MOTT MACDONALD

Port Angeles Primary Atlantic Salmon Net Pens Engineering Assessment

January 29, 2018

State of Washington Department of Natural Resources

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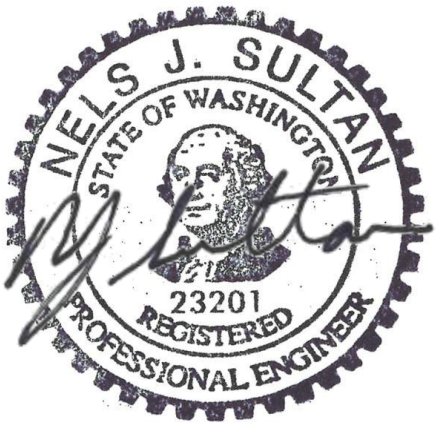
Acronyms and Abbreviations

AGS	American Gold Seafoods
AIS	marine vessel Automatic Identification System
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
BAP	Best Aquaculture Practices
DNR	Washington State Department of Natural Resources
ECY	Washington State Department of Ecology
ft.	feet
Hs	Significant Wave height
in.	inch
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
NOAA	National Oceanographic and Atmospheric Administration
OHW	Ordinary High Water
ORN	Orchard Rocks – North
ORS	Orchard Rocks - South
PATON	Coast Guard Private Aids to Navigation
ROV	Remotely Operated Vehicle
Tp	Peak wave period
USACE	US Army Corps of Engineers

Certifications

This report has been prepared by Mott MacDonald under the supervision of a Professional Engineer, including all findings and recommendations.

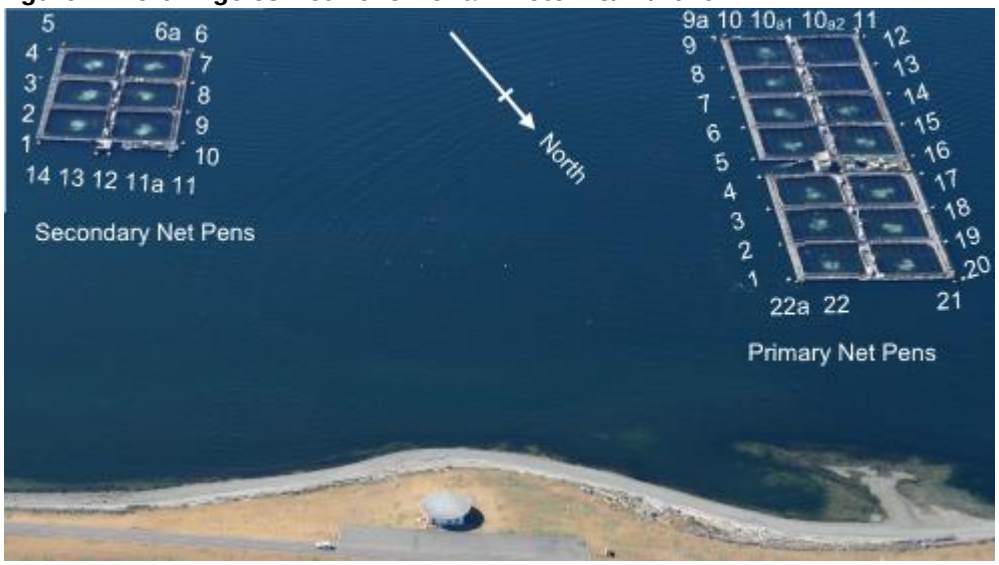


Date: January 29, 2018

1 Introduction

This report presents the results of a document review, site visit and assessment of the primary net pen facility in Port Angeles, WA, owned by Cooke Aquaculture. **Figure 1** is an aerial photo of both the primary and secondary net pen facilities, including the mooring line numbers. This work has been performed by Mott MacDonald for the State of Washington Department of Natural Resources (DNR). The dive inspection portion of the work has been performed by Collins Engineers, Inc. as a sub-consultant to Mott MacDonald.

Figure 1: Port Angeles Net Pens Aerial Photo – 8/12/2016



Source: Washington State Department of Ecology Aerial Photo

This report is one of seven engineering assessment reports that are being prepared by Mott MacDonald, one for each net pen at different sites in Puget Sound and Port Angeles. DNR holds several lease agreements with Cooke that authorize Cooke to operate Atlantic salmon net pen facilities in Washington state waters at four locations. The locations of the facilities with reports by Mott MacDonald for this study are as follows:

Hope Island	(1 facility)
Port Angeles Harbor	(2 facilities; Primary net pen and Secondary net pen)
Rich Passage	(2 facilities; Orchard Rocks net pen and Fort Ward net pen)
Cypress Island	(2 facilities; Site 1 and Site 3)

In addition to these seven facilities and reports, Mott MacDonald previously prepared a report for DNR in October 2017 concerning the Clam Bay net pen facility in Rich Passage. Mott MacDonald is also involved in the investigation of the Cypress Island Site 2 net pen failure that occurred in August 2017.

1.1 Purpose and Methods

The work performed includes a review of relevant documents provided by Cooke and DNR. References and standards applicable to salmon aquaculture and net pens have also been researched by Mott MacDonald and applied. During the site visit an above water visual and

tactile inspection of each facility was performed that focused on the structural elements of the net pen superstructure and permanent floating structures (barges with sheds). An underwater visual and tactile inspection was performed by Collins Engineers (Collins). Underwater areas that were inspected included conditions of every anchor and mooring line; permanent floating structures; selected areas of the net pen floatation system; and underneath the superstructure that are areas of typical potential damage or concern. The underwater inspection was completed by Collins using both divers and Remotely Operated Vehicles (ROV).

The purpose of the work is to conduct a site visit and review available documents to provide an engineering assessment of the net pen facility. This report is for use by DNR and state agencies in making proprietary and regulatory decisions

The document review includes the following:

- DNR lease requirements.
- Best Aquaculture Practices (BAP)
- Permit documentation (inspection reports, design conditions, etc.)
- Inspection type and frequency.
- Maintenance and repair history.
- Facility design documentation and lease requirements.
- Industry standards for design, operations, maintenance, and best management practices.

This work is limited in scope. Detailed inspection and physical material sampling were not performed. A load rating or structural analysis has not been performed. Repair or maintenance recommendations are not included in this report.

The site visit and inspection only included those elements at the time of the site visit. Not included in this review are mechanical systems and utilities, such as lighting, power and water pumping equipment.

1.2 Inspection Scope and Standards

Mott MacDonald and Collins Engineers have followed the recommended standards and practices in ASCE Manual No. 130 - *Waterfront Facilities Inspection and Assessment* published by the American Society of Civil Engineers (ASCE, 2015).

The above water inspection by Mott MacDonald staff is consistent with a Level I visual and tactile inspection of all surfaces that were visible without removing coatings or opening hatches. The methods were consistent with a "Routine" type of inspection. The Collins Engineers dive inspection is consistent with a Level I inspection with a Level II inspection at selected areas. The Level I and II methods and Routine inspection type are defined in ASCE No. 130.

Condition assessment definitions from ASCE Manual No. 130 are applied in this report, copied below in **Table 1**. These are assigned to the major components of the facility.

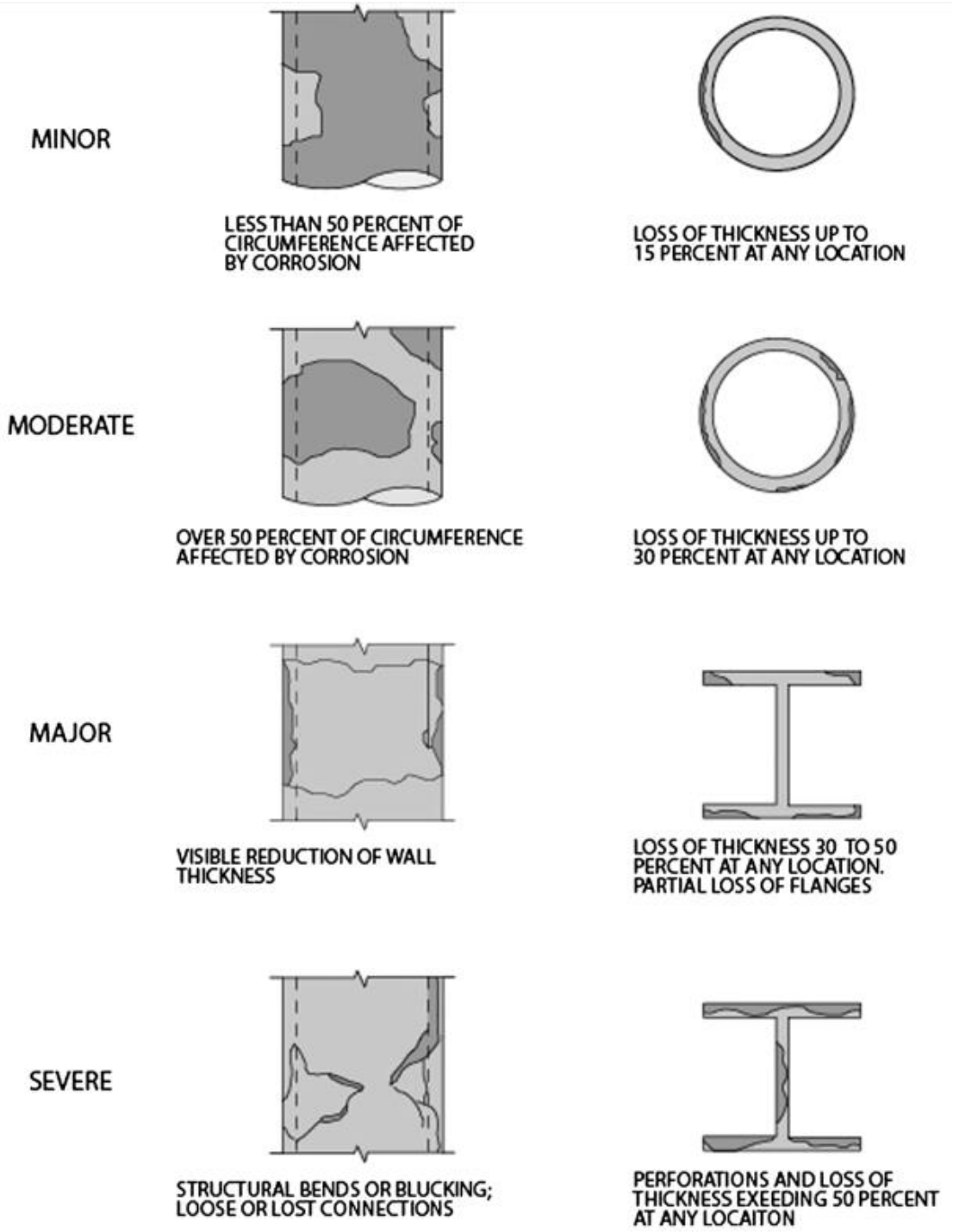
Table 1: Condition Assessment Rating

Rating	Description
6 Good	No visible damage or only minor damage noted. Structural elements may show very minor deterioration, but no overstressing observed. No repairs are required.
5 Satisfactory	Limited minor to moderate defects or deterioration observed but no overstressing observed. No repairs are required.
4 Fair	All primary structural elements are sound but minor to moderate defects or deterioration observed. Localized areas of moderate to advanced deterioration may be present but do not significantly reduce the load-bearing capacity of the structure. Repairs are recommended, but the priority of the recommended repairs is low.
3 Poor	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.
2 Serious	Advanced deterioration, overstressing, or breakage may have significantly affected the load-bearing capacity of primary structural components. Local failures are possible, and loading restrictions may be necessary. Repairs may need to be carried out on a high-priority basis with urgency.
1 Critical	Very advanced deterioration, overstressing, or breakage has resulted in localized 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.

Source: Table 2-14 in ASCE Manual No. 130

The damage/condition rating system in ASCE Manual No. 130 is applied in this report. It includes the following condition ratings "Minor, Moderate, Major, and Severe," which are defined for different material types. The damage rating definitions for Steel elements are shown below in **Figure 2** for ease of reference. Similar figures from ASCE Manual No. 130 exist for mooring hardware, timber, and other materials.

Figure 2: Damage Rating for Steel Elements



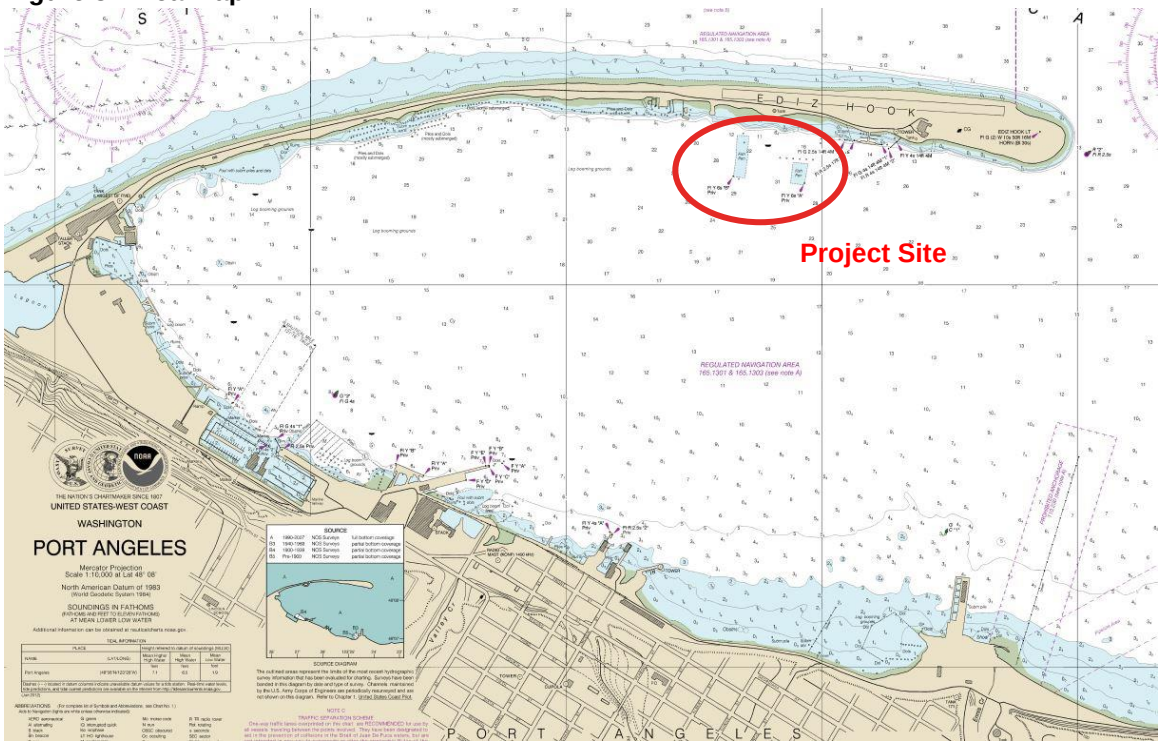
Source: ASCE Standard of Practice No. 130 "Waterfront Facilities Inspection and Assessment"

2 Document Review

The Port Angeles Net Pen facilities owned by Cooke Aquaculture are located south of Ediz Hook, near the Port Angeles Coast Guard Facility. **Figure 3** is an area map. **Figure 4** shows the bathymetry in more detail. The Port Angeles facility was in deeper water than the other three Cooke Aquaculture facilities located in Puget Sound. Depths varied from 100 ft on the north to over 170 feet on the south relative to Mean Lower Low Water (MLLW). Drawings in Appendix A show a general plan and photos of the existing facilities. Additional site photos are in Appendix C.

The age of the existing net pens has not been determined. Net pens have been at the site since at least July 18, 1990 based on historical aerial photography on GoogleEarth and shoreline aerial photos from the Washington Department of Ecology. Aerial photos also show net pens with the same size and configuration, as the primary and secondary net pens currently at the site were likely installed before May 31, 2002. The primary net pens were likely installed before December 6, 2000. The typical service life for this type of facility is 15 years and will vary depending on the level of maintenance and exposure to waves and currents.

Figure 3: Area Map



Source: NOAA Chart 18468

2.1 Document Review

Documents reviewed by Mott MacDonald are described in **Table 2**. Document interpretations are included elsewhere in this report.

Table 2: Document Review – Summary

No.	Description	Comments
General Documents received from Cooke		
1	October 2017 Pollution Prevention Plan Updated, 6 pages	Not relevant to this report
2	October 2017 Spill Prevention Control and Response Plan Updated, 5 pages	Not relevant to this report.
	System farm large steel cage system, 16 pages	Technical description and figures for a “SystemFarm” by Marine Construction.
	Cooke Aquaculture Fish Escape Prevention Plan (January 2017).	Outlines requirements for moorage system damage inspections, frequency of inspection and post-storm inspection
3	Wavemaster Steel Cage Specs, 3 pages	Brochure-style with graphics. it contains general information from the manufacturer.
Port Angeles Specific Documents received from Cooke		
5	Port Angeles lease agreement (No. 22-B02777), signed November 2015, 38 pages plus exhibits	Exhibit A is the legal description of the property, and Exhibit B is the plan of operations for the facility, including a description of the facility. Attachment 1 is the video dive survey protocol. Attachment 2 describes the underwater camera equipment.
6	Port Angeles Land Survey	4 pages including plan and profile of the net pens, dated February 17, 2005.
7	Port Angeles Site Spill Kit Locations, 1 page	Includes a site map.
8	NPDES Permit Port Angeles, 30 pages	Issued 2007 and expires 2012. Not relevant to this report.
10	Port Angeles Site Plan	Schematic diagram with a number for each net pen and anchor, and a description of the anchors and mooring lines. It is included in the drawings in Appendix A to this report.
11	Surface Inspection Sheets, 6 pages	Inspection sheets including repair logs and inspections for mooring points, shackles, thimbles, hardware, mooring lines, chain connections, hinge points, grating conditions.
12	Square Net Cage drawings, 3 pages	Diagrams and instructions for the net cages
13	AGS Cage Husbandry History, 10 pages	Monthly cage activity reports March or May 2017 to October 2017
14	2017 Oct -Net pen inventory, 1 page	Inventory includes dimensions, mesh size, make, year made, etc.
Standards, Guidelines, Studies, Plans		

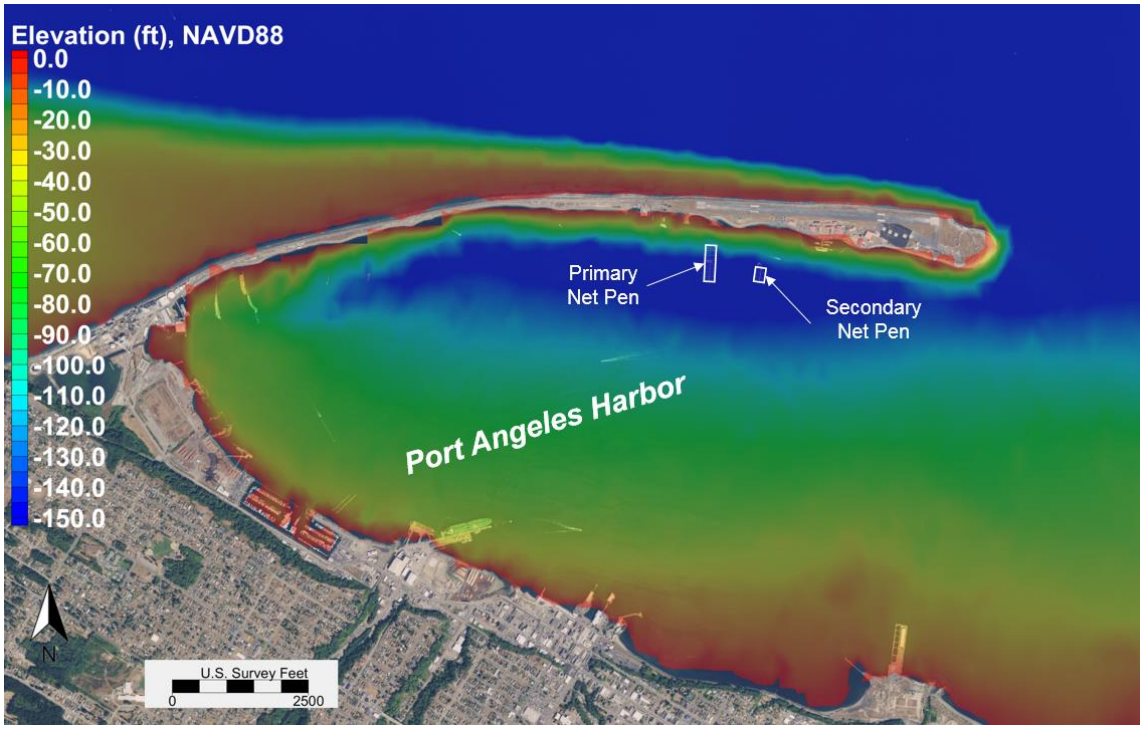
No.	Description	Comments
15	Norwegian Standard NS 9415.E:2009 -- Marine fish farms Requirements for site survey, risk analyses, design, dimensioning, production, installation, and operation	The standard includes site survey requirements, load and load combinations, general requirements for the main components of a marine fish farm, requirements regarding net pens, floating collars, rafts, and mooring.
16	Aquaculture Facility Certification Salmon Farms Best Aquaculture Practices (BAPs) Certification Standards, Guidelines, - by the Global Aquaculture Alliance	BAPs are practices adopted and self-enforced by the industry. A number of references are available from different states and countries. In Washington state, the BAPs are assumed to include the 1986 interim guidelines (described below).
17	Recommended Interim Guidelines for the Management of Salmon Net-Pen Culture in Puget Sound – December, 1986	These interim guidelines prepared for the Washington Department of Ecology are intended to provide a coordinated agency approach to management of salmon net-pens in Puget Sound. The guidelines are for interim use until a programmatic EIS can be completed and focus on environmental protection. Guidelines include water quality, site selection, and environmental surveys.
Miscellaneous		
18	2014 Fin Fish Aquaculture Plan of Operation – updated June 2014 by American Gold Seafoods (AGS)	Obtained by Mott MacDonald. The 2014 plan includes an overview of existing farming sites, stock species, and health certifications and screenings. Attachment A lists the facility locations and permits, 2014 Fish Escape Prevention Plan, Employee and guidance for routine handling procedures to minimize the potential for escape. It states that the Port Angeles net pens have been replaced “using Marine Construction and Wavemaster manufactured cage systems.”

Source: Mott MacDonald

3 Metocean Review

A review of environmental conditions at the net pens located in Port Angeles Harbor was conducted as part of the facility review. Mott MacDonald was provided with the original lease agreement document (22-B02777) between Cooke Aquaculture (then Icicle Acquisition subsidiary, LLC) with DNR. The lease document was found to provide no information regarding the environmental conditions (i.e., waves, currents, tides, winds, vessel wakes) at the Port Angeles net pen facility. In lieu of any provided environmental conditions data, Mott MacDonald conducted an independent feasibility-level study to characterize the environmental conditions at the facility. Environmental conditions were developed based in part on prior project experience in the area.

