



Stantec Consulting Ltd.
100-300 Hagey Boulevard,
Waterloo ON N2L 0A4

February 7, 2024

Project: 161413338

Mr. Michael Witmer

Development Engineering Division
Department of Engineering and Transportation Services
City of Guelph
1 Carden Street
Guelph ON N1H 3A1

Dear Michael,

Reference: Infiltration Testing Results in Response to Second Submission Comments and in Support of Third Draft Plan Submission - 220 Arkell Road, City of Guelph, Ontario

Stantec Consulting Limited (Stantec) prepared a Hydrogeological Assessment report (Stantec, 2019¹) on behalf of Rockpoint Properties Inc. for the lands located at 220 Arkell Road in the City of Guelph, Ontario (the Site) in support of a Draft Plan Application. As a part of the hydrogeological assessment, a pre- and post-development water balance was completed for the Site, with this water balance in turn being updated to respond to first submission comments issued by the City of Guelph (City) (Stantec, 2023a²). As provided in the City of Guelph's second submission comments memo dated September 11, 2023, and titled 2nd Submission Engineering Comments, 220 Arkell Road, Comment No. 23 stated the following:

Comment No. 23 – *In-situ infiltration is required, as per the Development Engineering Manual (DEM). Infiltration rates cannot be determined based on laboratory or particle size distribution results. Please perform in-situ testing as per the DEM and update the findings accordingly. This must be completed during the draft plan stage to ensure water balance targets can be met without the need to revise plans and re-size infiltration galleries.*

Based on their review, the Grand River Conservation Authority (GRCA) made a similar request in their letter dated September 7, 2023, and titled OZS19-017 – Second Submission of Draft Plan of Subdivision and Zoning By-law Amendment, 220 Arkell Road, City of Guelph:

Comment No. 11 – *It is noted in the Revised Water Balance Calculations memo that in-situ infiltration tests will be conducted during detailed design to confirm that the soils are sufficiently permeable as well as determine hydraulic conductivities of the site soils. Please comment on whether the assumptions made in the water balance calculations with respect to infiltration capacity of the site soils, in the absence of in-situ testing, are conservative and whether there will be sufficient space available on the proposed lots to accommodate the required mitigation measures if the hydraulic conductivities obtained indicate that the site soils are less conducive to infiltration.*

¹ Stantec Consulting Ltd. 2019. Hydrogeological Assessment, 220 Arkell Road, Guelph, ON. May 28, 2019.

² Stantec Consulting Ltd. 2023a. Revised Water Balance Calculations in Response to First Submission Comments Draft Plan Application – 220 Arkell Road, City of Guelph, Ontario. Technical Memorandum issued to City of Guelph dated March 29, 2023.

Reference: Infiltration Testing Results in Response to Second Submission Comments and in Support of Third Draft Plan Submission - 220 Arkell Road, City of Guelph, Ontario

To address these previously mentioned comments, Stantec coordinated and implemented a field program to evaluate the infiltration capacity of on-Site soils in those areas of the property where low impact development (LID) infiltration infrastructure is proposed.

Figure 1 shows the location of the Site, with details on the field work performed and the subsequent results of this work being presented in the sections below. Figures and tables referenced in this report are presented in Attachments 1 and 2, respectively, with borehole logs provided in Attachment 3.

Methods

From November 13 to 16, 2023, Moser Landscape Group (MLG) excavated 14 test pits (TP01-23 to TP14-23; Figure 1) in the footprints of proposed LID infiltration infrastructure (i.e., infiltration galleries).

Under the observation of Stantec, MLG excavated the previously mentioned test pits to depths ranging from 0.6 m and 2.8 m below ground surface (BGS), representing the projected base elevation of the future infiltration galleries. At those locations where an infiltration gallery base would occur at an elevation higher than the existing grade, MLG only removed the topsoil layer to expose the underlying native soil deposits (i.e., TP01-23 to TP03-23, TP06-23, TP09-23, TP12-23, and TP14-23). Stantec determined the test pit excavation depths / elevations by following the protocols outlined in Appendix C of the Credit Valley Conservation (CVC) and Toronto and Region Conservation (TRCA) (2010³) *Low Impact Stormwater Management Planning and Design Guideline*, which requires that the excavations extend to the projected base elevation of a given infiltration gallery for the performing of in-situ soil infiltration testing.

Stantec classified the soils targeted for infiltration testing using the ASTM guideline for visual-manual description and identification of soils (ASTM D2488-00). Once each test pit was no longer required, MLG backfilled the excavations to the existing grade.

Assessment of the infiltration potential for the on-Site soils involved the use of a Guelph Permeameter (a constant head permeameter designed to measure in-situ vertical hydraulic conductivities of a given substrate). At the base of each test pit, Stantec personnel used a hand auger to drill three 50 mm diameter cylindrical holes into the native soil to be tested, with the depths of these holes ranging from 0.2 m to 0.3 m BGS. The Guelph Permeameter was then filled with water, inserted into the hole while making a concerted effort to avoid knocking debris into the hole, and then stabilized against the substrate. Once set-up, Stantec proceeded to record the eventual steady-state rate of water recharge into the soil. The infiltration rate for each soil tested was converted from the measured vertical hydraulic conductivity to an infiltration rate using the established relationship between vertical hydraulic conductivity and infiltration rate presented by the CVC/TRCA (2010). Stantec performed two successful infiltration tests in each test pit, except for TP03-23, TP07-23 and TP12-23 where one of the tests failed. Table 1 summarizes the results of the soil infiltration testing.

³ Credit Valley Conservation - Toronto and Region Conservation Authority (CVC-TRCA), 2010. Low Impact Development Stormwater Management Planning and Design Guide – Version 1.0.

Reference: Infiltration Testing Results in Response to Second Submission Comments and in Support of Third Draft Plan Submission - 220 Arkell Road, City of Guelph, Ontario

Although recommended in CVC/TRCA (2010), the test pits were not extended an extra 1.5 m below their initial depth for additional infiltration testing given that the subsurface soil profile near the testing locations is relatively uniform in structure and often characterized by an elevated groundwater table. As shown in boreholes drilled near the infiltration testing locations, the soil profile largely consists of silty sand to sandy silt (ranging from diamicton to glaciofluvial sediments) up to 3.8 m below the base elevations of the proposed infiltration galleries (Figure 1; Attachment 3).

