RECEIVED
By Nova Scotia Aquaculture Review Board at 10:47 pm, Jan 22, 2024

NOVA SCOTIA AQUACULTURE REVIEW BOARD

IN THE MATTER OF: *Fisheries and Coastal Resources Act*, SNS 1996, c 25

- and -

IN THE MATTER OF: An Application by KELLY COVE SALMON LTD. for a boundary amendment and two new finfish aquaculture licenses and leases for the cultivation of Atlantic salmon (*Salmo salar*) - AQ#1205x, AQ#1432, AQ#1433, in Liverpool Bay, Queens County (the "**Application**")

Affidavit of Adam Turner affirmed on January 16, 2024

I affirm and give evidence as follows:

1. I am Adam Turner, PEng of Saint John, New Brunswick.

2. I have personal knowledge of the evidence affirmed in this affidavit except where otherwise stated to be based on information and belief.

3. I state, in this affidavit, the source of any information that is not based on my own personal knowledge, and I state my belief of the source.

Background

4. I am a professional engineer licensed to practice in New Brunswick, Nova Scotia and Newfoundland and Labrador and employed by Cooke Aquaculture Inc.

5. Kelly Cove Salmon Ltd ("**KCS**") is the Canadian Farming Division of Cooke Aquaculture Inc. ("**Cooke**").

6. My CV is attached as **Exhibit A**.

Marine Finfish Farm Design - Containment Management

7. In my role as engineer in the Cooke Engineering Department, my job duties and responsibilities include, in part, the design of the marine finfish farm mooring and containment systems for Cooke, including KCS' Nova Scotia operations and the Coffin Island site (AQ#1205).

8. The mooring and containment systems at each farm are custom designed by a professional engineer. The KCS marine finfish farms are engineered based on the most up-to-date industry accepted practices, including proposed new farms and existing farms.

9. During the design of a marine finfish farm, the Cooke engineers consider a variety of factors including wind data, wave data, currents, water depth and tidal range as required by the *Aquaculture Management Regulations*.

10. The Cooke engineers rely on various standards in the aquaculture industry and other offshore industries for technical guidance in developing the technical design specifications for the marine finfish mooring and containment systems, including, for example:

    (a) Standards Norge, “NS 9415:2009 – Marine fish farms: Requirements for farm survey, risk analyses, design, dimensioning, production, installation and operation” Marine fish farms: Requirements for farm survey, risk analyses, design, dimensioning, production, installation and operation”, 1st Edition, November 10, 2009;

    (b) Marine Scotland, “A Technical Standard for Scottish Finfish Aquaculture”, June 2015;

    (c) International Organization for Standardization, “ISO16488 – International Standard: Marine fish farms – open net cage – design and operation”, 1st Edition, July 2015; and

    (d) American Petroleum Institute, “API RP 2SK – Design and Analysis of Station keeping Systems for Floating Structures”, 3rd Edition, October 2005.

11. The Cooke engineers also utilize various widely accepted and validated commercial software packages, such as ProteusDS (developed by DSA Ocean, an ocean engineering consulting firm), to perform design modelling and analysis of marine finfish farm containment systems.

12. In Nova Scotia, prior to stocking a farm with fish, the design of the marine finfish farm mooring and containment systems must be:

    (a) approved by a professional engineer; and

    (b) the professional engineer’s approval must be reviewed and approved by the Department of Fisheries and Aquaculture (“**DFA**”).

Coffin Island Farm

13. In 2023, prior to stocking the Coffin Island farm, I reviewed the design and structures in place at the Coffin Island farm with respect to containment management to ensure the installed infrastructure was suitable to withstand the expected long-term environmental conditions.

14. On April 10, 2023, I approved the design of the mooring and containment systems for the Coffin Island farm as set out in my Site Infrastructure Analysis Report for Coffin Island ("**Infrastructure Report**"), attached as **Exhibit B.**

15. The Coffin Island mooring layout for the 14 cages is attached as **Exhibit C.**

16. Following which, the KCS Operations team, under my direction, conducted a surface and subsurface inspection of the Coffin Island site. The inspection findings were relayed to me, which covered aspects such as the mooring lines, grid lines, compensators, and the 14 cages. Upon review, I verified that these components were constructed and installed in accordance with the specifications outlined in the Infrastructure Report.

17. The Infrastructure Report as well as my confirmation that the Coffin Island farm mooring and containment systems was constructed and installed properly was submitted to DFA for review and was approved prior to stocking.

The Development Plan

18. The Liverpool Bay Development Plans for the Coffin Island expansion (AQ#1205x) and two new finish farms at Brooklyn Point (AQ#1432) and Mersey Point (AQ#1433) prepared by Sweeney International Marine Corp for KCS dated March 6, 2019 (the "**Development Plan**") addressed the proposed mooring and containment systems for the three farms.

19. Tables 25 and 26 of the Development Plan details the infrastructure and materials used at Coffin Island farm, respectively, which was also proposed for the new Brooklyn and Mersey Points farms. This data is outdated due to the passage of time since the Development Plan was prepared.

20. The updated Tables 25 and 26 are attached as **Exhibits D and E.**

21. In the event that KCS' Application is granted, the mooring and containment systems for all three farms must obtain a new engineer's approval prior to stocking.

AFFIRMED before me in, Saint John, New Brunswick on January 16, 2024.	
[redacted]	[redacted]
New Brunswick Commissioner of Oaths	Adam Turner

TAB A

T

Application AQ#1205X, AQ#1432, AQ#1433

This is Exhibit "A" referred to in the Affidavit
of Adam Turner, affirmed before me
on January 16, 2024.

[redacted]

New Brunswick Commissioner of Oaths

Adam Turner, P.Eng.
Saint John, NB, Canada
[redacted]

C.V. HIGHLIGHTS

- Extensive experience in open ocean aquaculture engineering, including net hydrodynamics, and mooring system design and analysis.
- Expertise in fluid dynamics, dynamic analysis, and CAD modelling.
- Over 8 years of experience in the aquaculture and marine technology industries.
- Professional Engineer (P.Eng.) registered in Nova Scotia, New Brunswick, and Newfoundland.

EDUCATION

- **Master of Science in Mechanical Engineering** | University of New Brunswick (2015)
  - Graduate Thesis: "Experimental Investigation of Canadian East and West Coast Fish Farm Hydrodynamic Wake Properties and Its Implications for Integrated Multi-Trophic Aquaculture"
  - Research Topics: Hydrodynamics, turbulence, experimental measurements, similitude theory, biological waste dispersion.

- **Bachelor of Science in Mechanical Engineering** | University of New Brunswick (2013)

TECHNICAL SKILLS AND TRAINING

- Dynamic analysis for ocean environments (ProteusDS).
- Advanced 2D/3D CAD (Rhino3D, Solidworks, AutoCAD/DraftSight).
- Advanced programming (Python, C#, Matlab).
- Use of commercial CFD software (ANSYS CFX, Altair VWT/Acusolve)
- Nearshore wave modeling (STWAVE)
- Subsea sensors (ADCPs, load cells, accelerometers)

- Extensive use of MS Word, Excel, LT X.
- Desktop publishing and graphic design software (Inkscape, GIMP, Adobe Photoshop).
- Subversion revision control software
- Microsoft Teams & MS365 Environment

PROJECTS OVERVIEW

Kelly Cove Salmon | *Cooke Aquaculture – Internal (2019 – 2024)*

- Ongoing work to provide engineering analysis of various fish farm moorings according to applicable offshore mooring standards.
- Design of fish transport systems for hatcheries.
- Analysis of metocean conditions (ADCP data, wind data, wind/wave hindcast models) to determine appropriate design conditions.
- Development of near-shore wave propagation models to determine local wave conditions.
- Determined loads and motions of mooring grids as well as cages and nets using dynamic analysis (ProteusDS).
- Detailed CAD drawings of site layout and equipment.
- Developed detailed bill of materials for installation.

GMG Fish Services | *Cooke Aquaculture – Internal (2019 – 2024)*

- Detailed drawings of equipment and hardware used on fish farm installations.
- Design and analysis of new equipment prototypes used to improve operational efficiencies.
- Design and analysis of plastic cage components for fish farm installations

Tassal | *Cooke Aquaculture – Internal (2023 – 2024)*

- Provide analysis of various fish farm moorings according to applicable offshore mooring standards.
- Analysis of metocean conditions (ADCP data, wind data, wind/wave hindcast models) to determine appropriate design conditions.
- Determined loads and motions of mooring grids as well as cages and nets using dynamic analysis (ProteusDS).
- Detailed CAD drawings of site layout and equipment.
- Developed detailed bill of materials for installation.

Culmarex | *Cooke Aquaculture – Internal (2019 – 2023)*

- Provide analysis of various fish farm moorings according to applicable offshore mooring standards.
- Analysis of metocean conditions (ADCP data, wind data, wind/wave hindcast models) to determine appropriate design conditions.
- Determined loads and motions of mooring grids as well as cages and nets using dynamic analysis (ProteusDS).
- Detailed CAD drawings of site layout and equipment.
- Developed detailed bill of materials for installation.

Ngai Tahu Seafoods | *Dynamic Systems Analysis (2019)*

- Completed design of Stewart Island (New Zealand) fish farm mooring system, including grow out moorings, smolt moorings, and feed barge moorings according to Norwegian Standard NS9415.
- Completed analysis of metocean conditions (ADCP data, wind data, wind/wave hindcast models) to determine appropriate analysis conditions.
- Determined loads and motions of mooring grids, cages, nets, and feed barges using dynamic analysis (ProteusDS).
- Determined appropriate materials (ropes, chains, anchors) to be used on site to meet required safety factors of applicable engineering standards.
- Detailed CAD drawings of site layout and equipment.
- Developed detailed bill of materials for installation.
- Communicated results to project manager / client.

Cooke Aquaculture | *Dynamic Systems Analysis (2016-2019)*

- Ongoing consulting to provide analysis of various fish farm moorings according to Norwegian Standard NS9415.
- Analysis of metocean conditions (ADCP data, wind data, wind/wave hindcast models) to determine appropriate design conditions.
- Determined loads and motions of mooring grids as well as cages and nets using dynamic analysis (ProteusDS).
- Determined appropriate materials (ropes, chains, anchors) to be used on site to meet required safety factors of applicable engineering standards.
- Detailed CAD drawings of site layout and equipment.
- Developed detailed bill of materials for installation.

- Communicated results to project manager / client.

C. A. Goudey & Associates | *Dynamic Systems Analysis (2019)*

- Assisted in analysis to determine loads and motions of a unique kelp farm design.
- Assessed the effect of varying compensator buoy sizes on loads and motions of the farm.
- Assessed the effect of different pretension levels on the loads and motions of the farm.
- Communicated results to project manager / client.

MOWI Canada | *Dynamic Systems Analysis (2018-2019)*

- Performed visual cage inspections for steel walkway style fish farms in British Columbia.
- Used ultra-sonic thickness gauge to determine material loss to corrosion on various components.
- Worked with site operators to determine areas of concern.
- Made recommendations on component repairs and replacements required to bring sites up to safe and acceptable working condition.

Department of Fisheries and Aquaculture Nova Scotia | *Dynamic Systems Analysis (2018-2019)*

- Completed nearshore wave modeling for various aquaculture sites around Nova Scotia.
- Assessed the differences in the application of different engineering standards to overall site design.
- Assessed the effects of different fatigue calculation approaches on the overall design of aquaculture sites.
- Assisted in the collection of ADCP current data at an aquaculture site in Nova Scotia to compare the design effects of utilizing spatially varying current measurements.

Offshore Energy Research Association (OERA) | *Dynamic Systems Analysis (2017-2018)*

- Devised a scale model experiment to assess vortex induced vibration (VIV) on tidal energy plat-form power umbilicals.
- Assisted in the design of a scale model power umbilical and platform buoy for deployment in the Minas Passage (Nova Scotia).
- Assisted in procurement of materials and construction of the scale model platform buoy, as well as sensors for experimental measurement.
- Managed materials and equipment budget for project.

- Tank testing of prototype buoy at Dalhousie University Aquatron Laboratory to determine feasibility of design.
- Assisted in deployment of scale model buoy and mooring.
- Processed sensor data and operated VIV prediction software to compare measured results with software predictions.

Cooke Aquaculture | *Dynamic Systems Analysis (2018)*

- Completed experimental pull tests of various anchors to determine holding capacity in different soil conditions.
- Operated a wireless load cell on site to monitor loading on anchor assemblies.
- Worked with and gave instructions to heavy equipment operators.
- Processed load cell data to make conclusions on holding capacity of different anchors.
- Communicated results to project manager / client.

Grieg Seafood | *Dynamic Systems Analysis (2018)*

- Completed analysis of Esperanza (British Columbia) fish farm mooring system according to Norwegian Standard NS9415.
- Completed analysis of metocean conditions (ADCP data, wind data, wind/wave hindcast models) to determine appropriate analysis conditions.
- Determined loads and motions of mooring grid as well as cages and nets using dynamic analysis (ProteusDS).
- Determined appropriate materials (ropes, chains, anchors) to be used on site to meet required safety factors of applicable engineering standards.
- Detailed CAD drawings of site layout and equipment.
- Developed detailed bill of materials for installation.
- Communicated results to project manager / client.

Enterprises Shippagan | *Dynamic Systems Analysis (2018)*

- Assisted in design of Wallace Cove (Newfoundland) fish farm mooring system according to Norwegian Standard NS9415.
- Completed analysis of metocean conditions (ADCP data, wind data, wind/wave hindcast models) to determine appropriate design conditions.
- Determined loads and motions of mooring grid as well as cages and nets using dynamic analysis (ProteusDS).
- Determined appropriate materials (ropes, chains, anchors) to be used on site to meet required safety factors of applicable engineering standards.

- Detailed CAD drawings of site layout and equipment.
- Developed detailed bill of materials for installation.
- Communicated results to project manager / client.

Swan Net-Gundry | *Dynamic Systems Analysis (2018)*

- Assisted in design of Dury Voe (Shetland Islands, Scotland) fish farm mooring system according to Norwegian Standard NS9415.
- Completed analysis of metocean conditions (ADCP data, wind data, wind/wave hindcast models) to determine appropriate design conditions.
- Determined loads and motions of mooring grid as well as cages and nets using dynamic analysis (ProteusDS).
- Determined appropriate materials (ropes, chains, anchors) to be used on site to meet required safety factors of applicable engineering standards.
- Detailed CAD drawings of site layout and equipment.
- Developed detailed bill of materials for installation.
- Communicated results to project manager / client.

