



ADDRESS BTMI Engineering, P.C.  
276 Fifth Avenue  
Suite 1006  
New York, NY 10001

TEL 646-545-2125

FAX 203-268-8821

WWW [cowi-na.com](http://cowi-na.com)

DECEMBER 2017  
GREELEY AND HANSEN LLC

# SOUTHWEST BROOKLYN MARINE TRANSFER STATION BULKHEAD INVESTIGATION

ANNUAL BULKHEAD INSPECTION

PROJECT NO. A092286  
DOCUMENT NO.  
VERSION 4  
DATE OF ISSUE 12/28/2017 (Rev 1 – 02/26/2018)  
PREPARED SPWN  
CHECKED DDJS  
APPROVED JOAC

## EXECUTIVE SUMMARY

At the request of Greeley and Hansen LLC (G-H), BTMI Engineering, P.C. (COWI), formerly operating in New York as Ocean and Coastal Consultants Engineering, P.C., (OCC|COWI), performed an above and below water investigation of three bulkheads at the site of the Southwest Brooklyn Marine Transfer Station (SWB MTS), under construction in the Gravesend section of Brooklyn, New York. The purpose of the inspection was to perform a 100 percent Level I investigation on each of the three bulkheads at the SWB MTS, the three bulkheads are steel sheet pile shore retaining structures: The West Bulkhead (approximately 189 LF), the North Bulkhead (approximately 426 LF), and the East Bulkhead (approximately 144 LF). It should be noted that it is COWI's understanding that only the North Bulkhead will be utilized during barge operations once the SWB MTS is operational.

The bulkhead sections have been assigned an overall Condition Assessment Rating (CAR) of Fair due to widespread moderate to advanced corrosion of the steel in the tidal and splash zones and minor coating loss with surface corrosion to isolated areas of the below water steel sheet piles. Additional deterioration is present in isolated locations along the steel cellular cofferdams, which includes the typical above water corrosion described above, one hole in the West Bulkhead with exposed fill, isolated loose hardware, and isolated splash zone repair failures located below water. Areas of exposed epoxy coated steel reinforcement and/or poorly consolidated concrete were observed in the new partial concrete encasement repair of the North Bulkhead steel sheet piles. It is COWI's understanding that repair of this defect is underway.

The following recommendations have been developed based on the results of the inspection. Due to ongoing construction efforts, pursuant to the U.S. Army Corps of Engineer's (USACE) permit issued for the construction of the MTS (NAN-2009-00077), many of the recommendations may already be included within the scope of work for the North Bulkhead. It is COWI's understanding that the scope of work for the improvements to the North Bulkhead includes a concrete encasement of the existing North Bulkhead sheet pile wall and the installation of a new fendering system along the North Bulkhead

Table 1 SWB MTS Bulkhead Repair Recommendations

Structure	Recommendation
North Bulkhead	<p>Re-form and pour, or patch, the areas of exposed epoxy coated steel reinforcement and/or poorly consolidated concrete in the new partial concrete encasement repair of the North Bulkhead steel sheet piles. Additionally, all existing and future hardware penetrations into the reinforced concrete matrix should be sealed watertight via non-shrink grout or splash zone epoxy patches. It is COWI's understanding that the onsite contractor is in the process of repairing the observed defects.</p>
	<p>Clean and patch exposed steel sheet pile bulkhead below concrete encasement with splash zone epoxy during a future bulkhead maintenance project, after this scope of work is completed.</p>
	<p>Clean and recoat the exposed portions of the double channel tie-back wale. It is our understanding that the entire length of the North Bulkhead is scheduled to be encased in concrete, pursuant to the USACE permit NAN-2009-00077. This repair is currently in the process of being installed. Once the installation of the encasement repair is complete, it would adequately address this recommendation for that section of bulkhead.</p>
	<p>Clean and recoat the exposed portions of the steel anchor tie-backs and associated hardware. It is our understanding that the entire length of the North Bulkhead is scheduled to be encased in concrete, pursuant to the USACE permit NAN-2009-00077. This repair is currently in the process of being installed. Once the installation of the encasement repair is complete, it would adequately address this recommendation for that section of bulkhead.</p>
	<p>Clean and recoat the steel sheet pile cells from MLW to the top of the element at each cell. Additionally, the splash zone repairs located below MLW should be cleaned and patched, as required. Where splash zone coating failures have occurred, the exposed steel should be assessed by a qualified professional to determine if structural repairs are required.</p>
East Bulkhead	<p>Clean and recoat the steel sheet piles from MLW to the top of the element.</p>
	<p>Clean and recoat the double channel tie-back wale.</p>
	<p>Clean and recoat the exposed portions of the steel anchor tie-backs and associated hardware.</p>
	<p>Remove the existing timber fender system to reduce the dead load on the steel sheet piles, and provide access to the steel sheet pile bulkhead should cleaning and recoating repairs be necessary.</p>
	<p>Clean and patch the end of the concrete wall at Station 0+14.</p>
	<p>Clean and patch the observed open spalling located at Station 0+66.</p>

Table 1 cont. SWB MTS Bulkhead Repair Recommendations

Structure	Recommendation
West Bulkhead	Clean and recoat steel sheet piles from MLW to the top of the element.
	Clean and recoat the steel sheet pile cells from Mean Low Water (MLW) to the top of the element at each cell. Additionally, the splash zone repairs located below MLW should be cleaned and patched, as required. Where splash zone coating failures have occurred, the exposed steel should be assessed by a qualified professional to determine if structural repairs are required.
	Install and coat a steel patch plate (approximately 12 inches by 12 inches) over the approximate 6 inch diameter hole observed at the intermediate cell adjacent to Cell F-1 at the West Bulkhead.
	Repair the loose transition anchor bracket connection between the West Bulkhead and the intermediate cell adjacent to Cell F-1. This repair will require the bearing plate to be realigned, and the nut to be tightened.
Facility	Install a bulk anode cathodic protection system along each of the three bulkheads. It is our understanding that an impressed current cathodic protection system is scheduled to be installed along the North Bulkhead, pursuant to the USACE permit NAN-2009-00077. That would adequately address this recommendation for this section of bulkhead.

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# 1 INTRODUCTION

At the request of Greeley and Hansen LLC (G-H), BTMI Engineering, P.C. (COWI), formerly operating in New York as Ocean and Coastal Consultants Engineering, P.C. (OCC|COWI), performed an above and below water investigation of three bulkheads at the former Southwest Brooklyn Marine Transfer Station (SWB MTS), located in Brooklyn, New York. The inspection was performed on December 21, 2017 by a three-person Engineer Dive Team using surface supplied commercial diving equipment. The purpose of the inspection was to perform a 100 percent Level I investigation on each of the three steel sheet pile shore retaining structures: The West Bulkhead (Approximately 189 LF), the North Bulkhead (Approximately 426 LF), and the East Bulkhead (Approximately 144 LF). The level of sand fill within the bulkheads' cellular cofferdams, if accessible, was to be observed and measured. The investigation was performed in general accordance with ASCE Underwater Investigation Practice Manual No. 101, and in accordance with OSHA requirements.

A figure set was developed for the MTS bulkhead (Appendix A), and representative photographs were collected to detail the observed conditions (Appendix B). The MTS bulkhead was given an overall Condition Assessment Rating (CAR), as was each section of bulkhead inspected as part of this investigation (Appendix C). Finally, sand elevation measurements were collected at ten cofferdam access ports along the North Bulkhead, per DEC Permit Special Conditions item 24-ii requirements (Appendix D). A structural analysis was not included in this scope of work.

## 2 DESCRIPTION OF STRUCTURES

The former Southwest Brooklyn Marine Transfer Station (MTS) is located on the south shore of Brooklyn, New York, west of Coney Island (Sketch 1). The former MTS facility is not currently in use, however the site was formerly used for the transfer of solid waste from trucks onto barges. At the time of the inspection, construction was in progress, inshore of the steel sheet pile bulkhead (Photograph 1 and Photograph 2). The bulkhead at the MTS facility is comprised of the North, East, and West Bulkheads, which form a square peninsula along the shoreline (Sketch 2).

### 2.1 North Bulkhead

The North Bulkhead is located along the offshore face of the facility, and is parallel to the waterway (Photograph 6). This section of bulkhead intersects the northeast end of the North Pier, and extends south for approximately 426 LF. The northern section of the North bulkhead comprises steel sheet pile cells forming cellular cofferdams (approximately 75 LF) (Photograph 7), which transitions to Z-shape steel sheet piles to the south (approximately 351 LF) (Photograph 8). The steel sheet pile portion of the North Bulkhead is tied back with a series of steel anchor rods, which are attached to an external double channel wale (Photograph 9). The steel anchor rod tie-backs for the North Bulkhead are presumably connected to a deadman system, located inshore of the bulkhead. However, details of the inshore portions of the tie-back system are not known. Additionally, the existing sheet pile was reportedly installed as oversheeting, outboard of the original steel sheet pile cells.

