

FINFISH AQUACULTURE SITE AQUACULTURE STEWARDSHIP COUNCIL REPORT

GORE ISLAND, NOOTKA SOUND, BC

SITE LICENSE: AQ1762

SURVEY TYPE: ASC

SURVEY DATE: MAY 11 AND 12, 2022

REPORT DATE: JUNE 1, 2022

PREPARED FOR:

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Summary

This document presents the qualitative and quantitative assessment of sediment obtained during the survey completed at the Gore Island finfish aquaculture site operated by Grieg Seafood BC Ltd in Nookta Sound, BC, on May 11 and 12, 2022. Sediment was collected and the data analyzed according to the *Aquaculture Activities Regulations* (AAR) and adapted to address Criterion 2.1 and 5.2 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.

As required by Criterion 5.2 of the ASC monitoring for parasiticide residue was completed at the station outside the AZE on Transects A, B and C and at three reference stations. Enamectin benzoate was below detectable limits in all collected samples.

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/>

Table of Contents

Summary.....	ii
Table of Contents.....	iii
1.0 Introduction.....	1
2.0 Methods.....	3
2.1 Field Sampling	3
2.2 Data Analysis.....	6
3.0 Results and Discussion	7
3.1 Redox Potential and Sulphide Levels.....	7
3.2 Parasiticide Residue	7
4.0 References	8
Appendix 1 – Sample Photographs	I
Appendix 2 – Site name Field Data	VI
Appendix 3 – Gore Island ASC Survey Summary	VIII

1.0 Introduction

This document presents the marine sediment data collected as part of a benthic study completed at the Gore Island finfish aquaculture site operated by Grieg Seafood BC Ltd (Campbell River, BC). The Gore Island site is located in Nookta Sound, 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. Additional analysis of the collected sediment was also completed to address Criterion 5.2 of the ASC.

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. In addition, testing for parasiticide residue in sediment collected at the two reference stations and at the stations outside the AZE was completed to address Criterion 5.2.1 of the ASC.

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).

