2023-08-03

Deltini Commercial Developments/1461125 Ontario Limited
1350 Shawson Drive
Mississauga, Ontario
L4W 1C5

Attention: Ms. Marika Zigon

RE: Storm Water Management Pond and Swale / Infiltration Swale Geotechnical Recommendations

Dear Madam:

WSP Canada Inc. (WSP) was retained by Deltini Commercial Developments/1461125 Ontario Limited to provide a preliminary review regarding the infiltration capacity of the soils for the northern drainage swale LID facility, as well as to provide general geotechnical recommendations regarding the proposed Storm Water Management (SWM) facility and the southern drainage swale at the site. The site is located at 636040 Prince of Wales Rd West in Primrose, Ontario (Site); the Site location is shown on **Figure 1**.

BACKGROUND AND PROJECT DESCRIPTION

The Site is located on the west side of Prince of Wales Road West and north of Highway 89 in a mixed-use area in the Town of Primrose, Ontario (**Figure 1**).

Based on the Preliminary Stormwater Management and Functional Servicing Report (dated August 2021) and the overall Site Section Drawings provided to our office by Jones Consulting Group Ltd. (dated February 2023), the Site is proposed to be developed with three proposed industrial blocks, one access road, one snow storage block, one SWM block, and approximately 8.4 ha of environmental protection area. It is WSP's understanding that the proposed SWM pond, LID systems (Enhanced Swales), and drainage swale are being considered at the west, north and south sides of the property, respectively.

PREVIOUS WORK

A preliminary geotechnical investigation was completed by WSP in 2018, and included boreholes advanced throughout the site. Eleven boreholes (Nos. BH18-01 to BH18-11) were advanced throughout the site, Boreholes BH18-01 and BH18-03 were advanced within proximity to the proposed SWM Pond; Borehole BH18-02 was advanced within proximity to the proposed LID system along the north side of the site; and Boreholes BH18-07, BH18-08, BH18-09 and BH18-10 were advanced within proximity to the proposed southern drainage easement area of the site. The depth of the boreholes ranged between 2.1 meters below existing ground surface (mbgs) to 7.0

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mbgs. Boreholes BH18-2, BH18-3, BH18-07, BH18-08, and BH18-10 were outfitted with 30 mm to 50 mm diameter monitoring wells as shown on **Figure 1**. The boreholes were advanced at the Site between February 26 to March 1, 2018.

An in-situ infiltration testing (IT) assessment was conducted by WSP on September 24 and 25, 2018 to determine the infiltration potential of the varying soil conditions at the Site for consideration of Low Impact Development (LID) techniques for the proposed infiltration system(s). The in-situ infiltration testing was completed at seven locations (via test pits) at the site, with eight (8) tests completed (IT1 to IT8) to determine the infiltration rate (I) of the soils. The location of the infiltration tests is shown on **Figure 1**. The testing was conducted with a double-ring infiltrometer in the test-pits, which were excavated to a depth ranging between 0.5 to 1.6 m below ground surface (mbgs).

Groundwater was measured as high as 1.5 mbgs upon borehole completion at the borehole locations. A summary of the groundwater levels measured in the monitoring wells (MWs) subsequent to the drilling operations is provided in **Appendix A**.

PRELIMINARY GEOTECHNICAL RECOMMENDATIONS

1. PROPOSED STORM WATER MANAGEMENT POND

Based on the preliminary design drawings provided by Jones Consulting, it is understood that one SWM Pond will be constructed at the northwest side of the Site. Boreholes BH18-01and BH18-03 were advanced within proximity of the footprint of the SWM Pond. The proposed SWM Pond base elevations and the approximate existing ground surface elevations at the locations of the boreholes are summarized in the following table:

Table 1.1 Proposed SWM Pond Details

BH NO.	EXISTING GROUND SURFACE ELEVATIONS (masl)	GROUND WATER ELEVATION (masl)	PROPOSED POND BASE ELEVATIONS (masl)
BH18-01	459.4	Dry	452.50 (Main Cell) 452.50 (Forebay) 451.0 (Plunge Pool)
BH18-03	456.2	455.1 - 453.5	

