Trow

Geotechnical Investigation
Sewage Lagoon
Hamlet of Arctic Bay, Nunavut

Prepared for:
Government of Nunavut
Department of Community and Government Services
Project Management Division – Baffin Region

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Executive Summary

A geotechnical investigation was undertaken at the site of the existing sewage lagoon and the proposed sewage lagoon in the Hamlet of Arctic Bay, Nunavut. This work was requested by the Government of Nunavut on July 18, 2007.

It is proposed to construct a new lagoon approximately 800 m northwest of the existing lagoon and to decommission the existing lagoon.

The investigation has revealed that the berms of the existing lagoon comprise of sand and gravel fill which extends to 1.2 m to 1.7 m. The fill is underlain by silty sand to sandy gravel.

The area of the proposed new lagoon is located in an approximately 70 m to 90 m wide and 7 to 12 m deep valley. A pond is located in part of the area proposed for construction of the lagoon. It is proposed to construct two berms (northwest and southeast) across the valley to create the sewage lagoon. The investigation has revealed that the natural soils are permeable, ice rich layered sand and gravel, silty sand and silty sand till which extend to the bedrock surface. Ice layers, which varied in thickness from 0.5 m to 3.7 m were encountered in the majority of the boreholes drilled at the site. The overburden soils close to the toe of the southwest wall of the valley are underlain by Galbro bedrock at a depth of 1.6 m (elevation 95.8 to 95.9 m). The overburden soils close to the toe of the northeast valley wall are underlain by Quartzate bedrock at a depth of 1.5 m to 2.5 m (Elevation 94.4 m to 94.9 m). Galbro bedrock was encountered at 3.8 m depth (Elevation 93.2 m) in Borehole 8 drilled in the bottom of the valley. However, bedrock was not encountered in any of the other boreholes (Boreholes 5, 7, 9 and 11) drilled in the valley bottom to a depth of 3.7 m to 5.5 m (Elevation 91.3 m and 93.5 m). These observations indicate that the bedrock in the bottom of the valley likely slopes down towards the northwest and southeast from the high point at Elevation 93.2 m in the vicinity of Borehole 8.

The investigation has revealed that the soils on the site are ice rich. Therefore, construction of conventional berms for the lagoons would experience large settlements due to thaw of the underlying soils. Also, the on-site soils are permeable and as such the lagoons would have to be lined. Installation of synthetic liners in lagoons constructed on ice rich soils are likely to rupture because of the anticipated large settlements. The exception to this is if the soils underlying the berms are maintained in a constantly frozen state. This may be achieved by installation of thermosyphons. In this case, the berms would not experienced large settlements due to permafrost degradation. However, the lagoons would have to be lined to prevent excessive seepage out of the lagoons. The lagoons may be lined fully or liner incorporated in the berms and sealed into the permafrost. An alternative would be to construct the berms as 'ice dams' i.e. the soil in the core of the berms and the underlying ice rich soils are maintained in a permanently frozen state. In this case, the frozen soil would act as a liner.

It is recommended that a geothermal analysis should be performed to determine if agradation of the frost into the berms and the underlying natural soils can be achieved naturally or would require installation of thermosyphons.

Stability of slope analyses were performed to determine the steepest slopes of the berms that would be stable under prevailing conditions. The analyses assumed that the berms would either be lined or constructed as 'ice dams' and that in either case, the underlying foundation soils will be maintained in a constantly frozen state. If the berms are lined, seepage through the berms is not expected. The exception to this is if the liner leaks or if any of the joints fail. If the berms are constructed as 'ice dams', the central core of the berms would be maintained in a constantly frozen state. However, the outside and inside slopes of the berms would be subjected to seasonal freezing and thawing. For these reasons, the inside slopes of the berms were analysed for completely submerged case whereas the outside slopes of the berms were analysed for steady stated seepage conditions. Static as well as seismic loading were considered for each case.

The analysis revealed that the inside and outside slopes of the southeast berm would be stable when constructed at a slope of 3H:1V. An upstream and downstream slope of 3H:1V would meet the requisite factor of safety for the northwest berm.

The stability of slope analysis has also revealed that if the berms are to be designed for rapid drawdown condition, inside slope of 3.5 H:1V would be required for the southeast berm and 4H:1V for the northwest berm.

The above and other related considerations have been discussed in greater detail in the report.

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Figures

1.0 Introduction

A geotechnical investigation was undertaken at the site of the existing sewage lagoon and at the site of the proposed sewage lagoon in the Hamlet of Arctic Bay, Nunavut. This work was authorized by the Government of Nunavut on July 18, 2007.

It is proposed to construct a new sewage lagoon approximately 800 m northwest of the existing lagoon. The lagoon is to be located in an existing valley. The existing lagoon is to be decommissioned subsequent to construction of the new lagoon.

Trow terms of reference for the geotechnical investigation were as follows:

(1) Establish geotechnical profile of the existing lagoon berm ;

(2) Establish the geotechnical profile at the location of the proposed lagoon; and

(3) Make recommendations regarding the design and construction of the new lagoon from a geotechnical perspective.

The comments and recommendations given in this report are based on the assumption that the above-described design concept will proceed into construction. If changes are made either in the design phase or during construction, this office must be retained to review these modifications. The result of this review may be a modification of our recommendations or it may require additional field or laboratory work to check whether the changes are acceptable from a geotechnical viewpoint.

2.0 Procedure

2.1. Drilling and Soil Sampling

The fieldwork for the geotechnical investigation was undertaken between August 25 and August 30, 2007 with a Hilti drill rig. The fieldwork was supervised by a representative of Trow Associates Inc. (Trow) on a full time basis.

The fieldwork consisted of drilling 12 boreholes to depths varying between 1.65 m and 5.5 m. The locations of the boreholes are shown on Site Plan, Figures 1 and 1A.

The boreholes were initially advanced by performing continuous standard penetration tests and retrieving the soil samples. However, the boreholes could only be advanced by this method in unfrozen soil to a depth of 0.6 m to 1.7 m below which frost was encountered. The boreholes were then cased and advanced by core drilling techniques with the Hilti drill rig. Most of the boreholes were drilled by dry coring. Water was used in cases where the core barrel could not be advanced by dry coring. During core drilling, a careful record of colour of wash water, wash water return and any sudden drops of the drill rods was kept.

Thermisters were installed in Boreholes 7 and 11 to monitor the ground temperatures.

Water level observations were made in the boreholes during the course of the fieldwork. All the soil samples were visually examined in the field for textural classification, preserved in plastic bags and identified. The boreholes were logged. Similarly, the rock core was placed in the core boxes, identified and logged. On completion of drilling, all the soil samples and rock core were transported to the Trow laboratory in the City of Ottawa.

The locations and elevations of the boreholes were established by representative of Trow Associates Inc. The elevations of the borehole refer to the Geodetic datum.

All the soil samples and rock core were visually examined in the laboratory by a geotechnical engineer and borehole logs prepared. The engineer also assigned the laboratory testing. The laboratory testing consisted of performing natural moisture content on all the samples and grain size analysis, on selected soil samples.

3.0 Site and Soil Description

Arctic Bay is located on the Borden Peninsula of Baffin Island, Nunavut (Figure 1). This northern community is connected by a 21 km road to the mining Town of Nanisivik. The present sewage lagoon, which services approximately 640 residents, is located 2.5 km west of the community of Arctic Bay.

The proposed lagoon will be located approximately 800 metres northwest of the existing lagoon in a valley. The ground surface elevations in the bottom of the valley vary from Elevation 97.0 m to 97.5 m approximately at borehole locations. The ground surface on the northeast side of the valley rises to Elevation 102 m at the north end to Elevation 110 m at the south end. The ground surface on the southwest side of the valley rises to Elevation 105 m approximately. It is proposed to construct two berms across the valley to create the lagoon. The top of the berms would be at Elevation 103.0 m approximately. The height of the berms will therefore vary from 6.0 m to 6.5 m.

A detailed description of the geotechnical conditions encountered in the eleven boreholes drilled are given on Borehole Logs, Figures 2 to 13 inclusive. The borehole logs and related information depict subsurface conditions only at the specific locations and times indicated. Subsurface conditions and water levels at other locations may differ from conditions at the locations where sampling was conducted. The passage of time also may result in changes in the conditions interpreted to exist at the locations where sampling was conducted. Boreholes were drilled to provide representation of subsurface conditions as part of a geotechnical exploration program and are not intended to provide evidence of potential environmental conditions.

3.1. Existing Lagoon

Borehole 1 to 3 inclusive were drilled on top of the existing ice pack holding area. This lagoon is to be decommissioned once the new lagoon has been constructed and is operational. A review of the borehole logs (Figures 2 to 4) indicates that the surficial soil in Boreholes 1 to 3 is fill placed for construction of the berms. It is estimated that the fill extends to a depth of 1.2 m in Borehole 1 to 2 and to the entire depth investigated in Borehole 3 (1.7 m). The fill comprises of sand and gravel to sandy gravel with some silty sand layers. The results of a grain size analyses performed on samples of the fill from Borehole 1 is shown on Figure 14. A review of this figure indicates that the composition of the fill consist of 7 percent clay, 5 percent silt, 30 percent sand and 58 percent gravel. The permeability of the fill was estimated as 2.5×10^{-5} cm/sec (Table 1).

Table 1
Estimated Permeability of On-site Soils

Borehole #	Depth (m)	Soil Description	Estimated Permeability (cm/sec)	Figure No.
1	0.6 – 1.2	Sandy gravel, some silt (fill)	2.5×10^{-5}	14
2	1.2 – 1.8	Gravel, some sand	1.6×10^{-3}	15
5	0 – 0.6	Silty sand, some clay (topsoil)	$<1 \times 10^{-6}$	16
8	0.3 – 0.6	Sandy gravel, some silt	4×10^{-4}	17
12	0.6 – 1.2	Sand and gravel, some silt	1.7×10^{-4}	18
10	1.3 – 1.6	Sand, some silt and gravel	3.6×10^{-5}	19
11	1.2 – 1.5	Gravelly sand, some silt, trace clay	4×10^{-6}	20
9	0.6 – 1.2	Silty gravelly sand	1.2×10^{-5}	21

The fill in Borehole 1 is underlain by silty sand to the entire depth investigated (1.65 m) whereas sandy gravel underlies the fill in Borehole 2 and extends to the entire depth investigated (1.8 m). A grain size analysis performed on the sandy gravel stratum from Borehole 2 yielded a soil composition of 3 percent clay, 8 percent silt, 16 percent sand and 73 percent gravel (Figure 15). The permeability of this stratum was estimated as 1.6×10^{-3} cm/sec. The permeability of the soil was estimated using Hazen's Formula*.

3.2. Proposed Lagoon

Boreholes 4 to 6 were drilled at the location of the proposed southeast berm whereas Boreholes 10 to 12 were located at the proposed location of the northwest berm. Boreholes 7 to 9 were located in the lagoon area (Figure 1A).

The area of the proposed lagoon contains 50 mm to 400 mm of topsoil. A grain size analysis performed on a sample of the topsoil from Borehole 5 revealed a soil composition of 15 percent clay, 29 percent silt, 49 percent sand and 7 percent gravel (Figure 16). The topsoil in Boreholes 5, 7, 8 and 12 is underlain by a sand and gravel stratum which extends to 1.2 m to 2.8 m depth (Elevation 94.2 m to 95.7 m). Two grain size analyses performed on this stratum are given on Figures 17 and 18. A review of these figures indicates that this stratum contains 4 to 5 percent clay, 11 to 16 percent silt, 34 to 35 percent sand and 45 to 50 percent gravel. Its permeability varies from 4×10^{-4} cm/sec to 1.7×10^{-4} cm/sec.

* Hazen A (1892) "Physical Properties of sands and gravels with reference to their use in filtration", Rept. Mass. State Board of Health.

The topsoil in Boreholes 6 and 11 is underlain by sandy gravel to gravelly sand to 0.6 m to 1.5 m depth (Elevation 95.3 m to 96.3 m). This stratum contains 4 percent clay, 16 percent silt, 35 percent sand and 45 percent gravel (Figure 20). Its permeability is 4 x 10^{-6} cm/sec.

The topsoil in Boreholes 4 and 10, sand and gravel in Borehole 5 and the sandy gravel in Borehole 6 are underlain by silty sand to 1.5 m to 1.6 m depth (Elevation 95.3 m to 95.9 m). This stratum contains 5 percent clay, 21 percent silt, 57 percent sand and 17 percent gravel (Figure 19). Its permeability is in the order of 3.6 x 10^{-5} cm/sec.

A layer of ice was encountered underlying the silty sand in Boreholes 5 and 6, sand and gravel in Borehole 8, 11 and the topsoil in Borehole 9. The ice layer extends to 1.2 m to 5.2 m depth (Elevation 91.6 m to 96.0 m).

The ice in Boreholes 5, 6, 9 and 11 is underlain by silty sand till to 2.5 m to 5.5 m depth (Elevation 91.3 m to 94.4 m). This stratum contains 7 percent clay, 25 percent silt, 41 percent sand and 27 percent gravel (Figure 21). The permeability of the till was computed as 1.7 x 10^{-4} cm/sec.

The silty sand in Boreholes 4 and 10 and the ice in Borehole 8 are underlain by Gasbro bedrock to the entire depth investigated i.e. 3.5 m to 5.2 m (Elevation 91.8 m to 93.9 m). The bedrock is grey to black in colour and massive. It contains some inclined fractures. A Total Core Recovery (TCR) and Rock Quality Designation (RQD) of 40 to 100 percent and 0 to 83 percent respectively was encountered when core drilling the bedrock. On this basis, the bedrock quality may be described as very poor to good quality.

The silty sand till in Borehole 6 and the sand and gravel stratum in Borehole 12 are underlain by Quartzite bedrock. The bedrock is beige to grey in colour and contains calcite intrusions. It is of very poor quality as indicated by Total Core Recovery (TCR) and Rock Quality Designation (RQD) of 40 to 100 percent and 0 percent respectively.

Thermisters were installed in Boreholes 7 and 10 to monitor the ground temperatures. The measured ground temperatures have been tabulated on Table 2.

Table 2
Results of Ground Temperature Monitoring

Borehole #	Depth Below GS (m)	Temperature Reading	
		September 10, 2007	September 18, 2007
10	0	-1°C	-1°C
	0.5	-2°C	-2°C
	1.0	-3.2°C	-3°C
	1.5	-4.2°C	-4°C
	2.0	-5.1°C	-5°C
	2.5	-6.0°C	-5.6°C
	3.0	-6.7°C	-6.5°C
7	0.3	5.3°C	2°C
	0.8	5.1°C	1°C
	1.3	5.2°C	1°C
	1.8	1.4°C	0.5°C
	2.3	0.7°C	0°C
	2.8	0.3°C	0°C
	3.3	0°C	-0.5°C
	3.8	-1.5°C	-1.5°C
	4.3	-2°C	-2°C
	4.8	-2.8°C	-3°C

4.0 Discussion

The geotechnical investigation has revealed that the site of the proposed lagoon construction is underlain by ice rich soils which contain ice layers up to 3 m thick. The on site ice rich soils are prone to thaw due to degradation of the permafrost because of construction of the lagoon. This will result in large settlements of the berms.

In addition, the on site soils are permeable and are not suitable for construction of a water tight lagoon. For construction of a water tight lagoon, a synthetic liner would be required. Any liner installed in the lagoon constructed on ice rich soils may rupture due to the large settlements that the berms may experience.

It is therefore considered that there are two alternatives available. The first alternative is to maintain the founding soil underlying the berms in a permanently frozen state and construct conventional berms. This would require installation of thermosyphons to maintain the founding soils in a permanently frozen state. The lagoon may be fully lined or only the berms lined and the liners anchored into the permafrost. The second alternative is to construct the berms of the lagoon as 'ice dams' i.e. maintain the central core of the berms and the underlying natural soils in a constantly frozen state. In this case, the frozen soil will act as a liner. For this purpose, a geothermal analysis should be performed to determine if the agradation of the permafrost into the berms can be achieved by natural process and the time required for this to occur. If the analysis indicates that agradation of the permafrost into the berms cannot be achieved by natural means or that this time required to achieve this would be long, it may be necessary to install thermosyphons in the berms to maintain the central core of the berms and the underlying foundation soils in a constantly frozen state.

5.0 Slope Stability Analysis

It is noted that with 'ice dam' method of construction of the berms, the central core of the berms and the underlying foundation soils would be permanently maintained in a frozen state. However, the surfaces of the inside and outside slopes of the berms would be subject to seasonal freezing and thawing. Also, although the permeability of the frozen soil is very low, it is feasible that a steady state seepage condition may develop in the berms over a long period of time. Therefore, the stability of slope analyses to compute the design side slopes of the berms were based on unfrozen soils. It is considered that this assumption will also be valid for a lined lagoon since these conditions may develop if the liner gets damaged or if the joint(s) fail. However, the analyses assumed that the underlying founding soils would be maintained in a permanently frozen state.

The stability of the slopes was analyzed by using Bishop's Modified Method. Slope/W. Geoslope office, Version 4.23 Computerized system was used to assess stability of the slopes. Two cross-sections of the berm (Cross-Section AA and BB) were analysed. These represent the proposed southeast (Section AA) and northwest berms (Section BB) of the lagoon. The locations of the cross-sections are shown on Figure 1A.

The following assumptions were made in the slope stability analyses:

(1) The crest of the berm is at Elevation 103.0 m. The crest width of the berm is 5 m. The inside and outside slopes of the southeast berm were analysed for a slope of 3.0H:1V and 3.5H:1V. The inside slope of the northwest berm was analysed for an inclination of 3H:1V and 3.5H:1V. The outside slope of this berm was analysed for a slope of 3.5H:1V and 4H:1V.

(2) The berms will be constructed with silty sand and gravel fill which contains some cobbles and boulders. The berms would be founded on silty sand to sandy silt soils which are ice rich.

(3) The ice rich soils underlying the berms would be maintained in a permanently frozen state.

(4) The engineering properties of the various layers were assumed to be as follows:

Soil Type	Unit Weight (kN/m3)	Effective Cohesion c' (kPa)	Effective Angle of Internal Friction ϕ (degrees)
Sand and Gravel	22	0	34
Sandy Gravel	22	0	34
Ice	9	100	0
Sandy Gravel and Silty Sand Till	22	0	34

(5) The water level in the pond would be at Elevation 102.0 m approximately or lower and that the berms would not be overtopped at any time. Also, the berms would not be subject to rapid drawdown condition.

The inside slopes were analysed for a fully submerged condition whereas the outside slopes were analysed for steady state seepage condition. The analysis was performed for static as well as seismic loading conditions.

The results of the analyses are given on Figures 22 to 41 inclusive and have been tabulated on Table 3.

Table 3
Computed Factors of Safety for Upstream and Downstream Berm Slopes

Slope Section	Slope Identification	Slope Inclination	Loading Condition	Computed Factor of Safety	Figure #
AA South East Berm	Upstream Slope (inside)	3H:1V	Completely submerged	2.29	22
		3.H:1V	Completely submerged with seismic loading	1.80	23
		3H:1V	Lagoon drained. Water level in berms at Elevation 99.0 m	1.58	24
		3H:1V	Lagoon drained. Water level in berms at Elevation 92.0 m with seismic loading	1.38	25
		3.5H:1V	Completely submerged	2.60	26
		3.5H:1V	Completely submerged with seismic loading	1.97	27
	Downstream Slope (outside)	3.0H:1V	Steady state seepage	1.54	28
		3.0H:1V	Steady state seepage with seismic loading	1.35	29
		3.0H:1V	Lagoon drained. Water level in berms at Elevation 99.0 m	1.73	30
		3.0H:1V	Lagoon drained. Water level in berms at Elevation 99.0 m with seismic loading	1.50	31
		3.5H:1V	Steady state seepage	1.58	32
		3.5H:1V	Steady state seepage with seismic loading	1.36	33

Table 3 (cont.)
Computed Factors of Safety for Upstream and Downstream Berm Slopes

Slope Section	Slope Identification	Slope Inclination	Loading Condition	Computed Factor of Safety	Figure #
BB	Upstream Slope (inside)	3H:1V	Completely submerged	2.19	34
		3H:1V	Completely submerged with seismic loading	1.72	35
		3.5H:1V	Completely submerged	2.54	36
		3.5H:1V	Completely submerged with seismic loading	1.92	37
	Downstream Slope (outside)	3.0H:1V	Steady state seepage	1.52	38
		3.0H:1V	Steady state seepage with seismic loading	1.33	39
		4H:1V	Steady state seepage	1.89	40
		4H:1V	Steady state seepage with seismic loading	1.59	41

Based on current practice in the industry, a minimum factor of safety of 1.5 is required for static loading conditions and a factor of safety of 1.1 for seismic loading conditions. A review of Table 3 indicates that a 3.H:1V upstream and downstream slope would satisfy the requisite factors of safety for the southeast berm. An upstream and downstream slope of 3H:1V would meet the requisite factors of safety for the northwest berm. Therefore, these slopes may be used in the design. However, it is noted that geothermal considerations may require the inside slope of the berms to be constructed at a flatter inclination than recommended.

It is noted that the computed slopes would be stable provided that the berms are not overtopped, that they are not subjected to rapid drawdown conditions and that the underlying ice rich soils are permanently maintained in a frozen state.

6.0 Rapid Drawdown Condition

The upstream slope was also analysed for rapid drawdown condition. The results are given on Table 4.

Table 4
Computed Factors of Safety of Inside Slope of the Berms for Rapid Drawdown Condition

Section	Slope Inclination	Loading Condition	Computed Factor of Safety	Figure #
AA	3.5H:1V	Static	1.53	42
AA	3.5H:1V	Seismic	1.33	43
BB	4H:1V	Static	1.51	44
BB	4H:1V	Seismic	1.29	45

A review of Table 4 indicates that an upstream slope of 3.5H:1V would have adequate factor of safety for the rapid drawdown condition in the case of the southeast berm. A slope inclination of 4H:1V would have adequate factor of safety against the rapid drawdown condition in the case of the northwest berm. Consequently, if the berms are to be designed to satisfy rapid drawdown conditions, the inside slope of the southeast berm should be constructed at a slope of 3.5H:1V whereas the inside slope of the northwest berm should be constructed at an inclination of 4H:1V.

