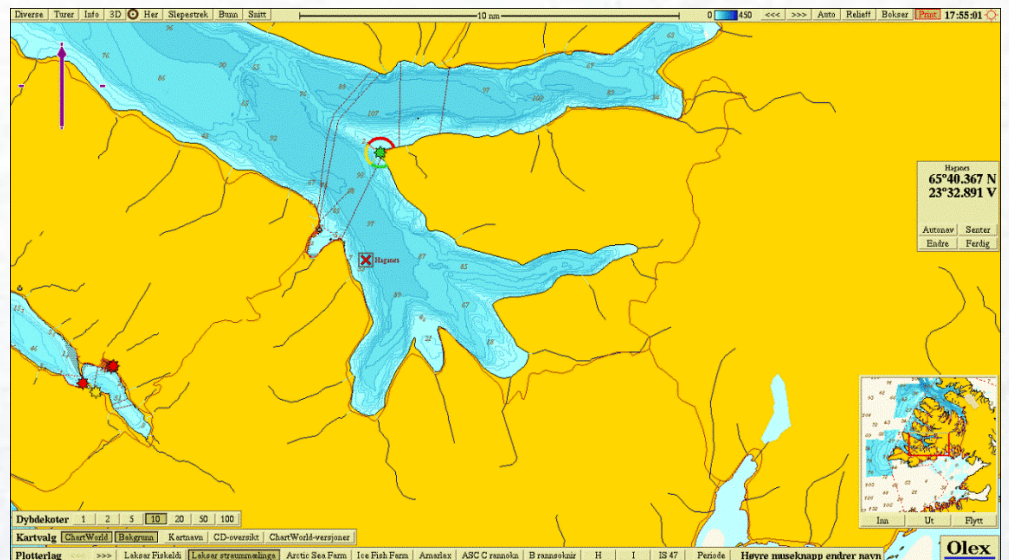


Haganes, Arnarlax hf.
B-bottom survey,
June 2020
(fallow period)



Information client			
Titel	Haganes, Arnarlax hf. B-bottom survey, June 2020		
Report number	APN-62254.B01		
Site name	Haganes	Coordinates site	65°40.367 N 023°32.891 V
County		Municipality	Vesturbyggð
MTB-or estimated max biomass	6.672 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	
Type/time of survey	Mark with X	Comments	
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	0,04	Gr. III. Sensory	1
GR. II + III	0,02	GR. II+ III	1
Date field work	11.06 2020	Date report	08.07.20
Site status (NS 9410:2016):			1



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

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Preface

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 19 sampling stations within the mooring lines of the fish farm. However due to extensive hard bottom at the site and difficulty getting grab samples decision was taken to reduce the number of stations to total of 10. The estimated max biomass for the current generation farmed salmon at the site Haganes is 6.245 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 Haganes was done 11.06 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 8. juli 2020


Snorri Gunnarsson
Project manager

1 Introduction

The sampling date for the present site survey was 11.06 2020 and done by Akvaplan-niva AS contracted by Arnarlax hf. in relation to the company's fish farming activity at the site in Arnarfjörður, Haganes.

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 Haganes is located.

