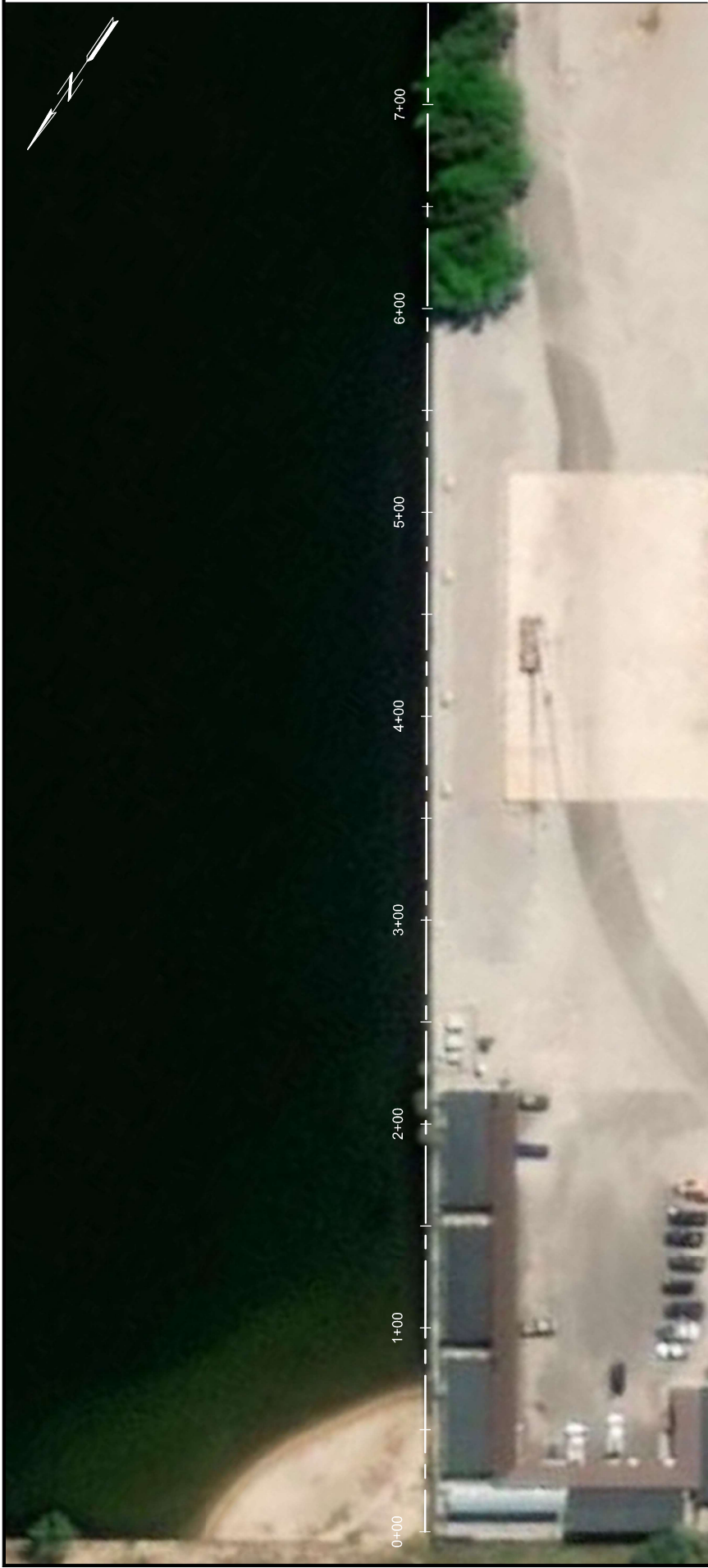


Low area between bulkheads from Sta. 10+25 to 12+00

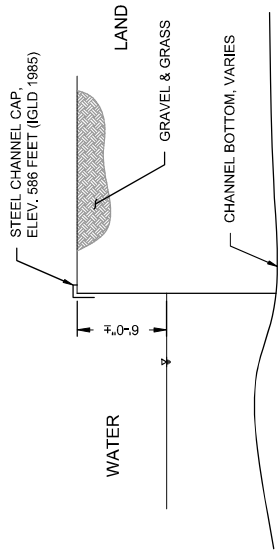


Low area between bulkheads from Sta. 16+00 to 21+00

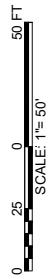
Appendix B – Figures



MATCHLINE REFER TO SHEET 2



TYPICAL SECTION
STA: 0+00 TO 9+75
N.T.S.