Approximately 234 LF of concrete deck and curb was demolished during construction of a new deck, inshore of the steel sheet pile bulkhead (Photograph 10). A reinforced concrete bulkhead was installed, approximately 3 LF inshore of the existing steel sheet pile bulkhead (Photograph 11). The annulus between these structures was partially filled with concrete prior to the 2016 inspection, typically up to the anchor rod elevation, excluding one 7 LF segment, located between Sta. 1+97 and Sta. 1+90, where the reinforced bulkhead extends to the face of the steel sheet pile bulkhead (Photograph 12). Additionally, epoxy coated reinforcement was installed between 2015 and 2016 and embedded into the new concrete bulkhead along this segment of demolished bulkhead (Photograph 13). The remainder of the annulus has been filled and the epoxy coated reinforcement was formed and poured to create a new concrete deck surface inshore of the steel sheet pile bulkhead. The nearly completed concrete deck is

equipped with new mooring hardware which is still in the process of being constructed (Photograph 14).

The bulkhead to the south of this area (Sta. 0+96 to Sta. 0+00) remains, excluding a 39 inch by 20 inch section of deck and curb where the North and East Bulkheads intersect. This section of deck and curb was removed prior to the 2016 inspection to accommodate the installation of a transition element between the North and East bulkheads and the steel sheet pile fender and revetment retaining structure, which extends to the west (Photograph 15 and Photograph 16).

Construction has occurred above and below water along the full length of the offshore face of the North Bulkhead. At each outer and inner flange, typically six (6) to seven (7) elevations of shear bolts were installed. The shear bolts are typically grouped in four (4) bolt clusters, excluding the upper cluster which is only two (2) bolts, beginning at the top of the bulkhead (Photograph 17 and Photograph 18). Typically, two (2) clusters are present above the wale system, and two (2) clusters are present below the wale system. At the northern extent of the steel sheet pile bulkhead, threaded rods and steel brackets were present at each offshore double section but have since been encased in concrete (Photograph 19 and Photograph 20). These elements were utilized as a part of the partial concrete encasement of the steel sheet pile bulkhead, wale, and anchor rods, which currently extends from Sta. 3+25 to Sta. 0+30 (Photograph 21 through Photograph 23). The encasement is typically 18 inches thick from the deck elevation extending down 5 feet to cover the existing steel wale. At the bottom of the cap the encasement reduces in thickness to approximately 11 inches, extending down an addition 6.5 feet. The encasement terminates approximately 3 feet below MLW.

## 2.2 East Bulkhead

The East Bulkhead intersects the southern extent of the North Bulkhead, and returns inshore, to the east, approximately 144 LF (Photograph 24). Typically, the bulkhead is composed of Z-shaped steel sheet piles with an external double channel wale, which is secured with a series of steel anchor rods. As stated above, new steel sheet piles that extend west from the intersection between the East and North Bulkheads, are retaining the stone revetment to the south, and providing fendering to the north (Photograph 25). Additionally, the eastern 14 LF of bulkhead is partially demolished with the concrete deck and curb removed (Photograph 26).

The steel anchor rod tie-backs for the East Bulkhead are presumably connected to a deadman system, located inshore of the bulkhead. However, details of the inshore portions of the tie-back system are not known. Additionally, the existing sheet pile was reportedly installed as overshooting outboard of the original steel sheet pile cells.

## 2.3 West Bulkhead

The West Bulkhead extends from the shoreline to the west for approximately 189 LF, and is composed of Z-shape steel sheet piles for the eastern 164 LF (Photograph 3). The western 25 LF of the West Bulkhead is constructed of steel sheet pile cells (Photograph 4), and are within the scope of this inspection. To the west of the West Bulkhead, and outside of the scope of this inspection, the steel sheet pile cellular cofferdams continue along the North Pier (Photograph 5).



## 2.4 Fender System

The fender system observed during previous inspection efforts has been removed from the North Bulkhead. Remnants of the removed fender system were observed along the mudline offshore of the North Bulkhead. The fender system is still present along the offshore face of the East Bulkhead. The East Bulkhead fender system consists of 6 inch by 12 inch fender planks, two (2) elevations of 12 inch by 12 inch timber wales, and steel brackets, which tie the system back to the steel sheet pile bulkhead (Photograph 27).

### 3 OBSERVED CONDITIONS

The bulkhead sections are in overall Fair condition with widespread moderate to advanced corrosion of the steel in the tidal and splash zones. Minor to moderate coating loss and surface corrosion was observed in isolated areas below MLW.

Notable defects were observed in the newly constructed partial concrete encasement of the North Bulkhead steel sheet piles. Poor consolidation of the concrete and exposed reinforcement were observed intermittently from approximately 2 feet above MLW to the bottom of the partial encasement, along its full length.

Additional deterioration is present in isolated locations along the steel cellular cofferdams, which includes the typical above water corrosion described above, one hole in the West Bulkhead with exposed fill, isolated loose hardware, and isolated splash zone repair failures located below water. Though the site is protected from direct ocean swells by Coney Island, it is open to the southwest, across Lower New York Bay. Waves up to two (2) feet have been observed at the site.

#### 3.1 North Bulkhead

The North Bulkhead is in Fair condition due to moderate to advanced corrosion and coating failure located within the splash and tidal zones of the steel sheet piles in the sections still pending partial concrete encasement, the sections of exposed steel anchor tie-backs, and the steel cellular cofferdams (Photograph 34). Additionally, the partial concrete encasement of the steel sheet piles exhibits intermittent areas of exposed epoxy coated steel reinforcement due to poor consolidation of the concrete during the pouring process. The observed deteriorated is located along the bottom of the partial concrete encasement, and along the full length of the vertical cold joints (Photograph 35 through Photograph 37).

The formwork for this partial encasement was held in place by threaded rods anchored to the steel sheet piles that penetrated through, terminating with backing plates and compression nuts. The penetrations through the concrete encasement were not sealed after the forms were removed, which could result in accelerated deterioration of the concrete and any exposed steel reinforcement due to saltwater intrusion (Photograph 38).

The steel sheet pile bulkhead is typically in moderate condition below the partial concrete encasement, with isolated areas of failed coating and surface corrosion (Photograph 39). The steel sheets exhibit moderate to advanced corrosion from the tidal zone to the splash zone in the areas still pending encasement in concrete (Photograph 40), and isolated coating loss and splash zone failures with surface corrosion on the steel sheet pile cellular cofferdams (Photograph 41).

The mooring hardware in place between Sta. 0+96 and 0+00 are in moderate condition with coating loss and corrosion deterioration (Photograph 42). The recently installed mooring hardware between 0+96 and 3+30 is in minor condition with some light abrasion likely incurred during the installation process (Photograph 43).

The cellular cofferdam access hatches, located inshore of the rehabilitated steel sheet pile bulkhead, which was previously installed as overshooting for the cofferdams, were accessible during the inspection and sand levels were collected (See Photographs 44 and 45). At each access hatch the sand elevation was contained within the access port, meaning the cofferdam interior was not visible, and the elevation within the cofferdam, rather than within the access port, could not be confirmed. Since the interior cofferdam sand elevation could not be confirmed, the inspection results could not be used to make a determination in regards to the DEC Permit Special Conditions Section 24-ii. Access hatch inspection results are provided in Appendix D.

## 3.2 East Bulkhead

Overall, the East Bulkhead is in Fair condition due to moderate corrosion and coating failure located within the splash and tidal zone of the steel sheet piles and of the steel anchor tie-backs (Photograph 46 and Photograph 47), and isolated spalling of the concrete cap (Photograph 48). Below MLW, the steel sheet pile bulkhead is typically sound with isolated areas of failed coating and surface corrosion. The external double channel wale has 100 percent coating loss with moderate corrosion (Photograph 49).

## 3.3 West Bulkhead

Overall, the West Bulkhead is in Poor condition due to an isolated hole within the intermediate cell adjacent to Cell F-1 noted during the 2016 inspection, a loose bracket at the cell-to-bulkhead intersection, moderate corrosion and coating failure located within the splash and tidal zones of the steel sheet piles and cellular cofferdams (Photograph 28 through Photograph 30). Below MLW, the steel sheet pile bulkhead is typically in moderate condition with isolated areas of failed coating and surface corrosion (Photograph 31), and isolated coating loss and splash zone failures with surface corrosion on the steel sheet pile cellular cofferdams (Photograph 32). The steel sheet pile cellular cofferdams, located at the western extent of the bulkhead, have been repaired with a splash zone coating along the exposed face of the sheets, extending from the mudline to approximately mean high water. Additionally, the missing steel pile cap section, located at the western edge of the Z-shape steel sheet pile bulkhead, noted during the previous inspection is still missing (Photograph 33).

### 3.4 Fender System

The fender system along the North Bulkhead has been removed, and is scheduled to be replaced. The East Bulkhead fender system is in Serious condition due to rot and weathering at the upper wale and at the top foot of the timber planks (Photograph 50).

## 4 REPAIR RECOMMENDATIONS

COWI has developed recommendations for repairs in order to maintain the structural integrity and service life of the three bulkheads. Additionally, COWI recommends the repairs be carried out within the next year, unless otherwise stated, to minimize the potential for facility limitations or load restrictions. Due to ongoing construction efforts, many of the recommendations may already be included within the current scope of work for the North Bulkhead, which is the only bulkhead that will be utilized during barge operations when the SWB MTS is operational.

