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Executive Summary

Bald Head Island Transportation Authority (BHITA) is in the process of obtaining ownership of marine ferry terminal facilities at Deep Point Marina (DPM) and Bald Head Island (BHI) and contracted Moffatt & Nichol (M&N) to conduct a due diligence level inspection. From December 17-23, 2018, M&N's inspection team carried out the field work using the company's trailered boat and surface-supplied air diving spread in accordance with the Code of Federal Regulation (CFR) and Association of Diving Contractors International (ADCI) industry standards for commercial diving operations. Led by a Professional Engineer-Diver and accompanied by the Bald Head Island, LTD. Project Engineer Mr. Bill Mack, all team members were certified in underwater structural inspections per the National Highway Institute (NHI) training program.

Each structure was inspected above and below water (from deck level to mudline) in accordance with the American Society of Civil Engineers (ASCE) Manuals and Reports on Engineering Practice No. 130: "Waterfront Facilities Inspection and Assessment", which includes standardized condition ratings for structural elements. (Excerpts from this manual are included in Appendix C.) For the purposes of due diligence, these condition ratings are simplified as either Good or Poor.

This report includes a brief description of each structure, findings, and recommendations for short-term repair priority as well as within the 10-year planning horizon. The short-term priority (Low-Medium-High) is based on severity & urgency to repair particular defects, while the long-term recommendations address the overall lifecycle of each structure with respect to major capital investment. Table 0-1 shows a summary of Condition and Repair Priority for all structures inspected.

High Repair Priority

No critical structural issues necessitating a high repair priority were found in any of the 11 facilities inspected.

Medium Repair Priority

Three (3) waterfront ferry terminal facilities at DPM were determined to have a medium repair priority:

1. B-Gate Contractor Landing
2. Concrete Bulkhead Wall
3. Barge Ramp

Two (2) waterfront ferry terminal facilities at BHI were determined to have a medium repair priority:

1. Barge Ramp
2. Passenger Landing

The BHI Passenger Landing was found to be in fair overall condition and replacement is recommended within the 10-year planning horizon. Several piles were found to be severely deteriorated with 50% or more section loss. The structure has surpassed the typical expected design life of marine timber structures of 25 years and has undergone significant repairs in order to maintain capacity.

The steel barge ramps at DPM and BHI are in satisfactory condition however may require refurbishment/ replacement within the 10-year planning horizon due to corrosion of framing elements. In order to minimize disruption to barge operations, replacement is preferable and fabricating at least one new ramp would allow the shortest time for removal and installation. It may be cost effective to refurbish one of the existing ramps after it has been replaced (instead of fabricating a second replacement) and then return it to service in place of the remaining original.

The DPM barge ramp concrete substructure and adjacent sheet pile bulkhead repair area are in satisfactory condition but may require retrofit/replacement within the 10-year planning horizon or beyond. A tension crack has developed in the ramp substructure and the adjacent section of bulkhead wall has previously displaced and been repaired. The crack damage appears to be caused by the berthing/mooring forces imposed by the tug-barge. This area should be monitored for signs of worsening and the forces evaluated in greater detail for

potential operational improvements in order to extend the service life of the ramp substructure and bulkhead wall.

Numerous sinkholes were evident behind the concrete sheet pile bulkhead wall along the DPM shoreline which have been filled with sand; these are typical of this type of construction and will likely continue to require ongoing maintenance. Repair with engineered fill including varying types/sizes of fill material (stone, etc.) or more substantial grout fill may stop the sinkholes from recurring in these areas.

Low Repair Priority

The remaining six (6) waterfront ferry terminal facilities assessed are in good to satisfactory condition with minimal recommended repair costs. These facilities include, at DPM:

1. A-Gate Passenger Landing
2. Maintenance Fixed Pier
3. Maintenance Finger Dock
4. "G" Berthing Platform
5. "H" Berthing Platform

And at BHI:

1. Contractor Landing

The following is a summary of the structures, ratings, repair priority, and estimated repair costs:

TABLE 0-1: SUMMARY OF ALL STRUCTURES INSPECTED

Location	Facility	ASCE Condition Rating	Due Diligence Rating	Repair Priority Ranking	Recommended Repair Cost Estimate
Deep Point Ferry Marina	A-Gate Passenger Landing	Good	Good	Low	$0
	B-Gate Contractor Landing	Satisfactory	Good	Medium	$11,000
	Maintenance Fixed Pier	Good	Good	Low	$1,000
	Maintenance Finger Dock	Satisfactory	Good	Low	$10,000
	"G" Berthing Platform	Good	Good	Low	$0
	"H" Berthing Platform	Good	Good	Low	$0
	Bulkhead Wall	Satisfactory	Good	Medium	$137,000
	DPM Barge Ramp	Satisfactory	Good	Medium	$154,000
Bald Head Island	BHI Barge Ramp	Satisfactory	Good	Medium	$130,000
	Contractor Landing	Good	Good	Low	$10,000
	Passenger Landing	Fair	Good	Medium	$900,000
				Total:	$1,353,000

The total estimated cost of recommended replacements and repairs over the next ten years, based on the defects observed during this investigation, is $1,353,000. As part of the recommended routine inspections and maintenance for all of the structural components of the waterfront facilities, routine inspections should be conducted once every five years. The estimated cost to complete each routine inspection is $65,000, or $130,000 total over the next ten years. Anticipated additional structural component maintenance repair items discovered during those inspection items can typically be expected on the order of $100,000 - $150,000 over the next 10 years based on the conditions observed and typical life expectancy of timber and concrete marine structures. A breakdown of estimated repair/replacement costs is provided in Appendix B.

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1. Introduction

Bald Head Island Transportation Authority (BHITA) is performing due diligence on the Ferry Terminal and related waterfront structures at the Deep Point Marina (DPM) and Bald Head Island (BHI) sites in North Carolina. Moffatt & Nichol was contracted to carry out an above and below water inspection of these during the week of December 17-21, 2018. The purpose of the inspection was to assess the overall general condition of each structure, identify major deficiencies, and recommend needed repairs within a 10-year planning horizon.

The Moffatt & Nichol (M&N) inspection team conducted an above and below water assessment of each structure using surface-supplied air (SSA) diving equipment and the company's 32 ft. inspection boat *Pier Review III*. All members of the crew are commercially trained in this mode of diving and structural inspection including the Team Leader, who is also a licensed (Civil) Professional Engineer.

This report includes the findings of the inspection for each structure, including overall condition, significant defects, and repair priorities and recommendations. The short-term priority (Low-Medium-High) is based on severity & urgency to repair particular defects, while the long-term recommendations address the overall lifecycle of each structure with respect to major capital investment.