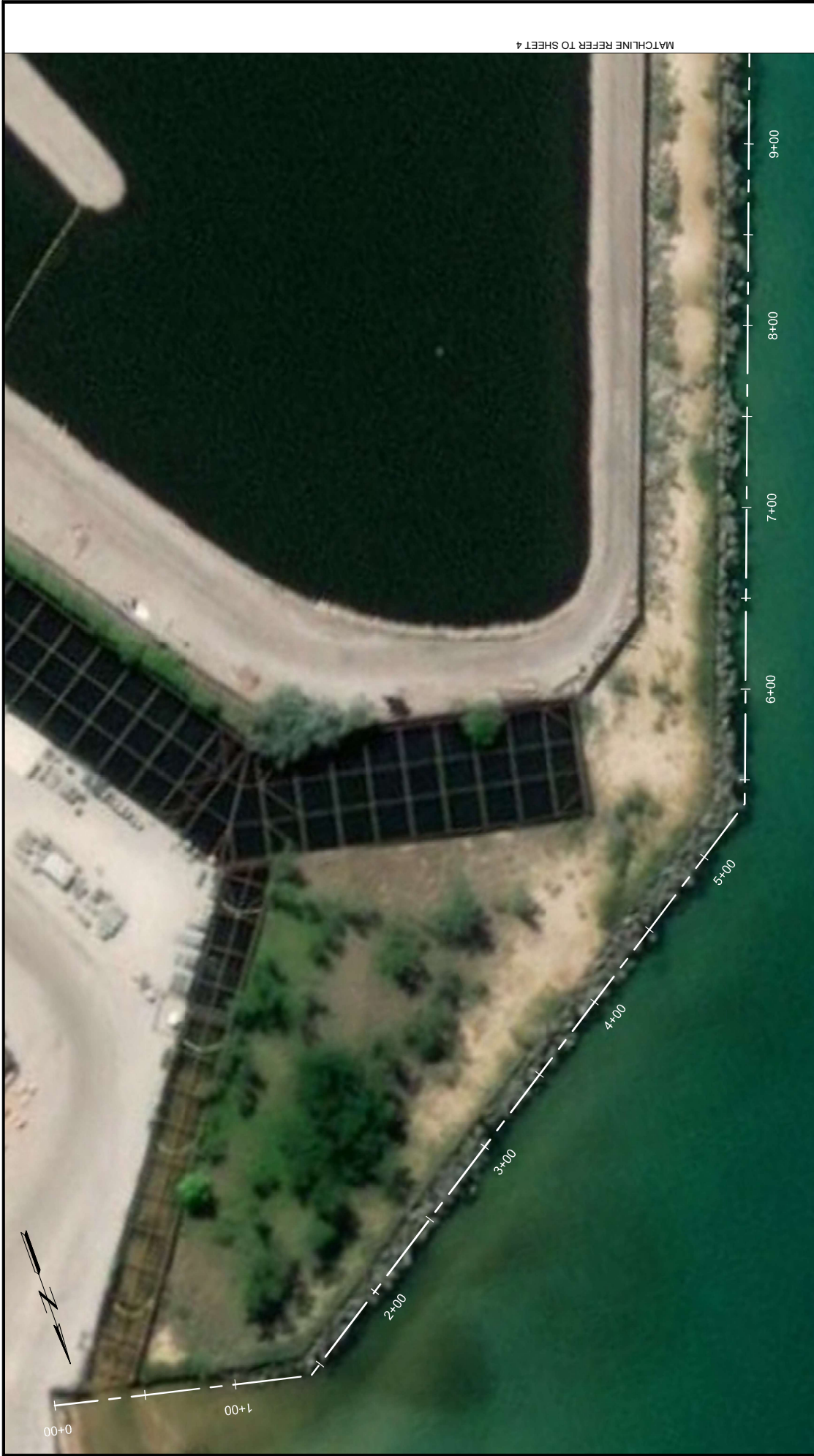


ON SITE: JUNE 14, 2018
PROJECT NUMBER
MSI 01-18-071

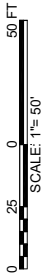
WATERFRONT STRUCTURE AND SHORELINE
INSPECTIONS
AMEC FOSTER WHEELER

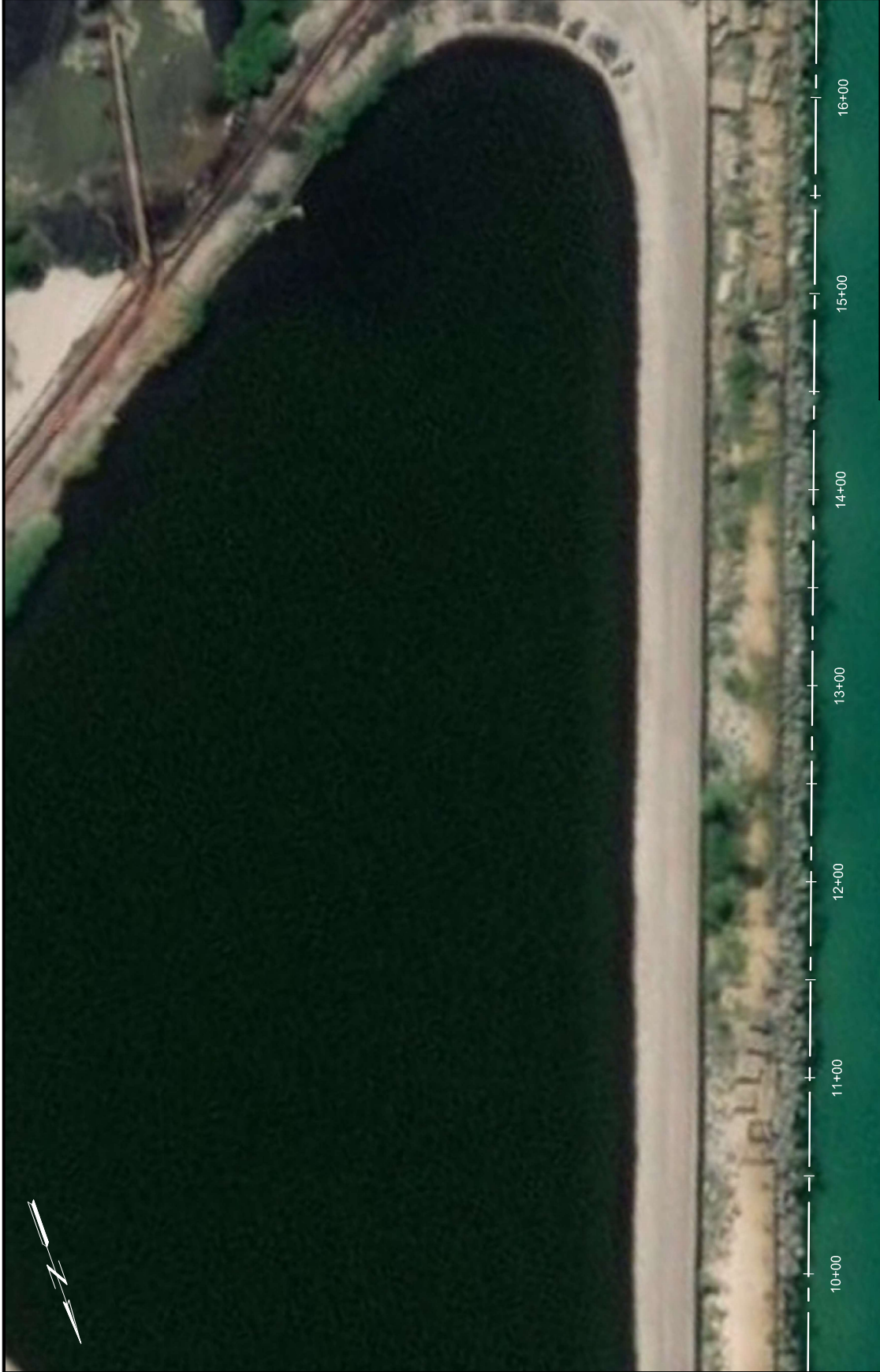
NORTHERN INDIANA
POWER MICHIGAN CITY
GENERATING STATION
MICHIGAN CITY, INDIANA
BULKHEAD PLAN

DWG NO
1



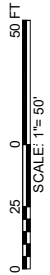
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| MARINE SOLUTIONS | | WATERFRONT STRUCTURE AND SHORELINE INSPECTIONS | |
| ON SITE: JUNE 14, 2018 | | AMEC FOSTER WHEELER | |
| PROJECT NUMBER MSI 01-18-071 | | NORTHERN INDIANA POWER MICHIGAN CITY GENERATING STATION MICHIGAN CITY, INDIANA SHORE PROTECTION PLAN | |
| | | DWG NO 3 | |

