



Port Angeles Secondary Atlantic Salmon Net Pens Engineering Assessment

January 29, 2018

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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 secondary 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.

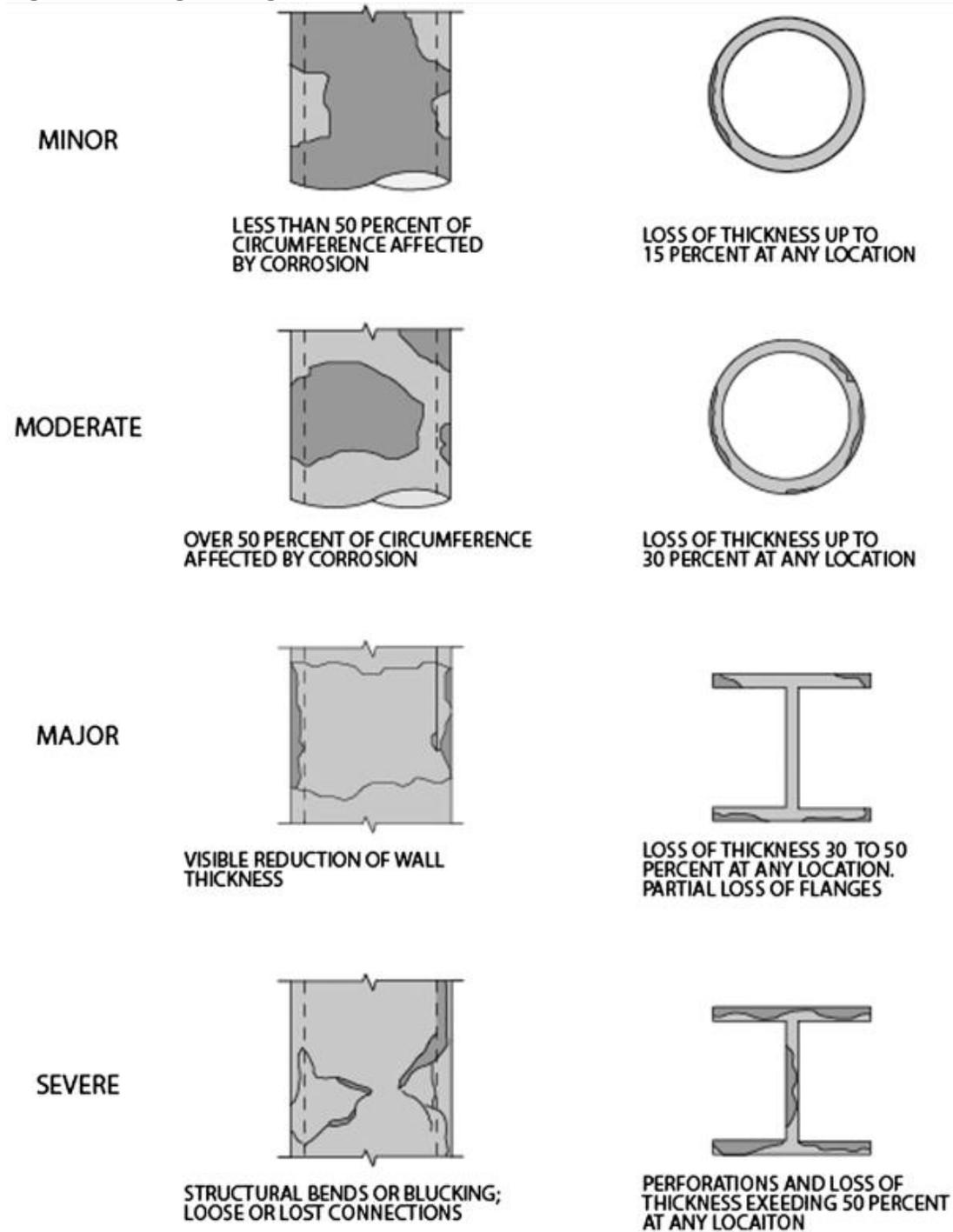
Table 1: Condition Assessment Rating

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



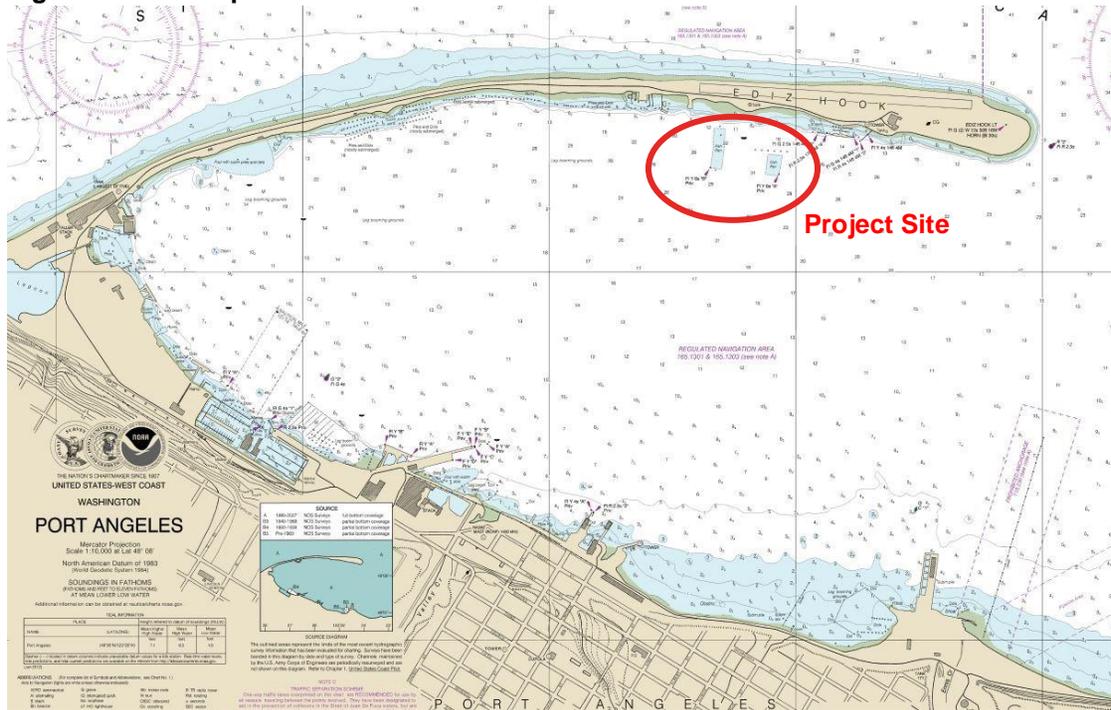
Source: ASCE Standard of Practice No. 130 "Waterfront Facilities Inspection and Assessment"

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

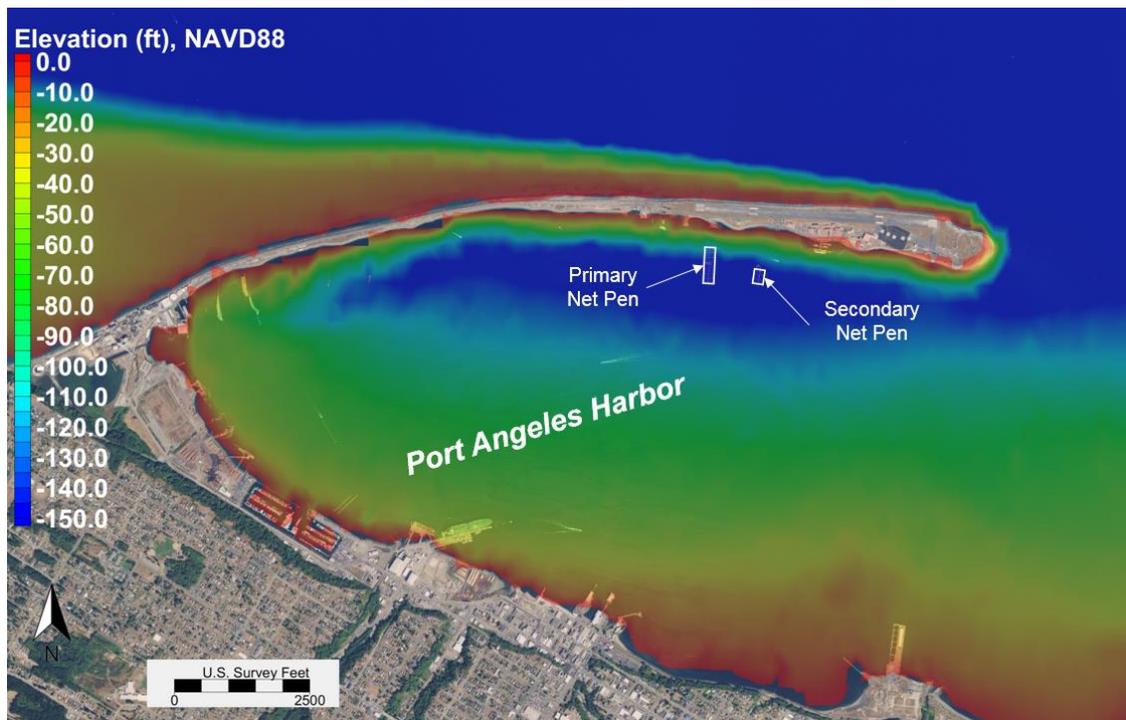
No.	Description	Comments
14	2017 Oct -Net pen inventory, 1 page	Inventory includes dimensions, mesh size, make, year made, etc.
Standards, Guidelines, Studies, Plans		
15	Norwegian Standard NS 9415.E:2009 - - Marine fish farms Requirements for site survey, risk analyses, design, dimensioning, production, 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.