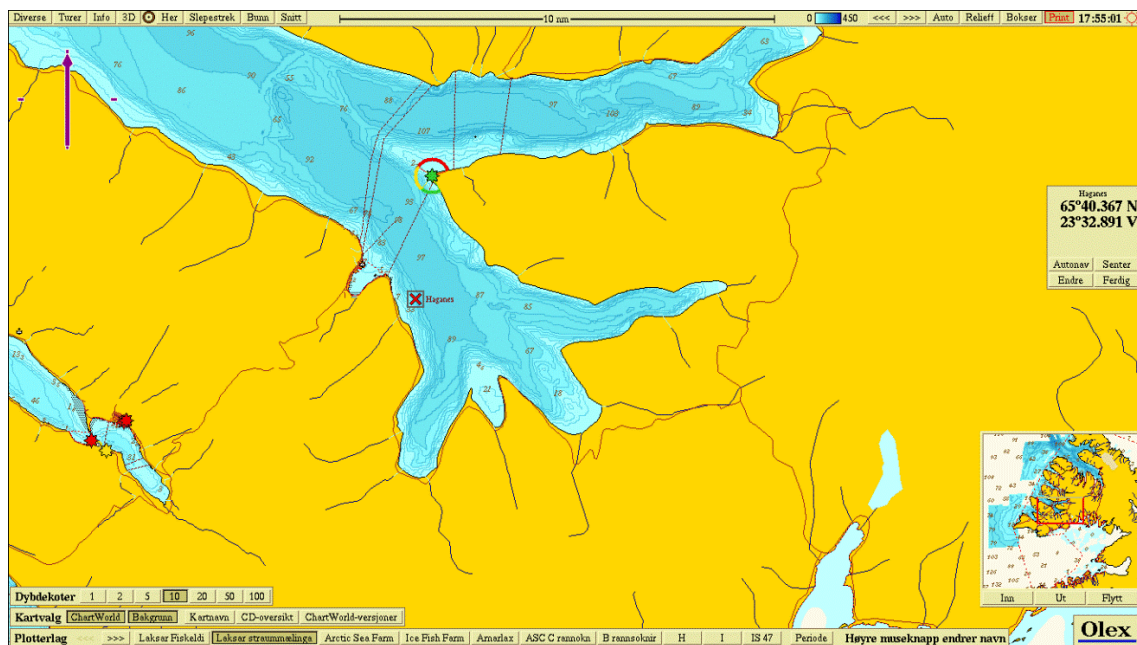


Figure 1. An overview map with the Haganes site marked with a red cross.

2 Professional program and methods

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 cm²). 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">- Condition 1 – next site survey at next max biomass- Condition 2 – next site survey at next 50% max biomass and at max biomass- 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 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 m²)

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

3.1 Info site operation

The Haganes site is located in Arnarfjörður Iceladn about 2 km east from Bíldudalur. The cages are lined in a northeast direction from land (30 degrees). The depth under cages ranges from about 47 m in the southwest part of the farm up to about 83 in the northeast part of the fish farming site. The more shallower area of the farm is at the northernmost part.

The Haganes site is has been in fallow state for just over 9 months at the date of sampling. The fish farm at the site has a 2 x 3 mooring system with a possibility total of 6 cages, each with 120 m circumference. The Haganes site has been in use since spring 2014 with the past generation of salmon as the second generation fish at the site. The planned timing for putting smolts into sea is summer/fall 2020. The last generation of farmed salmon at Haganes was salmon farmed from June 2017 to fall 2019.

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

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

Generation of fish (G)	Production (ton)	Feed usage (ton)
Generation 2017-2019 salmon	2.484	3.342
Generation 2014 -2016 salmon	2.609	3.673

3.2 Present and past site surveys

Table 2 shows the results and date for previous B-surveys at the site.

Table 3. Past surveys in the local impact zone for Haganes.

Date of sampling	Report number	Survey type	Overall site status
05.09.2018	APN-60528.01 (Gunnarsson 2019)	Max biomass	1
22.10.2013	Pre farming B survey (Moe 2013)	Pre survey new site	1

3.3 Dispersing current

Characters of spread current have not been established for the Haganes (work in progress). So we use data from current measurements at 15 m depth. These indicate the main current direction and mass transport of water is in direction north (345-360 degrees) with a small counter current towards east (90 degrees) and southeast (150 degrees). Average current speed at 15 m depth is 9.1 cm/s (Eriksen, 2017).

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 Haganes in Arnarfjörður. Depth at the site is

in the range from about 47 to 83 meters. The placement of sampling stations were chosen to give a good picture of the whole local impact zone in the area with cages that were used during previous production cycle. The sampling stations had a depth varying from 55 m to 81 m. The placement of the sampling stations is regarded to be in accordance with the descriptions for a survey of the local impact zone given in NS 9410:2016. There were planned sampling for up to 19 stations at the site. But due to extensive hard bottom at the site it was strenuous and time consuming work to collect samples at the site it was decided (by project manager) to reduce the number of stations to 10. Drift of the boat added to the difficulty that at the time of sampling as there was only one cage installed that we could anchor the work boat to.

