STRUCTURAL ASSESSMENT
OF
MARSHWALK AND VETERANS PIER
MURRELLS INLET, SC
EW #: 161166.003

February 24, 2021

PREPARED FOR:

GEORGETOWN COUNTY
PARKS AND RECREATION DEPARTMENT

PREPARED BY:

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STRUCTURAL ASSESSMENT
MARSHWALK AND VETERANS PIER, MURRELLS INLET, SC

EXECUTIVE SUMMARY AND RECOMMENDATIONS

The EARTHWORKS Group was retained to evaluate the current structural condition of the Marshwalk and Veterans Pier in Murrells Inlet, SC. The damages found at the Marshwalk Phases 1 through 4 can generally be classified as structural damage to timber decking and framing (guardrails, posts and ancillary framing), and corrosion damage to connectors (both screws and framing connectors). The cause of damage to framing can be directly attributed to age of materials and exposure to the elements (sunlight and moisture). Corrosion damage can be attributed to long term exposure to salt spray, and replacement of corroded connectors is required to mitigate future storm damage by maintaining solid connection of framing components, which is critical to minimizing damage to the deck from floatation and uplift.

Phases 1C, 1E, and 3D are concrete sidewalks at grade (CONC) that were recently replaced in 2017 and 2020 and do not have significant damage that require repair, with the exception of the inside guard rails in Phases 1C and 1E. Phase 5 is a wood boardwalk over water (WBOW) that was constructed in 2015 and also does not have significant damage that would require repair.

Phases 1A, 1B, 1D and 2 are wooden boardwalks (WBOW, WBOS) that are approximately 20 years old. Phases 3A, 3C and 4A are wood boardwalks (WBOW) that are approximately 15 years old. Significant damage to the timber decking and guard rails has been observed (rot due to moisture, checking, splitting) that would warrant a full removal and replacement of the materials, since the material has reached the expected service life. Most of the framing components observed during the site visits (joists, pile caps, posts and piles) appear to be in good condition.

The following bullet points highlight the various items identified during this assessment and to be addressed during repairs:

- Wood decking on Phases 1A, 1B, 1D, 2, 3A, 3C and 4A have significant damage to the wood and loss of screws due to corrosion and should be removed and replaced with 316 stainless steel screws.
- Wood top handrails, mid-rails, and bottom rails should be removed and replaced where found to be damaged. Some locations may be able to complete partial replacement when existing framing is not significantly damaged. Locations where the wood rails are 20 years old should be completely replaced.
- All locations where significant galvanized bolt corrosion is found should be repaired using new hot dipped galvanized (HDG) or 316 stainless steel hardware.
- New 316 stainless steel uplift connectors should be installed at all pilecap locations in Phases 3C and 4A to mitigate potential damage in future storms. All other phases should have damaged connectors replaced as needed.

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INTRODUCTION

The EARTHWORKS Group was retained to evaluate the current structural condition of all wooden and concrete sections of the Marshwalk and Veterans Pier in Murrells Inlet, SC. This assessment is intended to document the current condition of the structure and provide recommendations for preparation of a Scope of Work for repairs. This facility consists of a combination of concrete walkways at grade, wood framed walkways at grade, and wood framed walkways over water on a timber pile foundation, with elevated entries connected back to the concrete and wood walkways.

Photo 1 - Aerial View of Marshwalk and Veterans Pier (courtesy of Google Earth)

This structure was built in 5 phases, Phases 1A to 1E from Wahoo's to Mullet Hut was built in 2000, Phase 2 from Mullet Hut to Dead Dog Saloon was built in 2001, Phase 3 from Dead Dog Saloon to Wicked Tuna was built in 2004 and Phase 4A, the Veterans Pier was built in 2005. A portion of the Veterans Pier (phase 4B) was not completed in accordance to the permitted plans. Phase 5 was an addition at the north end in front of Bovines completed in 2014.

Several phases of the Marshwalk and Veterans Pier have been repaired from previous storm events. Concrete walkways in Phase 1C, 1E, and 3D have been replaced, some guard rails in these areas have been replaced, and one section of retaining wall was constructed to protect Phase 3D. General long term maintenance issues are being addressed during this assessment.

METHODOLOGY

Assessment of this structure included visual inspection of the various exterior elements and photo-documentation to determine what type of repairs may be necessary for the Marshwalk and Veterans Pier.

Exterior elements were photographed to document existing conditions. The assessment was conducted from the ground. Access under the Marshwalk and Pier (only on the over water portions) allowed an observation of foundation elements, including steel connectors and wood beams for the framing and uplift. The concrete walkway portions running east-west that connect the main Marshwalk structure to the parking lots and Highway 17 were not included. All concrete walkways parallel to the creek (Phases 1C, 1E, 3B and 3D) are included in this report.

No intrusive or destructive testing was conducted at this time to determine the extent of any damage found. No materials were removed to expose framing or components except as listed within specific portions of the report.

The photographs contained in this report are typical of the conditions found, all photographs were not included. General as-built plans were compiled from data provided by Georgetown County, construction plans for several EARTHWORKS (EW) projects, and additional survey work completed to determine horizontal and vertical locations. Specific design of repairs or corrective actions were developed concurrently with this assessment report.

An evaluation of the following components were completed during this assessment:

1. Structural framing
2. Corrosion of metal connectors
3. Concrete pathway settlement

Specific standards referenced include:

1. 2018 International Building Code
2. ANSI A117.1-2015 Accessible and Usable Buildings and Facilities (ADA)
3. ASCE 2010 Minimum Design Loads for Buildings and Other Structures
4. SCDHEC-OCRM Critical Area Permitting Regulations (R 30.1 – R 30.19)

FINDINGS

The initial assessment started by classifying each phase based on construction. Three general construction types for the wood construction were shown in the permitting documents, a wood boardwalk over land (WBOL), a wood boardwalk over water (WBOW) and a wood boardwalk over seawall (WBOS). A fourth construction type for concrete walkway at grade (CWAG) was also found.

Phase Name		Length	Permit Date	Construction Date
Phase 1A:	Wood boardwalk over land	87 LF	1998	2000
Phase 1B:	Wood boardwalk over seawall	156 LF	1998	2000
Phase 1C:	Concrete walkway at grade	117 LF	1998	2000/2018
Phase 1D:	Wood boardwalk over water	108 LF	1998	2000
Phase 1E:	Concrete walkway at grade	345 LF	1998	2000/2018
Phase 2:	Wood boardwalk over water	380 LF	1999	2000
Phase 3A:	Wood boardwalk over water	135 LF	2002	2004
Phase 3B:	Concrete walkway at grade	185 LF	2002	2004
Phase 3C:	Wood boardwalk over water	39 LF	2002	2004
Phase 3D:	Concrete walkway at grade	305 LF	2002	2020
Phase 4A:	Wood boardwalk over water	780 LF	2003	2005
Phase 5:	Wood boardwalk over water	105 LF	2014	2015

Assessment of the following items were considered for each phase:

1. Structural Framing
2. Corrosion of Metal Connectors
3. Concrete walkways

Specific wood framing items reviewed included wood support pilings (where visible), pile caps, deck joists, cross bracing, metal framing connectors, guardrail posts, lower guardrails, and upper handrail assembly.

Specific concrete walkway issues reviewed included settlement of ground surfaces (concrete and pavers), sinkholes, discharge of sediments on the outside of retaining walls, movement of guardrail posts, and associated loss of soils under the walkway.

Measurements for length and area of each phase was taken from permit plans, aerial photography, and site measurements. Due to geometry of each phase, measurements are generally taken along the centerline of the boardwalk alignment. Quantities shown for the Opinion of Probable Construction Cost are estimated based on available information, some items are shown as a percentage of the total amount installed to provide an allowance for budget purposes.

Phase 1A Evaluation

Structural - Phase 1A consists of 87 LF of Wood Boardwalk over Land (WBOL) that is constructed behind the existing concrete seawall adjacent to Wahoo's Tiki Bar. Phase 5 is to the north (in front of Bovines) and Phase 1B is to the south (in front of Wahoo's). The timber piles, pile caps, and joists were not accessible without disassembly of the walkway, except at the edge adjacent to the concrete retaining wall. Timber decking and guardrails were visible and assessed. This material has been installed for approximately 20 years, and the wood decking and the guardrails have visible damage in approximately 25% of the area observed. Metal connector corrosion (screws and pile cap/joist connectors) is expected to be widespread based on similar sections nearby that have loose boards.

