MOTT MACDONALD

Hope Island
Atlantic Salmon Net Pens
Engineering Assessment

January 29, 2018

State of Washington Department of Natural Resources

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Issue and revision record

Revision	Date	Originator	Checker	Approver	Description
1b	1/29/2018	JL	AM	NS	Issued for use
1a	12/13/2017	JL	AM	NS	Draft

Document reference: 391980 | 1 | b

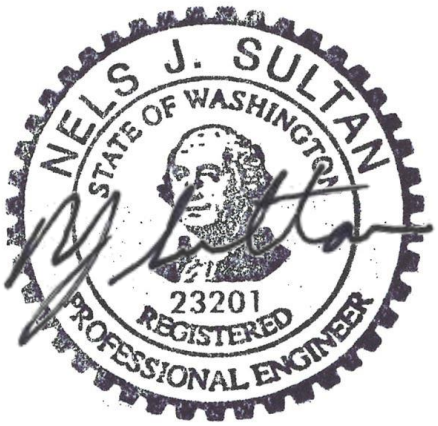
Information class: Standard

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.

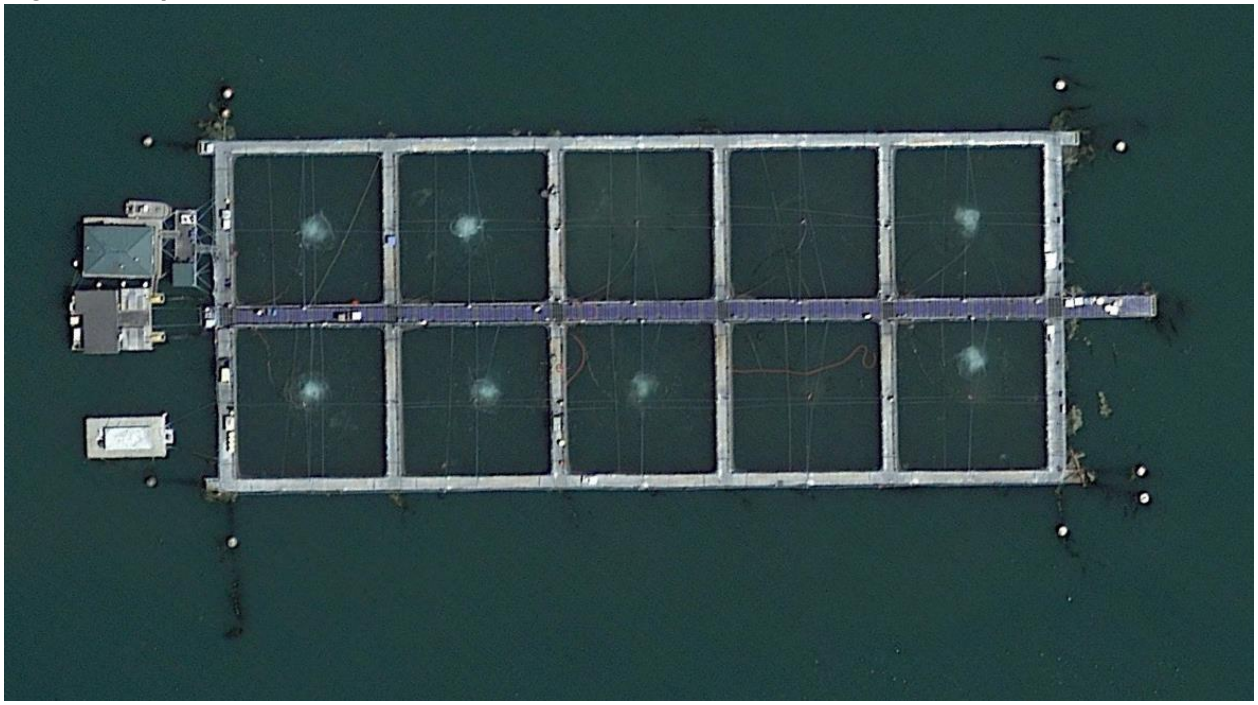


Date: January 29, 2018

1 Introduction

This report presents the results of a document review, inspection, and engineering assessment of the Atlantic salmon net pen facility near Hope Island, owned by Cooke Aquaculture Pacific, LLC (Cooke). The facility is in Kiket Bay, northeast of Hope Island and West of the Swinomish Reservation. **Figure 1** is an aerial photo of the facility. 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. (Collins) as a sub-consultant to Mott MacDonald.

Figure 1: Hope Island Net Pens – Aerial Photo 7/24/2017



Source: GoogleEarth

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 these facilities and the planned reports by Mott MacDonald 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 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. 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 were areas of 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 and site visit includes review of the following general elements:

- DNR lease requirements.
- Best Aquaculture Practices (BAP).
- Permit applicant 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 lines, and pumps.

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.

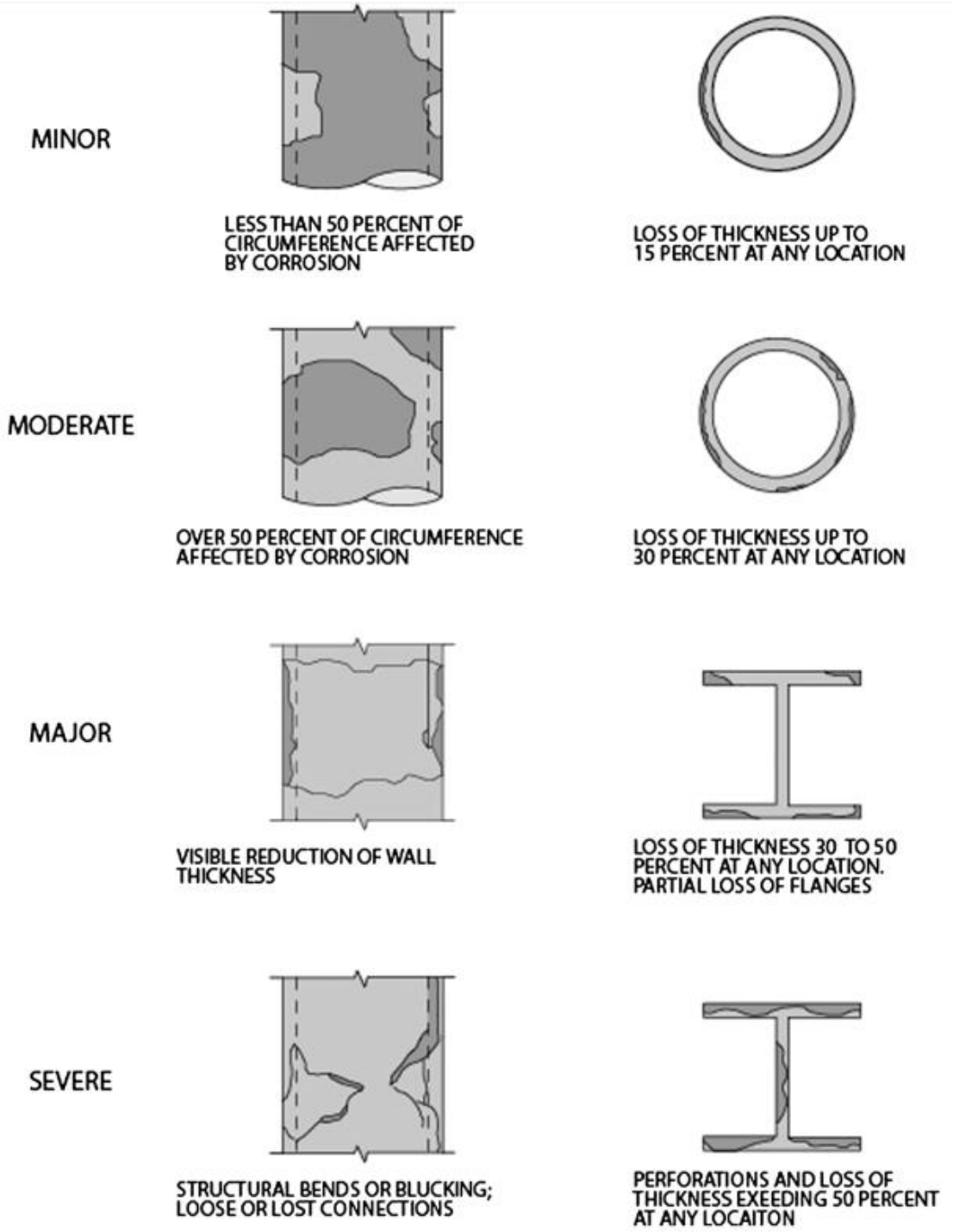
Table 1: Condition Assessment Rating

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 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, concrete and other materials.

Figure 2: Damage Rating for Steel Elements



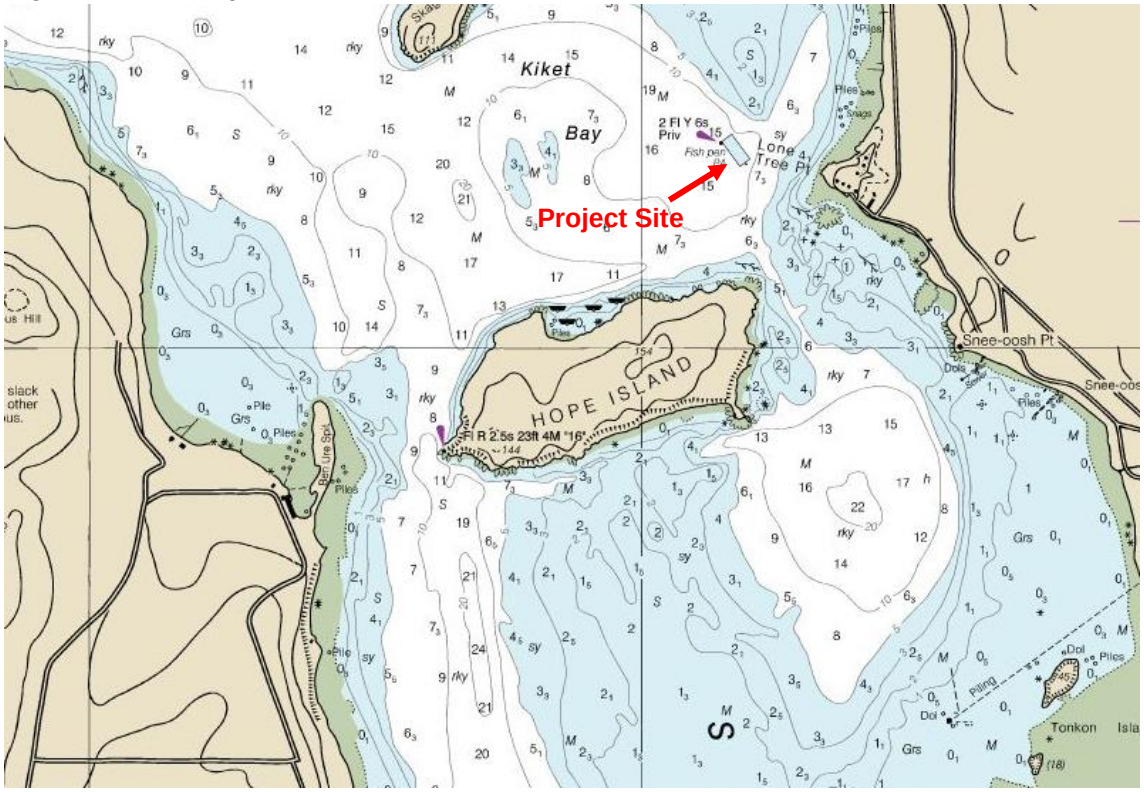
Source: ASCE Standard of Practice No. 130 "Waterfront Facilities Inspection and Assessment"

2 Document Review

The Hope Island net pen facility is located northeast of Hope Island, west of the Swinomish Reservation, and east of Deception Pass. **Figure 3** is an area map. **Figure 4** shows the bathymetry in a heat map format. The depth is approximately 60 feet to 100 feet (MLLW) along the length of the Hope Island net pens. Drawings in Appendix A show a general plan and photos of the existing facilities. Additional site photos are in Appendix C.

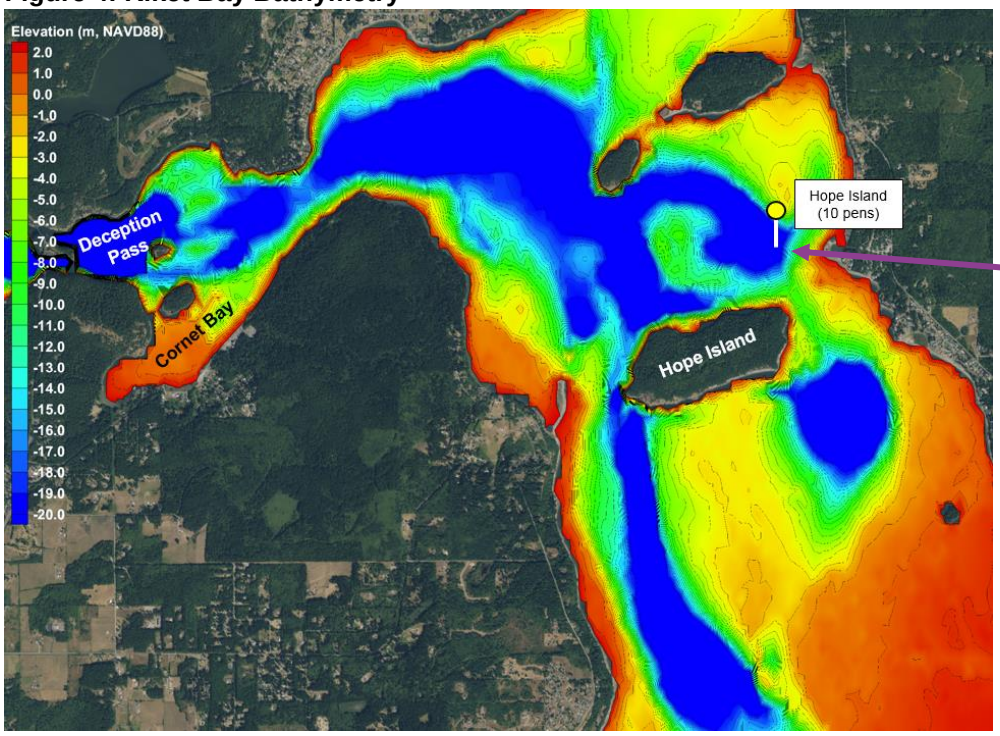
The exact date of installation is not known, but it is assumed the net pens were replaced with the current system between 9/10/2009 and 8/25/2011 based on a review of aerial photography in GoogleEarth.

Figure 3: Area Map



Source: NOAA Chart 18427

Figure 4: Kiket Bay Bathymetry



Source: NOAA Digital Elevation Model (DEM) of Puget Sound Bathymetry

2.1 Document Review

Documents reviewed by Mott MacDonald and relevant to the Hope Island net pens 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. The net pens on site are generally consistent with this document, although the mooring plan described in the document is different from the mooring plan at Hope Island.
3	Wavemaster Steel Cage Specs, 3 pages	Brochure-style with graphics. it contains general information from the manufacturer.
Hope Island Specific Documents received from Cooke		

No.	Description	Comments
5	Hope Island lease agreement (No. 20-B12356), signed September and October 2007, 21 pages plus exhibits	Exhibit A is a map and Exhibit B is a description of the of the facility, including operations, the mooring system, and other details. It notes the facility was “initially permitted and installed around 1986”, with several improvements and “the last replacement was carried out in 2001.” The current net pen structure was replaced between 9/10/2009 and 8/25/2011 based on aerial photos in GoggleEarth. The dimensions of the facility are now different from what is described in the lease agreement. According the lease agreement “The new cage has an average expected service life of approximately 15 years.”
6	Hope Island Site Spill Kit Locations, 1 page	Includes a site map.
7	NPDES Permit – Hope Island, 30 pages	Issued 2007 and expires 2012. Not relevant to this report.
8	Hope Island Mooring Diagram, Excel spreadsheet	Mooring diagram of existing conditions, includes piles, anchors, chains, roads, and information on inspection and replacement
10	Surface Inspection Sheets	Inspection sheets including repair logs and inspections for mooring points, shackles, thimbles, hardware, mooring lines, chain connections, hinge points, grating conditions.
11	2016 Debris Log for Net Washing	Net Washing and Service Records by Badinotti for all 10 net pens in 2016.
Standards, Guidelines, Studies, Plans		
12	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.
13	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).
14	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 the Puget Sound. The guidelines are for interim use until a programmatic EIS can be completed and focus on environmental protection.

No.	Description	Comments
		Guidelines include water quality, site selection, and environmental surveys.
Miscellaneous		
15	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 Hope Island net pens have been replaced "using Marine Construction and Wavemaster manufactured cage systems."

Source: Mott MacDonald

3 Metocean Review

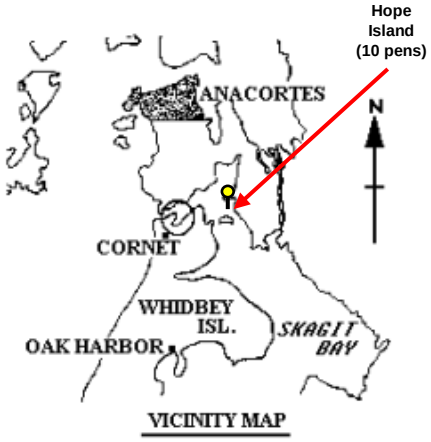
Environmental conditions at Hope Island, WA were reviewed as part of this engineering assessment. The net pen was located approximately 1,000 feet offshore, in approximately 80 feet of water depth. The environmental conditions were described by the lessee in the lease agreement document. To evaluate the environmental conditions Mott MacDonald conducted an independent assessment, which includes utilizing information in the vicinity of Hope Island from an internal Mott MacDonald project database. Environmental conditions reviewed include water levels, currents, winds, waves, and vessel traffic.

3.1 Water Levels

Tides at the Hope Island Net Pen site were described by American Gold Seafoods (AGS) in the DNR lease document (20-B12356) as follows; *"The extreme tidal range for the project is approximately 13.5 feet."*

Water levels at nearby tide gage stations were reviewed, including NOAA water level stations and United States Army Corps of Engineers (USACE) sources. Review of historical tidal datums at Cornet Bay indicate a diurnal tide range of 10.2 feet and an estimated extreme tidal range[1] of 17.5 feet to 19.5 feet. The relative location of Cornet Bay and Hope Island Net Pens, and the tidal datums at Cornet bay are shown in **Figure 5**.

Figure 5: Historical tidal datums for Cornet Bay



Relation Between Various Datum Planes			
Datum Plane	MLLW	NGVD 29	NAVD 88
Highest Estimated Tide	14.00 +/- 0.5		
Mean Higher High Water	10.20	4.76	8.54
Mean High Water	9.30	3.86	7.64
Mean (Half) Tide Level	6.00	0.56	4.34
NGVD	5.44	0.00	3.78
Mean Low Water	2.70	-2.74	1.04
Mean Lower Low Water	0.00	-5.44	-1.66
Lowest Estimated Tide	-4.50 +/- 0.5		

Source: USACE

The extreme tide range reported by the lessee may be low, depending on the definition of extreme tidal range implied by the lessee (e.g. annual extreme or 100-year extreme).

3.2 Currents

Current velocities at the Hope Island Net Pen site were described by AGS in the DNR lease document agreement as:

[1] Calculated as difference between Highest Estimated Tide and Lowest Estimated Tide

- *Maximum current velocity for the site is 0.95 cm/s (J. Rensel, Current Velocity Study, 1996)*
- *Average current velocity for the site is 0.55 cm/s (J. Rensel, Current Velocity Study, 1996)*

The Current Velocity Study by J. Rensel (1996) was not provided to Mott MacDonald for review. However, the reported maximum current velocity of less than 0.95 centimeter per second (0.02 knots) was not consistent with site observations by Mott MacDonald of 1.5 knot currents. Based on prior project experience in Puget Sound, it was likely that the units were reported in error, and that currents at the site in this study were intended to be in meters per second. Therefore, for this review it was assumed currents provided by AGS are:

- Maximum current velocity for the site is 0.95 m/s (1.85 knots)
- Average current velocity for the site is 0.55 m/s (1.07 knots)

Reported currents were reviewed relative to publicly available information, site observations by Mott MacDonald, and our regional experience and judgment. The report *Development of a Hydrodynamic Model of Puget Sound and Northwest Straits* (PNNL, 2007) indicates surface current velocities near the net pen facility of approximately 0.5 meters per second for both flood and ebb tide conditions (associated tide range not specified). Observed surface currents during the site visit (November 27, 2017, approximately 10:15 AM) were estimated to be approximately 0.5 – 0.75 m/s (1 - 1.5 knots). Based on review of tidal elevations and phase during the site visit, it was likely the observed currents during the site visit were representative of typical conditions.

