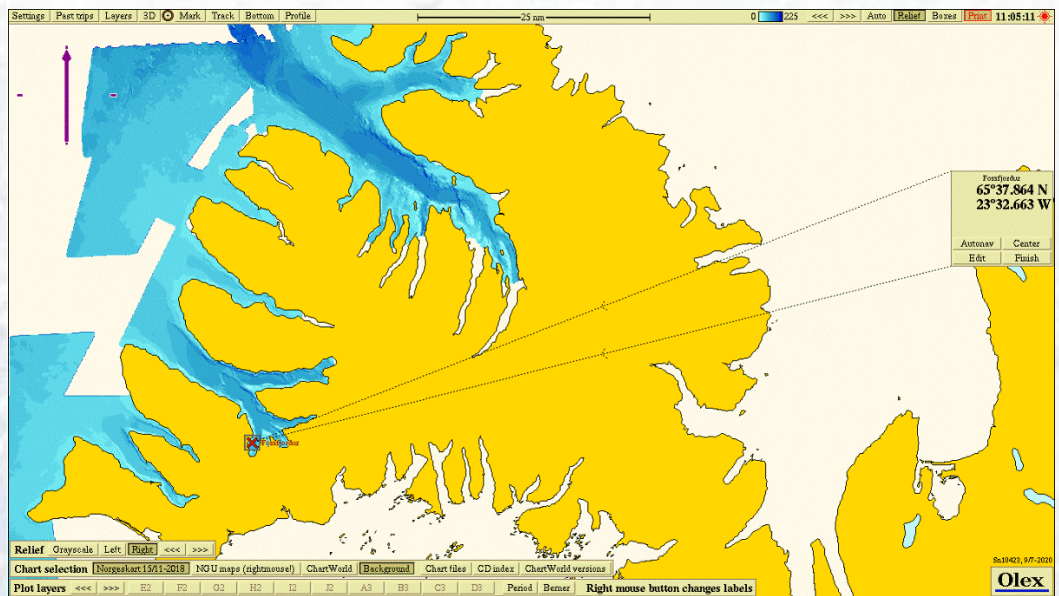




Fossfjörður, Arnarlax hf.  
B-bottom survey,  
June 2020  
(fallow period)



Information client			
Titel	Fossfjörður, Arnarlax hf. B-bottom survey, June 2020		
Report number	APN-62252.B01		
Site name	Fossfjörður	Coordinates site	65°37.864 N 023°32.663 V
County		Municipality	Vesturbyggð
MTB-or estimated max biomass	2.733 tonn	Site manager/contact	Silja Baldvinsdóttir
Client name	Arnarlax hf.		

Biomass/production/status at date of survey			
Biomass at date of survey	0 ton	Feed use	0
Fish type	Salmon	Amount produced	
<b>Type/time of survey</b>	<b>Mark with X</b>	<b>Comments</b>	
At maximal biomass see kap 7.9	<input type="checkbox"/>		
A follow up survey	<input type="checkbox"/>		
Half maximal biomass	<input type="checkbox"/>		
Survey prior to putting out smolt	<input checked="" type="checkbox"/>		
A pre-survey new site	<input type="checkbox"/>		
Other	<input type="checkbox"/>		
Last following period:			

Results from B-survey iht. NS 9410:2016 (main results)			
Parameters and indexes		Parameters and site status	
Gr. II. pH/Eh	0,00	Gr. II. pH/Eh	1
Gr. III. Sensory	0,39	Gr. III. Sensory	1
GR. II + III	0,19	GR. II+ III	1
Date field work	12.06 2020	Date report	09.07.20
<b>Site status (NS 9410:2016):</b>			<b>1</b>

Report writing and project leader	Snorri Gunnarsson	Signature	
Quality control	Arnþór Gústavsson	Signature	

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# Preface

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The survey is carried out according to guidelines in NS 9410:2016 which includes evaluation of sediment, faunal investigation and bottom topography. The environmental survey is regulated by § 35 in the Norwegian «akvakulturdriftsforskriften. The survey also fulfills the requirements regarding bottom surveys in the standard ISO 12878.