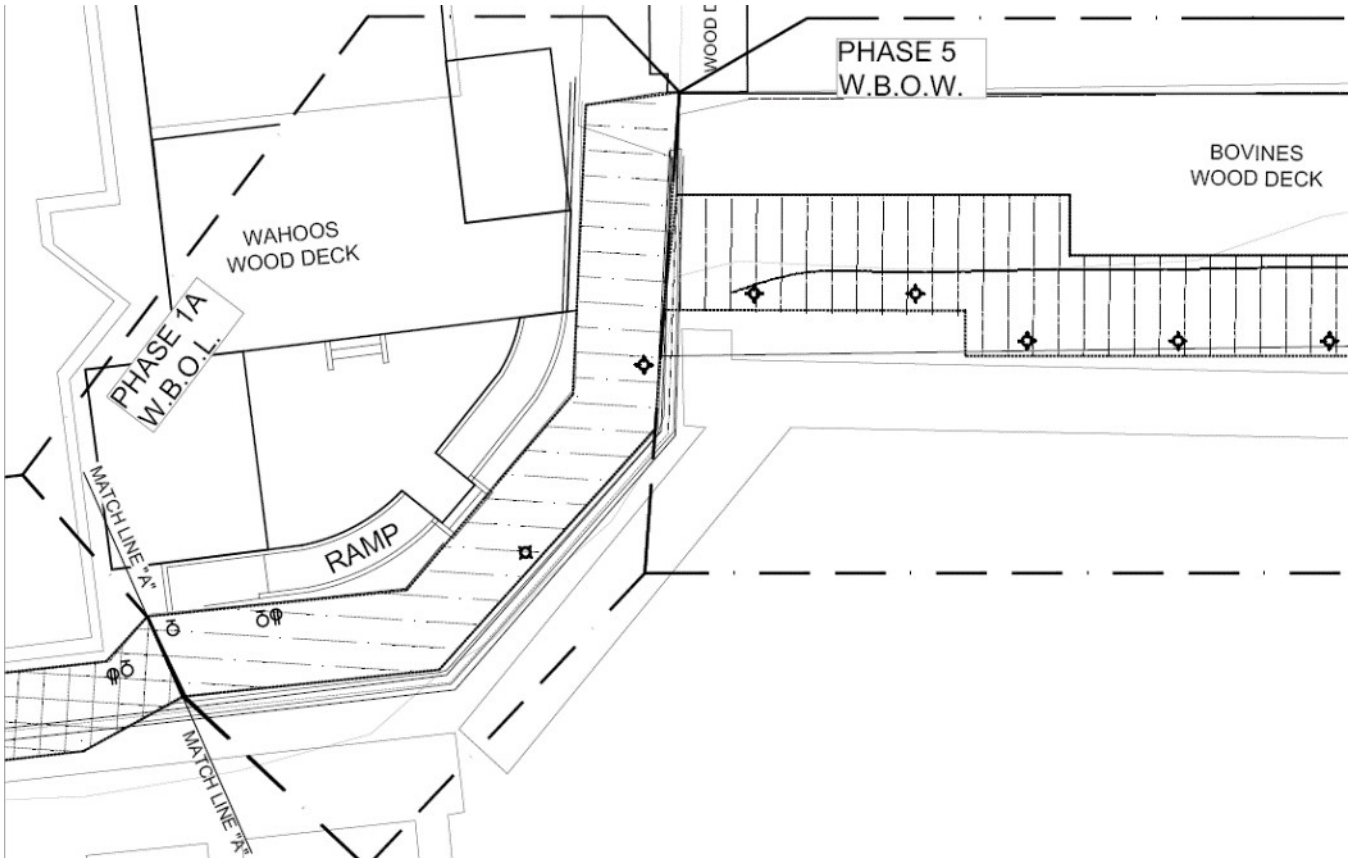


Figure 1 – Phase 1A Location and layout

Removal of the wood decking may reveal additional structural concerns with the joists and pile caps, which could result in the removal and replacement of deck supports on an as-needed basis. The joist to pile cap connectors may require replacement due to corrosion, but none were open for observation.

The boardwalk decking consists of treated 2x8s attached to the joists using galvanized or coated screws. Structural damage, including wood rot from moisture and splitting/checking of wood was observed in numerous locations consistent with exterior use (pedestrian traffic and environmental exposure to sun and rain).

The guardrail consists of 6x6 posts, 2x6 lower guardrail, a 2x6 middle guardrail, and a combination 2x6 and 2x12 cap rail screwed together for structural integrity. The guardrail in Phase 1A will require repairs due to damaged boards, corrosion of connectors, and other age related deterioration.

Photo 2 & 3 - Phase 1A view from entry between Bovines and Wahoos and looking South at corner

Photo 4 & 5 – Deteriorated wood decking and guardrails in Phase 1A due to age of materials

Corrosion of Metal Fasteners – Metal fasteners in this Phase were difficult to observe, visible bolts along the outside edge of concrete seawall appeared to be in good condition. Pile cap to joist connectors were not observed.

Concrete pathway settlement – Phase 1A does not contain any concrete walkways subject to settlement.

Phase 1B Evaluation

Structural - Phase 1B consists of 155 LF of Wood Boardwalk over Seawall (WBOS) where the piles are located behind the existing concrete seawall adjacent to Wahoo's and a portion of the walkway is cantilevered over the seawall. The timber piles were not accessible without disassembly of the walkway, and only a portion of the pile caps and joists were visible from the floating docks below. The observed damage includes deterioration of wood decking and railings due to age and corrosion of metal connectors.

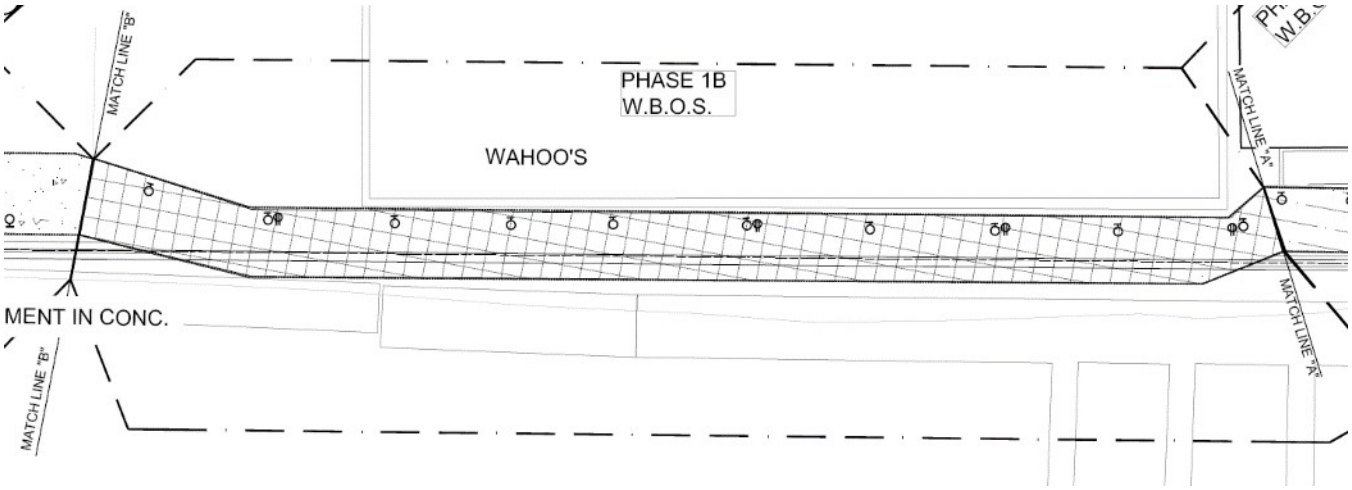


Figure 3 – Phase 1B layout

The foundation is constructed from 6x6 piles with double 2x12 pile caps bolted to the pilings, with approximately 24" of cantilever over the seawall. Treated 2x8 joists at 16" spacing were used for walkway decking support. Only the portions of the walkway that were open from below were observable. Typical conditions observed show that the piles and pile caps appear to be in good shape, and deck joists did not have visible signs of deterioration. Removal of the wood decking may reveal additional structural concerns with the joists and pile caps, which could result in the removal and replacement of deck supports (joists or pile caps) on an as-needed basis. Several joist to pile cap connectors were observed that require replacement due to corrosion, but the majority were intact.

The boardwalk decking consists of treated 2x8s attached to the joists using galvanized or ceramic coated screws. Structural damage, including wood rot from moisture and splitting/checking of wood was observed in scattered locations consistent with exterior use (pedestrian traffic and environmental exposure to sun and rain).

The guardrail consists of 6x6 posts, and 2x6 lower guardrail, a 2x6 middle guardrail, and a combination 2x6 and 2x12 cap rail screwed together for structural integrity. The outside guardrail post on the cantilever portion has a 6x6 knee brace back into the pile caps to transfer lateral loads. The guardrail in Phase 1B will require repairs due to damaged boards, corrosion of connectors, and other age related deterioration.

Corrosion of Metal Fasteners – Metal fasteners in this Phase were in various states of corrosion, with some fasteners completely corroded and other having light rust. The majority of the pile cap to joist connectors in this phase were in good condition and do not require replacement. A few of the galvanized

bolts connecting pile caps, braces, and guardrail posts were corroded and should be marked for replacement.

Concrete pathway settlement – Phase 1B does not contain any concrete walkways subject to settlement.


Photo 6 & 7 - Phase 1B looking South behind Wahoo's at start and end of boardwalk


Photo 8 & 9 – Metal connector (screw) corrosion failure and wood deterioration of deck boards

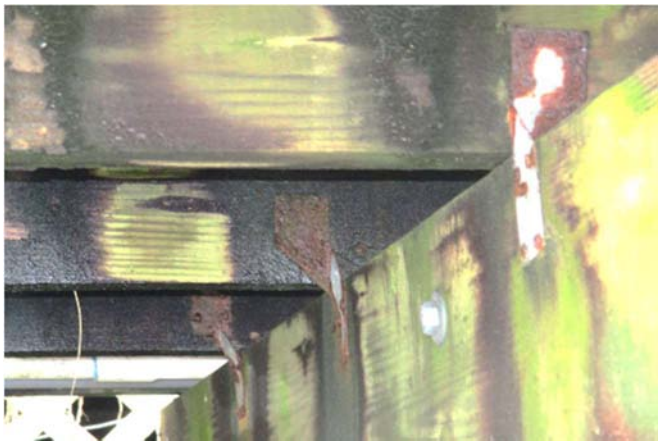



Photo 10 & 11 – Metal connector (screw) corrosion failure and wood deterioration of deck boards

Phase 1C Evaluation

Structural - Phase 1C consists of 115 LF of Concrete Walkway at Grade from the terminus of Phase 1 B to the start of Phase 1D (south property line). The concrete walkway was replaced in 2018 and the outside guard rail was repaired to adjust the height. This phase has one timber framed landing that connects the private docks into the public walkway. All connecting docks, landings and ramps are privately owned and maintained and are not discussed in this report.