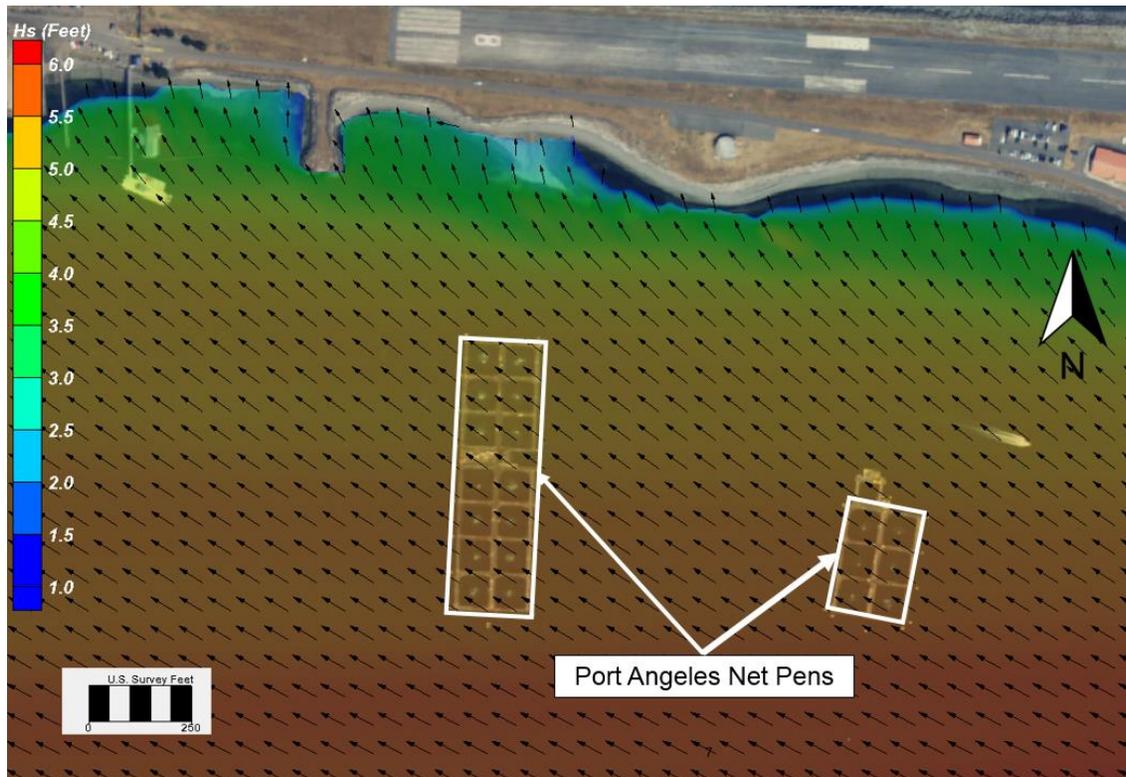
Table 3: 100-year Waves Near Port Angeles Net Pens¹

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 feet². 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 include passenger ferry traffic (passing within 1 mile of the 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 adjacent to the facility to the North and includes vessel traffic to and from the facility. Also, a new Navy pier is planned near the net pen facility to moor relatively large vessels that can generate potentially large wakes.

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. However, they were found to include Danforth type drag anchors, and concrete block 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 and Chain at Port Angeles Secondary Net Pen Figure 7 is a photo of a typical connection at the secondary net pen, mooring line No. 10.

Figure 7: Mooring Brackets and Chain at Port Angeles Secondary 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 secondary net pens. Photographs are included in Appendices A and C. The dive inspection report by Collins is in Appendix B.

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

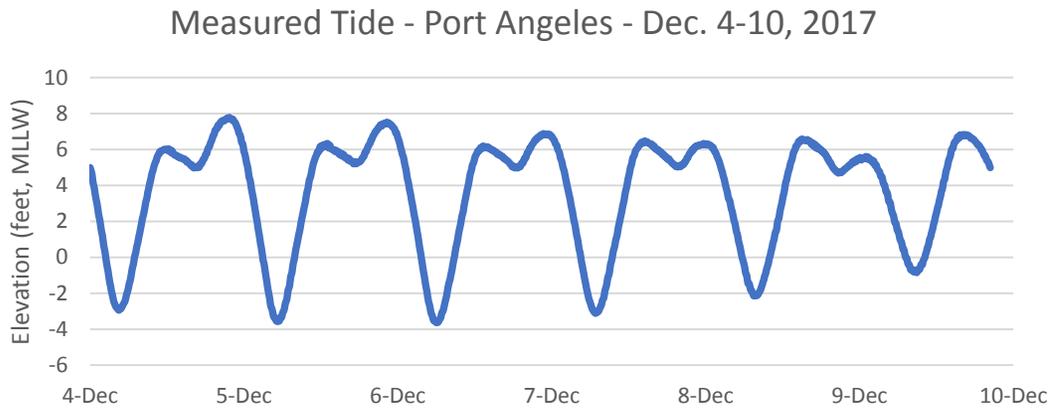


Source: Mott MacDonald photograph December 5, 2017

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. But some anchors were different.	The drag anchors on the surface should be fully buried. Anchors 1, 2, 3, 11, 12A, 13, and 14 were found partially exposed. Anchors 11, 13, and 14 were found to be concrete blocks. There may be design deficiencies.	Satisfactory, but most anchors were not observed because they were buried. Concrete anchors with vertical steel posts have been installed upside down.
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, connected by shackle to an anchor.	Mooring lines wrapped around other lines, lines too steep, severe damage on some lines, unusual combinations/sequences of line and chain, mixed mooring types and varying tension.	Fair, but with serious deficiencies in some areas. Need to address missing cotter pins, abrading lines, and damaged buoys. Balanced loads on all anchors will need to be verified.

Component	Year Built (estimate)	Description	Deficiencies	Overall Assessment
			<p>Anchor line 6A is missing a Buoy</p> <p>Anchor line 7, vertical upper chain of smaller cross section than other anchorages.</p> <p>Anchor line 8 has a damaged buoy</p> <p>Anchor line 11 exhibits fraying</p> <p>Anchor lines 12 and 13 utilize 1 chain each, not a bridle pair.</p> <p>Anchor lines 12A and 13 overlap tightly</p> <p>Missing cotter pins on 4 and 12A</p>	
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 7-inches to 20-inches.	No damage observed Low freeboard at southern 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 access rout 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 corners of net pen system, surface rust typical on grating	Good to satisfactory

Component	Year Built (estimate)	Description	Deficiencies	Overall Assessment
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,	Good to satisfactory with minor repairs
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	Standard 10 feet wide main float with wooden shed, housing generator	Typical marine growth and light to moderate corrosion	Good to satisfactory
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

- The anchors are a mix of old and new. The age and condition of some of the anchors has not been determined.
- The anchors are different types, Danforth, and concrete gravity anchors.
- Anchors 1, 2, 3, 11, 12A, 13, and 14 were partially exposed. There was no indication that the anchors were unstable and/or shifting in the seabed.
- Anchors 11, 13, 14 were not Danforth anchors but rather two large concrete blocks with two steel rails cast into and protruding from the concrete. The steel rails extended upward and not into the seabed.

6.2 Mooring Lines

- Above water the anchor mooring lines consist of steel chains and shackles ranging from 1.5-inch to 2-inch diameter. Several mooring lines are taut and at a relatively shallow angle of the chain to the water where it connects 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 observed were in good to satisfactory condition, but with significant defects in places.
 - The vertical chain at anchor 7 was noted to be smaller than at other anchors.
 - The vertical chain at anchor 10 exhibited heavier than normal corrosion with up to 1/8 in. pitting and striations.
 - Anchor Line 12a crosses over Anchor line 13 at a depth of 43 feet, then is vertical to the channel bottom. Anchor line 13 crosses under a third anchor line.
 - Anchor line 6A (an additional anchor line not shown on the design drawings, along with 12A) did not have a buoy, and had only 1 bridal chain attached directly vertical and taught.
- Above water mooring brackets were observed during our site visit to be in fair 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. 11. See also Figure C-23 in Appendix C.

Figure 10: Mooring Brackets at Line No. 11



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 Storage Float and Wood Shed

- The storage floats at the secondary net pens were steel framed floats supported by plastic floatation tubs, and likely the same design as the central walkways. The floats provide extra storage space and also support a timber frame shed approximately 8x8 feet. The floats were observed level, not listing to one side.
- A structural condition assessment of the wood shed is outside of our scope of work.
- The float was integrated into the net pen facility using the typical hinged connection details. The storage floats are also connected to anchor lines 11 and 12a. See the drawings in Appendix A for the general arrangement.
- There was minor to moderate corrosion observed on the grating and framing of the float.

6.8 Records and Documents On-Site

Documents and records are likely stored on site but we did not ask to see them.

7 Conclusions

In general, the secondary net pen facility is in fair condition, with some repairs needed as noted in this report. Of the components that were reviewed, the grating along areas of the walking surface, the low freeboard along the southern perimeter and the uneven tension of the anchor bridles are of concern as they exhibit moderate conditions that need to be addressed. The structure is a robust, heavy steel frame design, relative to the sheltered conditions in Port Angeles Bay. However, the mooring system is a significant concern and design documentation is not available.

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 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 notes describing the existing components were made available. The information is not complete and was not correct for some mooring lines. 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, some anchors observed were not Danforth anchors.
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 good condition, with some exceptions.
 - b. The mooring system includes a mix of different anchor types, mooring lines, line tension and lengths. Lines were observed in contact with other mooring lines. The mooring system is complex in places and difficult to analyze. It appears to 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. Anchor 6A has no buoy
 - d. Anchor 7 utilizes an upper chain of smaller cross section than all other anchors.
 - e. Anchor 8 buoy is damaged.
 - f. Anchors 11, 13 and 14 are exposed and the anchors were not Danforth but rather large concrete blocks.
 - g. Anchor Line 12a crosses over Anchor line 13 at a depth of 43 feet, then is vertical to the channel bottom. Anchor line 13 crosses under a third anchor line.
7. Above Water Components: The above water portions of the float system appear to be 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 needs to be adjusted.
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. 1 through 4 of the 6 Secondary net pens. 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.

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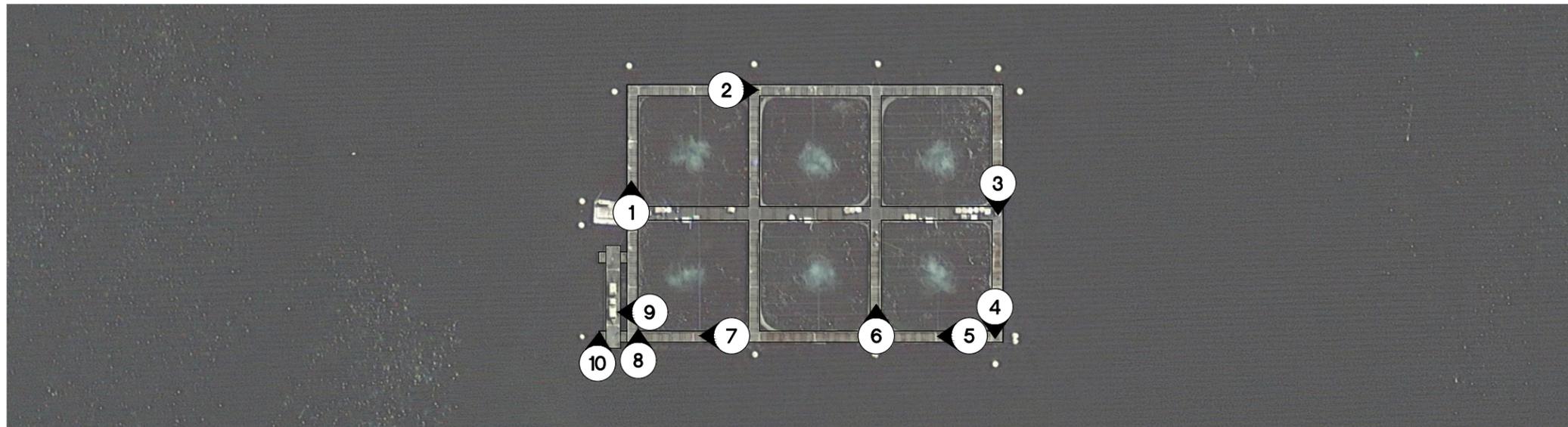
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LEGEND

