Port Orchard Marina
Underwater Inspection of Marine Facilities

707 Sydney Parkway, Port Orchard, WA 98366

Aerial Photo

Prepared by SDS Consultant
Seattle Diving Services, LLC
November 2018

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Underwater Inspection of Marine Facilities – Port Orchard Marina

Introduction

ln October 2018, Seattle Diving Services, LLC completed an underwater inspection of the Marine Facilities of the Port Orchard Marina. The inspection was performed by a dive team under the direction of Seattle Diving Services, LLC, and included a visual and tactile inspection of the Marina's Breakwater Mooring System, Pilot Piles, Timber Pile #45, and Shoreline Building and Approach Dock Wood Piles & Supports.

Summary

The underwater portions of the substructure components were found to be in overall Fair condition due to the limited amount of deterioration. No evidence of major defect or failure critical to the integrity of the marina was observed. The conditions of the underwater inspection are based on Level I visual & tactile inspection from the high tide line to the seabed. The task also included Level II inspection of 13 bridle chains and thickness & corrosion potential readings of six pilot piles throughout the marina. Visual representation is provided of the general conditions and specified problem areas. The information contained within this report is based on the conditions at the time of inspection.

(1.0) BREAKWATER

(additional photos & video on flash drive)

The objective of this project is to provide a general description and assessment with recommendations of the underwater condition of the Floating Wave Attenuator and associated mooring connections and cathodic components.

Observations

The floating breakwater, associated mooring system, connections, and cathodic protection are generally in overall Fair condition with localized areas of moderate to advanced deterioration. The structures are generally covered in heavy marine growth. Representative areas were cleaned using hand tools for closer examination. The photos within this report provide a visual representation of the typical underwater conditions and deterioration.

The floating breakwater was observed to be in general overall satisfactory condition. Heavy marine growth covered the majority of the breakwater's surface. However, no cracking, spalling, severe corrosion, major damage, or deterioration due to over stress was detected during the inspection.

Floating breakwater mooring lines were found to be in overall Fair condition with localized areas of moderate deterioration. Heavy marine growth covered the majority of the mooring lines. However, the growth was minimal enough to conduct an adequate level I inspection and determine anode & mooring line condition. (See Photo1) .Mooring line numbers 11, 20, 54, 68, & 70 were all observed to have advanced corrosion such as surface rust on the bottom chain and connections. (See Photos 2-3) Recently installed cathodic protection for bottom chain of mooring line number 50 was disconnected on resting on the seafloor. (See Photo 4) No surface corrosion was observed as previously installed anodes appeared to be providing residual cathodic protection but this should be considered temporary.

All mooring lines have anodes installed at the top, as close to the breakwater as possible, at the connection between the top chain and mooring rope thimble, and on the upper portion of each bottom chain. Anode conditions provided in TABLE 1.

Assessments

Based on our underwater inspection, the floating breakwater, associated mooring systems, connections, and cathodic protection are generally in overall Fair condition due to localized areas of moderate to advanced deterioration. The deterioration noted in this report is considered moderate and no load reductions are required as a result of the underwater structures.

The detailed examination of the mooring lines and associated hardware determined that the identified bottom chains exposed to underwater electrolysis without cathodic protection requires rehabilitation to provide an extended service life.

Recommendations & Repairs

Mooring line numbers 11, 20, 54, 68, & 70 were all observed to have advanced corrosion on the bottom chain and connections. In-kind rehabilitation would involve one additional anode installed at the top of the bottom chain and include proper cleaning sufficient enough to ensure contact between the bottom chain and cathodic protection. These repairs need to be carried out with moderate urgency.
Mooring lines and cathodic protection components should continue to be inspected annually. All anodes 50% or below should be considered for replacement within the next two quarters. Continued annual inspection should considered for future planning.

Seattle Diving Services, LLC — Photographic log

Port Orchard Underwater Inspection	Breakwater	Location: Mooring Line 47

Photo 1	Oct. 2018

Client:
Port Orchard Marina
Port Orchard, Wa. 98336

Description:
View of typical marine growth on mooring line 47.