The primary objective of a B-survey is to fulfil the requirements regarding maximum biomass survey (MTB) as they are defined in NS9410:2016. There is a requirement of 12 sampling stations within the mooring lines of the fish farm. The estimated max biomass for the current generation farmed salmon at the site Fosfjörður is 2.733 ton.

The following have participated in the survey:


Snorri Gunnarsson	Akvaplan-niva AS	Prosjektleder.
Snorri Gunnarsson	Akvaplan-niva AS	Fieldwork and Report. Charts (Olex).

The sampling at Fosfjörður was done 12.06 2020.

## Accredited survey:

The following parts of the survey are done in accordance to accreditation methods:

Sampling and treatment of sediment samples, analysis of samples and evaluations of the results. It should be pointed out that as Icelandic officials have not set standards regarding different parameters based on samplings at Icelandic conditions so the site characters in this report should be interpreted with that disclaimer in mind.

	Akvaplan-niva AS er akkreditert av Norsk Akkreditering for prøvetaking og faglig vurderinger og fortolkninger, akkrediteringsnummer TEST 079. Akkrediteringen er iht. NS-EN ISO/IEC 17025 Akkrediteringen omfatter bla. NS 9410, NS-EN ISO 5667-19 og NS-EN ISO 16665.
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Akvaplan-niva AS thanks Arnarlax hf. and their personnel for the cooperation during the conductance of this site survey.

Kópavogi 9. juli 2020



Snorri Gunnarsson  
Project manager

# 1 Introduction

---

The sampling date for the present site survey was 12.06 2020 and done by Akvaplan-niva AS contracted by Arnarlax hf. in relation to the company's fish farming activity at the Fossfjörður site in Arnarfjörður.

The objective of the B-survey is to document the environmental condition of the local impact zone of the fish farm according to NS 9410:2016 (and ISO 12878) which includes condition of the seabed, faunal evaluation and bottom topography registration.

The survey gives an estimate and evaluation of the site condition regarding organic load and feasibility assessment of the site for fish farming activity.

Figure 1 shows map of the fjord system of Vestfirðir where the site Fossfjörður is located.

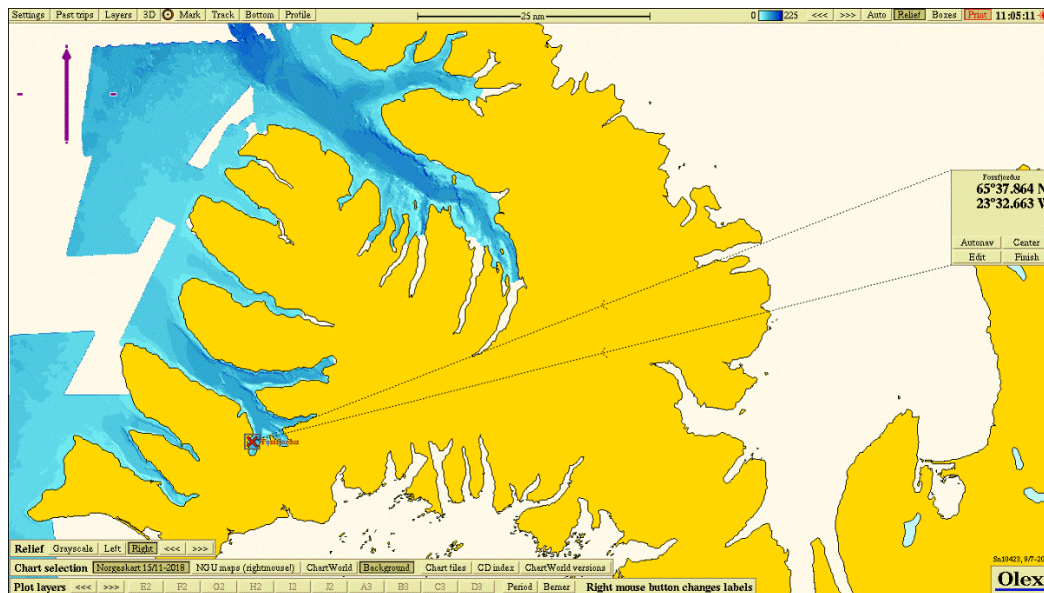


Figure 1. An overview map with the Fossfjörður site marked with a red cross.

