MOTT MACDONALD

Cypress Island Site 3 Atlantic Salmon Net Pens Engineering Assessment

January 29, 2018

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Acronyms and Abbreviations

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

Certifications

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

Date: January 29, 2018

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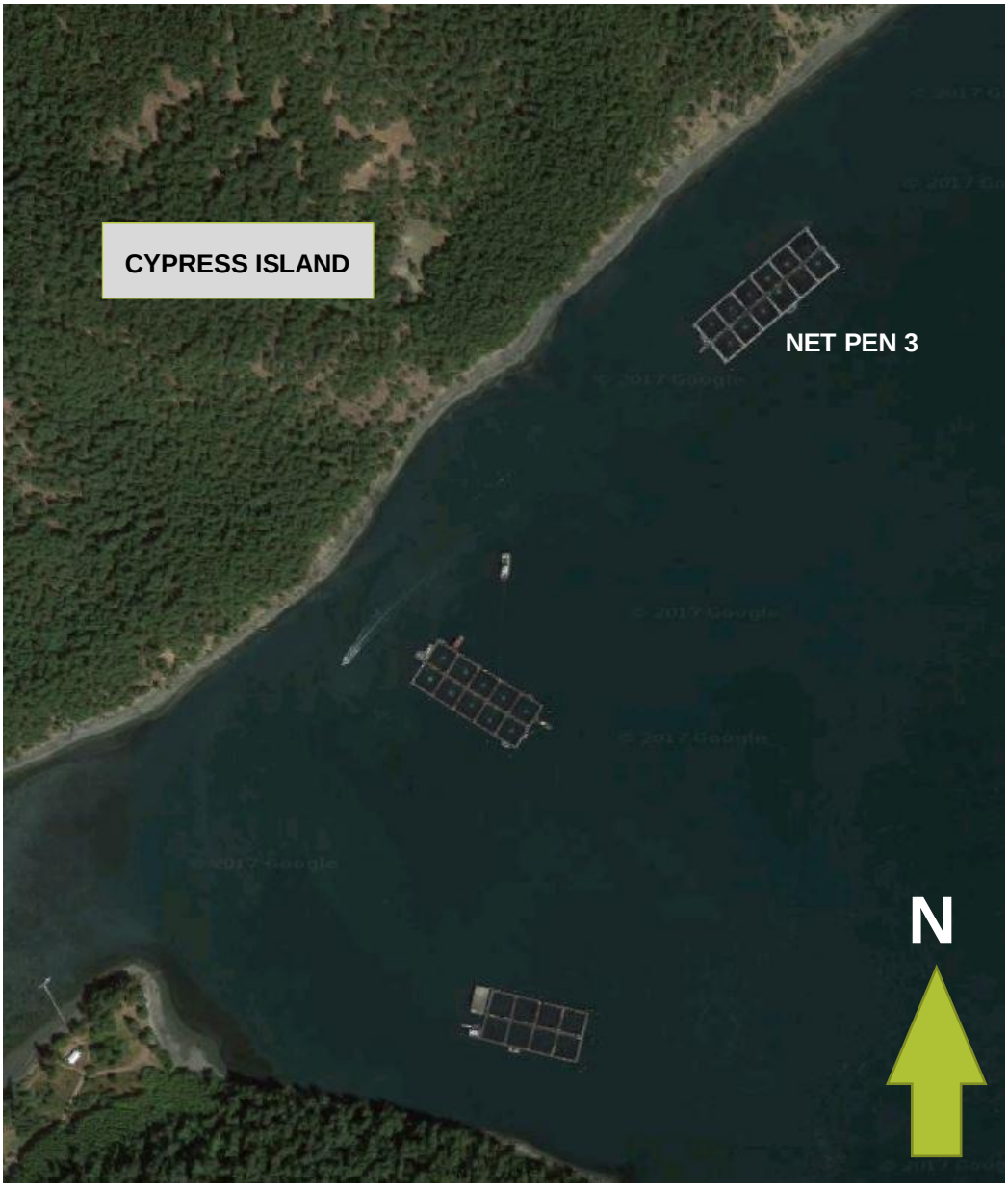
1 Introduction

This report presents the results of a document review, site visit and engineering assessment of Site 3, near Cypress Island, owned by Cooke Aquaculture. **Figure 1** is an aerial photo of the site. This work has been performed by Mott MacDonald for the State of Washington Department of Natural Resources (DNR). The dive inspection portion of the work has been performed by Collins Engineers, Inc. as a subconsultant to Mott MacDonald.

Figure 1: Cypress Island Net Pens – Aerial Photo



Source: GoogleEarth 7/24/2017

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

This report is for use by DNR and other state agencies. The information from the engineering assessment reports may be used by DNR to address outstanding lease obligations and for making proprietary and regulatory decisions.

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. 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 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.
- Site visit observations and dive inspection with respect to the above listed documents and standards.

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 above water at the time of the site visit. These included the grating, the visible framing components of the floats, mooring brackets on the floats, and cleats. Not included in this review are mechanical systems and utilities, such as lighting, power and water lines, pumps, and fish feeder systems.

This assessment is focused on the structural elements of the net pens. The floating shed and barge and the crew quarters (The House) are included for completeness, but were not inspected in detail. Mott MacDonald did not access closed spaces or access the roof of the floating shed or the House.

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 and listed below in **Table 1**. These are assigned to the major components of the facility.

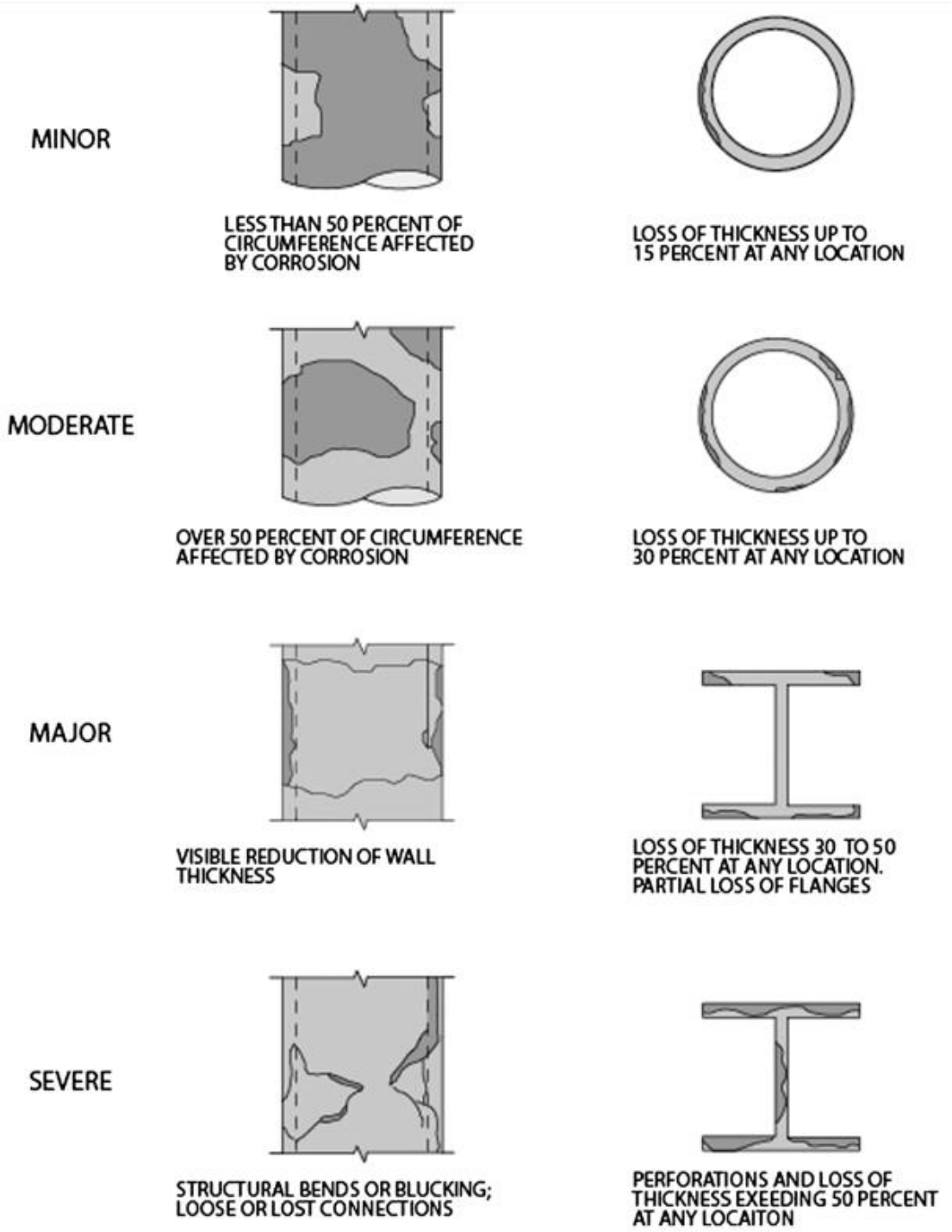
Table 1: Condition Assessment Rating

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

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

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

Figure 2: Damage Rating for Steel Elements



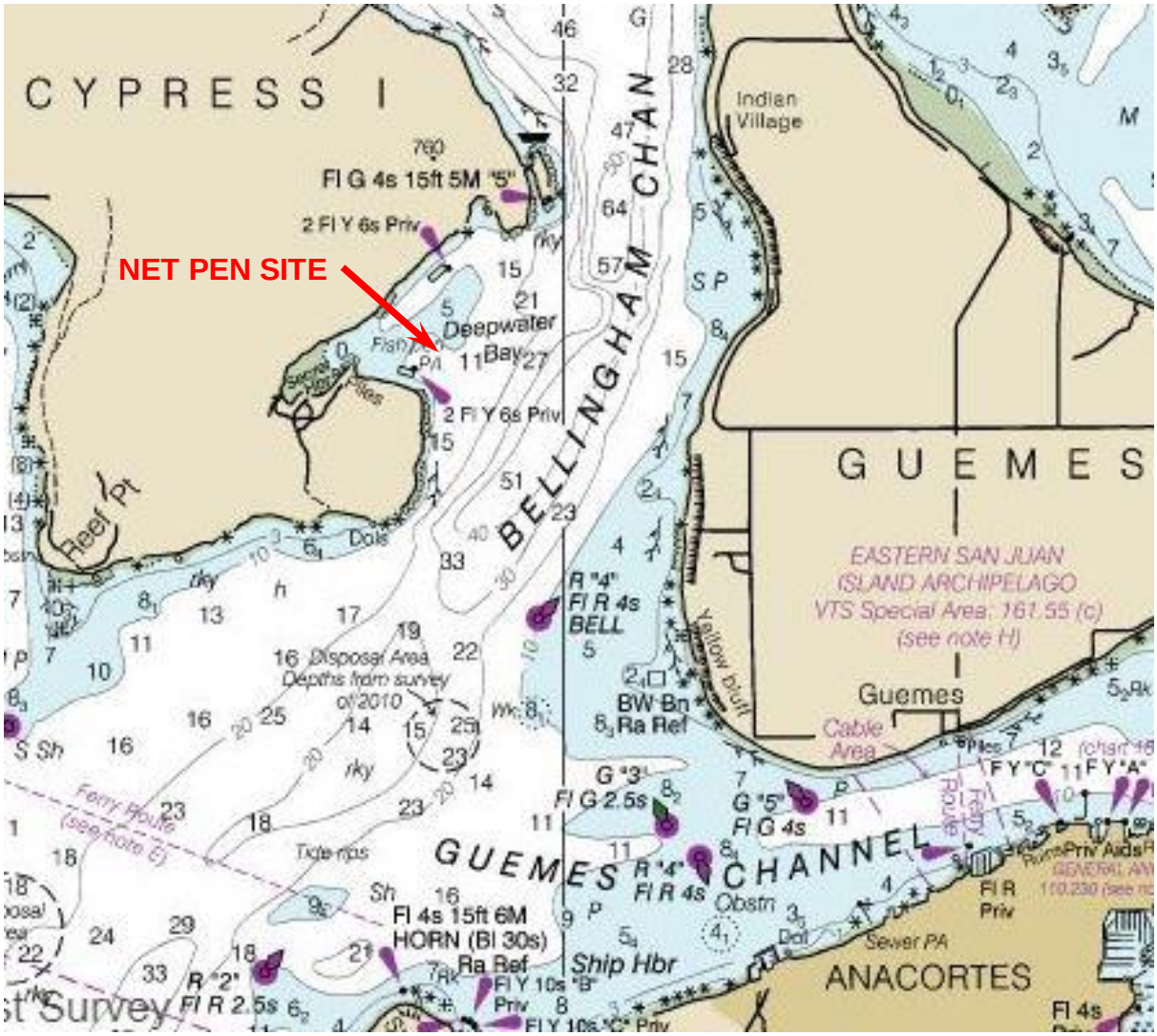
Source: ASCE Standard of Practice No. 130 "Waterfront Facilities Inspection and Assessment"

2 Document Review

The Cypress Island fish farm consisted of three net pens. Each net pen was made up of a moored floating structure relying upon forces imposed on the walkway floats and net systems to be resisted by a series of mooring chains and anchors. The following is a summary of the key components of Site 3:

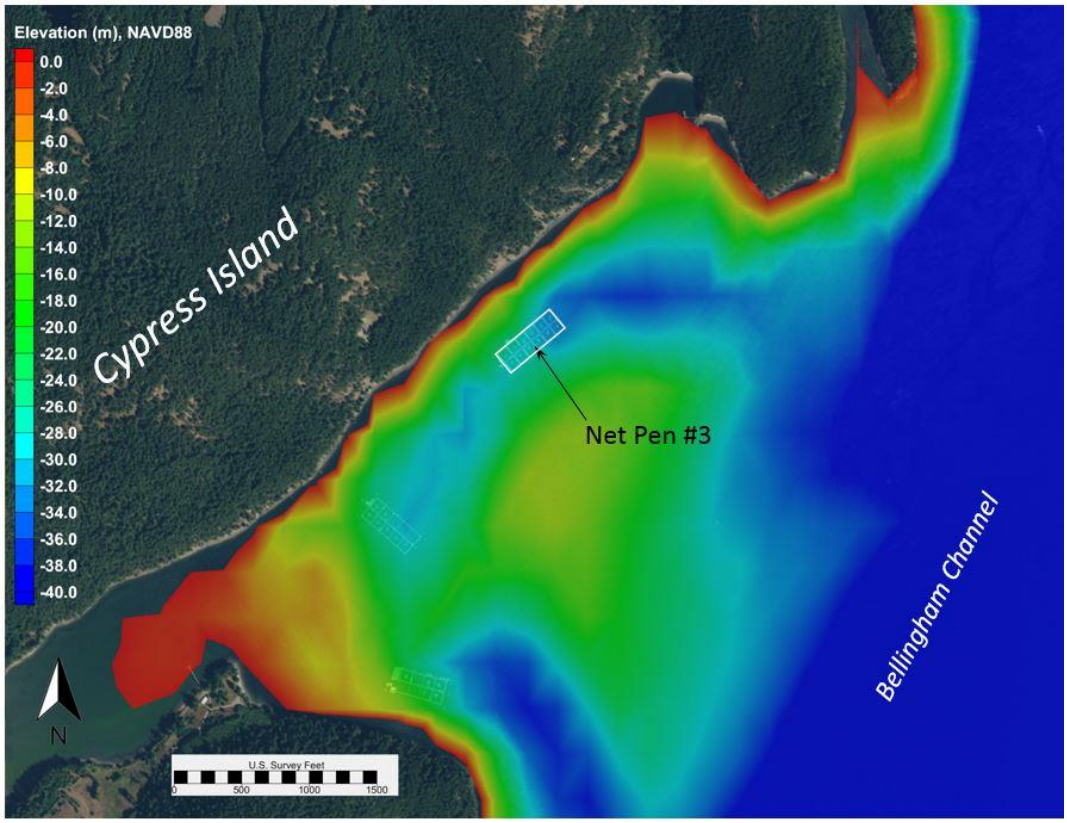
The Cypress Island facility is located in Deepwater Bay on the east side of Cypress Island. **Figure 3** is an area map. **Figure 4** shows the bathymetry in more detail. The depths appear to be between 60 feet and 100 feet (MLLW) along the length of the Cypress Island net pens. Drawings in Appendix A show a general plan and photos of the existing facilities. Additional site photos are in Appendix C.