Seattle Diving Services, LLC — Photographic log

Port Orchard Underwater Inspection	Breakwater	Location: Mooring Line 20

Photo 2	Oct. 2018

Client:
Port Orchard Marina
Port Orchard, Wa. 98336

Description:
View of bottom connection corrosion & 90% anode with bad connection on mooring line 20.

Seattle Diving Services, LLC — Photographic log

Port Orchard Underwater Inspection	Breakwater	Location: Mooring Line 11

Photo 3	Oct. 2018

Client:
Port Orchard Marina
Port Orchard, Wa. 98336

Description:
View of bottom chain advanced corrosion on mooring line L-11.

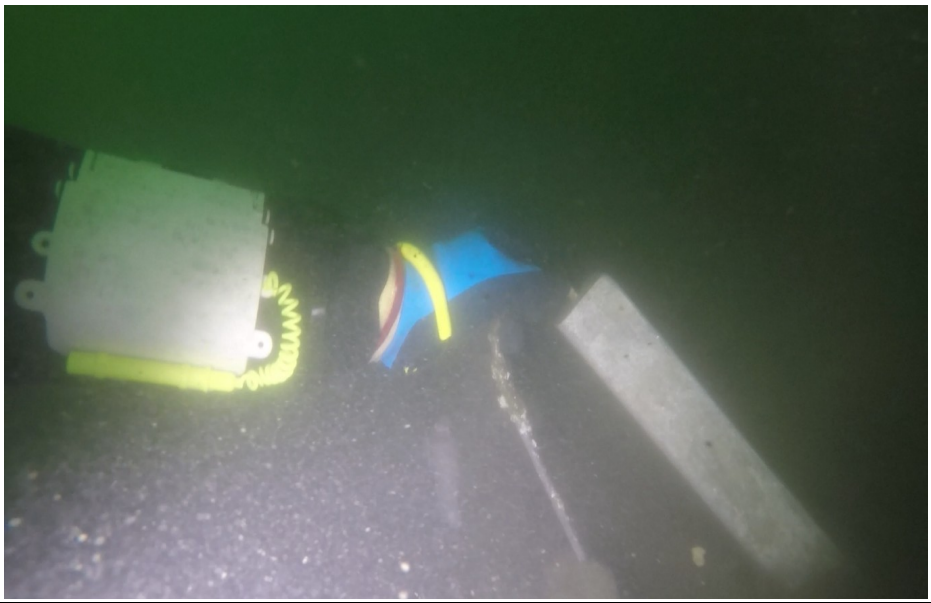
Seattle Diving Services, LLC — Photographic log

Port Orchard Underwater Inspection	Breakwater	Location: Mooring Line 50

Photo 4	Oct. 2018

Client:
Port Orchard Marina
Port Orchard, Wa. 98336

Description:
View of 100% anode disconnected on bottom off mooring line 50. Hardware malfunction.



(2.0) 13 BRIDAL CHAINS

(additional photos & video on flash drive)

The objective of this project is to provide a Level II cleaning and assessment with recommendations of the underwater condition of the (13) bridle chains on the floating wave attenuator (breakwater) and associated cathodic components.

Observations

The floating breakwater's bridle chain systems and cathodic protection are generally in overall Fair condition with localized areas of advanced deterioration. The structures are generally covered in heavy marine growth and representative areas were cleaned using hand tools for closer examination. The photos within this report provide a visual representation of the typical underwater conditions and deterioration.

Thirteen bridal chain systems were listed for level II inspection. Fourteen bridal chain systems were found, two of which were disconnected. Mounting brackets for bridle chain numbers 11 & 35 were both subject to advanced deterioration and connection failure. (See Photos 5 & 6) The originating cause behind the failure is suspected to be ordinary wear from the 1" shackle connecting the 5/8" long-link bridle chain to the bracket. Under the influence of waves, currents, and electrochemical corrosion these two components had worn and failed. The lower connection of these bridle chains were still connected to the mooring lines and were found to have advanced deterioration. Early stages of pad-eye wearing was found on bridle chain bracket numbers 19 & 42. (See Photo 7) All other bridle brackets, chains, and associated hardware was in satisfactory condition with minor but typical deterioration.
(See Photo 8)

All bridle chains have one anode installed at the top of the chain as close to the bracket as possible. Anode conditions provided in TABLE 1.

