

FINFISH AQUACULTURE SITE AQUACULTURE STEWARDSHIP COUNCIL REPORT Noo-LA, CLIO CHANNEL, BC

SITE LICENSE: AQ1825

SURVEY TYPE: ASC

SURVEY DATE: JULY 27 AND 28, 2023

REPORT DATE: AUGUST 2, 2023

PREPARED FOR:

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Summary

This document presents the qualitative and quantitative assessment of sediment obtained during the survey completed at the Noo-La finfish aquaculture site operated by Grieg Seafood BC, Ltd in Clio Channel, BC, on July 27 and 28, 2023. Sediment was collected and the data analyzed according to the *Aquaculture Activities Regulations* (AAR) and adapted to address Criterion 2.1 of the Aquaculture Stewardship Council (ASC) Salmon Standard.

The measured and observed characteristics of the sediment collected during the sampling confirmed that the stations outside the Allowable Zone of Effect (AZE) on Transects A, B and C had mean sulphide levels less than the ASC Salmon Standard acceptable limit of 1500 µm. Redox potential measured in sediment obtained outside the AZE on Transect A, B and C was greater than the ASC Salmon Standard acceptable lower limit of 0 mV.

An assessment and identification of the benthic organisms present in the sediment was not completed to evaluate for potential impacts to habitat, as BC salmon farms have been granted a variance to Indicators 2.1.2 and 2.1.3 and instead rely on the scientifically proven and federally regulated sulfide surrogates (ASC VR224)¹.

¹ <http://variance-requests.asc-aqua.org/questions/vr-224-benthic-biodiversity-and-benthic-effects-salmon-v1-0-2-1-2-2-1-3/>

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1.0 Introduction

This document presents the marine sediment data collected as part of a benthic study completed at the Noo-La finfish aquaculture site operated by Grieg Seafood BC, Ltd (Campbell River, BC). The Noo-La site is located in Clio Channel, BC (Figure 1).

The study was completed by adapting the methodology required for operational monitoring of waste dispersion required under *Aquaculture Activities Regulations* (AAR) and comparing the results with the indicators listed in Criterion 2.1 of the Aquaculture Stewardship Council (ASC) Salmon Standard.

The purpose of the ASC Salmon Standard is to evaluate concerns of potential environmental impact related to salmon farming. The Standard is based on a combination of requirements and performance levels that must be reached to determine if potential impacts are being addressed. Principle 2 of the Standard addresses the “*potential impacts from salmon farms on natural habitat, local biodiversity and ecosystem function*” (ASC, 2012).

This survey was specifically designed to address Criterion 2.1 within Principle 2 of the ASC Salmon Standard which involved the collection of sediment within and outside of the Allowable Zone of Effect (AZE). Sediment was analyzed for redox potential and sulphide levels to evaluate benthic habitat conditions.

An assessment and identification of the benthic organisms present in the sediment was not completed to evaluate for potential impacts to habitat, biodiversity and ecosystem function, as BC salmon farms have been granted a variance to Indicators 2.1.2 and 2.1.3 and instead rely on the scientifically proven and federally regulated sulfide surrogates (ASC VR224).