C2i-Inc | *Dynamic Systems Analysis (2017-2018)*

- Completed a CFD analysis of a subsea tractor device to determine hydrodynamic forces acting on structure.
- Determined operating envelope for device based on varying current conditions.
- Assisted in design decisions to improve operability and reduce hydrodynamic forcing on device.
- Communicated results to project manager / client.

Big Moon Power |*Dynamic Systems Analysis (2016-2017)*

- Completed an extensive numerical analysis of a floating tidal energy device.
- Developed an algorithm for safely and optimally controlling the tidal energy device.
- Worked with client to help optimize design for cost and power production.
- Developed methods and models for predicting annual power production.
- Completed CFD analysis to determine hydrodynamic forces acting on device.
- Communicated results to project manager / client.

Ultra Electronics Maritime Systems | *Dynamic Systems Analysis (2016)*

- Completed a layback analysis in ProteusDS of a towed array to determine shape of array and position of components when exposed to varying forward speeds and wave conditions.
- Developed a spreadsheet to easily visualize results of analysis.
- Communicated results to project manager / client.

Allswater | *Dynamic Systems Analysis (2016)*

- Completed numerical analysis of tailings pond dredge barge pipeline.
- Determined number of oats required for pipeline to remain on surface.
- Determined expected loads from pipeline acting on the dredge barge.
- Assessed acceptable curvature of pipeline.
- Determined amount of pipeline to deploy in pond to minimize loading and provide required compliance.
- Communicated results to project manager / client.

NRCAN ecoENERGY Innovation Initiative | *Dynamic Systems Analysis (2015-2016)*

- Assisted in design of mooring system for floating tidal platform in Grand Passage, NS.
- Assisted in procuring materials and equipment for mooring and platform.
- Assisted on site in the decommissioning of the platform and mooring.

Dynamic Systems Analysis | *Dynamic Systems Analysis – Internal (2015-2016)*

- Created ProteusDS input les for automatic testing suite based on software tutorials.
- Developed new software tutorials and introduced new Python/HTML based tutorial platform.
- Validation and optimization of ProteusDS net drag with published research and personal thesis.
- Validation of mooring analysis in ProteusDS for Bull Harbour fish farm site with results of previous engineering report.
- Developed procedure for converting TurbSim turbulence data for use in ProteusDS simulations.
- Assisted in development and testing of new STL clamp-on load cell devices.
- Assisted in C++ development of ProteusDS dynamic analysis software.

GMG Fish Services / Cooke Aquaculture | *Cooke Aquaculture - Internal, Dynamic Systems Analysis (2014-2019)*

- Detailed drawings of fish cage netting, including rope and mesh plans.

- Detailed drawings of mooring hardware.
- 3D models / high resolution renderings of fish cages and components.

WORK EXPERIENCE

- **Cooke Aquaculture Inc** (2019-present)
  - Design and analysis of fish farm mooring systems according to applicable engineering standards.
  - Design of fish transport systems for hatcheries
  - Detailed CAD drawings of aquaculture moorings and hardware.
  - Research and development for ocean related infrastructure and operations.
  - Project management of various capital projects for company operations

- **Dynamic Systems Analysis Ltd** (2015-2019)
  - Ocean engineering consulting in the aquaculture and marine technology industry.
  - Design and analysis of fish farm mooring systems according to applicable engineering standards (NS9415, ISO16488).
  - Detailed CAD drawings of aquaculture moorings and hardware.
  - Inspections of steel fish farm walkways.
  - Research and development for aquaculture and tidal energy sectors in Nova Scotia.
  - Design and analysis of other marine structures and mooring systems for tidal energy, oil & gas, and defense.

- **GMG Fish Services / Cooke Aquaculture** (2014-2015)
  - Detailed drawings of fish cage netting, including rope and mesh plans.
  - Detailed drawings of mooring hardware.
  - 3D models / high resolution renderings of fish cages and components.

- **University of New Brunswick** (2013-2015)
  - Conduct literature reviews.
  - Prepare experiments.
  - Design components for experiments.
  - Prepare progress and design reports.
  - Running lab courses for students.
  - Grading assignments and midterms.

PROFESSIONAL AFFILIATIONS

- Registered Professional Engineer in Nova Scotia (since 2019)
- Registered Professional Engineer in New Brunswick (since 2019)
- Registered Professional Engineer in Newfoundland (since 2021)

PUBLICATIONS

1. Turner, A., Steinke, D., Nicoll, R., Stenmark, P., *Comparison of Taut and Catenary Mooring Systems For Finfish Aquaculture*, Proceedings of the ASME 2018 37th International Conference on Ocean, Offshore and Arctic Engineering (OMAE2018), June 17th, 2018.
2. Baron, A., Steinke, D., Turner, A., Trowse, G., Cheel, R., Hay, A., Karsten, R., Roc, T., Jeans, T., *Dynamic Analysis Validation of the Floating ecoSpray Tidal Energy Test Platform*, Proceedings of the 2017 European Wave and Tidal Energy Conference (EWTEC2017), August 28th, 2017.
3. Turner, A., Nicoll, R., Steinke, D., *Application of Wake Shielding Effects With a Finite Element Net Model in Determining Hydrodynamic Loading on Aquaculture Net Pens*, Proceedings of the ASME 2017 36th International Conference on Ocean, Offshore and Arctic Engineering (OMAE2017), June 25th, 2017.
4. Turner, A., Jeans, T., Reid, G., *Experimental Investigation of Fish Farm Hydrodynamics on 1:15 Scale Model Square Aquaculture Cages*, ASME Journal of Offshore Mechanics and Arctic Engineering, 138(6), August 9th, 2016.
5. Turner, A., Jeans, T., Reid, G., *Experimental Investigation of Fish Farm Hydrodynamic Wake Properties on 1:15 Scale Model Circular Aquaculture Cages*, Proceedings of the ASME 2015 International Conference on Ocean, Offshore and Arctic Engineering (OMAE2015), June 1st, 2015.
6. Turner, A., Del Bel Belluz, J., Sprague, S., Byrne, A., Reid, G., *Effects of Circular Fish Cage Arrays on Current Dynamics: Implications for Nearfield Velocity Reduction, Nutrient Concentrations and Cage Clearance Times*, World Aquaculture Magazine Vol. 14 No. 4, December 2015.
7. Turner, A., *Experimental Investigation of Canadian East and West Coast Fish Farm Hydrodynamic Wake Properties and Its Implications for Integrated Multi-Trophic Aquaculture*, Master’s Thesis, University of New Brunswick, April 2015.

TAB B

Application AQ#1205X, AQ#1432, AQ#1433

This is Exhibit "B" referred to in the Affidavit
of Adam Turner, affirmed before me
on January 16, 2024.

[redacted]

New Brunswick Commissioner of Oaths

Site Infrastructure Analysis Report

CONFIDENTIAL

Coffin Island

[redacted]

Original date: 2023-04-04
Last revised: 2023-04-10
Revision: A
Status: FINAL
Written by: Adam Turner, P.Eng.
Approved by: Jeff Nickerson, Ted Weaire

Revisions

Revision	Status	Description	Revisions by	Date (d/m/y)
A	Draft	Initial draft		2023-03-01
A	Final			2023-04-10

Table of Contents

1 Introduction

The fish farm currently operating on the Coffin Island lease (NS-1205) in Liverpool Bay, Nova Scotia, has been analyzed to determine if infrastructure installed on the site is suitable to withstand the expected long term environmental conditions. The Coffin Island fish farm consists of 14-100m cages, arranged in a 2x7 grid (160 ft). As part of the analysis, any infrastructure deemed insufficient has been recommended for upgrading, which includes ropes, chains, anchors, connecting hardware, and plastic cages. The recommended site configuration is presented for analysis in this report.

This report outlines the results of a load analysis completed for the site, including the mooring system (rope, chain, anchors), and containment system (plastic cages, nets). The load analysis was completed using the dynamic analysis software, ProteusDS, as shown in Figure 1.

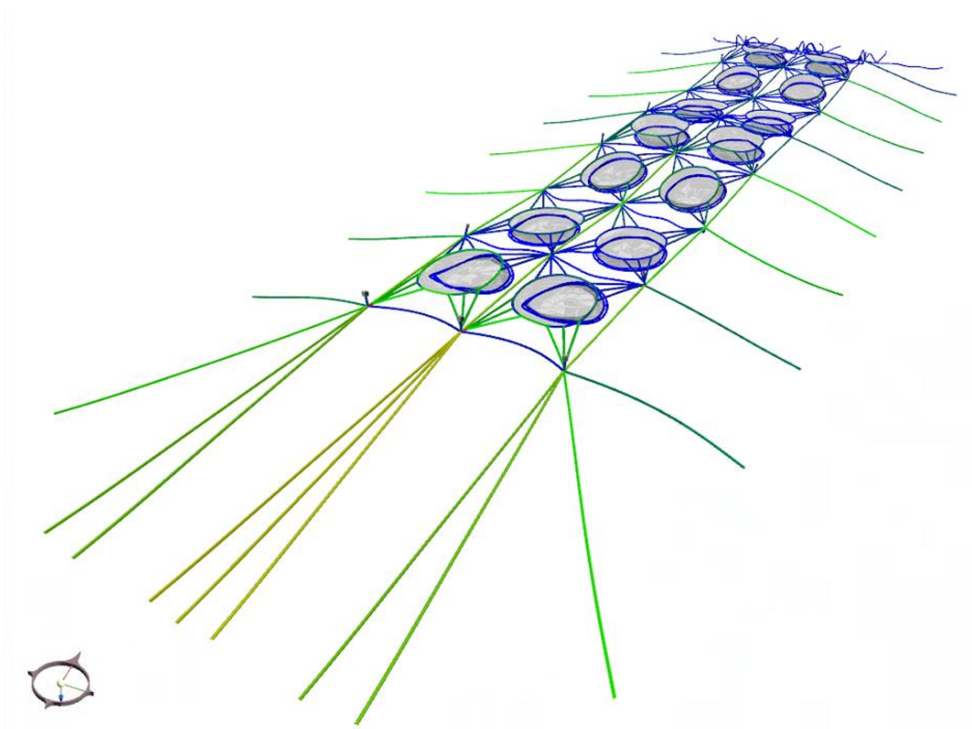


Figure 1: Dynamic model of Coffin Island fish farm in ProteusDS

The analysis was carried out using guidance from the following engineering standards:

- NS 9415:2009 – "Marine fish farms: Requirements for site survey, risk analyses, design, dimensioning, production, installation and operation" [1]
- "Marine Scotland: A Technical Standard for Scottish Finfish Aquaculture" [2]
- ISO16488 – "International Standard: Marine fish farms – open net cage – design and operation" [3]
- API RP 2SK – "Design and Analysis of Stationkeeping Systems for Floating Structures" [4]
- DNV-OS-E301 – "Position Mooring" [5]

2 Analysis Method

The load analysis was completed on the mooring design and containment system using the software ProteusDS, which is a dynamic analysis tool built for marine applications. The software utilizes advanced hydrodynamic and finite element models to determine loading on nets, lines, and other components (such as floating collars, buoys, barges, etc.) under defined environmental conditions.

Mechanical properties for components in the mooring (rope, chain, nets, buoys) and containment system (plastic collars, nets) were determined using accepted methods in applicable engineering standards.

Three sets of analyses were completed (as per NS9415 guidelines):

1. Ultimate limit state (ULS)
2. Accident limit state (ALS)
3. Fatigue limit state (FLS)

Each analysis determined maximum loading on components from individual load cases. Component loads are then compared with applicable safety factors and minimum breaking loads to determine their suitability.

2.1 Ultimate Limit State (ULS)

The purpose of the ultimate limit state analysis is to ensure the mooring and containment system will safely withstand expected long term extreme environmental conditions. Simulations were completed using extreme environmental conditions in an "intact" condition, representing expected behaviour.

2.2 Accident Limit State (ALS)

The purpose of the accident limit state analysis is to ensure the system can safely withstand expected long term extreme environmental conditions in a "damaged" condition. Examples of damaged conditions include:

- Breaks in mooring lines, grid lines, bridle lines, or other lines, including lines that are carrying the largest loads, or lines that are critical for the strength of the fish farm.
- Puncturing or loss of critical buoyancy components, such as floating collars, or compensator buoys.
- Extreme water levels. Moorings should be analysed at water levels of at least 1 meter above the expected upper tidal level to account for extreme tidal changes and storm surge.

2.3 Fatigue Limit State (FLS)

The purpose of the fatigue limit state analysis is to ensure that that mooring can safely withstand cyclical loading over its life span. Fatigue in materials occurs from cyclical loading patterns of varying frequencies. Cyclical loading on mooring components occurs mainly from waves (short period), flow turbulence (short, and long period), and tides (long period).

Consideration was paid to loads that vary with wave frequency, as it is expected that variable wave loading will cause the greatest fatigue damage on mooring components.

Fatigue was analysed over a 12-year life cycle, as all mooring and cage components are fully replaced after 3 grow-out cycles (4 years per cycle).

2.4 Safety Factors & Design Criteria

Each component that affects the structural integrity of the fish farm must satisfy the following condition:

$$F_{max} \leq \frac{MBS}{C_{SF}} \tag{1}$$

where F_{max} is the maximum force on the component determined from a set of simulations (i.e. ULS, ALS), MBS is the minimum break strength of the component, and C_{SF} is the required safety factor. For anchoring, MBS is taken as the minimum holding capacity of the anchor. Factors of safety for each analysis type based on recommendations from API RP 2SK [4] and NS9415 [1] are presented in Table 1.

Table 1: Factors of safety used for mooring components by analysis type

Analysis type	Component	Factor of safety (C_{SF})
ULS	Line (i.e. rope, chain, connecting hardware)	1.67
ALS	Line (i.e. rope, chain, connecting hardware)	1.25
ULS	Anchor	1.5
ALS	Anchor	1.0
ULS	Plastic components	1.25
ALS	Plastic components	1.0
ULS/ALS	Netting rope (Grade 0 only)	4.5

Stated safety factors ensure the ultimate strength of the each component has a margin of error to safely handle expected extreme mooring loading. However, these safety factors do not take into account wear and corrosion on steel components. Based on reccomendations from API RP 2SK [4] and DNV-OS-E301 [5], steel chain diameters are increased by 0.3 mm per year of service life to account for corrosion and wear in the splash zone and thrash zone on hard bottom. The fish farm has a target service life of 12 years, therefore an additional increase in chain diameter of 3.6mm is required from the original chain size calculated from the strength analysis (ULS/ALS).