7.0 Erosion Protection

It is noted that the computed upstream and downstream slope of inclinations will be stable provided that the berms are not overtopped. Potential exists for considerable erosion and possibly failure of the berms if overtopped. Overtopping of the berms may be prevented by construction of a proper spillway structure which is capable of holding the overflow.

8.0 General Comments

The comments given in this report are intended only for the guidance of design engineers. The number of boreholes required to determine the localized underground conditions between boreholes affecting construction costs, techniques, sequencing, equipment, scheduling, etc., would be much greater than has been carried out for the design purposes. Contractors bidding on or undertaking the works should, in this light, decide on their own investigations, as well as their own interpretations of the factual borehole results, so that they may draw their own conclusions as to how the subsurface conditions may affect them.

The information contained in this report is not intended to reflect on environmental aspects of the soils. Should specific information be required, including for example, the presence of pollutants, contaminants or other hazards in the soil, additional testing may be required.

We trust that the information contained in this report will be satisfactory for your purposes. Should you have any questions, please do not hesitate to contact this office.

Trow Associates Inc.

REGISTERED PROFESSIONAL ENGINEER
Apr 1 25/08
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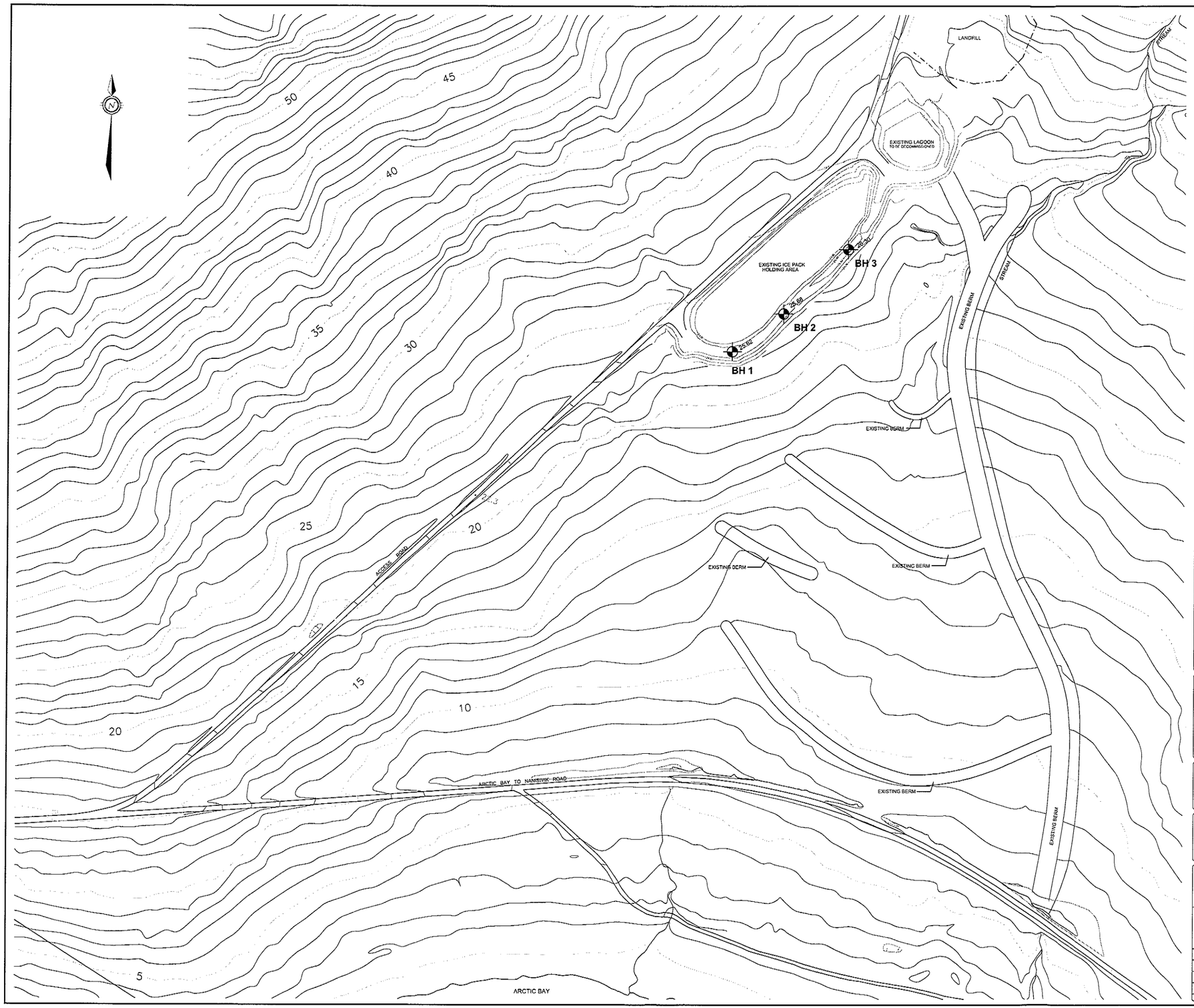
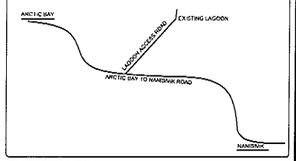
Figures



KEY PLAN

PROPOSED LAGOON



LEGEND

BH 3 — BOREHOLE NUMBER AND LOCATION

65.47 — EXISTING ELEVATION

NOTES :

1. THE BOUNDARIES AND SOIL TYPES HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES THEY ARE ASSUMED AND MAY BE SUBJECT TO CONSIDERABLE ERROR.
2. SOIL SAMPLES AND ROCK WILL BE RETAINED IN STORAGE FOR THREE MONTHS AND THEN DESTROYED UNLESS THE CLIENT ADVISES THAT AN EXTENDED TIME PERIOD IS REQUIRED.
3. TOPSOIL QUANTITIES SHOULD NOT BE ESTABLISHED FROM THE INFORMATION PROVIDED AT THE BOREHOLE LOCATIONS.
4. BOREHOLE ELEVATIONS SHOULD NOT BE USED TO DESIGN BUILDING(S) OR FLOOR SLABS OR PARKING LOT(S) GRADES.
5. THIS DRAWING FORMS PART OF THE REPORT PROJECT NUMBER AS REFERENCED AND SHOULD BE USED ONLY IN CONJUNCTION WITH THIS REPORT.
6. BASE PLAN OBTAINED FROM TROW ASSOCIATES INC. PROJECT OTCD00019054A DRAWING ES-1 DATED SEPT 10, 2007

BENCH MARK

BM 1 ELEV. = 59.12

CONTOUR ELEVATIONS WERE DERIVED FROM NAD 83 CONTROL MONUMENT 7038914 LOCATED NORTH OF THE ARCTIC BAY AIRPORT UNDER CONSTRUCTION.

No.	DESCRIPTION	DATE	BY	APP'D

REVISIONS

0 10m 30m 60m

HORIZONTAL 1:1000

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CLIENT

GOVERNMENT OF NUNAVUT

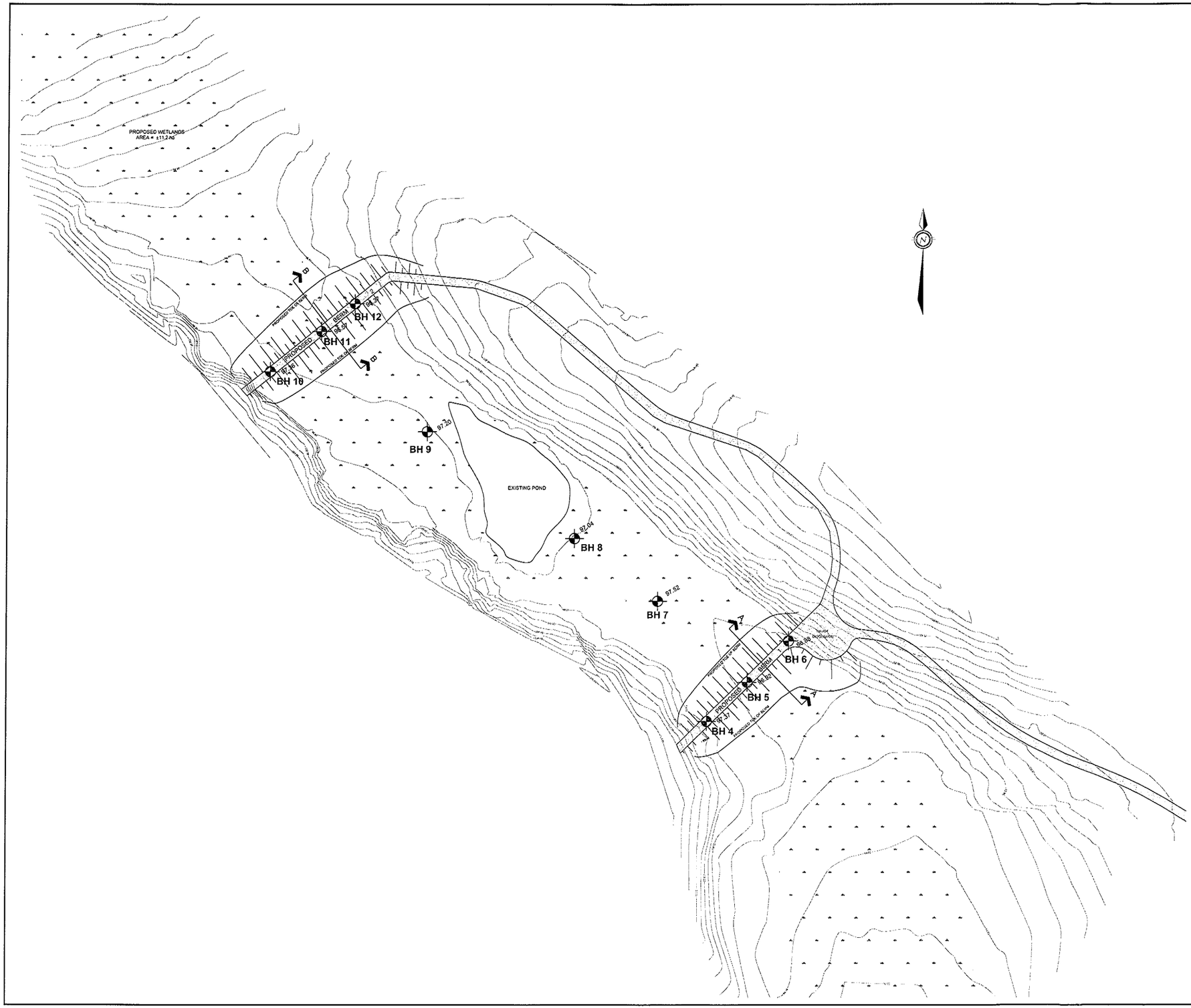
PROJECT

ARCTIC BAY WASTEWATER LAGOON

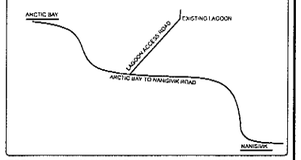
TITLE

BOREHOLE LOCATION PLAN

design by	S. AGGARWAL	project	OTGE00019054B
drawn by	M. NUGENT	drawing no.	FIG. 1
checked by	S. AGGARWAL		
date	30/11/2007		
scale	S. AGGARWAL		



KEY PLAN



LEGEND

BH 3 — BOREHOLE NUMBER AND LOCATION

65.41 — EXISTING ELEVATION

NOTES :

1. THE BOUNDARIES AND SOIL TYPES HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES THEY ARE ASSUMED AND MAY BE SUBJECT TO CONSIDERABLE ERROR.
2. SOIL SAMPLES AND ROCK WILL BE RETAINED IN STORAGE FOR THREE MONTHS AND THEN DESTROYED UNLESS THE CLIENT ADVISES THAT AN EXTENDED TIME PERIOD IS REQUIRED.
3. TOPSOIL QUANTITIES SHOULD NOT BE ESTABLISHED FROM THE INFORMATION PROVIDED AT THE BOREHOLE LOCATIONS.
4. BOREHOLE ELEVATIONS SHOULD NOT BE USED TO DESIGN BUILDING(S) OR FLOOR SLABS OR PARKING LOT(S) GRADES.
5. THIS DRAWING FORMS PART OF THE REPORT PROJECT NUMBER AS REFERENCED AND SHOULD BE USED ONLY IN CONJUNCTION WITH THIS REPORT.
6. BASE PLAN OBTAINED FROM TROW ASSOCIATES INC. PROJECT OTCD00019054A DRAWING OP-1 DATED SEPT. 10, 2007

BENCH MARK

BM 1 — ELEV. = 59.12

CONTOUR ELEVATIONS WERE DERIVED FROM NAD 83 CONTROL MONUMENT 7038914 LOCATED NORTH OF THE ARCTIC BAY AIRPORT UNDER CONSTRUCTION.

No.	DESCRIPTION	DATE	BY	APP'D

REVISIONS

0 10m 20m 40m
HORIZONTAL 1:1000

Trow Associates Inc.
154 Colonnade Road South
Ottawa, Ont. K2E 7J5
Tel:(613)225-9940
Fax:(613)225-7337

CLIENT
GOVERNMENT OF NUNAVUT

PROJECT
ARCTIC BAY WASTEWATER LAGOON

TITLE
BOREHOLE LOCATION PLAN

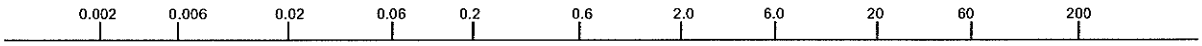
design by	S. AGGARWAL	project no.	OTCD00019054B
drawn by	M. NUGENT	drawing no.	FIG 1A
checked by	S. AGGARWAL		
date	30/11/2007		
scale	1:1000		

Notes On Sample Descriptions

1. All sample descriptions included in this report follow the Canadian Foundations Engineering Manual soil classification system. This system follows the standard proposed by the International Society for Soil Mechanics and Foundation Engineering. Laboratory grain size analyses provided by Trow Associates Inc. also follow the same system. Different classification systems may be used by others; one such system is the Unified Soil Classification. Please note that, with the exception of those samples where a grain size analysis has been made, all samples are classified visually. Visual classification is not sufficiently accurate to provide exact grain sizing or precise differentiation between size classification systems.

ISSMFE SOIL CLASSIFICATION

CLAY	SILT			SAND			GRAVEL			COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE		



EQUIVALENT GRAIN DIAMETER IN MILLIMETRES

CLAY (PLASTIC) TO	FINE	MEDIUM	CRS.	FINE	COARSE
SILT (NONPLASTIC)	SAND			GRAVEL	

UNIFIED SOIL CLASSIFICATION

2. Fill: Where fill is designated on the borehole log it is defined as indicated by the sample recovered during the boring process. The reader is cautioned that fills are heterogeneous in nature and variable in density or degree of compaction. The borehole description may therefore not be applicable as a general description of site fill materials. All fills should be expected to contain obstruction such as wood, large concrete pieces or subsurface basements, floors, tanks, etc., none of these may have been encountered in the boreholes. Since boreholes cannot accurately define the contents of the fill, test pits are recommended to provide supplementary information. Despite the use of test pits, the heterogeneous nature of fill will leave some ambiguity as to the exact composition of the fill. Most fills contain pockets, seams, or layers of organically contaminated soil. This organic material can result in the generation of methane gas and/or significant ongoing and future settlements. Fill at this site may have been monitored for the presence of methane gas and, if so, the results are given on the borehole logs. The monitoring process does not indicate the volume of gas that can be potentially generated nor does it pinpoint the source of the gas. These readings are to advise of the presence of gas only, and a detailed study is recommended for sites where any explosive gas/methane is detected. Some fill material may be contaminated by toxic/hazardous waste that renders it unacceptable for deposition in any but designated land fill sites; unless specifically stated the fill on this site has not been tested for contaminants that may be considered toxic or hazardous. This testing and a potential hazard study can be undertaken if requested. In most residential/commercial areas undergoing reconstruction, buried oil tanks are common and are generally not detected in a conventional geotechnical site investigation.

3. Till: The term till on the borehole logs indicates that the material originates from a geological process associated with glaciation. Because of this geological process the till must be considered heterogeneous in composition and as such may contain pockets and/or seams of material such as sand, gravel, silt or clay. Till often contains cobbles (60 to 200 mm) or boulders (over 200 mm). Contractors may therefore encounter cobbles and boulders during excavation, even if they are not indicated by the borings. It should be appreciated that normal sampling equipment cannot differentiate the size or type of any obstruction. Because of the horizontal and vertical variability of till, the sample description may be applicable to a very limited zone; caution is therefore essential when dealing with sensitive excavations or dewatering programs in till materials.

Log of Borehole 1

Trow

Project No: OTGE00019054B

Project: Geotechnical Investigation - Existing Sewage lagoon

Location: Arctic Bay, Nunavut

Figure No. 2

Sheet No. 1 of 1

Date Drilled: 'August 25, 2007

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	▯	Natural Moisture Content	×
SPT (N) Value	o	Atterberg Limits	⊢—⊖
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOLE	SOIL/ROCK DESCRIPTION	Geodetic Elevation m	Depth m	Standard Penetration Test N Value / Shear Strength kPa	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Unit Weight kN/m³
		FILL Sandy gravel, fine to coarse, slightly cohesive, some silt, brown, moist to wet (loose to compact)	25.6	0	20 40 60 80 50 100 150 200 9 10	250 500 750 10 20 30		
		SILTY SAND Slightly cohesive, red brown, wet (very dense) Frozen below 1.6 m depth	24.4	1	160/275 mm			
		Refusal to split spoon sampler @ 1.65 m Depth	24.0					

NOTES:
1. Borehole/Test Pit data requires Interpretation by Trow before use by others
2. A 19 mm slotted standpipe was installed upon completion of drilling
3. Field work supervised by a Trow representative
4. See Notes on Sample Descriptions
5. This Figure is to read with Trow Associates Inc. report OTGE00019054B

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BH1TO1~1.GPJ TROW OTTAWA.GDT 23/1/08

Log of Borehole 2

Trow

Project No: OTGE00019054B

Project: Geotechnical Investigation - Existing Sewage lagoon

Location: Arctic Bay, Nunavut

Figure No. 3

Sheet No. 1 of 1

Date Drilled: 'August 25, 2007

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	▮▯	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢—○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOLE	SOIL/ROCK DESCRIPTION	Geodetic Elevation m	Depth
		FILL Sand and gravel, silty, occassional cobbles, brown to red brown, moist to wet (loose to dense)	25.7	0
		SANDY GRAVEL Silty, slightly cohesive, red brown, wet (dense) Frozen below 1.8 m depth	24.5	1
		Refusal @ 1.8 m Depth	23.9	

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 10 20 30

SAMPLES

Unit Weight kN/m³

7 10 31

NOTES:
1. Borehole/Test Pit data requires Interpretation by Trow before use by others
2. Borehole backfilled upon completion of drilling
3. Field work supervised by a Trow representative
4. See Notes on Sample Descriptions
5. This Figure is to read with Trow Associates Inc. report OTGE00019054B

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BH1TO1-1.GPJ TROW OTTAWA.GDT 23/1/08

Log of Borehole 3

Trow

Project No: OTGE00019054B

Project: Geotechnical Investigation - Existing Sewage lagoon

Location: Arctic Bay, Nunavut

Figure No. 4

Sheet No. 1 of 1

Date Drilled: 'August 25, 2007

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	▮	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢—⊖
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOLE	SOIL/ROCK DESCRIPTION	Geodetic Elevation m	Depth
		FILL Sandy gravel, silty, fine to coarse, brown, moist to wet (loose to very dense)	26.3	0
		Ice lenses below 1.3 m depth	24.6	1
		Refusal @ 1.68 m Depth		

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % / Atterberg Limits (% Dry Weight): 10 20 30

SAMPLES

Unit Weight kN/m³

9 ○ ×

46 ○ 141 ×

104 ○ 139 ×

NOTES:
1. Borehole/Test Pit data requires Interpretation by Trow before use by others
2. A 19 mm slotted standpipe was installed upon completion of drilling
3. Field work supervised by a Trow representative
4. See Notes on Sample Descriptions
5. This Figure is to read with Trow Associates Inc. report OTGE00019054B

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE BH1TO1~1.GPJ TROW OTTAWA.GDT 23/1/08

Log of Borehole 4

Trow

Project No: OTGE00019054B

Project: Geotechnical Investigation - New Sewage Lagoon

Location: Arctic Bay, Nunavut

Figure No. 5

Sheet No. 1 of 1

Date Drilled: 'August 28, 2007

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◫	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL/ROCK DESCRIPTION	Geodetic Elevation	Depth
		PEATY TOPSOIL ~300 mm	97.4 m	0
		SILTY SAND Trace clay, gravel and organics, brown (compact) Frozen below 1.4 m depth	97.1	
		GABBRO BEDROCK Grey to black, some inclined fractures, massive, medium to coarse grained	95.8	1
		Borehole Terminated @ 3.51 m Depth	93.9	2 3

Standard Penetration Test N Value: 20 40 60 80

Shear Strength: 50 100 150 200 kPa

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 10 20 30

SAMPLES

Unit Weight kN/m³

19

20

40/150 mm

44

NOTES:
1. Borehole/Test Pit data requires Interpretation by Trow before use by others
2. A 19 mm slotted standpipe was installed upon completion of drilling
3. Field work supervised by a Trow representative
4. See Notes on Sample Descriptions
5. This Figure is to read with Trow Associates Inc. report OTGE00019054B

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	1.63 - 2.39	93	57
2	2.39 - 2.69	92	83
3	2.69 - 3.51	97	80

LOG OF BOREHOLE NEWBH1TO1~1.GPJ TROW OTTAWA.GDT 26/11/07

Log of Borehole 5

Trow

Project No: OTGE00019054B

Project: Geotechnical Investigation - New Sewage Lagoon

Location: Arctic Bay, Nunavut

Figure No. 6

Sheet No. 1 of 1

Date Drilled: 'August 26, 2007

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◧	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL/ROCK DESCRIPTION	Geodetic Elevation	Depth
		TOPSOIL Slightly cohesive, organics, trace gravel, reddish brown, wet (very loose)	96.9 m	0
		SAND AND GRAVEL Fine to coarse, some ice lenses, frozen, reddish brown 75 mm thick ice layer	96.4	
		SILTY SAND Some gravel, slightly cohesive, reddish brown, wet	95.7	1
		ICE Some silty sand and gravel ~ 80 to 90 percent ice content	95.3	
		SILTY SAND Some gravel, slightly cohesive, reddish brown, wet	94.8	2
		Borehole Terminated @ 4.27 m Depth	92.6	3 4