Figure 4: Bathymetry of Port Angeles Harbor

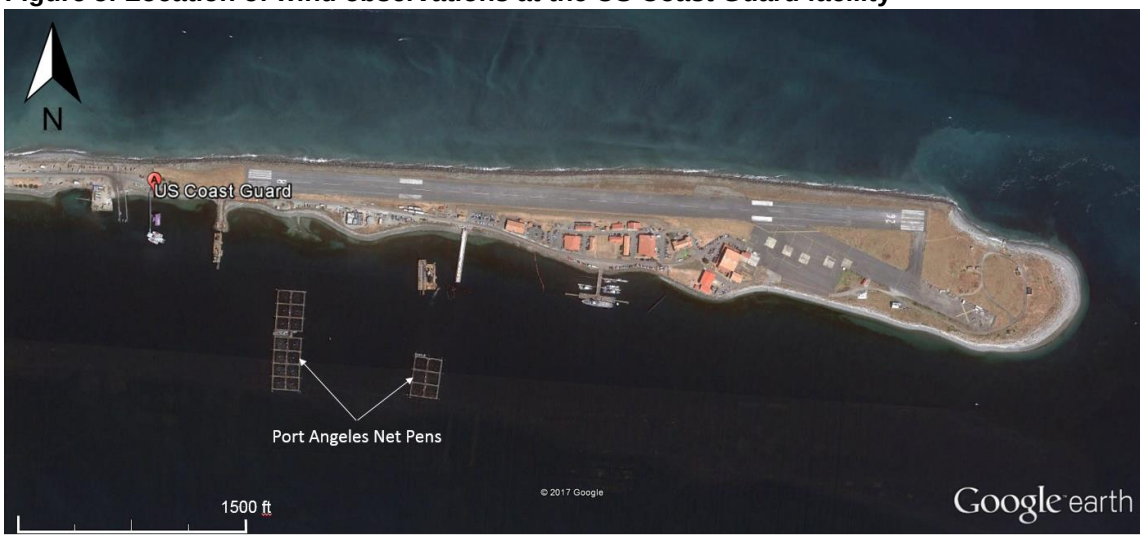


Source: NOAA Digital Elevation Model

3.1 Winds

A review of measured wind data near the net pen facility was conducted to estimate the wind climate. Extreme wind speeds based on wind observations made at the Port Angeles Coast Guard Facility (NCEI station ID # 74201099999) were available. The measurements are 1,200 feet from the net pens (**Figure 5**). Extreme sustained (2-minute average) wind speeds were analyzed. The 2-year return period wind speed is 12 to 37 miles per hour, varying with direction, and the 50-year return period windspeed is 24 to 51 miles per hour, varying with direction.

Figure 5: Location of wind observations at the US Coast Guard facility



Source: GoogleEarth Aerial Photo

3.2 Waves

Long term wave measurements were not available for the net pens facility or Port Angeles Harbor. In lieu of measured wave data, a review of wind-wave conditions at the net pen site was conducted based on our previous experience with projects in the harbor. Ocean swell from the west does not significantly affect the site because it is protected by Ediz Hook.

Existing wind-wave model results, developed using the 2-dimensional SWAN numerical wave model, from the Mott MacDonald internal database were reviewed. Wave model results include significant wave height estimates for a 100-year return period. An example of the wave model output is shown in **Figure 6**, including the net pen locations and the model grid. Significant wave heights for a 100-year return period event in the vicinity of the net pen facility are summarized in **Table 3**. Estimates for significant wave heights for the 100-year return period wave event range from 2.1 – 4.9 feet, with peak wave periods ranging 3.0 – 4.3 seconds, varying with the wave direction.

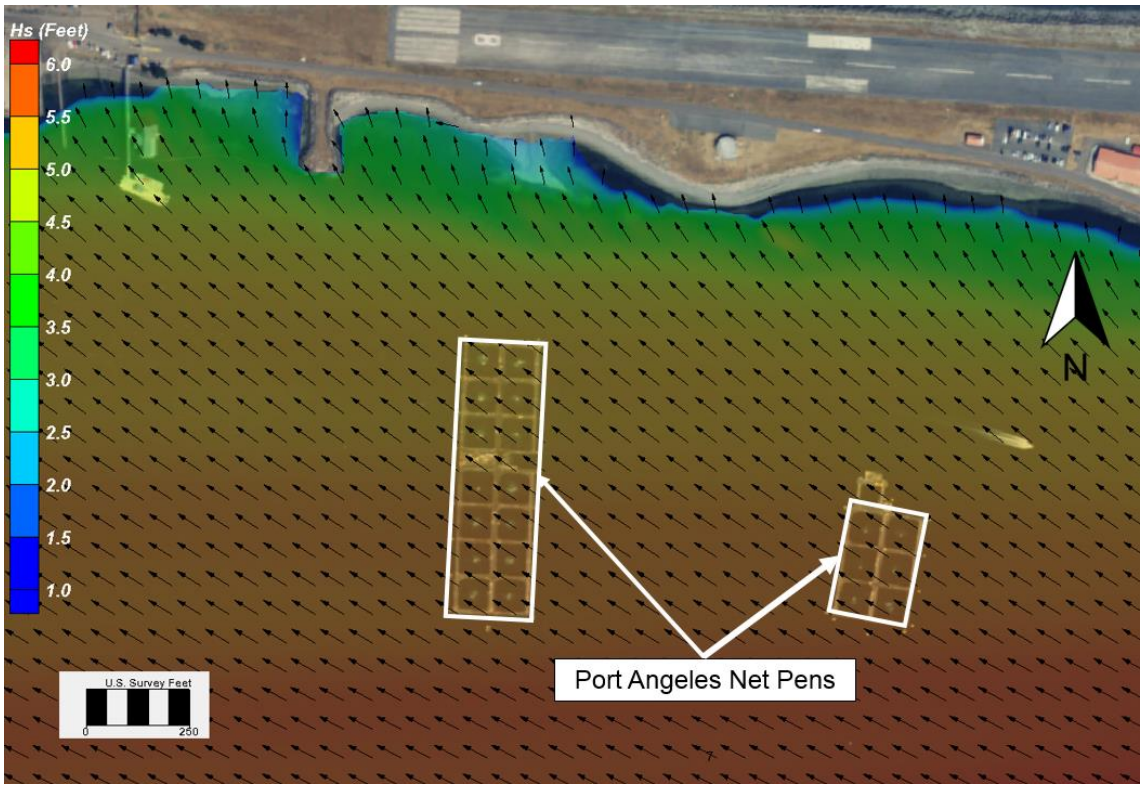
Table 3: 100-year Waves Near Port Angeles Net Pens[1]

Wind Direction	Significant Wave Height (feet)	Peak Wave Period (seconds)	Peak Wave Direction
Northeast	3.1	4.3	East
East	4.3	4.6	East-Southeast
Southeast	5.3	4.3	Southeast
South	2.6	3.0	South
Southwest	3.3	3.2	Southwest

Source: Mott MacDonald

[1] Estimates vary slightly by location.

Figure 6: SWAN Wave Model Output for 100-year Waves from South



Source: Mott MacDonald

3.3 Water Levels

Water levels and tidal datum data from a NOAA station (ID # 9444090) in Port Angeles Harbor were reviewed. The Port Angeles station has a diurnal tidal range of 7.06 feet and an estimated extreme tidal range of 13.90 feet[2]. The tidal datums and water levels are in **Table 4**.

Table 4: Tidal Datums for Port Angeles, WA (NOAA Station ID # 9444090)

Water Level	Elevation (feet, MLLW)
Highest Observed Water Level (Jan. 2, 2003)	10.51
Highest Astronomic Tide (predicted tide)	9.06
MHHW	7.06
MHW	6.51
MSL	4.24
MLW	1.92
NAVD88	0.42
MLLW	0.0
Lowest Astronomic Tide (predicted tide)	-3.76
Lowest Observed Water Level (June 13, 1982)	-4.84

Source: NOAA

[2] Extreme tidal range was defined as the difference in elevation between high astronomical tide (HAT) and low astronomical tide (LAT).

3.4 Currents

No measured current data is available at the Port Angeles net pen facility. Previous studies of surface current velocities (by others) were reviewed by Mott MacDonald as part of this environmental conditions assessment. Yang and Khangaonkar (2004), using the 3-dimensional hydrodynamic and transport model EFDC, described predicted maximum surface currents in the Port Angeles Harbor area as “relatively small”, in the order of 0.10 meters per second or less. Ebbesmeyer *et al.* (1999) measured mid-depth current velocities within Port Angeles Harbor over a period of 19 days, finding a mean current speed at the mouth of Port Angeles of 0.031 meters per second at a depth of 5 meters. Based on existing information, and observations during the ROV inspection of the anchors and mooring lines, it is concluded that currents at the project site are typically low, less than 0.5 meters per second.

3.5 Vessel Traffic

A review of historical marine vessel automatic identification system (AIS) data in the waters surrounding the Port Angeles net pens facility was conducted using the publicly available marinecadastre.gov online resource. Vessel traffic was found to be composed of passenger ferry traffic (passing within 1 mile of pens), recreational traffic from local marinas, and cargo/tanker vessel traffic. AIS data shows tanker, tugboat, and recreational vessel traffic pass within 1,000 feet of the net pen facility. The US Coast Guard Station is located directly adjacent to the facility to the north and includes vessel traffic to and from the facility. Based on review of available data, and nearby in-water uses, the waters surrounding the Port Angeles net pen facility appear to be used by a wide variety of vessels. Passing vessel wake analysis has not been conducted. Relatively large vessel wakes are possible considering the size of vessels that are known to transit the harbor.

4 Net Pen Structure

The Port Angeles fish farm facility is a SystemFarm Large Steel Cage system manufactured by Marine Construction. The fabricated steel structure includes mooring and net pen system and hardware attached to floating walkway structures which are supported by rotary molded polyethylene and polystyrene foam filled pontoons for floatation. The primary net pen system is a catenary moored floating structure relying upon forces imposed on the floatation pontoons and net systems to be resisted by a series of mooring chains, rope, and anchors. The following is a summary of the key components of the system which we reviewed as a part of our site assessment work. The basis of the information includes the documents provided for review and our observations during the site visit. Drawings of the net pen structure are in Appendix A and photographs are in Appendix C. The underwater dive inspection report is in Appendix B.

The primary and secondary net pens have similar construction, but differ in the following ways:

- Primary system has 14 net pens, the secondary only 6 net pens.
- Permanent floating support structures are different. See the drawings in Appendix A that show the arrangement. Primary net pens include the concrete barge. Secondary net pens only have a wood shed structure on floats that are the same construction as the net pen floats.
- The age appears to be different based on historical aerial photography.

4.1 Anchors

Where visible, mooring lines were observed as shackled to the anchor at the seabed. Anchor types were reported as all Danforth in the information provided by the net pen owner. All the anchors are assumed to be Danforth type drag anchors, as discussed later in this report.

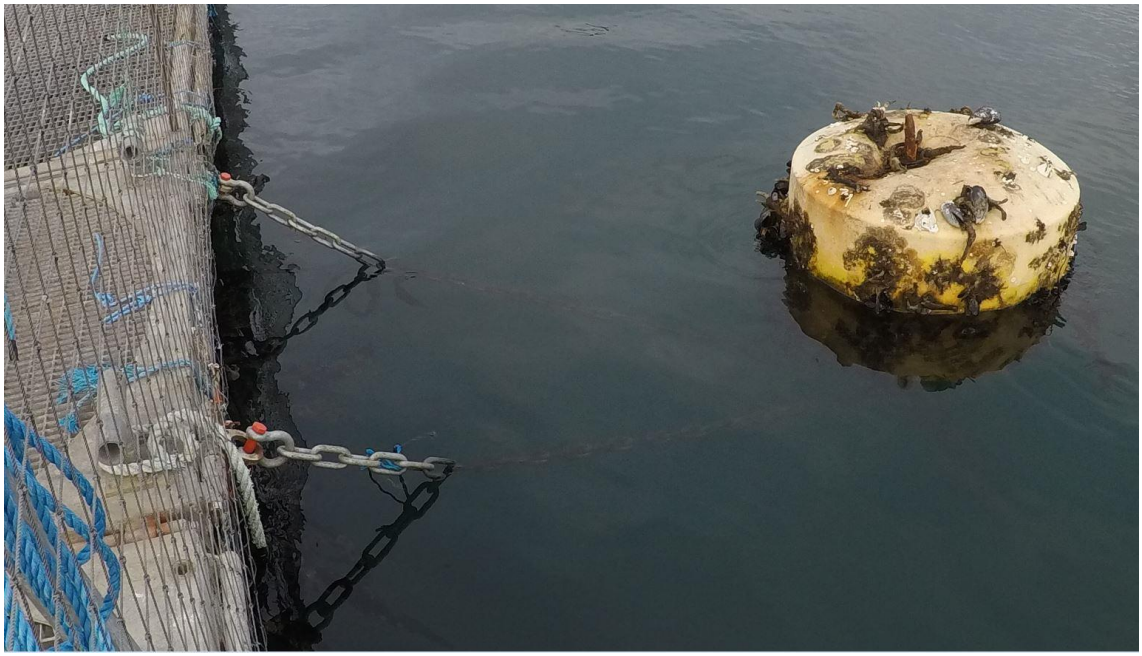
4.2 Mooring Line & Hardware

Mooring lines were composed of a combination of stud link and navy chain, synthetic rode line, shackles, and other mooring hardware. Mooring lines were shackled to anchors at the seabed. Each mooring line was connected to a buoy on the surface to help support the weight of the chain and mooring line. The buoy was connected to the float frame by a pair of chains shackled to hinged mooring brackets (also called tabs or padeyes). The pair of chains form a bridle or “hens foot” connection.

4.3 Mooring Line to Float Connection

Mooring brackets were attached to the walkway structure frame via the hinges near the walking surface. The hinge assembly were approximately 18-inches long and included a 1-inch diameter stainless steel bolt. Figure 7: Mooring Brackets, Chain and Buoy at Port Angeles Net Pen Figure 7 is a photo of a typical connection.

Figure 7: Mooring Brackets, Chain and Buoy at Port Angeles Net Pen



Source: Mott MacDonald

4.4 Predator Net

Predator nets connect to the steel structural frame of the docks around the pen's outer perimeter. The net system included weights on the bottom and were closed at the bottom. The nets were not included in this inspection.

4.5 Fish Pen Net

Fish containment nets connect to steel pipe along the inboard edge of the walkway frame. The net system included weights on the bottom and were closed at the bottom. The nets were not included in this inspection.

4.6 Walkway Frame

Walkway frames are constructed from square section steel tubing along both sides with heavy duty angles at the ends. Corners are stabilized with brackets, gusset plates and other structural members. There are cross members to support the walkway deck grating.

4.7 Pontoon

Pontoons are rotary-molded polyethylene and filled with polystyrene.

5 Inspection, Maintenance & Repair History

A review of the inspection, maintenance and repair history was conducted based on the information provided and as described by Cooke personnel.

5.1 Background

The following documents and standards apply to the net pen system inspection and maintenance activities.

- Aquatic Lease #22-B02777 (signed November 2015). Minor maintenance to the cage structures, anchor lines and netting occurs throughout the year and on a continual basis. Major maintenance of cage structures is typically replacement. Average service life expectancy is approximately 15 years according to other lease agreements. Service life expectancy was not stated in the lease agreement for this site. Metal fatigue can be a factor based on constant wave action and corrosive environment. Inspection of submerged mooring systems are to be made periodically by divers and surface connections checked daily.
- Cooke Aquaculture Fish Escape Prevention Plan (January 2017). The document outlines requirements for moorage system damage inspections. It also outlines requirements for frequency of inspection and post-storm inspection requirements.
- SystemFarm W24-3,16 Large Steel Cage System – 16-page technical description and with figures and other information. The cover of the document shows the supplier was Marine Construction and was dated June 16, 1999. It appears to be prepared for Omega Salmon Group Ltd. and Cypress Island Inc. for 12 cages delivered on March 1999. The primary net pen at Port Angeles is 14 cages. This document was assumed by Mott MacDonald to have been prepared for net pen facilities at Cypress Island. However, the system described appears similar to the system at Port Angeles. The document includes recommended maintenance intervals for different components.
- Industry Standards. Various industry standards and other governmental standards for marine fish farming facility inspection and maintenance exist. These include requirements in other U.S. States, Canada, and Norway. These other governments and industry practice have a summary of recommended inspection and maintenance activities for net pen systems.

5.2 Inspection

The following documents were reviewed pertaining to inspection of the net pen facility.

- Three weekly inspection forms were reviewed, from October 20 to November 3, 2017. They include the mooring plan and a table with condition of the following:
    - System Mooring Points (Pad eyes, Mooring Plates)
    - Surface Shackles, Thimbles, Hardware
    - Mooring Lines (column was left blank)
    - Surface Chain Connections
    - Walkway Hinge Points
    - Walkway Grating Condition

- AGS Cage Husbandry History. Logs from March to October 2017 show that the sides of the nets were washed on a monthly basis. Each cage has a separate log sheet. Routine visual inspections are reported done by Cooke staff on a weekly basis.
- Dive Inspections. Documentation of independent dive inspection work was not found in the records provided. The data of dive inspections by Cooke and the assessment are included in the weekly inspection spreadsheet document.

5.3 Maintenance & Repair History

- Square Net Cage Diagrams (5 pages): Contains dimensions and descriptions of the net cage components. Document was prepared by Garware-Wall Ropes Ltd (GWRL) on November 15, 2016, revised November 21, 2016. The company is based in India. Attached invoice shows that 6 nets were purchased by Cooke Aquaculture on March 25, 2017.
- Port Angeles Pet Net Inventory (1 page): October 2017. Spreadsheet lists the ID number of each net, its location (pen number), nominal dimensions, water depths, mesh size, make, net type, twine type, and year made. The nets are meant for Smolt and are a mix of Garware and unspecified brands. Not all nets list year made, but those that do are all from 2010 and 2011.
- Port Angeles Surface Mooring Inspection and Replacement Log (1 page): October 11 through October 18, 2017. All 22 anchors were serviced during this period, the log noting specific changes made. Repairs included replacing bridle chains, shackles, padeyes (anchor 10), resetting an anchor (anchor 20), and completely replacing the anchor system (anchors 6 and 17). It is unknown how often Cooke staff performs maintenance on these components.

5.4 Assessment

The following is our assessment of the inspection, maintenance and repairs being conducted at the facility.

- Documentation of historical maintenance and repair work was sparse based on the information provided at the time of this assessment.
- Nets, walkways, and mooring line systems are inspected on a regular basis and prior to fish stocking, with repairs and component replacement conducted prior to fish restocking.
- Inspection of other key float frame and net support systems such as the predatory nets, structural frame, and fish net support pipe system do not appear to be logged despite verbal indication by cook staff that inspections and repairs of these structures occurred periodically. Inspection of these structural elements should be documented.
- Inspections as outlined in the supplier documentation and industry standards typically require a greater level of inspection and documentation thereof, than what appears to be conducted and as outlined in the information provided for this assessment.

6 Site Visit and Existing Conditions

Mott MacDonald visited the net pen facility on December 4 and 5, 2017. Collins Engineers performed an underwater inspection December 4-9. **Figure 8** shows the primary net pens. Photographs are included in Appendices A and C. The dive inspection report by Collins is in Appendix B.

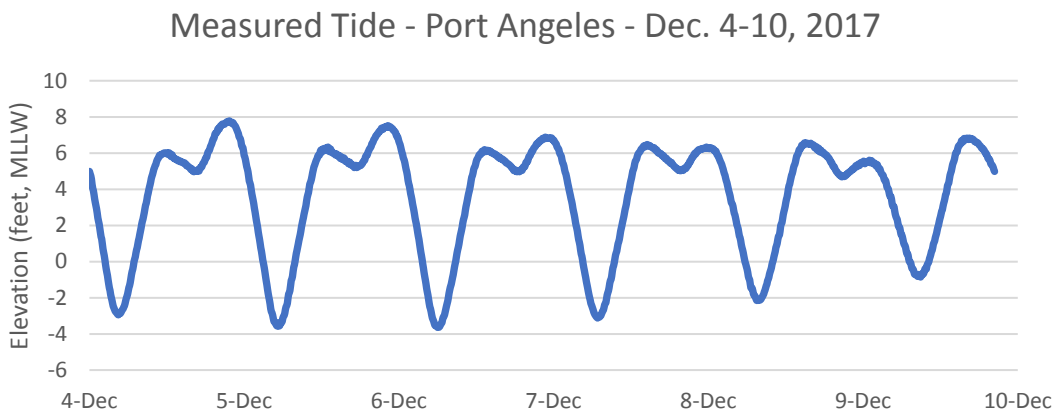
Figure 8: Port Angeles Primary Net Pens – View from Northwest

Source: Mott MacDonald photograph December 5, 2017

During the site visit observations were made and photos were taken. On December 4 and 5 at noon the weather was cold, 43°F, clear sky, with winds light and variable, and calm seas. Wake waves from the Harbor pilot vessel up to approximately 2 feet high were observed passing through the structure with little to no observable motion of the net pen while the waves propagated through the facility. The measured tide elevations are below. Mean Higher High Water (MHHW) is elevation +6.64 feet, NAVD88. The mean tide range is 7.06 feet.

No current station exists within the bay, therefore predicted currents were not available.

Figure 9: Tide Elevations During Site Visit



Source: Tides&Currents Software

The components and observed deficiencies are discussed below and summarized in **Table 5**. The assessment is based on the conditions observed on December 4-08, 2017, our document review and our professional judgment and experience. See the drawings in Appendix A for the numbering system.

The estimated year built is based on a review of available documents and historic aerial photos, discussions with Cooke Aquaculture employees on site, and our experience with marine facilities in the region.

