FUNCTIONAL SERVICING REPORT

Orangeville Highlands
Phase II

Town of Orangeville

Prepared for

Orangeville Highlands Ltd.

Project #: 06-233-PH2

First Submission: April 2018
Second Submission: April 2019

Urbantech Consulting, A Division of Leighton-Zec Ltd.
3760 14th Avenue, Suite 301 Markham, Ontario L3R 3T7
TEL: 905.946.9461 FAX: 905.946.9595
www.urbantech.com

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Executive Summary

The purpose of this submission is to provide functional servicing design information in support of the Orangeville Highlands Phase II plan of subdivision prepared for Orangeville Highlands Ltd. in the Town of Orangeville. This report demonstrates how the proposed development complies with the Town's Engineering Design Criteria as well as the Credit Valley Conservation (CVC) environmental standards and tie into existing boundary and servicing conditions. The findings and recommendations of this report are divided into 6 key sections as follows:

1. **Site Description** – The 17.95 ha property is located north of Hansen Boulevard and immediately west of the Orangeville Mall (west of First Street) in the Town of Orangeville. The South Branch of the Middle Monora Creek is located on the north half of the property; this natural feature will be protected during development and preserved within an NHS/open space block within the draft plan. Refer to **Appendix A** for the Draft Plan of Subdivision.

2. **Development Constraints** – Main site constraints include maintaining appropriate setbacks from the woodlot drip-line, wetland features, Middle Monora Creek, and Regional floodplain and matching existing grades along the property lines and right of way. Refer to **Figure 1A** for the limit of development. It is likely that lot-level groundwater recharge will be required.

3. **Site Grading –** The subdivision has been graded to conform to the Town of Orangeville design standards and to accommodate existing storm drainage and boundary conditions. An erosion and sediment control plan for the site will be designed in conformance with the CVC and Town of Orangeville Guidelines.

4. **Storm Drainage** / **Stormwater Management** – Storm sewer routing alignments are identified to convey post-development flows to a SWM facility on the south-east corner of the site. This facility discharges to an existing drainage feature connected to the Middle Monora Creek and will be designed to treat and control stormwater flows up to and including the 100-year event. A water balance analysis has been completed by Azimuth.

5. **Sanitary Servicing –** The sanitary sewers for the proposed development will drain to the existing 300mm diameter sanitary sewers on Hansen Boulevard.

6. **Water Distribution** – The proposed watermain infrastructure will be looped at the two access points to the site and will connect into the existing watermain on Hansen Boulevard.

1. Introduction

1.1. Subject Site

The subject site is located on the north side of Hansen Boulevard, immediately west of the Orangeville Mall (west of First Street) in the Town of Orangeville. The property is approximately 17.95 ha; however, the developable tableland is 11.69 ha. The South Branch of the Middle Monora Creek crosses the north part of the property. The proposed land use consists of 207 medium density residential units (town homes), 334 units in the multiple-dwelling (apartment) block, 2.10 ha of park/open space blocks, and a stormwater management facility block (1.24 ha). Please refer to the Draft Plan dated April 3, 2019 prepared by GSAI (provided in **Appendix A**).

Storm drainage, sanitary drainage, water distribution, lot grading and street grading will comply with the Town of Orangeville Engineering Design Standard Specifications and Drawings. CVC approvals will be obtained where applicable.

This report is applicable for any future revisions to the concept plan, assuming revisions are in general conformance with the servicing and stormwater management concepts outlined in this functional servicing plan.

The development concepts contained in this report are an extension of the information in the following reports:

- "Addendum to Environmental Impact Study and Management Plan, Orangeville Highlands Phase 2", Azimuth Environmental Consulting Inc., April 2019
- "Fluvial Geomorphological Assessment: Erosion Threshold & Meander Belt Width Assessments and Flood Plain Mapping", Water's Edge Environmental Solutions Team Ltd., April 2019
- "Hydrogeological Addendum Report", Azimuth Environmental Consulting Inc., April 2019
- "Groundwater Infiltration Study, Proposed Orangeville Highlands Development Phases 1 & 2", Jagger Hims Limited, September 2003
- "Supplemental Monitoring and Hydrogeological Assessments, Proposed Orangeville Highlands Development Phase 1", Jagger Hims Limited, July 2005
- Lower Monora Creek Environmental Management Plan Part A, June 1999
- Geotechnical Investigation by Soil-Mat Engineers & Consultants Ltd., August 2013, and Supplemental SWM Pond Considerations, April 2019.

2. Development Constraints

2.1. Existing Site Conditions

The subject property is moderately sloped from west to east with slopes ranging from 0.5% to 5%. The north end of the site slopes towards the South Branch of the Middle Monora Creek. Refer to **Figures 1A and 1B** for development constraints and existing drainage patterns.

2.1.1. Vegetation / Terrestrial Features

The majority of the subject lands have been traditionally used for agricultural purposes. Confirmed and potential Significant Natural Heritage Features identified on the property include: Provincially Significant Wetland, woodland, valleyland, Significant Wildlife Habitat, Watercourse (Middle Monora Creek), Habitat for Endangered and Threatened Species and Floodplain. A soil stockpile dating from the time of the adjacent mall construction is located on the site.

The development respects the required setbacks from the dripline, surveyed wetlands, the Middle Monora Creek and the floodplain. However, minimal transitional grading will be required within the buffer areas which is further discussed in Section 3.1. These areas will be restored to native self-sustaining vegetation for long term stabilization.

There are trees located around the perimeter of the property, primarily the western boundary and a Tree Inventory and Preservation Plan was completed in 2011 by Kuntz and updated in April 2019. Trees within the developable area that have been identified for preservation are indicated on **Figure 2**.

An impact assessment is provided within Azimuth's Environmental Impact Study and Management Plan to address potential impacts to the identified Significant Natural Heritage Features. The drip-line (staked 2011), setbacks, and natural features, that form the development limit on the site, are identified on **Figure 1A**.

2.1.2. Aquatic Features and Floodplain Storage

The Middle Monora Creek is a cold-water feature that traverses the north part of the property. There are several development limits related to the watercourse; specifically:

- 10m setback from identified meanderbelt
- 30m setback from watercourse (i.e. Middle Monora Creek)
- 10m setback from Regional floodplain

An area of floodplain storage associated with an existing drainage feature is located parallel to the eastern property limit. This drainage feature was excavated in order to maintain the total Regional floodplain storage during construction of the Orangeville Mall, which required filling within the floodplain. This channelized area will act as the proposed SWM facility outfall and presents opportunities for restoration / naturalization and enhanced stormwater quality control (e.g. additional water quality polishing, thermal mitigation, etc.). The floodplain in this area was delineated by Water's Edge in April 2019 based on the available HEC-RAS model files and topographic mapping. A 10m setback has been provided from the floodplain. Note that the floodplain storage feature itself was not included in the HEC-RAS model cross-sections.

The setbacks from the natural features were used to determine the development limit. The dripline was been established (walked & staked) with CVC staff in 2011. The proposed grading currently does not encroach into the setback with the exception of a few locations where minor transition grading is necessary to achieve the minimum lot depth. It should be noted that a reduced setback was approved for the Orangeville Highlands Phase I development in similarly-constrained areas. Where necessary, restoration of the buffer was undertaken to compensate for the minor encroachments. It is recommended that a similar approach be used for the Phase II development. Refer to the Addendum to Environmental Impact Study and Management Plan by Azimuth for additional details regarding encroachments.

The Department of Fisheries and Oceans guidelines will be reviewed regarding construction timing window for cold-water fisheries (i.e the Middle Monora Creek).

2.1.3. Soil Conditions and Groundwater Considerations

Based on observations from the Azimuth hydrogeological study, the soils consist of sand with minor gravel and some bog deposits including peat. This classification agrees with the surficial geologic mapping of the Phase 2 area provided in the 2003 Jagger Hims Limited "Groundwater Infiltration Study" for Orangeville Highlands Phases 1 and 2.

The maximum observed groundwater table contours resulting from the Jagger Hims Limited study are indicated on **Figure 2**. Proposed grading ensures that basements will be situated at minimum 0.5m above the maximum observed water table. In addition, the wet portion of the pond and forebay are designed to be below the water table, while the remaining components are near the high water table elevation. As such, the pond and forebay are proposed to be lined, which would limit the hydraulic connection between the pond and underlying aquifer. As a result, temporary dewatering may be required to facilitate construction of the facility. Further direction from a geotechnical engineer will be required to confirm the design of the pond liner and construction dewatering requirements.

Similar to the Orangeville Highlands Phase I development, and as identified in the Lower Monora Creek Environmental Management Plan Part A (1999), the Phase II lands have been identified as a recharge area. Refer to Section 4.6 for additional discussion regarding water balance and the use of LID controls, as well as the Hydrogeological Report by Azimuth.

As recommended in the Azimuth hydrogeological study, it is recommended that trench plugs be used to eliminate permanent dewatering along these servicing trenches in the areas where the utility trenches are below the high water table.

3. Preliminary Grading

3.1. Existing Topography and Grading Criteria

Figure 1A indicates the existing topography and grading constraints. These include:

- Hansen Boulevard
- 10m setback from drip-line at north development limit
- 30m setback from watercourse (Middle Monora Creek)
- 10m setback from Regional Storm floodplain
- Existing residential area on west property limit
- Regional flood elevation along east property limit

The proposed grading (refer to **Figure 2**) respects the existing topographic features and constraints and will satisfy the following requirements:

- Conform to Town of Orangeville's grading criteria,
- Minimize cut & fill operations and work towards a balanced site,
- Match existing boundary grading conditions,
- Provide minimum cover on proposed servicing,
- Provide overland flow conveyance for major storm conditions, and
- Match existing grades for ROW access points (Victor Large Way and Amelia Street)

In addition, the proposed SWM facility permanent pool elevation has been set at 421.0m, above the Regional water level in the receiving floodplain storage channel and observed groundwater table. The permanent pool elevation controls the proposed storm sewer inverts and site fill requirements.