Wind-generated surface currents were estimated using an industry standard wind drag coefficient approximation (Weber, 1983). The estimated surface current velocity due to a 50-year storm wind speed was approximately 1.0 m/s (1.9 knots).

Measured current data was available online from NOAA station “Skagit Bay channel, SW of Hope Island (PUG1628)” for the period April 27 to June 9, 2016. The station was approximately 5,500 feet west of the net pens. Maximum near surface current speed during this interval was approximately 2.7 knots measured approximately 6 feet below the surface.

This measured current speed exceed 1.85 knots. Mott MacDonald concludes that the reported maximum current velocity for the site of 1.85 knots was too low, and that larger current speeds should be considered for design of the net pen system.

3.3 Winds

Winds at the Hope Island Net Pen site were described in the DNR lease agreement as follows:

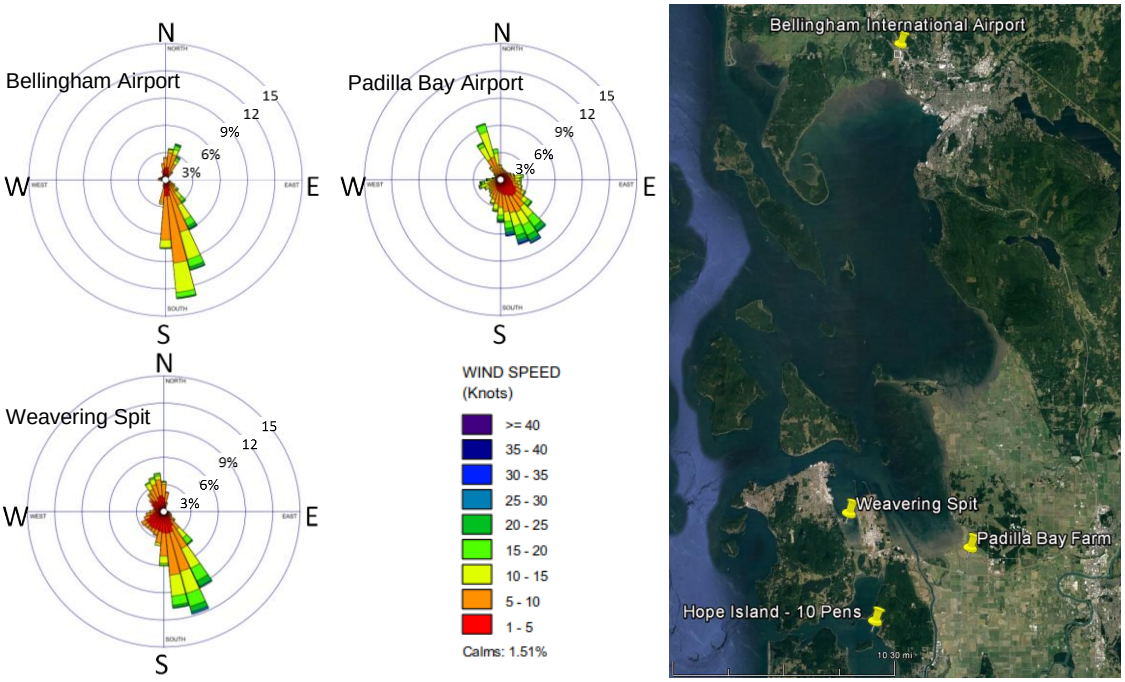
- Storm winds can exceed 60 knots.
- Typical storm winds are in the range of 20-30 knots (personal observation of farm staff).
- South winds have the highest potential for large waves at the net pen site.

A review of nearby wind conditions from previous project experience in Puget Sound was conducted. The review includes three wind stations located within 30 miles of the Hope Island facility (Weavering Spit, Padilla Bay Airport, and Bellingham Airport), as shown in the right panel of **Figure 6**. The corresponding wind roses for each of the three locations is shown in the left panel of **Figure 6**. Wind roses from the three locations indicate that the prevailing wind direction, including storms, was from the South.

Extremal value analysis to estimate extreme wind speeds in the project area was conducted. In lieu of long-term data at the facility, 13 years of observed wind data (from internal Mott MacDonald database) at Padilla Bay Farm was used for the analysis. The 50-year return period

sustained windspeed at Padilla Bay Farm was estimated by Mott MacDonald as approximately 58 knots (primarily from the south), and the 2-year wind storm was estimated to be 13 – 38 knots, varying with direction. These windspeeds are a 2-minute average and lower than the gust windspeed.

Figure 6: Wind Roses 2007-2010



Source NOAA:

Mott MacDonald takes no exception to the wind conditions described in the lease agreement.

3.4 Waves

Waves at the Hope Island Net Pen site were described in the lease agreement as follows:

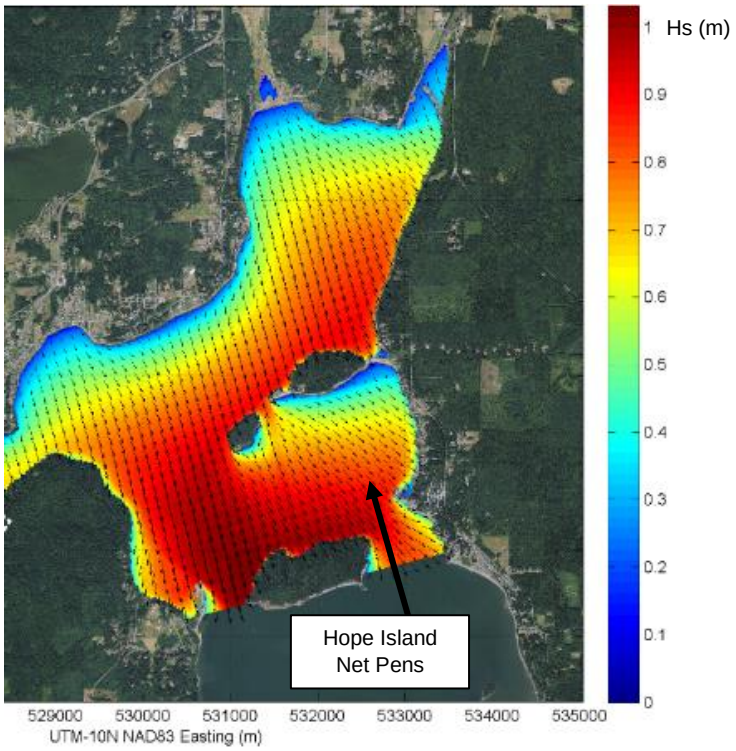
- Maximum wave height typically less than 4 feet, occasionally exceeded.
- Greatest exposure to wind-generated waves is from the south direction.
- South winds generate larger wind waves.

Wave generation potential (fetch distance), and wave model results from the Mott MacDonald database of Puget Sound wave conditions were reviewed. Based on the wind data and fetch distance it was anticipated that the largest storm waves at the site would be from the south. However, wind waves could develop from any direction. The site was protected from ocean swell waves.

Potential storm waves at the project site were developed based on available information. Based on previous Mott MacDonald numerical wave models in the area (**Figure 7**) it is concluded that the significant wave height generated from 50-year north winds can reach up to approximately 3.0 feet with a peak period of approximately 2.5 seconds. Modeled wave conditions for wind-waves generated from south winds were not available from past projects, therefore a conceptual-level empirical fetch analysis using methods developed by USACE (2013) was performed. A wind speed of 60 knots (as described in the lease agreement) was selected to

generate waves. Results of the conceptual-level fetch analysis estimate that for a 50-year storm out of the south, a significant wave height of approximately Hs = 4.5 feet and a peak period of approximately Tp= 3 seconds would occur at the net pen during the peak of the storm.

Figure 7: Waves Heights for 50-year Return Period North Wind



Source: Mott MacDonald

Mott MacDonald takes no exception to the wave conditions described in the lease agreement.

3.5 Vessel Traffic and Marine Navigation

Vessel traffic and marine navigation at the Hope Island Net Pen site were described in the lease agreement as follows:

- A mix of recreation and/or commercial navigation use around Hope Island and within Skagit Bay
- No recreation or commercial navigation in the immediate area of the net pen
- The location of the net pen allows for safe navigation around the net pen for most marine vessels
- There are no commercial shipping lanes near the pens

A review of historical marine vessel Automatic Identification System (AIS) data in the waters surrounding the Hope Island Net Pen (Skagit Bay, Similk bay, and Deception Pass) was conducted using the publicly available online data. Vessel traffic was found to be consistent with the description provided by AGS.

Mott MacDonald takes no exception to the vessel traffic and marine navigation described in the lease agreement.

4 Net Pen Structure

According to the lease agreement signed 2007, a net pen was initially permitted and installed around 1986, and the last replacement was in 2001. However, the net pens were replaced after 2001 and the facility dimensions are now different from what was described in the lease agreement Exhibits. The mooring system description in the lease agreement was generally consistent with the mooring system observed on site.

The current net pen structure at the Hope Island facility appears to have been designed and manufactured by Wavemaster®, part of the Akva Group of aquaculture technology and services. The net pens on site are similar to the photographs and figures shown in the Wavemaster brochure provided by Cooke, and in figures on the Akva Group web site (Akva, 2017). The Fin Fish Aquaculture Plan of Operation (Icicle, 2014) states that the net pens at Hope Island were manufactured by Marine Construction and Wavemaster.

The facility currently consists of 10 modular net pens, with galvanized steel walkways connected via hinges and supported by plastic, foam-filled flotation tubs. Each net pen was approximately 85 feet (26 m) square. The overall dimensions not including the permanent barges and float extensions was approximately 440 feet x 181 feet. The walkways are arranged in a grid with a fish pen contained within each section of the grid. The facility was moored in place by a system of chains and anchors, attached to the net pen frame at the ends of the walkways.

Below is a summary of the components that comprise the net pen structure, and were inspected during our site investigations. The basis of the information includes the documents provided for review and our observations while visiting the facility. Drawings of the net pen structure are in Appendix A and photographs are in Appendix C. The underwater inspection report is in Appendix B.

4.1 Anchors

A mooring system schematic plan was provided by Cooke and is included on Sheet 2 of Appendix A. There were 25 mooring lines identified on the Cooke Mooring plan, which are connected to anchors on the seafloor. There was one additional anchor at Line No. 18 that is used for temporary mooring of work barges. Also, there were mooring lines with anchors not shown on the Cooke mooring plan at the west barge, which is used for additional feed storage.

The mooring system schematic plan provided by Cooke does not identify the anchor or line types on lines 20, 21 or 25. However, based on divers' observations, two concrete gravity anchors are located along mooring line 20 – a circular concrete anchor at the end of the anchor line assembly and a secondary concrete anchor attached to a rope running from the anchor to the center of the middle chain section (see Appendix B). On all other lines, the reported anchor types are Danforth and Navy drag anchors that vary in size. Most anchors were observed by the divers to be buried under the seabed, as expected, except for the anchors at lines 11 and 20. The buried anchors were not observed during the underwater inspection.

4.2 Mooring Line & Hardware

The mooring lines are comprised of a combination of steel stud link or shot chain, rode line, shackles, and other mooring hardware. The chains vary in size and length, ranging from 1- to 2-inches in diameter. The mooring lines are connected to the steel framing at the surface, and to

the anchor by a chain and shackle connection. In between the lengths of chain was a synthetic mooring line that varies in length and was typically longer in deeper water.

Mooring lines at the corners of the facility (Lines 1, 7, 8, 11, 12, 18, 19, 24 in Appendix A, Sheets 2 and 3) include a floatation buoy that support the weight of the mooring line and chain. The other lines do not include floatation buoys. The corners of the net pen had low freeboard, apparently due to the weight of the chain and anchor line loads, as discussed elsewhere in this report.

4.3 Mooring Line to Framing Connection

The mooring lines are connected by steel shackles to steel plate mooring brackets. The mooring brackets are also known as “tabs” or “padeyes”. At Hope Island the brackets were not hinged. A typical bracket is shown in **Figure 8**. Most anchor mooring lines had a single point of attachment, rather than a “bridle” or “hen’s foot” arrangement where the mooring line is divided near the net pen into two lines that attach to two different points on the net pen structure. The synthetic line in the photo below appeared to be used to moor a buoy and was not part of the mooring line system connected to the anchor.

Figure 8: Mooring Bracket at Hope Island Net Pens

Source: Mott MacDonald

4.4 Predator Exclusion Net

A predator exclusion net system surrounds the exterior of the facility, connected to a steel pipe railing that runs along outboard perimeter of the walkway framing. This predator exclusion net was weighted by steel pipes at the bottom, was typically vertical in the water, and closed at the bottom. Above the waterline, the net extends vertically approximately 4 feet above the walkway to prevent seals and sea lions from accessing the floats and also discourage trespassing.

Vertical extensions are connected to steel poles that are slotted into the walkways at regular intervals.

4.5 Fish Pen Net

The fish stock containment nets connect to a steel pipe railing that runs along the inboard perimeter of the walkway framing, are additionally tied to the tops of the handrails to keep fish contained when jumping. According to Cooke, each fish stock containment net extends approximately 40-feet into the water.

4.6 Aviary Net

Aviary nets are stretched across the top of each fish pen and secured to the tops of the handrails to prevent birds from landing inside the pen and consuming the fish or feed.

4.7 Walkway Frame

The fabricated galvanized steel structure provides support for the walkways, main bridge, mooring lines, predator exclusion nets, and fish pen nets. Walkways are modular units connected by a series of bushing type hinges with stainless steel pins. At walkway intersections, the framing was rigidly connected with horizontal steel bolts, reviewed documents indicate connections were tightened with a torque wrench. Underneath the walkways, the framing was supported by plastic, foam-filled flotation tubs similar to a typical marina dock system. The center walkway was wider with additional framing and flotation. The center walkway supports the fish feeding equipment and provides a route for a small forklift. Forklifts operate only on the center walkway.

4.8 Float Tubs

The steel walkways are supported by plastic, foam-filled tubs approximately 2.5 feet x 4 x 6.5 feet, and bolted to the underside of the walkway framing. The float tubs result in a freeboard approximately 1.75 feet above the water surface.

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, standards and information apply to the net pen system inspection and maintenance activities.

- Aquatic Lease #20-B12356 (signed October 19, 2007). Minor maintenance to the cage structures, anchor lines and netting occurs throughout the year and on a continual basis. Major maintenance of cage structures was typically replacement. Average service life expectancy was approximately 15 years. Metal fatigue can be a factor based on constant wave action and corrosive environment. Inspection of submerged mooring systems are to be made by divers and surface connections checked daily.
- Cooke Aquaculture Fish Escape Prevention Plan (January 2017). Document outlines requirements for moorage system damage inspections. It also outlines requirements for frequency of inspection and post-storm inspection requirements.
- 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 24 to November 6, 2017. They include a table with the date of last mooring line inspection and their condition, the mooring plan, and a table with condition of the following:
  - System Mooring Points (Pad eyes, Mooring Plates)
  - Surface Shackles, Thimbles, Hardware
  - Mooring Lines
  - Surface Chain Connections
  - Walkway Hinge Points
  - Walkway Grating Condition
- Net Washing and Service Records by Badinotti for all 10 net pens in 2016. The forms detailed net cleaning and repairs by an independent company. Routine visual inspections are reported done by Cooke staff on a weekly basis.
- Dive Inspections. Documentation of independent dive inspection work was no found in the records provided. The data of dive inspections by Cooke and the assessment are included in the weekly inspection spreadsheet document.
- A 2016 debris log was reviewed. It contains the ID numbers for 10 nets and the weight before and after washing for each net. The weight of the debris removed from each net varied from 167% to 354% of the weight of the clean net.

5.3 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 stocking with repairs and component replacement conducted prior to restocking.
- Inspection of other key float frame and net support systems such as the structural frame and fish net support pipe system do not appear to be occurring. Consideration for inspection of these elements should be made in the future as they are integral elements of the overall net pen structural support system.
- 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 between 8:30 am and 4:00 pm on November 27, 2017. Collins Engineers performed a week-long dive inspection, from November 27 to December 1, 2017. An ROV inspection of some anchor lines in depths deeper than 100 feet was done on December 10, 2017. The personnel present included Nels Sultan and James LaFave with Mott MacDonald, Cooke Aquaculture employees, and Washington State staff. James LaFave was additionally on-site December 1 to wrap up the above water site investigation and observe the ROV inspection. **Figure 9** shows the net pens. Additional photographs are included in Appendices A and C. The dive inspection report by Collins is in Appendix B.

Figure 9: Hope Island Net Pens – View from South

Source: Collins Engineers, Inc.

During the site visit observations were made and photos were taken. On November 27 at noon the weather was cool, 50°F, overcast sky, with winds light and variable, the sea calm. There was a constant current flowing from the south observed to be approximately 0.75 knots near the net pen structure and an estimated 1.5 knots further out from the net pen at 11:35 am on November 27, 2017. This current caused no observable motion to the net pen. The predicted tide elevations are below in **Table 3**. Mean Higher High Water (MHHW) is elevation +11.05 feet, MLLW. Mean Lower Low Water is +0.00, MLLW. The mean tide range was 7.63 feet. The predicted currents are in **Table 4**. The maximum predicted surface current speed during the site visit was approximately 1.9 knots during the peak flood.

Table 3: Predicted Tide: Daily Highs and Lows – Snee-oosh Point, WA

Tide	Time (Pacific Daylight)	Elevation
Low	11/27/2017 4:31 am	+2.80 feet, MLLW
High	11/27/2017 12:04 pm	+10.81 feet
Low	11/27/2017 6:56 pm	+4.29 feet

Tide	Time (Pacific Daylight)	Elevation
High	11/28/2017 12:10 am	+7.04 feet

Source: Tides&Currents Software, NOAA, Station 9448576

Table 4: Predicted Currents near Hope Island: Daily Maximum Floods and Ebbs

Time (Pacific Daylight)	Speed	Direction
11/27/2017 3:00 am	0	Slack
11/27/2017 5:42 am	1.8 knots	170°, Ebb
11/27/2017 9:24 am	0	Slack
11/27/2017 11:48 am	1.9 knots	345°, Flood
11/27/2017 4:12 pm	0	Slack
11/27/2017 6:30 pm	1.6 knots	170°, Ebb
11/27/2017 10:18 pm	0	Slack
11/28/2017 12:18 am	1.8 knots	345°, Flood

Source: Tides&Currents Software, NOAA, PUG1628

The components and observed deficiencies are discussed below, and summarized in **Table 5**. The assessment was based on the conditions observed on November 27 and December 1, 2017, the document review and our professional judgment and experience. See the drawings in Appendix A for the numbering system.

The new net pens were installed between 9/10/2009 and 8/25/2011 based on aerial photos in GoggleEarth. Cooke aquaculture employees on site did not know the year they were installed. The year the barges and other components were built is not known, but estimated based on our judgment and experience.