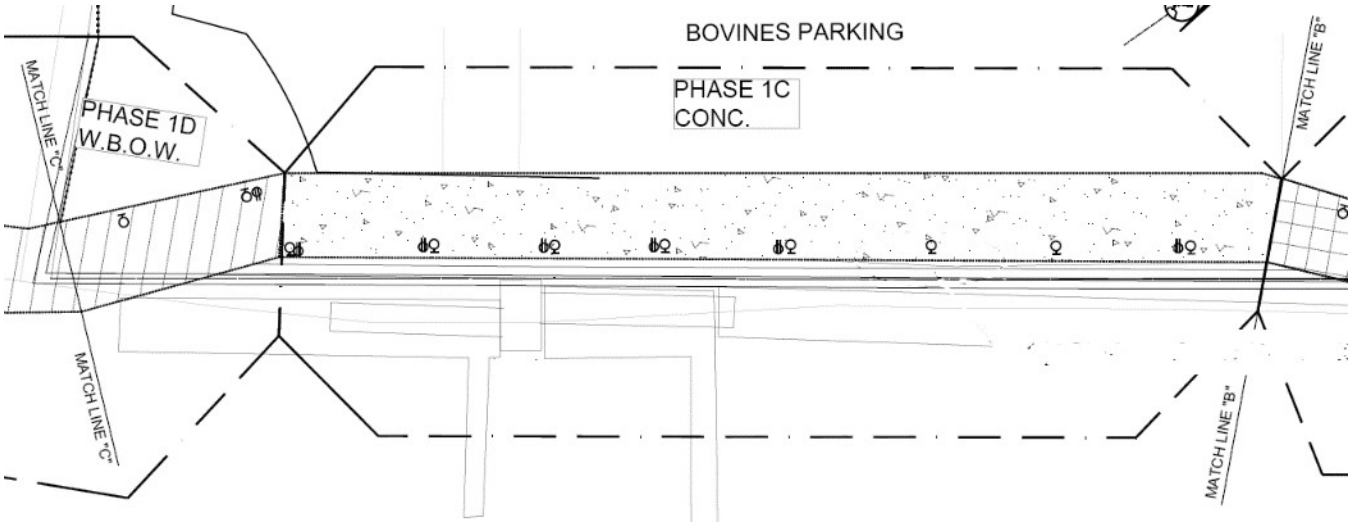


Figure 4 - Phase 1C location and layout

Photo 12 – Phase 1C looking north

Photo 13 – Inside Guardrail cap deterioration

The guardrail consists of 6x6 posts, 2x6 lower guardrail, a 2x6 middle guardrail, and a combination 2x6 and 2x12 cap rail screwed together for structural integrity. The outside guardrail in Phase 1C was repaired in 2018, but the interior guardrail was not included with this work. Some portions of the inside guardrail show wood deterioration consistent with the age, including splitting and checking, as well as metal connector failure. Portions of the rails have been replaced, new connectors have been installed into the existing rails to replace corroded connectors.

Photo 14 – Top rail deterioration due to knots

Photo 15 – Typical rail joint at post

Photo 16 – Post damage at north entry point

Photo 17 – Joint separation at post from shrinkage

Corrosion of Metal Fasteners – Metal fasteners in this Phase were mainly screws connecting the rails to the posts. Older connectors have been replaced in some areas with new screws due to corrosion failure. All new construction should be completed with stainless steel screws.

Concrete pathway settlement – Phase 1C was replaced in 2018 and does not require concrete repairs.

Phase 1D Evaluation

Structural - Phase 1D consists of 106 LF of Wood Boardwalk over water where the piles are located in the water outside of the vinyl seawall of Drunken Jacks. A portion transitions from the concrete walkway over the concrete retaining wall of Wahoo's. The timber framed pier at the south entry is privately owned and maintained.

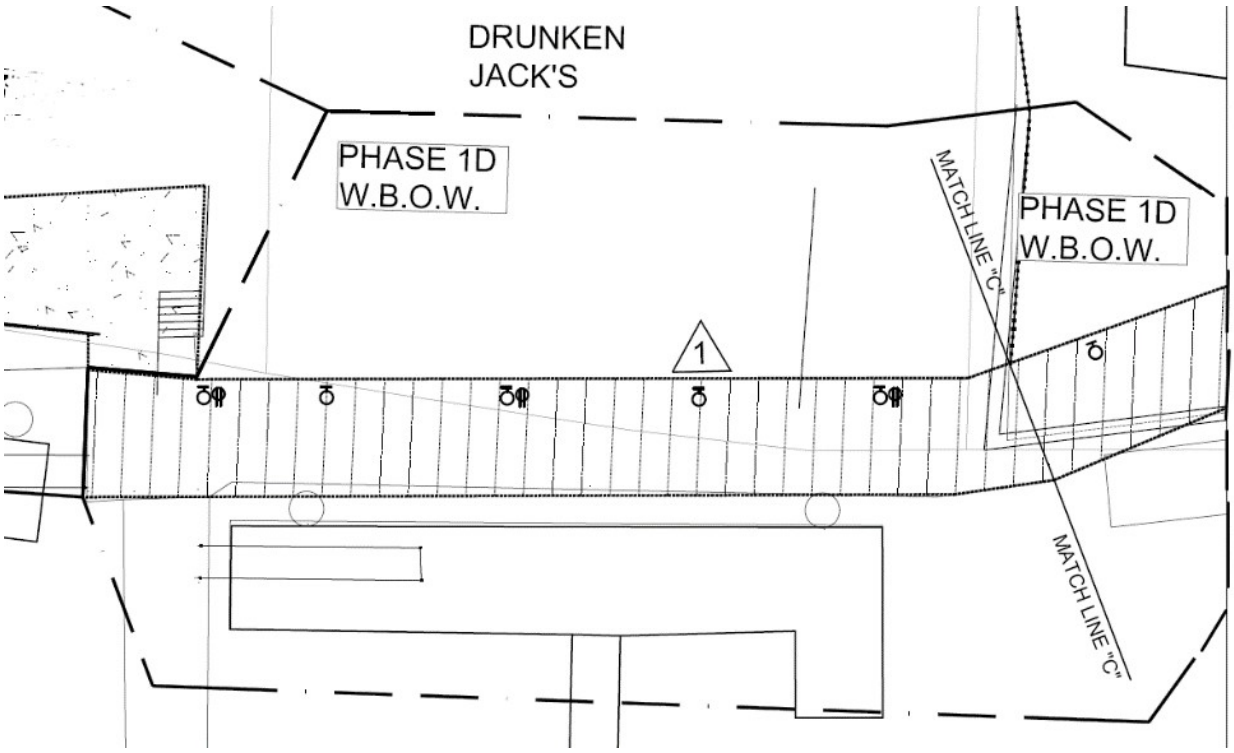


Figure 5 – Layout and location of Phase 1D

The foundation is 12" timber piles with 3x10 pile caps bolted to the pilings. Treated 3x8 joists at 24" spacing was used for walkway decking support. This area was observed from the adjacent floating docks. The boardwalk decking consists of treated 2x8s attached to the joists using galvanized or ceramic coated screws. Structural damage, including wood rot from moisture and splitting/checking of wood was observed in several locations consistent with exterior use (pedestrian traffic and environmental exposure to sun and rain). Some deck boards have been replaced during previous repairs.

The guardrail consists of 6x6 posts, and 2x6 lower guardrail, a 2x6 middle guardrail, and a combination 2x6 and 2x12 cap rail screwed together for structural integrity. The outside guardrail post is bolted directly into the outside 3x8 joist to transfer lateral loads. The guardrail in Phase 1D will require repairs due to damaged boards, corrosion of connectors, and other age related deterioration.

Corrosion of Metal Fasteners – Metal fasteners in this Phase were in various states of corrosion, with some fasteners completely corroded and other having light rust. The majority of the pile cap to joist connectors in this phase were in good condition and do not require replacement. Some of the galvanized bolts connecting pile caps, braces, and guardrail posts were corroded and should be marked for replacement.

Concrete pathway settlement – Phase 1D does not contain any concrete walkways subject to settlement.


Photos 18 & 19 – Phase 1D is a transition from concrete to wood in front of Drunken Jacks


Photos 20 & 21 – Typical framing of WBOW in Phase 1D showing pile caps, joists and bolts


Photo 22 & 23 - Typical deck board and rail damage at ends and corroded/replaced connectors

Phase 1E Evaluation

Structural - Phase 1E consists of 350 LF (measured down the centerline) of Concrete Walkway at Grade from the terminus of Phase 1D to the start of Phase 2 (north of the Mullet Hut). The concrete walkway was replaced in 2018 and the outside guard rail was repaired to adjust the height. The boardwalk surface consists of tabby textured concrete with embedded shells. This surface is in good condition and does not require repairs. The inside rail was not replaced. There are numerous privately owned and maintained finger piers in front of the Love Shack, J Peters and the Mullet Hut that are not included in this report.