Standard Penetration Test N Value: 20 40 60 80

Shear Strength: 50 100 150 200 kPa

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 10 20 30

4/150 mm

15

36/125 mm

SAMPLES: Run 1, Run 2, Run 3, Run 4, Run 5

Unit Weight kN/m³

NOTES:
1. Borehole/Test Pit data requires Interpretation by Trow before use by others
2. Borehole backfilled upon completion of drilling
3. Field work supervised by a Trow representative
4. See Notes on Sample Descriptions
5. This Figure is to read with Trow Associates Inc. report OTGE00019054B

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE NEWBH1TO1~1.GPJ TROW OTTAWA.GDT 26/11/07

Log of Borehole 6

Trow

Project No: OTGE00019054B

Project: Geotechnical Investigation - New Sewage Lagoon

Location: Arctic Bay, Nunavut

Figure No. 7

Feuille. 1 of 1

Date Drilled: 'August 27, 2007

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◫	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢—○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOLE	DESCRIPTION DU SOL	Depth Below Grade	Depth
			96.9m	0
		TOPSOIL ~150 mm	96.8	
		SANDY GRAVEL Silty, slightly cohesive, ice lenses throughout, reddish brown to brown, moist to wet	96.3	
		SILTY SAND Some gravel, slightly clayey, red-brown, wet, frozen below 1.0 m depth		1
			95.3	
		ICE Some silty sand, ~60 percent ice content	94.9	2
		SILTY SAND Slightly cohesive, ice lenses throughout, reddish brown to brown, moist to wet	94.4	
		QUARTZITE Beige to grey, iron oxidized, calcite intrusions, fractured (poor quality)		3
			92.9	
		Borehole Terminated @ 4.0 m Depth		4

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 20 40 60

SAMPLES

Natural Unit Wt. kN/m³

9

38/225 mm

NOTES:
1. Borehole data requires Interpretation by Trow before use by others
2. A 19 mm slotted standpipe was installed upon completion of drilling
3. Field work supervised by a Trow representative
4. See Notes on Sample Descriptions
5. This Figure is to read with Trow Associates Inc. report OTGE00019054B

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	2.59 - 3	100	0
2	3 - 3.15	67	0
3	3.15 - 3.63	89	0
4	3.63 - 3.76	100	0
5	3.76 - 3.89	40	0
6	3.89 - 4	100	0

LOG OF BOREHOLE NEWBH1TO1~1.GPJ TROW OTTAWA.GDT 24/4/08

Log of Borehole 7

Trow

Project No: OTGE00019054B

Project: Geotechnical Investigation - New Sewage Lagoon

Location: Arctic Bay, Nunavut

Date Drilled: 'August 30, 2007

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Figure No. 8

Sheet No. 1 of 1

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◧	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢—○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOLE	SOIL/ROCK DESCRIPTION	Geodetic Elevation	Depth
		FIBROUS PEAT ~300 mm	97.5 m	0
		SILTY SAND AND GRAVEL Fine to coarse, some cobbles, reddish brown, moist to wet	97.2	
		SILTY SAND TILL Some ice lenses, scattered gravel, cobbles and boulders, slightly cohesive, red brown Frozen below 1.45 m depth	96.3	1
				2
				3
				4
		Borehole Terminated @ 5.0 m Depth	92.5	5

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 10 20 30

SAMPLES

Unit Weight kN/m³

36

26

37/150 mm

44

NOTES:
1. Borehole/Test Pit data requires Interpretation by Trow before use by others
2. Borehole backfilled upon completion of drilling
3. Field work supervised by a Trow representative
4. See Notes on Sample Descriptions
5. This Figure is to read with Trow Associates Inc. report OTGE00019054B

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE NEWBH1TO1-1.GPJ TROW OTTAWA.GDT 26/11/07

Log of Borehole 8

Trow

Project No: OTGE00019054B

Project: Geotechnical Investigation - New Sewage Lagoon

Location: Arctic Bay, Nunavut

Figure No. 9

Sheet No. 1 of 1

Date Drilled: August 29, 2007

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◫	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOLE	SOIL/ROCK DESCRIPTION	Geodetic Elevation	Depth
		PEATY TOPSOIL ~300 mm	97 m	0
		SANDY GRAVEL Fine to coarse, some silt, slightly cohesive, reddish brown, moist to wet Frozen below 1.2 m depth Some ice crystals	96.7	
		ICE	94.2	3
		GABBRO BEDROCK Grey to black, some inclined fractures, massive, coarse grained	93.2	4
		Borehole Terminated @ 5.21 m Depth	91.8	5

Standard Penetration Test N Value: 20 40 60 80

Shear Strength: 50 100 150 200 kPa

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 10 20 30

SAMPLES

Unit Weight kN/m³

7

12

NOTES:
1. Borehole/Test Pit data requires Interpretation by Trow before use by others
2. Borehole backfilled upon completion of drilling
3. Field work supervised by a Trow representative
4. See Notes on Sample Descriptions
5. This Figure is to read with Trow Associates Inc. report OTGE00019054B

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	4.01 - 4.32	79	50
2	4.32 - 4.57	85	45
3	4.57 - 5.21	92	74

LOG OF BOREHOLE NEWBH1TO1-1.GPJ TROW OTTAWA.GDT 26/11/07

Log of Borehole 9

Trow

Project No: OTGE00019054B

Project: Geotechnical Investigation - New Sewage Lagoon

Location: Arctic Bay, Nunavut

Figure No. 10

Sheet No. 1 of 1

Date Drilled: 'August 29, 2007

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◧	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢—○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL/ROCK DESCRIPTION	Geodetic Elevation	Depth
		PEATY TOPSOIL ~400 mm Frozen below 0.5 m depth Some ice layers	97.2 m	0
		ICE Some silty sand and gravel Ice content 70 % - 80 %	96.8	
		SAND AND GRAVEL Silty, scattered cobbles and boulders, brown, moist to wet	96.0	1
		Borehole Terminated @ 3.66 m Depth	93.5	2 3

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 10 20 30

SAMPLES

Unit Weight kN/m³

26

271

NOTES:
1. Borehole/Test Pit data requires Interpretation by Trow before use by others
2. Borehole backfilled upon completion of drilling
3. Field work supervised by a Trow representative
4. See Notes on Sample Descriptions
5. This Figure is to read with Trow Associates Inc. report OTGE00019054B

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE NEWBH1TO1~1.GPJ TROW OTTAWA.GDT 26/11/07

Log of Borehole 10

Trow

Project No: OTGE00019054B

Project: Geotechnical Investigation - New Sewage Lagoon

Location: Arctic Bay, Nunavut

Figure No. 11

Sheet No. 1 of 1

Date Drilled: August 30, 2007

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◫	Natural Moisture Content	×
SPT (N) Value	o	Atterberg Limits	⊢—⊖
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL/ROCK DESCRIPTION	Geodetic Elevation	Depth	Standard Penetration Test N Value (20 40 60 80) / Shear Strength kPa (50 100 150 200)	Combustible Vapour Reading (ppm) (250 500 750) / Natural Moisture Content % Atterberg Limits (% Dry Weight) (10 20 30)	SAMPLES	Unit Weight kN/m³
		PEATY TOPSOIL ~330 mm	97.4 m	0				
		SAND Some silt and gravel, fine to coarse, brown, moist to wet	97.1	1	45	58		
		GABBRO BEDROCK Grey to black, massive, fine to coarse grained	95.9	2				
		Borehole Terminated @ 3.89 m Depth	93.5	3				

NOTES:
1. Borehole/Test Pit data requires Interpretation by Trow before use by others
2. Borehole backfilled upon completion of drilling
3. Field work supervised by a Trow representative
4. See Notes on Sample Descriptions
5. This Figure is to read with Trow Associates Inc. report OTGE00019054B

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %
1	2.82 - 3.2	60	0
2	3.2 - 3.89	70	0

LOG OF BOREHOLE NEWBH1TO1~1.GPJ TROW OTTAWA.GDT 26/11/07

Log of Borehole 11

Trow

Project No: OTGE00019054B

Project: Geotechnical Investigation - New Sewage Lagoon

Location: Arctic Bay, Nunavut

Figure No. 12

Sheet No. 1 of 1

Date Drilled: 'August 28, 2007

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◧	Natural Moisture Content	×
SPT (N) Value	○	Atterberg Limits	⊢—○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL/ROCK DESCRIPTION	Geodetic Elevation	Depth
		PEATY TOPSOIL ~300 mm	96.8 m	0
		GRAVELLY SAND Some silt, fine to medium, slightly cohesive, brown, moist to wet (compact) Frozen below 1.3 m depth	96.5	
		ICE Trace sand and gravel ~90 % - 100 % ice content	95.3	1
				2
				3
				4
				5
		SILTY SAND AND GRAVEL Brown, wet	91.6 91.3	
		Borehole Terminated @ 5.5 m Depth		

Standard Penetration Test N Value: 20 40 60 80

Shear Strength kPa: 50 100 150 200

Combustible Vapour Reading (ppm): 250 500 750

Natural Moisture Content % Atterberg Limits (% Dry Weight): 10 20 30

SAMPLES

Unit Weight kN/m³

20

17

60/250 mm

NOTES:
1. Borehole/Test Pit data requires Interpretation by Trow before use by others
2. A 19 mm slotted standpipe was installed upon completion of drilling
3. Field work supervised by a Trow representative
4. See Notes on Sample Descriptions
5. This Figure is to read with Trow Associates Inc. report OTGE00019054B

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

LOG OF BOREHOLE NEWBH1TO1~1.GPJ TROW OTTAWA.GDT 26/11/07

Log of Borehole 12

Trow

Project No: OTGE00019054B

Project: Geotechnical Investigation - New Sewage Lagoon

Location: Arctic Bay, Nunavut

Figure No. 13

Sheet No. 1 of 1

Date Drilled: 'August 28, 2007

Drill Type:

Datum: Geodetic

Logged by: _____ Checked by: _____

Split Spoon Sample	⊠	Combustible Vapour Reading	□
Auger Sample	◫	Natural Moisture Content	×
SPT (N) Value	o	Atterberg Limits	⊢—○
Dynamic Cone Test	——	Undrained Triaxial at % Strain at Failure	⊕
Shelby Tube	■	Shear Strength by Penetrometer Test	▲
Shear Strength by Vane Test	+ S		

GWL	SYMBOL	SOIL/ROCK DESCRIPTION	Geodetic Elevation	Depth	Standard Penetration Test N Value / Shear Strength (kPa)	Combustible Vapour Reading (ppm) / Natural Moisture Content % / Atterberg Limits (% Dry Weight)	SAMPLES	Unit Weight kN/m³
		TOPSOIL ~ 50 mm	96.4 m	0	20 40 60 80 / 50 100 150 200	250 500 750 / 10 20 30		
		SAND AND GRAVEL Fine to medium, some silt, brown, moist (compact) Frozen below 1.2 m depth	96.4		10	×		
				1	30	×		
						×		
		QUARTZITE BEDROCK Beige to grey, fractured, poor quality	94.9	2				
				3				
		Borehole Terminated @ 3.43 m Depth	93.0					
		See the attached sheet for core drilling record						

NOTES:
1. Borehole/Test Pit data requires Interpretation by Trow before use by others
2. Borehole backfilled upon completion of drilling
3. Field work supervised by a Trow representative
4. See Notes on Sample Descriptions
5. This Figure is to read with Trow Associates Inc. report OTGE00019054B

WATER LEVEL RECORDS

Elapsed Time	Water Level (m)	Hole Open To (m)

CORE DRILLING RECORD

Run No.	Depth (m)	% Rec.	RQD %

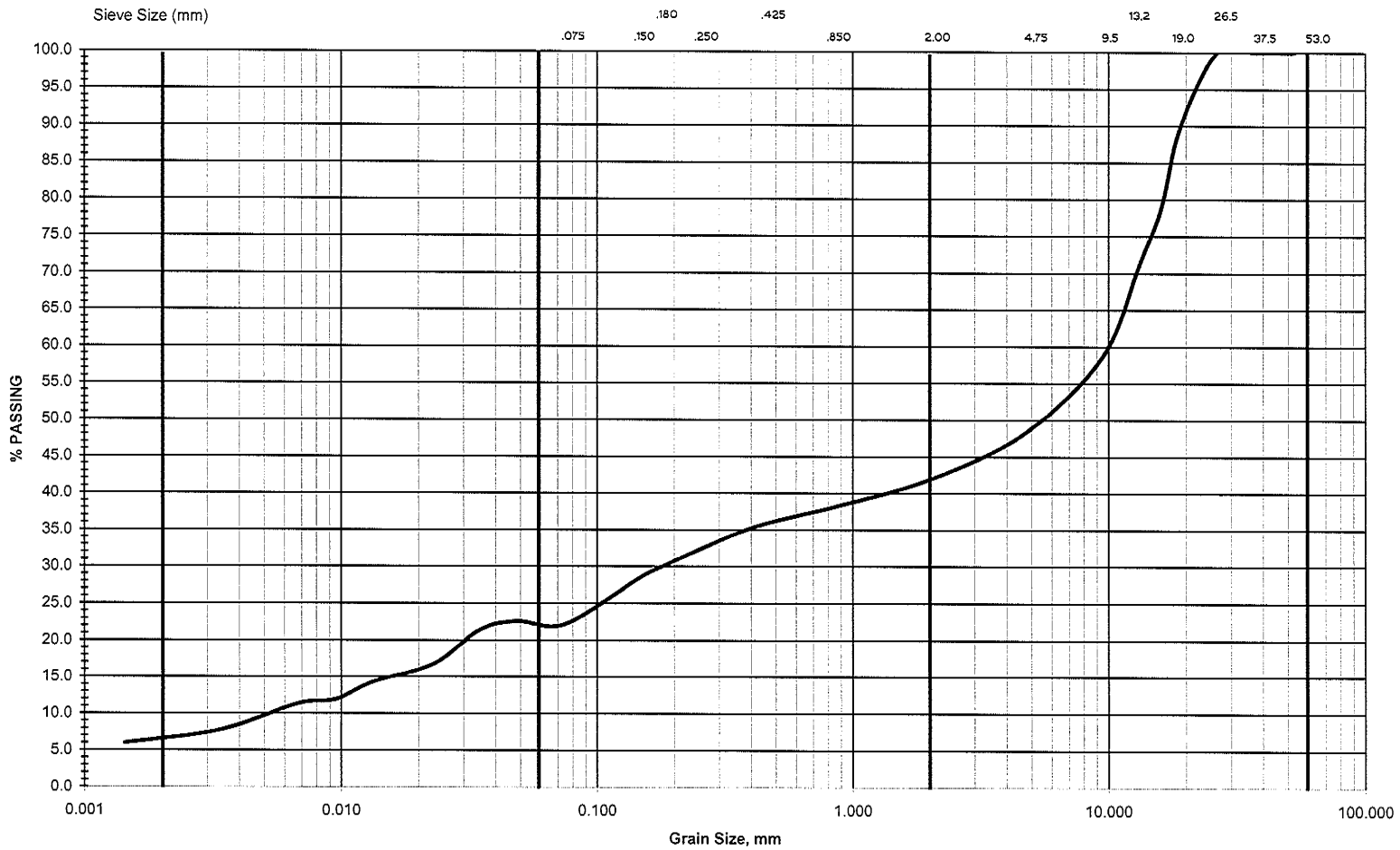
LOG OF BOREHOLE NEWBH1TO1~1.GPJ TROW OTTAWA.GDT 26/11/07

CORE DRILLING RECORD (BH12)			
Run No.	Depth (m)	Rec (%)	RQD (%)
1	1.52 - 1.68	92	0
2	1.68 - 1.80	90	0
3	1.80 - 2.06	90	0
4	2.06 - 2.31	90	0
5	2.31 - 2.52	100	0
6	2.52 - 2.72	88	0
7	2.72 - 2.97	90	0
8	2.97 - 3.07	100	0
9	3.07 - 3.25	86	0
10	3.25 - 3.43	86	0

Trow

FIGURE: 14

GRAIN SIZE DISTRIBUTION CURVE



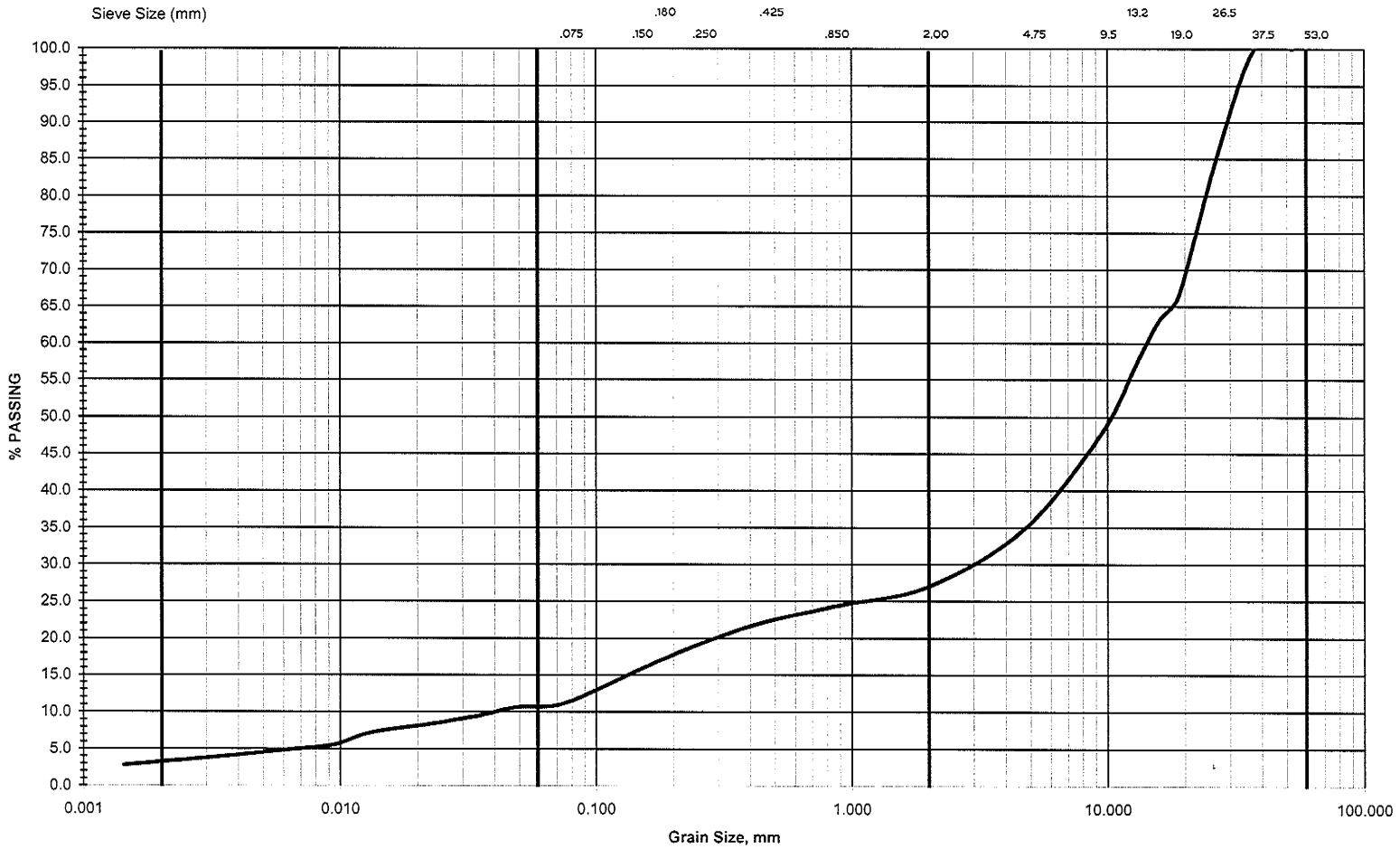
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
Modified M.I.T. Classification									

PROJECT :	**OTGE00019054B**	NAME & LOCATION:	**Proposed Sewage Lagoon - Arctic Bay, Nunavut (Existing Lagoon)**						
DATE SAMPLED:	**September 17, 2007**	BOREHOLE No.:	**BH 1**	SAMPLE No.:	**SS2**	DEPTH (m):	**0.6 to 1.2**		
SAMPLE DESCRIPTION:	**Sandy Gravel, Some Silt, Trace Clay**								