1.1 SWM POND DISCUSSION

Based on the preliminary design drawings provided to us by Jones Consulting Group Ltd. (Drawing No. FRE-17110-Base-R4-PND SECTIONS, dated February 2023) provided to our office, it is understood that the SWM Pond will be approximately 196.6 m in length and 83.0 m in width. The base of the pond main cell and forebay will be at El. 452.50 m and plunge pool at El. 451.50 masl. In general, the existing site grades are about 2 m to 3 m higher than the proposed SWM Pond base elevation; however, the maximum grade difference increases to about 5 m in the southeast corner of the SWM Pond. The permanent pool level will be at El. 454.0 m. The access road around the perimeter of the SWM Pond will be at El. 456.1 m. The side slopes of the SWM Pond range between 3 Horizontal : 1 Vertical (3H:1V) to 7H:1V.

The subsurface conditions at Boreholes BH18-01 and BH18-03 comprise surficial topsoil and reworked native soil, overlying glacial till of both silty clay and silty sand textures to a depth of

about 2.3 mbgs (Elevation 457.1 m); the till was underlain by compact to very dense silt to sand and gravel to the termination depth ranged between 3.2 mbgs and 5.0 mbgs (Elevation 456.2 m and 451.2 m).

From March 27, 2019, to March 9, 2020, the groundwater levels were recorded at depths ranging between 1.1 mbgs and 2.7 mbgs (corresponding Elevations 455.1 m to 454.5 m) in the monitoring well installed in BH18-03, which was advanced in proximity to the southwest corner of the SWM Pond. It is noted that the topography at the site slopes downward in a northwesterly direction from Borehole BH18-03; as no groundwater seepage was observed on the slope face, it is anticipated that the groundwater depth within the SWM Pond is generally consistent relative to the existing site topography.

Based on the proposed pond bottom / plunge pool elevations and the ground surface elevations at Boreholes BH18-01 and BH18-03, excavation depths of about 5.2 to 8.4 m below the existing ground surface within the topsoil, glacial till material and sand deposit may be required. As the groundwater depth measured in the monitoring well in Borehole BH18-03 was as high as 1.1 mbgs, and, anticipating that the groundwater depth generally follows the existing ground contours, groundwater control will likely be required during the pond excavation.

To maintain the pond plunge pool and side slopes of the SWM Pond, as well as the permanent pool elevation of 454.0 masl, it will be necessary to construct a hydraulic barrier to control groundwater flow through the pond side slopes. Consideration could be given to the construction of a clay liner using clay soils. However, a suitable on-site source of clay is not available based on the subsurface conditions encountered in the boreholes advanced as part of this project. Alternatively, a geosynthetic clay liner (GCL) could also be installed to limit the water seepage.

The stability of the hydraulic barrier on both the pond side slopes and pond base (basal stability) will need to be considered both when the pond is in operation, as well as when the water level in the pond is lowered for maintenance. In this regard, the liner will need to be covered with sufficient soil weight to counteract the upward seepage pressures based on the site water levels.

Assuming a synthetic liner is used, this would require 0.6 m of soil cover/ballast thickness to be provided for every 1 m of piezometric head acting on the base of the liner. Based on the Site Section Drawings provided to our office, the high groundwater level in the SWM Pond Forebay is at an Elevation of about 453.7 masl (about 1.1 m above the base elevation of the Forebay); the high groundwater level in the SWM Pond Main Cell is at a maximum elevation of about 454.4 masl (about 1.9 m above the base elevation of the Main cell). Assuming a minimum unit weight of 21 kN/m^3 for the soil ballast, the table below provides the minimum liner depths recommended for the GCL to achieve a Factor of Safety of 1.1 for resistance to upward seepage pressures.

SWM POND AREA	GCL DEPTH (m)	GCL ELEVATION (masl)	FACTOR OF SAFETY
Forebay	1.3	451.2	1.1
Main Cell	2.1	450.4	1.1

Alternatively, a subdrainage system could be installed beneath the liner to allow for water levels to be lowered either on a permanent basis (if permitted) or at the time that maintenance activities are to be carried out.

For this pond configuration, the use of a geosynthetic liner is considered preferable due to ease of installation in comparison to a clay liner. Additional comments regarding the use of a GCL are provided below.