Table 5: Port Angeles Net Pens – Existing Conditions Summary

Component	Year Built (estimate)	Description	Deficiencies	Overall Assessment
Anchors	varies	The mooring plan provided by the Owner says the anchors are 2,000 to 3,000-pound Danforth type anchors.	The drag anchors on the surface should be fully buried. Anchors 18, 19, 21, 22 and 22A were found partially exposed. There may be design deficiencies. Anchor line 14 must be addressed immediately. There is a broken link in the section of chain near the anchor	Satisfactory, but most anchors were not observed because they were buried. Anchor line 14 in critical condition with a broken link in the system. Anchor Lines 6 and 7 were not present
Mooring Lines	varies	Typically, a 1-inch shackle at the mooring bracket, two 2.75-inch chain lines leading to a buoy, then 30-feet of chain, a length of synthetic rope, 60-feet of chain,	Mooring lines missing, mooring lines wrapped around other lines, lines too steep, severe damage on some lines, unusual combinations/sequences of line and chain,	Fair, but with serious deficiencies in some areas. Anchor line 14 in critical condition with a broken link in the

Component	Year Built (estimate)	Description	Deficiencies	Overall Assessment
		Connected by shackle to an anchor. Anchors 6 and 17 were not present Anchor Line 10a1 and 10 were both installed in the same padeye.	Mixed mooring types and varying tension.	Section of chain near seabed. This is a critical condition as the anchor loads cannot be evenly distributed with missing anchors. This is a critical condition. Padeyes should only contain 1 shackle for proper operation of the components.
Plastic foam filled floatation tubs	2000	78-inch by 40-inch by 26-inch plastic tubs were foam filled and provided the floatation for the System Farm net pen manufactured system. The freeboard varied from 6-inches to 22-inches.	Some damage observed, punctures in the 7 observed tubs, and low freeboard at corners indicates more floatation is needed	Satisfactory
Superstructure above floatation tubs	2000	The superstructure consisted of steel framed walkways with mesh grating as the walking surface. This structure supports the nets and attaches to anchor chain. The walkways were 10 feet wide for the main center walkway running in a north - south direction along the centerline and the remaining walkways 8.5 foot wide. The grating was supported by 3-inch by 4-inch struts spaced 19-inches apart, with a 4-inch by 7-inch tubular member at all primary hinge locations for load transfer.	No significant deficiencies observed, low freeboard at southern corners of net pen system, surface rust typical throughout	Good to satisfactory
Walkways and Railings	2000	Steel fabrication with metal grate walking surface and hinge connections. Temporary Walkway repairs made with an Overlay of fiberglass grating	Surface rust, localized severe corrosion, holes in walkway,	Fair, permanent repairs are necessary

Component	Year Built (estimate)	Description	Deficiencies	Overall Assessment
Predator Nets	N/A	Nets to exclude birds and marine mammals, secured to pipe rail attached to structure	None observed	Not included in the inspection
Containment Nets	N/A	Nets to contain salmon, secured to pipe rail attached to structure	None observed	Not included in the inspection
Floating Shed	1990's	Foam filled concrete barge with wood frame shed and metal roof and siding. Barged is moored to the adjacent floats of the net pen system using a combination of chain and rope	Concrete float has a large damaged area along the eastern face, that seems to have been caused by impact. Fenders were not observed as being in place along the eastern face.	Fair Permanent repairs to the barge will need to be addressed to prevent further deterioration of the floatation system.
Records and Documents at site	N/A	The operations plan notes that records are kept on site	Not inspected	--

Source: Mott MacDonald

6.1 Anchors

- Anchors are a mix of old and new. The age and condition of some of the anchors has not been determined.
- Anchors are assumed to be all Danforth, since most of the anchors are buried, this cannot be confirmed
- Anchors 18, 19, 21, 22, and 22A were found to partially exposed.
- No anchors displayed indications that the anchor was unstable and/or shifting its position in the seabed.

6.2 Mooring Lines

- Above water, the anchor mooring lines consisted of galvanized steel chains and shackles ranging from 1.5-inch to 2-inch diameter. Several mooring lines were taut and at a relatively shallow angle of the chain to the water where it connected to the net pen. Other mooring lines were relatively steep between the buoy and anchor. We have not reviewed an engineering study or mooring plan for this facility.
- In general, the mooring lines assemblies observed were in satisfactory to fair condition, but with significant defects in places.
    - Anchor lines 6 and 17 were missing at the time of inspection. Additional lines were observed and inspected, see Appendix B.

  - The majority of the line ropes exhibited heavy marine growth coverage with typical thicknesses of 6 in. to 24 in. Minimal marine growth was only found on anchor lines 10A1, 10A2, 18, 19, and 20.
  - Anchor line 14, one link of the anchor leg chain was observed to be completely broken/fractured.
  - At anchor line 2, two sections of rope were connected to each other with knots and neither of the connected rope loops had protective sheathing or thimbles.
  - Some rope eye splices had bare rope connections, others had hose sheathing in place of steel thimbles.
  - Anchor line 7 and 21 did not have a cotter pin or safety wire in place on the shackles.
  - Anchor lines 10A1, and 10A2 did not have a buoy. Each line had one bridal chain connected to a padeye shared with an adjacent anchor line.

- Above water mooring brackets were observed during our site visit to be in satisfactory condition. Minor corrosion was observed at connecting elements to the steel frame. Wear and deformation of the hole in the mooring brackets was observed, resulting in lower load capacity. The mooring bracket appeared to be the weak link in the mooring lines. Workers on site were observed replacing old mooring brackets with new larger brackets. The workers said they were replacing all the mooring brackets. **Figure 10** shows an old bracket at mooring line No. 7 with wear at the point of contact with the shackle. A new, larger bracket is shown installed. See also Figure C-23 in Appendix C.

Figure 10: Mooring Brackets – New and Old

Source: Mott MacDonald

6.3 Steel Frame and Float Tubs

- The main structural members are a frame with steel tube sections. All hardware was hot-dip galvanized, except some areas where the galvanizing appears to have been lost due to corrosion.
- Steel walkways are supported by large, plastic, foam-filled tubs bolted to the underside of the walkway framing. These float tubs have a relatively high freeboard, typically raising the walkways approximately 1.75 feet above the water surface.
- Floatation was observed to be insufficient at the corners of the facility. The dive team inspected the tubs at the corners and did not find cracks, holes, or other indications of damage. The low freeboard at the corners was due to a lack of float tubs, a design issue, rather than failing floatation or damage to the steel frame. The load from anchors was concentrated at the corners, and was likely why the corners have low freeboard and not the entire structure.
- Other than at the corners, the freeboard was observed to be generally uniform, varying by up to 4-inches at different points along the structure.
- Some of the bolts connecting the float tubs to the steel framing were observed to be corroded. It is recommended that the owners inspect and replace these bolts as needed to ensure the floatation tubs are securely fastened to the structure.

- No corrosion protection such as sacrificial anodes were observed on site. According to Cooke, the facility design does not incorporate anodes due to the high freeboard of the floats keeping the steel framing away from the water surface. Corrosion was observed in localized areas. Corrosion was worst in the splash zone, in areas where there was wave splash when waves hit the tubs, or splash from the fish in the net pens.

6.4 Walkways and Railings

- Walkways consist of galvanized steel framing members, hinged together at regular intervals. The hinges were bushing type in design with one on each side of the walkway connection. Minor to moderate corrosion of the hinges was observed in places.
- The majority of the walkways include steel bar grating panels, welded directly to the framing. As such, the grating panels are not easily replaceable. The main central walkway has heavy duty steel bar grating that is capable of supporting net pen equipment and a small forklift, as observed on site. Areas of the grating had minor to severe corrosion. Fiberglass grating was overlaid as a repair in places.
- Railings are galvanized 1.5-inch diameter pipe and border all interior sides of the walkways, surrounding the net pens. They are removable as needed, slotted into holes in the steel framing. A sample of railings felt secure when force was applied. No significant corrosion was observed, with the galvanizing generally intact.

6.5 Predator Nets and Connections

- Predator nets include both in-water nets to prevent seals and other marine mammals from entering the pens, and above water nets to prevent bird predation of the salmon.
- Above water nets are supported by variable diameter pipe posts that are inserted into the steel framing post receptacles. The in-water nets were supported by the steel framing around the outer perimeter of the walkways. All components are in fair condition with surface rust. The nets are taut, extending straight down into the water and held in place by weighted pipes.
- Nets were not inspected but no obvious or major damage was observed above water while walking through the facility.

6.6 Containment Nets and Connections

- Containment nets confine the salmon inside each individual pen. The nets are supported by both 2.5-inch diameter pipe rails that surround the perimeter of each pen as well as the railing surrounding the pens. Surface corrosion was observed on the pipe connections to the frame.
- The nets were not inspected but no obvious or major damage was observed above water while walking through the facility.

6.7 Concrete Barge

- Concrete barge supports wood framed structures containing office space and a generator. A structural condition assessment of the buildings was outside of our scope of work. The barge was approximately 35 x 20 feet and was located between nets 6 and 8. See the photos in Appendix C for the general arrangement of the barge and mooring lines.

- An 8-foot long by 5-foot tall area of concrete is missing at the southeast corner exposing the reinforcing wire and floatation foam.
- On the northeast corner there is a 9-foot long by 2-foot tall area of concrete missing, exposing the reinforcing wire and floatation foam.
- Permanent floating structures were not extensively used at Port Angeles compared to other net pen sites in Puget Sound partly because land based facilities are relatively close.

6.8 Boarding Floats

- Boarding floats were steel framed floats supported by plastic floatation tubs and likely were a combination of the same design elements as the central and perimeter walkways. Floats were reported to be used for offloading feed and supplies. The float was observed level, not listing to one side.
- The floats were integrated into the net pen facility using the typical hinged connection details the only difference was where the main floats attached to the 8.5 ft wide perimeter float. This connection was made with mooring arms that damaged the float beneath.
- There was minor to severe corrosion observed on the grating and framing of the boarding floats.

6.9 Records and Documents On-Site

The documents note that records are stored on site but we did not ask to see them.

7 Conclusions

In general, the primary net pen facility at Port Angeles was in fair condition, with some recommended repairs as noted in this report. Of the components that were inspected, the grating along large areas of the walking surface, the low freeboard along the southern perimeter, the uneven tension of the anchor bridles as well as the damaged areas on the boarding area floats are of major concern as they exhibit conditions that need to be addressed. Otherwise, the structure system is a robust, heavy steel frame design, relative to the sheltered conditions in Port Angeles Bay. The mooring system design documentation was not available and there was insufficient information to verify adequacy for site conditions. Mooring anchor modifications have been made to the facility without documented engineering calculations of review to support the modifications.

Key findings

Based on our review of all available information and documents, the site investigation and our experience and judgment, Mott MacDonald offers the following findings:

1. Facility Age and Site History: The age of the existing net pens has not been determined. Net pens have been at the site since at least July 18, 1990 based on historical aerial photography on GoogleEarth and shoreline aerial photos from the Washington Department of Ecology. Aerial photos also show net pens with the same size and configuration as the net pens currently at the site were likely installed before May 31, 2002. The primary net pens were likely installed before December 6, 2000. The typical service life for this type of facility is 15 years and would vary depending on the level of maintenance and exposure to waves and currents.
2. Currents: The net pens were exposed to low to moderate current speeds, lower than at other net pen sites in Puget Sound such as Cypress Island and Hope Island. However, the current at this site were not trivial and can exert substantial loads on the nets, structure and mooring system. Current induced drag forces need to be accounted for during design.
3. System Design: No site specific stamped engineering drawings were provided for either the net pens or the mooring system. The system consists of a galvanized steel frame structure, elevated from the water by plastic foam-filled tubs for floatation.
4. Mooring Plan: A schematic mooring diagram and limited notes describing the existing components were made available. The information was not complete and was not correct for some mooring lines. Some lines were missing and there were additional lines not included in the mooring plan provided. The mooring plan states all anchors are 2,000 to 3,000-pound Danforth anchors. However, since most of the anchors were buried, this cannot be confirmed. Additionally, the precise location of anchors and length of mooring line was not able to be determined.
5. Mooring Brackets: The operator was observed in the process of replacing all the pad-eyes at the attachment points to the net pens with new, larger galvanized steel pad-eyes. Each anchor line was connected to a steel buoy that was intended to relieve the weight of the mooring line. The steel buoy was connected by two chains to two points on the mooring bracket, forming a triangle shaped “hens foot” or bridle connection.
6. Underwater Components: The following are some of the findings based on the underwater inspection. See Appendix A to this report for additional details.

a. The anchor and mooring line assemblies were typically found by the divers to be in satisfactory to fair condition, with some exceptions.

b. The mooring system included a mix of different mooring lines, line tension and lengths. Lines were observed in contact with other mooring lines. The mooring system was complex in places and difficult to analyze and may have evolved over the years, with old anchors and lines from net pens that were reused. Moorings should be designed to be symmetrical where possible, with the same anchor type, holding capacity and line tension around the perimeter of the structure.

c. Line 14 at the had severe damage to the chain and will need to be addressed.

d. Lines 6 and 17 were missing.

e. Line 2 had two sections of rope connected directly together without protective sheathing.

f. Lines 7 and 21 did not have a cotter pin or safety wire in place on the shackles.

g. Lines 10A1 and 10A2 did not have a buoy. Each line had one bridal chain connected to a padeye shared with an adjacent anchor line.

7. Above Water Components: The above water portions of the float system were in good to fair condition. Surface rust was widespread, with more serious localized corrosion damage observed in places such as the walking surface grating. Float sections at the corner locations along the southern perimeter were observed to have a reduced freeboard and were near or under the water surface in places. The freeboard at these locations requires adjustment. The boarding float along the western perimeter of the net pen (between the 6 and 8 pen sections) exhibited structural damage and requires repair or replacement. The office and generator buildings were constructed on a reinforced concrete foam filled barge. Areas of damage to the concrete included the southeast and northeast corners as well as spalled sections along the northern face. The damage has exposed the foam fill which will lead to deterioration of the foam. Seven pontoons were observed along the southern edge of pens 5 and 5 with holes in them and the polystyrene deteriorating. Holes were above the waterline.
8. Inspections: Inspections conducted by the Owner do not appear in accordance with manufacturer's recommendations or industry standards. Inspections of additional critical structure elements should be conducted. The Monthly and Annual inspection forms included in the SystemFarm document from Marine Construction should be used, or a form with similar content. The floating steel structure and mooring system should be inspected at least annually.
9. Anchor Locations: Some anchors are likely outside the limits of the leased area, based on the amount of ROV umbilical used for anchor line inspection. The following anchor lines are estimated to be 750 feet or greater in length: No. 12 through 16 of the Primary net pens. Additional anchor lines are likely outside the lease boundary. A multi-beam bathymetric survey is recommended to help determine the anchor locations.

The findings and results of this assessment work by Mott MacDonald do not constitute a certification of the facility structural integrity but rather an overall review of the condition as represented by the applicant and verified in the field during the site visit and dive inspection.

8 References

ASCE (2015). “Waterfront Facilities Inspection and Assessment”, ASCE Manuals and Reports on Engineering Practice No. 130.

Cooke Aquaculture (2017). Port Angeles Net Pen Plan in word and pdf

Cooke Aquaculture (2017). “Fish Escape Prevention Plan, Updated January 2017”.

Cooke Aquaculture (2017). “Pollution Prevention Plan, Updated October 2017”.

Cooke Aquaculture (2017). “Spill Prevention Control and Response Plan, Updated October 2017”.

Cooke Aquaculture (2017). “Port Angeles Lease No. 22-B02777”

Cooke Aquaculture. “Port Angeles Site Spill Kit Locations”.

Cooke Aquaculture. “Port Angeles Surface Inspection Sheets”.

Det Norske Veritas AS (2012). Recommended Practice DNV-RP-E301, Design and Installation of Fluke Anchors, Det Norske Veritas AS, Høvik, Norway, https://www.dnvgl.com/oilgas/download/dnvgl-rp-e301-design-and-installation-of-fluke-anchors.html (accessed December 11, 2017).

DNR. (2005). Aquatic Lands Aquaculture Lease No. 22-B02777”.

DOD (2001). “Maintenance and Operation: Maintenance of Waterfront Facilities”, Department of Defense, UFC 4-150-07, June 19, 2001, pp. 219.

Ebbesmeyer, C. C., *et al.* "Dynamics of Port Angeles Harbor and Approaches." *Prepared for the MESA (Marine Ecosystems Analysis) Puget Sound Project* (1979).

Global Aquaculture Alliance (2016). “Aquaculture Facility Certification-Salmon Farms-Best Aquaculture Practices-Certification Standards, Guidelines” v. 10/16, <www.gaalliance.org>.

Icicle Acquisition Subsidiary, LLC (2007). “NPDES Permit Site 4 – Port Angeles, Ediz Hook”.

Icicle Acquisition Subsidiary, LLC (2014). “2014 Fin Fish Aquaculture plan of Operation”.

MacLearnsberry, Inc. (2007). “American Gold Seafoods, LLC. Aquatic Lease No. 22-B02777 Land Survey”.

Marine Construction. (1999). “System Farm W24-3,16. Large steel cage system”.

Naval Facilities Engineering Command (1993). “Inspection of Shore Facilities”, Naval Facilities Engineering Command, NAVFAC MO-322, Volume II, January 1993, pp. 198.

Naval Facilities Engineering Command (2012). SP-2209-OCN Handbook for Marine Geotechnical Engineering, Naval Facilities Engineering Command Engineering Services Center, Port Hueneme, CA.

Standards Norway. (2010). “Marine fish farms Requirements for site survey, risk analysis, design, dimensioning, production, installation, and operation”. NS 9415.E:2009.

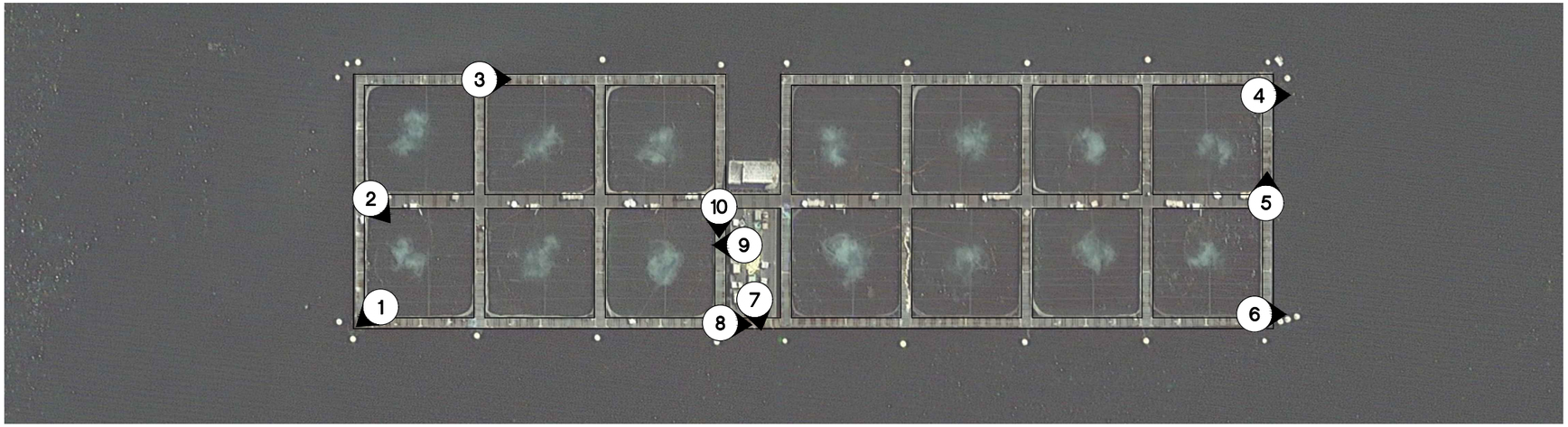
U.S. Army Corps of Engineers (2013). *Coastal Engineering Manual (Part II)*. U.S. Army Corps of Engineers, Engineering Manual EM 1110-2-1100, 31 January 2002.

U.S. Navy Civil Engineering Laboratory (1960). New and Modified Anchors for Moorings, Y-F015-10-001, Type B Final Report, U.S. Navy Civil Engineering Laboratory, Port Hueneme, CA.

Washington Dept. of Ecology (1986). “Recommended Interim Guidelines for the Management of Salmon Net-Pen Culture in Puget Sound”.

Weber, J.E. 1983. “Steady Wind-and Wave-Induced Currents in the Open Ocean”. Journal of Physical Oceanography, Volume 13.

Yang, Z., & Khangaonkar, T.P., 2003. “Development of a Hydrodynamic Model of Puget Sound and Northwest Straits”. Pacific Northwest National Laboratory.



PORT ANGELES PRIMARY NET PEN
PHOTOS–PLAN

0 50 100
SCALE IN FEET

LEGEND

1 PHOTO LOCATION AND ORIENTATION

NOTES

MOORING SYSTEM NOT SHOWN, SEE SHEET 3

PHOTO 1
TYPICAL CORROSION ON EXTERIOR CORNER WALKWAY GRATING

PHOTO 2
TYPICAL CORROSION ON 10 FT WIDE WALKWAY TRUSS MEMBER

PHOTO 3
TYPICAL CORROSION ON PERIMETER WALKWAY GRATING

PHOTO 4
IMPROPER ASSEMBLY OF 2 SHACKLES TO ONE PADEYE

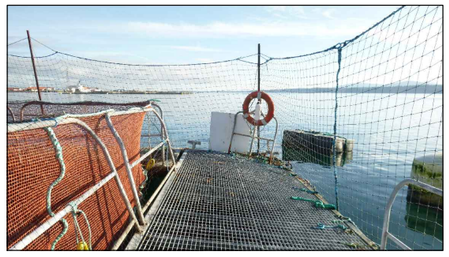


PHOTO 5
TYPICAL VIEW OF SOUTHERN END WITH LOWER SEAWARD FREEBOARD

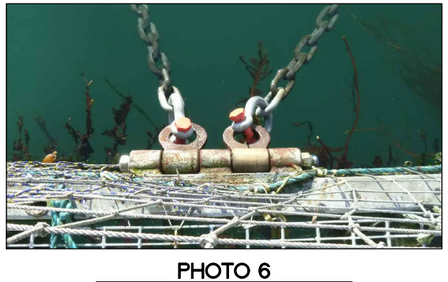


PHOTO 6
2 ANCHORS SHARING ONE HINGE

PHOTO 7
TYPICAL CORROSION AND DAMAGE TO PRIMARY FRAME OF BOARDING FLOATS

PHOTO 8
SEVERE CORROSION ON BOARDING FLOATS

PHOTO 9
DAMAGE TO FLOATING PONTOON

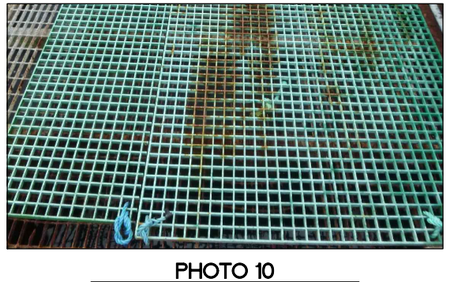


PHOTO 10
TEMPORARY REPAIR TO SEVERELY CORRODED GRATING

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Rev	Date	Drawn	Description	Ch'k'd	App'd
1	12/18/17	CT	PLAN AND PHOTOS	JL	NS

Project Number	B/O	Total
391980	1	9

Designed	J. LaFave		Eng check	S. Phillips	
Drawn	C. Taylor		Coordination		
Dwg check	N. Sultan		Approved		

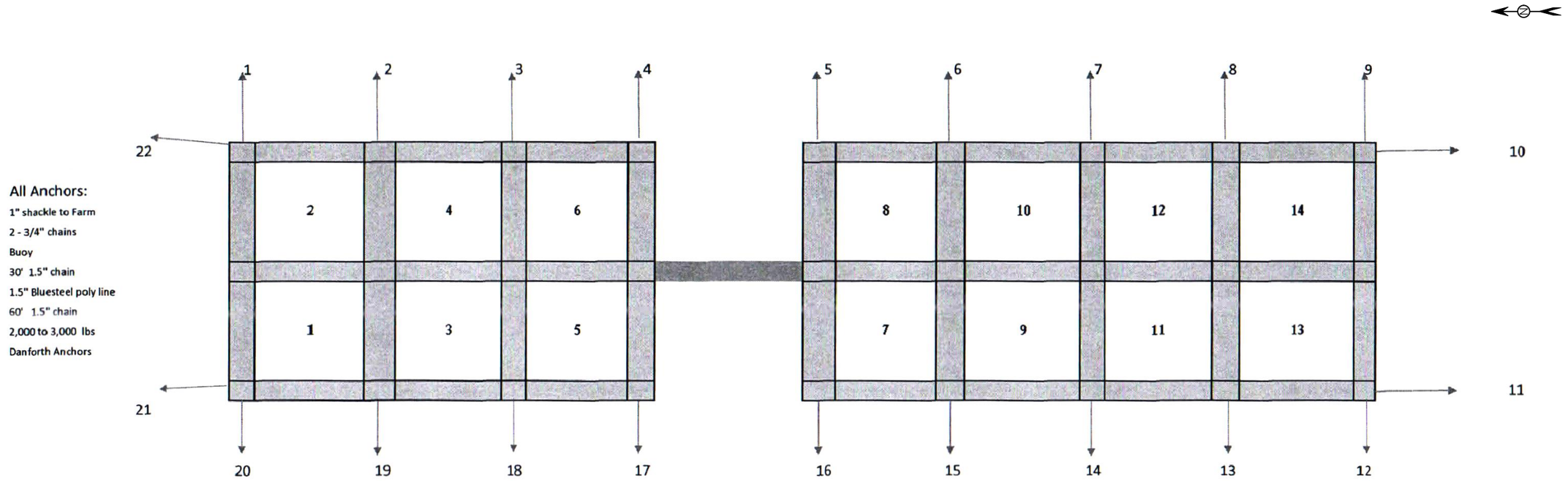
Scale at ANSI D	Status	Rev	Security
As Shown			

Drawing Number

Title

Washington State Department of Fish and Wildlife
Port Angeles Net Pen

Site Assessment Plan
Primary Net Pen



PORT ANGELES PRIMARY NET PEN

MOORING PLAN

NOT TO SCALE

NOTES

MOORING SYSTEM SCHEMATIC PLAN
PROVIDED BY COOKE AQUACULTURE.