### North Bulkhead

- › Re-form and pour, or patch, the areas of exposed epoxy coated steel reinforcement and/or poorly consolidated concrete in the new partial concrete encasement repair of the North Bulkhead steel sheet piles. Additionally, all existing and future hardware penetrations into the reinforced concrete matrix should be sealed watertight via non-shrink grout or splash zone epoxy patches. It is COWI's understanding that the onsite contractor is in the process of repairing the observed defects.
- › Clean and recoat all steel sheet piles from MLW to top of pile at each of the North Bulkhead. It is our understanding that the entire length of the North Bulkhead is scheduled to be encased in concrete, pursuant to the USACE permit NAN-2009-00077. This repair is currently in the process of being installed. Once the installation of the encasement repair is complete, it would adequately address this recommendation for that section of bulkhead.
- › Clean and patch exposed steel sheet pile bulkhead below concrete encasement with splash zone epoxy during a future bulkhead maintenance project, after this scope of work is completed.
- › Clean and recoat the double channel tie-back wale where exposed along the North Bulkhead. It is our understanding that the entire length of the North Bulkhead is scheduled to be encased in concrete, pursuant to the USACE permit NAN-2009-00077. This repair is currently in the process of being installed. Once the installation of the encasement repair is complete, it would adequately address this recommendation for that section of bulkhead.
- › Clean and recoat the exposed portions of the steel anchor tie-backs and associated hardware where exposed along the North Bulkhead. It is our understanding that the entire length of the North Bulkhead is scheduled to be

encased in concrete, pursuant to the USACE permit NAN-2009-00077. This repair is currently in the process of being installed. Once the installation of the encasement repair is complete, it would adequately address this recommendation for that section of bulkhead.

- › Clean and recoat the steel sheet pile cells from MLW to the top of the element at each cell. Additionally, the splash zone repairs located below MLW should be cleaned and patched, as required. Where splash zone coating failures have occurred, the exposed steel should be assessed by a qualified professional to determine if structural repairs are required.
- › Install a bulk anode cathodic protection system along each of the North Bulkhead. It is our understanding that an impressed current cathodic protection system is scheduled to be installed along the North Bulkhead, pursuant to the USACE permit NAN-2009-00077. That would adequately address this recommendation for those sections of bulkhead.

### **East Bulkhead**

- › Clean and recoat all steel sheet piles from MLW to top of pile at each of the East Bulkhead.
- › Clean and recoat the double channel tie-back wale where exposed along the East Bulkhead.
- › Clean and recoat the exposed portions of the steel anchor tie-backs and associated hardware where exposed along the East Bulkhead.
- › Remove the timber fender system located along the East Bulkhead to reduce the dead load on the steel sheet piles, and provide access to the steel sheet pile bulkhead should cleaning and recoating repairs be necessary.
- › Clean and patch the end of the concrete wall at East Bulkhead Station 0+14.
- › Clean and patch the observed open spalling located at East Bulkhead Station 0+66. If this segment of bulkhead is scheduled to be removed as a part of the ongoing construction efforts, this recommendation is not required.
- › Install a bulk anode cathodic protection system along each of the East Bulkhead.

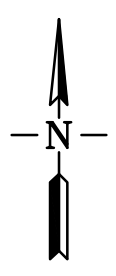
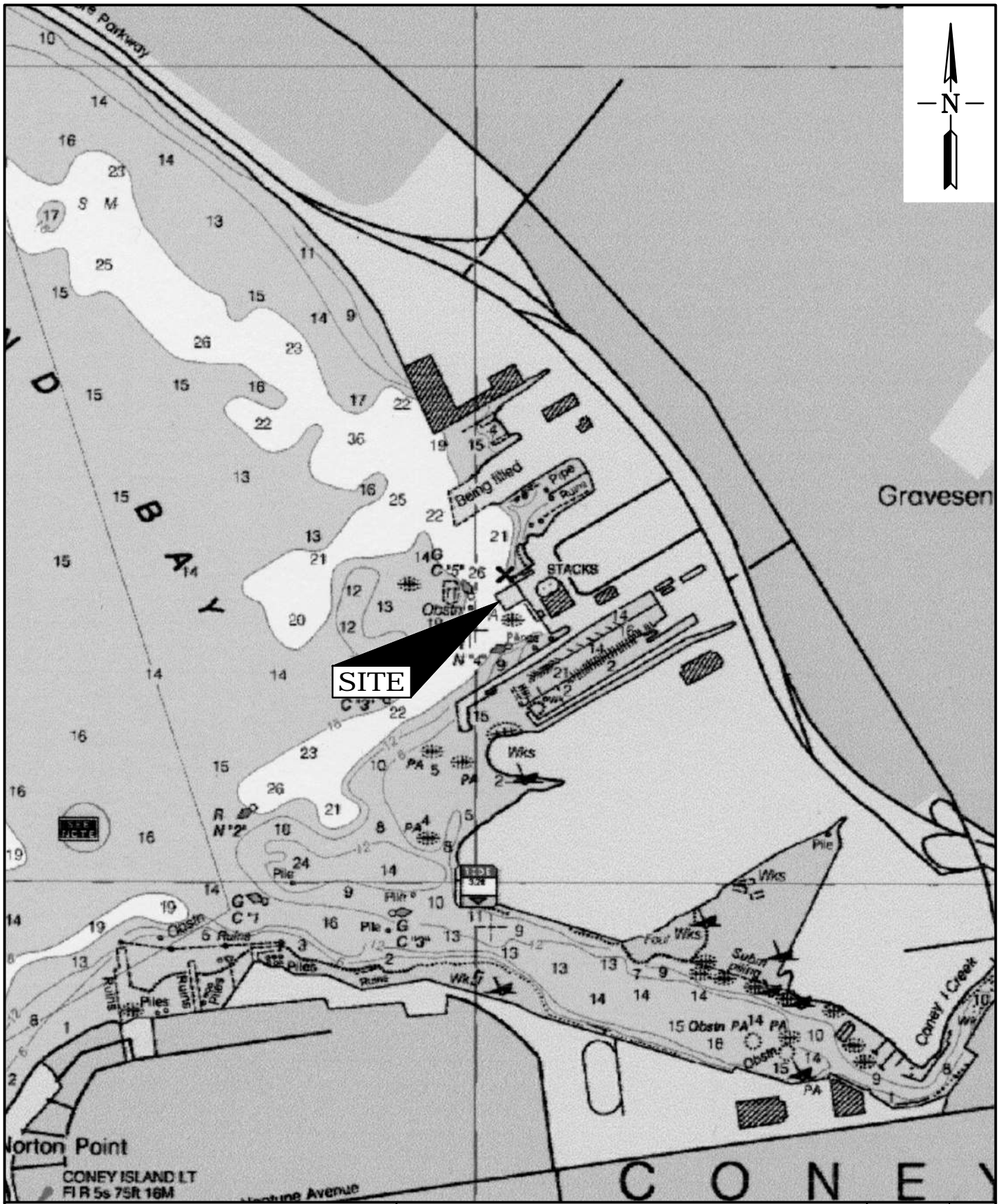
### **West Bulkhead**

- › Clean and recoat all steel sheet piles from MLW to top of pile at each of the West Bulkhead.
- › Clean and recoat the steel sheet pile cells from MLW to the top of the element at each cell. Additionally, the splash zone repairs located below MLW should be cleaned and patched, as required. Where splash zone coating failures have occurred, the exposed steel should be assessed by a qualified professional to determine if structural repairs are required.
- › Install and coat a steel patch plate (12 inches by 12 inches) over the approximate 6 inch diameter hole observed at the intermediate cell adjacent to Cell F-1 at the West Bulkhead.
- › Repair the loose transition anchor bracket connection between the West Bulkhead and intermediate cell adjacent to Cell F-1. This repair will require the bearing plate to be realigned, and the nut to be tightened.
- › Install a bulk anode cathodic protection system along each of the West Bulkhead.

