Appendix A:

Geotechnical Report

GEOTECHNICAL FACTUAL REPORT
LAWN, NL

(FFC File: 3079)

Prepared by:

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Submitted to:

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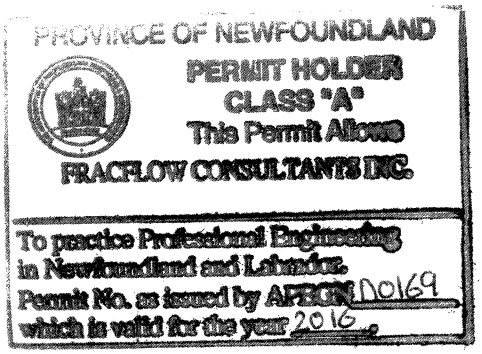
March 2016



Preface

AFN Engineering retained Fracflow Consultants Inc. on behalf of Fisheries and Oceans Canada under Contract F6142-150052 dated January 29, 2016, to undertake a marine geotechnical site investigation at Lawn NL.

The proposed scope of work for the Lawn project consisted of drilling and sampling three (3) barge based geotechnical boreholes and collecting marine sediment samples at the same three (3) locations. The field work was conducted between February 12 and 20, 2016. Due to adverse weather conditions and high winds, work could not be conducted on the barge on February 14, 15, and 17. The field work for these investigations utilized a Foremost Mobile B-47 geotechnical drill rig at the approximate locations specified by AFN Engineering. Split-spoon sampling and Standard Penetration Tests (SPTs) were conducted using a NW/NQ diamond drill string in each borehole at the standard 1.5 m interval. Marine sediment sampling was conducted using a grab sampler and a HW/HQ diamond drill string and a 76 mm diameter split spoon.

A visual inspection of the subsurface soil conditions encountered, based on the split-spoon samples that were recovered during the field program, was used to describe the soil conditions at the site. The end of hole depths of the three (3) boreholes ranged from -11.30 m LNT in BH2 to -12.55 m LNT in BH3.

The overburden, based on the three (3) boreholes that were completed as part of this geotechnical investigation, can be summarized as a layer of black organic material with fine sand and silt, overlying sand and gravel with trace silt or clay and cobbles/boulders of varying size (8 cm to 25 cm diameter). Bedrock was encountered in BH3 only, at -11.07 m LNT, and was a highly fractured metamorphosed volcanic rock.

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1.0 INTRODUCTION

AFN Engineering retained Fracflow Consultants Inc. on behalf of Fisheries and Oceans Canada to undertake a marine geotechnical site investigation at Lawn NL.

The proposed scope of work for the Lawn project consisted of drilling and sampling three (3) barge based geotechnical boreholes followed by marine sediment sampling at the same three (3) locations. The borehole locations are shown on the site plan in **Figure 1**, **Appendix A**. A summary of the geotechnical field work conducted is shown in **Table 1.1**. A summary of the marine sediment sampling is shown in **Table 1.2**. All sediment samples were delivered to Maxxam Analytics Inc. in St. John's on behalf of DFO.

This report contains a factual presentation and full disclosure of all findings of the subsurface investigation. The following sections provide: (1) a description of the site and the general geology of the area; (2) a summary of the investigative procedures used; and (3) a detailed description of the subsurface soil conditions. Appended to this report is a site plan showing the locations for each borehole, the detailed geotechnical logs for each borehole, and the grain size analysis reports and related laboratory data.

Table 1.1 Summary of geotechnical investigations at Lawn, NL.

Borehole ID	Overburden Drilled (m)	Bedrock Drilled (m)	Total Depth Drilled (m)	SPT & Split-spoon Samples Attempted	Split-spoon Samples Tested
BH1	9.03	0.00	9.03	7	3
BH2	8.41	0.00	8.41	8	1
BH3	8.22	1.48	9.70	7	2
Total	25.66	1.48	27.14	22	6

Table 1.2 Summary of marine sediment sampling at Lawn, NL.

Borehole No.	Depth to Harbour Bottom Relative to LNT (m)	Final Hole Depth Relative to LNT (m)	Split-spoon Samples Attempted	Sample ID's	Samples Analysed
BH1	-2.526	-3.447	1	BH1-SURFACE BH1-1m	2
BH2	-2.844	-3.736	1	BH2-SURFACE BH2-1m	2
BH3	-2.345	-3.564	1	BH3-SURFACE BH3-1m	2

2.0 SITE DESCRIPTION AND GENERAL GEOLOGY

The community of Lawn is located on the tip of the Burin Peninsula, approximately 50 km southwest of Marystown.

Overburden in the area is characterized by till veneer and moraine of varying thickness overlying bedrock (Water Resources Division, 1985). Bedrock in the area consists of "mafic to felsic volcanics including flows, pyroclastics, both subaerial and waterlain, minor chlorite and sericite schists" (Water Resources Division, 1985).

3.0 INVESTIGATIVE PROCEDURES

At the Lawn site, the project consisted of drilling and sampling three (3) barge based boreholes and collecting six (6) marine sediment samples, two (2) at each borehole location. The field work for these investigations utilized a Foremost Mobile B-47 geotechnical drill rig mounted on a barge at the locations shown in **Figure 1, Appendix A.**

Overburden material was drilled using 'NW' (OD 88.9 mm, ID 76.2 mm) flush joint casing and "NQ" (OD 69.9 mm, ID 60.3 mm) diamond drill string. Soil samples were collected using a 51 mm OD, 610 mm long, split-spoon sampler. In conjunction with this split-spoon soil sampling, SPTs were performed to estimate relative soil densities. The standard procedure is to drive each split-spoon into the ground using a 63.5 kg weight falling a distance of 760 mm. The number of blows is recorded for each 150 mm the split-spoon is advanced. After the first 150 mm advance, a N-value is calculated as the sum of the blow counts required to drive the spoon an additional 300 mm (i.e., the sum of the second and third set of blow counts). The calculated N-value is a direct reflection of the relative density of the soil strata as defined in the Canadian Foundation Engineering Manual (Canadian Geotechnical Society, 1992).

Marine sediment samples at ocean bottom were collected over the side of the barge using a grab sampler. Overburden samples were collected below ocean bottom from 0 m to 1.0 m using a 76 mm diameter split spoon. The top 10 cm (approximate) of the split spoon sample was discarded, and the remaining sample was collected. Where enough material was obtained, the sample was collected into one (1) 250 mL and one (1) 60 mL glass jar with no head space. Collection of the environmental samples followed the procedures that had been established by PWGSC/DFO. Samples were stored on ice before being submitted to the Maxxam Analytics in St. John's for analysis.

Both the soil samples and rock cores were logged and labelled in the field immediately after collection. Soil samples were stored in moisture proof containers and rock cores were stored in

wooden core boxes in the field. All soil and rock samples were returned to Fracflow's office and select soil samples collected during the investigation were tested. Soil testing in the laboratory consisted of standard mechanical sieve analyses and water content determinations that were performed according to ASTM standards as required. The soil and rock core samples are stored by Fracflow for a two-year period.

4.0 SUBSURFACE CONDITIONS AND CHARACTERIZATION

Subsurface characterization is based on the field data collected from the three (3) vertical boreholes that were completed at this site. Data collection included split-spoon sampling while drilling in conjunction with the SPTs. A description of the soil profiles is provided below using both terminologies defined in the Unified Soil Classification System (USCS) and in the Canadian Foundation Engineering Manual (CFEM) (CGS, 1992). Photographs of the overburden cobbles and boulders and core recoveries from each borehole are provided in **Figure 2, Appendix A**. Detailed logs of the geological conditions at each borehole location are provided in **Appendix B**. **Appendix C** contains the grain size analysis information for each soil sample tested.