Results

Vertical hydraulic conductivities for the native silty sand to sandy silt deposits exposed at the base of the test pits and measured using the Guelph Permeameter ranged from 1.0×10^{-5} m/s to 2.8×10^{-7} m/s, equating to infiltration rates ranging from 33 mm/hour to 87 mm/hour (Table 1).

In the absence of testing the soil layer at a depth of 1.5 m below the proposed base elevation of the infiltration galleries, as an alternative Stantec took the high and low infiltration rate estimated from the two in-situ tests completed in each test pit to calculate a ratio and assign a subsequent safety correction factor (from Table C2 of CVC/TRCA (2010)) to apply to the geometric mean infiltration rate calculated for the test pit. As shown in Table 2, a maximum safety correction factor of 3.5 is applicable to most of the test pit locations, resulting in design infiltration rates ranging from 10 mm/hour to 28 mm/hour across the Site. This range of infiltration rates exceeds the minimum value of 4.8 mm/hour previously used by Stantec to size the on-Site infiltration galleries (Stantec, 2023b⁴).

To conclude, the investigation confirms that the on-Site soils can support the updated post-development infiltration strategy proposed in Stantec (2024a⁵) and, subsequently, that water balance targets can be achieved for the Site as presented in Stantec (2024b⁶).

⁴ Stantec Consulting Limited. 2023b. 220 Arkell Road, Guelph – Revised Preliminary Servicing, Grading and Stormwater Management Report. April 2023.

⁵ Stantec Consulting Limited. 2024a. 220 Arkell Road, Guelph, Revised Preliminary Servicing, Grading and Stormwater Management Report, Addendum No.1 – Section 5.0 Stormwater Management. February 2024.

⁶ Stantec Consulting Limited. 2024b. Revised Water Balance Calculations in Response to First and Second Submission Comments Draft Plan Application - 220 Arkell Road, City of Guelph, Ontario (Third Submission). February 2024.

Reference: Infiltration Testing Results in Response to Second Submission Comments and in Support of Third Draft Plan Submission - 220
Arkell Road, City of Guelph, Ontario

Closure

We trust that the above information meets your current requirements. Please contact the undersigned if you need additional information.

Regards,

Stantec Consulting Ltd.

Grant Whitehead, MES, P.Geo. (Limited)

Senior Hydrogeologist

Phone: 519 585 7400

Cell: (519) 502-8933

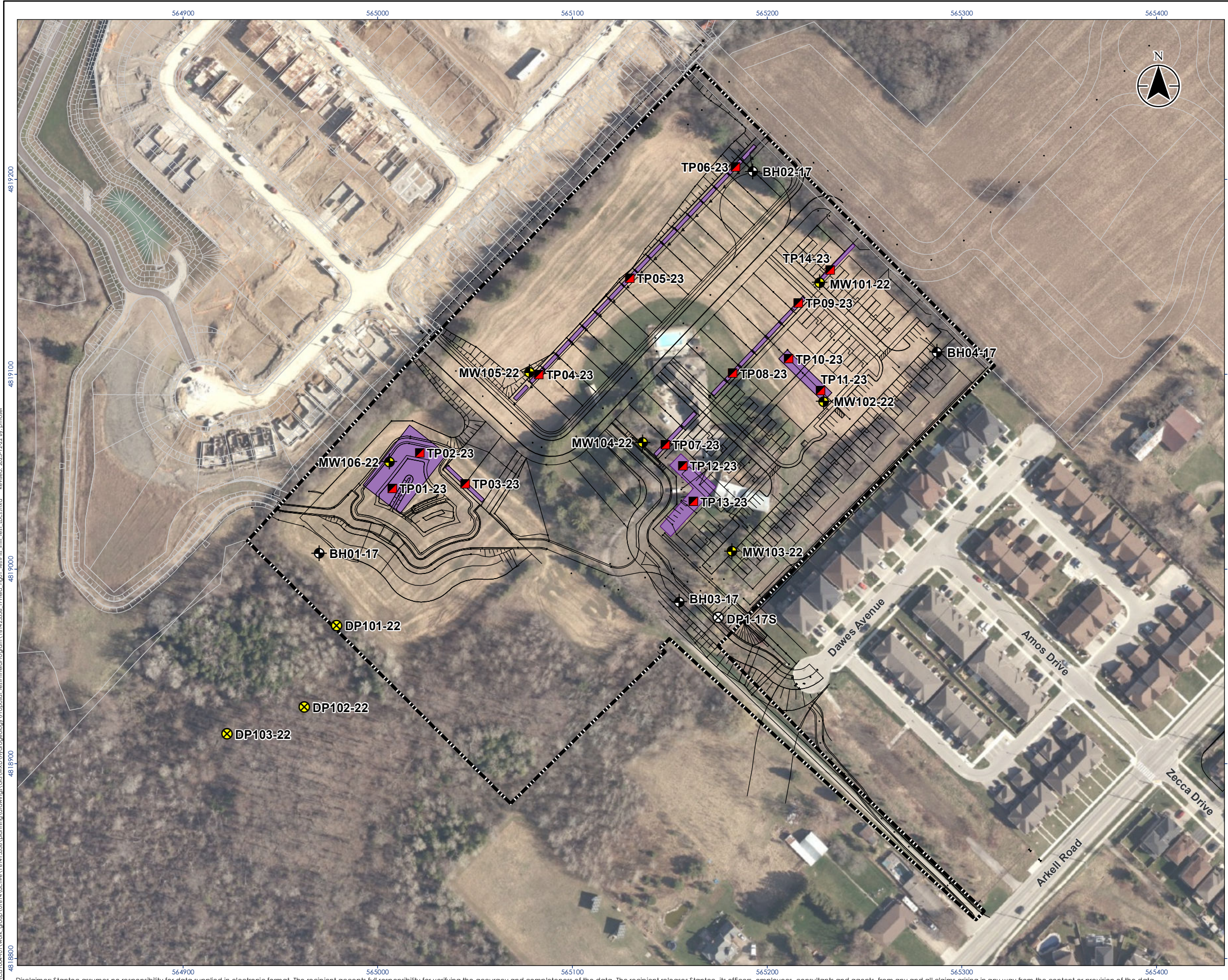
grant.whitehead@stantec.com

Attachments: Attachment 1: Figure 1 – Site Location
Attachment 2: Table 1 – Infiltration Test Results
Table 2 – Design Infiltration Rate Calculations
Attachment 3: Borehole Logs