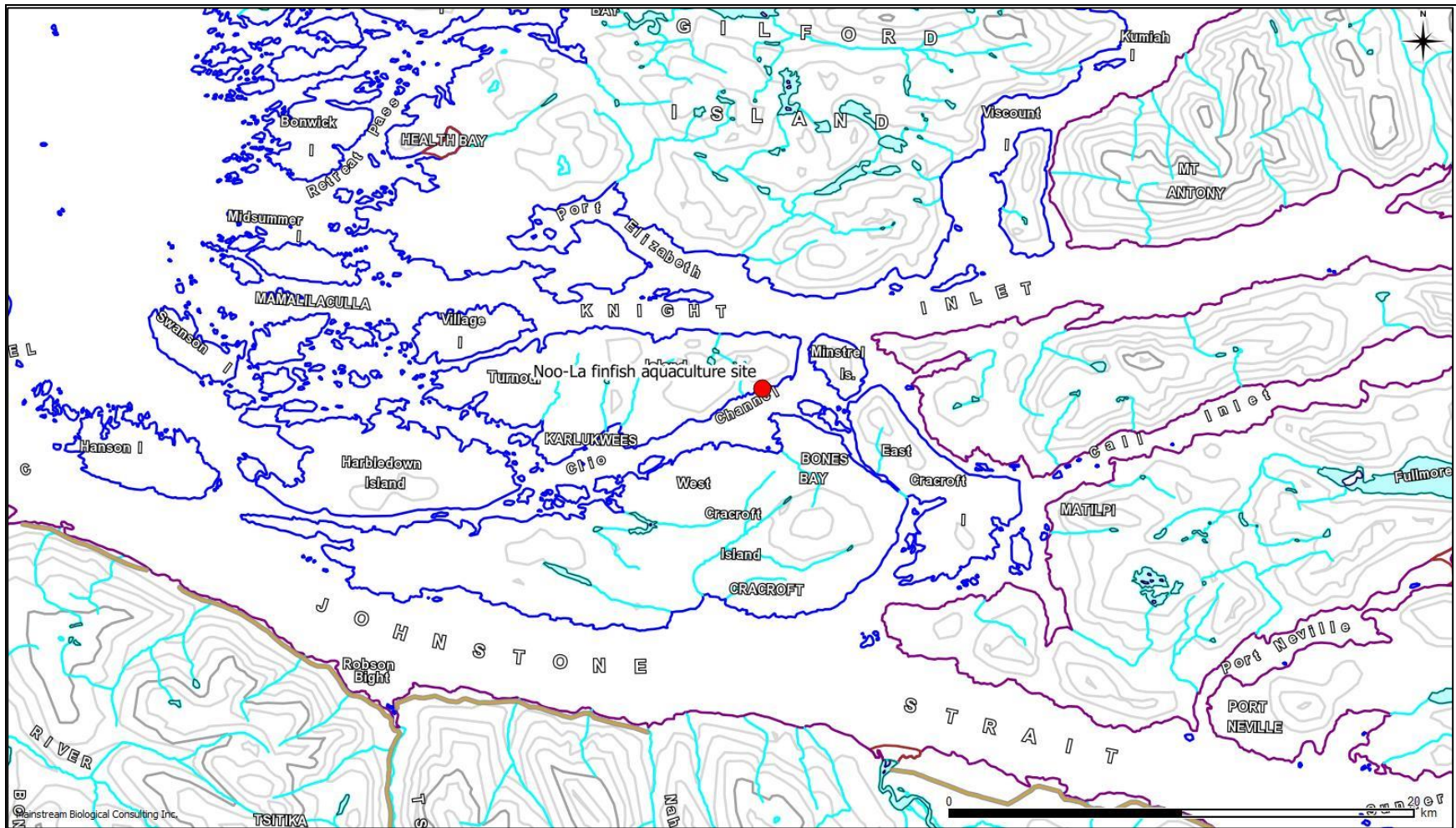


Figure 1: An overview map showing the approximate location of the Noo-La finfish aquaculture farm site (red dot) in Clio Channel, BC.

2.0 Methods

The substrate at the designated sampling locations at the Noo-La finfish aquaculture site had been previously identified to consist of “soft” sediment. Therefore, the field activities involved the collection of sediment samples for physical and chemical analysis.

2.1 Field Sampling

The locations of sediment sampling stations were provided by Grieg Seafood BC, Ltd.

Individual sediment sampling stations were located along three Transects A, B, and C. Stations within the AZE were located 5 m inside the 1 g DEPOMOD contour (Figure 2) for all three transects and also at the perimeter of the containment system for Transects A and B. Stations outside the AZE were located 25 m outside of the 1 g DEPOMOD contour. Additional stations were established at two reference sites within the range of 500 m to 1000 m from the aquaculture containment system as outlined in the ASC Salmon Standard (Figure 3).

Sediment was collected using a Van Veen sampler. Two sediment samples were collected at each station.

The coordinates of the sample locations were recorded using a Trimble GeoExplorer GeoXT (Firmware v1.05) using TerraSync 3.30 software and equipped with an external Hurricane antenna.

Data filters were set to standards recommended by the Resource Inventory Standards Committee (RISC)², with at least 15 fixes taken per location, using satellites greater than 15 % above the horizon with signal to noise ratios (SNR) greater than 40 and a horizontal dilution of precision (HDOP) of five. The GPS data was corrected post-mission with Pathfinder Office v5.40 software using data from the SEAT (Seattle, WA) base station.

The Trimble antenna was attached to the grab davit and positional fixes were obtained while the grab was completing the estimated bottom third of its descent. Positional fixes were completed when the grab was on the bottom and the drop line was as close vertical as possible.

The time at which each sample was successfully obtained and physical characteristics of the collected sediment were recorded. A digital photograph of each sample was also taken. As per Indicator 2.1.1, levels of free sulphides and redox potential of each sediment sample were measured in the field using an Orion A324 meter and the appropriate ISE probes. A digital thermometer was used to measure the temperature of the sediment.

² Integrated Land Management Bureau. 2008. Province of British Columbia Standards, Specifications and Guidelines for Resource Surveys Using Global Positioning System (GPS) Technology. Release 4.0d.