Figure 3: Area Map



Source: NOAA Chart 18421

Figure 4: Cypress Island Bathymetry



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

2.1 Document Review

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

Table 2: Document Review – Summary

No.	Description	Comments
General Documents received from Cooke		
1	Wavemaster Steel Cage System, brochure from AKVA Group.	This document includes a technical description of the cage system.
2	October 2017 Pollution Prevention Plan Updated, 6 pages	Not relevant to this report.
3	October 2017 Spill Prevention Control and Response Plan Undated, 5 pages.	Not relevant to this report.
4	2017 Cooke Aquaculture Fish Escape Prevention Plan. Updated January 2017, 9 pages.	Outlines requirements for moorage system damage inspections, frequency of inspection and post-storm inspection.
Cypress Island Specific Documents received from Cooke		
5	Cypress Island Aquatic Lands Net Pen Lease No. 201-B12517.	This document contains information about the net pen facility including the description of the facility, intended use, lease terms, existing and proposed improvements at the facility, and maintenance and repair

No.	Description	Comments
		requirements. The document also has plans showing the layout of the facility.
6	Cypress Island Site 1 and 3 site plan fuel storage and spill kit locations, 2 pages	Includes a schematic site map.
7	Surface Inspection Reports from Oct. 19, 2017 to Nov. 9, 2017.	These documents show the comments from the inspection of the net pen facility during the period Oct. 19, 2017 to Nov. 9, 2017.
8		
9	Cypress Island Mooring Diagram, Excel spreadsheet	Mooring diagram of existing conditions, includes piles, anchors, chains, rodes, and information on inspection and replacement
10	NPDES Permit for Cypress Island Sites 1 and 3, each 30 pages	Issued 2007 and expired 2012. Not relevant to this report.
11	Fish stock containment net packing lists dated April 29 and 30, 2016	List of fishing nets that seems to have been attached to an invoice.
12	October 2017 Net Inventory	Inventory includes dimensions, mesh size, make, year made, etc.
Standards, Guidelines, Studies, Plans		
13	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.
14	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).
15	Recommended Interim Guidelines for the Management of Salmon Net-Pen Culture in Puget Sound – Dec. 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. Guidelines include water quality, site selection, and environmental surveys.
Miscellaneous		
16	2014 Fin Fish Aquaculture Plan of Operation – updated June 2014 by American Gold Seafoods	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.

Source: Mott MacDonald

3 Metocean Review

A review of environmental conditions of the Cypress Island Net Pen facility located on the east shoreline of Cypress Island, WA within Deepwater Bay (shown in Figure 4) was conducted as part of the facility review. Net Pen 3 is located approximately 400 feet offshore, in approximately 65 to 100 feet water depth. Environmental conditions at the site were described by the lessee in the lease agreement document (*AQUATIC LANDS NET PEN LEASE 20-B12517)* with DNR. American Gold Seafoods, LLC (AGS) was the lessee of the Cypress Island Net Pens site at the time of lease application submittal, and that document was submitted to DNR by the current lessee (Cooke) as their understanding of existing environmental conditions at the site. To evaluate the environmental conditions described in the lease document, Mott MacDonald conducted an independent assessment. The evaluation used publicly available data, as well as data from internal Mott MacDonald project databases. Environmental conditions reviewed include water levels, currents, winds, waves, and vessel traffic.

3.1 Water Levels

Tides at the Cypress Island net pens were described in the DNR lease document (20-B12517) as "…The extreme tidal range for the project is approximately 13.5 feet…".

Water levels and tidal datum data from a NOAA station (ID # 9449932) at Armitage Island approximately 5.5 miles west of the site were reviewed. This station has a diurnal tidal range of 7.84 feet and an estimated extreme tidal range of 13.5 feet[1]. The tidal datums and water levels are in **Table 3**. The length of record at the Armitage Island tide gage is approximately 3 years.

Table 3: Tidal Datums for Armitage Island, WA (NOAA Station No. 9449932)

Water Level	Elevation (feet, MLLW)
Highest Observed Water Level (12/16/1997)	10.45
Highest Astronomic Tide (predicted tide)	9.42
MHHW	7.84
MHW	7.23
MSL	4.66
MLW	2.32
MLLW	0.0
Lowest Astronomic Tide (predicted tide)	-4.08
Lowest Observed Water Level (6/22/1986)	-3.66

Source: NOAA

Assessment:

Mott MacDonald takes no exception to an extreme tide range of 13.5 feet.

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

3.2 Currents

Current velocities at the Cypress Island Net Pen site were described in the lease agreement as follows:

- Maximum current velocity for the site is 0.45 cm/s *(J. Rensel, Current Velocity Study, 1996)*.
- Average current velocity for the site is 0.35 cm/s *(J. Rensel, Current Velocity Study, 1996)*.

The document, "*Current Velocity Study" (*J. Rensel, 1996) was not provided to Mott MacDonald for review. Reported velocities of less than one centimeter per second are unlikely. Based on prior project experience in the Puget Sound, it is likely that the units were reported in error, and that units were intended to be in meters per second. Therefore, for this review it is assumed currents reported in the lease agreement were intended to be:

- Maximum current velocity for the site is 0.45 m/s.
- Average current velocity for the site is 0.35 m/s.

Reported currents were reviewed relative to publicly available information and data provided to Mott MacDonald by DNR. Review of the document *"NPDES Sampling Report 2002. Cypress Island Inc Net Pens"* (Rensel, 2003) includes measured currents at Net Pen #1 from a single day (September 21, 1994). This date was described as a "average amplitude tidal day" (Rensel, 2003). Reported daily maximum current for the average amplitude day was reported as 0.45 m/s, which matches the reported maximum current velocity for the site in the lease document.

Based on engineering experience and local knowledge in Puget Sound, extreme current velocities do not typically occur on average amplitude tidal days. Review of measured and predicted current velocities (during 2017) from a NOAA station (PUG1740, PCT2121) located in the main Bellingham Channel, 1.2 miles to the east of the net pens site, indicate that seasonal maximum current velocities can significantly exceed the daily maximum on days with an average tidal amplitude. Also, current velocities and directions can vary significantly by location. Measured currents at the current station may not be representative of currents at Site 3. Without long term measurements at the specific net pen sites, or a validated numerical model, estimates for maximum current speeds or directions at the site are not determined.

Assessment:

The extreme current velocities reported by the lessee appear to be low. The lessee reported maximum current velocity appears to be more representative of an average current velocity. The maximum current velocity at Net Pens 1 and 3 cannot be estimated without additional measured data at each of the net pens, or a numerical hydraulic model. The measured currents at Site 1 may not be representative of the currents at Site 3.

3.3 Winds

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

- Storm winds can exceed 50 knots.
- Typical storm winds are in the range of 20-30 knots (personal observation of farm staff).

- Southeasterly winds have the highest potential for large waves and the net pens. Site 3 has the greatest exposure to southeast winds.

Wind in the vicinity of the facility was assessed based on available data. The wind record at Padilla Bay Reserve (12 miles away), was evaluated for comparison to the wind conditions described by the lessee in the lease document. The 2-year return period sustained wind speed (2-minute average) at Padilla Bay is estimated to be approximately 38 knots. The 25-year return period sustained wind speed (2-minute average) is estimated to be approximately 55 knots.

Assessment:

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

3.4 Waves

Waves at the Cypress Island net pens site were described in the lease agreement as follows:

- The maximum wave height is typically less than 4 feet; however, waves of greater heights are occasionally observed.
- The largest wave heights observed over the past 20 years are estimated at 6 feet by farm personnel.
- Site 3 has the greatest exposure to wind and fetch from the southeast direction.
- Southeasterly winds have the highest potential for large waves and the net pens.

A review of wind-wave conditions at the net pens site was conducted. The project site is not exposed to ocean swell, and therefore only wind-waves affect the site. Wind-waves are generated by the stress of winds acting over a distance of water (also known as fetch). The maximum fetch to generate wind-waves at the project site is approximately 3.5 miles. Based on a calculation using an empirical wave generation method (USACE) and a 25-year return period wind speed of 55 knots, the significant wave height for wind generated waves near the nets is estimated to be less than 4 feet. Larger significant and maximum wave heights are possible at higher wind speeds.

Assessment:

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

3.5 Vessel traffic and Marine Navigation

Vessel traffic and marine navigation at the Cypress Island net pens site were described in the lease agreement as follows:

- There is recreational navigational use of the waters around Cypress Island and within Deepwater Bay.
- There is no commercial navigational use of the project site.
- The net pens are located well inside Deepwater Bay, far away from the designated commercial shipping lanes of Rosario Strait, Guemes Channel, and Bellingham Channel.

- The potential is for minimum impact to recreational boating of the area occupied by the net pens:
    - There is ample area around the net pens for safe passage of recreational boaters.
    - The net pen sites are well marked with navigation devices.

According to publicly-available vessel tracking data (Marine Cadastre, 2017), vessel traffic in Bellingham Channel can consist of tugs, cargo vessels, navy vessels, research vessels, fishing vessels, pleasure craft, passenger vessels, and tankers. The channel is approximately 0.5 miles from the net pen sites. Vessel wakes are unlikely to affect the net pen sites.

Assessment:

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

4 Net Pen Structure

The Cypress Island fish farm facility was first built in 1985. It consisted of three net pen structures. New structures for the net pens were installed at Site 3 in 2001. The exact details of this installation are unknown. **Figure 5** shows satellite imagery of the fish farm facility. Sites 1 and 2 appear to have been relocated between 2008 and 2011 based on a review of aerial photos.

Figure 5: Cypress Island Fish Farm Facility

Source: Google Earth

In August 2017, the Site 2 net pen failed and was removed. At the time of the site visit by Mott MacDonald, only Site 1 and Site 3 remained in Deepwater Bay.

The existing net pen structures appears to be a Wavemaster steel cage system. Site 3 consists of 12 square cages 80 ft. by 80 ft. The structures consist of walkways made up of a framework of heavy gauged, galvanized, steel box beams with galvanized metal perforated grating walkway welded on top. The steel walkways are interconnected by hinges and supported by plastic, foam-filled, floatation tubs bolted underneath the framework. These floating walkway structures support the nets forming the fish pens. The structures rely upon a series of mooring chains and anchors to resist the forces imposed on the floats and net systems. Although Net Pen #1 has a similar construction, Site 3 shows some differences. The mooring bracket design and the hinges between the floats are two distinct features which are different from those on Net Pen #1. Site 3 also appears to be a much newer structure as it shows much less signs of corrosion than what was observed at Net Pen #1. The exact installation date of Site 3 is unknown.

Following is a summary of the key components of the system which were reviewed as part of the site assessment work. The basis of the information includes the documents provided for review and our observations during the site visit. Drawings of the net pen structure are in Appendix A.

As shown in the drawings, in addition to the walkway float structures, Site 3 has a shed installed on floats connected to the walkway floats on the south. A finger made up floats is connected to the south side of the main net pen structure in line with the central walkway. This finger is used to moor vessels and access the net pen facility.

4.1 Anchors

A mooring system schematic plan was provided by Cooke and is included on Sheet 2 of Appendix A. There are 28 mooring lines identified on the Cooke Mooring plan. However, there are two extra lines on site attached to the net pen structure. One extra line is between lines 6 and 7 and the other is between 13 and 14. These lines were labeled as 6A and 13A respectively. Lines 1 through 19 (including 6A and 13A) are connected to anchors on the seafloor. The anchors on all lines are identified as Danforth type anchors of different weights ranging from 2,500 lbs to 6,000 lbs, except for those on lines 2 through 6. The anchors on lines 2 through 6 are labeled as Navy type anchors of weights ranging from 6,000 lbs to 8,500 lbs.

Lines 20 through 28 are connected to piles labeled “Casing Pins” on the plan. The casing pins are steel piles embedded in the seabed, close to shore but submerged at all tide levels. There are 6-in. diameter piles at line 23 through 25, and 24-in. diameter piles for the others. The type of anchors for lines 6A and 13A are not known, as during the underwater inspection, they were found to be completely buried.

4.2 Mooring Line & Hardware

The mooring lines are composed of upper anchor chains (approximately 30 ft.), nylon rode lines (200 ft. to 400 ft.), lower anchor chains (approximately 90 ft.) connected with shackles and other mooring hardware. The upper chain of the mooring line is connected to the float frame at the top, with its trailing end connected to the rode line. The trailing end of the rode line is connected to the lower anchor chain, which is ultimately connected to the anchor on the seabed. All lines except for 2, 19, and 21 through 26 have buoys which support the mooring lines by connecting to the upper anchor chains.

4.3 Mooring Line to Float Connection

The mooring lines are connected by steel shackles to steel plate mooring brackets. These brackets were welded to the float framing and were not hinged, unlike at Site 1 which were hinged. A typical bracket is shown in **Figure 6**. Most anchor mooring lines had a single point of attachment, rather than a “bridle” or “hen’s foot” arrangement as shown on the plan provided by the owner. A bridle connection divides the mooring line near the net pen into two lines that attach to two different points on the net pen structure.

Figure 6: Cypress Island Site 3 Typical Mooring Bracket

Source: Mott MacDonald

4.4 Predator Exclusion Net

Predator exclusion nets surround the exterior of the facility, connected to steel pipe railings that runs along the outboard perimeter of the walkway float framing. The predator exclusion nets are weighted down by steel pipes at the bottom. These nets are typically vertical in the water, and enclose the bottom of the entire net pen. Above the waterline, the nets are connected to steel poles slotted into the walkways at regular intervals to extend the nets vertically for approximately 4 feet above the walkway. This prevents seals and sea lions from accessing the floats and net pens and also discourages trespassing.

4.5 Fish Stock Containment Net

The fish stock containment net system connects to a steel pipe railing that runs along the inboard perimeter of the walkway float framing. The fish stock containment nets are additionally tied to the tops of the handrails to keep fish contained when jumping. According to Cooke, each fish pen net extends approximately 40 ft. 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 Walkways

Steel structural framing provides support for the walkways, predator exclusion nets, fish pen nets, and aviary nets. Walkway floats are modular units connected by a series of hinges with stainless steel pins. Underneath the walkways, the framing was supported by plastic, foam-filled flotation tubs. The surface of the walkway is made of perforated steel grating. The center walkway is wider with additional framing and flotation. The center walkway supports the fish

feeding equipment and provides a route for a small forklift. Forklifts typically operate only on the center walkway.

4.8 Float Tubs

The walkways are supported by plastic, foam-filled tubs bolted to the underside of the walkway framing.

5 Inspection, Maintenance & Repair History

A review of the inspection, maintenance, and repair history was primarily based on the information provided and as described by Cooke personnel during our site visit. Surface inspection sheets (Weekly inspection logs) from October 19, 2017 to November 2, 2017 were also reviewed.

5.1 Background

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

- DNR Aquatic Lease #20-B12517 (January 14, 2008). Tenant shall, at its sole cost and expense, keep and maintain the Property and all improvements (regardless of ownership) in good order and repair, in a clean, attractive, and safe condition. Tenant shall, at its sole cost and expense, make any and all additions, repairs, alterations, maintenance, replacements, or changes to the Property or to any improvements on the Property which may be required by any public authority. Minor maintenance to the cage structures, anchor lines and netting occurs throughout the year and on a continual basis. Major maintenance of cage structures is typically replacement. Average service life expectancy of new structures is approximately 15 years. Metal fatigue can be a factor based on constant wave action and flexing. Visual inspections of the below water connections are made periodically by divers, while the surface connections can be checked daily by farm staff. Components in the mooring systems are periodically replaced on average every 6 years of service; however, repairs are made as needed. Maintenance of fish stock containment nets is carried out on a year-round basis. Nets are replaced after approximately 6 years of service.
- Cooke Aquaculture Pacific Pollution Prevention Plan (October 2017). Document includes netwashing practices, weekly visual inspections of exposed lines, shackles, and mooring points, and annual inspection of below water mooring components.
- Wavemaster Steel Cages – Extracts from a brochure by AVKA Group, p.34 to 39. It include a description of the system and a specification table that lists the key dimensions and features for different model numbers.
- 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 19 to November 2, 2017. There is an additional inspection form which is undated. These include the mooring plan, and a table with the 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

- A table showing the inspection from October 2017 of the mooring line and anchor system listing their condition. Since this inspection covers the components underwater, this was likely a dive inspection.

- No other inspection documents were available for review.

The inspection reports state that all inspected components of Site 3 were “OK”.

5.3 Assessment

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

- Documentation of original design and historical maintenance is sparse based on the information provided at the time of this assessment.

- Inspections as outlined in the supplier documentation, and industry standards typically require a greater level of inspection and documentation thereof than what appears to be conducted and as outlined in the information provided for this assessment.

6 Site Visit and Existing Conditions

Mott MacDonald visited the net pen facility on January 10 and 14, 2018. Collins Engineers performed underwater inspection work on site from January 10-14, 2018, using both divers and ROV. The personnel present included Nels Sultan and John Jacob with Mott MacDonald, divers with Collins Engineers, Cooke Aquaculture employees, and DNR staff. **Figure 7** shows the net pens. Photographs are included in Appendices A and C. The dive inspection report by Collins is in Appendix B.