Table 5: Hope Island Net Pens – Existing Conditions Summary

Component	Year Built (estimate)	Description	Deficiencies	Overall Assessment
Anchors	unknown	Most underwater anchors appear to exist but were not observed directly.	Most were not observed by divers, although there may be design deficiencies.	Satisfactory condition
Mooring Lines	varies, unknown	Most underwater mooring lines and hardware appeared in good to satisfactory condition.	none observed by divers, although there may be design deficiencies	Satisfactory conditions but with severe damage observed on mooring line 20, and

Component	Year Built (estimate)	Description	Deficiencies	Overall Assessment
				questions about the design.
Steel Frame and Mooring Brackets	2010	Galvanized steel tube and structural sections, welded to form units connected by hinges.	Minor surface corrosion in localized areas	Good to Satisfactory
Float Tubs (plastic)	2010	Plastic, foam-filled tubs, bolted to underside of steel walkways	Inadequate flotation in localized areas. Damage to individual tubs not observed.	Good
Walkways, Gratings, and Railings	2010	Steel fabrication with metal grate walking surface and hinged connections	Surface rust, localized minor and moderate corrosion, dissimilar metals	Satisfactory
Predator Exclusion Nets	unknown	Aviary nets cover each fish pen and nets line to perimeter of the facility to keep out marine mammals	None observed, not part of this inspection	N/A
Containment Nets	unknown	Nets deployed within active fish pens	None observed, not part of this inspection	N/A
Floating Main Barge	1980's	Concrete barge with wood framed shed, metal roof and siding	Several mooring cleats are broken or missing. Fenders not observed in use when tender vessel was alongside barge.	Satisfactory
Floating Feed Barge	1980's	Concrete barge with wood framed shed, metal roof and siding	Concrete float has localized cracking near bull-rail support. Shed siding was exposed on west side of barge.	Good to Satisfactory
Dive Float (between main barge and net pen)	2000's	Single float in-between net pens and Main Barge. Steel framing, plastic flotation tubs. Small shed with metal roof and siding.	Surface rust, moderate framing corrosion. No separate mooring, rafted to main barge and net pens.	Satisfactory
West Barge (secondary feed barge)	1990's	Concrete barge	No or minimal damage observed.	Good to Satisfactory

Component	Year Built (estimate)	Description	Deficiencies	Overall Assessment
Gangways	2000's	Steel gangways that interconnect the floating barges and provide access to the net pen facility	Not attached to barges, just bearing on deck and restrained by ropes. Surface rust on grating.	Fair
Records and Documents at site	N/A	The operations plan notes that records are kept on site	not inspected	not inspected

Source: Mott MacDonald

6.1 Anchors

- Based on the dive reports, the drag anchor at mooring line 11 was visible on the surface, as were the concrete gravity anchors at mooring line 20 (see Appendix B). The other anchors appeared completely buried.
- Anchors and chains are a mix of old and new because they have been replaced over time. The records of anchor maintenance, inspection and replacement are not clear. The type and condition of the anchors has not been directly observed. The age was not certain.
- Anchors are reported by Cooke to include Navy and Danforth anchor types. Divers observed concrete gravity anchors at the end of mooring line No. 20. The primary gravity anchor was a cylinder at the end of the mooring line. A secondary concrete anchor was attached to the center of the middle chain section.
- Drag anchors must trip, dig-in, and remain stable as they are dragged into place. The holding capacities are dependent not just on the anchor weight and sediment properties, but also the fluke angle, the angle of the chain relative to the bottom, and the lengths that the anchors are dragged upon installation. Keeping the chain angle near zero degrees relative to the bottom, and dragging the anchors for longer distances during installation increases the anchor holding capacities. The mooring system should be designed so that the anchor will drag before the mooring line, mooring bracket, or other structure component fails. Anchor dragging is preferable to a mooring line break because the anchor dragging will re-distribute the load to the other anchors.
- The U.S. Navy (2012) *Handbook for Marine Geotechnical Engineering* recommends sizing the drag embedment anchor as the "weaker link" of a mooring system. In particular, the manual states that "It is preferable to allow the anchor to drag instead of breaking the mooring line. Anchor drag results in redistribution of the overstressed mooring line to its neighboring lines and helps the mooring to survive in storms when environmental loads exceed the design loads". Accurate soil properties are needed for design.
- The estimated holding capacities of the anchors at the site vary from 6,700-10,800 pounds for the 2,500-pound Navy anchor at Line No. 15, to 29,000 to 54,500 pounds for the 6,000-pound Danforth anchor at Line No. 7. The estimated holding capacities are based on U.S. Navy (2012, 1960) manuals and test reports.
- Det Norske Veritas (2012) notes that monitoring of the anchor installation should, as a minimum, provide data on line tension, line pitch angle, anchor drag, and anchor penetration. This information was not available for review.

6.2 Mooring Lines and Mooring Brackets

- Mooring brackets are attached to the walkway structure frame near the walking surface. The brackets are evenly distributed around the net pen facility, located at walkway intersections. Details of the connection are shown below in **Figure 10** and in **Figure 8**, and on sheet 4 of the drawings in Appendix A. The mooring brackets are not hinged, unlike mooring connections at other net pens observed in Washington waters, and typically have three holes for connecting three mooring lines. Typically, only one mooring line was connected to each bracket, typically the middle hole, but not always.
- Mooring brackets were observed during our site visit to be in good to satisfactory condition. Minor corrosion was observed in places but the galvanizing was generally intact.

Figure 10: Typical Mooring Bracket at Hope Island

Source: Collins Engineers, Inc.

- Above water the anchor mooring lines consist of steel chains and shackles connected to the steel frame. Several mooring lines are at a relatively shallow angle of the chain to the water where it connects to the net pen. A mooring line with too much tension when there was minimal wind, wave and current load may become overloaded during an extreme storm event.
- Mooring Line 20 include a chain with severe corrosion as discussed in the dive report in Appendix B. Mooring Line 20 was found disconnected from the anchor by Collins. Cooke was informed and the anchor line was re-attached by Cooke. Collins then

confirmed the line was connected to the anchor. A spreadsheet from Cooke “Anchor Map with hardeware dates.xlsx” (sic) includes a table that reports that line 20 was last inspected on 2017-5-3 and under comments the table reports “good”.

6.3 Steel Frame and Float Tubs

- Hardware was observed with hot-dip galvanizing coating, except in 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, raising the walkways approximately 1.75 feet above the water surface.
- Flotation 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 damage. The low freeboard at the corners was due to a lack of float tubs, a design issue, rather than failing flotation or damage to the steel frame. The load from anchors was concentrated at the corners, and that was 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 flotation 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.
- Majority of the walkways include steel grating panels with perforated surfacing 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 surface rust, due to splash back from the fish in the net pens.
- Central walkway bullrails exhibited minor corrosion at several locations, presumably due to the splash back from the fish in the net pens.
- Observation cameras are mounted on aluminum poles along the central walkway. Direct contact between dissimilar metals was observed, with steel bolts connecting an aluminum plate to steel grating. Without isolation, these dissimilar metals will cause galvanic corrosion to occur. This can be easily prevented by placing a barrier between the dissimilar metals, such as UHMW pads or washers.

- 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 Exclusion Nets and Connections

- Predator exclusion nets include both in-water nets to prevent seals and other marine mammals from entering the pens, and above water nets to prevent birds from reaching the salmon or their feed. The predator exclusion nets also discourage trespassing, theft, and vandalism.

- In-water nets are supported by 2.5-inch diameter pipe rails attached along the perimeter of the facility to the steel framing. Pipe rails are in good condition with localized areas of minor surface rust. Nets are taut, extending straight down into the water and held in place by weighted pipes. The nets were not included in the inspection, but no major deficiencies in the portion visible above water were observed during the site visit.

- To remove marine growth fouling, the staff onsite reported that nets are pulled from the water and allowed to dry. Cooke employs divers who routinely inspect the nets for damage and to evaluate marine growth fouling.

6.6 Stock Containment Nets and Connections

- The stock containment nets confine the salmon inside each individual pen. The nets are supported by 2.5” diameter pipe rails that surround the perimeter of each pen. Localized minor to moderate surface corrosion was observed on the pipe connections to the frame at various locations around the facility. The nets were not included in the inspection, but no major deficiencies in the portion visible above water were observed during the site visit.

- Significant displacement of the nets from vertical was observed during the site visit, due to the current imposed drag load.

- Nets are routinely inspected to remove fouling and check for damage.

6.7 Floating Main Barge

- The floating feed barge consists of a concrete substructure with timber rub-strips. It was moored with a combination of anchors and mooring lines (No. 20 and 21) and chains and synthetic lines connected to the net pen structure. The barge was level, not listing to one side.

- The shed on the concrete barge was a one-story structure, consisting of timber framing with metal roof and siding. The interior contains the operations office, which includes a kitchenette and bunk. Inspection and structural condition assessment of the shed and structure above the floating barge was not included in this report. However, based on general observations during a walk-though the shed structure appeared to be in good to satisfactory condition.

- Several of the mooring cleats around the perimeter of the barge were broken, lacking one of their horns or missing altogether.

- Fenders were not observed to be in use when the tender vessel was alongside the barge.

6.8 Floating Feed Barge

- The floating feed barge consists of a concrete substructure with timber rub-strips, moored in place with a system of anchor chains, mooring line, and shackles. The barge was level, not listing to one side.
- The shed on the concrete barge was a one-story structure, consisting of timber framing with metal roof and siding. The interior stores the large bags of fish feed. The structure extends the entire with of the barge, with rolling door openings in the front and the back. A forklift permanently resides on the barge and was used to transfer the feed bags into the feed silos. The silos are located outside on the front of the barge.
- A structural condition assessment of the shed was outside of our scope. However, the siding of the west side of the shed was observed to be damaged, peeled back away from the wall. The area of damage was located above one of the anchor chain attachment points.
- Two CCS Feed Blowers manufactured by Akvasmart are attached to the front of the barge, and used to distribute the feed in net pens. Using air pressure, the feed was transported from the silos through feed tubes out to the rotor spreaders that float inside each net pen.
- Concrete on the front face of the barge was observed to be cracked and nearly spalling off. The crack was centralized around a support post for a steel bullrail, located on the front of the barge in-between the two feed blowers. Nothing was attached to the bullrail at the time of inspection, but there are concerns if any significant load is applied in the future.
- A portable restroom was located on the backside of the feed barge, serving as the only restroom facility on site.

6.9 Dive Float

- The dive float was a single, steel framed float supported by plastic flotation tubs. It appears to be the same design as the central walkways, with similar steel grating and bull-rails. The float was level, not listing to one side.
- The float was not independently anchored. Rather, it was moored directly to the main barge and the net pen facility be a series of ropes.
- A structural condition assessment of the shed was outside of our scope. It was observed that the shed contains diving equipment and other tools needed for maintaining the net pens.
- There was minor to moderate corrosion on the grating and framing on the west side of the float, located behind the shed. At this time, it does not seem to be critically affecting functionality, but could be a concern over time if corrosion continues to worsen.

6.10 Gangways

- A series of steel gangways interconnect the two barges, the dive float, and the net pen facility.

- Gangways directly bear on the floating structures and are not hinged or attached in any way. A series of lines (ropes) keep the gangways in place, but they are free to move around on the deck surface. Old, rubber tires were placed underneath some of the gangway corners to act as a bumper.
- Gangway grating was generally in fair condition. The grating on the gangway between the main barge and the feed barge was completely covered in surface rust with no galvanizing remaining. The other two gangways leading to the net pen facility had minor rust and dents that have deformed the grating panels.
- Guardrails appeared sturdy with no immediate concerns.

6.11 Records and Documents On-Site

Reviewed documents from Cooke indicate that copies of routine inspection reports would be stored on site. We did not inspect documents on site.

7 Conclusions

The above water steel structure had corrosion in areas, but no major damage. The biggest concern is the mooring system. The adequacy of the moorings to resist the currents and environmental loads observed at the site could not be verified with any documentation.

Based on a review of the documents, the site visit and our judgment and experience the following is noted:

1. Tidal current loads and mooring system: The net pens are exposed to high loading conditions because of large tidal currents (channeled to and from Deception Pass) and subject to high debris load (from the Skagit River outlet). Mooring system design and maintenance is critical for proper operation and minimizing risk of failures. Routine maintenance of accumulated debris is also important to reduce the risk of mooring system damage or overload.

2. Net Pen System Design: No site specific stamped engineering drawings were provided. Information in the manufacturer supplied information (Wavemaster brochure) appears to be generic, and not specific to the system installed near Hope Island. The drawings and information in the document from Marine Construction appear to be general information intended for a system delivered to Cypress Island.

3. Mooring System Analysis & Design: The design of the mooring system is not documented. A schematic mooring diagram and notes describing the existing components were made available. A review of the installed mooring system relative to a specified design to assess overall adequacy could not be conducted with the information made available for this assessment.

4. Mooring Arrangement: The mooring system in general is composed of industry standard components (chain, rope and drag type anchors) with a few exceptions. Anchor 20 consisted of a concrete block in lieu of a drag anchor. Mott MacDonald recommends that all the anchors and mooring lines be the same type, size and length, arranged in a symmetrical pattern, and with the same pre-tension. Accurate sediment properties are needed for design.

5. Mooring System Inspections: Regular inspections are recommended to review the condition of the mooring system. A few discrepancies were noted between the inspection records from Cooke and observations for this report. Anchor Line No. 20 was reported “good” in March 2017. However, divers during this inspection observed chain at this line with severe corrosion. Also, Anchor Line No. 20 was found by the divers to be disconnected from the anchor. After notifying Cooke the anchor line was re-attached by Cooke, and Collins later confirmed this by dive inspection.

6. Underwater Components: Most of the underwater portions of the mooring system and pontoons appear to be in good to satisfactory condition. The drag anchor at mooring line No. 11 was visible on the surface, as were the concrete gravity anchors at mooring line No. 20. The drag anchors on the surface, not buried, will have much reduced holding capacity. An important aspect of anchor performance is penetration depth, which relates to holding capacity and suitability for a given application. Full holding capacity is only achieved at full penetration depth which can be roughly one fluke length for drag type anchors in sand. Installation of the anchors may need to be further

investigated, possibly with sub-surface sonar profilers and multi-beam bathymetry measurements, to determine if they are properly set for their required capacity.

7. Above Water Components: The above water portions of the float system appear to be in good or satisfactory condition. Surface rust and minor, localized corrosion damage was observed on the above water portion of the structure. The galvanized coating is intact except for localized areas. The net pens are relatively newer structures compared to net pens elsewhere in Puget Sound. Float sections at the corner locations were observed to have a reduced freeboard and were near or under the water surface at times. The freeboard at these need 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. The floating steel structure and mooring system should be inspected at least annually.

9. Anchor Locations: It could not be confirmed if the Hope Island anchors at the ends were inside of the lease boundary based on the length of the diver umbilical line used for anchor line inspection. A multi-beam bathymetric survey is recommended to locate the anchors.

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 a site visit and dive inspection.

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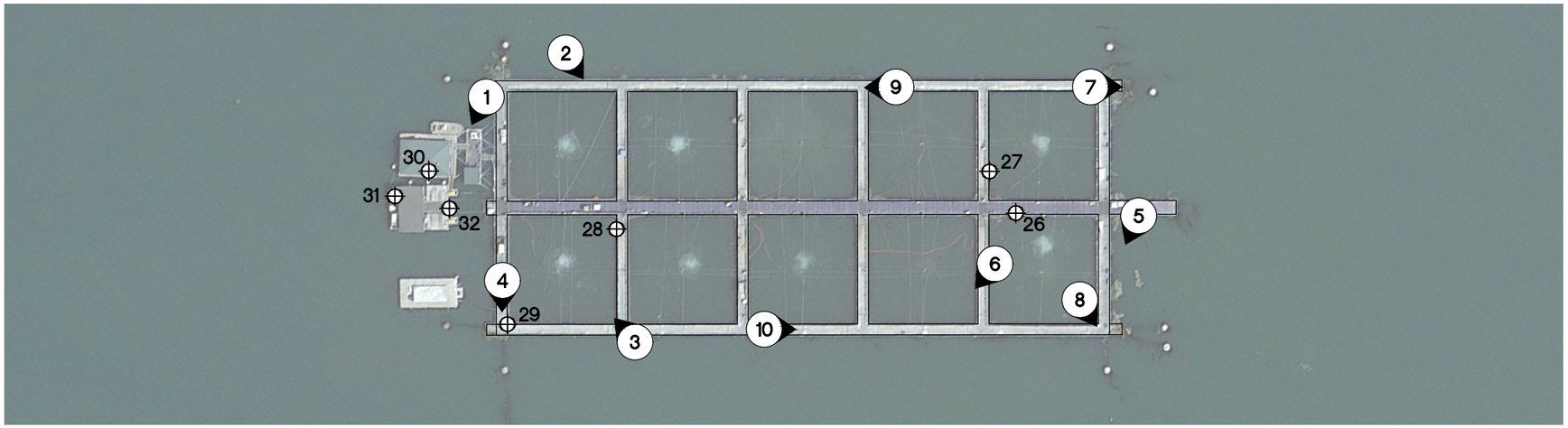

HOPE ISLAND NET PEN
PHOTOS–PLAN

0 50 100
SCALE IN FEET

LEGEND

1 PHOTO LOCATION AND ORIENTATION

26 PHOTO NUMBER TENT LOCATION

NOTES

MOORING SYSTEM NOT SHOWN, SEE SHEETS 2 AND 4

PHOTO 1
FLOATING BARGES

PHOTO 2
EXTERIOR WALKWAY AND PREDATOR NET

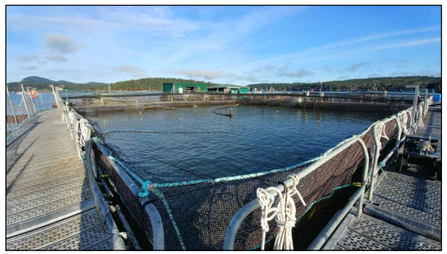

PHOTO 3
FISH PEN

PHOTO 4
WALKWAY INTERSECTION

PHOTO 5
DEBRIS BUILDUP ON SOUTH END OF FACILITY

PHOTO 6
FISH CONTAINMENT NETS DEFLECTED DUE TO CURRENT DRAG

PHOTO 7
HINGED MOORING BRACKET AND ANCHOR CHAINS

PHOTO 8
MOORING CHAIN

PHOTO 9
FIXED WALKWAY CONNECTION

PHOTO 10
WALKWAY HINGE

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Rev	Date	Drawn	Description	Ch'k'd	App'd
1	12/13/17	CT	PLAN AND PHOTOS	JL	NS

Project Number: 391980 | B/O: 1 | Total: 6

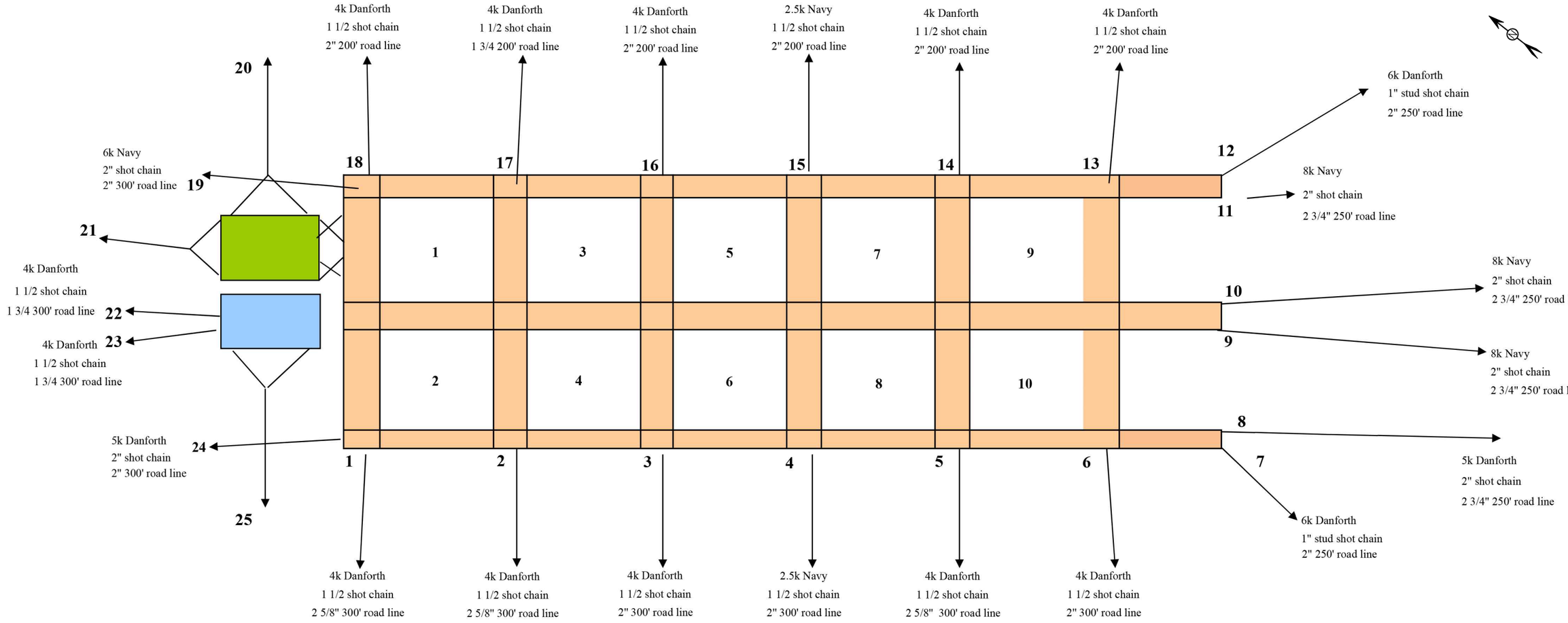
Drawing Number:

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

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

Title: Washington State Department of Natural Resources Hope Island Net Pen

Photos and Photo Locations Plan



HOPE ISLAND NET PEN

MOORING PLAN

NOT TO SCALE

NOTES

MOORING SYSTEM SCHEMATIC PLAN
PROVIDED BY COOKE AQUACULTURE.