- Cover soils should not contain particles larger than 50 mm in diameter; in addition, uniform materials (e.g. uniform sand or silt deposits) should not be used as cover soil on the pond sideslopes due to the potential for instability.
- The GCL be extended to the crest of the containment berm.
- The GCL should be protected with a minimum 0.3 m thick layer of soil/fill cover with no particle sizes greater than 50 mm to help prevent damage during contraction and maintenance of the SWM pond.
- Low ground pressure construction equipment should be used when placing materials above the GCL to limit the potential for damage to the liner.
- The GCL should be anchored beyond the interior crest to prevent movement of the liner prior to placement of the 0.3 m thick protective layer. The liner installation methodology and anchorage details should be approved by the liner supplier.
- Holes through geosynthetic clay liners can be generated by the growth and subsequent decay of vegetative root systems (e.g., reeds, cattails etc.). Therefore, measures should be taken to ensure that such vegetation is not permitted to grow within the pond or a root resistant GCL material be used.
- The presence of the liner and the requirement to maintain the cover soil above the liner should be highlighted in the operations manual in order to reduce the potential for liner damage during cleaning events.

Geotechnical comments regarding the installation of a clay liner are provided below.

- The materials used to construct the clay liner should have a minimum content of clay-sized particles of 20 per cent (by weight), a plasticity index (PI) of greater than 7, a maximum particle size of 0.1 m, and no greater than 15 percent of the material larger than 4.8 mm (No. 4 sieve)
- The clay liner should have a minimum thickness of 0.6 m and should be compacted in a minimum of four lifts using a padfoot compactor with a minimum weight of 13 tonnes. Full-time inspection by qualified geotechnical personnel should be carried out during these operations.
- The water content of the clay liner materials at the time of compaction should be in a range between the optimum water content for compaction and four per cent above the optimum water content for compaction.
- The clay liner materials should be compacted to a dry density greater than or equal to 97 per cent of their Standard Proctor maximum dry density.
- The surface of the liner should be sealed with a smooth drum roller and should be covered with water in a timely manner following placement of the clayey soils in order to reduce the potential for desiccation cracking. In addition, a minimum soil cover of 0.15 m should be placed/nominally compacted above the clay liner.
- As there is likely to be insufficient suitable material generated during the construction works, the use of imported clayey soils would likely be required. Any proposed import materials should be tested prior to importation to the site to confirm that they meet the identified criteria.

- Liner materials should not contain any frozen soil and in this regard, liner construction in the winter is not recommended. The liner construction must be conducted under the full-time supervision of qualified WSP geotechnical personnel.

1.2 SWM POND CONSTRUCTION

Based on the SWM Pond drawing provided to WSP and the existing grades, a new containment berm will be constructed using engineered fill. It is anticipated that at least portions of the berm will be constructed from cut materials removed from within the SWM Pond footprint; however, importing of material may also be required to supplement the native material. If imported materials are required, they should consist of well-graded glacial till materials or well-graded granular materials which must be approved prior to importation.

It is strongly recommended that a global stability and seepage analysis be completed during the detailed design stages of the project to confirm the long-term stability of the structural berm to be constructed.

Any existing topsoil materials, or other soils containing significant amounts of organic and deleterious matter, are not considered suitable as subgrade soils for berm construction or for reuse as engineered fill materials within the berm. Following stripping of the topsoil and reworked native materials, and prior to placement of engineered fill for construction of the containment berm, the prepared subgrade should be heavily compacted and proof rolled under the supervision of the geotechnical engineer. Any softened or poorly performing areas of the subgrade soils must be subexcavated and replaced with engineered fill as directed by the geotechnical engineer.

Based on the results of the investigation, the native sand materials encountered within the borehole advanced in proximity to the pond that are free from topsoil, organic matter and other deleterious materials are considered suitable for reuse as engineered fill to construct the containment berm. However, all materials should be approved by qualified geotechnical personnel prior to use.

The engineered fill materials should be placed in lifts not exceeding 200 mm in thickness and should be uniformly compacted to 100% of the materials SPMDD. Given the potential for poor performance including potential for instability if the berm is not properly constructed, confirming that the berm is properly constructed is of utmost importance and, as such, full-time observation and in situ density testing by experienced geotechnical personnel should be carried out during engineered fill placement/berm construction and liner installation.