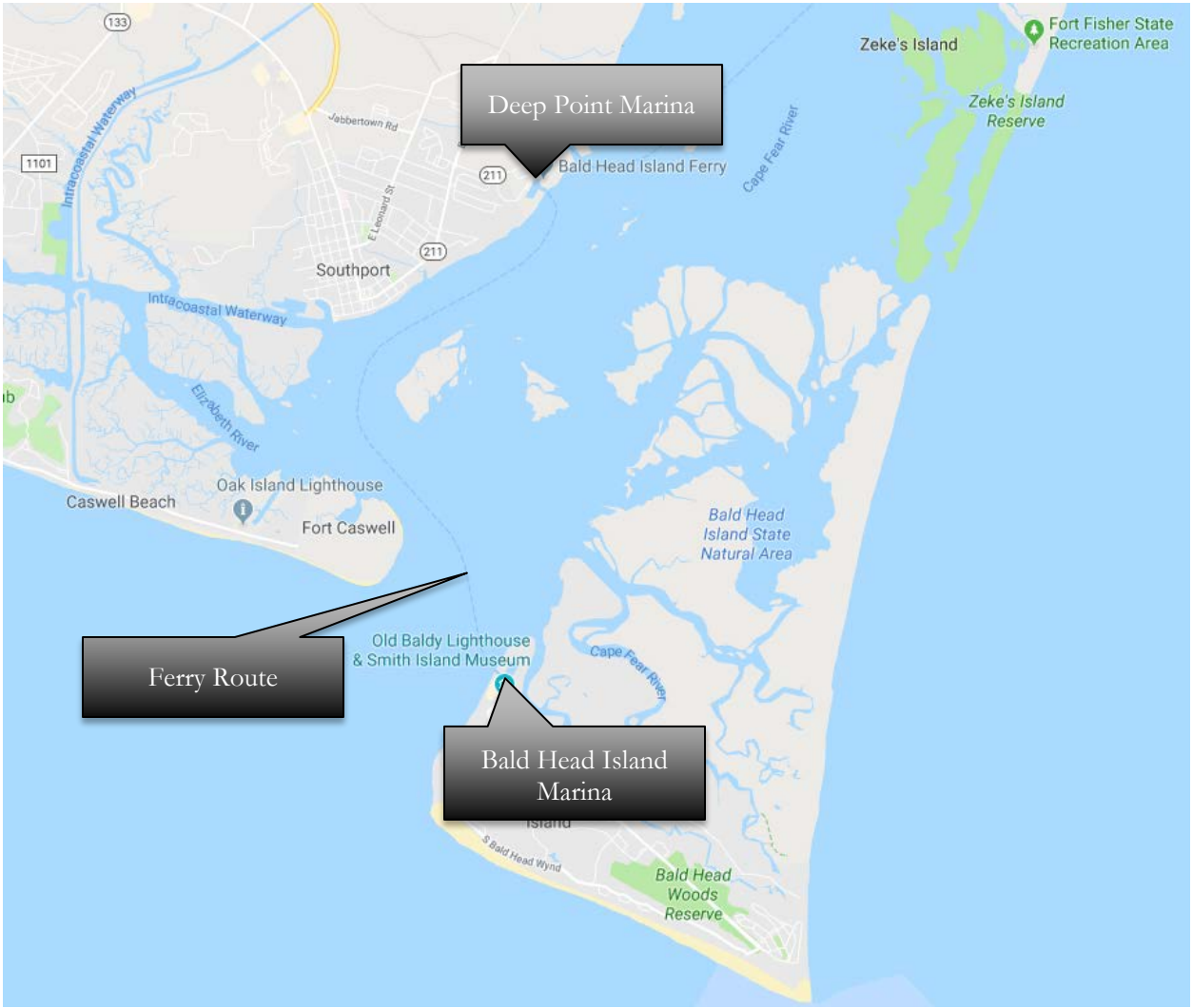
Budgetary cost estimates for recommended repairs and maintenance over the next 10 years are based on general quantities and repair/ replacement in-kind with similar materials, construction, and overall size of the structure.

1.1. Scope of Work

A total of 11 structures were inspected at the Deep Point Marina (DPM) and Bald Head Island (BHI) including sections of the bulkhead wall at DPM. The following Figure 1-1 provides an overview location map of the two ferry terminal facilities. See Table 1-1 and the additional figures that follow for a complete list and illustration of the facilities assessed.

The scope of work included above and below water inspection of support piles, below deck substructure framing and deck undersides (for pile supported docks & landings), and barge ramp concrete substructure and steel structural elements. The DPM concrete bulkhead wall delineated in Figure 2-10 was inspected above water during low tide along its entire length, and in selected areas underwater, focusing on the previously repaired area adjacent to the barge ramp.

FIGURE 1-1: LOCATION MAP



Source: Google Maps

TABLE 1-1: KEY STRUCTURES INCLUDED IN THE ASSESSMENT

No.	Facility
1	A-Gate Passenger Landing
2	B-Gate Contractor Landing
3	Maintenance Fixed Pier
4	Maintenance Finger Dock
5	"G" Berthing Platform
6	"H" Berthing Platform
7	Bulkhead Wall (See Figure 2-10)
8	DPM Barge Ramp
9	BHI Barge Ramp
10	BHI Contractor Landing
11	BHI Passenger Landing

FIGURE 1-2: DEEP POINT MARINA

Facilities Inspected highlighted in yellow. Limits of Bulkhead Wall shown separately in

FIGURE 1-3: BALD HEAD ISLAND MARINA

Facilities Inspected highlighted in yellow.

1.2. Assessment Methodology

Based on the inspection findings and understanding of each structure's history, an overall condition rating was assigned based on the ASCE system and further simplified as described below. The short-term priority (Low-Medium-High) is based on severity & urgency to repair particular defects.

1.2.1. Condition Rating System

The ASCE Manuals and Reports on Engineering Practice No. 130: "Waterfront Facility Inspection and Assessment" (2014) provides standardized definitions for overall condition in tiers from 1 ("Good") to 6 ("Critical") based on the types and severity of defects. For the purposes of Due Diligence, these have been further reduced to two tiers: Good and Poor. This simplified rating system is used by Moffatt & Nichol for Due Diligence inspections to specifically address whether capital investment is required within the planning horizon in order to maintain current capacity. Descriptions of each rating category are provided in Table 1-2.

1.2.2. Repair Priority Rankings

The priority and cost of repairs relative to a future acquisition should be considered when determining the future costs and usable life associated with each facility. These are defined as High, Medium, and Low and relate to the ASCE Condition (1-6) as follows:

(H) High Priority – Ferry terminal structures in *poor, serious* or *critical* condition.

(M) Medium Priority – Ferry terminal structures in *fair* condition.

(L) Low Priority – Ferry terminal structures in *satisfactory* or *good* condition.

1.2.3. Opinion of Probable Construction Costs

Order-of-magnitude budgetary cost estimates are provided for repairs and replacements that are recommended to be completed within the next 10 years as a result of the conditions observed during this assessment. The order-of-magnitude costs typically include two options: major rehabilitation to extend the useful service life of the structure; and replacement with a modern version of the same structure. Construction costs are based on Moffatt & Nichol's knowledge of similar construction projects in the region, along with publicly available construction estimating tools, and expands on the data collected during the due diligence inspection.

In addition, costs for future recommended routine structural inspections at five-year intervals are provided, as well as a budgetary estimate of additional structural maintenance and repair items discovered during those future inspections over the next 10 years.

1.2.4. Timber Structures in the Marine Environment

Most of the structures at DPM and BHI are constructed of timber piles, framing, and deck. In warmer climates, treated timber structures in the marine environment typically have a design service life of 25 years, as the structural members and galvanized steel hardware deteriorates from exposure. At the end of the design service life, it is typical for the structures to require significant repair or complete replacement.

Even after structures are repaired, the existing components that are not repaired or replaced will continue to deteriorate and require additional future maintenance. Although repair options appear to be attractive (lower cost) than replacement in the near-term, they become less so when considered over the useful life of the structure and it is advantageous to replace timber structures when they approach the end of their design.

TABLE 1-2: DUE DILIGENCE ASSESSMENT RATINGS (BASED ON ASCE MOP 130)

Due Diligence Rating		ASCE 130 Condition Rating	Description
Good	Maintain capacity by routine maintenance. No significant repairs required within the planning horizon.	6 - Good	No visible damage or only minor damage noted. Structural elements may show very minor deterioration, but no overstressing observed. No repairs are required
		5 - Satisfactory	Limited minor to moderate defects or deterioration observed, but no overstressing observed. No repairs are required
		4 - 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. Repairs are recommended, but the priority of the recommended repairs is low.
Poor	Repairs must be made within the planning horizon in order to maintain capacity	3 - Poor	Advanced deterioration of overstressing observed on widespread portions of the structure. Repairs may need to be carried out with moderate urgency.
		2 - 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. Repairs may need to be carried out on a high-priority basis with urgency
		1 - Critical	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. Repairs may need to be carried out on a very high priority basis with strong urgency.

2. Findings and Recommendations

This section includes the findings and recommendations for each structure assessed. The findings include Overall Condition (1-6), Repair Priority (Low-Medium-High), Summary of Significant Defects, and Recommendations for each structure inspected. A summary table is provided for each location, as well as a brief description and representative photos. Additional details such as updated pile layouts for selected structures are included in Appendix A and recommendations for repair or replacement in Section 3.

2.1. Deep Point Marina Ferry Terminal Facilities

The DPM Ferry Terminal facilities include the "A" and "B" Gate ferry terminals, multiple smaller landings and docks for berthing and servicing vessels, as well as the barge loading ramp adjacent to the entrance channel from the river. A concrete bulkhead runs along the shoreline and on the south side of the entrance channel, where it transitions into the entrance channel jetty (Section 2.1.7, Figure 2-10 includes a plan view of the DPM bulkhead limits.)