2.5 Cage Design & Dimension Grade

This section lays out strength requirements for cage netting and integrated ropes, according to NS9415 [1]. For sites with a maximum dimensioning significant wave height lower than 2.5m and maximum dimensioning current velocity of less than 0.75 m/s, the "dimension grade" of the site is determined using Table 2, otherwise the dimension grade is set at 0.

Table 2: Dimension grades

Cage depth (m)	**Cage circumference (m)**							
	<49	50-69	70-89	90-109	110-129	130-149	150-169	>170
0 – 15	I	II	III	IV	V	V	VI	0
15.1 – 30	II	II	IV	IV	V	VI	VII	0
30.1 – 40	III	III	IV	V	V	VI	VII	0
> 40	0	0	0	0	0	0	0	0

Based on the dimension grade of the site, requirements for netting twine and integrated ropes are determined using Table 3 and Table 4, respectively.

Table 3: Twine breaking strength by dimension grade

Half-mesh (mm)	**Dimension grades**							
	I	II	III	IV	V	VI	VII	0
	Minimum mesh strength in cage (kg)							
< 6.0	21	21	25	25	25	25	25	25
6.0 – 8.0	25	31	31	39	39	39	39	39
8.1 – 12.0	31	39	47	55	55	55	55	55
12.1 – 16.5	39	47	55	63	71	71	79	79
16.6 – 22.0	47	63	79	79	79	95	95	95
22.1 – 29.0	63	71	95	95	117	136	136	136
29.1 – 35.0	95	95	117	117	136	136	151	151

Table 4: Netting rope requirements by dimension grade

		Dimension grades						
		I	II	III	IV	V	VI	VII
Minimum break strength (kg)		1900	1900	2800	3400	4100	4100	5000
Top rope	Min no.	1	1	1	1	1	1	1
Main rope	Min no.	1	1	1	1	1	1	1
Bottom rope	Min no.	1	1	1	1	1	1	1
Vertical rope spacing	Max distance	7.5m	7.5m	6.5m	6.5m	5.0m	5.0m	5.0m

For cages of dimension grade 0, maximum forces in netting twine and rope must be determined through ULS and ALS simulations. For integrated rope, the minimum break strength must then be determined using safety factors in Table 1. The minimum breaking strength of the netting mesh must be determined using Table 3, similar to procedures for all other dimension grades.

3 Site Information

3.1 Location

The fish farm lease is located to the west of Coffin Island in Nova Scotia. An expansion to the current lease has been proposed for a future expansion. Proposed lease boundary corners are listed below in Table 5.

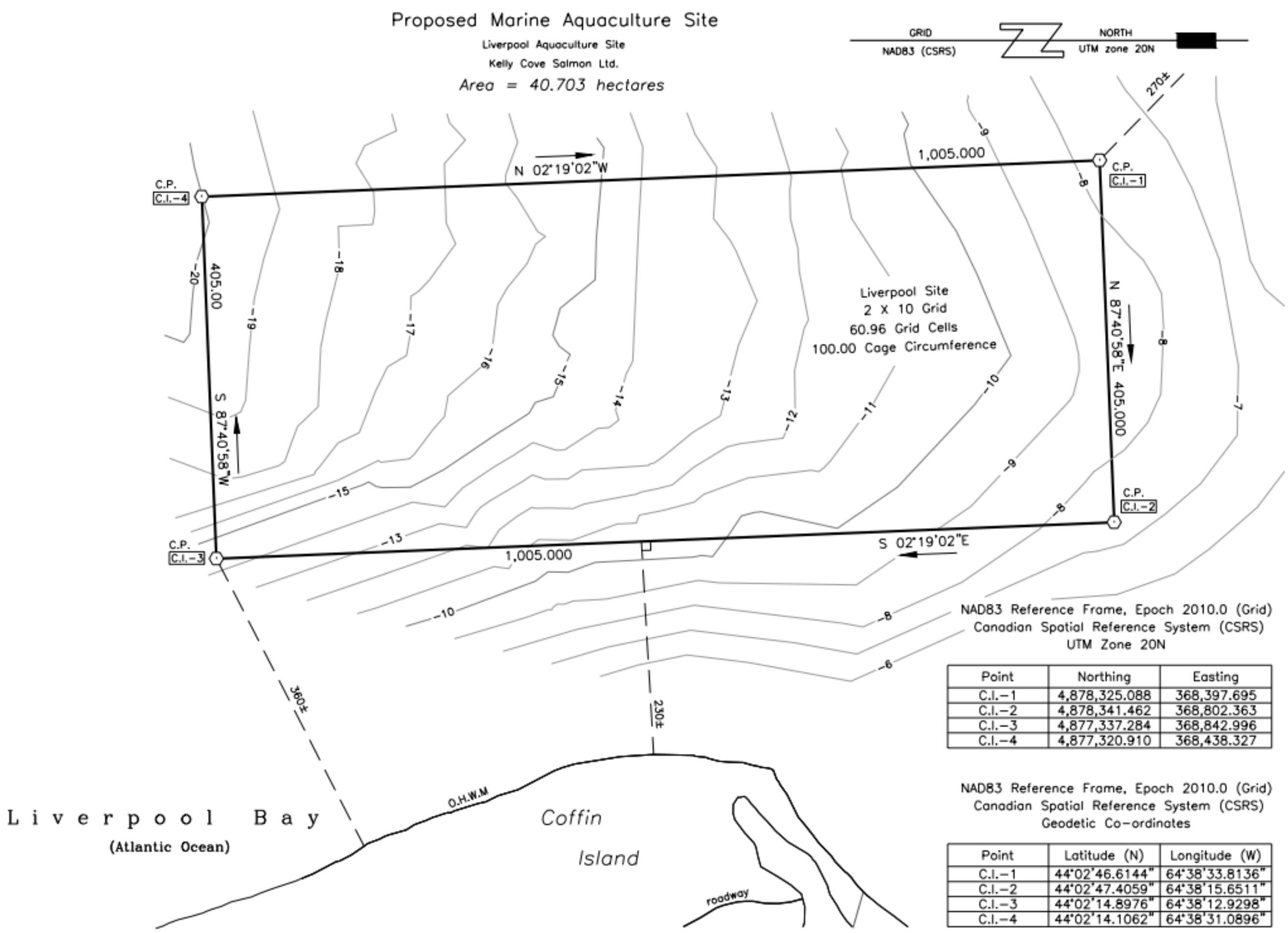
Table 5: Lease boundary corners

Boundary corner	Location (Latitude, Longitude)
1	44.657675°, -64.642726°
2	44.046502°, -64.637681°
3	44.037472°, -64.636925°
4	44.037252°, -64.641969°

Figure 2: Coffin Island fish farm site location

3.2 Seabed

Bathymetry information at the site was determined from the site development plan, which was developed by SIMCorp in 2019, as shown in Figure 3. Depths within the lease area range from 8m on the northern end of the lease to 20m on the southern end of the lease. Maximum estimated tidal range for the site is 2.11m.



Point	Northing	Easting
C.I.-1	4,878,325.088	368,397.695
C.I.-2	4,878,341.462	368,802.363
C.I.-3	4,877,337.284	368,842.996
C.I.-4	4,877,320.910	368,438.327

Point	Latitude (N)	Longitude (W)
C.I.-1	44°02'46.6144"	64°38'33.8136"
C.I.-2	44°02'47.4059"	64°38'15.6511"
C.I.-3	44°02'14.8976"	64°38'12.9298"
C.I.-4	44°02'14.1062"	64°38'31.0896"

Figure 3: Coffin Island site development plan and bathymetry. Depths shown in meters at low water level

3.3 Current

Current conditions at the site were determined from a 32-day ADCP deployment from September 2nd, 2010 to October 4th, 2010. A rose plot of current speeds over the 32-day deployment at 5m depth is shown in Figure 4. See referenced ADCP report [6] for more information on the current conditions at the site.

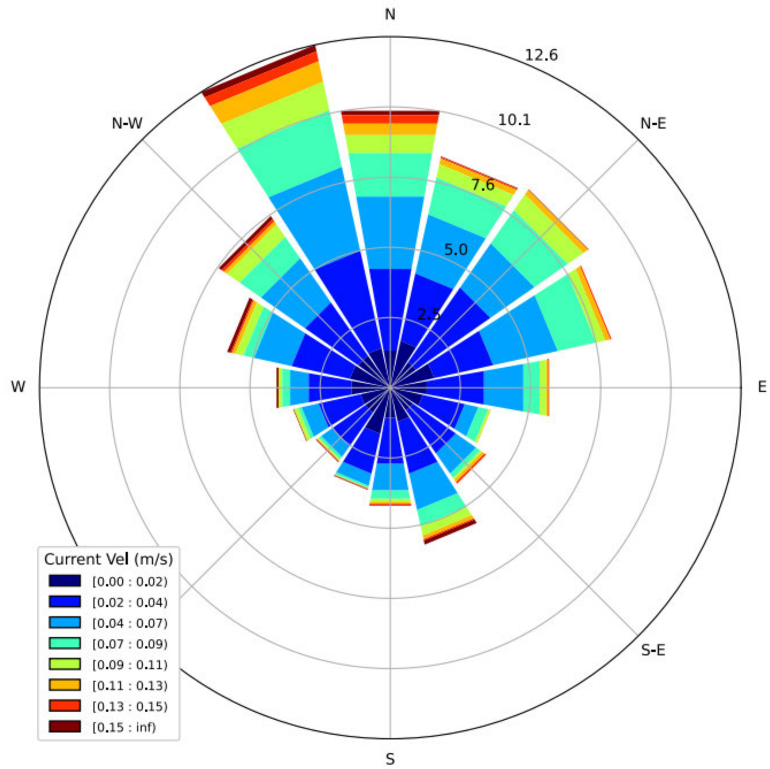


Figure 4: Rose plot of current speeds for Coffin Island at 5m depth

Extreme current conditions for 10-year and 100-year return periods were determined using scaling factors guided by NS9415 recommended extreme current scaling factors, which are based on a one-month ADCP record and maximum recorded current speeds. Scaling factors used were 1.65 and 2.0 for 10-year and 100-year return periods, respectively. For the 270 degree current heading, a "percent over threshold" peak fit of 5% was used due to large spikes in current velocity observed during the measurement period. If standard multiplication factors based on maximum observed values were used for extreme value scaling, unrealistic values would likely be achieved.

3.4 Wind & Waves

Wind and wave conditions near the site were determined from the MSC50 Wind and Wave Climate Hindcast model [7]. Grid point "M6005981" (44.0°, -64.6°) was chosen as the nearest grid point to the site location. The grid point is approximately 5km from the site.

Wind conditions used for the site analysis were taken directly from the MSC50 hindcast model, as they are expected to not change significantly between the grid point location and the site location.

The site is located to the west of Coffin Island and is fully exposed to open-ocean swell from the south. Open ocean wave conditions are accurately captured in the MSC50 hindcast model, however, it is expected that wave conditions from the MSC50 grid point will be transformed by land features, changing bathymetry, and bottom friction as they propagate towards the site. To account for wave transformation, a wave propagation analysis was completed using STWAVE [8], which is a steady-state, finite difference, spectral model based on the wave action balance equation. The entire Coffin Island region was modeled, as shown in Figure 5.

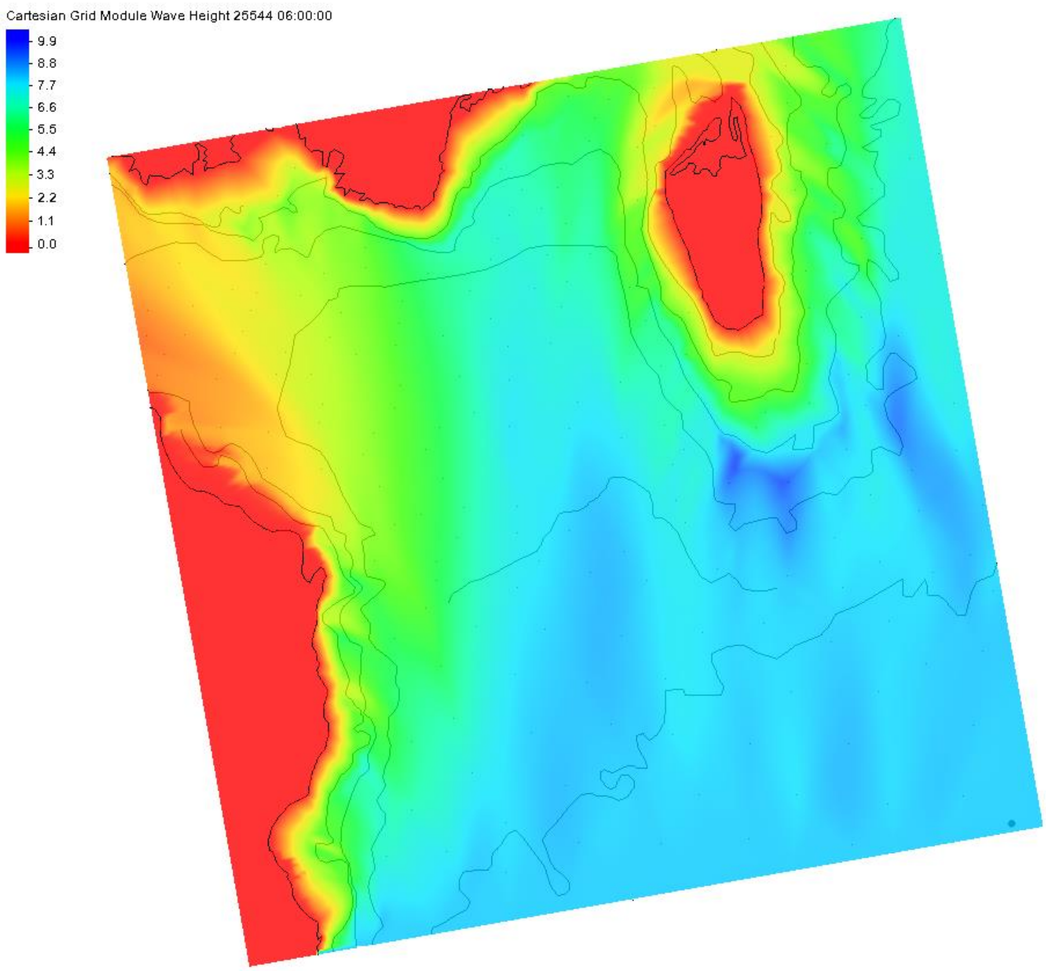


Figure 5: Sample wave simulation of Coffin Island region. Wave heading – 0 deg. Colours indicate significant wave height (Hs)

In all other directions where ocean swell is not considered to have an effect, such as from the west, a wind speed / fetch-based model was adapted to determine wave conditions.