4.1 Soil Description

The overburden, based on the three (3) boreholes that were completed as part of this geotechnical investigation, can be summarized as a layer of black organic material with fine sand and silt, overlying sand and gravel with trace silt or clay and cobbles of varying size (8 cm to 25 cm diameter). Bedrock was encountered in BH3 only, at -11.07 m LNT.

Six (6) soil samples were analysed in the lab using mechanical grain size analysis. Overburden was generally characterized by CFEM as "Gravelly Sand, trace Silt/Clay", "Gravel and Sand, trace Silt/Clay", or "Sand, some Gravel, trace Silt/Clay". One sample from -10.2 m LNT in BH1 was classified as "Gravelly Sand, some Silt/Clay)".

When characterized by USCS, the samples varied from "SP-SM" to "SW-SM" (poorly graded sand with silt and gravel to well graded sand with silt and gravel), "GP-GM" to "GW-GM" (poorly graded gravel with silt and sand to well graded gravel with silt and sand), "SP (poorly graded sand with gravel)", and "SM (silty sand with gravel)".

4.2 Bedrock Description

The general description of bedrock in the area consists of mafic to felsic volcanics (Water Resources Division, 1985).

Bedrock was encountered in one (1) borehole, BH3. Bedrock elevation was -11.07 m LNT, 8.22 m below ocean bottom. Bedrock was a highly fractured metamorphosed volcanic rock, with a Rock Quality Designation (RQD) value of 0%. Bedrock recoveries ranged from 66% to 81%.

5.0 REFERENCES

Canadian Geotechnical Society (CGS), 1992, *Canadian Foundation Engineering Manual, 3rd Edition*, Technical Committee on Foundations, 512 p.

Water Resources Division, 1985. *Hydrogeology of the Burin Peninsula Area*, Water Resources Report 2-7, Water Resources Division, Newfoundland Department of Environment.

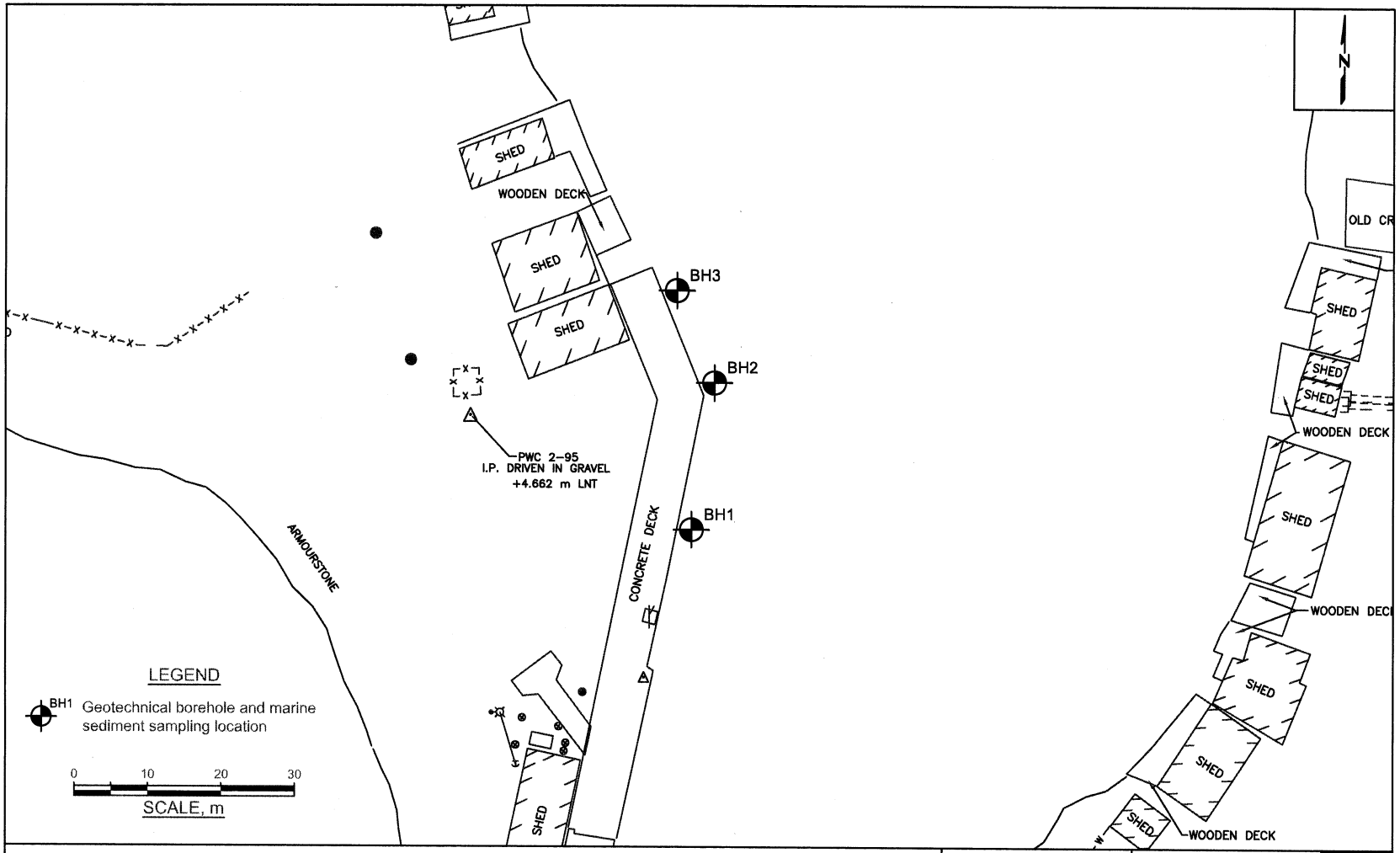


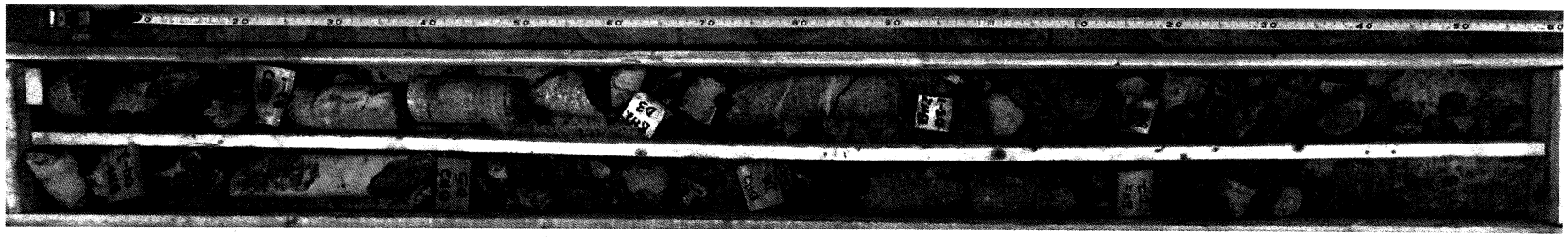
Figure 1 Borehole and marine sediment sampling location map, Lawn, NL.

Project No.	Document Reference
3079	FFC-NL-3079
Location	Date
Lawn, NL	March 2016

FFC

Hole ID: BH1

Hole ID: BH2



Hole ID: BH3

Figure 2 Photographs of core recovered during drilling from borehole BH1, BH2, and BH3.