## Appendix A Figure Set



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**SITE**

**BTMI** | **COWI**  
 BRIDGE TUNNEL MARINE  
 A New York State Registered Company

DESIGNED BY: DDJS    DRAWN BY: REBU    CHECKED BY: JOAC

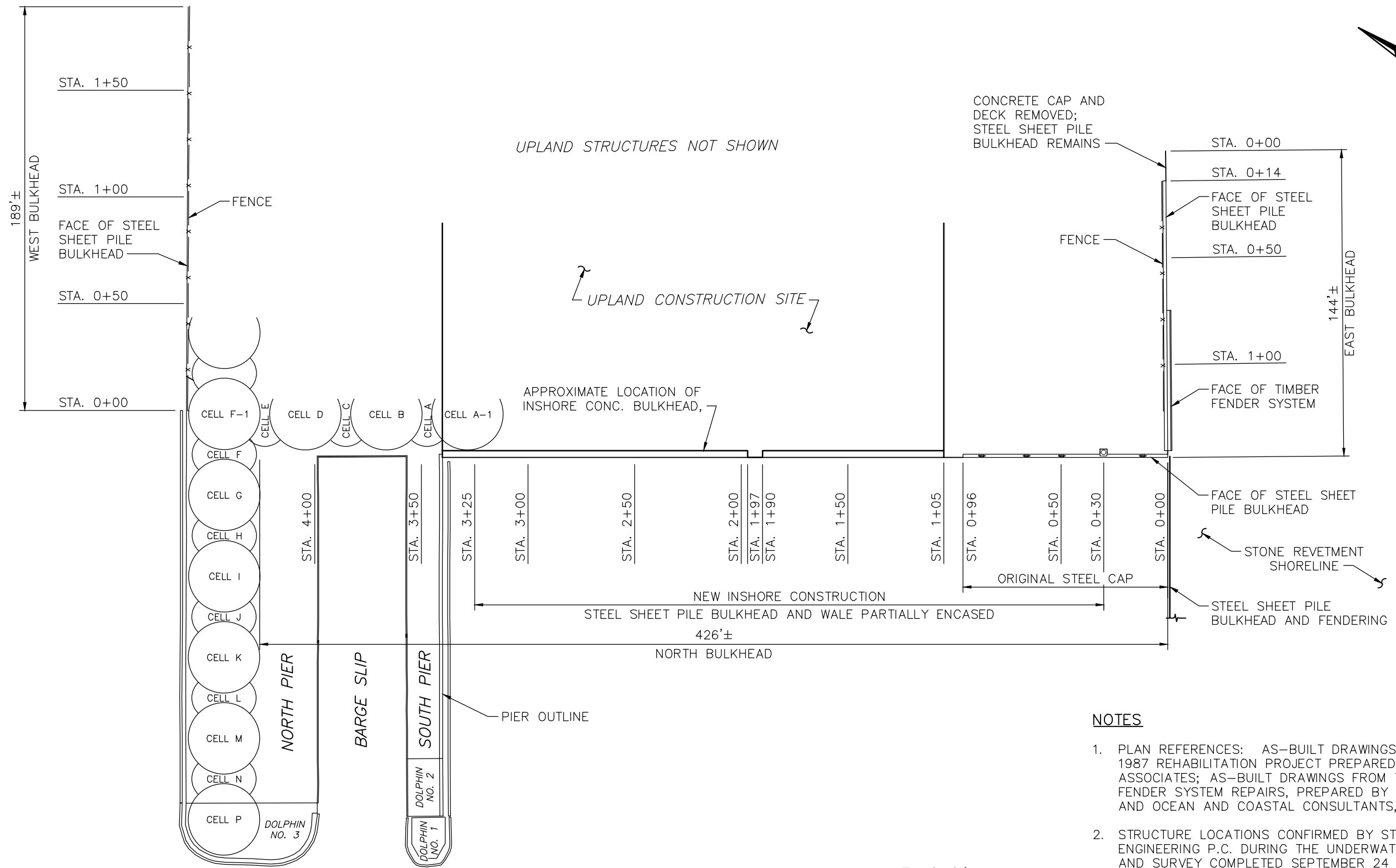
SOUTH WEST BROOKLYN  
 MARINE TRANSFER STATION

VICINITY MAP

SCALE N.T.S.	REVISION
DATE 12/27/17	
SKETCH NO. SK-01	



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GRAVESEND BAY

NOTES

1. PLAN REFERENCES: AS-BUILT DRAWINGS FROM THE 1987 REHABILITATION PROJECT PREPARED BY SOROS ASSOCIATES; AS-BUILT DRAWINGS FROM THE 1993 FENDER SYSTEM REPAIRS, PREPARED BY ATOMETRICS AND OCEAN AND COASTAL CONSULTANTS, INC.
2. STRUCTURE LOCATIONS CONFIRMED BY STANLEY WHITE ENGINEERING P.C. DURING THE UNDERWATER INSPECTION AND SURVEY COMPLETED SEPTEMBER 24 THRU OCTOBER 7, 2003.

**BTMI** | **COWI**  
 BRIDGE TUNNEL MARINE  
 A New York State Registered Company

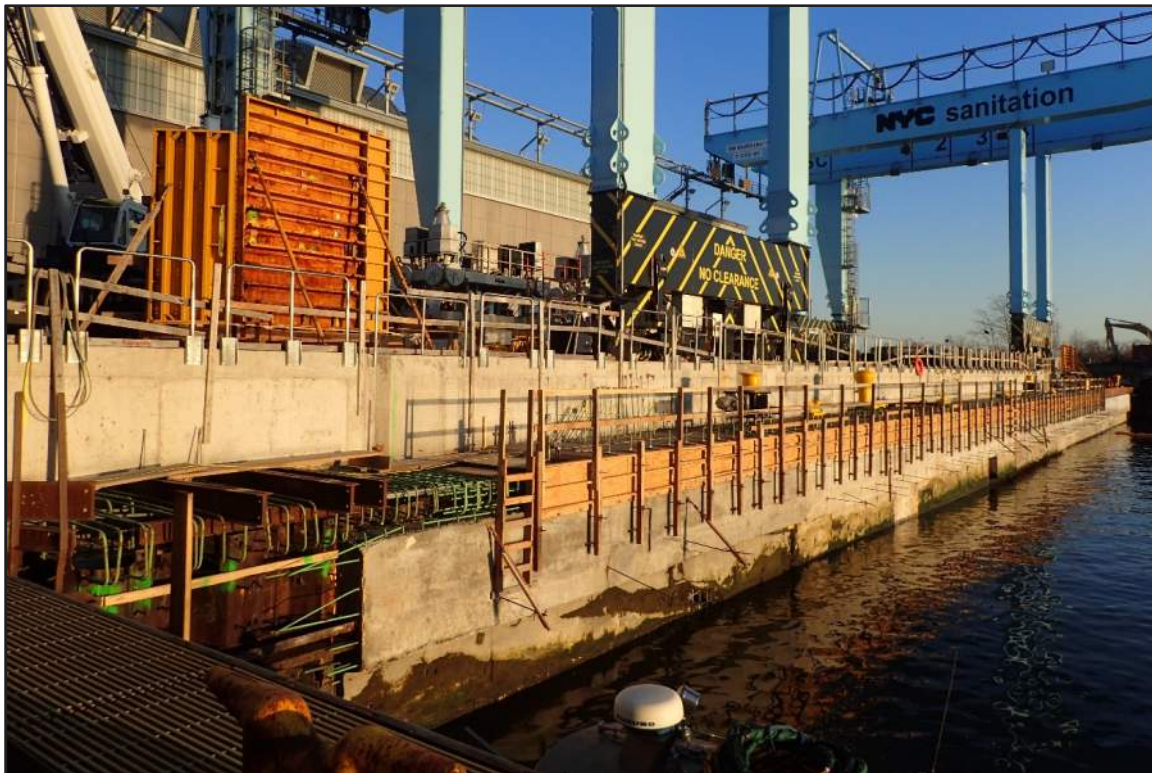
DESIGNED BY: DDJS    DRAWN BY: REBU    CHECKED BY: JOAC

SOUTH WEST BROOKLYN MARINE TRANSFER STATION		SCALE 1"=50'-0"	REVISION
EXISTING GENERAL PLAN		DATE 12/27/17	
		SKETCH NO.	
		SK-02	

## Appendix B Photographs



*Photograph 1: Former southwest Brooklyn Marine Transfer Station and ongoing inshore construction (Looking east)*



*Photograph 2: Overview of the North Bulkhead and active construction site (Looking southeast)*





*Photograph 3: Overview of the West Bulkhead (Looking east)*



*Photograph 4: West Bulkhead - Steel sheet pile cell interface with steel sheet pile bulkhead (Looking southeast)*





*Photograph 5: West Bulkhead – Transition between West Bulkhead and North Pier steel sheet pile cofferdams (Looking southwest)*



*Photograph 6: Overview of the North Bulkhead (Looking northeast)*





Photograph 7: North Bulkhead – Steel sheet pile cell under North Pier (Looking southeast)



Photograph 8: North Bulkhead – Transition from steel sheet pile cell to steel sheet pile bulkhead (Looking east)





Photograph 9: North Bulkhead - Typical steel double channel wale, anchor rod, and hardware (Looking southeast)



Photograph 10: North Bulkhead – Area of removed curb and deck replaced with new deck, which interfaces with an original steel cap (Looking northeast)





*Photograph 11: North Bulkhead – Concrete bulkhead with partially filled annulus between concrete and steel sheet pile bulkheads from 2016 inspection (Looking north)*



*Photograph 12: North Bulkhead – Extended concrete bulkhead between Sta. 1+90 and 1+97 from 2016 inspection (Looking southwest)*





*Photograph 13: North Bulkhead – Partially constructed structure from 2016 inspection with exposed epoxy coated reinforcement (Looking north)*



*Photograph 14: North Bulkhead – Nearly fully constructed deck structure with exposed epoxy coated reinforcement at the base of the new mooring hardware installations (Looking north)*



*Photograph 15: North Bulkhead – Interface between North and East bulkheads and steel sheet pile fender and revetment retaining structure to the west (Looking northwest)*