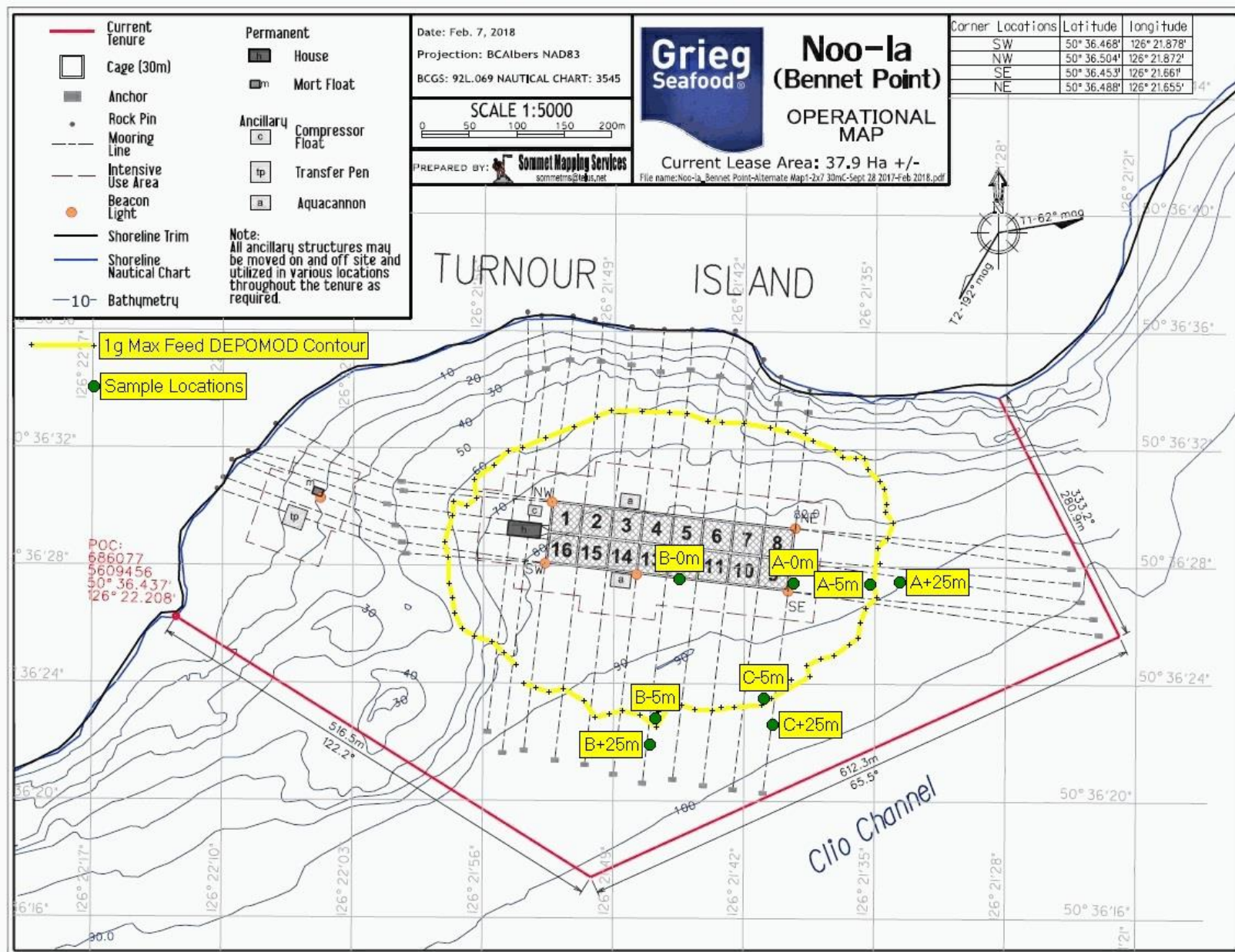


Figure 2: The locations of the sampling stations for the ASC survey at the Noo-La finfish aquaculture site in relation to the pen system and surrounding area on July 27 and 28, 2023.