APPENDIX B

Borehole Logs

Project: Geotechnical Investigation

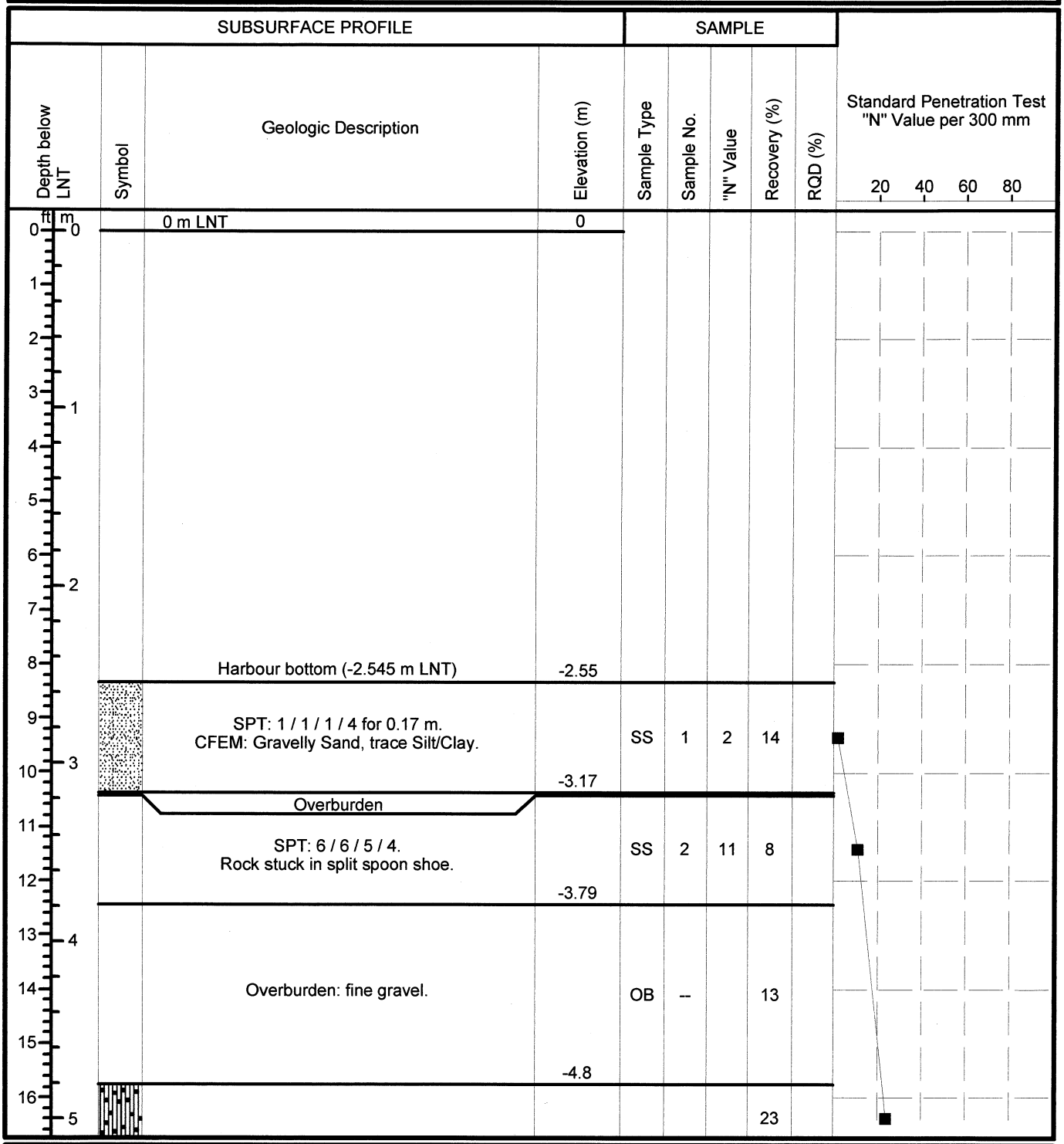
Client: Department of Fisheries and Oceans

Location: Lawn, NL

Log of Borehole: BH1

Project No: 3079

Date: February 12 - 13, 16, 2016



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Drilling Method: NW casing / NQ coring

Driller: Formation Drilling Ltd.

Datum: LNT

Project: Geotechnical Investigation

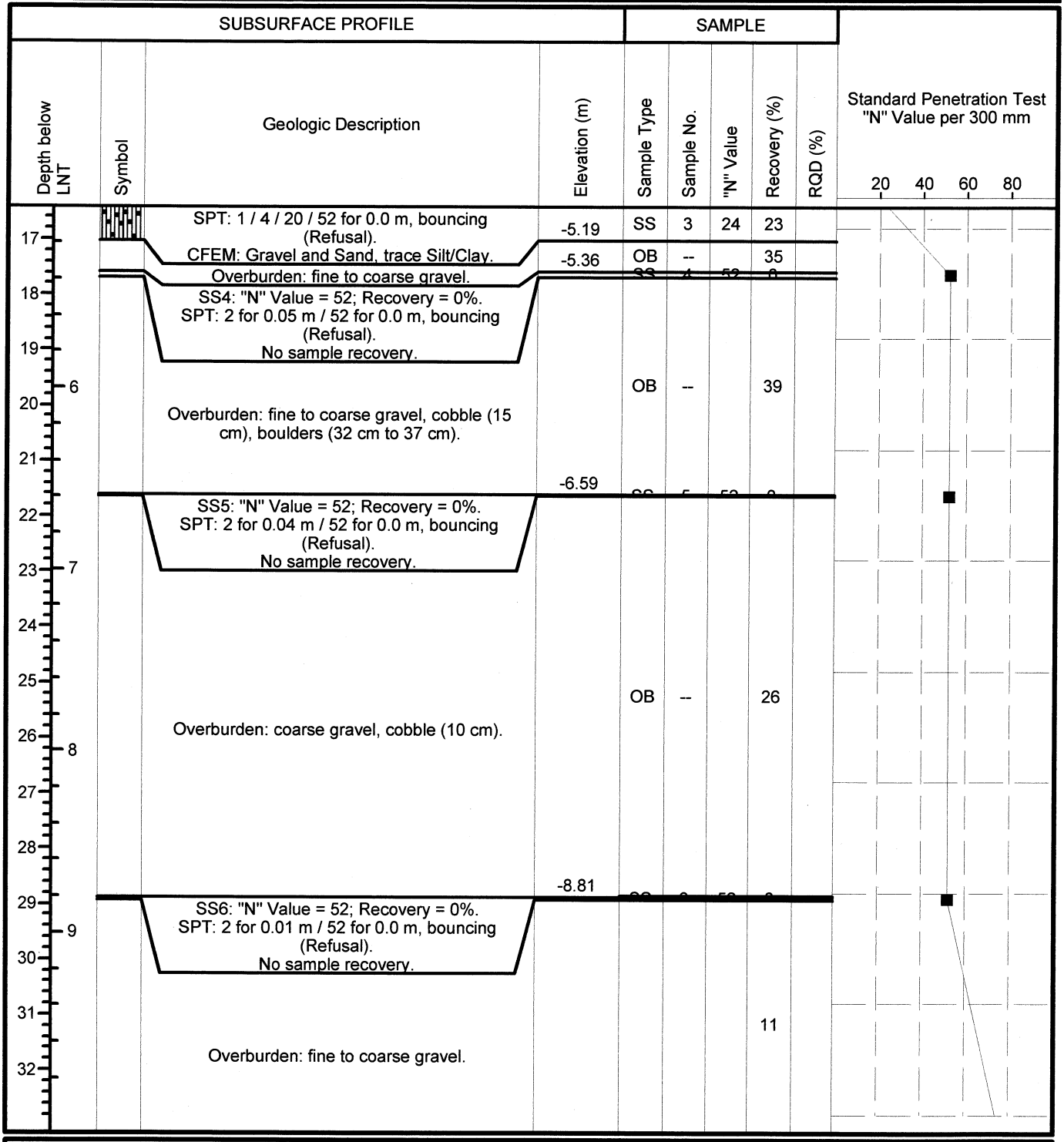
Client: Department of Fisheries and Oceans