*Photograph 16: North Bulkhead – Deck demolition at North and East bulkhead interface to install transition element for new steel sheet pile to the west*





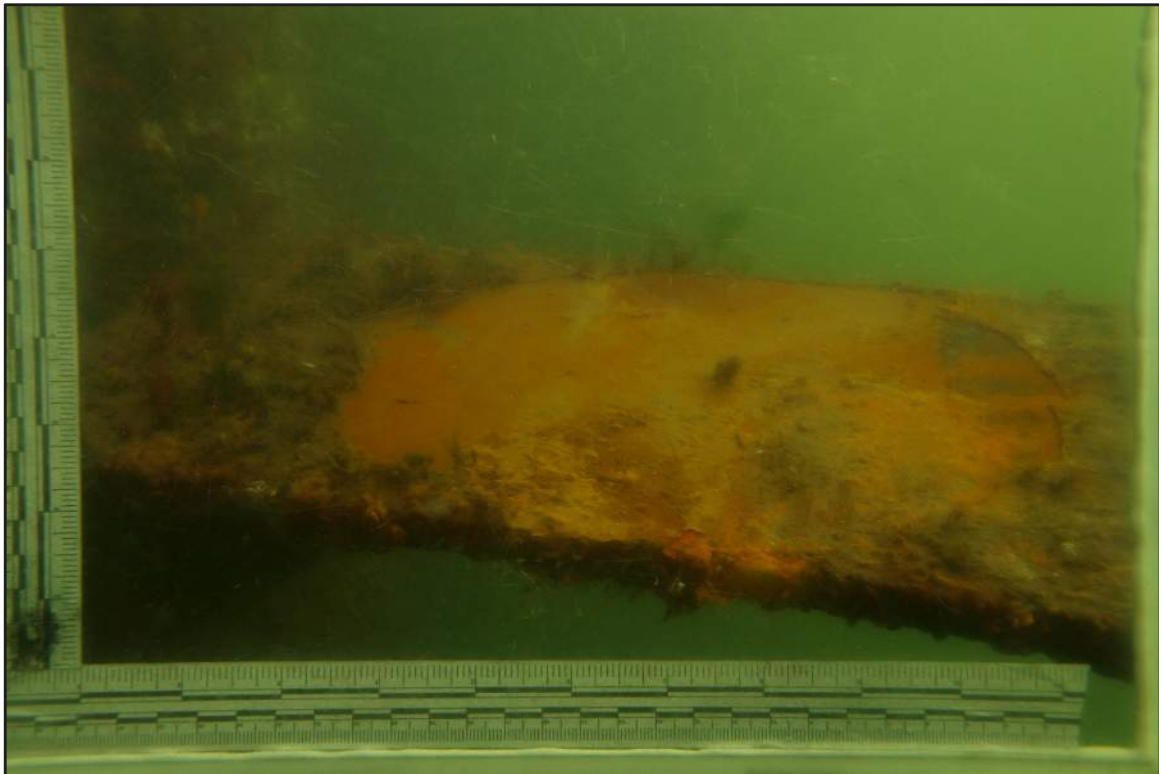
Photograph 17: North Bulkhead – Typical shear bolt installation above water on exposed steel sheet piles (Looking southeast)



Photograph 18: North Bulkhead –Elevation of shear bolts below wale system on outer flanges



*Photograph 19: North Bulkhead – Threaded rod installed between shear bolt elevations observed prior to installation of partial encasement during the 2016 inspection*

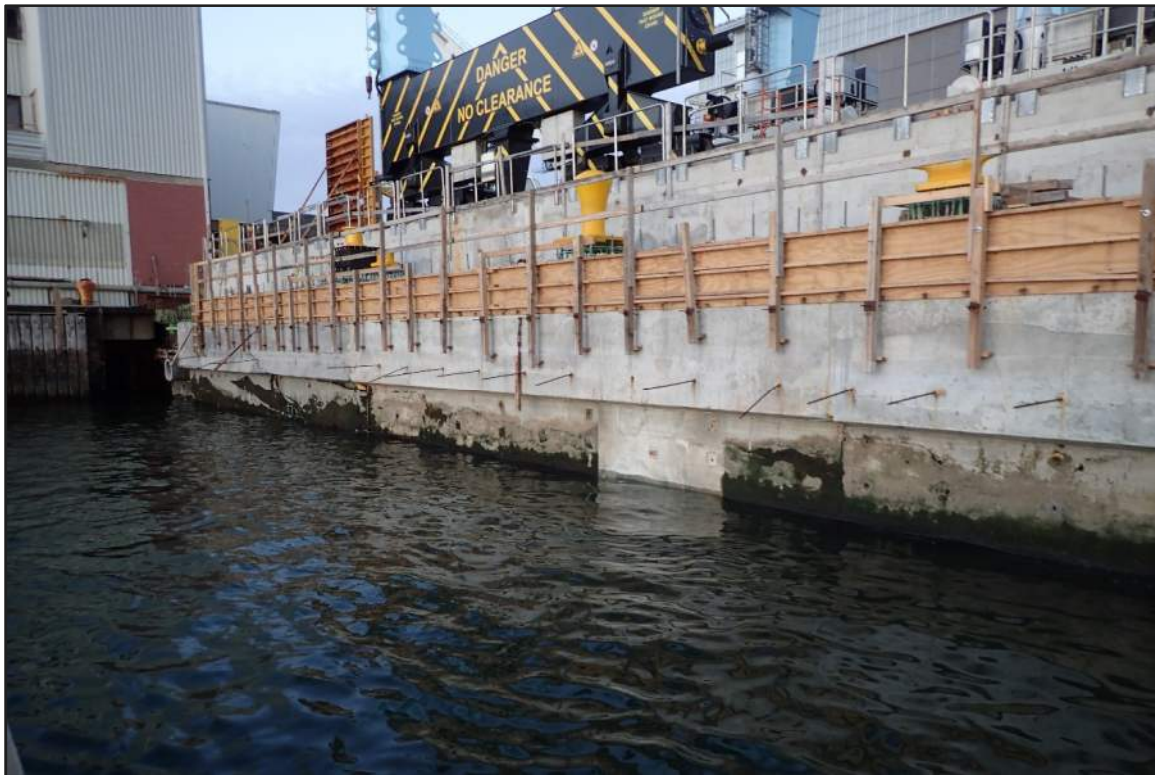


*Photograph 20: North Bulkhead – Steel bracket installed below shear bolts observed prior to installation of partial encasement during the 2016 inspection*





*Photograph 21: North Bulkhead – Encased-to-exposed transition at north end of the North Bulkhead (Looking east)*



*Photograph 22: North Bulkhead – Typical view of encased length of the North Bulkhead steel sheet piles (Looking northeast)*



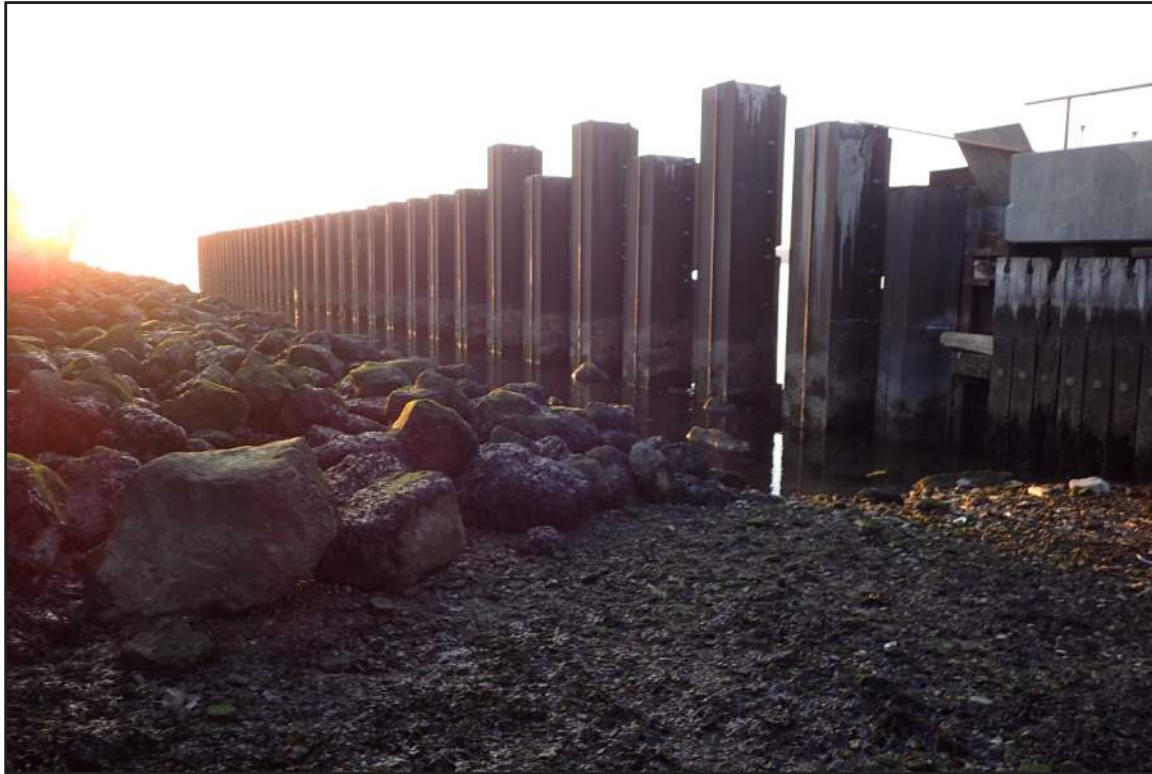


*Photograph 23: North Bulkhead – Encased-to-exposed transition at south end of the North Bulkhead (Looking east)*



