Geotechnical Evaluation and Remedial Plan

Cell 20-1, Slope Issues - Clean Harbors Lambton Facility Landfill Corunna, Ontario

Clean Harbors Canada, Inc.

November 12, 2021

→ The Power of Commitment

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1. Introduction

Clean Harbors Canada, Inc. (Clean Harbors) operates a hazardous waste landfill facility (Facility or Site) in Corunna, Lambton County, Ontario. The Facility is located on Lots 8 and 9 of Concession 10, in St. Clair Township, Lambton County. The Site has a total property area of 140 hectares (ha). The layout of the existing Facility is shown on Figure 1.

This report pertains to the below-grade landfill expansion of the cell identified as Cell 20-1 (Cell), at the location shown on Figure 2. Excavation of the Cell commenced in the spring of 2021. Clean Harbors hired Murphy Contracting (Murphy) to carry out the construction of the Cell.

Excavation of the Cell commenced in the spring of 2021. The excavation of the Cell consisted of two excavation zones simultaneously. A bulk excavation zone of the central portion of the Cell was conducted by an excavator, trucks, and scrappers, and a cell perimeter excavation zone was established that excavated the perimeter of the cell in accordance with the cell design. The Cell design included a ramp down into the base of the cell located along the east wall. The base of the Cell was excavated to the design bottom elevation of 182 m AMSL in a south to north direction. The excavation of the Cell perimeter was progressing to the north-east corner with about 3 weeks of excavation remaining. By mid-July, approximately 50 percent of the excavation of the west wall had been completed. Late on the morning of August 18, Murphy staff observed that a crack was observed in the native clay on the west wall in the north-west section. Approximately 45 minutes later, the west side wall started to visually shift / rotate and an upward bulge of west portion of the Cell floor was observed (Slope Issues). GHD completed a drone survey of the Slope Issues on August 19. Contours generated from the drone survey are shown on Figure 3 and the extent of the Slope Issues can be seen in the contours shown on this Figure.

In response to the Slope Issues, the MECP issued correspondence to Clean Harbors including Condition 46 as follows:

> 46. The Owner shall not place any waste into the eastern half of cell 19-3 or Cell 20-1 until a report is prepared by a Professional Engineer confirming that landfilling can resume in these cells in a manner that is protective of the health and safety of people and the environment.

GHD has prepared this report to address the requirement set out in Condition 46, and at the direction of Clean Harbors. This report concludes that the remedial efforts taken by GHD, Clean Harbors and Murphy to date have stabilized the Slope Issues and will allow landfilling to continue in a manner that satisfies the requirements of Condition 46.

2. Cell 20-1 West Slope Issue Evaluation

2.1 Geotechnical Inspection of Slope Issues

Following an initial inspection of the Slope Issues on August 18, GHD proceeded with the following course of action:

- Excavation work was halted
- Detailed photographs of the area were obtained by the Geotechnical Engineer
- GHD mobilized a drone camera on August 19 for areal photographs and detailed contour survey of the excavated Cell and Slope Issues

Based on visual observations of the Slope Issues, the movement of the slope was considered to be rotational in nature. The horizontal benches excavated on the west side slope were visually rotated upwards, and the floor of the Cell had been rotated and pushed upwards. GHD's initial estimates of the approximate centre of rotational arcs

matched the drone survey data and are shown on Figure 3. These preliminary rotational surfaces were further evaluated using slope stability modelling software. GHD re-inspected the slope on August 19. Following this re-inspection and an evaluation of the data obtained through the drone survey, GHD has determined that any movement of the slope had stopped by August 19. There is no evidence that any leachate escaped the Cell into the natural environment. Following discussions with Clean Harbors management and out of an abundance of caution, GHD recommended the construction of a north-south berm east of the bulge to contain leachate that was observed in the base of the Cell. In addition to further leachate protection, this berm also provides part of a stabilizing clay buttress in the floor of the cell, at the toe of the slope, as a measure to prevent further slope movement. Construction of this berm and clay buttress began on August 20 and was substantially completed by September 30. The Geotechnical Engineer inspected the work on September 30 and GHD completed an addition drone survey on October 13. Both the Geotechnical Engineer's inspection and the October 13 drone survey support a conclusion that the slope has stabilized, as neither showed any evidence of further movement and both instead show that the slope is reinforced and stabilized by the newly constructed berm and clay buttress.

Photographs of the Slope Issues and the Geotechnical Engineer's September 30 inspection are presented in Appendix A.

2.2 Goals of the Slope Stability Modelling

Based on GHD's observations of the Slope Issues, GHD recommended that it perform additional slope stability modelling to help determine the best course of remedial action, to prevent further slope movement, and to allow waste placement to take place in the Cell 20-1.

GHD utilized the Geo-Studio 2021 (Version 11.0.1.21429) suite of Software developed by Geo-Slope International of Calgary, Alberta for the slope stability modelling. The software comprises three modules SEEP/W, SLOPE/W and SIGMA/W.

The SLOPE/W module employs mainly limit-equilibrium methods such as Bishop, Janbu, Spencer, or Morgenstern & Price methods. GHD carried out the slope stability analyses for this study using the Morgenstern & Price Method, which is a general method of slices developed on the basis of limit equilibrium that requires satisfying equilibrium of forces and moments acting on individual blocks. The software allows for an optimization of the failure plane, to evaluate deviations from pure circular rotational arcs. GHD employed this optimization option in the modelling analyses.

The goals of the modelling were:

- Input the observed aerial survey conditions for the Cell at the location of the Slope Issues.
- Utilize the August 19 aerial drone survey data to model the stability of the slope in its current state using a 'back-analysis' approach.
- Determine the depth of the rotational surface of the failure plane using the drone survey and inputting the suspected depth of the rotational plane into the model.
- Model the proposed construction of the remedial clay buttress, to provide values of the factor of safety (FS) for the remedial approach, and to ensure that the approach would provide stable slope conditions to allow use of the Cell for waste landfilling.
- Model the placement of waste and a new clay cover over any pre-existing waste exposed as the result of the Slope Issues to address any odour control and leachate management concerns.

2.3 Cross Sections Analyzed

Cross-sections modelled for the analyses were similar those evaluated prior to the design and construction of Cell 20-1. The cross-section location for the slope issue analysis is shown as A-A' on Figure 3

2.4 Stratigraphy and Material Properties

The properties required for the stability analyses of the slopes are the bulk densities and shear strength parameters of the materials involved. Relevant geotechnical properties comprising bulk density and shear strength of the different subsurface units were kept consistent with those determined prior to the design and construction of the Cell which are summarized in Table 3.1. The data obtained from these tests, and our previous experience at the Clean Harbors site, were used to determine the appropriate clay material properties, including bulk density and effective shear strength parameters, for the slope stability analyses. The clayey silt units have been divided into geologic subunits based on their geotechnical properties. These are referred to as the St. Joseph Till, and Black Shale Till, based on historical geotechnical reports and geologic descriptions.

2.5 Piezometric Conditions

The stabilized pieziometric (groundwater table) surface in the model was assumed to be at elevation 197 m. This elevation is similar to the maximum leachate head within the leachate collection system and elevation of the groundwater elevations at the Site and is about 3m below ground surface. The excavation for the Cell is therefore mainly in the saturated clay deposits. The excavation of the Cell causes a change in the stabilized piezometric surface (the groundwater table is drawn down by the process of excavation). This change in the piezometric conditions is evaluated using a transition from the ‘undrained” state to the “drained” state for the clay deposits, and the modelling software can simulate this change of piezometric conditions over a period of time defined by the modeller. The post-excavation piezometric surface was determined for the modelling analyses after a period of approximately 30 days, to simulate the conditions that were present at the time of the Slope Issues occurred.

2.6 Minimum Factors of Safety

The factor of safety (FS) in slope stability analysis can be defined as the ratio of the available shear strength to that of the applied stresses along a potential failure plane. An FS of 1 or greater indicates stable conditions and a value of less than 1 represents unstable conditions and failure. Given the variability and uncertainty in the selection of strength parameters for natural soil and waste material, an FS above 1 is usually required to provide confidence in the model results. The Canadian Foundation Engineering Manual provides recommendations for typical accepted FS for various structures, depending on the risks associated with the failure.

2.7 Slope Stability Back Analyses and Modelling of the Clay Buttress Remediation

While GHD has not determined the exact cause of the Slope Issues, GHD has examined the proximity of the Pre-1986 waste landfill (Pre-1986 Waste) has been examined as a potential cause of the Slope Issues and used this posited cause to analyze the efficacy of the remedial solution. Figure 5 shows the construction of a slope stability model where the boundary location of the Pre-1986 Waste limit has been moved closer to the Cell excavation.

The rotational movement of the slope will have caused a weakened (or remoulded) clay zone along the path of the rotational movement. This weakened clay layer was simulated in the model, as shown on Figure 5 (remoulded clay layer), along the estimated rotational surface that was preliminarily determined from the aerial drone survey. The shear strength of this weakened zone was back-calculated, using a “back-analysis” approach, by reducing the strength of the weakened zone until an FS of approximately 1.0 was achieved in the model. This model was then used to evaluate the improvement in the FS by construction of the clay buttress. Initial modelling of the buttress constructed to about Elevation 190 m, shows that the FS would increase from about 1.0, to about 1.46, in its fully constructed state (see Figure 6). This FS is considered acceptable to ensure long term stable conditions of the failed slope. These results were presented at a virtual meeting with the MECP on October 13. During the meeting, Clean Harbors requested permission to regrade the waste in the area of the Slope Issues, with the goal of covering any exposed waste with a clay cap, and regrading the area to minimize surface water infiltration into the waste. GHD

modelled the regraded effort, and the results are shown on Figure 7. The FS for this condition is approximately 1.32 which, based on the requirements outlined in the abovementioned Canadian Foundation Engineering Manual indicates that this work could be done without affecting the stability of the slope.

2.8 Confirmation of Rotational Plane

GHD will be completing additional field investigations to verify the depth of the rotational plane associated with the Slope Issues. Based on the drone survey, the rotational plane is suspected to be between Elevation 175 and 180 m in the area below the Cell 20-1 floor. GHD will use the cone penetration test (CPT) technique in the west slope area to verify the depth of the rotational plane. The CPT test consists of hydraulically pushing an instrumented cone tip into the ground using a conventional drill rig. The instrumented cone tip records tip resistance, side friction, and pore pressures at 2 cm intervals as it is pushed into the ground. This data is collected using an onboard data acquisition system, and plots of the data with depth are generated during the CPT penetration. The approximate locations of the CPT tests are shown on Figure 8.