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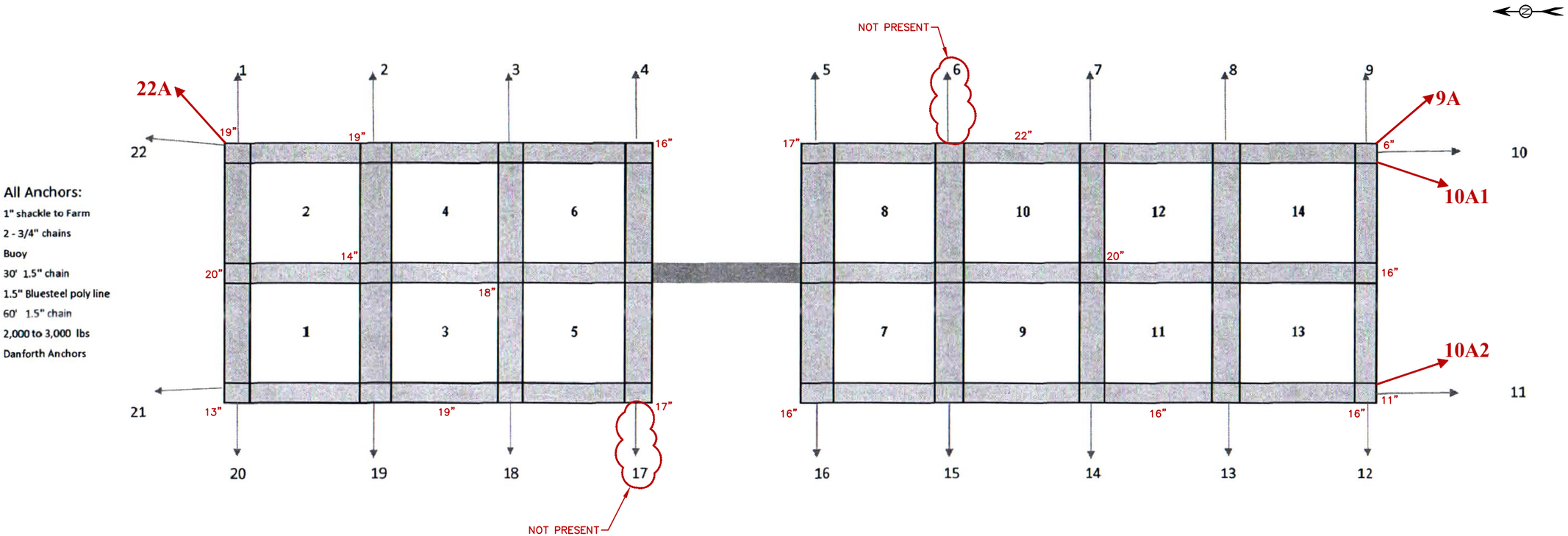
Title

Washington State
Department of Fish and Wildlife
Port Angeles Net Pen

Mooring Schematic
Primary Net Pen

pw://pimspwise.hmmg.cc:pw_ports_harbors/Documents/391980-PUGET SOUND NET PEN ASSESSMENT/Drawings_Models/12_MA_Marine/7 - Design/CAD/E - Preliminary/391980-Port Angeles Plan.dwg Dec 18, 2017 - 6:22PM TAY70899



All Anchors:

1" shackle to Farm
2 - 3/4" chains
Buoy
30' 1.5" chain
1.5" Bluesteel poly line
60' 1.5" chain
2,000 to 3,000 lbs
Danforth Anchors

PORT ANGELES PRIMARY NET PEN

MOORING PLAN

NOT TO SCALE

LEGEND

18" FREEBOARD MEASURED 12–5–2017

NOTES

1. MOORING SYSTEM SCHEMATIC PLAN PROVIDED BY COOKE AQUACULTURE.
2. CORRECTIONS AND NOTES BY MOTT MACDONALD ARE IN RED.

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Drawn	C. Taylor		Coordination		
Dwg check	N. Sultan		Approved		

Scale at ANSI D: As Shown | Status | Rev | Security

Drawing Number

Title: Washington State Department of Fish and Wildlife Port Angeles Net Pen

Mooring Schematic - Primary Net Pen - Revised, With Notes

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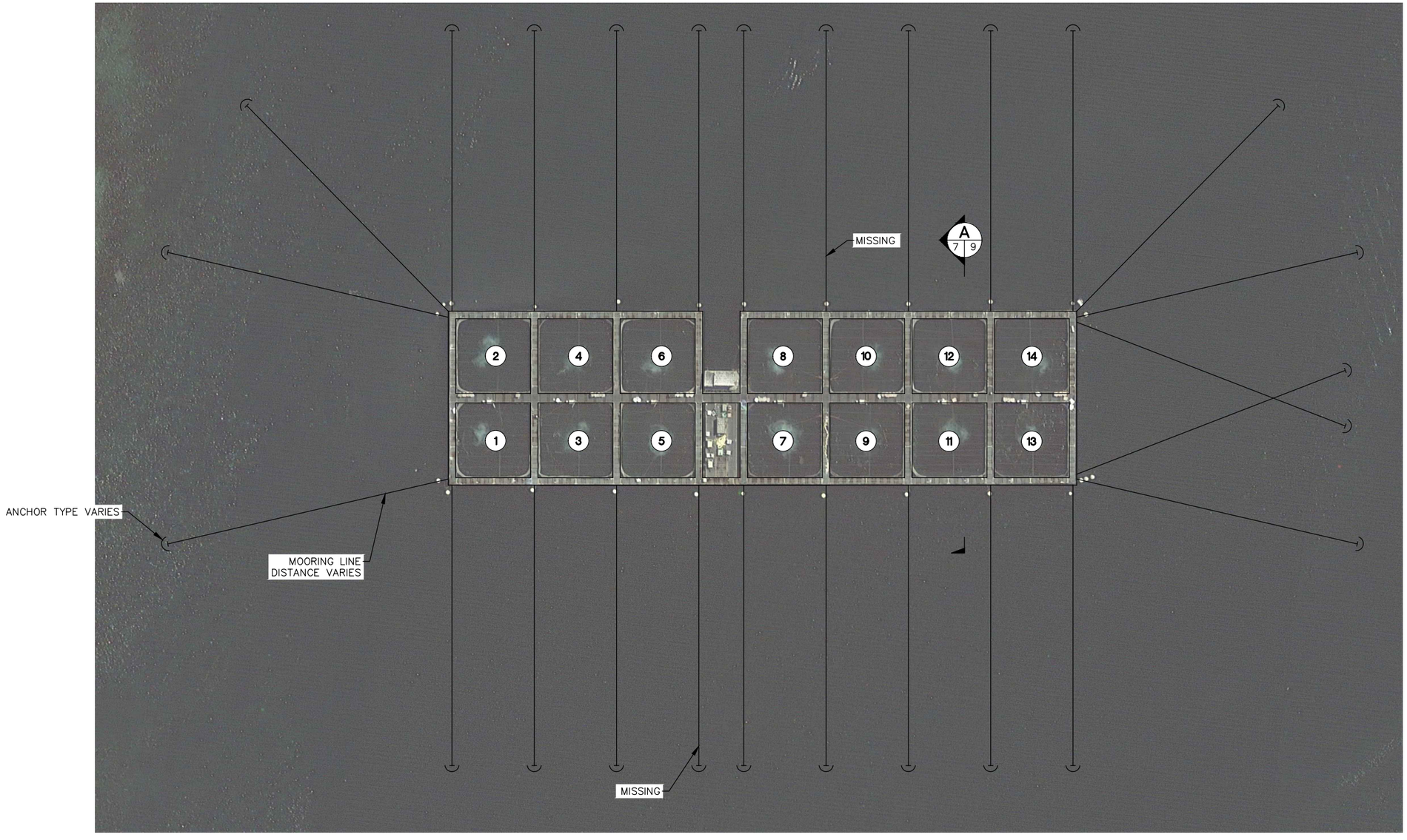

PORT ANGELES PRIMARY NET PEN

NOT TO SCALE

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Drawn	C. Taylor		Coordination		
Dwg check	N. Sultan		Approved		

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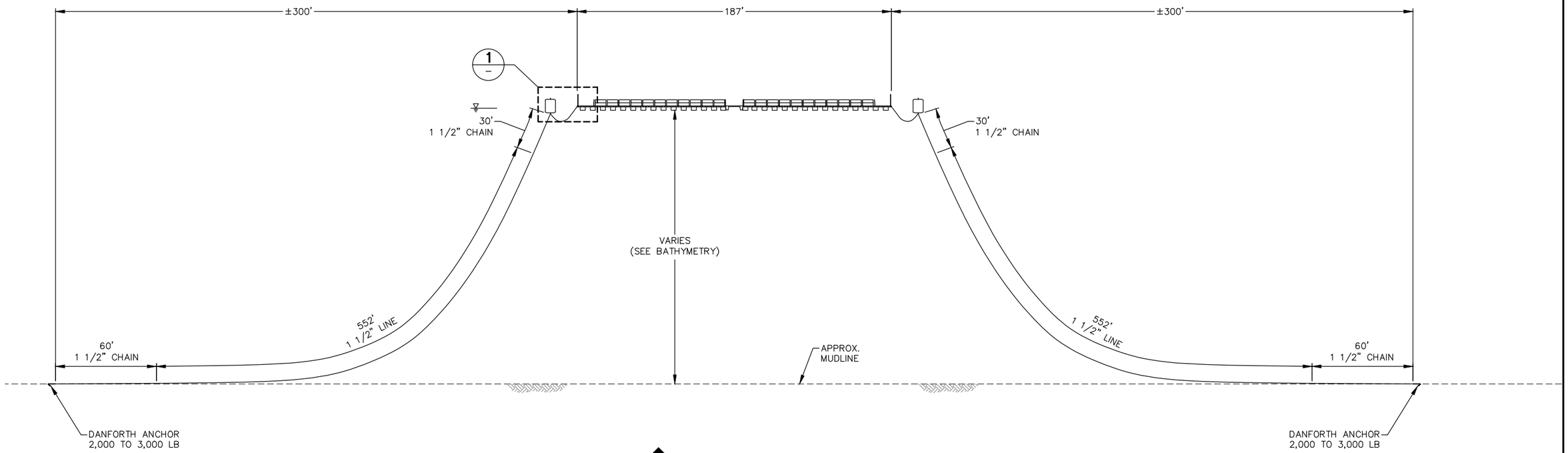
Drawing Number

Title: Washington State Department of Fish and Wildlife
Port Angeles Net Pen

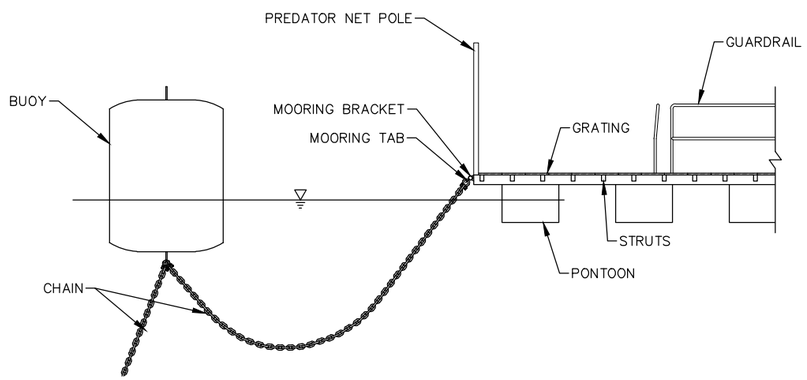
Existing Site - Moorings
Primary Net Pen



A 7,8 9 **SECTION**

0 20 40

SCALE IN FEET



1 **DETAIL**

0 4 8

SCALE IN FEET

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Project Number	B/O	Total
391980	9	9

Drawing Number

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Drawn	C. Taylor		Coordination		
Dwg check	N. Sultan		Approved		

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As Shown			

Title

Washington State
Department of Fish and Wildlife
Port Angeles Net Pen

Section - Mooring

January 29, 2018
Collins Job No. 45-10819

Underwater Inspection of the Port Angeles
Primary Net Pens System in Port Angeles, WA

Mr. Nels Sultan, Ph.D, P.E.
Principal Engineer
North America Ports, Coastal and Offshore
Mott MacDonald
110 James Street, Suite 101
Edmonds, WA 98020

Dear Mr. Sultan,

Collins Engineers, Inc. conducted an underwater inspection of the Port Angeles Primary Net Pens System located in Port Angeles, WA from December 4 through 9, 2017. The scope of the inspection was to perform a below water (diving and ROV) inspection of the facility, and then based on the findings, comment on the integrity and stability of the submerged components of the net pen system.

The net pen system components inspected included the anchor line assemblies, building support floats, and select walkway support floats in areas of suspected damage. The diving inspection intensity consisted primarily of a Level I inspection effort (visual and tactile techniques), with very limited cleaning of existing marine growth, and the overall inspection process followed the guidelines established by the ASCE Manual of Practice 101 – Underwater Investigations: Standard Practice Manual. The inspection was performed by a dive team consisting of five (5) Association of Diving Contractors (ADCI) engineer/divers with rotating rolls to optimize dive time and safety. All anchor lines were inspected to a depth of 100 fsw by divers. An underwater Remotely Operated Vehicle (ROV) was utilized to inspect the portions of each anchor line that was located in water deeper than 100 fsw, which is the OSHA limitation for commercial dive operations not requiring a recompression chamber to be onsite. Due to the prevailing water depths at the Primary System only Anchor Lines 21, 22, and 22A (line running northeast from the northeast corner of the system) did not require an ROV inspection.

Refer to Photographs 1 through 71 for views of the typical and specific conditions observed during the underwater inspection of the Port Angeles Primary Net Pens system components. In addition, all of the photographs and videos taken during the underwater inspection of the Port Angeles Net Pens system components have been made available for reference under separate cover.

Overall, the underwater inspection for the Primary Net Pens System revealed the following key findings:

- Anchor Lines 6 and 17 were missing at the time of inspection. Additional anchor lines (not shown on provided drawings) were observed and inspected at the following locations: 9A (runs southeast from the southeast corner of the system), 10A1 (runs southwest from the southeast corner of the system), 10A2 (runs southeast form the southwest corner of the system), and 22A (runs northeast form the northeast corner of the system).

- The anchor line assemblies were typically found to be in satisfactory to fair condition, with varying degrees of age-related deterioration, but with nearly all connection elements secure at this time. The majority of the anchor line ropes exhibited heavy marine growth coverage (primarily tube worms and anemones), with typical thicknesses of 6 in. to 24 in. Minimal marine growth was only found at Anchor Lines 10A1, 10A2, 18, 19, and 20. It should be noted that no significant rope damage was identified; however, the extent of the marine growth on a majority of the ropes would preclude readily detections of any lesser damage.

- At Anchor Line 14, one link of the anchor leg chain along the seabed was observed to be completely broken/fractured and only held in place by the friction/tension in the anchor line and numerous other links were very heavily deteriorated with link section losses estimated at 50% or more of the original section.

- The anchor leg chains at all anchor lines exhibited up to 100% coverage of corrosion, although the majority of the deterioration did not have overly significant section loss associated with the observed corrosion. Typically, the extent of corrosion became heavier where the chains were embedded to some extent in the seabed.

- The majority of the anchor lines inspected had an estimated 90 ft (full shot length) or less of the anchor leg chain exposed directly above and/or partially embedded in the seabed, with the anchor shackle and anchor fully buried in the seabed; i.e. no anchor exposure. Portions of the anchor were found exposed at Anchor Lines 18, 19, 21, 22, and 22A. Overall, there were no anchors that displayed indications that the anchor was unstable and/or shifting its position in the seabed.

- At Anchor Line 2, two sections of rope were connected to each other with knots at approximately 62 ft below the surface, and neither of the connected rope loops had thimbles or a protective sheathing.

- Some of the rope eye splices had a hose sheathing in place of a steel thimble. They were noted at the following locations: Anchor Line 5 at 40 ft below waterline, Anchor Line 8 at 15 ft below the waterline, Anchor Line 9A at 37 ft below waterline, Anchor Line 22A at 70 ft below waterline, and Anchor Line 22A at 89 ft below waterline.

- Some of the rope eye splices did not have a thimble and there was just bare rope at the connection. This condition was noted at the following locations: 80 ft below waterline on Anchor Line 21, 70 ft below waterline on Anchor Line 22.

- Some of the shackles at the rope connections did not have a cotter pin or safety wire in place. These were noted at the following locations: 45 ft below waterline at Anchor Line 7 and 80 ft below waterline on Anchor line 21.

- Anchor Lines 10A1 and 10A2 had no buoys. Each anchor line had one chain that was connected to a padeye. In the case of Anchor 10A, the shackle was connected to the same padeye as Anchor Line 10. Where Anchor Lines 10A1 (heading southwest from the southeast corner) and 10A2 (heading southeast from the southwest corner) cross, the Anchor Line 10A2 rope makes one complete wrap around the Anchor Line 10A1 rope before going downward to the seabed.

- The office building barge float located between the north and south pen clusters exhibited several areas of impact damage along its east face:

    - There was an 8 ft long by 5 ft tall area of missing concrete with exposed reinforcing wire at the southeast corner. The exposed floatation foam had 1 ft penetration at the top of the defect and 5 ft penetration at the bottom.
    - Three steel plates were attached to the outside edge of the east face (purpose of plates is unknown). The middle plate had a 2.5 ft long horizontal crack.
    - There was an area of missing concrete with exposed reinforcing wire at the northeast corner that extended 6 ft horizontally on the east face and 3 ft horizontally on the north face and was 2 ft high. The exposed floatation foam had 1 ft penetration throughout the defect.

- At the south end of the pen system, the outside edge of the walkway and underlying floats were depressed downward (lower in elevation) up to 1 ft due to concentrated loading from the weight of the anchor line assemblies. This condition may be exacerbated by the lack of buoys at Anchor Lines 10A1 and 10A2. No defective walkway floats were found along the south walkway and the floatation spacing was similar to other locations throughout the pen system.

- Some of the walkway floats along the south end of the north pen cluster had what appears to be heat damage (melted plastic) located approximately 6 in. above the waterline on their south faces. For reference purposes, the floats were numbered from east to west (1 through 24).

    - Floats 3 and 7 exhibited melting with no holes detected.
    - Floats 4 and 8 exhibited a 4 in. dia. hole with 6 in. penetration into the foam.
    - Float 5 exhibited a 6 in. dia. hole with 2 in. penetration into the foam.
    - Floats 6 and 9 exhibited a 12 in. dia. hole with 12 in. penetration into the foam.
    - Float 10 exhibited an 18 in. dia. hole with 12 in. penetration into the foam.
    - Float 15 exhibited a 4 in. dia. hole with 3 in. penetration into the foam.

The general underwater inspection findings and assessment of the observed existing condition of the Primary Net Pens System and its various components are as follows:

Anchor Line Assemblies

The anchor line assemblies typically consisted of:

- Connection to the net pen structure
- Two chain (bridle) connection to the buoy
- Steel buoy
- Upper Anchor Chains (±30 ft)
- Ropes (200 ft – to possibly as much as an estimated 600 ft – rode line)
- Lower Anchor Chains (90 ft – one shot of chain)
- Anchors (Danforth type)

The building/pens support float to upper anchor chain connections were typically found to be fully intact, sufficiently secure, and in satisfactory condition. The length of the mooring lines varied and the angle of the lines relative to the water surface varied. The steel shackles typically exhibited only minor deterioration, and in many instances appeared to be relatively new. The shackles were also found to be properly aligned and secure, with the restraining wires or cotter pins for the shackle pins typically in place and properly installed. The accessible portions of the steel framing that provide the connection between the shackles and the pen support floats and perimeter walkway were also observed to be sound and secure with no concerns for instability.

The upper and lower anchor chain to rope connections (eye splice with thimble and shackle) were also typically found to be fully intact, secure, and in satisfactory condition. The steel thimbles typically exhibited no structurally significant deterioration, and the ropes were typically secured beyond the thimble with an eye splice at least 12 in. in length at the upper and lower connections. The steel shackles also typically exhibited no structurally significant deterioration, and were found

to be properly aligned and secure, with the restraining wires or cotter pins for the shackle pins typically in place and properly installed.

The ±30 ft long anchor chains were typically found to be in satisfactory condition with no structurally significant deterioration. The below water portions of the upper lengths of chain typically exhibited moderate (1/4 in. to 3 in. thick) marine growth. The buoy's and their related connections to the upper chains, which were most likely installed to help lessen the concentrated loading from the weight of the anchor line assemblies, were typically found to be fully intact, secure and in good to satisfactory condition.

