Port of Bremerton
Underwater Inspection of Marine Facilities

120 Washington Beach Ave. Bremerton, WA 98337

Aerial Photo

Prepared by SDS Consultant
Seattle Diving Services, LLC
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TABLE OF CONTENTS **Page**

Underwater Inspection of Marine Facilities – Port of Bremerton

Introduction

During October 2018, Seattle Diving Services, LLC completed an underwater inspection of the Marine Facilities of the Port Orchard Marina & the Port of Bremerton. 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 Systems, Pilot Piles, Shoreline Structures, and the USS Turner Joy's Mooring System.

Summary

The underwater portions of the substructure components were found to be in overall Satisfactory condition due to the limited amount of deterioration. No evidence of major defect or failure 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 thickness measurements & corrosion potential readings of ten 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) USS TURNER JOY - MOORING SYSTEM

(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 bow anchors, chains, floats, and cathodic protection components of the USS Turner Joy.

Observations

The structures are generally covered in light 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 mooring systems are in generally satisfactory condition overall with limited areas of minor deterioration. The deterioration is generally more concentrated around upper half of the mooring systems.

The splash zone of the bow chains showed typical but minor marine corrosion with minimal paint chipping, peeling, and rust. The mooring floats had similar corrosion at the splash zone and underwater portions. (See Photo1)

Seattle Diving Services, LLC		Photographic log
Bremerton Underwater Inspection	USS Turner Joy	Location: Splash Zone
Photo 1	Oct. 2018	
Client: Port of Bremerton Bremerton, Wa. 98337		
Description: View of minor corrosion on anchor chain in the splash zone.		

The upper portions of the mooring systems showed accelerated deterioration due to ordinary wear under the influence of waves, currents, electrochemical corrosion and action from the motion of the buoys. Surface rust and pitting was observed on all hardware from the submerged portion of the bow chains to the upper portion of the bottom heavy chain. Minor corrosion was present throughout the rest of the heavy chain resting on bottom and on the anchors. Anchor flukes were dug into the seabed and lower portion of the heavy chain were observed to be partially buried confirming secure anchoring for the USS Turner Joy. The only anodes found were on bottom chain A-2. All other lines had depleted anodes less than 20%.

It was noted during the inspection that the bottom shackle-pin for the mooring float of line ‘A1’ was coming loose. This shackle had become free after initial inspection. Mooring float ‘A4’ had become disconnected and was not present during initial underwater inspection.

Assessments

Based on our underwater inspection, the underwater condition of the USS Turner Joy's Mooring System is Satisfactory due to isolated areas of minor deterioration. The deterioration noted in this report is considered minor and no load adjustments are required as a result of the underwater structures. Detailed examinations of the bottom heavy chain and anchors were observed to be in good condition due to their limited amount of corrosion. The detailed examination of the floats, concrete stabilizers, and top end hardware determined that mooring system exposed to higher oxygen levels, wave action, and underwater electrolysis requires rehabilitation to provide an extended service life. (See Photos 2-4)

Recommendations & Repairs

The top end of the mooring systems are progressively deteriorating and recommended they be protected from corrosion by installing sacrificial anodes at the top, middle, and bottom portions of each mooring system.

The mooring floats 'A1' and 'A4' were and had become disconnected during the time of the underwater inspection. A change order was made and Seattle Diving Services, LLC was contracted to reconnect the mooring floats.

Seattle Diving Services, LLC — **Photographic log**

Bremerton Underwater Inspection	USS Turner Joy	Location: Mooring Line A-1

Photo 2 | Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa. 98337

Description:

View of upper portion of bottom chain corrosion on mooring line A-1.

Seattle Diving Services, LLC — Photographic log

Bremerton Underwater Inspection	USS Turner Joy	Location: Mooring Line A-1

Photo 3 | Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of mooring float chain and top hardware on mooring line A-1.

Loose shackle pin.

Seattle Diving Services, LLC — Photographic log

Bremerton Underwater Inspection	USS Turner Joy	Location: Mooring Line A-4

Photo 4 | Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of submerged portion of bow chain on Mooring line A-4.