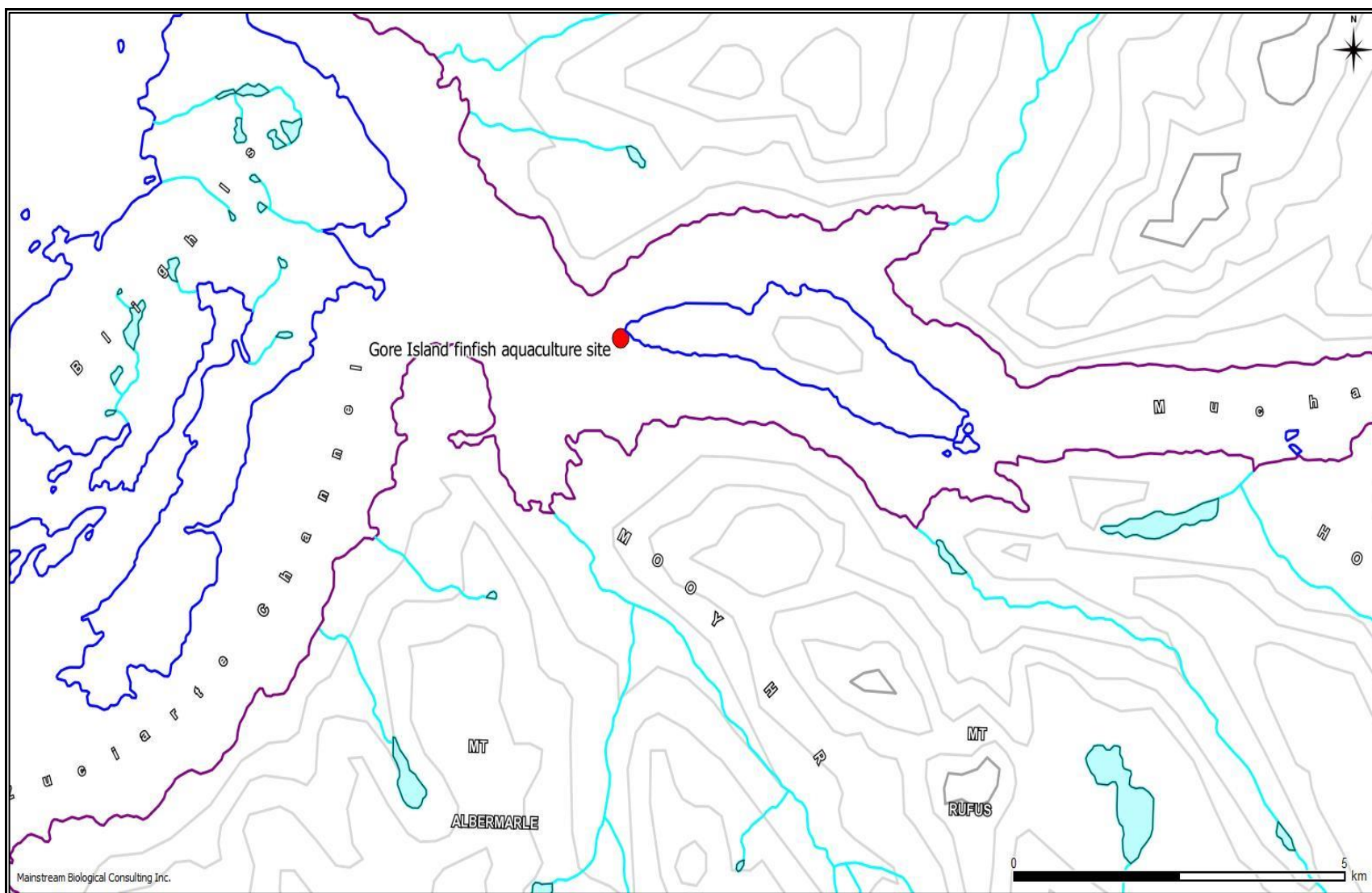


Figure 1: An overview map showing the approximate location of the Gore Island finfish aquaculture farm site (red dot) in Nootka Sound, BC.

2.0 Methods

The substrate at the designated sampling locations at the Gore Island 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 (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. On Transect A, the station at the perimeter of the containment system was the same as the station 5 m inside the 1 g DEPOMOD contour. 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 Petite Ponar and 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 Nootka base station (NTKA).

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.

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.

