Bill Burton Fishing Pier
Cambridge, Maryland
Modified Underwater Inspection Report
February 2022

For:

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By:

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PROFESSIONAL CERTIFICATION:
“I hereby certify that this document was prepared or approved by me, and that I am a duly licensed professional engineer under the laws of the State of Maryland, License No. 52301; Expiration Date: 02/14/2024.”

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1 Introduction

Marine Solutions, Inc. (Marine Solutions) was retained by EBA Engineering, Inc. (EBA Engineering) to perform a modified underwater inspection of the substructure units that comprise the Bill Burton Fishing Pier near Cambridge, Maryland. The modified underwater inspection was to perform a Level I inspection of 32 bents out of the 151 bents (approximately 20%), complete a Level II inspection (cleaning three 12" high bands near the splash zone, mid-height, and near mudline) on 32 piles (approximately 20%), and document water depth measurements at both ends of each bent during the dates of February 22nd through the 24th 2022. The purpose of the inspection was to document existing structural conditions, assess the overall site conditions, and provide recommendations for future actions. This report includes a description of the facility, inspection procedures, condition assessment criteria, observed conditions, and recommendations for repairs.

Previous inspection reports and facility plans were available and provided by EBA Engineering and used for comparison during the modified underwater inspection. For reporting purposes, bents and piles were numbered from the south and the east, respectively.

1.1 Description of the Facility

The Bill Burton Fishing Pier was originally constructed in 1935 as the Emerson C. Harrington Bridge. The original bridge was approximately two miles long spanning across the Choptank River connecting the Maryland towns of Trappe and Cambridge. Due to increased traffic demands, the four-lane Frederick C. Mulkus Bridge was constructed in 1987 adjacent to the original bridge and became the current Route 50 bridge. The draw bridge section was removed from the original bridge to allow vessel traffic to pass through. The structure was turned into a pedestrian fishing pier and later named after Bill Burton, a local fisherman, writer, and reporter.

The Bill Burton Fishing Pier is currently comprised of two separate structures. The south structure is approximately 3,000' long and is supported by 56 bents (Photo 1). The south pier is approximately 5,000' long and supported by 95 bents (Photo 2). The bents are typically comprised of 5 square reinforced concrete piles with a horizontal concrete strut that encompasses all five piles (Photos 3 and 4). The struts are located 4' below the top of the piles within the tidal zone. Several bents appear to have had the strut removed and pile jackets installed (Photo 5). Approximately every 8 bents consist of a 10-pile double bent with a reinforced concrete strut (Photo 6).

Pier Wall 1 (Bent 56) is the northern most bent on the south structure and consists of two reinforced concrete columns orientated east and west (Photo 7). The columns are connected by a full-height reinforced concrete web wall. The columns and the web wall are founded on a reinforced concrete footing and subfooting. Pier Wall 6 (Bent 57) is the southernmost bent on the north structure and consists of two reinforced concrete columns orientated east and west (Photo 8). The columns are connected by a partial height reinforced concrete strut that extends from 7' below the high-water mark down to the top of the footing. The columns are founded on a footing and subfooting. The North Abutment (Bent 151) is comprised of a reinforced concrete stem, two reinforced concrete wingwalls, and a footing (Photo 9). The South Abutment was dry and did not require an underwater inspection.

1.2 Inspection Procedures

The underwater inspection was performed by a three-person dive team lead by a Professional Engineer/Dive Supervisor. Diving operations were conducted using surface-supplied diving equipment with hardwire communications between the diver and topside personnel, and in accordance with all applicable ADCI, OSHA, and USCG regulations. The operations were staged from a fully equipped diving support vessel (DSV). All Marine Solutions on-site personnel were
experienced in the inspection, maintenance, rehabilitation, and construction of waterfront structures.

The inspection was performed in general accordance with ASCE Manuals and Reports on Engineering Practice No. 130: *Waterfront Facilities Inspection and Assessment* (ASCE Manual). The purpose of the inspection was to document existing structural conditions, assess the overall site conditions, and provide recommendations for future actions.