1 PHOTO LOCATION AND ORIENTATION

NOTES

MOORING SYSTEM NOT SHOWN, SEE SHEET 5

PORT ANGELES SECONDARY NET PEN

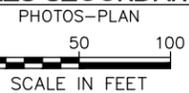


PHOTO 1
 TYPICAL VIEW OF NORTH WALKWAY LOOKING EAST



PHOTO 2
 TYPICAL VIEW OF EAST WALKWAY LOOKING SOUTH



PHOTO 3
 TYPICAL VIEW OF SOUTH WALKWAY LOOKING WEST



PHOTO 4
 TYPICAL VIEW OF SOUTHWEST CORNER WALKWAY LOOKING WEST



PHOTO 5
 TYPICAL VIEW OF WEST WALKWAY LOOKING NORTH SHOWING MODERATE CORROSION

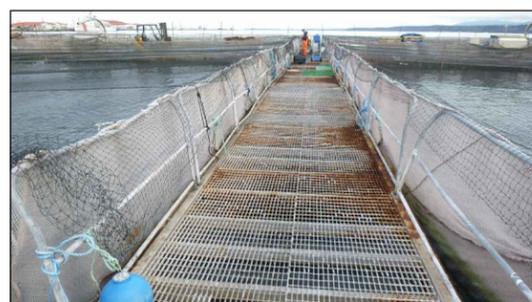


PHOTO 6
 TYPICAL VIEW OF TRANSVERSE WALKWAY LOOKING EAST



PHOTO 7
 TYPICAL VIEW OF WEST WALKWAY LOOKING NORTH SHOWING MODERATE CORROSION



PHOTO 8
 TYPICAL VIEW OF NORTH WALKWAY LOOKING EAST

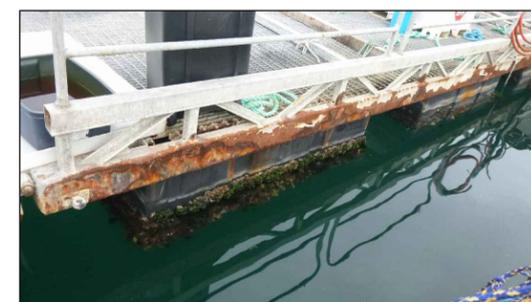


PHOTO 9
 ELEVATION VIEW OF 10 FT WIDE FLOAT



PHOTO 10
 TYPICAL VIEW OF BOARDING FLOAT

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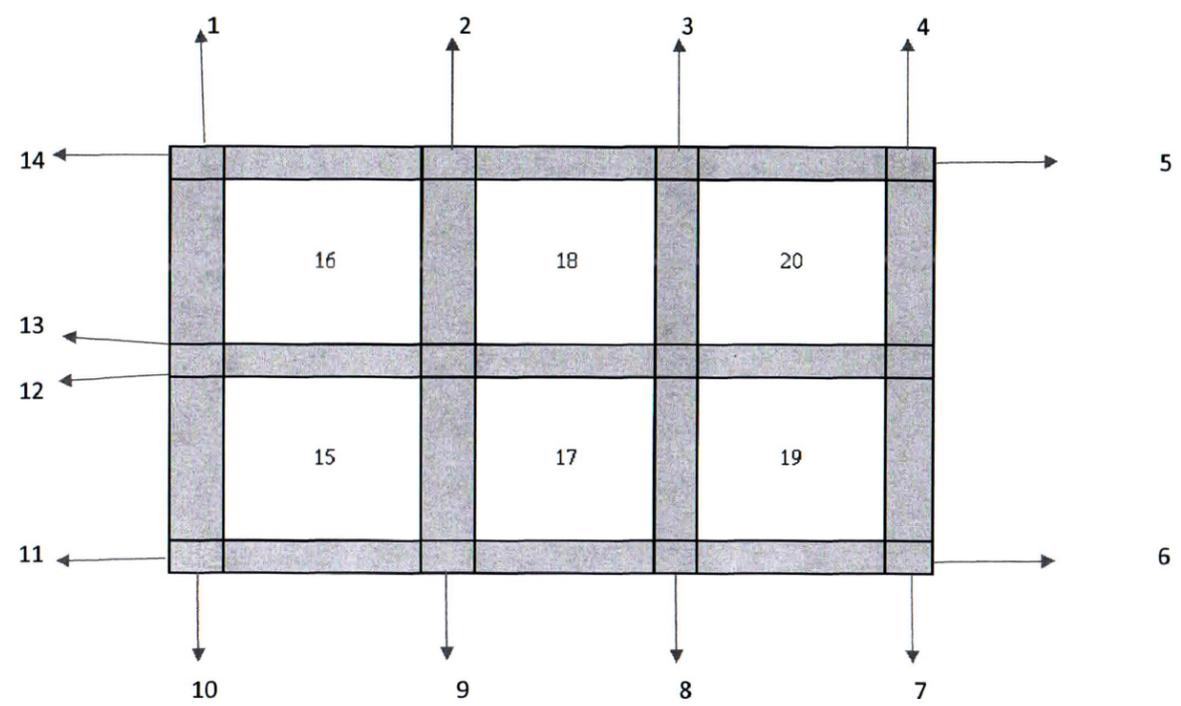
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Drawn	C. Taylor	Coordination	
Dwg check	N. Sultan	Approved	
Scale at ANSI D	As Shown	Status	Rev
Drawing Number		Security	

Title
 Washington State
 Department of Fish and Wildlife
 Port Angeles Net Pen
 Site Assessment Plan
 Secondary Net Pen



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 SECONDARY NET PEN
 MOORING PLAN
 NOT TO SCALE

NOTES
 MOORING SYSTEM SCHEMATIC PLAN
 PROVIDED BY COOKE AQUACULTURE.

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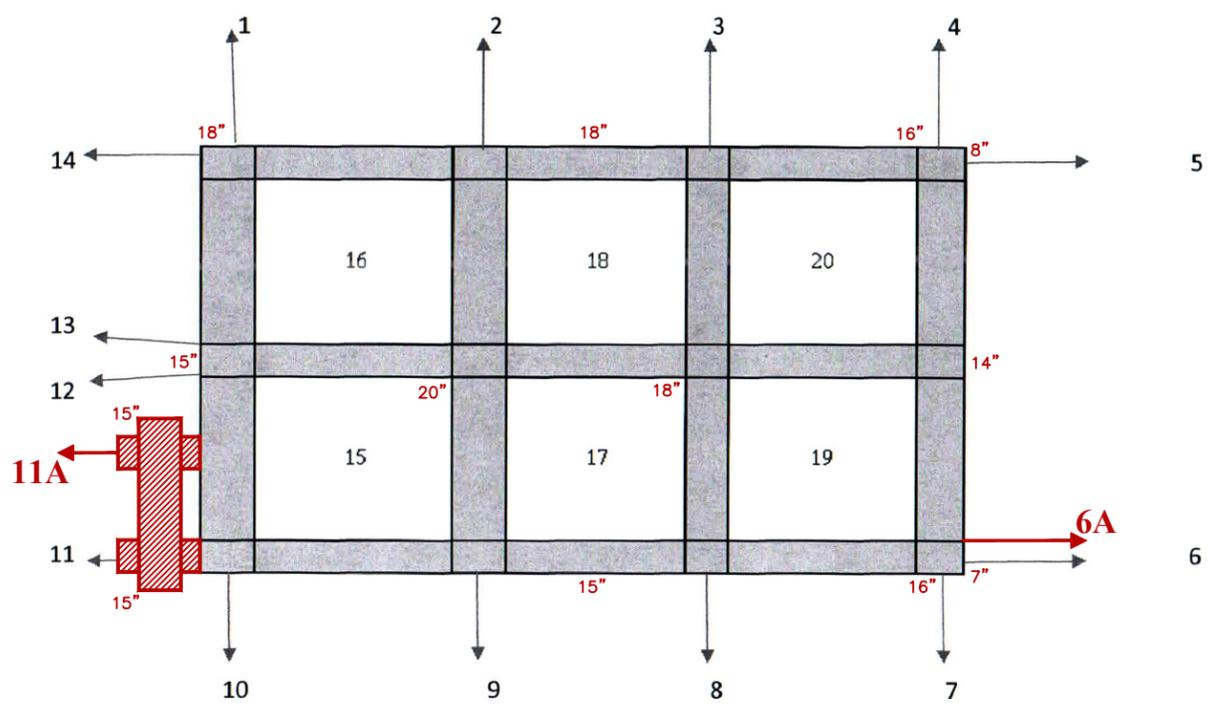
Title

Washington State
 Department of Fish and Wildlife
 Port Angeles Net Pen

Mooring Schematic
 Secondary Net Pen



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 SECONDARY 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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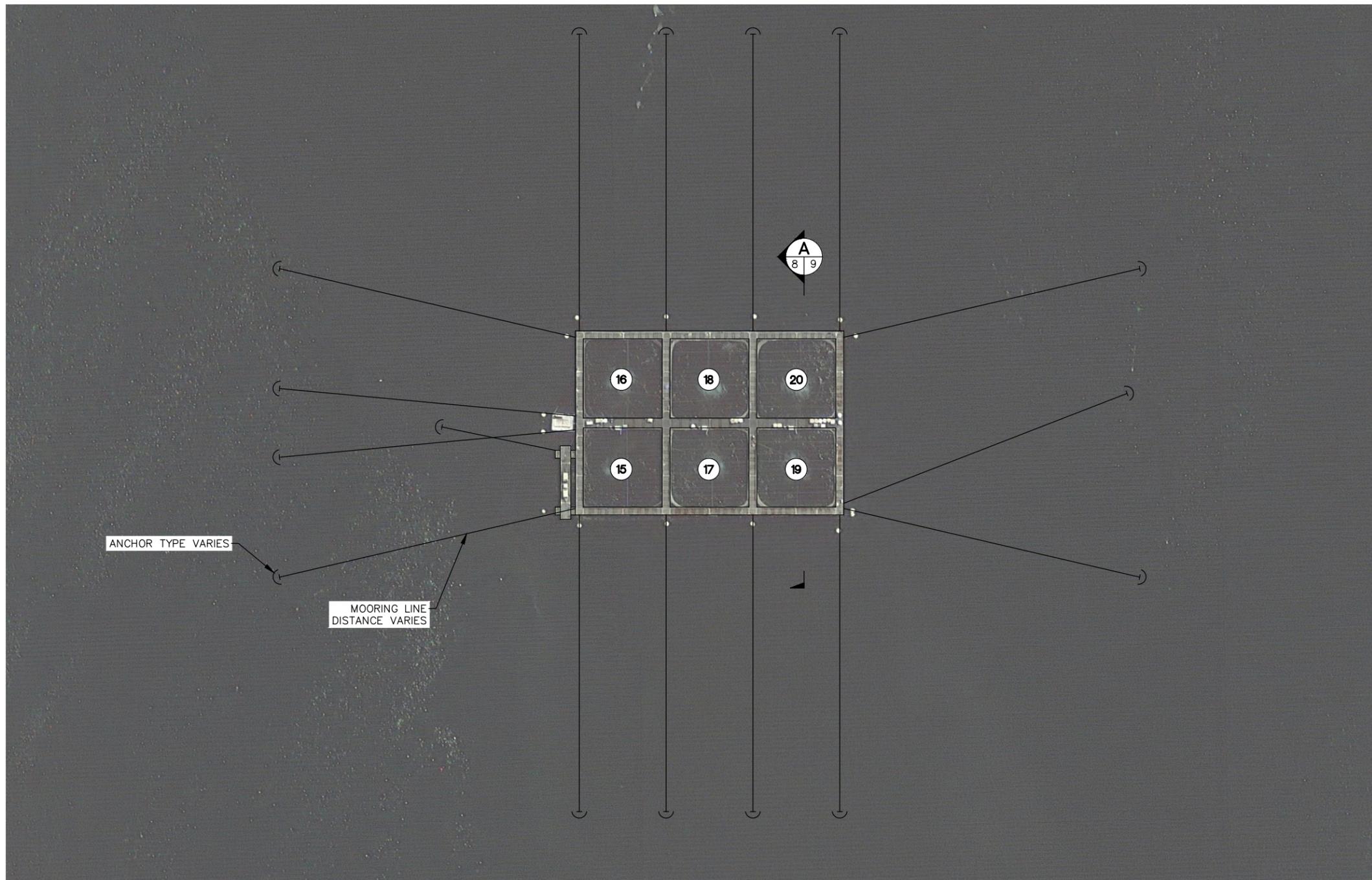