Past failures of water retention structures have often occurred as a result of seepage and/or poor compaction of fill materials around outlet structures. In this regard, all outlet piping should incorporate anti-seepage collars at regular spacing; an anti-seepage collar should be incorporated into the liner system. Furthermore, it is critical that full-time geotechnical inspection and adequate compaction testing be carried out to confirm that fill materials surrounding the outlet piping and manhole are properly compacted.

Post-construction inspections of the containment berm should be carried out on a regular basis following construction of the SWM Pond to identify any potential signs that the berm may not be functioning properly (e.g., cracking, bulging of the toe, seepage through berm). The inspection should be carried out by qualified geotechnical personnel capable of identifying signs of potential slope instability. At a minimum, inspections should be carried out after each extended rainfall or snowmelt event in the first two years of operation which semi-annual inspections completed thereafter. Any signs of seepage or instability observed should be reported immediately to the

geo-consultant for an evaluation of the corrective measures to be taken (if necessary). A maintenance program should also be established to periodically inspect the downslope vegetative cover integrity and repair any bare or eroded zones as well as any areas of surficial sloughing.

Groundwater must be lowered to at least 1 m below the final excavation depth; the groundwater must be kept at this depth prior and during construction. As such, it is likely that dewatering will be required at the site and an Environmental Activity and Sector Registry (EASR) or a Permit to Take Water (PTTW) will likely be required for the excavations along specific areas of the proposed roadway alignment. Daily water takings of 50 m^3/day require registration of the MECP EASR database, and daily water takings of 400 m^3/day require a PTTW. Both the EASR and the PTTW require a hydrogeological assessment report to support the specific application. In addition, a permit to discharge the collected water to the sewer system/water body will be required from the applicable agency. A PTTW application requires a minimum of 90 days for the MOECC to process; in this regard, appropriate lead time should be factored into the overall project schedule to accommodate the PTTW process, if required.

In any areas requiring dewatering, a specialized dewatering contractor should be retained to design and install the dewatering system.

2. PROPOSED DRAINAGE SWALES

SWALE	BH NO.	EXISTING GROUND SURFACE ELEVATIONS (m)	GROUND WATER ELEVATION (m)	PROPOSED SWALE BASE ELEVATION (m)
North Swale	BH18-02	459.4	457.9 - 454.7	Ranging between 456.2 m to 454.0 m
South Swale	BH18-07-	457.8	455.8 - 455.5	Ranging between 457.8 m to 454.0 m
	BH18-08-	461.1	456.2 - 455.2	
	BH18-10	458.1	456.6 - 455.7	

Based on the preliminary report and design drawings (Drawing No. FRE-17110-PP-DRAINAGE EASEMENT SECTION, Dated, May 2021) provided to us by Jones Consulting Group Ltd., it is understood that drainage swales will be constructed along / near the north and south boundaries of the site, and will drain into the proposed SWM Pond. Further, an enhanced swale (which will include LID structures) will be constructed as part of the northern swale.

In general, the construction of the drainage swales at the site is considered feasible. General site grading and soil cutting / filling will be required as part of the swale construction. In this regard, we recommend that similar construction techniques as provided in Section 1.2, above, be completed for areas where fill placement is required to construct the drainage swale.

We note that long-term groundwater information, and in particular the number of locations of monitoring wells across the Site, is limited. Based on the available groundwater information at the Site, groundwater was measured in the monitoring wells as shallow as 1.1 mbgs. In this regard, if groundwater is encountered during construction, it may be required to line certain portions of the swale with either clayey soils or a GCL to provide a hydraulic barrier between the swales and the groundwater. An additional subsurface investigation can be completed within the proposed

alignment of the swales to provide further input and delineation towards locations where groundwater may be prevalent.

As noted above, the northern drainage swale is proposed to comprise LID features toward the western portion of the swale. Infiltration testing was completed by WSP at one location (adjacent to Borehole BH18-01) in proximity to the proposed enhanced swale. Based on the results from the infiltration testing, the infiltration rate was about 5 mm / hour in the clayey silt soils at this location of the Site. Due to the clayey silt soils and associated low infiltration rates within this area of the site, it is anticipated that water infiltration into these site soils will be limited; however, consideration should still be given to the construction of the enhanced swale to promote some groundwater infiltration, with any water not infiltrating into the ground to be routed to the SWM Pond.

