LULEÅ TEST DREDGING

ENVIRONMENTAL MONITORING REPORT

MIAS No. **752-10138**

Boskalis Sweden. **S6091**

HED No. **15053-01-R-02-02-FGOO**

DOCUMENT CONTROL SHEET

Client:	Sjöfartsverket
Project:	Luleå test dredging
Title:	Environmental Monitoring Report

Summary

Presentation of the Environmental Monitoring results and observations made during the test dredging campaign from 29 June to 4 June 2015 at Lulea, Sweden.

Rev.	Issue Date	Prepared by	Reviewed by (DIC/IDC)
01	27-08-2015	FGOO	JVE
02	03-09-2015	FGOO	HKEY

DIC: Department Internal Check / IDC: Inter-Department Check

Tick appropriate degree of review (see HED506 section 5):

[x] 1 Check on starting points, conditions and (order of magnitude of) results

[ ] 2 Calculation check step by step

[ ] 3 Complete independent recalculation or redrawing of (sub)object

[ ] 4 Independent external judgement by comparing with other projects

Document number:	15053-01-R-02-02-FGOO
Status:	☐ Draft ☐ Preliminary ☒ Final

REVISION LOG SHEET

REV.	DATE	PAGE	DESCRIPTION
01	27-08-2015	All	Document issued for review and approval
02	03-09-2015	19-20	Table 8, 9 and 10 revised following comments from Sjöfartsverket

TABLE OF CONTENTS

1 INTRODUCTION

1.1 PROJECT DETAIL

- Project name: Luleå test dredging
- Location: Luleå, Sweden
- Project numbers: S6091 (Boskalis Sweden) / MIAS 752-10138 (Boskalis)
- Project manager: Sami Soikkeli
- Site manager: Jarmo Siimos
- Main contractor: Boskalis Sweden AB
- Project organisation: See Quality Plan (LS – 2)

1.2 SCOPE OF WORK

Boskalis Sweden(“Boskalis”) has been awarded a trial dredging campaign at the approach channel entering Lulea Port. In total, seven test pits along the fairway are dredged. The material is dredged by means of the Backhoe Dredger “Nordic Giant”. The dredged material is placed into a Split Hopper Barges and subsequently disposed in a designated disposal area with the existing fairway.

The purpose of the executed test dredging is to investigate dredgeability and composition of the in situ soil and presence of boulders in moraine.

Besides the dredging and disposal works, Boskalis performed hydrographic surveys and environment monitoring.

The works are performed between 29 June and 4 July 2015.

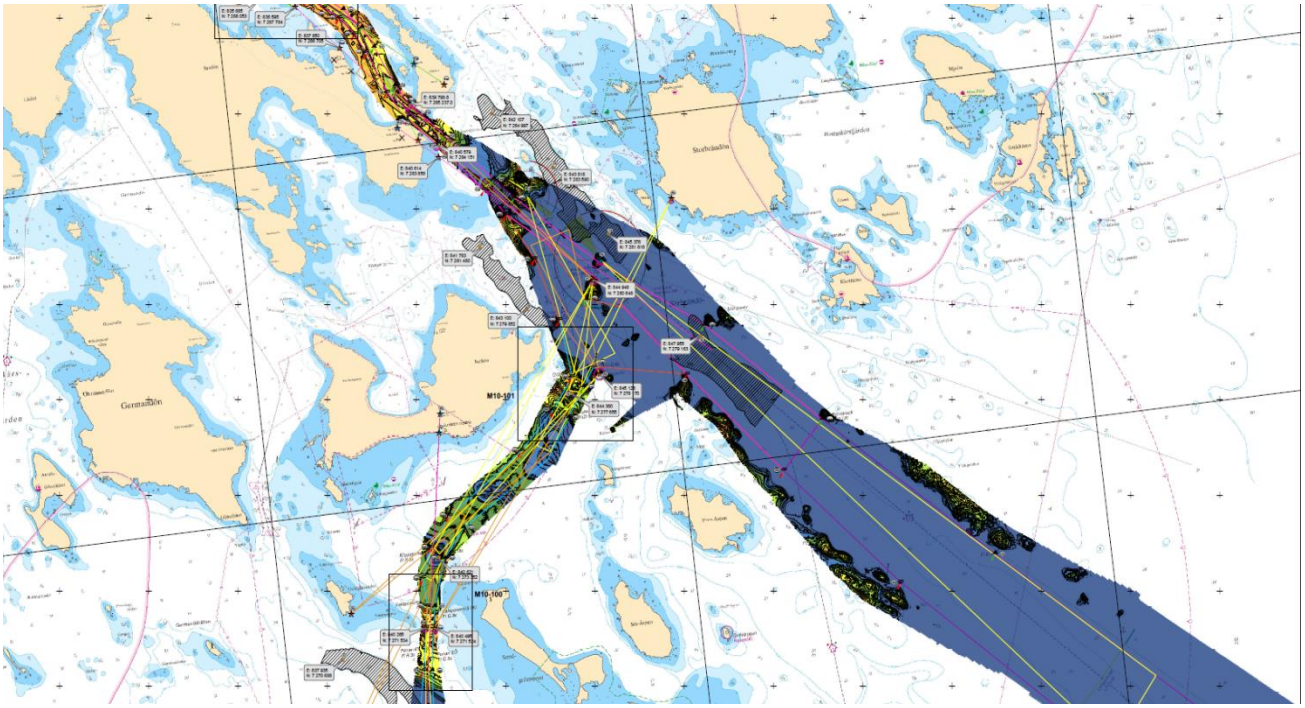

Figure 1: Project location

1.3 PURPOSE

The purpose of the report is to present the environmental monitoring data collected during the dredging campaign. The following results are presented:

- Total Suspended Sediment water sample results for calibration purposes between the level of suspended substances and turbidity;
- Turbidity survey taken at 100m from the dredger and at the disposal site.

Further reference is made to Boskalis' Environmental Monitoring Plan (15053-01-R-02-01-FGOO) which presents the following information:

- Requirements;
- Methods;
- Instrumentation;
- Location; and
- Data processing and reporting.

2 TSS AND TURBIDITY CORRELATION

Turbidity readings are only valid for measuring suspended sediment concentrations when they are properly calibrated against suspended sediment concentration values obtained from water samples with suspended matter from the monitoring site.

The calibration is based on membrane filtration which involves taking a number of water samples, passing the water through a pre-weighed filter which is re-weighed after drying. The difference in weight corresponds to the dry weight of the suspended particles in the water sample. The sample analysis is carried out according the SS-EN 872 - Water quality - Determination of suspended solids.

The calibration is site specific and is therefore carried out in the project area. Turbidity measurements and water samples are collected simultaneously in the same spot to ensure a proper relation between the two. This is done by tying the end of the hose to the turbidity sensor. Turbidity readings are logged at the same time that a water sample is taken (Figure 2).

Figure 2: Equipment setup during water sampling

In total 50 1.0 Litre samples are taken. Reference is made to Appendix 1 which presents the water sample log sheet.

All the samples are tested on Total Suspended Sediments according the SS-EN 872 - Water quality - Determination of suspended solids by accredited laboratory ALS. The samples are taken on the same day as the samples are taken. The test reports are presented in Appendix 2.

On the basis of the analysed samples and the turbidity readings in NTU, a correlation between the two is established and conversion factors are defined. The results are presented in Figure 3. Raw test results were inspected for major anomalies, spikes and erroneous/unrealistic results. In total 7 test results were removed from the final data set.

Based on the TSS analyses, a Turbidity-TSS correlation of 1 [NTU] to 2.06 [mg/l] is determined, with a R^2 = 0.82.