Rear lot swales and catchbasins will be provided for internal town house blocks. Where required, swales will comply with the Town of Orangeville design standards. Swales will have minimum and maximum grades of 2% and 5%, respectively. Rear yard swales will be offset 1.0m from the lot line, will not exceed 60m in length, and will have minimum and maximum depths of 0.15m and 0.30m, respectively.

Groundwater monitoring data provided in the 2005 Jagger Hims and 2018 Azimuth report indicated the maximum observed groundwater table elevations for Phase II. This information was used to ensure that basement and foundation drains were situated with 0.5m or more clearance above the groundwater table.

Road grading within the development will meet the following constraints:

- Match the existing road grades of Hansen Boulevard, Victor Large Way, and Amelia Street at the common property line,
- Maintain positive overland flow drainage from the major system to the SWM facility at the south east corner of the property.

Proposed road grades will utilize the Town of Orangeville criteria for minimum 0.5% slope and maximum 5.0% slope. The net slope will accommodate major system flow conveyance. Internal and external design will be required to conform to Town of Orangeville right-of-way and pavement make-up design standards.

A retaining wall is proposed along west side of Street 'B' due to the grading transition between Hansen Boulevard and the rear yards along the west property line of the site.

Minor transitional grading encroachments have been proposed into the buffer block behind Blocks 5 and 6 due to challenges with matching existing grades and lot grading requirements. The extension of the 3.0m walkway between Blocks 4 and 5 into the buffer also results in transition grading and a short retaining wall (within the walkway block) to match existing trail grades and to meet accessibility standards. Refer to **Figures 3A and 3B** for grading cross sections.

3.2. Earthworks Program

The overall earthworks strategy for this site will be to minimize earth movement and achieve a balance of cut and fill. A detailed cut and fill plan will be provided at the detail design stage. As discussed above, the existing top-soil pile can be moved and re-distributed across the site so that the grades along the north property line can be restored to natural conditions.

3.3. Erosion & Sediment Control

The erosion and sediment control plan for the site will be designed in conformance with the Town of Orangeville and CVC guidelines. Erosion and sediment control will be implemented for all construction activities including topsoil stripping, foundation excavation and stockpiling of materials.

The following erosion and sediment control measures will be installed and maintained during construction:

- A temporary sediment control fence will be placed prior to grading.
- Sediment traps will be provided upstream of drainage outlets at the site boundaries.
- Gravel mud mats will be provided at construction vehicle access points to minimize off-site tracking of sediments
- All temporary erosion and sediment control measures will be routinely inspected and repaired during construction. Temporary controls will not be removed until the areas they serve are restored and stable.
- Rock check dams will be placed in perimeter swales to prevent erosion and promote sedimentation by slowing flow velocities and/or filtering concentrated flows.
- Settling trenches will be excavated upstream of the rock check dams to a minimum depth of 0.6m and volume of three cubic metres.
- Use of a turbidity curtain within the SWM pond during the active phases of construction (to improve pond performance/settling efficiency if necessary).

All required measures will be taken to ensure that sediment loading to the Middle Monora Creek is minimized both during and following construction. Drawings will be completed as part of the detailed design.

4. Storm Servicing

4.1. Existing Storm Drainage

The existing topography divides the site into 3 main sub-catchments as shown in **Figure 1B** with outlets to the NHS north of the site, the existing channel east of the site, and Hansen Boulevard to the south. The north portion of the site drains towards the Middle Monora Creek Valley, while the central area drains to Feature B, a drainage feature between the subject lands and the Orangeville Mall which discharges to the Middle Monora watercourse. The following table describes the existing drainage patterns illustrated on **Figure 1B**.

Table 4.1 – Existing Drainage Patterns

Area Description	Land Use	Area [ha]	Outlet	Water Balance considerations
External 1	Roof tops / rear yards	0.31	Middle Monora NHS (via subject lands)	Drains to NHS Within Q1/Q2 area
Drainage to NHS 1	Undeveloped	0.92	Middle Monora NHS	Within Q1/Q2 area
Drainage to NHS 2	Undeveloped	0.33	Middle Monora NHS	Drains to NHS
Drainage to NHS 3	Undeveloped	0.72	Middle Monora NHS via Feature A	Drains to Feature A
External 2	Roof tops / rear yards	0.03	Feature B	Drains to Feature B Within Q1/Q2 area
Drainage to Feature B 1	Undeveloped	1.51	Feature B	Drains to Feature B Within Q1/Q2 area
Drainage to Feature B 2	Undeveloped / Dog Park	5.07	Feature B	Drains to Feature B
Drainage to Feature B 3	Undeveloped	1.93	Feature B	Drains to Feature B
Feature B	Drainage Feature	0.55	Feature B	Drains to Feature B
Drainage to Hansen Boulevard 1	Undeveloped	0.42	Hansen Boulevard ROW	Within Q1/Q2 area
Drainage to Hansen Boulevard 2	Undeveloped	1.07	Hansen Boulevard ROW	None
Drainage to Hansen Boulevard 3	Undeveloped	0.32	Hansen Boulevard ROW	None

4.2. Proposed Storm Drainage

All major and minor flows from the proposed development, with the exception of the park, rear yards adjacent to the NHS, and transition grading along Hansen Boulevard will be directed to a SWM facility at the south east corner of the property shown on **Figure 4**. The total post-development drainage area serviced by the SWM facility is 10.28 ha. Refer to **Figures 1C** and **Figure 5A** for details. Approximately 2.17 ha will drain uncontrolled to the adjacent creek including a portion of the external area, approximately half of the park, and rear-yards / roofs from several blocks. Note that the total uncontrolled drainage to Hansen Boulevard will be reduced significantly compared to existing conditions.

Table 4.2 – Proposed Drainage Patterns

Area Description	Land Use	Area [ha]	Outlet	Water Balance considerations
External 1	Roof tops / rear yards	0.25	Middle Monora NHS (via subject lands)	Drains to NHS Within Q1/Q2 area
Drainage to NHS 1	Park	0.75	Uncontrolled to Middle Monora NHS	Within Q1/Q2 area
Drainage to NHS 2	Park / Rear Yards	0.13	Uncontrolled to Middle Monora NHS	Drains to NHS
Drainage to NHS 3	Roof tops / rear yards	0.27	Uncontrolled to Middle Monora NHS via Feature A	Drains to Feature A
External 2	Roof tops / rear yards	0.09	Pond / Feature B	Drains to Feature B Within Q1/Q2 area
Drainage to Feature B 1	Park / ROW / Development	2.25	Pond / Feature B	Drains to Feature B Within Q1/Q2 area
Drainage to Feature B 2	ROW / Development	7.02	Pond / Feature B	Drains to Feature B
Drainage to Feature B 3	Roof tops / rear yards	0.16	Uncontrolled to Feature B	Drains to Feature B
Feature B	Drainage Feature	0.61	Feature B	Drains to Feature B
Pond	SWM Facility	1.01	Feature B	Drains to Feature
Drainage to Hansen Boulevard 2	Transition slope	0.17	Hansen Boulevard ROW	None
Drainage to Hansen Boulevard 3	Transition slope	0.23	Hansen Boulevard ROW	None

The minor system is a series of storm sewers sized to convey the 10-year return period storm and outlet to the proposed interim channel as noted above. Refer to **Figure 5A** for the conceptual storm sewer layout and **Appendix B** for the storm sewer design sheets.

The major system uses the proposed right-of-ways to convey overland flow from major storm events (up to and including the 100-year storm flows) to the proposed SWM facility.

The proposed SWM facility outfall will discharge into Feature B long the east property line. The outlet pipe will be situated above the anticipated Regional floodplain elevation (419.71m) to avoid impact on the function of the storage feature.

Sump pumps may be required to service the proposed townhouse blocks in areas of high groundwater table.

The applicable CVC criteria are:

a. Quantity: post to pre control for all storms (i.e. 2, 5, 10, 25, 50, 100 year).

b. Quality: Enhanced Level of Protection (80% TSS removal)

c. Erosion: 25mm-48 hr detention or a site appropriate erosion threshold as determined by a geomorphological assessment.

d. Water balance: site specific and feature-based water balance and maintenance of recharge is required.

4.3. Quantity Control

Hydrologic analysis of the site was completed using Visual OTTHYMO 5.0 to determine the existing and proposed development flows for the 2 to 100-year storm event. The SCS Type II 24-hour distribution was used in the analysis. The pervious areas were modelled with a CN=61 and depression storage of 5mm, while the developed areas including the future site plan blocks were measured to be 70% impervious with a depression storage of 1mm.

The detailed model output files are included in **Appendix B**. The model was completed using the Town of Orangeville Design standards for runoff coefficients and design storms. The facility does not service any external drainage areas. Drainage areas within the proposed development, shown in **Figure 5A** were delineated using the most recent concept plan provided by the client and resulting grading plan.

The proposed SWM facility will control post-development peak flow to pre-development levels. An outlet control structure will be designed to ensure that the proposed target flows are not exceeded for events up to and including the 100-year event. A broad crested weir will be placed at or above the 100-year water level to permit the safe release of flows above the 100-year event. Pond grading will be predominantly 5:1, with 3:1 transition grading above the access road on the east embankment to match grades along the mall property.

Table 4-3 compares flows from the 100-year event under existing and proposed conditions. As indicated above, the pre-development drainage area to the Middle Monora Creek system from the subject lands (and external areas) is 11.37 ha. The proposed area serviced by the pond is 10.28 ha; an additional 2.17 ha including the park, roofs / rear yards will flow uncontrolled to the Middle Monora Creek. The SWM facility will therefore be sized to "over-control" the 10.28 ha area so that the total post-development runoff (controlled and uncontrolled) will not exceed the pre-development runoff rates.