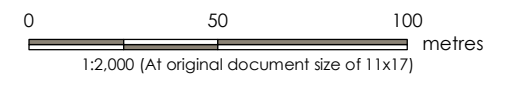
February 7, 2024
Mr. Michael Witmer

Reference: Infiltration Testing Results in Response to Second Submission Comments and in Support of Third Draft Plan Submission -
220 Arkell Road, City of Guelph, Ontario

Attachment 1 Figure 1 – Tet Pit / Infiltration Testing Locations



- Site Boundary
- Test Pit (Stantec, 2023)
- Monitoring Well (Stantec, 2022)
- Monitoring Well (Stantec, 2017)
- Drive-Point Piezometer (Stantec, 2022)
- Drive-Point Piezometer (Stantec, 2017)
- Proposed Subdivision
- Proposed Infiltration Gallery



- Notes**
1. Coordinate System: NAD 1983 UTM Zone 17N
 2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2017.
 3. Orthoimagery © First Base Solutions, 2023.



Project Location: Guelph, Ontario
 Prepared by CMC on 2023-12-22
 Technical Review by GW on 2023-12-22
 161423338 REVA

Client/Project:
ROCKPOINT PROPERTIES INC.
 HYDROGEOLOGICAL ASSESSMENT
 220 ARKELL ROAD, GUELPH, ONTARIO

Figure No.
1
 Title
Test Pit / Infiltration Testing Locations

\\Cd\1004\01\work_group\01\41\active\4141\3338\planning\drawings\GIS\WXD\Hydrogeology\Proposal\TP\PH\field\Program\161423338\TP\field_500\TP\TPs\Infil_Test_Loc.mxd
 Revised: 2023-12-22 By: pmoser
 4819200
 4819100
 4819000
 4818900
 4818800

February 7, 2024
Mr. Michael Witmer

Reference: Infiltration Testing Results in Response to Second Submission Comments and in Support of Third Draft Plan Submission - 220
Arkell Road, City of Guelph, Ontario

Attachment 2 Table 1 – Infiltration Test Results
Table 2 – Design Infiltration Rate Calculations

**TABLE 1
INFILTRATION TESTING RESULTS**

Test Pit Location ID	Test No.	Ground Surface Elevation ⁽¹⁾ (m AMSL)	Test Pit Excavation Depth		Projected Infiltration Gallery Base Elevation (m AMSL)	Vertical Hydraulic Conductivity			Infiltration Rate ⁽²⁾ (mm/hr)	Soil Substrate Tested
			(m BGS)	(m AMSL)		(cm/s)	(m/s)	Geomean (m/s)		
Guelph Permeameter Testing										
TP01-23	1	333.75	0.95	332.80	335.00	9.7E-05	9.7E-07	1.4E-06	51	Fine SAND, some silt
	2		0.90	332.85		2.0E-04	2.0E-06			
TP02-23	1	334.25	0.84	333.41	335.00	4.6E-04	4.6E-06	4.2E-06	68	Silty SAND to SILT with some sand
	2		0.75	333.50		3.9E-04	3.9E-06			
TP03-23	1	334.00	1.05	332.95	334.86	3.2E-04	3.2E-06	-	63	Fine SAND
TP04-23	1	338.40	1.70	336.70	336.80	2.1E-04	2.1E-06	1.7E-06	53	SILT with some fine sand (DIAMICTON)
	2		1.75	336.65		1.4E-04	1.4E-06			
TP05-23	1	338.50	1.15	337.35	337.40	3.4E-05	3.4E-07	2.8E-07	33	Sandy SILT to Fine SAND
	2		1.25	337.25		2.3E-05	2.3E-07			
TP06-23	1	337.20	0.98	336.22	338.00	2.2E-04	2.2E-06	2.9E-06	61	Sandy SILT to Silty SAND (DIAMICTON)
	2		0.94	336.26		3.9E-04	3.9E-06			
TP07-23	1	337.50	1.50	336.00	336.30	1.7E-04	1.7E-06	-	53	Gravelly SAND, some cobbles
TP08-23	1	340.00	2.80	337.20	337.30	6.1E-04	6.1E-06	3.2E-06	63	Fine SAND, some coarse sand and cobbles
	2		2.70	337.30		1.7E-04	1.7E-06			
TP09-23	1	338.50	1.05	337.45	338.10	1.3E-03	1.3E-05	1.0E-05	86	Silty Fine SAND
	2		1.05	337.45		8.4E-04	8.4E-06			
TP10-23	1	339.50	1.93	337.57	337.84	3.9E-04	3.9E-06	4.3E-06	68	Silty SAND (DIAMICTON)
	2		1.97	337.53		4.7E-04	4.7E-06			
TP11-23	1	340.00	2.20	337.80	337.84	2.4E-04	2.4E-06	5.8E-07	40	SILT (DIAMICTON)
	2		2.20	337.80		1.4E-05	1.4E-07			
TP12-23	1	335.80	0.63	335.00	336.30	1.1E-03	1.1E-05	-	87	Silty Fine SAND, some coarse sand
TP13-23	1	336.30	0.99	335.31	335.50	7.2E-05	7.2E-07	2.3E-06	58	Silty CLAY to Clayey SILT
	2		0.81	335.49		7.3E-04	7.3E-06			
TP14-23	1	338.20	0.83	337.37	338.03	1.7E-04	1.7E-06	4.3E-06	68	Sandy SILT to Silty SAND (DIAMICTON)
	2		0.95	337.25		1.1E-03	1.1E-05			
GEOMEAN =						3.1E-06	-	62		

Notes:

- (1) Ground surface elevation estimated from existing condition / pre-development topographic contour mapping prepared by J.D. Barnes Limited (January 2023).
- (2) Infiltration rate calculated based on established relationship between vertical hydraulic conductivity and infiltration rate presented in *Credit Valley Conservation and Toronto and Region Conservation (2010) Low Impact Stormwater Management Planning and Design Guideline - Version 1.0*. The estimated infiltration rate for the soil substrate in each test pit is based on the geometric mean vertical hydraulic conductivity estimated for that pit.