Figure 7: Cypress Island Site 3 – View from Southeast

Source: Mott MacDonald photograph January 10, 2018

During the site visit, observations were made and photos were taken. On January 10 at 7:40 am the weather was cool, 50°F, overcast, no precipitation, with winds light and variable, and the sea calm. Wake waves from passing vessels were not observed to be noticeable at the net pens during the site visit. The predicted tide elevations are below in **Table 4**. The predicted currents in are in **Table 5**. The predicted current speeds are at a point approximately 0.75 miles northeast of the Site 1 net pen**.** The maximum predicted current speed during the site visit on January 10 was 2.98 knots in the middle of the channel, but this current magnitude was not observed at the net pens during the site visit.

Table 4: Predicted Tide Elevation at Anacortes on January 10, 2018

Tide	Time (Pacific Daylight)	Elevation
High	1/10/2018 12:30 am	+5.7 feet, MLLW
Low	1/10/2018 4:46 am	+4.7 feet
High	1/10/2018 11:21 am	+8.7 feet
Low	1/10/2018 6:49 pm	+1.6 feet

Source: Tides&Currents Software

Table 5: Predicted Currents in Bellingham Channel on January 10, 2018

Time (Pacific Daylight)	Speed	Direction
2018-01-10 05:24 AM	0	slack
2018-01-10 08:44 AM	1.24 knots	045°, Flood
2018-01-10 10:53 AM	0	slack
2018-01-10 03:21 PM	2.98 knots	185°, Ebb
2018-01-10 07:48 PM	0	slack
2018-01-10 11:50 PM	0.79 knots	045°, Flood

Source: www.tidesandcurrents.noaa.gov

The components and observed deficiencies are discussed below, and summarized in **Table 6**. The assessment is based on the conditions observed during the site visit, a document review and our professional judgment and experience. See the drawings in Appendix A for the numbering system.

The year built is not known but the above water components appear newer than the Site 1 net pens.

Table 6: Cypress Island Site 1 – Existing Conditions Summary

Component	Year Built (estimate)	Description	Deficiencies	Component
Anchors	Unknown	All underwater anchors appear to exist but were not observed closely.	Anchor at line 19 was not aligned and adequately embedded in the seabed.	Satisfactory except for anchor at line 19 which does not have adequate embedment.
Mooring Lines	Unknown	Most underwater mooring lines and hardware appeared in satisfactory condition.	Some lines were observed to have corrosion with section losses up to 50%.	Satisfactory conditions but with severe section loss observed on anchor lines 17, 18, 19, and 23.
Steel Frame and Mooring Brackets	Unknown	Galvanized steel tube and structural sections, welded to form units connected by hinges.	Some surficial corrosion.	Satisfactory.
Float Tubs (plastic)	Unknown	Plastic, foam-filled tubs, bolted to underside of steel walkways.	Inadequate flotation along the East and West walkways causing the floating walkways to list outward.	Fair to Satisfactory.
Walkways, Gratings, and Railings	Unknown	Steel fabrication with metal perforated grate walking surface and hinged connections.	Minor corrosion at some locations.	Fair to Satisfactory.
Predator Exclusion Nets	Unknown	Aviary nets cover each fish pen and nets line to perimeter of the	None observed, not part of this inspection.	N/A

Component	Year Built (estimate)	Description	Deficiencies	Component
		facility to keep out marine mammals.		
Fish Stock Containment Nets	Unknown	Nets deployed within active fish pens	None observed, not part of this inspection.	N/A
Floating Barge and Shed	Unknown	Floats with wood framed shed on south of Site 3.	None observed, not part of this inspection.	N/A
Records and Documents at site	N/A		Not inspected.	Not inspected.

Source: Mott MacDonald

6.1 Anchors

- The anchors are three different types: Danforth, Navy, and casing pins (steel piles).
- Most anchors were observed by the divers to be almost completely buried under the seabed with minimal exposure, as expected, except for the anchors at line 19. This anchor was out of alignment, and consequently, had only one anchor fluke and its peg embedded to some extent in the seabed.
- The buried anchors were not observed during the underwater inspection.
- None of the anchors showed any signs of appreciable movement along the seabed.
- All casing pins indicate a stable anchorage. The piles at anchor line 20 and 26 are inclined approximately 30° to 45° horizontal towards the fish pens. This appears to be the result of excessive load exerted on the anchor line. It appears that the steel yielded (deformed) rather than a deformation of the soil.

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 structure, located at walkway intersections. Each bracket consists of a steel plate, approximately 1.34” thick, welded to the steel framing of the walkway floats. The mooring brackets typically have three holes each. Details of the connection are shown on Sheet 4 of the drawings in Appendix A. Typically, only one mooring line was connected to a single hole in each bracket.
- Mooring brackets were observed during our site visit to be in fair to satisfactory condition with minor corrosion observed in places.
- Above water, the anchor mooring lines consist of steel chains and shackles connected to the steel frame. Mott MacDonald has not reviewed an engineering study or mooring plan for this facility.
- Connections between the upper anchor chains of the mooring lines and the net pen float framing were generally found to be in satisfactory condition.
- The upper and lower anchor chains typically exhibited light to moderate corrosion. At anchor lines 17, 18, 19, and 23, the chains showed an estimated 25% to 50% section loss at certain locations on the upper anchor chain. On lines 26 and 27, the upper chains showed an estimated section loss of approximately 20%.

- The nylon rode lines were typically found to be in satisfactory condition with no excessive fraying or other detectable abrasion damage.
- In general, the mooring brackets and mooring lines observed were in satisfactory condition.

6.3 Steel Framing

- The primary structural framing consists of rectangular HSS steel members. The condition of the framing members is satisfactory with some members showing some surface corrosion.

6.4 Walkways

- Walkway surfaces consist of perforated steel grating panels.
- The walkways are interconnected by bushing type hinges at the ends of the framing members. Floats along the perimeter are connected to the interior floats by barrel hinges installed at the surface of the walkways. Generally, the hinges were in satisfactory condition. Minor corrosion of the hinges was observed in places.
- No corrosion protection measures such as anodes were observed on the facility.

6.5 Floats

- The walkways are supported by large, plastic, foam-filled tubs bolted to the underside of the framing.
- Flotation was observed to be insufficient along the east and west walkways of Site 3. These walkways were listing towards the outer periphery. According to Cooke staff, the floats were listing because there were no fish stock containment nets on the inside of the net pens to balance the weights holding predator exclusion nets on the outside.

6.6 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 bird predation of the fish stock. The predator exclusion nets also discourage trespassing, theft, and vandalism.
- The in-water nets are supported by pipe rails attached to the steel framing along the outside of the walkway floats. The nets are taut, vertical in the water when there is no current, and held in place by pipe weights at the bottom.

6.7 Fish Stock Containment Nets and Connections

- The containment nets confine the fish stock inside each individual pen. The nets are supported by pipe rails that surround the inside perimeter of each pen. Surface corrosion was observed on the pipe connections to the frame. Some of the nets had been pulled up on the date of the site visit with no fish in those pens. The nets in those pens were observed to be in fair condition.

6.8 Floats with Shed

- The floating shed is a one-story structure, consisting of timber framing on top of a floats. The purpose of this shed appears to be a temporary shelter for staff while working at Site 3 while also providing a storage space for miscellaneous equipment and documents. An assessment of the shed structure condition above the barge is outside the scope of this study.

6.9 Records and Documents On-Site

- No records or documents on site were reviewed.

7 Conclusions

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

1. Site History and Facility Age: Net pens have been at the site since the 1980's based on information in the lease agreement. It is believed that the net pens were installed new in 2008 or later. The exact age of the Site 3 net pens has not been determined.

   The age of the net pens at Site 3 (but not the mooring lines) is estimated to be 10 years or less. The lease agreement states that "the new cages have an average expected service life of approximately 15 years".

1. Environmental Conditions: The net pens are exposed to moderate to strong tidal currents, in addition to wind, wave and vessel wakes. The current has the potential to exert substantial loads on the nets, structure, and mooring systems. Current induced drag forces and other environmental loads need to be accounted for in the design and a site-specific mooring analysis.
2. Net Pen System Design:

   a. No site specific stamped engineering design documents for the original net pen structure design were available for review. Information in the manufacturer supplied information appears to be generic, and not specific to the system installed. The drawings and information in the brochure from AKVA Group are general information for the installed system.

   b. Site 3 appears to be a newer construction and installation than Site 1.

3. Mooring System Analysis and Design:

   a. The design of the mooring system is not documented. As such, there is no information to verify adequacy for site conditions.

   b. The schematic mooring diagram and notes describing the existing components, which was provided, does not show all the components of Site 3 accurately. There are additional anchor lines in the mooring system than what is shown on the schematic plan. 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. Underwater Components: Except for a few locations where corrosion was observed in the anchor chains, the mooring system appears to be in satisfactory condition. Although one anchor was found to not be adequately embedded in the seabed, there was no indication that any of the anchors had moved. The underwater inspection did not reveal any significant deterioration or deficiencies for the components or their connections that would suggest any appreciable reduction in their originally designed integrity or stability.
5. Components Above Water: The float framing, mooring brackets, and the walkway surfaces were observed to be in satisfactory condition. Besides a few spots showing surficial corrosion, the components above water did not show any significant signs of corrosion or damage.

6. Corrosion Protection: No corrosion protection measures were observed on Site 3 other than galvanizing.
7. Review of Inspection Documents:
    a. No Inspection reports besides the weekly inspection forms between October 19 and November 2 were available for review. The inspections conducted by Cooke do not appear to be in accordance with industry standards, or Cooke's latest Pollution Prevention Plan.

Overall, Site 3 appeared to be in satisfactory condition with no need for immediate major repairs.

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 underwater inspection.

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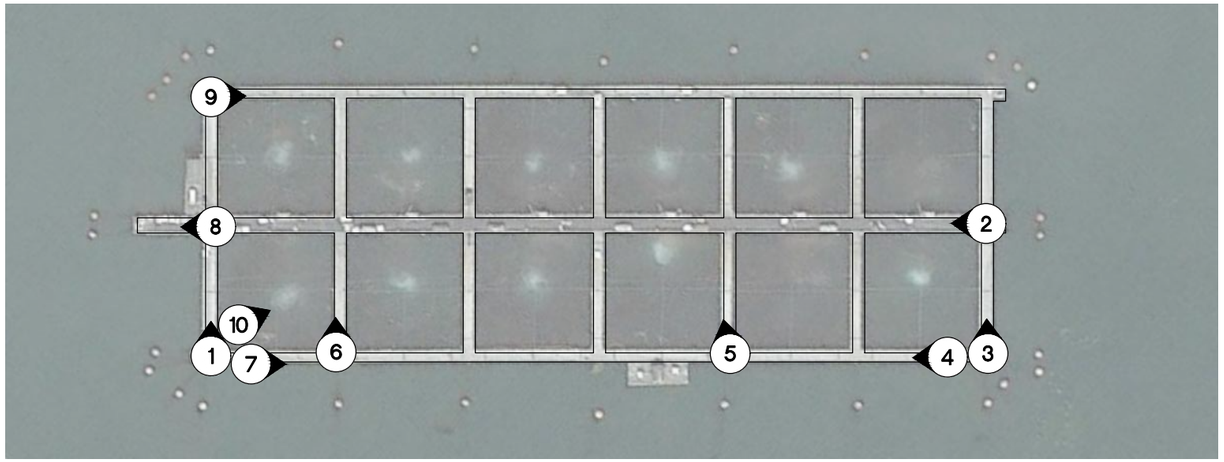
Weekly Cypress Site 1 Surface Inspection Sheet – 10/19/2017; 10/26/2017; 11/02/2017.



LEGEND

1 PHOTO LOCATION AND ORIENTATION

NOTES

MOORING SYSTEM NOT SHOWN, SEE SHEETS 2 AND 3

CYPRESS ISLAND NET PEN #3

PHOTOS-PLAN

0 50 100

SCALE IN FEET

PHOTO 1

PHOTO 2

PHOTO 3

PHOTO 4

PHOTO 5

PHOTO 6

PHOTO 7

PHOTO 8

PHOTO 9

PHOTO 10

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WASHINGTON DEPARTMENT OF NATURAL RESOURCES

Rev	Date	Drawn	Description	Ch'k'd	App'd
1	1/24/18	TM	PLAN AND PHOTOS	JJ	NS

Project Number 391980 | B/O 1 | Total 5

Designed	J. Jacob		Eng check	S. Phillips	
Drawn	T. Morrison		Coordination		
Dwg check	N. Sultan		Approved		

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

Drawing Number

Title

Washington State
Department of Natural Resources
Cypress Island Net Pen #3

Photo Locations Plan

Appendix A

CYPRESS ISLAND NET PEN #3

MOORING PLAN

NOT TO SCALE

NOTES

MOORING SYSTEM SCHEMATIC PLAN
PROVIDED BY COOKE AQUACULTURE.

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Project Number	B/O	Total
391980	2	5

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

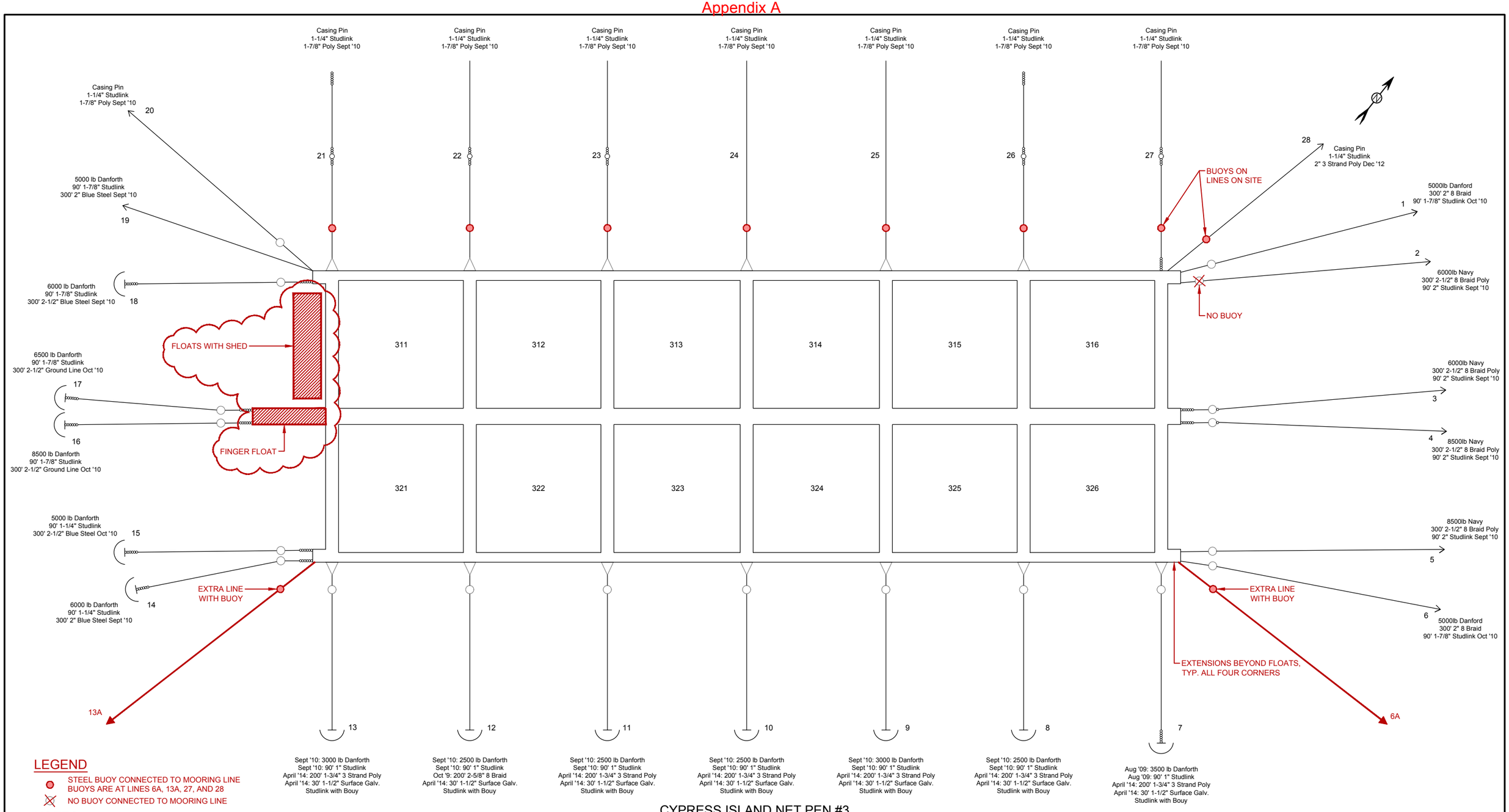
Drawing Number

Title

Washington State
Department of Natural Resources
Cypress Island Net Pen #3

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-Cypress Island Net Pen #3.dwg Jan 25, 2018 - 2:57PM MOR69830