Table 4-3 Existing and Proposed Peak Flows (Combined outlets)

Design Event	Existing Flow 11.37 ha $[m^3/s]$	Post-Development Flow 12.45 ha (Uncontrolled) $[m^3/s]$	Pond Outflow 10.28 ha (Controlled) + 2.17 ha (Uncontrolled) $[m^3/s]$
25mm	0.051	1.00	0.151
2-year	0.323	1.433	0.32
5-year	0.569	1.995	0.566
10-year	0.748	2.357	0.659
25-year	0.984	2.944	0.82
50-year	1.184	3.327	0.914
100-year	1.407	3.735	**1.012**
Regional	1.474	1.662	**1.563**

4.4. Quality Control

Suitable permanent pool and extended detention storage will be provided according to the MOE SWM Planning and Design Manual criteria. The facility will maintain quality & erosion rates and provide a minimum 48-hour drawdown time for the 25mm design storm. Based on the proposed site plan, it was estimated that the imperviousness is approximately 70%, including the SWM block. Based on the 10.28 ha drainage area directed to the pond, the required permanent pool and extended detention storage were determined according to Table 3.2 in the SWM Planning and Design Manual. **Table 4-4** below indicates the required and provided water quality storage volume. Any uncontrolled / developed areas (other than clean rooftop and rear yard drainage) discharging directly to the adjacent watercourse or natural features requires Enhanced/Level 1 quality control. Due to the relatively small uncontrolled area, it is recommended that quality control is provided using a treatment train approach with low-impact development measures as opposed to an oil/grit separator.

Table 4-4 – Water Quality Storage Requirements

Water Quality Volume Criteria	Unit Rate [m^3/ha]	Required [m^3]
Permanent Pool Volume	185 (based on 70%IMP)	1,902
Extended Detention Storage	**Greater of 40m^3/ha or post-to-pre control of 25mm event**	**1,722**

4.5. Pond Design

Based on the above targets, the proposed SWM facility grading has been designed to provide sufficient storage for all events as shown in **Table 4-5**. A lower release rate was required for the 25mm event (0.007 m^3/s) to ensure that a minimum 24 to 48 drawdown time could be achieved. Despite controlling to this low release rate, the uncontrolled areas cause a minor exceedance in the total 25mm event flow from the subject lands into the Middle Monora Creek. This will be addressed through the use of LIDs along the uncontrolled blocks as shown on **Figure 5B** and discharge to the Feature A wetland. LID features within the future park could also be implemented to reduced the 25mm runoff into the NHS (subject to Town approval).

The pond grading respects the Town guidelines and the pond layout / components are consistent with the Orangeville Highlands Phase 1 facility. A sediment forebay is proposed in accordance with the MOE SWM Planning & Design Manual; calculations in **Appendix B** demonstrate that sufficient settling and dispersion lengths have been provided. The pond layout, with sections, is shown in **Figure 4.** A pond liner is required as per the geotechnical study in Appendix D.

Table 4-5 – Preliminary Pond Design

Pond component	Stage (m)	Storage volume (m3)		Target release rate (m3/s)
		REQUIRED	PROVIDED	
Pond bottom	418.50 wet cell 420.00 (forebay)	-	-	-
Permanent pool	421.00	1902	5049	0
25mm (extended detention)	421.35	1722	1882	0.007*
2-year	421.50	2475	2762	0.241
5-year	421.60	3304	3349	0.312
10-year	421.70	3826	3936	0.379
25-year	421.80	4539	4523	0.444
50-year	421.90	5100	5109	0.492
100-year	422.00	5408	5696	0.735
Spillway invert	422.50	-	8673	-
Emergency (Regional)	422.70	10048	10170	1.4
Top of Pond	423.00	-	-	-

* this is the minimum outflow achievable using a 75mm orifice plate. This flow rate provides a sufficient drawdown time for the 25mm event

4.6. Mitigation of Thermal Impacts

In order to mitigate thermal impacts from the SWM facility, the wet cell has been deepened to 2.5m to facilitate thermal stratification within the pond in conjunction with use of a reverse slope outlet pipe to pull the deeper, cooler water from the bottom of the pond. These measures, in combination with additional planting and shading of the adjacent drainage feature, which conveys pond drainage to the creek, will assist in the mitigation of thermal impacts associated with the SWM facility. Other measures can be considered at the detailed design stage.

4.7. Site Water Balance/Low Impact Development Features

Post-development infiltration rates will be affected by the presence of impervious surfaces (i.e., building rooftops and asphalt roads/driveways), which based on the proposed development plan will comprise approximately 64% of the development area of the property or 44% of the entire property. Upon completion of the site development, it is estimated that there will be a loss of approximately 44% in ground water infiltration between the pre-development and post-development conditions, assuming no mitigation strategies are employed.

As a 44% deficit is not acceptable, LID features will be incorporated into the site design (as shown on **Figure 5B**) to reduce the deficit. The proposed LID practices include front and rear yard soakaway pits for the freehold townhouses, a detail of which is available on **Figure 5B**. Within the site plan blocks, LIDs have been shown conceptually, but the exact type and details will be confirmed at detailed design. LID sizing is based on maximizing the storage volume from the proposed surface to 1m above the groundwater elevation. The available storage was used to back-calculate the total precipitation volume that could be accommodated in each feature. The results in Appendix B indicated that the LIDs can capture between 3mm to 109mm. This correlates to a significant amount of annual rainfall / runoff capture, sufficient to meet the recharge deficit.

As indicated by Azimuth, if the proposed LID mitigation measures are employed, an overall recovery in ground water infiltration of approximately 19,461 m3/year would be expected, for a net loss of approximately 5%. The deficit is redirected to Middle Monora Creek so that it remains within the same watershed. As the deficit mainly occurs during spring and fall (periods of high water), the net effect is minimized. Finally, this deficit equates to only approximately 15 mm/year/m2, which is insignificant relative to pre-development infiltration rate of 275 mm. A reduction of infiltration by this amount will theoretically reduce the on-site water table elevation by 0.005 to 0.015 metre, which is within the existing seasonal fluctuations, which have been shown at some monitoring wells to vary between 1.5 to 2 m, therefore is not considered to be significant.

4.8. Feature Based Water Balance

A feature-based water balance was undertaken for the wetland features to the north of the subject site by Azimuth. From a surface drainage perspective, the product (AxC) of existing and proposed drainage areas and runoff coefficients were compared for the areas draining to the NHS and Feature A. As shown in Table 4-6, the surface drainage to each feature can be matched / exceeded to ensure sufficient runoff volume continues to feed each feature. The Azimuth hydrogeological study in **Appendix D** provides further details of the feature based water balance.

Table 4-6: Feature Based Water Balance

	Pre-development			Post- development			Difference
	Area (ha)	Runoff Coefficient	AxC	Area (ha)	Runoff Coefficient	AxC	
Drainage to NHS	1.56	0.25	0.39	1.04	0.4	0.42	+7%
Drainage to NHS via Feature A	0.72	0.25	0.18	0.27	0.7	0.19	+5%

5. Sanitary Servicing

Internal site design will provide sanitary service connections to all residential lots. Refer to **Figure 6** for the proposed sanitary drainage plan.

The proposed sanitary sewers will be designed with the maximum achievable slopes for this development to accommodate flows from the subject lands (including the ultimate development) and achieve the highest scour velocities possible within the constraints of this development. All sanitary sewers will be 250mm to 300mm in diameter and will be designed according to the requirements and criteria of the Town of Orangeville.

Contributing population to the sanitary sewers was determined based on a population density of 3 people per unit and per capita flow of 450 L per day. A population of 475 people per hectare was applied to the high density / multi-dwelling apartment blocks. Peak factors were based on the Harmon population-based formula with a maximum factor of 4.0. Infiltration and inflow was accounted for on a per-hectare basis (0.14 L/s/ha). Sanitary sewer design calculations are provided in **Appendix C**.

The proposed development outlets to the existing sanitary manhole on Hansen Boulevard opposite of Victor Large way. The receiving sanitary sewer system is a 300mm diameter sanitary trunk which has been designed to accommodate the ultimate Phase II development and other developments to the west according to the 2010 Front Ending Agreement between the Town and Orangeville Highlands Ltd.

6. Water Distribution

The proposed development is supplied by a single pressure district. A looped system consisting of a 300mm diameter main and 200mm diameter local distribution pipes is proposed. Detailed design will ensure that the minimum hour, peak hour, maximum day, and fire flow requirements are met. **Figure 7** illustrates the proposed water distribution concept.

7. Conclusion & Recommendations

The Orangeville Highlands Phase 2 lands can be serviced while respecting all relevant design guidelines. As indicated in the above sections, several items must be clarified through detailed design and discussion with the agencies and consultants including tree restoration, modification to regional floodplain, removal of the minor drainage swale, requirements for clay liners and soak away pits, and minor encroachments into the buffers to support transition grading. This report is applicable for any future revisions to the concept plan, assuming the revisions are in general conformance with the servicing and stormwater management concepts outlined in this FSR.