## 2 Professional program and methods

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Environmental monitoring of the impact from the fish farming activities on the seabed is a standardised system. All fish farming sites in the sea are to be regularly assessed. The methods for monitoring in Iceland, are based on description in the ISO 12878 standard and methodology described in the NS 9410:2016 is followed. The Icelandic Environmental agency (Umhverfisstofnun) can also set forward specific requirements regarding frequency of samplings for different fish farming sites that can overrule the requirements in the above-mentioned standards.

The B-survey is a trend study of the benthic conditions at or in close proximity to the fish farming site (local impact zone). Sediment is collected by use of grab (min 250 cm<sup>2</sup>). Each grab sample is investigated with regard to three observation types of benthic characters; faunal parameters, chemical parameters (pH and redox-potential) and a sensory evaluation (gas bobbles, smell, texture, colour and the thickness of the precipitated slam layer in the sediment). The different benthic parameters are given a character on the scale from 1 to 4, according to the scale of the impact on the benthic conditions from organic load, see criteria in table 1. The number of sampling stations are decided based on the estimated max standing biomass for the given year class for farmed fish at the site and it is the weighted average for all the sampling stations that gives the sites condition.

*Table 1. Frequency of category B-research for the location of the farm based on state of the defined farming area.*

Site condition at the time of sampling	Sampling frequency for B-surveys (NS 9410:2016)
1-very good	At next max biomass
2-good	Prior to putting next generation into sea and again at next max biomass.
3-bad	Prior to putting next generation into sea. Based on the site condition prior to putting next generation into sea: <ul style="list-style-type: none"><li>- Condition 1 – next site survey at next max biomass</li><li>- Condition 2 – next site survey at next 50% max biomass and at max biomass</li><li>- Condition 3 – next site survey at next 50% max biomass and at max biomass. Some conditions should apply for farming of next generation at the site</li></ul> If any of the samples result in character 4 it is a sign of overload.
4-very bad	Overload

### 2.1 Field equipment

The following field equipment was used during the site survey:

Grabb: Van Veen grabb (0,1 m<sup>2</sup>)

Sieve 1 mm: Akvaplan-niva

pH meter: Electrode, YSI Professional Plus

Redox-meter: Electrode, YSI Professional Plus

Position determination– Garmin GPS mapping tool.

Digital camera



## 3 Site description and bottom topography

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### 3.1 Info site operation

The Fossfjörður site is located in Arnarfjörður Iceland about 6.5 km southeast from Bíldudalur. At the date of sampling there were no cages installed at the site but the sampling was done at the planned area for installation of frame and cages. The planned installation of cages is 700 – 1000 m north of the previous farming site in Fossafjörður. The depth under cages ranges from about 61 m closer to land up to about 77 m further into the fjord. The more shallower area of the farm is at the western part of the farming site.

The Fossfjörður site has been in fallow state since October 2016 or for about 3 years and 8 months at the date of sampling. Previously there has been farmed two generations of fish at the site. The planned fish farm at the site has a 2x3 mooring system with a possibility total of 6 cages, each with 120 m circumference. The planned timing for putting smolts into sea is summer/fall 2020.

Table 2 shows the production and feed usage for the past generation.