Assessments

Based on our underwater inspection, the bridle chains, connections, and cathodic protection are generally in overall Fair condition due to localized areas of advanced deterioration. The deterioration noted in this report is considered moderate and no load reductions are required as a result of the underwater structures.

The detailed examination of the identified bottom chains, bridal chains, and associated hardware determined that areas of the mooring system exposed to wave action and areas exposed to underwater electrolysis without cathodic protection requires rehabilitation to provide an extended service life. Repairs need to be carried out with moderate urgency.

Recommendations

The bridle chain numbers 11 & 35 have brackets that have deteriorated to a point of failure. These brackets and associated bridle chains should be considered for in-kind replacement as soon as possible. New cathodic protection will need to be installed on the bridle chain only.

Bridle bracket numbers 19 & 42 should be considered for replacement within the next year due to typical wear from wave action.

Seattle Diving Services, LLC **Photographic log**

Port Orchard Underwater Inspection	Bridal Chains	Location: Bridal 11

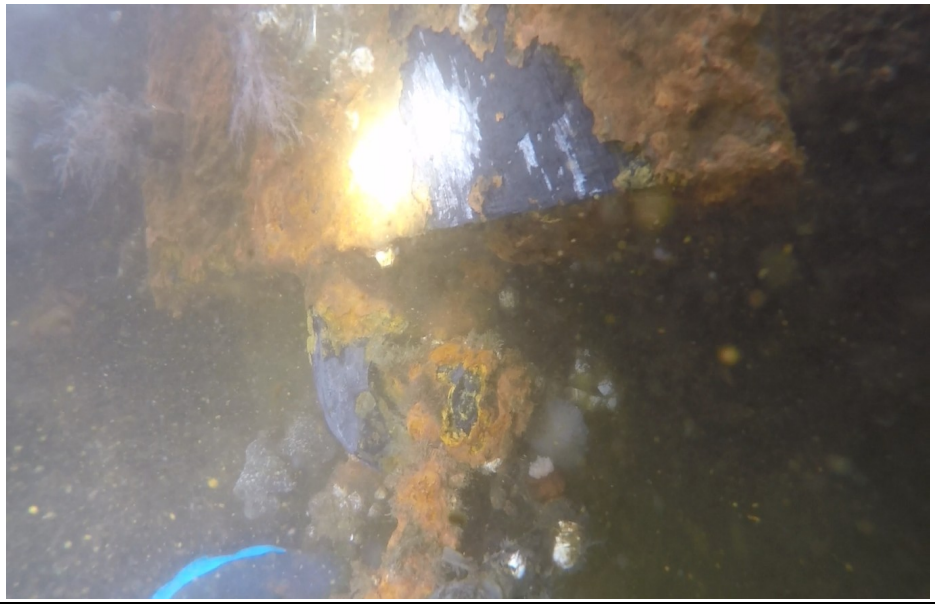
Photo 5 Oct. 2018

Client:

Port Orchard Marina
Port Orchard, Wa. 98336

Description:

View of bridal bracket advanced corrosion & chain disconnected on Bridal 11.



Seattle Diving Services, LLC — Photographic log

Port Orchard Underwater Inspection	Bridal Chains	Location: Bridal 35

Photo 6	Oct. 2018

Client:
Port Orchard Marina
Port Orchard, Wa. 98336

Description:
View of bridal bracket corrosion & hardware failure on Bridal 35.

Seattle Diving Services, LLC — Photographic log

Port Orchard Underwater Inspection	Bridal Chains	Location: Bridal 19

Photo 7	Oct. 2018

Client:
Port Orchard Marina
Port Orchard, Wa. 98336

Description:
View of padeye wearing & chafing on Bridal 19.

