

FINFISH AQUACULTURE SITE AQUACULTURE STEWARDSHIP COUNCIL REPORT

TSA-YA, CLIO CHANNEL, BC

SITE LICENSE: AQ7273

SURVEY TYPE: ASC

SURVEY DATE: SEPTEMBER 6, AND 7, 2023

REPORT DATE: SEPTEMBER 22, 2023

PREPARED FOR:

*GRIEG SEAFOOD BC LTD
#106 1180 IRONWOOD ST.
CAMPBELL RIVER, BC
V9W 5P7*



Summary

This document presents the qualitative and quantitative assessment of sediment obtained during the survey completed at the Tsa-Ya finfish aquaculture site operated by Grieg Seafood BC Ltd in Clio Channel, BC, on September 6, and 7, 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/>

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.....	5
3.0 Results and Discussion	6
3.1 Redox Potential and Sulphide Levels.....	6
4.0 References	7
Appendix 1 – Sample Photographs	I
Appendix 2 – Tsa-Ya Field Data	VI
Appendix 3 – Tsa-Ya ASC Survey Summary	VIII

1.0 Introduction

This document presents the marine sediment data collected as part of a benthic study completed at the Tsa-Ya finfish aquaculture site operated by Grieg Seafood BC Ltd (Campbell River, BC). The Tsa-Ya 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).