*Table 2. Production and feed usage at the site Fossfjörður, data is based on info given from the fish farmer.*

Generation of fish (G)	Production (ton)	Feed usage (ton)
Generation 2 salmon	4.972	6.296
Generation 1 salmon	3.215	3.610

### 3.2 Present and past site surveys

There are no previous B-surveys done at the site Fossfjörður. In relation to farming of the two previous generations salmon at Fossfjörður in 2011-2013 and 2014-2016 there were done benthic surveys prior to putting fish into sea (Þórisson *et al.* 2010), at max biomass (Þórisson *et al.* 2015 and Gallo 2016) and at fallow period after the first generation. The placement of the cages for these two generations was about 700-1000 m south of the planned fish farming site for the next generation at Fossfjörður. The previous benthic surveys described substantial and long lasting effects from the fish farming activity at Fossfjörður site mainly in close proximity to the cages. Main reason for these negative impacts is suggested to be overfeeding the fish (Þórisson *et al.* 2015).

Table 2 shows shows the dates for previous benthic surveys at the site.

Table 3. Past benthic surveys for Fossfjörður.

Date of sampling	Report number	Survey type	Overall site status
2010	Þórisson <i>et al.</i> 2010	Pre survey	NA
August 2012	Þórisson <i>et al.</i> 2015	Max biomass	NA
June 2013	Þórisson <i>et al.</i> 2015	Fallow	NA
Mai 2014	Þórisson <i>et al.</i> 2015	Fallow	NA
October 2015	Gallo 2016	Max biomass	NA

### 3.3 Dispersing current

Dispersing current has not been measured at Fossfjörður so current data from 15 m is used instead. Dominating current (15 m) is in direction V or 270 degrees (Hermansen, 2020). Average current speed at 15 m is measured to be 4,1 cm/s.

### 3.4 Position of sampling stations

Description of the stations in the survey is given in Figure 2 and Table 4. Positioning of the stations was chosen based guidance and perimeters described in NS 9410:2016 and the bottom topography and planned configuration of the farm. Depth at the site is in the range from about 61 to 77 meters. The placement of sampling stations were chosen to give a good picture of the whole local impact zone. The planned area for this next generation fish is about 700-1000 m north of the site used for farming the two previous generations. The sampling stations had a depth varying from 61 m to 76 m. The placement of the sampling stations is regarded to be in accordance with the descriptions for survey of local impact zone given in NS 9410:2016.