Trow

FIGURE: 15

GRAIN SIZE DISTRIBUTION CURVE



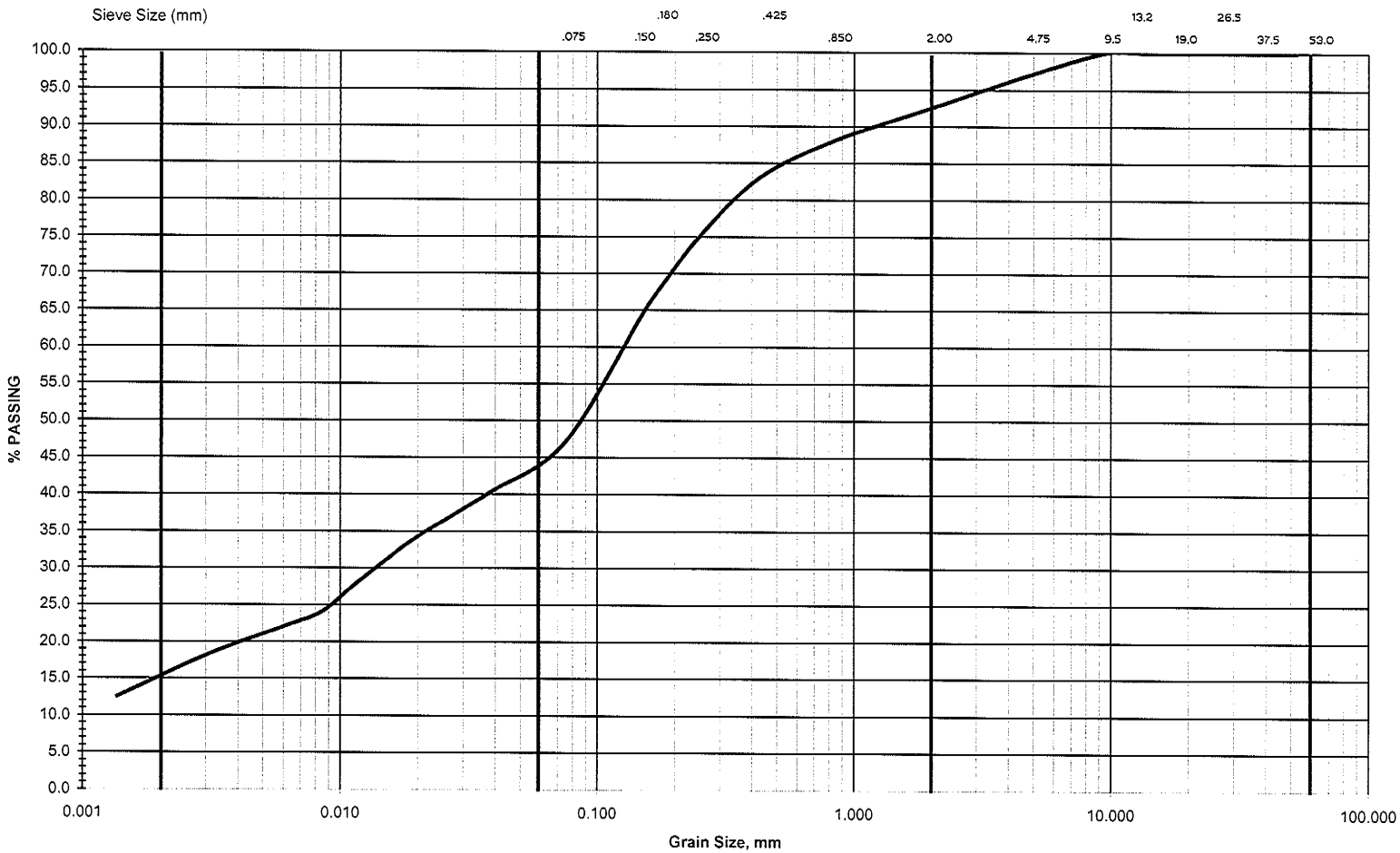
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
Modified M.I.T. Classification									

PROJECT :	**OTGE00019054B**	NAME & LOCATION:	**Proposed Sewage Lagoon - Arctic Bay, Nunavut**				
DATE SAMPLED:	**September 17, 2007**	BOREHOLE No.:	**BH 2**	SAMPLE No.:	**SS3**	DEPTH (m):	**1.2 to 1.8**
SAMPLE DESCRIPTION:	**Gravel, Some Sand, Trace Silt and Clay**						

Trow

FIGURE: 16

GRAIN SIZE DISTRIBUTION CURVE



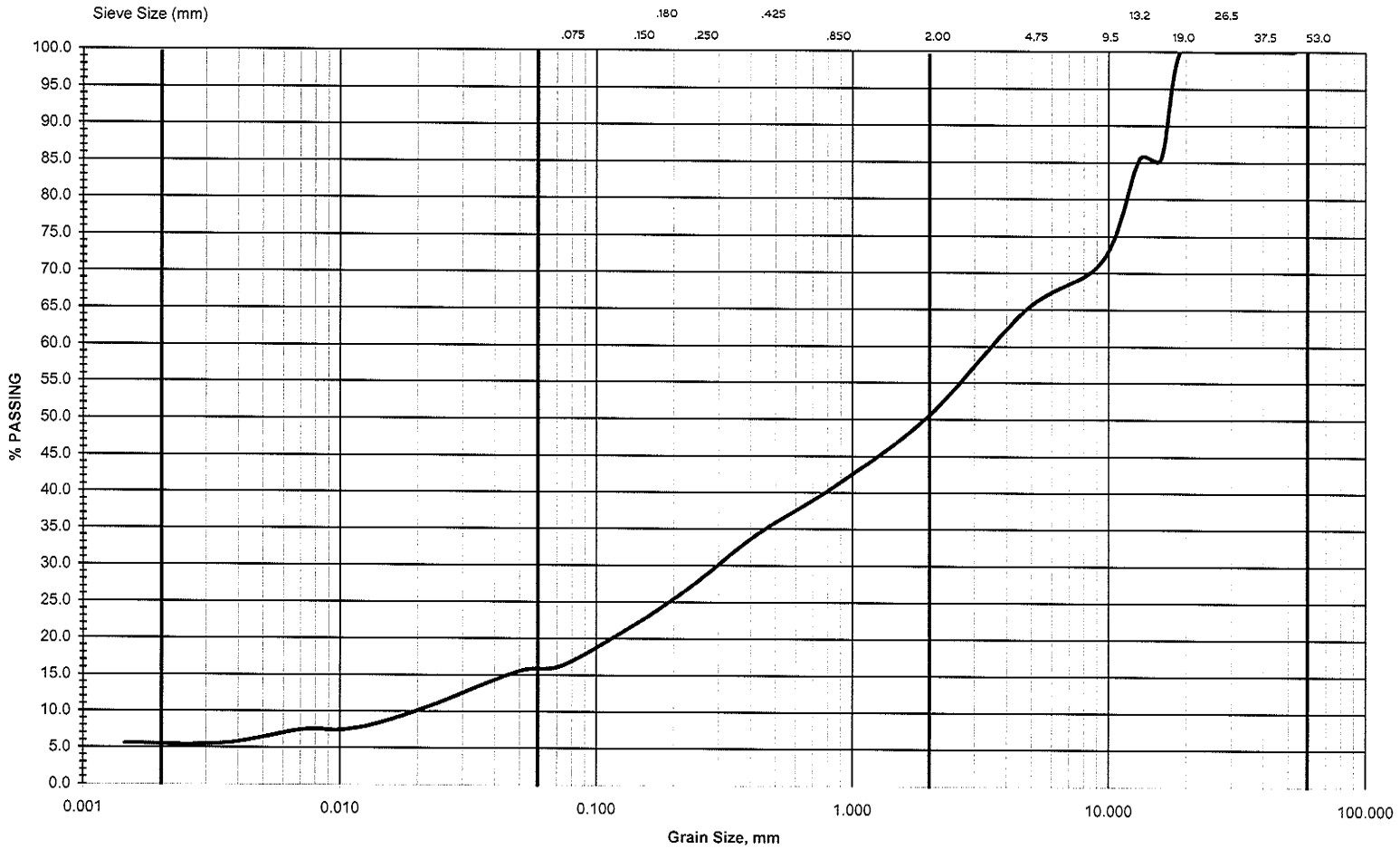
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
Modified M.I.T. Classification									

PROJECT :	**OTGE00019054B**	NAME & LOCATION:	**Proposed Sewage Lagoon - Arctic Bay, Nunavut (Existing Lagoon)**			
DATE SAMPLED:	**September 17, 2007**	BOREHOLE No.:	**BH 5**	SAMPLE No.:	**SS1**	DEPTH (m): **0 to 0.5**
SAMPLE DESCRIPTION:	**Silty sand, Some Clay, Trace Gravel (Topsoil)**					

Trow

FIGURE: 17

GRAIN SIZE DISTRIBUTION CURVE



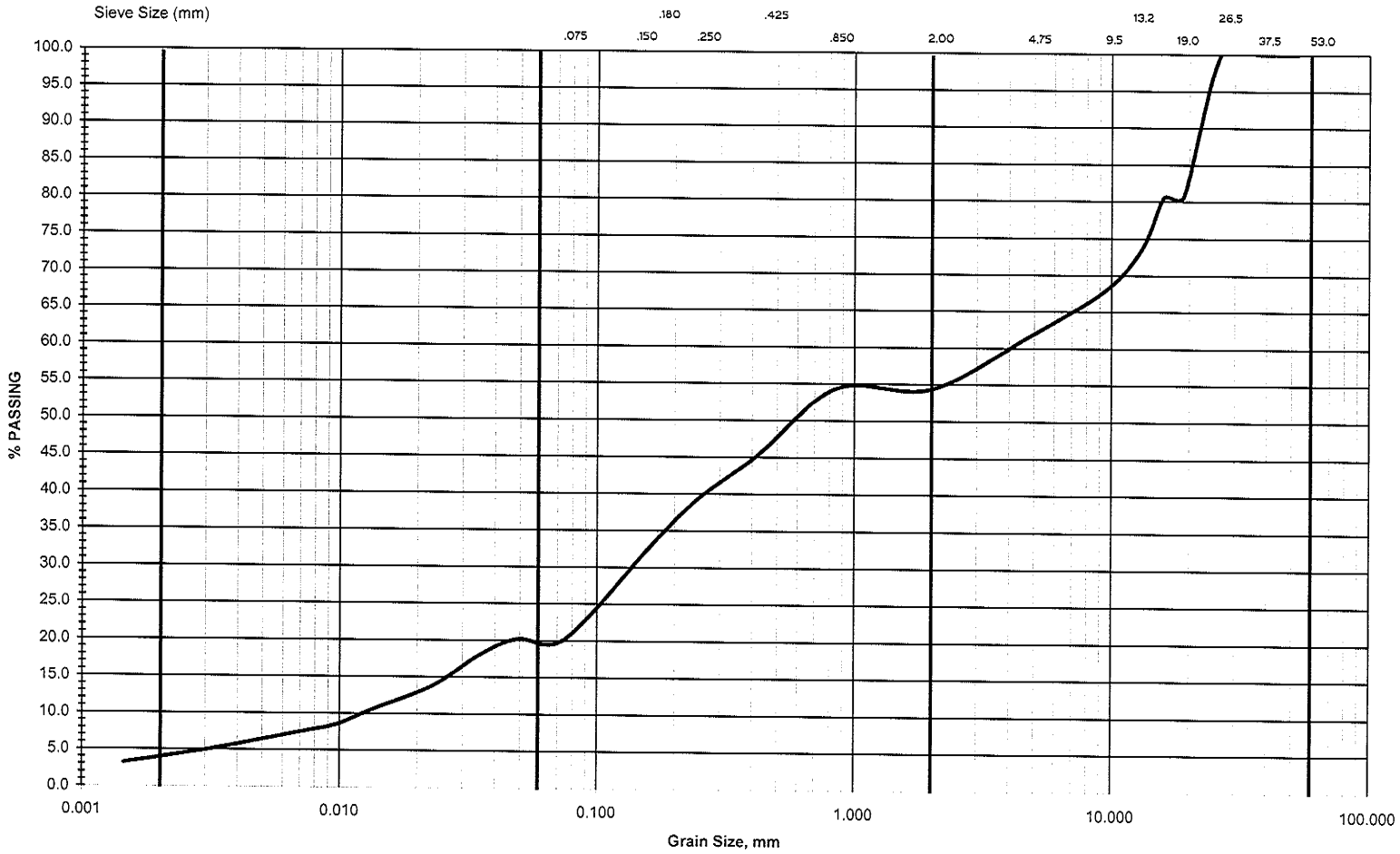
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
Modified M.I.T. Classification									

PROJECT :	**OTGE00019054B**	NAME & LOCATION:	**Proposed Sewage Lagoon - Arctic Bay, Nunavut**				
DATE SAMPLED:	**September 17, 2007**	BOREHOLE No.:	**BH 8**	SAMPLE No.:	**SS1**	DEPTH (m):	**0 to 0.6**
SAMPLE DESCRIPTION:	**Sandy Gravel, Trace Silt and Clay**						

Trow

FIGURE: 18

GRAIN SIZE DISTRIBUTION CURVE



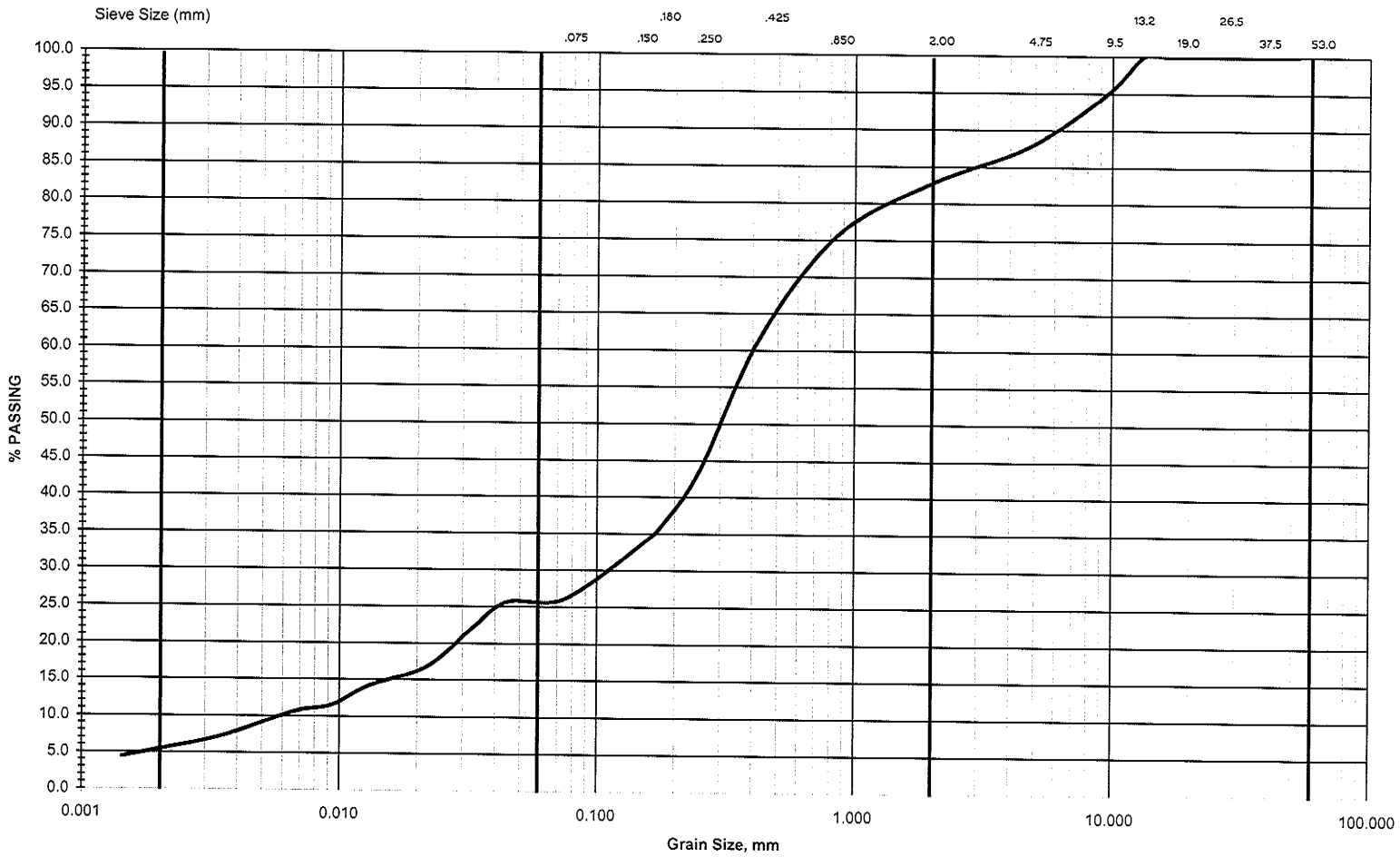
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
Modified M.I.T. Classification									

PROJECT :	**OTGE00019054B**	NAME & LOCATION:	**Proposed Sewage Lagoon - Arctic Bay, Nunavut**				
DATE SAMPLED:	**September 17, 2007**	BOREHOLE No.:	**BH 12**	SAMPLE No.:	**SS2**	DEPTH (m):	**0.6 to 1.2**
SAMPLE DESCRIPTION:	**Sand and Gravel, Some Silt, Trace Clay**						

Trow

FIGURE: 19

GRAIN SIZE DISTRIBUTION CURVE



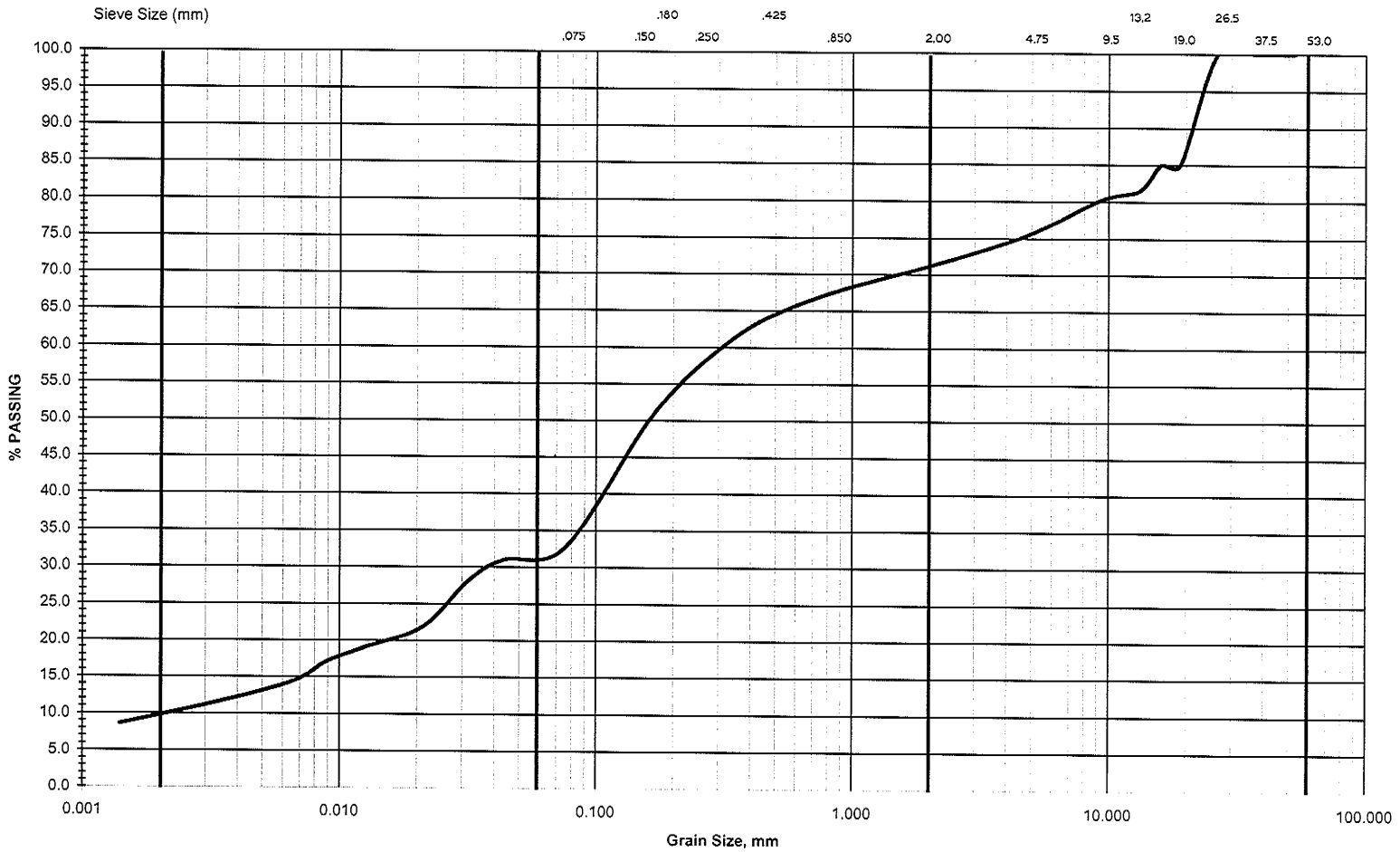
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
Modified M.I.T. Classification									

PROJECT :	**OTGE00019054B**	NAME & LOCATION:	**Proposed Sewage Lagoon - Arctic Bay, Nunavut**				
DATE SAMPLED:	**September 17, 2007**	BOREHOLE No.:	**BH 10**	SAMPLE No.:	**SS2**	DEPTH (m):	**1.3 to 1.6**
SAMPLE DESCRIPTION:	**Sand, Some Silt and Gravel, Trace Clay**						

Trow

FIGURE: 20

GRAIN SIZE DISTRIBUTION CURVE



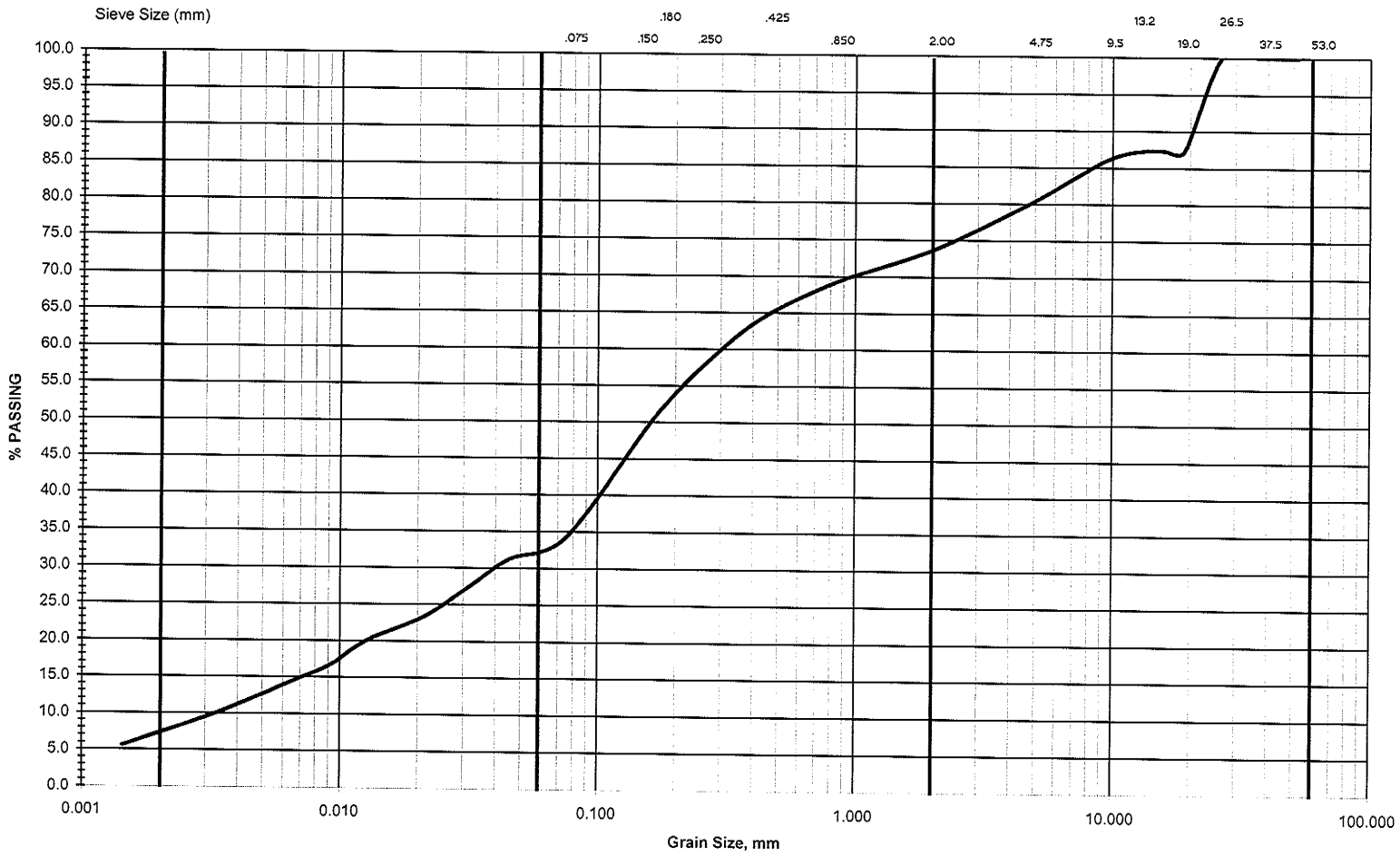
CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
Modified M.I.T. Classification									