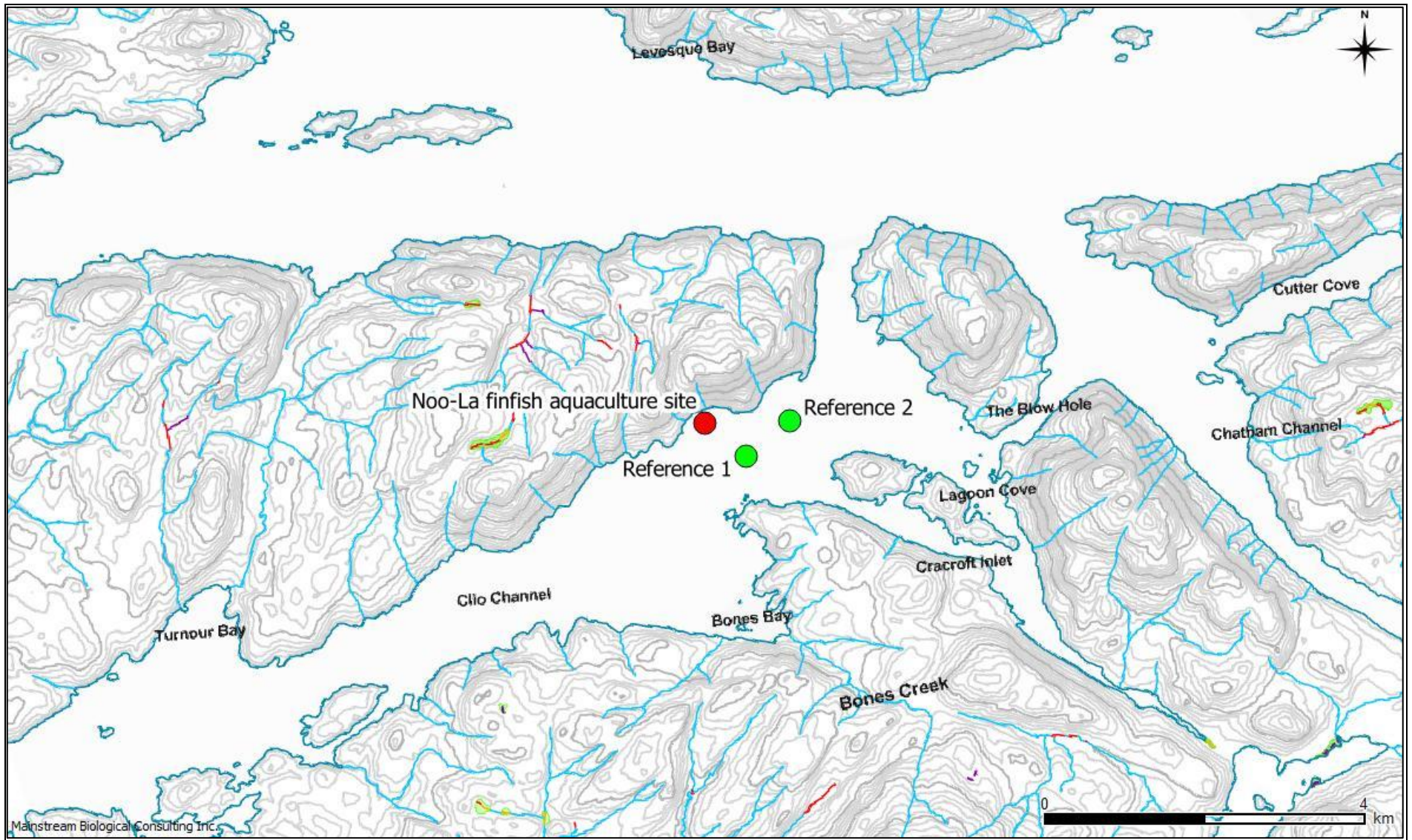


Figure 3: The locations of the reference stations for the ASC survey at the Noo-La finfish aquaculture site in relation to the site and surrounding area on July 28, 2023.

2.2 Data Analysis

To evaluate if the benthic conditions at and near the Noo-La site met the requirements of Criterion 2.1 of the ASC Salmon Standard, the data collected was compared to required levels for indicators of potential finfish farm impacts. These indicators represent a combination of chemical and biodiversity measurements to evaluate the status of benthic health, biodiversity and ecosystem function and to detect potential impacts related to the salmon farm operation. The indicators considered for this assessment are summarized below in Table 1.

Additional analysis of parasiticide residue was completed to fulfill the requirement for monitoring of these chemicals but there is no required level presented in the ASC to compare these results to.

Table 1: Summary of indicators of benthic health, biodiversity and ecosystem function that were considered during the evaluation of the Noo-La finfish aquaculture site. The indicators have been adopted from Criterion 2.1 of the ASC Salmon Standard.

Criterion Number	Indicator	ASC Salmon Standard Requirement
2.1.1	Redox potential in sediment outside the AZE ¹ .	>0 millivolts (mV)
2.1.1	Sulphide levels in sediment outside the AZE.	≤1500 microMoles / L (µM)

1: AZE = Allowable Zone of Effect

3.0 Results and Discussion

Representative photographs of sediment obtained at each sampling station are presented in Appendix 1. Raw data obtained from sediment sampled in the field is presented in Appendix 2 and the summarized data is presented in Appendix 3.