LEGEND

- STEEL BUOY CONNECTED TO MOORING LINE
  BUOYS ARE AT LINES 6A, 13A, 27, AND 28
- NO BUOY CONNECTED TO MOORING LINE

NOTES

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

CYPRESS ISLAND NET PEN #3

MOORING PLAN

NOT TO SCALE

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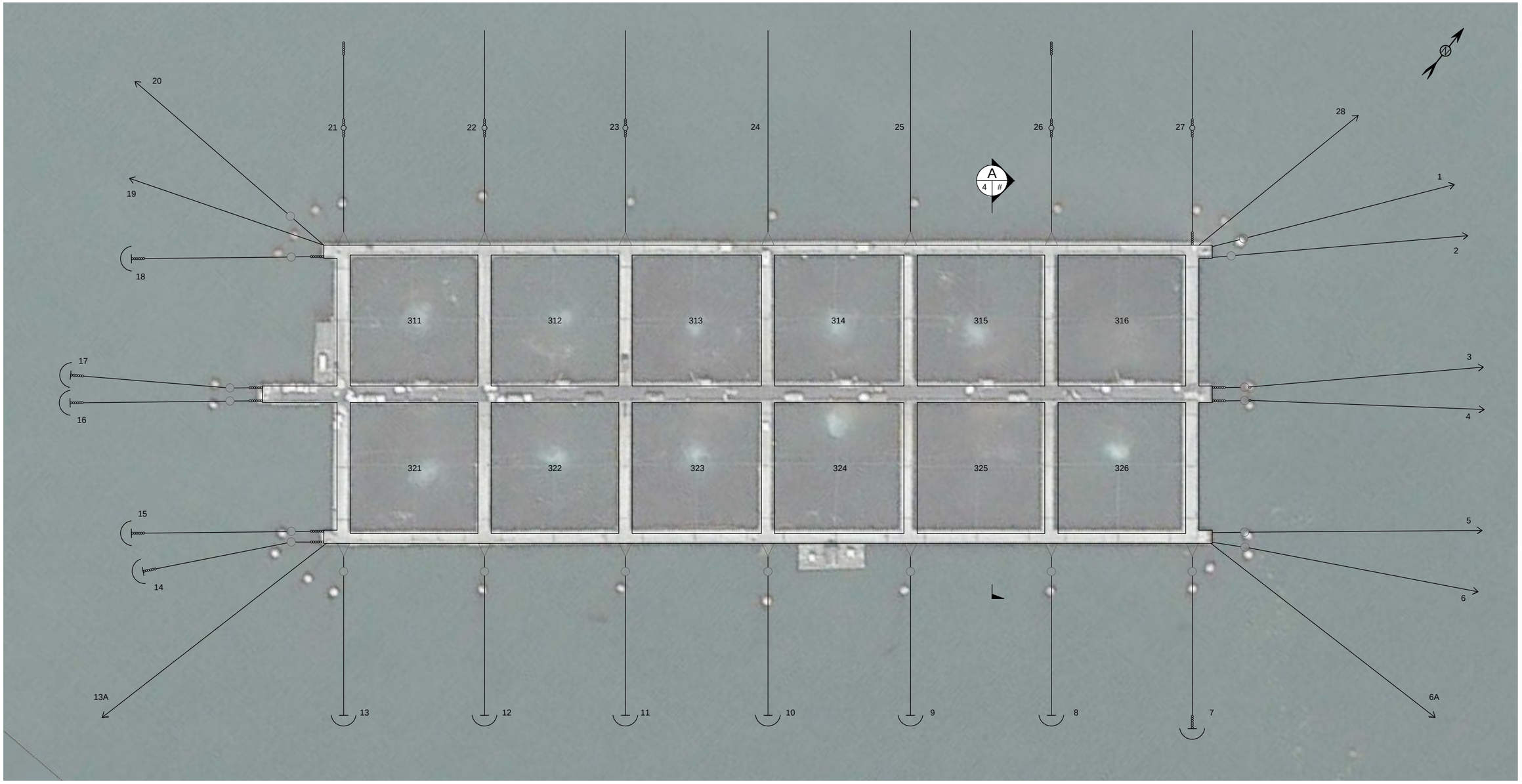
Project Number: 391980 | B/O: 3 | Total: 5

Drawing Number

Title: Washington State Department of Natural Resources
Cypress Island Net Pen #3

Mooring Schematic Plan
Revised with Notes



CYPRESS ISLAND NET PEN #3

0 30 60

SCALE IN FEET

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Dwg check	N. Sultan		Approved		

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Project Number: 391980 | B/O: 4 | Total: 5

Drawing Number

Title

Washington State
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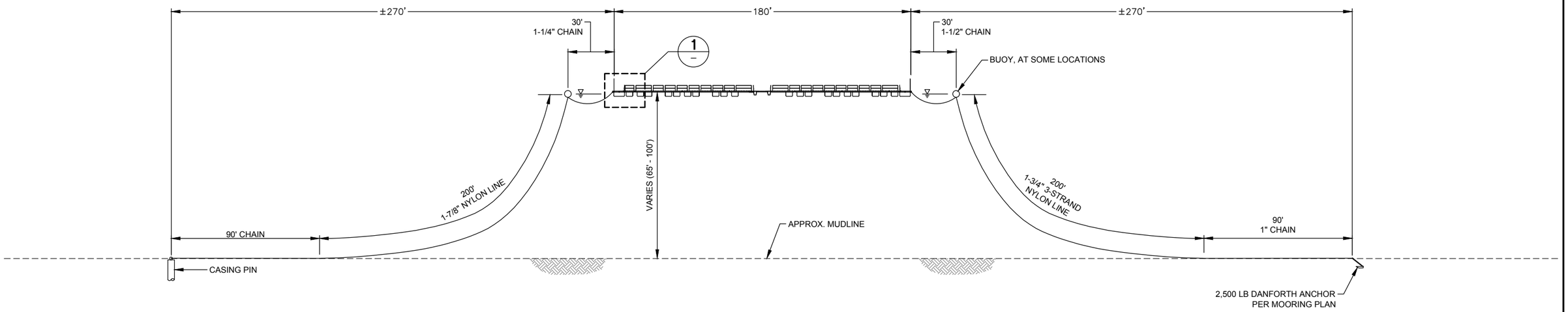
Cypress Island Net Pen #3

Existing Site - General Plan



A/3.5 SECTION

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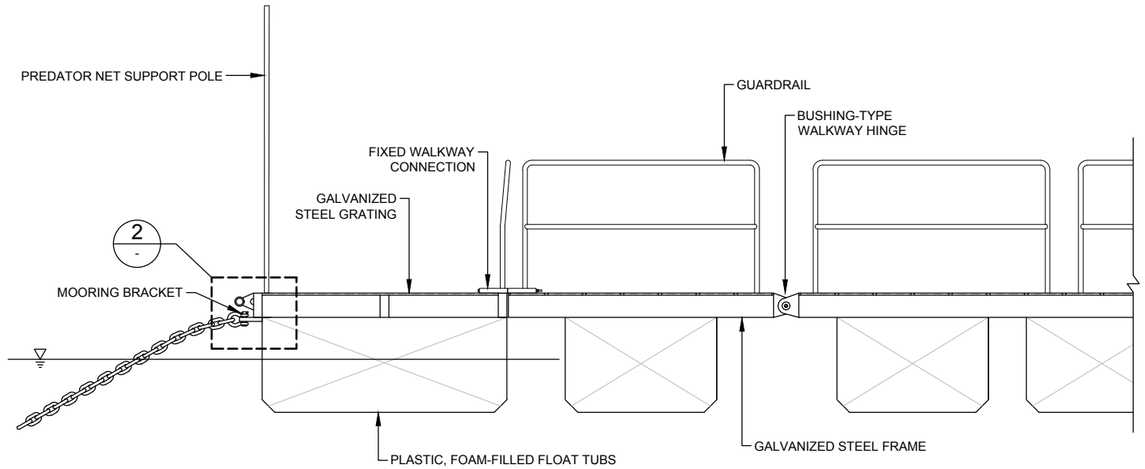
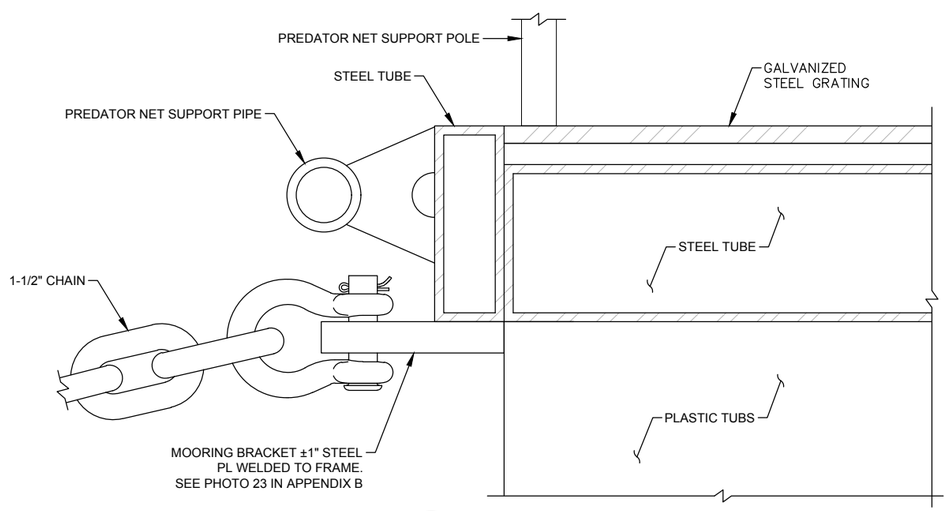


1 DETAIL

0 2 4

SCALE IN FEET



2 DETAIL

0 3 6

SCALE IN INCHES

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391980	5	5

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Drawn	T. Morrison		Coordination		
Dwg check	N. Sultan		Approved		

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As Shown			

Drawing Number

Title

Washington State
Department of Natural Resources
Cypress Island Net Pen #3

Sections and Details

January 29, 2018
Collins Job No. 45-10819

Underwater Inspection of the Site 3 Cypress Island
Fish Net Pens System in Deepwater 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 Site 3 Cypress Island Fish Net Pens System located in Deepwater Bay, WA from January 10 through January 14, 2018. The scope of the inspection was to perform a below water visual and tactile inspection of the facility components, consisting exclusively of the anchor line assemblies, and then based on the findings, comment on the integrity and stability of the submerged components of the fish net pens system.

The fish net pens system components inspected included exclusively all of the anchor line assemblies that stabilize and maintain the position of the net pens system. 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 also utilized to inspect the anchor lines with their lower portions located in water deeper than 100 fsw, which is the OSHA limitation for commercial dive operations not requiring a recompression chamber to be on site. In this regard, due to prevailing water depths being greater than 100 fsw at the anchor location, ROV inspection was used to supplement the diving inspection at Anchor Lines 1 through 6 and 14 through 18 at the Site 3 Cypress Island Net Pens System.

Refer to Photographs 1 through 86 for views of the typical and specific conditions observed during the underwater inspection of the Site 3 Cypress Island Fish Net Pens System components. In

addition, all of the photographs and videos taken during the underwater inspection of the Site 3 Cypress Island Fish Net Pens System components have been made available for reference digitally.

Overall, the underwater inspection revealed the following key findings for the Site 3 Cypress Island Net Pens System:

- The anchor line arrangement was consistent with the drawing provided by Cooke Aquaculture, with the exception that there were two additional anchor lines, one running northeasterly from the northeasterly corner of the net pens system, designated as Anchor Line 6A, and one running southeasterly from the southeasterly corner of the net pens system, designated as Anchor Line 13A.
- The anchor line assemblies were generally found to be in satisfactory condition, with no structurally significant deterioration in most instances, and in all cases with all connection elements presently intact and secure. Regarding the various shackles used throughout the system, although presently secure, there were, however, approximately 50% instances of no safety wire/chord (screw type pin) or cotter pin (bolt and nut type pin) in place. In addition, and most notably, at Anchor Lines 17 and 18, there was no or only the remnants of the nut present on the shackle pin at the lower anchor chain connection, apparently due to significant nut deterioration.
- Overall, the extent of marine growth on the various chains and rode lines of the anchor line assemblies was fairly consistent throughout the entire net pens system suggesting that the all of the anchor lines have been in service for a comparable length of time.
- The majority of the anchor line ropes were attached at their connections to the upper and lower lengths of chain with a loop protected with a thimble and secured with a bowline knot at the upper connection and with an eye splice rope weave of sufficient length at the lower connection. The main exceptions to this was at Anchor Lines 3 and 14 through 17, where the rope loop was protected and secured with smaller rope lashing. In all instances, the rode line rope connections were secure and sound, although at the rope to chain connection for Anchor Lines 12 (upper) and 15 (lower), there was no thimble in place, but with no notable rope loop damage thus far.
- The upper and lower lengths of chain in the anchor lines, as well as their related shackles used at the rope connections, typically exhibited light to moderate corrosion that was not structurally significant and had pitting that was 1/16 in. deep or less. The only exceptions to this were observed at the lower anchor chain runs at Anchor Lines 26 and 27, where it appeared that a smaller than typical chain size was used and random links had up to an estimated 20% loss of original section.
- A majority of the anchor lines had steel buoys supporting their upper lengths of anchor chain apparently in an effort to relieve some of the downward load on the floating net pens system. Typically, the smaller chains used to make the buoy to anchor line chain

connections exhibited an extent of corrosion similar to that of the anchor line chains, although at Anchor Lines 17 through 19 and 23, there was an estimated 25% to 50% loss of original section observed for the smaller buoy chain links due to both corrosion and wear. In addition, at Anchor Line 2, the buoy was sunk and situated alongside the upper anchor chain as it extended vertically downward.

- At Anchor Lines 8 through 13, 13A, 14, 15 and 18, between 60 ft and 90 ft (full shot length) of the lower anchor chain was exposed before becoming fully embedded in the seabed along with its respective anchor. Typically, at the remainder of the anchor lines, there was just minimal anchor exposure (top of stem and/or head of Danforth or Navy type anchor), suggesting that the anchor was well-founded. The exception to this was observed for the anchor of Anchor Line 19, where the anchor (Danforth type) was mostly resting on the seabed, with its orientation approximately 90 degrees from normal and only one fluke partially embedded. At Anchor Lines 20 through 28, the anchor line anchorage was either a driven 6 in. or 24 in. diameter pipe/pile, which presently appeared to be providing adequate support, although at Anchor Line 20, the pipe was inclined at a 45 degree angle, which could have been due to an overload.

Anchor Line Assemblies

The anchor line assemblies typically consisted of:

- Upper Anchor Chains (±30 ft)
- Ropes (200 ft to 300 ft – rode line)
- Lower Anchor Chains (90 ft – one shot of chain)
- Anchors (Danforth, Navy or pile type)

The connections between the net pens framing and the upper anchor chains were typically found to be fully intact, secure, and in good to satisfactory condition. In most instances, the padeyes were fully galvanized and exhibited little or no corrosion. The steel shackles also typically exhibited little, if any, deterioration, and in many instances appeared to be relatively new. The shackles were typically found to be properly aligned and secure, and although the screw in type shackle pins were always tight, the majority of the shackles did not have any restraining wire or chord in place for the shackle pin. The inspection of the accessible portions of the steel framing that provides the overall attachment between the aforementioned padeyes and the pen system walkway construction typically revealed that framing to be sound and secure with no concerns for instability.

The upper and lower anchor chain to rode line rope connections (thimble and shackle) were typically found to be fully intact, secure, and in satisfactory condition. These components generally exhibited a moderate layer of marine growth, consisting of up to a ½ in. thick layer of hard growth covered by 1 in. to 3 in. of softer growth. The steel thimbles, which were in place for

the rope loops in most instances, typically exhibited only light to moderate corrosion with up to 1/16 in. deep pitting. It should be noted that there were two instances, at Anchor Lines 12 (upper connection) and 15 (lower connection), where there was no thimble in place for the rope loop. In these instances, presently there was no rope damage and the connection was still secure; however, ideally a thimble should ultimately be installed to afford the rope the best protection. There were also no thimbles in place at the upper and lower rope connections of Anchor Lines 3 and 14 through 17 because the rope loop was protected and connected instead with small rope lashing, which in all cases was affording a sound and secure connection. For a majority of the anchor lines, the ropes were secured beyond the thimble with a bowline knot at the upper anchor chain connection and an eye splice rope weave at the lower anchor chain connection, all of which that typically appeared to be adequately secure. It should be noted though, while still appearing secure, the bowline knots at Anchor Lines 19 (lower connection) and 27 (upper connection) had essentially no rope "tail" beyond the knot. Similar to the thimbles, the steel shackles used for these connections also only exhibited light to moderate corrosion with up to 1/16 in. deep pitting, and the shackles were always found to be properly aligned and secure. Although the shackle pins, which were either the screw type or bolt and nut type, were always tight, it should be noted that only an estimated 50% of the shackles had either a restraining wire/chord, zip ties, or cotter pin place as an added measure of keeping the pin secure and in place. Zip ties were observed as a means of securing the pins at some locations (refer to Photograph 46). Zip ties are not recommended for underwater applications because they rely on a small, thin steel plate inside the plastic to secure the tie. When that metal plate corrodes, the zip tie has the tendency to fail. In addition and much more of a concern, it was observed from the ROV inspection that there was no or only the remnants of the nut present on the shackle pin at the lower anchor chain connection of Anchor Lines 17 and 18, apparently due to significant nut deterioration.