(2.0) FLOATING WAVE ATTENUATOR (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 (breakwater) and associated mooring connections and cathodic components.

Observations

The floating breakwater, associated mooring system, connections, and cathodic protection are generally in overall Satisfactory condition with limited areas of minor 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 breakwater floats were observed to be in general overall satisfactory condition. Heavy marine growth visually obstructed the level I inspection and thorough tactile methods had to be used. However, no cracking, spalling, severe corrosion, major damage, or deterioration due to over stress was detected during the inspection.

Engineering plans call for cathodic protection (one 30 lb. zinc anode) be installed on four locations on each mooring line. One on each top chain section, located at the bottom. Two on each wire rope section, one at the top, one at the bottom. One on each bottom chain section, at the top. In addition, as a

fail-safe each wire rope eye-socket had a zinc plate pre-installed. (See Photo 5) For the most part, all cathodic protection components were up to specification besides the top chain.

Heavy marine growth obstructed views of the top chain sections as the majority of the chains were covered in large 2’x3’ groups of tube-worm colony's. However, the growth was minimal enough to conduct an adequate level I inspection and determine whether anodes were installed recently. (See Photo 6) All mooring lines have anodes previously installed located towards the bottom section of each top chain. The remaining anode cores and hardware were still fixed to each structure and a handful of these anodes appeared to have been replaced recently and were in fair condition. However, it became present during the inspection that most of the top chain anodes had either completely depleted or had become detached from the mooring lines, providing no immediate protection for the top chains. The suspected causes are multiple. Little to no surface corrosion was observed as anodes further down the mooring lines are providing residual protection but this should be considered temporary.

The remaining hardware from old anodes were securely fixed to each mooring section with no play whatsoever. Almost all of the recently replaced anodes (anodes above 50% life remaining) were found to have been installed loosely (hand tight) or the u-bolt threads on the hardware securing the anode to the mooring lines were not long enough to securely fasten the anodes to the mooring lines. Under repetitive wave action, stress, & currents, the anodes had become progressively more loose over time, causing them to detach from the structures. Some anodes were discovered detached and resting on the sea-bed when inspecting the lower portions of the mooring lines. (See Photo7)Therefore, with the majority of the wave action being at the top of the water column, it is suspected this is the cause for the lack of cathodic protection on the top chain sections.

Floating breakwater mooring lines were found to be in overall satisfactory condition with limited areas of minor deterioration. Mooring line numbers 6S, 20N, & 37 were observed to have minor corrosion such as surface rust on the bottom chain sections, anchor, and connections. (See Photos 8-9) Mooring line numbers 21, 22, & 31N were observed to have minor corrosion such as surface rust on the top chain sections and connections. (See Photo10)

No surface corrosion was observed as previously installed anodes appeared to be providing residual protection but this should be considered temporary. The majority of top chain sections with opposing mooring lines showed signs of fretting & minor wear caused from tide fluctuations and wave action from movement of the breakwater. (See Photo11)

The majority of the anodes were found to be in fair condition. 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 minor deterioration. The deterioration noted in this report is considered minor and no load reductions are required as a result of the underwater structures.

The detailed examination of the cathodic protection components determined that the identified lines exposed to underwater electrolysis without cathodic protection requires rehabilitation and repair to provide an extended service life.

Recommendations

Mooring line numbers 6S, 20N, 21, 22 31N, & 37 were observed to have Minor corrosion on the top or bottom chains. In-kind rehabilitation would involve one anode installation on the corresponding chain section and include proper cleaning sufficient enough to ensure contact between the bottom chain and cathodic protection. These repairs should be carried out with moderate urgency.

All anodes 50% or below should be considered for replacement within the next two quarters. All mooring line sections missing anodes should be considered for installation within the same time frame. Mooring lines and cathodic protection components should continue to be inspected annually.

Seattle Diving Services, LLC		Photographic log
Bremerton Underwater Inspection	Breakwater Mooring Lines	Location Mooring L-7

Photo 5	Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of wire cable anode on top of the eye on mooring line L-7

Seattle Diving Services, LLC — Photographic log

Bremerton Underwater Inspection	Breakwater Mooring Lines	Location: Mooring L-5

Photo 6	Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of heavy marine growth and anode 70% at top section.