As previously noted, all of the Primary System anchor lines, except Anchor Lines 21, 22, and 22A, required inspection by ROV for the anchor line components (rope, anchor chain, and anchor when exposed) that were located below a water depth of 100 fsw. Between the two net pens systems, (east of Primary System and west of 6 Cage System), there were numerous errant/abandoned anchor line ropes (larger diameter ropes comparable in size to that of the ropes of the active anchor lines) either draped over or wrapped around the anchor lines of the two net pens systems (often causing ROV hang-ups and snags to occur). In addition, the anchor lines running between the two systems crossed at numerous locations and crab pot lines were frequently wrapped around the anchor lines. Stray (errant/abandoned) large diameter ropes were present at Anchor Lines 5, 7, 10A1 and 16 of the Primary System.

Based on the amount of ROV umbilical used for each anchor line inspection or the approximate distance of the ROV pilot vessel from net pens structure when live-boating that was necessary due to anchor line length, it is estimated that the anchor lines on the south and west side of the Primary System typically extend 350 ft or more from the net pens system. In this regard, Anchor Lines 12 through 16, in particular, were especially long and estimated as being 750 ft or greater in length (approximate distance from net pens system to the anchor or point of anchor chain embedment).

The 200 ft to as much as an estimated 600 ft long ropes (road lines) were typically found to be in satisfactory condition with no fraying or detectable abrasion damage. The ropes typically exhibited 3 in. to 6 in. thick marine growth near the connection to the upper chain that increased to a maximum of 3 ft thick at 50 ft below the waterline. It should be noted that no significant rope damage was identified; however, the extent of the marine growth on a majority of the ropes would preclude readily detections of any lesser damage

The 90 ft long (one shot of chain) lower anchor chains were typically found to be in satisfactory to fair condition, with varying degrees of age-related deterioration and marine growth. The corrosion on the anchor chains typically covered 100% of the chain surfaces, but currently the corrosion in most instances did not appear to be structurally significant. The exception to this was found at Anchor Line 14. At Anchor Line 14, one link of the anchor leg chain along the seabed

was observed to be completely broken/fractured and numerous other links were very heavily deteriorated with link section losses estimated at 50% or more of the original section

Typically, between 15 and 85 ft of the lower anchor chains were exposed on or slightly embedded in the seabed. A majority of the anchor lines inspected had an estimated 90 ft (full shot length) or less of the anchor leg chain exposed directly above and/or partially embedded in the seabed, with the anchor shackle and anchor fully buried in the seabed; that is, no anchor exposure. Portions of the anchor were only found exposed at Anchor Lines 18, 19, 21, 22, and 22A of the Primary System. Overall, there were no anchors that displayed indications that the anchor was unstable and/or shifting its position in the seabed.
The chain resting on and/or embedded in the seabed suggests an appropriate anchor location and anchor line assembly length to promote proper setting and subsequent grip of the Danforth type anchors, purported to have been used at the Primary System. In this regard, the exposed portions of the lower anchor chains were generally embedded half way into the seabed with no evidence of seabed rutting, which suggests that the lower anchor chains are not being lifted up or being moved from side-to-side in the seabed. As for the anchors, the majority were found to be completely buried, which suggests that they were well-seated and gripping into the seabed.

Building/Pen Support Floats

The building support float was constructed of concrete and was typically found to be in fair to poor condition with several areas of significant section loss noted along the east face. The floats typically exhibited up to 2 ft thick marine growth on 100% of the submerged surface areas. The areas of damage along the east face included:

- There was an 8 ft long by 5 ft tall area of missing concrete with exposed reinforcing wire at the southeast corner. The exposed floatation foam had 1 ft penetration at the top and 5 ft penetration at the bottom of the defect.
- Three steel plates were attached to the outside edge of the east face (purpose of plates is unknown). The middle plate had a 2.5 ft long horizontal crack.
- There was an area of missing concrete with exposed reinforcing wire at the northeast corner that extended 6 ft horizontally on the east face and 3 ft horizontally on the north face and was 2 ft tall. The exposed floatation foam had 1 ft penetration throughout the defect.

The walkway support floats were constructed of polyethylene float modules supporting continuous steel perimeter and interior walkways. A full inspection of these components was not performed as part of this inspection but, select areas were inspected, including primarily along the southern perimeter of both the north and south pen clusters. The float modules typically exhibited a 3 in. thick layer of marine growth on 100% of their submerged surface areas. Several walkway float modules along the south end of the north pen cluster had heat damage (melted plastic) located

approximately 6 in. above the waterline on the south face. For reference purposes, the floats were numbered from east to west (1 through 24).

- Floats 3 and 7 exhibited melting with no holes detected.
- Floats 4 and 8 exhibited a 4 in. dia. hole with 6 in. penetration into the foam.
- Float 5 exhibited a 6 in. dia. hole with 2 in. penetration into the foam.
- Floats 6 and 9 exhibited a 12 in. dia. hole with 12 in. penetration into the foam.
- Float 10 exhibited an 18 in. dia. hole with 12 in. penetration into the foam.
- Float 15 exhibited a 4 in. dia. hole with 3 in. penetration into the foam.

At the south end of the south pen cluster, the outside edge of the walkway and underlying floats was depressed downward (lower in elevation) up to 1 ft due to concentrated loading from the weight of the anchor line assemblies. This condition may be exacerbated by the lack of buoys at Anchor Lines 10A1 and 10A2. No defective walkway floats were found along the south walkway and the floatation spacing was similar to other locations throughout the pen system.

Conclusions

The anchor line assemblies were typically found to be in satisfactory to fair condition, with for the most part no structurally significant deterioration, and with all connection elements sound and secure. Except for the broken lower chain section at Anchor Line 14, which would be considered a critical condition, the lengths of chain inspected typically exhibited up to 100% coverage of corrosion that had no apparent appreciable loss of original chain section associated with it. With respect to the ropes running between the upper and lower anchor chains, they appeared to be in full original section condition, with no evidence of fraying or abrasion related damage. It should be noted that no significant rope damage was identified; however, the extent of the marine growth on a majority of the ropes would preclude readily detections of any lesser damage. The thimbles and related rope knots and splices, which were used to connect the ropes to the upper and lower chain shackles, were also found to be sound and secure with no evidence of any condition that would compromise the connections.

The building barge and pen support floats were typically found to be in satisfactory to at times poor (building barge float) condition. The loss of floatation at the east side of the building float and at the walkway floats on the south side of the north pen cluster does not appear to be adversely affecting functionality at this time. The south corners of the south pen cluster, however, were depressed downward due to apparent concentrated loading from the weight of the anchor line assemblies. Although the downward displacements don't currently compromise the stability of the net pen system, they should be evaluated to see if they can be eliminated or reduced by adding additional float modules and/or buoys or by changing out the corner float assemblies for a more stable float assembly type. Buoys and proper bridle chains should also be attached to Anchor Lines 10A1 and 10A2 to help alleviate the downward pull of these anchorages. In addition, the

wrapped anchor lines condition at the intersection of Anchor Lines 10A1 and 10A2 should be rectified to ensure both anchor lines functioned as intended.

Except for the broken and heavily deteriorated anchor chain at Anchor Line 14 and the two missing anchor line assemblies at Anchor Lines 6 and 17, which should all be replaced, the underwater inspection of the Port Angeles Primary Net Pens System did not reveal any notable deficiencies that would suggest a significant reduction in the inherently integrity or stability of the net pens system relative to its original design. In that regard, the components inspected below water were typically found to be in sound condition with no indication that a reduction in the originally intended capacity of a component or connection could be expected.
If you have any questions or require any additional information with respect to the underwater inspection findings, please don't hesitate to contact me.

January 29, 2018

Very truly yours,

COLLINS ENGINEERS, INC.

Daniel G. Stromberg, P.E.
Chief Structural Engineer/Diver

Photograph 1: Overall View of the Primary Fish Net Pens System, Looking Northwest.

Photograph 2: Overall View of the Primary Fish Net Pens System, Looking South.

Photograph 3: Overall View of the Primary Fish Net Pens System, Looking West.

Photograph 4: Overall View of the Primary Fish Net Pens System, Looking East.

Photograph 5: Overall View of the Primary Fish Net Pens System, Looking Southeast.

Photograph 6: Overall View of the Primary Fish Net Pens System, Looking Northwest.

Photograph 7: View of the Typical Anchor Line Buoy Attachment at the Northwest Corner, Looking Southeast.

Photograph 8: View of the Anchor Line Buoy System at the Southwest Corner, Looking North.

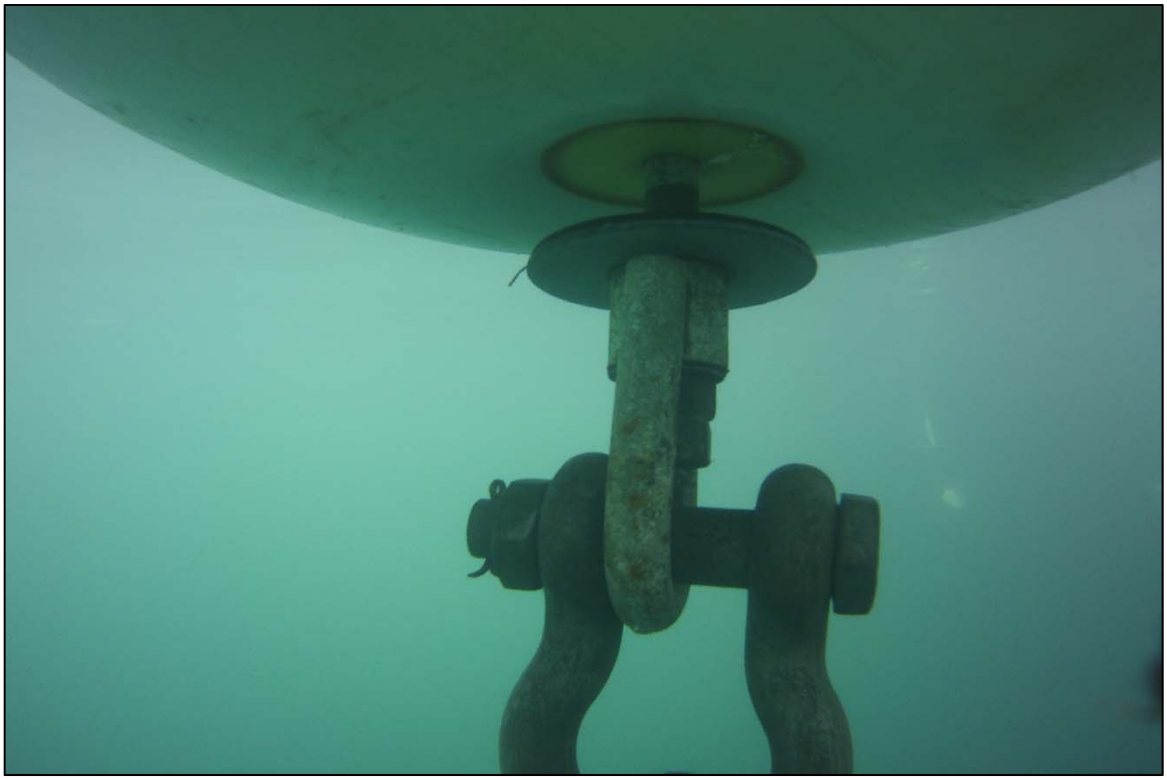
Photograph 9: View of the Anchor Line Buoy System in the Southeast Corner, Looking North.

Photograph 10: View of the Anchor Line Buoys System in the Northwest Corner, Looking South.

Photograph 11: View of the Depressed Pen Support Float at the Southeast Corner, Looking Northeast.

Photograph 12: View of the Typical Walkway float Condition.

Photograph 13: View of the Depressed Anchor Line Buoy at Anchor Line 20, Looking Southeast.



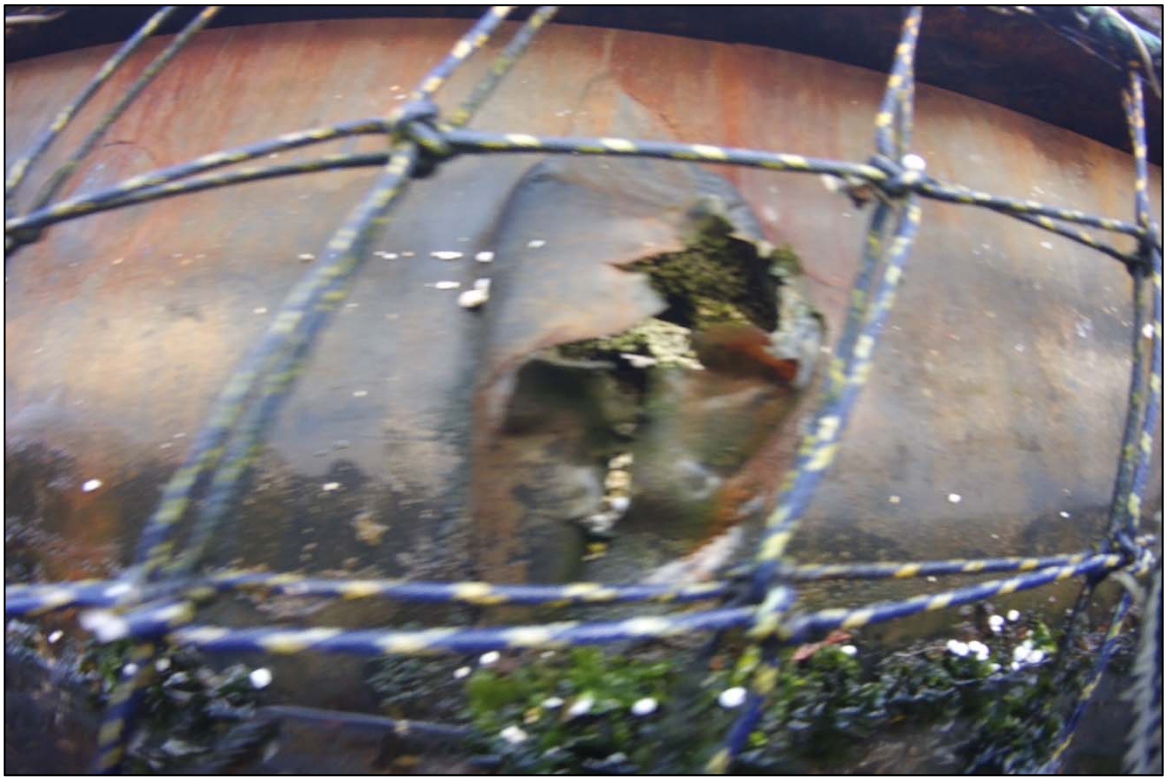
Photograph 14: View of the Typical Anchor Line to Buoy Connection, Anchor Line 20 Shown.

Photograph 15: View of the Typical Buoy, Anchor Chain, and Bridle Chain Connection, Anchor Line 20 Shown.

Photograph 16: View of the Typical Buoy, Anchor Chain, and Bridle Chain Connection, Anchor Line 16 Shown.

Photograph 17: View of the Heat Damage (Melted Plastic) Float 4 Shown, Looking North.

Photograph 18: View of the Heat Damage (Melted Plastic) Float 2 Shown, Looking North.



Photograph 19: View of the Heat Damage (Melted Plastic) Float 5 Shown, Looking North.

Photograph 20: View of the Storage Buildings Located between Pens 6 and 8, Looking West.

Photograph 21: View of the Storage Buildings Located between Pens 6 and 8 and Area of Deterioration at the Southeast Corner, Looking West.

Photograph 22: View of the Area of Section Loss and Exposed Foam Floatation on the Southeast Corner of the Building Barge Float, Looking Northwest.

Photograph 23: View of the Area of Section Loss and Exposed Foam Floatation on the Southeast Corner of the Building Barge Float, Looking South.

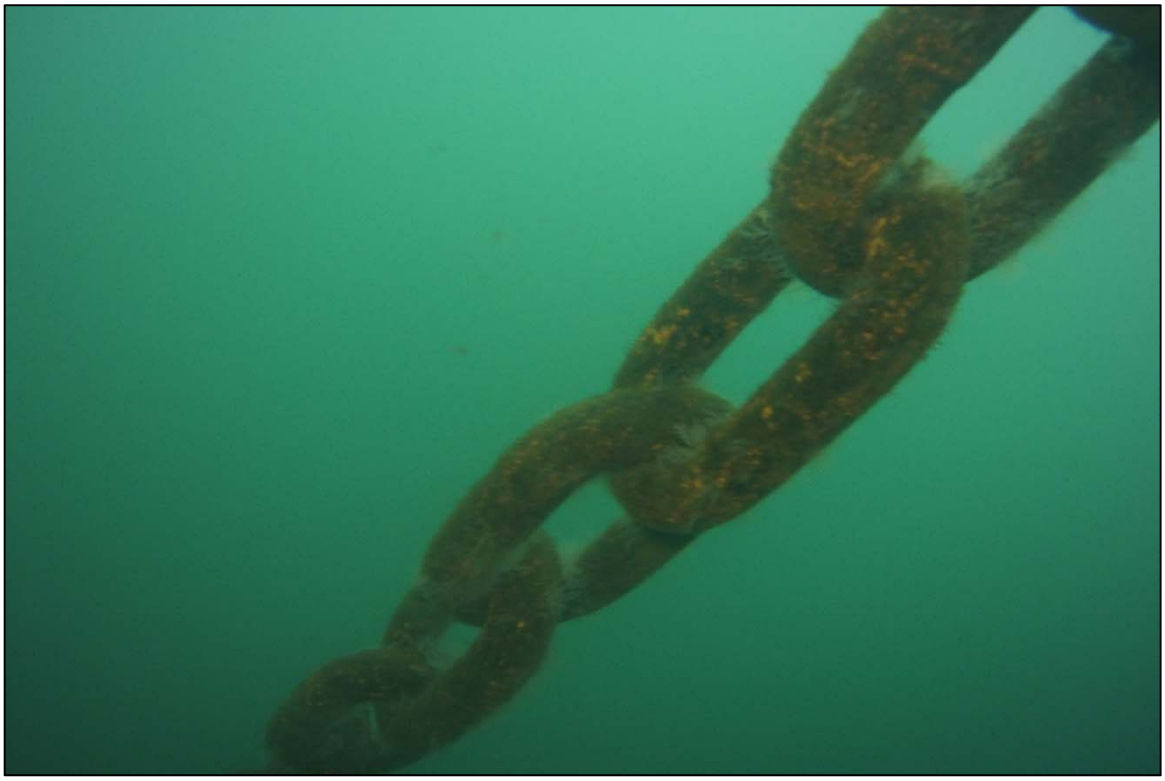
Photograph 24: View of the Typical Condition of the Office Building Float at the Waterline, Looking South.

Photograph 25: View of Typical Concrete Condition of the Office Building Barge Float, Looking East.

Photograph 26: View of Typical Heavy Marine Growth on the Bottom of the Office Building Barge, Looking West.

Photograph 27: View of the Upper Pen to Anchor Line Connection (Shackle and Padeye) at Anchor Line 2, Looking West.

Photograph 28: View of Bridle Chain, Buoy, Anchor Chain Connection (Shackles and Chain) at Anchor 2, Looking South.

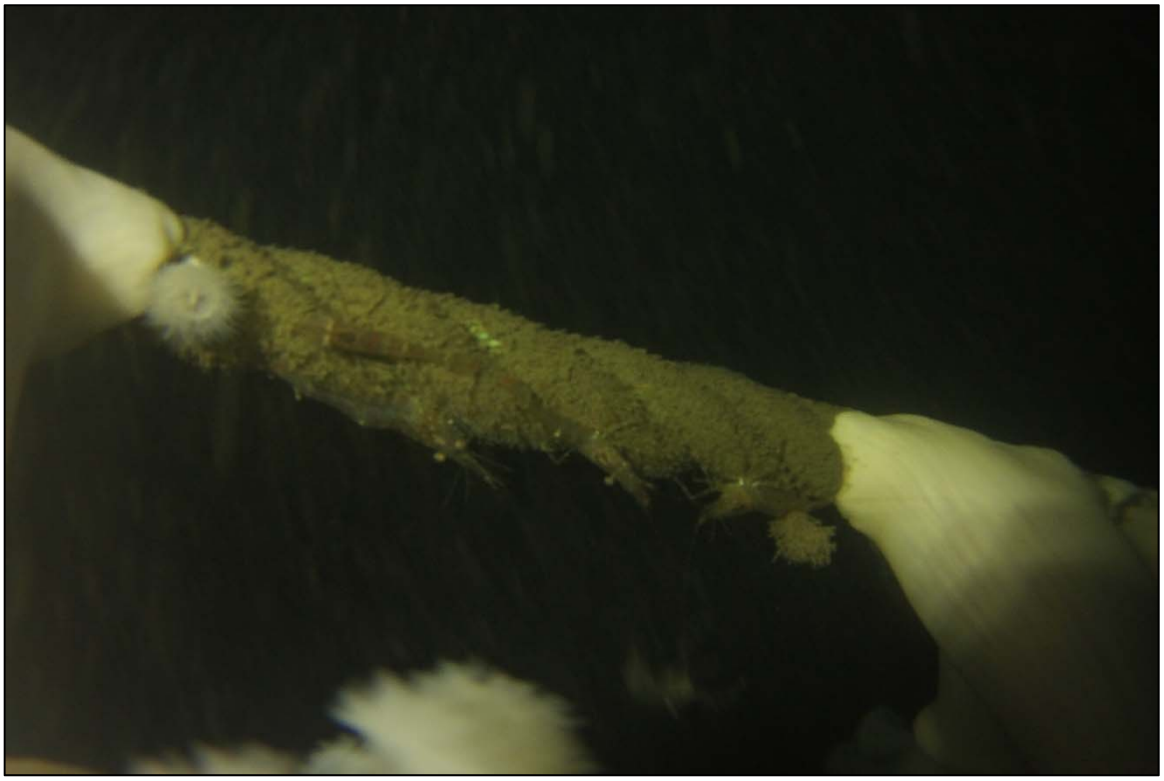


Photograph 29: View of Upper Chain Condition at Anchor 12 (Typical), Looking North.