The ±30 ft long upper anchor chains were typically found to be in satisfactory condition with no structurally significant deterioration. The upper lengths of chain generally exhibited only light to moderate corrosion that had minimal section loss associated with it and just pitting that was typically 1/16 in. deep or less. The below water portions of the upper anchor chains typically exhibited a moderate layer of marine growth, consisting of up to a 1/2 in. thick layer of hard growth covered by 1 in. to 3 in. of softer growth. The upper anchor chains of all of the anchor lines around the net pens system had steel buoys attached to and supporting the upper chain in an apparent effort to relieve some of the downward load on the floating net pens system. The one exception to this was at Anchor Line 2, where the buoy was sunk below water alongside the upper anchor chain, thus exerting a downward load on the anchor line. Typically, the smaller chains used to make the buoy to anchor line chain connections exhibited an extent of corrosion similar to that of the upper anchor line chains, although at Anchor Lines 17 through 19 and 23, there was an estimated 25%

to 50% loss of original section (as little as 3/8 in. link diameter remaining) observed for the smaller buoy chain links due to both corrosion and wear.

The 200 ft to 400 ft long rode line ropes were typically found to be in satisfactory condition with no excessive fraying or other detectable abrasion damage observed. In general, all of the rode line ropes exhibited comparable amounts of marine growth, which typically consisted of a softer growth that was 2 in. to 4 in. thick along the upper portions of the ropes that then mostly increased to be 6 in. to 12 in. thick in deeper water closer to the seabed. The marine growth on the ropes also typically included clusters of larger barnacles at random locations along the rope. For the most, there always appeared to be sufficient tension in the rode line ropes, suggesting that each rope, and in turn the entire anchor line assembly, was being relied on to afford support to the net pens system.

The 90 ft long (one shot of chain) lower anchor chains were typically found to be in satisfactory condition, typically with minimal marine growth and no structurally significant deterioration. The lower lengths of chain generally exhibited only light to moderate corrosion that had minimal section loss associated with it and just pitting that was typically 1/16 in. deep or less. There was, however, some heavier than normal corrosion observed at the lower anchor chains of Anchor Lines 26 and 27. At each of these anchor lines, the lower length of chain was of a noticeably smaller size than that of all of the other anchor lines, and there was heavier corrosion present that has resulted in up to an estimated 20% loss of original section for various links along the chain. As little as 60 ft and typically (at 22 of the 30 anchor lines) the full shot length of 90 ft of the lower anchor chain was exposed and resting or slightly embedded the seabed as the anchor chain progressed to the anchor location. In that regard, less than 90 ft of the lower anchor chain was only exposed at Anchor Lines 8 through 13, with the anchor chain becoming fully embedded in the seabed before the anchor was reached. Similarly, at Anchor Lines 14, 15 and 18, the anchor chain also became completely buried, but in those instances, nearly the full 90 ft of chain was exposed and just the anchor shackle and the anchor were buried. The chain resting on and/or embedded in the seabed typically suggests an appropriate anchor location and anchor line assembly length to promote proper setting and subsequent grip of the Danforth (typical) and Navy (four locations) type anchors. In most instances, the manner in which the chain was on or in the seabed, with no notable rutting or plowing of the seabed, 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 either completely buried (Anchor Lines 8 through 13, 13A, 14, 15 and 18) or with very minimal exposure (just the top of stem and/or head – Anchor Lines 1 through 5, 6A, 7, 11, 16 and 17), which suggests that they were well-seated and adequately gripping into the seabed. One of the exceptions to this was at Anchor 19, which was just slightly embedded in the seabed. At that particular anchor location, the anchor was generally set 90 degrees from what would normally be the proper alignment for a Danforth type anchor (flukes parallel to seabed rather than perpendicular), and as a result, just one of the anchor flukes, and it's corresponding peg, were embedded to some extent into the seabed. In this instance, however, the

configuration of the seabed in and around the anchor, as well the lay of the lower anchor chain leading up to the anchor, still suggested that the anchor was adequately founded and that there has been no appreciable movement of the anchor since originally placed. Another minor exception was observed at Anchor 6, where the top of the two flukes of the Danforth type anchor were flush with the seabed, but still adequately gripping the channel bottom. Regarding Anchor Lines 20 through 28, the anchor type was that of a driven pipe/pile (±6 in. diameter at Anchor Lines 23 through 25 and ±24 in. diameter at Anchor Lines 20 through 22 and 26 through 28), with the lower anchor chain secured to the pipe/pile anchor with a padeye when exposed (connection buried in seabed at Anchor Lines 21 and 23 through 26). Where the chain to pipe/pile anchor connection was exposed at Anchor Line 20, it was observed to be secure, although with the chain wrapped once around the pipe/pile before reaching the shackle at the padeye. For all of the pipe anchors, the existing conditions suggested a stable anchorage, although at Anchor Lines 20 and 26, the pipe/pile anchor appeared to be inclined somewhat towards the net pens system (approximately 30 to 45 degrees off of vertical), with the inclination appearing to have been potentially due to an excessive load exerted on the anchor line.

Conclusions

Overall, the anchor line assemblies were generally found to be in satisfactory condition, typically with no structurally significant deterioration, and with all connection elements sound and secure. The rating of satisfactory is deemed appropriate since it 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 lower anchor chains at Anchor Lines 26 and 27, the various lengths of chain and related shackles inspected along the anchor lines exhibited only minor deterioration, with just light to moderate corrosion being present that had no appreciable loss of original section associated with it. Regarding the many shackle connections throughout the various anchor lines, again, they were all observed to be presently secure; however, the lower anchor chain connection shackles at Anchor Lines 17 and 18 were somewhat deficient with the nut on the shackle essentially gone due to deterioration. With respect to the ropes running between the upper and lower anchor chains, they were always found to be in a satisfactory, full original section condition, with no evidence of notable fraying or abrasion related damage. The thimbles and related rope knots or splices, which were used to connect the ropes to the upper and lower chain shackles, were also typically found to be sound and secure with no evidence of any conditions that would compromise the connections. Presently, all of the anchor line anchors, whether it be the Danforth or Navy type anchor or the driven pipe/pile type, and including the one anchor that was minimally embedded in the seabed, were observed to be stable and affording what appeared to be sufficient anchorage for the net pens system. Currently, one of the items of possible concern noted was the two lower anchor chain shackles with missing nut pins, which should have new pins installed to restore full shackle stability and eliminate the risk of anchor line failure. Also of possible concern are the instances of heavier section loss due to deterioration and wear on the smaller chains connecting the steel buoys to the upper anchor chains

of Anchor Lines 9 and 17. In particular, this implies a deficiency in the system components leading to a failure of the buoy system and greater loading in the net pen system with unintended consequences.

In conclusion, the underwater inspection of the Site 3 Cypress Island Fish Net Pens System did not reveal any structurally significant deterioration or other notable deficiencies that would suggest any appreciable reduction in the inherent integrity or stability of the overall system. In that regard, the components inspected below water were typically found to be in sound condition with no indication that an appreciable reduction in the originally intended capacity of a component or connection could be expected. It should again be noted, however, that while the aforementioned deficient buoy attachments do not affect the capacity of the anchor lines per se, if they were to fail, that could disrupt the equilibrium of the overall net pens system, and therefore, consideration should be given to renewing the heavily deteriorated items.

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 Site 3 Fish Net Pens System, Looking Northwest.

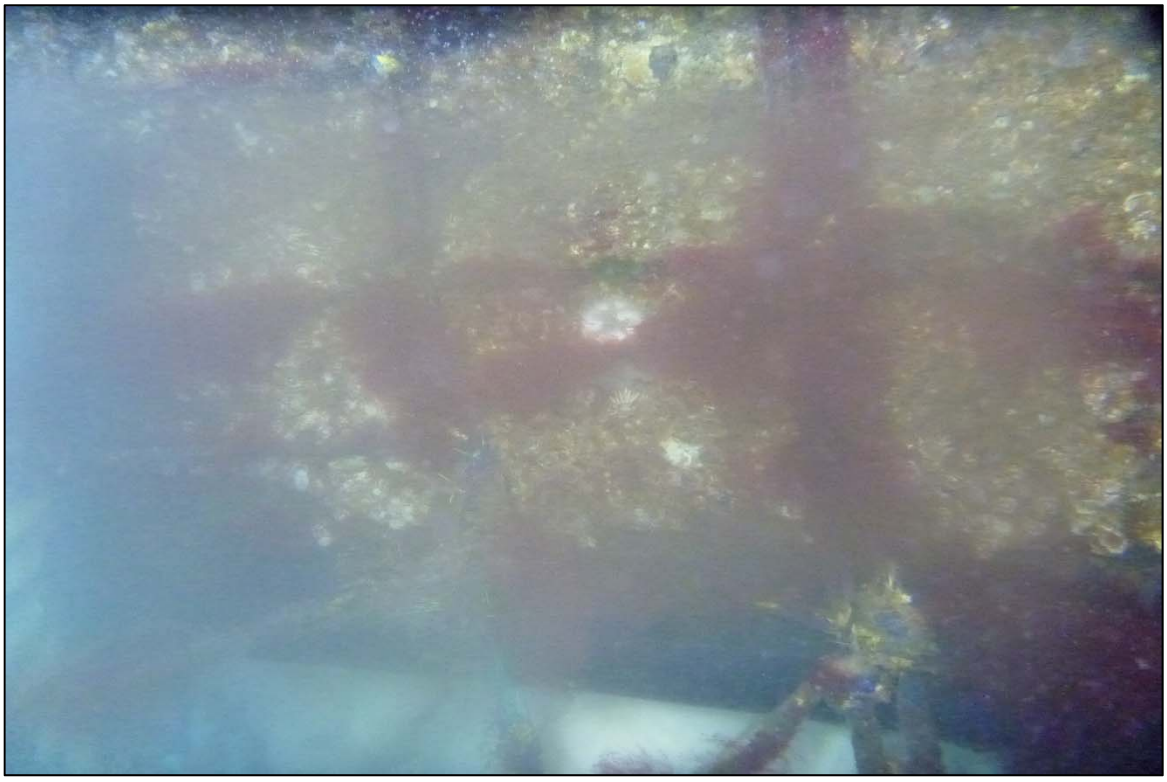
Photograph 2: Overall View of the Site 3 Fish Net Pens System, Looking North.

Photograph 3: Overall View of the Site 3 Fish Net Pens System, Looking Northeast.

Photograph 4: Overall View of the Site 3 Fish Net Pens System, Looking East.

Photograph 5: Overall View of the Site 3 Fish Net Pens System, Looking Southwest.

Photograph 6: Overall View of the Site 3 Fish Net Pens System, Looking West.



Photograph 7: View of the Float Condition at Site 3 Fish Net Pens System, Looking Northwest.

Photograph 8: View of the Float Condition at Site 3 Fish Net Pens System, Looking Northeast.

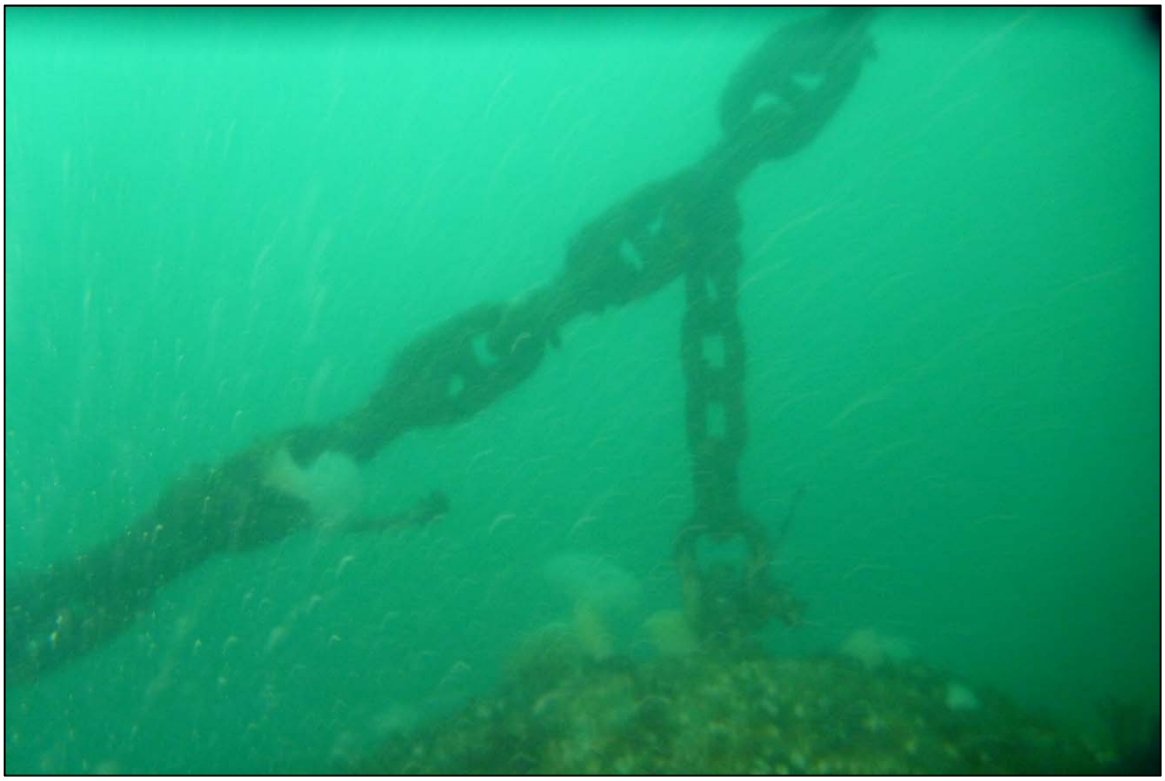
Photograph 9: View of Upper Anchor Chain to Float Connection at Site 3 Anchor Line 11, Looking Northeast.

Photograph 10: View of Upper Anchor Chain to Float Connection at Site 3 Anchor Line 10, Looking North.

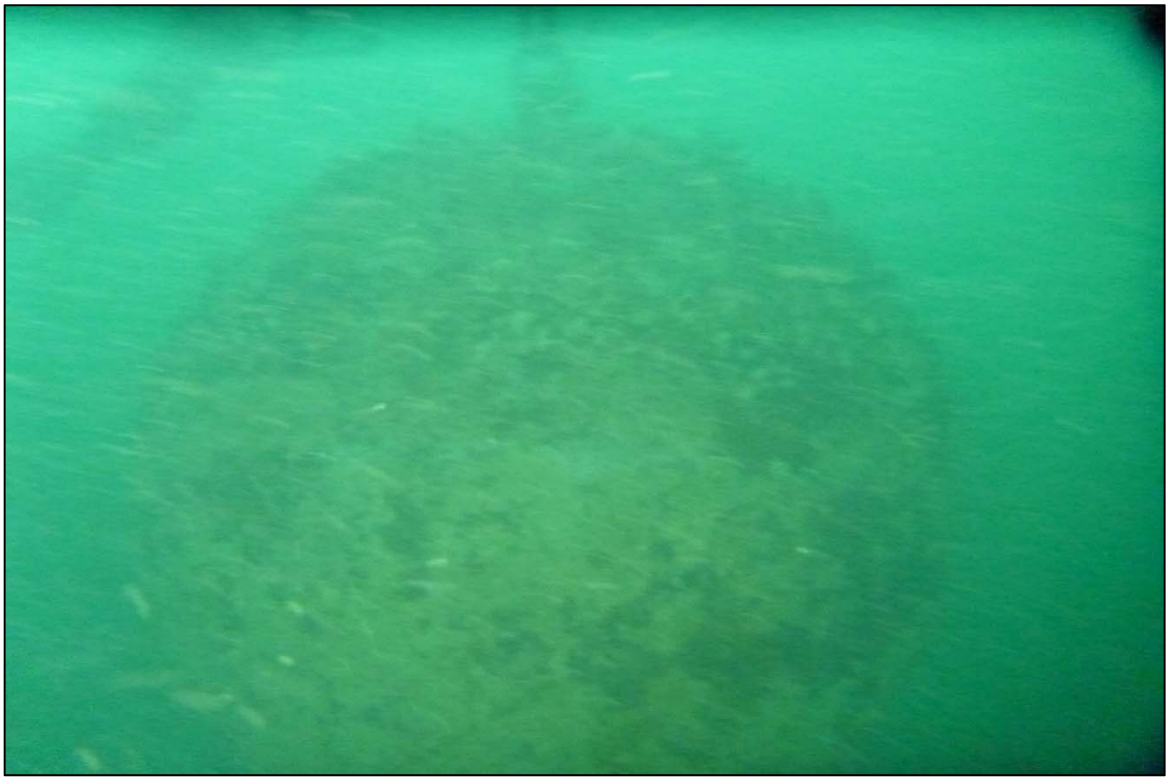
Photograph 11: View of Upper Anchor Chain to Float Connection at Site 3 Anchor Line 21, Looking Southwest.