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Rev	Date	Drawn	Description	Ch'k'd	App'd
1	12/13/17	CT	PLAN AND PHOTOS	JL	NS

Project Number	B/O	Total
391980	2	6

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Dwg check	N. Sultan		Approved		

Scale at ANSI D	Status	Rev	Security
As Shown			

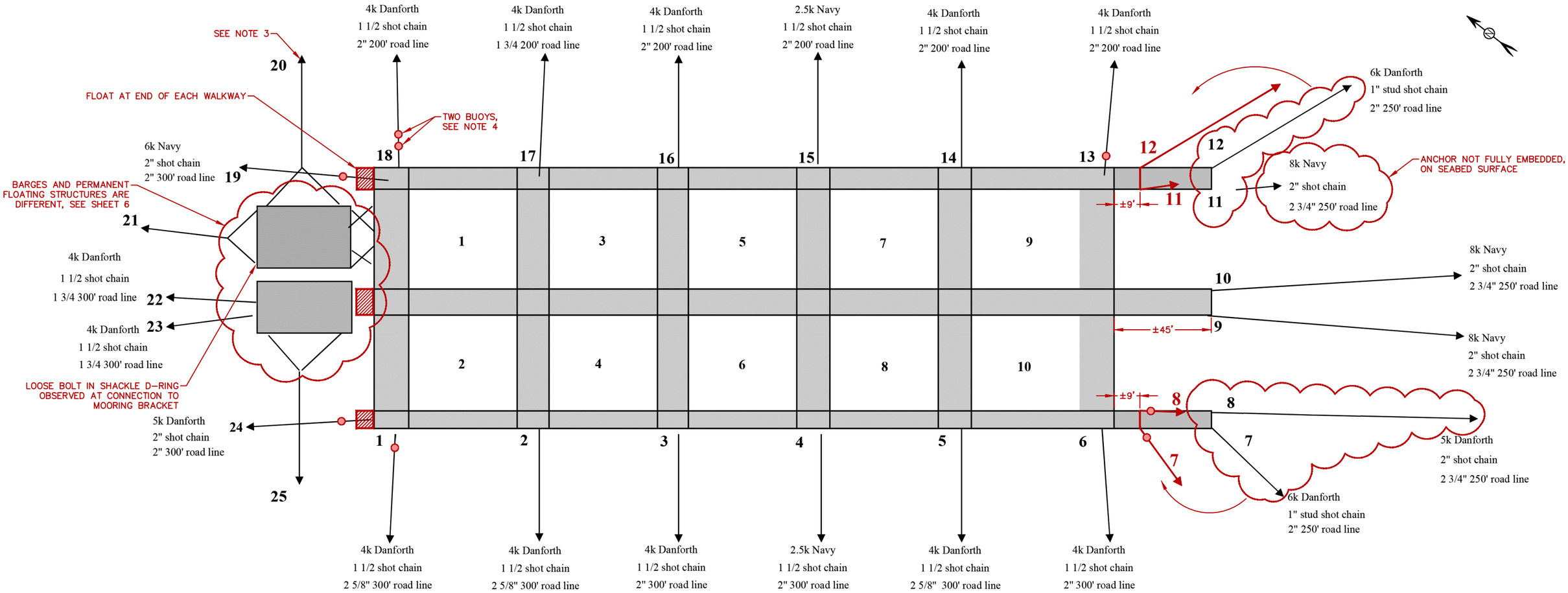
Drawing Number

Title

Washington State
Department of Natural Resources
Hope Island Net Pen

Mooring Schematic Plan

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-Hope Island Plan.dwg Dec 13, 2017 - 3:29PM TAY70899



HOPE ISLAND NET PEN

MOORING PLAN

NOT TO SCALE

LEGEND

STEEL BUOY CONNECTED TO MOORING LINE
BUOYS ARE AT LINES 1, 7, 8, 13, 18, 19, 24

NOTES

1. MOORING SYSTEM SCHEMATIC PLAN PROVIDED BY COOKE AQUACULTURE.
2. CORRECTIONS AND NOTES BY MOTT MACDONALD ARE IN RED.
3. LINE NO. 20 CONSISTS OF AN UPPER CHAIN, UPPER ROPE, MIDDLE CHAIN, LOWER ROPE, LOWER CHAIN, AND 2 EACH CIRCULAR CONCRETE ANCHORS ON THE SURFACE OF SEABED. SEVERE DAMAGE OBSERVED AT MIDDLE CHAIN.
4. THERE ARE TWO BUOYS AT LINE NO. 18. ONE IS CONNECTED TO ANCHOR NO. 18. THE OTHER IS CONNECTED TO A SECOND ANCHOR USED FOR TEMPORARY MOORING OF WORK BARGES.

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Client

Rev	Date	Drawn	Description	Ch'k'd	App'd
1	12/13/17	CT	PLAN AND PHOTOS	JL	NS

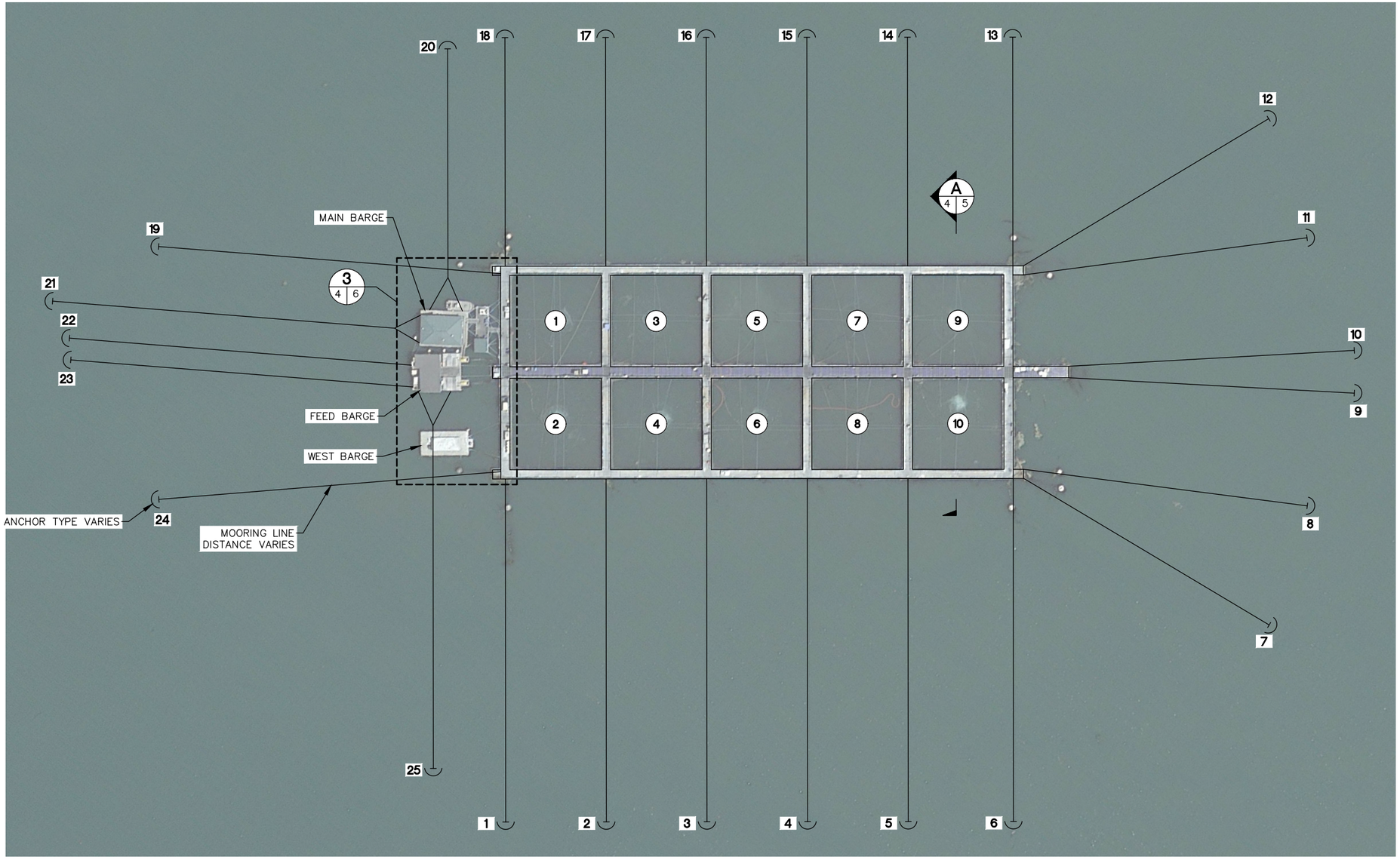
Project Number	B/O	Total
391980	3	6

Designed	J. LaFave		Eng check	S. Phillips	
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 Natural Resources Hope Island Net Pen

Mooring Schematic Plan - Revised, with Notes



HOPE ISLAND NET PEN

0 50 100

SCALE IN FEET

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

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

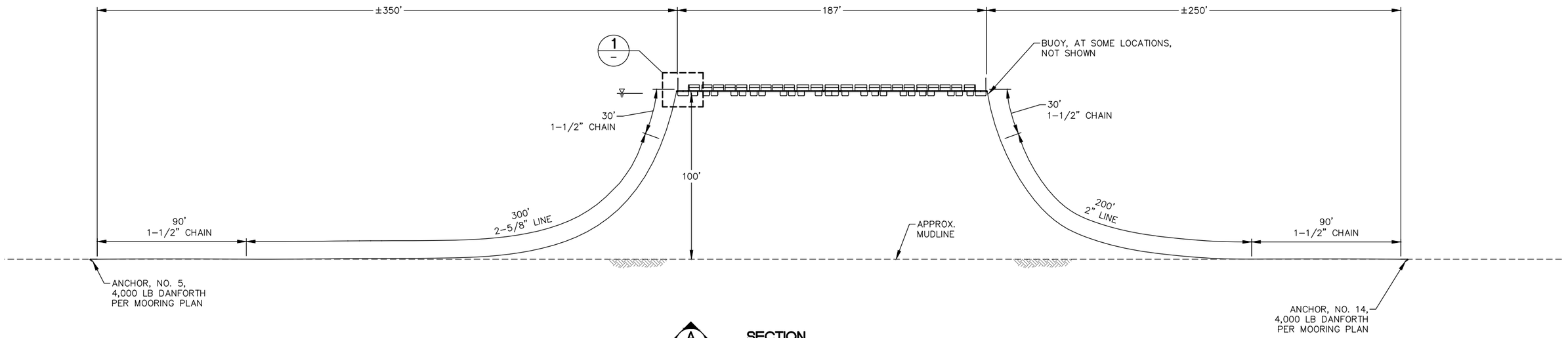
Project Number: 391980 | B/O: 4 | Total: 6

Drawing Number

Title

Washington State
Department of Natural Resources
Hope Island Net Pen

Existing Site - General Plan



A 4 5 SECTION

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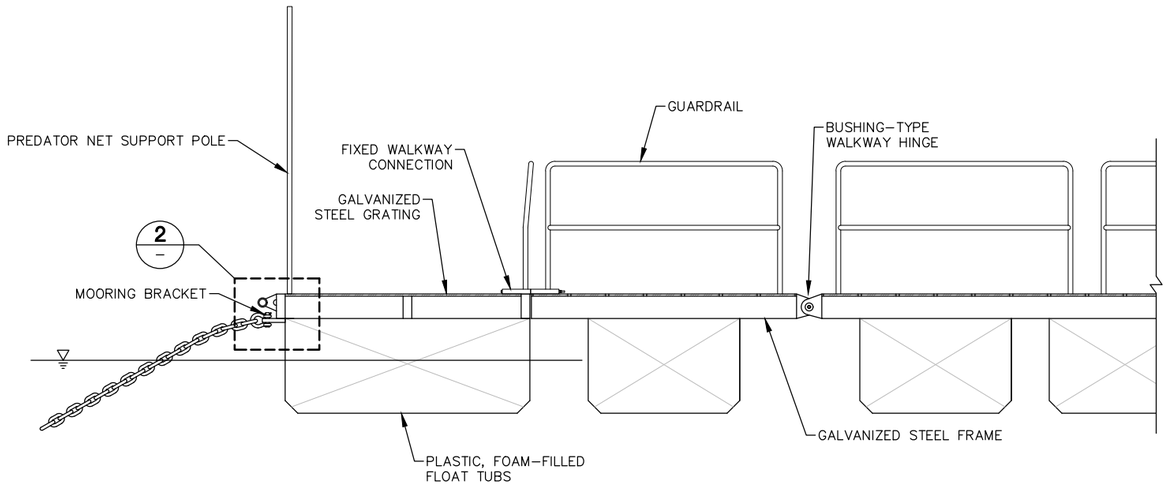

1 DETAIL

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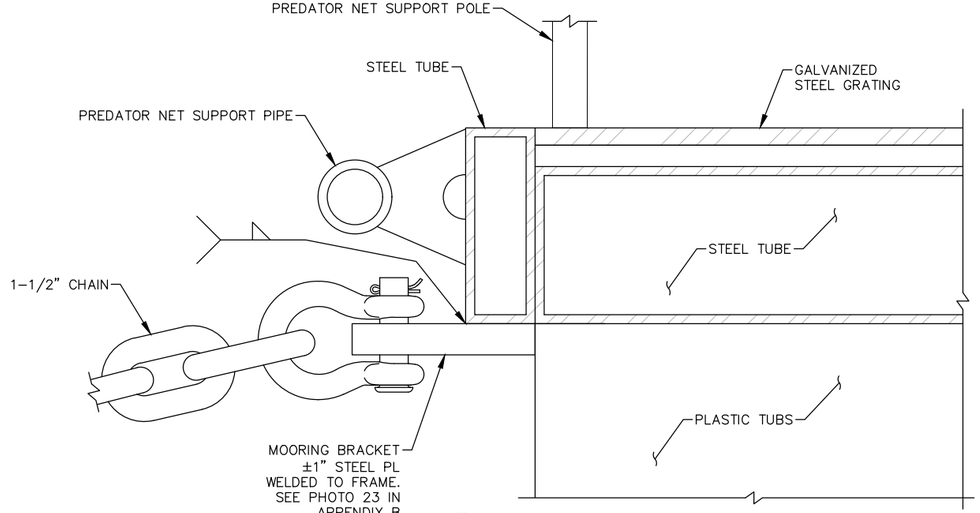

2 DETAIL

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Project Number	B/O	Total
391980	5	6

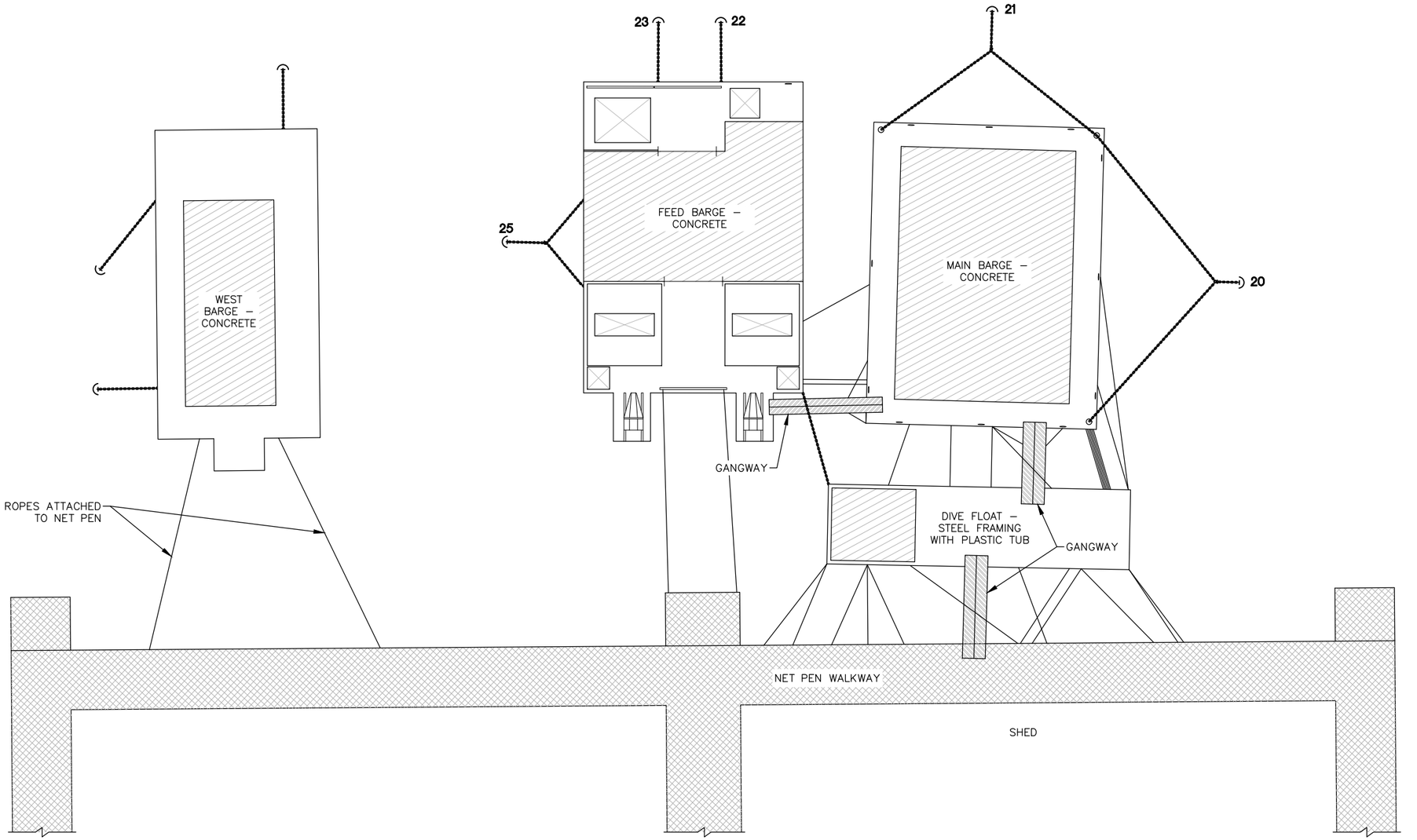
Designed	J. LaFave		Eng check	S. Phillips	
Drawn	C. Taylor		Coordination		
Dwg check	N. Sultan		Approved		
Scale at ANSI D: As Shown	Status		Rev		Security

Drawing Number

Title

Washington State
Department of Natural Resources
Hope Island Net Pen

Sections



3 / 4 6 **PLAN**

BARGES

0 8 16

SCALE IN FEET

LEGEND

SYNTHETIC LINE (ROPE)

CHAIN

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Designed	J. LaFave		Eng check	S. Phillips	
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 Natural Resources
Hope Island Net Pen

Floating Permanent Structures

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-Hope Island Plan.dwg Dec 13, 2017 - 3:29PM TAY70899

January 29, 2018
Collins Job No. 45-10819

Underwater Inspection of the Hope Island
Fish Net Pen System in Kiket Bay, WA

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 Hope Island Fish Net Pen System located in Kiket Bay, WA from November 27 through December 1, 2017. On December 18, 2017 ROV inspections were completed for 5 anchors and mooring lines that were deeper than 100 fsw. The scope of the inspection was to perform a below water visual and tactile inspection of the facility, and then based on the findings, comment on the integrity and stability of the submerged components of the fish net pen system.

The fish net pen system components inspected included the anchor line assemblies, building support floats, and a representative sample of the pen framing/walkway support floats. The 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 and ASCE Manual of Practice 130 – Waterfront Facilities Inspection and Assessment. 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. An underwater Remotely Operated Vehicle (ROV) was utilized on December 18, 2017 to inspect the portions of Anchors 1, 2, 3, 24 and 25 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.

Refer to Photographs 1 through 44 for views of the typical and specific conditions observed during the underwater inspection of the Hope Island Fish Net Pens System components. In addition, all

of the photographs and videos taken during the underwater inspection of the Hope Island Fish Net Pens System components have been made available for reference digitally.

Overall, the underwater inspection revealed the following key findings:

- The anchor and mooring line arrangement was consistent with the "Hope Island Anchor Diagram" drawing provided by Cooke Aquaculture. All mooring lines shown on the drawing were observed and none seemed to be missing.
- The anchor line assemblies were typically found to be in good to satisfactory condition, with minimal deterioration, and with all connection elements sound and secure. Approximately 50% of the ropes appeared to be relatively new based on the lack of marine growth.
- The anchor line rope at Anchor 11 exhibited minor abrasion damage where it passed by and was in contact with a large concrete block located on the seabed.
- All anchors, except for Anchors 11 and 20, were fully embedded in the seabed, which suggests that they were well-seated and affording the expected anchorage. Anchors 11 and 20, which were resting on top of or just partially embedded in the seabed, displayed no indications of detectable displacement or movement since anchor placement.
- The anchor line makeup of Anchor 20 differed from the other 24 anchors at the facility. Anchor 20 consisted, from top to bottom, of an upper chain, upper rope, middle chain, lower rope, lower chain, and dual concrete anchors. The majority of the anchor components exhibited conditions similar to the other anchors; however, the middle chain section exhibited severe deterioration with up to 85% loss of link section, especially where the first anchor rope was attached.
- The mooring line No. 21 connection at the barge was observed with the shackle bolt not fully engaged in the D-ring at the barge mooring bracket; additionally, the stainless steel seizing wire was observed to be broken. The steel tab mooring line bracket is not co-linear with the mooring line, resulting in the shackle D-ring touching the bracket. This contact appears to cause loosening of the shackle bolt when the shackle moves.
- The building and pen support floats were typically found to be in good to satisfactory condition with no appreciable deterioration or other deficiencies. At all four corners of the pen system, however, the walkway ends and underlying floats were depressed downward up to 2 ft due to concentrated loading from the weight of the anchor line assemblies.