Seattle Diving Services, LLC		Photographic log
Port Orchard Underwater Inspection	Bridal Chains	Location Bridal 61

Photo 8	Oct. 2018

Client:

Port Orchard Marina
Port Orchard, Wa. 98336

Description:

View of general Bridal conditions & typical minor surface corrosion on bridal 61.

(3.0) TIMBER PILE #45

(additional photos & video on flash drive)

The objective of this project is to provide a general description and assessment with recommendations for timber mooring pile No. 45.

Observations

The structure is generally covered in heavy marine growth and representative areas were cleaned using hand tools for closer examination. The photos within this report provide a visual representation of the typical underwater conditions and deterioration.

No major defects or deterioration was found, only minor abrasion in the tidal zone cause by the pile guide was noted. Minor deterioration of the creosote coating was detected but is typical. Hammer soundings determined the pile to be in overall sound condition. Physical examination did not detect any rot, borer holes, or major deterioration, only minimal cracking was discovered. (See Photo 9)

Assessments

Based on our underwater inspection, the underwater condition of this structures is Satisfactory. The deterioration noted in this report is considered minor and no load reductions are required as a result of the underwater structures. The pile was observed to be creosote-treated, it is probably 30 years or older. The detailed inspection determined that the timber mooring pile should not require short-term rehabilitation to provide an extended service life.

Recommendations

No repairs are recommended to the underwater portion of the timber pile. The timber pile is estimated to have approximately 10- 15 years of useful life remaining before replacement or similar repair should be considered.

Seattle Diving Services, LLC **Photographic log**

Port Orchard Underwater Inspection	Timber Pile	Location Pile #45

Photo 9	Oct. 2018

Client:
Port Orchard Marina
Port Orchard, Wa. 98336

Description:
View of surface area cleaned, no damage. Timber Pile #45.

(4.0) PILOT PILES (6 PILES)

(additional photos & video on flash drive)

The objective of this project is to provide a general description and assessment with recommendations for the (6) outlined Pilot Piles. Visual, ultrasonic, and corrosion potential inspections were performed.

Observations

The structures are generally covered in heavy marine growth and representative areas were cleaned using hand tools for closer examination. The photos within this report provide a visual representation of the typical underwater conditions and deterioration.

The six pilot piles are generally in overall sound condition with extensive areas of moderate deterioration. The deterioration was most severe in the tidal and submerged zones of the pilot piles. All pilot pilings besides D-32 were observed to have moderate to advanced pitting and surface rust covering any exposed surface area below the low tide line. (See Photos 10-11) Piling D-32 was observed to have typical corrosion which is considered minor, no surface rust was observed. (See Photo12) All anodes have cathodic protection systems installed. Wire cable sections for anodes on pilings C-16 & 27 had failed, most likely under influence from tide fluctuations. All anodes appeared to be in good condition with a layer of calcium deposits, which is typical. Upon physical examination, anodes instantly crumbled and revealed their true condition to be poor, less than 50% remaining. Pile thickness and corrosion potential readings provided in TABLE 1.

Assessments

Based on our underwater inspection, the underwater condition of these structures is Fair due to extended areas of moderate deterioration. The deterioration noted in this report is considered moderate and no load reductions are required as a result of the underwater structures. Detailed visual and thickness examinations of the pilot piles determined that the submerged zones may require future rehabilitation to provide an extended service life.

Recommendations

Piling anodes C-16 & 27 were found damaged & disconnected. These anodes and cables should be considered for repair and replacement as soon as possible. All remaining anodes were below 25% service life remaining and should be considered for replacement within the next quarter. Anode replacement should be considered within the next quarters for all protected pilings on B, C, & D docks.

The time of previous anode replacement is unknown, two out of six of the cathodic protection systems were found damaged and disconnected. Semi-Annual inspection and cleaning of the systems is recommended. A quarterly schedule should be considered to detect any faults before further deterioration occurs.

Seattle Diving Services, LLC **Photographic log**

Port Orchard Underwater Inspection	Pilot Piles	Location: Pile B-1

Photo 10 | Oct. 2018

Client:

Port Orchard Marina
Port Orchard, Wa. 98336

Description:

View of advanced surface corrosion in the submerged zone on B-1.