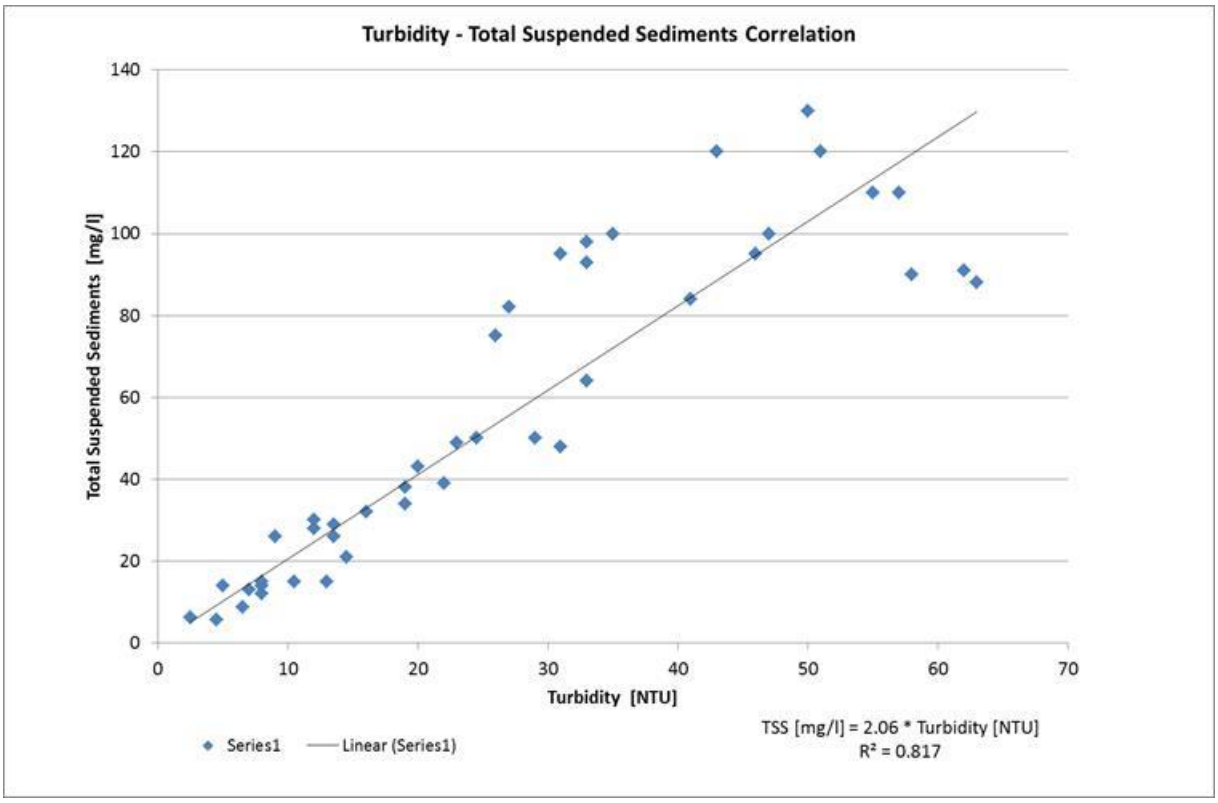

Figure 3: Correlation graph between turbidity (NTU) and concentration of suspended sediments obtained from a Total Suspended Solids (TSS) analysis based on membrane filtration.

3 CURRENT MEASUREMENTS

To ensure that turbidity measurements are taken in the densest parts of the turbidity plume, an Acoustic Doppler Current Profiler (ADCP) was used to determine real time current speed and direction. During the monitoring campaign, it was observed that the current speed was so low that accurate backscatter measurements could not be taken. Subsequently, current directions could not be determined. Typically current speeds were below 5 cm/s.

As such, dredge plume directions were observed through visual observations.

4 TSS MONITORING RESULTS

4.1 METHOD

Turbidity is measured with an optical back scatter sensor probe, type YSI 600 or similar and combines turbidity and CTD (Conductivity, Temperature and Depth) sensors (see Appendix A). This probe measures turbidity in NTU as an optical backscatter sensor records the intensity of light which is reflected by particles in the water. To prevent bio fouling, the sensor is equipped with a self-cleaning wiping device. It is noted that the salinity is derived from conductivity measurements.

The turbidity measurements are taken manually from the survey vessel according the following procedure:

- The vessel will sail to the monitoring location;
- The monitoring location and depth will logged;
- The turbidity sensor will be lowered in the water;
- Once the readings are stable, the sensor will be slowly lowered in order to obtain a vertical profile measurement;
- Turbidity will be logged for at least 1 minute; and
- The logged data is checked and stored accordingly.

Measurements are taken at 100 m downstream from the Backhoe Dredger during dredging and . Where possible, background measurements will be taken up stream from the dredger to provide information on the natural turbidity levels. Figure below provides an indicative location.

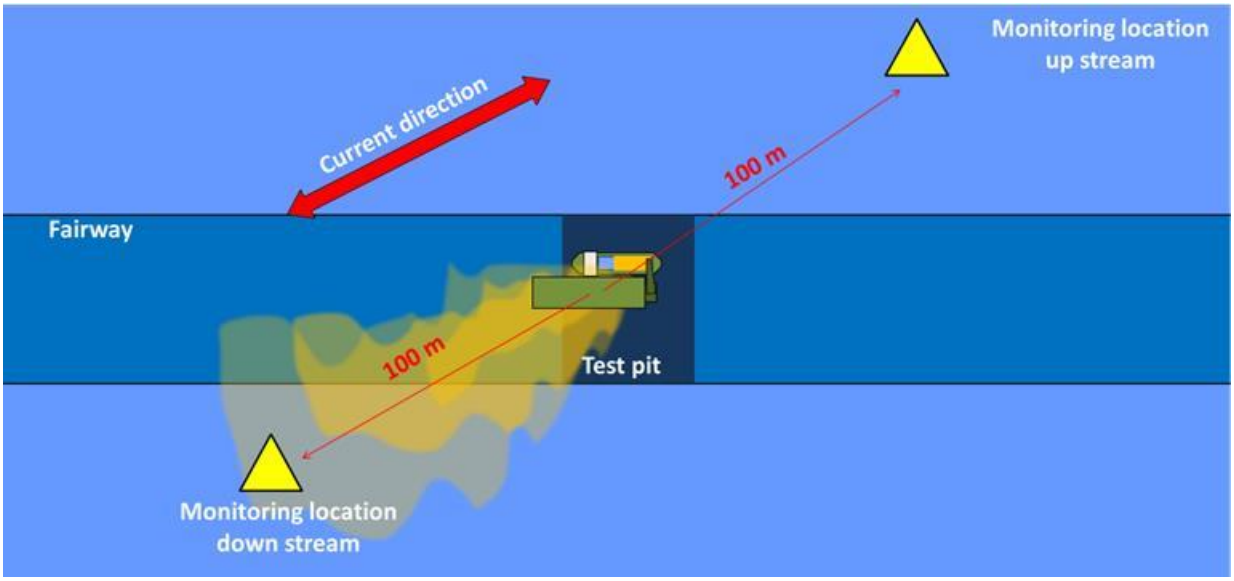

Figure 4: Example of the current / back scatter logs

Dredging of the pits will be done in layers of 2 m until the required depth is reached. During each layer Boskalis are take 2 turbidity measurements (vertical profile). It is noted that no dredging operations were undertaken in Pit 1 and Pit 4. As such, no measurements were taken at these sites. The locations are presented in Figure 5.

In addition, measurements are taken at the disposal site during disposal operations.

For more information on the methodology and equipment used, reference is made to Boskalis' Environmental Monitoring Plan (15053-1-R-01-01-FGOO).

Appendix 3 shows the field log sheets.