4 Site Design

4.1 Mooring design

A drawing of the mooring design for the Coffin Island fish farm site is shown in Figure 6. This mooring arrangement has not yet been confirmed to be installed, and is shown as a recommended site configuration to attain required engineering approvals. Current infrastructure installed on site is not fully known. The site consists of 14-100m cages, arranged in a 2x7 grid (160 ft). Each cage is supported by 12 bridle lines. In total, there are 31 mooring lines anchoring the farm to the seabed. Further information on mooring layout, lengths, materials, and hardware is presented in the site engineering drawings [9].

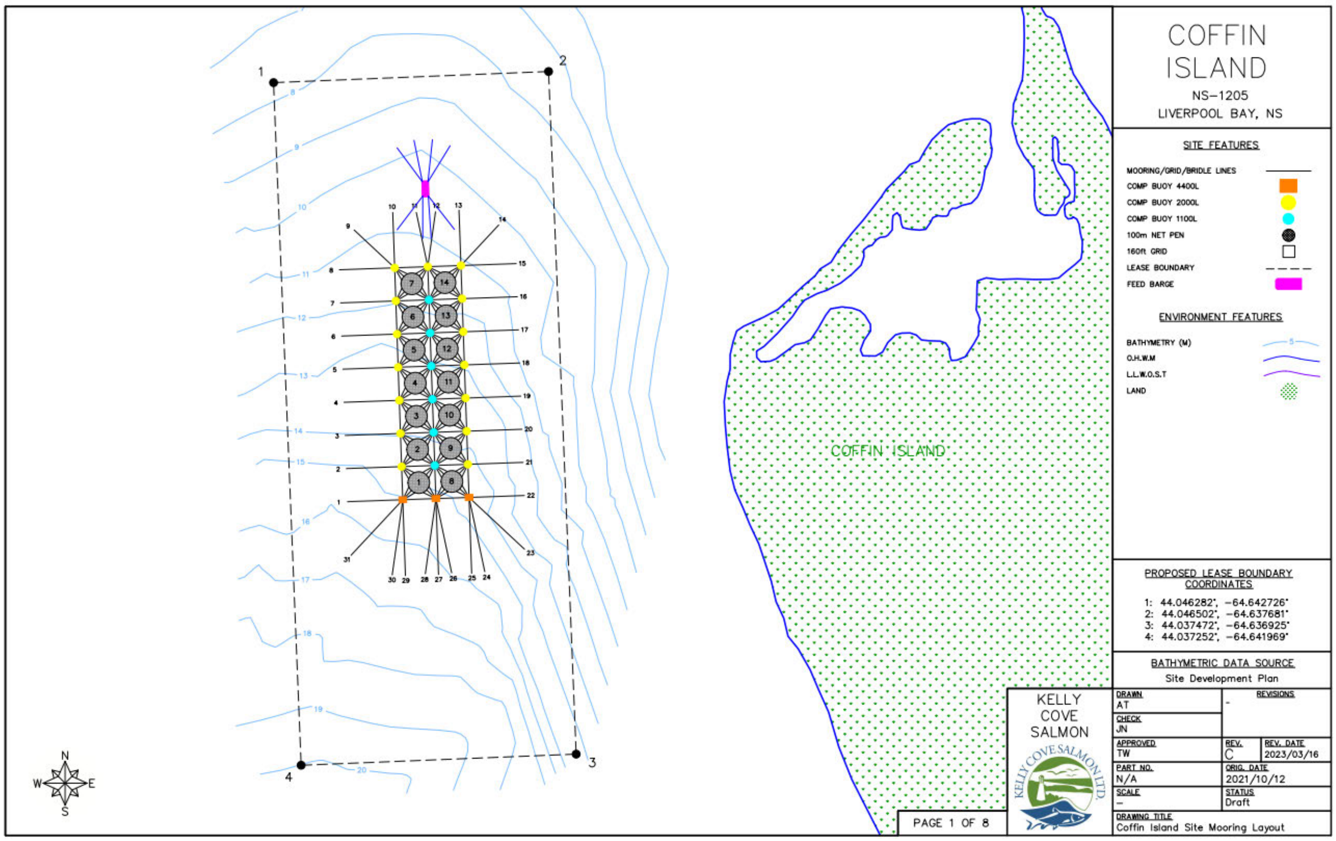


Figure 6: Mooring layout of Coffin Island site [9]

Materials used for the mooring are presented in Table 6 for rope & chain, and in Table 7 for anchors.

Table 6: Mooring materials list

Type	Details	MBS (kN)
West side moorings (1-8)		
Chain	Openlink G2 38mm (1-1/2")	749
Rope	Proflex 8str 48mm (2")	359

North end moorings (9-14)		
Chain	Openlink G2 38mm (1-1/2")	749
Rope	Proflex 8str 48mm (2")	359
East side moorings (15-22)		
Chain	Openlink G2 38mm (1-1/2")	749
Rope	Proflex 8str 48mm (2")	359
South end moorings (23-31)		
Chain	Openlink G2 38mm (1-1/2")	749
Rope	Proflex 8str 48mm (2")	359
Grid lines		
Rope	Proflex 8str 48mm (2")	359
Bridle lines – Cells 1-2, 8-9		
Chain	Openlink G2 38mm (1-1/2")	749
Rope	Proflex 8str 36mm (1-1/2")	202
Bridle lines – Cells 3-7, 10-14		
Chain	Openlink G2 28mm (1-1/8")	407
Rope	Proflex 8str 36mm (1-1/2")	202
Buoy lines		
Chain	Openlink G2 28mm (1-1/8")	407

Table 7: Anchoring details

Mooring #	Anchor details	Estimated holding power (kN)
1-8	500kg plow anchor + 8T concrete block	274.7
9-14	1000kg plow anchor + 8T concrete block	470.9
15-22	1000kg plow anchor + 8T concrete block	470.9
23-31	1000kg plow anchor + 8T concrete block	470.9

Compensator buoys used at the site are a combination of 4400L, 2000L, and 1100L buoys. In total there are 24 compensator buoys used, with locations of each indicated in the site engineering drawings [9].

4.2 Cage Design

Two types of cages will be used at the Coffin Island site. Both sets of cages used on the site are 100m in circumference and 9m deep, however, four cages on the southern end of the site utilize a double bridle system to better distribute bridle loads on the float pipe.

- Cages 1-2 & 8-9 utilize a floating collar that is made of 2x315mm **DR21** HDPE pipes, with 48 connecting brackets and 12 bridle connection adapters. The floating collar has a net buoyancy of 157 kg/m.

- Cages 3-7 & 10-14 utilize a floating collar that is made of 2x315mm **DR21** HDPE pipes, with 48 connecting brackets and 24 bridle connection adapters to accommodate a double bridle system. The floating collar has a net buoyancy of 157 kg/m.

The sinker tube for all cages is made of a single 6″ (DR11) HDPE pipe filled with concrete. The sinker tube has a wet weight of 26.3 kg/m.

Each cage consists of a containment net and a predator net. The containment net is typically a knotless smolt netting for a portion of the grow cycle. The smolt netting has a significantly higher solidity than the regular containment netting, therefore the smolt netting has been used in this analysis. Details on each net are presented in Table 8.

Table 8: Net details

Type	**Material**	**Twine diameter (mm)**	**Half mesh (mm)**	**Top circ. (m)**	**Bottom circ. (m)**	**Depth (m)**	**Mesh break strength (kg)**
Smolt	Star Knotless	3.5	19	101.0	95.0	8.0	129
Market	Sapphire UC	2.6	29	101.0	95.0	8.0	150
Predator	Sapphire UC	3.8	75	101.0	95.0	9.0	380

For dynamic simulations, all nets include a 50% increase in twine diameter to account for biofouling of the net, as per requirements of NS9415 [1]. Twine diameters presented in Table 8 represent the unfouled netting.

All nets (smolt, market, predator) contain an integrated top line, water line, bottom line, and 72 vertical down lines, meeting requirements set out by NS9415 [1]. All integrated lines are made of 16mm Maxima rope, which has a minimum break strength of 4800kg.

5 Load Cases

5.1 Ultimate Limit State (ULS)

Table 9: ULS simulation cases

	Case	Heading (deg)	Current @5m (m/s)	Current @15m (m/s)	Wind (m/s)	Sig. wave height (m)	Peak period (s)
100yr current, 10yr wave/wind	1	0	0.46	0.36	21.18	4.16	8.50
	2	45	0.34	0.28	21.20	1.03	8.00
	3	90	0.32	0.20	21.97	0.80	2.58
	4	135	0.66	0.22	21.38	0.38	1.59
	5	180	0.40	0.60	21.46	0.54	2.01
	6	225	0.78	0.68	22.38	0.78	2.51
	7	270	0.92	0.63	20.83	0.26	1.25
	8	315	0.68	0.46	20.72	0.42	1.72
10yr current, 100yr wave/wind	9	0	0.38	0.30	28.06	5.84	12.00
	10	45	0.28	0.23	27.16	1.19	8.00
	11	90	0.26	0.17	25.61	0.97	2.74
	12	135	0.54	0.18	26.67	0.50	1.74
	13	180	0.33	0.50	25.03	0.66	2.14
	14	225	0.64	0.56	25.33	0.91	2.64
	15	270	0.72	0.53	23.48	0.30	1.31
	16	315	0.56	0.38	26.91	0.58	1.91

5.2 Accident Limit State (ALS)

Table 10: ALS simulation cases

Case	Details	Heading (deg)	Current @5m (m/s)	Current @15m (m/s)	Wind (m/s)	Sig. wave height (m)	Peak period (s)
17	Break mooring_3	0	0.38	0.30	28.06	5.84	12.00
18	Break mooring_12	225	0.78	0.68	22.38	0.78	2.51
19	Break mooring_19	270	0.92	0.63	20.83	0.26	1.25
20	Break mooring_27	0	0.38	0.30	28.06	5.84	12.00
21	Break gridX0_1	0	0.38	0.30	28.06	5.84	12.00
22	Break bridle7_0_0	0	0.38	0.30	28.06	5.84	12.00
23	Break bridleChain2_0_0	0	0.38	0.30	28.06	5.84	12.00
24	Rupture float_0_0	0	0.38	0.30	28.06	5.84	12.00
26	Water level + 3.11m	0	0.38	0.30	28.06	5.84	12.00

5.3 Fatigue Limit State (FLS)

Table 11: FLS simulation cases

Case	Heading (deg)	Current @5m (m/s)	Current @15m (m/s)	Wind (m/s)	Sig. wave height (m)	Peak period (s)
27	0	0.38	0.30	28.06	0.58	3.78
28	0	0.38	0.30	28.06	1.17	5.34
29	0	0.38	0.30	28.06	1.75	6.54
30	0	0.38	0.30	28.06	2.34	7.55
31	0	0.38	0.30	28.06	2.92	8.44
32	0	0.38	0.30	28.06	3.50	9.25
33	0	0.38	0.30	28.06	4.09	9.99
34	0	0.38	0.30	28.06	4.67	10.68
35	0	0.38	0.30	28.06	5.26	11.33
36	0	0.38	0.30	28.06	5.84	11.94

6 Mooring System Results

6.1 Pretension

Mooring lines were not pretensioned to a specific tension level. Mooring line initial conditions are assumed as a straight line from the grid plate to the anchor position. As heavy anchor chain falls to the seabed, low amounts of pretension in the mooring line will develop, typically less than 15 kN.

6.2 Ultimate Limit State (ULS)

The ultimate limit state analysis was completed with load cases described in Table 9. Load case 9 produced the highest loads on the mooring, as shown in Figure 7.

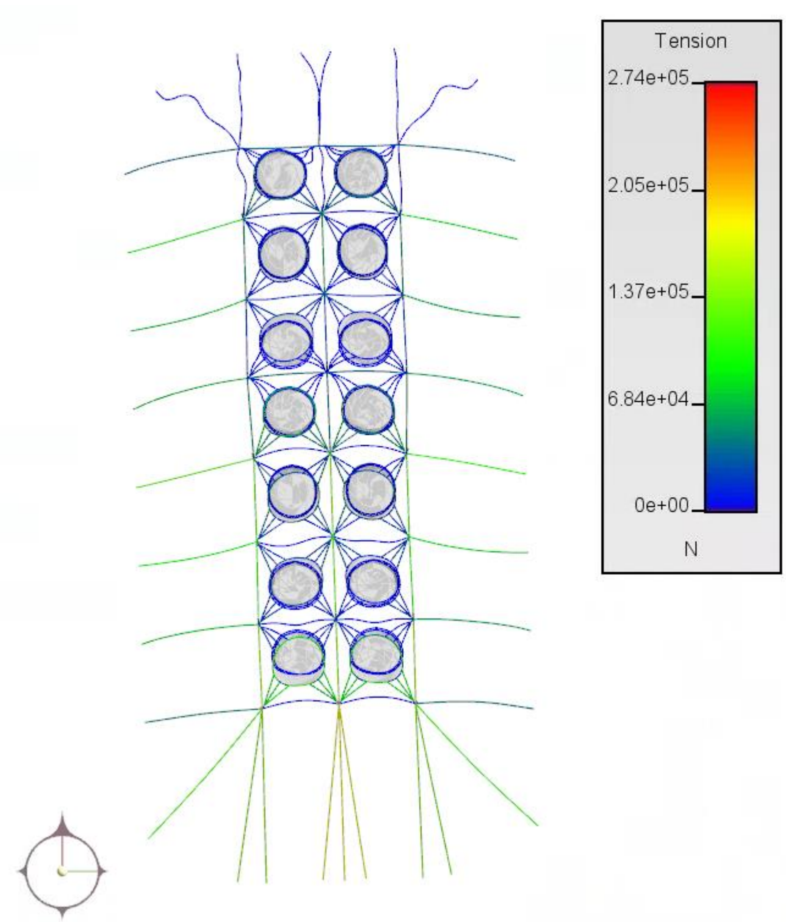


Figure 7: ULS simulation case 9

A summary of maximum loads and corresponding observed safety factors are presented in Table 12 for rope & chain, and in Table 13 for anchors. "Max load" represents maximum tension for rope/chain, and maximum reference force for anchors.