CLOSURE

As noted above, it is recommended that prior to detailed design, additional boreholes and monitoring wells be advanced at the site to confirm groundwater level and infiltration rates at the specific location and base elevation of the proposed LID system, and within different soil strata within 1.5 m below the base of the LID system. As indicated in the CVC and TRCA Low Impact Development Stormwater Management Planning and Design Guide, the preferred testing period is during April and May, when infiltration is likely to be diminished by saturated conditions.

We trust that this memorandum meets your requirements. If you have any questions regarding the content of this technical memorandum, please do not hesitate to contact this office.

Yours truly,

Prepared By:

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Reviewed by:

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FJ/NL/kj

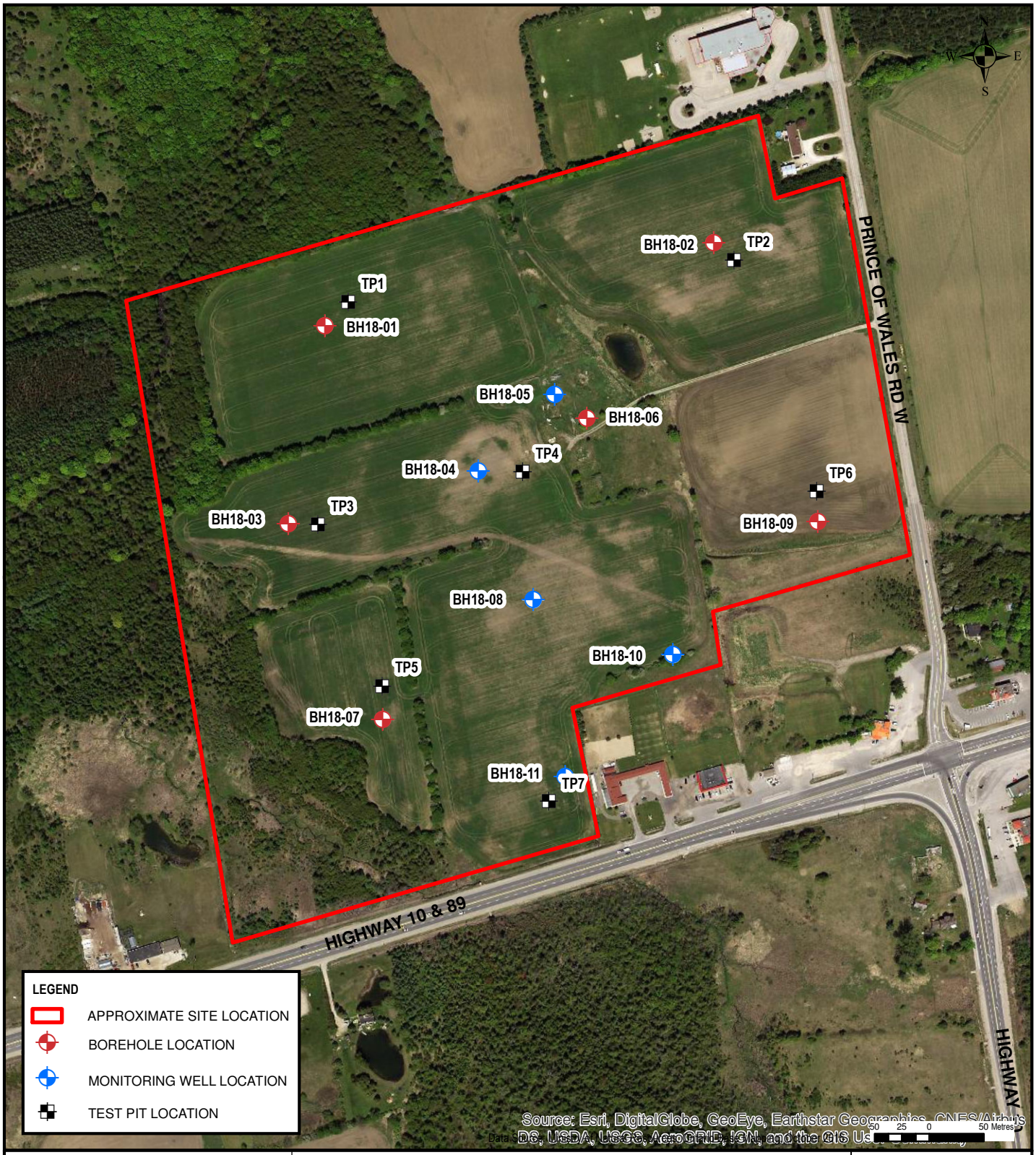
WSP ref.: Project No: 181-01582-03

Attachments

Figure 1 – Borehole Location Plan

Appendix A – Groundwater level record document

FIGURES



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PROJECT:
INFILTRATION TESTING
636040 PRINCE OF WALES ROAD WEST
PRIMROSE, TOWNSHIP OF MULMUR, ONTARIO

TITLE:
TEST PIT LOCATION MAP

CLIENT:
DELTINI COMMERCIAL DEVELOPMENTS / 1461125 ONTARIO INC

SCALE:	1:5,000
DRAWN BY:	TP
CHECKED BY:	-
PROJECT NO:	181-01582-01
DATE:	OCTOBER 2018
FIGURE NO:	1
REV.:	-

Document Path: T:\181-01582-00\MXD\400\181-01582-00 200 Figure 1 Test Pit Location.mxd

APPENDIX

A GROUNDWATER LEVEL RECORD DOCUMENT

GROUNDWATER ELEVATIONS
636040 PRINCE OF WALES ROAD WEST
PRIMROSE, TOWNSHIP OF MULMUR, ONTARIO