<u>Anchor Line Assemblies</u>

The anchor line assemblies typically consisted of:

- Upper Anchor Chains (±30 ft)
- Ropes (200 ft – 300 ft)
- Lower Anchor Chains (90 ft – one shot of chain)
- Anchors (Navy and Danforth type)

The building/pen support float to upper anchor chain connections were typically found to be fully intact, secure, and in good to satisfactory condition. The steel shackles typically exhibited little, if any, 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 for the shackle pins typically in place and properly installed. The accessible portions of the steel framing that provide the connection between the aforementioned 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 (thimble and shackle) were also typically found to be fully intact, secure, and in good to satisfactory condition. The steel thimbles typically exhibited minimal deterioration, and the ropes were typically secured beyond the thimble with a bowline knot at the upper connection and eye splice at the lower connection. The steel shackles also typically exhibited minimal deterioration, and were found to be properly aligned and secure, with the restraining wires for the shackle pins typically in place and properly installed.

The ±30 ft long upper anchor chains were typically found to be in good to satisfactory condition with minimal deterioration (less than 15% section loss). The below water portions of the upper anchor chains typically exhibited moderate (1 to 3 in. thick) marine growth. Steel buoys were attached to the upper anchor chains at Anchors 1, 7, 8, 13, 18 (two buoys), 19 and 24. The buoys, which were most likely installed to help to 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 200 ft to 300 ft long ropes (road lines) were typically found to be in good to satisfactory condition with no fraying or detectable abrasion damage. The one exception to this was at Anchor 11 where minor abrasion damage was observed in the rope where it passed by and was in contact with a large concrete block located on the seabed. The ropes at 13 anchors (Anchors 1, 2, 3, 4, 6, 13, 14, 15, 16, 18, 20, 21 and 25) exhibited minimal marine growth, and the ropes at 12 anchors (Anchors 5, 7, 8, 9, 10, 11, 12, 17, 19, 22, 23 and 24) exhibited moderate to heavy (3 to 12 in. thick) marine growth.

The 90 ft long (one shot of chain) lower anchor chains were typically found to be in good to satisfactory condition, with minimal deterioration and marine growth. Typically, between 15 and 85 ft of the lower anchor chains were exposed on (or slightly below) the seabed and the anchors were fully embedded in the seabed. In particular, between 10 ft and 30 ft of the lower anchor chain was exposed at Anchors 15, 19, 20, 21, 22 and 23, between 45 ft and 60 ft of the lower chain was exposed at Anchors 6, 14, 16 and 17, and between 80 ft and approximately 90 ft (full shot length) of the lower anchor chain was exposed at Anchors 4, 5, 7, 8, 9, 10, 11, 12, 13 and 18. 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 Navy and Danforth type

anchors. 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. The only exception to this was at Anchors 11 and 20, which were resting on top of or only partially embedded in the seabed. At these two locations, however, the corresponding lower anchor chains exhibited the same typical amount of embedment into the seabed, which suggests that there has been no appreciable movement of these anchors since they were placed. The exposed lower anchor chain to anchor connections at Anchors 11 and 20 were also found to be in good to satisfactory condition, with minimal deterioration, and with all connection elements sound and secure.

With regard to Anchor 20, both the anchor line assembly and anchor type differed from the other 24 anchors at the facility. The anchor line assembly, from top to bottom, consisted of: upper chain; upper rope; middle chain; lower rope; lower chain; and two circular concrete anchors. The upper and lower chains exhibited minor deterioration and marine growth similar to the other anchors. The ropes (both upper and lower) also exhibited conditions similar to the other anchors with minimal marine growth. The middle chain section, however, was approximately 5 ft long and exhibited severe deterioration with up to 85% loss of link section. All of the various connections were in satisfactory condition, with minimal deterioration, and with all connection elements sound and secure. The circular concrete anchor at the end of the anchor line assembly, which was the primary anchor, was also sound and secure. In addition to the primary anchor, a secondary concrete anchor was attached to the center of the middle chain section (at the two chain links with the greatest loss of section) by a rope which extended vertically to the seabed.

As previously indicated, due to being located in water depths greater than 100 fsw, it became necessary to inspect the lower portions of Anchor Lines 1, 2, 3, 24 and 25 with the use of an ROV. Ultimately, the ROV inspection of those anchor lines revealed the existing conditions in general to be very comparable to those observed from the diving inspections at the other Hope Island anchor lines. In particular, the lower rope to chain connections were always secure, with a proper rope eye splice and with a thimble and shackle that exhibited minimal deterioration. Regarding the lower anchor chains, they were typically resting on or embedded to some degree in the seabed for an approximate length ranging between only 20 ft, on the low end, and up to 90 ft (one shot of chain) at the most, with the chain exhibiting minimal deterioration and marine growth. The anchor chains also always appeared to be well-established with regard to their position on or in the seabed, with no notable rutting of the seabed, suggesting that the anchor chains are not displacing appreciably, and that their alignment is conducive to promoting proper setting and subsequent grip of their respective anchors. As for the anchors of the anchor lines inspected with the ROV, anchor exposure was only encountered at Anchor Line 3 and the extent of exposure was very minimal (essentially just a short length of the anchor stem exposed). Otherwise, there was no other anchor exposure encountered, and for all for all of the anchor lines inspected by ROV, the existing channel

bottom conditions suggested that the anchor was well-seated and gripping adequately in the seabed. As for Anchor Line 25, which is a supplemental anchor line that just stabilizes the barge supporting one of the facility's buildings, it should be noted that there was a very heavy accumulation of apparently abandoned rope around the anchor line rope itself, such that it was deemed to be unfeasible to progress the ROV beyond the rope accumulation, especially given the very limited underwater visibility at the time of inspection.

Building/Pen Support Floats

The east and west building support floats were constructed of concrete and were typically found to be in satisfactory condition with no appreciable deterioration or other notable deficiencies. The floats typically exhibited moderate (1 to 3 in. thick) marine grow on 100% of the submerged surface areas.

The pen support floats were constructed of polyethylene float modules supporting continuous steel perimeter and interior walkways. The representative inspection of these components revealed them to be typically in good condition with no notable deterioration or damage. The float modules typically exhibited a mostly light (1 in. thick) layer of marine growth on 90% to 100% of the submerged surface areas. All four corners of the fish net pen system were depressed downward by up to 2 ft due to concentrated loading from the weight of the anchor line assemblies connected to the free ends of the walkways. In an attempt to lessen the corner float depressions (downward displacements), three float modules were installed at the southeast and southwest corners (2 stacked outboard and 1 adjacent inboard) and two float modules were installed at the northeast and northwest corners (2 adjacent side-by-side). In addition to the extra float modules, steel buoys were attached to the upper anchor chains at the corners. Although the steel buoys likely relieve some of the concentrated loading during slack tide and flood (southerly) tidal flows, they are also appear to be adding to the loading, and consequently, further depressing the southeast and southwest corners during high ebb (northerly) tidal flows. The pen support floats below the interior walkway between Pens 4 and 6 on the westerly side of the pen system, where a heavy piece of equipment (generator) was staged, were also specifically examined due to that portion of the walkway being noticeably displaced downward. At this location, the floats again did not exhibit any detectable damage that would be the related to the depressed nature of the walkway, and the walkway displacement appeared to be exclusively related to the excessive weight of the equipment.

Conclusions

The anchor line assemblies were typically found to be in good to satisfactory condition, with minimal deterioration, and with all connection elements sound and secure. The rating of good to satisfactory is deemed appropriate since good implies essentially no deficiencies, and satisfactory implies that there may be some deterioration or other defects present, but those conditions are

primarily minor and not compromising the integrity of the affected component. Except for the middle chain section at Anchor 20, the lengths of chain inspected exhibited only very minor deterioration, with just light surface corrosion being present that had no appreciable loss of original chain section associated with it. With respect to the ropes running between the upper and lower anchor chains, they were found to be in good, full original section condition, with no evidence of fraying or abrasion related damage. The exception to this was at Anchor 11 where minor abrasion damage was observed in the rope where it passed by and was in contact with a large concrete block located on the seabed. 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 moderate marine growth on all of the upper chains and the moderate to heavy marine growth on 12 of the 25 ropes relate to the age of the components, and did not appear to be detrimental to the facility at this time. The remaining 13 ropes, which exhibited essentially no growth, were relatively new (likely installed within the last 1 to 2 years).

The building and pen support floats were typically found to be in good to satisfactory condition with no appreciable deficiencies or deterioration. All four corners of the fish net pen system, however, were depressed due to concentrated loading from the weight of the anchor line assemblies. This loading was partially relieved by the addition of extra float modules and chain buoys in the corners; however, the buoys also likely add to the loading and consequently further depress the southeast and southwest corner floats during high ebb tidal flows. In that regard, the southerly walkway ends were observed to extend below water somewhat during a strong combined ebb (northerly) tidal flow and northerly wave action. The moderate to heavy marine growth on the south end ropes (Anchors 7 through 12) also likely adds to the loading and south end float downward displacement during high ebb tidal flows. Although the downward displacements don't currently compromise the stability of the fish 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.

Except for the anchor line assembly at Anchor 20, which should be replaced, the underwater inspection of the Hope Island Fish Net Pen System did not reveal any significant deterioration or other notable deficiencies that would suggest any appreciable reduction in the inherently designed integrity or stability of the 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.

January 29, 2018

Very truly yours,

COLLINS ENGINEERS, INC.

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

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

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

Photograph 3: Overall View of the Fish Net Pen System, Looking Southeast.

Photograph 4: Overall View of the Fish Net Pen System, Looking Southwest.

Photograph 5: Overall View of the Fish Net Pen System, Looking Northwest.

Photograph 6: Overall View of the Fish Net Pen System, Looking Northeast.

Photograph 7: View of the Anchor Line Buoys in the Northwest Corner, Looking Southeast.

Photograph 8: View of the Anchor Line Buoys in the Northeast Corner, Looking Southwest.

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

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

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

Photograph 12: View of the Northwest Corner Pen Support Float, Looking Southeast.

Photograph 13: View of the Depressed Pen Support Float at the Northeast Corner, Looking South.

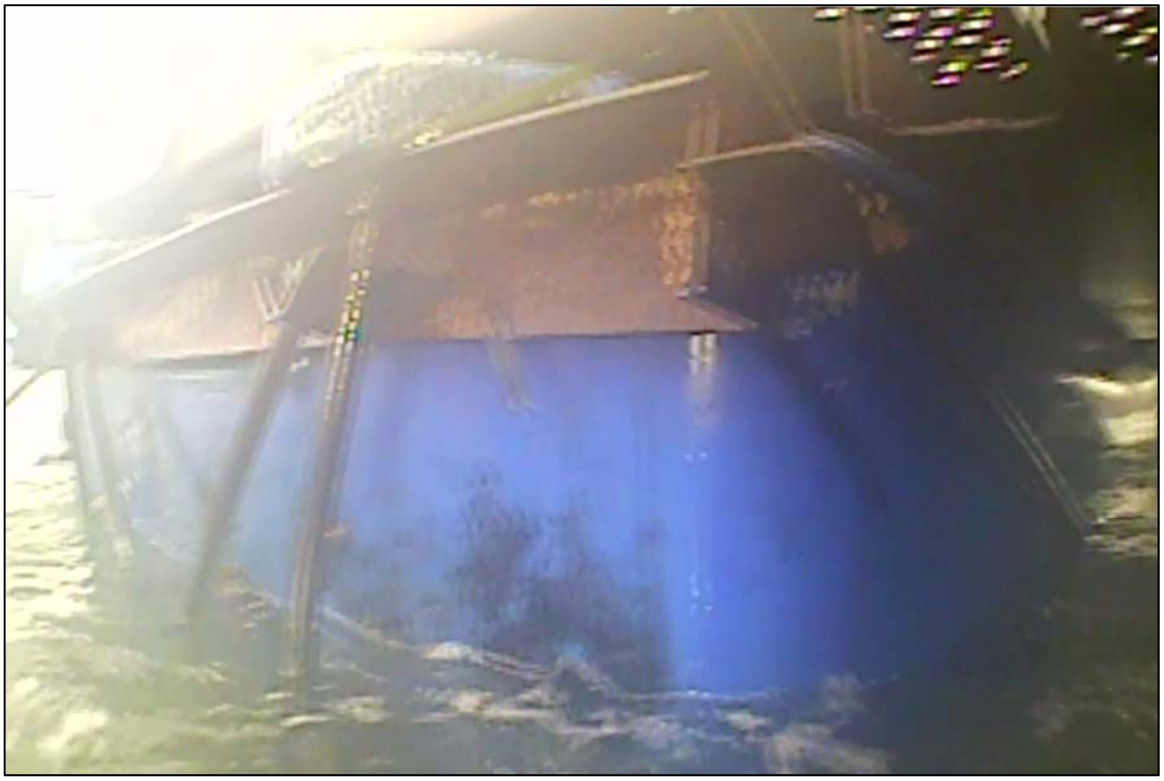
Photograph 14: View of the Northeast Corner Pen Support Float, Looking Southwest.

Photograph 15: View of the Depressed Pen Support Float (During High Ebb Tidal Flow) at the Southeast Corner, Looking North.

Photograph 16: View of the Southeast Corner Pen Support Float and Bracing Below Water, Looking Southeast.

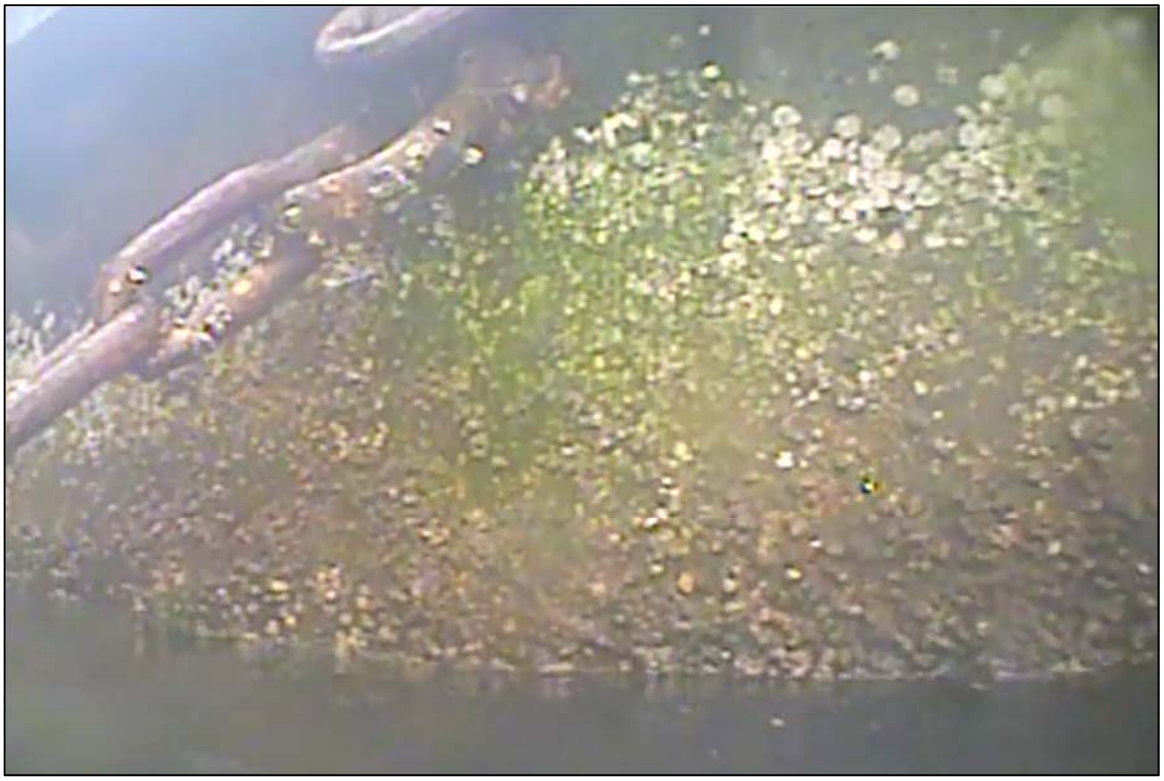
Photograph 17: View of the Depressed Pen Support Float (During High Ebb Tidal Flow) at the Center of the South End, Looking Northeast.

Photograph 18: View of the Depressed Pen Support Float (During High Ebb Tidal Flow) at the Southwest Corner, Looking Northeast.



Photograph 19: View of the Southwest Corner Pen Support Float, Looking Southwest.

Photograph 20: View of the Storage Buildings Located on the North End, Looking South.

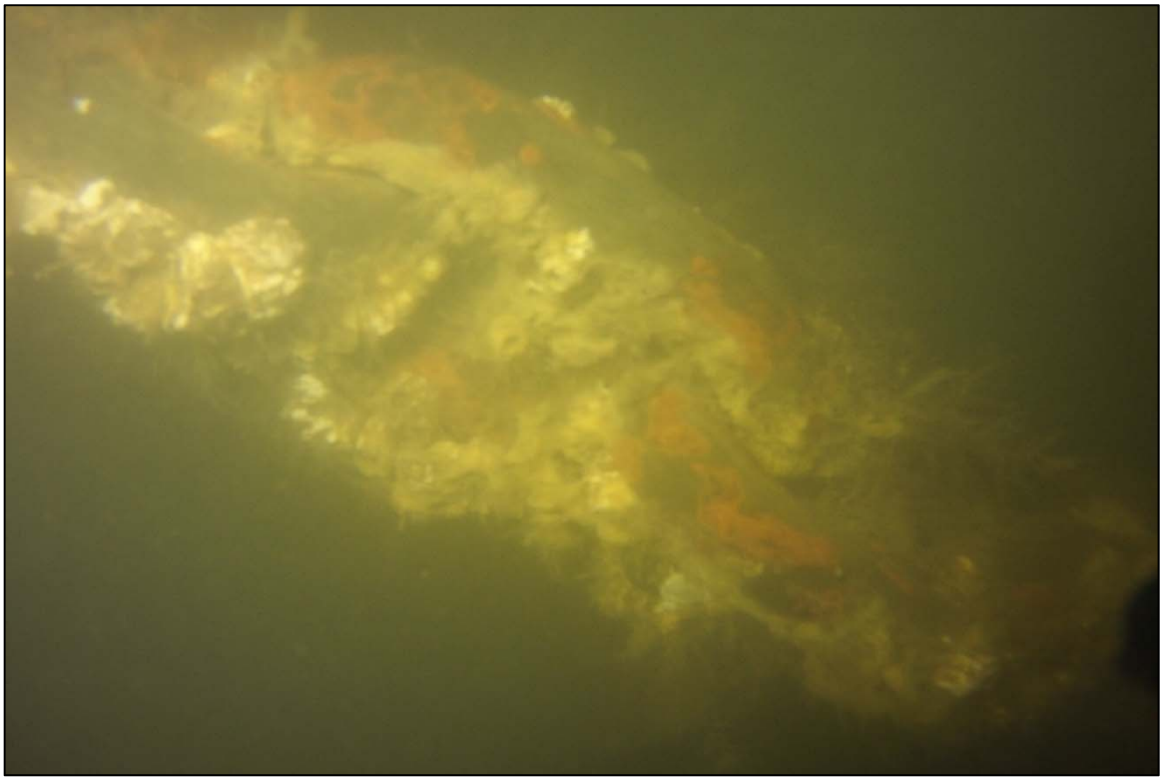


Photograph 21: View of the Typical Concrete Condition at the Waterline at the East Building Support Float, Looking East.

Photograph 22: View of the Abandoned Float Located on the North End, Looking Southeast.

Photograph 23: View of Pen Support Float to Upper Anchor Chain Connection at Anchor 18 (Typical), Looking Northwest.

Photograph 24: View of Upper Anchor Chain at Anchor 16 (Typical), Looking Southwest.