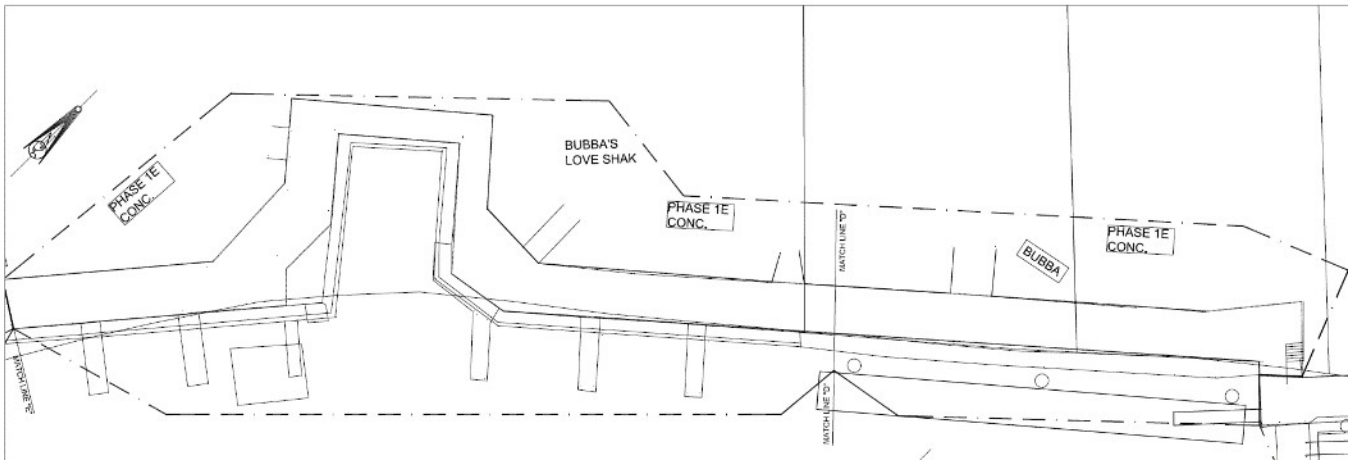
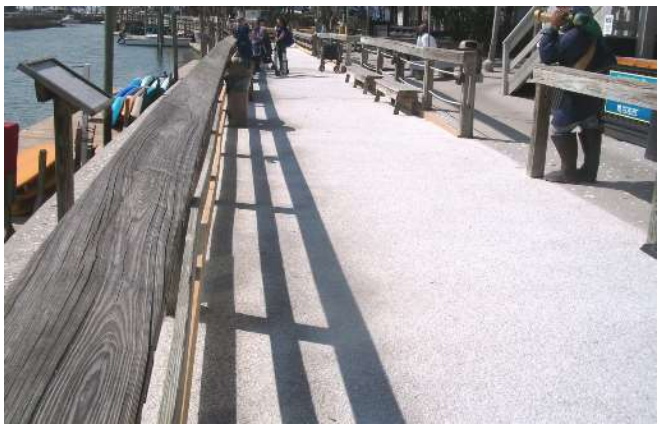


Figure 7 – Phase 1E location and layout




Photos 24 & 25 – Phase 1E looking south from Drunken Jacks (start) and to Mullet Hut (end)

The guardrail consists of 6x6 posts, 2x6 lower guardrail, a 2x6 middle guardrail, and a combination 2x6 and 2x12 cap rail screwed together for structural integrity. The outside guardrail in Phase 1E was replaced in 2018, but the interior guardrail was not included with this work. Some portions of the inside guardrail show wood deterioration consistent with the age, including splitting and checking, as well as metal connector failure. Selected locations on the top cap of the outside guardrail show deterioration of the wood due to splitting and checking. Portions of the inner rails have been replaced, new connectors have been installed into the existing rails to replace corroded connectors.

The inside guardrails at Drunken Jacks are built differently from the outside guardrail, but do not need to meet the 42" height requirement. The posts of the guardrail adjacent to the Love Shack are lower due to the raised concrete surface, and appear to be leaning from lateral loads where boards are attached to retain the higher grades west of the walkway.

Photos 26 & 27 – Typical top cap of replaced guardrail with material defects (knots, splitting/checking)

Photos 28 & 29 – Inside guardrails separating the Marshwalk from private property

Photos 30 & 31 – Inside guardrail joint separation at corners showing damaged ends and connectors

Corrosion of Metal Fasteners – Metal fasteners in this Phase were mainly screws connecting the rails to the posts. Older connectors have been replaced in some areas with new screws due to corrosion failure. All new construction should be completed with stainless steel screws.

Concrete pathway settlement – Phase 1E was replaced in 2018 and does not require concrete repairs.

Phase 2 Evaluation

Structural - Phase 2 consists of 375 LF of Wood Boardwalk over water where the piles are located in the water outside of the vinyl seawall of the Mullet Hut, Creek Ratz and Dead Dog Saloon. There are three privately owned landings that connect to private docks that are not included in this report. Phase 2 stops at the walkway between Dead Dog and Claw House.

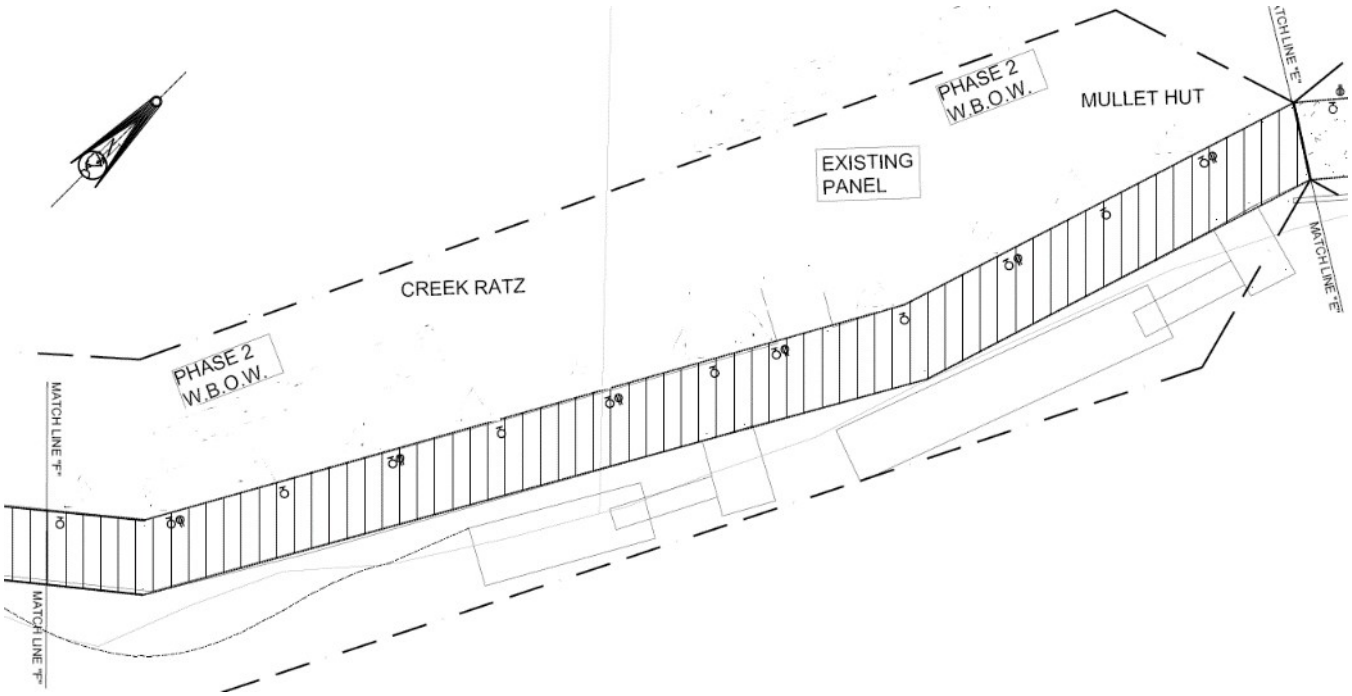


Figure 9 – North end of Phase 2 from Mullet Hut to Creek Ratz

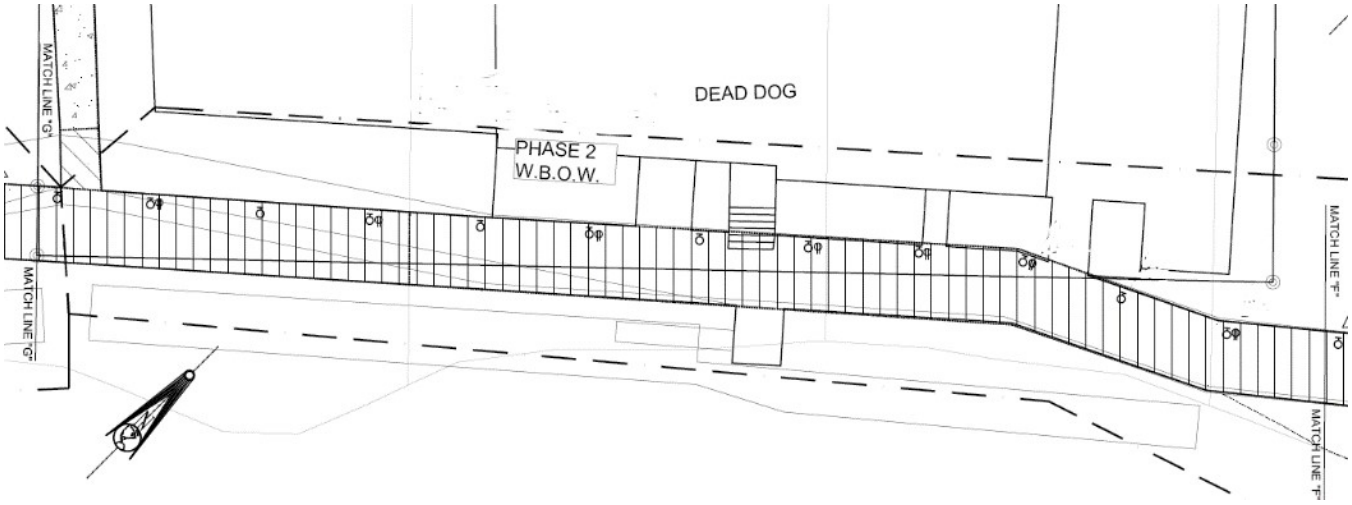


Figure 10 – South End of Phase 2 in front of Dead Dog Saloon

The foundation is constructed as 12" timber piles with 4x12 pile caps bolted to the pilings. Treated 4x8 joists at 24" spacing was installed for walkway decking support. This area was observed from the

adjacent floating docks. The boardwalk decking consists of treated 2x8s attached to the joists using galvanized or ceramic coated screws. Structural damage, including wood rot from moisture and splitting/checking of wood was observed in several locations consistent with exterior use (pedestrian traffic and environmental exposure to sun and rain). Several deck boards have been replaced during previous repairs, and numerous stainless steel screws have been installed to replace corroded connectors.

The guardrail consists of 6x6 posts, and 2x6 lower guardrail, a 2x6 middle guardrail, and a combination 2x6 and 2x12 cap rail screwed together for structural integrity. The outside guardrail post is bolted directly into the outside 3x8 joist to transfer lateral loads. The guardrail in Phase 2 will require repairs due to damaged boards, corrosion of connectors, and other age related deterioration.