Photograph 12: View of Upper Anchor Chain Corrosion at Site 3 Anchor Line 1, Looking Northwest.

Photograph 13: View of Upper Anchor Chain to Anchor Rope Connection at Site 3 Anchor Line 1, Looking Northwest.



Photograph 14: View of Submerged Steel Buoy at Site 3 Anchor Line 2, Looking Northwest.



Photograph 15: View of Submerged Steel Buoy at Site 3 Anchor Line 2, Looking Northwest.

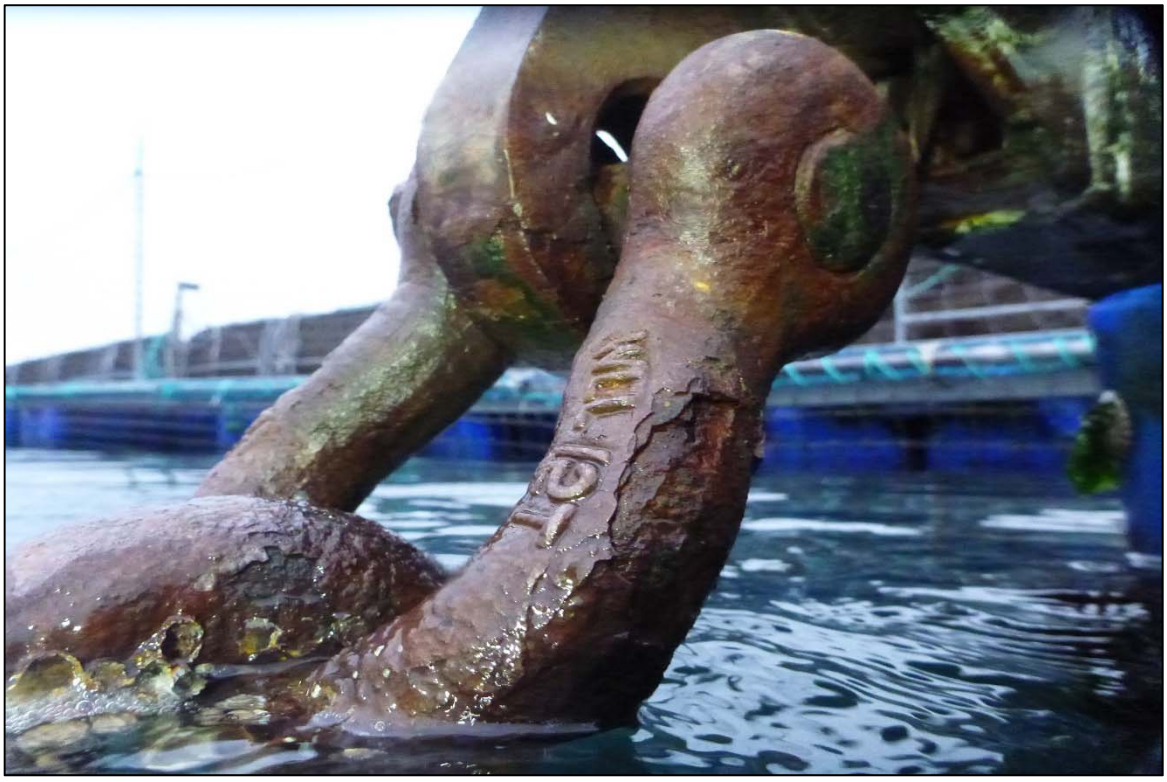
Photograph 16: View of Rope to Lower Anchor Chain Connection (Shackle and Thimble) at Site 3 Anchor Line 2, Looking North.

Photograph 17: View of Lower Anchor Chain to Anchor Stem Connection (Shackle) at Site 3 Anchor Line 2, Looking North.

Photograph 18: View of Upper Chain to Float Connection at Site 3 Anchor Line 3, Looking Southeast.

Photograph 19: View of Heavy Marine Growth on the Anchor Rope at Site 3 Anchor Line 3, Looking North.

Photograph 20: View of Upper Anchor Chain to Rope Connection (Thimble) at Site 3 Anchor Line 3, Looking North.



Photograph 21: View of Upper Chain to Float Connection Section Loss and Corrosion at Site 3 Anchor Line 4, Looking East.

Photograph 22: View of Upper Chain with Marine Growth at Site 3 Anchor Line 4, Looking North.

Photograph 23: View of Lower Chain to Chain Connection (Shackle) at Site 3 Anchor Line 4, Looking North.

Photograph 24: View of Anchor Rope Condition at Site 3 Anchor Line 5, Looking North.

Photograph 25: View of Upper Anchor Chain Condition at Site 3 Anchor Line 5, Looking Northwest.

Photograph 26: View of Rope Debris on the Anchor Rope at Site 3 Anchor Line 5, Looking North.

Photograph 27: View of Upper Anchor Chain to Anchor Rope Connection (Thimble) at Site 3 Anchor Line 6, Looking North.

Photograph 28: View of Top of Anchor with Fluke Exposure at Site 3 Anchor Line 6, Looking North.

Photograph 29: View of Upper Chain to Float Connection (Shackle) at Site 3 Anchor Line 6A, Looking West.

Photograph 30: View of Upper Anchor Chain at Site 3 Anchor Line 6A, Looking West.

Photograph 31: View of Lower Anchor Rope to Anchor Chain Condition (Shackle and Thimble) at Site 3 Anchor Line 6A, Looking North.

Photograph 32: View of Lower Anchor Chain to Anchor (Shackle and Stem) on the Channel Bottom at Site 3 Anchor Line 6A, Looking East.

Photograph 33: View of Top of Exposed Anchor at Site 3 Anchor Line 6A, Looking East.

Photograph 34: View of Chain to Buoy (Shackle) at Fort Ward Anchor Line 7, Looking Southeast.

Photograph 35: View of Upper Anchor Chain to Anchor Rope Connection (Shackle and Safety Rope) at Site 3 Anchor Line 7, Looking Southeast.

Photograph 36: View of Lower Anchor Chain laying on the Channel Bottom at Site 3 Anchor Line 7, Looking Southeast.

Photograph 37: View of Lower Chain to Anchor Connection (Shackle) on the Channel Bottom at Site 3 Anchor Line 7, Looking East.

Photograph 38: View of Upper Anchor Chain Condition at Site 3 Anchor Line 8, Looking Northwest.

Photograph 39: View of Lower Anchor Chain to Rope Connection (Shackle and Thimble) at Site 3 Anchor Line 8, Looking North.

Photograph 40: View of Lower Anchor Chain to Anchor Connection (Shackle and Stem) at Site 3 Anchor Line 8, Looking North.

Photograph 41: View of Upper Chain with Trapped Timber Debris between Predator Net and Anchor Chain at Site 3 Anchor Line 9, Looking Northwest.

Photograph 42: View of Rope, Possibly Debris, on the Anchor Rope at Site 3 Anchor Line 9, Looking North.

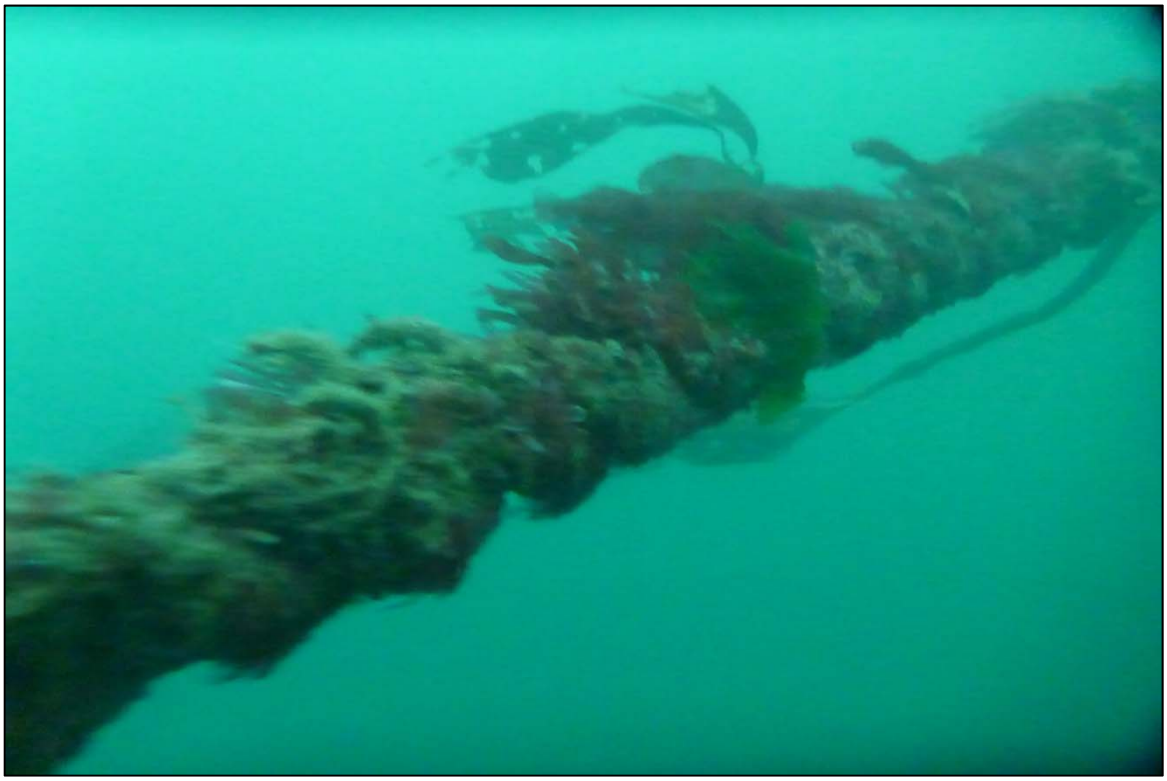
Photograph 43: View of Lower Anchor Chain to Anchor Rope Connection (Shackle and Thimble) at Site 3 Anchor Line 9, Looking East.

Photograph 44: View of Lower Anchor Chain Mostly Buried at the Channel Bottom Anchor Line 9, Looking North.

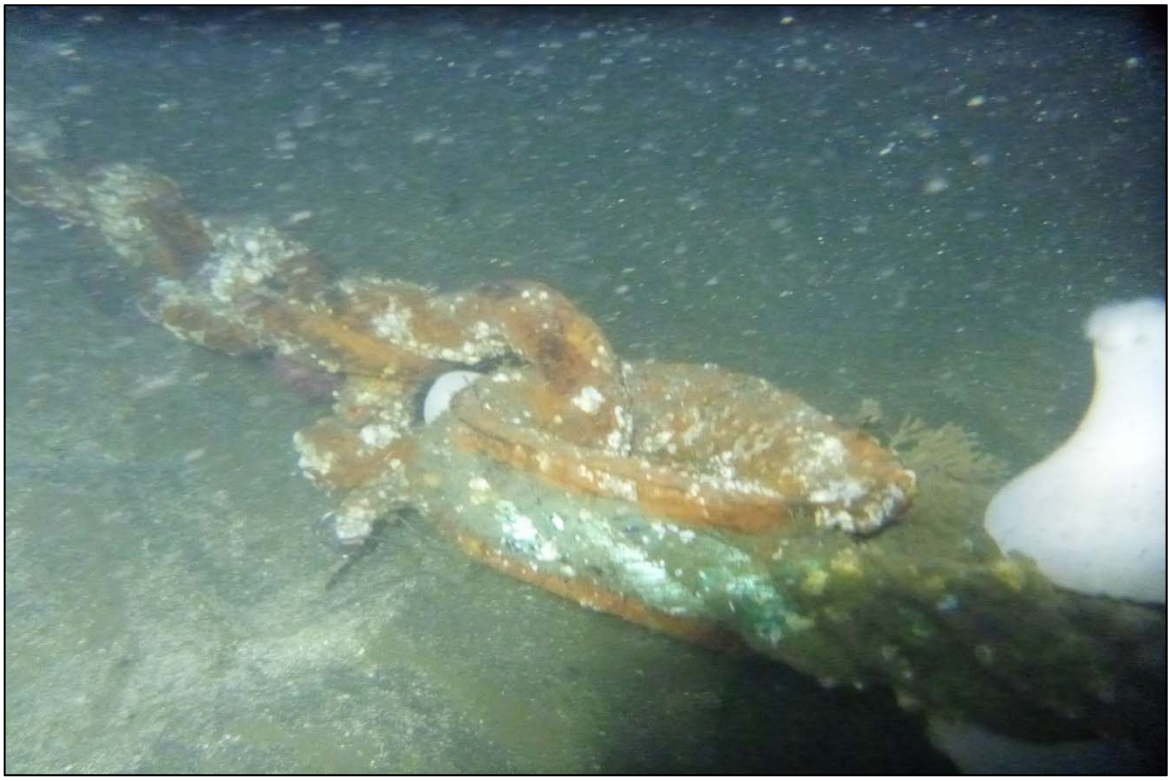
Photograph 45: View of Upper Anchor Chain to Float Connection (Shackle) at Site 3 Anchor Line 10, Looking North.

Photograph 46: View of Lower Anchor Chain to Anchor Rope Connection with Safety Zip-Tie at Site 3 Anchor Line 10, Looking Northeast.

Photograph 47: View of Lower Anchor Chain Mostly Embedded at Site 3 Anchor Line 10, Looking Southeast.



Photograph 48: View of Anchor Rope Heavy Marine Growth at Site 3 Anchor Line 11, Looking North.



Photograph 49: View of Lower Anchor Chain to Anchor Rope (Shackle and Thimble) at Site 3 Anchor Line 11, Looking Northeast.

Photograph 50: View of Chain to Buoy Connection at Site 3 Anchor Line 12, Looking Northeast.

Photograph 51: View of Upper Anchor Rope Condition (Bowline Knot) at Site 3 Anchor Line 12, Looking Northeast.

Photograph 52: View of Top of the Anchor at Site 3 Anchor Line 12, Looking Southeast.

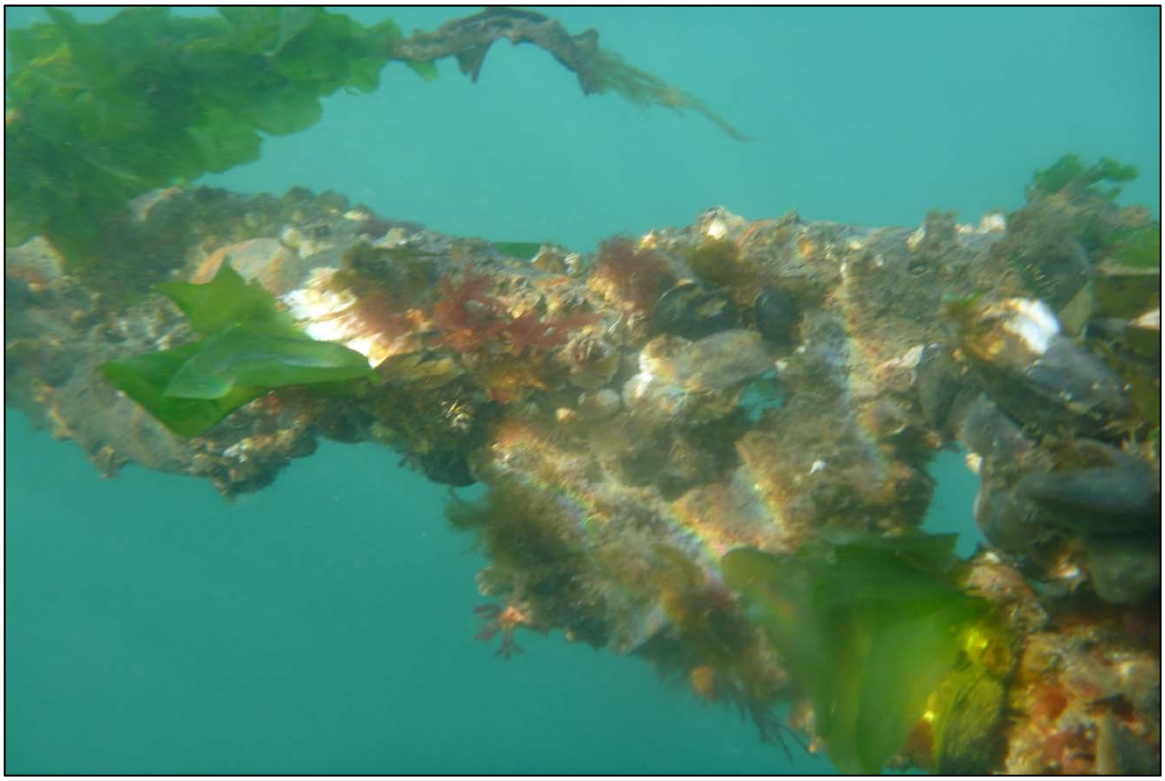
Photograph 53: View of Upper Anchor Chain to Anchor Rope Connection (Shackle and Thimble) at Site 3Anchor Line 13, Looking North.