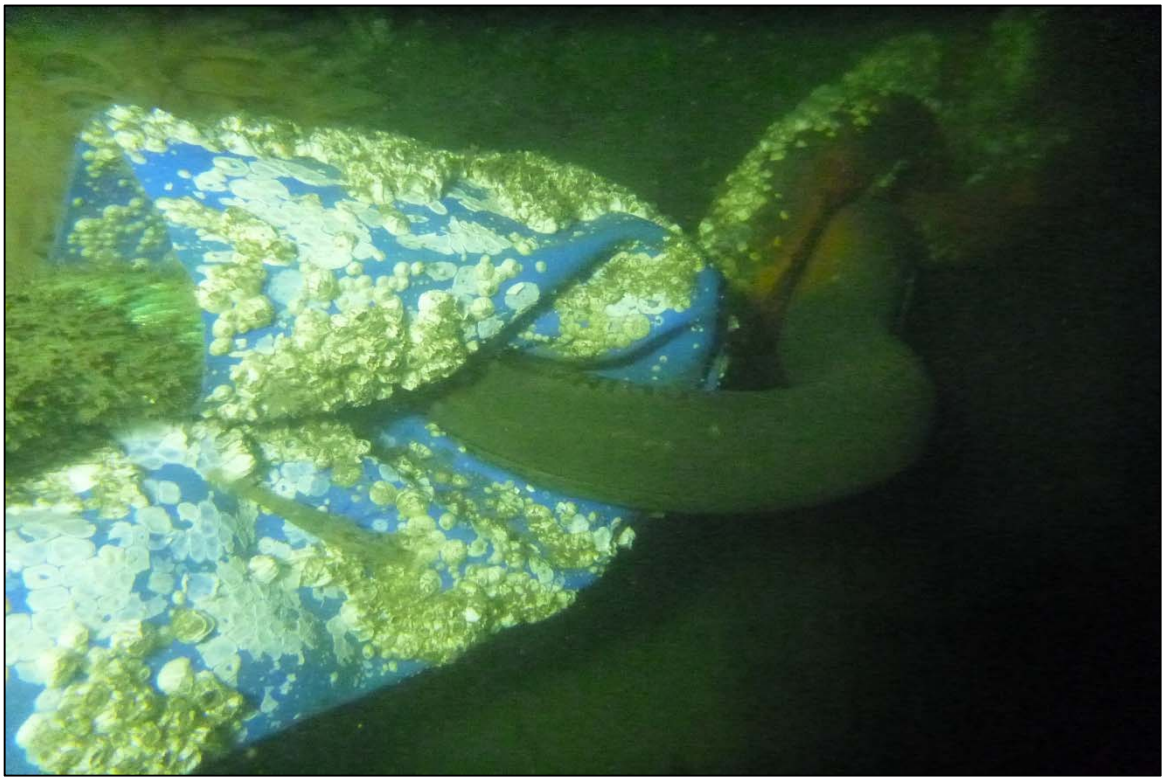
Photograph 30: View of Upper Chain Condition with Heavier Marine Growth at Anchor 8 (Typical), Looking North.

Photograph 31: View of the Upper Rope to Chain Connection at Anchor Line 15 (Typical), Looking South.

Photograph 32: View of Rope with Heavy Marine Growth at Anchor 8 (Typical), Looking South.



Photograph 33: View of Rope with Minor Marine Growth at Anchor 10 (Typical), Looking South.



Photograph 34: View of the Lower Anchor Chain to Rope Connection at Anchor 23 (Typical Observed by Diver), Looking East.

Photograph 35: View of the Anchor Chain on the Channel Bottom at Anchor Line 21 (Typical Observed by Diver), Looking North.

Photograph 36: View of the top of the Anchor at Anchor Line 21 (Typical Observed by Diver), Looking North.

Photograph 36: View of Anchor Stem to Anchor Chain Connection at Anchor 22 (Typical Observed by Diver), Looking Southwest.

Photograph 38: View of Anchor Head at Anchor 22 (Typical Observed by Diver), Looking South.

Photograph 39: View of Lower Anchor Chain to Rope Connection at Primary System Anchor Line 4, Looking East.

Photograph 40: View of Lower Anchor Chain Condition (Typical) at Primary System Anchor Line 4, Looking East.

Photograph 41: View of Lower Anchor Chain Embedment in the Channel Bottom at Primary System Anchor Line 4, Looking East.

Photograph 42: View of Knots in the Anchor Line Rope at Primary System Anchor Line 10A1, Looking South.

Photograph 43: View of Primary System Anchor Line 10A2 wrapped around Primary System Anchor Line 10A1, Looking South.

Photograph 44: View of Lower Anchor Chain to Rope Connection (Rope and Shackle) at Primary System Anchor Line 11, Looking South.

Photograph 45: View of Lower Anchor Chain Embedment in the Channel Bottom at Primary System Anchor Line 11, Looking South.

Photograph 46: View of Lower Anchor Chain Condition (Typical) at Primary System Anchor Line 12, Looking West.

Photograph 47: View of Lower Anchor Chain Embedment in the Channel Bottom at Primary System Anchor Line 13, Looking West.

Photograph 48: View of Lower Anchor Chain to Rope Connection (Thimble and Shackle) at Primary System Anchor Line 14, Looking West.

Photograph 49: View of a Broken Chain Link in the Lower Anchor Chain at Primary System Anchor Line 14, Looking West.

Photograph 50: View of a Broken Chain Link in the Lower Anchor Chain at Primary System Anchor Line 14, Looking West.

Photograph 51: View of Heavy Section Loss in the Lower Anchor Chain at Primary System Anchor Line 14, Looking West.

Photograph 52: View of Lower Anchor Chain Embedment in the Channel Bottom at Primary System Anchor Line 14, Looking West.

Photograph 53: View of Lower Anchor Chain to Rope Connection (Thimble and Shackle) at Primary System Anchor Line 15, Looking West.

Photograph 54: View of Lower Anchor Chain Condition (Typical) at Primary System Anchor Line 15, Looking West.

Photograph 55: View of Lower Anchor Chain to Rope Connection (Rope and Shackle) at Primary System Anchor Line 16, Looking West.

Photograph 56: View of Lower Anchor Chain Condition (Typical) at Primary System Anchor Line 16, Looking West.

Photograph 57: View of Lower Anchor Chain on Channel Bottom at Primary System Anchor Line 16, Looking West.

Photograph 59: View of Lower Anchor Chain Embedment in the Channel Bottom at Primary System Anchor Line 16, Looking West.

Photograph 60: View of Buoy and Ropes in the Channel Bottom where Lower Anchor Chain is Embedded at Primary System Anchor Line 16, Looking West.

Photograph 61: View of Lower Anchor Chain Condition (Typical) at Primary System Anchor Line 18, Looking West.

Photograph 62: View of Anchor Line 19 Crossing Below Anchor Line 20, Looking North.

Photograph 63: View of Lower Anchor Chain to Rope Connection (Rope and Shackle) at Primary System Anchor Line 19, Looking Northwest.

Photograph 64: View of Lower Anchor Chain Condition (Typical) at Primary System Anchor Line 19, Looking West.

Photograph 65: View of Lower Anchor Chain Embedment in the Channel Bottom at Primary System Anchor Line 19, Looking West.

Photograph 66: View of Lower Anchor Chain to Anchor Connection (Shackle) at Primary System Anchor Line 19, Looking West.

Photograph 67: View of Anchor North Fluke Embedment in the Channel Bottom at Primary System Anchor Line 19, Looking West.

Photograph 68: View of Anchor South Fluke Exposure in the Channel Bottom at Primary System Anchor Line 19, Looking West.

Photograph 69: View of Anchor 20 Crossing Above Anchor Line 19, Looking Southwest.

Photograph 70: View of Lower Anchor Chain Condition (Typical) at Primary System Anchor Line 20, Looking Southwest.

Photograph 71: View of Lower Anchor Chain Embedment in the Channel Bottom at Primary System Anchor 20, Looking Southwest.

Appendix C – Photographs at Port Angeles Primary Net Pens

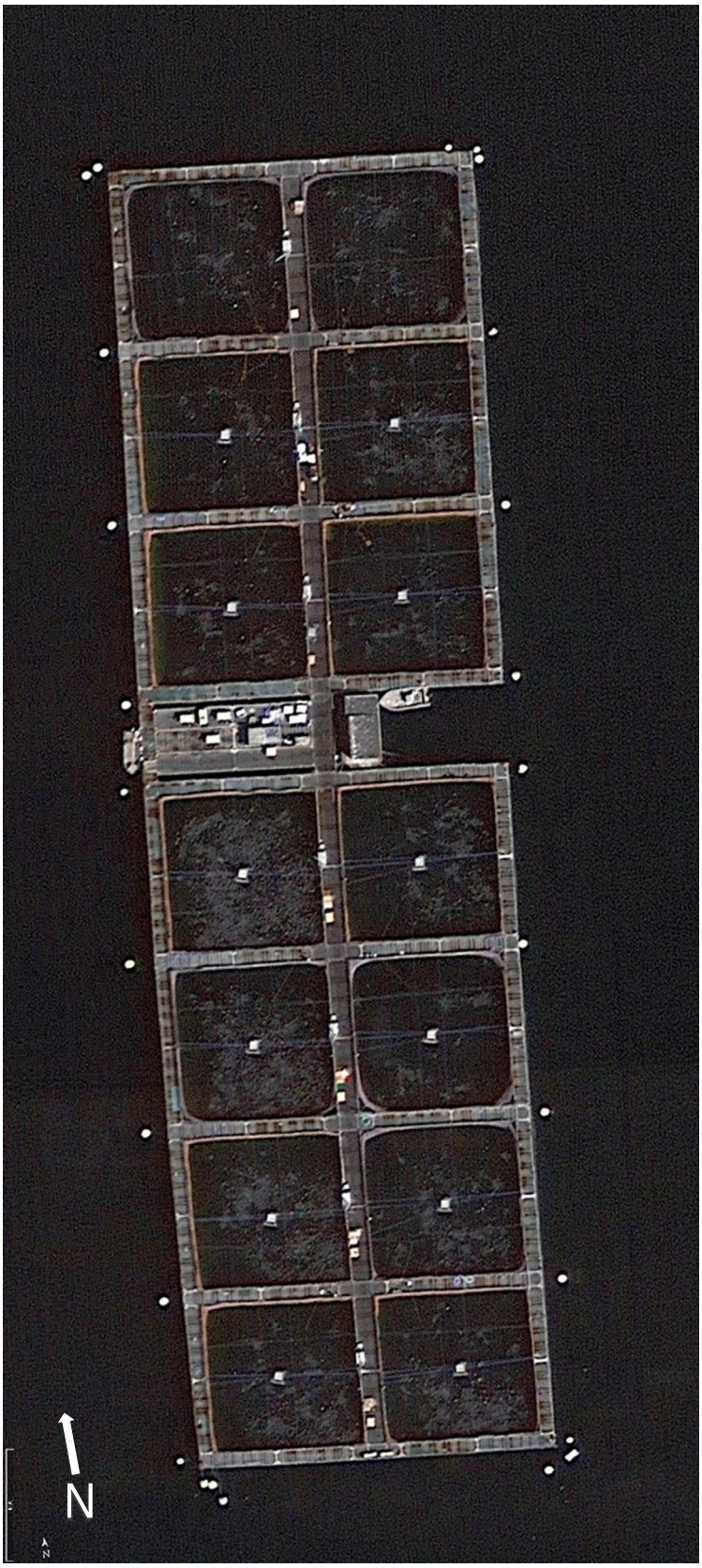


Figure C-1: Port Angeles Primary Net Pens (Google Earth – Aerial Photo July 30 2017)

Figure C-2: Port Angeles Net Pens – North East Corner Anchor 1 and 22

Figure C-3: Anchor 1- Shackle and Padeye

Figure C-4: Floating Docks Between Anchor 1 and 2 (Looking South)

Figure C-5: Anchor 2

Figure C-6: Anchor 2 Left Bridle Chain

Figure C-7: Anchor 2 Right Bridle Chain

Figure C-8: Floating Docks Between Anchor 2 and 3 (Looking South)

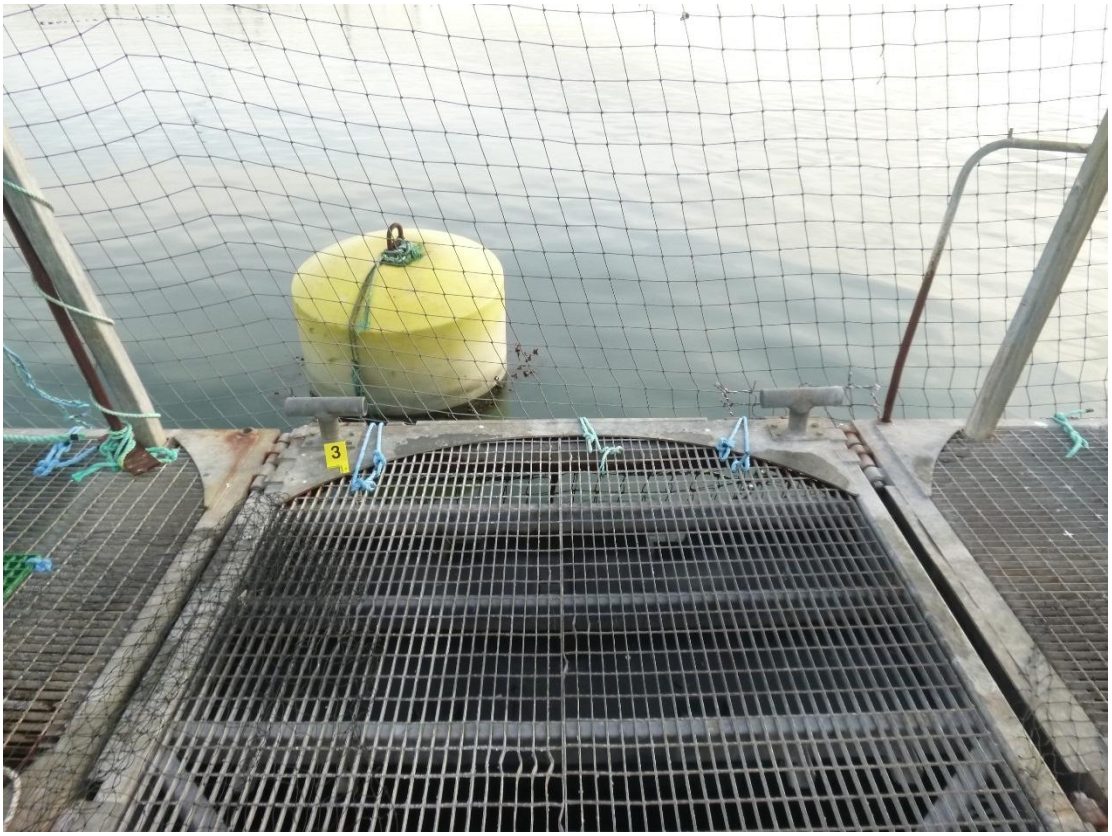


Figure C-9: Anchor 3

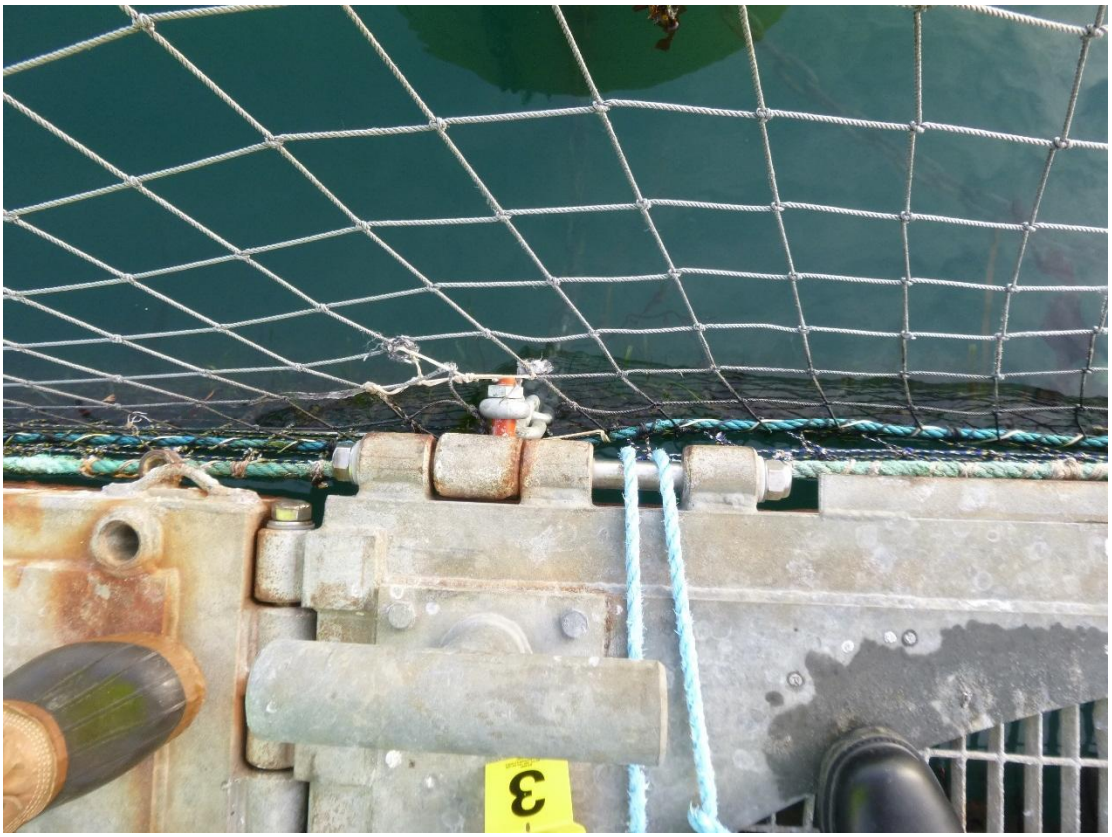


Figure C-10: Anchor 3 Bridle Chain

Figure C-11: Anchor 4 Showing Severe Corrosion of Grating in Corner

Figure C-12: Anchor 4 Bridle Chain and Buoy

Figure C-13: Anchor 4 Right Bridle Chain, Shackle and Padeye (Looking South)

Figure C-14: Anchor 5 (Looking East)