LICENSED PROFESSIONAL ENGINEER
afata
A. M. FATA
100159069
April 17, 2019
PROVINCE OF ONTARIO

Andrew Fata, M.Sc.Eng.
Associate, Water Resources

APPENDIX A
Figures

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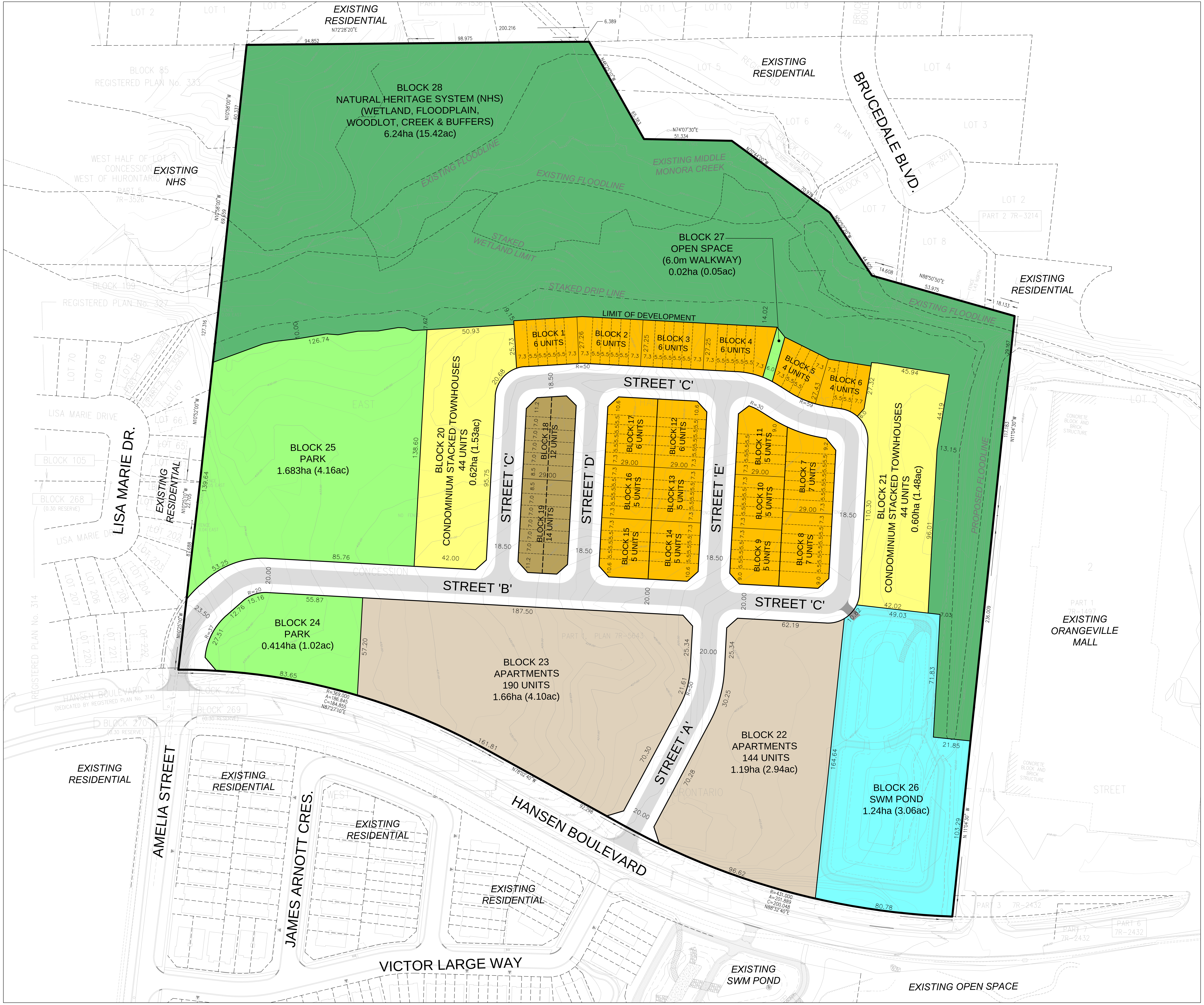
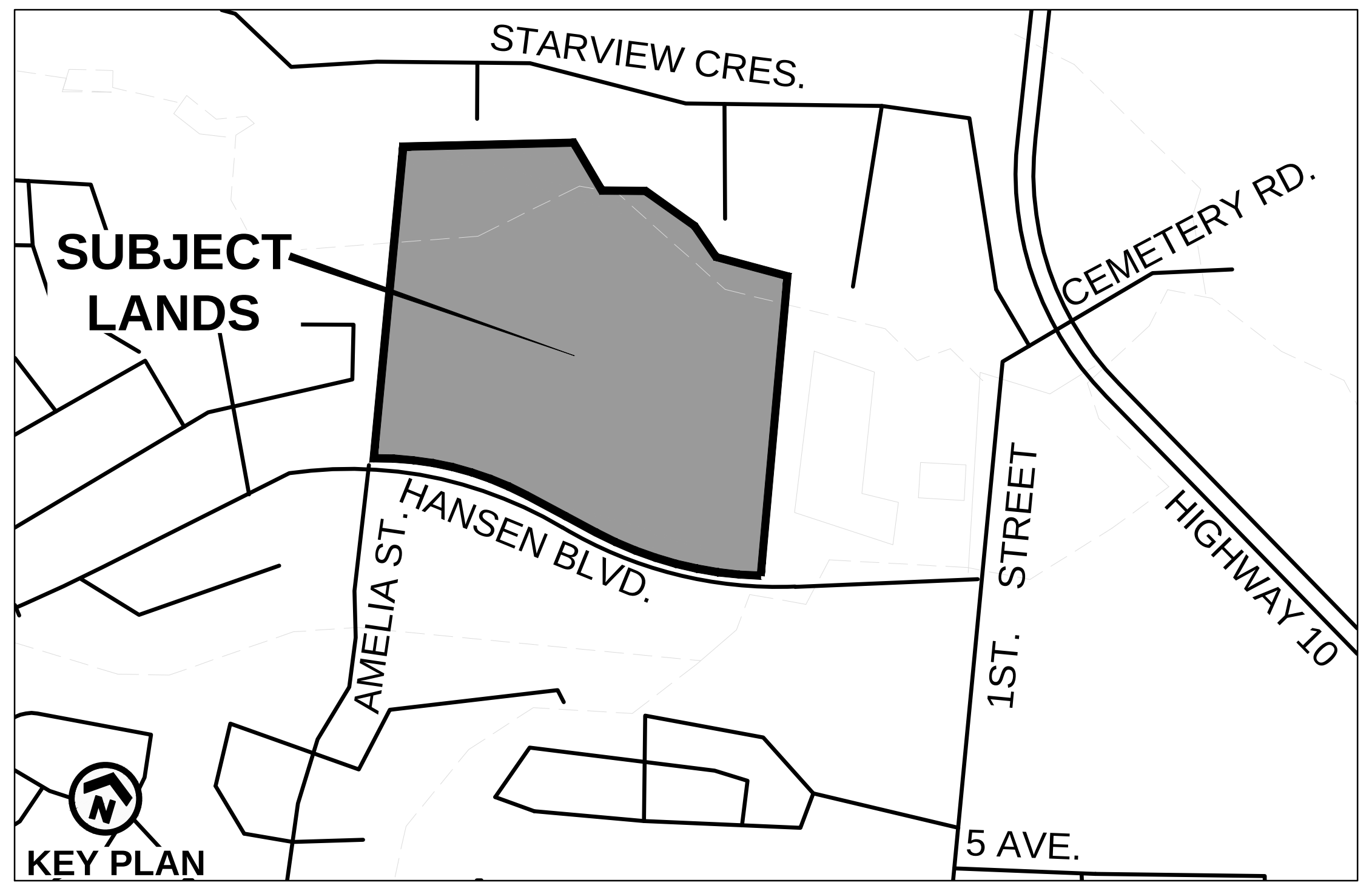




KEY PLAN

DRAFT PLAN OF SUBDIVISION ORANGEVILLE HIGHLANDS LIMITED & BRUCEDALE INVESTMENTS INC.

FILES: OPZ 5/10 & S 1/10

PART OF LOT 3,
CONCESSION 2 W.H.S.,
TOWN OF ORANGEVILLE
DUFFERIN COUNTY

OWNERS CERTIFICATE

I HEREBY AUTHORIZE GLEN SCHNARR & ASSOCIATES INC. TO PREPARE AND SUBMIT THIS DRAFT PLAN OF SUBDIVISION TO THE TOWN OF ORANGEVILLE FOR APPROVAL.

BRUCEDALE INVESTMENTS INC.

SIGNED ______ JOHN G. NESBITT, PRESIDENT ______ GILBERT L. BOLAND, DIRECTOR DATE OCT. 17, 2017

ORANGEVILLE HIGHLANDS LIMITED

SIGNED ______ GILBERT L. BOLAND, PRESIDENT ______ JOHN G. NESBITT, SECRETARY DATE OCT. 17, 2017

SURVEYORS CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED AS SHOWN ON THIS PLAN AND THEIR RELATIONSHIP TO ADJACENT LANDS ARE CORRECTLY AND ACCURATELY SHOWN.

SIGNED ______ DATE SEPT. 28, 2017

THOMAS SALB, O.L.S.
JD BARNES LIMITED
401 WHEELABRATOR WAY, SUITE A
MILTON, ONTARIO L9T 3C1

ADDITIONAL INFORMATION

(UNDER SECTION 51(17) OF THE PLANNING ACT) INFORMATION REQUIRED BY CLAUSES A,B,C,D,E,F,G,J & L ARE SHOWN ON THE DRAFT AND KEY PLANS.