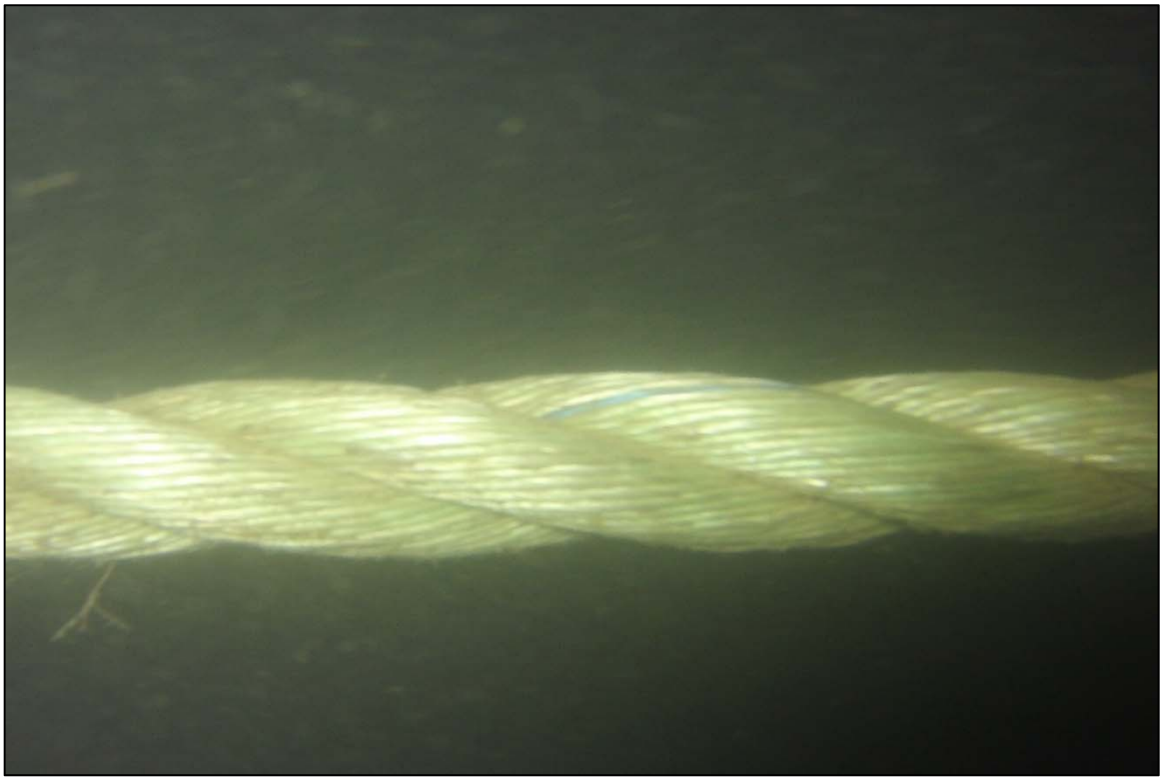


Photograph 25: View of Upper Anchor Chain Below Water at Anchor 21 (Typical), Looking West.

Photograph 26: View of Upper Anchor Chain to Rope Connection (Thimble and Shackle) at Anchor 18 (Typical), Looking North.

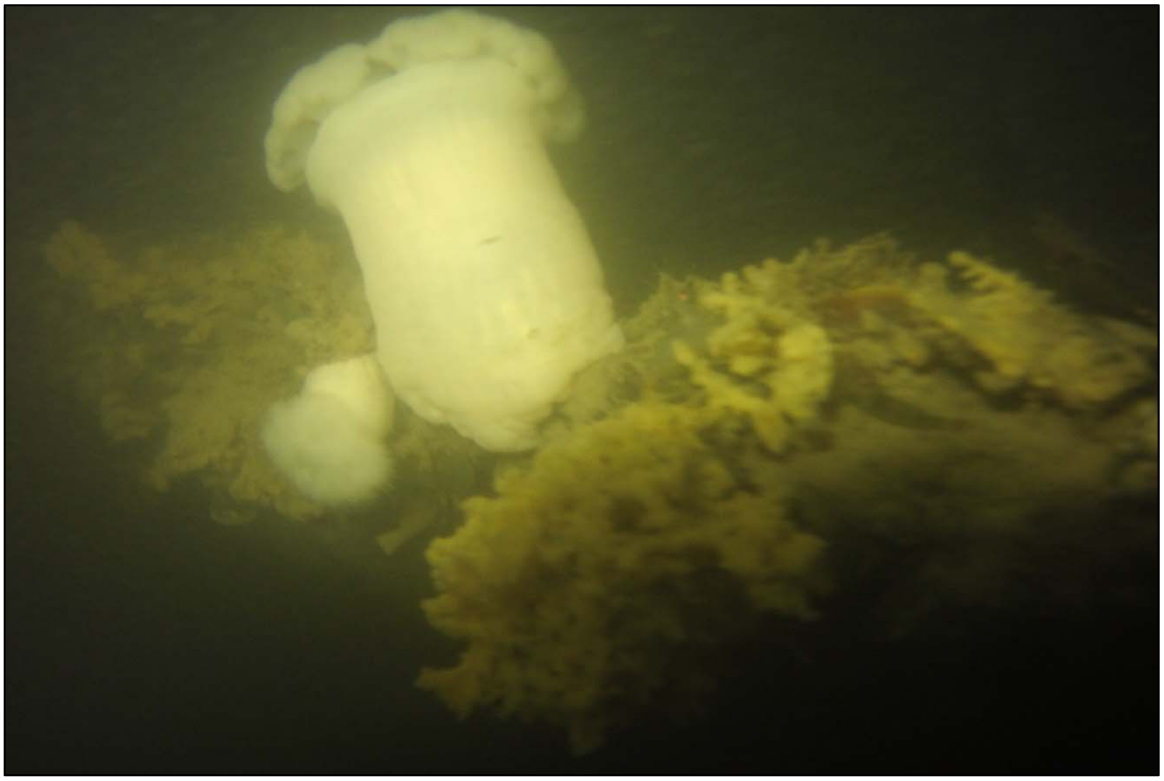
Photograph 27: View of Safety Wire Located on Upper Anchor Chain to Rope Connection (Thimble and Shackle) at Anchor 14 (Typical), Looking Northeast.

Photograph 28: View of Upper Thimble at Anchor 18 (Typical), Looking North.



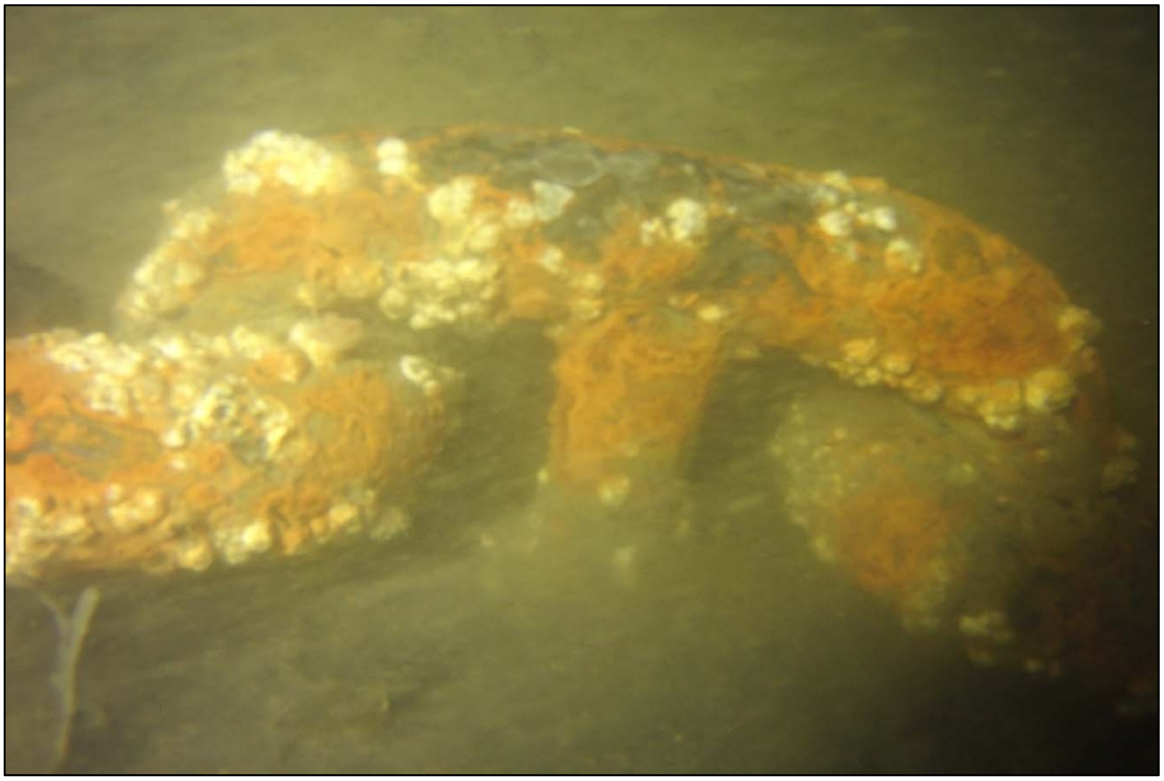
Photograph 29: View of Rope with No Significant Marine Growth at Anchor 18 (Typical), Looking North.

Photograph 30: View of Rope with Light Marine Growth at Anchor 22 (Typical), Looking Northwest.

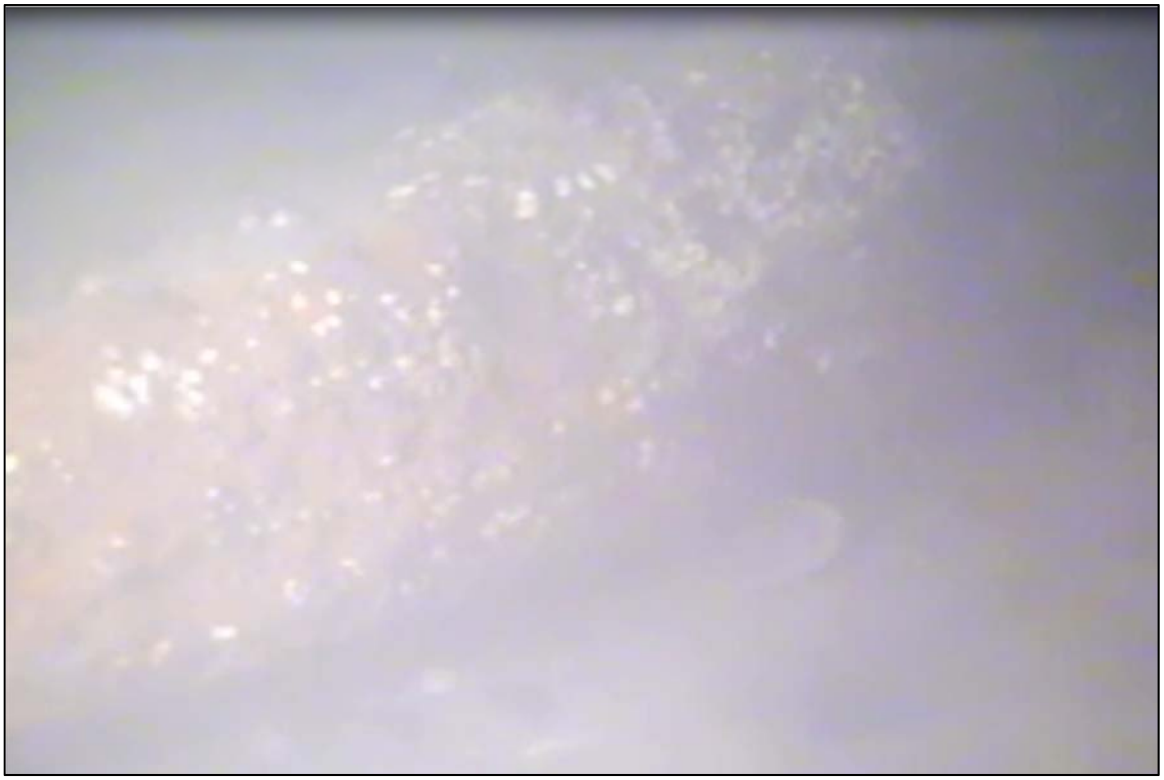


Photograph 31: View of Rope with Heavy Marine Growth at Anchor 17 (Typical), Looking South.

Photograph 32: View of Lower Anchor Chain to Rope Connection (Thimble and Shackle) at Anchor 21 (Typical), Looking East.



Photograph 33: View of Lower Anchor Chain on Channel Bottom at Anchor 21 (Typical), Looking East.



Photograph 34: View of Anchor Stem Located on the Channel Bottom at Anchor 11, Looking Southeast.

Photograph 35: View of Anchor Fluke Located on the Channel Bottom at Anchor 11, Looking Southeast.

Photograph 36: View of Upper Anchor Chain Below Water at Anchor 14, Looking Southeast.

Photograph 37: View of Lower Anchor Chain on Channel Bottom at Anchor 15, Looking East.

Photograph 38: View of Lower Thimble on Channel Bottom at Anchor 19, Looking Southeast.

Photograph 39: View of Severe Section Loss in the Anchor Chain at Anchor 20, Looking South.

Photograph 40: View of Concrete Anchor Attached to Area of Severe Section Loss in Anchor Chain at Anchor 20, Looking South.

Photograph 41: View of Lower Anchor Chain on Channel Bottom at Anchor 22, Looking Northwest.

Photograph 42: View of the Exposed Anchor Stem at Anchor 3, Looking Southwest. Photo taken from an ROV.

Photograph 43: View of half-buried Shackle at the Lower Anchor Line to Anchor Connection at Anchor 2, Looking West. Photo taken from an ROV.

Photograph 44: View of the Lower Anchor Chain on the Channel Bottom at Anchor 1, Looking Southwest. Photo taken from an ROV.

Appendix C – Photographs at Hope Island Net Pens

Figure C-1: Hope Island Net Pens (GoogleEarth – July 2017)