2.9 Verification of North, South, and East Excavation Side Slope Stability

CPT tests will also be obtained at strategic locations on the north, south, and east slopes. The CPT information will be used to re-assess the slope stability models for these sections. The results of these models will be presented in a separate report.

3. Conclusion

The Slope Issues have been stabilized by the construction of the berm and clay buttress. Furthermore, even with conservative modelling regarding the possible impact of unknown conditions related to the exact location of the Pre-1986 Waste, the remediated area is shown to achieve an appropriate safety factor. As such, for the reasons outlined herein, GHD concludes that landfilling of the Cell and any adjacent cells can resume in a manner that is protective of the health and safety of people and the environment.

4. Limitations

This report: has been prepared by GHD for Clean Harbors Canada, Inc. and may only be used and relied on by Clean Harbors Canada, Inc. for the purpose agreed between GHD and Clean Harbors Canada, Inc. as set out in section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Clean Harbors Canada, Inc. arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

All of Which is Respectfully Submitted,

GHD

Bruce Polan, M.A.Sc., P.Eng.

James R. Yardley, P.Eng.

SOURCE:

EXISTING TOPOGRAPHY AND SITE FEATURES PER DRAWING NO. 5, STORMWATER MANAGEMENT, DATED FEBRUARY 23, 2015, PREPARED BY TETRA TECH.

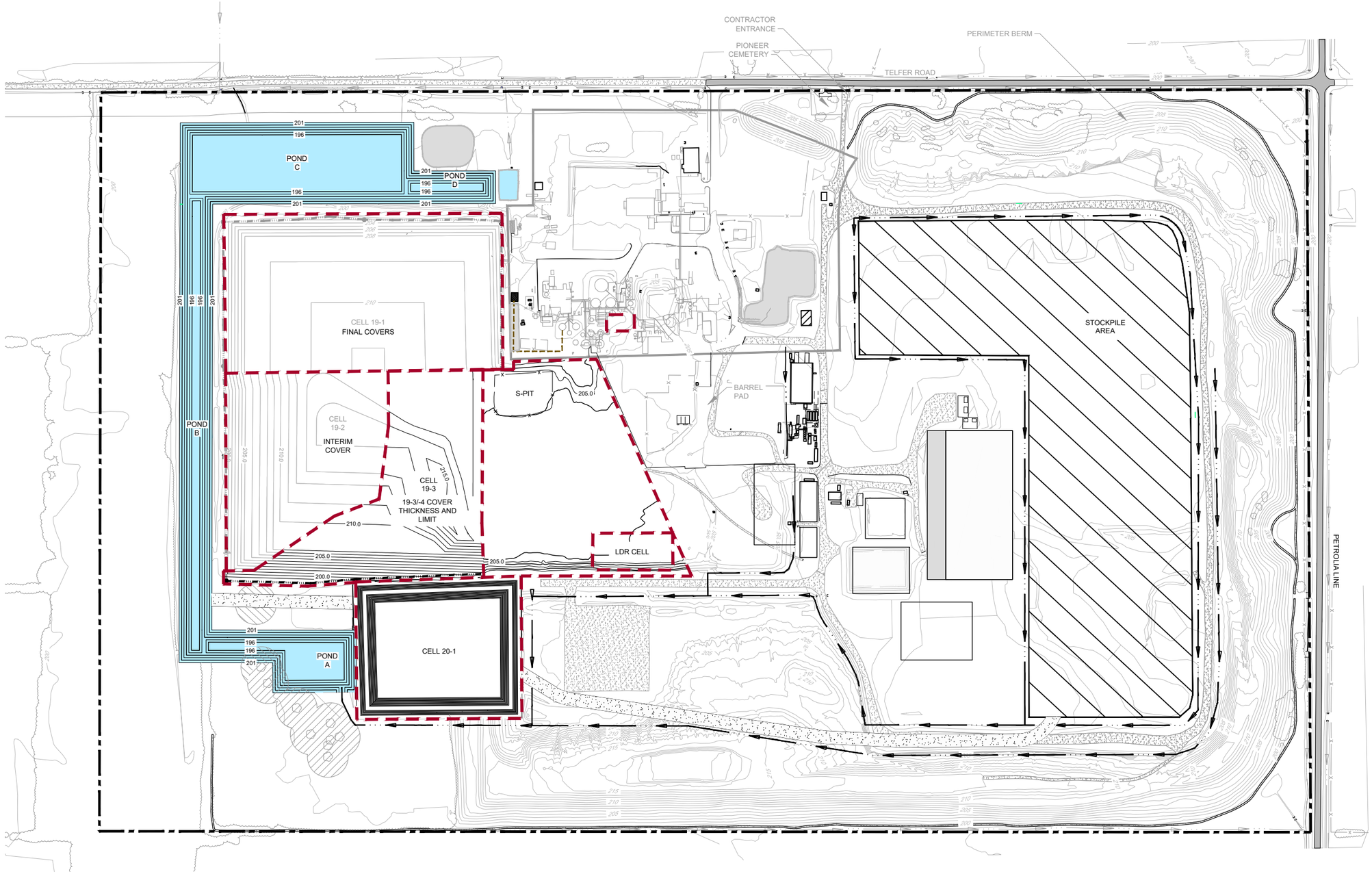
FINAL COVER CONTOURS PER DRAWING NO. 20, FINAL COVER CONTOURS, DATED FEBRUARY 23, 2015, PREPARED BY TETRA TECH.

BUTTERNUT TREES PER DRAWING NO. 13, LANDFILL EXPANSION SUBCELL FILL PROGRESSION PLAN, DATED FEBRUARY 23, 2015, PREPARED BY TETRA TECH.

LEGEND:

- EXISTING MAJOR CONTOUR (5m INTERVAL)
- EXISTING MINOR CONTOUR (1m INTERVAL)
- PROPOSED CONTOUR (2m INTERVAL)
- PROPOSED CONTOUR (1m INTERVAL)
- PROPERTY BOUNDARY
- LIMIT OF WASTE
- LEACHATE COLLECTION SYSTEM
- EXISTING DRAINAGE SWALE
- PROPOSED DRAINAGE SWALE
- FENCELINE
- STORM WATER DRAINAGE DIVIDE
- PAVED ROADWAY
- GRAVEL ROADWAY
- BUILDING / STRUCTURE
- TREELINE
- STORM WATER POND
- PROCESSED WATER
- PROPOSED ACCESS ROAD

0 20 40 60 80m



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Client
CLEAN HARBORS CANADA, INC. LAMBTON COUNTY, ONTARIO

Project
2021 CAPITAL WORKS CELL DESIGN ECA 1065-9VVJSW

No.	Issue	Drawn	Approved	Date

Drawn	K. DHALIWAL	Designer	
Drafting Check	J. YARDLEY	Design Check	J. YARDLEY
Project Manager	J. YARDLEY	Date	-
This document shall not be used for construction unless signed and sealed for construction.		Scale	1:750
Original Size	ANSI D	Bar is 20mm on original size drawing	0 20mm

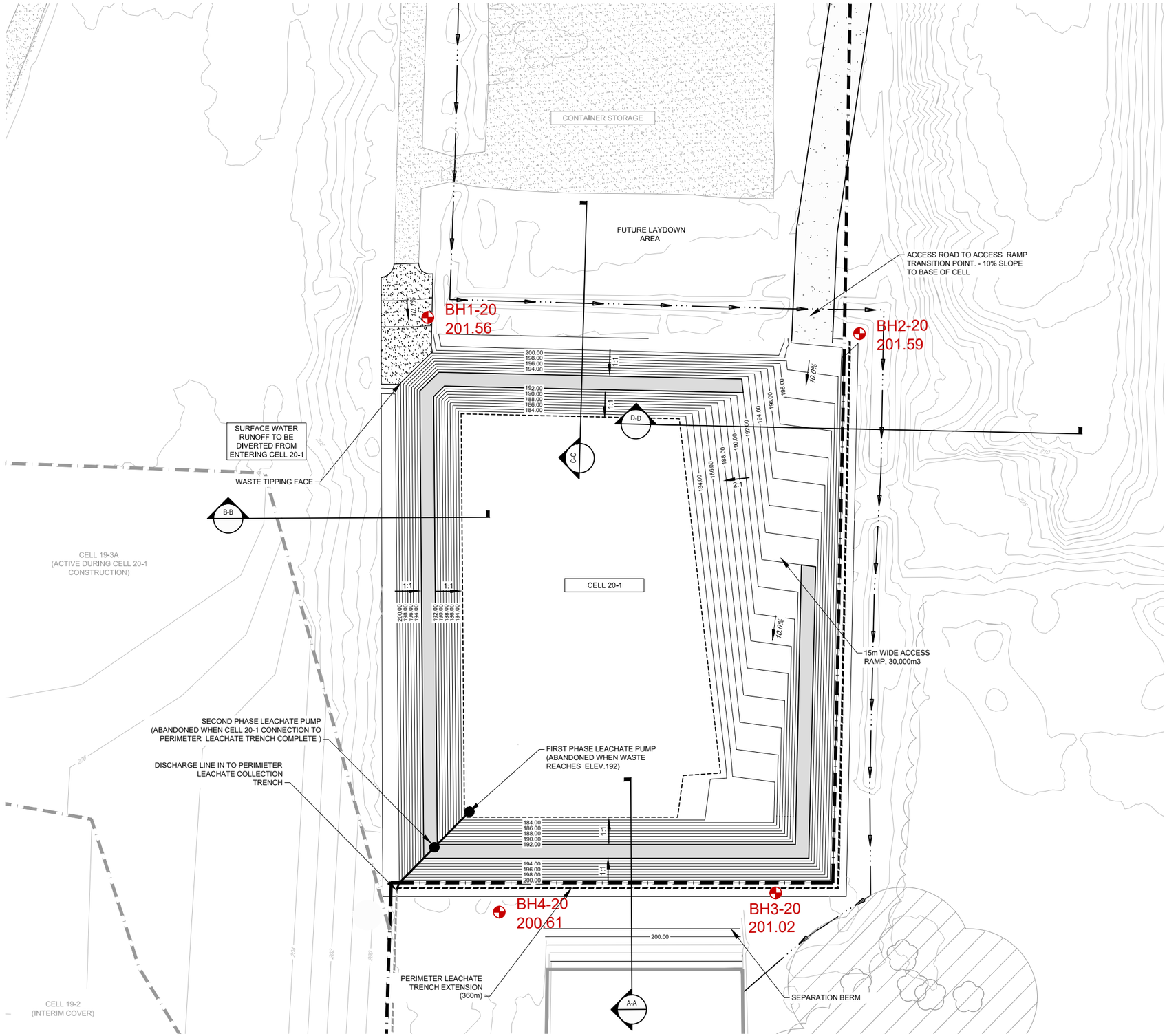
Project No. **44985-50**

Title
2020 CAPITAL WORKS PHASING PLANS

Sheet No.
FIGURE 1

Sheet 1 of 2

Plot Date: 18 January 2021 - 1:00 PM Plotted By: Akram Yusuf CAD File: P:\drawings\44000s\44985\44985-REPORTS\44985-98(045)\44985-98(045)CI-WA001.dwg