H) MUNICIPAL AND PIPED WATER TO BE PROVIDED
I) SANDY LOAM AND CLAY LOAM
K) SANITARY AND STORM SEWERS TO BE PROVIDED

LAND USE SCHEDULE

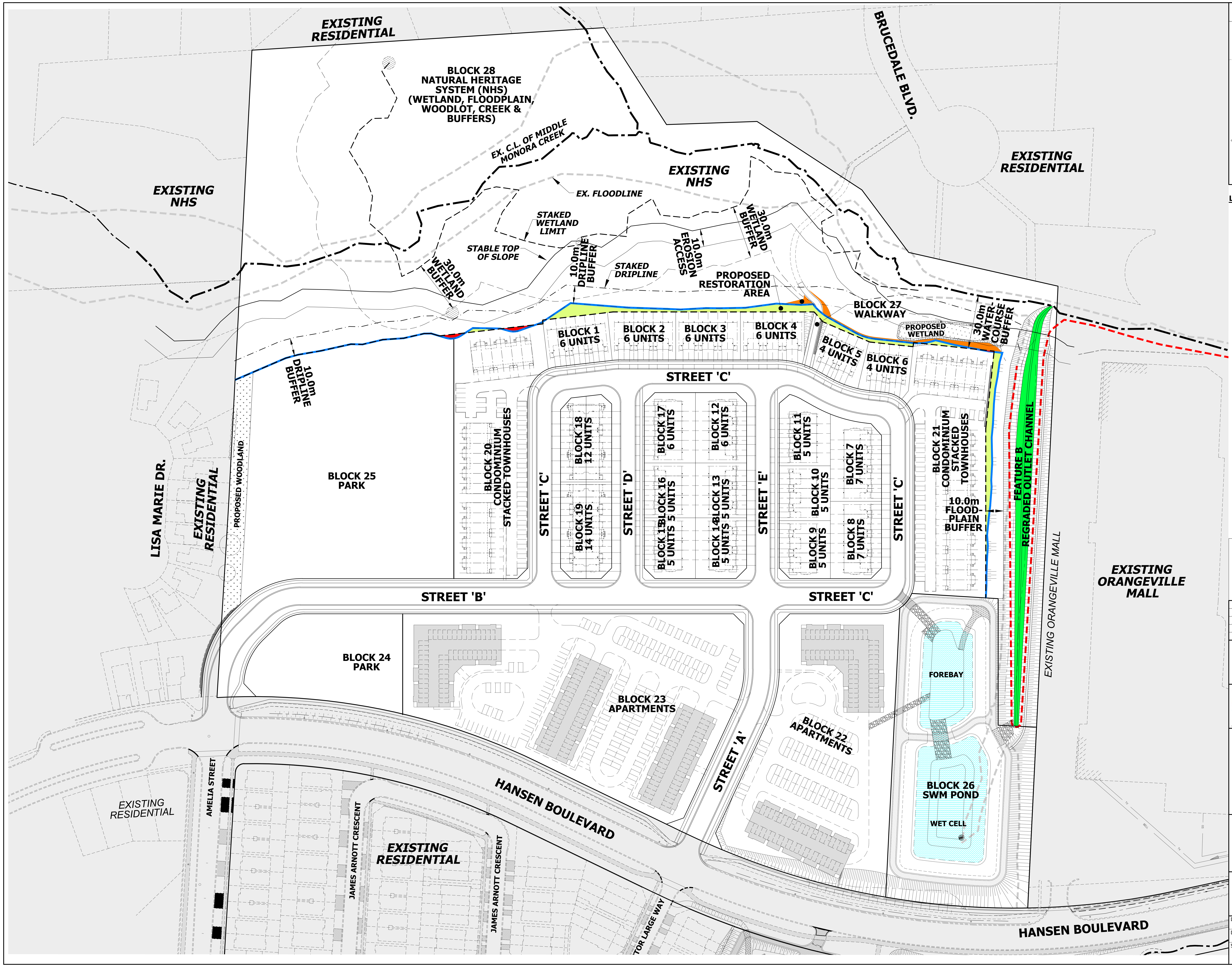
LAND USE	BLOCKS	AREA (ha)	AREA (ac)	UNITS
TOWNHOUSE (STREET) - 5.5m (18')	1-17	1.71	4.23	93
TOWNHOUSE (BACK TO BACK) - 7.0m (23')	18,19	0.29	0.72	26
TOWNHOUSE (CONDOMINIUM STACKED)	20,21	1.22	3.01	88
APARTMENTS	22,23	2.85	7.04	334
PARK	24,25	2.10	5.19	
SWM POND	26	1.24	3.06	
OPEN SPACE (WALKWAY)	27	0.02	0.05	
NATURAL HERITAGE SYSTEM & BUFFER (NHS)	28	6.24	15.42	
18.5m ROW (615m)		1.15	2.84	
20.0m - 23.5m ROW (561m)		1.13	2.79	
TOTAL	**28**	**17.95**	**44.36**	**541**

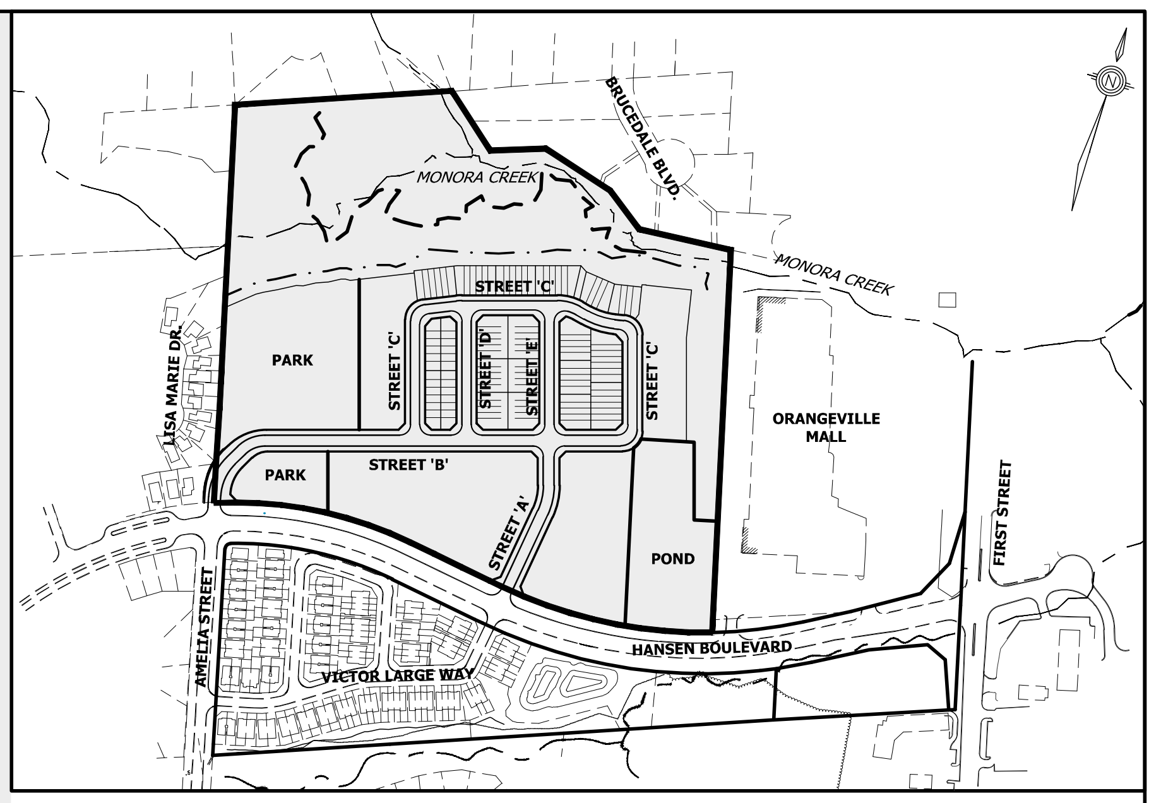
NOTES

- Streets A / B & Hansen Blvd. intersection daylight triangles = 7.5m x 7.5m
- All other daylight triangles are 6m x 6m
- Pavement Illustration is diagrammatic only
- Natural Heritage System constraint information provided by Urbantech April, 2019

Scale 1:1000
(24 x 36)
April 3, 2019

GSAI





KEY PLAN
NTS

LEGEND

— — —	PROPOSED DEVELOPMENT LIMIT
━━━	CONSTRAINT LIMIT (BASED ON 10m DRIPLINE BUFFER, 10m FLOODPLAIN BUFFER, 30m WATERCOURSE BUFFER AND 30m WETLAND BUFFER)
—·—·—	EXISTING C/L MIDDLE MONORA CREEK
- - -	EXISTING REGIONAL FLOODLINE
- - -	PROPOSED REGIONAL FLOODLINE
⬜	EXTERNAL/EXISTING AREA
🟨	DEVELOPABLE AREA TO BE DEDICATED TO NHS/OPEN SPACE (CUMULATIVE AREA = 1039m²)
🟥	DEVELOPMENT ENCROACHMENT BEYOND CONSTRAINT LIMIT (CUMULATIVE AREA = 54m²)
🟧	TRANSITION GRADING ENCROACHMENT BEYOND CONSTRAINT LIMIT
🟩	EXISTING DRAINAGE FEATURE TO BE REGRADED

BENCHMARK

STATION: 00819688502 ELEVATION: 417.719
502-68: ONE STOREY BROWN BRICK MORTUARY (FOREST LAWN MORTUARY) ON EAST SIDE OF HWY 10 AND 24, 1.9 KM NORTH OF NORTH JCT OF HWYS 9, 10 AND 24 AT ORANGEVILLE. 1.4 KM SOUTH OF MONO TWP SIDEROAD 5 (DUFFERIN CTY RD 7) AND 301.8 M EAST OF CENTERLINE OF HWY 10 AND 24 ALONG CEMETERY RD. TABLET IS SET HORIZONTALLY IN NORTH FACE OF CONCRETE FOUNDATION, 2.59 M EAST OF N.W. CORNER AND 43 CM BELOW BRICKWORK.