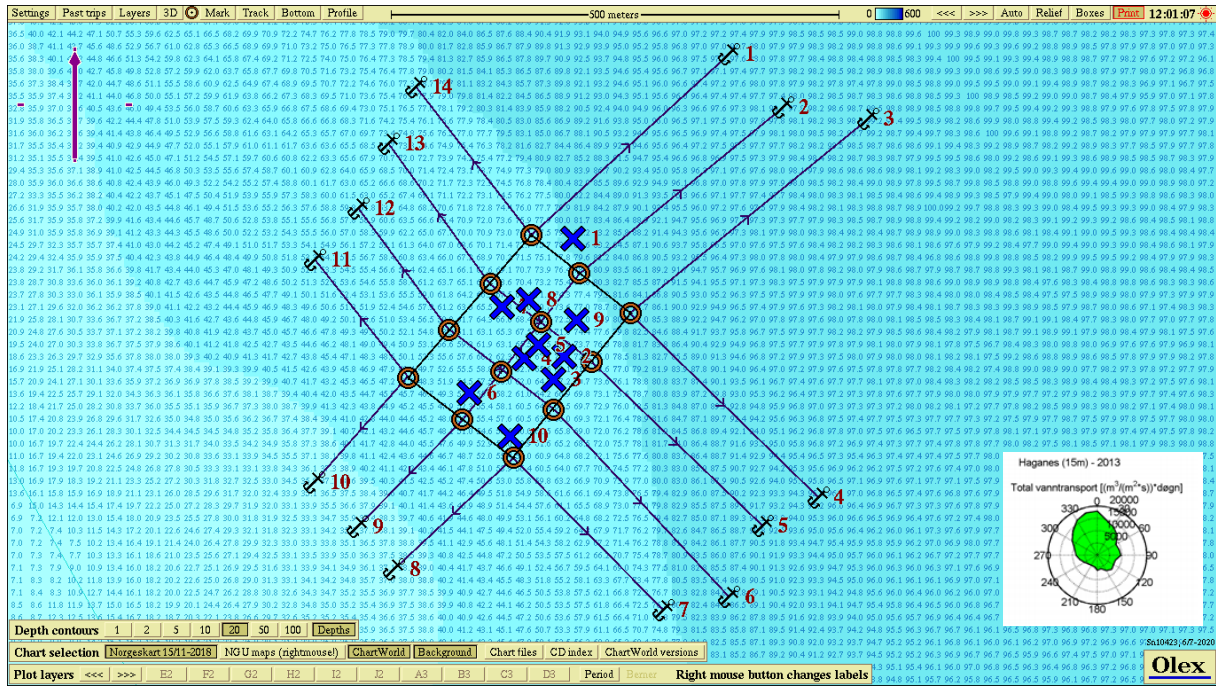


Figure 2. Chart showing depths at the site Haganes. Sampling stations st. 1 – 10 are marked with color codes that describe the condition according to NS 9410:2016, chapter 7.11. Color codes: Blue = very good condition, green = good condition, yellow = bad condition, red = very bad condition.

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

Station number	North	Vest	Depth (m)
St 1	65°40.433	23°32.817	81
St 2	65°40.362	23°32.831	71
St 3	65°40.348	23°32.846	67
St 4	65°40.361	23°32.889	66
St 5	65°40.369	23°32.868	69
St 6	65°40.340	23°32.969	55
St 7	65°40.392	23°32.921	68
St 8	65°40.396	23°32.882	71
St 9	65°40.384	23°32.812	75
St 10	65°40.314	23°32.906	59

4 Results

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 condition for the site is 1 «very good». Overall the condition for group II parameters (pH/Eh) was 1 or «very good» as well as for condition for group III parameters (sensory) and average group II + III parameters (mean value) see Table 5. 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 Haganes 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 two stations out of the ten sampled and seven stations were assigned as hard bottom type. This indicates that in general there is a hard bottom in the local impact zone at Haganes.

For the group II parameters (pH/redox), for sensory parameters (group III) and for combined parameters II and III (pH/redox and sensory) all ten stations had conditions 1 «very good». Animals were present in all three soft bottom samples and in two of the hard bottom samples.