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Title
 Washington State
 Department of Fish and Wildlife
 Port Angeles Net Pen
 Mooring Schematic - Secondary
 Net Pen - Revised, With Notes



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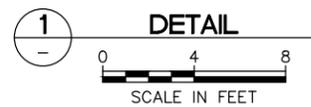
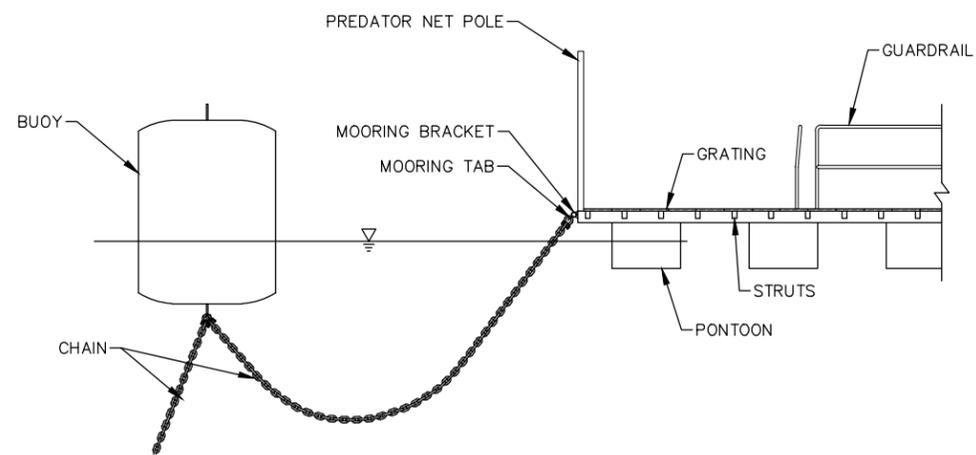
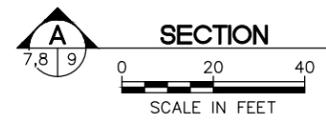
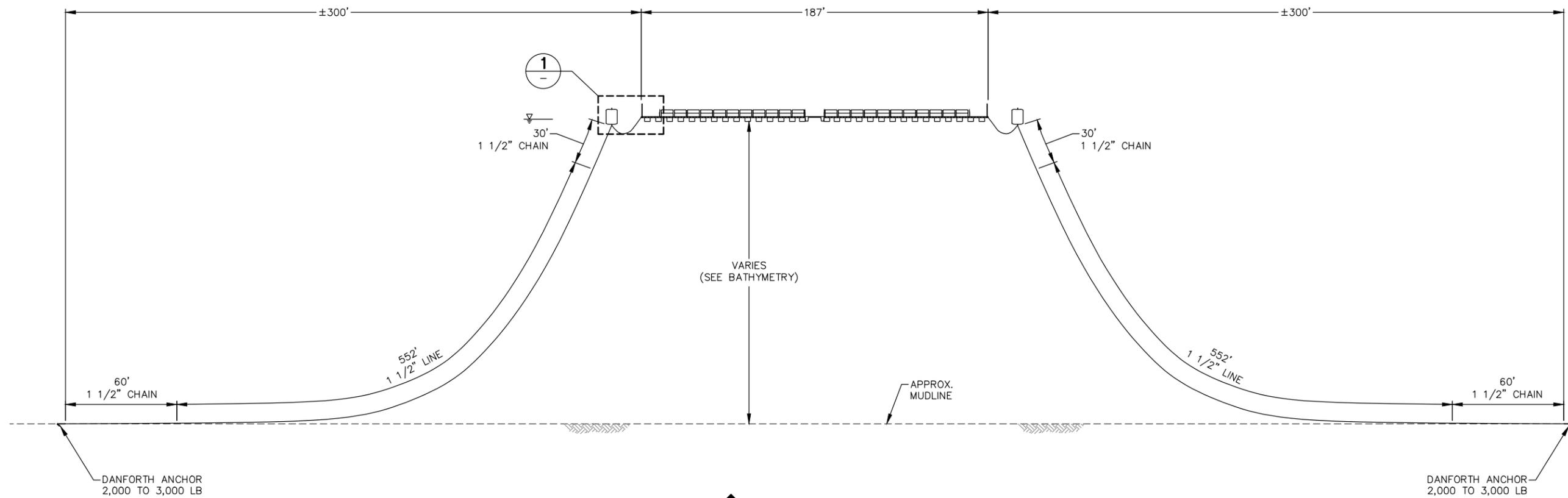
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Project Number	B/O	Total
391980	8	9

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Drawing Number			

Washington State
Department of Fish and Wildlife
Port Angeles Net Pen

Existing Site - Moorings
Secondary Net Pen



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Total
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Drawing Number			

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
Secondary Net Pens System in Port Angeles, WA

Mr. Nels Sultan, Ph.D, P.E.
Principal Engineer
North America Ports, Coastal and Offshore
Mott MacDonald
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Dear Mr. Sultan,

Collins Engineers, Inc. conducted an underwater inspection of the Port Angeles Secondary Net Pen System located in Port Angeles, WA from December 6 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 pens 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 inspected to a depth of 100 fsw by divers. An underwater Remotely Operated Vehicle (ROV) was utilized to inspect the portions of Anchors that were 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 Secondary System all of the anchor lines required ROV inspection.

Refer to Photographs 1 through 20 for views of the typical and specific conditions observed during the underwater inspection of the Port Angeles Secondary 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 Secondary Net Pens System revealed the following key findings:

- Additional anchor lines (not shown on provided drawings) were observed and inspected at the following locations: 6A (runs southeast from south corner of west system) and 12A (at the building float located at north end just west of Anchor Line 12).
- The anchor line assemblies were typically found to be in satisfactory to fair condition, with varying degrees of age-related deterioration, but with all connection elements sound and secure. 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 8, 11 and 12A. It should be noted that no significant rope damage was identified; however, the extent of marine growth on a majority of the ropes would preclude readily detections of any lesser damage.
- The vertical chain at Anchor Line 10 exhibited heavier than normal corrosion with up to 1/8 in. pitting and striations of the chain surfaces.
- 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 it. Typically, the extent of corrosion became heavier where the chains were embedded to some extent 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 1, 2, 3, 11, 12A, 13, and 14. Overall, there were no anchors that displayed indications that the anchor was unstable and/or shifting its position in the seabed.
- At Anchors 11, 13 and 14, the exposed anchor was not a Danforth style, but rather two large concrete blocks that had two steel rails cast into and protruding from the concrete. The rails were apparently to serve as “pegs” to be embedded in the seabed; however, the rails were always situated such that they extended upward based on the blocks orientation on the seabed.
- At Anchor Lines 4 and 12A, the two bridle chain to walkway/float shackles did not have cotter pins or safety wires.

- At Anchor Line 6, the buoy shackle was missing a cotter pin.
- Anchor Line 6A did not have a buoy and only had one bridle chain that was attached directly to the vertical chain, and the bridle chain was very taught.
- At Anchor Line 7, that the vertical upper chain appeared smaller than at all other anchorages.
- At Anchor Line 8, the buoys steel center shaft was pulled downward approximately 4 ft in relation to the buoy.
- At Anchor Line 11, there was a smaller diameter rope spliced into the main rope at 89 ft below the waterline. Random fraying of the main rope was observed for a distance of approximately 15 ft below this location.
- Anchor Line 12A (at building float) crosses tight over Anchor Line 13 at approximately 43 ft below the waterline and then goes vertically downward to the channel bottom. At 65 ft below the waterline, Anchor Line 13 crosses tight under another anchor line (presumably a line from the Main Net Pens System). Marine growth at both locations appears to be rubbed off in these vicinity, but no fraying was detected.
- Anchor Lines 12 and 13 only had one bridal chain connecting them to their respective floats.
- At the south end of the overall 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 a buoy at Anchor Line 6A. No defective walkway floats were found along the south walkway and the floatation spacing was similar to other locations throughout the pen system.
- The small building float located just west of Anchor Line 12 at the north end of the pens system was in satisfactory condition, with 3 in. thick marine growth below water and no detectable deterioration.

The general findings and assessment of the observed existing conditions of the Secondary Net Pens System and its various components are as follows:

Anchor Line Assemblies

The anchor line assemblies typically consisted of:

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

The building/pens support float to upper anchor chain connections were typically found to be fully intact, sufficiently secure, and in satisfactory condition. 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 buoys 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. The exception to this was the Buoy at Anchor Line 8 where the steel center shaft was pulled 99% of the way through the center of the buoy.

As previously indicated, all of the Secondary System anchor lines 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 Main System and west of

Secondary 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 3, 7, 8, and 10 of the Secondary 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 east side of the Secondary System typically extend 350 ft or more from the net pens system. In this regard, Anchor Lines 1 through 4, in particular, were especially long and estimated as being 750 ft or greater in length (approximate distance from net pens system to anchor or point of anchor chain embedment).

The 200 ft to possibly as much as an estimated 600 ft long ropes (rode 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.

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 10. The vertical chain at Anchor Line 10 exhibited heavier than normal corrosion with up to 1/8 in. pitting and striations of the chain surfaces.

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 1, 2, 3, 11, 12A, 13, and 14 of the Secondary System. Overall, there were no anchors that displayed indications that the anchor was unstable and/or shifting its position in the seabed. At Anchors 11, 13 and 14, the exposed anchor was not a Danforth style, but rather two large concrete blocks that had two steel rails cast into and protruding from the concrete. The rails were apparently to serve as “pegs” to be embedded in the seabed; however, the rails were always situated such that they extended upward based on the blocks orientation on 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 Secondary 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. When not completely buried, the anchor also appeared to be well founded and affording sufficient anchorage, with no evidence of anchor movement or other instability. This observation would also apply to the concrete block anchor location, which again did not present any detectable indication of anchor slippage.

Building/Pen Support Floats

The building support float was constructed of steel with plastic foam filled tubs was typically found to be in satisfactory condition with no defects or significant deterioration noted. The floats typically exhibited up to 3 in. thick marine growth on 100% of the submerged surface area

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 primarily along the southern perimeter on the net pens system. The float modules typically exhibited a 3 in. thick layer of marine growth on 100% of their submerged surface areas.