2.1.1. A-Gate Passenger Landing

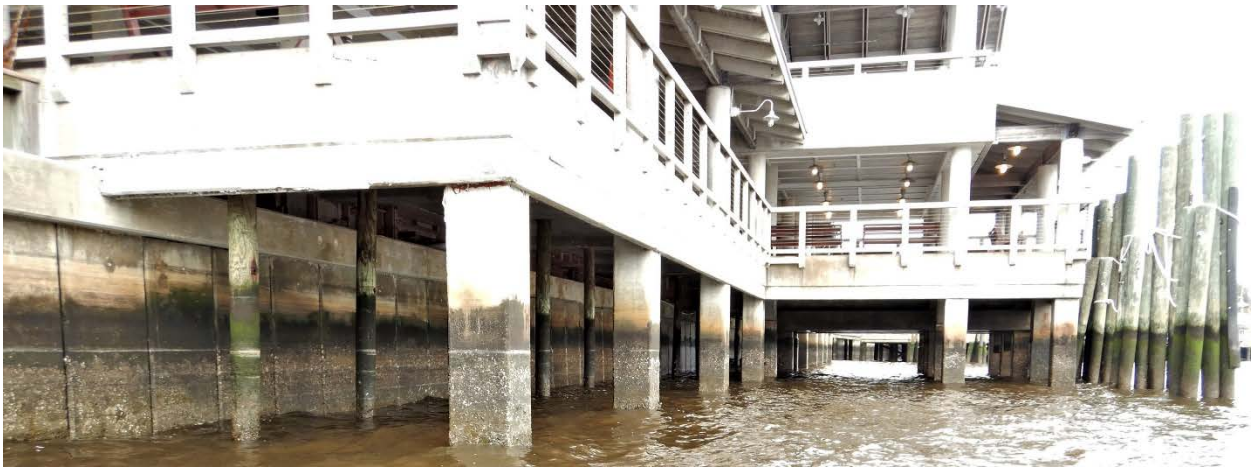
The A-Gate Passenger Landing is a reinforced concrete dock supported by prestressed concrete piles. A series of timber pile dolphins are arranged along the berthing face to provide vessel breasting and mooring. Overall, the structure was found to be in good condition with no visible sign of damage or repairs needed.

TABLE 2-1: A-GATE PASSENGER LANDING SUMMARY

Summary	
Construction	Concrete
Overall Condition	Good
Repair Priority	Low
Significant Defects	None
Recommendations	Routine Inspection & Maintenance
Recommended Repairs Estimate	$0

FIGURE 2-1: DPM A-GATE PASSENGER LANDING ELEVATION VIEW (LOOKING WEST)

FIGURE 2-2: DPM A-GATE PASSENGER LANDING (LOOKING NORTH)



End view of concrete support piles, timber fender piles (right), and adjacent concrete bulkhead (left)

Seven of the 24 concrete support piles have been retrofitted with fiberglass and epoxy jackets, reportedly following original construction (pile driving). These were found to be good condition with no signs of deterioration or damage. A series of timber piles along the bulkhead wall were installed to support construction loads and are no longer serving any function. The mudline along the bulkhead wall has been fortified at the south end with cut off sections of concrete pile laid sideways and rip rap stone at the north end between Bent 1 and Bent 5. See the marine pile plan layout (FIG-A1) in Appendix A for more detail.

2.1.2. B-Gate Contractor Landing

The B-Gate Contractor Landing is constructed of timber piles and framing with aluminium gangways and a series of timber pile dolphins along the berthing face. The structure was found to be in satisfactory overall condition with minor decay found on the timber piles and framing—typical for timber structures of this age in the marine environment. There are split/ broken timber joists in two locations and steel tie straps between the under-deck joists and the timber stringers below are severely corroded throughout the structure and should be replaced.

TABLE 2-2: B-GATE CONTRACTOR LANDING SUMMARY

Summary	
Construction	Timber
Overall Condition	Satisfactory
Repair Priority	Medium
Significant Defects	Steel tie straps are corroded/ wasted. Joist boards split 2 places
Recommendations	Repair minor timber framing defects and corroded steel tie straps.
Recommended Repairs Estimate	$11,000

FIGURE 2-3: DPM B-GATE CONTRACTOR LANDING ELEVATION VIEW (LOOKING WEST)

FIGURE 2-4: DPM B-GATE CONTRACTOR LANDING UNDER DECK FRAMING

Note the corroded tie straps at each joist and broken joist at one location

2.1.3. Maintenance Fixed Pier

The maintenance fixed pier is constructed of timber pile bents and timber deck rated for a nominal 250 psf. Timber pile dolphins on either side of the pier are used to berth and moor vessels. The structure is in good overall condition with minor defects including open bolt holes and a split cross-brace board in one location. These can be addressed with routine maintenance efforts in order to preserve the structural capacity of the dock.

TABLE 2-3: MAINTENANCE FIXED PIER SUMMARY

Summary	
Construction	Timber
Overall Condition	Good
Repair Priority	Low
Significant Defects	Open bolt holes in piles.
Recommendations	Repair minor defects including bolt holes in timber piles and split bracing.
Recommended Repairs Estimate	$1,000

FIGURE 2-5: DPM MAINTENANCE FIXED PIER ELEVATION VIEW (LOOKING WEST)

FIGURE 2-6: DPM MAINTENANCE FIXED PIER TIMBER PILE BENTS

2.1.4. Maintenance Finger Dock

The Maintenance Finger Dock is a floating dock captured by timber piles and accessed from the bulkhead wall by a gangway. The scope of inspection for this structure included only the gangway support piles, which were found to be in satisfactory condition with abrasion/loss of section and should be repaired or replaced within the 10-year planning horizon. The timber mooring/fender piles, floating dock guide piles, and floating dock were not included in the scope of this assessment.

TABLE 2-4: MAINTENANCE FINGER DOCK SUMMARY

Summary	
Construction	Floats with Timber Piles
Overall Condition (Gangway Support Piles)	Satisfactory
Repair Priority	Low
Significant Defects	Gangway support pile section loss
Recommendations	Repair/replace gangway support pile
Recommended Repairs Estimate	$10,000

FIGURE 2-7: DPM MAINTENANCE FINGER ELEVATION VIEW (LOOKING NORTHWEST)

2.1.5. "G" Berthing Platform

"G" Berthing platform is constructed of a timber deck supported by the marina bulkhead cap on the landside and a timber piles in the water. An above and below water inspection found the structure to be in good overall condition with no visible signs of damage or repairs needed.

TABLE 2-5: "G" BERTHING PLATFORM SUMMARY

Summary	
Construction	Timber
Overall Condition	Good
Repair Priority	Low
Significant Defects	None
Recommendations	Routine Inspection & Maintenance
Recommended Repairs Estimate	$0

FIGURE 2-8: DPM "G" BERTHING PLATFORM ELEVATION VIEW (LOOKING SOUTH)

2.1.6. "H" Berthing Platform

"H" Berthing platform is constructed of a timber deck supported by the marina bulkhead cap on the landside and a timber piles in the water. An above and below water inspection found the structure to be in good overall condition with minor abrasions (up to ¾" deep) on the piles above water.

TABLE 2-6: "H" BERTHING PLATFORM SUMMARY

Summary	
Construction	Timber
Overall Condition	Good
Repair Priority	Low
Significant Defects	Minor abrasions on piles
Recommendations	Routine Inspection & Maintenance
Recommended Repairs Estimate	$0

FIGURE 2-9: DPM "H" BERTHING PLATFORM ELEVATION VIEW (LOOKING WEST)

2.1.7. DPM Bulkhead Wall

The shoreline at DPM is comprised of a concrete sheet pile bulkhead wall with a reinforced concrete cap. The limits of the bulkhead wall are shown in Figure 2-10. On the north and west perimeter of the marina, the bulkhead extends from the barge ramp around to just beyond the "A" Gate Ferry Terminal Building. The bulkhead wall along the south bank of the inlet channel is also included in this assessment. Segments to the south of the yellow highlighted walls in Figure 2-10 along the marina floating docks are not part of the scope for this assessment.

This section includes the typical conditions for the bulkhead overall (2.1.7.1) as well as for a section of the wall adjacent to the barge ramp which was previously repaired (2.1.7.2).