The underwater inspection included 35 randomly selected bents which included Pier Wall 1, Pier Wall 6, and the North Abutment. A Level I inspection effort (visual/tactile) was performed on 100% of the accessible structural elements within the selected bents from the high-water mark down to the mudline. A Level II inspection effort (visual inspection of cleaned areas) was performed on approximately 20% of the accessible structural elements within the selected bents. Water depths measurements were recorded at the east and west ends of each selected bents using a diver carried depth gauge. See Appendix A for detailed inspection notes and water depth measurements.

### 1.3 Condition Assessment Criteria

In accordance with ASCE, the inspection condition and assessment criteria use a six-point standardized rating system provided in the ASCE Manual. The condition assessment of the facility is determined based on the findings during the underwater inspection. These ratings are required to categorize the results of the inspection and to provide a basis for comparison of new deficiencies in future inspections or other facilities. The condition assessment ratings as defined in the ASCE manual are described in Table 1 below.
### Table 1: ASCE Condition Assessment Ratings.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
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<tr>
<td>6 – Good</td>
<td>No visible damage or only minor damage noted. Structural elements may show very minor deterioration, but no overstressing observed. No repairs are required.</td>
</tr>
<tr>
<td>5 – Satisfactory</td>
<td>Limited minor to moderate defects or deterioration observed but no overstressing observed. No repairs are required.</td>
</tr>
<tr>
<td>4 – Fair</td>
<td>All primary structural elements are sound but minor to moderate defects or deterioration observed. Localized areas of moderate to major 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.</td>
</tr>
<tr>
<td>3 – Poor</td>
<td>Advanced deterioration or overstressing observed on widespread portions of the structure but does not significantly reduce the load-bearing capacity of the structure. Repairs may need to be carried out with moderate urgency.</td>
</tr>
<tr>
<td>2 – Serious</td>
<td>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.</td>
</tr>
<tr>
<td>1 - Critical</td>
<td>Very advanced deterioration, overstressing, or breakage has resulted in localized failure(s) of primary structural components. More widespread failures are possible or likely to occur, and loading restrictions should be implemented as necessary. Repairs may need to be carried out on a very high-priority basis with strong urgency.</td>
</tr>
</tbody>
</table>

Each structural element was evaluated and assessed an element level damage rating (minor, moderate, major, or severe). See Appendix C for the ASCE Manual Element Level Damage Rating Figure. The element damage ratings were utilized to give an overall condition rating to each structural element inspected based on the marine environment, overall use, redundancy, section loss, bearing capacity, physical damage, and deterioration of each individual element.

## 2 Observed Conditions

The observed conditions of each structural element inspected at the Bill Burton Fishing Pier is discussed in the following sections. Please refer to Appendix A for Field Note Data detailing the exact locations, type, and extend of the observed defects. Refer to Appendix B for photographs of observed defects. Refer to Appendix C for ASCE Element Level Damage Rating Figure.

### 2.1 Reinforced Concrete Pile Bents

Marine Solutions inspected 27 reinforced concrete five pile bents and 5 reinforced concrete ten pile bents. Seven out of the 32 reinforced concrete bents did not have reinforced concrete struts. The reinforced concrete piles and struts are discussed in more detail in the sections below.

#### 2.1.1 Reinforced Concrete Struts

The reinforced concrete struts are in overall Poor condition. The north and south faces of the struts typically have severe spalling that extends full length x full height and up to 10” deep (full-
depth) with the deepest areas of spalling concentrated in a 2' high band at the bottom of the strut (Photos 10 and 11). The spalling exposes all the main longitudinal bars and stirrups, which exhibit severe corrosion and section loss. The exposed stirrups typically are debonded and have areas of 100% section loss. The exposed longitudinal reinforcing bars are intermittently debonded and have 50% section loss throughout with isolated areas of up to 90% section loss. Areas without spalling typically have corrosion cracks with rust staining up to 1/4" wide with associated delamination.

The east and west faces of the struts typically have severe spalling that extends full width x full height and up to 20" deep (full-depth) with the deepest areas of spalling concentrated within the top and bottom 1' of the strut (Photos 12 through15 ). The spalling exposes several horizontal and vertical steel reinforcing bars which exhibit severe corrosion and section loss. The exposed reinforcing bars are intermittently debonded in random areas and have up to 100% section loss. Areas without spalling typically have corrosion cracks with rust staining up to 1/4" wide with associated delamination.