The sediment successfully collected at the Noo-La sampling stations typically consisted of brown mud. Shell hash, tube worms and terrigenous material were common.

3.1 Redox Potential and Sulphide Levels

Following Criterion 2.1.1 of the ASC Salmon Standard, the results of redox potential and sulphide testing at the station outside the AZE were analyzed to help evaluate if the Noo-La facility was meeting the certification requirements (Appendix 3).

The mean sulphide level in sediment collected at the stations outside AZE on Transects A, B and C (131 μM , 47.8 μM and 74.7 μM respectively) on July 27 and 28, 2023 were less than the ASC Salmon Standard sulphide upper limit of 1500 μM .

Mean redox potential in sediment collected at the stations outside the AZE on Transect A, B and C (179.9 mV, 187.0 mV and 142.7 mV respectively) were greater than the 0 mV minimum requirement cited in Criterion 2.1.1 of the ASC Salmon Standard.

4.0 References

- Aquaculture Stewardship Council. 2012. ASC Salmon Standard Version 1.3. Available online: www.asc-aqua.org.
- Salas, F., Patrício, J. and Marques, J.C. 2006. Ecological Indicators in Coastal and Estuarine Environmental Quality Assessment - A user friendly guide for practitioners. Imprensa da Universidade de Coimbra.

Appendix 1 – Sample Photographs



Photo 1

Sediment sample collected at the 0m station on Transect A at the Noo-La site on July 27, 2023.



Photo 2

Sediment sample collected at the station inside the AZE on Transect A at the Noo-La site on July 27, 2023.



Photo 3

Sediment sample collected at the station outside the AZE on Transect A at the Noo-La site on July 27, 2023.

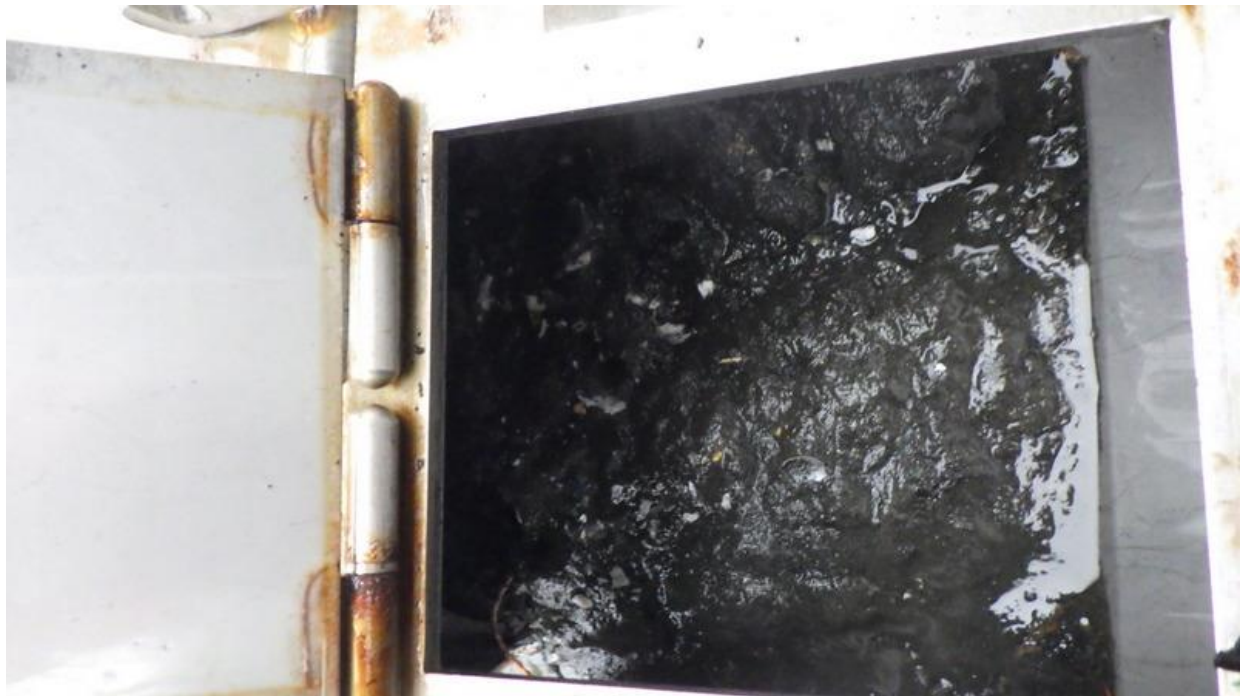


Photo 4

Sediment sample collected at the 0B station at the Noo-La site on July 28, 2023.