Monitor Designation	Elevation of T.O.P.	Ground Elevation	PVC Casing Stick-up	Measurement Date	Depth to Water		Groundwater Elevation
	m ASL	m ASL	m		m bmp	m bgl	m ASL
BH18-2	460.338	459.398	0.94	27-Mar-19	4.25	3.31	456.09
				19-Apr-19	4.90	3.96	455.44
				2-May-19	2.43	1.49	457.91
				9-May-19	2.84	1.90	457.50
				31-May-19	3.70	2.76	456.64
				26-Jun-19	4.39	3.45	455.95
				15-Aug-19	5.30	4.36	455.04
				20-Sep-19	5.60	4.66	454.74
				07-Oct-19	5.59	4.65	454.75
				09-Dec-19	5.28	4.37	455.06
				07-Feb-20	5.11	4.17	455.23
				09-Mar-20	4.79	3.85	455.55
BH18-3	457.296	456.223	1.07	27-Mar-19	2.60	1.53	454.70
				19-Apr-19	2.39	1.32	454.91
				2-May-19	2.20	1.13	455.10
				9-May-19	2.39	1.32	454.91
				31-May-19	2.53	1.46	454.77
				26-Jun-19	2.71	2.71	454.59
				15-Aug-19	3.03	1.96	454.27
				20-Sep-19	2.96	1.89	454.34
				7-Oct-19	2.98	1.91	454.32
				9-Dec-19	2.72	1.65	454.58
				7-Feb-20	2.75	1.68	454.55
				9-Mar-20	2.53	1.46	454.77
BH18-4	463.653	462.719	0.93	27-Mar-19	7.62	6.69	456.03
				19-Apr-19	7.65	6.72	456.00
				2-May-19	7.45	6.52	456.20
				9-May-19	7.33	6.40	456.32
				31-May-19	7.18	6.25	456.47
				26-Jun-19	7.35	6.42	456.30
				15-Aug-19	7.75	6.82	455.90
				20-Sep-19	7.96	7.03	455.69
				7-Oct-19	8.05	7.12	455.60
				9-Dec-19	7.85	6.92	455.80
				7-Feb-20	7.81	6.88	455.84
				9-Mar-20	7.84	6.91	455.81
BH18-5	460.50	459.696	0.80	27-Mar-19	3.52	2.72	456.98
				19-Apr-19	3.85	3.05	456.65
				2-May-19	2.88	2.08	457.62
				9-May-19	2.94	2.14	457.56
				31-May-19	3.15	2.35	457.35
				26-Jun-19	3.50	2.70	457.00
				15-Aug-19	4.92	4.12	455.58
				20-Sep-19	4.38	3.58	456.12
				7-Oct-19	4.51	3.71	455.99
				9-Dec-19	4.05	3.25	456.45
				7-Feb-20	3.98	3.18	456.52
				9-Mar-20	3.75	2.95	456.75