TABLE 2-7: DPM BULKHEAD WALL SUMMARY

Summary	
Construction	Concrete Sheet Pile
Overall Condition	Satisfactory
Repair Priority	Medium
Significant Defects	Sinkholes behind the wall Minor spalls & cracks
Recommendations	1. Repair/ fill sinkholes as needed 2. Monitor the repair section adjacent to the barge ramp & plan a permanent repair during the next major CAPEX cycle.
Recommended Repairs Estimate	$137,000

FIGURE 2-10: DEEP POINT MARINA PLAN VIEW

Ferry Terminal bulkhead wall scope limits highlighted in yellow

FIGURE 2-11: VIEW OF DPM (LOOKING WEST)

View of DPM bulkhead wall at marina inlet (foreground left and right) and end of scope limits between Ferry Terminal Building and A Dock (yellow, background center-left)

2.1.7.1. Bulkhead Wall Typical Conditions

The DPM bulkhead wall is constructed of concrete sheet pile panels which interlock with a tongue-and-groove type fit and a reinforced concrete cap along the top of the wall, typically level with the adjacent sand fill/lawn.

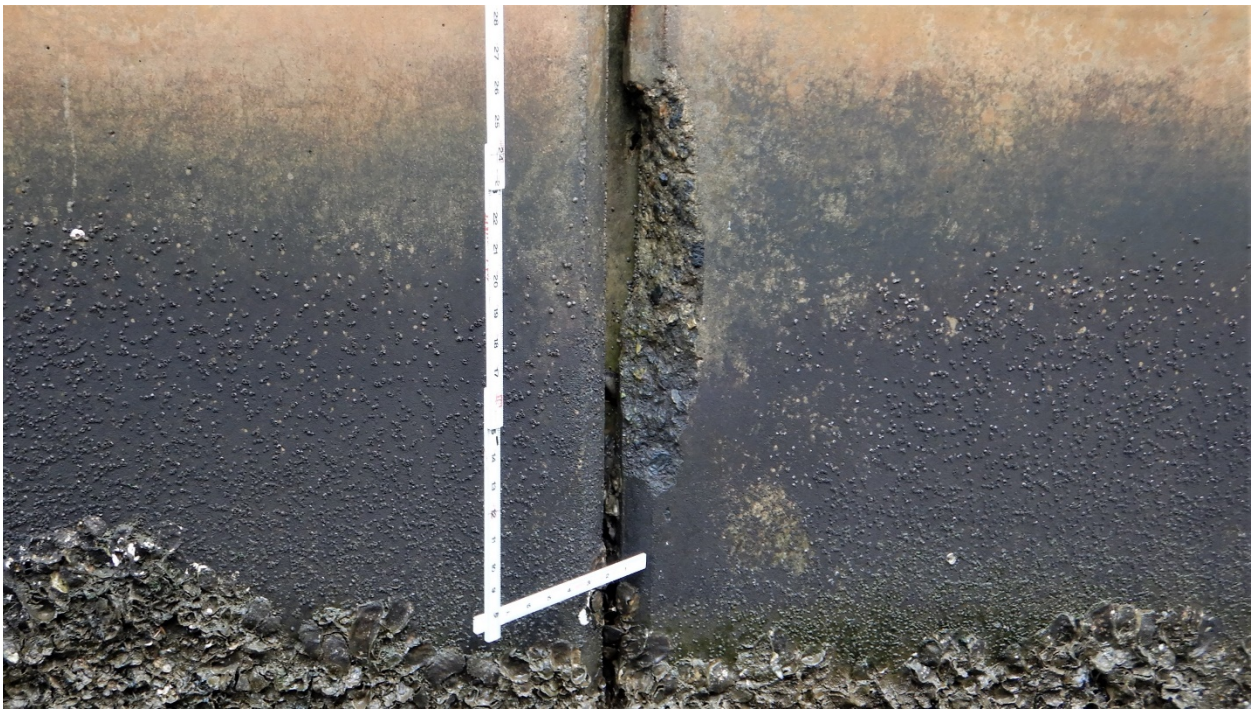
Inspection of the above water portion of the wall was performed during low tide. With the exception of the section adjacent to the barge ramp (see next section). The bulkhead is in overall good condition with isolated/localized spalls and cracks.

FIGURE 2-12: TYPICAL BULKHEAD WALL ELEVATION AT LOW TIDE

Location adjacent to "H" Berth and Maintenance Docks, looking West

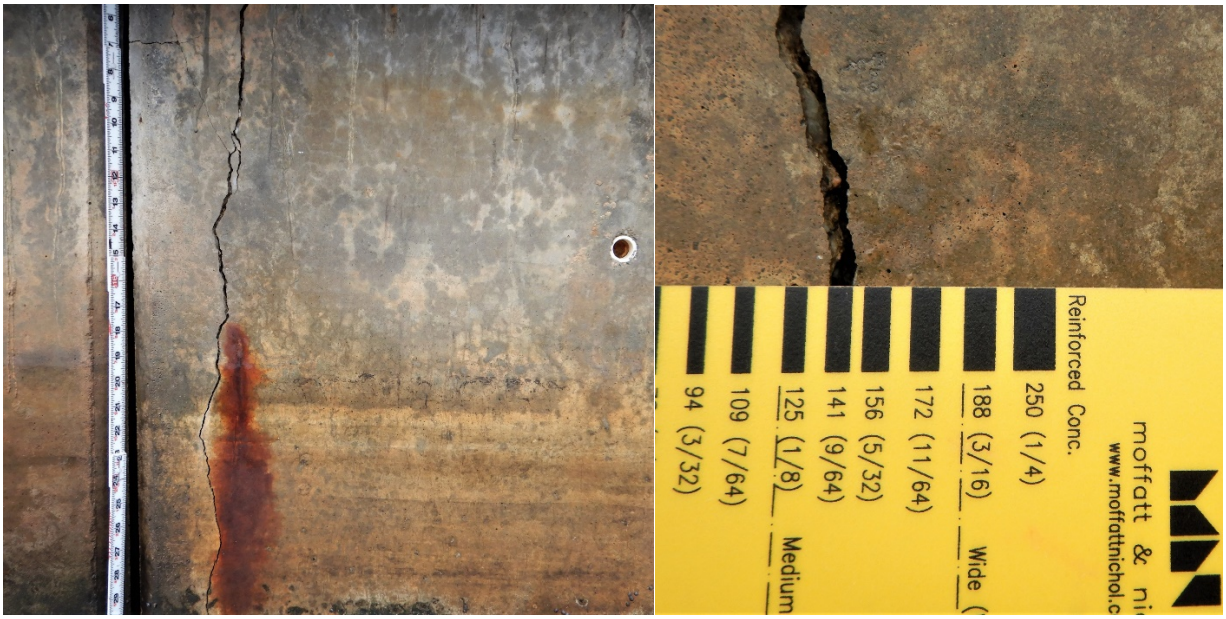
The spalls and cracking in the sheets are typically along the groove side of the tongue-and-groove interlock, exposing the tongue from the adjacent sheet but not creating open voids. Areas behind the wall have loss of fill or "sinkholes" which are typical for this type of construction. Locations with minor fill loss and sinkholes can be addressed by regular maintenance with replacement sand/stone fill material when needed.

FIGURE 2-13: TYPICAL CONCRETE SHEET PILE SPALL



Note tongue-and-grove fit between the sheets, visible inside the spall

FIGURE 2-14: CONCRETE SHEET PILE CRACKING



Overall and close up view shown of medium-width "worst case" cracking observed in the bulkhead wall at intermittent locations

FIGURE 2-15: TYPICAL SINKHOLES BEHIND WALL

Sinkholes in sand fill behind interlocking concrete sheet pile construction of this type is typically caused by migration of the sand backfill through the joint. This may be mitigated by varying the size and gradation of repair materials, i.e. backfilling with larger size gravel or stone. More robust repairs including the installation of filter fabric and/or the use of grout or flowable fill could be considered in the future if sinkholes become larger or more prevalent. Fill loss should be monitored during routine inspections to determine if more substantial repair methods are recommended.

2.1.7.2. Bulkhead Repair Section

An area of the bulkhead wall along the inlet channel and adjacent to the barge ramp has previously been repaired after developing a "tension crack" and displacement of the concrete sheet pile, likely due to the forces imposed by the tug and barge.