PROJECT :	**OTGE00019054B**	NAME & LOCATION:	**Proposed Sewage Lagoon - Arctic Bay, Nunavut**			
DATE SAMPLED:	**September 17, 2007**	BOREHOLE No.:	**BH 11**	SAMPLE No.:	**SS3**	DEPTH (m): **1.2 to 1.8**
SAMPLE DESCRIPTION:	**Gravelly Sand, Some Silt, Trace Clay**					

Trow

FIGURE: 21

GRAIN SIZE DISTRIBUTION CURVE



CLAY	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE	FINE	MEDIUM	COARSE
	SILT			SAND			GRAVEL		
Modified M.I.T. Classification									

PROJECT :	**OTGE00019054B**	NAME & LOCATION:	**Proposed Sewage Lagoon - Arctic Bay, Nunavut**				
DATE SAMPLED:	**September 17, 2007**	BOREHOLE No.:	**BH 9**	SAMPLE No.:	**SS2**	DEPTH (m):	**1.2 to 1.8**
SAMPLE DESCRIPTION:	**Silty Gravelly Sand, Trace Clay**						

Figure 22

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section A-A
Inner Slope @ 3.0H to 1V
Completely Submerged

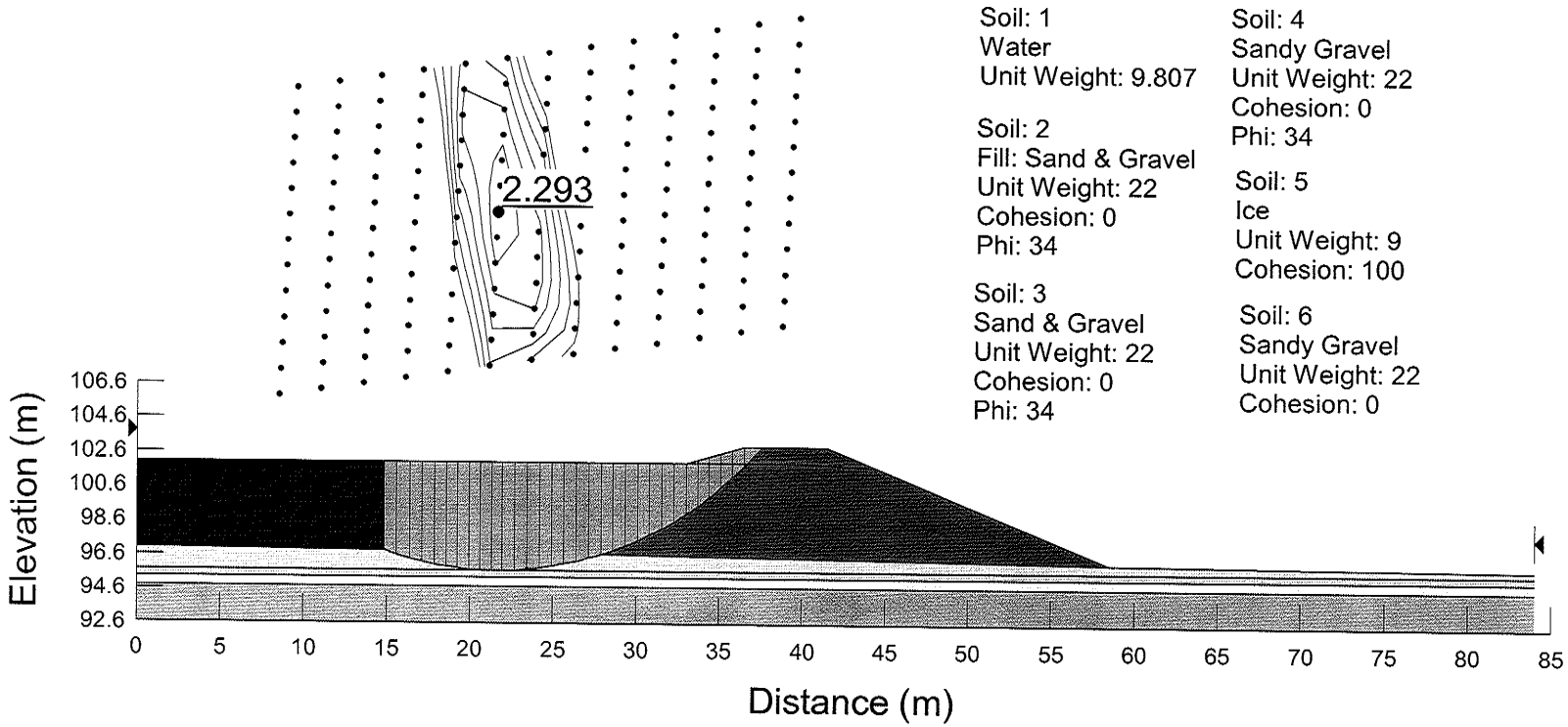


Figure 23

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section A-A
Inner Slope @ 3.0H to 1V
Completely Submerged
Seismic = 0.05g

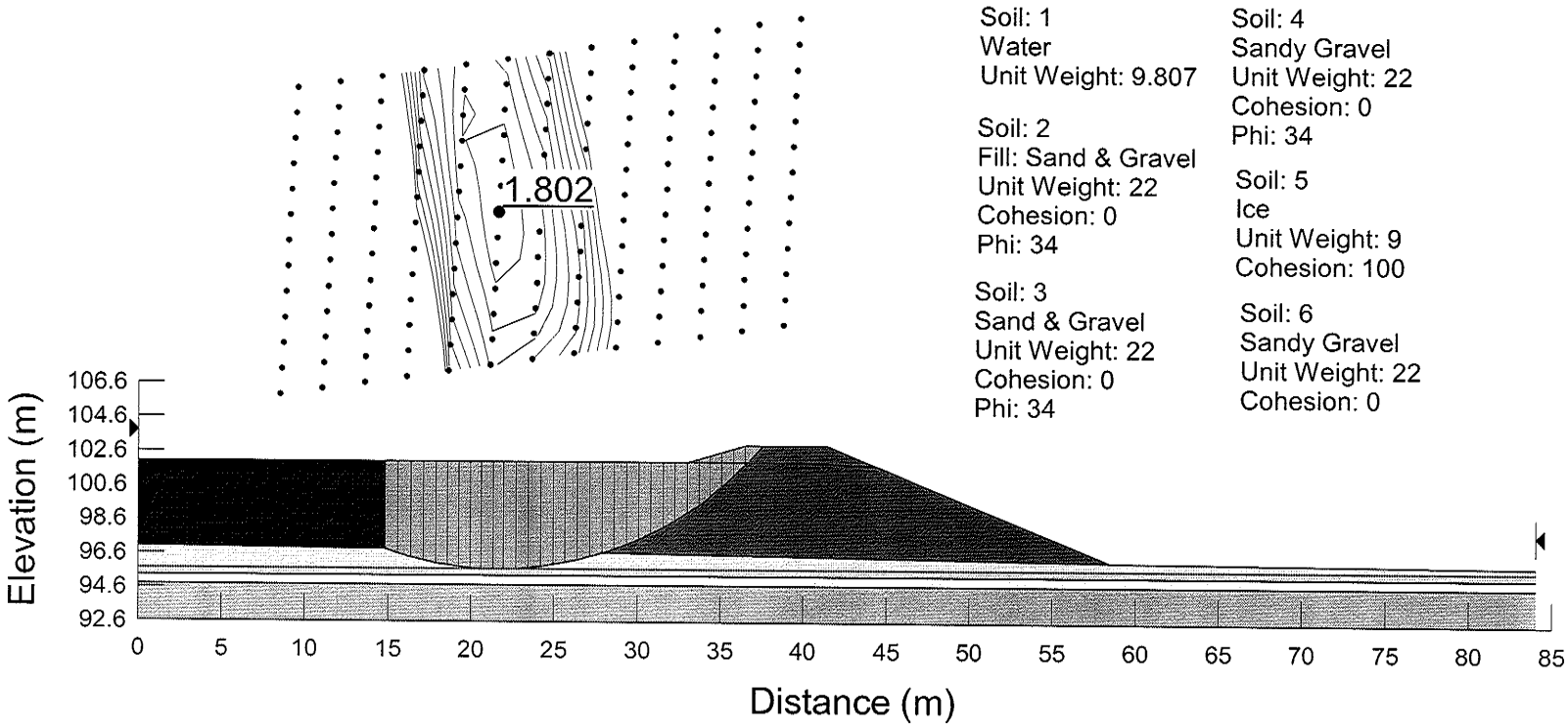
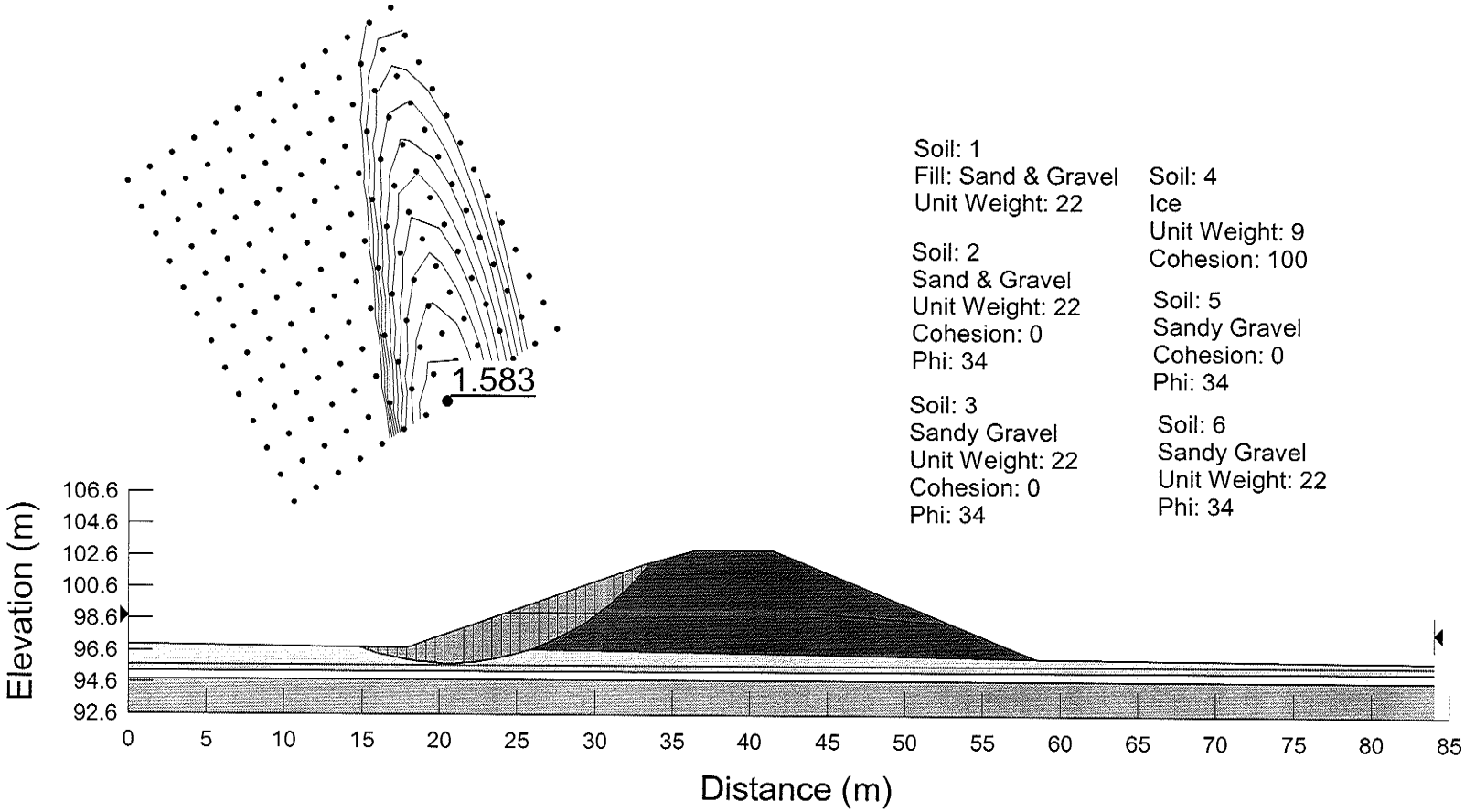


Figure 24

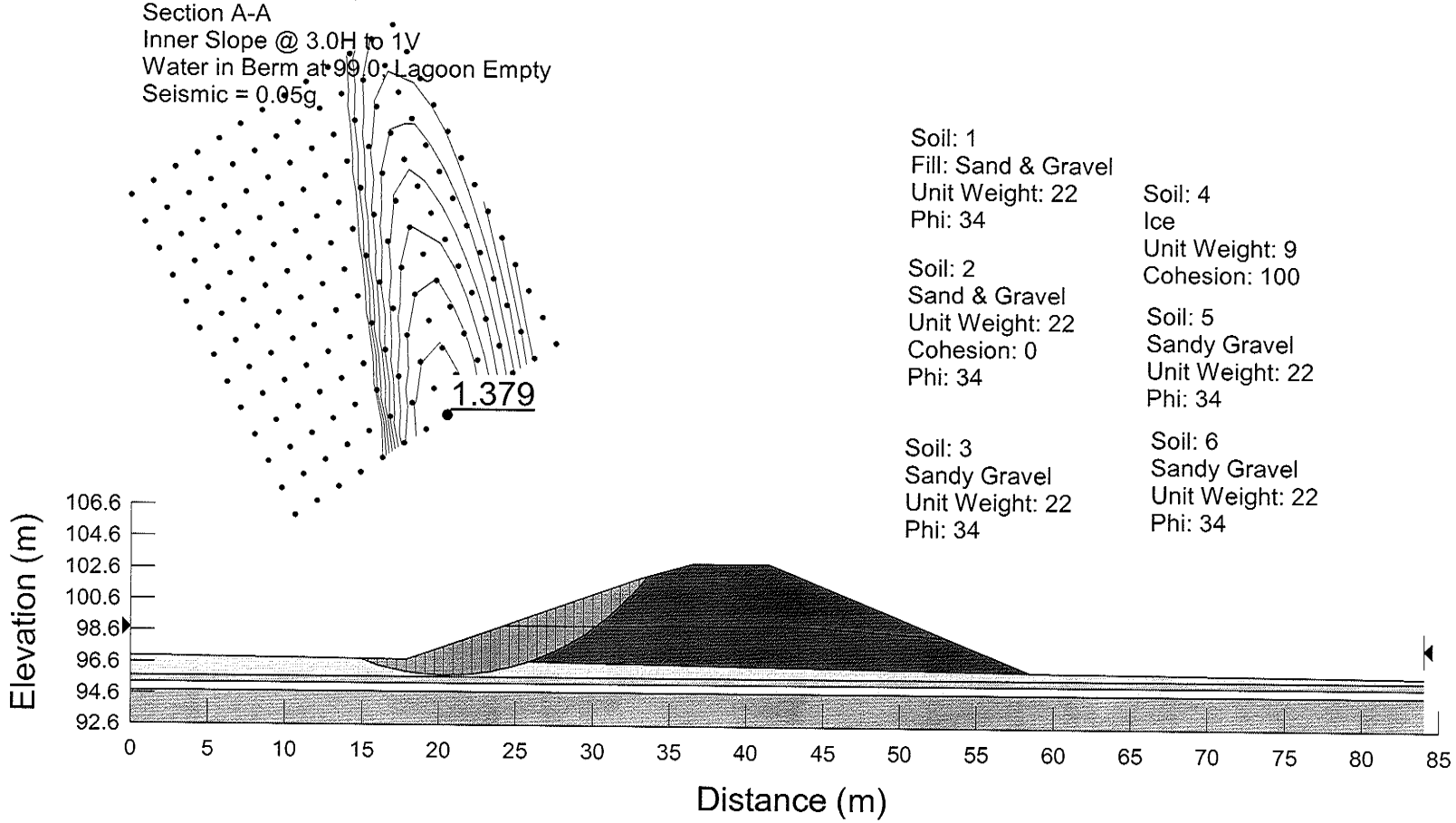
OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section A-A
Inner Slope @ 3.0H to 1V
Water in Berm at 99.0, Lagoon Empty



OTGE00019054B

Figure 25

New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section A-A
Inner Slope @ 3.0H to 1V
Water in Berm at 99.0; Lagoon Empty
Seismic = 0.05g



OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section A-A
Inner Slope @ 3.5H to 1V
Completely Submerged

Figure 26

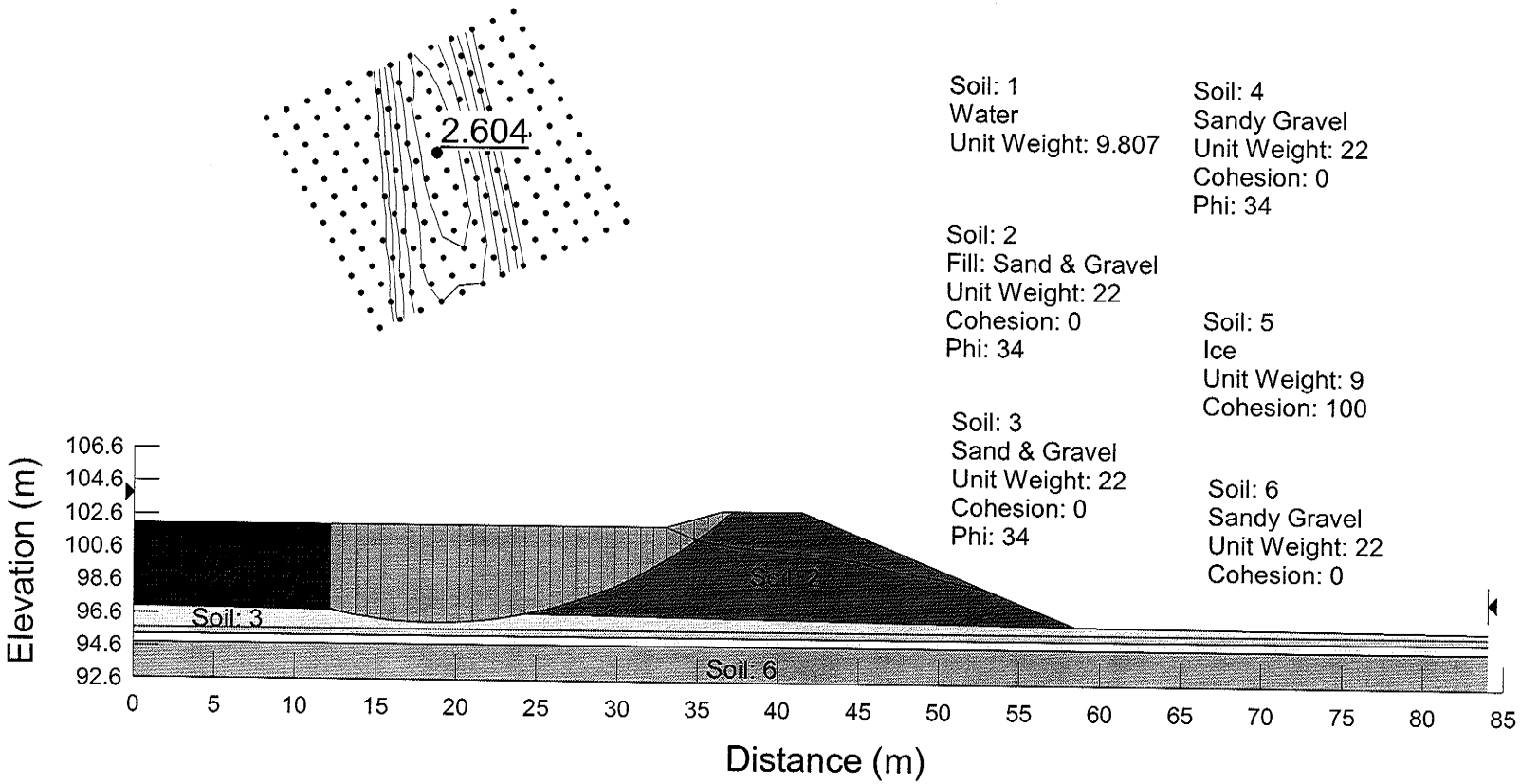


Figure 27

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section A-A
Inner Slope @ 3.5H to 1V
Completely Submerged
Seismic = 0.05g