TABLE 2 - DESIGN INFILTRATION RATE CALCULATIONS

Proposed Infiltration Facility									
Test Pit Location / ID	TP01-23		TP02-23		TP03-23		TP04-23		
Base of Facility									
High Vertical K (m/s) / Infiltration Rate (mm/hr) ⁽¹⁾	2.0E-06	56	4.6E-04	70	3.2E-06	63	2.1E-06	56	
Low Vertical K (m/s) / Infiltration Rate (mm/hr)	9.7E-07	46	3.9E-04	66	-	-	1.4E-06	51	
Ratio ⁽²⁾		1.2		1.1		-		1.1	
Safety Factor ⁽³⁾		3.5		3.5		3.5		3.5	
Design Infiltration Rate		16		20		18		16	

Test Pit Location / ID	TP05-23		TP06-23		TP07-23		TP08-23		
Base of Facility									
High Vertical K (m/s) / Infiltration Rate (mm/hr) ⁽¹⁾	3.4E-07	35	3.9E-06	67	1.7E-06	53	6.1E-06	75	
Low Vertical K (m/s) / Infiltration Rate (mm/hr)	2.3E-07	31	2.2E-06	57	-	-	1.7E-06	53	
Ratio ⁽²⁾		1.1		1.2		-		1.4	
Safety Factor ⁽³⁾		3.5		3.5		3.5		3.5	
Design Infiltration Rate		10		19		15		21	

Test Pit Location / ID	TP09-23		TP10-23		TP11-23		TP12-23		
Base of Facility									
High Vertical K (m/s) / Infiltration Rate (mm/hr) ⁽¹⁾	1.3E-05	92	4.7E-06	70	2.4E-06	58	1.1E-05	88	
Low Vertical K (m/s) / Infiltration Rate (mm/hr)	8.4E-06	82	3.9E-06	67	1.4E-07	27	-	-	
Ratio ⁽²⁾		1.1		1.0		2.1		-	
Safety Factor ⁽³⁾		3.5		2.5		3.5		3.5	
Design Infiltration Rate		26		28		17		25	

Test Pit Location / ID	TP13-23		TP14-23	
Base of Facility				
High Vertical K (m/s) / Infiltration Rate (mm/hr) ⁽¹⁾	7.3E-06	79	1.1E-05	88
Low Vertical K (m/s) / Infiltration Rate (mm/hr)	7.2E-07	42	1.7E-06	53
Ratio ⁽²⁾		1.9		1.7
Safety Factor ⁽³⁾		3.5		3.5
Design Infiltration Rate		23		25

Notes:

- (1) Infiltration rate calculated based on established relationship between vertical hydraulic conductivity and infiltration rate presented in *Credit Valley Conservation and Toronto and Region Conservation (2010) Low Impact Stormwater Management Planning and Design Guideline - Version 1.0*.
- (2) Given the structural consistency of the geological deposits / soils present beneath the Site together with the presence of an elevated groundwater table, Stantec did not complete additional infiltration testing of soils situated 1.5 m below the base of the proposed LID infiltration galleries. As an alternative, Stantec calculated the ratio and subsequent Safety Factor using the high and low vertical hydraulic conductivity results estimated for the soil at the projected base elevation of each gallery.
- (3) Table C2 provided on Page C8 (Appendix C) of the *CVC/TRCA (2010) Low Impact Stormwater Management Planning and Design Guideline - Version 1.0*.

Low Impact Development Stormwater Management Planning and Design Guide

Table C2: Safety correction factors for calculating design infiltration rates

Ratio of Mean Measured Infiltration Rates¹	Safety Correction Factor²
≤ 1	2.5
1.1 to 4.0	3.5
4.1 to 8.0	4.5
8.1 to 16.0	6.5
16.1 or greater	8.5

Source: Wisconsin Department of Natural Resources. 2004. Conservation Practice Standards. Site Evaluation for Stormwater Infiltration (1002). Madison, WI.

Notes:

1. Ratio is determined by dividing the geometric mean measured infiltration rate at the proposed bottom elevation of the BMP by the geometric mean measured infiltration rate of the least permeable soil horizon within 1.5 metres below the proposed bottom elevation of the BMP.
2. The design infiltration rate is calculated by dividing the geometric mean measured infiltration rate at the proposed bottom elevation of the BMP by the safety correction factor.

February 7, 2024
Mr. Michael Witmer

Reference: Infiltration Testing Results in Response to Second Submission Comments and in Support of Third Draft Plan Submission - 220
Arkell Road, City of Guelph, Ontario

Attachment 3 Borehole Logs



BOREHOLE RECORD

N: 4 819 008 E: 564 970

Sheet 1 of 1

BH01-17

CLIENT Carson Reid Homes Ltd.

PROJECT No. 161413338

LOCATION 220 Arkell Road, Guelph, ON

DATUM Geodetic

DATES: BORING April 5, 2017

WATER LEVEL _____

TPC ELEVATION 334.36

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
						TYPE	NUMBER	RECOVERY (mm) / TCR(%)/SCR(%)	N-VALUE OR RQD(%)	WATER CONTENT & ATTERBERG LIMITS DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼ STANDARD PENETRATION TEST, BLOWS/0.3m ●												
										50 100 150 200												
										Wp W Wp Li												
										10 20 30 40 50 60 70 80 90 100												
0	333.5	Grass Field			0																	
	333.2	300 mm TOPSOIL			1	SS	1	$\frac{280}{610}$	6	•												
1		Loose to compact, brown, SAND (SM) - trace gravel and silt - wet		W	2																	
					3																	
					4	SS	2	$\frac{250}{610}$	9	•												
					5																	
					6	SS	3	$\frac{100}{610}$	17	•												
2		- grey, some silt		W	7																	
					8																	
					9																	
					10																	
3				W	11	SS	5	$\frac{460}{610}$	5	•												
					12																	
4	329.4	Very dense, grey, Silty Sand with Gravel (SM) TILL - wet		W	13																	
					14																	
					15																	
					16	SS	6	$\frac{380}{610}$	54	•												
5	328.3	END OF BOREHOLE at approximately 5.2 m below existing grade. Water level measured at 2.1 m below grade on completion of drilling. Monitoring well installed with 50 mm screen from approximately 1.5 m to 4.6 m below grade.		W	17																	
6					18																	
					19																	
					20																	
					21																	
					22																	
					23																	
					24																	
					25																	
					26																	
					27																	
					28																	
10					29																	
		30																				
		31																				
		32																				
		33																				
		34																				
		35																				
		36																				
		37																				
		38																				
12		39																				