Figure C-15: Anchor 5 New Right Padeye and Shackle

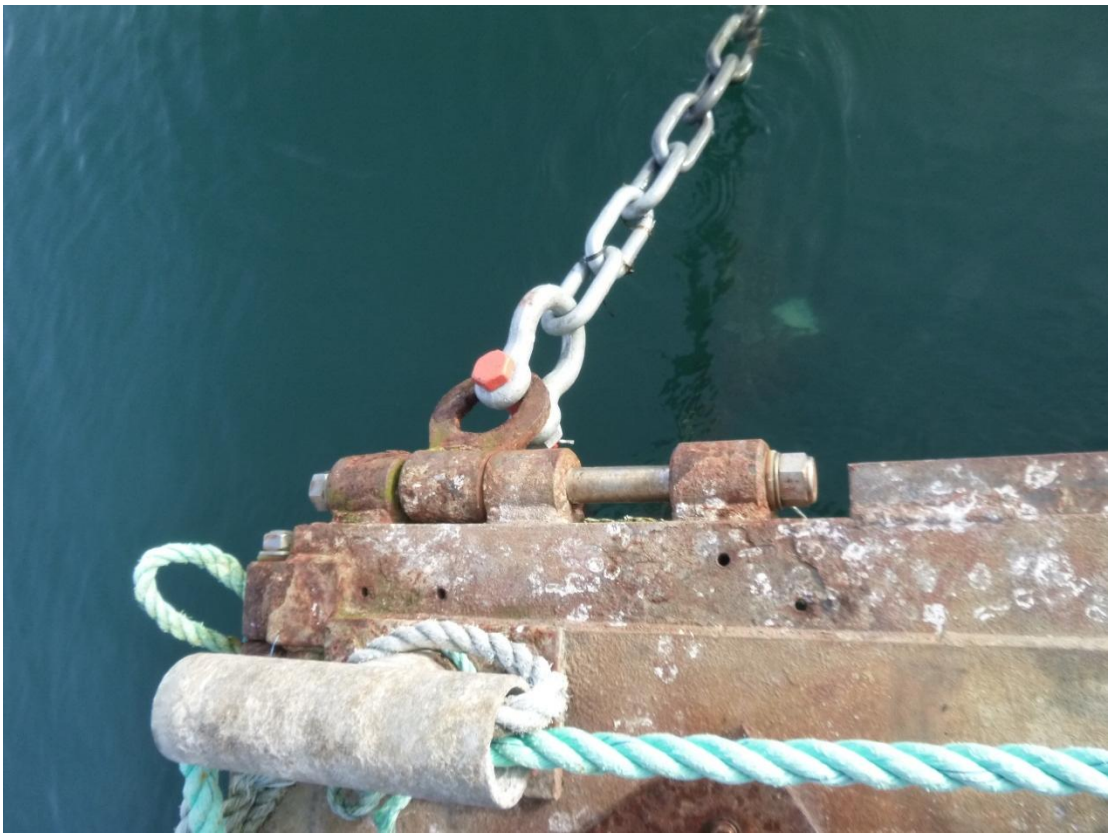


Figure C-16: Anchor 5 Left Padeye, Shackle and Bridle

Figure C-17: Anchor 5 Bridle Chain

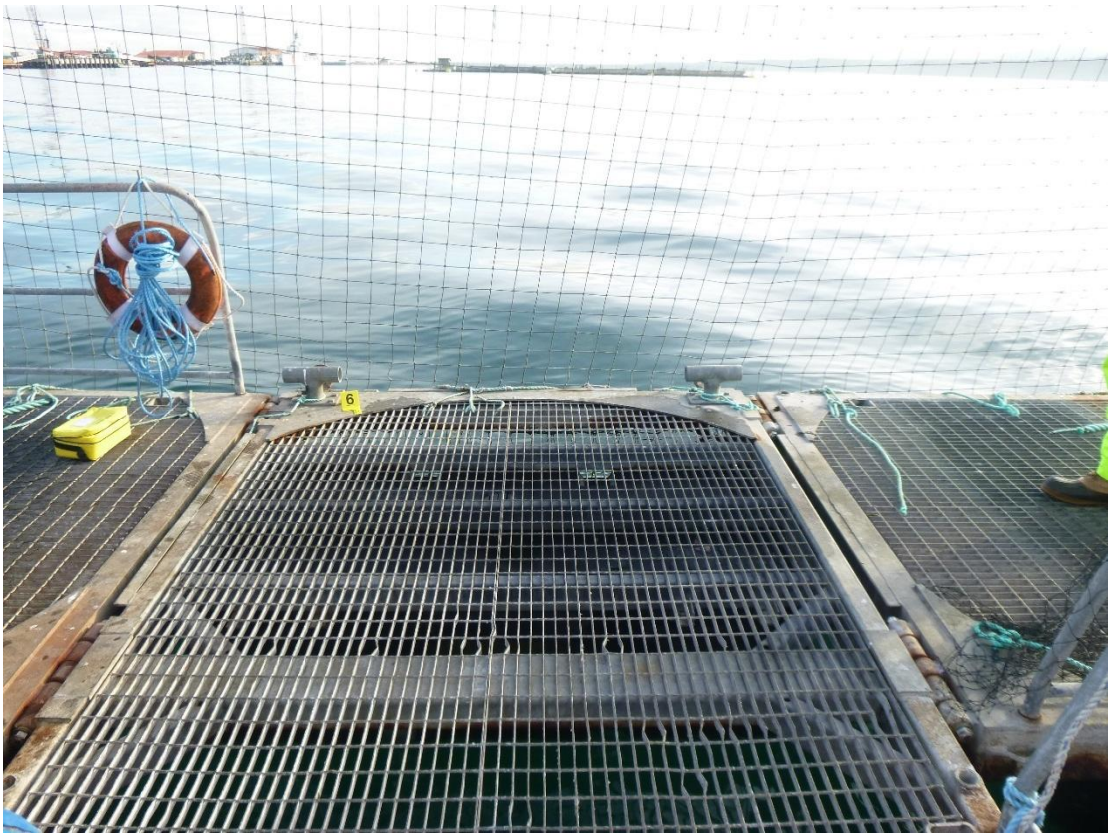


Figure C-18: Anchor Location 6 – Missing Anchor Lines and Buoy

Figure C-19: Anchor 6 Right Padeye Showing Wear

Figure C-20: Anchor 7

Figure C-21: Anchor 7 New Left Padeye

Figure C-22: Anchor 7 New Right Padeye Showing old Padeye

Figure C-23: Comparison of Old and New Padeye

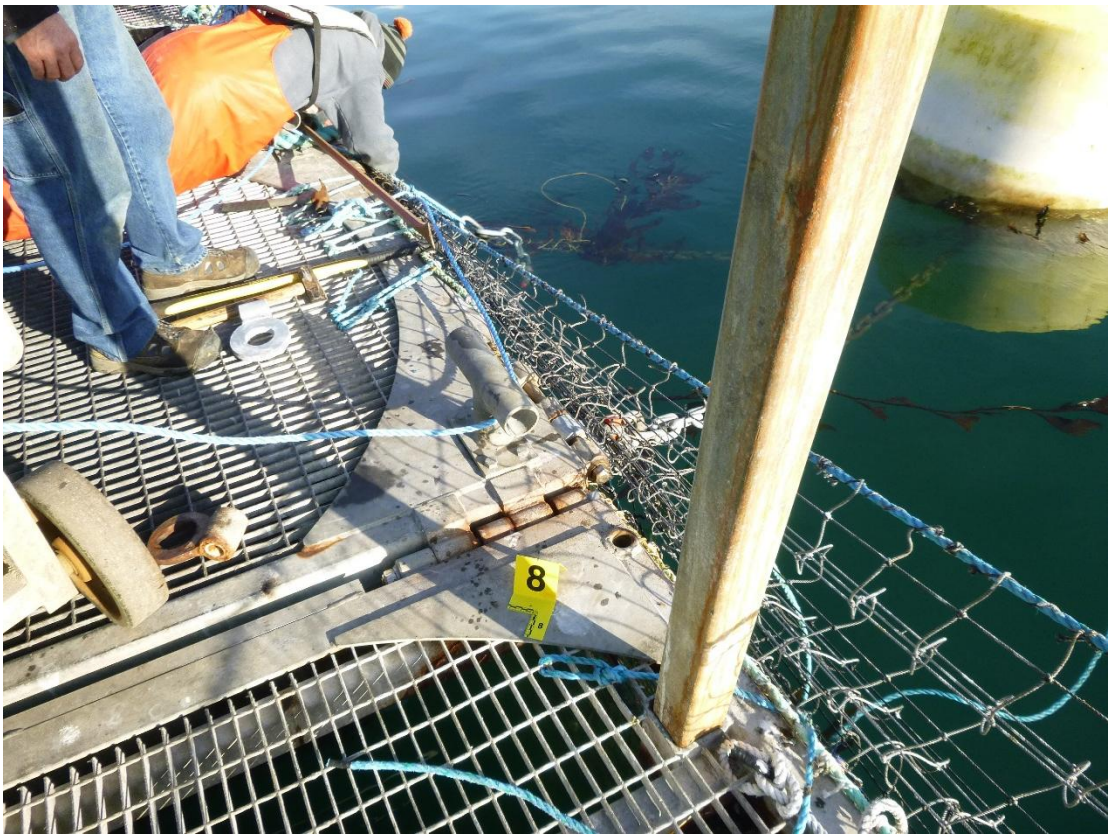


Figure C-24: Anchor 8 – Replacement of Padeyes

Figure C-25: Anchor 8 Bridle Chain & Shackles

Figure 26: Docks Between Anchor 8 and Anchor 9 (From Anchor 9 looking North)

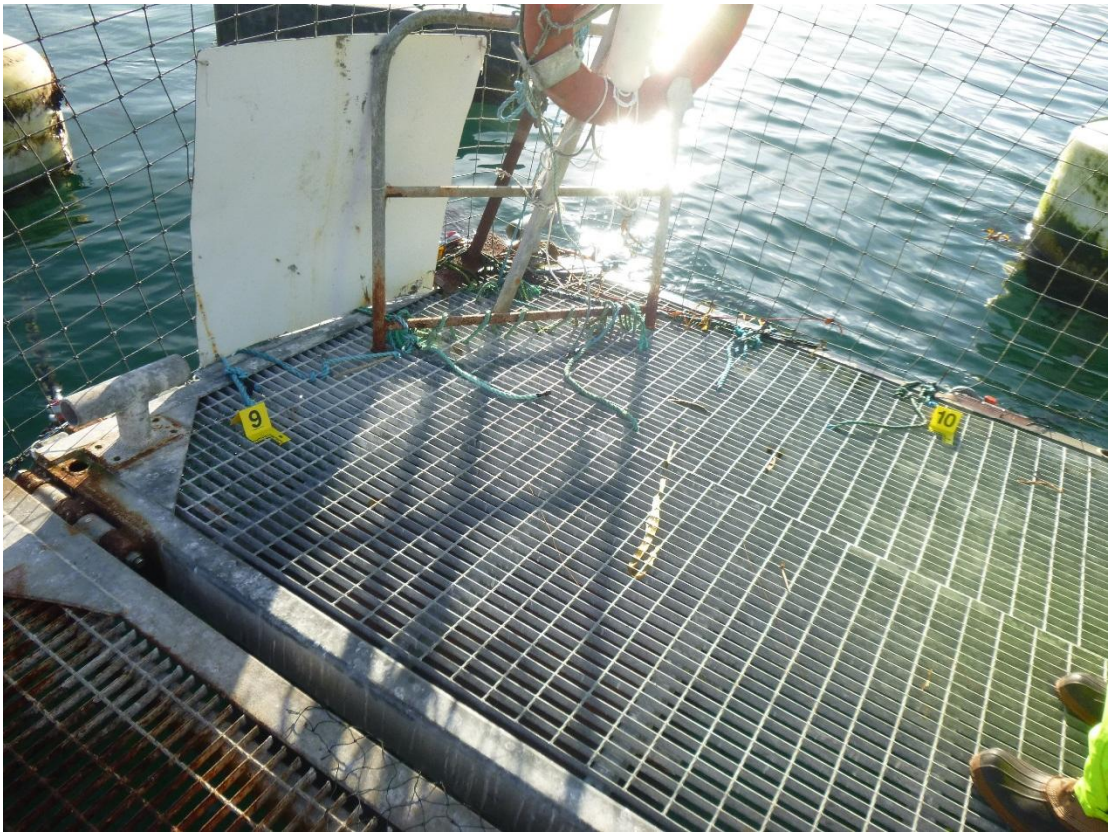


Figure C-27: Anchor 9 and 10 Showing Uneven Freeboard Looking Southeast

Figure C-28: Anchor 9 Bridle Chain and Buoy

Figure C-29: South East Corner Showing Additional Anchor Pontoon Float and Padeye

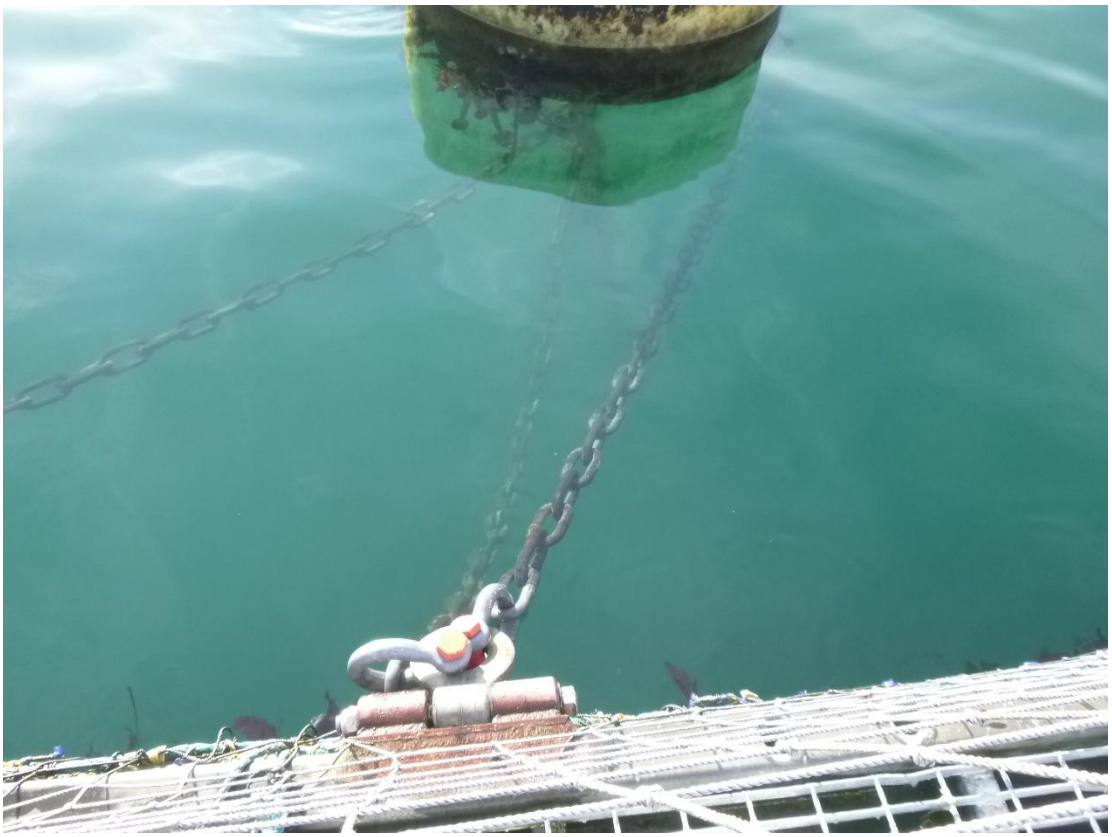


Figure C-30: Anchor 10 and Chain From Additional Unknown Anchor. Note Two Shackles in One Padeye

Figure C-31: Showing Sloped Docks Along South Edge of Pen 14 Looking East

Figure C-32: Showing Sloped Docks Along South Edge of Pen 14 - Looking North

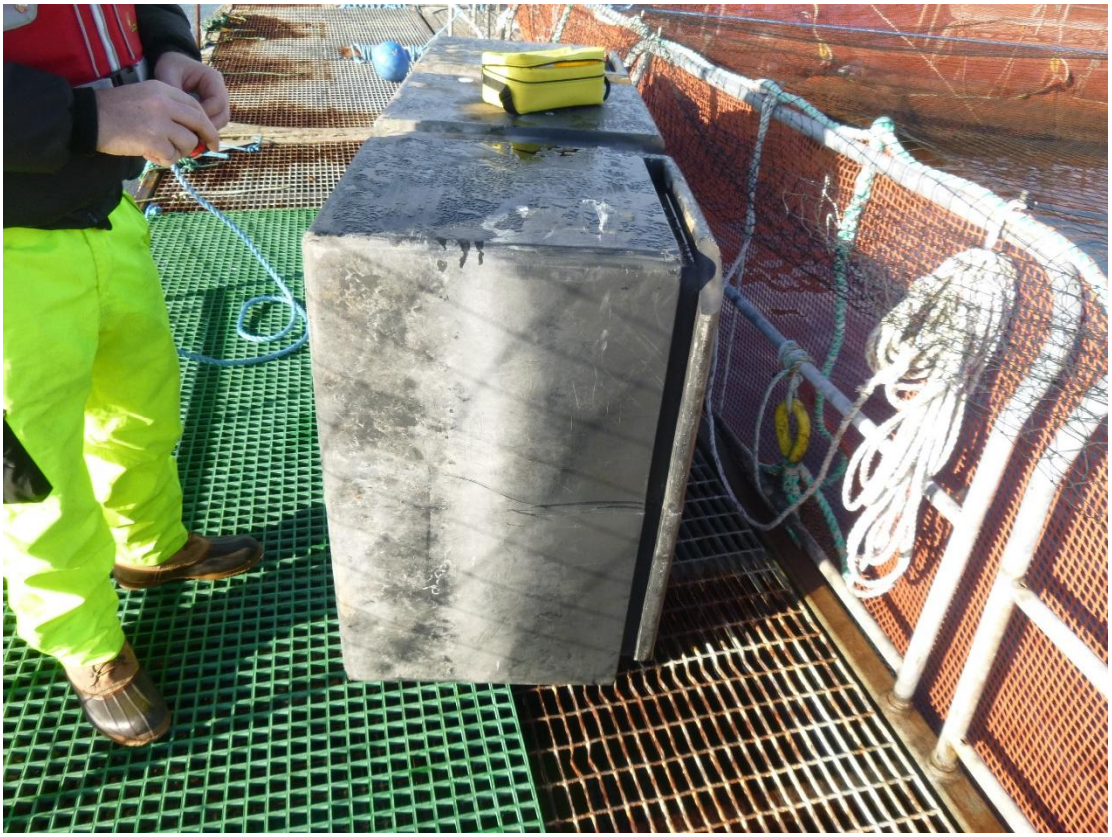


Figure C-33: Typical Polystyrene Filled Moulded Polyethylene Pontoon

Figure C-34: Padeye Midway Between Anchor 10 and Anchor 11

Figure C-35: Anchors 11 and 12

Figure C-36: Anchor 11 Padeye and Bridle on right, Unknown Anchor Chain on left

Figure C-37: Anchor 11 Buoy and Bridle Chains Unevenly Loaded

Figure C-38: Anchor 12 Bridle Chains and Buoy

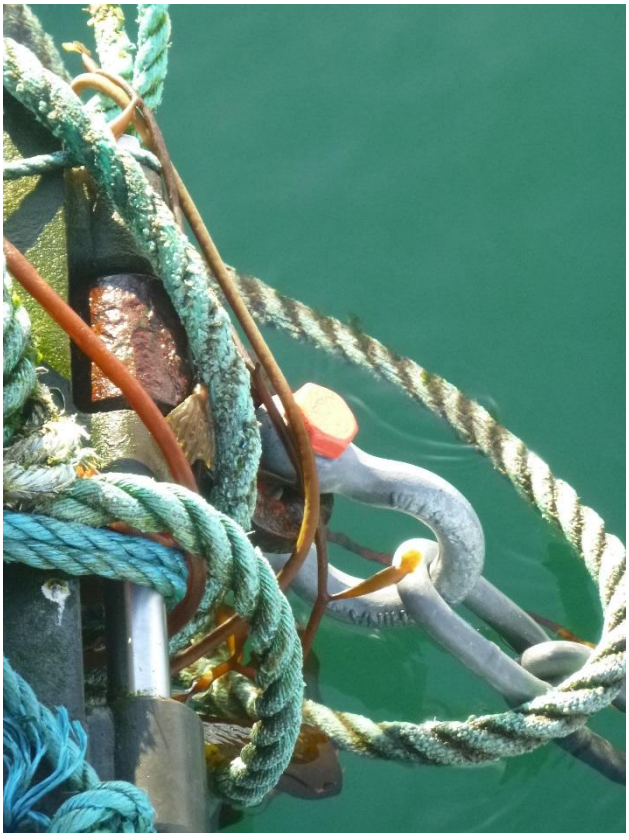


Figure C-39: Anchor 12 Left Bridle Connection

Figure C-40: Anchor 12 Right Bridle Connection

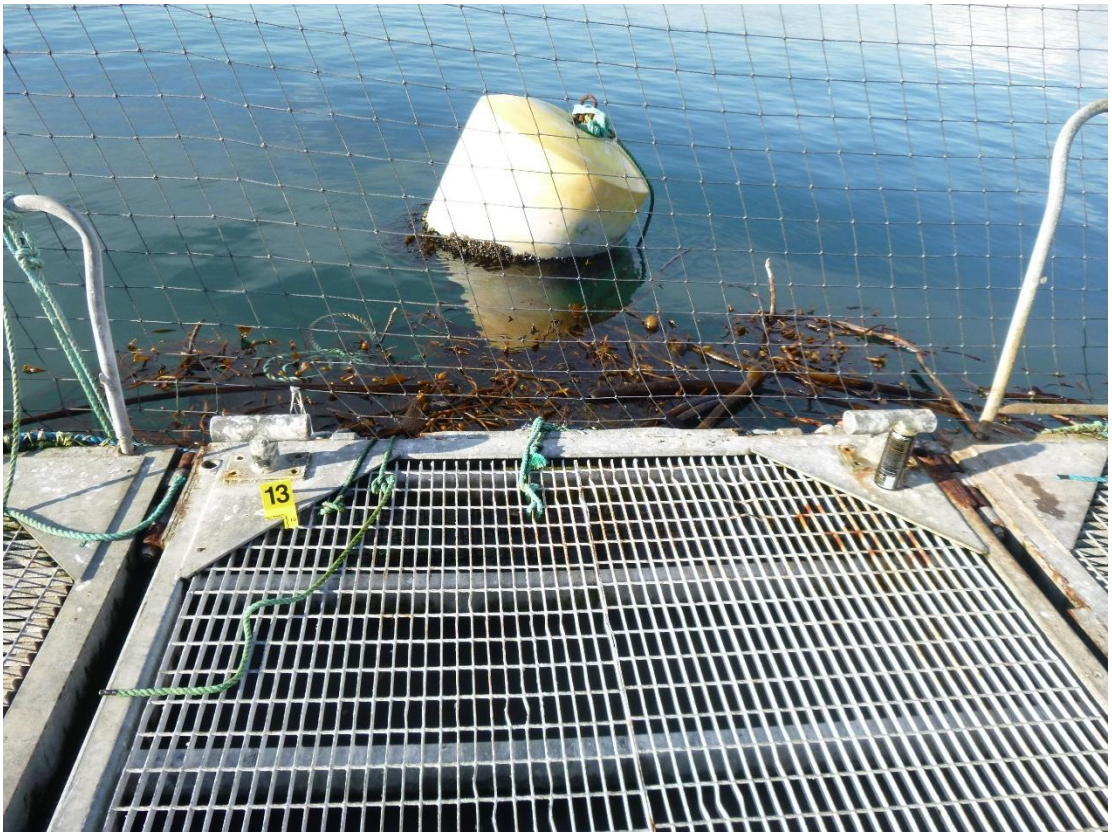


Figure C-41: Anchor 13 (Looking West)

Figure C-42: Anchor 13 Bridle Chains

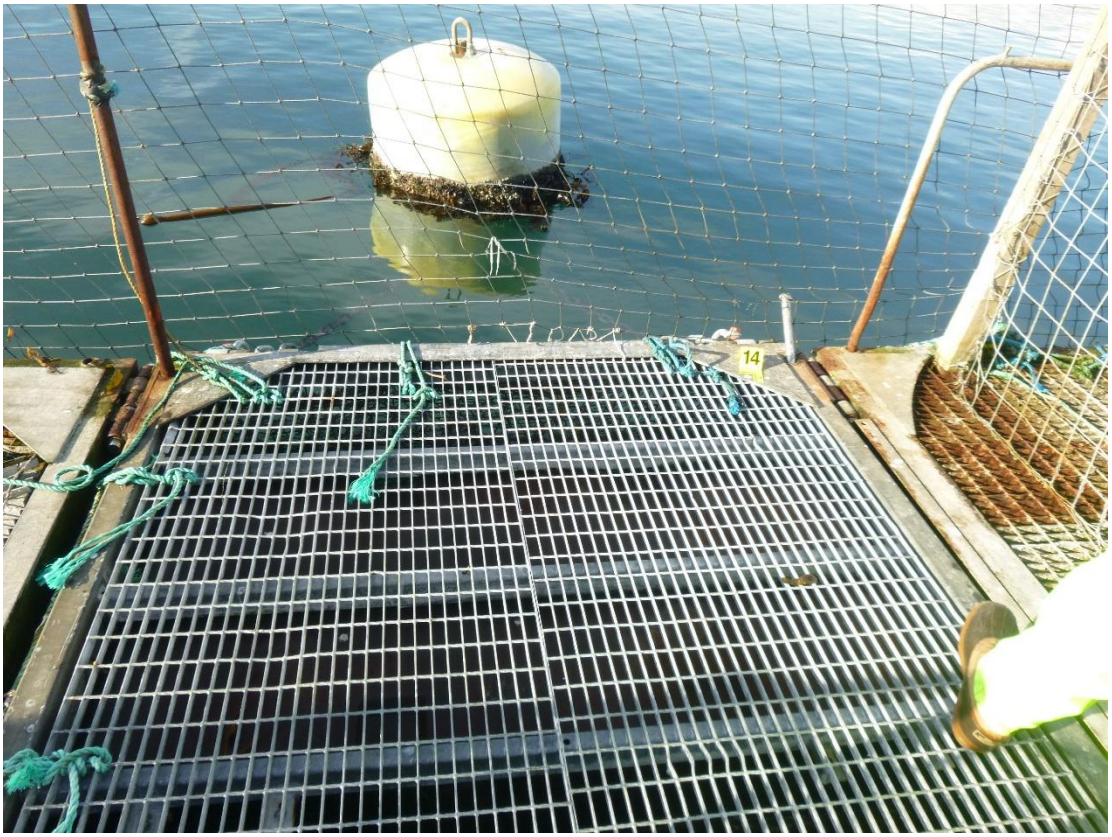


Figure C-43: Anchor 14 (Looking West)