Photo 34– Phase 2 looking south from Mullet Hut

Photo 35 – Phase 2 from Creek Ratz looking south

Photos 36 & 37 – Phase 2 framing of piles, pile caps, joists and metal connectors


Photos 38 & 39 – Guardrail damage included missing, split and broken boards due to age and moisture

Corrosion of Metal Fasteners – Metal fasteners in this Phase were in various states of corrosion, with some fasteners completely corroded and other having light rust. Numerous deck screws have failed, resulting in loose walk boards. The majority of the pile cap to joist connectors in this phase were in good condition and do not require replacement. Some of the galvanized bolts connecting pile caps, braces, and guardrail posts were corroded and should be marked for replacement.

Concrete pathway settlement – Phase 2 does not contain any concrete walkways subject to settlement.

Phase 3A Evaluation

Structural - Phase 3A consists of 129 LF of Wood Boardwalk over water where the piles are located in the water outside of the vinyl seawall of the Claw House. There is one privately owned and maintained landing that connects to private docks that is not discussed in this report.

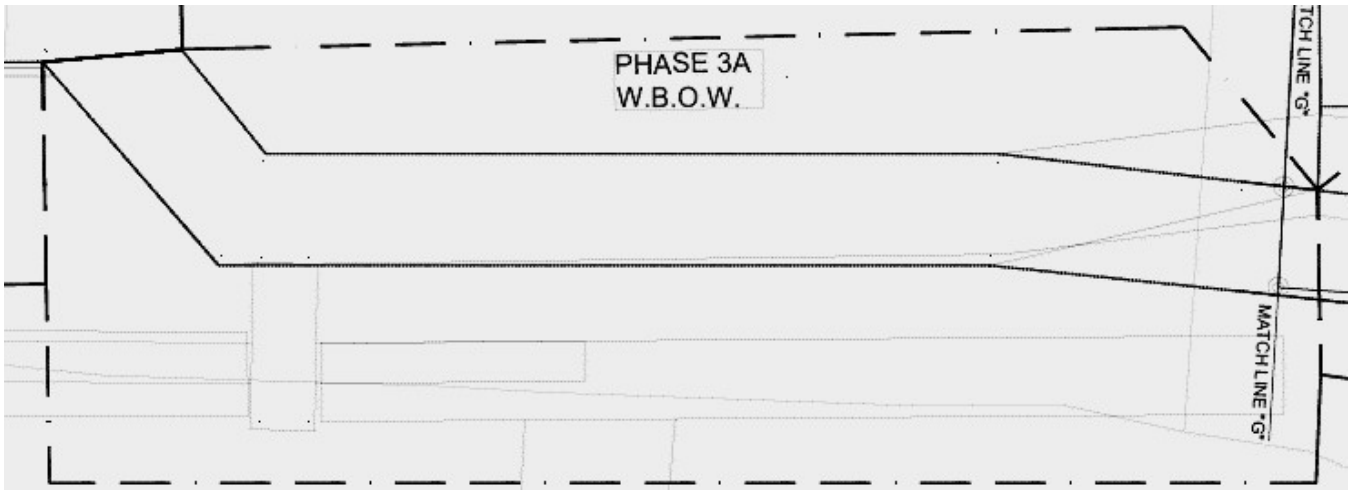


Figure 11 – Location and layout of Phase 3A

Photo 40 & 41 - Phase 3A viewed from the North and the South ends, respectively

The foundation is constructed as 12" timber piles with 4x12 pile caps bolted to the pilings. Treated 2x12 joists at 16" spacing are installed for walkway decking support. This area was observable from the adjacent floating docks.

Photo 42 & 43 - Typical pile, pile cap, and joist framing below Ph 3A and connection at Ph 2 boardwalk

The boardwalk decking consists of treated 2x8s attached to the joists using galvanized or ceramic coated screws. Structural damage, including wood rot from moisture and splitting/checking of wood was observed in several locations consistent with exterior use (pedestrian traffic and environmental exposure to sun and rain). Several deck boards have been replaced during previous repairs, and numerous stainless steel screws have been installed to replace corroded connectors. Galvanized metal connectors are installed from the pile caps to the joists.

The guardrail consists of 6x6 posts, 2x6 lower guardrail, a 2x6 middle guardrail, and a combination 2x6 and 2x12 cap rail screwed together for structural integrity. The guardrail in Phase 3A will require repairs due to damaged boards, corrosion of connectors, and other age related deterioration.

Corrosion of Metal Fasteners – Metal fasteners in this Phase were in various states of corrosion, with some fasteners completely corroded and other having light rust. The majority of the pile cap to joist connectors in this phase were in good condition and do not require replacement. Some of the galvanized bolts connecting pile caps, braces, and guardrail posts were corroded and should be marked for replacement.

Concrete pathway settlement – Phase 3A does not contain any concrete walkways subject to settlement.

Phase 3B Evaluation

Structural - Phase 3B consists of 185 LF of Concrete Walkway at Grade from the terminus of Phase 3A to the start of Phase 3C (wood boardwalk across the tip of the marina basin). The outside guardrails are original, there are no inside rails.

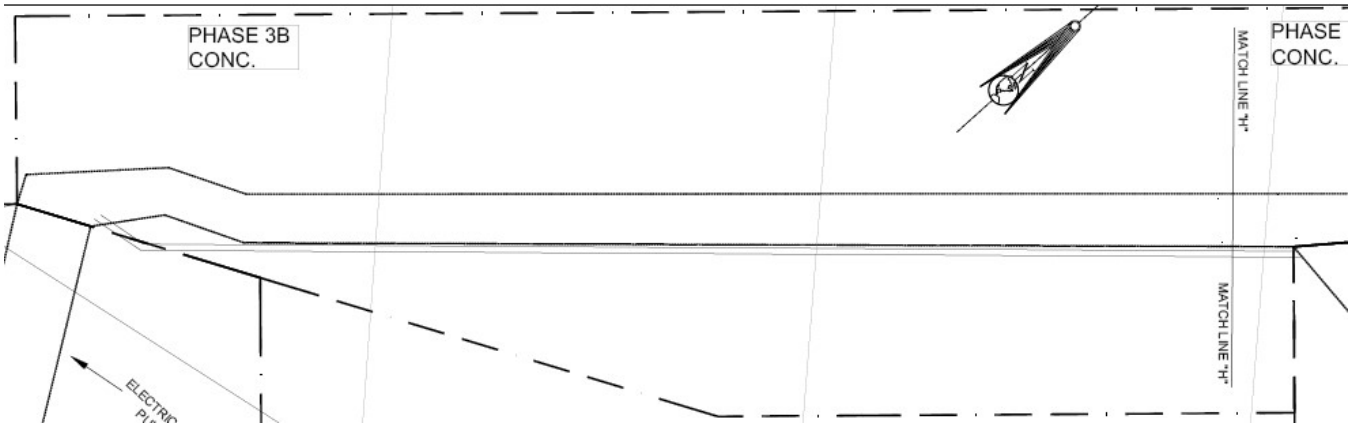


Figure 13 – Location of Phase 3B


Photo 44 & 45 – Phase 3B looking South from Claw House and from middle toward Phase 3C

The boardwalk surface consists of tabby textured concrete with embedded shells and the majority of the damage observed beyond normal wear was cracks and settlement of edges near joints. This section of concrete sidewalk is at or below the slag and gravel surface of the parking lot, and surface runoff brings sediment onto the surface of the sidewalk. There are vehicle stops placed on the surface, which also contributes to sediment tracking onto the concrete sidewalk.

The guardrail consists of 6x6 posts, 2x4 lower guardrail, a 2x6 middle guardrail, and a combination 2x6 and 2x12 cap rail screwed together for structural integrity. The guardrail in Phase 3B is deteriorated due to exposure of the wood to the elements and will require replacement.

Corrosion of Metal Fasteners – Metal fasteners in this Phase were mainly screws connecting the rails to the posts. Older connectors have been replaced in some areas with new screws due to corrosion failure. All new construction should be completed with stainless steel screws.

Photo 46 – Typical Cap rail damage in Phase 3B

Photo 47 – Bottom rail mounted too close to ground

Concrete pathway settlement – Phase 3B is a concrete walkway subject to settlement. Several locations have been covered with sediment from the adjacent parking lot and several locations are holding water after rainfall events, but no significant settlement had been observed. The southerly portion adjacent to Phase 3C has several cracks and is lower than the adjacent wood boardwalk section, which allows standing water and sediment to collect at this location. Other sections in Phase 3B hold water due to trapped sediments at the bottom rail on the east side.

Photo 48 – Standing water due to blockage at rail

Photo 49 – Cracked concrete and trapped sediment

Phase 3C Evaluation

Structural - Phase 3C consists of 39 LF of Wood Boardwalk over Water where the piles are located in the water between the vinyl seawall of the western parking and the timber seawall of Wicked Tuna.