Field Vane Test, kPa
 Remoulded Vane Test, kPa
 Pocket Penetrometer Test, kPa

CLIENT Carson Reid Homes Ltd. PROJECT No. 161413338
 LOCATION 220 Arkell Road, Guelph, ON DATUM Geodetic
 DATES: BORING April 5, 2017 WATER LEVEL _____ TPC ELEVATION 338.12

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL					
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)																
0	337.2	Grass Field			0					50 100 150 200 WATER CONTENT & ATTERBERG LIMITS W _p W W _L DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m ▼ STANDARD PENETRATION TEST, BLOWS/0.3m ●															
	336.9	280 mm TOPSOIL			1	SS	1	200 / 610	5	●															
		Compact, brown, SAND (SM) - trace gravel and silt - moist			2																				
					3																				
1					4	SS	2	51 / 610	11	○															
	335.8	Loose, brown, Silty Sand (SM) TILL - wet			5																				
					6																				
					7																				
					8	SS	4	250 / 250	50 / 100	○															
					9																				
					10																				
					11	SS	5	230 / 230	50 / 76	○															
					12																				
					13																				
					14																				
					15																				
					16	SS	6	250 / 280	50 / 130	○															
					17																				
					18																				
					19																				
					20																				
					21	SS	7	76 / 76	50 / 76	○															
					22																				
					23																				
	330.0				24																				
					25																				
					26	SS	8	280 / 280	50 / 130	○															
	329.3	Hard, grey, Silty Clay (CL) TILL - trace gravel - moist			27																				
					28																				
					29																				
					30																				
					31																				
					32																				
					33																				
					34																				
					35																				
					36																				
					37																				
					38																				
					39																				
12																									

- Field Vane Test, kPa
- Remoulded Vane Test, kPa
- △ Pocket Penetrometer Test, kPa



BOREHOLE RECORD

N: 4 818 983 E: 565 155

BH03-17

Sheet 1 of 1

CLIENT Carson Reid Homes Ltd. PROJECT No. 161413338
 LOCATION 220 Arkell Road, Guelph, ON DATUM Geodetic
 DATES: BORING April 5, 2017 WATER LEVEL _____ TPC ELEVATION 335.26

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES				UNDRAINED SHEAR STRENGTH (kPa)										REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) TCR(%) / SCR(%)	N-VALUE OR RQD(%)	WATER CONTENT & ATTERBERG LIMITS DYNAMIC CONE PENETRATION TEST, BLOWS/0.3m STANDARD PENETRATION TEST, BLOWS/0.3m										
0	334.3	Grass Field			0					50 100 150 200										
	334.0	FILL: 300 mm TOPSOIL			1	SS	1	460 / 610	8	10 20 30 40 50 60 70 80 90 100										
		FILL: brown silty sand, some clay, trace gravel - moist			2															
					3															
1	332.9	FILL: brown sandy silty clay, trace gravel - moist			4	SS	2	200 / 610	8											
					5															
					6	SS	3	250 / 610	6											
					7															
2	331.9	Compact, brown, Silty Sand with Gravel (SM) TILL - moist to saturated			8	SS	4	25 / 610	25											
					9															
					10															
					11	SS	5	300 / 610	26											23 28 41 8
					12															
					13															
					14															
					15															
5	329.1	END OF BOREHOLE at approximately 5.2 m below existing grade.			16	SS	6	430 / 610	28											
		Water level measured at 2.4 m below grade on completion of drilling.			17															
		Monitoring well installed with 50 mm screen from approximately 1.5 m to 4.6 m below grade.			18															
6					19															
					20															
					21															
					22															
					23															
					24															
					25															
					26															
					27															
					28															
					29															
					30															
					31															
					32															
					33															
					34															
					35															
					36															
					37															
					38															
					39															

- Field Vane Test, kPa
- Remoulded Vane Test, kPa
- Pocket Penetrometer Test, kPa



BOREHOLE RECORD

N: 4 819 111 E: 565 287

BH04-17

Sheet 1 of 1

CLIENT Carson Reid Homes Ltd.

PROJECT No. 161413338

LOCATION 220 Arkell Road, Guelph, ON

DATUM Geodetic

DATES: BORING April 5, 2017

WATER LEVEL

TPC ELEVATION 340.86

DEPTH (m)	ELEVATION (m)	STRATA DESCRIPTION	STRATA PLOT	WATER LEVEL	DEPTH (ft)	SAMPLES		UNDRAINED SHEAR STRENGTH (kPa)		REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
						TYPE	NUMBER	RECOVERY (mm) / TCR(%) / SCR(%)	N-VALUE OR RQD(%)	
0	340.0	Grass Field			0					
	339.7	280 mm TOPSOIL			1	SS 1	230 / 610	8		
	339.3	Loose, brown, SAND (SM) - some gravel, trace silt - wet			2					
1		Compact to very dense, brown, Silty Sand with Gravel (SM) TILL - moist			3					
					4	SS 2	460 / 610	11		
					5					
					6	SS 3	430 / 610	26		
					7					
					8	SS 4	460 / 610	67		
					9					
					10					
				11	SS 5	460 / 610	87			
				12						
				13						
				14						
				15	SS 6	250 / 250	50 / 100			
				16						
				17						
				18						
				19						
				20	SS 7	130 / 130	50 / 130			
				21						
				22						
				23						
				24						
				25						
				26	SS 8	460 / 610	84			
				27						
		END OF BOREHOLE at approximately 8.2 m below existing grade.			28					
		Water level measured at 6.4 m below grade on completion of drilling.			29					
		Monitoring well installed with 50 mm screen from approximately 4.6 m to 7.6 m below grade.			30					
					31					
					32					
					33					
					34					
					35					
					36					
					37					
					38					
					39					

- Field Vane Test, kPa
- Remoulded Vane Test, kPa
- Pocket Penetrometer Test, kPa

Monitoring Well: MW101-22

Project: 220 Arkell Road
Client: Carson Reid Homes Ltd.
Location: Guelph ON
Number: 161413338
Field investigator: J. Hale
Contractor: Aardvark Drilling Inc.