Figure C-44: Anchor 14 Right Shackle, Padeye and Typical S.S. Hinge Pin

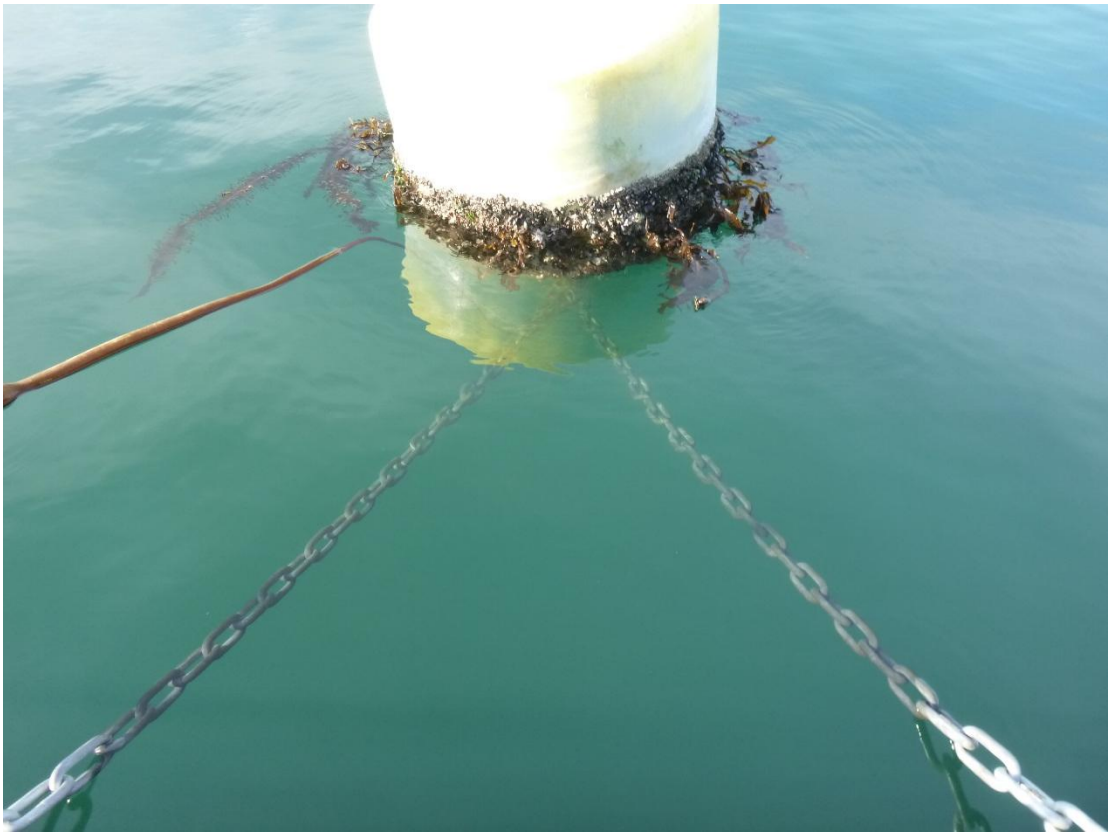


Figure C-45: Anchor 14 Bridle Chains

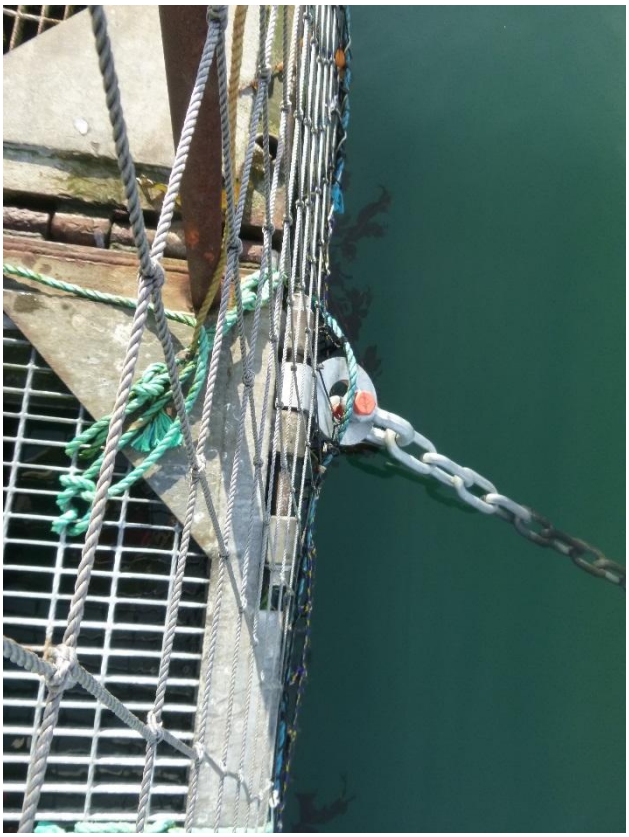


Figure C-46: Anchor 14 Left Shackle and Padeye

Figure C-47: Anchor 15

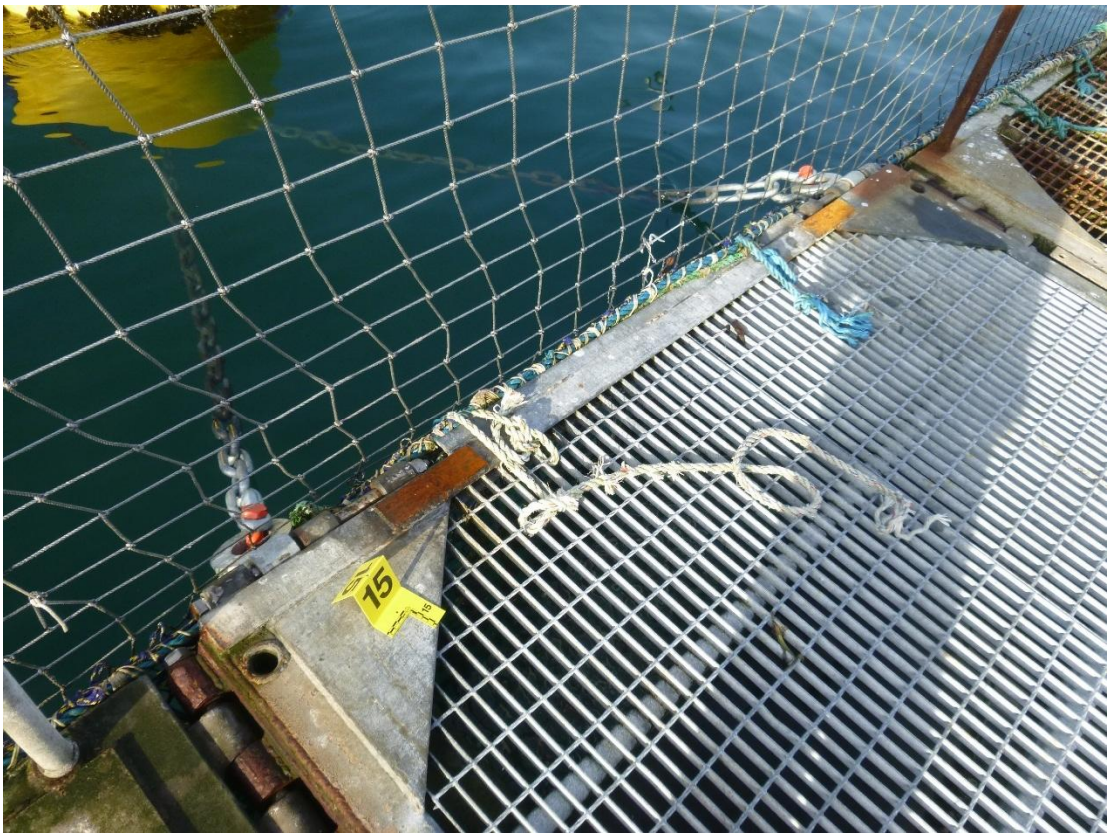


Figure C-48: Anchor 15 Bridle, Shackles and Padeyes

Figure C-49: Anchor 16 Showing Moderate to Severe Corrosion of Grating

Figure C-50: Anchor 16 Left Shackle and Padeye

Figure C-51: Anchor 16 Right Shackle and Padeye

Figure C-52: Floating Dock Boarding Area Between 6 and 8 Pen Sections on West Side

Figure C-53: Floating Dock Boarding Area Looking South

Figure C-54: Floating Dock Boarding Area, Damage to Dock Frame From Arms

Figure C-55: Floating Dock Boarding Area, Broken Dock Frame From Arms

Figure C-56: Anchor 17 Missing. Showing Severe Corrosion of Grating

Figure C-57: Anchor 17 Missing - Right Padeye Hinge

Figure C-58: Anchor 17 Left Padeye Hinge

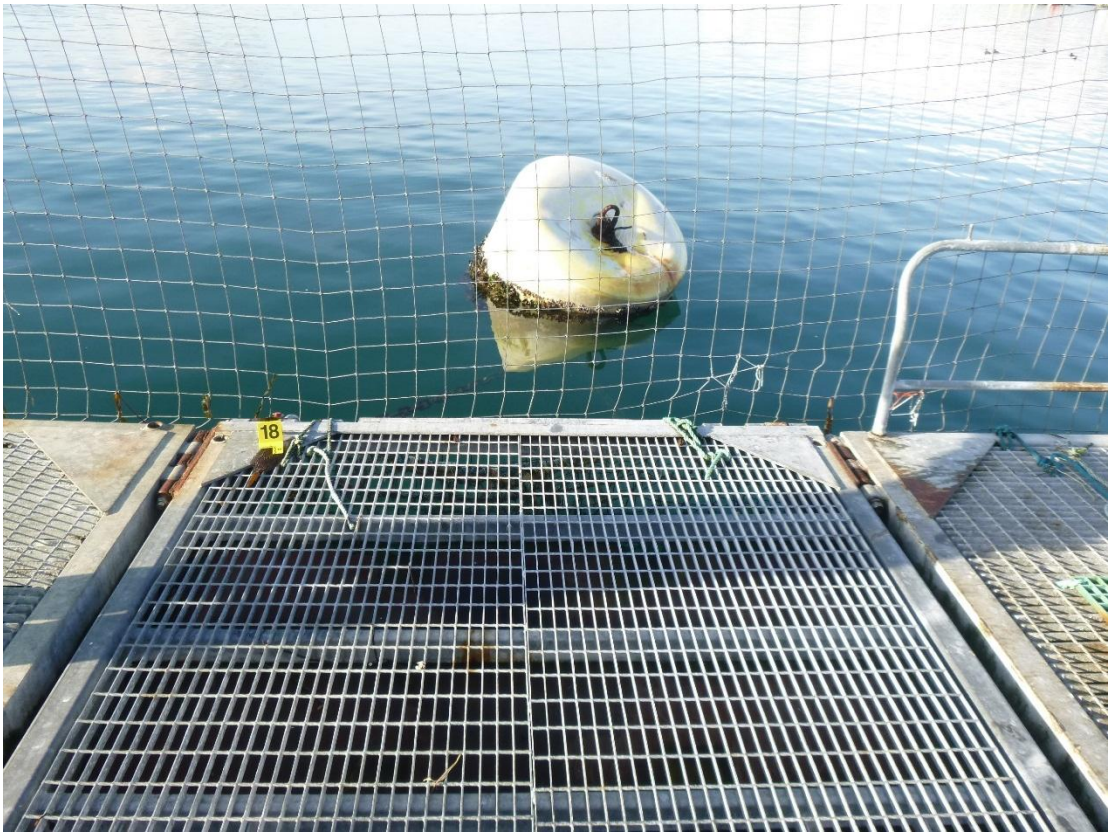


Figure C-59: Anchor 18

Figure C-60: Anchor 18 Left Padeye, Shackle and Chain

Figure C-61: Anchor 18 Right Padeye Shackle and Chain

Figure C-62: Anchor 18 Bridle Chain

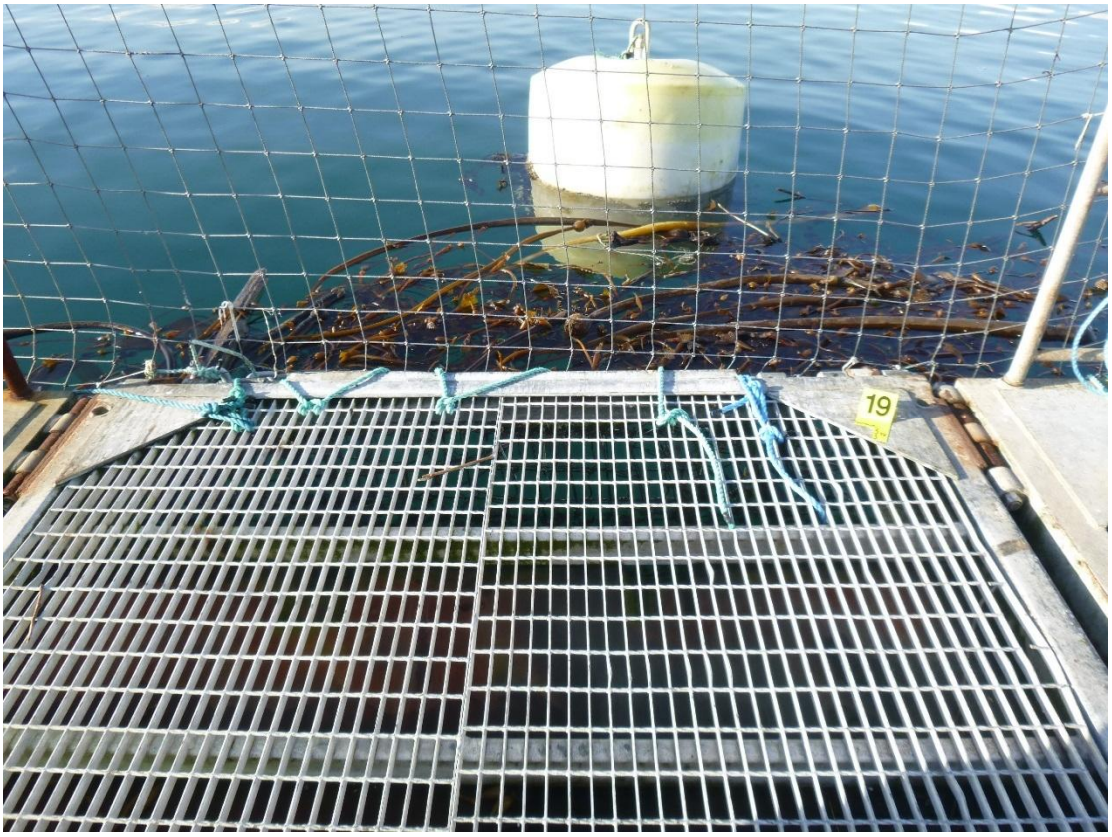


Figure C-63: Anchor 19

Figure C-64: Anchor 19 Right Padeye and Chain

Figure C-65: Anchor 19 Left Padeye and Chain

Figure C-66: Anchor 20 and 21 (Looking North West)

Figure C-67: Anchor 20 Left Padeye, Shackle and Chain

Figure C-68: Anchor 20 Right Padeye, Shackle and Chain

Figure C-69: Anchor 21 Showing Severe Corrosion in Grating

Figure C-70: Anchor 21 Right Padeye, Shackle and Chain (Single Hinge Setup)

Figure C-71: Anchor 21 Left Padeye, Shackle and Chain (Single Hinge Setup)

Figure C-72: Anchor 22

Figure C-73: Anchor 22 Left Padeye, Shackle and Chain

Figure C-74: Anchor 22 Right Padeye, Shackle and Chain

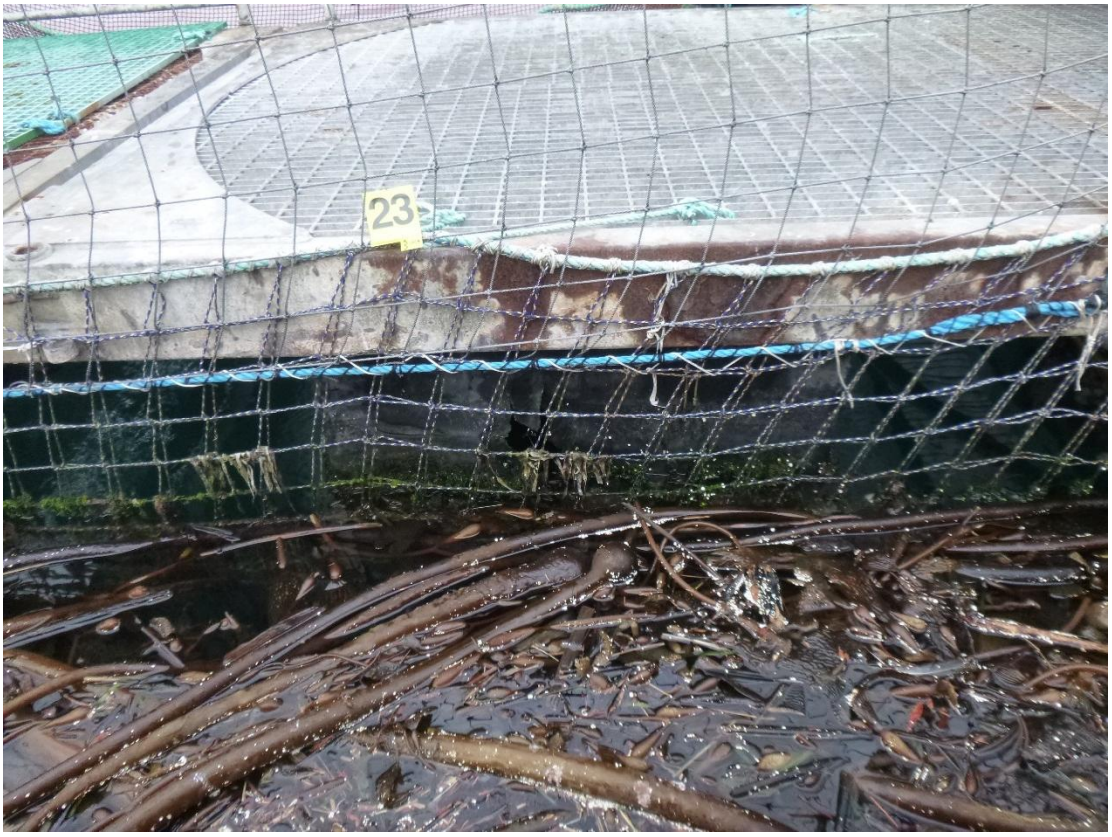


Figure C-75: Location 23 Damaged Pontoon (South Edge of Pen 5)

Figure C-76: Location 23 Damaged Pontoon (South Edge of Pen 5)

Figure C-77: Location 24 South Edge of Pen 5 (Looking West)

Figure C-78: Fiberglass Mesh Covers Severe Corrosion in Grating

Figure C-79: Typical 10ft Wide Dock Section with Light to Moderate Corrosion on Truss Members

Figure C-80: Boarding Area Between 6 and 8 Pen Sections- South Dock looking west

Figure C-81: Boarding Area Between 6 and 8 Pen Sections – Middle Dock Looking West

Figure C-82: Boarding Area Between 6 and 8 Pen Sections – North Dock Looking West

Figure C-83: Main Dock Between Boarding Area and Barge – Looking South

Figure C-84: East face of Office and Gen-set Barge – Looking West

Figure C-85: Northeast Corner of Office and Gen-set Barge – Looking South

Figure C-86: North Face of Office and Gen-set Barge – Looking Southwest

Figure C-87: Northwest Corner of Office and Gen-set Barge – Looking Southeast

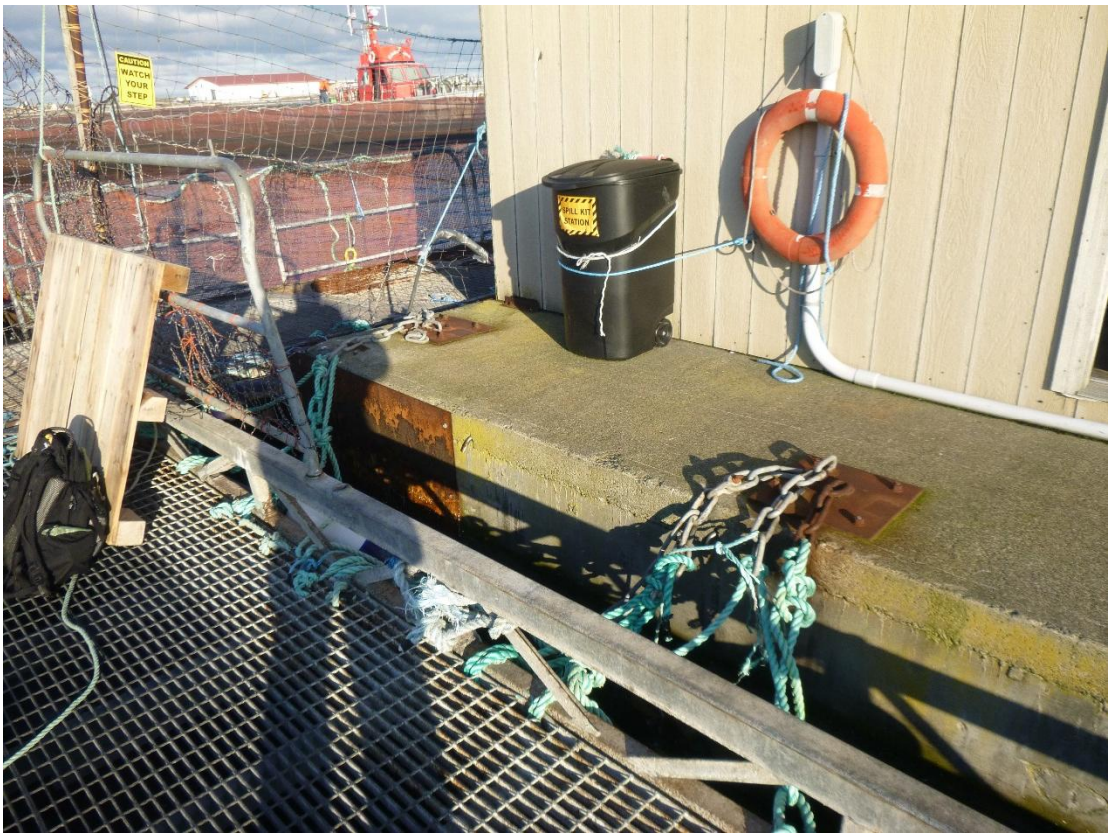


Figure C-88: West Face of Office and Gen-set Barge – Looking Northeast

Figure C-89: West Face of Office and Gen-set Barge – Looking East

Figure C-90: Southwest Corner of Office and Gen-set Barge – Looking East

Figure C-91: Southwest Corner of Office and Gen-set Barge – Looking East

Figure C-92: Southeast Corner of Office and Gen-set Barge

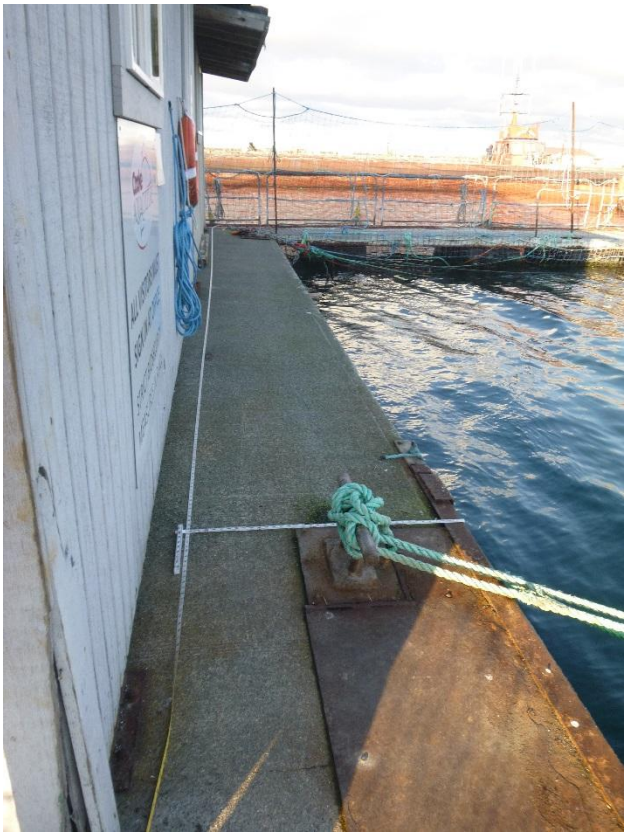


Figure C-93: East Side of Office and Gen-set Barge – Looking North