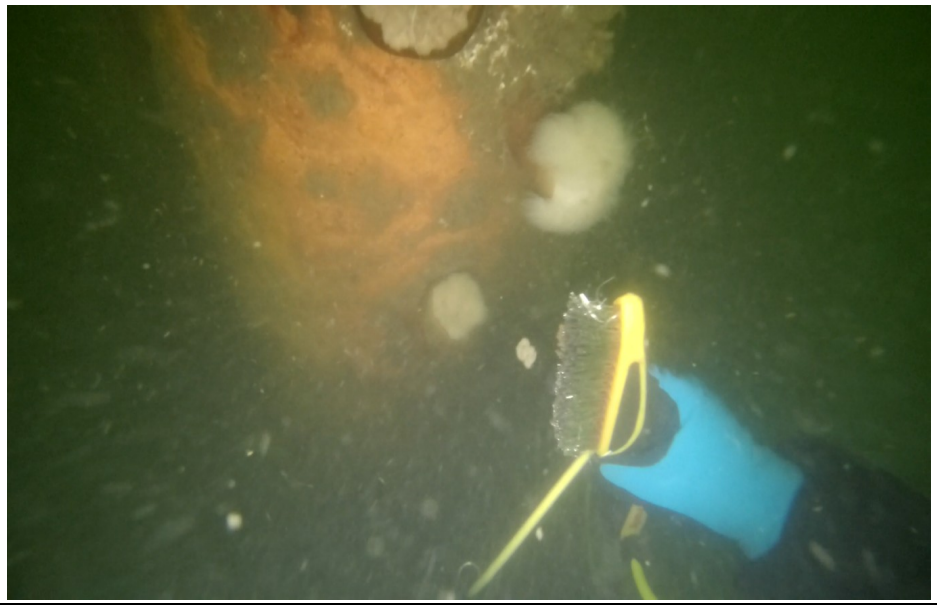
Seattle Diving Services, LLC — Photographic log

Port Orchard Underwater Inspection	Pilot Piles	Location: Pile B-6

Photo 11	Oct. 2018

Client:
Port Orchard Marina
Port Orchard, Wa. 98336

Description:
View of advanced surface corrosion in the submerged zone on Pile B-6.



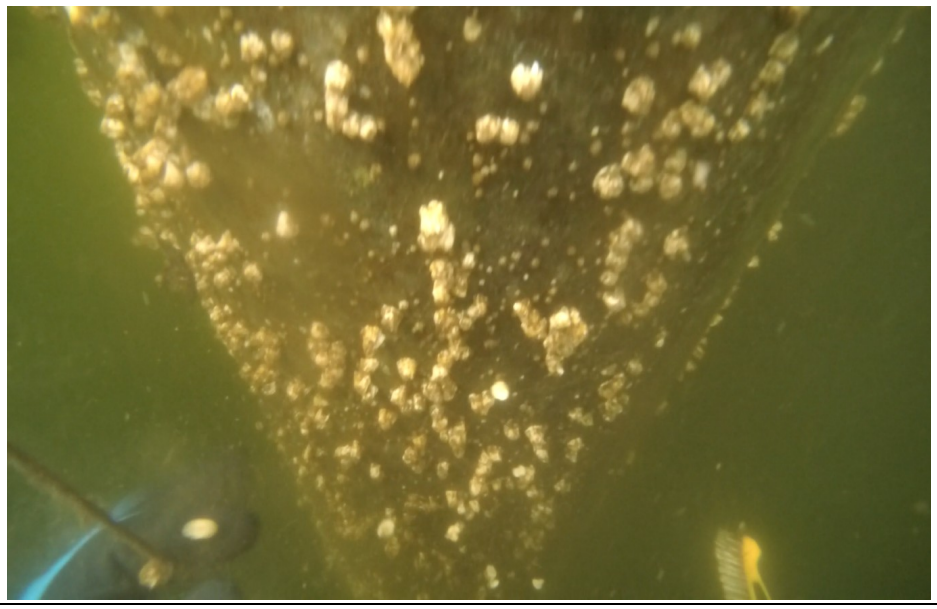
Seattle Diving Services, LLC — Photographic log

Port Orchard Underwater Inspection	Pilot Piles	Location: Pile D-32

Photo 12	Oct. 2018

Client:
Port Orchard Marina
Port Orchard, Wa. 98336

Description:
View of minor corrosion, no advanced surface rust on Pile D-32.