Location: Lawn, NL

Log of Borehole: BH1

Project No: 3079

Date: February 12 - 13, 16, 2016



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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Geotechnical Investigation

Client: Department of Fisheries and Oceans

Location: Lawn, NL

Log of Borehole: BH1

Project No: 3079

Date: February 12 - 13, 16, 2016

SUBSURFACE PROFILE				SAMPLE					
Depth below LNT	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample No.	"N" Value	Recovery (%)	RQD (%)	Standard Penetration Test "N" Value per 300 mm (20 40 60 80)
33			-10.2	OB	--		11		
34		SPT: 10 / 29 / 52 for 0.01 m, bouncing (Refusal). CFEM: Gravelly Sand, some Silt/Clay.	-10.6	SS	7	81	28		
35									
36		Overburden: fine to coarse gravel.		OB	--		20		
37									
38			-11.6						
		End of Borehole							
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									

11 12 13 14

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Datum: LNT

Project: Geotechnical Investigation

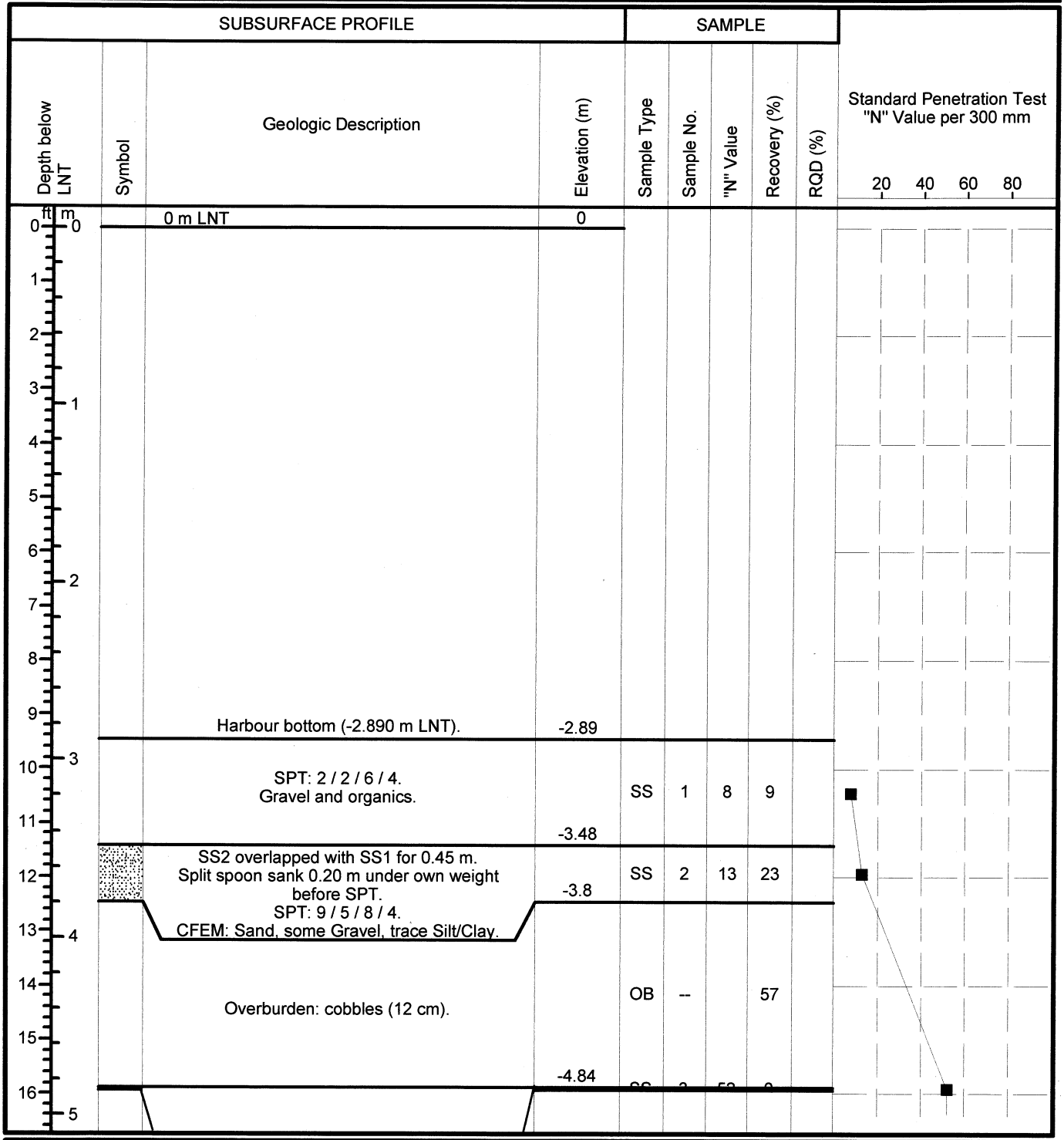
Client: Department of Fisheries and Oceans

Location: Lawn, NL

Log of Borehole: BH2

Project No: 3079

Date: February 18, 2016



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Driller: Formation Drilling Ltd.