GROUNDWATER ELEVATIONS
636040 PRINCE OF WALES ROAD WEST
PRIMROSE, TOWNSHIP OF MULMUR, ONTARIO

Monitor Designation	Elevation of T.O.P.	Ground Elevation	PVC Casing Stick-up	Measurement Date	Depth to Water		Groundwater Elevation
	m ASL	m ASL	m		m bmp	m bgl	m ASL
BH18-7	459.012	457.793	1.22	27-Mar-19	3.54	2.32	455.47
				19-Apr-19	3.41	2.19	455.60
				2-May-19	3.24	2.02	455.77
				9-May-19	3.26	2.04	455.75
				31-May-19	Standpipe Damaged		
				26-Jun-19	Standpipe Damaged		

GROUNDWATER ELEVATIONS
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Monitor Designation	Elevation of T.O.P.	Ground Elevation	PVC Casing Stick-up	Measurement Date	Depth to Water		Groundwater Elevation
	m ASL	m ASL	m		m bmp	m bgl	m ASL
BH18-8	462.097	461.056	1.04	27-Mar-19	6.22	5.18	455.88
				19-Apr-19	6.87	5.83	455.23
				2-May-19	6.01	4.97	456.09
				9-May-19	5.89	4.85	456.21
				31-May-19	5.90	4.86	456.20
				26-Jun-19	6.09	5.05	456.01
				15-Aug-19	6.46	5.42	455.64
				20-Sep-19	6.54	5.50	455.56
				7-Oct-19	6.57	5.53	455.53
				9-Dec-19	6.49	5.45	455.61
				7-Feb-20	6.31	5.27	455.79
				9-Mar-20	6.37	5.33	455.73
BH18-10	459.129	458.059	1.07	27-Mar-19	2.83	1.76	456.30
				19-Apr-19	2.71	1.64	456.42
				2-May-19	2.66	1.59	456.47
				9-May-19	2.58	1.51	456.55
				31-May-19	3.64	2.57	455.49
				26-Jun-19	2.94	2.94	456.19
				15-Aug-19	3.36	2.29	455.77
				20-Sep-19	3.39	2.32	455.74
				7-Oct-19	3.39	2.32	455.74
				9-Dec-19	3.12	2.05	456.01
				7-Feb-20	3.19	2.12	455.94
				9-Mar-20	3.13	2.06	456.00
BH18-11	460.265	459.393	0.87	27-Mar-19	4.34	3.47	455.93
				19-Apr-19	4.29	3.42	455.98
				2-May-19	4.15	3.28	456.12
				9-May-19	4.11	3.24	456.16
				31-May-19	4.19	3.32	456.08
				26-Jun-19	4.35	4.35	455.92
				15-Aug-19	4.65	3.78	455.62
				20-Sep-19	4.67	3.80	455.60
				7-Oct-19	4.41	3.84	455.86
				9-Dec-19	4.57	3.84	455.70
				7-Feb-20	4.43	3.56	455.84
				9-Mar-20	4.32	3.45	455.95

GROUNDWATER ELEVATIONS
636040 PRINCE OF WALES ROAD WEST
PRIMROSE, TOWNSHIP OF MULMUR, ONTARIO

Monitor Designation	Elevation of T.O.P.	Ground Elevation	PVC Casing Stick-up	Measurement Date	Depth to Water		Groundwater Elevation
	m ASL	m ASL	m		m bmp	m bgl	m ASL

Notes:
1) "m ASL" indicates metres above sea level.
2) "m" indicates metres.
3) "m bmp" indicates metres below measurement point, which is the top of pipe (referred to as T.O.P.)
4) "m bgl" indicates metres below ground level.
5) Monitoring wells are installed with flushmount casings.
6) Elevation for base of staff gauge was estimated using available site topography mapping. Ground elevation and T.O.P. eleveations for the
7) Depth to Water measurements for SG indicate the depth of the surface water