Photograph 54: View of Lower Anchor Chain to Anchor Rope Connection (Shackle and Thimble) at Site 3 Anchor Line 13, Looking North.

Photograph 55: View of Upper Anchor Chain Condition with Corrosion and Pitting at Site 3 Anchor Line 13A, Looking West.

Photograph 56: View of Upper Anchor Chain to Buoy Chain Connection at Site 3 Anchor Line 13A, Looking West.

Photograph 57: View of Lower Anchor Rope Condition at Site 3 Anchor Line 14, Looking West.



Photograph 58: View of Upper Anchor Chain to Anchor Rope Connection with Heavy Marine Growth at Site 3 Anchor Line 15, Looking Southwest.

Photograph 59: View of Upper Anchor Chain Condition with Corrosion at Site 3 Anchor Line 16, Looking North.

Photograph 60: View of Lower Anchor Chain to Anchor Rope Condition with Smaller Rope Lashing at Site 3 Anchor Line 16, Looking North.

Photograph 61: View of Upper Anchor Chain Corrosion and Section Loss due to Abrasion at Site 3 Anchor Line 17, Looking Northwest.

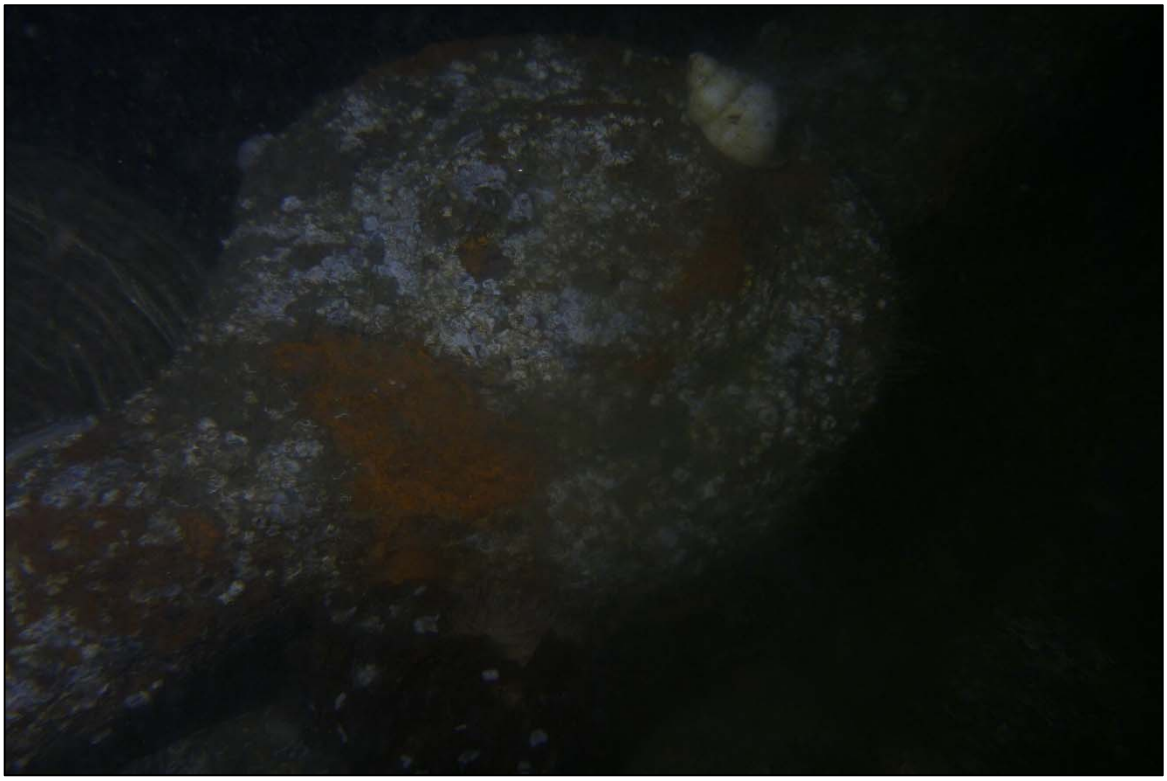
Photograph 62: View of Upper Anchor Chain Condition with Heavy Marine Growth at Site 3 Anchor Line 17, Looking North.

Photograph 63: View of Upper Anchor Chain to Float Connection (Shackle) at Site 3 Anchor Line 18, Looking North.

Photograph 64: View of Anchor Rope with Heavy Marine Growth at Site 3 Anchor Line 18, Looking West.

Photograph 65: View of Anchor Chain to Buoy Chain Connection (Shackle) with Corrosion and Pitting at Site 3 Anchor Line 19, Looking Northwest.

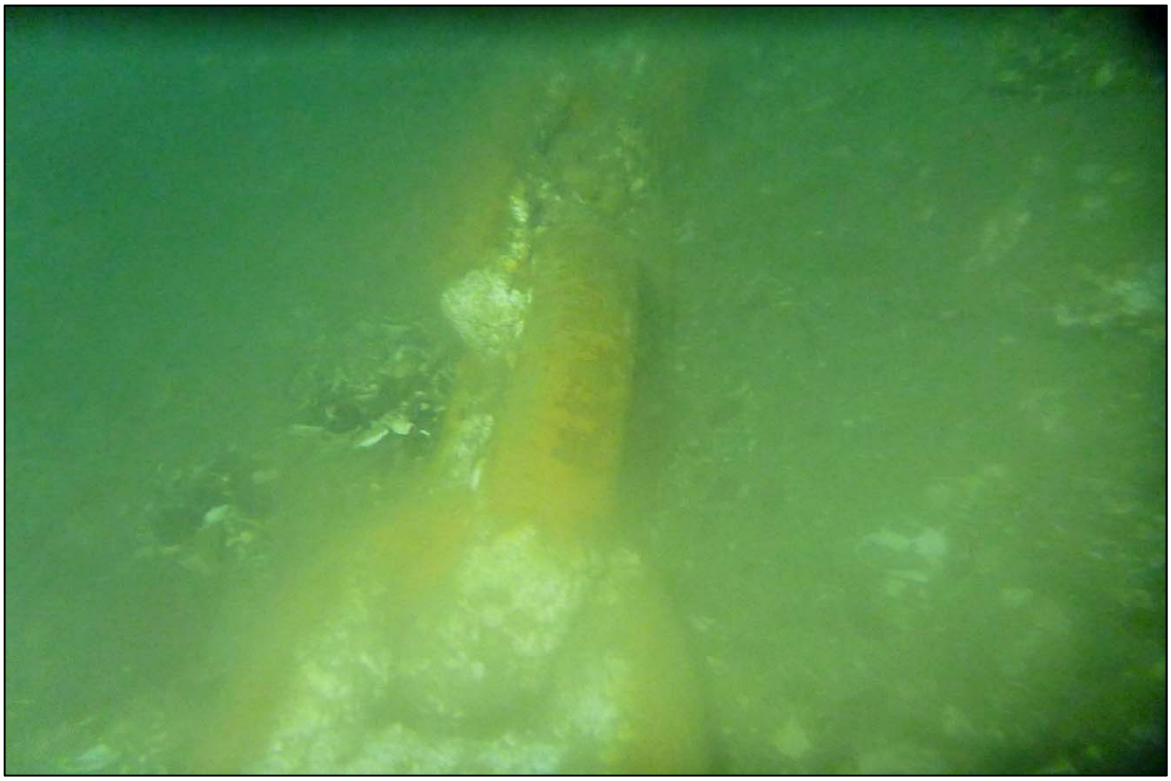
Photograph 66: View of Lower Anchor Chain Condition (Shackle) with Loose Safety Wire and Corrosion at Site 3 Anchor Line 19, Looking West.



Photograph 67: View of Exposed Anchor Stem at Site 3 Anchor Line 19, Looking West.

Photograph 68: View of Upper Anchor Chain at the Upper Connection with Corrosion and Pitting at Site 3 Anchor Line 20, Looking East.

Photograph 69: View of Upper Anchor Chain to Anchor Rope Connection (Shackle and Thimble) at Site 3 Anchor Line 20, Looking North.



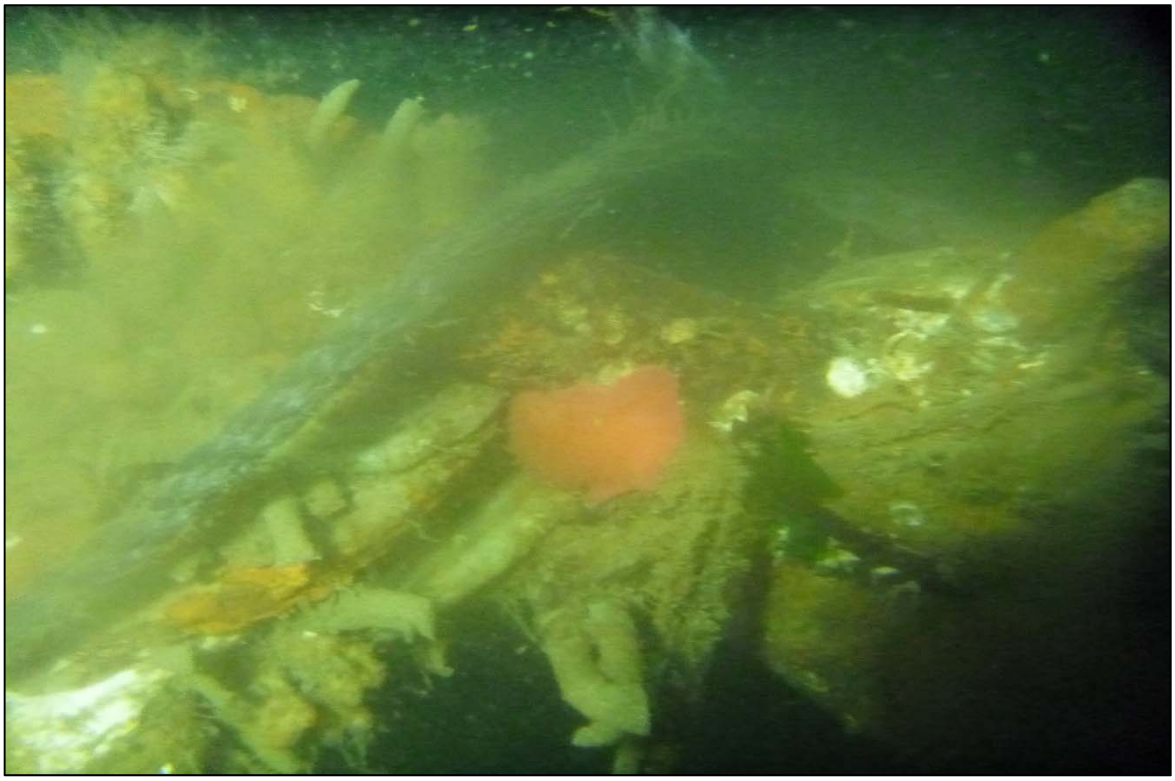
Photograph 70: View of Lower Anchor Chain on the Channel Bottom at Site 3 Anchor Line 20, Looking West.

Photograph 71: View of Buoy Connection at Site 3 Anchor Line 21, Looking Northeast.

Photograph 72: View of Lower Anchor Chain to Anchor Rope Connection with Heavy Barnacle Growth (Thimble) at Site 3 Anchor Line 21, Looking Northeast.

Photograph 73: View of Pile Anchor at Site 3 Anchor Line 21, Looking Northwest.

Photograph 74: View of Lower Anchor Chain on the Channel Bottom at Site 3 Anchor Line 22, Looking North.



Photograph 75: View of Lower Anchor Chain to Anchor Rope Connection with Heavy Marine Growth (Thimble) at Site 3 Anchor Line 22, Looking Northeast.

Photograph 76: View of Section Loss on the Buoy Chain due to Abrasion between the Links at Site 3 Anchor Line 23, Looking North.

Photograph 77: View of Lower Anchor on the Channel Bottom at Site 3 Anchor Line 23, Looking Northwest.

Photograph 78: View of Buoy to Chain Connection at Site 3 Anchor Line 24, Looking Northeast.

Photograph 79: View of Lower Anchor Chain to Anchor Rope Connection with Loose Safety Wire (Shackle) at Site 3 Anchor Line 24, Looking West.

Photograph 80: View of Top of Anchor Pin at Site 3 Anchor Line 24, Looking Northwest.

Photograph 81: View of Upper Anchor Chain to Anchor Rope Connection with Corrosion and Pitting (Shackle and Thimble) at Site 3 Anchor Line 25, Looking North.

Photograph 82: View of Lower Anchor Chain to Anchor Rope Connection with Corrosion and Pitting (Thimble) at Site 3 Anchor Line 25, Looking Northwest.

Photograph 83: View of Lower Anchor Chain to Anchor Rope Connection with Corrosion (Shackle) at Site 3 Anchor Line 27, Looking Northwest.

Photograph 84: View of Lower Anchor Chain to Anchor Connection with (Shackle) at Site 3 Anchor Line 27, Looking North.

Photograph 85: View of Upper Anchor Chain to Float Connection with (Shackle) at Site 3 Anchor Line 28, Looking Southeast.

Photograph 86: View of Upper Anchor Chain to Buoy Chain (Shackle) at Site 3 Anchor Line 28, Looking East.

Appendix C – Photographs at Cypress Island Site 3 Net Pens

Figure C-1: Cypress Island Net Pen Site 3 – Oblique Aerial from East

Figure C-2: Cypress Island Net Pen Site 3 – Overview from southeast

Figure C-3: Cypress Island Net Pen Site 3 – Anchor Lines 1 and 2 on northwest corner

Figure C-4: Cypress Island Net Pen Site 3 – Anchor Lines 3 and 4

Figure C-5: Cypress Island Net Pen Site 3 – Anchor Lines 5, 6, 6A, and 7 on northeast corner