0 6 12 18 24m

LEGEND:

- LIMIT OF WASTE
- CELL BOUNDARIES
- CELL 20-1 TOE OF SLOPE (ELEV. 182)
- EXISTING MAJOR CONTOUR (2m INTERVAL)
- EXISTING MINOR CONTOUR (1m INTERVAL)
- MAJOR CONTOUR (PROPOSED BASE GRADES)
- MINOR CONTOUR (PROPOSED BASE GRADES)
- EXISTING LEACHATE COLLECTION TRENCH
- EXISTING DRAINAGE DITCH
- EXISTING ACCESS ROADS
- LEACHATE COLLECTION TRENCH EXTENSION
- ACCESS ROAD/TIPPING FACE
- CELL 20-1 BENCH (ELEV, 192)
- BH2-20 201.59 GEOTECHNICAL BOREHOLE AND GROUND SURFACE ELEVATION

SOURCE:

EXISTING TOPOGRAPHICAL AND SITE FEATURES FROM MAY 22, 2020 GHD SURVEY. EXISTING TOPOGRAPHICAL SURVEY ADJUSTED 0.510m TO MATCH HISTORICAL VERTICAL DATUM.

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Project
2021 CAPITAL WORKS CELL DESIGN

No.	Issue	Drawn	Approved	Date

Drawn	K. DHALIWAL	Designer	
Drafting Check	J. YARDLEY	Design Check	J. YARDLEY
Project Manager	J. YARDLEY	Date	-
This document shall not be used for construction unless signed and sealed for construction.		Scale	1:750
Original Size	ANSI D	Bar is 20mm on original size drawing	0 20mm

Project No. **44985-50**

Title
BOREHOLE LOCATION PLAN- CELL 20-1

Sheet No.
FIGURE 2

Sheet **2** of **2**

Plot Date: 18 January 2021 - 1:24 PM Plotted By: Akram Yusuf CAD File: P:\drawings\44000s\44985\44985-REPORTS\44985-98(045)\44985-98(045)CI-WA002.dwg