Table 12: ULS mooring results

Component	Details	Case of max load	Max load (kN)	MBS (kN)	Safety factor
West side moorings (1-8)					
Chain	Openlink G2 38mm (1-1/2")	9	129.6	749	5.78
Rope	Proflex 8str 48mm (2")	9	129.6	359	2.77
North end moorings (9-14)					
Chain	Openlink G2 38mm (1-1/2")	6	147.0	749	5.10
Rope	Proflex 8str 48mm (2")	6	147.0	359	2.44
East side moorings (15-22)					
Chain	Openlink G2 38mm (1-1/2")	7	154.5	749	4.85
Rope	Proflex 8str 48mm (2")	7	154.5	359	2.32
South end moorings (23-31)					
Chain	Openlink G2 38mm (1-1/2")	9	184.9	749	4.05
Rope	Proflex 8str 48mm (2")	9	184.9	359	1.94
Grid lines					
Rope	Proflex 8str 48mm (2")	9	198.4	359	1.81
Bridle lines – Cells 1-2, 8-9					
Chain	Openlink G2 38mm (1-1/2")	9	273.7	749	2.74
Rope	Proflex 8str 36mm (1-1/2")	9	54.4	202	3.71
Bridle lines – Cells 3-7, 10-14					
Chain	Openlink G2 28mm (1-1/8")	9	176.4	407	2.31
Rope	Proflex 8str 36mm (1-1/2")	9	83.4	202	2.42
Buoy lines					
Chain	Openlink G2 28mm (1-1/8")	N/A	N/A	407	N/A

Table 13: ULS anchor results

Mooring #	Anchor details	Case of max load	Max load (kN)	Estimated holding capacity (kN)	Safety Factor
1-8	500kg plow anchor + 8T concrete block	9	127.2	274.7	2.16
9-14	1000kg plow anchor + 8T concrete block	6	146.7	470.9	3.21
15-22	1000kg plow anchor + 8T concrete block	7	154.1	470.9	3.06
23-31	1000kg plow anchor + 8T concrete block	9	186.5	470.9	2.52

6.3 Accident Limit State

The accident limit state analysis was completed with load cases described in Table 10. Load case 21 produced the highest loads on the mooring, as shown in Figure 8.

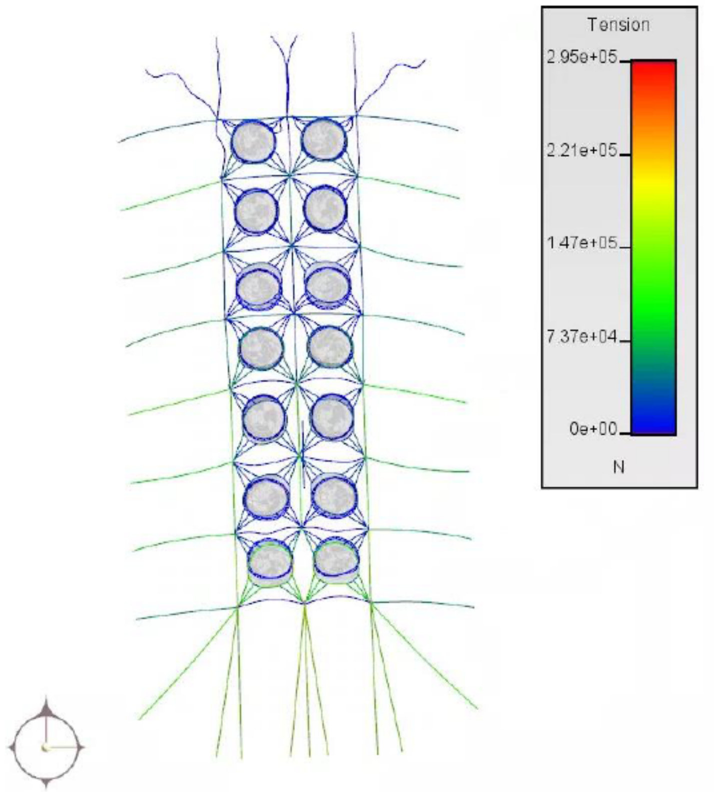


Figure 8: ALS simulation case 21

A summary of maximum loads and corresponding observed safety factors are presented in Table 14 for rope & chain, and in Table 15 for anchors. "Max load" represents maximum tension for rope/chain, and maximum reference force for anchors.

Table 14: ALS mooring results

Component	Details	Case of max load	Max load (kN)	MBS (kN)	Safety factor
West side moorings (1-8)					
Chain	Openlink G2 38mm (1-1/2")	21	143.3	749	5.23
Rope	Proflex 8str 48mm (2")	21	143.3	359	2.51
North end moorings (9-14)					
Chain	Openlink G2 38mm (1-1/2")	18	178.8	749	4.19
Rope	Proflex 8str 48mm (2")	18	178.8	359	2.01
East side moorings (15-22)					
Chain	Openlink G2 38mm (1-1/2")	19	215.4	749	3.48

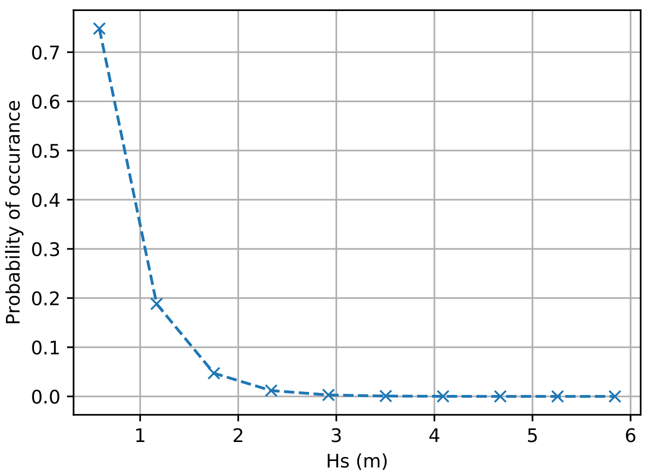
Rope	Proflex 8str 48mm (2")	19	215.4	359	1.67
South end moorings (23-31)					
Chain	Openlink G2 38mm (1-1/2")	20	237.2	749	3.16
Rope	Proflex 8str 48mm (2")	20	237.2	359	1.51
Grid lines					
Rope	Proflex 8str 48mm (2")	23	228.2	359	1.57
Bridle lines – Cells 1-2, 8-9					
Chain	Openlink G2 38mm (1-1/2")	21	294.6	749	2.54
Rope	Proflex 8str 36mm (1-1/2")	22	80.2	202	2.52
Bridle lines – Cells 3-7, 10-14					
Chain	Openlink G2 28mm (1-1/8")	21	180.3	407	2.26
Rope	Proflex 8str 36mm (1-1/2")	23	94.7	202	2.13
Buoy lines					
Chain	Openlink G2 28mm (1-1/8")	N/A	N/A	407	N/A

Table 15: ALS anchor results

Mooring #	**Anchor details**	**Case of max load**	**Max load (kN)**	**Estimated holding capacity (kN)**	**Safety Factor**
1-8	500kg plow anchor + 8T concrete block	21	141.0	274.7	1.95
9-14	1000kg plow anchor + 8T concrete block	18	178.5	470.9	2.64
15-22	1000kg plow anchor + 8T concrete block	19	215.1	470.9	2.19
23-31	1000kg plow anchor + 8T concrete block	20	238.8	470.9	1.97

6.4 Fatigue Limit State (FLS)

A simplified estimate of the probability of wave states occurring at the site over a long-term period are shown in Figure 9. The probability distribution is estimated by fitting a Weibull distribution through the 100-year wave condition with a location parameter of 0, and a shape parameter of 1.



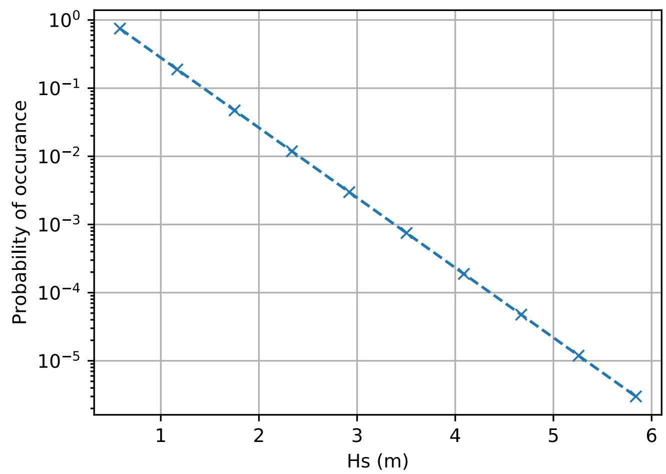


Figure 9: Expected probability of wave states

Of all analysed components, five specific steel components have been analysed for fatigue damage, completed with the load cases described in Table 11. The results of the fatigue analysis are presented in Table 16. A total damage of 1.0 would represent a life span of 12 years.

Table 16: FLS fatigue damage results

	mooring_27	mooring_28	mooring_26	bridleChain2_0_0	bridleChain1_1_0
Case 26	4.62e-03	4.74e-03	4.48e-03	4.33e-02	3.57e-02
Case 27	3.73e-03	3.76e-03	3.52e-03	1.38e-01	7.88e-02
Case 28	9.00e-03	8.85e-03	8.67e-03	1.66e-01	1.37e-01
Case 29	7.31e-03	7.23e-03	6.99e-03	1.23e-01	8.55e-02
Case 30	4.44e-03	4.36e-03	4.29e-03	3.97e-02	3.36e-02
Case 31	3.10e-03	3.13e-03	2.91e-03	2.98e-02	2.40e-02
Case 32	1.05e-03	1.04e-03	1.00e-03	1.20e-02	9.48e-03
Case 33	3.58e-04	3.47e-04	3.31e-04	4.25e-03	3.38e-03
Case 34	2.41e-04	2.38e-04	2.31e-04	1.98e-03	1.65e-03
Case 35	1.29e-04	1.28e-04	1.23e-04	8.31e-04	7.00e-04
Damage total	0.03	0.03	0.03	0.56	0.41
Expected life (yrs)	> 12 yrs	> 12 yrs	> 12 yrs	> 12 yrs	> 12 yrs

7 Containment System Results

7.1 Dimension Grade

Based on the specifications for cage dimension grades described in Section 2.5, the site has been determined to be dimension grade **0**. This site meets the requirements for a grade 0 site due to the maximum dimensioning significant wave height being greater than 2.5 m and the maximum dimensioning current velocity being greater than 0.75 m/s.

7.2 Plastic Floating Collar

The failure criteria of both sets of 100m cages used at the Coffin Island site was estimated using the finite element method (FEM). A sample FEM simulation is shown in Figure 10.

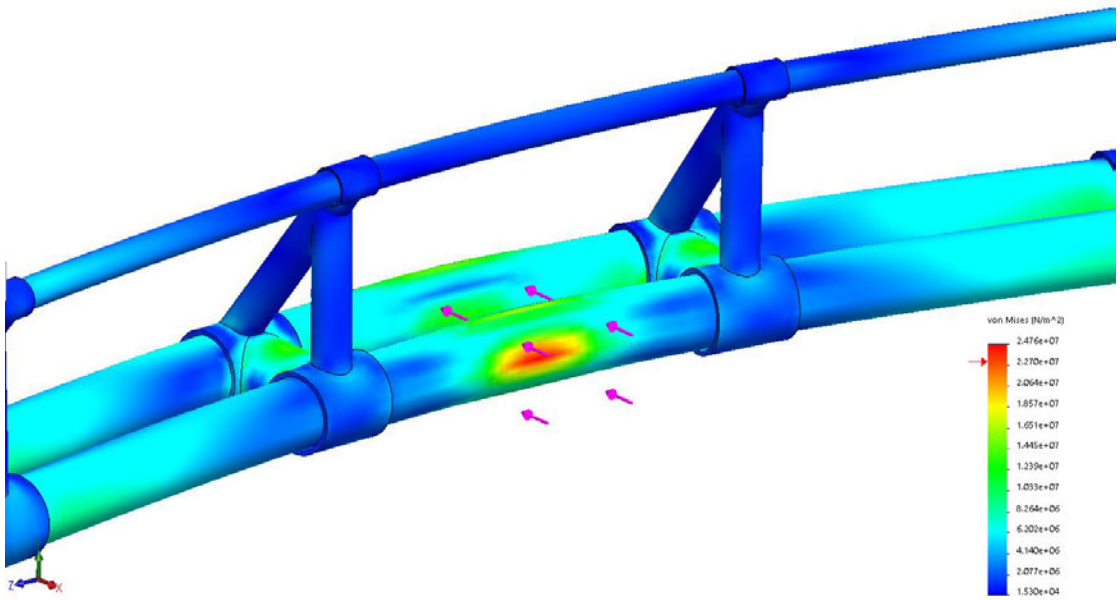


Figure 10: Sample FEM simulation of plastic cage

The analysis assumed that the highest stresses in the floating collar are the result of the attached bridle line connection. The total load from FEM simulations that created a stress equal to the yield stress (23.0 MPa) of the HDPE material was chosen as the minimum break strength of the cage itself.

However, depending on the dimensions of the pipe, local cracking may act as the failure mode before plastic material yield in areas with locally concentrated loads. Local cracking is calculated as follows:

$$F_e = 0.5\frac{tE}{D}$$

where F_e is the cracking stress, t is the pipe wall thickness, D is the pipe diameter, and E is the modulus of elasticity.

Results of the plastic floating collar analysis, including ULS and ALS loads and safety factors are presented in Table 17. The reduction in minimum break strength of the cage due to local cracking has been considered.

Table 17: Plastic floating collar analysis results

Cage #	Cage failure strength (kN)	ULS load (kN)	ULS safety factor	ALS load (kN)	ALS safety factor
1-2, 8-9	202.0	108.8	1.86	160.3	1.26
3-7, 10-14	111.0	83.4	1.33	94.7	1.17

Fatigue in the plastic pipe is not considered to be a failure mode for cages at this site. High frequency and amplitude variations in stress in the floating collar are not expected.

7.3 Netting

Table 18 shows a comparison of breaking strength of netting used in the cage design against the NS9415 [1] requirements for netting mesh strength (Table 4) based on dimension grade of the site.

Table 18: Netting mesh breaking strength comparison

Netting type	Half mesh size (mm)	Required mesh break strength (kg)	Design mesh break strength (kg)
Smolt	19	95	129
Market	29	151	150
Predator	75	151	380

The market net used has a break strength of 1 kg less than the required mesh break strength for a grade VII site. This difference is not considered to be an issue and the netting is considered to be suitable for the conditions at the site.