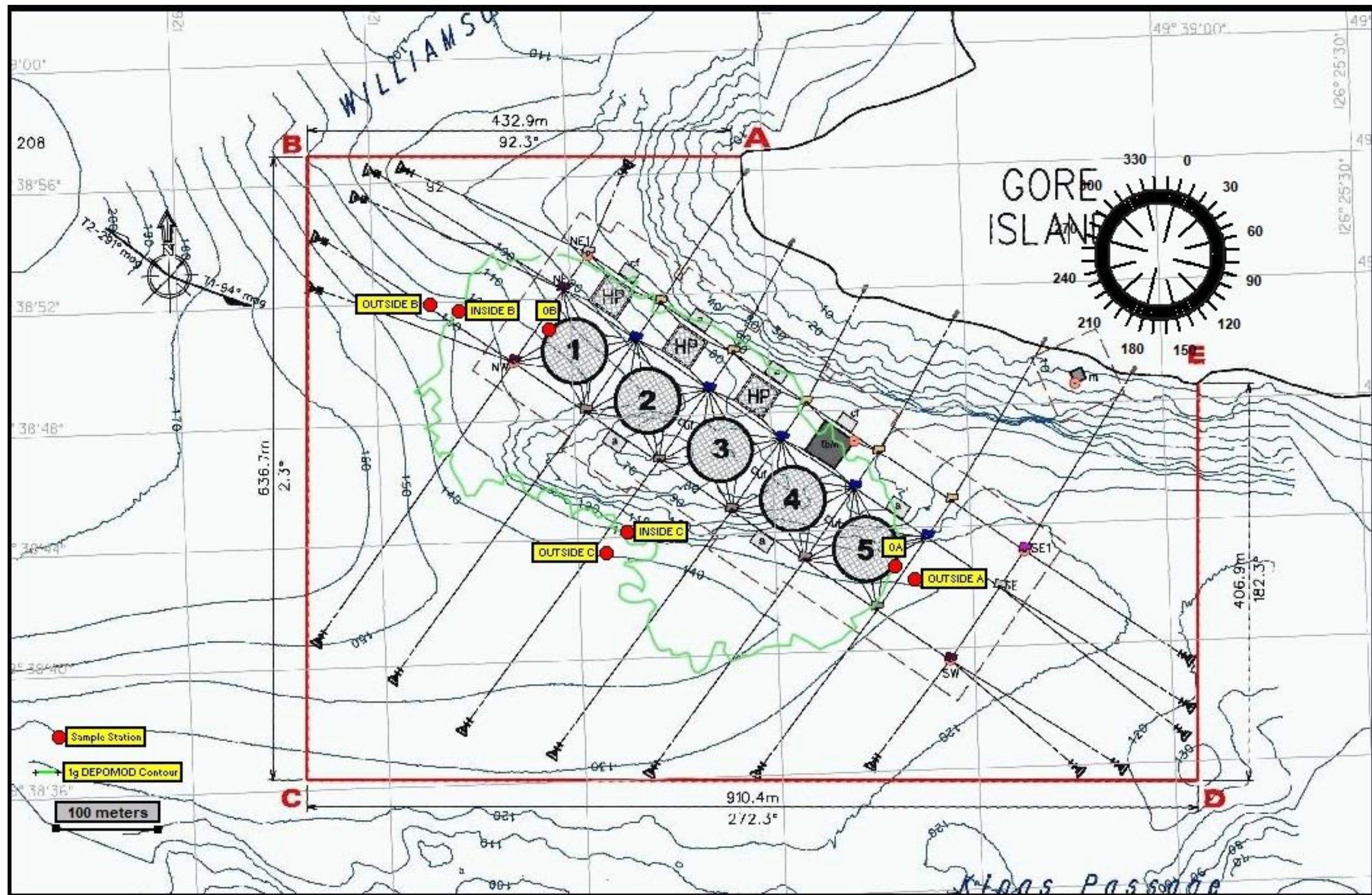


Figure 2: The locations of the sampling stations for the ASC survey at the Gore Island finfish aquaculture site in relation to the pen system and surrounding area on May 11 and 12, 2022.