Datum: LNT

Project: Geotechnical Investigation

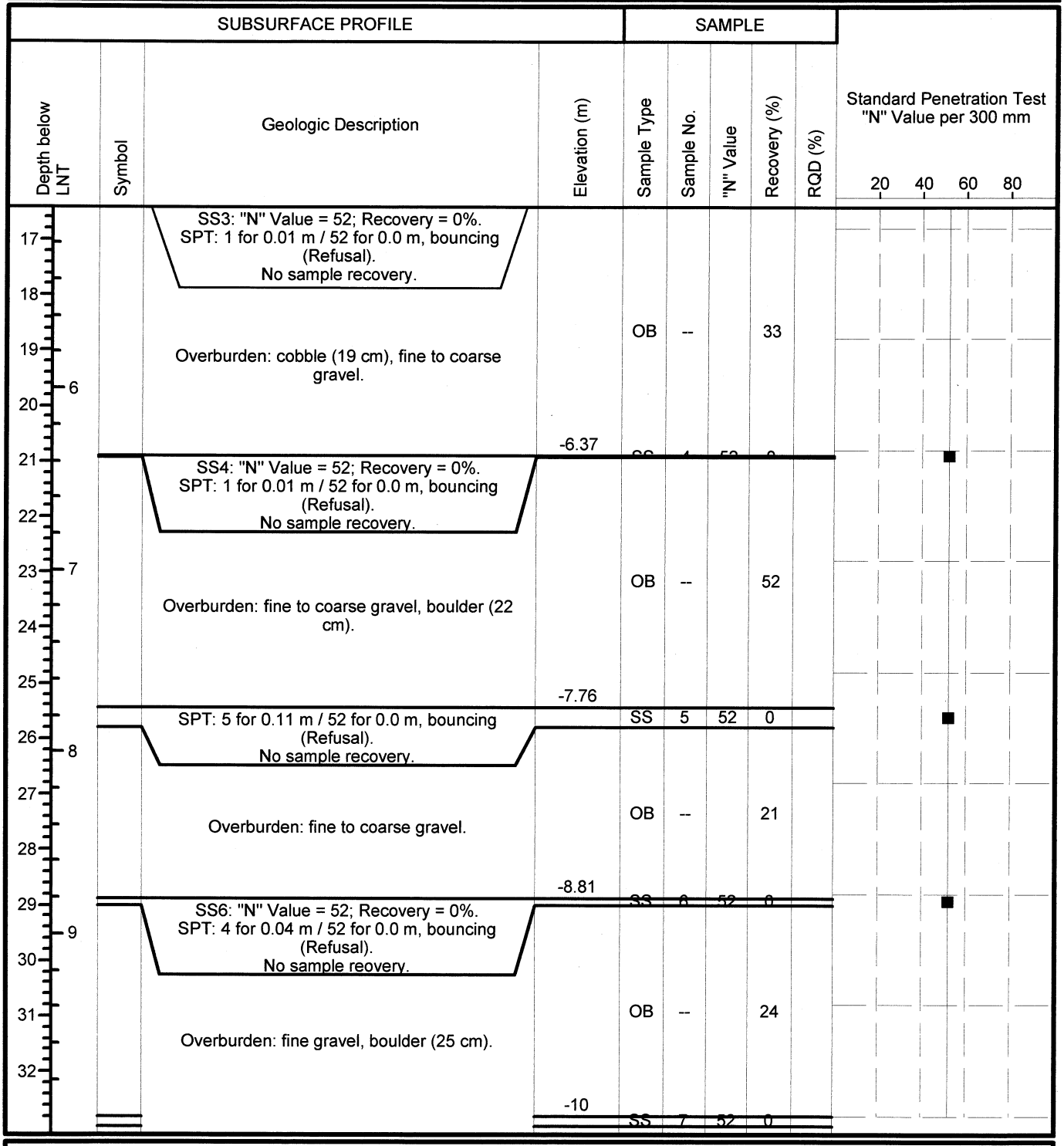
Log of Borehole: BH2

Client: Department of Fisheries and Oceans

Project No: 3079

Location: Lawn, NL

Date: February 18, 2016



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Datum: LNT

Driller: Formation Drilling Ltd.

Project: Geotechnical Investigation

Log of Borehole: BH2

Client: Department of Fisheries and Oceans

Project No: 3079

Location: Lawn, NL

Date: February 18, 2016

SUBSURFACE PROFILE				SAMPLE					
Depth below LNT	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample No.	"N" Value	Recovery (%)	RQD (%)	Standard Penetration Test "N" Value per 300 mm (20 40 60 80)
33		SS7: "N" Value = 52; Recovery = 0%. SPT: 2 for 0.05 m / 52 for 0.0 m, bouncing (Refusal). Rock stuck in split spoon shoe.		SS	7	52	0		
34									
35				OB	--		43		
36		Overburden: fine to coarse gravel.							
11									
37			-11.3						
38		SS8: "N" Value = 52; Recovery = 0%. SPT: 2 for 0.01 m / 52 for 0.0 m, bouncing (Refusal). No sample recovery.							
39		End of Borehole							
12									
40									
41									
42									
13									
43									
44									
45									
46									
14									
47									
48									
49									

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Drilling Method: NW casing / NQ coring

Datum: LNT

Driller: Formation Drilling Ltd.

Sheet: 3 of 3

Project: Geotechnical Investigation

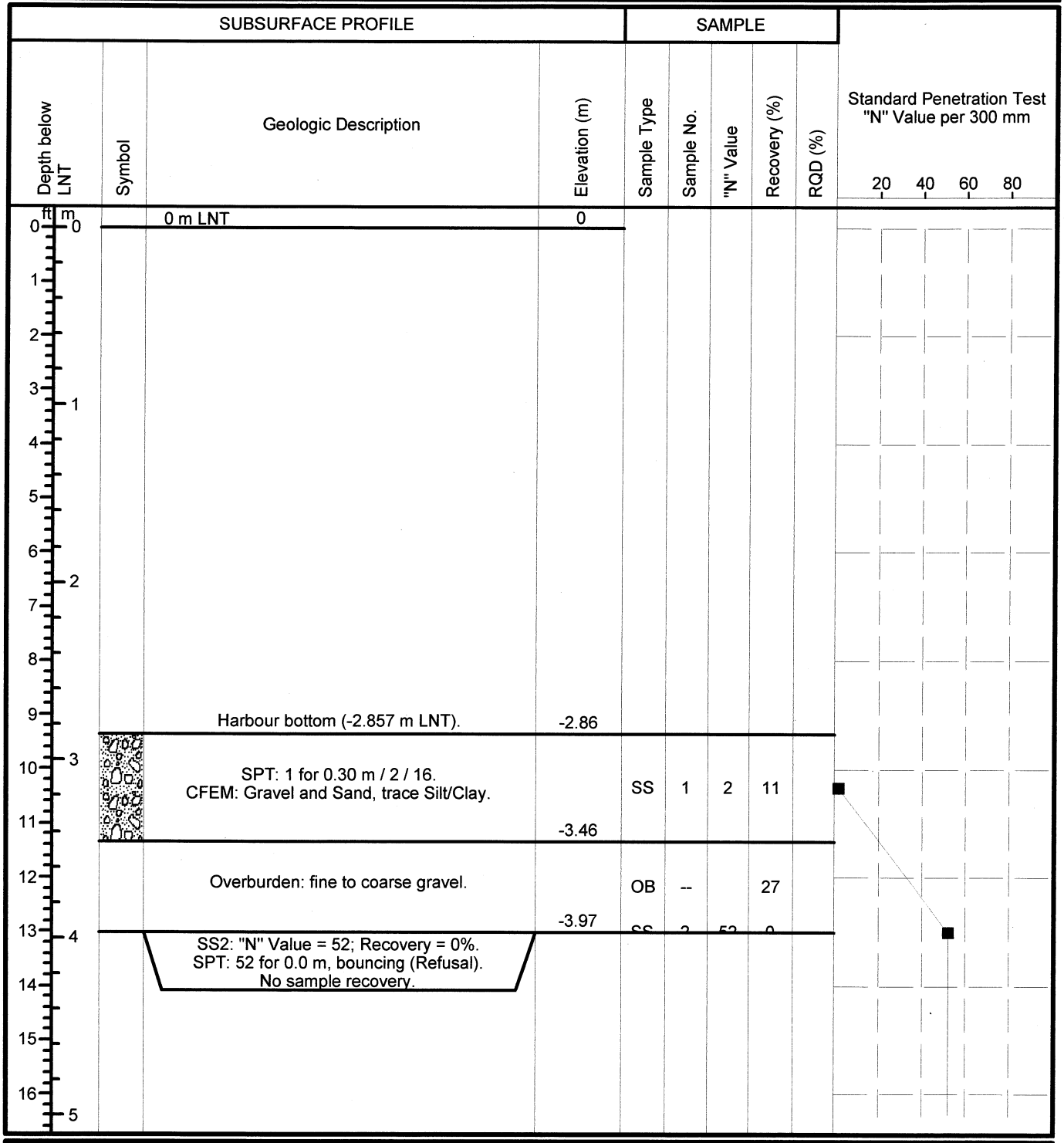
Log of Borehole: BH3

Client: Department of Fisheries and Oceans

Project No: 3079

Location: Lawn, NL

Date: February 19, 2016



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Drilling Method: NW casing / NQ coring

Datum: LNT

Driller: Formation Drilling Ltd.