FIGURE 2-16: BULKHEAD REPAIR SECTION ELEVATION VIEW (LOOKOING NORTH)

Photo taken from inlet channel showing affected concrete panels, steel tie rod with square plate washer, and steel repair plate on the concrete cap

FIGURE 2-17: DISPLACED CONCRETE SHEET PILES AT BULKHEAD REPAIR SECTION

The bulkhead repair section was inspected above and below water and found to be in satisfactory condition. The sheets were found to be intact with no voids or signs of recent movement.

A permanent repair should be planned for the next major Capital Expenditure (CAPEX) cycle and should be designed to address the berthing/mooring forces imposed by the tug and barge at the adjacent DPM Barge Ramp.

2.1.8. DPM Barge Ramp

The DPM Barge Ramp is a moveable steel loading ramp supported by a monolithic reinforced concrete substructure. Timber pile dolphins on either side of the ramp provide protection against impact and bitts are located landside for moorings. The scope of this assessment included only the structural components of the ramp and not any hydraulic systems required for operation.

Above and below water inspection found the structure to be in satisfactory condition with a crack in the concrete substructure wall corresponding to the adjacent bulkhead repair area as well as minor to moderate corrosion affecting the ramp steel framing, cylinder bases, and other weldments.

TABLE 2-8: DPM BARGE RAMP SUMMARY

Summary	
Construction	Steel Ramp with Concrete Substructure
Overall Condition	Satisfactory
Repair Priority	Medium
Significant Defects	Moderate corrosion of steel elements Crack in concrete substructure
Recommendations	1. Monitor tension crack associated with bulkhead repair section. 2. Monitor steel corrosion and plan refurbishment during the next major CAPEX cycle.
Recommended Repairs Estimate	$154,000

FIGURE 2-18: DPM BARGE RAMP ELEVATION VIEW (LOOKING SOUTHWEST)

FIGURE 2-19: DPM BARGE RAMP TENSION CRACK IN CONCRETE SUBSTRUCTURE

2.2. Bald Head Island Ferry Terminal

The Ferry Terminal structures located within BHI Marina include a barge ramp as well as timber Passenger and Contractor Ferry Landings.

2.2.1. BHI Barge Ramp

The BHI Barge Ramp is similar to its counterpart at DPM, with a moveable steel frame loading ramp and reinforced concrete substructure with concrete sheet pile side walls and bulkhead. These were found to be in satisfactory condition with moderate corrosion to steel elements and minor spall and cracking defects on the concrete sheet pile side and bulkhead walls.

TABLE 2-9: BHI BARGE RAMP SUMMARY

Summary	
Construction	Steel Ramp with Concrete Substructure
Overall Condition	Satisfactory
Repair Priority	Medium
Significant Defects	Moderate corrosion of steel elements
Recommendations	Monitor steel corrosion and plan refurbishment during the next major CAPEX cycle.
Recommended Repairs Estimate	$130,000

FIGURE 2-20: BHI BARGE RAMP ELEVATION VIEW (LOOKING SOUTHEAST)

FIGURE 2-21: BHI BARGE RAMP STEEL FRAMING MODERATE CORROSION

2.2.2. BHI Contractor Landing

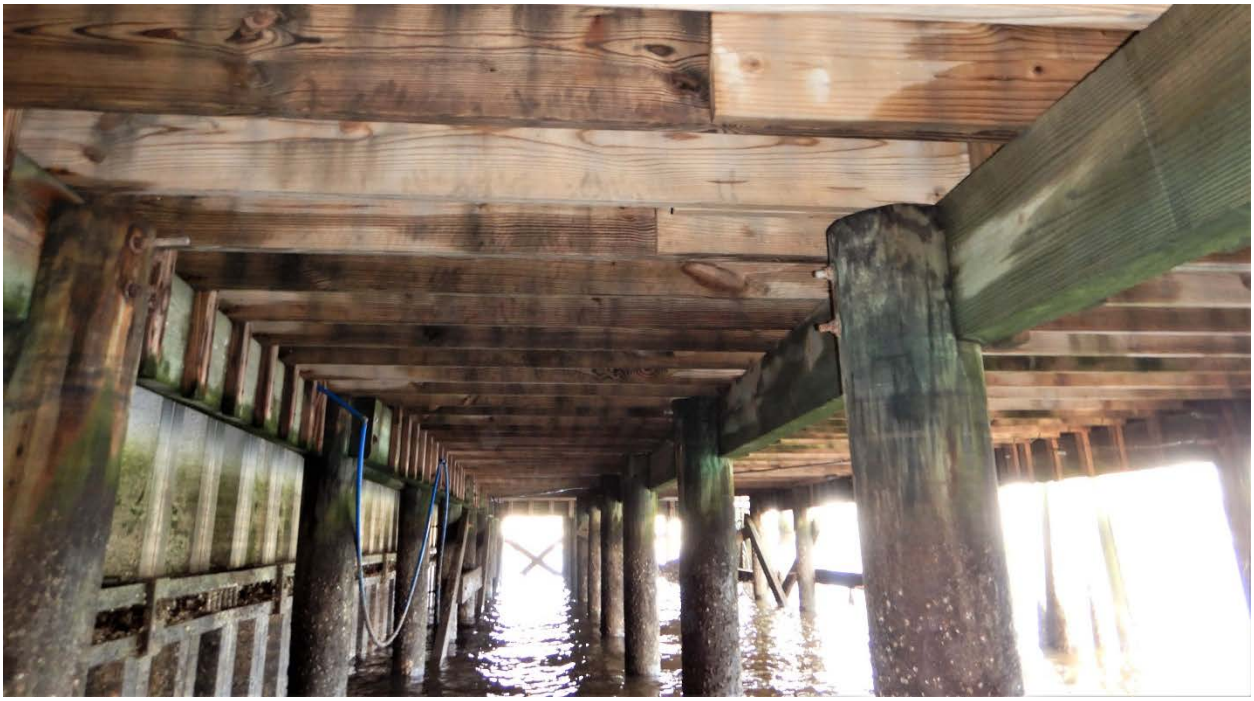
The BHI Contractor landing is a timber structure fully supported by timber piles; the deck cantilevers over he bulkhead wall along the shoreline but does not bear on it. A series of timber pile dolphins along the berthing face provides fendering and moorings for vessels. Above and below water inspection found the structure to be in good overall condition with minor defects on the timber piles, typical of timber structures in a marine environment. These include internal and external decay (10% section loss or less), open bolt holes, and other surface defects such as abrasions, checks, and shakes.

TABLE 2-10: BHI CONTRACTOR LANDING SUMMARY

Summary	
Construction	Timber
Overall Condition	Good
Repair Priority	Low
Significant Defects	Minor decay on 3 piles Open bolt holes and minor timber defects (abrasion/ check/ shake)
Recommendations	Routine Inspection & Maintenance Cover open bolt holes with epoxy
Recommended Repairs Estimate	$10,000

FIGURE 2-22: BHI CONTRACTOR LANDING END VIEW (LOOKING SOUTH)

FIGURE 2-23: BHI CONTRACTOR LANDING UNDERDECK VIEW (LOOKING NORTH)



2.2.3. BHI Passenger Landing

The BHI Passenger Landing is a timber structure supported by various types of piles/columns and timber substructure elements, either from the original construction or installed during its repair history. The original round timber piles (installed by pile-driving them into the subsurface) have been augmented by additional timber piles driven where access was available or by square columns jetted into the subsurface. These have been connected directly to the original timber framing stringers or with additional structural members to create "crutch bents" in order to support the loads from the deck and structure above. There are a series of timber pile dolphins along the berth face for vessel breasting and mooring.

Connecting ramps span between the Passenger Landing and the bulkhead along shore, accommodating the change in elevation between the ground level and (lower) deck level. Two of the three ramps are pile supported next to the bulkhead end, however the third (cargo ramp) is supported by the horizontal timber wale of the bulkhead itself.

Above and below water inspection of the piles confirmed the current pile/column layout (see Appendix A) and assessed their condition underwater by visual/ tactile inspection and "sounding" the piles with a hammer and the above water framing and fasters were visually inspected.

Several of the original piles have significant decay and section loss, up to 100% in certain locations, and have been identified in "severe" condition, although they may have been abandoned in place and augmented with repair piles/columns. The capacity of the repair piles/columns is difficult to verify, particularly those installed with jetting techniques.