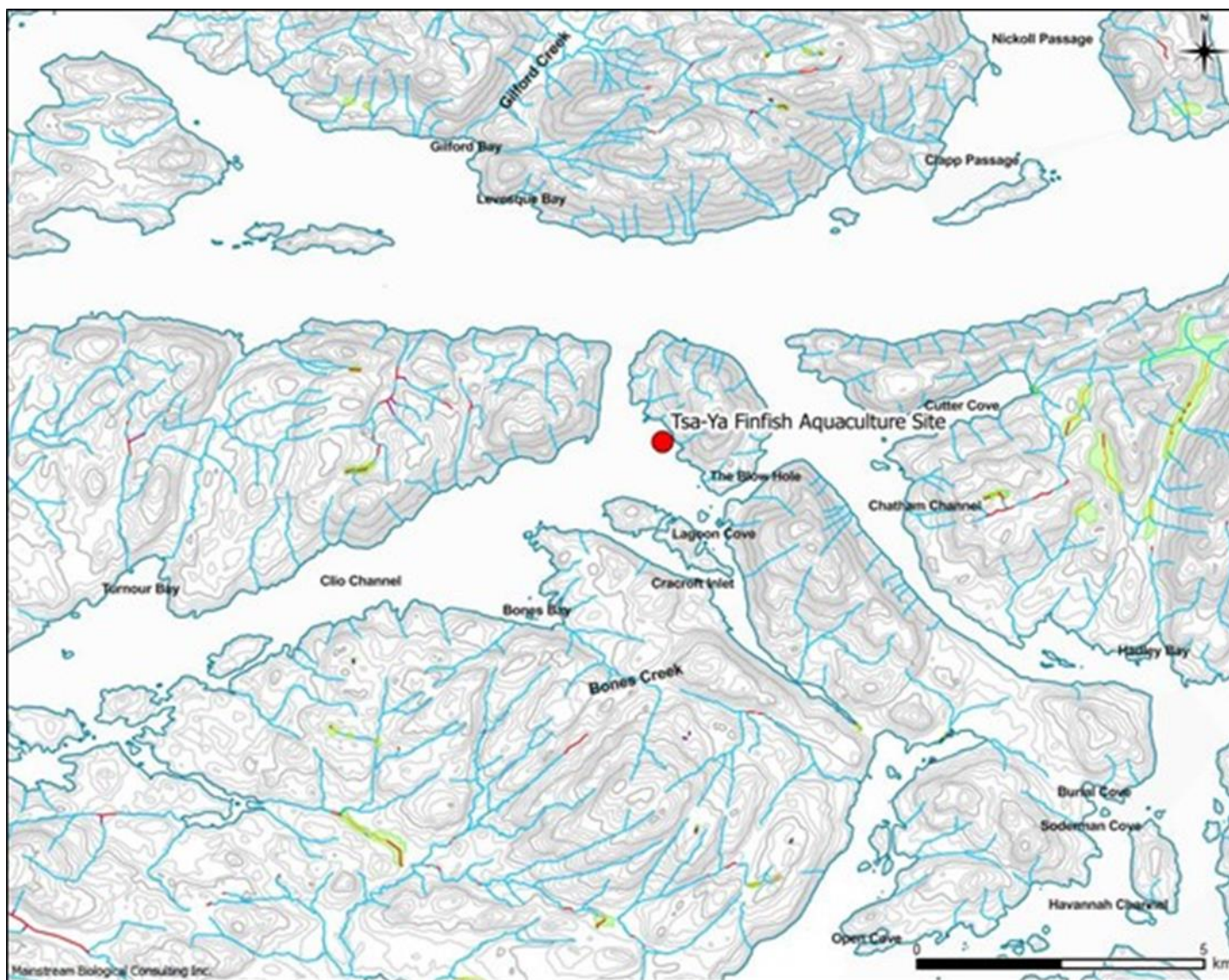


Figure 1: An overview map showing the approximate location of the Tsa-Ya finfish aquaculture farm site (red dot) in Clio Channel, BC.

2.0 Methods

The substrate at the designated sampling locations at the Tsa-Ya 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 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 2).

Sediment was collected using a Petite Ponar 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.