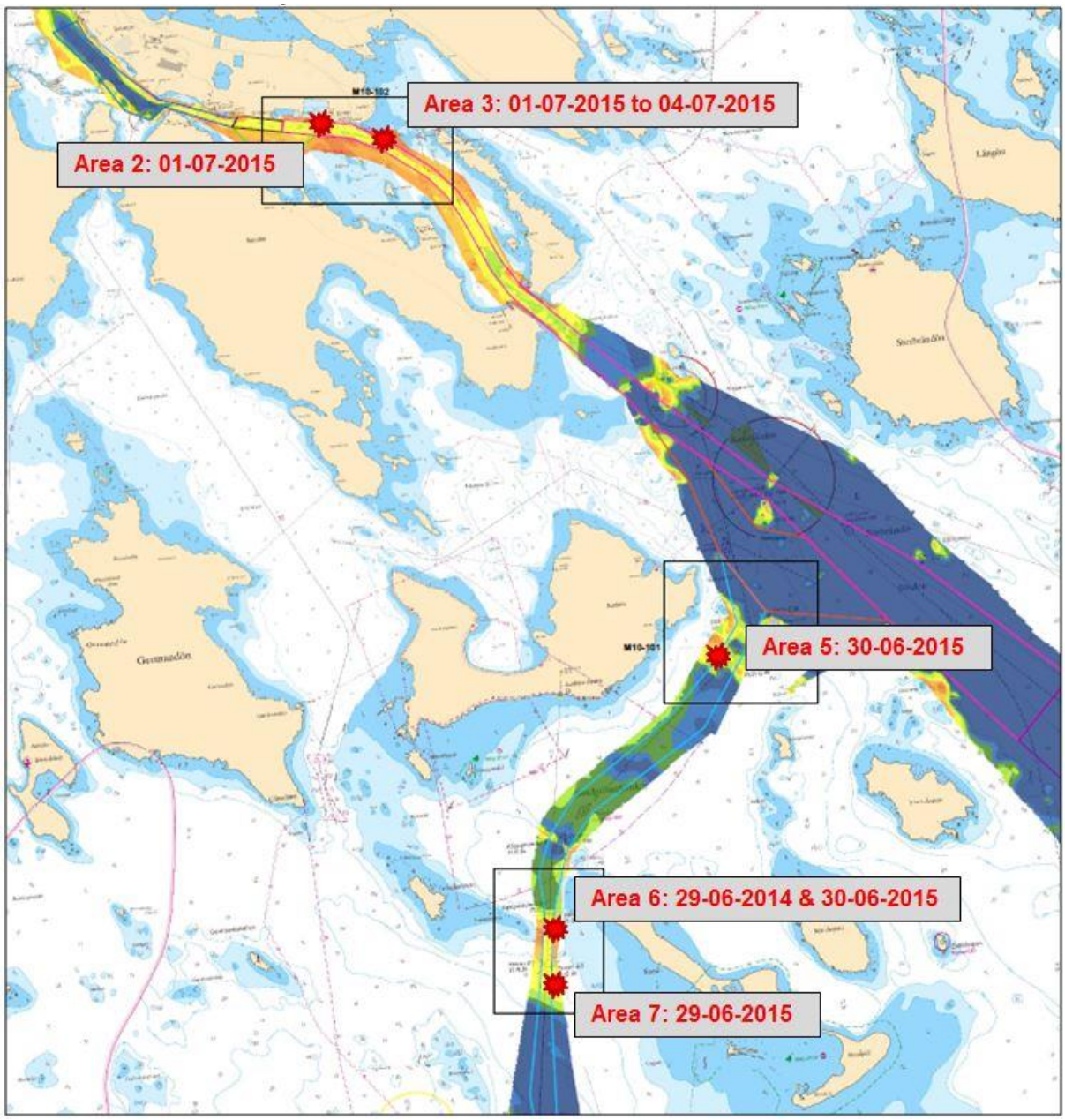

Figure 5: Measurement locations

4.2 RESULTS

The below sections present the turbidity monitoring results. The data is presented in TSS concentration with use of the conversion factor presented in Chapter 2. For each result some observations and findings are presented.

The results are presented in TSS profiles (horizontal axis) relative to the water depth (vertical axis). Usually the turbidity sensor was lowered and brought again, resulting in two consecutive profiles. In some cases erroneous readings (spikes and negative turbidity readings) were removed from the dataset. Specific comments on the dataset are presented in each subsection below.

4.2.1 Pit 2

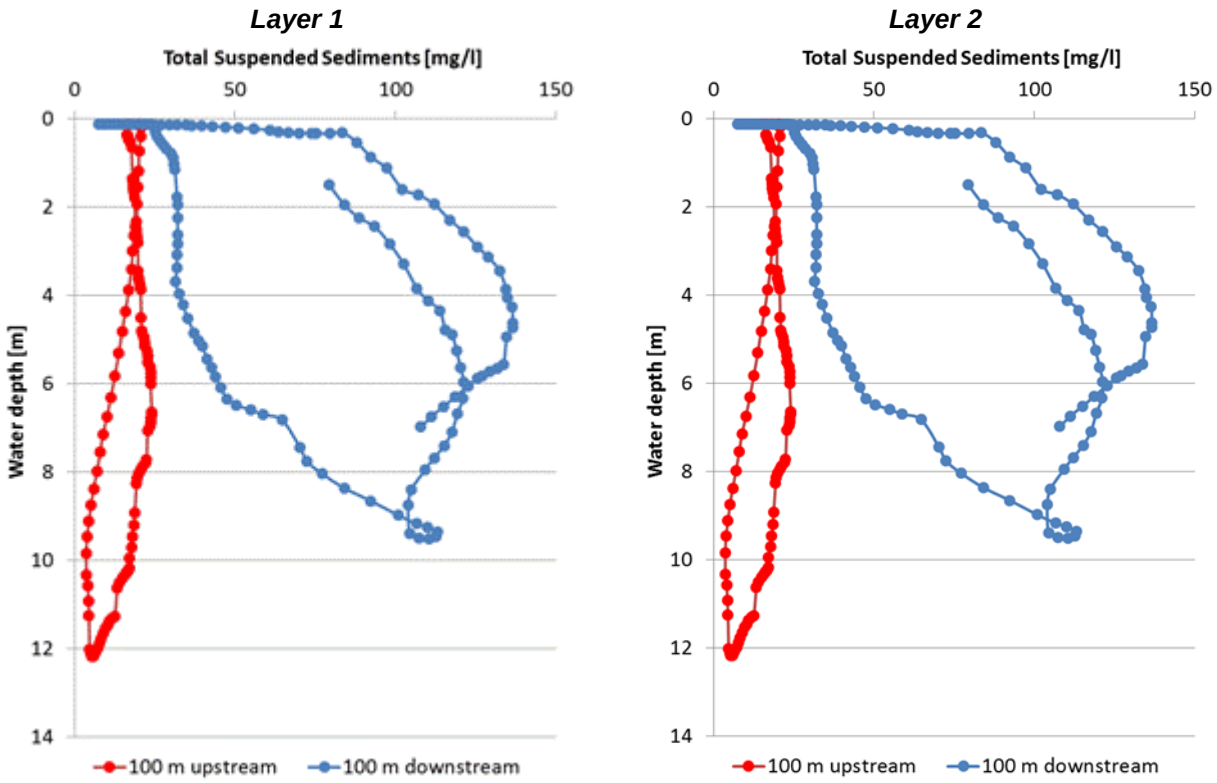

Figure 6: TSS monitoring results of Pit 2, layer 1-2.

Table 1: Summary of the monitoring results Upstream Pit 2

Upstream			
	Layer 1	Layer 2	Overall
Average	1.7	16.2	10.3
Median	1.4	18.1	8.0
Minimum	0.8	3.7	0.8
Maximum	2.9	24.1	24.1
Stdev	0.7	5.9	8.5

Table 2: Summary of the monitoring results Downstream Pit 2

Downstream			
	Layer 1	Layer 2	Overall
Average	10.6	68.3	37.7
Median	8.9	63.4	23.9
Minimum	0.8	7.4	0.8
Maximum	27.8	136.6	136.6
Stdev	7.4	42.5	39.0

Observations

- During the measurements it was cloudy, very low currents and no waves.
- During the excavation of both layers higher TSS concentrations were measured downstream of the

dredger compared to upstream.