7.4 Rope

Grade 0 sites require integrated netting rope to be sized according to forces found in ULS and ALS simulations, and require a 4.5 safety factor, as stated in Table 1. Integrated rope used in cage netting used at the Fish Cove site is 16mm Maxima rope, which has an MBS of 4800kg. A summary of the maximum netting rope forces and safety factors is presented in Table 19.

Table 19: Netting rope breaking strength comparison

Rope MBS (kg)	ULS load (kg)	ULS safety factor	ALS load (kg)	ALS safety factor
4800	321.2	14.94	430.6	11.15

8 Discussion & Conclusion

Based on the results presented in this report, it has been determined that the mooring and containment system designed for use at the Coffin Island site is suitable to withstand the expected environmental conditions. All mooring and containment system components meet the design and strength requirements described in Section 2.

References

[1] Standards Norge, "*NS 9415:2009 – Marine fish farms: Requirements for site survey, risk analyses, design, dimensioning, production, installation and operation" Marine fish farms: Requirements for site survey, risk analyses, design, dimensioning, production, installation and operation*.", 1st Edition, November 10, 2009.

[2] Marine Scotland, *"A Technical Standard for Scottish Finfish Aquaculture"*, June 2015.

[3] International Organization for Standardization, "*ISO16488 – International Standard: Marine fish farms – open net cage – design and operation*", 1st Edition, July 2015.

[4] American Petroleum Institute, *"API RP 2SK – Design and Analysis of Stationkeeping Systems for Floating Structures"*, 3rd Edition, October 2005.

[5] Det Norske Veritas, *"DNV-OS-E301 – Position Mooring"*, July 2015.

[6] Cooke Aquaculture Engineering, *"ADCPReport_Liverpool 2010,* December 2020.

[7] Environment Canada, Oceanweather Inc., *"The MSC50 Wind and Wave Reanalysis"*, September 2006.

[8] US Army Corps of Engineers, *"STWAVE: Steady-State Spectral Wave Model User's Manual for STWAVE"*, September 2011.

[9] Cooke Aquaculture Engineering, *"Coffin Island Site Mooring Layout"*, March 2023.

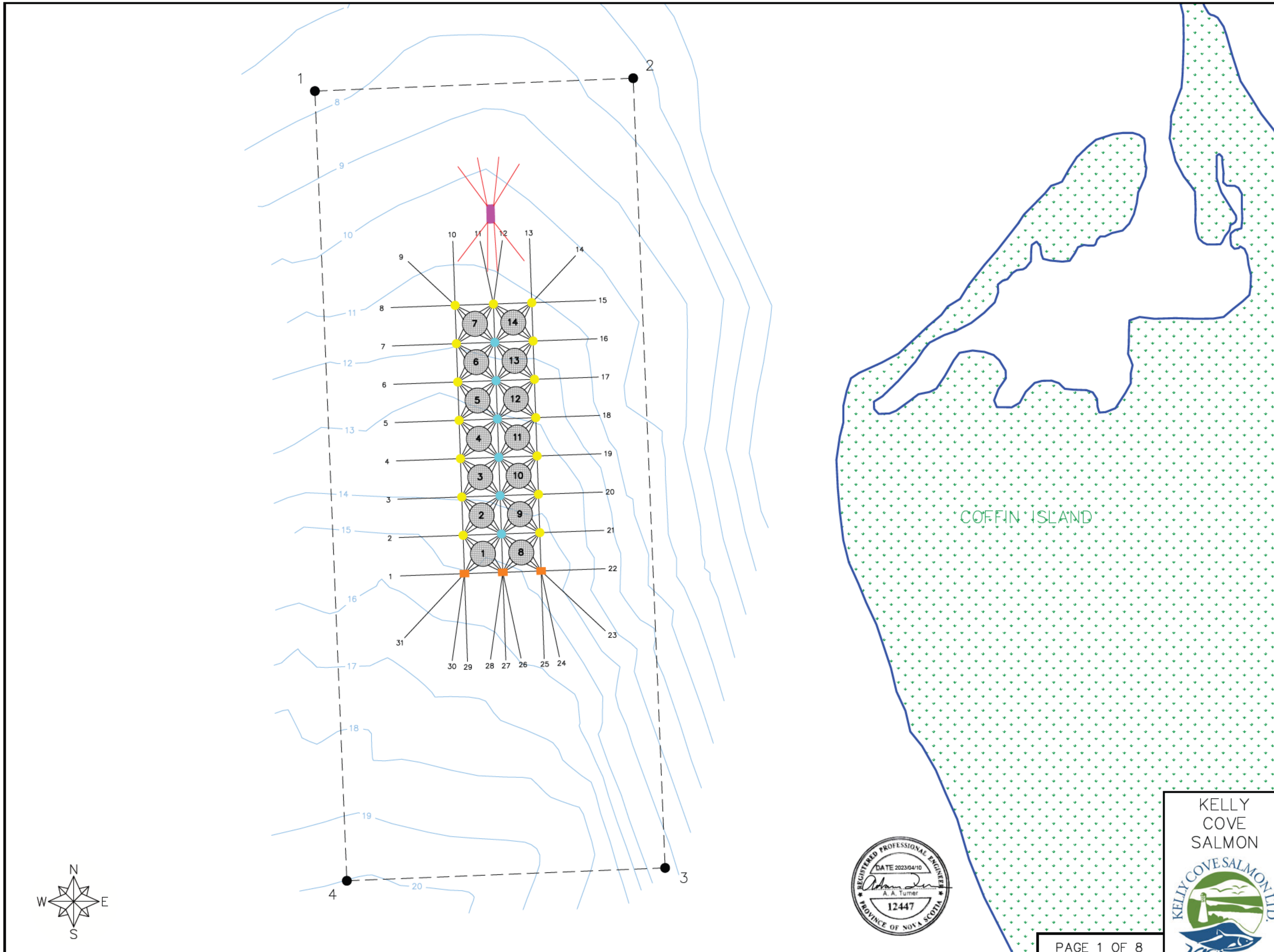
TAB C

Application AQ#1205X, AQ#1432, AQ#1433

This is Exhibit "C" referred to in the Affidavit
of Adam Turner, affirmed before me
on January 16, 2024.

[redacted]

New Brunswick Commissioner of Oaths



COFFIN ISLAND

NS–1205

LIVERPOOL BAY, NS

SITE FEATURES

- MOORING/GRID/BRIDLE LINES
- COMP BUOY 4400L
- COMP BUOY 2000L
- COMP BUOY 1100L
- 100m NET PEN
- 160ft GRID
- LEASE BOUNDARY
- FEED BARGE

ENVIRONMENT FEATURES

- BATHYMETRY (M)
- O.H.W.M
- L.L.W.O.S.T
- LAND

PROPOSED LEASE BOUNDARY COORDINATES

1: 44.046282˚, –64.642726˚
2: 44.046502˚, –64.637681˚
3: 44.037472˚, –64.636925˚
4: 44.037252˚, –64.641969˚

BATHYMETRIC DATA SOURCE

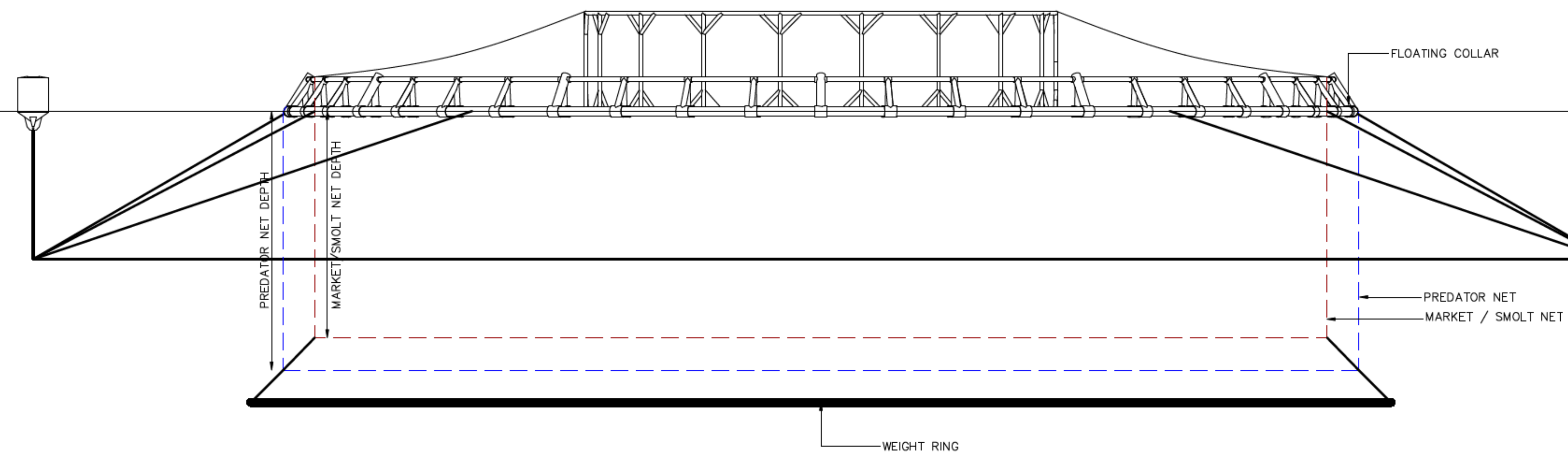
Site Development Plan

KELLY COVE SALMON

DRAWN		REVISIONS	
AT		-	
CHECK			
JN			
APPROVED		REV.	REV. DATE
JN, TW		C	2023/04/10
PART NO.		ORIG. DATE	
N/A		2021/10/12	
SCALE		STATUS	
–		FINAL	

DRAWING TITLE

Coffin Island Site Mooring Layout



CELL	FLOATING COLLAR DESIGN	WEIGHT RING DESIGN	SMOLT NET DEPTH	MARKET NET DEPTH	PREDATOR NET DEPTH
1	2x315mm DR21 HDPE PIPES, WITH DOUBLE BRIDLES AND ADAPTER SLEEVES	6" DR11 HDPE PIPE, CONCRETE FILLED	7m	7m	8m
2	2x315mm DR21 HDPE PIPES, WITH DOUBLE BRIDLES AND ADAPTER SLEEVES	6" DR11 HDPE PIPE, CONCRETE FILLED	7m	7m	8m
3	2x315mm DR21 HDPE PIPES, WITH BRIDLE ADAPTER SLEEVE	6" DR11 HDPE PIPE, CONCRETE FILLED	7m	7m	8m
4	2x315mm DR21 HDPE PIPES, WITH BRIDLE ADAPTER SLEEVE	6" DR11 HDPE PIPE, CONCRETE FILLED	7m	7m	8m
5	2x315mm DR21 HDPE PIPES, WITH BRIDLE ADAPTER SLEEVE	6" DR11 HDPE PIPE, CONCRETE FILLED	7m	7m	8m
6	2x315mm DR21 HDPE PIPES, WITH BRIDLE ADAPTER SLEEVE	6" DR11 HDPE PIPE, CONCRETE FILLED	7m	7m	8m
7	2x315mm DR21 HDPE PIPES, WITH BRIDLE ADAPTER SLEEVE	6" DR11 HDPE PIPE, CONCRETE FILLED	7m	7m	8m
8	2x315mm DR21 HDPE PIPES, WITH DOUBLE BRIDLES AND ADAPTER SLEEVES	6" DR11 HDPE PIPE, CONCRETE FILLED	7m	7m	8m
9	2x315mm DR21 HDPE PIPES, WITH DOUBLE BRIDLES AND ADAPTER SLEEVES	6" DR11 HDPE PIPE, CONCRETE FILLED	7m	7m	8m
10	2x315mm DR21 HDPE PIPES, WITH BRIDLE ADAPTER SLEEVE	6" DR11 HDPE PIPE, CONCRETE FILLED	7m	7m	8m
11	2x315mm DR21 HDPE PIPES, WITH BRIDLE ADAPTER SLEEVE	6" DR11 HDPE PIPE, CONCRETE FILLED	7m	7m	8m
12	2x315mm DR21 HDPE PIPES, WITH BRIDLE ADAPTER SLEEVE	6" DR11 HDPE PIPE, CONCRETE FILLED	7m	7m	8m
13	2x315mm DR21 HDPE PIPES, WITH BRIDLE ADAPTER SLEEVE	6" DR11 HDPE PIPE, CONCRETE FILLED	7m	7m	8m
14	2x315mm DR21 HDPE PIPES, WITH BRIDLE ADAPTER SLEEVE	6" DR11 HDPE PIPE, CONCRETE FILLED	7m	7m	8m