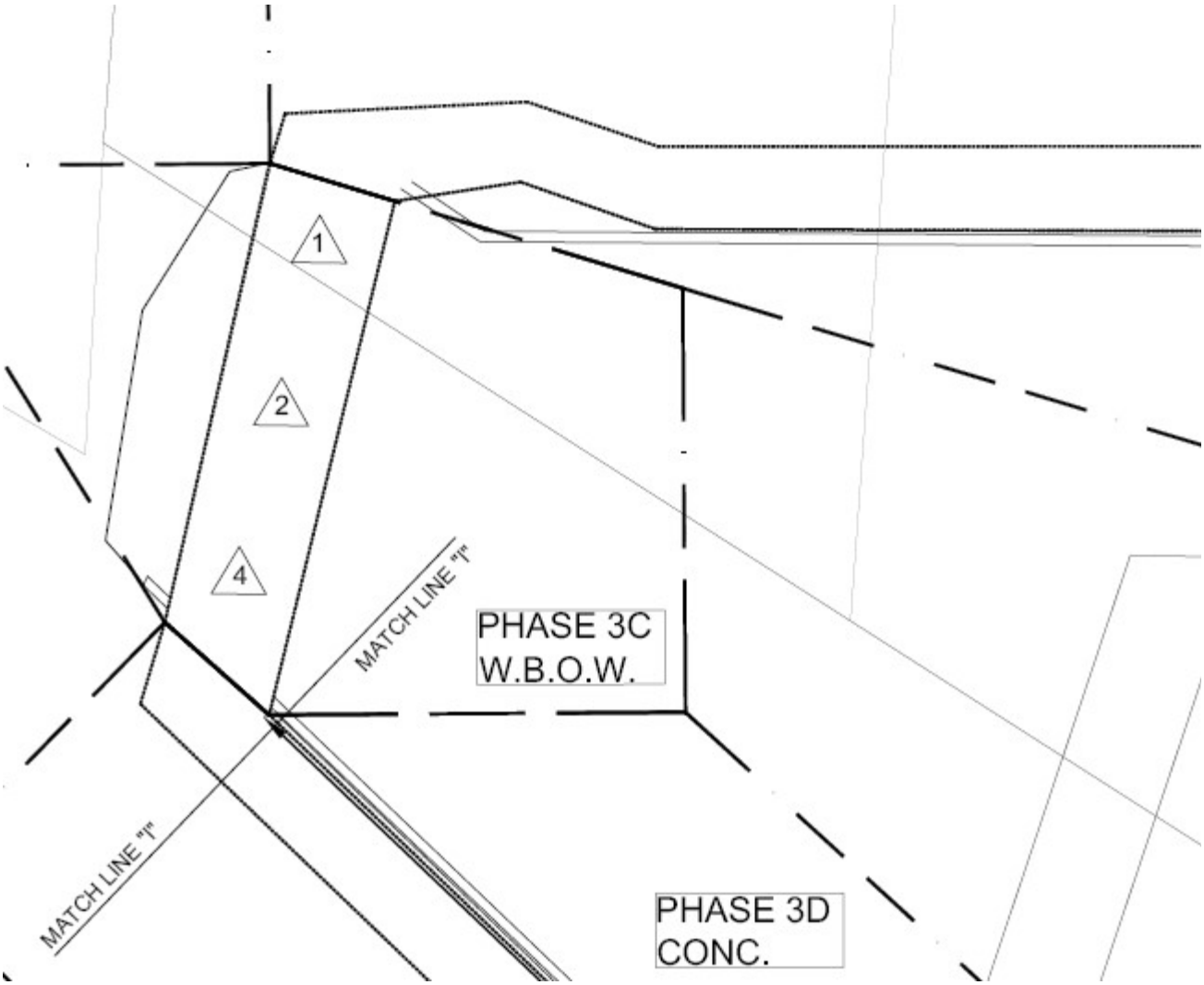


Figure 15 – Location of Phase 3C

The foundation is constructed as 12” timber piles with 4x12 pile caps bolted to the pilings. Treated 2x12 joists at 16” spacing was installed for walkway decking support. This area was observable from the adjacent ground.

The boardwalk decking consists of treated 2x8s attached to the joists using stainless steel screws. Structural damage, including wood rot from moisture and splitting/checking of wood was observed in several locations consistent with exterior use (pedestrian traffic and environmental exposure to sun and rain). Galvanized metal connectors were not observed to be installed from the pile caps to the joists.

Photo 50 & 51 – Phase 3C viewed from the west and the east ends, respectively

Photo 52 - Piles, pile caps and joists at Phase 3C

Photo 53 – Typical guardrail condition at Phase 3C

The guardrail consists of 6x6 posts, 2x6 or 2x4 lower guardrail, a 2x6 middle guardrail, and a combination 2x6 and 2x12 cap rail screwed together for structural integrity. The guardrails in Phase 3C will require repairs due to damaged boards, corrosion of connectors, and other age related deterioration.

Corrosion of Metal Fasteners – Metal fasteners in this Phase were in good condition where observed, deck screws were not observed. No joist to pile cap connectors were observed in this phase. Most of the galvanized bolts connecting pile caps, braces, and guardrail posts were in good condition and do not require replacement. A small number of bolts and nuts corroded and should be marked for replacement.

Concrete pathway settlement – Phase 3C does not contain any concrete walkways subject to settlement.

Phase 3D Evaluation

Structural - Phase 3D consists of 303 LF of Concrete Walkway at Grade from the terminus of Phase 3C to the start of Phase 4A (the Veterans Pier). The concrete walkway and guardrail were replaced in March 2020 and are in good shape. The retaining wall at Wicked Tuna was also replaced, so no repairs in this phase are required.

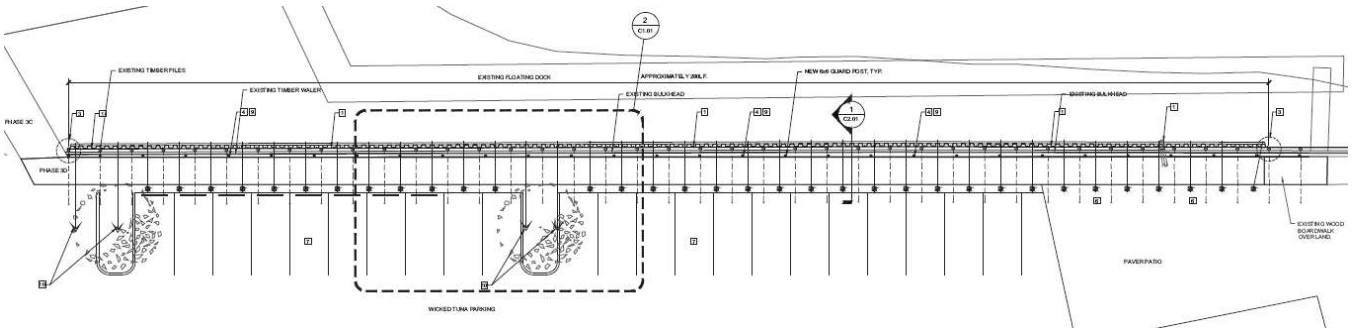


Figure 18 – Site Plan of Phase 3D showing location and area of seawall and walkway repair


Photos 54 & 55 – Phase 3D walkway looking from South toward Phase 4A at start and end

The guardrail consists of 6x6 posts, a 2x6 lower guardrail, a 2x6 middle guardrail, and a combination 2x6 and 2x12 cap rail screwed together for structural integrity. The guardrail in Phase 3D was replaced in March 2020 and does not show any signs of damage.

Corrosion of Metal Fasteners – Metal fasteners in this Phase were in good condition. No repairs are necessary at this time.

Concrete pathway settlement – Phase 3D consists of new construction, where the concrete sidewalk and guardrail was installed after the retaining wall replacement. No repairs are necessary at this time.

Phase 4A Evaluation

Structural - Phase 4A consists of 780 LF of Wood Boardwalk over water where the piles are located in the water North of Wicked Tuna parking lot. The connection between the concrete sidewalk in Phase 3D and the Phase 4A pier consists of a wood walkway at grade (WBAG), which was repaired in 2017. The portion of the retaining wall back to Phase 3D behind the existing timber wall required complete removal and replacement of the framing and decking.