- Relatively high variations in TSS concentrations downstream throughout the water column. This is most likely due to the high turbulence in the water in the port area where Pit 2 is located

4.2.2 Pit 3

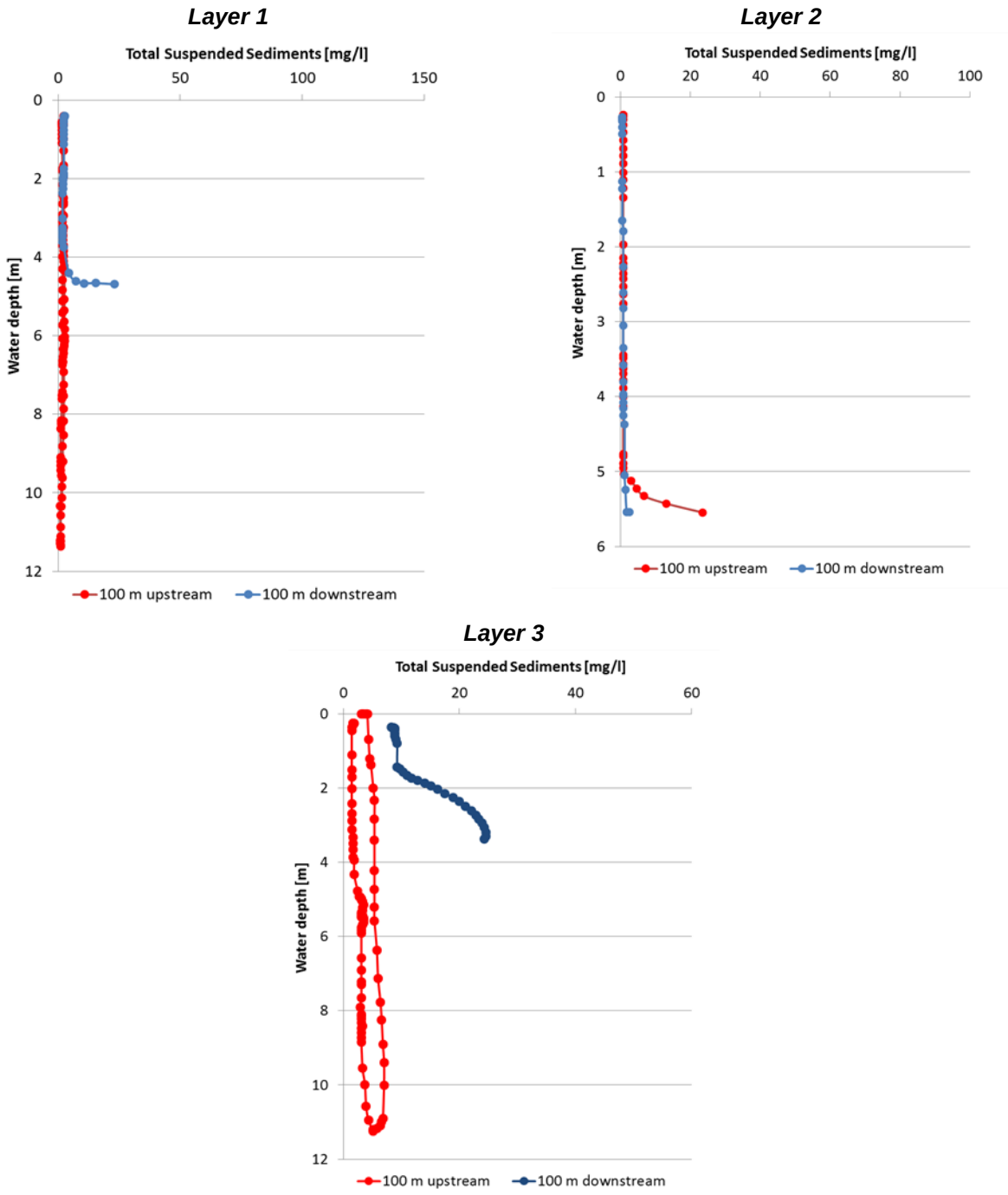

Figure 3: TSS monitoring results of Pit 3, layer 1-3.

Table 3: Summary of the monitoring results Upstream Pit 3

Upstream				
	Layer 1	Layer 2	Layer 3	Overall
Average	1.8	1.9	3.4	2.5
Median	1.8	0.8	3.1	1.8
Minimum	0.8	0.8	1.4	0.8
Maximum	2.9	23.5	7.0	23.5
Stdev	0.5	4.0	1.6	2.1

Table 4: Summary of the monitoring results Downstream Pit 3

Downstream				
	Layer 1	Layer 2	Layer 3	Overall
Average	3.7	0.9	16.3	8.3
Median	2.3	0.8	16.9	2.6
Minimum	1.8	0.6	8.2	0.6
Maximum	23.1	2.7	24.5	24.5
Stdev	4.4	0.4	6.7	8.6

Observations:

- During the measurements it was cloudy, very low currents and no waves
- Plume direction determined through visual observation
- Small variation between upstream and downstream TSS concentrations
- Slight increase in TSS concentration at the seabed, possibly due to settlement of plume within the excavated pit
- The north side of the excavation Put 3 very shallow areas were observed which made it difficult to obtain downstream measurements. Although the plume was clear going over the shallow shoal, some measurements (especially layer 3) could not be taken properly due to safety reasons.

4.2.3 Pit 5

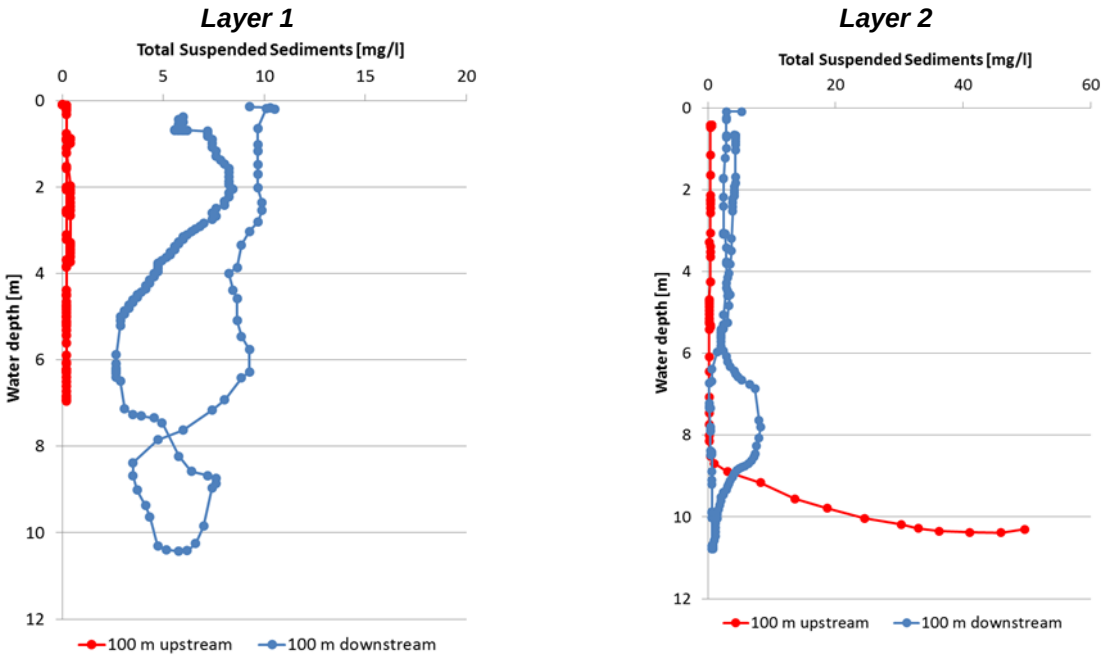

Figure 3: TSS monitoring results of Pit 5, layer 1-2.