Project: Geotechnical Investigation

Log of Borehole: BH3

Client: Department of Fisheries and Oceans

Project No: 3079

Location: Lawn, NL

Date: February 19, 2016

SUBSURFACE PROFILE				SAMPLE					
Depth below LNT	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample No.	"N" Value	Recovery (%)	RQD (%)	Standard Penetration Test "N" Value per 300 mm (20 40 60 80)
17									
18		Overburden: fine to coarse gravel, cobbles (9 cm to 10 cm).		OB	--		62		
19									
6 20			-6.17						
		SS3: "N" Value = 52; Recovery = 0%. SPT: 2 for 0.08 m / 52 for 0.0 m, bouncing (Refusal). No sample recovery.		SS	3	52	0		
21									
22									
7 23									
24		Overburden: fine gravel, cobbles (8 cm to 9 cm).		OB	--		24		
25									
26			-7.98						
8		SPT: 30 / 2 for 0.01 m / 52 for 0.0 m, bouncing (Refusal). No sample recovery.	-8.13	SS	4	52	0		
27									
28									
29		Overburden: fine to coarse gravel.		OB	--		14		
9 30									
31			-9.5						
		SS5: "N" Value = 52; Recovery = 0%. SPT: 1 for 0.01 m / 52 for 0.0 m, bouncing (Refusal). No sample recovery.		SS	5	52	0		
32									

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Drilling Method: NW casing / NQ coring

Datum: LNT

Driller: Formation Drilling Ltd.

Project: Geotechnical Investigation

Log of Borehole: BH3

Client: Department of Fisheries and Oceans

Project No: 3079

Location: Lawn, NL

Date: February 19, 2016

SUBSURFACE PROFILE				SAMPLE					
Depth below LNT	Symbol	Geologic Description	Elevation (m)	Sample Type	Sample No.	"N" Value	Recovery (%)	RQD (%)	Standard Penetration Test "N" Value per 300 mm (20 40 60 80)
33									
34		Overburden: coarse gravel.		OB	--		9		
35			-10.9						
36 11		SPT: 20 / 2 for 0.03 m / 52 for 0.0 m, bouncing (Refusal). CFEM: Gravel and Sand, trace Silt/Clay.	-11.1	SS	6	52	50		
37		Bedrock: metamorphosed volcanic rock.		RC	--		75	0	
38									
39			-12	SS	7	52	0		
40 12		SS7: "N" Value = 52; Recovery = 0%. SPT: 1 for 0.01 m / 52 for 0.0 m, bouncing (Refusal). No sample recovery. Bedrock: metamorphosed volcanic rock.		RC	--		68		
41			-12.6						
42		End of Borehole							
43 13									
44									
45									
46 14									
47									
48									
49									

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Drilling Method: NW casing / NQ coring

Datum: LNT

Driller: Formation Drilling Ltd.

Sheet: 3 of 3

APPENDIX C

Grain Size Analysis Reports

GRAIN SIZE ANALYSIS

Project : 3079 - Lawn, NL

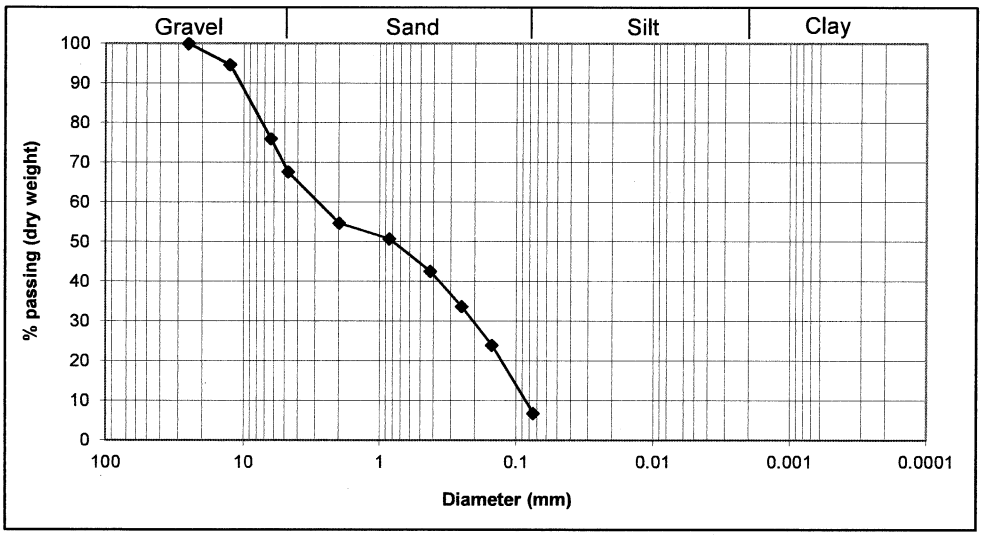
Sample No. : BH1-SS1

Depth below LNT: 2.55 m - 3.17 m

Sieve Analysis

Dry weight of sample (g) = 133.84

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret.	% Passing
2	50.8	0.00			
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	7.12	5.32	5.32	94.68
1/4"	6.35	25.12	18.77	24.09	75.91
4	4.76	11.12	8.31	32.40	67.60
10	2.00	17.24	12.88	45.28	54.72
20	0.85	5.25	3.92	49.20	50.80
40	0.425	10.98	8.20	57.40	42.60
60	0.25	11.91	8.90	66.30	33.70
100	0.15	13.07	9.77	76.07	23.93
200	0.075	23.04	17.21	93.28	6.72
pan	---	8.99	6.72	100.00	---
		133.84			



D_{10} = 0.085

D_{30} = 0.205

D_{60} = 2.859

Cu = 33.64

Cc = 0.17

USCS: SP-SM (Poorly graded sand with silt and gravel)