Photo 5

Sediment sample collected at the station inside the AZE on Transect B at the Noo-La site on July 28, 2023.



Photo 6

Sediment sample collected at the station outside the AZE on Transect B at the Noo-La site on July 28, 2023.



Photo 7

Sediment sample collected at the station inside the AZE on Transect C at the Noo-La site on July 28, 2023.



Photo 8

Sediment sample collected at the station outside the AZE on Transect C at the Noo-La site on July 28, 2023.



Photo 9

Sediment sample collected at the Reference 1 at the Noo-La site on July 28, 2023.



Photo 10

Sediment sample collected at the Reference 2 at the Noo-La site on July 28, 2023.

Appendix 2 – Noo-La Field Data

Reference Information:	
Farm site:	Noo-La
Field Crew:	T Kajarla, E Jarry
Aquaculture Company:	Grieg Seafood BC, Ltd
Field Investigator:	Mainstream Biological Consulting Inc.
Site Reference #:	AQ1825
Laboratory:	
Geographic Region:	Clio Channel, BC

Transect A, B, C Name	Sampling Station Name	Replicate Number	Transect A, B, C Bearing (Magnetic)	Reference Station (Y/N)	Distance from Pens (m)	Sampling Device Type	Sampling Device Capacity (m2)	Quality Control Replicate (Y/N)	Replicate Analysis Type	Sample Date (YYYY-MM-DD)	Sample Time (24HH:MM)	Sample Latitude (Degrees)	Sample Latitude (Minutes)	Sample Longitude (Degrees)	Sample Longitude (Minutes)	GPS Correction Status	Ocean Depth (m)	Sample Depth (cm)
A	A-0m	1	72		0	Van Veen	0.10			2023-07-27	14:30	50	36.4564	126	21.6576	Post-process corrected	88.0	5
A	A-0m	2	72		0	Van Veen	0.10			2023-07-27	14:40	50	36.4565	126	21.6576	Post-process corrected	88.1	14
A	A-5m	1	72		80.3	Van Veen	0.10			2023-07-27	15:05	50	36.4560	126	21.5893	Post-process corrected	88.9	10
A	A-5m	2	72		80.2	Van Veen	0.10			2023-07-27	15:12	50	36.4548	126	21.5889	Post-process corrected	88.0	8
A	A-5m	2	72		80.2	Van Veen	0.10	Y	Duplicate	2023-07-27	15:12	50	36.4548	126	21.5889	Post-process corrected	88.0	8
A	A-5m	2	72		80.2	Van Veen	0.10	Y	Triplicate	2023-07-27	15:12	50	36.4548	126	21.5889	Post-process corrected	88.0	8
A	A+25m	1	72		110	Van Veen	0.10			2023-07-27	15:23	50	36.4573	126	21.5611	Post-process corrected	90.8	13
A	A+25m	2	72		110	Van Veen	0.10			2023-07-27	15:30	50	36.4564	126	21.5606	Post-process corrected	89.5	16
B	B-0m	1	172		0	Van Veen	0.10			2023-07-28	06:20	50	36.4601	126	21.7561	Post-process corrected	86.1	10
B	B-0m	1	172		0	Van Veen	0.10	Y	Duplicate	2023-07-28	06:20	50	36.4601	126	21.7561	Post-process corrected	86.1	10
B	B-0m	1	172		0	Van Veen	0.10	Y	Triplicate	2023-07-28	06:20	50	36.4601	126	21.7561	Post-process corrected	86.1	10
B	B-0m	2	172		0	Van Veen	0.10			2023-07-28	06:28	50	36.4595	126	21.7577	Post-process corrected	86.2	12
B	B-5m	1	172		160	Van Veen	0.10			2023-07-28	06:52	50	36.3762	126	21.7839	Post-process corrected	96.1	16
B	B-5m	2	172		160	Van Veen	0.10			2023-07-28	07:00	50	36.3754	126	21.7823	Post-process corrected	96.3	18
B	B+25m	1	172		190	Van Veen	0.10			2023-07-28	07:16	50	36.3608	126	21.7864	Post-process corrected	98.1	18
B	B+25m	2	172		190	Van Veen	0.10			2023-07-28	07:24	50	36.3594	126	21.7861	Post-process corrected	97.6	15
C	C-5m	1	142		120	Van Veen	0.10			2023-07-28	07:56	50	36.3707	126	21.6764	Post-process corrected	98.2	18
C	C-5m	2	142		120	Van Veen	0.10			2023-07-28	08:02	50	36.3701	126	21.6776	Post-process corrected	98.7	18
C	C+25m	1	142		16	Van Veen	0.10			2023-07-28	07:37	50	36.3867	126	21.6862	Post-process corrected	100	18
C	C+25m	2	142		160	Van Veen	0.10			2023-07-28	07:45	50	36.3876	126	21.6834	Post-process corrected	100	16
Reference	Ref 1	1			610	Van Veen	0.10			2023-07-28	08:20	50	36.1657	126	21.4547	Post-process corrected	105	20
Reference	Ref 1	2			610	Van Veen	0.10			2023-07-28	08:28	50	36.1625	126	21.4553	Post-process corrected	105	20
Reference	Ref 2	1			890	Van Veen	0.10			2023-07-28	08:50	50	36.3873	126	20.9568	Post-process corrected	108	8
Reference	Ref 2	2			890	Van Veen	0.10			2023-07-28	09:00	50	36.3865	126	20.9619	Post-process corrected	108	8