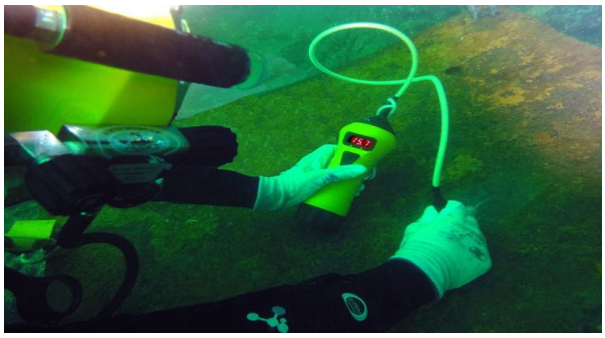


(5.0) READINGS & MEASUREMENTS

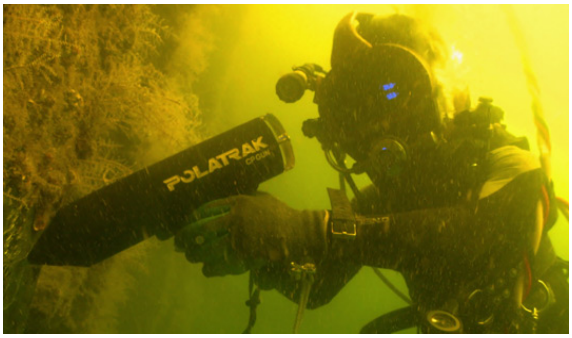
Thickness readings were taken using a Tritex Multigauge 3000 Underwater Thickness Meter which was calibrated and tested on-site using a 0.500 testing block. CP Measurements were taken using a Polatrak CP Gun which was calibrated and tested on-site using a 0.500 testing block.

Port Orchard	THICKNESS READING				CP MEASUREMENT		
Location	**Waterline**	**Mid-Water**	**Seabed**	***Depth***	**Waterline**	**Mid-Water**	**Seabed**
B-1	**0.385**	**0.455**	**0.385**	**35**	**-691**	**-683**	**-690**
B-6	**0.49**	**0.48**	**0.475**	**35**	**-681**	**-682**	**-677**
C-32	**0.425**	**0.475**	**0.415**	**30**	**-688**	**-683**	**-689**
C-17	**0.525**	**0.52**	**0.5**	**30**	**-698**	**-699**	**-693**
D-32	**0.485**	**0.47**	**0.46**	**20**	**-696**	**-701**	**-703**
D44	**0.515**	**0.515**	**0.515**	**20**	**-743**	**-746**	**-737**

https://www.tritexndt.com/product/mg3000-underwater-thickness-meter



http://polatrak.stoprust.com/products/cp-gun/



(6.0) PORT ORCHARD MOORING LINE ANODE PERCENTAGS

Mooring Line #	Top Chain Anode %	Connection Anode %	Bottom Chain Anode %
1	60	60	70
2	60	60	60
3	60	60	80
Bridle 3	60	N/A	N/A
4	80	60	60
5	80	60	80
6	30	70	60
7	70	60	80
8	60	60	60
9	80	60	90
Bridle 9	70	N/A	N/A
10	60	70	80
11	70	60	90
Bridle 11	N/A	N/A	N/A
12	70	50	60
13	90	90	60
14	70	60	60
15	50	60	60
16	70	60	80
17	60	60	60
Bridle 17	60	N/A	N/A
18	50	60	60
19	60	60	60
Bridle 19	50	N/A	N/A
20	80	60	80
21	60	60	60
22	60	50	60
23	60	60	60
24	70	60	60
25	40	90	40
26	30	40	90
27	40	40	50
Bridle 27	70	N/A	N/A
28	60	30	60
29	90	60	90
30	70	50	90
31	60	60	40
32	50	70	70
33	70	70	70
Bridle 33	60	N/A	N/A
34	70	40	50
35	40	60	50
Bridle 35	N/A	N/A	N/A
36	90	90	60
37	60	60	60