Table 5: Summary of the monitoring results Upstream Pit 5

Upstream			
	Layer 1	Layer 2	Overall
Average	0.2	5.0	2.2
Median	0.2	0.4	0.2
Minimum	0.0	0.2	0.0
Maximum	0.4	49.6	49.6
Stdev	0.1	11.9	8.0

Table 6:: Summary of the monitoring results Downstream Pit 5

Downstream			
	Layer 1	Layer 2	Overall
Average	6.0	2.9	4.6
Median	6.0	2.9	4.3
Minimum	0.0	0.2	0.0
Maximum	10.5	8.2	10.5
Stdev	2.4	1.9	2.7

Observations

- During the measurements it was partially sunny, very low currents and no waves
- Plume direction determined through visual observation
- Small variation between upstream and downstream TSS concentrations
- Slight increase in TSS concentration at the seabed, possibly due to settlement of plume within the excavated pit

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4.2.4 Pit 6

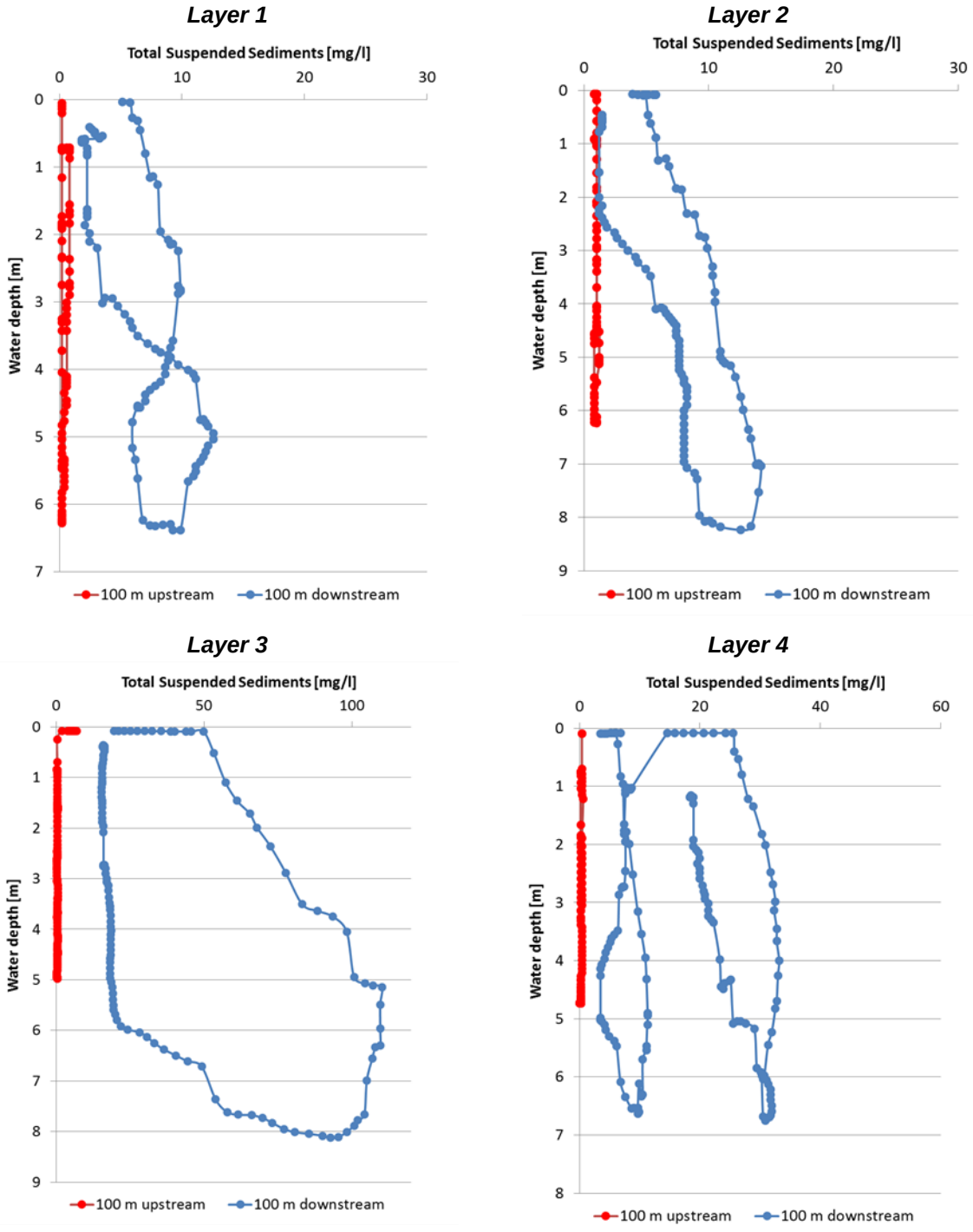


Figure 7: TSS monitoring results of Pit 6, layer 1-4.

Table 7: Summary of the monitoring results Upstream Pit 6

Upstream					
	Layer 1	Layer 2	Layer 3	Layer 4	Overall
Average	0.4	1.0	0.7	0.3	0.6
Median	0.2	1.0	0.4	0.2	0.4
Minimum	0.2	0.8	0.2	0.0	0.0
Maximum	0.8	1.2	7.0	0.6	7.0
Stdev	0.2	0.1	1.1	0.1	0.7

Table 8: Summary of the monitoring results Downstream Pit 6

Downstream					
	Layer 1	Layer 2	Layer 3	Layer 4	Overall
Average	6.9	7.0	39.8	16.8	18.7
Median	7.1	7.6	19.2	16.6	10.9
Minimum	1.9	1.2	15.5	3.5	1.2
Maximum	12.6	14.2	110.2	33.2	110.2
Stdev	3.3	3.6	32.1	10.3	22.0

Observations

- During the measurements it was partially sunny, very low currents and no waves
- Plume direction determined through visual observation
- Relatively large variation between upstream and downstream TSS concentrations
- Low background concentrations, < 7 mg/l
- Highest values were recorded during the dredging operations of Pit 6. Consistent readings of +100 mg/l are observed
- Slight increase in TSS concentration at the seabed, possibly due to settlement of plume within the excavated pit

4.2.5 Pit 7

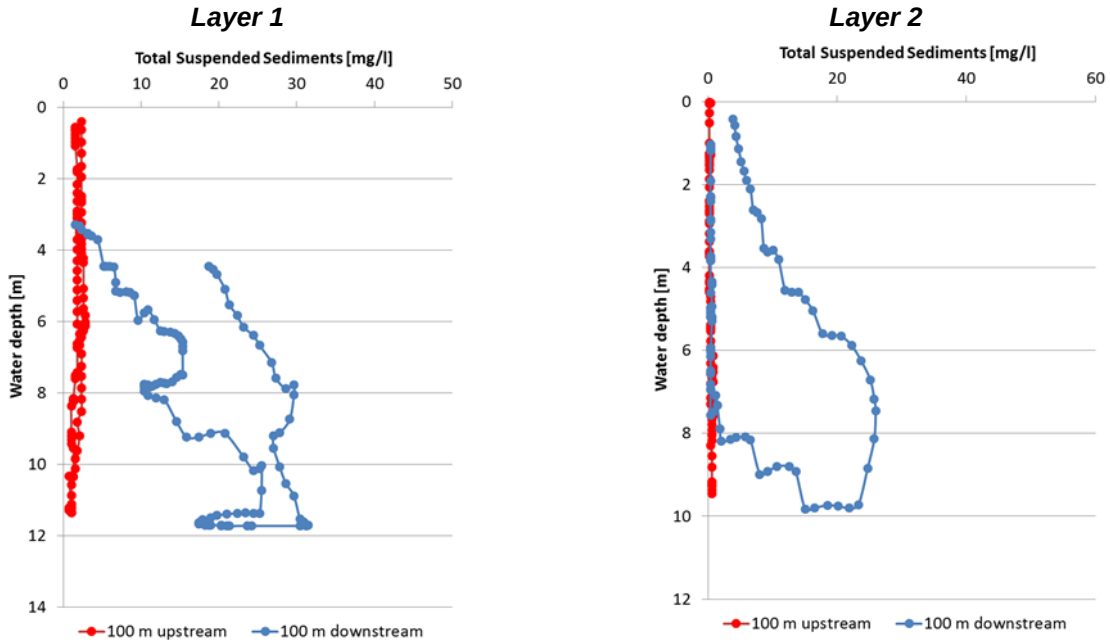


Figure 3: TSS monitoring results of Pit 2, layer 1-2

Table 9: Summary of the monitoring results Upstream Pit 7

Upstream			
	Layer 1	Layer 2	Overall
Average	1.8	0.4	1.1
Median	1.8	0.4	1.0
Minimum	0.8	0.2	0.2
Maximum	2.9	0.8	2.9
Stdev	0.5	0.2	0.8