The substructure timber framing was found to be in fair condition with exterior decay and moderate corrosion on fasteners; typical conditions for construction of this type in the marine environment. Extensive substructure timber framing (stringer) repairs have also been made, typically by adding a "sister" board and through-bolting to the original or other segments which are not continuous across multiple support piles.

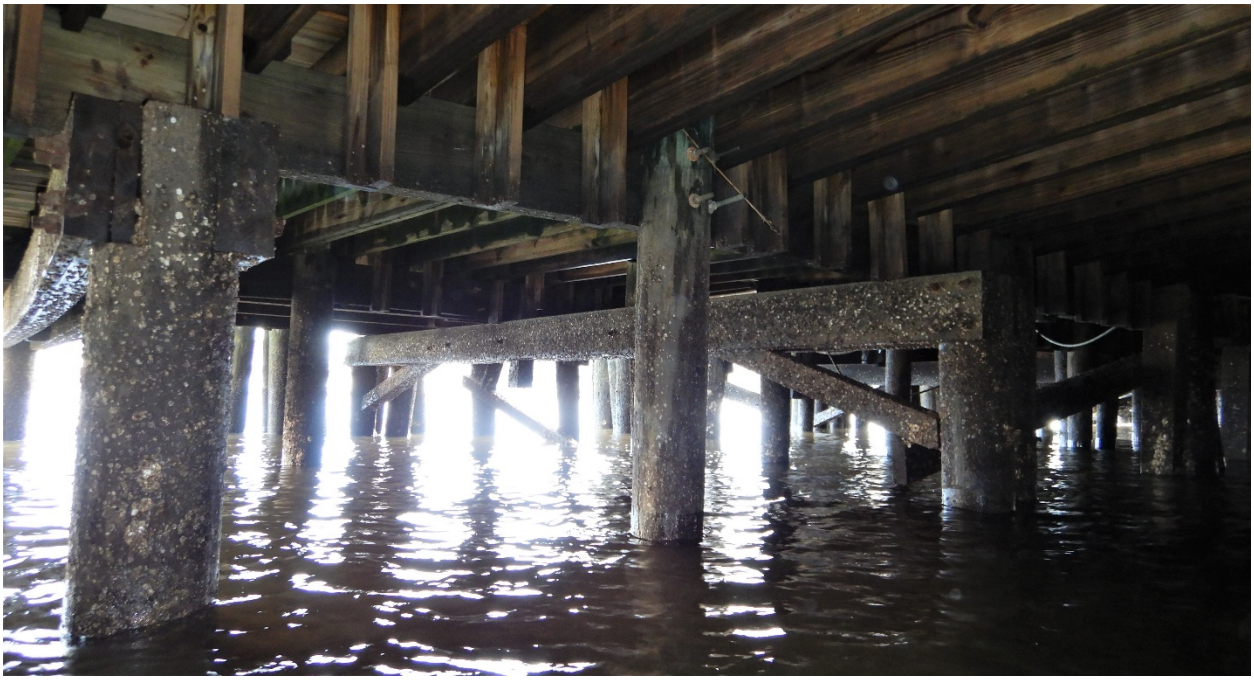
A series of "crutch bents" are constructed of piles driven outside of the deck footprint (where access was available) with beams built-up from multiple boards fastened together in place. Several of these beams are visibly distorted (bowed) and may lose their strength over time due to deterioration (corrosion) of the fasteners.

TABLE 2-11: BHI PASSENGER LANDING SUMMARY

Summary	
Construction	Timber
Overall Condition	Fair
Repair Priority	Medium
Significant Defects	Multiple repairs & retrofits; load path may not be adequate for current conditions (multiple piles are no longer bearing; repair history is unknown) Cargo Ramp is bearing on bulkhead Crutch bents are bowed
Recommendations	1. Monitor piles and framing for deterioration 2. Plan replacement of the substructure
Recommended Repairs Estimate	$900,000

FIGURE 2-24: BHI PASSENGER LANDING ELEVATION VIEW (LOOKING WEST)

FIGURE 2-25: BHI PASSENGER LANDING UNDERDECK VIEW (LOOKING EAST)



Two long-span crutch bents are visible at left and center of the photo. Bowing of timber crutch bent cap visible to the left (others similar).

FIGURE 2-26: UNDERDECK VIEW OF TIMBER STRINGER

Stringer has been repaired with thru-bolted “sistered” boards. Note the various repairs do not form a continuous member and are out of alignment.

FIGURE 2-27: UNDERDECK VIEW OF CARGO RAMP

Cargo ramp at Passenger Landing is supported by the marina bulkhead wall (foreground). For comparison, the adjacent Contractor Landing is fully supported with a row of timber piles (center background).

3. Conclusions and Recommendations

No critical structural issues were found in any of the 11 facilities inspected. The following conclusions and recommendations are listed in order of repair priority.

High Repair Priority

None

Medium Repair Priority

1. **Replacement of the BHI Passenger Landing is recommended within the 10-year planning horizon.** The structure has surpassed its original expected design life and has undergone significant repairs in order to maintain capacity.
2. **The steel barge ramps at DPM and BHI may require refurbishment/replacement within the 10-year planning horizon due to corrosion of framing elements.** In order to minimize disruption to barge operations, replacement is preferable and fabricating at least one new ramp would allow the shortest time for removal and installation. It may be cost effective to refurbish one of the existing ramps after it has been replaced (instead of fabricating a second replacement) and then return it to service in place of the remaining original. The cost estimates provided assume full replacement of both ramps within the next 10 years.
3. **The DPM barge ramp concrete substructure and adjacent sheet pile bulkhead repair area may require retrofit/replacement within the 10-year planning horizon or beyond.** The tension crack in the ramp substructure and the previously repaired bulkhead wall failure likely have the same cause: the berthing/mooring forces imposed by the barge. This area should be monitored for signs of worsening and the forces evaluated in greater detail for potential improvements in order to extend the service life of the substructure and bulkhead wall.
4. **The sinkholes behind the concrete sheet pile bulkhead wall along the DPM shoreline are typical of this type of construction and will likely continue to require ongoing maintenance**. Repair with engineered fill including varying types/sizes of fill material (stone, etc.) may stop the sinkholes from recurring in these areas. In regions with more substantial fill loss, or specific locations with habitual fill loss despite the placement of additional fill material, more extense repairs should be considered. Compaction grouting, grout columns, or placement of flowable fill behind the bulkhead wall would provide increased soil stability with a denser material that would greatly reduce the potential for fill loss through the bulkhead joints.

Low Repair Priority

The remaining waterfront ferry terminal facilities assessed are in good to satisfactory condition with minimal recommended repair costs that can be completed during regular maintenance cycles.