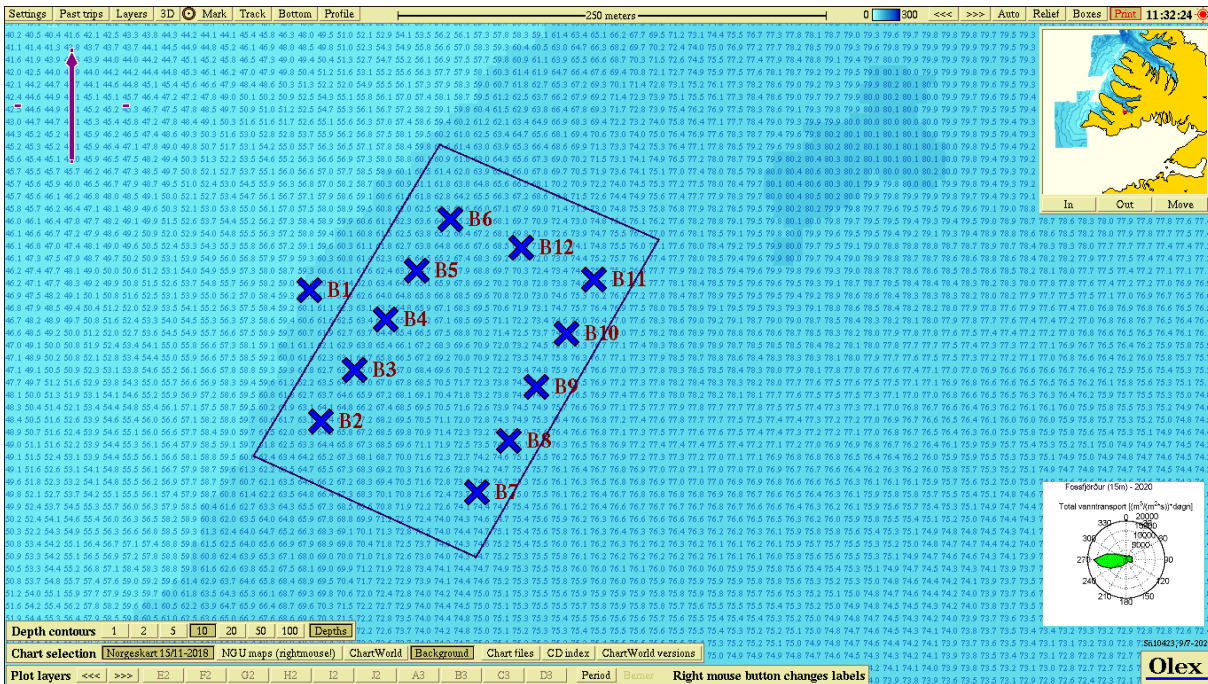


Figure 2. Chart showing depths at the site Fossfjörður. Sampling stations st. 1 – 12 are marked with color codes that describe the condition according to NS 9410:2016, chapter 7.11. Color codes: Blue = very good condition, green = good condition, yellow = bad condition, red = very bad condition.



Table 4. Placement and depth of the sampling stations in the B-survey.

Station number	North	Vest	Depth (m)
St 1	65°37.888	23°32.779	61
St 2	65°37.846	23°32.770	64
St 3	65°37.862	23°32.744	65
St 4	65°37.878	23°32.721	64
St 5	65°37.898	23°32.697	65
St 6	65°37.910	23°32.671	65
St 7	65°37.824	23°32.651	74
St 8	65°37.840	23°32.627	75
St 9	65°37.857	23°32.606	75
St 10	65°37.874	23°32.583	75
St 11	65°37.891	23°32.562	76
St 12	65°37.901	23°32.617	71

## 4 Results

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Results for the different parameters are given in Table 5. The overall site condition was 1 «very good» and is the result of the weighed average for all sampling stations. Overall the condition for group II parameters (pH/Eh), for group III parameters (sensory) and average group II + III parameters (mean value) was 1 «very good». A complete filled sampling sheet with calculations for each parameter is attached in appendix.

*Table 5. Results from the classifications of the local impact zone of the fish farm Fossfjörður in June 2020.*

Parameter	Condition
Group II - parameters (pH/Eh)	1
Group III – parameters, (sensory)	1
Group II + III – parameters (mean value)	1
Site condition	1

There were collected valid sediment samples at all twelve sampling stations. This indicates that in general there is soft bottom in the whole local impact zone. The sediment type consisted mainly of clay.

Animals were present in all samples and redox values were positive.

## 5 Conclusion

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Based on the criteria given in NS 9410:2016 the fish farming site has been assigned a site condition 1 «very good» at the date of sampling. A total of 18 grabs were taken with Van Veen grab (0,1 m<sup>2</sup>), divided on 12 stations placed around the Fossfjörður local impact zone. ». For combined parameters II and III (pH/redox and sensory) all twelve stations had condition 1 «very good».

This survey in the local impact zone is done at fallow period of about 3 years and 8 months at the date of sampling. The overall conclusion for the Fossfjörður site is a very good condition. The planned fish farming site in Fossfjörður (area under surveillance here) is about 700-1000 m north of the area used for farming the two previous generations. Therefore a direct comparison can not be made with previous benthic surveys also because these were of different type (C-surveys) than the present B-survey. The previous benthic surveys described substantial and long-lasting effects from the fish farming activity at Fossfjörður site mainly in close proximity to the cages (Þórisson *et al.* 2015).. Main reason for these negative impacts is suggested to be overfeeding the fish. The present results indicate however overall good condition and no organic load can be detected from previous fish farming activity in this B-survey.