R_{200} = 93.28

R_4 = 32.40

R_4/R_{200} = 0.35

SF = 60.89

GF = 32.40

% Gravel = 32.40

% Sand = 60.89

% Silt & Clay = 6.72

% Clay = NA

CFEM: Gravelly Sand, trace Silt/Clay

Moisture Content (%): 24.88

GRAIN SIZE ANALYSIS

Project : 3079 - Lawn, NL

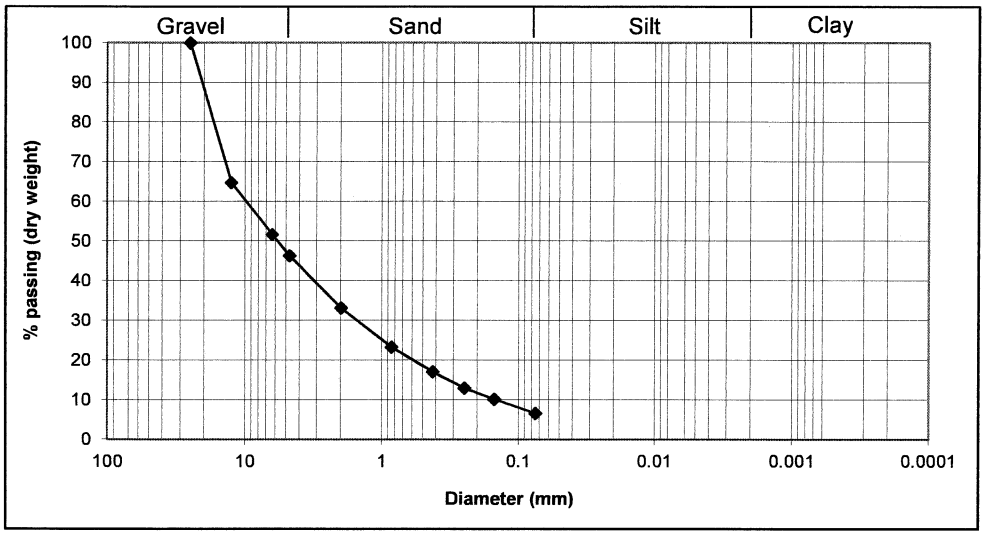
Sample No. : BH1-SS3

Depth below LNT: 4.80 m - 5.19 m

Sieve Analysis

Dry weight of sample (g) = 204.44

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret.	% Passing
2	50.8	0.00			
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	72.12	35.28	35.28	64.72
1/4"	6.35	26.83	13.12	48.40	51.60
4	4.76	10.75	5.26	53.66	46.34
10	2.00	26.95	13.18	66.84	33.16
20	0.85	20.21	9.89	76.73	23.27
40	0.425	12.73	6.23	82.95	17.05
60	0.25	8.34	4.08	87.03	12.97
100	0.15	5.87	2.87	89.90	10.10
200	0.075	7.24	3.54	93.45	6.55
pan	—	13.40	6.55	100.00	—
		204.44			



D_{10} = 0.148

D_{30} = 1.52

D_{60} = 9.95

Cu = 67.23

Cc = 1.57

USCS: GW-GM (Well-graded gravel with silt and sand)

R_{200} = 93.45

R_4 = 53.66

R_4/R_{200} = 0.57

SF = 39.79

GF = 53.66

% Gravel = 53.66

% Sand = 39.79

% Silt & Clay = 6.55

% Clay = NA

CFEM: Gravel and Sand, trace Silt/Clay

Moisture Content (%): 8.54

GRAIN SIZE ANALYSIS

Project : 3079 - Lawn, NL

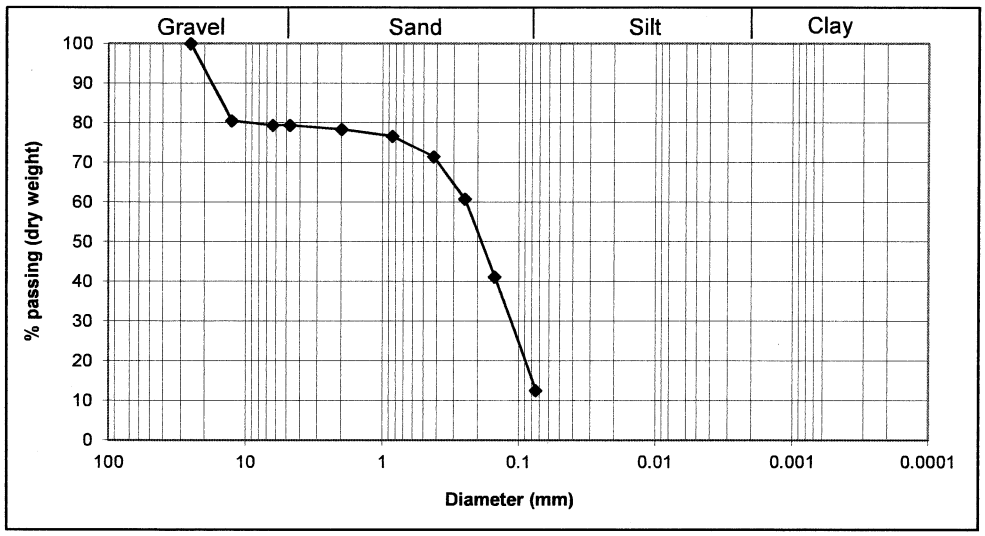
Sample No. : BH1-SS7

Depth below LNT: 10.18 m - 10.55 m

Sieve Analysis

Dry weight of sample (g) = 128.91

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret.	% Passing
2	50.8	0.00			
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	25.10	19.47	19.47	80.53
1/4"	6.35	1.55	1.20	20.67	79.33
4	4.76	0.00	0.00	20.67	79.33
10	2.00	1.26	0.98	21.65	78.35
20	0.85	2.16	1.68	23.33	76.67
40	0.425	6.68	5.18	28.51	71.49
60	0.25	13.78	10.69	39.20	60.80
100	0.15	25.30	19.63	58.82	41.18
200	0.075	36.91	28.63	87.46	12.54
pan	---	16.17	12.54	100.00	---
		128.91			



D_{10} = NA

D_{30} = 0.115

D_{60} = 0.246

Cu = NA

Cc = NA

USCS: SM (Silty sand with gravel)

R_{200} = 87.46

R_4 = 20.67

R_4/R_{200} = 0.24

SF = 66.78

GF = 20.67

% Gravel = 20.67

% Sand = 66.78

% Silt & Clay = 12.54

% Clay = NA

CFEM: Gravelly Sand, some Silt/Clay

Moisture Content (%): 19.18

GRAIN SIZE ANALYSIS

Project : 3079 - Lawn, NL

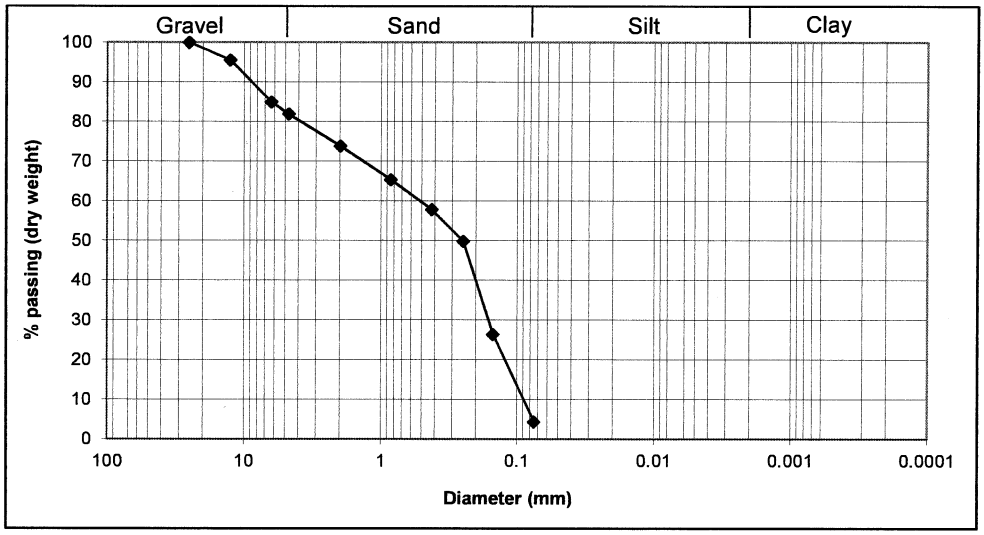
Sample No. : BH2-SS2

Depth below LNT: 3.03 m - 3.80 m

Sieve Analysis

Dry weight of sample (g) = 434.78

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret.	% Passing
2	50.8	0.00			
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	19.68	4.53	4.53	95.47
1/4"	6.35	45.72	10.52	15.04	84.96
4	4.76	13.22	3.04	18.08	81.92
10	2.00	34.92	8.03	26.11	73.89
20	0.85	36.91	8.49	34.60	65.40
40	0.425	32.76	7.53	42.14	57.86
60	0.25	34.77	8.00	50.14	49.86
100	0.15	102.07	23.48	73.61	26.39
200	0.075	96.11	22.11	95.72	4.28
pan	---	18.62	4.28	100.00	---
		434.78			