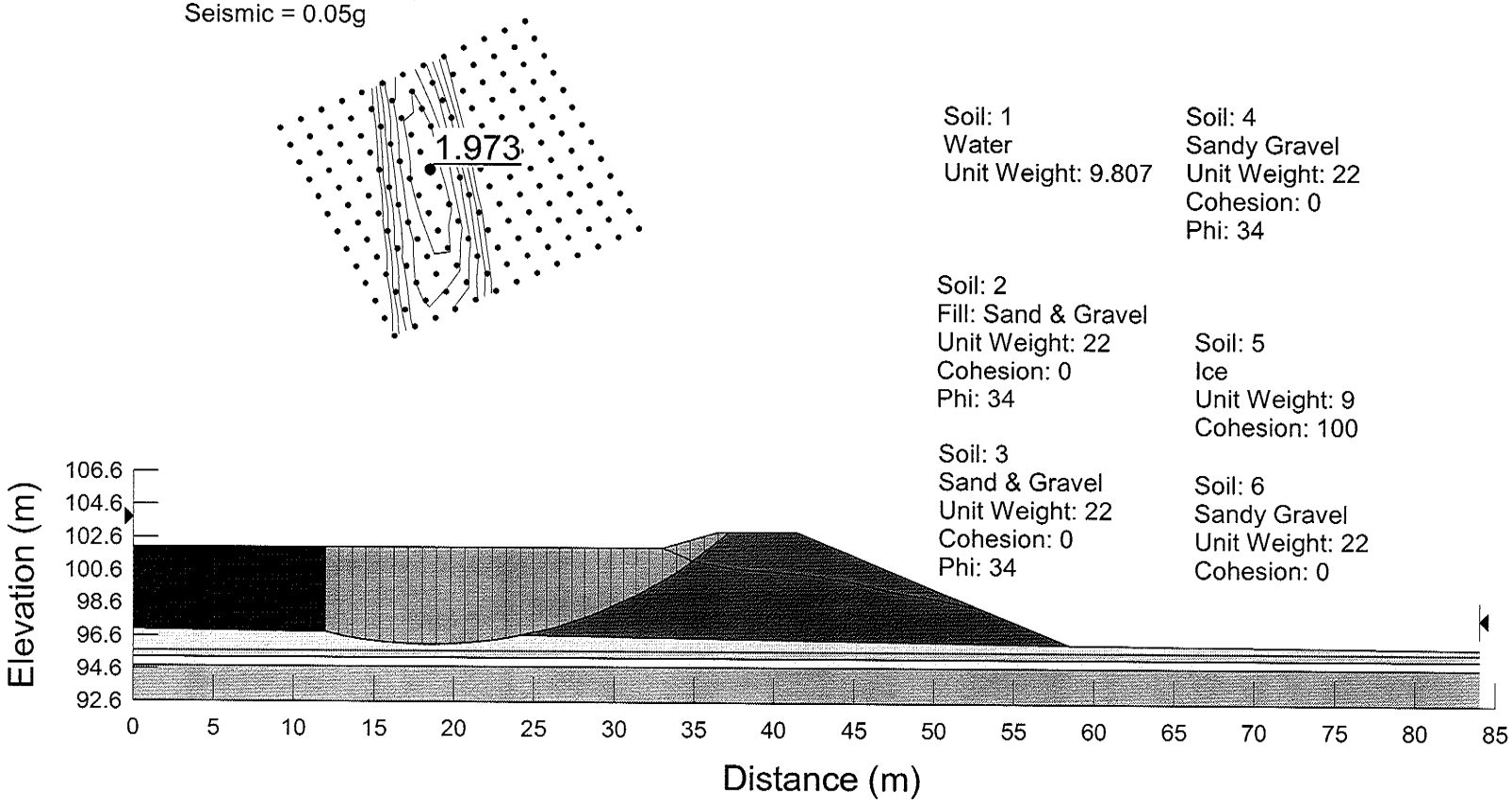


Figure 28

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section A-A
Outside Slope @ 3.0H to 1V
Steady State Seepage

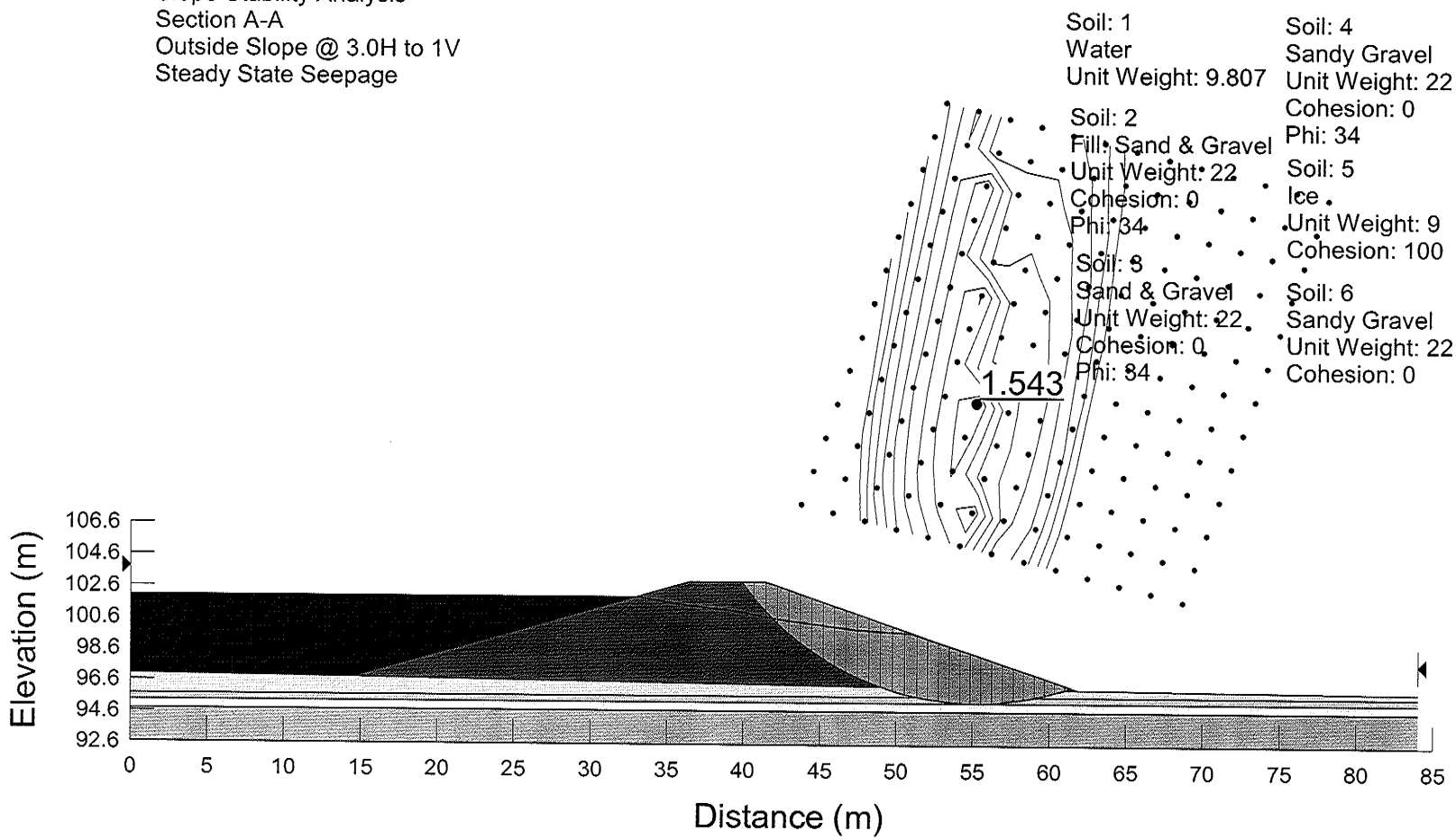
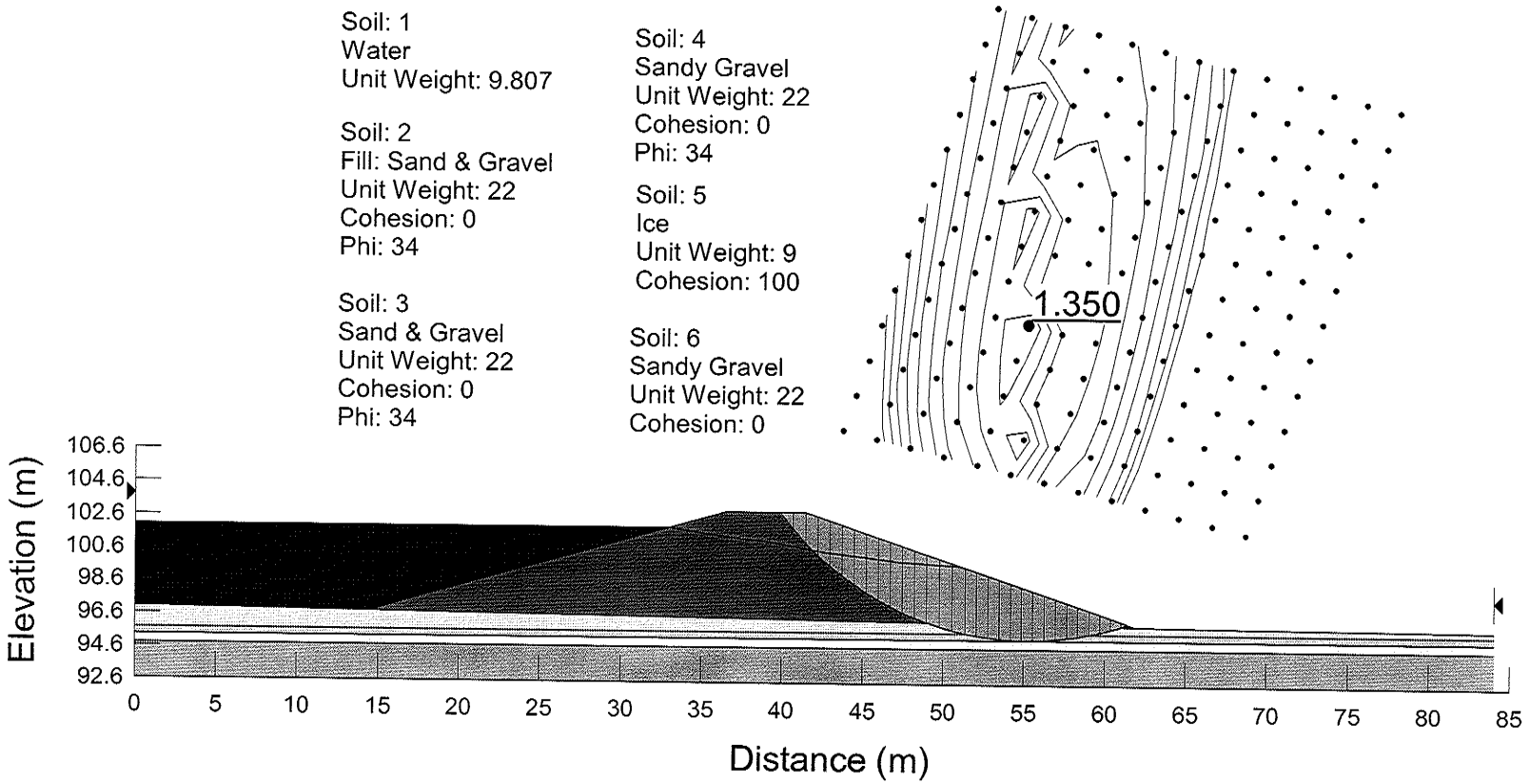


Figure 29

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section A-A
Outside Slope @ 3H to 1V
Steady State Seepage
Seismic = 0.05 g



OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section A-A
Outside Slope @ 3.0H to 1V
Pond Empty- Water at 99.0 m

Figure 30

Soil: 1
Fill: Sand & Gravel
Unit Weight: 22

Soil: 2
Sand & Gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

Soil: 3
Sandy Gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

Soil: 4
Ice
Unit Weight: 9
Cohesion: 100

Soil: 5
Sandy Gravel
Unit Weight: 22
Cohesion: 0

Soil: 6
Sandy Gravel
Unit Weight: 22
Cohesion: 0

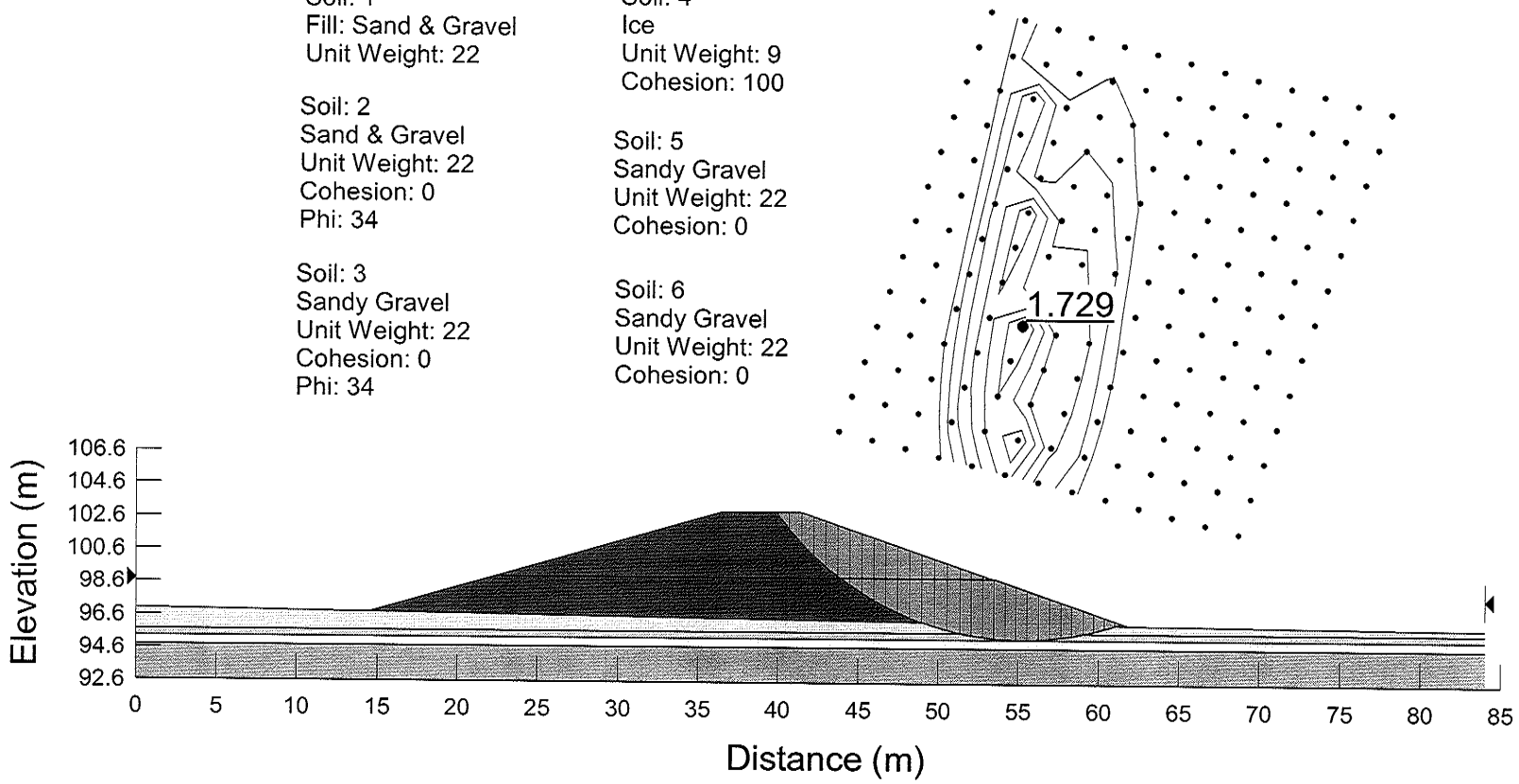


Figure 31

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section A-A
Pond Empty- Water at 99.0 m
Seismic = 0.05g

Soil: 1
Fill: Sand & Gravel
Unit Weight: 22

Soil: 2
Sand & Gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

Soil: 3
Sandy Gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

Soil: 4
Ice
Unit Weight: 9
Cohesion: 100

Soil: 5
Sandy Gravel
Unit Weight: 22
Cohesion: 0

Soil: 6
Sandy Gravel
Unit Weight: 22
Cohesion: 0

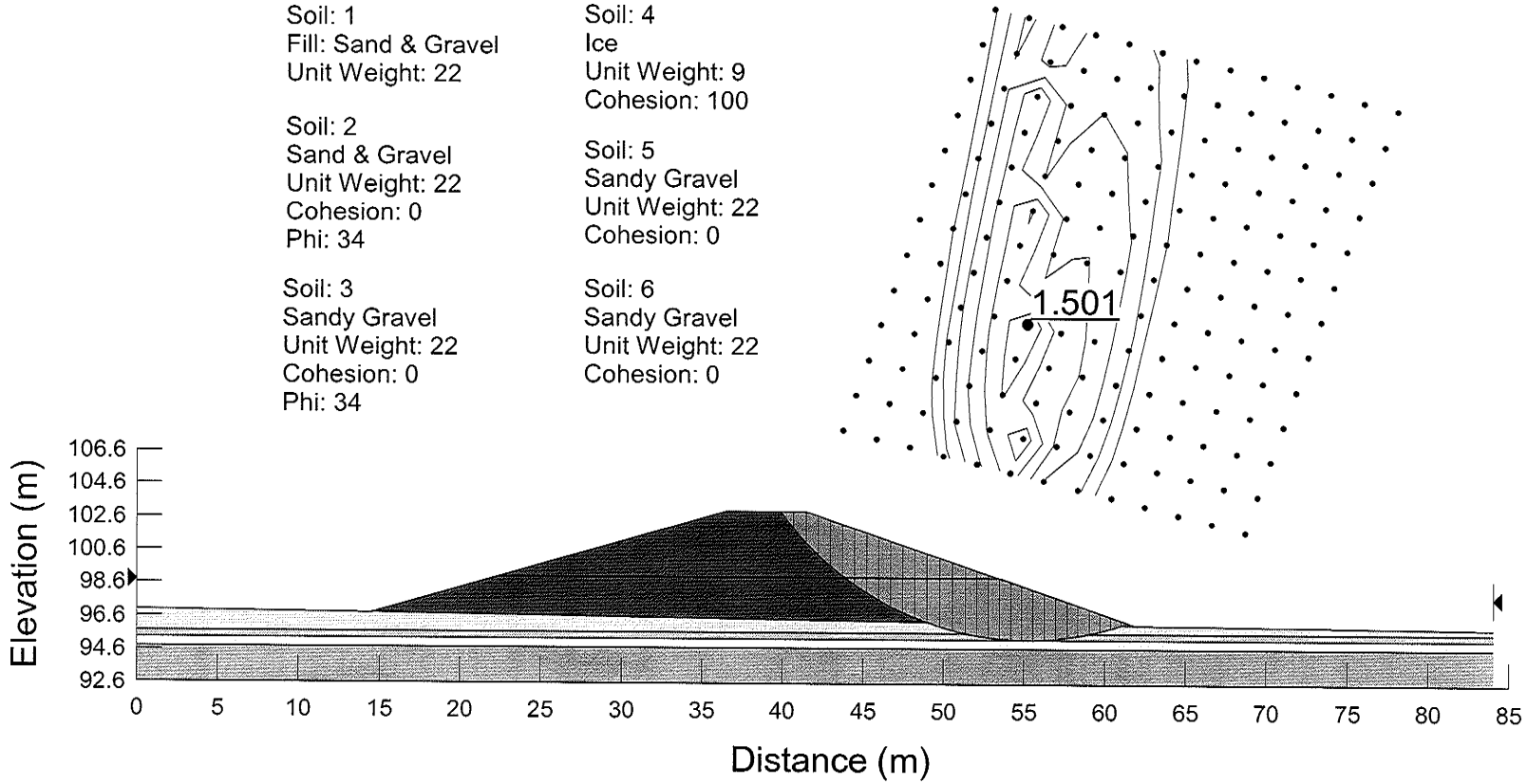
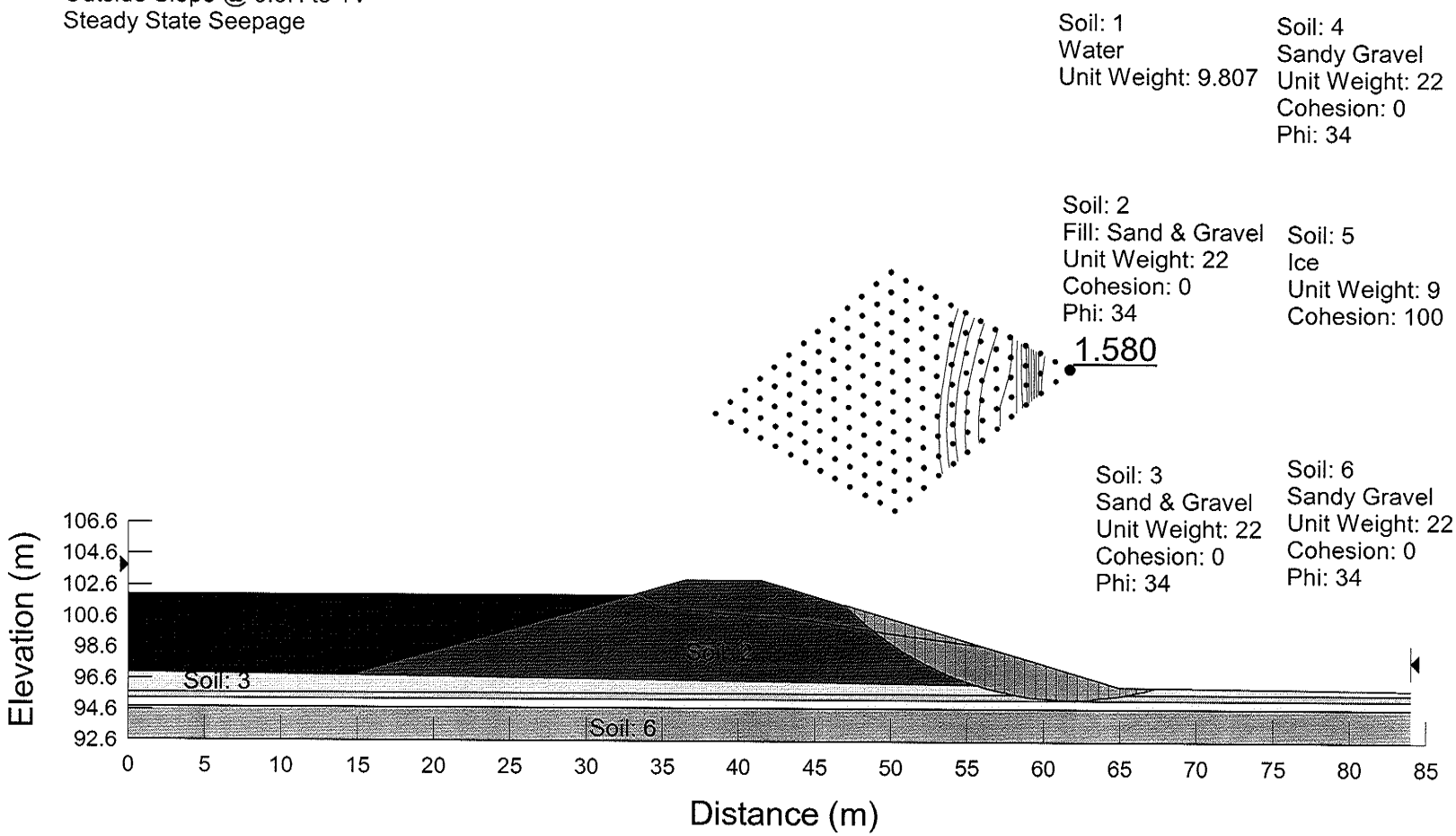