### 2.1.1 Square Reinforced Concrete Piles

The square reinforced concrete piles are in overall Fair condition. This is due to widespread minor to moderate abrasion, spalling, and cracking (Photos 16 through 19). Most of these defects are located within the top 4' of the pile above the reinforced concrete strut. Piles that do not have a strut or repairs in the tidal zone typically have abrasion up to 2" deep most notably at the corners. Bent 148, Pile 4 has an area of abrasion with exposed reinforcement where the strut is missing due to deterioration (Photo 20). Approximately 18% of the piles have corner spalls within the top 5’ of the piles (Photos 21). The spalls are up to 5'-0" high x up to 10" wide x up to 7" deep with exposed reinforcement that exhibits 50% to 75% section loss. Three piles (Bent 90 Pile 1 and 5; Bent 149 Pile 5) have several spalling and deterioration from 3’ to 7’ below the top of the piles (Photo 22). These spalls are approximately 4'-0" long x full-width x 7" deep with exposed and corroded reinforcement with up to 50% section loss. Approximately 75% of the piles have cracking typically 1/8" to 1/4" wide with isolated 1/2" wide cracks within the top 4' of the pile. As a result of the cracking, there are areas of associated delamination and spalling on all faces of the affected piles (Photos 18 through 22). See Table 3 for total quantities and percentages of piles with observed defects.

#### Table 2: Type and Number of Pile Defects.

<table>
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<tr>
<th>Defect Type</th>
<th>No. of Piles</th>
<th>Percentage of Piles with Defect</th>
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<tr>
<td>Abrasion</td>
<td>15</td>
<td>8%</td>
</tr>
<tr>
<td>Spall</td>
<td>34</td>
<td>18%</td>
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<tr>
<td>Cracking</td>
<td>138</td>
<td>75%</td>
</tr>
<tr>
<td>&lt; 1/8&quot; Wide</td>
<td>15</td>
<td>8%</td>
</tr>
<tr>
<td>1/8&quot; to 1/4&quot; Wide</td>
<td>112</td>
<td>61%</td>
</tr>
<tr>
<td>&gt;=3/8&quot; Wide</td>
<td>11</td>
<td>6%</td>
</tr>
<tr>
<td>With Spalling and Delamination</td>
<td>36</td>
<td>19%</td>
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</table>

Approximately 92% of the piles have been previously repaired with either a square epoxy filled fiberglass jacket or a grout filled fabric bag with welded wire mesh. Piles within bents without a strut typically have the square epoxy filled fiberglass jackets. These jacket repairs typically extend
from 3’ to 10’ below the top of the pile (Photo 23). Isolated piles with these repairs have areas of missing or damaged epoxy epoxy jackets typically from 4’ to 9’ below the top of the pile (Photos 24 and 25). Piles within bents with a strut typically have the grout filled fabric bag repairs. The bag repairs typically extend from the bottom of the strut to 13’ below the top of the pile. Isolated bag repairs have voids up to 1'-0' high x 8” wide x 2” deep exposing the wire mesh within the grout (Photo 26). At these locations the underlying pile is not exposed. For specific repair numbers and percentages, see Table 3.

Table 3: Number of Pile Repairs and Defects.

<table>
<thead>
<tr>
<th>Repair Type</th>
<th>No. of Piles</th>
<th>No. of Pile with Damage/Missing Area</th>
<th>Percentage of Total Piles Inspected</th>
<th>Percentage of Total Repairs with Defects</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Repair</td>
<td>15</td>
<td>0</td>
<td>8%</td>
<td>0%</td>
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<tr>
<td>Square Epoxy Jacket</td>
<td>34</td>
<td>5</td>
<td>18%</td>
<td>15%</td>
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<tr>
<td>Grout Filled Fabric Bag</td>
<td>136</td>
<td>3</td>
<td>74%</td>
<td>2%</td>
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<tr>
<td>Totals:</td>
<td>185</td>
<td>8</td>
<td>100%</td>
<td>4%</td>
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2.2 Pier Wall 1 (Bent 56)

Pier Wall 1 (Bent 56) is in Poor condition. The west column exhibits random areas of scale up to full height x 3" deep. Full circumference of the footing/column interface, there is spalling up to 10'-0" wide x 2'-6" high x 6" deep with exposed and corroded reinforcement. The east column exhibits random areas of scale up to full height x 3" deep. Full circumference of the footing/column interface, there is spalling up to 10'-0" wide x 3'-0" high x 10" deep with exposed and corroded reinforcement.