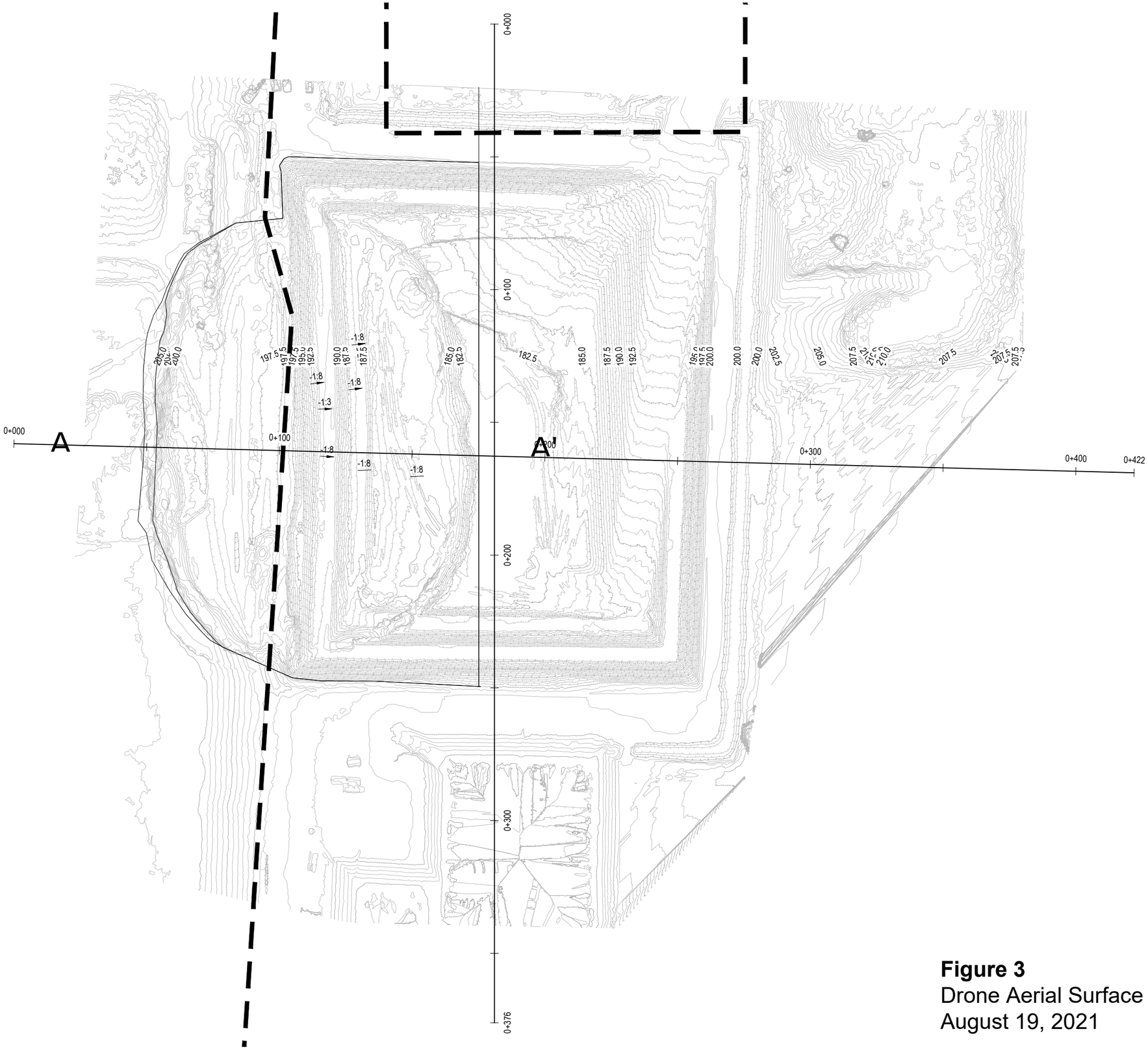


Figure 3
Drone Aerial Surface Contours
August 19, 2021

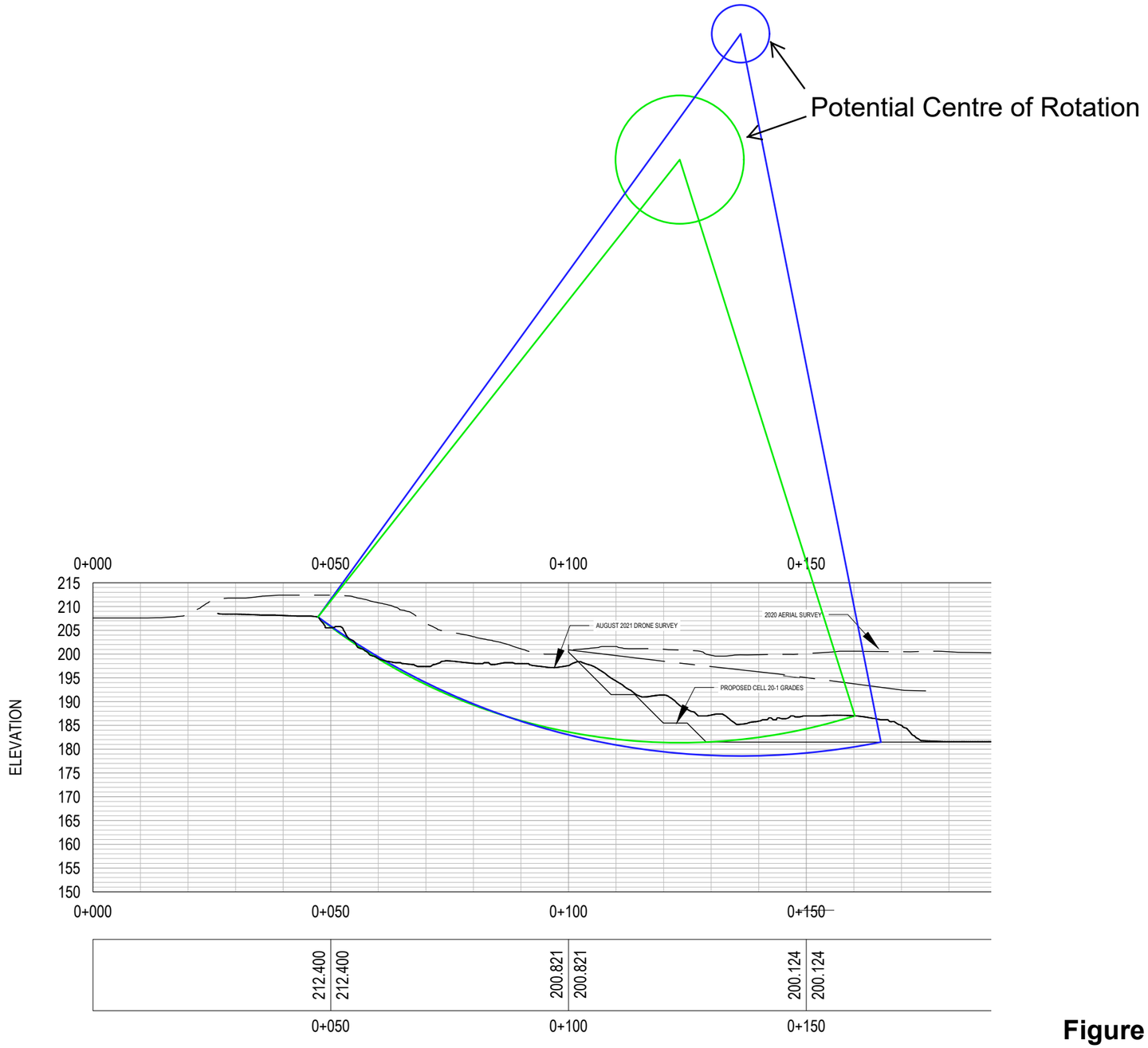


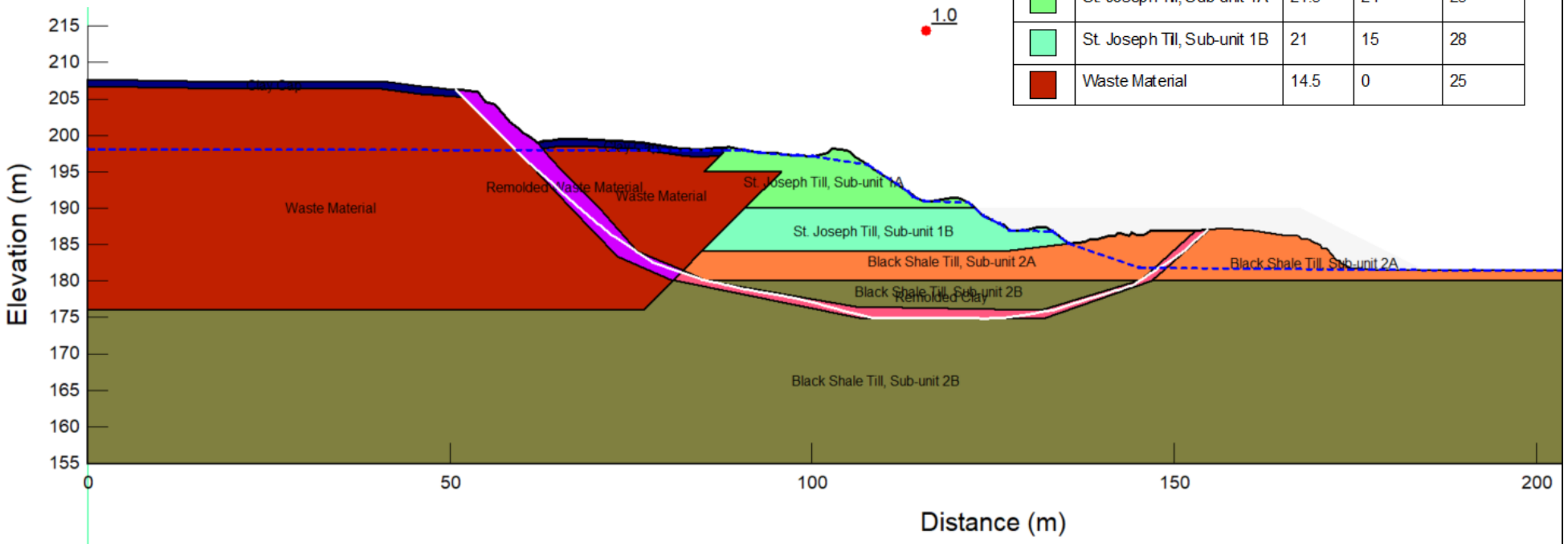
Figure 4
Preliminary Slope Rotation Arcs

Figure 5

West Slope Issue- Back Calculation Analysis of Rotated Surface

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Black Shale Till, Sub-unit 2A	20	13	26
	Black Shale Till, Sub-unit 2B	18.2	13	26
	Clay Cap	21	0	25
	Remolded Clay	18	0	14
	Remolded Waste Material	14.5	0	14
	St. Joseph Till, Sub-unit 1A	21.5	24	25
	St. Joseph Till, Sub-unit 1B	21	15	28
	Waste Material	14.5	0	25

Note: Soil layers in rotated section on figure not adjusted to reflect post-rotation configuration.



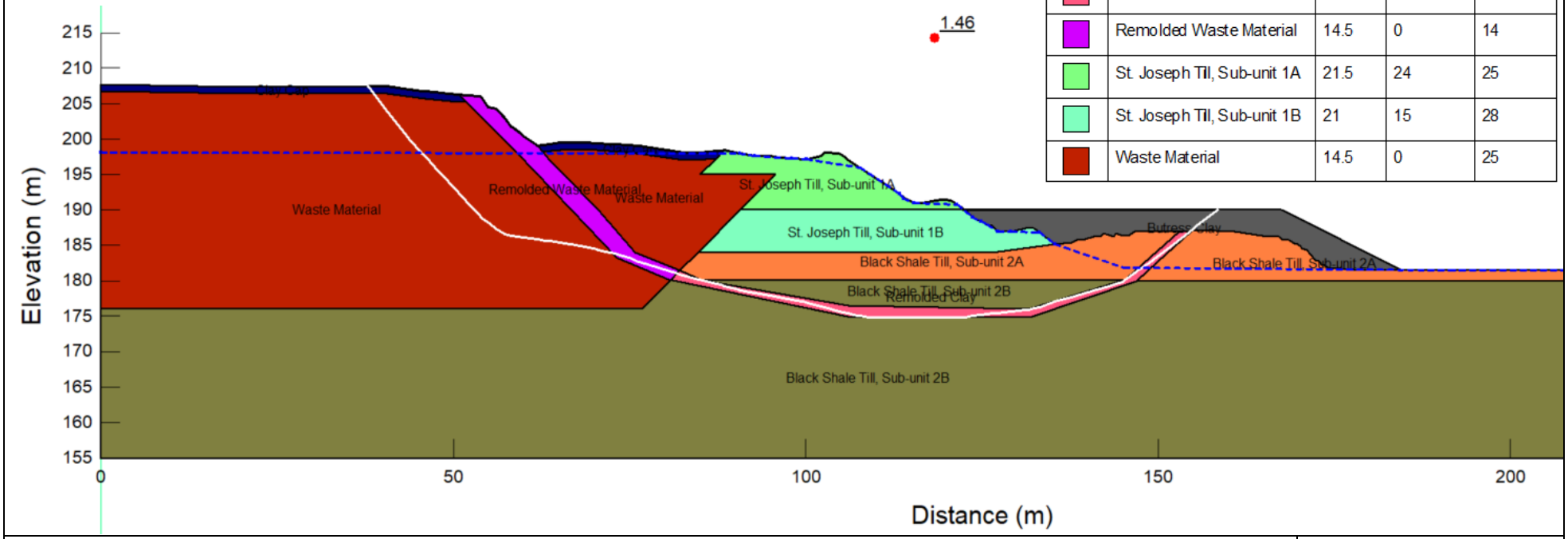
Client :	Clean Harbors Canada Inc.	
Projet :	Cell 20-1 Slope Issues	
Reference :	44985	
Location :	West Slope	
Analysis :	Static Drained	F.S : 1.0

Figure 6

West Slope- Proposed Buttress Stabilization

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Black Shale Till, Sub-unit 2A	20	13	26
	Black Shale Till, Sub-unit 2B	18.2	13	26
	Butress Clay	18	5	25
	Clay Cap	21	0	25
	Remolded Clay	18	0	14
	Remolded Waste Material	14.5	0	14
	St. Joseph Till, Sub-unit 1A	21.5	24	25
	St. Joseph Till, Sub-unit 1B	21	15	28
	Waste Material	14.5	0	25

Note: Soil layers in rotated section on figure not adjusted to reflect post-rotation configuration.



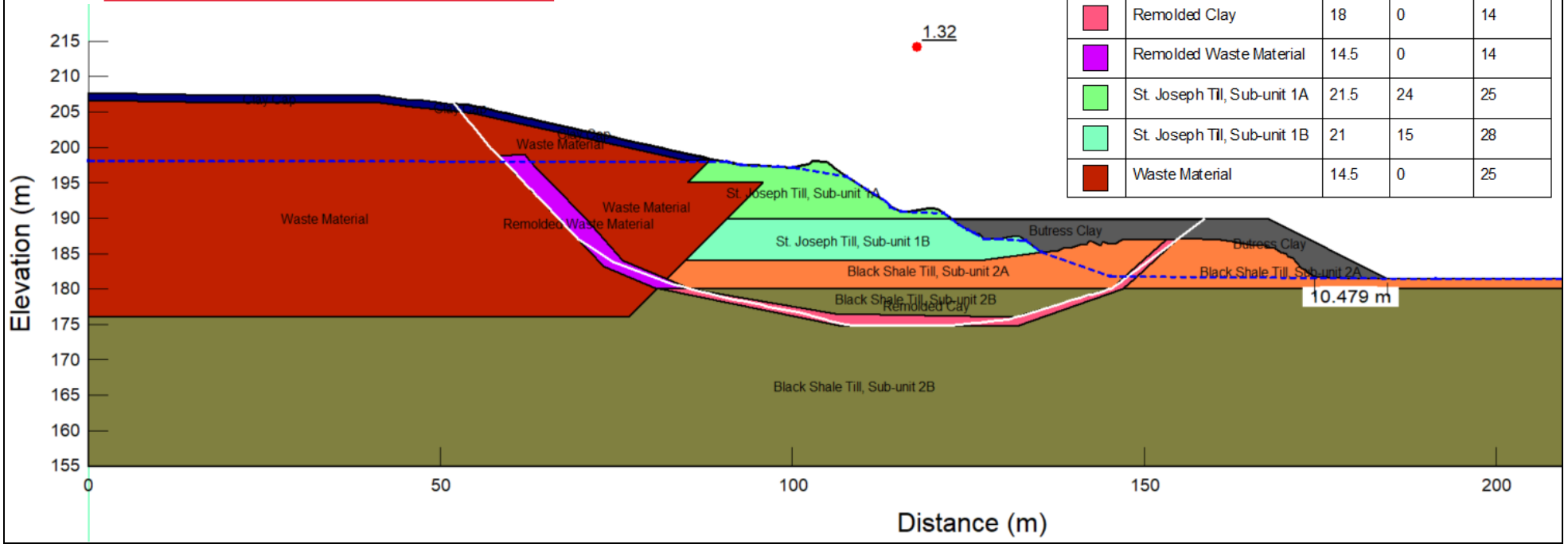
Client :	Clean Harbors Canada Inc.	
Projet :	Cell 20-1 Slope Issues	
Reference :	44985	
Location :	West Slope	
Analysis :	Static Drained	F.S : 1.46