Seattle Diving Services, LLC — Photographic log

Bremerton Underwater Inspection	Breakwater Mooring Lines	Location: Mooring L-37

Photo 7	Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of broken anode hardware on seabed. Hardware malfuction.

Seattle Diving Services, LLC — Photographic log

Bremerton Underwater Inspection	Breakwater Mooring Lines	Location: Mooring L 20N

Photo 8 | Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of minor surface corrosion on L-20N

Seattle Diving Services, LLC — Photographic log

Bremerton Underwater Inspection	Breakwater Mooring Lines	Location: Mooring L-37

Photo 9 | Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of L-37 mooring anchor with minor surface rust.

Seattle Diving Services, LLC — Photographic log

Bremerton Underwater Inspection	Breakwater Mooring Lines	Location: Mooring Line L-22

Photo 10	Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of minor surface corrosion on top chain Mooring L-22.

Seattle Diving Services, LLC — Photographic log

Bremerton Underwater Inspection	Breakwater Mooring Lines	Location: Mooring Line L-32

Photo 11	Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of chafing of top chain on mooring line L-32.

(3.0) SOUTH SIDE WAVE ATTENUATOR WALL (additional photos & video on flash drive)

The objective of this project is to provide a general description and assessment with recommendations for the underwater & topside of the wave attenuator on the south side of the marina.

Observations

The structures are generally covered in light 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 concrete is generally in overall sound condition with limited areas of minor deterioration. Twenty – 4”x7” areas on the north-side of the wave attenuator wall were subject to cracking and spalling. These areas are suspected to be “pick-points” during installation as they are all in the same locations on each wall, same dimensions, and there is some minor rust staining coming through the concrete protective patches. (See Photo12) All patches are on the north-side of the wall section, just above the high tide line.

The H-Pilings are in overall fair condition, deterioration was most severe just above the high tide line. (See Photo13) In addition, all wall supporting components welded to the H-Pilings were subject to accelerated deterioration. This form of corrosion is common and is caused when two dissimilar and joined together and submerged. One metal will corrode faster than the other and in this case, it is the wall bracing and supports. The H-Pilings them selves have typical-moderate deterioration.
(See Photos 14-15)

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, no load adjustments are required as a result of the underwater structures. The detailed inspection determined

that concrete in the tidal & atmospheric zones and the H-Pilings located in the tidal & submerged zones of the structure require future rehabilitation to provide an extended service life.

Recommendations

The concrete patches on the North-side of the wave attenuator wall are cracking and spalling. It is recommended the failing patches be removed and new patches be installed. The wall support welded to the H-Pilings are progressively deteriorating and recommended that cathodic protection be installed on each H-Piling. Repairs should be carried out within the next year.

Seattle Diving Services, LLC — **Photographic log**

Bremerton Underwater Inspection	Wave Attenuator Wall	Location: South Seawall

Photo 12 | Oct. 2018

Client:
Port of Bremerton
Bremerton, Wa.98337

Description:
View of typical wall patch deterioration on north side of seawall

Seattle Diving Services, LLC — **Photographic log**

Bremerton Underwater Inspection	Wave Attenuator Wall	Location: South Seawall

Photo 13 | Oct. 2018

Client:
Port of Bremerton
Bremerton, Wa.98337

Description:
View of typical H-Beam corrosion above splash zone.

Seattle Diving Services, LLC — Photographic log

Bremerton Underwater Inspection	Wave Attenuator Wall	Location: South Seawall

Photo 14	Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of typical wall support corrosion.

Seattle Diving Services, LLC — Photographic log

Bremerton Underwater Inspection	Wave Attenuator Wall	Location: South Seawall

Photo 15	Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of typical corrosion on square tube bracing.