CAGE SPECIFICATIONS

COFFIN ISLAND

NS-1205
LIVERPOOL BAY, NS

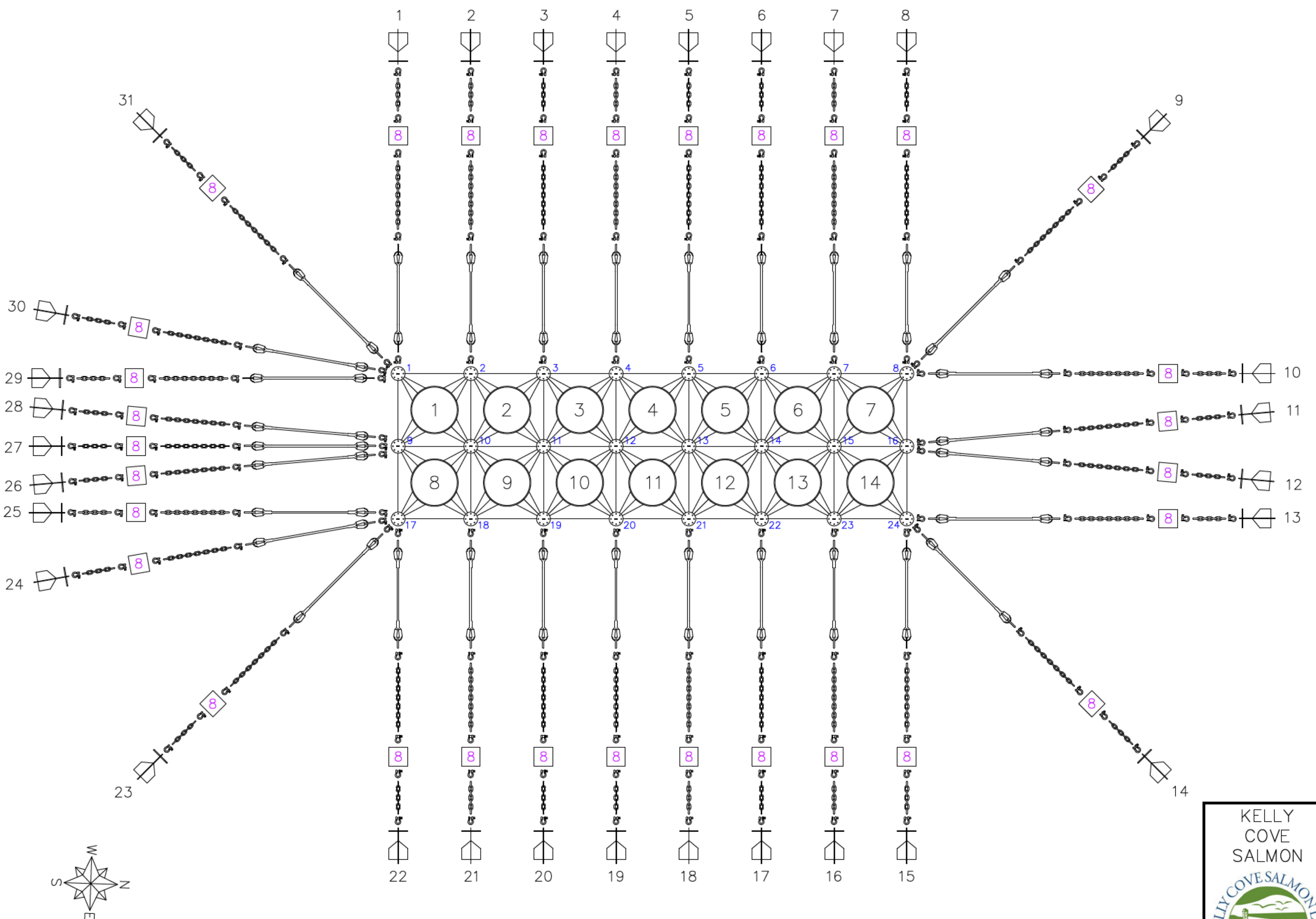
KELLY COVE SALMON

DRAWN: AT	REVISIONS: -
CHECK: JN	
APPROVED: JN, TW	REV.: C / REV. DATE: 2023/04/10
PART NO.: N/A	ORIG. DATE: 2021/10/12
SCALE: N/A	STATUS: FINAL
DRAWING TITLE: Coffin Island Site Mooring Layout	

COFFIN ISLAND

NS–1205

LIVERPOOL BAY, NS



MOORING HARDWARE LAYOUT – NOT TO SCALE

COMPONENT LIST

Moorings 1–8

Component	Qty
500kg plow anchor	1 pc
Openlink chain 38mm (1–1/2")	30 ft
8T concrete block	1 pc
Openlink chain 38mm (1–1/2")	90 ft
Proflex 8str 48mm (2")	150 ft

Moorings 9–22

Component	Qty
1000kg plow anchor	1 pc
Openlink chain 38mm (1–1/2")	30 ft
8T concrete block	1 pc
Openlink chain 38mm (1–1/2")	90 ft
Proflex 8str 48mm (2")	150 ft

Moorings 23–31

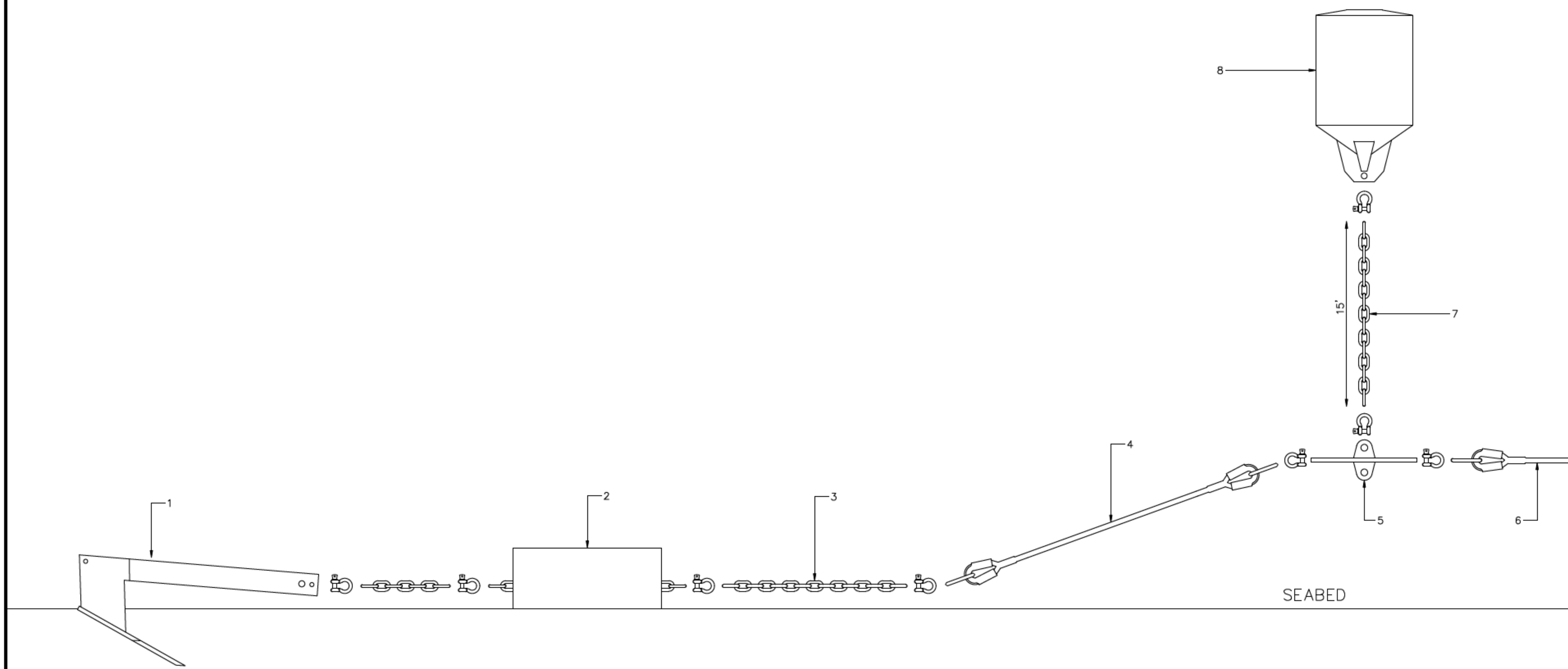
Component	Qty
1000kg plow anchor	1 pc
Openlink chain 38mm (1–1/2")	30 ft
8T concrete block	1 pc
Openlink chain 38mm (1–1/2")	90 ft
Proflex 8str 48mm (2")	250 ft

KELLY COVE SALMON

DRAWN: AT	REVISIONS: -
CHECK: JN	
APPROVED: JN, TW	REV.: C — REV. DATE: 2023/04/10
PART NO.: N/A	ORIG. DATE: 2021/10/12
SCALE: N/A	STATUS: FINAL
DRAWING TITLE: Coffin Island Site Mooring Layout	

COFFIN ISLAND

NS–1205
LIVERPOOL BAY, NS



TYPICAL MOORING LAYOUT – NOT TO SCALE

LEGEND

1. PLOW ANCHOR
2. CONCRETE BLOCK
3. ANCHOR CHAIN
4. MOORING ROPE
5. GRID PLATE
6. GRID ROPE
7. COMPENSATOR CHAIN
8. COMPENSATOR BUOY

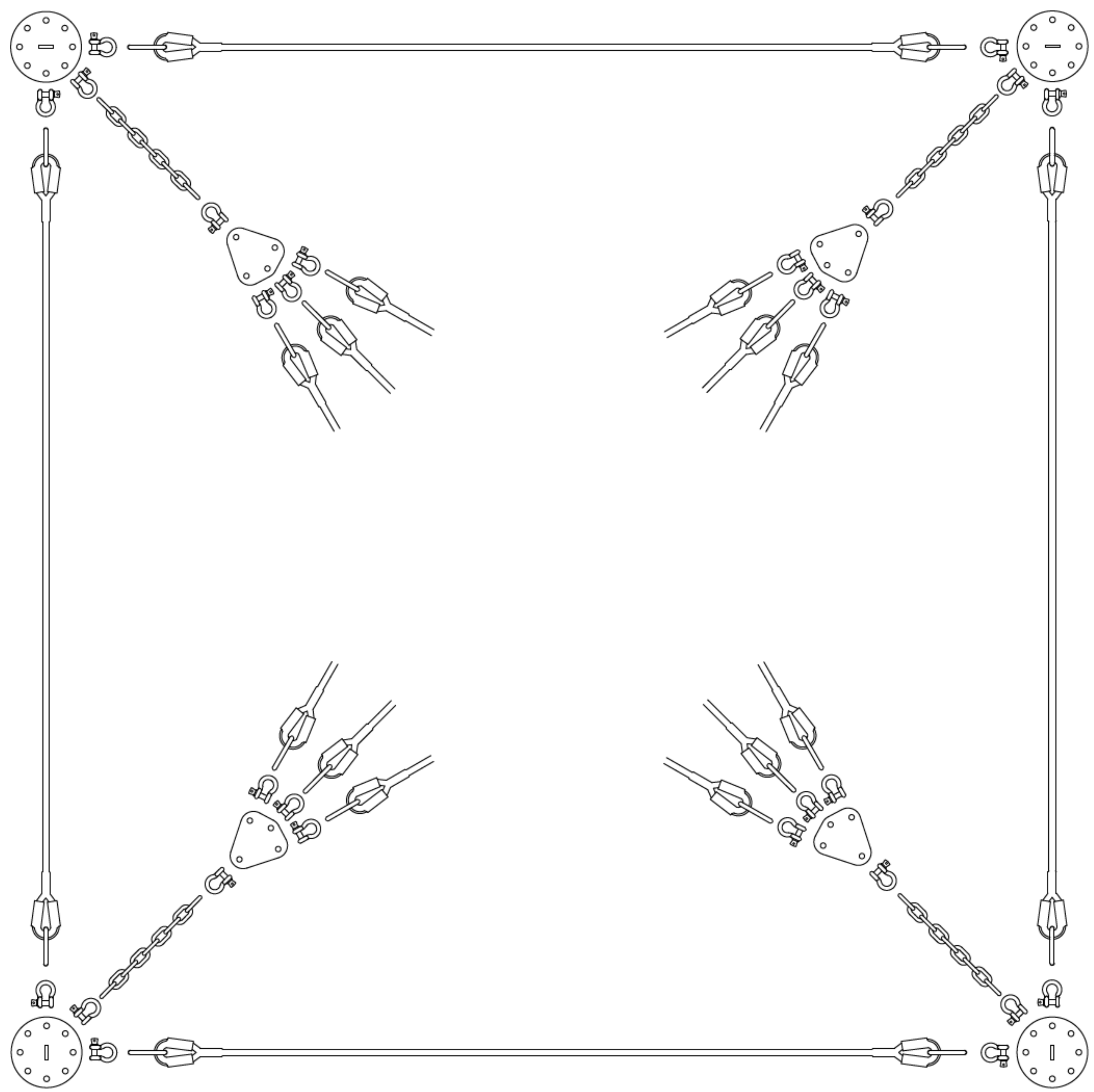
KELLY COVE SALMON

DRAWN AT	REVISIONS -		
CHECK JN			
APPROVED JN, TW	REV. C	REV. DATE 2023/04/10	
PART NO. N/A	ORIG. DATE 2021/10/12		
SCALE N/A	STATUS FINAL		
DRAWING TITLE Coffin Island Site Mooring Layout			

COFFIN ISLAND

NS-1205

LIVERPOOL BAY, NS



CELL HARDWARE LAYOUT CELLS 3-7, 10-14
NOT TO SCALE

COMPONENT LIST (CELLS 3-7, 10-14)

Grid Lines

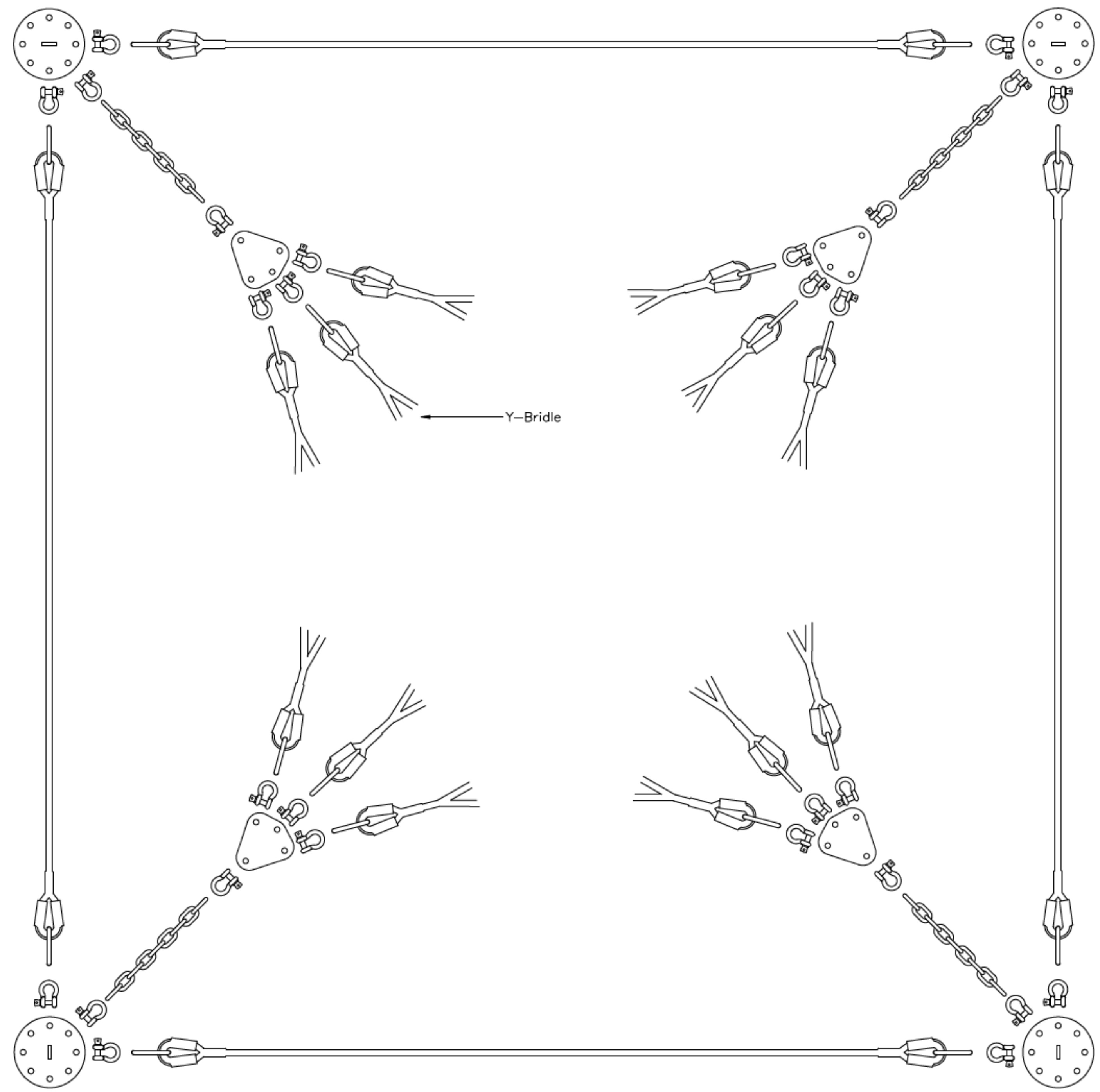
Component	Qty
Proflex 8str 48mm (2")	160 ft