Table 10: Summary of the monitoring results Downstream Pit 7

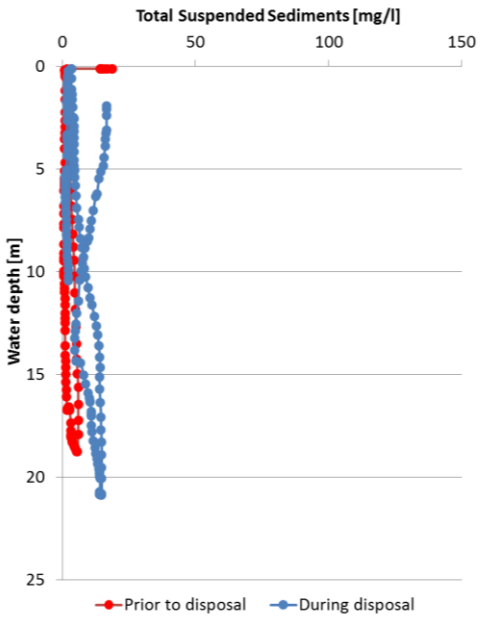
Downstream			
	Layer 1	Layer 2	Overall
Average	17.3	6.2	11.8
Median	17.7	2.1	10.9
Minimum	1.6	0.4	0.4
Maximum	31.5	26.0	31.5
Stdev	7.9	7.8	9.6

Observations

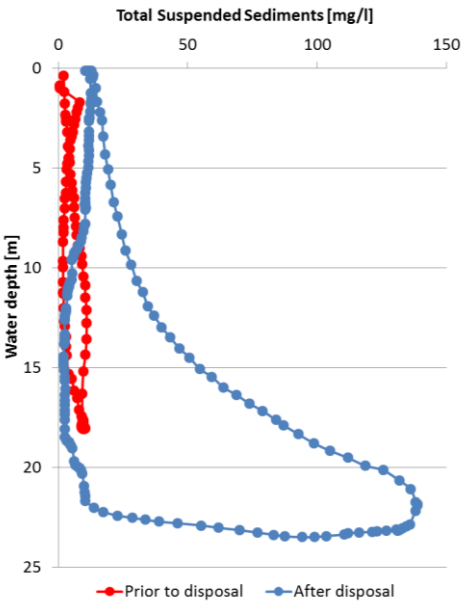
- During the measurements it was cloudy, light wind and wind waves
- Plume direction determined through visual observation. Direction driven by wind direction.
- Relatively large variation between upstream and downstream TSS concentrations
- Low background concentrations, < 6 mg/l
- Slight increase in TSS concentration at the seabed, possibly due to settlement of plume within the excavated pit

4.2.6 Disposal site

Disposal 1



Disposal 2



Observations:

- Measurements were taken on 2nd July when material from pit 3 was disposed
- TSS background conditions were relatively low, with concentrations below 10 mg/l.
- During the first disposal operation, measurements were taken but no plume could be detected. This was within 10s of meters from the disposal operation.
- During the second operation, relatively high TSS concentrations were detection near the seabed bottom only. When the sensor was brought up a decrease in TSS concentration was observed.

5 SUMMARY OF FINDINGS

The following main findings are presented:

- Low current speed which makes ADCP measurements inaccurate
- Shallow areas and port obstacles seem to result in more turbulent plume development
- Natural background conditions are low, typically < 10 mg/l during good weather conditions (no measurements were taken during bad weather conditions)
- Often high TSS concentrations were detected in the lower region of the water column which could suggest the plume settles slowly within the excavated pit
- Large variation in TSS concentrations at 100 m downstream from the dredging operations. Concentrations of +100 mg/l were observed.
- TSS plume during disposal operations is very difficult to detect. This suggests that the disposed material act like a density current with little stripping of fines sediment causing increased TSS.
- Visual observations shows that the dredge plume settles quickly outside the 100 m zone.
- The two presented disposal measurements are considered representative for typical TSS concentration resulting from disposal operations. Dredged material consisted of big lumps with little water so when disposed it results in very little stripping of fines: the materials behaves as a density current straight downwards to the seabed. Due to the low currents very little spreading of suspended sediments was observed.

Figure 8: High TSS concentrations (+100 mg/l) were often observed in the vicinity of the excavation observations.

Figure 9: No visual indication of plume development around the disposal operations

Appendix 1: TSS water sample log sheet

SAMPLE LOG SHEET

Date 20150701 / 02
Name Gael, Robin, Fokko
Vessel: Survey Vessel SubMarine

Sample #	Date sampling	Time sampling	Sample location	Depth	NTU
1	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	8
2	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	7
3	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	10.5
4	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	12
5	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	8
6	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	8
7	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	12
8	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	2.5
9	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	26
10	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	22
11	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	16
12	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	23
13	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	19
14	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	29
15	20150701	10:00 - 10:30	Pit 2 layer 2 Down stream approximately 80 m from the BHD	2-4	20
16	20150701	11:30 - 12:00	Pit 2 layer 3 Down stream approximately 80 m from the BHD	4-6	6.5
17	20150701	11:30 - 12:00	Pit 2 layer 3 Down stream approximately 80 m from the BHD	4-6	5
18	20150701	11:30 - 12:00	Pit 2 layer 3 Down stream approximately 80 m from the BHD	4-6	31
19	20150701	11:30 - 12:00	Pit 2 layer 3 Down stream approximately 80 m from the BHD	4-6	33
20	20150701	11:30 - 12:00	Pit 2 layer 3 Down stream approximately 80 m from the BHD	4-6	33
21	20150701	11:30 - 12:00	Pit 2 layer 3 Down stream approximately 80 m from the BHD	4-6	44
22	20150701	11:30 - 12:00	Pit 2 layer 3 Down stream approximately 80 m from the BHD	4-6	63
23	20150701	11:30 - 12:00	Pit 2 layer 3 Down stream approximately 80 m from the BHD	4-6	27
24	20150701	11:30 - 12:00	Pit 2 layer 3 Down stream approximately 80 m from the BHD	4-6	19
25	20150701	11:30 - 12:00	Pit 2 layer 3 Down stream approximately 80 m from the BHD	4-6	9
26	20150701	11:30 - 12:00	Pit 2 layer 3 Down stream approximately 80 m from the BHD	4-6	24.5
27	20150701	11:30 - 12:00	Pit 2 layer 3 Down stream approximately 80 m from the BHD	4-6	4.5
28	20150701	11:30 - 12:00	Pit 2 layer 3 Down stream approximately 80 m from the BHD	4-6	13
29	20150702	9:00 - 9:30	Pit 3 layer 1 Down stream approximately 30 m from the BHD	3-4	48
30	20150702	9:00 - 9:30	Pit 3 layer 1 Down stream approximately 30 m from the BHD	3-4	62
31	20150702	9:00 - 9:30	Pit 3 layer 1 Down stream approximately 30 m from the BHD	3-4	63
32	20150702	9:00 - 9:30	Pit 3 layer 1 Down stream approximately 30 m from the BHD	3-4	55
33	20150702	9:00 - 9:30	Pit 3 layer 1 Down stream approximately 30 m from the BHD	3-4	58
34	20150702	9:00 - 9:30	Pit 3 layer 1 Down stream approximately 30 m from the BHD	3-4	41