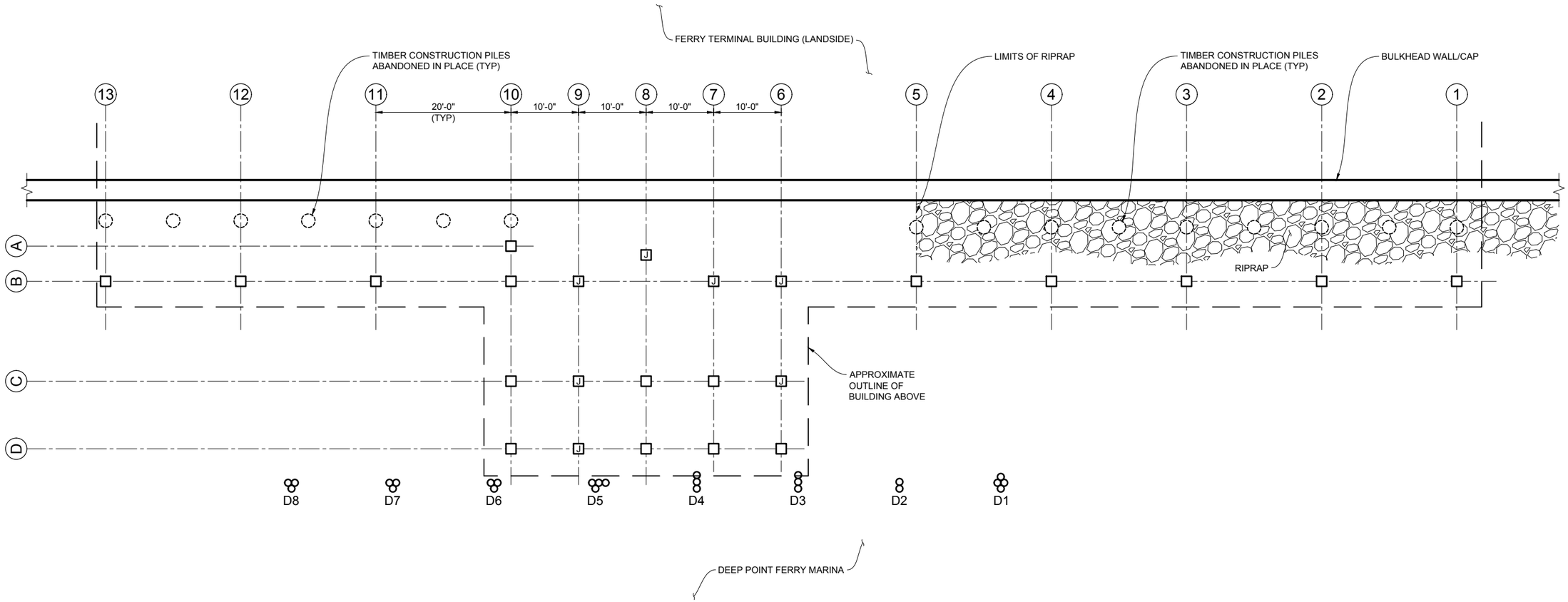
The total estimated cost of the recommended replacements and repairs mentioned over the next ten years is $1,353,000. Moving forward, routine inspections of the waterfront ferry terminal facilities should be conducted once every five years. The estimated cost to complete each routine inspection is $65,000, or $130,000 total over the next ten years. Anticipated additional structural component maintenance repair items discovered during those inspection items can typically be expected on the order of $100,000 - $150,000 over the next 10 years based on the conditions observed and typical life expectancy of timber and concrete marine structures.

Despite the nature of timber structures in the marine environment, certain measures can be taken in order to slow their deterioration. The simplest are done at the time of design & construction, using marine grade materials in sizes better proportioned (larger), fewer in number, and with details which do not create

opportunity for decay and deterioration—e.g. reduce the number of braces and bolted connections which penetrate through the piles, particularly at or below the waterline.

Slowing the deterioration of marine timber structures which have already constructed is focused on protecting piles and bracing in the waterline area and other sources of moisture, typically by wrapping or encapsulating with any of a variety of commercially available products. The various solutions all have benefits and drawbacks, and any investment should be carefully considered against the overall useful life of the structure. For the structures inspected during this scope of work, for example, few if any would be likely to realize useful benefit or extension of service life from these types of countermeasures. The piles and waterline bracing at the BHI Passenger Landing show signs of advanced deterioration that would neither be remedied nor significantly slowed by encapsulation or wrapping.

Appendix A: Figures



LEGEND

- PRESTRESSED CONCRETE PILE
- PRESTRESSED PILE WITH FIBERGLASS JACKET
- TIMBER PILE DOLPHIN

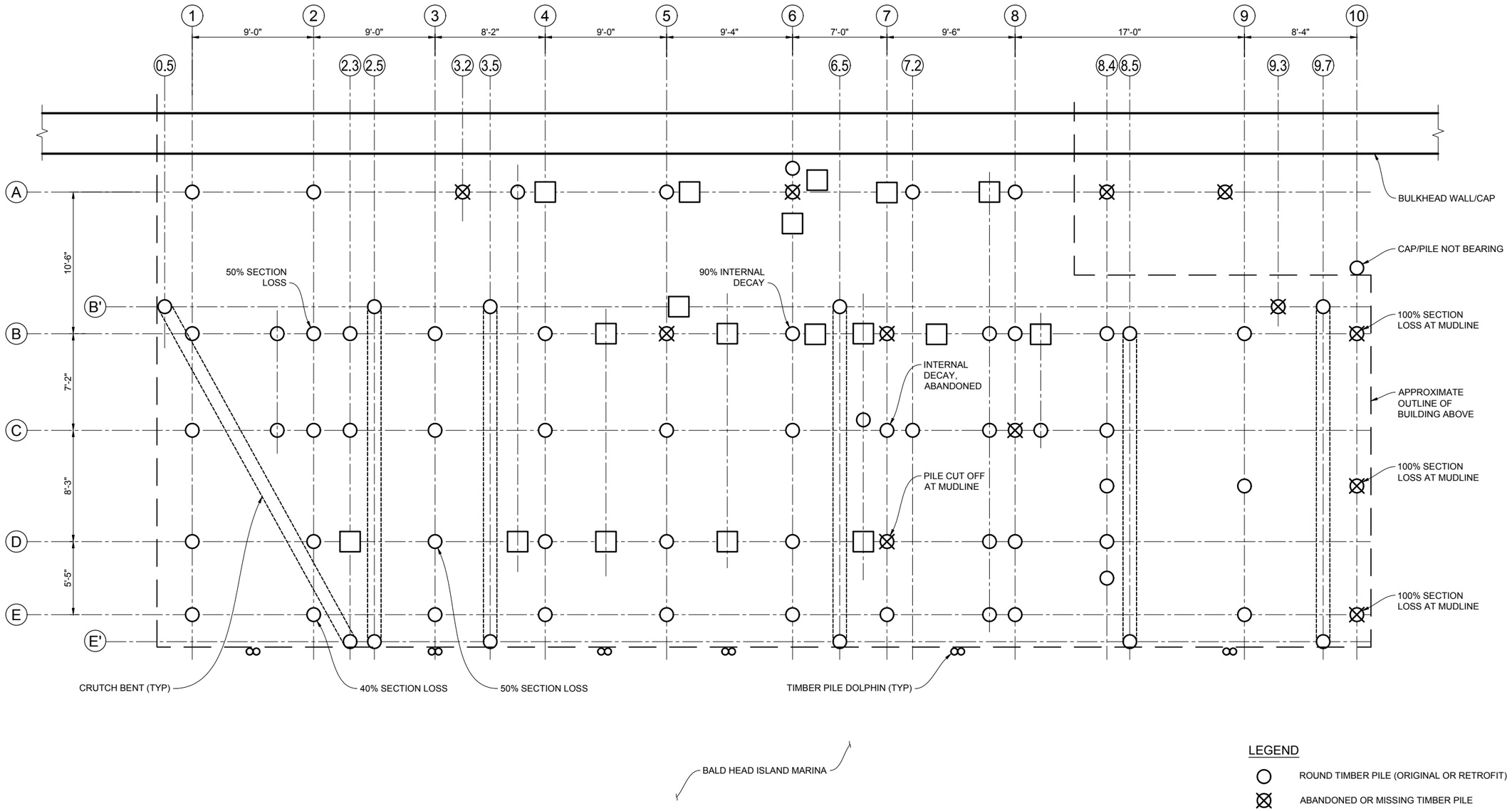
8' 0'-0" 8' 16'

GRAPHICAL SCALE

A-GATE PASSENGER TERMINAL PILE PLAN

moffatt & nichol

FIG-A1



LEGEND

- ROUND TIMBER PILE (ORIGINAL OR RETROFIT)
- ABANDONED OR MISSING TIMBER PILE
- SQUARE TIMBER COLUMN (RETROFIT)
- TIMBER PILE DOLPHIN

4' 0'-0" 4' 8'

GRAPHICAL SCALE

PASSENGER LANDING PILE PLAN

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FIG-A2

Appendix B:
Recommended Repair/Replacement Cost Estimates

BHITA	**Deep Point Marina B-Gate**	**Date Prepared**	**18-Feb-19**
Due Diligence Inspection	**Opinion of Probable Cost**	**M&N Job Number**	**10413**

Repair Cost Summary

	Description	Quantity	Units	Unit Price	Subtotal	Total
Timber Dock						**$ 11,000**
	Steel Tie Straps	100	EA	$ 50	$ 5,000	
	Joists	60	LF	$ 60	$ 3,600	
	Mob/Contingency	30%			$ 2,580	