At the south end of the pen system, 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 a buoy at Anchor Line 6A. 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 vertical chain at Anchor Line 10, which would be considered a fair to poor condition, the lengths of chain inspected typically 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 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.

For the majority of the anchor lines, the anchors were not found exposed above the seabed, and when they were exposed, they typically were observed to be adequately founded in the seabed. The exception to this was at some of the northern and eastern lines where concrete block anchors versus Danforth type anchors were apparently used. Overall, there were no major concerns observed for the lines inspected by ROV, with the lower portions of the ropes and/or chains most often embedded in the seabed to varying extents. The one particular overall aspect of concern was the “crisscrossing” of lines from the two systems for the lines between the two systems, as well as a significant number of what appeared to be abandoned anchor lines. This condition made the ROV inspection very difficult at times and lead to a number of ROV fouls that had to be “unsnagged.”

The building and pen support floats were typically found to be in satisfactory condition with no appreciable deficiencies or deterioration. The south corners of the net pen system, 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. A buoy and proper bridle chains should be attached to Anchor Line 6A to help alleviate the downward pull of this anchorage. Additionally, proper bridle chains should be attached to Anchor Lines 12 and 13. In addition, the over-lapping anchor line condition at the intersection of Anchor Lines 12A and 13 should be rectified to ensure both anchor lines function as intended.

Mr. Nels Sultan

January 29, 2018

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Except for the frayed rope at Anchor Line 11 and the damaged buoy at Anchor Line 8, which should be replaced, and the more heavily deteriorated upper chain at Anchor Line 10, which at the minimum should be more closely monitored, the underwater inspection of the Port Angeles Secondary 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. 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.

Very truly yours,

COLLINS ENGINEERS, INC.



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

January 29, 2018



Photograph 1: Overall View of the Secondary Fish Net Pens System, Looking West.



Photograph 2: Overall View of the Secondary Fish Net Pens System, Looking East.



Photograph 3: Overall View of the Secondary Fish Net Pens System, Looking North.



Photograph 4: Overall View of the Secondary Fish Net Pens System, Looking South.



Photograph 5: View of the Typical Pen Support Float Below Water, Looking North.



Photograph 6: View of Pen Support Float to Upper Anchor Chain Connection at Anchor Line 2 (Typical), Looking Northwest.



Photograph 7: View of Upper Anchor Chain at Anchor Line 11 (Typical), Looking West.



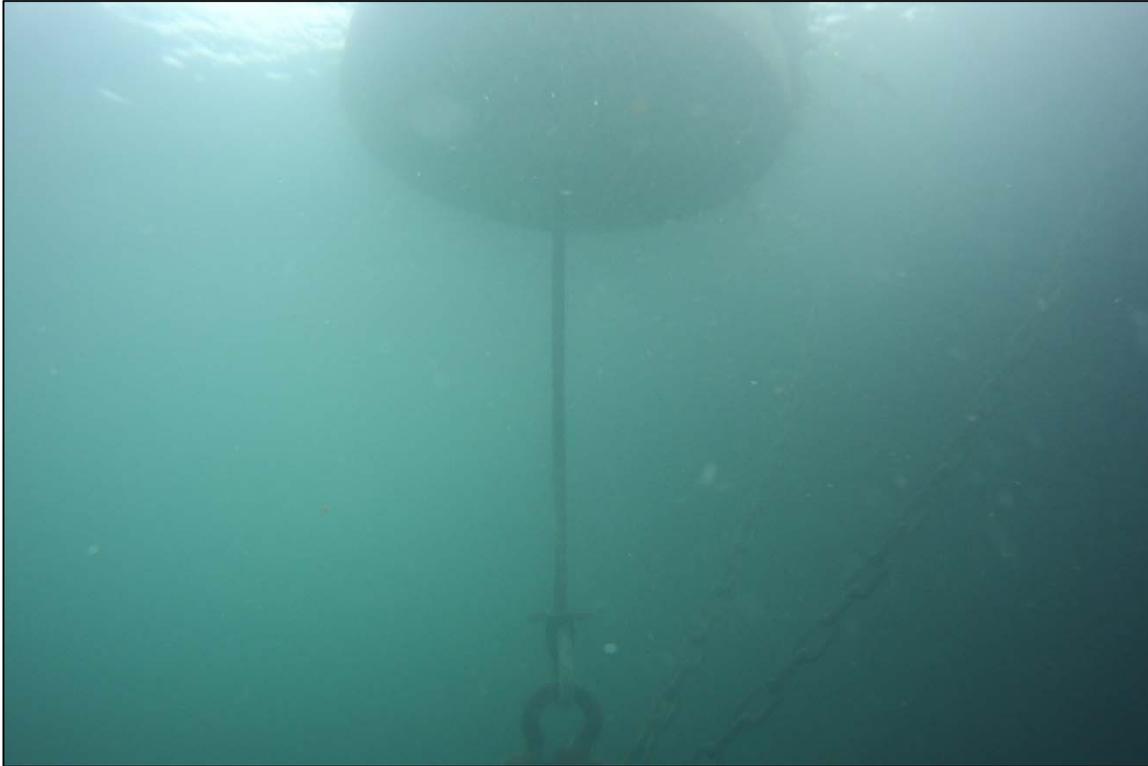
Photograph 8: View of Upper Anchor Chain at Anchor Line 4 with Missing Cotter Pin, Looking West.



Photograph 9: View of the Depressed Floats at the South End, the Southwest Corner Shown, Looking South.



Photograph 10: View of Upper Anchor Chain, Bridle Chain, and Buoy Connection at Anchor Line 14 (Typical), Looking West.



Photograph 11: View of Buoy Shaft at Anchor Line 8 Pulled Downward Approximately 4 ft, Looking West.



Photograph 12: View of Upper Anchor Chain at Anchor Line 11 (Typical), Looking West.



Photograph 13: View of Upper Anchor Chain to Bridle Chain at Anchor Line 4 (Typical), Looking West.



Photograph 14: View of Upper Anchor Chain at Anchor Line 4 (Typical), Looking South.



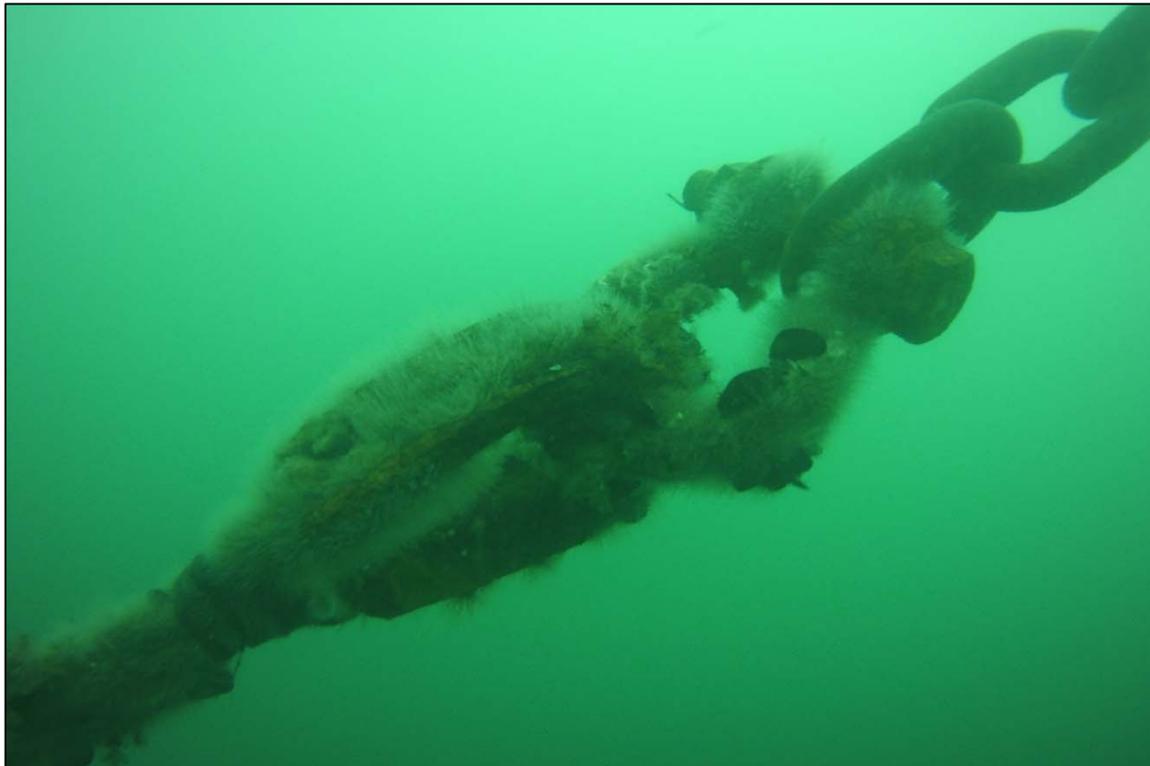
Photograph 15: View of Upper Anchor Chain at Anchor Line 10, Heavier than Normal Corrosion, Looking South.



Photograph 16: View of Upper Anchor Chain Below Water at Anchor 12 (Typical), Looking North.



Photograph 17: View of Upper Anchor Chain to Rope Connection (Thimble and Shackle) at Anchor Line 12 (Typical), Looking South.



Photograph 18: View of Upper Anchor Chain to Rope Connection (Thimble and Shackle) at Anchor Line 14 (Typical), Looking South.



Photograph 19: View of Rope with Light Marine Growth at Anchor 4 (Typical), Looking East.



Photograph 20: View of Rope with Heavy Marine Growth at Anchor 7 (Typical), Looking West.



Photograph 21: View of Anchor Line 12A Crossing Anchor Line 13, Looking West.



Photograph 22: View of Lower Anchor Chain Condition (Typical) at Secondary System Anchor Line 1, Looking East.



Photograph 23: View of Errant Chain running away from the Anchor at Secondary System Anchor Line 1, Looking East.



Photograph 24: View of Fishing Nets along Lower Anchor Chain at Secondary System Anchor Line 12, Looking North.



Photograph 25: View of Lower Anchor Chain Condition (Typical) at Secondary System Anchor Line 14, Looking North.



Photograph 26: View of Lower Chain Embedment in the Channel Bottom at Secondary System Anchor Line 14, Looking North.



Photograph 27: View of Concrete Block Anchors Condition (Typical) at Secondary System Anchor Line 14, Looking North.