*Photograph 24: Overview of the East Bulkhead (Looking northwest)*





*Photograph 25: Overview of revetment and steel sheet piles extending offshore from intersection of North and East Bulkheads (Looking west)*



*Photograph 26: East Bulkhead – Demolished concrete curb and deck at Sta. 0+14 (photograph reference from 2016 inspection) (Looking north)*



Photograph 27: East Bulkhead – Timber fender system (Looking north)



Photograph 28: West Bulkhead – Hole through splash zone repair and steel sheet pile cell with exposed fill and active fill loss at intermediate cell adjacent to Cell F-1 observed in 2016 inspection





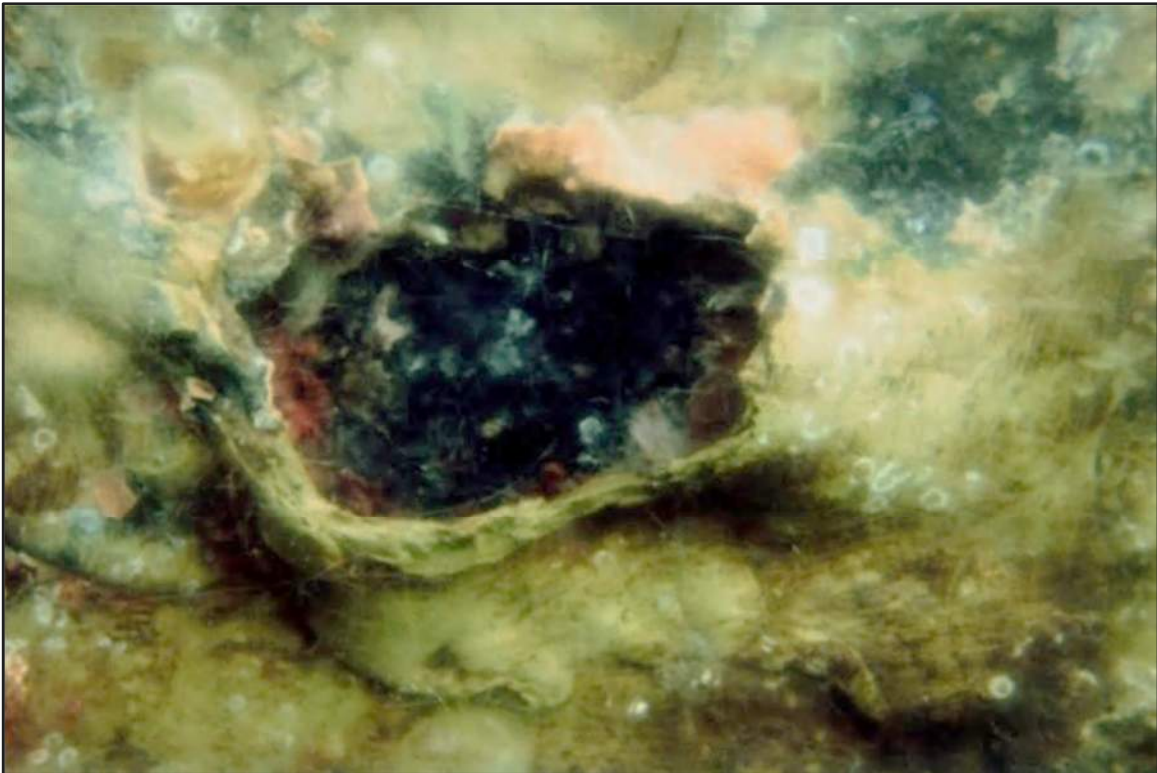
*Photograph 29: West Bulkhead – Loose bracket at interface between steel sheet pile bulkhead and steel sheet pile cell*



*Photograph 30: West Bulkhead – Typical coating failure with moderate corrosion of steel sheet pile in splash/tidal zone (Looking east)*



*Photograph 31: West Bulkhead – Typical isolated coating loss on steel sheet pile bulkhead below water*



*Photograph 32: West Bulkhead – Typical splash zone repair failure with moderate corrosion of exposed steel sheet pile*