5 Conclusion

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 27 grabs were taken with Van Veen grab (0,1 m²), divided on 10 stations placed around the Haganes local impact zone. For combined parameters II and III (pH/redox and sensory) all ten stations had condition 1 «very good»

This survey in the local impact zone is done at fallow period after over eight month resting period. In the previous B-survey at max biomass the that also gave the overall condition 1 more than half of the sampling stations were of hard bottom type and this is even more apparent in the present study. The status of the three soft bottom stations in the present study was very good and there were no signs of organic load while in the previous B-survey at max biomass there were signs of some organic load in the deeper areas of the local impact zone. The conditions seem therefore to have overall improved at the site during the present fallow period.

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

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

Gunnarsson, S. 2019. Arnarlax hf, B-undersøkelse, september 2018 Haganes (maksimal belastning). Akvaplan-niva AS rapport nr. 60528.01.

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.

Moe A.A. 2013. Environmental monitoring (MOM B) at finfish farm site Haganes. October 2013. Helgeland Havbruk report nr. AR131125C. 28 p.

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7 Appendix:

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

Sample scheme B.1																
Company		Arnarlax														
Site:		Haganes, brakklekking														
Fieldworker:		Snorri Gunnarson (SGU)														
Date:		11.06 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	H	H	H	S	S	H	H	H	H				
I	Animals > 1mm	Yes (0) No (1)	0				0	0		0		0				
II	pH	value	7,5				7,8									
	Eh (mV)	ORP	189				8									
		plus ref. verdi	389				208									
	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	1			
	Buffer-temp			10,0 C			Sea temp			7,7 C			Sediment temp		3,2 C	
	pH sea		8,1	ORP sea		215,0 mV		Eh sea		415,0 mV		Reference electrode		200,0 mV		
	III	Gas bubbles	Yes (4) No (0)	0	0	0	0	0	0	0	0	0	0			
		Colour	Light/grey (0)	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	0			
		Light (2)														
		Strong (4)														
Consistency		Solid (0)	0	0	0	0	0	0	0	0	0	0	0			
		Soft (2)														
		Aqueous (4)														
Grab volume (v)		v < 1/4 (0)	0	0	0	0	0	0	0	0	0	0	0			
		1/4 < v < 3/4 (1)														
		v > 3/4 (2)	2													
Thickness of sludge (t)		t < 2 cm (0)	0	0	0	0	0	0	0	0	0	0	0			
		2 < t < 8 cm (1)														
		t > 8 cm (2)														
Sum			2,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0				
Corrected (*0,22)			0,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0				
Status station			1	1	1	1	1	1	1	1	1	1				
Average group II & III			0,2	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0				
Status station			1	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:	Haganes, brakklegging
Fieldworker:	Snorri Gunnarson (SGU)

Date:	11.06 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)														30	70	
I	Animals > 1mm	Yes (0) No (1)															
II	pH	value															
	Eh (mV)	ORP															
plus ref. verdi																	
	pH/Eh	from figure														0,00	
Status station																	
Status group II			1	Buffer temp	10,0 C	Sea temp	7,7 C	Sediment temp	3,2 C								
	pH sea	8,1	ORP sea	215 mV	Eh sea	415 mV	Reference electrode	200 mV									
III	Gas bubbles	Yes (4) No (0)															
	Colour	Light/grey (0)															
		Brown/black (2)															
	Smell	None (0)															
		Light (2)															
		Strong (4)															
	Consistency	Solid (0)															
		Soft (2)															
		Aqueous (4)															
	Grab volume (v)	v < 1/4 (0)															
		1/4 < v < 3/4 (1)															
		v > 3/4 (2)															
	Thickness of sludge (t)	t < 2 cm (0)															
		2 < t < 8 cm (1)															
		t > 8 cm (2)															
	Sum																
	Corrected (*0,22)															0,04	
Status station																	
Status group III			1														
Average group II & III																0,02	
Status station																	
Status group II & III			1														
pH/Eh																	
Corr.sum																	
Index																	
Average																	
		< 1,1	1														
		1,1 - <2,1	2														
		2,1 - <3,1	3														
		≥3,1	4														

Status site: 1

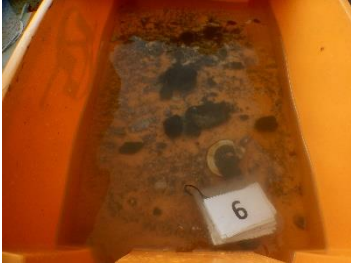



Sample scheme B.2

Company:	Arnarlax	Date:	11.06 2020
Site:	Haganes, brakklegging	Site no.:	0
Fieldworker:	Snorri Gunnarson (SGU)		