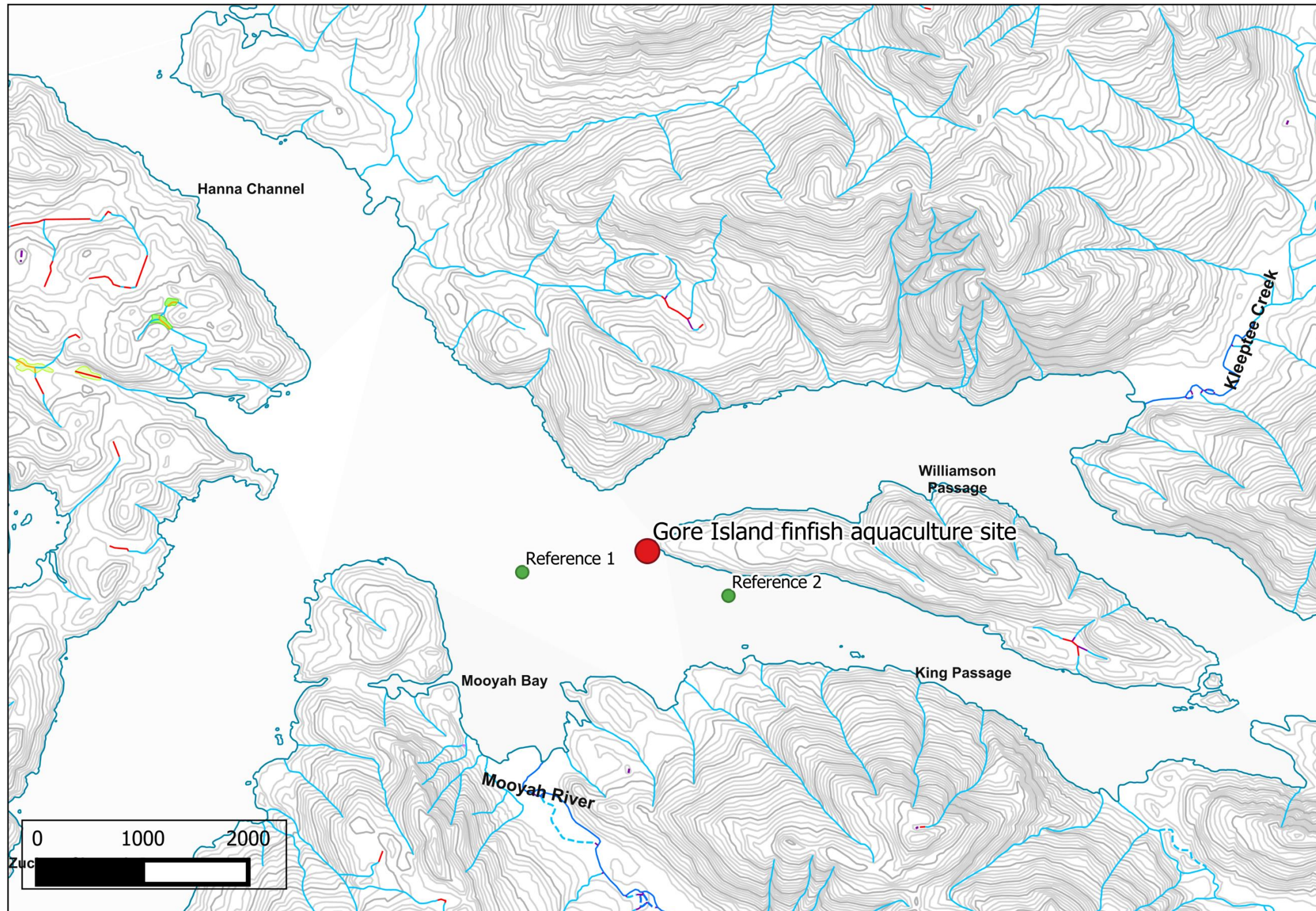


Figure 3: The locations of the reference stations for the ASC survey at the Gore Island finfish aquaculture site in relation to the site and surrounding area on May 12, 2022.

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.

As per Indicator 5.2.1, portions of the grab samples collected at the stations outside the AZE on Transects A, B and C as well as the reference stations were retained for analysis. Retained samples were stored at 4° Celsius and transported to SGS Canada Inc for analysis for emamectin benzoate.

2.2 Data Analysis

To evaluate if the benthic conditions at and near the Gore Island 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 Gore Island 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 Gore Island sampling stations consisted of grey or brown mud with shell hash and terrigenous material.

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 Gore Island 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 (87.6 μM , 71.5 μM and 120 μM respectively) on May 11, 2022, 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 (209.8 mV, 260.0 mV and 102.4 mV respectively) were greater than the 0 mV minimum requirement cited in Criterion 2.1.1 of the ASC Salmon Standard.

3.2 Parasiticide Residue

Analysis of the sediment collected from the stations outside the AZE on Transects A, B, C and the two reference stations for emamectin benzoate are shown in Table 3. The analysis was completed to fulfill the requirement of the ASC Salmon Standard Criterion number 5.2.1. All of the collected sediment samples analyzed had parasiticide residue concentrations less than the laboratory detectable limit.

Table 3: The parasiticide residue concentration of collected sediment at the stations outside the AZE on Transects A, B, C and the two reference stations at the Gore Island finfish aquaculture site on May 11 and 12, 2022.

Station Name	Sample Number	Emamectin Benzoate (ppm)
Detection Limit		1.0
Outside AZE A	1	<1.0
Outside AZE A	2	<1.0
Outside AZE B	1	<1.0
Outside AZE B	2	<1.0
Outside AZE C	1	<1.0
Outside AZE C	2	<1.0
Reference 1	1	<1.0
Reference 1	2	<1.0
Reference 2	1	<1.0
Reference 2	2	<1.0

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 Gore Island site on May 11, 2022.



Photo 2

Sediment sample collected at the station outside the AZE on Transect A at the Gore Island site on May 11, 2022.



Photo 3

Sediment sample collected at the 0B station at the Gore Island site on May 11, 2022.



Photo 4

Sediment sample collected at the station inside the AZE on Transect B at the Gore Island site on May 11, 2022.



Photo 5

Sediment sample collected at the station outside the AZE on Transect B at the Gore Island site on May 11, 2022.



Photo 6

Sediment sample collected at the station inside the AZE on Transect C at the Gore Island site on May 11, 2022.



Photo 7

Sediment sample collected at the station outside the AZE on Transect C at the Gore Island site on May 11, 2022.



Photo 8

Sediment sample collected at the Reference 1 at the Gore Island site on May 12, 2022.



Photo 10

Sediment sample collected at the Reference 2 at the Gore Island site on May 12, 2022.