Figure 7

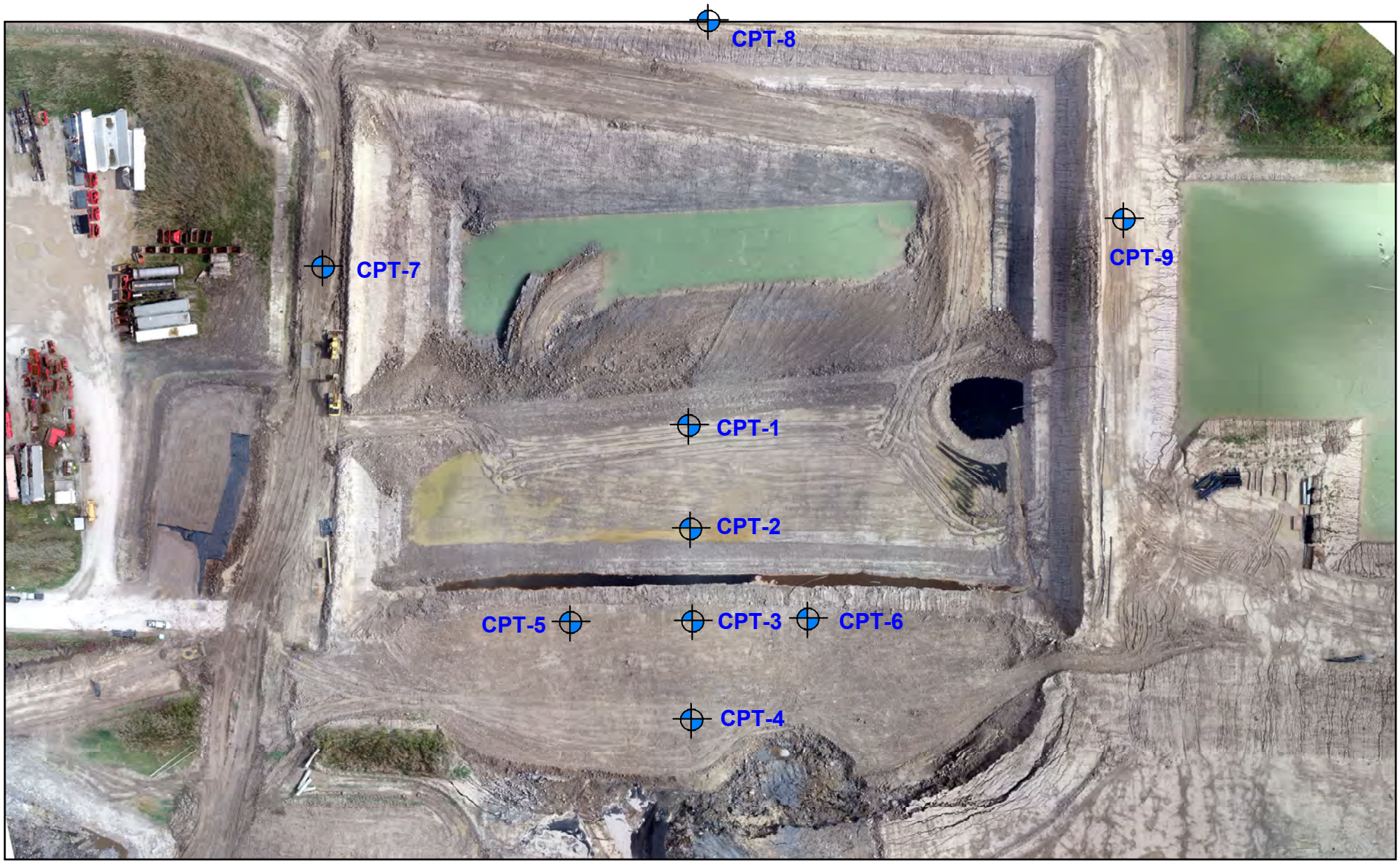
West Slope- Buttress Stabilization and Pre-1986 Waste Cell Graded and Capped

Color	Name	Unit Weight (kN/m³)	Effective Cohesion (kPa)	Effective Friction Angle (°)
	Black Shale Till, Sub-unit 2A	20	13	26
	Black Shale Till, Sub-unit 2B	18.2	13	26
	Butress Clay	18	5	25
	Clay Cap	21	0	25
	Remolded Clay	18	0	14
	Remolded Waste Material	14.5	0	14
	St. Joseph Till, Sub-unit 1A	21.5	24	25
	St. Joseph Till, Sub-unit 1B	21	15	28
	Waste Material	14.5	0	25

Note: Soil layers in rotated section on figure not adjusted to reflect post-rotation configuration.



Client :	Clean Harbors Canada Inc.	
Projet :	Cell 20 Slope Issues	
Reference :	44985	
Location :	West Slope	
Analysis :	Static Drained	F.S : 1.32



Paper Size ANSI A

0 10 20 30 40

Meters

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

Clean Harbours Lambton Facility Landfill
4090 TELFER ROAD,
ST. CLAIR TOWNSHIP,
COUNTY OF LAMBTON

Cone Penetration Testing Locations

Project No. 044985
Revision No. -
Date Oct 13, 2021

FIGURE 8

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Data Source: Drone imagery captured on-site by GHD on August 4th, 2021. Basemap: ESRI

TABLE 3.1

SUMMARY OF GEOTECHNICAL LABORATORY TEST RESULTS
CELL 20-1 GEOTECHNICAL INVESTIGATION
CLEAN HARBORS LAMBTON FACILITY, CORUNNA, ON

Sample Number	*Sample Location*	*Sample Date*	*Sample Type*	*Material Description*	*Sample Depth (metres below grade)*	*Laboratory Sample No.*	*Particle Size Distribution (%)*					*As Received Moisture Content (%)*	*Atterberg Limits (%)*			*Unconfined Strength*	*Bulk Unit Weight*	*CU Compression Test*	
							Gravel	*Sand*	*Silt*	*Passing No. 200 Sieve*	*Clay (< 0.002 mm)*		*Liquid Limit (LL)*	*Plastic Limit (PL)*	*Plasticity Index (PI)*	*Shear Strength (kPa)*	*(kN/m^3)*	*Effective Strength (kPa)*	*Effective Angle of Internal Friction (degree)*
1	BH1-20, ST-1	5-Oct-20	Shelby Tube	Silt and Clay, trace sand, trace gravel	13.0 m - 13.6 m	WLT 453-1	1	6	57	93	36	19	32	17	15	143.9	20.1		
2	BH1-20, ST-2	5-Oct-20	Shelby Tube	Clay and Silt, trace sand, trace gravel	22.9 m - 23.5 m	WLT 453-2	1	7	43	92	49	24	41	21	20	32.6	20.0	22	25
3	BH2-20, ST-1	8-Oct-20	Shelby Tube	Silt and Clay, some sand, trace gravel	10.7 m - 11.3 m	WLT 453-3	1	17	46	82	36	19	30	15	15	63.5	21.0	27	26
4	BH2-20, ST-2	8-Oct-20	Shelby Tube	Clayey Silt	21.3 m - 21.9 m	WLT 453-4										64.3	18.1		
5	BH3-20, ST-1	7-Oct-20	Shelby Tube	Clayey Silt	10.7 m - 11.3 m	WLT 453-5										105.0	21.0		
6	BH3-20, ST-2	7-Oct-20	Shelby Tube	Clay and Silt, trace sand, trace gravel	21.3 m - 21.9 m	WLT 453-6	2	7	42	91	49	25	41	21	20	42.9	19.9		
7	BH4-20, ST-1	6-Oct-20	Shelby Tube	Clayey Silt	10.7 m - 11.3 m	WLT 453-7										104.6	21.1		
8	BH4-20, ST-2	6-Oct-20	Shelby Tube	Clay and Silt, trace sand, trace gravel	21.3 m - 21.9 m	WLT 453-8	1	8	44	91	47	27	41	20	21	26.2	20.0	24	21

Notes:
(1) NP denotes Non Plastic

Appendices

Appendix A

Photographic Log

Photo 1- West Side wall of Cell 20-1, after slope movement, August 18, 2021.

Site Photographs
Cell 20-1 Slope Issues
Clean Harbors Lambton Facility Landfill, Corunna

Photo 2- West side wall of Cell 20-1, looking south, August 18, 2021.

Photo 3- Top of Slide Area, looking north, August 18, 2021.

Site Photographs
Cell 20-1 Slope Issues
Clean Harbors Lambton Facility Landfill, Corunna

Photo 4- Top of Slide Area, looking north, September 30, 2021.

Photo 5- Completed buttress, looking southeast, September 30, 2021.

Photo 6- Completed buttress, looking north, September 30, 2021.

Photo 7- South sidewall, looking west, September 30, 2021.

Site Photographs
Cell 20-1 Slope Issues
Clean Harbors Lambton Facility Landfill, Corunna

Appendix B

2020 Borehole Logs

REFERENCE No.: 044985-50-04 ENCLOSURE No.: A-1

BOREHOLE No.: BH1-20
ELEVATION: 201.56 m

BOREHOLE REPORT

Page: 1 of 3

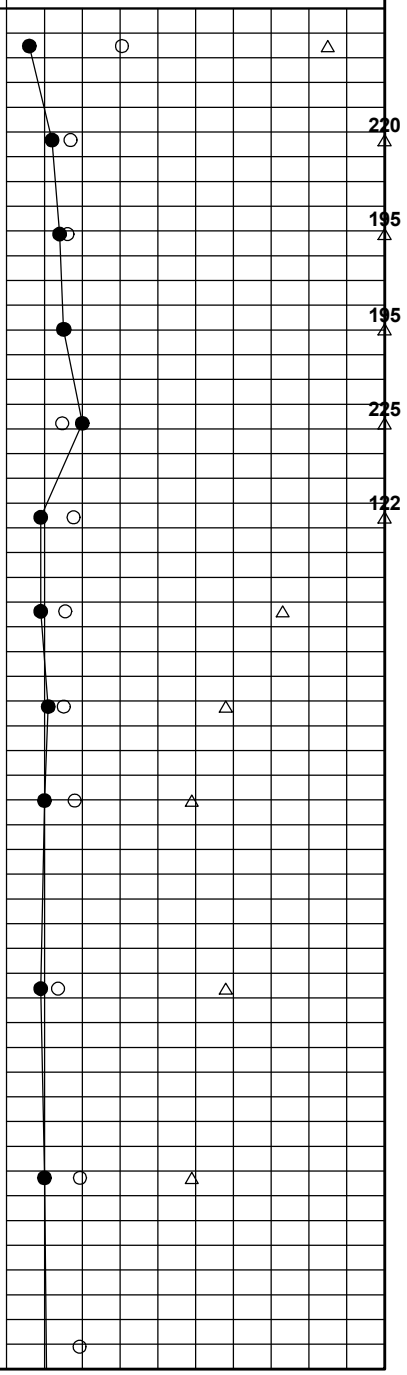
CLIENT: Clean Harbors - Lambton Facility
PROJECT: Geotechnical Investigation - Cell 20-1
LOCATION: Clean Harbors Lambton Facility, 4090 Telfer Rd. Corunna, ON
DESCRIBED BY: Ahmed Mneina CHECKED BY: Abdul Hafeez Khan
DATE (START): 5 October 2020 DATE (FINISH): 5 October 2020