The web wall exhibits random areas of scaling 1" deep and isolated areas 9" deep concentrated at the waterline (Photo 27). The top of the footing is approximately 5'-6" below the waterline and approximately 8'-0" high. There are random areas of scaling up to 8" deep throughout with exposed and loose aggregate. The footing has large areas of latent concrete throughout resulting in small voids and removal of the concrete matrix when sounded with a hammer. At the west face near the centerline, there is an area of undermining 3'-0" long x 1'-6" high x 2'-0" deep.

2.3 Pier Wall 6 (Bent 57)

Pier Wall 6 (Bent 57) is in Poor condition. The west and east columns have 9'-0" high grout filled fiberglass jackets that begin 4’ above the waterline and extend within 4" to the top of the strut. In the tidal zone, there are random areas of missing jacket throughout exposing the underlying grout layer. The grout exhibits 3" deep scale; however, is not deep enough to reach the original column. This deterioration is most notable on the west faces of both columns (Photo 28).

The top of the reinforced concrete strut is located approximately 7' below the high water mark and has random areas of voids and spalling up to 1'-0" diameter x 3" deep (Photo 29). The top of the footing is located approximately 15’ below the high-water mark. The footing is 5'-0" high x 4'-0" wide and encompasses both columns. The footing has large areas of latent concrete throughout resulting in small voids and removal of the concrete matrix when sounded with a hammer. There are random up to 1'-0" diameter x 3" deep voids throughout (Photos 30 and 31).
The top of the subfooting is located approximately 20’ below the high-water mark. The subfooting is exposed up to 7'-0" x 2'-0" wide and encompasses the entire footing. The subfooting has large areas of latent concrete throughout resulting in small voids and removal of the concrete matrix when sounded with a hammer. There are random up to 5'-0" diameter x 1'-6" deep voids throughout (Photo 32). No signs of undermining were observed during the inspection.

2.4 North Abutment (Bent 151)

The North Abutment (Bent 151) is in Fair condition. The footing of the North Abutment and both wingwalls is exposed full-length x up to 3'-0" high with no signs of undermining and up to 3" deep scale. At the centerline of the stem wall and extending to the footing, there is a 6'-0" high x 2'-0" wide x 2" deep spall. At the east end of the stem wall, there is a spall of similar size. At the west end of the stem wall, there is a 2'-0" high x 1'-0" wide x 3" deep spall (Photos 33 and 34). At the interface of the stem wall and Northwest Wingwall near the waterline, there is a 2'-0" high x 1'-0" wide x 2" deep spall.

3 Conclusions and Recommendations

The Bill Burton Fishing Pier was assigned a combined overall Condition Assessment Rating (CAR). The CAR is assigned based on the type and level of severity of the deterioration observed on the individual structural components of each structure. Recommendations are provided based on the facilities current use, redundancy of structural elements, known history and age of the facility, and based on the areas inspected during this modified underwater inspection.

3.1 Overall Condition Assessment Rating

The Bill Burton Fishing Pier is in overall Poor condition. This CAR is given due to widespread areas of minor to moderate deterioration and isolated areas of major to severe deterioration on the primary structural elements.

3.2 Recommendations

Marine Solutions has developed recommendations for additional actions and rehabilitation to the various structures or areas at the Bill Burton Fishing Pier based on observed conditions. The following recommendations should be compared with facility use and production parameters to determine the most practical and economical allocation of funds.

Recommendations have been separated by immediate, priority, and routine repair items. It is recommended that immediate repair items be performed as soon as possible within the next six months. Immediate recommendations typically include action items to increase the facilities overall safety or to address significant structural concerns. Priority repair items should be executed within the next two years to minimize the potential for facility limitations or load restrictions. Typically, structural components which are observed with major to severe deterioration are included in the priority repair category due to potential loss of capacity to the element. Routine repair items are maintenance items which should be executed within the next five years. Routine maintenance items help extend the service life of the facilities and minimize the need for structural repairs and rehabilitation which are often costly and can involve temporary facility shutdowns.