No.	REVISION	DATE
4		
3		
2	2nd SUBMISSION	APRIL 2019
1	1st SUBMISSION	APRIL 2018

ORANGEVILLE HIGHLANDS PHASE 2 FUNCTIONAL SERVICING

Orangeville
Historic Charm Dynamic Future

Corporation of the Town of Orangeville Ontario, Canada

REVIEWED BY THE TOWN OF ORANGEVILLE

DATE

DIRECTOR OF PUBLIC WORKS

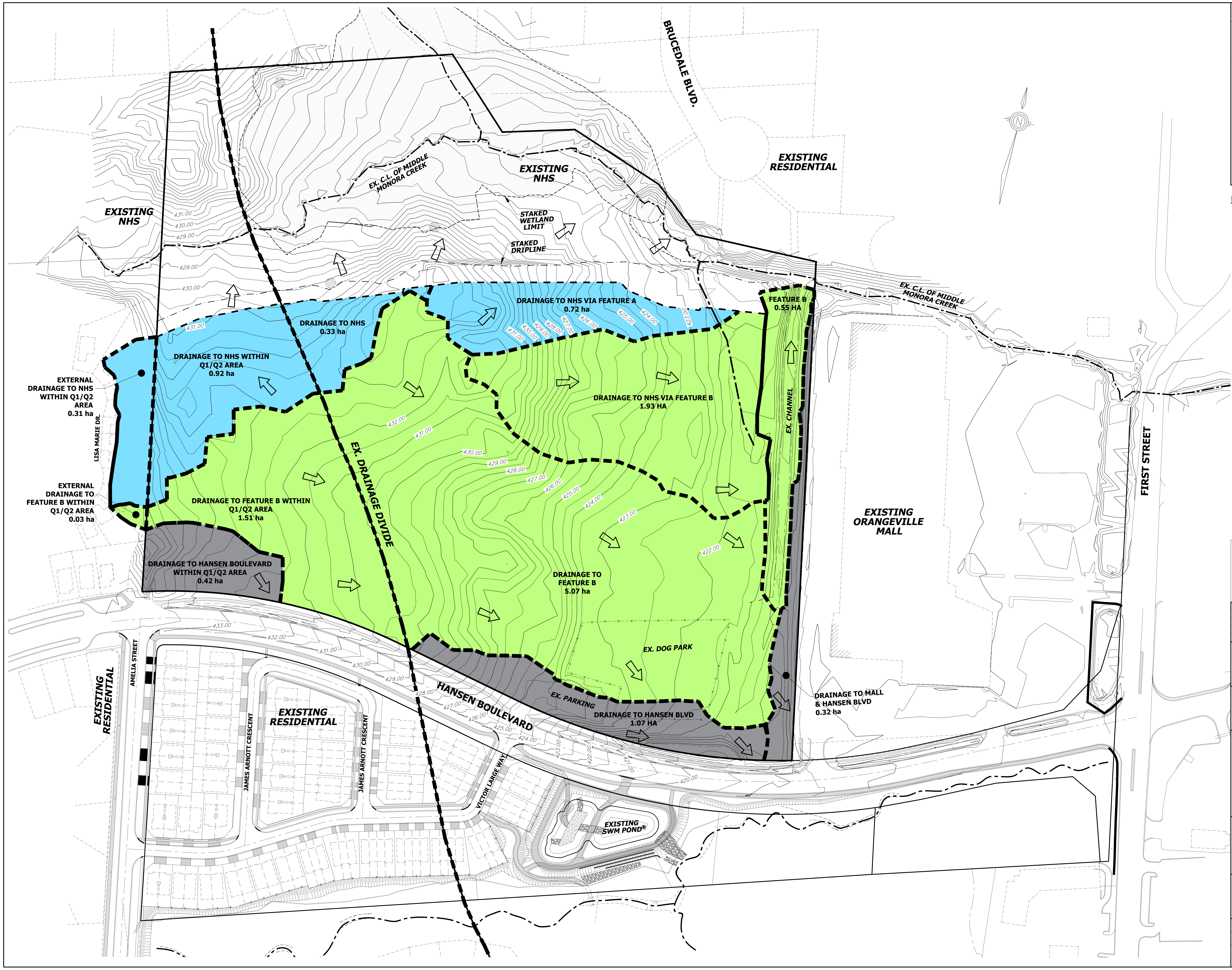
urbantech
Urbantech Consulting, A Division of Leighton-Zec Ltd.
25 Royal Crest Court, Suite 201, Markham, Ontario L3R 9X4
tel: 905.946.9461 fax: 905.946.9595
www.urbantech.com

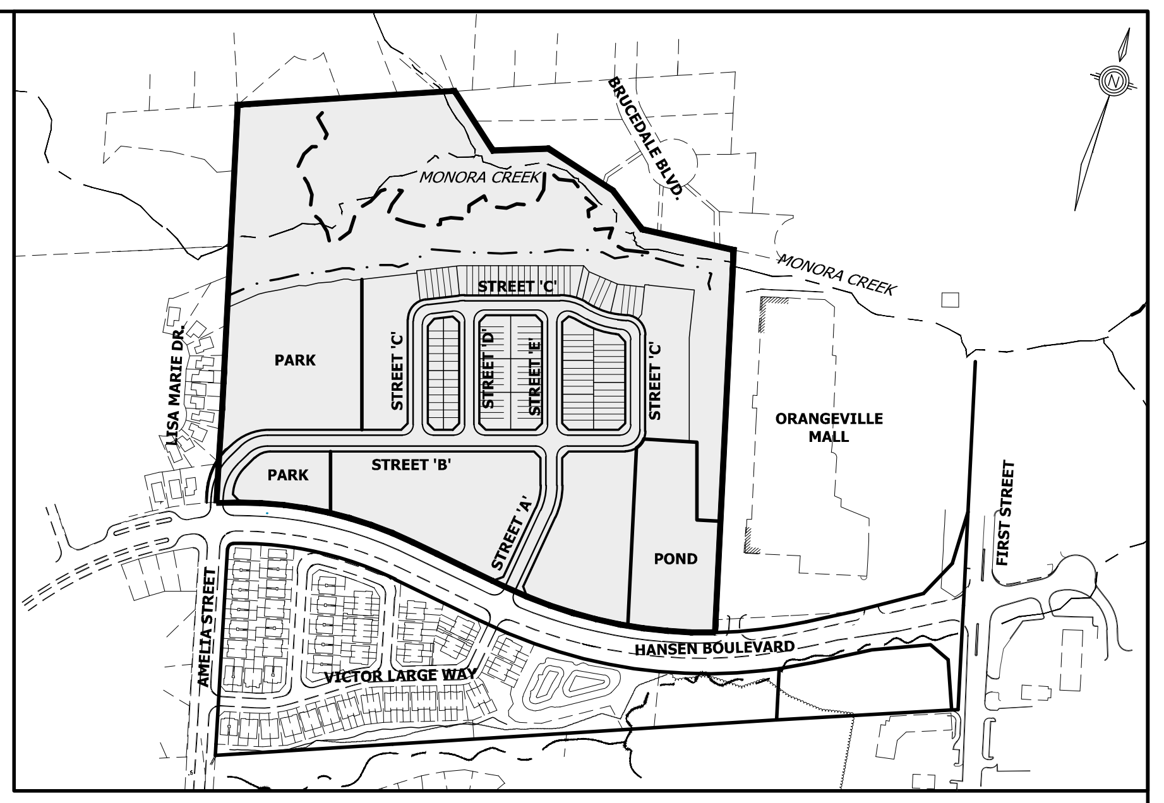
S.B. RIEMER
100214712
APRIL 2019

MODIFIED DEVELOPMENT LIMIT

DESIGNED:	D.Z.	CHECKED:	D.Z.	PROJECT No.:	06-233-PH2
DRAWN:	V.P.	DATE:	MARCH 2019	FIGURE No.:	1A
SCALE:			H 1:1000		

File: P:\Projects\06-233-Phase 2\FSR\F1A-FSR MODIFIED DEVELOPMENT LIMIT.dwg - Revised by <DZEC> : Mon, Mar 25 2019 - 9:13am





KEY PLAN
NTS

LEGEND

423.00	EXISTING CONTOUR
⇨	EXISTING FLOW DIRECTION
▬ ▬ ▬ ▬	EXISTING DRAINAGE BOUNDARY
— — — —	DEVELOPMENT CONSTRAINT LIMIT
—·—·—	EXISTING C/L MIDDLE MONORA CREEK
🟩	DRAINAGE TO FEATURE B
🟦	DRAINAGE TO NHS
⬛	DRAINAGE TO HANSEN BOULEVARD AND ORANGEVILLE MALL

BENCHMARK

STATION: 00819688502 ELEVATION: 417.719
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1	1st SUBMISSION	APRIL 2018

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Historic Charm Dynamic Future

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tel: 905.946.9461 fax: 905.946.9595
www.urbantech.com

LICENSED PROFESSIONAL ENGINEER
S.B. RIEMER
100214712
APRIL 2019
PROVINCE OF ONTARIO

EXISTING DRAINAGE TO FEATURES

DESIGNED:	D.Z.	CHECKED:	D.Z.	PROJECT No.:	06-233-PH2
DRAWN:	V.P.	DATE:	MARCH 2019	FIGURE No.:	
SCALE:	H 1:1250				1B

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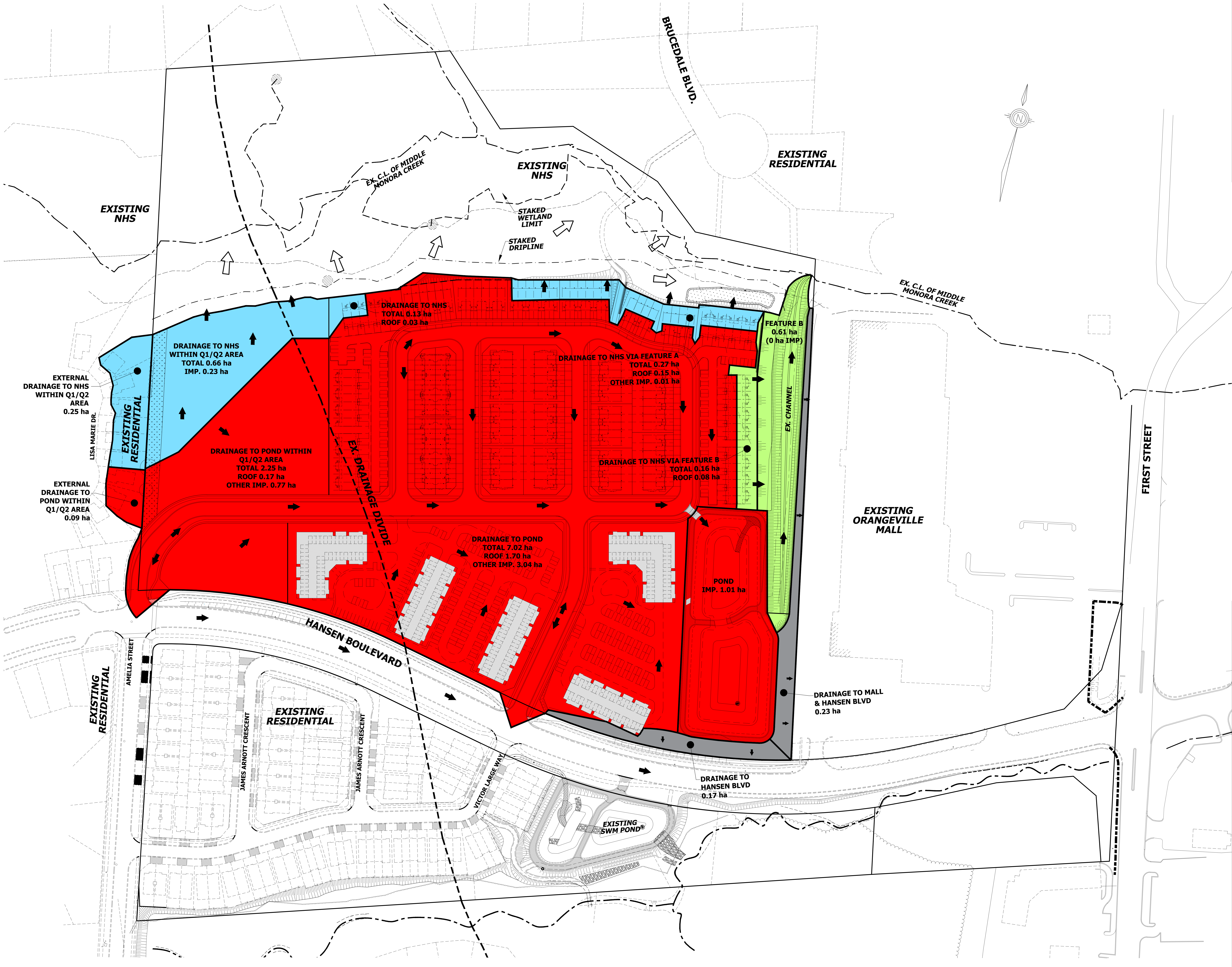