Method: CME 850/Hollow Stem Auger/Split Spoon
Date started/completed: 10-Mar-2022
Ground surface elevation: 338.22 m AMSL
Top of casing elevation: 339.08 m AMSL
Easting: 4819147
Northing: 565227

SUBSURFACE PROFILE				SAMPLE DETAILS				INSTALLATION DETAILS	
Depth	Graphic Log	Stratigraphic Description	Elevation (m AMSL) Depth (m BGS)	Sample Number	Sample Type	Recovery	N Value	Diagram	Description
0		Ground Surface	338.22						
0		TOPSOIL Some clay, trace sand, organics, very dark greyish brown, moist, very loose	0.00	1	SS	8" 33%	3		Above Ground Casing 0.86 m stick-up
		SILTY SAND Trace organics, dark brown, moist, loose	337.46	2	SS	6" 25%	7		
5		SANDY SILT (TILL) Brown, very moist, loose	336.70	3	SS	6" 25%	6		Water level 1.19 m BGS 31-Mar-2022
2		Trace cobbles and gravel from 2.44 to 3.05 m, very stiff	1.52	4	SS	8" 33%	26		Holeplug 0 to 4.18 m BGS
10		Hard		5	SS	16" 67%	78		203 mm Borehole Diameter 0 to 7.62 m BGS
4		SILTY SAND (TILL) Some gravel, brown, moist, hard	334.41	6	SS	10" 42%	50		
15				7	SS	8" 33%	50		
20		SILT (TILL) Trace sand, gravel and cobbles, grey, moist, hard	332.12	8	SS	8" 33%	50		No.2 Silica Sand 4.18 to 7.53 m BGS
6		No soil sample collected	331.36	9	SS	10" 42%	50		No. 10 Slot Schedule 40 PVC Screen 4.48 to 7.53 m BGS
25		End of Borehole	330.60						
8			7.62						

Screen Interval: 4.48 - 7.53 m BGS
 Sand Pack Interval: 4.48 - 7.53 m BGS
 Well Seal Interval: 0.00 - 4.18 m BGS

Notes:
 m AMSL - metres above mean sea level
 m BGS - metres below ground surface
 SS - split-spoon sample
 n/a - not available

AGS - Above Ground Surface

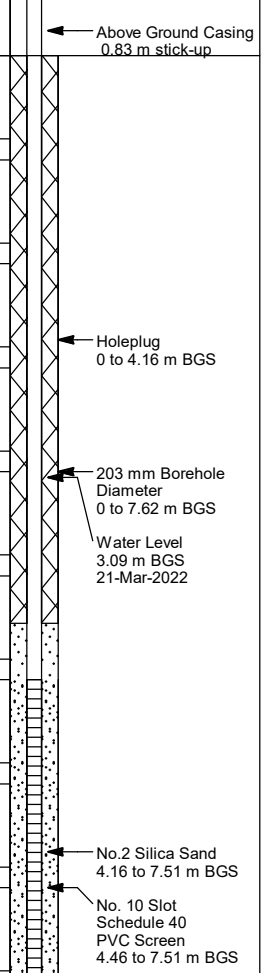


Monitoring Well: MW102-22

Project: 220 Arkell Road
Client: Carson Reid Homes Ltd.
Location: Guelph ON
Number: 161413338
Field investigator: J. Hale
Contractor: Aardvark Drilling Inc.

Method: CME 850/Hollow Stem Auger/Split Spoon
Date started/completed: 10-Mar-2022
Ground surface elevation: 340.06 m AMSL
Top of casing elevation: 340.89 m AMSL
Easting: 4819086
Northing: 565229

SUBSURFACE PROFILE				SAMPLE DETAILS				INSTALLATION DETAILS	
Depth (ft) (m)	Graphic Log	Stratigraphic Description	Elevation (m AMSL) Depth (m BGS)	Sample Number	Sample Type	Recovery	N Value	Diagram	Description
0		Ground Surface	340.06						
0		TOPSOIL Organics, silt, some clay and sand, trace silt, dark brown, moist, loose	0.00	1	SS	20" 83%	6		
			339.30						
		SAND Trace silt, and trace gravel, moist, loose	0.76	2	SS	12" 50%	7		
5			338.54						
		SILTY SAND Some coarse gravel, moist, dense	1.52	3	SS	14" 58%	31		
			337.77						
		SAND Some gravel, trace silt, light brown, moist, dense	2.29	4	SS	20" 83%	34		
10			337.01						
		SILT (TILL) Some sand and gravel, light brown, moist, hard	3.05	5	SS	20" 83%	50		
				6	SS	12" 50%	50		
		No gravel, trace sand, wet		7	SS	8" 33%	50		
				8	SS	24" 100%	66		
				9	SS	18" 75%	86		
		Some gravel, trace sand, light brown-grey, wet		10	SS	3" 13%	n/a		
25			332.44						
		End of Borehole	7.62						



Screen Interval: 4.57 - 7.51 m BGS
 Sand Pack Interval: 4.57 - 7.51 m BGS
 Well Seal Interval: 0.00 - 4.16 m BGS

Notes:
 m AMSL - metres above mean sea level
 m BGS - metres below ground surface
 SS - split-spoon sample
 n/a - not available

AGS - Above Ground Surface



Monitoring Well: MW103-22

Project: 220 Arkell Road
Client: Carson Reid Homes Ltd.
Location: Guelph ON
Number: 161413338
Field investigator: J. Hale
Contractor: Aardvark Drilling Inc.

Method: CME 850/Hollow Stem Auger/Split Spoon
Date started/completed: 10-Mar-2022
Ground surface elevation: 335.01 m AMSL
Top of casing elevation: 335.85 m AMSL
Easting: 4819009
Northing: 565182

SUBSURFACE PROFILE				SAMPLE DETAILS				INSTALLATION DETAILS	
Depth (ft) (m)	Graphic Log	Stratigraphic Description	Elevation (m AMSL) Depth (m BGS)	Sample Number	Sample Type	Recovery	N Value	Diagram	Description
0		Ground Surface	335.01						← Above Ground Casing 0.84 m stick-up
		TOPSOIL Sandy silt, trace organics, moist, loose	0.00	1	SS	16" 67%	9		
		No Recovery - cobble in tip of split spoon.	0.76	2	SS	0" 0%	22		← Water Level 0.7 m BGS 31-Mar-2022
5		SAND Trace silt and gravel, brown, moist, compact	333.49						← Holeplug 0 to 2.52 m BGS
			1.52	3	SS	18" 75%	25		
		SILT (TILL) Trace sand and gravel, brown, moist, very stiff	331.96						← 203 mm Borehole Diameter 0 to 6.10 m BGS
		SILTY SAND (TIFF) Trace gravel, brown, wet, very stiff	331.20						
			3.81	4	SS	8" 33%	28		
				5	SS	12" 50%	24		
				6	SS	10" 42%	22		← No.2 Silica Sand 2.52 to 5.87 m BGS
				7	SS	12" 50%	15		← No. 10 Slot Schedule 40 PVC Screen 2.82 to 5.87 m BGS
		Hard		8	SS	8" 33%	50		
20		End of Borehole	328.91						
			6.10						