3.2.1 Immediate (Within 6 months)

Based on the inspection limits and observed conditions at the time of inspection, Marine Solutions recommends the following repair items on an immediate basis:

- Due to the age of the structure and the overall CAR of poor, the Bill Burton Fishing Pier should have a complete underwater inspection of the remaining piers not included within this inspection.
• Perform a load rating analysis to determine if the current loading criteria requires the reinforced concrete struts to provide adequate structural capacity to the piers. If the struts are required, then they should be repaired on all bents where they remain. If they are not required, then they should be removed, and the underlying pile section should be inspected.

• Even though the struts are in overall poor condition and several struts have severe deterioration, some struts only had moderate to major deterioration and act as a protective element around the piles in the tidal zone. If the load rating determines the struts are not required for structural capacity, then struts with moderate to major damage could be left in place.

• Three piles have severe deterioration with exposed and debonded main reinforcing members. These piles should be repaired with new reinforcing bars and a grout filled structural jacket.

3.2.2 Priority (Within 2 years)

Based on the inspection limits and the observed conditions at the time of inspection, Marine Solutions recommends the following repair items on a priority basis:

• Replace all damaged or missing square epoxy filled fiberglass jackets with new grout filled fiberglass jackets.
• At Pier Wall 1 (Bent 56), there is an area of undermining. Backfill and place scour protection countermeasures to prevent further undermining.
• Remove areas of unsound concrete, clean corroded reinforcement, and patch the areas of deep (>1" deep) spalling on the piles, pier walls, and North Abutment (Bent 151).
• At Pier Wall 1 (Bent 56) and Pier Wall 6 (Bent 57), repair the areas of voids in the footing and subfooting.

3.2.3 Routine (Within 5 years)

Based on the inspection limits and observed conditions at the time of inspection, Marine Solutions recommends the following repair items on a routine basis:

• Epoxy seal all cracks equal to and greater than 1/8" wide on the piles.
• Continue to monitor the condition of the Bill Burton Fishing Pier by maintaining a consistent underwater inspection cycle.
Appendix A – Field Inspection Notes
**Abbreviations Used in the Field Inspection Notes:**

N – North
S - South
W – West
E – East
NE – Northeast
NW – Northwest
SW – Southwest
SE - Southeast
SEC – Southeast Corner
SWC – Southwest Corner
NWC – Northwest Corner
NEC – Northeast Corner
SL – Section Loss
FL – Full-Length
FW – Full Width
FD – Full Depth
FH – Full Height
ML – Mudline
CRX – cracks
HL – Hairline
ISO – Isolated
B1 – Bent Number 1
P1 – Pile Number 1
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Note: The table contains data on defect conditions, inventory data, and repair tag information for various bar numbers and dates. The data includes measurements and observations related to concrete strut notes and repair applications.
### Marine Solutions, Inc. Appendix A - Field Inspection Notes February 2022

#### Defect Condition Data

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#### Additional Notes

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**Notes:**

- *Marine Solutions, Inc.* Appendix A - Field Inspection Notes February 2022
- Page 3 of 5
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**Defect Cond**

- Full Width X Full Depth X Scale/Spalling
- Concrete Strut Notes
- Addtional Notes

**Event**

- Full Length X Full Height X Full Depth Scale/Spalling
- North and South Faces

**Cond**

- Full Height X Full Depth X Scale/Spalling
- East and West Sides

**Additional Notes**

- Spalls/Remain Case: Exposed Decking
- North and South Faces
- Full Length X Full Height X Full Depth Scale/Spalling
- East and West Sides
- Full Length X Full Height X Full Depth Scale/Spalling
- NWC Spall

**Status / Repair Notes**

- Strut Missing
- East and West Sides
- North and South Faces
- Full Length X Full Height X Full Depth Scale/Spalling
- North and South Faces

**Concrete**

- East and West Sides
- North and South Faces
- Full Length X Full Height X Full Depth Scale/Spalling
- East and West Sides
- Full Length X Full Height X Full Depth Scale/Spalling
- East and West Sides