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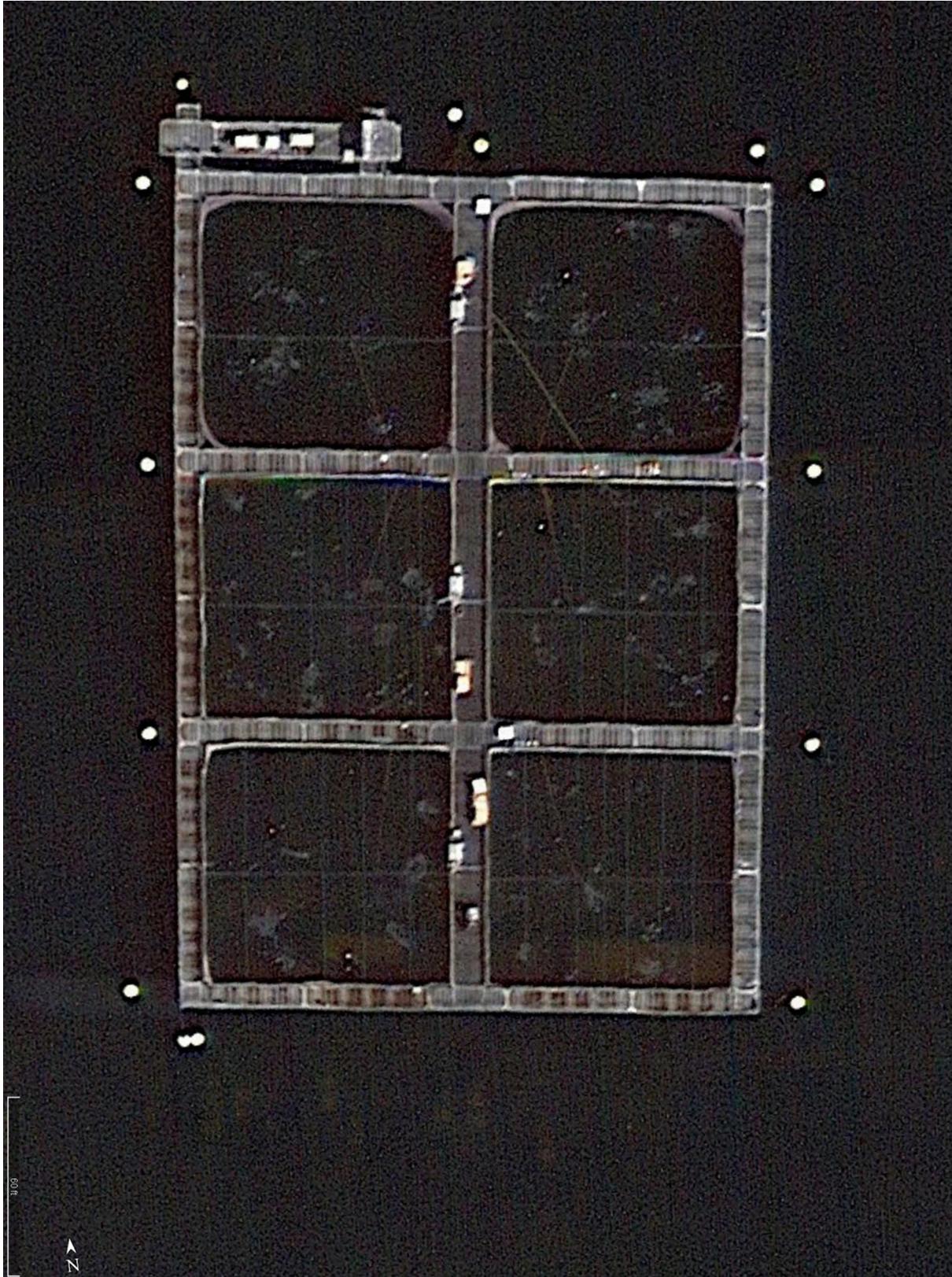


Figure C-1: Port Angeles Secondary Net Pens (Google Earth – Aerial Photo July 30, 2017)



Figure C-2: Port Angeles Secondary Net Pens – View from Northwest



Figure C-3: Anchors 1 and 14 (Northeast Corner)



Figure C-4: Anchor 1 Bridle Chain and Hinges



Figure C-5: Anchor 1 Right Bridle Chain Connection



Figure C-6: Anchor 1 Left Bridle Chain Connection



Figure C-7: Anchor 2



Figure C-8: Anchor 2 Right Bridle Chain Connection

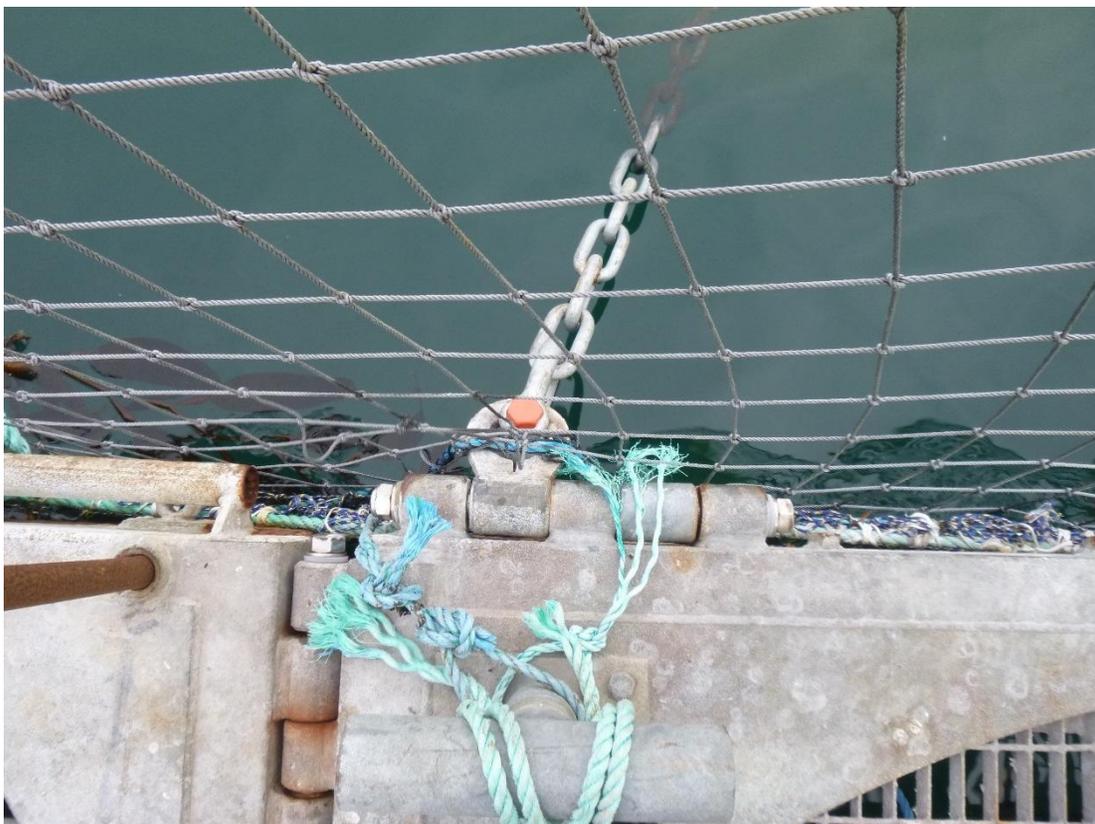


Figure C-9: Anchor 2 Left Bridle Chain Connection



Figure C-10: Anchor 3



Figure C-11: Anchor 3 Right Bridle Chain Connection



Figure C-12: Anchor 3 Left Bridle Chain Connection



Figure C-13: Anchors 4 & 5 showing moderate corrosion on grating



Figure C-14: Anchor 4



Figure C-15: Anchor 4 Right Bridle Chain Connection. Anchor 5 Left Bridle Chain Connection



Figure C-16: Anchor 4 Left Bridle Chain Hinge



Figure C-17: Anchor 4 Left Bridle Chain Padeye



Figure C-18: Anchor 5 Left Bridle Chain Connection

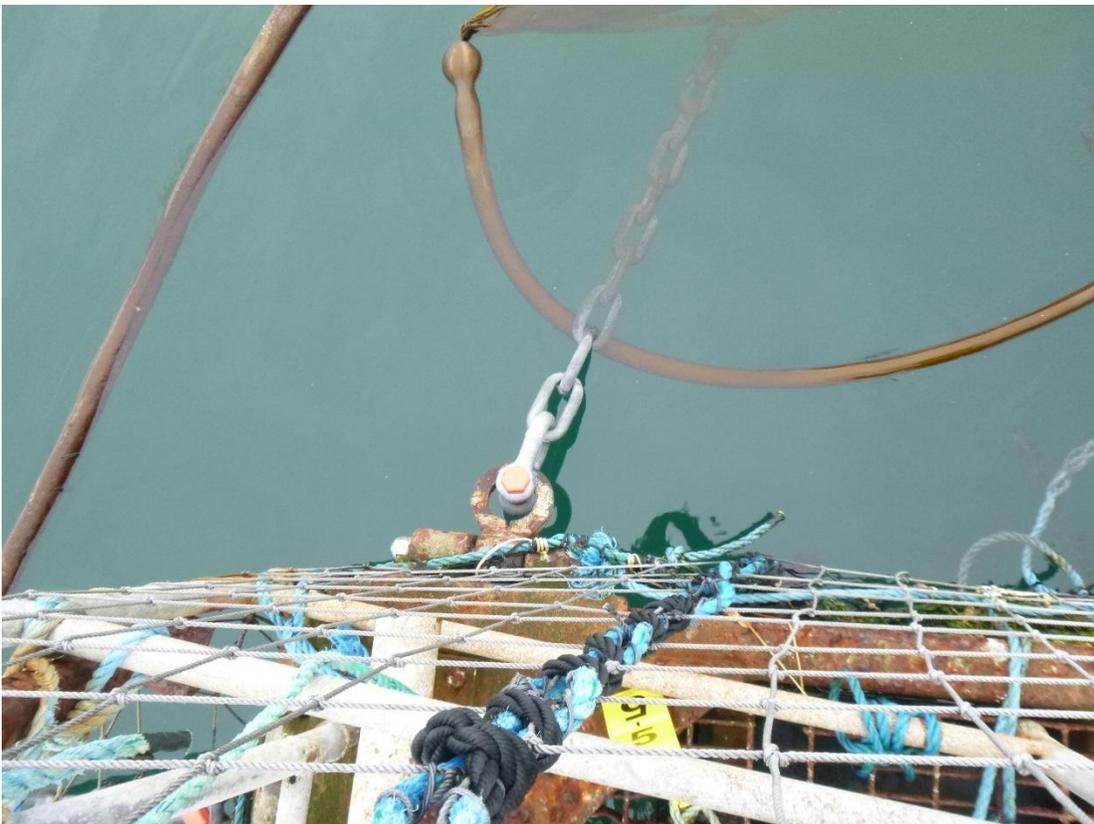


Figure C-19: Anchor 5 Left Bridle Chain Connection Padeye



Figure C-20: Anchor 5 Right Bridle Chain Connection



Figure C-21: Anchor 5 Right Bridle Chain Connection Damaged Padeye



Figure C-22: Low Freeboard at Anchors 4 & 5



Figure C-23: Anchors 6 & 7



Figure C-24: Anchor 6 Left Bridle Chain Connection and Unidentified Additional Anchor 6a



Figure C-25: Anchor 6 Left Bridle Chain Connection and Unidentified Additional Anchor 6a