**The site is assigned a condition factor 1 "Very good" according to calculations based on methodology described in NS 9410:2016 and sample sheet Table B.1 and B.2 (se chapter 7 Appendix).**

## 6 References

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Forskrift om drift av akvakulturanlegg (akvakulturdriftsforskriften) §§ 35 og 36.

Gallo, C. 2016. Monitoring of the benthic community in Fossfjörður 2015. Worked for Fjarðalax. NV nr. 19-16.

Hermansen, S. 2020. Arnarlax hf, Lokalitetsrapport og havsjømodellering for lokalitet Fossfjörður, 2020. APN report 62152.01,

ISO 5667-19:2004. Guidance on sampling of marine sediments.

ISO 12878:2012. Environmental monitoring of the impacts from marine finfish farms on soft bottom.

Norsk Standard NS 9410:2016. Miljøovervåking av bunnpåvirkning fra marine akvakulturanlegg.

[www.fiskeridir.no](http://www.fiskeridir.no)

Þórisson, B., Gallo, C. and Eiríksson, Þ. 2010. Botndýrarannsóknir á þremur svæðum í Arnarfirði 2010. Unnið fyrir Fjarðalax. NV nr. 8-10.

Þórisson, B., Gallo, C. and Jóhannesdóttir, E.D. 2015. Botndýraathuganir í Fossfirði 2011-14. Unnið fyrir Fjarðalax. NV nr. 02-15.

# 7 Appendix:

## 7.1 Sheet (B.1 og B.2) NS 9410:2016

Sample scheme B.1												
Company		Arnarlax										
Site:		Fossfjörður, brakklegging										
Fieldworker:		Snorri Gunnarson (SGU)										
Date:		12.06 2020										
Site no.:												
Gr	Parameter	Point	Sample number									
			1	2	3	4	5	6	7	8	9	10
	Bottom type: S (soft) eller H (hard)		S	S	S	S	S	S	S	S	S	S
I	Animals > 1mm	Yes (0) No (1)	0	0	0	0	0	0	0	0	0	0
II	pH	value	7,7	7,8	7,7	7,8	7,6	7,7	7,8	7,6	7,8	7,9
	Eh (mV)	ORP	-10	75	8	115	61	75	25	43	-11	90
		plus ref. verdi	190	275	208	315	261	275	225	243	189	290
	pH/Eh	from figure	0	0	0	0	0	0	0	0	0	0
	Status station			1	1	1	1	1	1	1	1	1
	Buffer-temp			10,0 C			Sea temp			6,9 C		
	Sediment temp			2,7 C								
	pH sea			8,1			ORP sea			115,0 mV		
	Eh sea			315,0 mV			Reference electrode			200,0 mV		
	III	Gas bubbles	Yes (4) No (0)	0	0	0	0	0	0	0	0	0
Colour		Light/grey (0)	0	0	0	0	0	0	0	0	0	0
		Brown/black (2)										
Smell		None (0)	0	0	0	0	0	0	0	0	0	0
		Light (2)										
		Strong (4)										
Consistency		Solid (0)	0	0	0	0	0	0	0	0	0	0
		Soft (2)										
		Aqueous (4)										
Grab volume (v)		v < 1/4 (0)					0					
		1/4 < v < 3/4 (1)						1				
		v > 3/4 (2)	2	2	2	2			2	2	2	2
Thickness of sledge (t)		t < 2 cm (0)	0	0	0	0	0	0	0	0	0	0
		2 < t < 8 cm (1)										
		t > 8 cm (2)										
Sum			2,0	2,0	2,0	2,0	0,0	1,0	2,0	2,0	2,0	
Corrected (**0,22)			0,4	0,4	0,4	0,4	0,0	0,2	0,4	0,4	0,4	
Status station			1	1	1	1	1	1	1	1	1	
Average group II & III			0,2	0,2	0,2	0,2	0,0	0,1	0,2	0,2	0,2	
Status station			1	1	1	1	1	1	1	1	1	
Grab ID	k-3											
pH / Eh ID	YSI-professional plus											