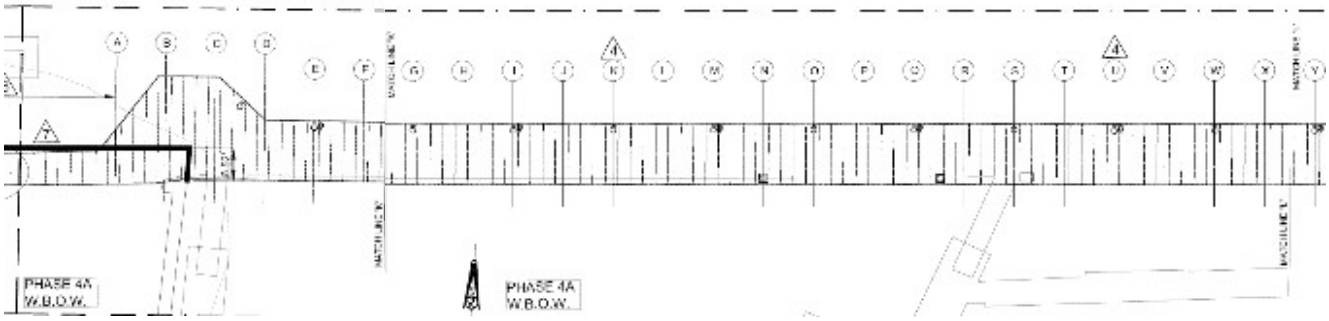


Figure 19 – Start of Phase 4A at corner of timber and concrete retaining wall

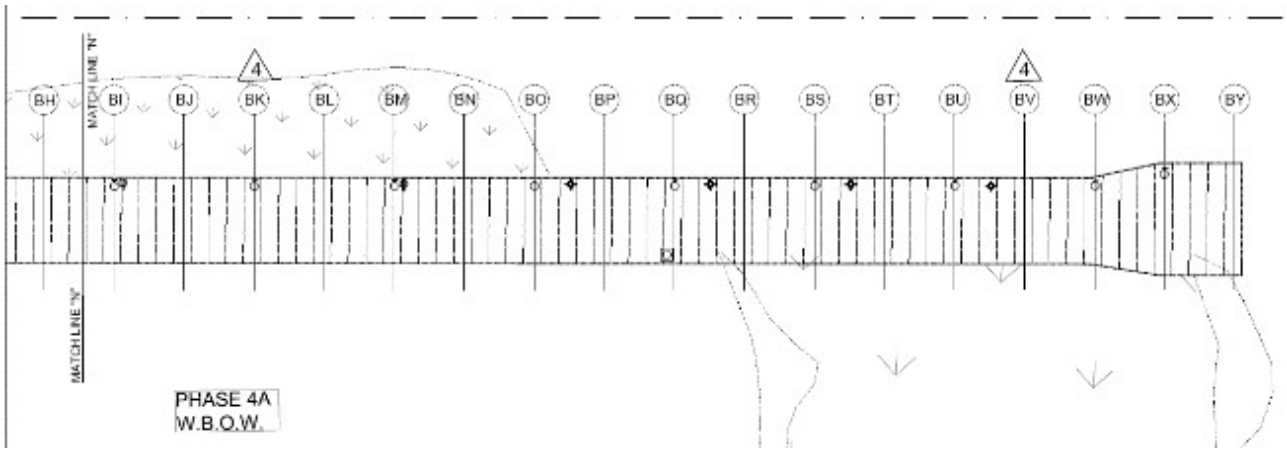
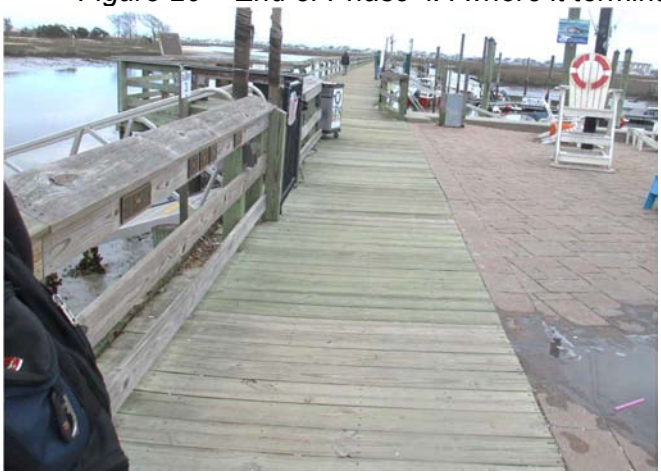


Figure 20 – End of Phase 4A where it terminates over water (Pile groups Z – BG not shown)

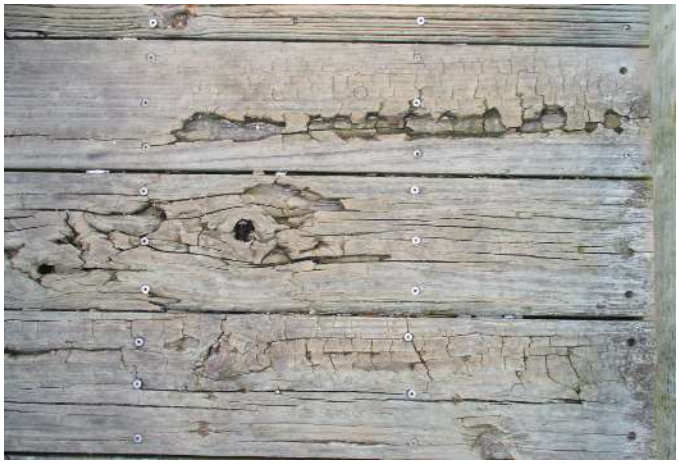



Photos 56 & 57 – Phase 4A walkway landward of retaining wall that was replaced in 2017

The foundation of the WBAG was similar to Phase 1A and is not discussed since it was replaced in 2017. The foundation for the WBOW is constructed as 12" timber piles with 4x12 pile caps bolted to the pilings. Pile cap spacing is 10 feet on center, with a total of 77 groups of pile caps (A – BY). Treated 2x12 joists at 16" spacing were installed for walkway decking support. This area was observable from the ground below the pier and from the adjacent floating docks. The galvanized metal connectors on Phase 4A are the most severely corroded on all phases observed, and the majority of these connectors are missing. These connectors are designed to reduce damage to the walkway framing from flotation during the storm surge, and replacement of these uplift connectors is critical to minimize damage from future storm events

The boardwalk decking consists of treated 2x8s attached to the joists using stainless steel screws. Structural damage, including splitting and checking of wood was observed in numerous locations consistent with exterior use (pedestrian traffic and environmental exposure to sun and rain). Portions of the decking over land were replaced in 2017, with the portions over water originally constructed in 2005.

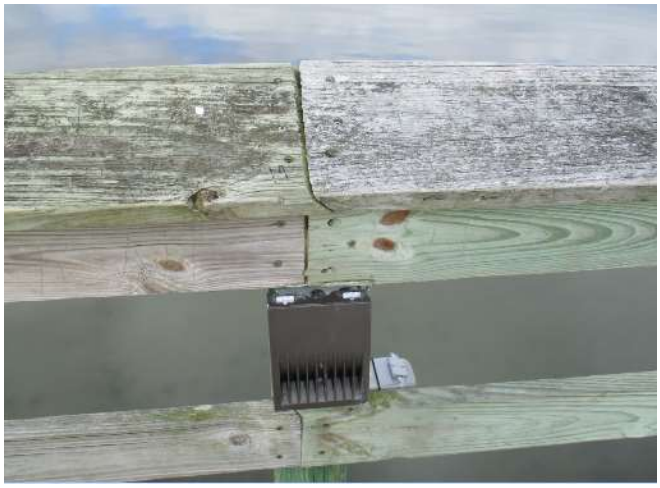

Photos 58 & 59 – Phase 4A walkway seaward of retaining wall that was constructed in 2005




Photos 60 & 61 – Typical wood decking deterioration observed over large portions of Phase 4A

The guardrail consists of 6x6 posts, and 2x6 lower guardrail, a 2x6 middle guardrail, and a combination 2x6 and 2x12 cap rail screwed together for structural integrity. The outside guardrail post is connected back into the pile caps to transfer lateral loads. The guardrail in Phase 4A will require repairs due to damaged boards, corrosion of connectors, and other age related deterioration. This entire phase can be

repaired by either complete replacement of the railings or by removal and replacement of railings that have significant damage. Approximately 25% of these boards need replacement but due to the age of the material, additional replacement would be required over the next 10 years if repairs are performed on a spot basis.




Photos 62 & 63 – Typical wood railing deterioration observed in isolated areas of Phase 4A


Photo 64 & 65 – Damaged metal connectors and galvanized bolts on Phase 4A to be replaced

Corrosion of Metal Fasteners – Metal fasteners in this Phase were severely corroded. Most pile cap to Joist connectors were completely corroded or missing. Most of the galvanized bolts connecting pile caps, and braces, were significantly corroded and require replacement. Bolts connecting guardrail posts were mostly in good condition. A small number of bolts and nuts were in good condition and should be marked to remain.

Concrete pathway settlement – Phase 4A does not contain any concrete walkways subject to settlement.

Phase 5 Evaluation

Structural - Phase 5 consists of 105 LF of Wood Boardwalk over Water that is constructed in front of Bovine's restaurant and is a 10 ft wide portion of the overall structure that also includes the wood deck in front of Bovine's. This structure was built in 2015 by the property owner.

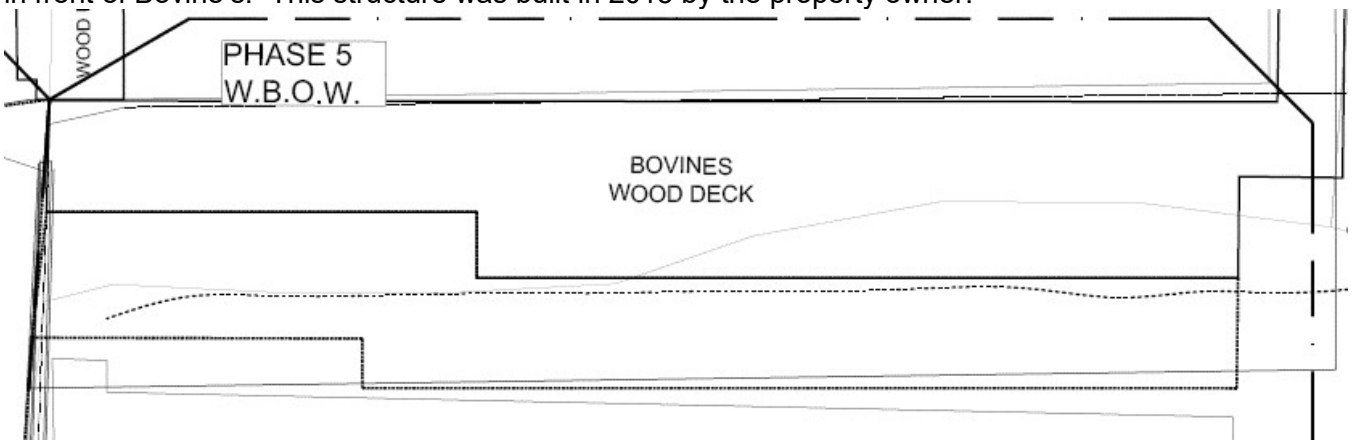


Figure 21 – Phase 5 Location

The foundation is constructed as 12" timber piles with 4x12 pile caps bolted to the pilings. Pile cap spacing is 10 feet on center. Treated 2x12 joists at 16" spacing were installed for walkway decking support. This area was observable from the adjacent floating docks. The boardwalk decking consists of treated 2x8s attached to the joists using stainless steel screws. No significant damage was observed beyond normal wear consistent with exterior use (pedestrian traffic and environmental exposure to sun and rain).

The guardrail consists of 6x6 posts, 2x6 lower guardrail, a 2x6 middle guardrail, and a combination 2x6 and 2x12 cap rail screwed together for structural integrity. The guardrail in Phase 5 did not show any significant damage and did not appear to require repairs.


Photo 66 & 67 – Phase 5 in front of Bovines did not appear to have damage requiring repairs

Corrosion of Metal Fasteners –The majority of the pile cap to joist connectors and bolts observed in this phase are in good condition and do not require replacement.

Concrete pathway settlement – Phase 5 does not contain any concrete walkways subject to settlement.