Total Repair Cost for Deep Point Marina B-Gate	**$ 11,000**

BHITA	**Deep Point Marina Maintenance Fixed Pier**	**Date Prepared**	**18-Feb-19**
Due Diligence Inspection	**Opinion of Probable Cost**	**M&N Job Number**	**10413**

Description	Quantity	Units	Unit Price	Subtotal	Total

Repair Cost Summary

Fixed Pier						**$ 1,000**
	Fill Bolt Holes	5	CF	$ 50	$ 250	
	Split Bracing	10	LF	$ 60	$ 600	
	Mob/Contingency	30%			$ 255	

Total Repair Cost for Maintenance Fixed Pier	**$ 1,000**

BHITA	**Deep Point Marina Maintenance Finger Dock**	**Date Prepared**	**18-Feb-19**
Due Diligence Inspection	**Opinion of Probable Cost**	**M&N Job Number**	**10413**

Repair Cost Summary

	Description	Quantity	Units	Unit Price	Subtotal	Total
Finger Dock						**$ 10,000**
	Demolition/Pile Removal	1	EA	$ 750	$ 750	
	New Support Pile	50	LF	$ 50	$ 2,500	
	Mob/Contingency	200%			$ 6,500	

Total Repair Cost for Maintenance Finger Dock	**$ 10,000**

BHITA	**Deep Point Marina Bulkhead**	**Date Prepared**	**18-Feb-19**
Due Diligence Inspection	**Opinion of Probable Cost**	**M&N Job Number**	**10413**

Description	Quantity	Units	Unit Price	Subtotal	Total

Repair Cost Summary

Bulkhead						**$ 137,000**
	Sinkhole Fill	100	CF	$ 50	$ 5,000	
	Concrete Spall Repair	15	CF	$ 2,500	$ 37,500	
	Concrete Crack Repair	25	LF	$ 1,250	$ 31,250	
	New Bulkhead Sections	400	SF	$ 50	$ 20,000	
	New Bulkhead Anchorage	10	EA	$ 1,200	$ 12,000	
	Mob/Contingency	30%			$ 31,725	

Total Repair Cost for DPM Bulkhead	**$ 137,000**

BHITA	**Deep Point Marina Ferry Ramp**	**Date Prepared**	**18-Feb-19**
Due Diligence Inspection	**Opinion of Probable Cost**	**M&N Job Number**	**10413**

Description	Quantity	Units	Unit Price	Subtotal	Total

Replacement Cost Summary

DPM Ferry Ramp						**$ 130,000**
	Demolition / Removal	15	Tons	$ 750	$ 11,250	
	Steel Ramp	15	Tons	$ 6,000	$ 90,000	
	Mob/Contingency	30%			$ 30,375	

Total Replacement Cost for DPM Ferry Ramp	**$ 130,000**

Repair Cost Summary

Ferry Ramp						**$ 24,000**
	Concrete Spall Repair	8	CF	$ 2,500	$ 18,750	
	Mob/Contingency	30%			$ 5,625	

Total Repair Cost for Ferry Ramp	**$ 24,000**

BHITA	**Bald Head Island Marina Ferry Ramp**	**Date Prepared**	**18-Feb-19**
Due Diligence Inspection	**Opinion of Probable Cost**	**M&N Job Number**	**10413**

Description	Quantity	Units	Unit Price	Subtotal	Total

Replacement Cost Summary

BHI Ferry Ramp						**$ 130,000**
	Demolition / Removal	15	Tons	$ 750	$ 11,250	
	Steel Ramp	15	Tons	$ 6,000	$ 90,000	
	Mob/Contingency	30%			$ 30,375	

Total Replacement Cost for BHI Ferry Ramp	**$ 130,000**

BHITA	**Bald Head Island Contractor Landing**	**Date Prepared**	**18-Feb-19**
Due Diligence Inspection	**Opinion of Probable Cost**	**M&N Job Number**	**10413**

Repair Cost Summary

	Description	Quantity	Units	Unit Price	Subtotal	Total
Timber Dock						**$ 10,000**
	Fill Bolt Holes	10	CF	$ 50	$ 500	
	Timber Repairs	30	LF	$ 250	$ 7,500	
	Mob/Contingency	30%			$ 2,400	

Total Repair Cost for BHI Contractor Landing	**$ 10,000**

BHITA	**Bald Head Island Passenger Landing**	**Date Prepared**	**18-Feb-19**
Due Diligence Inspection	**Opinion of Probable Cost**	**M&N Job Number**	**10413**

Description	Quantity	Units	Unit Price	Subtotal	Total

Replacement Cost Summary

Timber Dock						**$ 900,000**
	Demolition / Removal	3150	SF	$ 20	$ 63,000	
	Covered Timber Dock	3150	SF	$ 200	$ 630,000	
	Mob/Contingency	30%			$ 207,900	

Total Replacement Cost for BHI Passenger Landing	**$ 900,000**

Appendix C:
Damage and Condition Assessment Rating Descriptions

Table C-1: Component Damage Rating Descriptions

COMPONENT RATING	DESCRIPTION
Not Inspected (NI)	Component was inaccessible or not included in the scope.
No Damage (ND)	Component had a sound material surface.
Minor (MN)	*Timber:* Checks, splits, and gouges less than 0.5 inches wide. *Steel*: Less than 50% of perimeter or circumference affected by corrosion at any elevation or cross-section; loss of thickness up to 15% of nominal thickness at any location. *Concrete:* Mechanical abrasion or impact dents; general cracks up to 1/16-inch wide; occasional corrosion stain or small pop-out corrosion spall.
Moderate (MD)	*Timber:* Checks and splits greater than 0.5 inches wide; diameter loss up to 15%; cross-section area loss up to 25%; corroded hardware; marine borer infestation. *Steel*: Greater than 50% of surface at any elevation/cross-section affected by corrosion; 15% to 30% loss of nominal thickness at any location. *Concrete:* Structural cracks up to 1/16-inch wide; corrosion cracks up to ¼-inch wide; chemical deterioration; random cracks up to 1/16-inch wide; soft concrete and rounding corners up to 1-inch deep; frequent corrosion stain or medium pop-out corrosion spall.
Major (MJ)	*Timber:* Checks and splits through full depth of cross-section; diameter loss 15% to 30%; cross-section loss 25% to 50%; heavily corroded hardware; displacement, misalignments at connections. *Steel:* Partial loss of flange edges or visible reduction of wall thickness; 30% to 50% loss of nominal thickness, any location. *Concrete:* Structural cracks 1/16-inch to ¼-inch wide; partial breakage (spalls); corrosion cracks greater than ¼-inch wide; multiple cracking and disintegration of surface due to chemical deterioration.
Severe (SV)	*Timber:* Diameter loss greater than 30%; cross-section area loss greater than 50%; loss of connections and/or fully non-bearing; partial or complete breakage. *Steel*: Structural bends or buckling, breakage and displacement at supports, loose or lost connections; greater than 50% loss of nominal thickness, any location. *Concrete:* Structural cracks greater than ¼-inch wide; breakage; loss of bearing and displacement at connections; reinforcing steel w/cover loss and greater than 30% diameter loss for any main bar; exposed steel due to chemical deterioration; cross section loss greater than 30% of any component for any reason.

Table C-2: Structure Condition Assessment Rating Descriptions

CAR Rating	Description
6 "Good"	No defects or only minor defects noted. Structural elements may show some very minor deterioration, but no significant reduction in structural capacity. No Repairs are required.
5 "Satisfactory"	Minor to moderate defects and deterioration observed, but no significant reduction in structural capacity. No repairs are required.
4 "Fair"	All primary structural elements are sound; but minor to moderate defects and deterioration observed. Localized areas of moderate to severe deterioration may be present but do not significantly reduce the structural capacity. Repairs are recommended, but the priority of the recommended repairs is low.
3 "Poor"	Major deterioration or overstressing observed on widespread portions of the structure. Some reduction in structural capacity. Repairs may need to be carried out with moderate urgency.
2 "Serious"	Severe deterioration, overstressing or breakage may have significantly affected the load bearing capacity of primary structural components. Local failures are possible. Repairs may need to be carried out on a high-priority basis with urgency.
1 "Critical"	Very severe deterioration, overstressing, or breakage has resulted in localized failure(s) of primary structural components. More widespread failures are possible or likely to occur. Repairs may need to be carried out on a very high priority basis with strong urgency.

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