Screen Interval: 2.82 - 5.87 m BGS
 Sand Pack Interval: 2.82 - 5.87 m BGS
 Well Seal Interval: 0.00 - 2.52 m BGS

Notes:
 m AMSL - metres above mean sea level
 m BGS - metres below ground surface
 SS - split-spoon sample
 n/a - not available

AGS - Above Ground Surface



Monitoring Well: MW104-22

Project: 220 Arkell Road
Client: Carson Reid Homes Ltd.
Location: Guelph ON
Number: 161413338
Field investigator: A.Singh
Contractor: Aardvark Drilling Inc.

Method: CME 850/Hollow Stem Auger/Split Spoon
Date started/completed: 11-Mar-2022
Ground surface elevation: 337.97 m AMSL
Top of casing elevation: 339.01 m AMSL
Easting: 4819065
Northing: 565136

SUBSURFACE PROFILE				SAMPLE DETAILS				INSTALLATION DETAILS	
Depth (ft) (m)	Graphic Log	Stratigraphic Description	Elevation (m AMSL) Depth (m BGS)	Sample Number	Sample Type	Recovery	N Value	Diagram	Description
		Ground Surface	337.97						
0		TOPSOIL Dark brown, loose	0.00	1	SS	12" 50%	1-1-2-3 (3)		Above Ground Casing 1.04 m stick-up
		SANDY SILT Dark brown, soft	0.76	2	SS	9" 38%	1-1-3-2 (4)		Holeplug 0 to 2.47 m BGS
5		SILTY SAND Brown, moist, compact Grey	1.52	3	SS	16" 67%	2-4-20-12 (24)		203 mm Borehole Diameter 0 to 6.10 m BGS
		No recovery	2.29	4	SS	0" 0%	7-9-30-19 (39)		Water Level 2.88 m BGS 31-Mar-2022
10		SILTY SAND Trace gravel, brown, dense	3.05	5	SS	16" 67%	6-20-14-40 (34)		No.2 Silica Sand 2.47 to 5.82 m BGS
		GRAVEL & COBBLES Trace sand, very dense	3.81	6	SS	4" 17%	21-50 (71)		No. 10 Slot Schedule 40 PVC Screen 2.77 to 5.82 m BGS
15		SILTY SAND Brown, wet, dense	4.57	7	SS	2" 8%	25-16-24-31 (40)		
		CLAYEY SILT Brown, hard	5.64	8	SS	16" 67%	2-2-12-50 (14)		
20		End of Borehole	6.10						

Screen Interval: 2.77 - 5.82 m BGS
 Sand Pack Interval: 2.77 - 5.82 m BGS
 Well Seal Interval: 0.00 - 2.47 m BGS

Notes:
 m AMSL - metres above mean sea level
 m BGS - metres below ground surface
 SS - split-spoon sample
 n/a - not available