Bridle Assembly (4 per cell)

Component	Qty
Openlink chain 28mm (1-1/8")	1 pc
Bridle Plate Combo	1 pc
Proflex 8str 36mm (1-1/2")	3 pc

KELLY COVE SALMON

DRAWN: AT		REVISIONS: -	
CHECK: JN			
APPROVED: JN, TW		REV.: C	REV. DATE: 2023/04/10
PART NO.: N/A		ORIG. DATE: 2021/10/12	
SCALE: N/A		STATUS: FINAL	
DRAWING TITLE: Coffin Island Site Mooring Layout			



CELL HARDWARE LAYOUT CELLS 1–2, 8–9
NOT TO SCALE

COFFIN ISLAND

NS–1205
LIVERPOOL BAY, NS

COMPONENT LIST (CELLS 1–2, 8–9)

Grid Lines

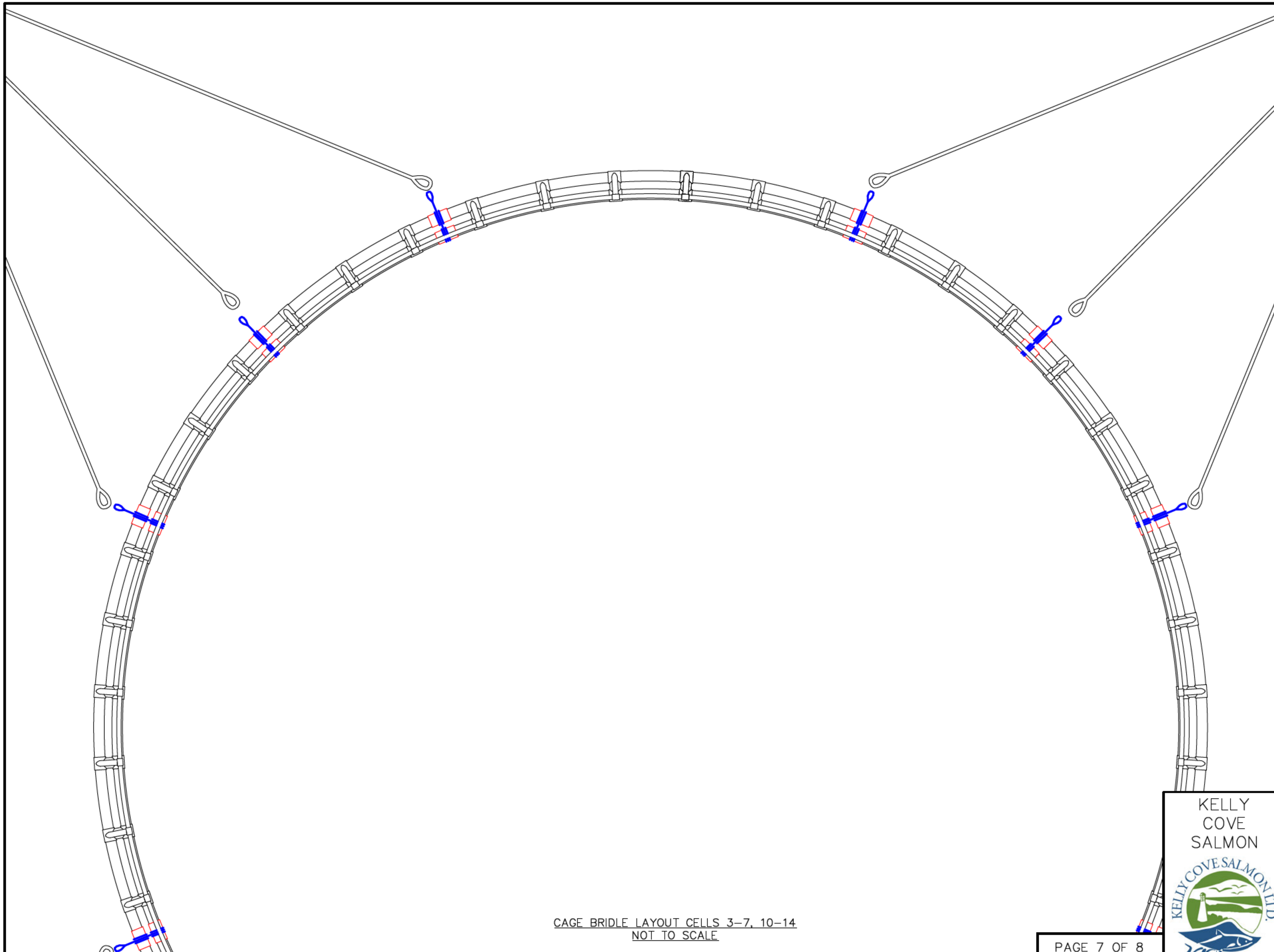
Component	Qty
Proflex 8str 48mm (2")	160 ft

Bridle Assembly (4 per cell)

Component	Qty
Openlink chain 38mm (1-1/2")	1 pc
Bridle Plate Combo	1 pc
Y-Bridle: Proflex 8str 36mm (1-1/2")	3 pc

KELLY COVE SALMON

DRAWN: AT	REVISIONS: -
CHECK: JN	
APPROVED: JN, TW	REV.: C — REV. DATE: 2023/04/10
PART NO.: N/A	ORIG. DATE: 2021/10/12
SCALE: N/A	STATUS: FINAL
DRAWING TITLE: Coffin Island Site Mooring Layout	



CAGE BRIDLE LAYOUT CELLS 3–7, 10–14
NOT TO SCALE

COFFIN ISLAND

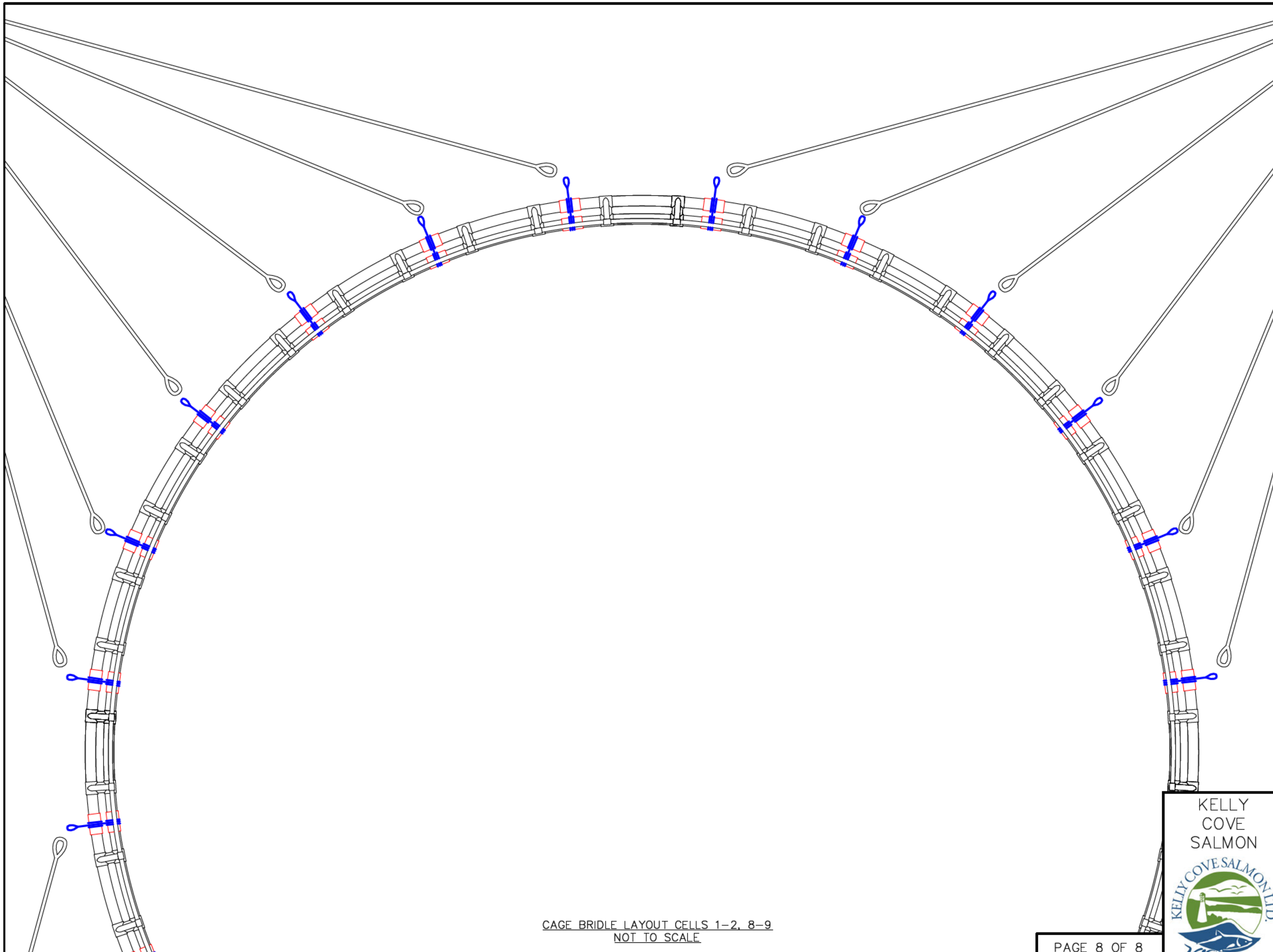
NS–1205
LIVERPOOL BAY, NS

KELLY COVE SALMON

DRAWN	REVISIONS	
AT	-	
CHECK		
JN		
APPROVED	REV.	REV. DATE
JN, TW	C	2023/04/10
PART NO.	ORIG. DATE	
N/A	2021/10/12	
SCALE	STATUS	
N/A	FINAL	
DRAWING TITLE		
Coffin Island Site Mooring Layout		

COFFIN ISLAND

NS-1205
LIVERPOOL BAY, NS



CAGE BRIDLE LAYOUT CELLS 1-2, 8-9
NOT TO SCALE

KELLY COVE SALMON

DRAWN: AT	REVISIONS: -
CHECK: JN	
APPROVED: JN, TW	REV.: C / REV. DATE: 2023/04/10
PART NO.: N/A	ORIG. DATE: 2021/10/12
SCALE: N/A	STATUS: FINAL
DRAWING TITLE: Coffin Island Site Mooring Layout	

TAB D

Application AQ#1205X, AQ#1432, AQ#1433

This is Exhibit "D" referred to in the Affidavit
of Adam Turner, affirmed before me
on January 16, 2024.

[redacted]

Ne[redacted]ner of Oaths

Table 25. Infrastructure Specifications at the Proposed Liverpool (#1205), Mersey Point and Brooklyn Aquaculture Sites

Infrastructure	Component	Diameter/Specification	Material	Operating Pressure (water @ 73.4ºF (23ºC))	Average Inside Diameter	Minimum Wall Thickness	Average Weight (lbs/ft)
Moorings	Mooring Rope	2-1/4" 8 Strand Proflex	Proflex Copolymer				
	Mooring Chain	1-1/2" Grade 2 Openlink Chain	Grade 2 Steel				
	Grid Rope	2-1/4" 8 Strand Proflex	Proflex Copolymer				
	Bridle Rope	2" 8 Strand Proflex	Proflex Copolymer				
	Bridle Chain	1-1/2" Grade 2 Openlink Chain	Grade 2 Steel				
	Bridle Connector Plates	1"x14"x13" Plate, 4 holes	AR400F steel				
	Grid Connector Plates	1"x23.5" Dia plate, 8 holes	AR400F steel				
	Shackles	- 1-1/8" Screw Pin Shackle 9.5T - 1-1/2" Screw Pin Shackle 17T	Grade 6 High Tensile Steel				
	Rope Thimbles	Glavanized Tube Thimble w/ Masterlink Combo (1-1/2", 2", 3")	Grade 45 Steel				
	Plow Anchor	1000kg Plow Anchor – 1-3/4" Plate	44W Steel				
	Concrete Block	8T Concrete Block	3000psi 3/4 Stone Aggregate				
Cages	Bird Stand	110mm DR17 Pipe	PE4710 HDPE Pipe	125 psi	96.5mm	6.5mm	1.43
	Float Pipe	315mm DR17 Pipe	PE4710 HDPE Pipe	80 psi	276.5mm	18.5mm	11.7
	Brackets	Injection molded HDPE	PE4710 HDPE Pipe	-	-	-	-
	Handrail	5" DR17	PE4710 HDPE Pipe	125 psi	4.87in	0.327in	2.36
	Weight Ring (HPDE)	6" DR11	PE4710 HDPE Pipe	200 psi	5.35in	0.602in	4.99

TAB E

Application AQ#1205X, AQ#1432, AQ#1433

This is Exhibit "E" referred to in the Affidavit
of Adam Turner, affirmed before me
on January 16, 2024.

[redacted]

New Brunswick Commissioner of Oaths

Table 26. Materials and Breaking Strengths/Specifications for the Components of the Proposed Liverpool (#1205), Mersey Point and Brooklyn Grid Systems

Grid System Component	**Specifications**	**Minimum Breaking Strength**
Grid Plate	AR400F steel	179,000 lbs (81193 kg)
Screw Pin Shackle	9.5T & 17T SWL (5:1)	47,500 kg & 85,000 kg
Mooring & Grid Rope	2-1/4" 8 Strand Proflex	114,640 lbs (52,000 kg)
Bridle Rope	2" 8 Strand Proflex	80,689 lbs (36,600 kg)
Chain	1-1/2" Grade 2 Openlink Chain	168,314 lbs (76,300 kg)