SAMPLE LOG SHEET

Date 20150701 / 02
Name Gael, Robin, Fokko
Vessel: Survey Vessel SubMarine

Sample #	Date sampling	Time sampling	Sample location	Depth	NTU
35	20150702	9:00 - 9:30	Pit 3 layer 1 Down stream approximately 30 m from the BHD	3-4	47
36	20150702	9:00 - 9:30	Pit 3 layer 1 Down stream approximately 30 m from the BHD	3-4	113
37	20150702	9:00 - 9:30	Pit 3 layer 1 Down stream approximately 30 m from the BHD	3-4	104
38	20150702	9:00 - 9:30	Pit 3 layer 1 Down stream approximately 30 m from the BHD	3-4	105
39	20150702	9:00 - 9:30	Pit 3 layer 1 Down stream approximately 30 m from the BHD	3-4	120
40	20150702	9:00 - 9:30	Pit 3 layer 1 Down stream approximately 30 m from the BHD	3-4	13.5
41	20150702	9:00 - 9:30	Pit 3 layer 1 Down stream approximately 30 m from the BHD	3-4	14.5
42	20150702	9:00 - 9:30	Pit 3 layer 1 Down stream approximately 30 m from the BHD	3-4	13.5
43	20150702	12:30 - 13:00	Pit 3 layer 2 Down stream approximately 20 m from the BHD	1-2	51
44	20150702	12:30 - 13:00	Pit 3 layer 2 Down stream approximately 20 m from the BHD	1-2	50
45	20150702	12:30 - 13:00	Pit 3 layer 2 Down stream approximately 20 m from the BHD	1-2	43
46	20150702	12:30 - 13:00	Pit 3 layer 2 Down stream approximately 20 m from the BHD	1-2	57
47	20150702	12:30 - 13:00	Pit 3 layer 2 Down stream approximately 20 m from the BHD	1-2	46
48	20150702	12:30 - 13:00	Pit 3 layer 2 Down stream approximately 20 m from the BHD	1-2	35
49	20150702	12:30 - 13:00	Pit 3 layer 2 Down stream approximately 20 m from the BHD	1-2	33
50	20150702	12:30 - 13:00	Pit 3 layer 2 Down stream approximately 20 m from the BHD	1-2	31

Appendix 2: TSS laboratory analysis results

Rapport

Sida 1 (6)

SWEDAC ACKREDITERING 2030 ISO/IEC 17025

L1519180

ZP8XAEIRHS

ALS

Registrerad **2015-07-01 14:25**
Utfärdad **2015-07-07**

MRM Konsult AB
Eleonor Ringström

Box 63
971 03 Luleå
Sweden

Projekt

Denna rapport med nummer L1519180 ersätter tidigare utfärdad rapport. Tidigare utsänd rapport bör kastas.

Analys: A01

Er beteckning	**Prov 1**
	8 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094702

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**12**	mg/l	1	V	ANRE

Er beteckning	**Prov 2**
	7 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094703

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**13**	mg/l	1	V	ANRE

Er beteckning	**Prov 3**
	10,5 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094704

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**15**	mg/l	1	V	ANRE

Er beteckning	**Prov 4**
	12 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094705

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**30**	mg/l	1	V	ANRE

ALS Scandinavia AB
Aurorum 10
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Rapport

L1519180

ZP8XAEIRHS

Er beteckning	**Prov 5**
	8 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094706

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**14**	mg/l	1	V	ANRE

Er beteckning	**Prov 6**
	8 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094707

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**15**	mg/l	1	V	ANRE

Er beteckning	**Prov 7**
	12 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094708

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**28**	mg/l	1	V	ANRE

Er beteckning	**Prov 8**
	2,5 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094709

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**6.3**	mg/l	1	V	ANRE

Er beteckning	**Prov 9**
	26 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094710

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**75**	mg/l	1	V	ANRE

Er beteckning	**Prov 10**
	22 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094711

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**39**	mg/l	1	V	ANRE

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ZP8XAEIRHS

Er beteckning	**Prov 11**
	16 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094712

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**32**	mg/l	1	V	ANRE

Er beteckning	**Prov 12**
	23 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094713

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**49**	mg/l	1	V	ANRE

Er beteckning	**Prov 13**
	19 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094714

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**38**	mg/l	1	V	ANRE

Er beteckning	**Prov 14**
	29 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094715

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**50**	mg/l	1	V	ANRE

Er beteckning	**Prov 15**
	20 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094716

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**43**	mg/l	1	V	ANRE

Er beteckning	**Prov 16**
	6,5 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094717

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**8.7**	mg/l	1	V	ANRE

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Er beteckning	**Prov 17**
	5,0 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094718

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**14**	mg/l	1	V	ANRE

Er beteckning	**Prov 18**
	31 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094719

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**48**	mg/l	1	V	ANRE

Er beteckning	**Prov 19**
	33 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094720

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**98**	mg/l	1	V	ANRE

Er beteckning	**Prov 20**
	33 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094721

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**64**	mg/l	1	V	ANRE

Er beteckning	**Prov 21**
	44 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094722

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**19**	mg/l	1	V	ANRE

Er beteckning	**Prov 22**
	63 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094723

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**38**	mg/l	1	V	ANRE

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Er beteckning	**Prov 23**
	27 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094724

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**82**	mg/l	1	V	ANRE

Er beteckning	**Prov 24**
	19 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094725

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**34**	mg/l	1	V	ANRE

Er beteckning	**Prov 25**
	9 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094726

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**26**	mg/l	1	V	ANRE

Er beteckning	**Prov 26**
	24,5 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094727

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**50**	mg/l	1	V	ANRE

Er beteckning	**Prov 27**
	4,5 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094728

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**5.7**	mg/l	1	V	ANRE

Er beteckning	**Prov 28**
	13 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-01**
Labnummer	U11094729

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**15**	mg/l	1	V	ANRE

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	Metod
1	Analys enligt Susp: SS-EN 872:2005 Tidskritisk, analys inom 48 h.

	Godkännare
ANRE	Annika Reimhagen

	Utf[1]
V	Våtkemi

* efter parameternamn indikerar icke ackrediterad analys.

Mätosäkerheten anges som en utvidgad osäkerhet (enligt definitionen i "Evaluation of measurement data - Guide to the expression of uncertainty in measurement", JCGM 100:2008 Corrected version 2010) beräknad med täckningsfaktor lika med 2 vilket ger en konfidensnivå på ungefär 95%.

Mätosäkerhet från underleverantör anges oftast som en utvidgad osäkerhet beräknad med täckningsfaktor 2. För ytterligare information kontakta laboratoriet.

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[1] Utförande teknisk enhet (inom ALS Scandinavia) eller anlitat laboratorium (underleverantör).

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Rapport

Sida 1 (5)

L1519322

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Registrerad **2015-07-02 14:26**
Utfärdad **2015-07-07**

MRM Konsult AB
Eleonor Ringström

Box 63
971 03 Luleå
Sweden

Projekt

Denna rapport med nummer L1519322 ersätter tidigare utfärdad rapport. Tidigare utsänd rapport bör kastas.

Analys: A01

Er beteckning	**Prov 29**
	48 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095254

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**270**	mg/l	1	V	ANRE

Er beteckning	**Prov 30**
	62 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095255

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**91**	mg/l	1	V	ANRE

Er beteckning	**Prov 31**
	63 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095256

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**88**	mg/l	1	V	ANRE

Er beteckning	**Prov 32**
	55 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095257

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**110**	mg/l	1	V	ANRE

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Er beteckning	**Prov 33**
	58 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095258

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**90**	mg/l	1	V	ANRE

Er beteckning	**Prov 34**
	41 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095259

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**84**	mg/l	1	V	ANRE

Er beteckning	**Prov 35**
	47 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095260

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**100**	mg/l	1	V	ANRE

Er beteckning	**Prov 36**
	113 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095261

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**100**	mg/l	1	V	ANRE

Er beteckning	**Prov 37**
	104 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095262

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**130**	mg/l	1	V	ANRE

Er beteckning	**Prov 38**
	105 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095263

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**130**	mg/l	1	V	ANRE

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Rapport

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Er beteckning	**Prov 39**
	120 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095264

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**180**	mg/l	1	V	ANRE

Er beteckning	**Prov 40**
	13,5 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095265

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**26**	mg/l	1	V	ANRE

Er beteckning	**Prov 41**
	14,5 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095266

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**21**	mg/l	1	V	ANRE

Er beteckning	**Prov 42**
	13,5 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095267

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**29**	mg/l	1	V	ANRE

Er beteckning	**Prov 43**
	51 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095268

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**120**	mg/l	1	V	ANRE

Er beteckning	**Prov 44**
	50 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095269

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**130**	mg/l	1	V	ANRE

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L1519322

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Er beteckning	**Prov 45**
	53 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095270

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**120**	mg/l	1	V	ANRE

Er beteckning	**Prov 46**
	57 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095271

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**110**	mg/l	1	V	ANRE

Er beteckning	**Prov 47**
	46 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095272

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**95**	mg/l	1	V	ANRE

Er beteckning	**Prov 48**
	35 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095273

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**100**	mg/l	1	V	ANRE

Er beteckning	**Prov 49**
	33 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095274

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**93**	mg/l	1	V	ANRE

Er beteckning	**Prov 50**
	31 NTU
Provtagare	**Boskalis**
Provtagningsdatum	**2015-07-02**
Labnummer	U11095275

Parameter	Resultat	Enhet	Metod	Utf	Sign
Susp mat	**95**	mg/l	1	V	ANRE

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L1519322

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	Metod
1	Analys enligt Susp: SS-EN 872:2005 Tidskritisk, analys inom 48 h.