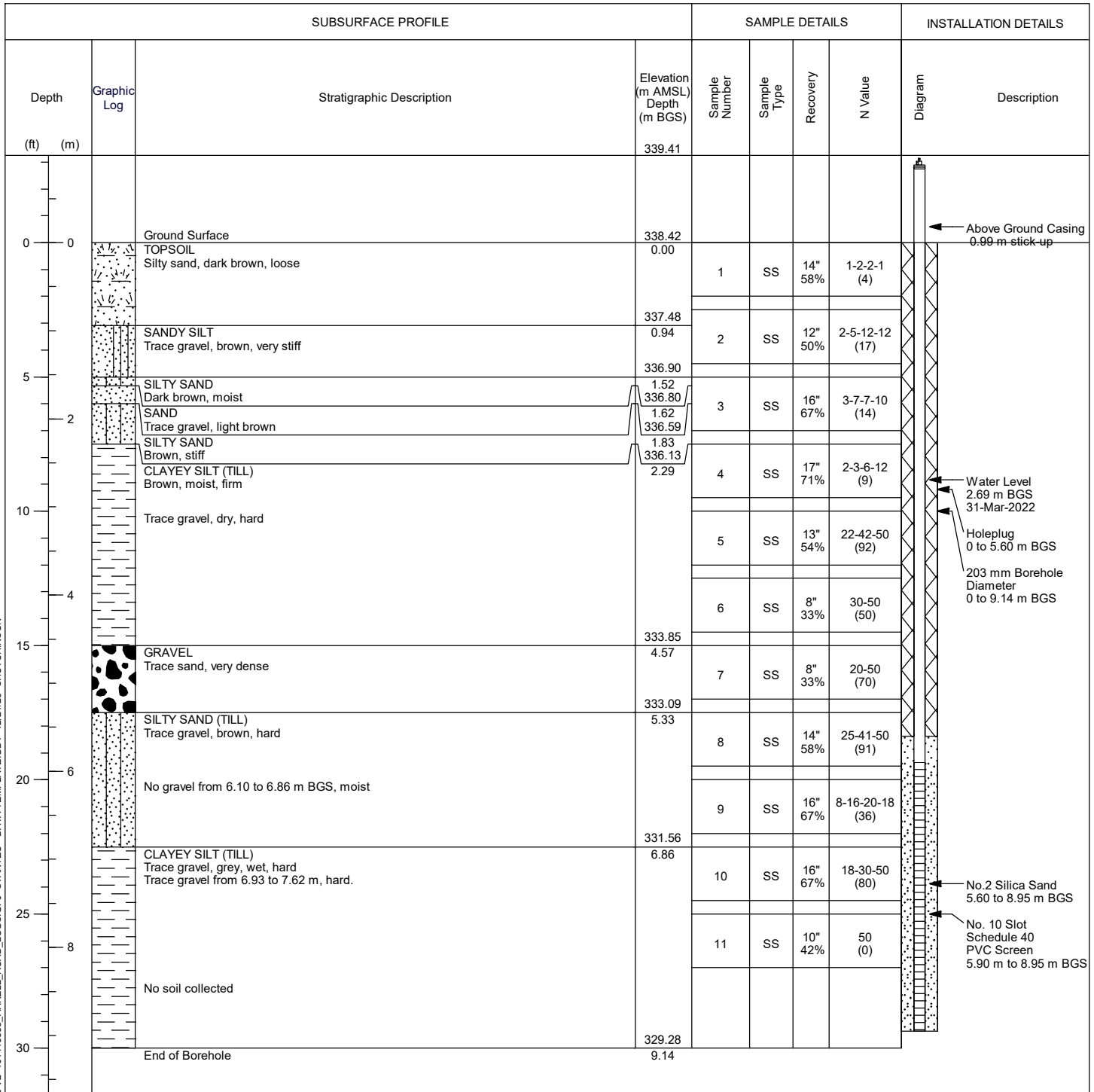
AGS - Above Ground Surface



Monitoring Well: MW105-22

Project: 220 Arkell Road
Client: Carson Reid Homes Ltd.
Location: Guelph ON
Number: 161413338
Field investigator: A.Singh
Contractor: Aardvark Drilling Inc.

Method: CME 850/Hollow Stem Auger/Split Spoon
Date started/completed: 11-Mar-2022
Ground surface elevation: 338.42 m AMSL
Top of casing elevation: 339.41 m AMSL
Easting: 4819101
Northing: 565078



Screen Interval: 5.90 - 8.95 m BGS
 Sand Pack Interval: 5.90 - 8.95 m BGS
 Well Seal Interval: 0.00 - 5.60 m BGS

Notes:
 m AMSL - metres above mean sea level
 m BGS - metres below ground surface
 SS - split-spoon sample
 n/a - not available

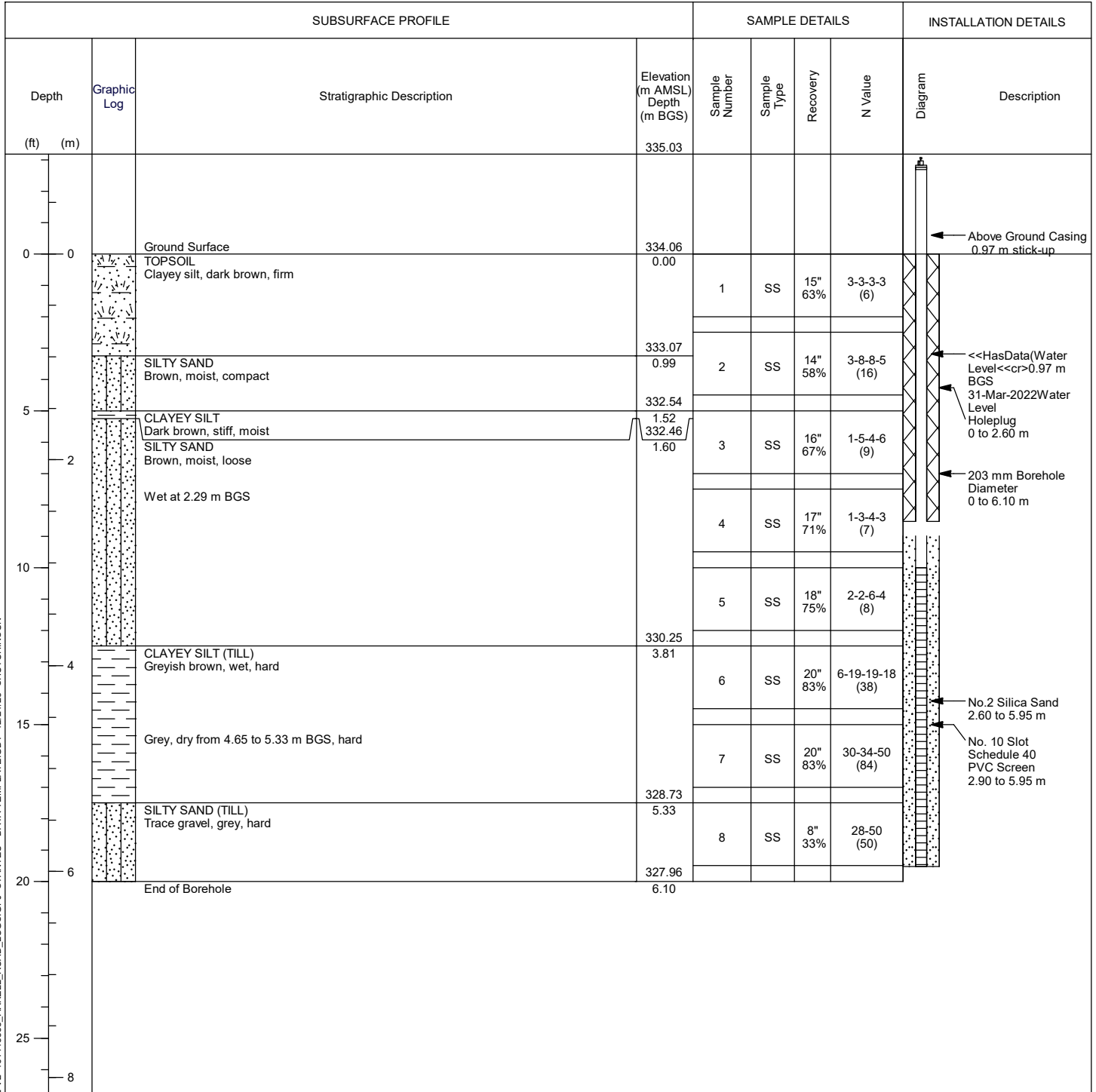
AGS - Above Ground Surface



Monitoring Well: MW106-22

Project: 220 Arkell Road
Client: Carson Reid Homes Ltd.
Location: Guelph ON
Number: 161413338
Field investigator: A.Singh
Contractor: Aardvark Drilling Inc.

Method: CME 850/Hollow Stem Auger/Split Spoon
Date started/completed: 11-Mar-2022
Ground surface elevation: 334.06 m AMSL
Top of casing elevation: 335.03 m AMSL
Easting: 4819055
Northing: 565006



Screen Interval: 3.05 - 5.95 m BGS
 Sand Pack Interval: 3.05 - 5.95 m BGS
 Well Seal Interval: 0.00 - 2.60 m BGS

Notes:
 m AMSL - metres above mean sea level
 m BGS - metres below ground surface
 SS - split-spoon sample
 n/a - not available

AGS - Above Ground Surface