SUMMARY AND RECOMMENDATIONS

The damages found at the Marshwalk Phases 1 through 4 can generally be classified as structural damage to timber decking and framing (guardrails, posts and ancillary framing), and corrosion damage to connectors (including screws, bolts and framing connectors). Phase 5 did not appear to have any significant damage that required repair at this time. The cause of damage to decking and framing can be directly attributed to age of materials and exposure to the elements (sunlight and moisture). Corrosion damage can be attributed to long term exposure to salt spray, and replacement of corroded connectors is required to mitigate future storm damage by maintaining solid connection of framing components, which is critical to minimizing damage to the deck from floatation and uplift.

Phases 1C, 1E, and 3D are concrete sidewalks at grade (CONC) that were recently replaced in 2017 and 2020 and do not have significant damage that require repair, with the exception of the inside guard rails in Phases 1C and 1E. Phase 5 is a wood boardwalk over water (WBOW) that was constructed in 2015 and also does not have significant damage that would require repair.

Phases 1A, 1B, 1D and 2 are wooden boardwalks (WBOW, WBOS) that are approximately 20 years old. Phases 3A, 3C and 4A are wood boardwalks (WBOW) that are approximately 15 years old. Significant damage to the timber decking and guard rails has been observed (rot due to moisture, checking, splitting) that would warrant a full removal and replacement of the materials, since the material has reached the expected service life. Most of the framing components observed during the site visits (joists, pile caps, posts and piles) appear to be in good condition.

An alternate to complete guardrail removal and replacement is feasible in some sections of the Marshwalk where the damage to the guardrail is not significant, such as Phase 4A. This would require identification and marking of specific rails that are serviceable to allow an accurate quantity estimate for bidding purposes.

Corrosion of metal connectors in the piles and pile caps is most significant in Phase 4A, where the majority of the pile cap to joist connectors are failing and many bolts have advanced corrosion that requires replacement. Other phases of WBOW do not have significant failures, and replacement of metal connectors should be completed on a case-by-case basis. This should be incorporated into the bid specifications to allow for accurate quantities.

STRUCTURAL REPAIRS

1. PHASES 1A, 1B, 1D, 2, 3A, 3C, 4A – WOOD DECK REPLACEMENT

All wood decking to be removed and replaced with new treated Southern Yellow Pine (SYP), #2 or better. Treatment level to be rated for UC4B (Ground Contact/Freshwater Heavy Duty). All wood shall be free from knots, splits, checks and other defects.

Treated 2x8 wood decking shall be installed to match existing patterns using a minimum of three (3) #12 x 3" stainless steel screws at each joist. Decking shall be fit and spliced at angles in a workmanlike manner to reduce joists and small segments.

Existing wood to be removed from the site and disposed of in an approved manner. Contractor shall notify the owner when joists and below grade framing has moisture damage or other conditions that require replacement of joists.

2. PHASES 1A, 1B, 1D, 2, 3A, 3B, 3C (4A OPTIONAL) – GUARDRAIL REPLACEMENT

All wood rails to be removed and replaced with new treated Southern Yellow Pine (SYP), #2 or better. Treatment level to be rated for UC4B (Ground Contact/Freshwater Heavy Duty). All wood shall be free from knots, splits, checks and other defects. Existing 6x6 posts to remain unless otherwise noted.

Wood framed top handrail (2x12 cap with 2x6 vertical on face of 6x6 guardrail post) shall be removed and replaced. All rail replacement shall span over three (3) guardrail posts where feasible and be fit in a workmanlike manner to match existing handrails. Cap rail to be connected to vertical rail at 12" OC minimum with #12 x 3" screws (316 stainless steel). Cap rail and vertical rails shall be attached to the 6x6 guardrail posts using a minimum of three (3) #12 x 3" stainless steel screws.

All Mid Rails (MR) and Bottom Rails (BR) shall be removed and replaced, with rails spanning over three (3) guardrail posts and be fit in a workmanlike manner to match existing rails. All rails shall be attached to the 6x6 guardrail posts using a minimum of two (2) #12 x 3" stainless steel screws. All bottom rail replacement to be treated 2x6 and placed 4" above the grade of the walkway.

3. ALL PHASES – TIMBER JOIST REPLACEMENT

Contractor shall notify the owner when joists and below grade framing has moisture damage or other conditions that require replacement of joists or pile caps. All framing found to be damaged shall be removed and replaced with new treated Southern Yellow Pine (SYP), #2 or better. Treatment level to be rated for UC4B (Ground Contact/Freshwater Heavy Duty). All wood shall be free from knots, splits, checks and other defects.

Treated 2x12 joists or pile caps (sized to match existing framing) shall be installed to match existing patterns using a minimum of two (2) stainless steel connectors (one at each joist end) to the existing pile cap. Damaged pile caps shall be installed using stainless steel bolts to existing piles.

Existing wood to be removed from the site and disposed of in an approved manner.

4. PHASE 1A, 1B, 1D, 2, 3A, 3C, 4A UPLIFT CONNECTOR REPLACEMENT

New stainless steel joist-to-pile cap uplift connectors shall be installed at all pile cap locations where they are missing or damaged due to corrosion. All connectors and nails in this locations should be Type 316L stainless steel to provide greater durability from corrosion. Uplift connectors should be Simpson H3 or USP RT3A (or equivalent), with a minimum of four (4) 8d (0.131") x 1.5" nails into each joist and pile cap.

5. PHASES 1C, 1E – INSIDE GUARDRAIL REPLACEMENT

All inside wood rails shall be removed and replaced with new treated Southern Yellow Pine (SYP), #2 or better. Treatment level to be rated for UC4B (Ground Contact/Freshwater Heavy Duty). All wood shall be free from knots, splits, checks and other defects. Existing 6x6 posts to remain unless otherwise noted.

Wood framed top handrail (2x12 cap with 2x6 vertical on face of 6x6 guardrail post) shall be removed and replaced. All rail replacement shall span over three (3) guardrail posts and be fit in a workmanlike manner to match existing handrails. Cap rail to be connected to vertical rail at 12" OC minimum with #12 x 3" screws (316 stainless steel). Cap rail and vertical rails shall be attached to the 6x6 guardrail posts using a minimum of three (3) #12 x 3" stainless steel screws.

All Mid Rails (MR) and Bottom Rails (BR) shall be removed and replaced, with rails spanning over three (3) guardrail posts and be fit in a workmanlike manner to match existing handrails. All rails shall be attached to the 6x6 guardrail posts using a minimum of two (2) #12 x 3" stainless steel screws. All bottom rail replacement to be treated 2x6.

6. PHASES 1C, 1E, 4A – TOP CAP RAIL REPLACEMENT

All top cap rails identified for replacement shall be removed and replaced with new treated Southern Yellow Pine (SYP), #2 or better. Treatment level to be rated for UC4B (Ground Contact/Freshwater Heavy Duty). All wood shall be free from knots, splits, checks and other defects. Existing 6x6 posts to remain unless otherwise noted.

Wood framed top handrail (2x12 cap with 2x6 vertical on face of 6x6 guardrail post) shall be removed and replaced in locations noted. All rail replacement shall span over three (3) guardrail posts and be fit in a workmanlike manner to match existing handrails. Cap rail to be connected to vertical rail at 12" OC minimum with #12 x 3" screws (316 stainless steel). Cap rail and vertical rails shall be attached to the 6x6 guardrail posts using a minimum of three (3) #12 x 3" stainless steel screws.

7. PHASE 4A – MID AND BOTTOM RAIL REPLACEMENT

All mid and bottom rails identified for replacement shall be removed and replaced with new treated Southern Yellow Pine (SYP), #2 or better. Treatment level to be rated for UC4B (Ground

Contact/Freshwater Heavy Duty). All wood shall be free from knots, splits, checks and other defects. Existing 6x6 posts to remain unless otherwise noted.

All Mid Rails (MR) and Bottom Rails (BR) shall be removed and replaced in locations where damage is noted, with rails spanning over three (3) guardrail posts and be fit in a workmanlike manner to match existing handrails. All rails shall be attached to the 6x6 guardrail posts using a minimum of two (2) #12 x 3” stainless steel screws. All mid and bottom rail replacement to be treated 2x6.

8. PHASES 1D, 2, 3A, 4A – GALVANIZED BOLT REPLACEMENT

All galvanized bolts connecting piles/pile caps, piles/cross bracing, and guardrail posts/pile caps that are identified for replacement shall be removed and replaced with new hot-dipped galvanized (HDG) or 316 stainless steel bolts of the same size.

Contractor to remove and replace bolts where feasible. An alternative to install new holes and bolts in locations where the integrity of the framing member will not be compromised and leave existing hardware in place will be considered on a case by case basis.

Use of stainless steel threaded rod and nuts/washers on both sides will also be considered on a case by case basis in locations where the bolt length exceeds 8”.

Other phases may require galvanized bolt replacement for a small number of locations.

PRIORITY OF REPAIRS

The proposed repairs can be implemented on a phased basis in order to meet scheduling and funding requirements. The priority of the repairs is listed below for each proposed category of repair:

1. WOOD DECK REPLACEMENT

This should be completed based on the age of the materials installed and severity of damage

Phase 1A & 1B
Phase 2
Phase 1D
Phase 3C & 3A
Phase 4A

2. GUARDRAIL REPLACEMENT

This should be completed based on the age of the materials installed and severity of damage

Phase 1A & 1B
Phase 2
Phase 1D
Phase 3C & 3A
Phase 3B
Phase 4A (Optional)

3. TIMBER JOIST REPLACEMENT

This should be completed on an “As Needed” basis during the wood deck replacement – All Phases

4. UPLIFT CONNECTOR REPLACEMENT

This should be completed based on the severity of damage and height of the deck above high tide. This should be completed during decking repairs, except in Phase 4A.

Phase 4A
Phase 3C
Phase 2
Phase 1B

5. INSIDE GUARDRAIL REPLACEMENT

This should be completed based on the age of the materials installed and severity of damage

Phase 1E
Phase 1C

6. TOP CAP RAIL REPLACEMENT

This should be completed on an “As Needed” basis during the wood deck replacement

7. MID AND BOTTOM RAIL REPLACEMENT

This should be completed on an “As Needed” basis during the wood deck replacement