## Sample scheme B.1

Company:	Arnarlax
Site:	Fossfjörður, brakklegging
Fieldworker:	Snorri Gunnarson (SGU)

Date:	12.06 2020
Site no.:	0

Gr	Parameter	Point	Sample number										Index					
			11	12	13	14	15	16	17	18	19	20	S%	H%				
	Bottom type: S (soft) or H (hard)		S	S											100	0		
I	Animals > 1mm	Yes (0) No (1)	0	0														
II	pH	value	7,7	7,7														
	Eh (mV)	ORP	76	28														
		plus ref. verdi	276	228														
	pH/Eh	from figure	0	0												0,00		
	Status station			1	1													
	Status group II			1	Buffer temp	10,0 C	Sea temp	6,9 C	Sediment temp	2,7 C								
	pH sea		8,1	ORP sea	115 mV	Eh sea	315 mV	Reference electrode	200 mV									
	III	Gas bubbles	Yes (4) No (0)	0	0													
		Colour	Light/grey (0)	0	0													
			Brown/black (2)															
Smell		None (0)	0	0														
		Light (2)																
		Strong (4)																
Consistency		Solid (0)	0	0														
		Soft (2)																
		Aqueous (4)																
Grab volume (v)		v < 1/4 (0)																
		1/4 < v < 3/4 (1)																
		v > 3/4 (2)	2	2														
Thickness of sledge (t)		t < 2 cm (0)	0	0														
		2 < t < 8 cm (1)																
		t > 8 cm (2)																
Sum			2,0	2,0														
Corrected (*0,22)			0,4	0,4												0,39		
Status station			1	1														
Status group III			1															
Average group II & III			0,2	0,2												0,19		
Status station			1	1														
Status group II & III			1															

pH/Eh Corr.sum Index Average	Status
< 1,1	1
1,1 - <2,1	2
2,1 - <3,1	3
≥3,1	4

Status site: **1**

Grab ID	k-3
pH / Eh ID	YSI-professional plus



## Sample scheme B.2

Company:		Arnarlax				Date:		12.06 2020			
Site:		Fossfjörður, brakklegging				Site no.:		0			
Fieldworker:		Snorri Gunnarson (SGU)									

Sample number	1	2	3	4	5	6	7	8	9	10
Depth (m)	61	64	65	64	65	65	74	75	75	75
Number of trials	1	2	1	2	3	1	1	2	1	2
Gas bubbles (in sample)	No	No	No	No	No	No	No	No	No	No
Sediment type	Clay	X	X	X	X	X	X	X	X	X
	Silt									
	Sand									
	Gravel					X	X			
	Shellsand		X							
Reef										
Rocky bottom (cobbles, boulders)										
Echinodermata, count		1								
Crustaceans, count										
Molluscs, count			5	4				5	4	
Polychaetes, count	>50	>20	>30	>50	>50	>30	>100	>100	>50	>100
Other animals, count										
<i>Beggiatoa</i>										
Feed										
Faeces										
Comments	Samples at stations 5 and 6 litle washed.									
Grab	Area [m <sup>2</sup> ]	0,1		Grab ID	k-3					

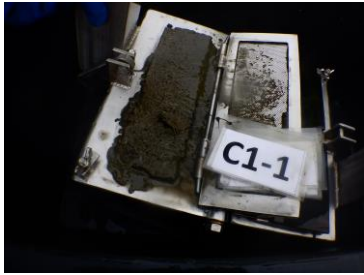







## Sample scheme B.2










Company:	Arnarlax	Date:	12.06 2020
Site:	Fossfjörður, brakklegging	Site no.:	0
Fieldworker:	Snorri Gunnarson (SGU)		