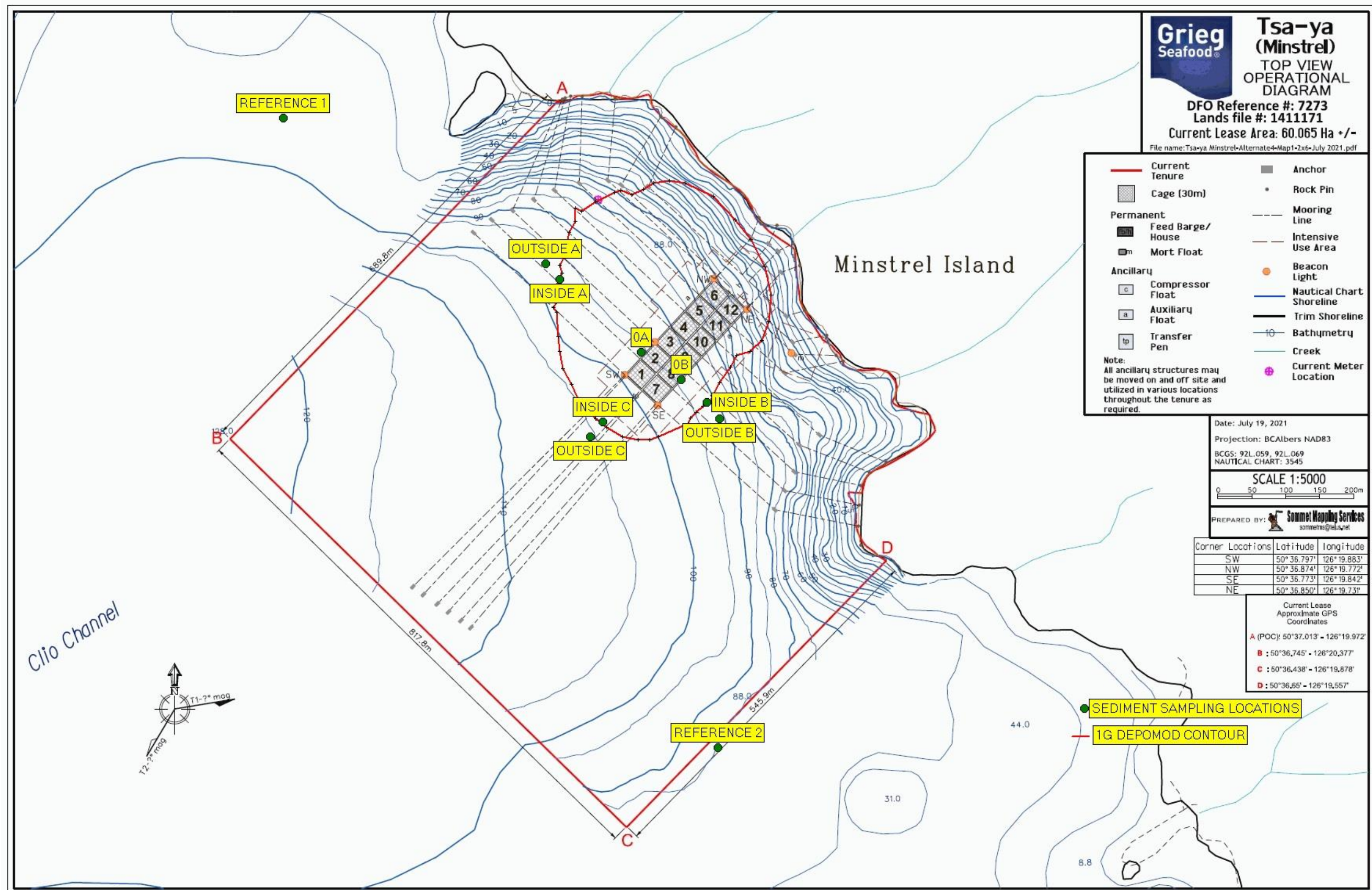


Figure 2: The locations of the sampling stations for the ASC survey at the Tsa-Ya finfish aquaculture site in relation to the pen system and surrounding area on September 6 and 7, 2023.

2.2 Data Analysis

To evaluate if the benthic conditions at and near the Tsa-Ya 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.

Table 1: Summary of indicators of benthic health, biodiversity and ecosystem function that were considered during the evaluation of the Tsa-Ya 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 Tsa-Ya sampling stations typically consisted of brown or light brown mud with shell hash and a mild or no sulphide odour except for Station 0A which had no shell hash and a strong sulphide odour.

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 Tsa-Ya 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 (230 μM , 26.3 μM and 42.7 μM respectively) on September 6, 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 (22.6 mV, 185.7 mV and 82.1 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 Tsa-Ya site on September 6, 2023.



Photo 2

Sediment sample collected at the station inside the AZE on Transect A at the Tsa-Ya site on June 20, 2019.



Photo 3

Sediment sample collected at the station outside the AZE on Transect A at the Tsa-Ya site on September 6, 2023.



Photo 4

Sediment sample collected at the 0B station at the Tsa-Ya site on September 6, 2023.



Photo 5

Sediment sample collected at the station inside the AZE on Transect B at the Tsa-Ya site on September 6, 2023.



Photo 6

Sediment sample collected at the station outside the AZE on Transect B at the Tsa-Ya site on September 6, 2023.



Photo 7

Sediment sample collected at the station inside the AZE on Transect C at the Tsa-Ya site on September 6, 2023.



Photo 8

Sediment sample collected at the station outside the AZE on Transect C at the Tsa-Ya site on September 6, 2023.



Photo 9

Sediment sample collected at the Reference 1 at the Tsa-Ya site on September 6, 2023.



Photo 10

Sediment sample collected at the Reference 2 at the Tsa-Ya site on September 7, 2023.

Appendix 2 – Tsa-Ya Field Data

Reference Information:

Farm site:	Tsa-Ya	Field Crew:	T. Karjala, E. Jarry
Aquaculture Company:	Grieg Seafood BC Ltd	Field Investigator:	Mainstream Biological Consulting Inc.
Site Reference #:	AQ7273	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	296		0	Ponar	0.02	N		2023-09-06	10:34	50	36.8159	126	19.8620	Post-process corrected	96.1	10
A	A-0m	2	296		0	Ponar	0.02	N		2023-09-06	10:40	50	36.8158	126	19.8620	Post-process corrected	96.0	8
A	A-5m	1	296		161	Ponar	0.02	N		2023-09-06	12:34	50	36.8739	126	19.9629	Post-process corrected	98.8	8
A	A-5m	2	296		161	Ponar	0.02	N		2023-09-06	12:43	50	36.8743	126	19.9630	Post-process corrected	99.0	9
A	A+25m	1	296		192	Ponar	0.02	N		2023-09-06	12:52	50	36.8862	126	19.9812	Post-process corrected	99.1	8
A	A+25m	2	296		192	Ponar	0.02	N		2023-09-06	12:59	50	36.8858	126	19.9831	Post-process corrected	99.4	9
B	B-0m	1	119		0	Ponar	0.02	N		2023-09-06	13:17	50	36.7937	126	19.8123	Post-process corrected	95.6	5
B	B-0m	1	119		0	Ponar	0.02	Y	Duplicate	2023-09-06	13:17	50	36.7937	126	19.8123	Post-process corrected	95.6	5
B	B-0m	1	119		0	Ponar	0.02	Y	Triplicate	2023-09-06	13:17	50	36.7937	126	19.8123	Post-process corrected	95.6	5
B	B-0m	2	119		0	Ponar	0.02	N		2023-09-06	13:24	50	36.7939	126	19.8122	Post-process corrected	95.1	5
B	B-5m	1	119		52	Ponar	0.02	N		2023-09-06	14:07	50	36.7755	126	19.7791	Post-process corrected	84.8	8
B	B-5m	2	119		52	Ponar	0.02	N		2023-09-06	14:21	50	36.7754	126	19.7785	Post-process corrected	85.8	8
B	B+25m	1	119		82	Ponar	0.02	N		2023-09-06	14:30	50	36.7620	126	19.7640	Post-process corrected	89.4	5
B	B+25m	2	119		82	Ponar	0.02	N		2023-09-06	14:35	50	36.7620	126	19.7642	Post-process corrected	88.6	7
C	C-5m	1	203		72	Ponar	0.02	N		2023-09-06	15:24	50	36.7602	126	19.9093	Post-process corrected	106.0	9
C	C-5m	2	203		72	Ponar	0.02	N		2023-09-06	15:45	50	36.7609	126	19.9099	Post-process corrected	106.0	9
C	C+25m	1	203		101	Ponar	0.02	N		2023-09-06	15:52	50	36.7481	126	19.9252	Post-process corrected	107.0	7
C	C+25m	2	203		101	Ponar	0.02	N		2023-09-06	15:59	50	36.7482	126	19.9257	Post-process corrected	107.0	6
Ref 1	Ref 1	1			629	Ponar	0.02	N		2023-09-06	16:19	50	37.0019	126	20.3082	Post-process corrected	85.6	5
Ref 1	Ref 1	2			629	Ponar	0.02	N		2023-09-06	16:42	50	37.0051	126	20.3096	Post-process corrected	84.9	6
Ref 2	Ref 2	1			546	Ponar	0.02	N		2023-09-07	13:49	50	36.5007	126	19.7658	Post-process corrected	85.4	5
Ref 2	Ref 2	1			546	Ponar	0.02	Y	Duplicate	2023-09-07	13:49	50	36.5007	126	19.7658	Post-process corrected	85.4	5
Ref 2	Ref 2	1			546	Ponar	0.02	Y	Triplicate	2023-09-07	13:49	50	36.5007	126	19.7658	Post-process corrected	85.4	5
Ref 2	Ref 2	2			546	Ponar	0.02	N		2023-09-07	14:09	50	36.5014	126	19.7660	Post-process corrected	86.1	5