Sample number	1	2	3	4	5	6	7	8	9	10
Depth (m)										
Number of trials	1	3	3	3	2	3	3	3	3	3
Gas bubbles (in sample)	No	No	No	No	No	No	No	No	No	No
Sediment type	Clay	X								
	Silt									
	Sand	X				X	X			
	Gravel					X	X			
	Shellsand						X			
Reef										
Rocky bottom (cobbles, boulders)										
Echinodermata, count						1		1		
Crustaceans, count										
Molluscs, count										
Polychaetes, count	>20				>30	2				2
Other animals, count										
<i>Beggiatoa</i>										
Feed										
Faeces										
Comments	St. 6. Mostly sandy, stones and dead shells (not able to measure pH/redoks). St. 8. One starfish and stone in grab nr. 3. St. 10. Only some small stones/pebbles in 3rd grab (not able to measure pH/redoks). No cages installed at the farm at sampling - therefore more difficult to take grab samples									
Grab	Area [m ²]	0,1			Grab ID	K-3				
	page 3 of 4 pages									

7.2 Pictures of samples at Haganes

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

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

7.3 Bottom topography and 3D view

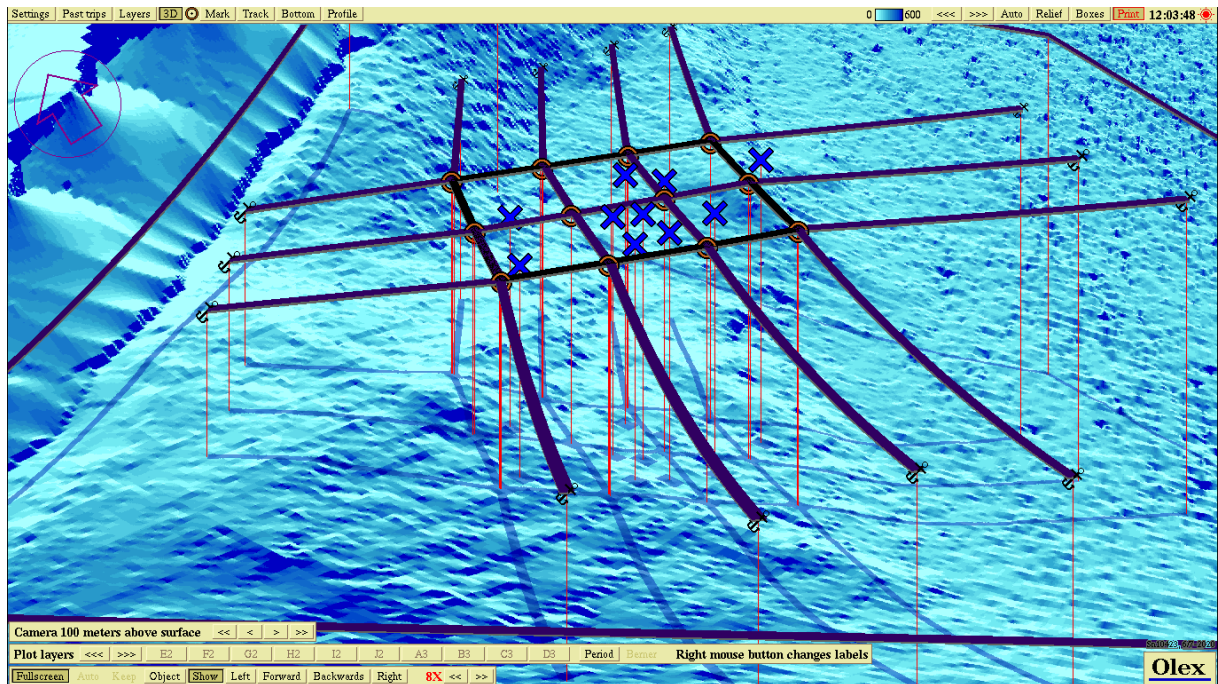


Figure 3. Showing bottom topography 3D at Haganes with each sampling station according to info in figure 2 and Table 3.