Appendix 2 – Site name Field Data

Reference Information:	
Farm site:	Gore Island
Aquaculture Company:	Grieg Seafood BC Ltd
Site Reference #:	AQ1762
Geographic Region:	Nookta Sound, BC
Field Crew:	E.Cicon & M. Easton
Field Investigator:	Mainstream Biological Consulting Inc.
Laboratory:	SGS Canada Inc

<i>Transect A, B, C Name</i>	<i>Sampling Station Name</i>	<i>Replicate Number</i>	<i>Transect A, B, C Bearing (Magnetic)</i>	<i>Reference Station (Y/N)</i>	<i>Distance from Pens (m)</i>	<i>Sampling Device Type</i>	<i>Sampling Device Capacity (m2)</i>	<i>Quality Control Replicate (Y/N)</i>	<i>Replicate Analysis Type</i>	<i>Sample Date (YYYY-MM-DD)</i>	<i>Sample Time (24HH:MM)</i>	<i>Sample Latitude (Degrees)</i>	<i>Sample Latitude (Minutes)</i>	<i>Sample Longitude (Degrees)</i>	<i>Sample Longitude (Minutes)</i>	<i>GPS Correction Status</i>	<i>Ocean Depth (m)</i>	<i>Sample Depth (cm)</i>
A	0m	1	107	N	0	Petite Ponar	0.02	N		2022-05-11	08:54	49	38.7107	126	25.8942	Post-process Corrected	105	8
A	0m	2	107	N	0	Petite Ponar	0.02	N		2022-05-11	09:02	49	38.7112	126	25.8947	Post-process Corrected	105	7
A	25m	1	107	N	21	Petite Ponar	0.02	N		2022-05-11	09:13	49	38.7043	126	25.8798	Post-process Corrected	119	8
A	25m	2	107	N	21	Petite Ponar	0.02	N		2022-05-11	09:30	49	38.7042	126	25.8793	Post-process Corrected	116	8
B	0m	1	266	N	0	Petite Ponar	0.02	N		2022-05-11	12:41	49	38.8513	126	26.1954	Post-process Corrected	103	5
B	0m	2	266	N	0	Van Veen	0.10	N		2022-05-11	12:48	49	38.8507	126	26.1960	Post-process Corrected	103	10
B	5m	1	266	N	86	Van Veen	0.10	N		2022-05-11	13:51	49	38.8616	126	26.2648	Post-process Corrected	113	10
B	5m	2	266	N	86	Van Veen	0.10	N		2022-05-11	14:05	49	38.8621	126	26.2662	Post-process Corrected	112	10
B	25m	1	266	N	114	Van Veen	0.10	N		2022-05-11	14:23	49	38.8667	126	26.2867	Post-process Corrected	112	11
B	25m	2	266	N	114	Van Veen	0.10	N		2022-05-11	14:36	49	38.8668	126	26.2873	Post-process Corrected	112	10
C	5m	1	209	N	95	Petite Ponar	0.02	N		2022-05-11	11:32	49	38.7345	126	26.1245	Post-process Corrected	129	10
C	5m	2	209	N	95	Petite Ponar	0.02	N		2022-05-11	11:41	49	38.7347	126	26.1253	Post-process Corrected	129	10
C	25m	1	209	N	124	Petite Ponar	0.02	N		2022-05-11	11:55	49	38.7235	126	26.1421	Post-process Corrected	132	10
C	25m	2	209	N	124	Petite Ponar	0.02	N		2022-05-11	12:12	49	38.7235	126	26.1410	Post-process Corrected	132	10
REF		1		Y		Petite Ponar	0.02	N		2022-05-12	10:00	49	38.5994	126	26.9553	Post-process Corrected	141	10
REF		2		Y		Petite Ponar	0.02	N		2022-05-12	10:29	49	38.5987	126	26.9492	Post-process Corrected	141	10
REF		1		Y		Petite Ponar	0.02	N		2022-05-12	10:43	49	38.6203	126	25.4007	Post-process Corrected	115	10
REF		2		Y		Petite Ponar	0.02	N		2022-05-12	10:50	49	38.6165	126	25.3997	Post-process Corrected	115	10