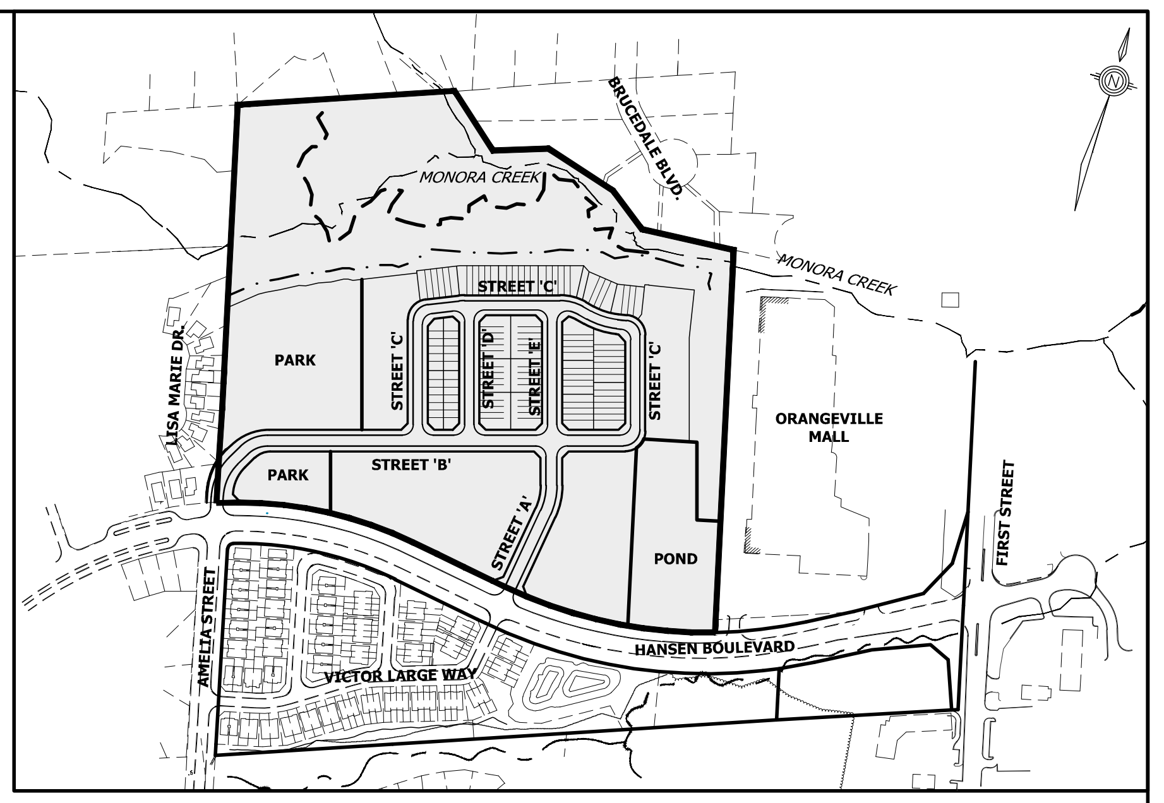

KEY PLAN
NTS

LEGEND

➡	PROPOSED OVERLAND FLOW DIRECTION
⇨	EXISTING FLOW DIRECTION
▬ ▬ ▬	EXISTING DRAINAGE BOUNDARY
▬▬▬	POST-DEVELOPMENT DRAINAGE BOUNDARY
– – – –	DEVELOPMENT CONSTRAINT LIMIT
– · – · –	EXISTING C/L MIDDLE MONORA CREEK
🟩	DRAINAGE TO FEATURE B
🟦	DRAINAGE TO NHS
⬛	DRAINAGE TO HANSEN BOULEVARD AND ORANGEVILLE MALL
🟥	DRAINAGE TO SWM POND

BENCHMARK

STATION: 00819688502 ELEVATION: 417.719
502-68: ONE STOREY BROWN BRICK MORTUARY (FOREST LAWN MORTUARY) ON EAST SIDE OF HWY 10 AND 24, 1.9 KM NORTH OF NORTH JCT OF HWYS 9, 10 AND 24 AT ORANGEVILLE. 1.4 KM SOUTH OF MONO TWP SIDEROAD 5 (DUFFERIN CTY RD 7) AND 301.8 M EAST OF CENTERLINE OF HWY 10 AND 24 ALONG CEMETERY RD. TABLET IS SET HORIZONTALLY IN NORTH FACE OF CONCRETE FOUNDATION, 2.59 M EAST OF N.W. CORNER AND 43 CM BELOW BRICKWORK.

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1	1st SUBMISSION	APRIL 2018

ORANGEVILLE HIGHLANDS PHASE 2
FUNCTIONAL SERVICING

Orangeville
Historic Charm Dynamic Future

**Corporation of the
Town of Orangeville
Ontario, Canada**

**REVIEWED BY
THE TOWN OF
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DATE

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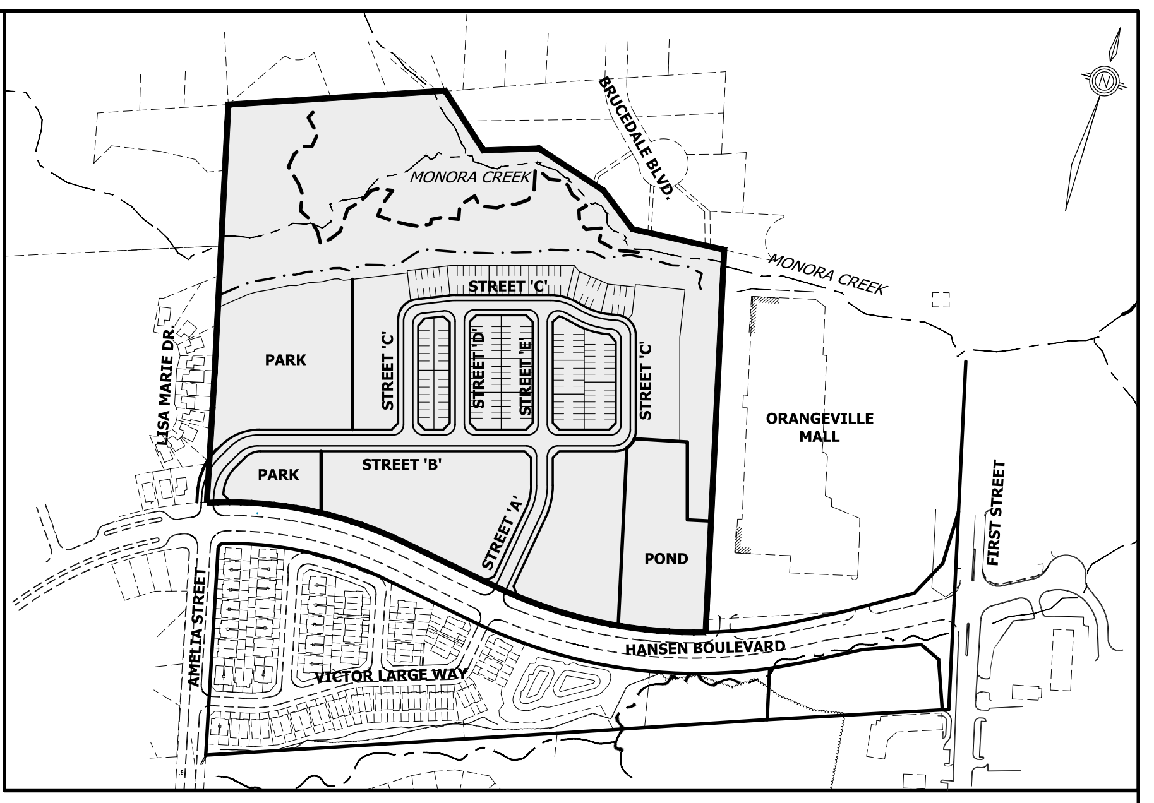
tel: 905.946.9461 fax: 905.946.9595
www.urbantech.com