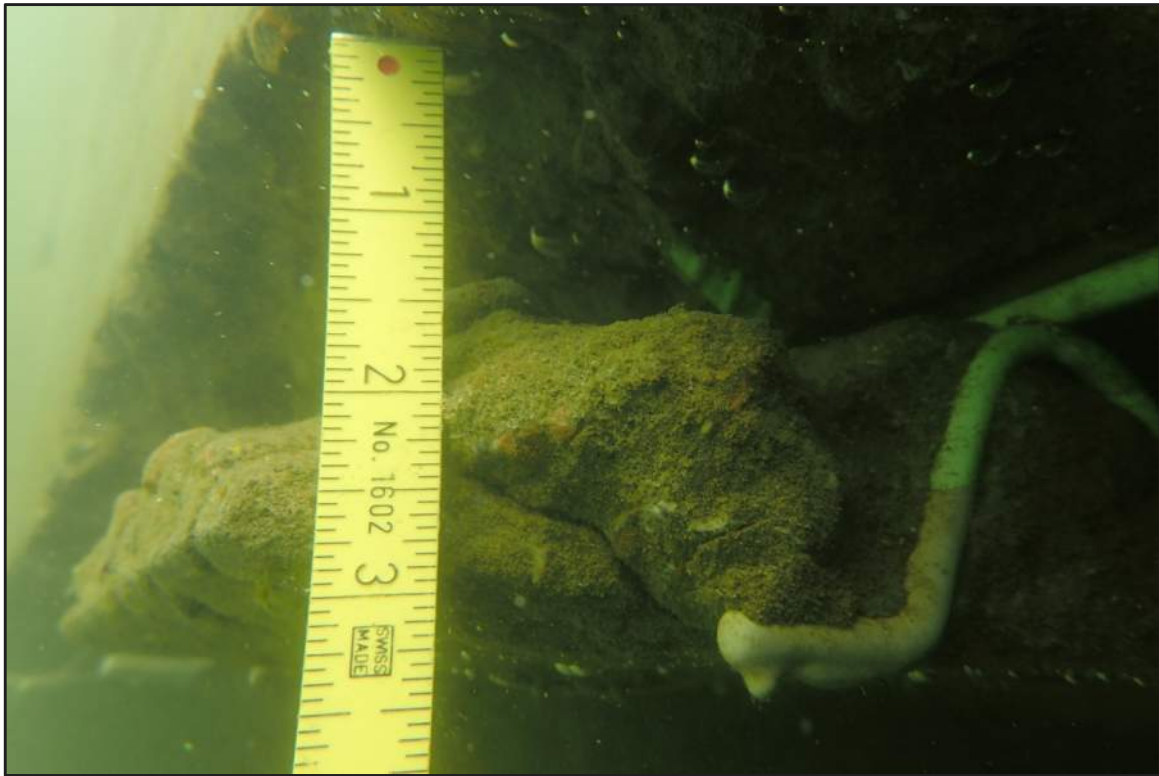




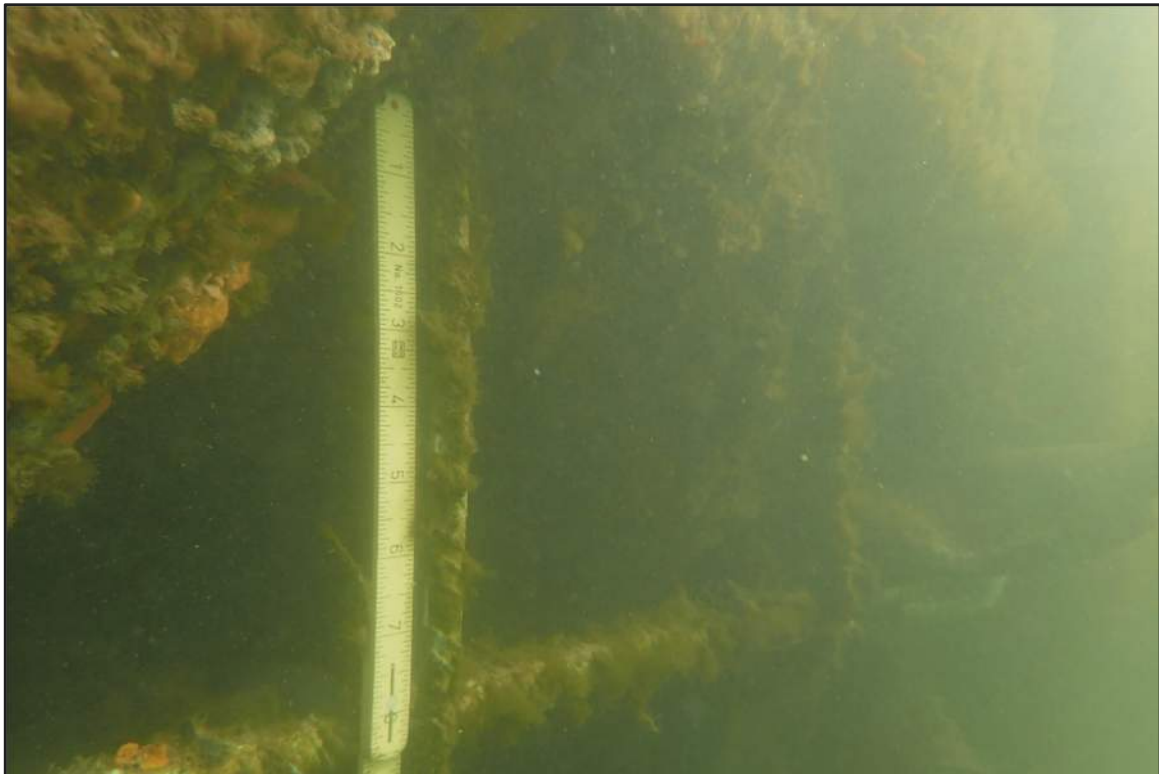
*Photograph 33: West Bulkhead - Missing steel pile cap (Looking southeast)*



*Photograph 34: North Bulkhead - Typical coating failure with moderate corrosion of steel channel wale, anchor rod, and hardware in splash/tidal zone that is not yet encased in concrete (Looking east)*



*Photograph 35: North Bulkhead – Poor consolidation of the concrete at the bottom of the partial concrete encasement (Looking northeast)*

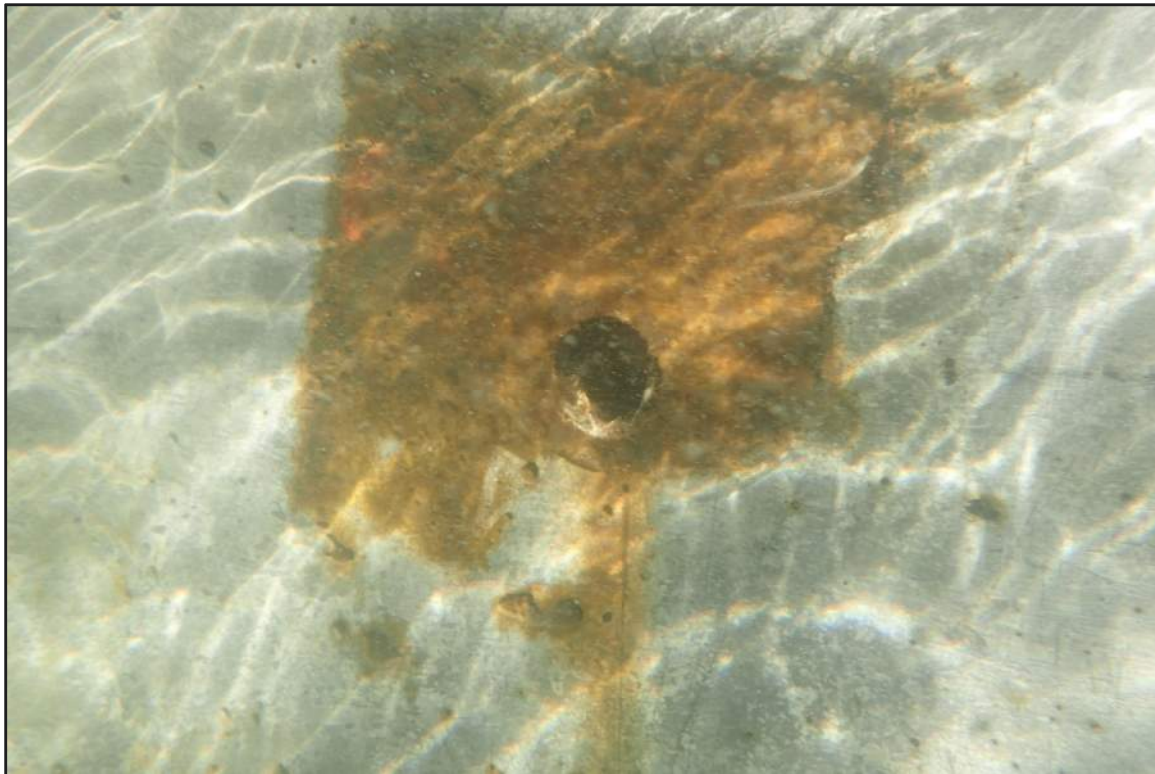


*Photograph 36: North Bulkhead – Poor consolidation of the concrete at the bottom of the partial concrete encasement (Looking northeast)*



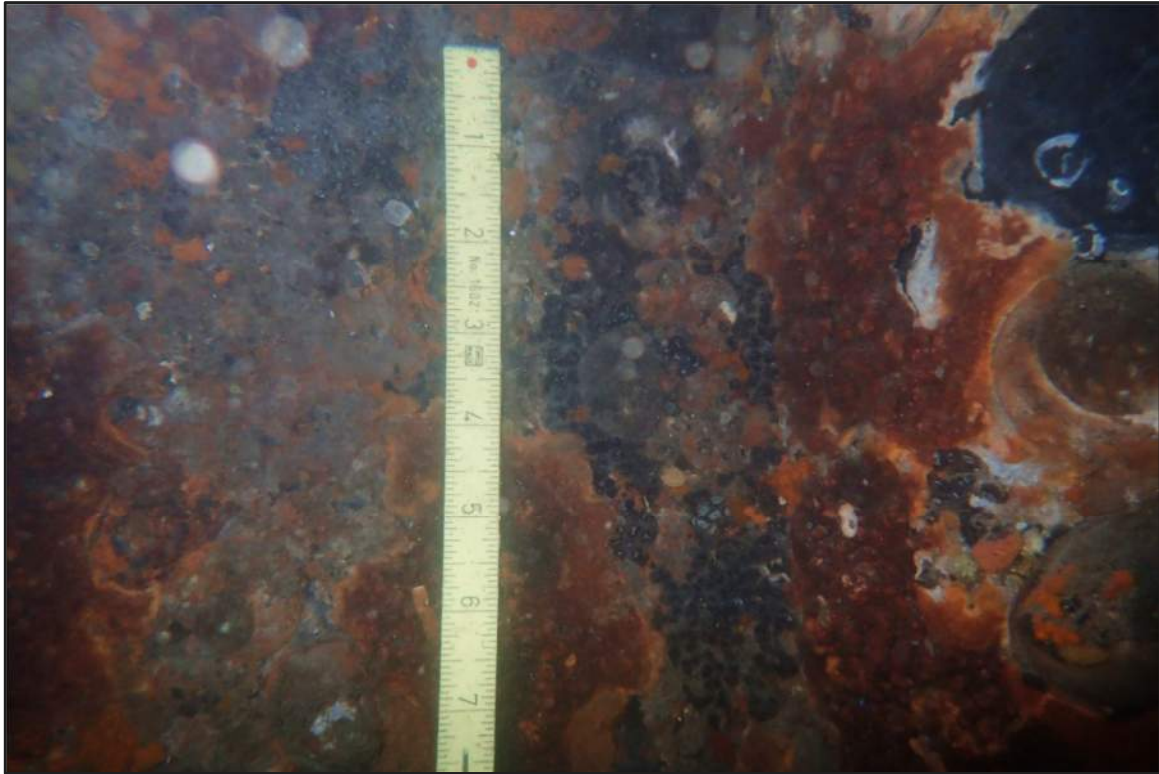


*Photograph 37: North Bulkhead – Poor consolidation of the concrete at the vertical cold joints of the partial concrete encasement (Looking east)*



*Photograph 38: North Bulkhead – Typical exposed formwork hardware penetration in the face of the partial concrete encasement (Looking east)*