<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	0m	1	15900	7.4	-285.2	-68.2								N	N	N	Y	4	N	N
A	0m	2	10800	7.5	-331.4	-115.4								N	N	N	N	4	N	N
A	25m	1	47.1	7.5	18.4	234.4								N	N	N	N	0	N	N
A	25m	2	128	7.5	-30.9	185.1								N	N	N	N	0	N	N
B	0m	1	5990	7.9	-330.6	-114.6								Y	N	N	N	4	N	N
B	0m	2	7160	7.6	-335.7	-119.7								Y	N	N	N	4	N	N
B	5m	1	80.4	7.3	16.8	233.8								N	N	N	N	0	N	N
B	5m	2	104	7.4	13.4	230.4								N	N	N	N	0	N	N
B	25m	1	83.5	7.3	46.1	263.1								N	N	N	N	0	N	N
B	25m	2	59.5	7.4	39.9	256.9								N	N	N	N	0	N	N
C	5m	1	85.1	7.6	-100.1	115.9								N	N	N	N	1	N	N
C	5m	2	114	7.7	-99.2	116.8								N	N	N	N	1	N	N
C	25m	1	135	7.6	-171.7	44.3								N	N	N	N	1	N	N
C	25m	2	104	7.7	-55.6	160.4								N	N	N	N	1	N	N
REF		1	88.4	8.3	202	418								N	N	N	N	0	N	N
REF		2	63.1	7.9	96.9	312.9								N	N	N	N	0	N	N
REF		1	33.2	8.0	-12.5	203.5								N	N	N	N	0	N	N
REF		2	34.9	7.9	-10.6	205.4								N	N	N	N	0	N	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>Megafauna Observed (Y/N)</i>	<i>Sediment Colour Observations</i>	<i>Sediment Texture Observations</i>	<i>Other Sample Observations (Comments)</i>
A	0m	1	N	Y	N	N	N	N	Dark brown	Mud	Cedar needles
A	0m	2	N	Y	N	N	N	N	Grey	Mud	
A	25m	1	N	Y	N	N	N	N	Green	Mud	
A	25m	2	N	Y	N	N	N	N	Grey	Mud	Trace shell hash
B	0m	1	N	Y	N	N	N	N	Dark grey	Sandy mud	Trace beggiatoa, some gravel
B	0m	2	N	Y	N	N	N	N	Dark grey	Sandy mud	
B	5m	1	N	Y	N	N	N	N	Brown	Sandy mud	Some gravel
B	5m	2	N	Y	N	N	N	Y	Brown	Sandy mud	Tubeworms
B	25m	1	N	N	N	N	N	Y	Brown	Sandy mud	Tubeworms
B	25m	2	N	Y	N	N	N	N	Brown	Sandy mud	
C	5m	1	N	Y	N	N	N	N	dark grey	Mud	Trace shell hash
C	5m	2	N	Y	N	N	N	N	Brown	Mud	
C	25m	1	N	Y	N	N	N	N	Brown	Mud	
C	25m	2	N	Y	N	N	N	Y	Brown	Mud	Hydroids
REF		1	N	N	N	N	N	N	Brown	Mud	
REF		2	N	N	N	N	N	N	Brown	Mud	
REF		1	N	N	N	N	N	N	Brown	Mud	
REF		2	N	Y	N	N	N	N	Brown	Mud	Flacks of shel hash

Appendix 3 – Gore Island ASC Survey Summary

Company:	Grieg Seafood BC Ltd	Sample date:	May 11 and 12, 2022
Farm Site:	Gore Island	Field crew:	E. Cicon & M. Easton
Site License #:	AQ1762	Analytical:	SGS Canada Inc
Site Location	Nootka Sound, BC		

SULPHIDES Indicator 2.1.1 Requirement ≤ 1500 (μm)					
Station	Rep 1	Rep 2	n	Mean	ASC Criteria Met
0m A	15900	10800	2	13400	
Outside AZE A	47.1	128	2	87.6	Yes
0m B	5990	7160	2	6580	
Inside AZE B	80.4	104	2	92.2	
Outside AZE B	83.5	59.5	2	71.5	Yes
Inside AZE C	85.1	114	2	100	
Outside AZE C	135	104	2	120	Yes
Reference 1	88.4	63.1	2	75.8	
Reference 2	33.2	34.9	2	34.1	

REDOX POTENTIAL Indicator 2.1.1 Requirement > 0 mV					
Station	Rep 1	Rep 2	N	Mean	ASC Criteria Met
0m A	-68.2	-115.4	2	-91.8	
Outside AZE A	234.4	185.1	2	209.8	Yes
0m B	-114.6	-119.7	2	-117.2	
Inside AZE B	233.8	230.4	2	232.1	
Outside AZE B	263.1	256.9	2	260.0	Yes
Inside AZE C	115.9	116.8	2	116.4	
Outside AZE C	44.3	160.4	2	102.4	Yes
Reference 1	418.0	312.9	2	365.5	
Reference 2	203.5	205.4	2	204.5	