LEGEND

- SS - SPLIT SPOON
- ST - SHELBY TUBE
- GS - GRAB SAMPLE
- RC - ROCK CORE
- WATER LEVEL

Depth (Feet)	Depth (Metres)	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm or RQD	Penetration Index N
0		201.56		GROUND SURFACE						
0 to 0.9	0 to 0.9	201.56 to 200.66		FILL: CLAYEY SILT - brown, trace sand, trace gravel, inclusion of topsoil, roots, moist-wet to moist		SS-1	75	31	3-3-3-3	6
0.9 to 1.4	0.9 to 1.0	200.66 to 200.16		NATIVE: CLAYEY SILT - grey/brown mottled, stiff, trace sand, trace gravel, moist		SS-2	96	17	3-5-7-9	12
1.4 to 2.9	1.4 to 2.0	200.16 to 198.66		becoming brown		SS-3	83	16	4-6-8-10	14
						SS-4	96	15	4-7-8-11	15
2.9 to 3.7	2.9 to 3.0	198.66 to 197.86		becoming greyish brown, very stiff		SS-5	92	15	7-8-12-15	20
3.7 to 4.5	3.7 to 4.0	197.86 to 197.06		becoming stiff		SS-6	100	18	3-5-4-9	9
4.5 to 5.2	4.5 to 5.0	197.06 to 196.36		becoming grey, some sand		SS-7	100	16	3-4-5-7	9
5.2 to 6.0	5.2 to 6.0	196.36 to 195.56		mud rotary drilling with 100 mm diameter casing some gravel becoming grey		SS-8	33	15	3-5-6-6	11
						SS-9	75	18	2-4-6-7	10
6.0 to 7.3	6.0 to 7.0	195.56 to 194.26		becoming sandy to some sand		SS-10	100	14	3-4-5-6	9
7.3 to 8.8	7.3 to 8.0	194.26 to 192.76		trace sand, occasional gravel, moist-wet		SS-11	100	19	3-4-6-7	10
8.8 to 10.5	8.8 to 10.0	192.76 to 191.06		some gravel						
10.5 to 10.7	10.5 to 10.7	191.06 to 190.86		Attempted Shelby tube sampling at 10.7		GS-1	--	19	--	--

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
Atterberg limits (%) W_p W_l
● "N" Value (blows / 12 in.-30 cm)



SOIL LOG WITH GRAPH 044985-50-04 - BOREHOLE LOGS (FINAL).GPJ GHD_Geotechnical 12/1/21

REFERENCE No.: 044985-50-04 ENCLOSURE No.: A-1

BOREHOLE No.: BH1-20
ELEVATION: 201.56 m

BOREHOLE REPORT

Page: 2 of 3

CLIENT: Clean Harbors - Lambton Facility
PROJECT: Geotechnical Investigation - Cell 20-1
LOCATION: Clean Harbors Lambton Facility, 4090 Telfer Rd. Corunna, ON
DESCRIBED BY: Ahmed Mneina CHECKED BY: Abdul Hafeez Khan
DATE (START): 5 October 2020 DATE (FINISH): 5 October 2020

LEGEND

- SS - SPLIT SPOON
- ST - SHELBY TUBE
- GS - GRAB SAMPLE
- RC - ROCK CORE
- WATER LEVEL

Depth Feet	Depth Metres	Elevation (m) BGS 201.56	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm or RQD	Penetration Index N
	11.4	190.16		m bgs, with zero recovery. Grabbed split spoon sample at 10.7 m bgs without SPT count						
	11.9	189.66		Attempted Shelby tube sampling at 11.4 m bgs, with zero recovery						
	12.0			trace gravel		SS-12	100	20	3-4-7-8	11
	13.0	188.56		Shelby tube sample at 12.96 m bgs **Grainsize Analysis:** Gr =1%, Sa =6%, Cl & Si =93%		ST-1	100	20	--	--
	13.6	187.96		becoming very stiff						
	14.0					SS-13	100	21	5-8-11-15	19
	15.0					SS-14	100	23	5-8-12-15	20
	16.0									
	16.5	185.06		occasional gravel		SS-15	58	23	4-8-10-14	18
	17.0									
	17.8	183.76		becoming stiff						
	18.0					SS-16	100	25	3-7-8-10	15
	19.0									
	19.5	182.06		becoming firm						
	20.0					SS-17	100	26	1-2-4-5	6
	21.0									

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

10 20 30 40 50 60 70 80 90

152 122 137

SOIL LOG WITH GRAPH 044985-50-04 - BOREHOLE LOGS (FINAL).GPJ GHD_Geotechnical 12/1/21

REFERENCE No.: 044985-50-04 ENCLOSURE No.: A-1

BOREHOLE No.: BH1-20
ELEVATION: 201.56 m

BOREHOLE REPORT

Page: 3 of 3

CLIENT: Clean Harbors - Lambton Facility
PROJECT: Geotechnical Investigation - Cell 20-1
LOCATION: Clean Harbors Lambton Facility, 4090 Telfer Rd. Corunna, ON
DESCRIBED BY: Ahmed Mneina CHECKED BY: Abdul Hafeez Khan
DATE (START): 5 October 2020 DATE (FINISH): 5 October 2020

LEGEND

- SS - SPLIT SPOON
- ST - SHELBY TUBE
- GS - GRAB SAMPLE
- RC - ROCK CORE
- WATER LEVEL

Depth (Feet)	Depth (Metres)	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm or RQD	Penetration Index N
		201.56								
75	22.9	178.69		Shelby tube sample at 22.87 m bgs **Grainsize Analysis:** Gr =1%, Sa =7%, Cl & Si =92%		ST-2	96	24	--	--
78	23.8	177.76		becoming moist-wet						
81						SS-18	100	27	3-3-4-6	7
82	25.0	176.56		END OF BOREHOLE AT 25.0 m bgs Borehole drilled using 70 mm inside diameter hollow stem augers up to 4.5 m bgs. Mud rotary drilling using 100 mm diameter casing below 4.5 m bgs. Borehole dry to 4.5 m bgs prior to switching to mud rotary drilling. Borehole backfilled with cement-bentonite grout to drilled depth, using tremie pipe. Surface sealed with hydrated bentonite pellets. m bgs - refers to meters below ground surface Gr =gravel; Sa =sand; Cl & Si =clay & silt						

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

10 20 30 40 50 60 70 80 90

SOIL LOG WITH GRAPH 044985-50-04 - BOREHOLE LOGS (FINAL).GPJ GHD_Geotechnical 12/1/21

REFERENCE No.: 044985-50-04 ENCLOSURE No.: A-2

BOREHOLE No.: BH2-20
ELEVATION: 201.59 m

BOREHOLE REPORT

Page: 1 of 3

CLIENT: Clean Harbors - Lambton Facility
PROJECT: Geotechnical Investigation - Cell 20-1
LOCATION: Clean Harbors Lambton Facility, 4090 Telfer Rd. Corunna, ON
DESCRIBED BY: Ahmed Mneina CHECKED BY: Abdul Hafeez Khan
DATE (START): 8 October 2020 DATE (FINISH): 8 October 2020

LEGEND

- SS - SPLIT SPOON
- ST - SHELBY TUBE
- GS - GRAB SAMPLE
- RC - ROCK CORE
- WATER LEVEL

Depth (Feet)	Depth (Metres)	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm or RQD	Penetration Index N
0		201.59		GROUND SURFACE						
0				FILL: CLAYEY SILT - brown, some sand, trace gravel, moist		SS-1	12	11	3-6-6-5	12
3	1.0					SS-2	63	15	3-3-4-5	7
6	2.0					SS-3	54	18	4-4-6-11	10
7	2.2	199.39		NATIVE: CLAYEY SILT - grey/brown mottled, stiff, some sand, trace gravel, moist		SS-4	79	17	3-4-7-11	11
9	2.9	198.69		becoming rust-stained, to greyish brown, very stiff		SS-5	100	16	6-10-12-12	22
10	3.0									
12	3.7	197.89		becoming stiff		SS-6	100	15	4-6-8-12	14
13	4.0									
15	4.5	197.09		trace sand		SS-7	95	16	3-5-7-7	12
16	5.0									
17	5.2	196.39		mud rotary drilling with 100 mm diameter casing		SS-8	100	16	3-4-5-7	9
19	6.0									
20	6.1	195.49		becoming firm		SS-9	100	19	2-3-5-5	8
23	7.0									
26	8.0					SS-10	75	20	3-3-4-5	7
29	8.8	192.79		becoming grey						
30	9.0					SS-11	83	19	W-3-3-4	6
33	10.0									
35	10.7	190.92		Shelby tube sample at 10.67 m bgs						

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

10 20 30 40 50 60 70 80 90

159 159 147 220 171 △

SOIL LOG WITH GRAPH 044985-50-04 - BOREHOLE LOGS (FINAL).GPJ GHD_Geotechnical 12/1/21

REFERENCE No.: 044985-50-04 ENCLOSURE No.: A-2

BOREHOLE No.: BH2-20
ELEVATION: 201.59 m

BOREHOLE REPORT

Page: 2 of 3

CLIENT: Clean Harbors - Lambton Facility
PROJECT: Geotechnical Investigation - Cell 20-1
LOCATION: Clean Harbors Lambton Facility, 4090 Telfer Rd. Corunna, ON
DESCRIBED BY: Ahmed Mneina CHECKED BY: Abdul Hafeez Khan
DATE (START): 8 October 2020 DATE (FINISH): 8 October 2020