<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	8630	9.5	-323.5	-109.5								N	N	Y	Y	4	N	Y
A	A-0m	2	9800	9.5	-332.3	-118.3								N	N	Y	Y	4	N	Y
A	A-5m	1	185	9.5	-174.3	39.7								Y	N	N	N	1	N	N
A	A-5m	2	153	9.5	-175.3	38.7								N	N	N	N	1	N	N
A	A+25m	1	250	9.7	-199.8	14.2								N	N	N	N	1	N	N
A	A+25m	2	209	9.8	-183.1	30.9								N	N	N	N	1	N	N
B	B-0m	1	164	10.0	-154.9	59.1								N	N	N	N	1	N	N
B	B-0m	1	131	10.0	-160.7	53.3								N	N	N	N	1	N	N
B	B-0m	1		10.0	-150.1	63.9								N	N	N	N	1	N	N
B	B-0m	2	313	10.6	-200.3	12.7								N	N	N	N	2	N	N
B	B-5m	1	11.7	10.5	-25.2	187.8								N	N	N	N	0	N	N
B	B-5m	2	14.8	10.8	-33.0	180.0								N	N	N	N	0	N	N
B	B+25m	1	27.1	10.9	-33.4	179.6								N	N	N	N	0	N	N
B	B+25m	2	25.5	10.7	-21.3	191.7								N	N	N	N	0	N	N
C	C-5m	1	113	10.8	-150.1	62.9								N	N	N	N	1	N	N
C	C-5m	2	96.7	10.4	-102.2	111.8								N	N	N	N	1	N	N
C	C+25m	1	41.6	10.3	-118.3	95.7								N	N	N	N	0	N	N
C	C+25m	2	43.7	9.5	-145.6	68.4								N	N	N	N	0	N	N
Ref 1	Ref 1	1	9.40	9.8	-40.2	173.8								N	N	N	N	0	N	N
Ref 1	Ref 1	2	18.4	9.7	-25.8	188.2								N	N	N	N	0	N	N
Ref 2	Ref 2	1	15.1	9.9	-4.2	209.8								N	N	N	N	0	N	N
Ref 2	Ref 2	1	18.9	9.9	-8.1	205.9								N	N	N	N	0	N	N
Ref 2	Ref 2	1		9.9	-9.6	204.4								N	N	N	N	0	N	N
Ref 2	Ref 2	2	21.4	9.7	-10.3	203.7								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	A-0m	1	Y	N	N	N	N	N	Brown	Mud	Fish feed and feces, Flocculant organics, gas bubbles
A	A-0m	2	Y	N	Y	N	N	N	Brown	Mud	Fish feed and feces, Flocculant organics, gas bubbles, twigs
A	A-5m	1	N	Y	N	N	N	N	Brown	Mud	Flecks shell hash, trace beggiatoa
A	A-5m	2	N	Y	N	N	N	N	Brown	Mud	Flecks shell hash
A	A+25m	1	N	Y	N	N	N	N	Brown	Mud	Flecks shell hash
A	A+25m	2	N	Y	Y	N	N	N	Brown	Mud	Flecks shell hash, pine needles
B	B-0m	1	N	Y	N	N	N	N	Light brown	Mud/sand	abundant shell hash
B	B-0m	1	N	Y	N	N	N	N	Light brown	Mud/sand	abundant shell hash
B	B-0m	1	N	Y	N	N	N	N	Light brown	Mud/sand	abundant shell hash
B	B-0m	2	N	Y	N	N	N	N	Light brown	Mud/sand	abundant shell hash
B	B-5m	1	N	Y	N	N	N	N	Light brown	Mud	Flecks shell hash
B	B-5m	2	N	Y	N	N	N	N	Light brown	Mud	Flecks shell hash
B	B+25m	1	N	Y	N	N	N	N	Light brown	Mud/gravel	Flecks shell hash
B	B+25m	2	N	Y	N	N	N	Y	Light brown	Mud/gravel	Flecks shell hash, tubeworm
C	C-5m	1	N	Y	N	N	N	N	Light brown	Mud	Flecks shell hash
C	C-5m	2	N	Y	N	N	N	N	Light brown	Mud	Flecks shell hash
C	C+25m	1	N	Y	N	N	N	N	Light brown	Mud	Flecks shell hash
C	C+25m	2	N	Y	N	N	N	N	Light brown	Mud	Flecks shell hash
Ref 1	Ref 1	1	N	Y	N	N	N	Y	Brown	Mud/sand/gravel	Flecks shell hash, tubeworm
Ref 1	Ref 1	2	N	Y	N	N	N	Y	Brown	Mud/sand/gravel	Flecks shell hash, tubeworm
Ref 2	Ref 2	1	N	Y	N	N	N	Y	Brown	Mud/sand/gravel	Flecks shell hash, tubeworm
Ref 2	Ref 2	1	N	Y	N	N	N	Y	Brown	Mud/sand/gravel	Flecks shell hash, tubeworm
Ref 2	Ref 2	1	N	Y	N	N	N	Y	Brown	Mud/sand/gravel	Flecks shell hash, tubeworm
Ref 2	Ref 2	2	N	Y	N	N	N	Y	Brown	Mud/sand/gravel	Flecks shell hash, tubeworm

Appendix 3 – Tsa-Ya ASC Survey Summary

Company:	Grieg Seafood BC Ltd	Sample date:	September 6 and 7, 2023
Farm Site:	Tsa-Ya	Field crew:	T. Karjala, E. Jarry
Site License #:	AQ7273	Analytical:	
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	8630	9800	2	9215	
Inside AZE A	185	153	2	169	
Outside AZE A	250	209	2	230	Yes
0m B	164	313	2	239	
Inside AZE B	11.7	14.8	2	13.3	
Outside AZE B	27.1	25.5	2	26.3	Yes
Inside AZE C	113	96.7	2	105	
Outside AZE C	41.6	43.7	2	42.7	Yes
Reference 1	9.40	18.4	2	13.9	
Reference 2	15.1	21.4	2	18.3	

REDOX POTENTIAL Indicator 2.1.1 Requirement > 0 mV					
Station	Rep 1	Rep 2	N	Mean	ASC Criteria Met
0m A	-109.5	-118.3	2	-113.9	
Inside AZE A	39.7	38.7	2	39.2	
Outside AZE A	14.2	30.9	2	22.6	Yes
0m B	59.1	12.7	2	35.9	
Inside AZE B	187.8	180.0	2	183.9	
Outside AZE B	179.6	191.7	2	185.7	Yes
Inside AZE C	62.9	111.8	2	87.4	
Outside AZE C	95.7	68.4	2	82.1	Yes
Reference 1	173.8	188.2	2	181.0	
Reference 2	209.8	203.7	2	206.8	