Figure 32

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section A-A
Outside Slope @ 3.5H to 1V
Steady State Seepage



OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section A-A
Outside Slope @ 3.5H to 1V
Steady State Seepage
Seismic = 0.05

Figure 33

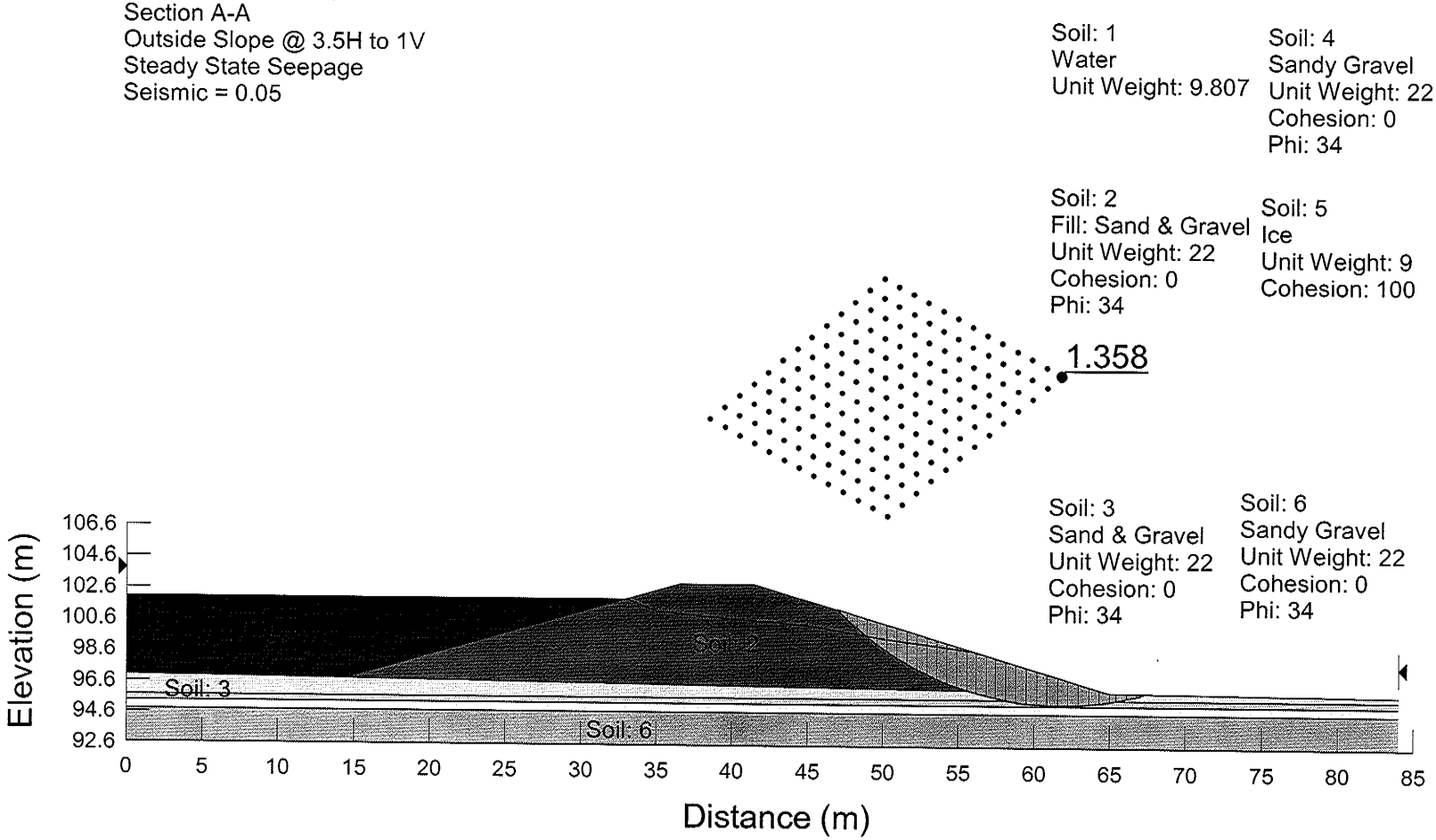


Figure 34

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section B-B
Inner Slope @ 3H to 1V
Completely Submerged

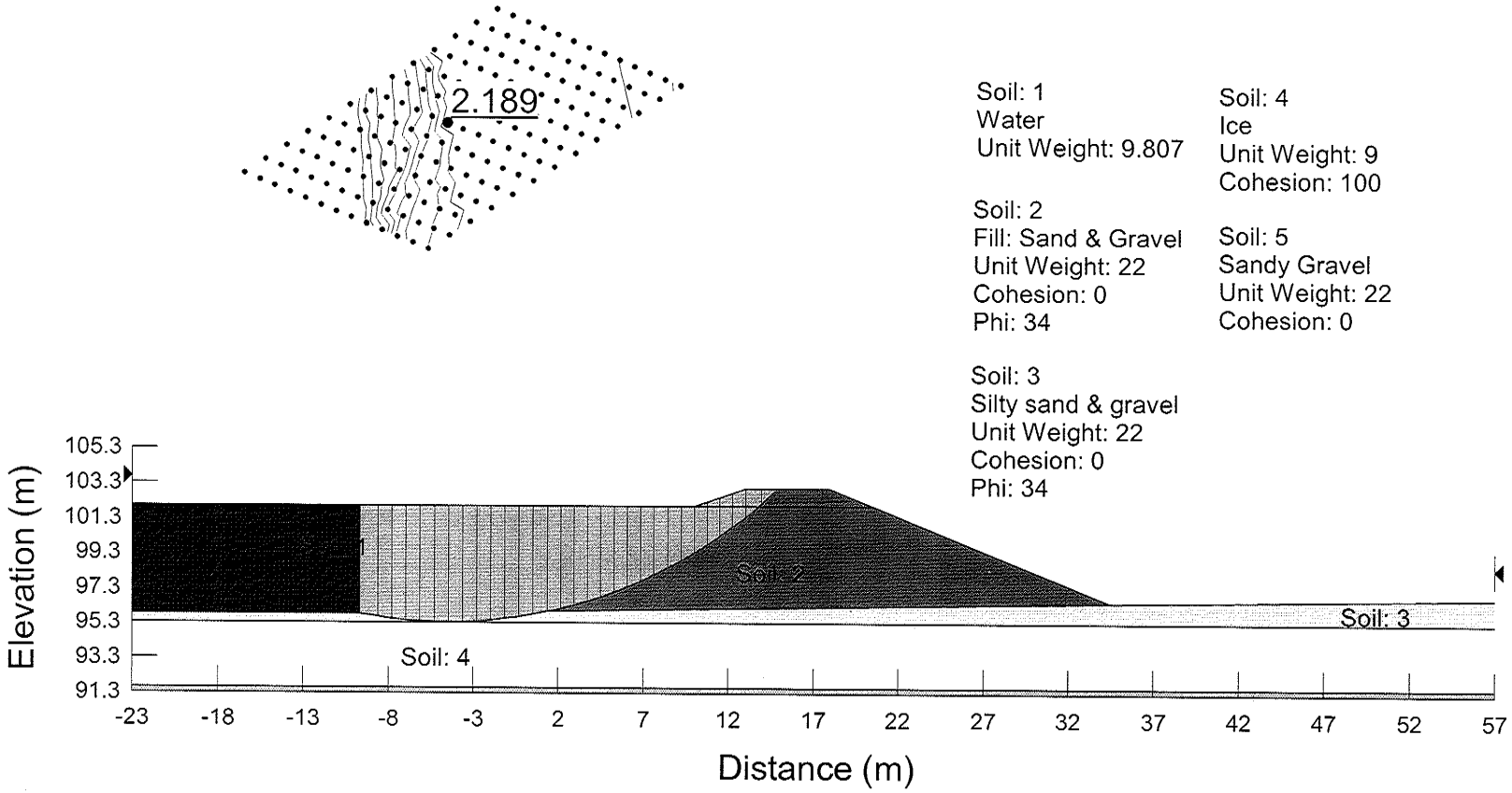


Figure 35

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section B-B
Inner Slope @ 3H to 1V
Completely Submerged
Seismic = 0.05

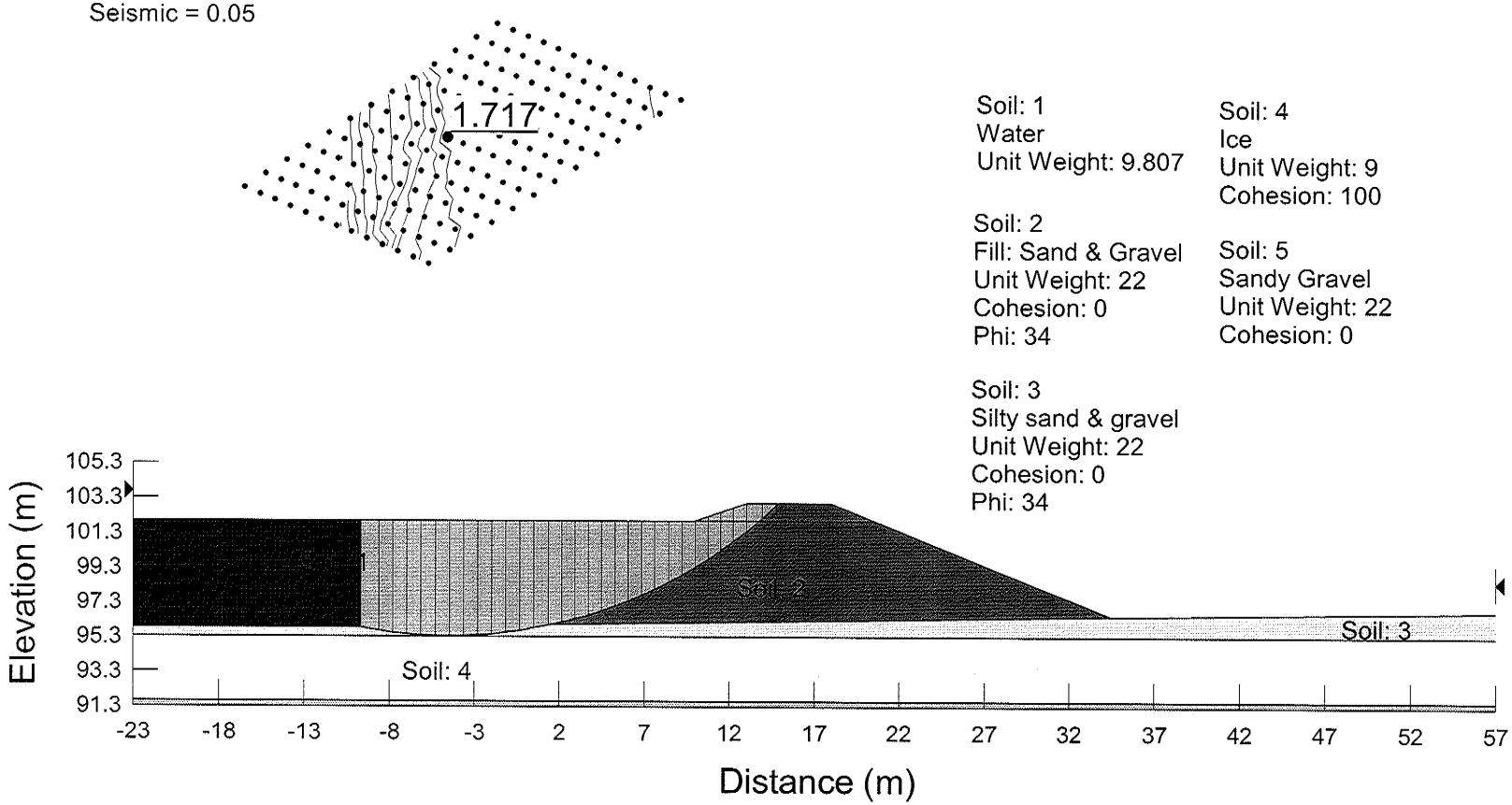
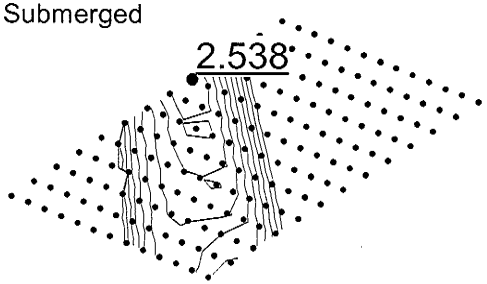


Figure 36

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section B-B
Inner Slope @ 3.5H to 1V
Completely Submerged



Soil: 1
Water
Unit Weight: 9.807

Soil: 2
Fill: Sand & Gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

Soil: 3
Silty sand & gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

Soil: 4
Ice
Unit Weight: 9
Cohesion: 100

Soil: 5
Sandy Gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

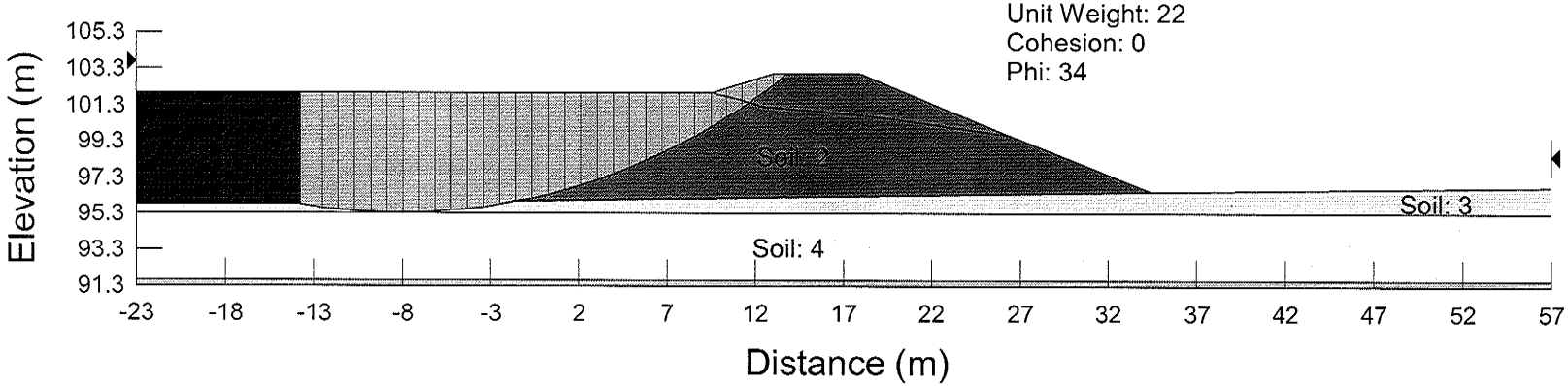
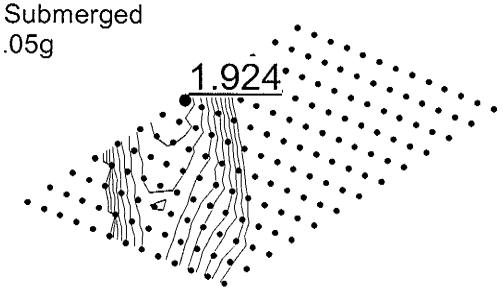


Figure 37

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section B-B
Inner Slope @ 3.5H to 1V
Completely Submerged
Seismic = 0.05g



Soil: 1
Water
Unit Weight: 9.807

Soil: 2
Fill: Sand & Gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

Soil: 3
Silty sand & gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

Soil: 4
Ice
Unit Weight: 9
Cohesion: 100

Soil: 5
Sandy Gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

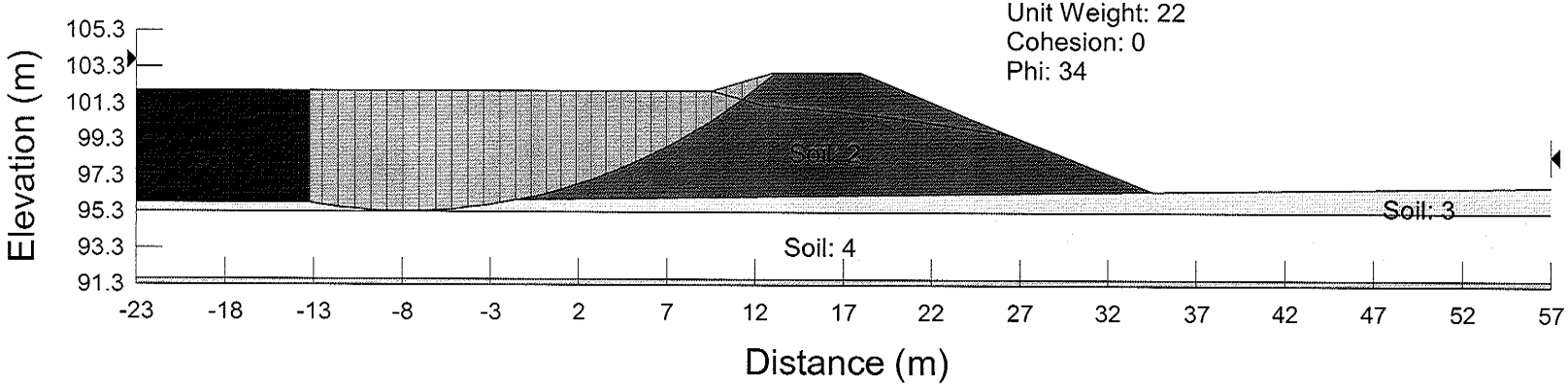


Figure 38

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section B-B
Outside Slope @ 3.0H to 1V
Steady State Seepage

Soil: 1
Water
Unit Weight: 9.807

Soil: 2
Fill: Sand & Gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

Soil: 3
Silty sand & gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

Soil: 4
Ice
Unit Weight: 9
Cohesion: 100

Soil: 5
Sandy Gravel
Unit Weight: 22
Cohesion: 0

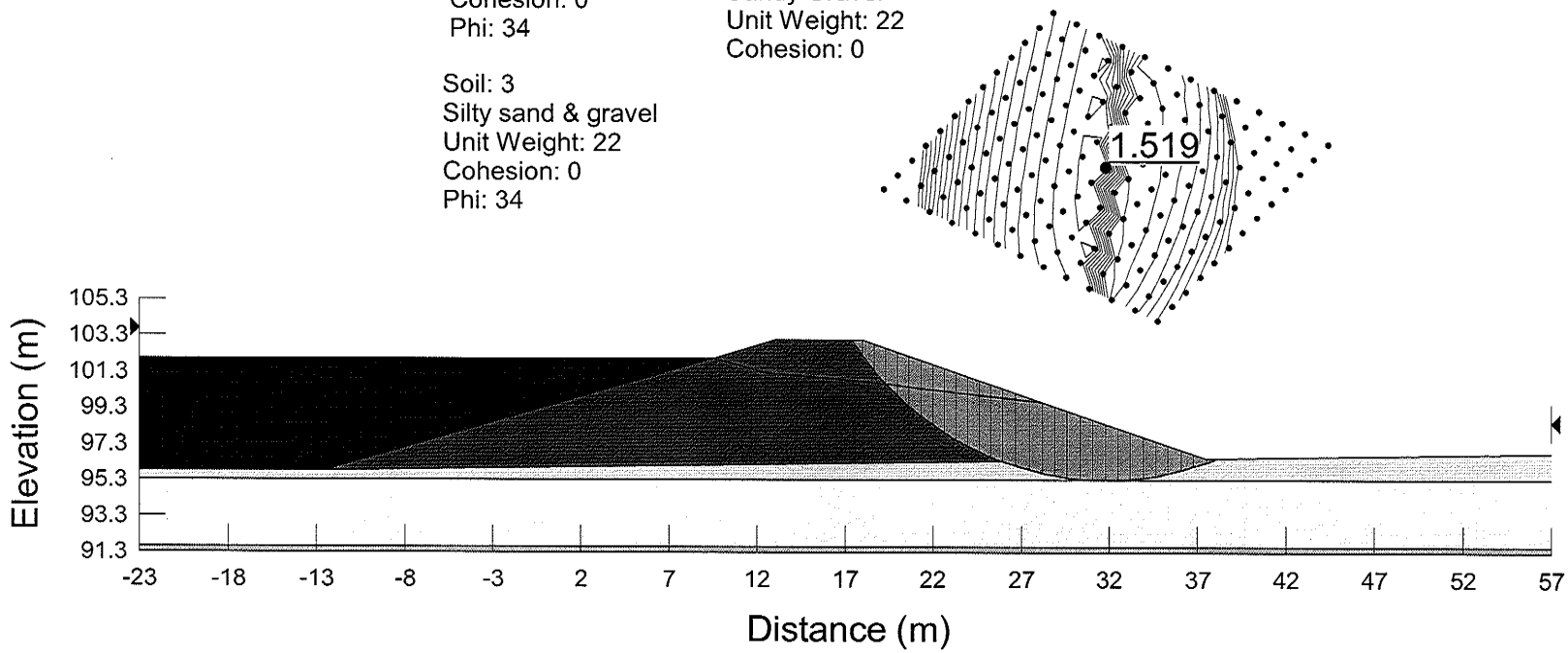


Figure 39

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section B-B
Outside Slope @ 3.0H to 1V
Steady State Seepage
Seismic = 0.05g