LEGEND

- SS - SPLIT SPOON
- ST - SHELBY TUBE
- GS - GRAB SAMPLE
- RC - ROCK CORE
- WATER LEVEL

Depth Feet	Depth Metres	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm or RQD	Penetration Index N
		201.59								
37				**Grainsize Analysis:** Gr =1%, Sa =17%, Cl & Si =82%		ST-1	92	15	--	--
38										
39	12.0									
40										
41						SS-12	96	23	1-3-5-5	8
42										
43	13.0									
44										
45										
46	14.0					SS-13	100	21	3-3-4-6	7
47										
48										
49	14.9	186.69								
50	15.0			becoming stiff, occasional gravel						
51						SS-14	100	22	4-5-8-10	13
52										
53	16.0									
54										
55										
56	17.0					SS-15	83	25	4-4-5-6	9
57										
58										
59	18.0									
60										
61						SS-16	100	24	3-4-6-7	10
62										
63	19.0									
64										
65										
66	20.0					SS-17	--	26	3-4-5-6	9
67										
68										
69	21.0									
70	21.3	180.25		Shelby tube sample at 21.34 m bgs						
71						ST-2	100	--	--	--

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

10 20 30 40 50 60 70 80 90

SOIL LOG WITH GRAPH 044985-50-04 - BOREHOLE LOGS (FINAL).GPJ GHD_Geotechnical 12/1/21

REFERENCE No.: 044985-50-04 ENCLOSURE No.: A-2

BOREHOLE No.: BH2-20
ELEVATION: 201.59 m

BOREHOLE REPORT

Page: 3 of 3

CLIENT: Clean Harbors - Lambton Facility
PROJECT: Geotechnical Investigation - Cell 20-1
LOCATION: Clean Harbors Lambton Facility, 4090 Telfer Rd. Corunna, ON
DESCRIBED BY: Ahmed Mneina CHECKED BY: Abdul Hafeez Khan
DATE (START): 8 October 2020 DATE (FINISH): 8 October 2020

LEGEND

- SS - SPLIT SPOON
- ST - SHELBY TUBE
- GS - GRAB SAMPLE
- RC - ROCK CORE
- WATER LEVEL

Depth Feet	Depth Metres	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm or RQD	Penetration Index N
		201.59								
	23.0					SS-18	--	27	2-4-6-8	10
	24.0									
	24.2	177.39		becoming firm						
						SS-19	--	27	4-3-5-6	8
	25.0	176.59		END OF BOREHOLE AT 25.0 m bgs						
	26.0									
	27.0									
	28.0									
	29.0									
	30.0									
	31.0									
	32.0									

Borehole drilled using 70 mm inside diameter hollow stem augers up to 4.5 m bgs. Mud rotary drilling using 100 mm diameter casing below 4.5 m bgs. Borehole dry to 4.5 m bgs prior to switching to mud rotary drilling.

Borehole backfilled with cement-bentonite grout to drilled depth, using tremie pipe. Surface sealed with hydrated bentonite pellets.

W - refers to sampler penetration under self weight
m bgs - refers to meters below ground surface
Gr =gravel; Sa =sand; Cl & Si =clay & silt

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

10 20 30 40 50 60 70 80 90

SOIL LOG WITH GRAPH 044985-50-04 - BOREHOLE LOGS (FINAL).GPJ GHD_Geotechnical 12/1/21

REFERENCE No.: 044985-50-04 ENCLOSURE No.: A-3

BOREHOLE No.: BH3-20
ELEVATION: 201.02 m

BOREHOLE REPORT

Page: 1 of 3

CLIENT: Clean Harbors - Lambton Facility
PROJECT: Geotechnical Investigation - Cell 20-1
LOCATION: Clean Harbors Lambton Facility, 4090 Telfer Rd. Corunna, ON
DESCRIBED BY: Ahmed Mneina CHECKED BY: Abdul Hafeez Khan
DATE (START): 7 October 2020 DATE (FINISH): 7 October 2020

LEGEND

- SS - SPLIT SPOON
- ST - SHELBY TUBE
- GS - GRAB SAMPLE
- RC - ROCK CORE
- WATER LEVEL

Depth (Feet)	Depth (Metres)	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm or RQD	Penetration Index N
		201.02		GROUND SURFACE						
0	0.1	200.92		FILL: CLAYEY SILT - dark brown, trace sand, trace gravel, inclusion of topsoil, moist		SS-1	33	16	2-1-2-7	3
1	0.7	200.32		NATIVE: CLAYEY SILT - grey/brown mottled, soft, some sand, trace gravel, moist		SS-2	79	16	6-8-9-12	17
2	1.0			becoming very stiff						
3	1.4	199.62		becoming brown, rust-stained		SS-3	88	15	5-7-10-14	17
4	2.0					SS-4	--	16	5-8-12-12	20
5	3.0									
6	3.1	197.92		becoming grey, stiff, trace sand		SS-5	100	15	3-5-6-8	11
7	4.0					SS-6	100	17	3-4-6-9	10
8	5.0					SS-7	100	14	3-4-6-8	10
9	5.2	195.82		mud rotary drilling with 100 mm diameter casing						
10	6.0	195.02		becoming very stiff		SS-8	100	17	6-9-9-11	18
11	7.0			becoming stiff		SS-9	100	18	3-4-7-8	11
12	7.3	193.72		reddish brown moist sand seems						
13	8.0					SS-10	100	10	2-4-6-8	10
14	8.8	192.22		becoming firm, occasional gravel						
15	9.0					SS-11	100	20	3-3-5-8	8
16	10.0									
17	10.7	190.35		Shelby tube sample at 10.67 m bgs						

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

10 20 30 40 50 60 70 80 90

175 208 220 220 137 122

SOIL LOG WITH GRAPH 044985-50-04 - BOREHOLE LOGS (FINAL).GPJ GHD_Geotechnical 12/1/21

REFERENCE No.: 044985-50-04 ENCLOSURE No.: A-3

BOREHOLE No.: BH3-20
ELEVATION: 201.02 m

BOREHOLE REPORT

Page: 2 of 3

CLIENT: Clean Harbors - Lambton Facility
PROJECT: Geotechnical Investigation - Cell 20-1
LOCATION: Clean Harbors Lambton Facility, 4090 Telfer Rd. Corunna, ON
DESCRIBED BY: Ahmed Mneina CHECKED BY: Abdul Hafeez Khan
DATE (START): 7 October 2020 DATE (FINISH): 7 October 2020

LEGEND

- SS - SPLIT SPOON
- ST - SHELBY TUBE
- GS - GRAB SAMPLE
- RC - ROCK CORE
- WATER LEVEL

Depth (Feet)	Depth (Metres)	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm or RQD	Penetration Index N
		201.02				ST-1	100	--	--	--
	11.8	189.22		becoming stiff						
	12.0					SS-12	75	21	3-5-8-12	13
	13.0									
	14.0					SS-13	--	21	3-5-8-11	13
	15.0					SS-14	88	22	3-5-8-11	13
	16.0									
	17.0					SS-15	75	26	3-5-8-9	13
	18.0					SS-16	58	26	3-4-6-6	10
	19.0									
	19.5	181.52		becoming firm, trace sand, trace gravel						
	20.0					SS-17	100	27	W-2-3-4	5
	21.0									
	21.3	179.68		Shelby tube sample at 21.34 m bgs **Grainsize Analysis:** Gr =2%, Sa =7%, Cl & Si =91%		ST-2	100	21	--	--

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

10 20 30 40 50 60 70 80 90

SOIL LOG WITH GRAPH 044985-50-04 - BOREHOLE LOGS (FINAL).GPJ GHD_Geotechnical 12/1/21

REFERENCE No.: 044985-50-04 ENCLOSURE No.: A-3

BOREHOLE No.: BH3-20
ELEVATION: 201.02 m

BOREHOLE REPORT

Page: 3 of 3

CLIENT: Clean Harbors - Lambton Facility
PROJECT: Geotechnical Investigation - Cell 20-1
LOCATION: Clean Harbors Lambton Facility, 4090 Telfer Rd. Corunna, ON
DESCRIBED BY: Ahmed Mneina CHECKED BY: Abdul Hafeez Khan
DATE (START): 7 October 2020 DATE (FINISH): 7 October 2020

LEGEND

- SS - SPLIT SPOON
- ST - SHELBY TUBE
- GS - GRAB SAMPLE
- RC - ROCK CORE
- ▼ - WATER LEVEL

Depth (Feet)	Depth (Metres)	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm or RQD	Penetration Index N
		201.02								
	22.5	178.52		becoming moist-wet						
	23.0					SS-18	46	28	1-3-5-7	8
	24.0					SS-19	100	28	1-3-5-6	8
	25.0	176.02		END OF BOREHOLE AT 25.0 m bgs						
	26.0			Borehole drilled using 70 mm inside diameter hollow stem augers up to 4.5 m bgs. Mud rotary drilling using 100 mm diameter casing below 4.5 m bgs. Borehole dry to 4.5 m bgs prior to switching to mud rotary drilling.						
	27.0			Borehole backfilled with cement-bentonite grout to drilled depth, using tremie pipe. Surface sealed with hydrated bentonite pellets.						
	28.0			W - refers to sampler penetration under self weight m bgs - refers to meters below ground surface Gr =gravel; Sa =sand; Cl & Si =clay & silt						
	29.0									
	30.0									
	31.0									
	32.0									

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

10 20 30 40 50 60 70 80 90

SOIL LOG WITH GRAPH 044985-50-04 - BOREHOLE LOGS (FINAL).GPJ GHD_Geotechnical 12/1/21