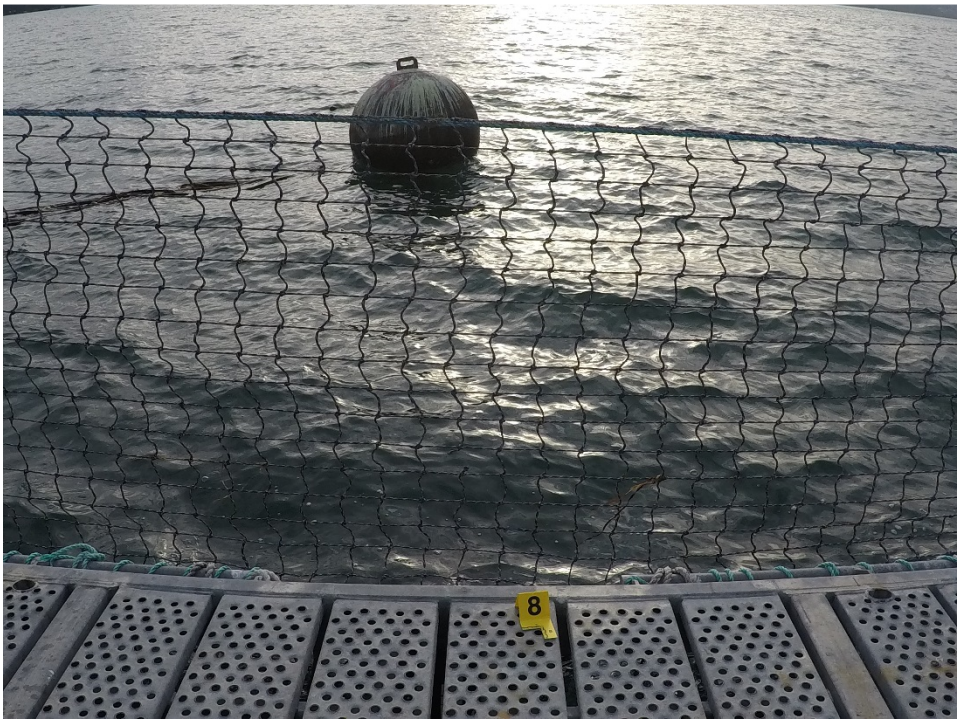


Figure C-6: Cypress Island Net Pen Site 3 – Anchor Line 8

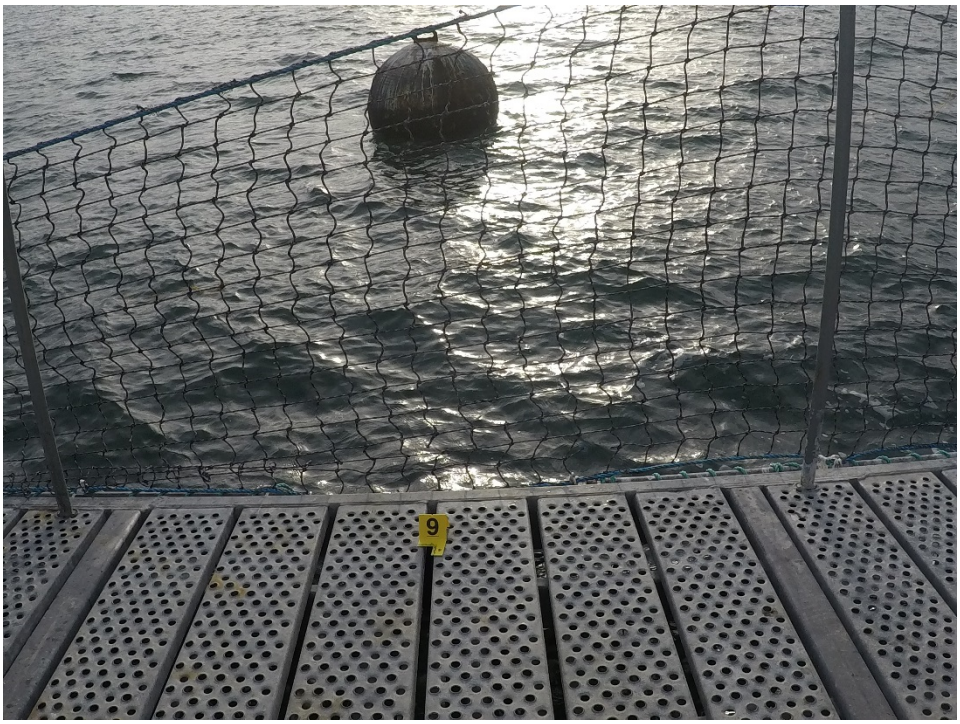


Figure C-7: Cypress Island Net Pen Site 3 – Anchor Line 9

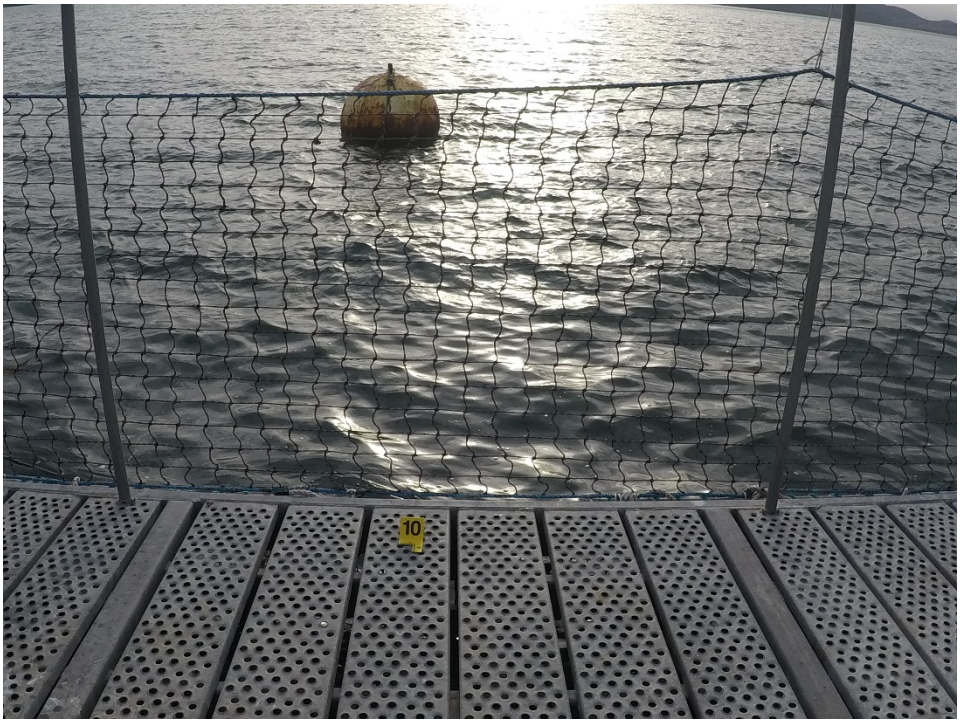


Figure C-8: Cypress Island Net Pen Site 3 – Anchor Line 10

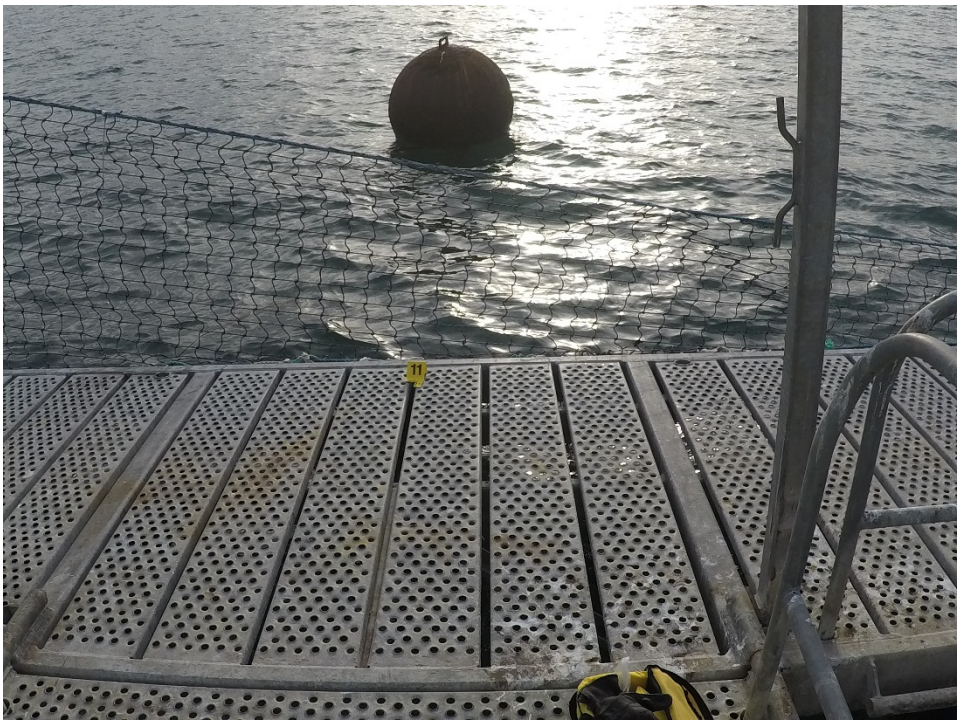


Figure C-9: Cypress Island Net Pen Site 3 – Anchor Line 11

Figure C-10: Cypress Island Net Pen Site 3 – Connection at Anchor Line 12

Figure C-11: Cypress Island Net Pen Site 3 – Anchor Lines 13, 13A, 14, and 15

Figure C-12: Cypress Island Net Pen Site 3 – Anchor Lines 16 and 17

Figure C-13: Cypress Island Net Pen Site 3 – Connection at Anchor Line 16

Figure C-14: Cypress Island Net Pen Site 3 – Connection at Anchor Line 17

Figure C-15: Cypress Island Net Pen Site 3 – Anchor Lines 18, 19, 20, and 21

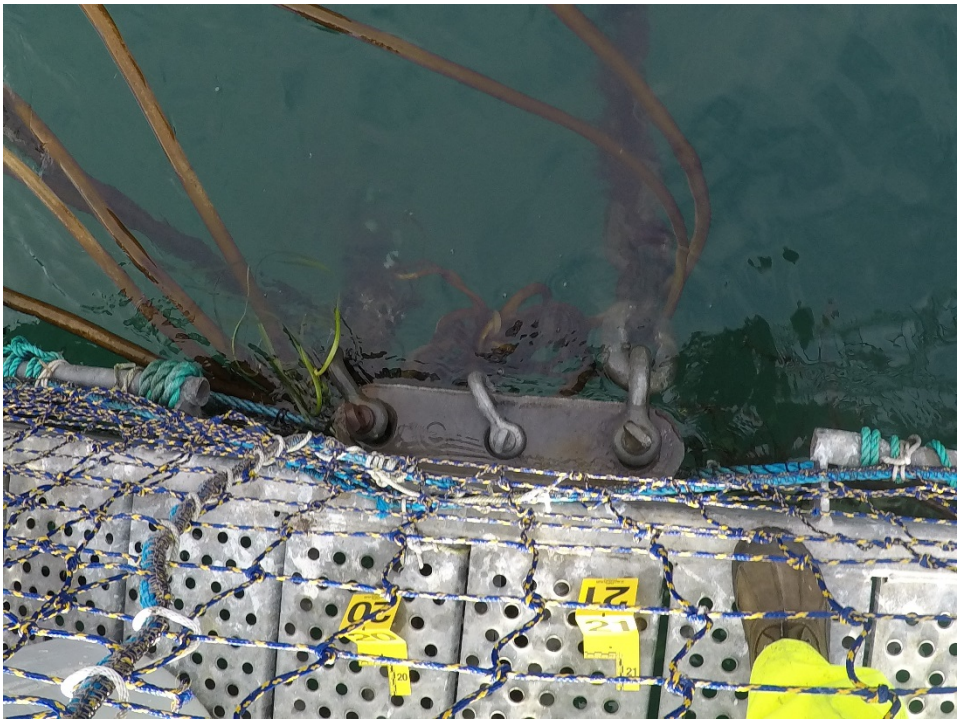


Figure C-16: Cypress Island Net Pen Site 3 – Connection at Anchor Lines 20 and 21

Figure C-17: Cypress Island Net Pen Site 3 – Connection at Anchor Line 22

Figure C-18: Cypress Island Net Pen Site 3 – Anchor Line 23

Figure C-19: Cypress Island Net Pen Site 3 – Connection at Anchor Line 23

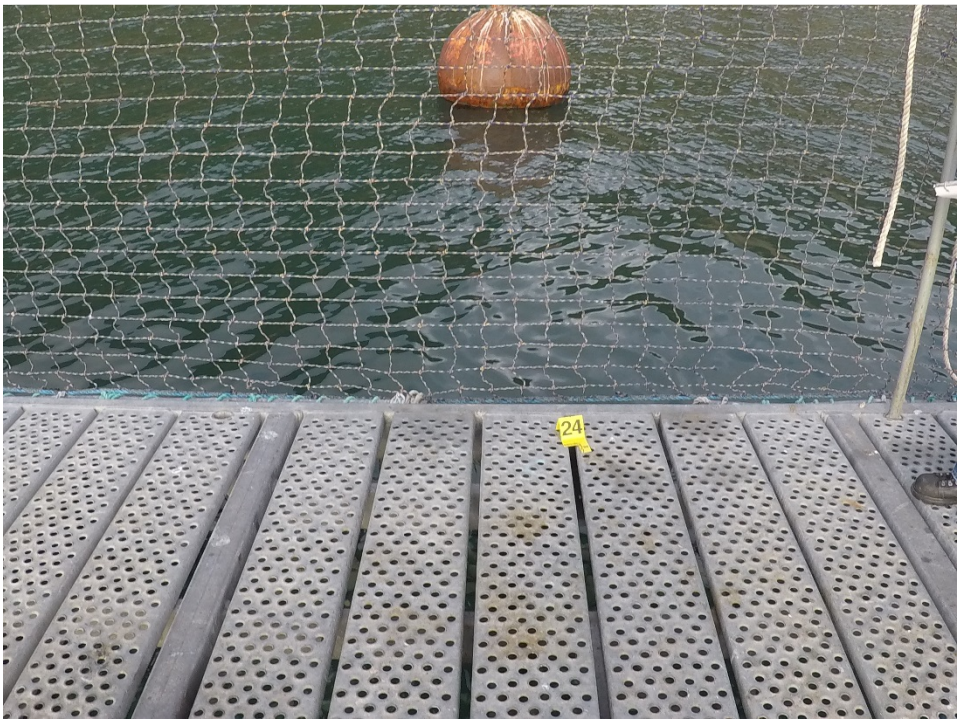


Figure C-20: Cypress Island Net Pen Site 3 – Anchor Line 24

Figure C-21: Cypress Island Net Pen Site 3 – Connection at Anchor Line 24

Figure C-22: Cypress Island Net Pen Site 3 –Anchor Line 25

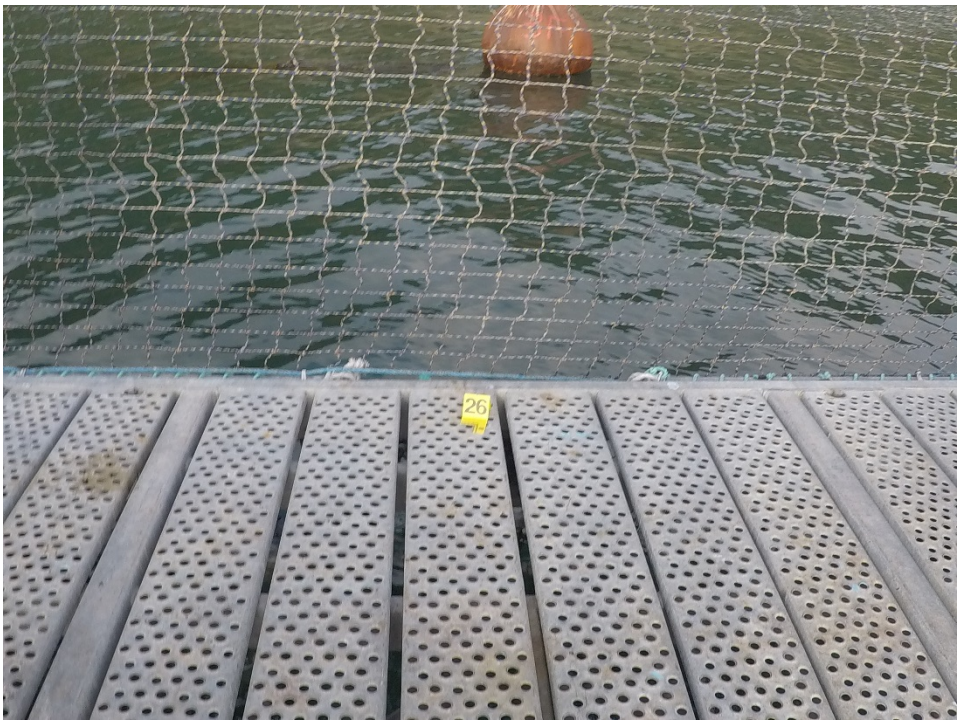


Figure C-23: Cypress Island Net Pen Site 3 – Anchor Line 26

Figure C-24: Cypress Island Net Pen Site 3 – Connection at Anchor Line 26

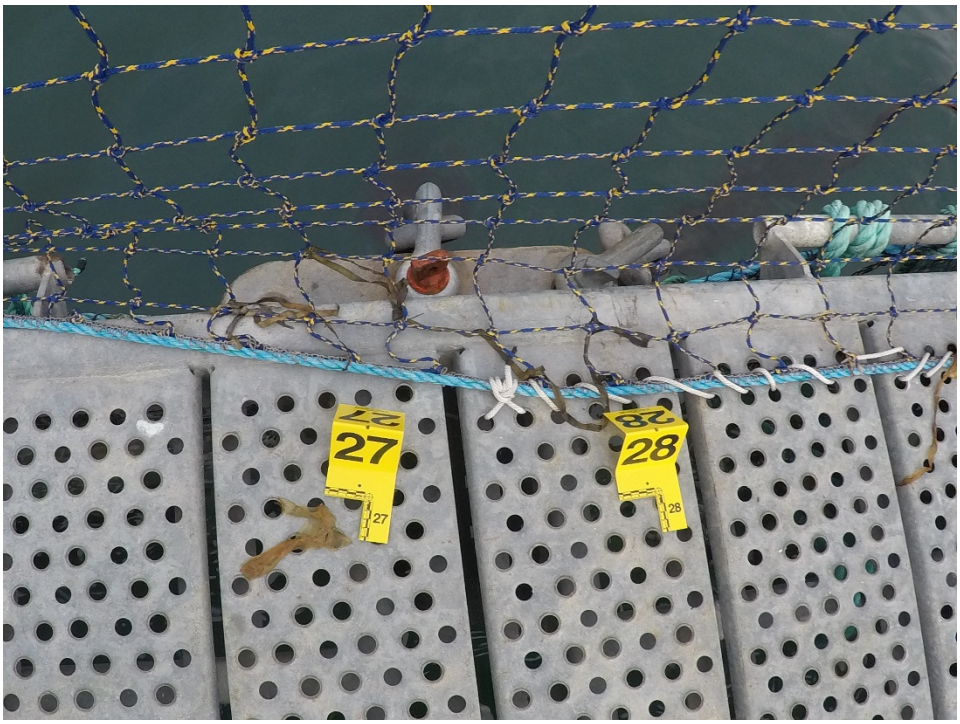


Figure C-25: Cypress Island Net Pen Site 3 – Connection at Anchor Lines 27 and 28

Figure C-26: Cypress Island Net Pen Site 3 – Raised containment nets