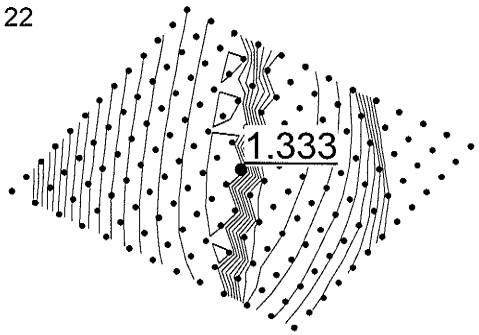
Soil: 1
Water
Unit Weight: 9.807

Soil: 2
Fill: Sand & Gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

Soil: 3
Silty sand & gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

Soil: 4
Ice
Unit Weight: 9
Cohesion: 100

Soil: 5
Sandy Gravel
Unit Weight: 22
Cohesion: 0



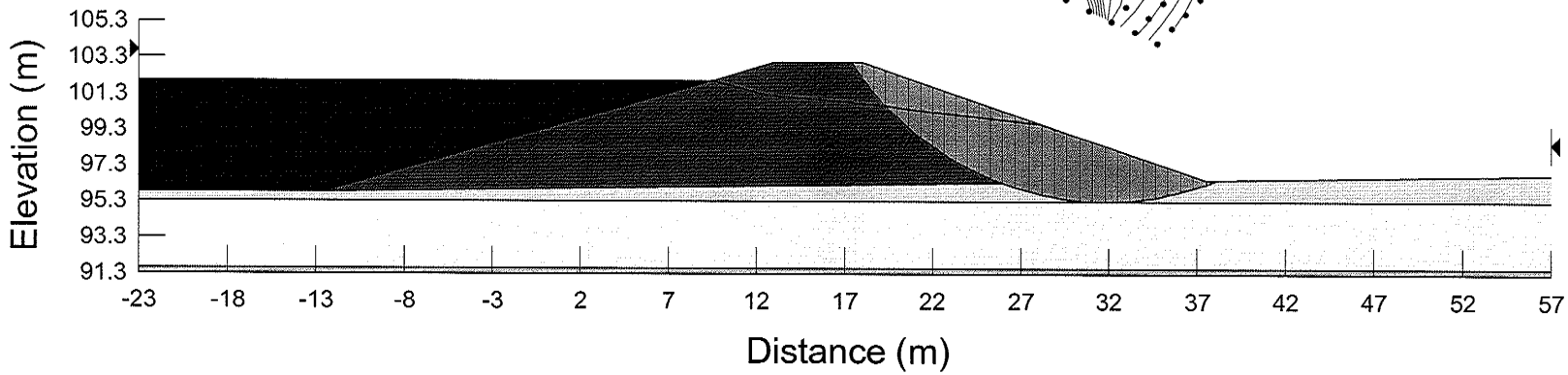


Figure 40

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section B-B
Outside Slope @ 4H to 1V
Steady State Seepage

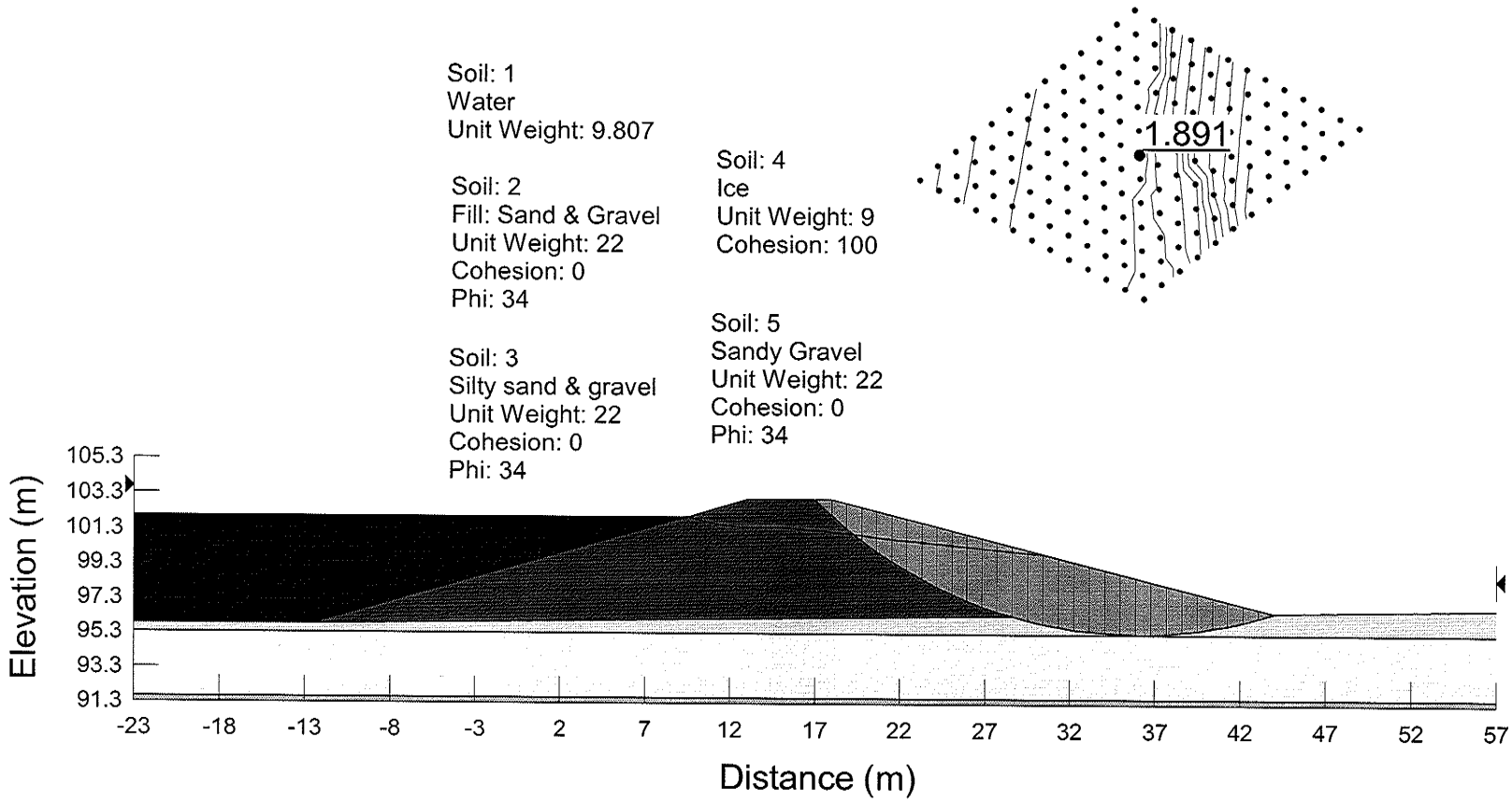


Figure 41

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section B-B
Outside Slope @ 4H to 1V
Steady State Seepage
Seismic = 0.05

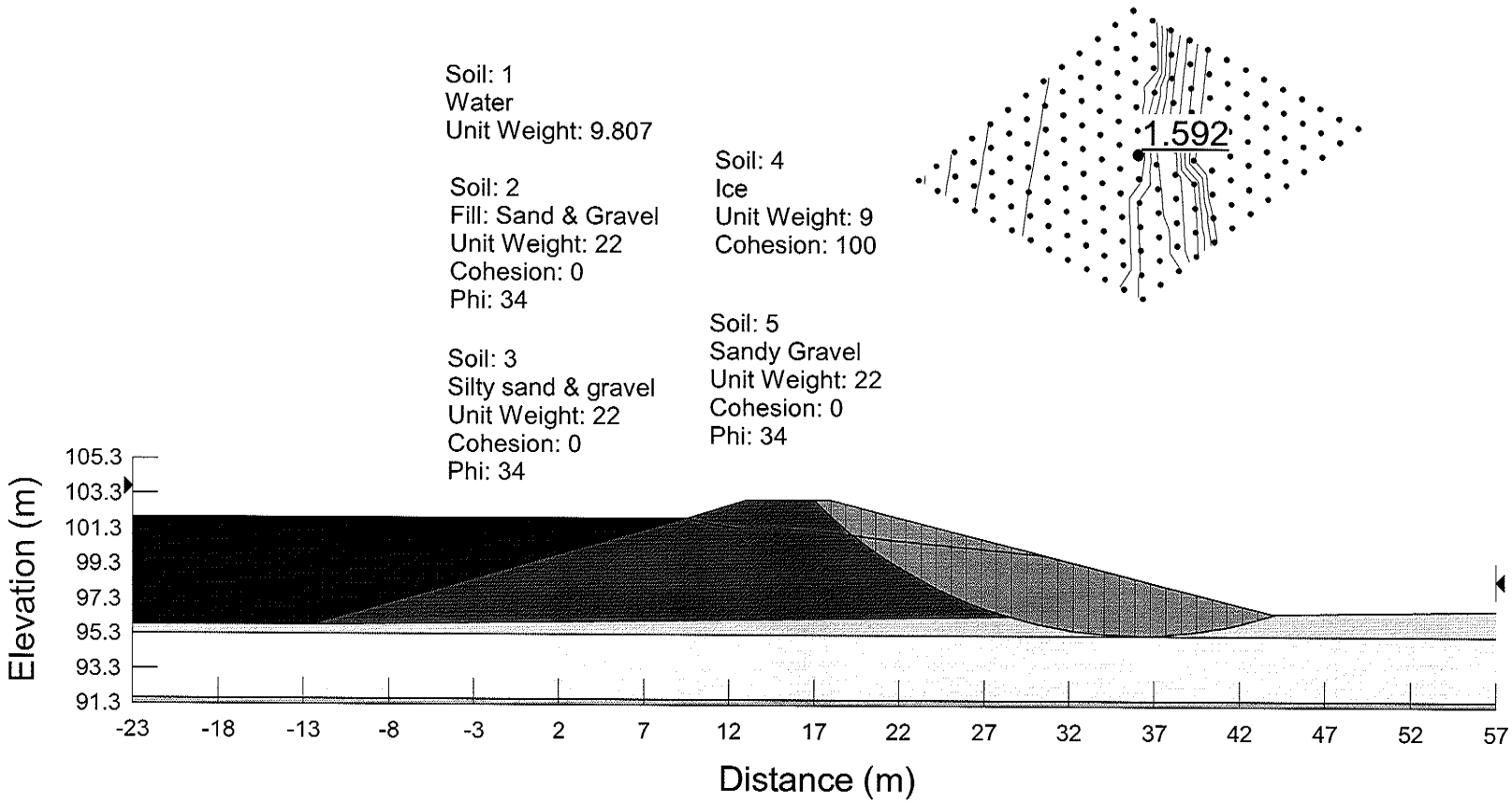


Figure 42

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section A-A
Inner Slope @ 3.5H to 1V
Rapid Drawdown

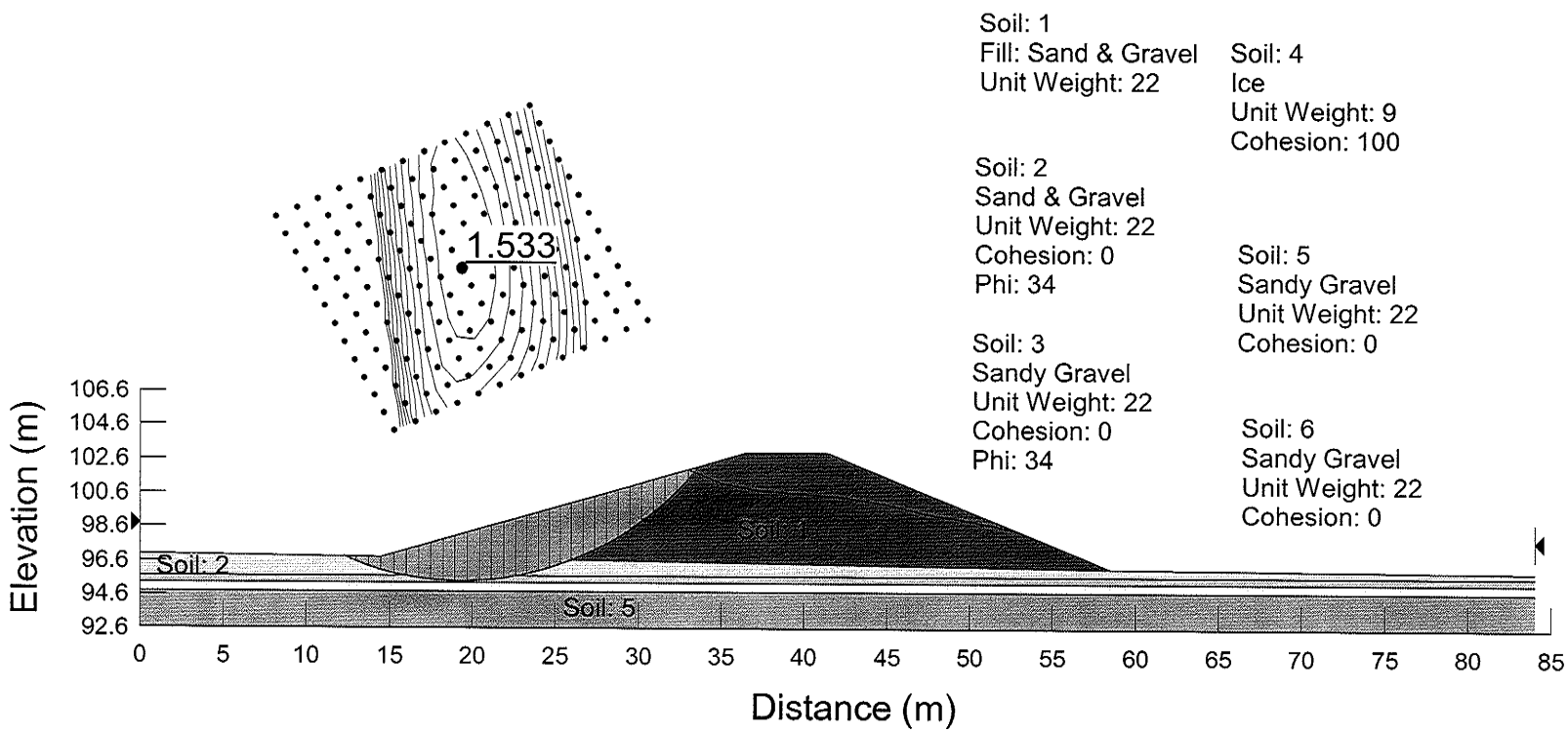


Figure 43

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section A-A
Inner Slope @ 3.5H to 1V
Rapid Drawdown
Seismic = 0.05g

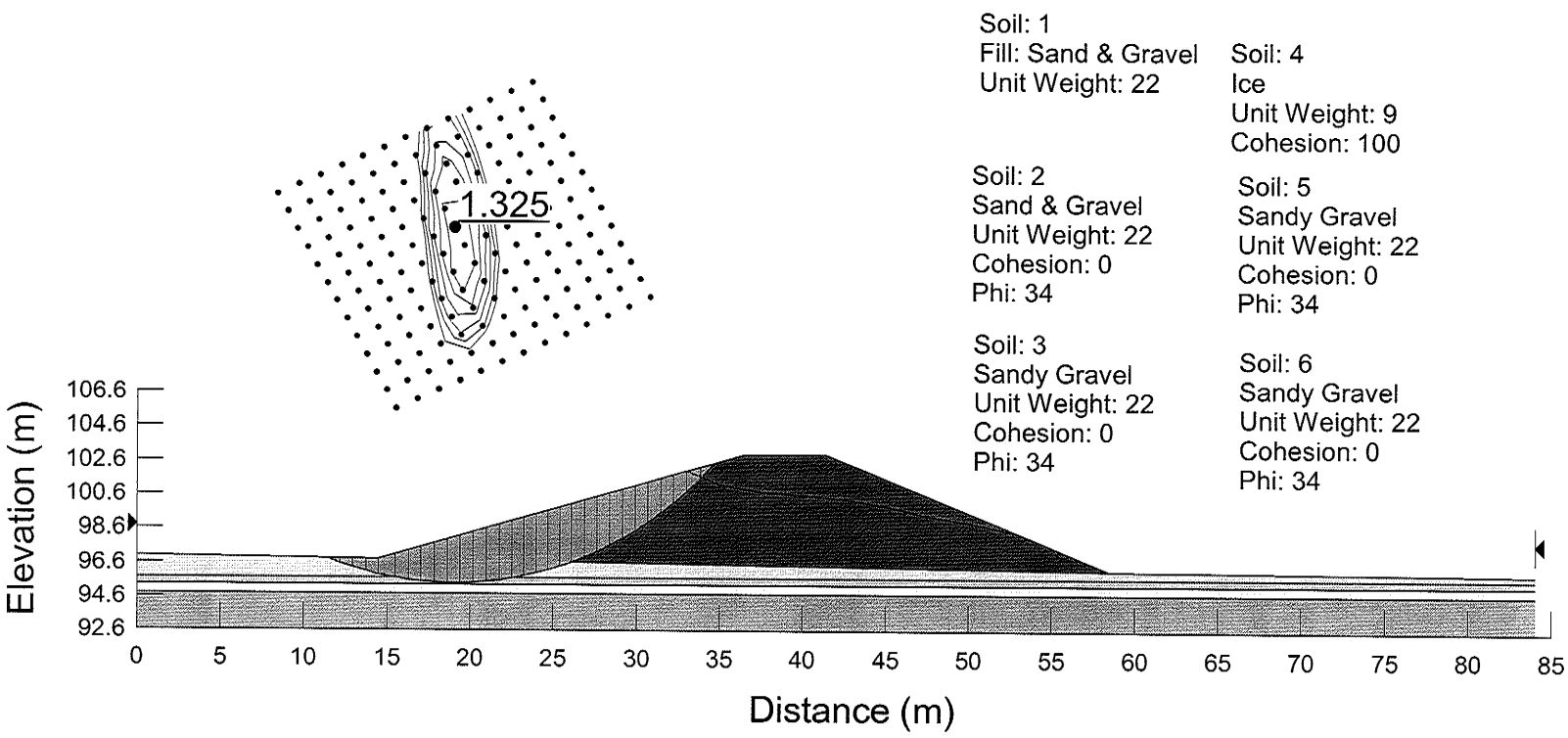
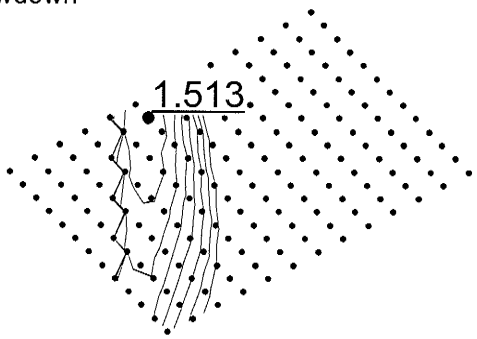


Figure 44

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section B-B
Inner Slope @ 4H to 1V
Rapid Drawdown



Soil: 1
Fill: Sand & Gravel
Unit Weight: 22

Soil: 2
Silty sand & gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

Soil: 3
Ice
Unit Weight: 9
Cohesion: 100

Soil: 4
Sandy Gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

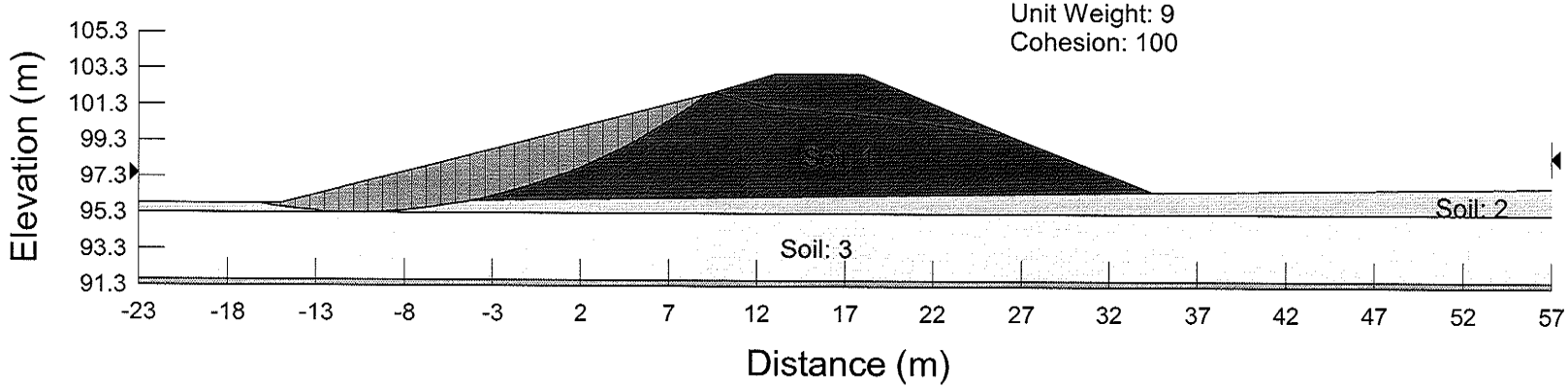
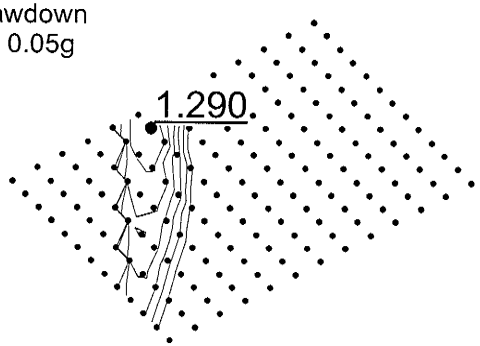


Figure 45

OTGE00019054B
New Sewage Lagoon & Decommission of Existing Sewage Lagoon
Arctic Bay
Nunavut
Slope Stability Analysis
Section B-B
Inner Slope @ 4H to 1V
Rapid Drawdown
Seismic = 0.05g



Soil: 1
Fill: Sand & Gravel
Unit Weight: 22

Soil: 2
Silty sand & gravel
Unit Weight: 22
Cohesion: 0
Phi: 34

Soil: 3
Ice
Unit Weight: 9
Cohesion: 100

Soil: 4
Sandy Gravel
Unit Weight: 22
Cohesion: 0
Phi: 34