(4.0) BREMERTON MARINA PILOT PILES (10-Piles) (additional photos & video on flash drive)

The objective of this project is to provide a general description and assessment with recommendations for the (10) 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 ten pilot piles are generally in overall sound condition with limited areas of minor deterioration. The deterioration was most severe just above the high tide line. (See Photo16) Little to no delamination was noted for all but two pilot pile coatings. Pilings E-49 & E-46 were observed to have moderate surface rust throughout the submerged zones of the piles. (See Photos 17-19) This form of corrosion is common and although moderate, should be considered when planning future rehabilitation. Pilings A-26 & A-15 had anodes installed with piling A-26 anode damaged & disconnected. (See Photo18) Piling A-15 anode had a 40% service life remaining. All other pilings did not have cathodic protection installed.

Assessments

Based on our underwater inspection, the underwater condition of these structures is Good due to isolated areas of minor deterioration. The deterioration noted in this report is considered minor 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 tidal & submerged zones may require future rehabilitation to provide an extended service life. However, no major defects were discovered.

Recommendations

Piling A-26 anode was found damaged & disconnected. This anode should be considered for repair and replacement as soon as possible. Pilings E-49 & E-46 did not have cathodic protection installed but moderate surface was rust discovered. Anode installation should be considered within the next year for pilings on E-dock.

Seattle Diving Services, LLC		Photographic log
Bremerton Underwater Inspection	Pilot Piles	Location Pile E-46
Photo 16 Oct. 2018		
Client: Port of Bremerton Bremerton, Wa.98337		
Description: View of deterioration on Pilot Pile splash zone.		

Seattle Diving Services, LLC — Photographic log

Bremerton Underwater Inspection	Pilot Piles	Location: Pile A-15

Photo 17	Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of typical underwater corrosion on Pilot Pile A-15

Seattle Diving Services, LLC — Photographic log

Bremerton Underwater Inspection	Pilot Piles	Location: Pile A-26

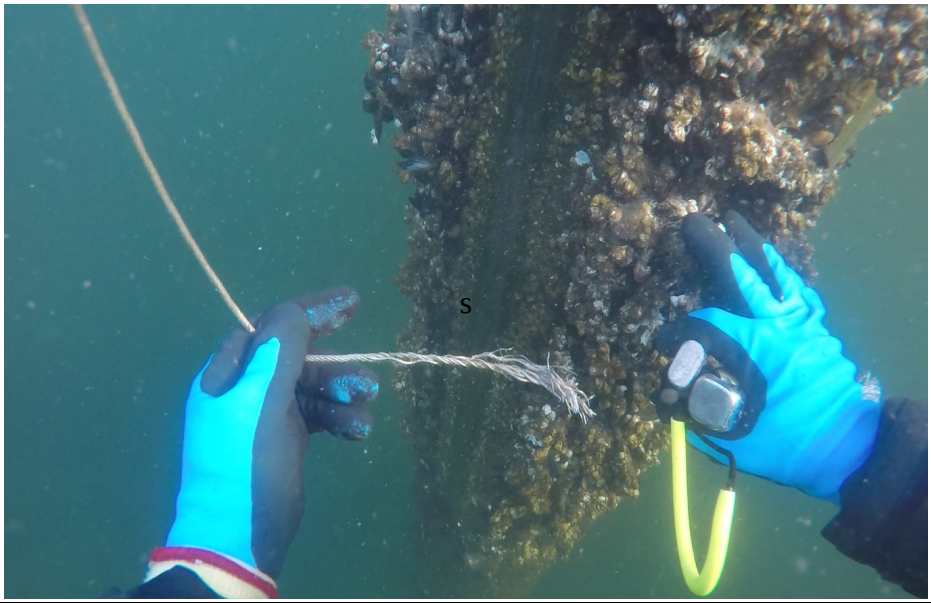
Photo 18	Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of broken anode cable on Pilot Pile A-26.



Seattle Diving Services, LLC — Photographic log

Bremerton Underwater Inspection	Pilot Piles	Location: Pile E-49

Photo 19	Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of advanced surface deterioration on Pilot Pile E-49.

Seattle Diving Services, LLC — Photographic log

Bremerton Underwater Inspection	Pilot Piles	Location: Pile P-35

Photo 20	Oct. 2018

Client:

Port of Bremerton
Bremerton, Wa.98337

Description:

View of typical abrasion from pile guide on P-35. No damage.