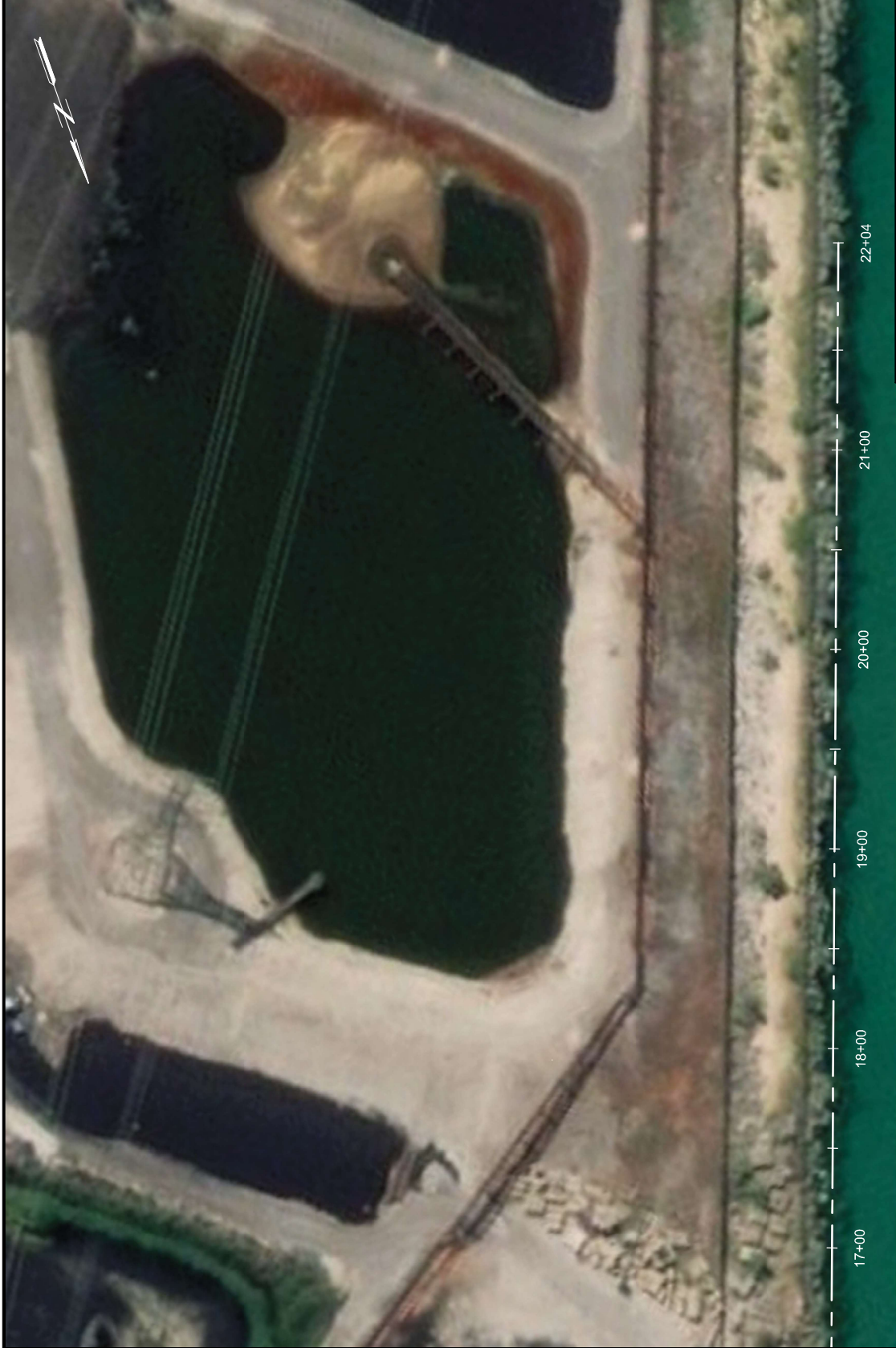




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| MARINE SOLUTIONS | |
| ONSITE: JUNE 14, 2018 | PROJECT NUMBER |
| | MSI 01-18-071 |

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| WATERFRONT STRUCTURE AND SHORELINE INSPECTIONS | |
| AMEC FOSTER WHEELER | |
| NORTHERN INDIANA POWER MICHIGAN CITY GENERATING STATION MICHIGAN CITY, INDIANA | DWG NO |
| SHORE PROTECTION PLAN | 4 |





MATCHLINE REFER TO SHEET 4



ON SITE: JUNE 14, 2018
PROJECT NUMBER
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WATERFRONT STRUCTURE AND SHORELINE
INSPECTIONS
AMEC FOSTER WHEELER

NORTHERN INDIANA
POWER MICHIGAN CITY
GENERATING STATION
MICHIGAN CITY, INDIANA
SHORE PROTECTION PLAN



DWG NO
5