Figure C-26: Anchor 6 Right Bridle Chain Connection



Figure C-27: Anchor 7 Left Bridle Chain Connection

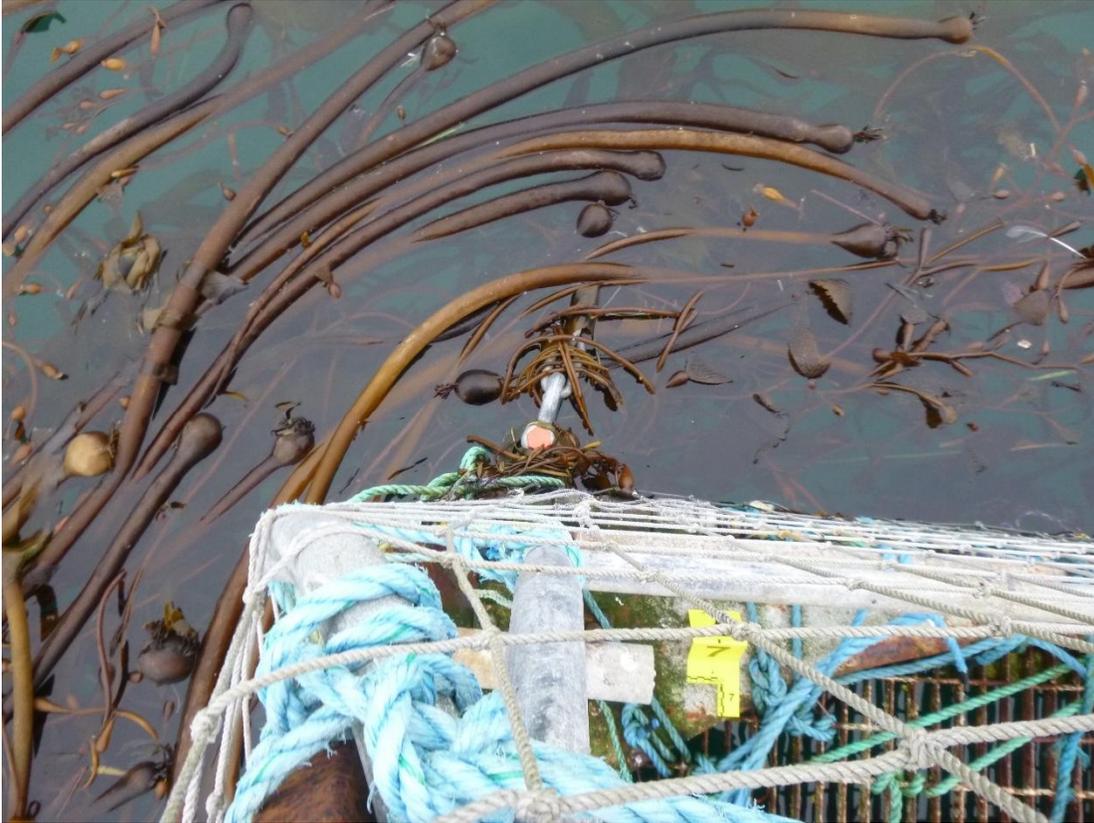


Figure C-28: Anchor 7 Left Bridle Chain Connection

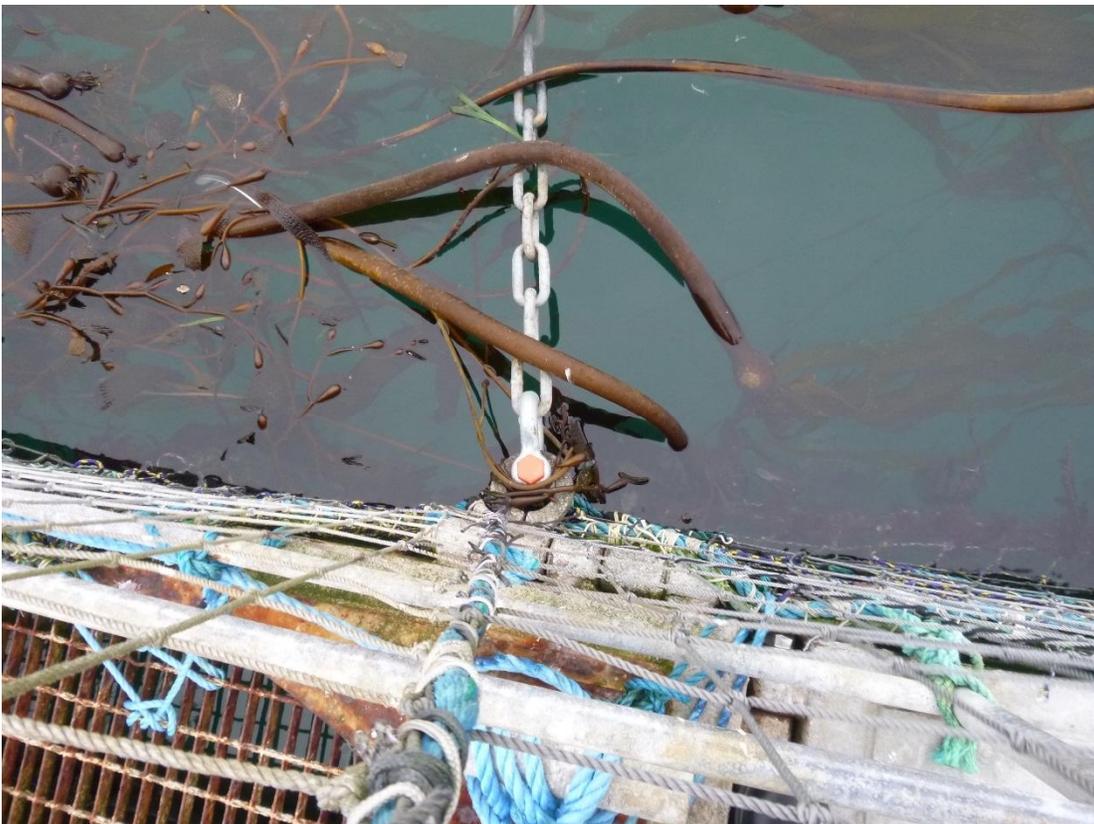


Figure C-29: Anchor 7 Right Bridle Chain Connection



Figure C-30: Low Freeboard at Anchors 6 & 7

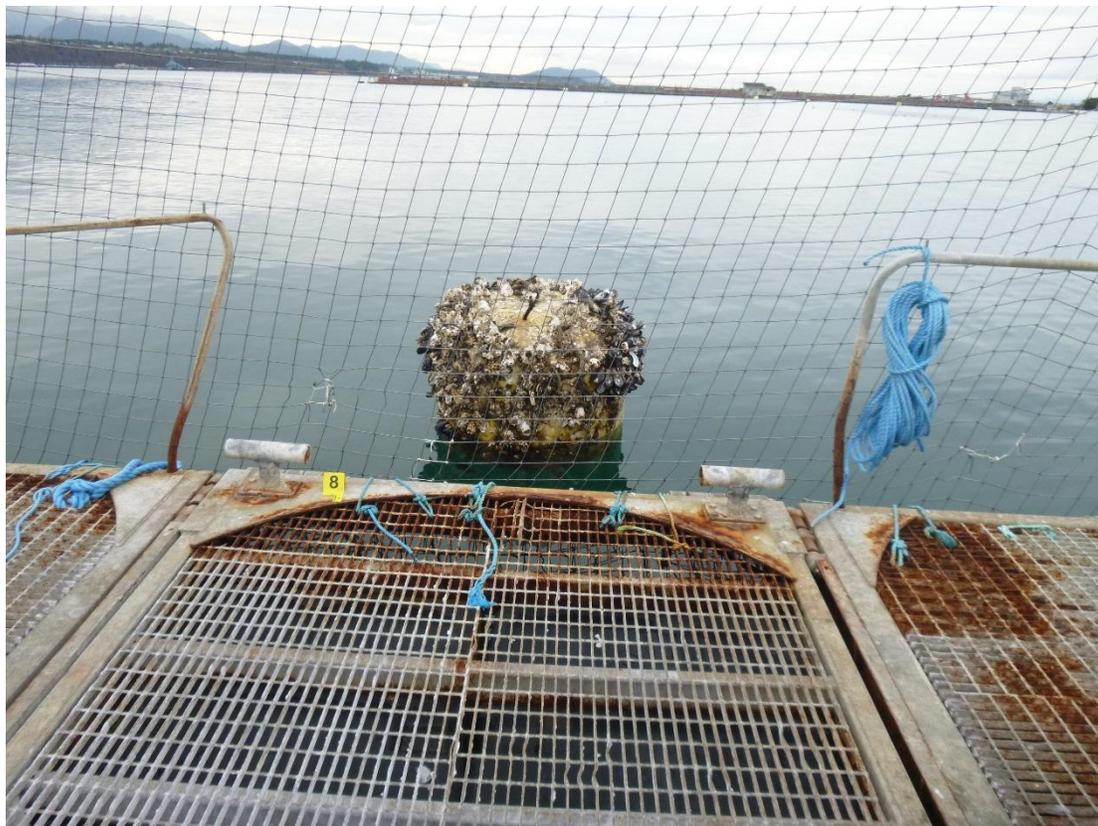


Figure C-31: Anchor 8, Moderate Corrosion on Grating



Figure C-32: Anchor 8 Left Bridle Connection



Figure C-33: Anchor 8 Right Bridle Connection



Figure C-34: Anchor 9



Figure C-35: Anchor 9 Right Bridle Connection



Figure C-36: Anchor 9 Left Bridle Connection



Figure C-37: Anchor 10



Figure C-38: Anchor 10 Left Bridle Connection

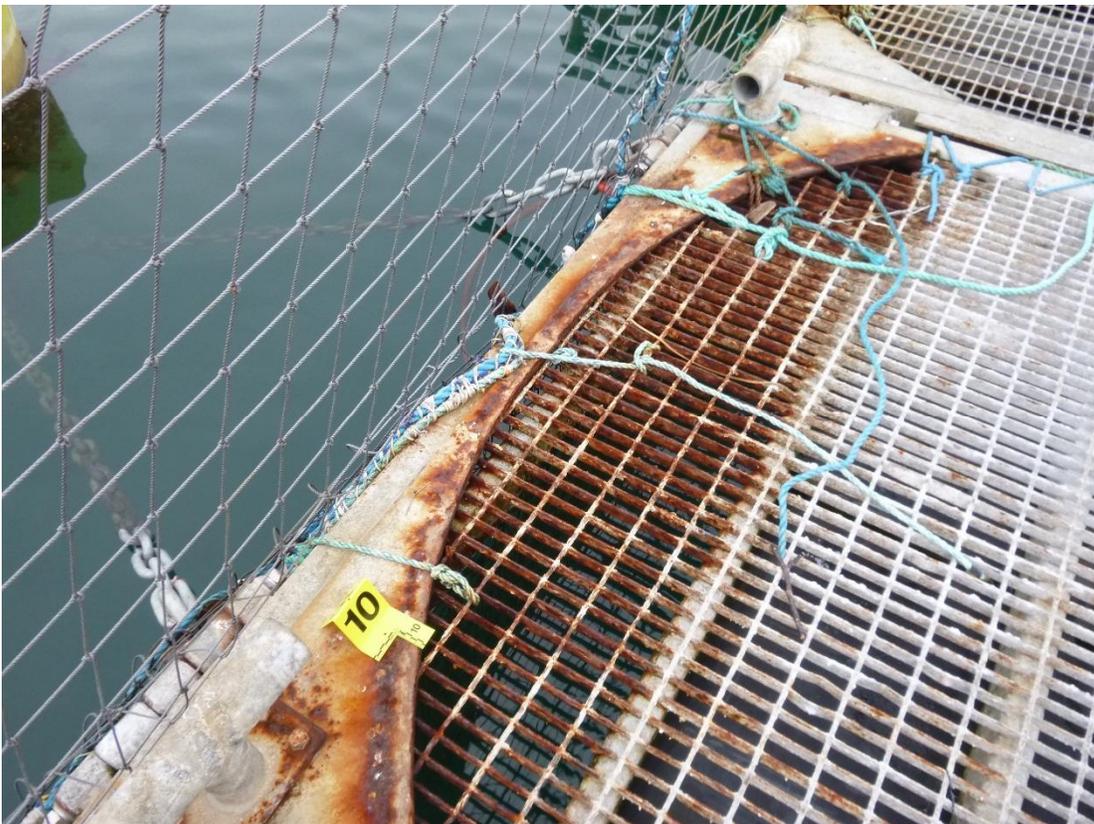