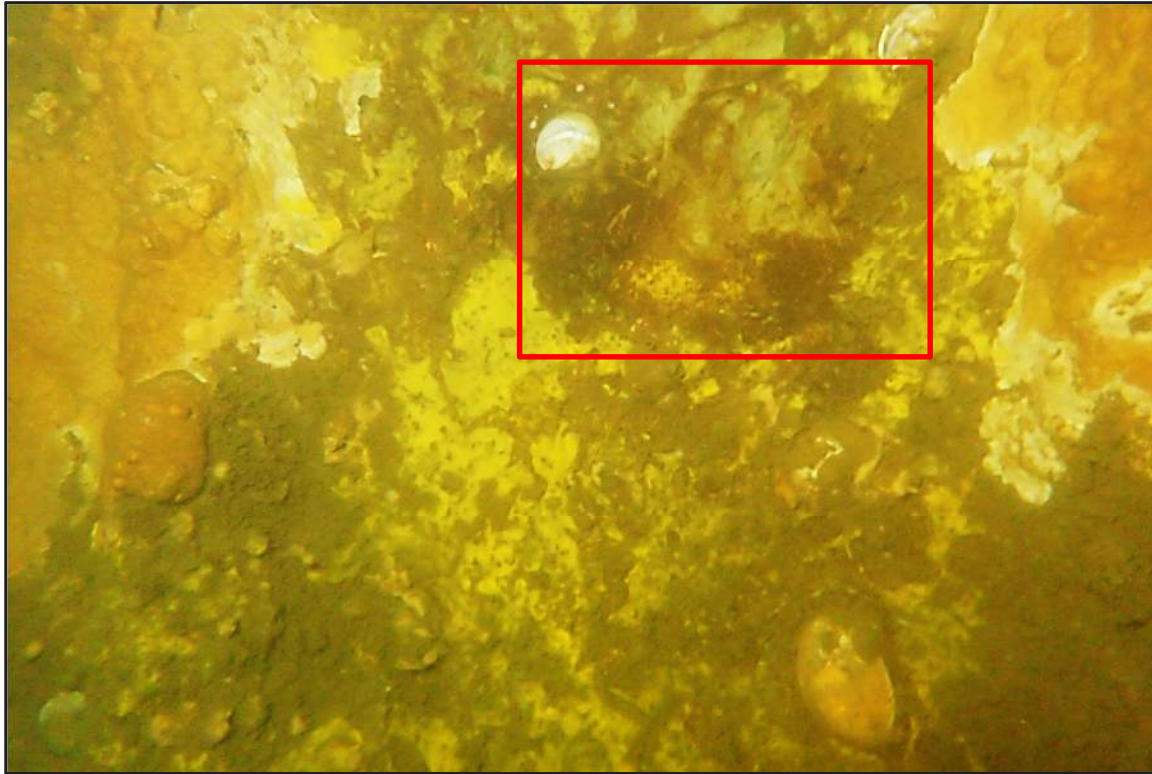




*Photograph 39: North Bulkhead - Isolated coating failure with moderate corrosion of steel sheet pile below the partial concrete encasement (Looking east)*



*Photograph 40: North Bulkhead - Moderate to advanced corrosion of steel sheet in the splash zone and tidal zone in the areas still pending concrete encasement (Looking east)*



*Photograph 41: North Bulkhead - Typical isolated epoxy failures with corrosion of steel cellular cofferdam in tidal zone (Looking east)*



*Photograph 42: North Bulkhead – Typical moderate corrosion of original vintage mooring hardware cleat (Looking south)*





Photograph 43: North Bulkhead - Typical minor coating loss of new mooring hardware cleat due to abrasion during installation process (Looking west)



Photograph 44: North Bulkhead – Cellular cofferdam access port 5.





*Photograph 45: North Bulkhead – Cellular cofferdam access port 8.*



*Photograph 46: East Bulkhead - Typical coating failure and moderate corrosion in the splash/tidal zone (Looking northwest)*



*Photograph 47: East Bulkhead - Typical coating failure with moderate corrosion of steel channel wale, anchor rod, and hardware in splash/tidal zone (Looking southwest)*

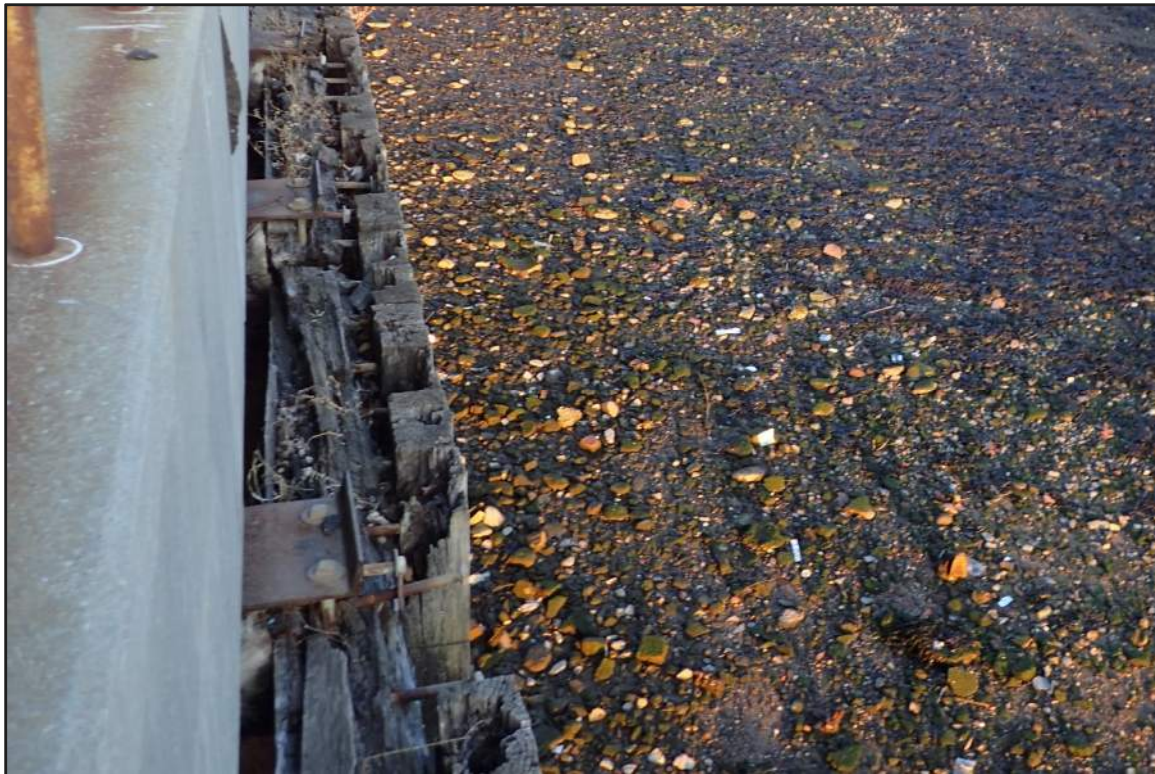


*Photograph 48: East Bulkhead – Open spalling with exposed reinforcement at Sta. 0+66 (Looking northwest)*





*Photograph 49: East Bulkhead - Typical coating failure with moderate corrosion of steel channel wale inshore of timber fender system in splash/tidal zone (Looking north)*



*Photograph 50: East Bulkhead - Failed timber fender system connections, upper timber horizontal wale, and panels due to heavy rot (Looking east)*

## Appendix C Condition Assessment Rating (CAR)

<b>Rating</b>	<b>Repairs</b>	<b>Description</b>
Good	No repairs required	No visible damage or only minor damage is noted. Structural elements may show very minor deterioration, but no overstressing is observed.
Satisfactory	No repairs required	Limited minor to moderate defects or deterioration are observed, but no overstressing is observed.
Fair	Repairs are recommended, but the priority of the recommended repairs is low.	All primary structural elements are sound, but minor to moderate defects or deterioration is observed. Localized areas of moderate to advanced deterioration may be present but do not significantly reduce the load-bearing capacity of the structure.
Poor	Repairs may need to be carried out with moderate urgency.	Advanced deterioration or overstressing is observed on widespread portions of the structure but does not significantly reduce the load-bearing capacity of the structure.
Serious	Repairs may need to be carried out on a high-priority basis with urgency.	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	Repairs may need to be carried out on a very high priority basis with strong urgency.	Very advanced deterioration, overstressing, or breakage has resulted in localized failures(s) of primary structural components. More widespread failures are possible or likely to occur, and load restrictions should be implemented as necessary.

**Routine Condition Assessment Ratings as provided in the American Society of Civil Engineers (ASCE) Underwater Investigations Manual.**

## Appendix D North Bulkhead Cofferdam Measurements

Port	Measurement (in.)	Top of Port El. (Site Datum*)	Access Port Sand El. (Site Datum*)	Height Above MHW (ft.)	Comments
1	110.5	11.0	1.8	1.4	Top elevation of sand within access port. Cofferdam opening not visible.
2	93.5	11.0	3.2	2.8	Top elevation of sand within access port. Cofferdam opening not visible.
3	102.5	11.0	2.5	2.0	Top elevation of sand within access port. Cofferdam opening not visible.
4	95.0	11.0	3.1	2.7	Top elevation of sand within access port. Cofferdam opening not visible.
5	89.0	11.0	3.6	3.2	Access port blocked with debris. Cofferdam opening not visible.
6	92.5	11.0	3.3	2.9	Top elevation of sand within access port. Cofferdam opening not visible.
7	40.0	6.5	3.2	2.7	Top elevation of sand within access port. Cofferdam opening not visible.
8	41.5	6.5	3.0	2.6	Top elevation of sand within access port. Cofferdam opening not visible.
9	41.0	6.5	3.1	2.7	Top elevation of sand within access port. Cofferdam opening not visible.
10	48.5	6.5	2.5	2.0	Top elevation of sand within access port. Cofferdam opening not visible.

\*Site Datum from USACE Permit Drawing is the Brooklyn Borough Datum. Site elevations determined from USACE Permit Drawings.