Figure C-2: Hope Island Net Pens - Overview from NW

Figure C-3: Hope Island Net Pens - Overview from NE

Figure C-4: Hope Island Net Pens - NE Corner of Pens

Figure C-5: Hope Island Net Pens - SE Corner of Pens, Looking North

Figure C-6: Hope Island Net Pens - SW Corner of Pens, Looking North

Figure C-7: Hope Island Net Pens - NW Corner of Pens, Looking North

Figure C-8: Hope Island Net Pens - NW Corner of Pens, Looking North

Figure C-9: Hope Island Net Pens - NW Corner of Pens, Looking North

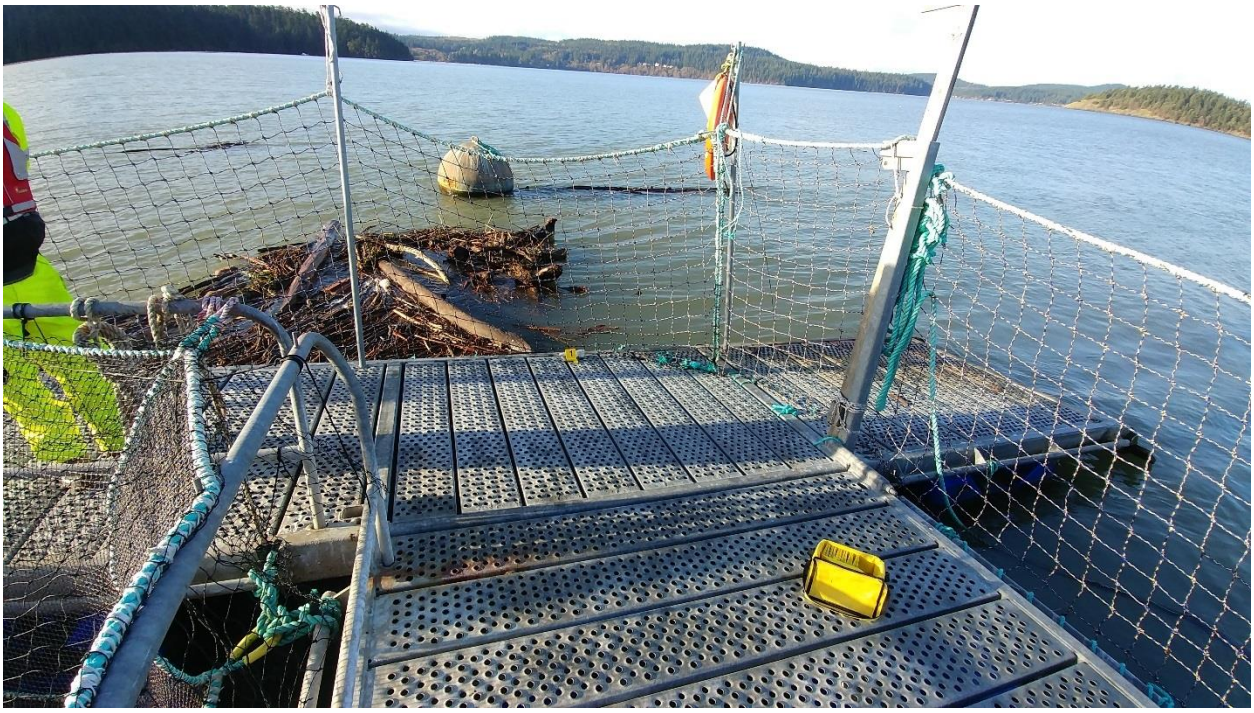


Figure C-10: Hope Island Net Pens - NW Corner, Inadequate Flotation

Figure C-11: Hope Island Net Pens - NW Corner, Sinking Platform

Figure C-12: Hope Island Net Pens - SE Corner, Inadequate Flotation

Figure C-13: Hope Island Net Pens - SE Corner, Sinking Platform

Figure C-14: Hope Island Net Pens - Debris Buildup on South End, Looking East

Figure C-15: Hope Island Net Pens - Debris Buildup on South End, Looking West

Figure C-16: Current from the South Traps Debris Against the Net Pen

Figure C-17: Current from the South Traps Debris Against the Net Pen

Figure C-18: Current from the South Creates Drag on the Containment Nets

Figure C-19: Current from the South Creates Drag on the Containment Nets

Figure C-20: Anchor #1, NW Corner of the Net Pens

Figure C-21: Anchor #1, NW Corner of the Net Pens

Figure C-22: Anchor #2, West Side of the Net Pens

Figure C-23: Anchor #2, West Side of the Net Pens

Figure C-24: Anchor #3, West Side of the Net Pens

Figure C-25: Anchor #3, West Side of the Net Pens

Figure C-26: Anchor #4, West Side of the Net Pens

Figure C-27: Anchor #4, West Side of the Net Pens

Figure C-28: Anchor #5, West Side of the Net Pens

Figure C-29: Anchor #5, West Side of the Net Pens

Figure C-30: Anchor #6, West Side of the Net Pens

Figure C-31: Anchor #6, West Side of the Net Pens

Figure C-32: Anchor #7, SW Corner of the Net Pens

Figure C-33: Anchor #7, SW Corner of the Net Pens

Figure C-34: Anchor #8, SW Corner of the Net Pens

Figure C-35: Anchor #8, SW Corner of the Net Pens

Figure C-36: Anchor #9, South Side of the Net Pens

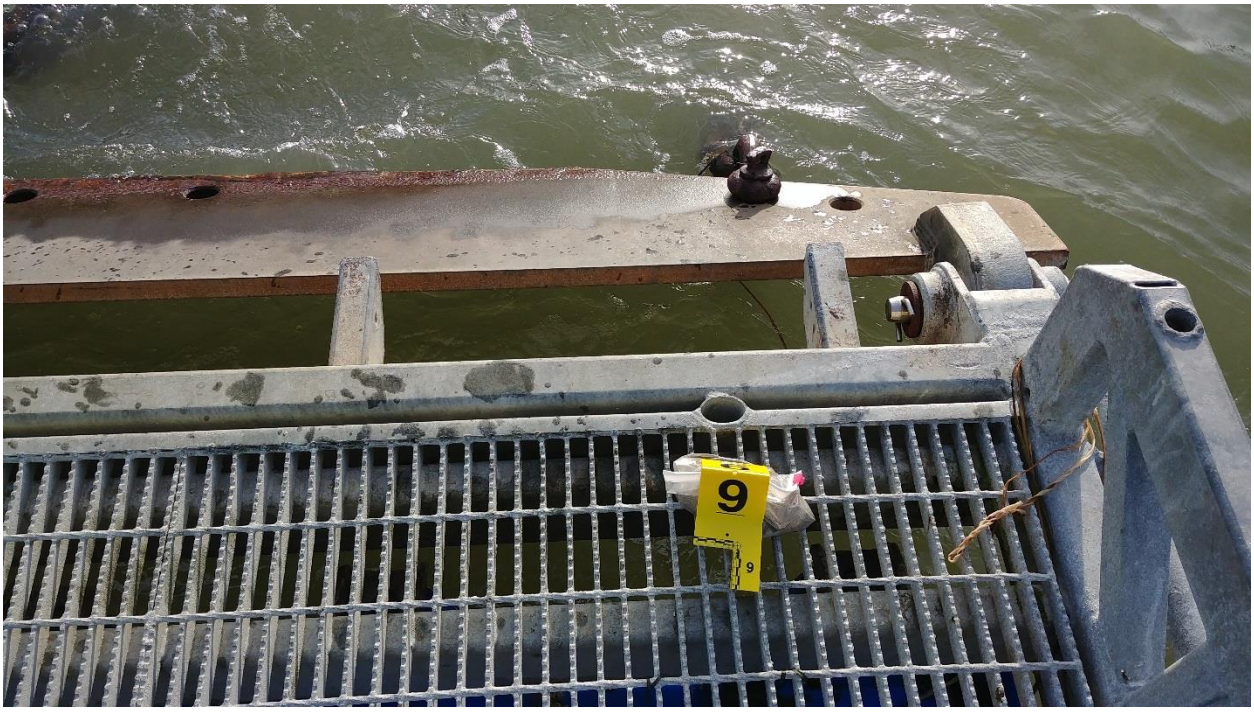


Figure C-37: Anchor #9, South Side of the Net Pens

Figure C-38: Anchors #9 and #10, South Side of the Net Pens

Figure C-39: Anchor #10, South Side of the Net Pens

Figure C-40: Anchor #11, SE Corner of the Net Pens

Figure C-41: Anchor #11, SE Corner of the Net Pens

Figure C-42: Anchor #12, SE Corner of the Net Pens

Figure C-43: Anchor #12, SE Corner of the Net Pens

Figure C-44: Anchor #13, East Side of the Net Pens

Figure C-45: Anchor #13, East Side of the Net Pens

Figure C-46: Anchor #14, East Side of the Net Pens

Figure C-47: Anchor #14, East Side of the Net Pens

Figure C-48: Anchor #15, East Side of the Net Pens

Figure C-49: Anchor #15, East Side of the Net Pens

Figure C-50: Anchor #16, East Side of the Net Pens

Figure C-51: Anchor #16, East Side of the Net Pens

Figure C-52: Anchor #17, East Side of the Net Pens

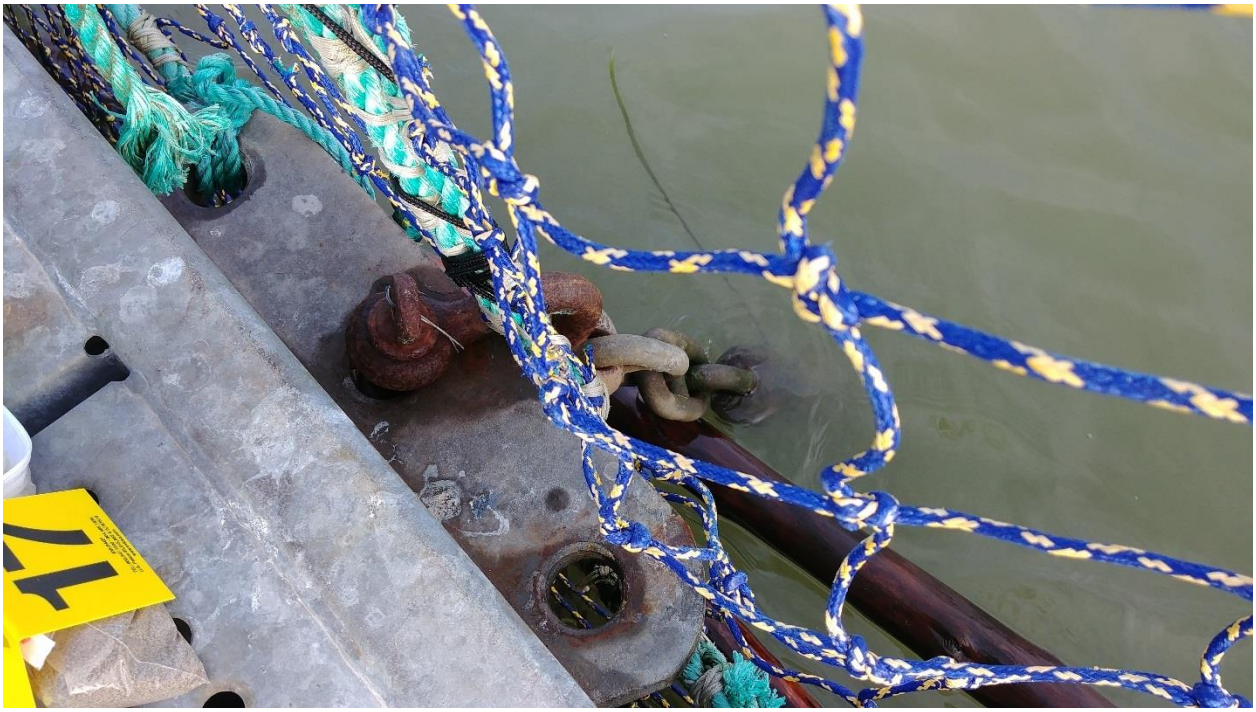


Figure C-53: Anchor #17, East Side of the Net Pens

Figure C-54: Anchor #18, NE Corner of the Net Pens

Figure C-55: Anchor #18, NE Corner of the Net Pens

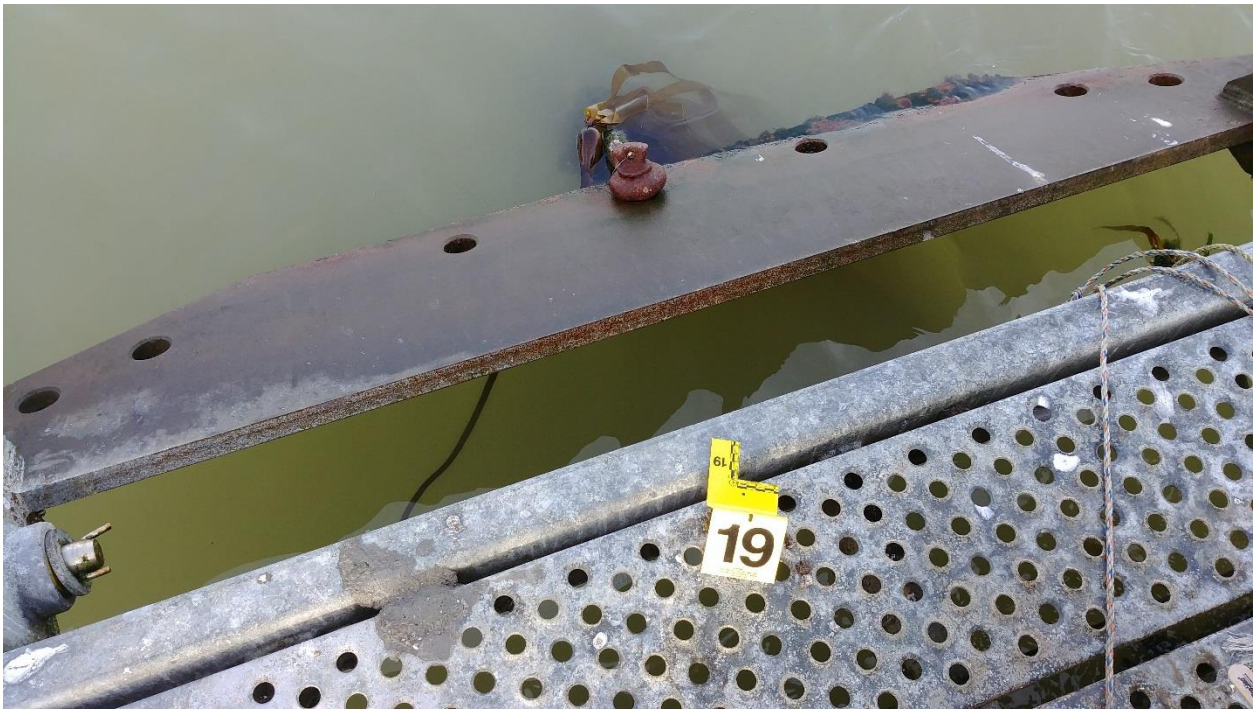


Figure C-56: Anchor #19, NE Corner of the Net Pens

Figure C-57: Anchor #20, SE Corner of the Main Barge. Part of an Anchor Bridle System.

Figure C-58: Anchor #20, SE Corner of the Main Barge. Part of an Anchor Bridle System.

Figure C-59: Anchor #20, NE Corner of the Main Barge. Part of an Anchor Bridle System.

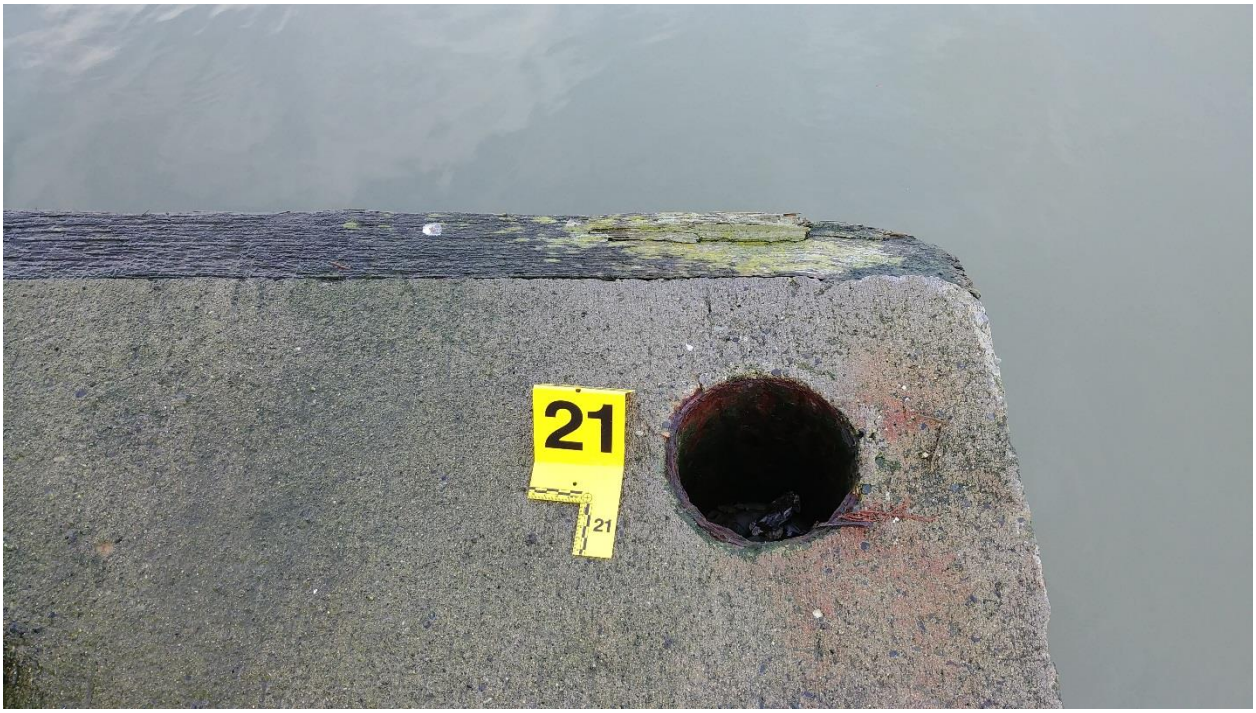


Figure C-60: Anchor #21, NE Corner of the Main Barge. Part of an Anchor Bridle System.

Figure C-61: Anchor #21, NE Corner of the Main Barge. Connection Point Shared with Anchor #21..

Figure C-62: Anchor #21, NW Corner of the Main Barge. Part of an Anchor Bridle System.

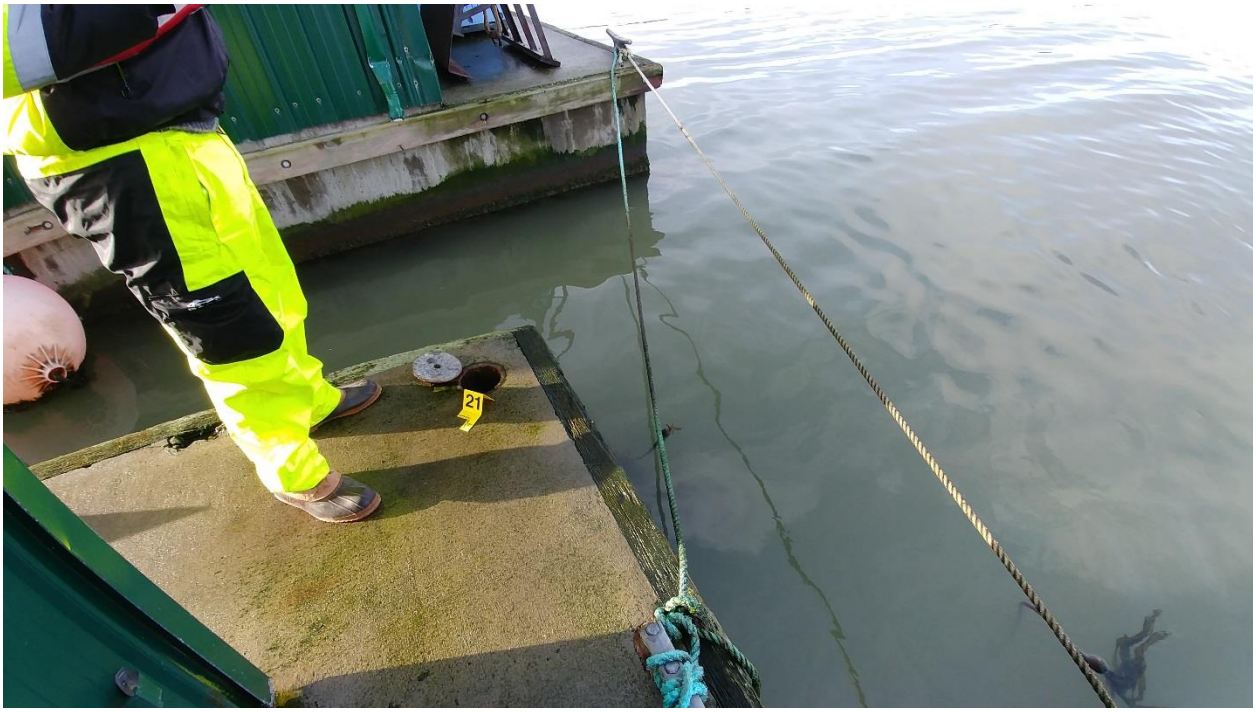


Figure C-63: Anchor #21, NW Corner of the Main Barge. Part of an Anchor Bridle System.

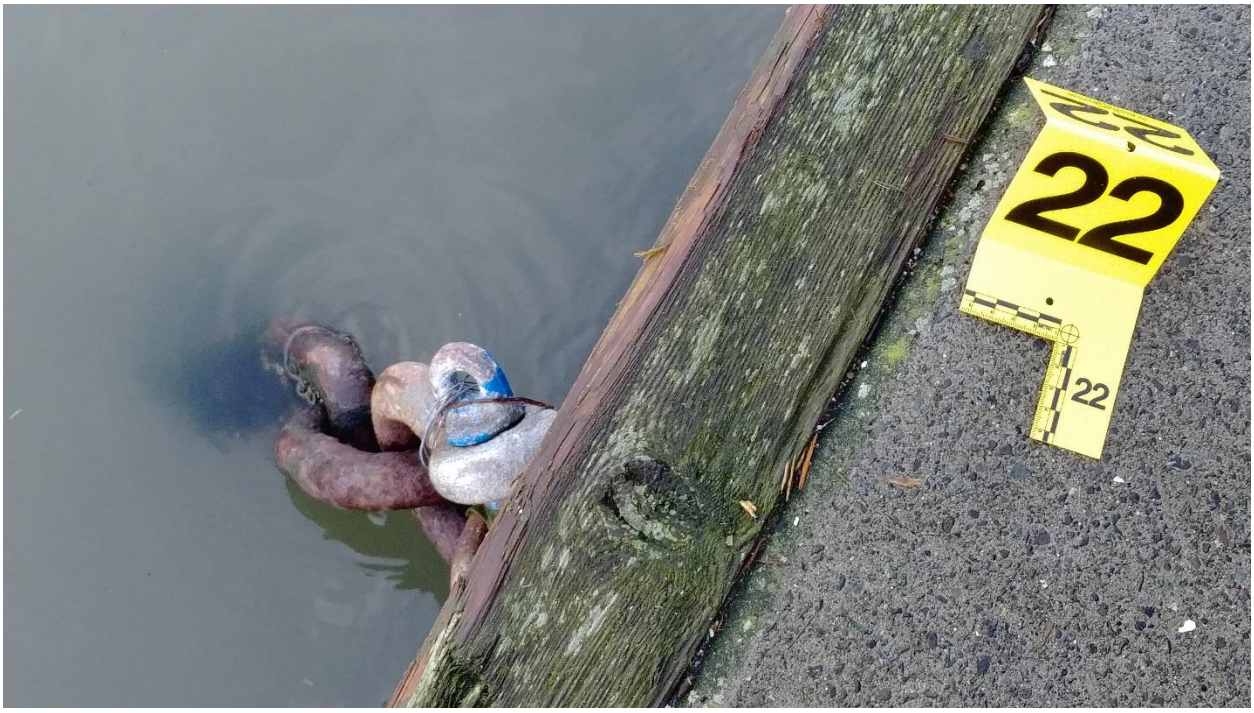


Figure C-64: Anchor #22, North Side of the Feed Barge, East of Centerline.

Figure C-65: Anchor #22, North Side of the Feed Barge, East of Centerline.

Figure C-66: Anchor #23, North Side of the Feed Barge, West of Centerline.

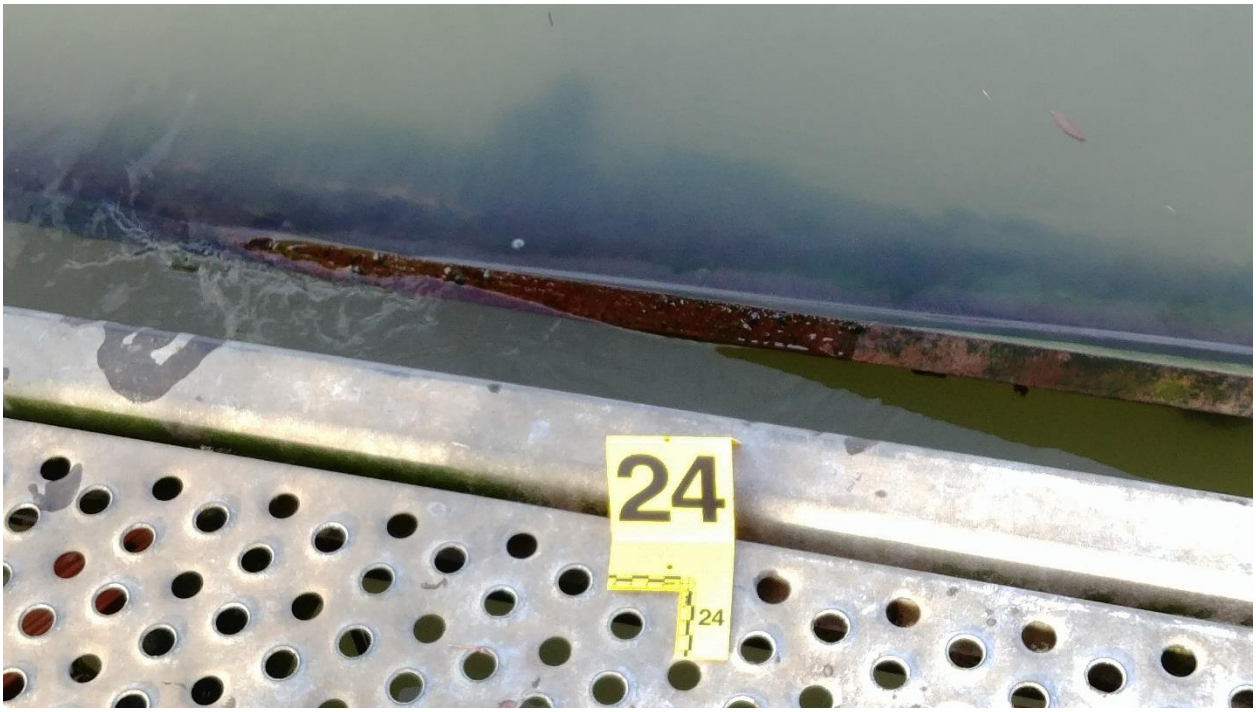


Figure C-67: Anchor #24, NW Corner of the Net Pens, Near Anchor #1

Figure C-68: Anchor #25, West Side of Feed Barge. Anchor Bridle System.

Figure C-69: Anchor #25, West Side of Feed Barge. Anchor Bridle System.