CONTINUED - PORT ORCHARD MOORING LINE ANODE PERCENTAGS

Mooring Line #	Top Chain Anode %	Connection Anode %	Bottom Chain Anode %
38	70	70	40
39	50	30	90
40	30	80	60
41	70	50	70
42	80	40	70
Bridle 42	40	N/A	N/A
43	60	40	20
44	70	70	60
Bridle 44	90	N/A	N/A
45	50	40	70
46	70	70	70
47	80	0	40
48	70	70	90
49	90	70	80
50	80	50	90
Bridle 50	70	N/A	N/A
51	50	70	60
52	60	50	90
Bridle 52	40	N/A	N/A
53	50	50	40
54	70	80	0
55	60	60	90
56	80	90	90
57	70	70	90
58	30	70	90
59	60	40	50
Bridle 59	60	N/A	N/A
60	60	50	70
61	70	50	90
Bridle 61	10	N/A	N/A
62	70	60	60
63	70	70	90
64	50	50	60
65	60	50	60
66	70	50	70
67	60	70	60
68	10	50	60
69	50	70	60
70	50	0	90
71	60	60	90
72	60	60	80

(7.0) SHORELINE BUILDINGS & APPROACH DOCK (additional photos & video on flash drive)

The objective of this project is to provide a general description and assessment with recommendations for the Shoreline Buildings & Approach Docks.

Observations

The structures are generally covered in heavy marine growth and representative areas were cleaned using hand tools for closer examination. The photos within this report provide a visual representation of the typical underwater conditions and deterioration. The building and approach dock timber piles and supports are generally in overall sound condition with limited areas of minor defects/ deterioration.

All pilings supporting the A-Dock approach dock were in Good condition with one 4”x12” Cross bracing support in Fair condition due to moderate rot and borer holes towards the bottom of one of the beams.

All but one piling supporting the B/C approach dock were in Good condition. The sister pile on the north-east corner of the approach dock was observed to have cracking in 4 areas with one - 2” borer hole located two feet above the mudline. Four cracks, 1/2” wide were visible during the inspection. The cracks ran vertically from the mudline and ranged from 1’ to 6’ in length.

D-dock approach piles and supports are overall in Good condition. The south-east timber pile was noted to have a 3/16” crack on the south facing side beginning from the top of the pile running 2’ down vertically. This damage is considered minor and probable cause was during installation of the cross-bracing. Associated pile cap stringer was noted to have a 1/8” wide, 5’ long crack running from the east end of the stringer to the middle of the stringer. This damage is also considered minor. All cross bracing

and supports are in good condition. There is one 2’x8’ cross member in good condition that appears to be un-treated.

G-dock approach piles and supports are generally in overall satisfactory condition with limited areas of moderate deterioration. The two pilings in the south-west corner of the approach dock have minor cracking 3/16” wide running vertically from the mudline and ranging 2’-6’ in length. No further rot or deterioration was observed and these pilings are considered to be in Fair condition. Extensive rot and deterioration was observed on one member of the 4”x12” cross bracing support the piles second closest to the shoreline. The affected area is on the lower 2’ of the cross member in the lower tidal zone. Severe cracking was observed on the submerged portion of the North-eastern most piling. The affected area ranged between 1”-2” wide and 12’ in overall length. The crack ran vertically from the mudline to the waterline at low tide and this pile is considered to be in Poor Condition. (See Photos 13-14) North-West batter/ support piling was observed to have minor cracking on the submerged portion of the pile. No further underwater rot or deterioration was observed however, topside visual inspection determined an estimated 50% material loss on pile cap. (See Photo15) Western most piling, second from the north is considered to be in Poor condition as there were multiple defects observed. One 1”x2” borer hole was discovered 10’ above the mudline with moderate deterioration from marine action. A 2’x1’ section of the pile was found to have extensive deterioration from marine insects including borer holes. The affected area is 8’ above the mudline and the remaining area of the pile below this section was also subject to extensive cracking and the beginnings of deterioration from marine action. (See Photo16)