	Godkännare
ANRE	Annika Reimhagen

	Utf[1]
V	Våtkemi

* efter parameternamn indikerar icke ackrediterad analys.

Mätosäkerheten anges som en utvidgad osäkerhet (enligt definitionen i "Evaluation of measurement data - Guide to the expression of uncertainty in measurement", JCGM 100:2008 Corrected version 2010) beräknad med täckningsfaktor lika med 2 vilket ger en konfidensnivå på ungefär 95%.

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Appendix 3: Turbidity survey log sheet

ONLINE WATER MONITORING LOG

Project: Lulea Test Dredging

Client: Sjofartsverket

Date: 6/30/2015

Vessel: Subsea

Surveyor: GVVE/RGAH

Parameters

- [x] Turbidity
- [ ] Dissolved Oxygen
- [ ] Conductivity
- [ ] pH
- [ ] Chlorophyll

Logsheet Number: 2

Weather / Sea state:

Cloudy, no swell, gets clearer in the afternoon.

Water Monitoring / Water Sampling

Time	Lat / Easting	Long / Northing	Area	Sample Depth	Water Depth	NTU	Monitoring File ID	Sampling bottle ID	Comment
08h05	65 23.98 N	22 20.521 E	pit6		6m		P6UPL2B.txt		upstream 100m Layer 2
08h11	65 23.285N	22 20.419	pit6		8m		P6DNL2.txt		downstream inside plume 100m Layer 2. upcast to check
12h39	65 23.374 N	22 20.541 E	pit 6		5m		P6UPL3.txt		upstream 100m Layer 3
12h47	65 23.28 N	22 20.509 E	pit 6		8m		P6DNL3B.txt		downstream inside plume 100m Layer 3. upcast to check
14h30	65 23.276 E	22 20.414	pit 6		7m		P6DNL4.txt		downstream inside plume 100m Layer 4. 2 times
14h45	65 23.405 N	22 20.520 E	pit 6		7m		P6UPL4.txt		upstream 100m Layer 4
17h15	65 26.231 N	22 25.793 E	pit 5		11m		P5DNL1.txt		downstream 100m in plume direction
17h25	65 26.310 N	22 25.902 E	pit5		7m		P5UPL1.txt		upstream 100m
18h30	65 26.281 N	22 25.967 E	pit 5		11m		P5UPL2.txt		upstream 100m
18h40	65 26.200 N	22 25.769 E	pit 5		11m		P5DNL2.txt		downstream 100m in plume direction

Surveyor

Name: _____

Signature: _____

Client

Name: _____

Signature: _____

150630-water-monitoring-logsheet

Royal Boskalis Westminster NV

ONLINE WATER MONITORING LOG

Project:

Client:

Date: 7/1/2015

Vessel: Subsea

Surveyor: GVVE

Parameters

- ☑ Turbidity
- ☐ Dissolved Oxygen
- ☐ Conductivity
- ☐ pH
- ☐ Chlorophyll

Logsheet Number: _____

Weather / Sea state:

_____

_____

_____

Water Monitoring / Water Sampling

Time	Lat / Easting	Long / Northing	Area	Sample Depth	Water Depth	NTU	Monitoring File ID	Sampling bottle ID	Comment
08h45	6532.673	2216.73	pit2, layer 1	11m	11m		P2L1TST.txt		
09h00	65 32.673 N	22 16.730 E	pit 2, layer 1	11m	11m		P2L1DN.txt		
09h46	65 32.700 N	22 16.880 E	pit2, layer 2	12m	12m		P2L2UP.txt		inside the plume
10h00	65 32.704 N	22 16.630 E	pit2, layer 2	11m	11m		P2L2DN.txt		down-up and down-up again, inside the plume
13h15	65 32.700 N	22 16.630 E	pit 2, layer 3				P2L3UP.txt		
15h05			pit 3		6m		P3DNL1.txt		100m downstream (a bit off plumebecause of depth)
15h15			pit 3		7m		P3UPL1.txt		100m upstream, touched bottom

Surveyor

Name: _____

Signature: _____

Client

Name: _____

Signature: _____

Online Water Monitoring Log Model_0107

Royal Boskalis Westminster NV

ONLINE WATER MONITORING LOG

Project:

Client:

Date: 7/2/2015

Vessel: Subsea

Surveyor: GVVE

Parameters

- [x] Turbidity
- [ ] Dissolved Oxygen
- [ ] Conductivity
- [ ] pH
- [ ] Chlorophyll

Logsheet Number:

Weather / Sea state: Cloudy, little current and mo waves

Water Monitoring / Water Sampling

Time	Lat / Easting	Long / Northing	Area	Sample Depth	Water Depth	NTU	Monitoring File ID	Sampling bottle ID	Comment
08h40	65 32.377 N	22 18.391 E	pit3, layer 1	11m	11m		P3L1UP.txt		
08h55	65 32.470 N	22 18.204 E	pit3, layer 1	5m	5m		P3L1DN.txt		may have touched the seabed, made another measure
08h56	65 32.470 N	22 18.204 E	pit3, layer 1	5m	5m		P3L1DN2.txt		
11h45	65 29.272 N	22 24.624 E	Dump area		20m		DPUP1.txt		Dump area upstream
11h55	65 29.086 N	22 24.563 E	Dump area		20m		DPDN2.txt		Downstream Dump area
16h00	65 29 13.3 N	22 24 25.1 E	Dump area		15m		DPUP3.txt		upstream Dump area
16h20	65 29 10.09 N	22 24 35.69 E	Dump area		20m		DPDN3.txt		Downstream Dump area

Surveyor

Name:

Signature:

Client

Name:

Signature:

Online Water Monitoring Log Model_150702

Royal Boskalis Westminster NV

ONLINE WATER MONITORING LOG

Project:

Client:

Date: 7/3/2015

Vessel: Subsea

Surveyor: GVVE

Parameters

- [x] Turbidity
- [ ] Dissolved Oxygen
- [ ] Conductivity
- [ ] pH
- [ ] Chlorophyll

Logsheet Number:

Weather / Sea state: Cloudy, little current and mo waves

Water Monitoring / Water Sampling

Time	Lat / Easting	Long / Northing	Area	Sample Depth	Water Depth	NTU	Monitoring File ID	Sampling bottle ID	Comment
08h50	65 32 26.918 N	22 18 08.064 E	pit 3		6m		P3DNL2.txt		downstream layer 2
08h55	65 32 27.785 N	22 18 19.282 E	pit 3		6m		P3UPL2.txt		upstream layer 2
15h50	65 32 26.918 N	22 18 08.064 E	pit 3		11m		P3UPL3.txt		upstream Layer 3
16h00	65 32 27.785 N	22 18 19.282 E	pit 3		4m		P3DNL3.txt		downstream layer 3

Surveyor

Name:

Signature:

Client

Name:

Signature:

Online Water Monitoring Log Model_150703

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