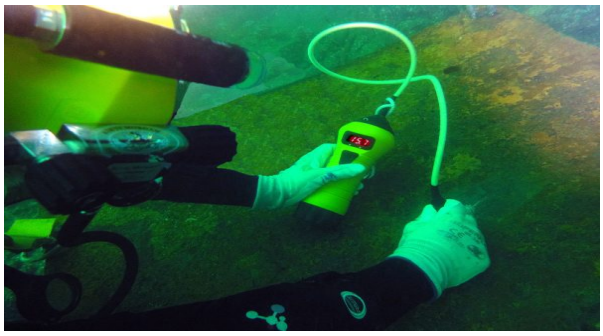
(5.0) BREMERTON READINGS & MEASUREMENTS

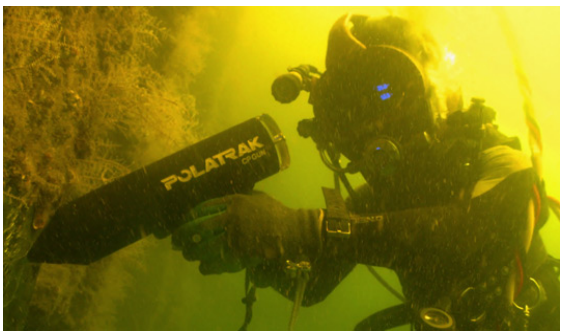
Thickness readings were taken using a Tritex Multigauge 3000 Underwater Thickness Meter which was calibrated and tested on-site using a 0.500 testing block. CP Measurements were taken using a Polatrak CP Gun which was calibrated and tested on-site using a 0.500 testing block. Both gauges are 2018 models and are the go-to units in the sub-sea inspection industry.

Bremerton	THICKNESS READING				CP MEASUREMENT		
Location	Waterline	Mid-Water	Seabed	Depth	Waterline	Mid-water	Seabed
A-26	0.35	0.39	0.39	20	-750	-738	-730
A-15	0.38	0.38	0.385	36	-749	-760	-760
B-44	0.395	0.4	0.39	20	-840	-877	-878
B-45	.325/.385	0.37	0.385	25	-718	-711	-724
C-49	0.565	0.575	0.58	22	-692	-697	-695
p-35	0.57	0.575	0.575	27	-690	-690	-690
D-39	0.57	0.575	0.565	30	-720	0.72	-721
E-49	-580	-590	0.575	25	-691	0.69	-691
P-2	0.575	0.575	0.58	65	-707	-709	-711
e -26	0.545	.535/580	0.52	30	-702	-707	-710

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

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





(6.0) BREMERTON MOORING LINE ANODE PERCENTAGES

Line #	Top Chain Anode %	Cable Anode %	Bottom Chain Anode %
1S	0	70/70	60
1N	30	70/70	50
2	40	40/80	50
3	50	40/40	30
4	0	60/60	60
5	30	70/70	70
6S	0	50/40	40
6N	0	50/50	30
7	0	20/30	60
8	30	60/70	40
9	0	60/70	60
10	0	70/70	60
11	0	60/60	60
12	10	50/70	60
13	10	60/60	60
14	10	60/60	60
15	10	70/80	30
16	50	60/60	60
17S	70	80/70	50
17N	10	80/70	40
18	10	80/70	50
19	40	80/70	60
20S	0	70/70	70
20N	0	70/30	0
21	0	60/60	70
22	0	60/60	0
23	10	60/60	60
24	0	60/60	60
25	10	60/60	60
26	10	60/60	60
27	10	60/60	60
28	10	60/60	60
29	10	60/60	60
30	10	60/60	60
31S	10	60/60	60
31N	0	80/70	40
32	0	70/60	60
33	0	60/60	0
34	70	80/70	50
35	0	60/60	60
36S	0	70/70	50
36N	0	70/70	0
37	0	70/70	0
38	10	60/60	60
39	10	60/60	60
40	10	60/60	60
41	60	60/60	60
42	10	60/60	60
43	10	60/60	60
44	10	60/60	60

(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.