<i>Transect A, B, C Name</i>	<i>Sampling Station Name</i>	<i>Replicate Number</i>	<i>Free Sulphide (micromolar)</i>	<i>Sediment Temperature (deg C)</i>	<i>Eh Uncorrected (mV)</i>	<i>Eh Corrected (mV)</i>	<i>Cu (micro-g/g)</i>	<i>Zn (micro-g/g)</i>	<i>Li (micro-g/g)</i>	<i>Gravel Percent</i>	<i>Sand Percent</i>	<i>Mud Percent</i>	<i>TVS Percent</i>	<i>Beggiatoa Observed (Y/N)</i>	<i>OPC Observed (Y/N)</i>	<i>Fish Feed Observed (Y/N)</i>	<i>Fish Feces Observed (Y/N)</i>	<i>Odour Rating</i>	<i>Black Sediment Observed (Y/N)</i>	<i>Gas Bubbles Observed (Y/N)</i>
A	A-0m	1	573	10.4	-153.3	60.7									N	N	N	N	2	N
A	A-0m	2	309	10.6	-139.1	73.9									N	N	N	N	2	N
A	A-5m	1	78.4	10.9	-25.7	187.3									N	N	N	N	0	N
A	A-5m	2	284	11.1	-103.6	109.4									N	N	N	N	1	N
A	A-5m	2	259	11.1	-108.4	104.6									N	N	N	N	1	N
A	A-5m	2		11.1	-109.3	103.7									N	N	N	N	1	N
A	A+25m	1	139	9.6	-46.4	167.6									N	N	N	N	1	N
A	A+25m	2	122	10.8	-20.8	192.2									N	N	N	N	1	N
B	B-0m	1	1770	8.8	-236.2	-21.2									N	N	N	N	4	N
B	B-0m	1	1490	8.8	-247.8	-32.8									N	N	N	N	4	N
B	B-0m	1		8.8	-255.2	-40.2									N	N	N	N	4	N
B	B-0m	2	6260	9.0	-323.4	-108.4									N	N	N	N	4	N
B	B-5m	1	52.7	8.7	-76.3	138.7									N	N	N	N	0	N
B	B-5m	2	43.6	8.7	-77.1	137.9									N	N	N	N	0	N
B	B+25m	1	39.1	8.7	-21.0	194.0									N	N	N	N	0	N
B	B+25m	2	56.5	8.9	-35.0	180.0									N	N	N	N	0	N
C	C-5m	1	44.8	8.8	-80.2	134.8									N	N	N	N	0	N
C	C-5m	2	72.8	9.7	-47.3	166.7									N	N	N	N	0	N
C	C+25m	1	65.7	8.5	-67.8	147.2									N	N	N	N	0	N
C	C+25m	2	83.6	8.4	-77.9	138.1									N	N	N	N	0	N
Reference	Ref 1	1	66.6	8.7	-65.3	149.7									N	N	N	N	0	N
Reference	Ref 1	2	46.5	9.5	-49.7	164.3									N	N	N	N	0	N
Reference	Ref 2	1	3.04	9.2	-58.2	156.8									N	N	N	N	0	N
Reference	Ref 2	2	1.44	9.8	-17.3	196.7									N	N	N	N	0	N

Table note:

- Odour rating: ranked on a scale of 0 (no odour) to 4 (very strong sulphide odour)