D_{10} = 0.09

D_{30} = 0.162

D_{60} = 0.525

Cu = 5.83

Cc = 0.56

USCS: SP (Poorly graded sand with gravel)

R_{200} = 95.72

R_4 = 18.08

R_4/R_{200} = 0.19

SF = 77.63

GF = 18.08

% Gravel = 18.08

% Sand = 77.63

% Silt & Clay = 4.28

% Clay = NA

CFEM: Sand, some Gravel, trace Silt/Clay

Moisture Content (%): 22.18

GRAIN SIZE ANALYSIS

Project : 3079 - Lawn, NL

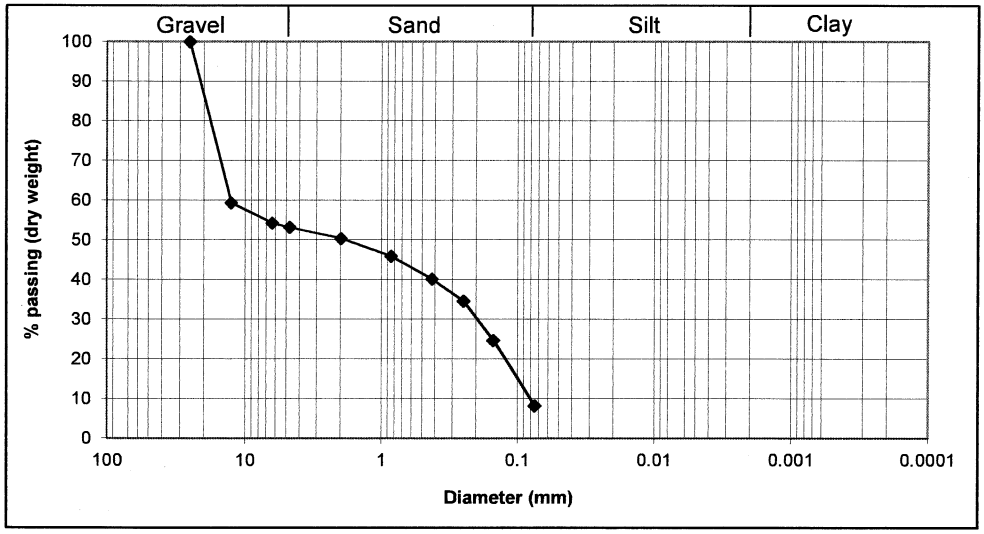
Sample No. : BH3-SS1

Depth below LNT: 2.86 m - 3.46 m

Sieve Analysis

Dry weight of sample (g) = 96.87

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret.	% Passing
2	50.8	0.00			
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	39.39	40.66	40.66	59.34
1/4"	6.35	4.96	5.12	45.78	54.22
4	4.76	1.02	1.05	46.84	53.16
10	2.00	2.65	2.74	49.57	50.43
20	0.85	4.35	4.49	54.06	45.94
40	0.425	5.59	5.77	59.83	40.17
60	0.25	5.40	5.57	65.41	34.59
100	0.15	9.61	9.92	75.33	24.67
200	0.075	15.99	16.51	91.83	8.17
pan	---	7.91	8.17	100.00	---
		96.87			



D_{10} = 0.082

D_{30} = 0.198

D_{60} = 12.7

Cu = 154.88

Cc = 0.04

USCS: GP-GM (Poorly graded gravel with silt and sand)

R_{200} = 91.83

R_4 = 46.84

R_4/R_{200} = 0.51

SF = 45.00

GF = 46.84

% Gravel = 46.84

% Sand = 45.00

% Silt & Clay = 8.17

% Clay = NA

CFEM: Gravel and Sand, trace Silt/Clay

Moisture Content (%): 44.22

GRAIN SIZE ANALYSIS

Project : 3079 - Lawn, NL

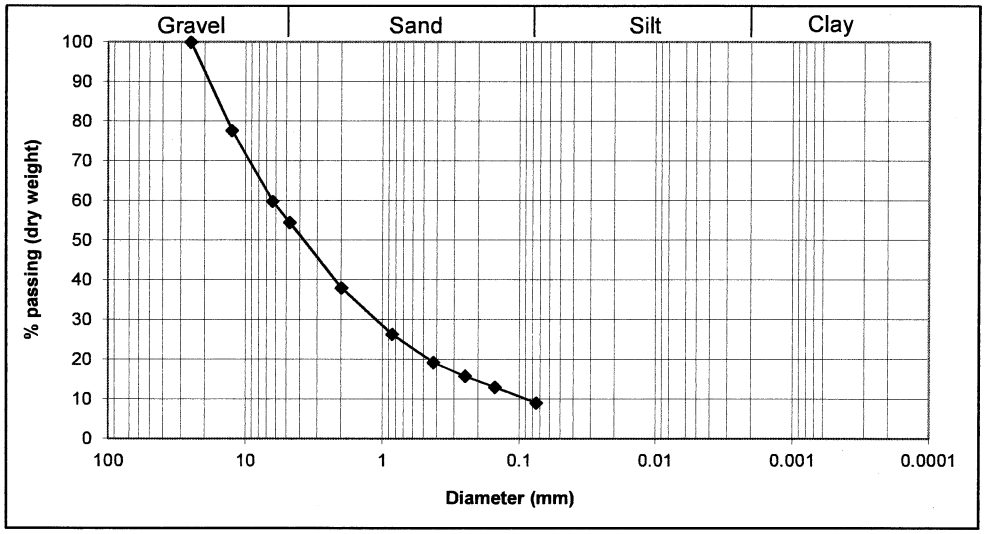
Sample No. : BH3-SS6

Depth below LNT: 10.89 m - 11.07 m

Sieve Analysis

Dry weight of sample (g) = 304.97

Sieve	Opening (mm)	Retained (g)	% Retained	Cumulative % Ret.	% Passing
2	50.8	0.00			
1	25.4	0.00	0.00	0.00	100.00
1/2"	12.7	68.27	22.39	22.39	77.61
1/4"	6.35	54.37	17.83	40.21	59.79
4	4.76	16.28	5.34	45.55	54.45
10	2.00	50.11	16.43	61.98	38.02
20	0.85	35.75	11.72	73.71	26.29
40	0.425	21.54	7.06	80.77	19.23
60	0.25	10.55	3.46	84.23	15.77
100	0.15	8.64	2.83	87.06	12.94
200	0.075	12.06	3.95	91.02	8.98
pan	---	27.40	8.98	100.00	---
		304.97			



D_{10} = 0.089

D_{30} = 1.12

D_{60} = 6.45

Cu = 72.47

Cc = 2.19

USCS: SW-SM (Well-graded sand with silt and gravel)

R_{200} = 91.02

R_4 = 45.55

R_4/R_{200} = 0.50

SF = 45.46

GF = 45.55

% Gravel = 45.55

% Sand = 45.46

% Silt & Clay = 8.98

% Clay = NA

CFEM: Gravel and Sand, trace Silt/Clay.

Moisture Content (%): 6.45