Figure C-70: Moderate Corrosion of

Figure C-71: Minor Corrosion

Figure C-72: Dissimilar Metals

Figure C-73: Exposed Nail

Figure C-74: Rusted chain and Barge Framing Members

Figure C-75: Rusted chain and Barge Framing Members

Figure C-76: Horn on Mooring Cleat Has Sheared Off at the Bolt

Figure C-77: Mooring Cleat Removed from its Original Location and Reattached into the Timber Waler

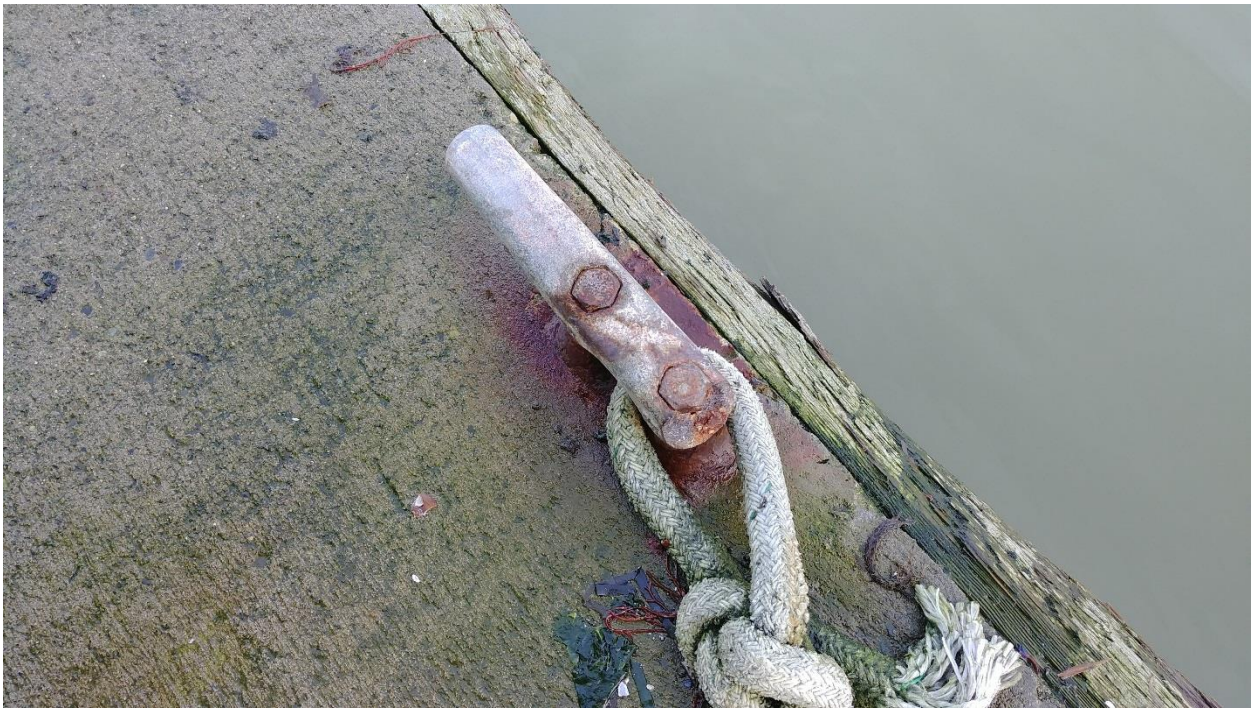


Figure C-78: Horn on Mooring Cleat Has Sheared Off at the Bolt

Figure C-79: Mooring Cleat has been Torn Out and is Missing

Figure C-80: Horn on Mooring Cleat Has Sheared Off at the Bolt.

Figure C-81: Concrete on South Side of Feed Barge is Cracked and Nearly Spalling Off

Figure C-82: Concrete on South Side of Feed Barge is Cracked and Nearly Spalling Off

Figure C-83: View Looking NW at the Main Barge

Figure C-84: Gangway Connecting Net Pens to Dive Float. Note Low Overhead Clearance.

Figure C-85: Gangway Connecting Dive Float to Main Barge. Note No attachment, only Bearing.

Figure C-86: South Side of Main Barge, Showing rafting of Intermediate Barge.

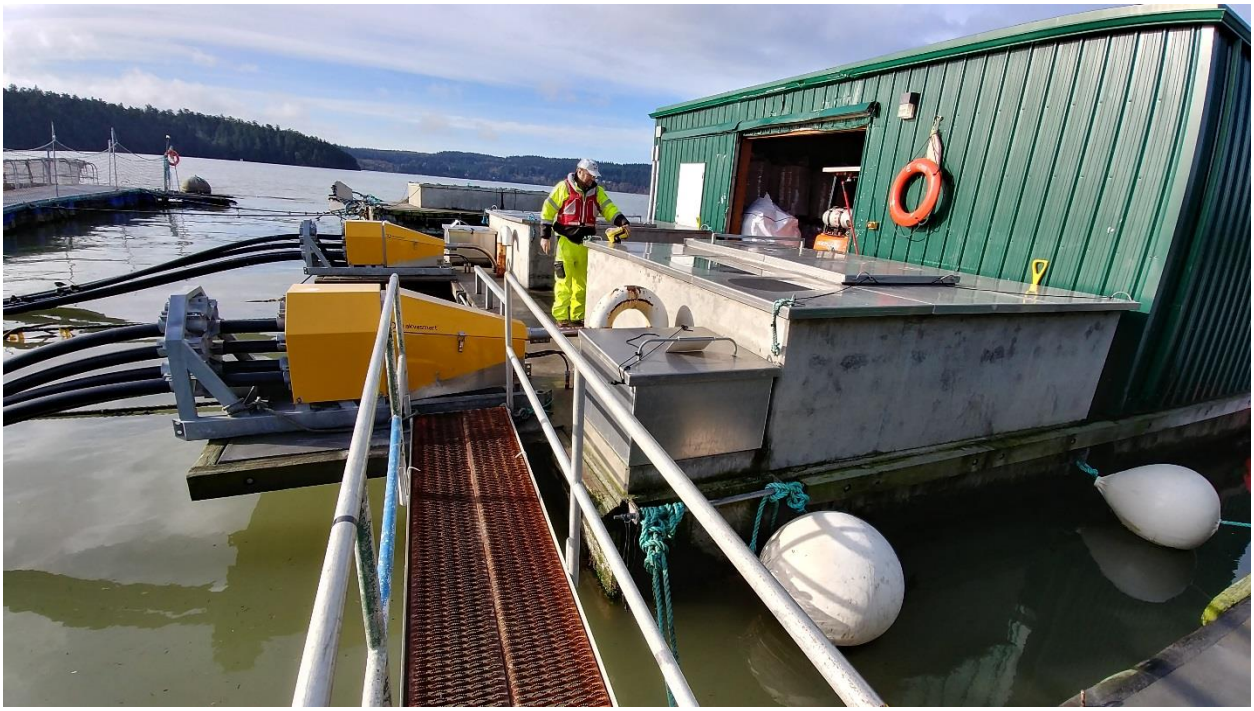


Figure C-87: View Looking NW at the Feed Barge

Figure C-88: Feed Blower Blocks Gangway between Main Barge and Feed Barge

Figure C-89: Feed Barge, Containing Feed Silos and Storage. Forklift does not leave Feed Barge.

Figure C-90: No Walkway Connection Between Feed Barge and Net Pens.

Figure C-91: Metal Siding on West Face of Feed Barge is Not Attached, Peeling Away from Wall

Figure C-92: Additional Feed Barge Tethered to Net Pens.

Figure C-93: Additional Feed Barge Tethered to Net Pens.

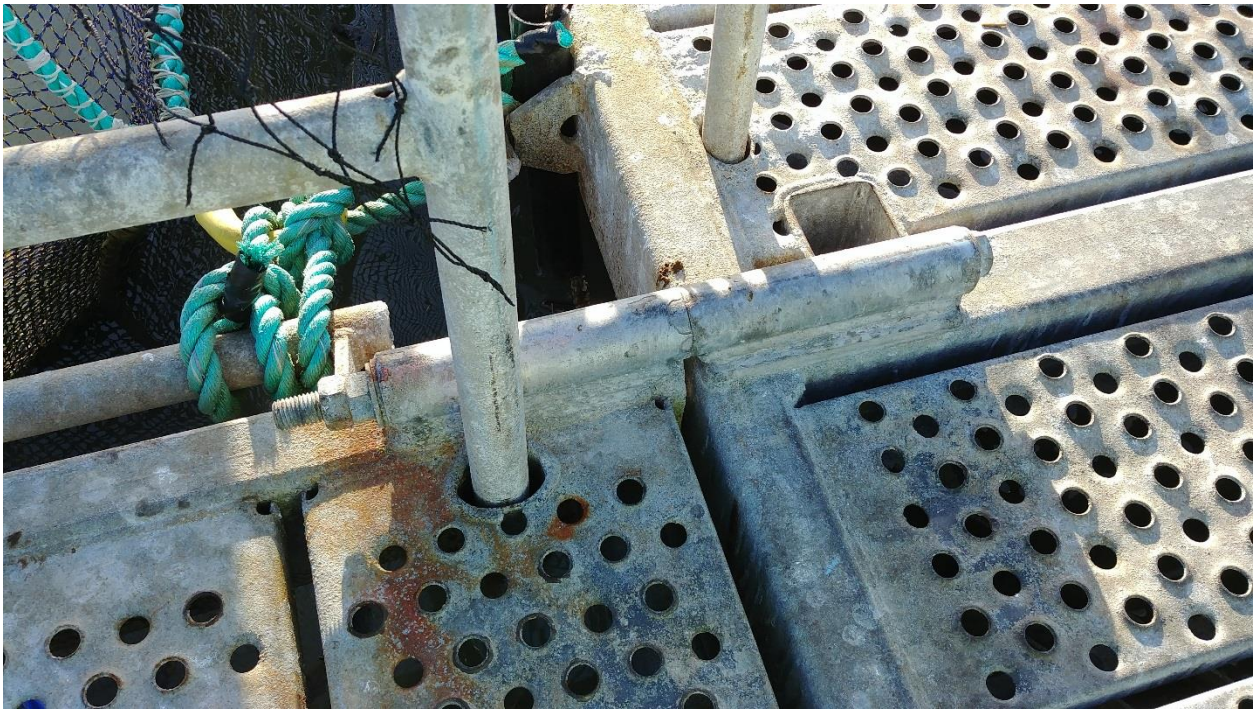


Figure C-94: Barrel Hinge Connection Between Main Walkways and

Figure C-95: Hinge between Segments of Main Walkways

Figure C-96: Hinge between Segments of Main Walkways with UHMW Covering Side Pipe

Figure C-97: Pin Connecting Hinged Segments of Main Walkways

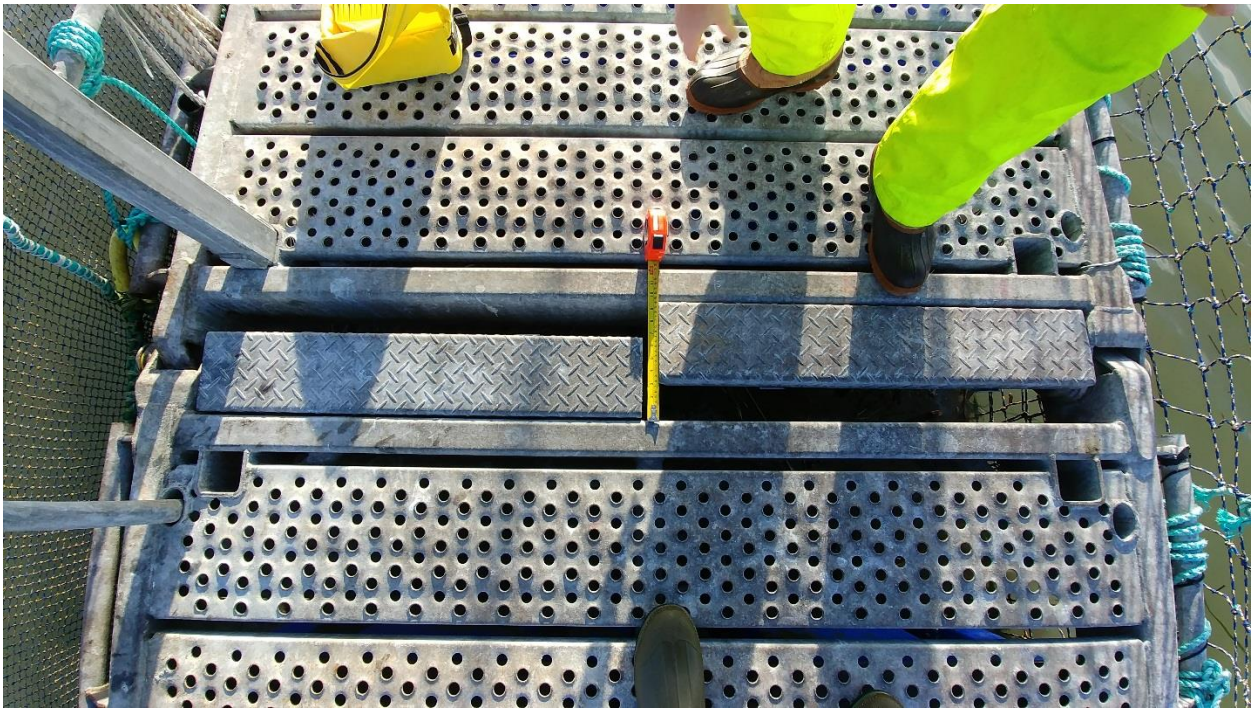


Figure C-98: Cantilevered Transition Plates between Main Walkway Segments

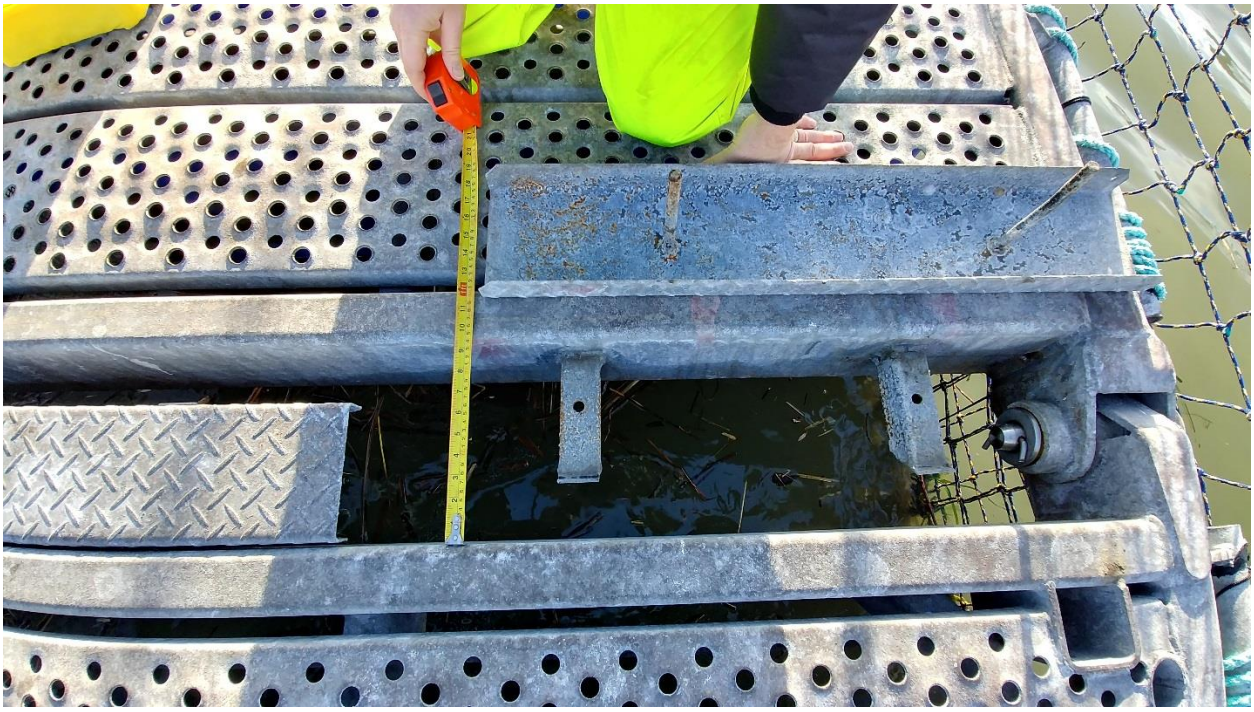


Figure C-99: Cantilevered Transition Plates between Main Walkway Segments - Removed

Figure C-100: Walkway Hinge Bushing, Containment Net Railing Being Used as a Conduit

Figure C-101: Float Tub Example – Plastic Tubs with Foam Inside

Figure C-102: Mooring Buoys, NE Corner. The Far-Right Buoy is not a part of the anchoring system.

Figure C-103: Mooring Buoys, SE Corner. Note the Current and the Floating Debris.

Figure C-104: Mooring Buoys, SW Corner. Note the Current Surrounding the Buoys.

Figure C-105: Mooring Buoys, NW Corner. Floating Debris Has Built up around the Buoy.

Figure C-106: Minor Corrosion of Walkway Hinge

Figure C-107: Damaged Predator Net Railing, West Side of-Facility

Figure C-108: Majorly Corroded Bolt and Steel Framing Connecting Float Tub

Figure C-109: Damaged Support Post Bracket

Figure C-110: Moderate Corrosion of Central Walkway Bullrail

Figure C-111: Minor Corrosion of Central Walkway Bullrail

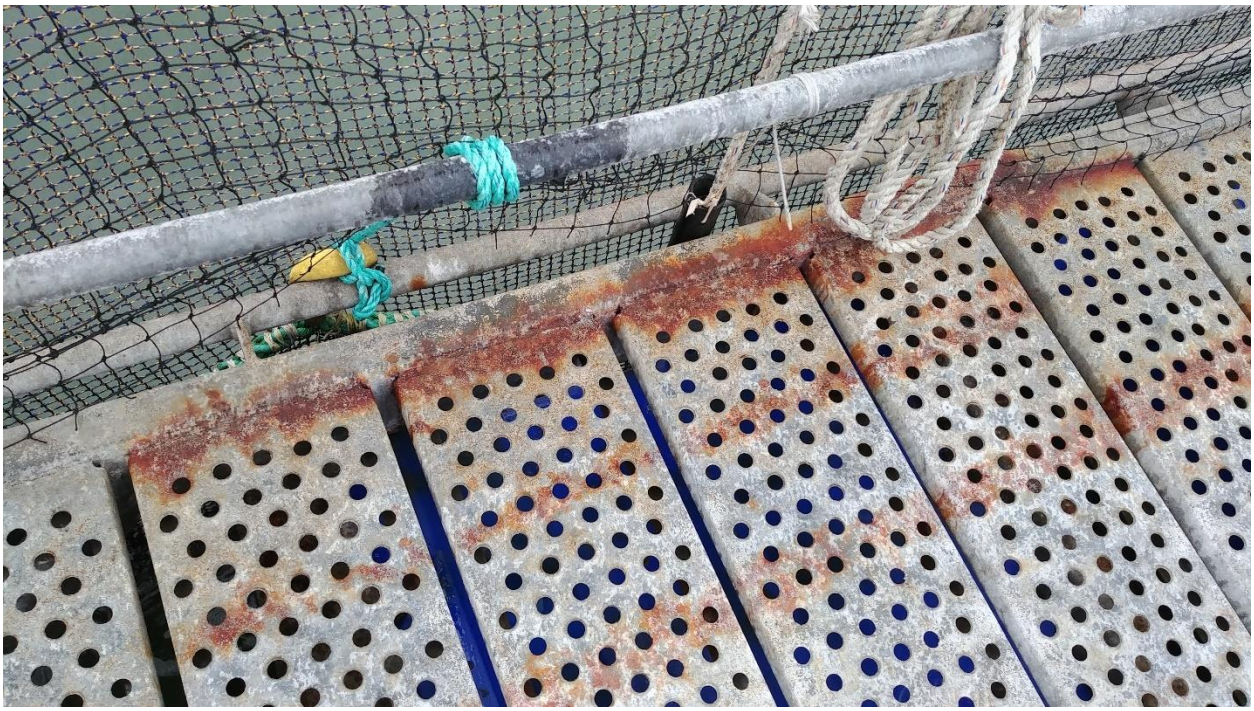


Figure C-112: Minor Corrosion of Steel Walkway Grating, Due to Fish Splash Back

Figure C-113: Non- Salmon Fish was Spotted Inside of one of the Pens

Figure C-114: Forklift Parked on Central Walkway

Figure C-115: Assorted Equipment on one of the Connecting Walkways

Figure C-116: Assorted Equipment is Causing Connecting Walkway to Deflect

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