Sample number	11	12	13	14	15	16	17	18	19	20
Depth (m)	76	71								
Number of trials	1	1								
Gas bubbles (in sample)	No	No								
Sediment type	Clay	X	X							
	Silt									
	Sand									
	Gravel									
	Shellsand									
Reef										
Rocky bottom (cobbles, boulders)										
Echinodermata, count										
Crustaceans, count										
Molluscs, count	7	8								
Polychaetes, count	>50	>50								
Other animals, count										
<i>Beggiatoa</i>										
Feed										
Faeces										
Comments										
Grab	Area [m <sup>2</sup> ]	0,1	Grab ID				k-3			
Signature fieldworker:										

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## 7.2 Pictures of samples at Fossfjörður

<p><i>St 1</i></p>		<p>NA</p>
<p><i>St 2</i></p>		
<p><i>St 3</i></p>		
<p><i>St 4</i></p>		
<p><i>St 5</i></p>	<p>NA</p>	

<p><i>St 6</i></p>		
<p><i>St 7</i></p>		
<p><i>St 8</i></p>		
<p><i>St 9</i></p>		<p>NA</p>
<p><i>St 10</i></p>		





### 7.3 Bottom topography and 3D view

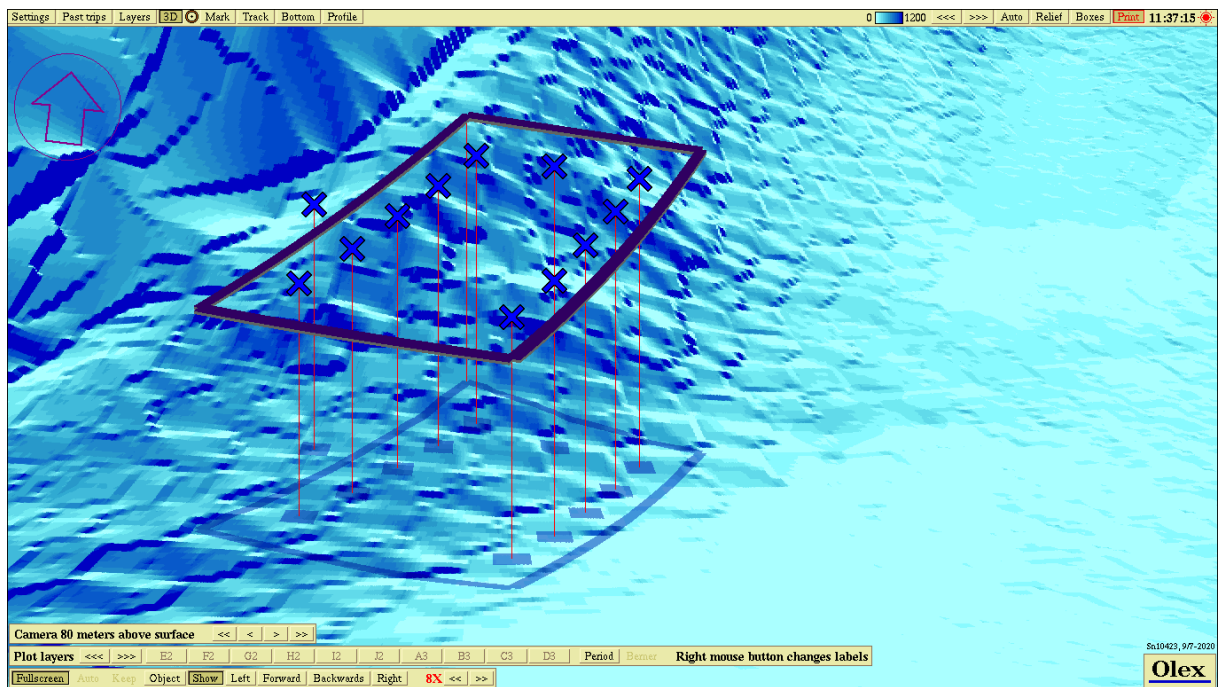


Figure 3. Showing bottom topography 3D at Fossfjörður with each sampling station according to info in figure 2 and Table 3. Two pictures shown w