<i>Transect A, B, C Name</i>	<i>Sampling Station Name</i>	<i>Replicate Number</i>	<i>Flocculent Organic Material Observed (Y/N)</i>	<i>Shell Hash Observed (Y/N)</i>	<i>Terrigenous Material Observed (Y/N)</i>	<i>Farm Litter Observed (Y/N)</i>	<i>Macrophytes Observed (Y/N)</i>	<i>Mega fauna Observed (Y/N)</i>	<i>Sediment Colour Observations</i>	<i>Sediment Texture Observations</i>	<i>Other Sample Observations (Comments)</i>
A	A-0m	1	N	Y	Y	N	N	N	Grey	Mud	Shell hash, pine needle
A	A-0m	2	N	Y	Y	N	N	N	Grey	Mud	Shell hash, pine needle
A	A-5m	1	N	N	N	N	N	Y	Green/brown	Mud/cobble	Tubeworm
A	A-5m	2	N	N	N	N	N	Y	Green/brown	Mud/cobble	Tubeworm
A	A-5m	2	N	N	N	N	N	Y	Green/brown	Mud/cobble	Tubeworm
A	A-5m	2	N	N	N	N	N	Y	Green/brown	Mud/cobble	Tubeworm
A	A+25m	1	N	Y	N	N	N	Y	Green	Mud/cobble	Flecks of shell hash, tubeworm
A	A+25m	2	N	Y	N	N	N	Y	Green	Mud/gravel	Flecks of shell hash, tubeworm
B	B-0m	1	N	Y	Y	N	N	N	Dark brown/black	Mud	Shell hash, pine needle
B	B-0m	1	N	Y	Y	N	N	N	Dark brown/black	Mud	Shell hash, pine needle
B	B-0m	1	N	Y	Y	N	N	N	Dark brown/black	Mud	Shell hash, pine needle
B	B-0m	2	N	Y	Y	N	N	N	Dark brown/black	Mud	Shell hash, pine needle
B	B-5m	1	N	Y	N	N	N	Y	Brown	Mud	Flecks of shell hash, tubeworm
B	B-5m	2	N	Y	N	N	N	Y	Brown	Mud	Flecks of shell hash, tubeworm
B	B+25m	1	N	Y	N	N	N	Y	Brown	Mud	Tubeworm
B	B+25m	2	N	Y	N	N	N	Y	Brown	Mud	Tubeworm
C	C-5m	1	N	Y	N	N	N	Y	Brown	Mud	Tubeworm
C	C-5m	2	N	Y	N	N	N	Y	Brown	Mud	Abundant tubeworms
C	C+25m	1	N	Y	N	N	N	Y	Brown	Mud	Tubeworm
C	C+25m	2	N	Y	N	N	N	Y	Brown	Mud	Tubeworm
Reference	Ref 1	1	N	Y	N	N	N	N	Brown	Mud	
Reference	Ref 1	2	N	Y	N	N	N	N	Brown	Mud	
Reference	Ref 2	1	N	Y	N	N	N	N	Brown	Mud/sand	Tubeworm
Reference	Ref 2	2	N	Y	Y	N	N	N	Brown	Mud/sand	Tubeworms and bark

Appendix 3 – Noo-La ASC Survey Summary

Company:	Grieg Seafood BC, Ltd	Sample date:	July 27 and 28, 2023
Farm Site:	Noo-La	Field crew:	T Kajarla, E Jarry
Site License #:	AQ1825	Analytical:	MBC
Site Location	Clio Channel, BC		

SULPHIDES Indicator 2.1.1 Requirement ≤ 1500 (μm)					
Station	Rep 1	Rep 2	n	Mean	ASC Criteria Met
0m A	573	309	2	441	
Inside AZE A	78.4	284	2	181	
Outside AZE A	139	122	2	131	Yes
0m B	1770	6260	2	4015	
Inside AZE B	52.7	43.6	2	48.8	
Outside AZE B	39.1	56.5	2	47.8	Yes
Inside AZE C	44.8	72.8	2	58.8	
Outside AZE C	65.7	83.6	2	74.7	Yes
Reference 1	66.6	46.5	2	56.6	
Reference 2	3.04	1.44	2	2.24	

REDOX POTENTIAL Indicator 2.1.1 Requirement > 0 mV					
Station	Rep 1	Rep 2	N	Mean	ASC Criteria Met
0m A	60.7	73.9	2	67.3	
Inside AZE A	187.3	109.4	2	148.4	
Outside AZE A	167.6	192.2	2	179.9	Yes
0m B	-21.2	-108.4	2	-64.8	
Inside AZE B	138.7	137.9	2	138.3	
Outside AZE B	194.0	180.0	2	187.0	Yes
Inside AZE C	134.8	166.7	2	150.8	
Outside AZE C	147.2	138.1	2	142.7	Yes
Reference 1	149.7	164.3	2	157.0	
Reference 2	156.8	196.7	2	176.8	