All shoreline building wood piles were found to be in satisfactory condition with little to no minor cracking. None of the wood piles were subject to moderate or extensive damage from rot or borer holes. One 4”x12” treated beam used for cross bracing underneath the marina office was subject to extensive rot and deterioration. The affected area is 1-1/2’ in length and is not yet affecting areas of connecting hardware such as thru-bolts. There are multiple cross members and cross bracing below the restroom building. Multiple wood supports appear to be untreated and are showing signs of surface rot. The wood was green and color and was relatively soft when probed.

Assessments

Based on our underwater inspection, the underwater condition of this structures is Fair due to isolated areas of deterioration. The deterioration noted in this report is considered moderate however, load reductions are required as a result of the underwater structures. The piles were observed to be creosote-treated, they are probably 30 years or older. The detailed inspection determined that wood piles and supports in the tidal & submerged zones require future rehabilitation to provide an extended service life.

Recommendations

The timber piles are estimated to have approximately 10- 20 years of useful life remaining before replacement or similar repair should be considered. The outlined pilings subject to rot and marine borer holes should be considered for piling encapsulation within the next year, or sooner if conditions worsen. All damaged wood cross bracing and supports should be considered for repair within the next year. All non-treated lumber used for cross bracing and supports should be replaced with treated timber within 1-3 years. Continued annual inspection should considered for future planning.

Seattle Diving Services, LLC — Photographic log

Port Orchard Underwater Inspection	Shoreline Structures & Approach Docks	Location: G-Dock - NE Pile

Photo 13 | Oct. 2018

Client:

Port Orchard Marina
Port Orchard, Wa. 98336

Description:

View of (1”-2”) wide crack – (12’) long from seabed.

Seattle Diving Services, LLC — Photographic log

Port Orchard Underwater Inspection	Shoreline Structures & Approach Docks	Location: G-Dock – NE Pile

Photo 14 | Oct. 2018

Client:

Port Orchard Marina
Port Orchard, Wa. 98336

Description:

View of (1”-2”) wide crack – (12’) long approximently midwater.

Seattle Diving Services, LLC — Photographic log

Port Orchard Underwater Inspection	Shoreline Structures & Approach Docks	Location: G-Dock – NW Pile

Photo 15	Oct. 2018

Client:

Port Orchard Marina
Port Orchard, Wa. 98336

Description:

View of advanced material loss on top of Pile.

Seattle Diving Services, LLC — Photographic log

Port Orchard Underwater Inspection	Shoreline Structures & Approach Docks	Location: G-Dock – NW Pile 2

Photo 16	Oct. 2018

Client:

Port Orchard Marina
Port Orchard, Wa. 98336

Description:

View of (2' x 1') extensive deterioration on NW Pile 2.

(7.0) CONDITION RATING DESCRIPTIONS

Good - No visible damage, or only minor damage is noted. Structural elements may show very minor deterioration, but no overstressing is observed. No repairs are required.

Satisfactory - Limited minor to moderate defects or deterioration are observed, but no overstressing is observed. No repairs are required.

Fair - All primary structural elements are sound, but minor to moderate defects or deterioration is observed. Localized areas of moderate to advanced deterioration may be present but do not significantly reduce the load-bearing capacity of the structure. Repairs are recommended, but the priority of the recommended repairs is low.

Poor - Advanced deterioration or overstressing is 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.

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.

Critical - Very advanced deterioration, overstressing, or breakage has resulted in localized failure(s) of primary structural components. More widespread failures are possible or likely to occur, and load restrictions should be implemented as necessary. Repairs may need to be carried out on a very high priority basis with strong urgency.