**Add (+) Notes**

- Struts Missing
- East and West Sides
- North and South Faces
- Full Length X Full Height X Full Depth Scale/Spalling
- North and South Faces
- Full Length X Full Height X Full Depth Scale/Spalling
- East and West Sides
### Marine Solutions, Inc. Appendix A - Field Inspection Notes
February 2022

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**Notes:**

- **West and East Sides:** Completely GONE...
- **North and South Faces:** Full Length X Full Height X 4” (Scale/Spalling)
- **Concrete Strut Notes:**
  - No Strut Here
  - Missing Jacket on South and West Faces
Appendix B - Photos
Photo 1: Overall of the South Half of the Pier (East Elevation).

Photo 2: Overall of the North Half of the Pier (East Elevation).
Photo 3: Typical 5-Pile Bent (Bent 8, North Elevation Shown).

Photo 4: Typical 5-Pile Bent (Bent 10, South Elevation Shown).
Photo 5: Typical Bent without a Reinforced Concrete Strut (Bent 129 Shown).

Photo 6: Typical 10-Pile Double Bent (Bent 8, North Elevation Shown).
Photo 7: South Elevation of Pier Wall 1 (Bent 56).

Photo 8: North Elevation of Pier Wall 6 (Bent 57).
Photo 9: North Abutment Elevation Looking Northeast.

Photo 10: Typical Spalling and Exposed Reinforcement on Strut (Bent 149 Shown).
Photo 11: Typical Spalling and Exposed Reinforcement on Strut (Bent 147 Shown).

Photo 12: Typical Spalling, Exposed Reinforcement, and Missing West and East Ends on Strut (Bent 111 Shown).
Photo 13: Typical Spalling and Exposed Reinforcement on Strut (Bent 28 Shown).

Photo 14: Typical Missing Strut on East and West Faces (Bent 39 Shown).
Photo 15: Typical Spalling and Exposed Reinforcement on West and East Ends of the Strut (Bent 30 Shown).

Photo 16: Typical Condition of Pile Underwater (Bent 30, Pile 1 Shown).
Photo 17: Bent 130, Pile 1, Corner Spall and Delamination.

Photo 18: Typical Vertical Cracking at the Top of Pile (Bent 150, Pile 5 Shown).
Photo 19: Bent 109, Pile 5, Area of Spalling and Delamination at the Top of Pile.

Photo 20: Bent 148, Pile 4, Area of Abrasion with Exposed Reinforcement (Underwater).
Photo 21: Bent 8, Pile 5, Corner Spall with Exposed and Corroded Reinforcement.

Photo 22: Bent 149, Pile 5, Spall with Exposed, Corroded, and Debonded Reinforcement.
Photo 23: Typical Condition of Square Epoxy Jacket Underwater (Bent 130, Pile 4 Shown).

Photo 24: Bent 130, Pile 2, Missing Jacket and Abrasion in the Tidal Zone.
Photo 25: Bent 130, Pile 2, Failed Square Epoxy Jacket (Underwater).

Photo 26: Bent 40, Pile 1, Void at the Top of the Grout Filled Fabric Bag Repair (Underwater).
Photo 27: Pier Wall 1 (Bent 56), Scaling and Voids at the Waterline.

Photo 28: Pier Wall 6 (Bent 57), Typical Void in Fiberglass Jacket at the Columns (Underwater).
Photo 29: Pier Wall 6 (Bent 57), Typical Condition of Reinforced Concrete Strut (Underwater).

Photo 30: Pier Wall 6 (Bent 57), Typical Condition of Footing (Underwater).
Photo 31: Pier Wall 6 (Bent 57), Void at Footing Sub footing Interface (Underwater).

Photo 32: Pier Wall 6 (Bent 57), Void in the Sub footing (Underwater).
Photo 33: North Abutment (Bent 151), Spalling at the Waterline.

Photo 34: North Abutment (Bent 151), Spalling at the Waterline.
Appendix C– ASCE Damage Rating Figure
Fig. 2-4. Damage ratings for reinforced concrete elements
Source:Courtesy of CH2M HILL, Inc. and COWI, Inc., reproduced with permission.