Figure C-39: Anchor 10 Bridle Connection, Typical Moderate Corrosion of Grating



Figure C-40: Anchor 11



Figure C-41: Anchor 11 Right Bridle Connection, Typical Corrosion on Padeye



Figure C-42: Anchor 11 Left Bridle Connection, Typical Corrosion on Padeye



Figure C-43: Anchor 11a – Not on Plans

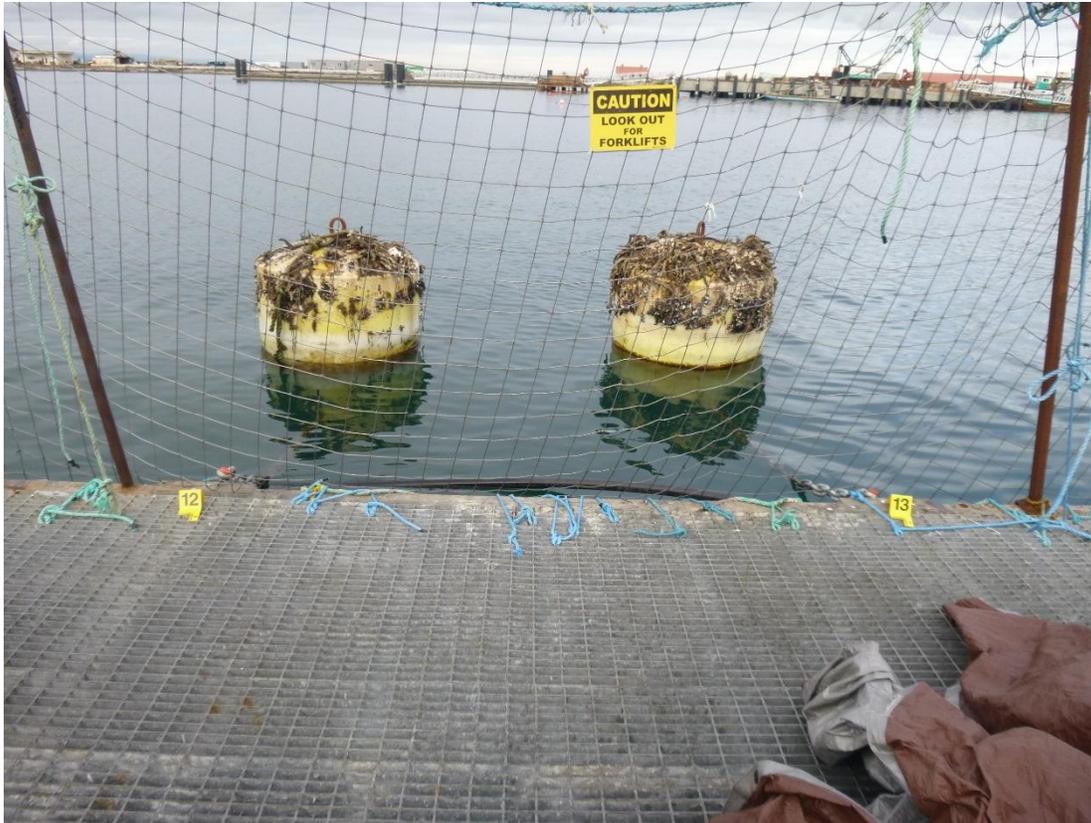


Figure C-44: Anchors 12 & 13 Single Chain Connections

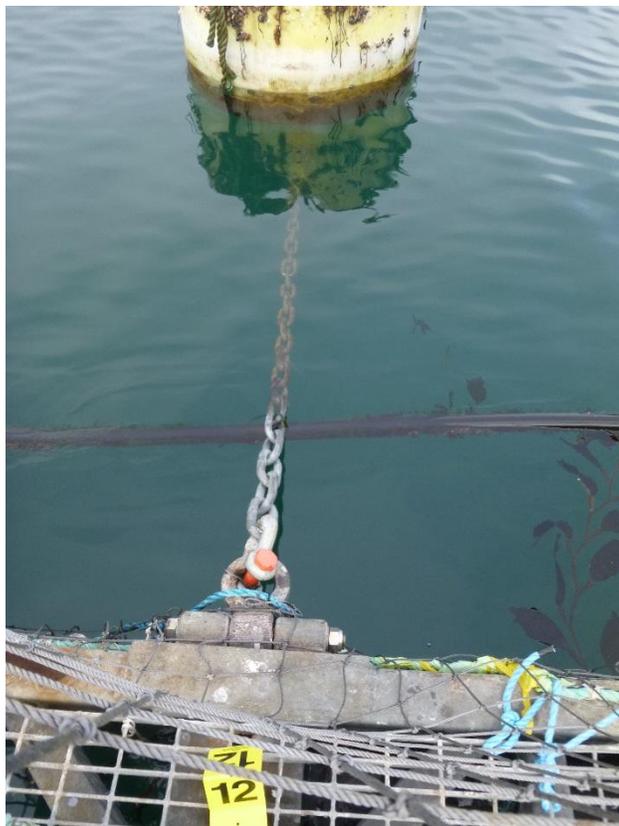


Figure C-45: Anchor 12, Single Chain

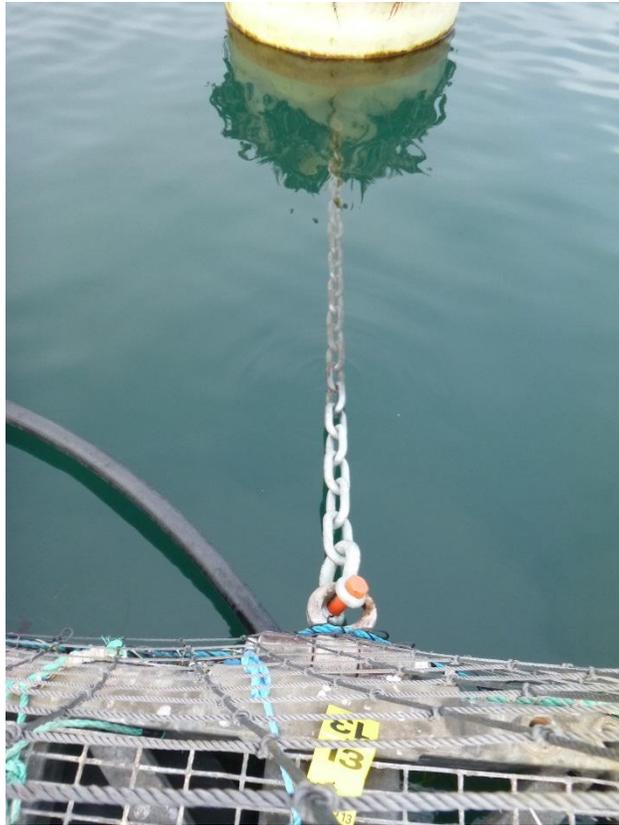


Figure C-46: Anchor 13, Single Chain



Figure C-47: Anchor 14



Figure C-48: Anchor 14 Left Bridle Connection

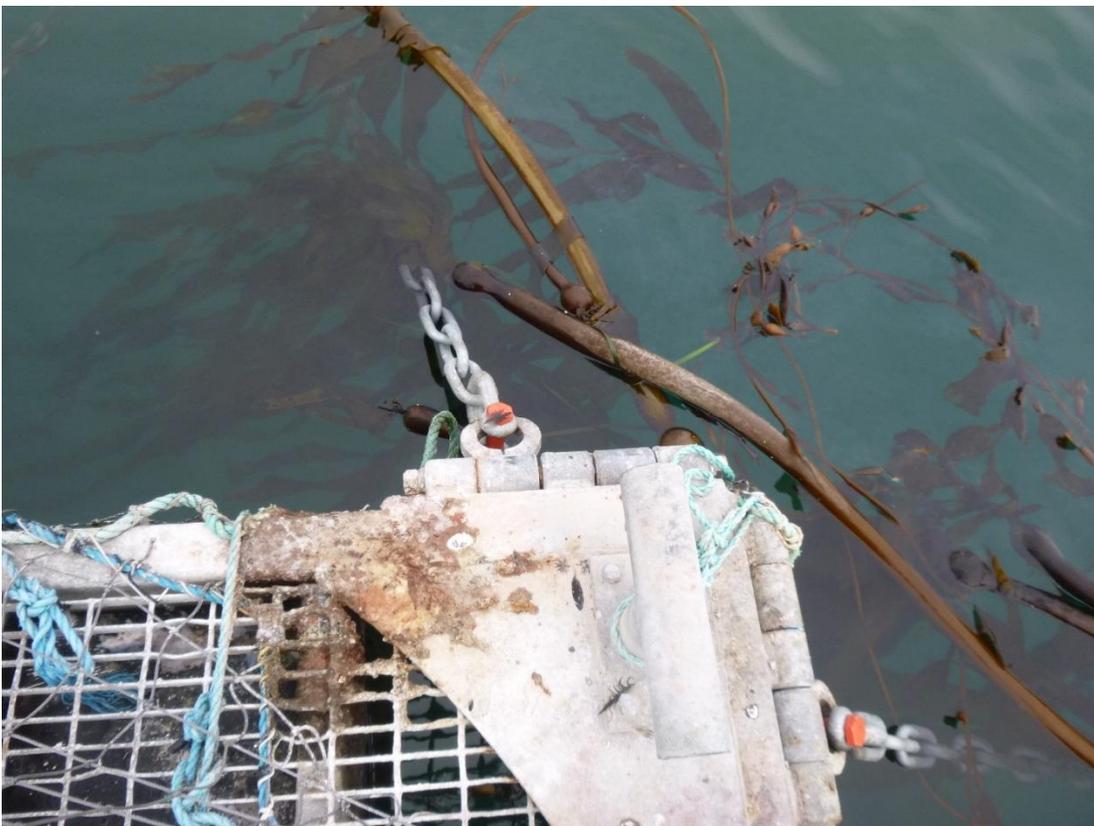


Figure C-49: Anchor 14 Right Bridle Connection



Figure C-50: Secondary Pen Boarding Float



Figure C-51: Secondary Pen Generator Shed