REFERENCE No.: 044985-50-04 ENCLOSURE No.: A-4

BOREHOLE No.: BH4-20
ELEVATION: 200.61 m

BOREHOLE REPORT

Page: 1 of 3

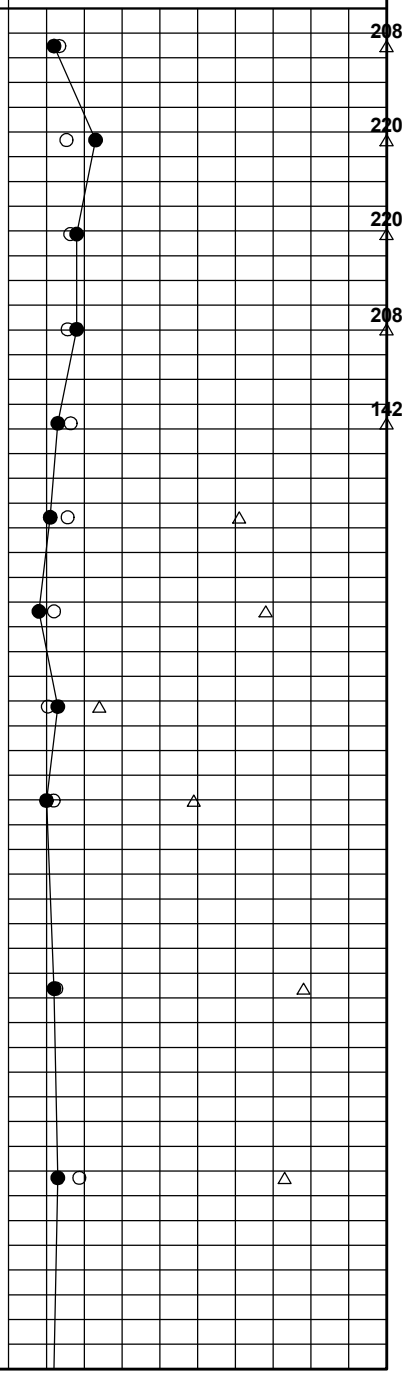
CLIENT: Clean Harbors - Lambton Facility
PROJECT: Geotechnical Investigation - Cell 20-1
LOCATION: Clean Harbors Lambton Facility, 4090 Telfer Rd. Corunna, ON
DESCRIBED BY: Ahmed Mneina CHECKED BY: Abdul Hafeez Khan
DATE (START): 6 October 2020 DATE (FINISH): 6 October 2020

LEGEND

- SS - SPLIT SPOON
- ST - SHELBY TUBE
- GS - GRAB SAMPLE
- RC - ROCK CORE
- WATER LEVEL

Depth (Feet)	Depth (Metres)	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm or RQD	Penetration Index N
		200.61		GROUND SURFACE						
0	0.1	200.51		FILL: CLAYEY SILT - dark brown, some sand, some gravel, trace topsoil, moist		SS-1	63	13	5-5-7-9	12
1										
2	0.7	199.91		NATIVE: CLAYEY SILT - grey/brown mottled, stiff, trace sand, trace gravel, moist						
3	1.0			becoming brown, very stiff		SS-2	67	15	11-11-12-12	23
4	1.4	199.21		becoming brown						
5										
6						SS-3	100	16	5-7-11-13	18
7	2.0									
8	2.2	198.41		rust-stained, some sand		SS-4	100	16	5-8-10-14	18
9										
10	3.0	197.61		becoming stiff, embedded brown moist sand seams		SS-5	100	16	4-6-7-11	13
11										
12	3.7	196.91		becoming grey						
13	4.0					SS-6	100	16	4-5-6-7	11
14										
15	4.5	196.11		becoming firm						
16						SS-7	100	12	3-4-4-5	8
17	5.0									
18	5.2	195.41		mud rotary drilling with 100 mm diameter casing becoming grey-brown, stiff		SS-8	100	10	5-6-7-8	13
19										
20	6.0	194.61		becoming grey, some sand						
21						SS-9	100	12	3-4-6-8	10
22										
23	7.0									
24	7.3	193.31		trace sand						
25										
26	8.0					SS-10	100	13	3-5-7-9	12
27										
28										
29										
30	9.0									
31						SS-11	100	19	3-5-8-10	13
32										
33	10.0									
34										
35	10.7	189.94		Shelby tube sample at 10.67 m bgs						

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)



SOIL LOG WITH GRAPH 044985-50-04 - BOREHOLE LOGS (FINAL).GPJ GHD_Geotechnical 12/1/21

REFERENCE No.: 044985-50-04 ENCLOSURE No.: A-4

BOREHOLE No.: BH4-20
ELEVATION: 200.61 m

BOREHOLE REPORT

Page: 2 of 3

CLIENT: Clean Harbors - Lambton Facility
PROJECT: Geotechnical Investigation - Cell 20-1
LOCATION: Clean Harbors Lambton Facility, 4090 Telfer Rd. Corunna, ON
DESCRIBED BY: Ahmed Mneina CHECKED BY: Abdul Hafeez Khan
DATE (START): 6 October 2020 DATE (FINISH): 6 October 2020

LEGEND

- SS - SPLIT SPOON
- ST - SHELBY TUBE
- GS - GRAB SAMPLE
- RC - ROCK CORE
- WATER LEVEL

Depth (Feet / Metres)	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm or RQD	Penetration Index N
	200.61				ST-1	100	--	--	--
12.0					SS-12	100	21	3-4-7-10	11
13.0									
14.0					SS-13	100	23	4-6-10-12	16
15.0									
16.0					SS-14	75	18	4-5-8-10	13
17.0					SS-15	88	26	3-4-7-10	11
17.8	182.81		becoming firm, moist-wet						
18.0					SS-16	100	22	2-3-4-5	7
19.0									
20.0					SS-17	--	25	1-2-4-5	6
21.0									
21.3	179.27		Shelby tube sample at 21.34 m bgs **Grainsize Analysis:** Gr =1%, Sa =8%, Cl & Si =91%		ST-2	100	27	--	--

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

10 20 30 40 50 60 70 80 90

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SOIL LOG WITH GRAPH 044985-50-04 - BOREHOLE LOGS (FINAL).GPJ GHD_Geotechnical 12/1/21

REFERENCE No.: 044985-50-04 ENCLOSURE No.: A-4

BOREHOLE No.: BH4-20
ELEVATION: 200.61 m

BOREHOLE REPORT

Page: 3 of 3

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Depth (Feet)	Depth (Metres)	Elevation (m) BGS	Stratigraphy	DESCRIPTION OF SOIL AND BEDROCK	State	Type and Number	Recovery %	Moisture Content %	Blows per 6 in. / 15 cm or RQD	Penetration Index N
		200.61								
	22.5	178.11		becoming soft, wet						
	23.0					SS-18	--	30	1-2-1-W	3
	23.8	176.81		becoming firm, moist-wet						
	24.0					SS-19	--	26	1-2-3-5	5
	25.0	175.61		END OF BOREHOLE AT 25.0 m bgs						

Shear test (Cu) △ Field
Sensitivity (S) □ Lab
○ Water content (%)
W_p W_l Atterberg limits (%)
● "N" Value (blows / 12 in.-30 cm)

10 20 30 40 50 60 70 80 90

Borehole drilled using 70 mm inside diameter hollow stem augers up to 4.5 m bgs. Mud rotary drilling using 100 mm diameter casing below 4.5 m bgs. Borehole dry to 4.5 m bgs prior to switching to mud rotary drilling.

Borehole backfilled with cement-bentonite grout to drilled depth, using tremie pipe. Surface sealed with hydrated bentonite pellets.

W - refers to sampler penetration under self weight
m bgs - refers to meters below ground surface
Gr =gravel; Sa =sand; Cl & Si =clay & silt

SOIL LOG WITH GRAPH 044985-50-04 - BOREHOLE LOGS (FINAL).GPJ GHD_Geotechnical 12/1/21

Notes on Borehole and Test Pit Reports

Soil description :

Each subsurface stratum is described using the following terminology. The relative density of granular soils is determined by the Standard Penetration Index ("N" value), while the consistency of clayey sols is measured by the value of undrained shear strength (Cu).

Classification (Unified system)

Clay	< 0.002 mm		
Silt	0.002 to 0.075 mm		
Sand	0.075 to 4.75 mm	fine	0.075 to 0.425 mm
		medium	0.425 to 2.0 mm
		coarse	2.0 to 4.75 mm
Gravel	4.75 to 75 mm	fine	4.75 to 19 mm
		coarse	19 to 75 mm
Cobbles	75 to 300 mm		
Boulders	>300 mm		

Terminology

"trace"	1-10%
"some"	10-20%
adjective (silty, sandy)	20-35%
"and"	35-50%

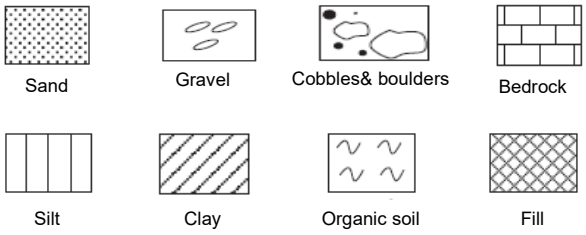
Relative density of granular soils	Standard penetration index "N" value (BLOWS/ft – 300 mm)
Very loose	0-4
Loose	4-10
Compact	10-30
Dense	30-50
Very dense	>50

Consistency of cohesive soils	Undrained shear strength (Cu) (P.S.F)	(kPa)
Very soft	<250	<12
Soft	250-500	12-25
Firm	500-1000	25-50
Stiff	1000-2000	50-100
Very stiff	2000-4000	100-200
Hard	>4000	>200

Rock quality designation

"RQD" (%) Value	Quality
<25	Very poor
25-50	Poor
50-75	Fair
75-90	Good
>90	Excellent

STRATIGRAPHIC LEGEND



Samples:

Type and Number

The type of sample recovered is shown on the log by the abbreviation listed hereafter. The numbering of samples is sequential for each type of sample.

SS: Split spoon
ST: Shelby tube
AG: Auger
SSE, GSE, AGE: Environmental sampling
PS: Piston sample (Osterberg)
RC: Rock core
GS: Grab sample

Recovery

The recovery, shown as a percentage, is the ratio of length of the sample obtained to the distance the sampler was driven/pushed into the soil

RQD

The "Rock Quality Designation" or "RQD" value, expressed as percentage, is the ratio of the total length of all core fragments of 4 inches (10 cm) or more to the total length of the run.

IN-SITU TESTS:

N: Standard penetration index
R: Refusal to penetration
N_c: Dynamic cone penetration index
Cu: Undrained shear strength
Pr: Pressure meter
k: Permeability
ABS: Absorption (Packer test)

LABORATORY TESTS:

I_p: Plasticity index
W_l: Liquid limit
Wp: Plastic limit
H: Hydrometer analysis
GSA: Grain size analysis
A: Atterberg limits
w: Water content
γ: Unit weight
C: Consolidation
CS: Swedish fall cone
CHEM: Chemical analysis
O.V.: Organic vapor

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