LICENSED PROFESSIONAL ENGINEER
S.B. RIEMER
100214712
APRIL 2019
PROVINCE OF ONTARIO

POST-DEVELOPMENT
DRAINAGE TO FEATURES

DESIGNED: D.Z.	CHECKED: D.Z.	PROJECT No.: 06-233-PH2
DRAWN: V.P.	DATE: MARCH 2019	FIGURE No.:
SCALE: H 1:1250		1C

File: P:\Projects\06-233-Phase 2\FSR\F1C-FSR POST DRAINAGE.dwg - Revised by <DFAN> : Mon, Apr 08 2019 - 11:11am



KEY PLAN
NTS

LEGEND

x 425.89	PROPOSED GRADE (m)
426.24	EXISTING ELEVATION (m)
421.50	EXISTING CONTOUR (m)
422.00	HIGH GROUND WATER ELEVATION CONTOUR (m)
⇦	EXISTING OVERLAND FLOW ROUTE
⬅	PROPOSED OVERLAND FLOW ROUTE
▨	RETAINING WALL

NOTES:

1. REFER TO FIGURES 3A AND 3B FOR CROSS SECTIONS A-A TO H-H
2. REFER TO FIGURE 4 FOR SWM POND DETAILS
3. REFER TO FIGURE 5B FOR PROPOSED LID DETAILS

BENCHMARK

STATION: 00819688502 ELEVATION: 417.719
502-68: ONE STOREY BROWN BRICK MORTUARY (FOREST LAWN MORTUARY) ON EAST SIDE OF HWY 10 AND 24, 1.9 KM NORTH OF NORTH JCT OF HWYS 9, 10 AND 24 AT ORANGEVILLE. 1.4 KM SOUTH OF MONO TWP SIDEROAD 5 (DUFFERIN CTY RD 7) AND 301.8 M EAST OF CENTERLINE OF HWY 10 AND 24 ALONG CEMETERY RD. TABLET IS SET HORIZONTALLY IN NORTH FACE OF CONCRETE FOUNDATION, 2.59 M EAST OF N.W. CORNER AND 43 CM BELOW BRICKWORK.

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1	1st SUBMISSION	APRIL 2018
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Historic Charm Dynamic Future

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LICENSED PROFESSIONAL ENGINEER
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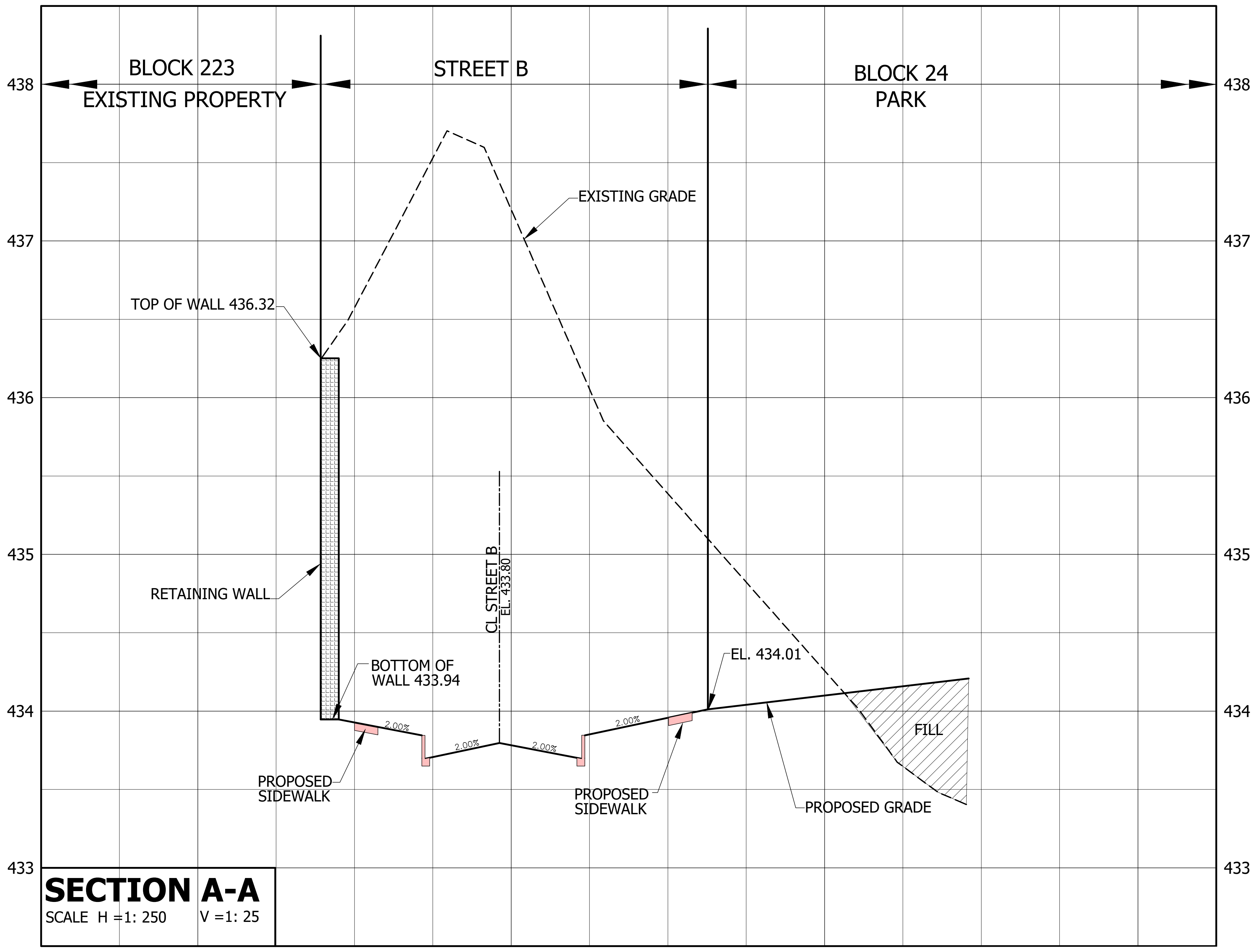
100214712
APRIL 2019
PROVINCE OF ONTARIO

PRELIMINARY GRADING PLAN AND OVERLAND FLOW ROUTE

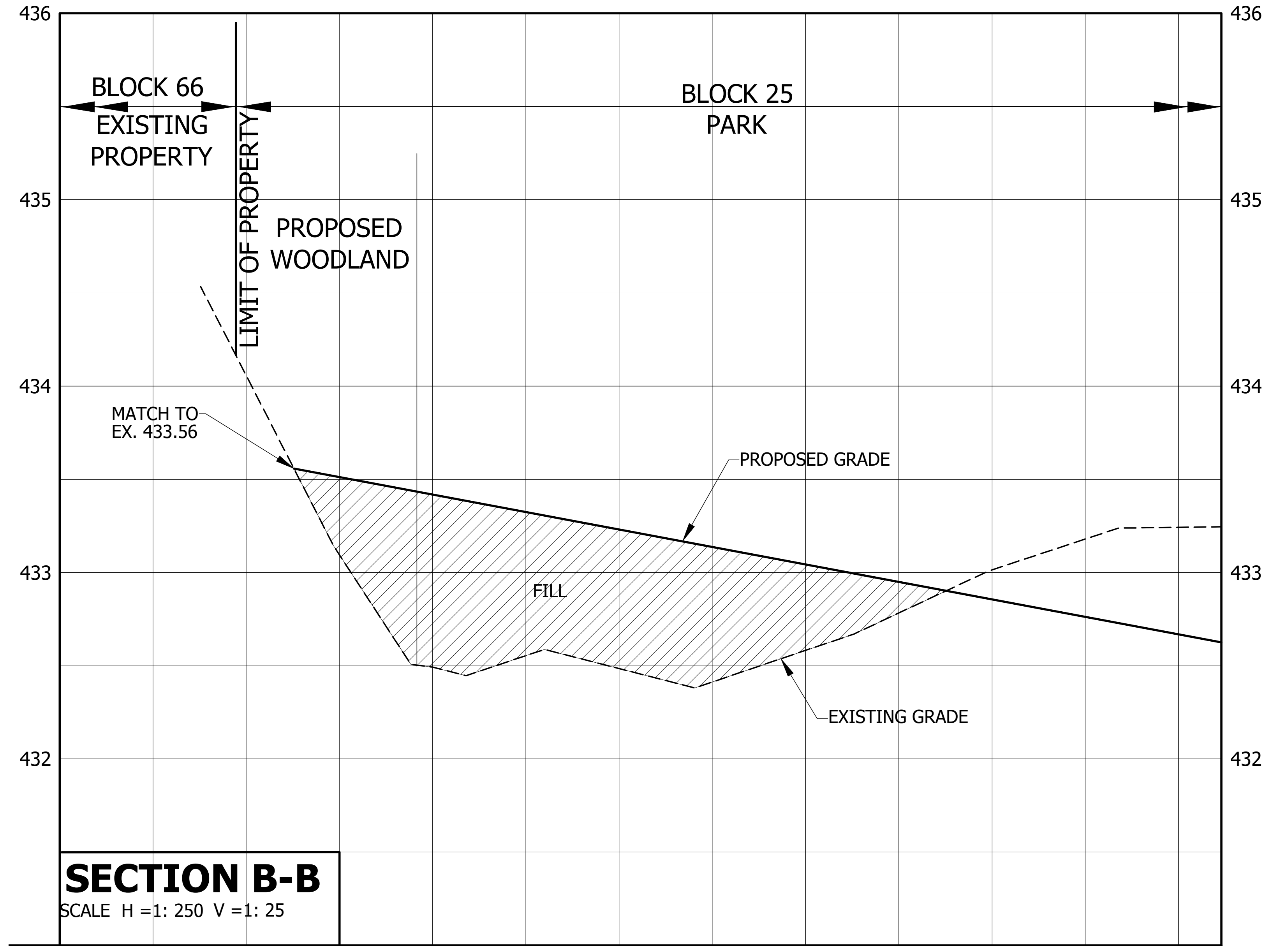
DESIGNED: D.Z.	CHECKED: D.Z.	PROJECT No.: 06-233-PH2
DRAWN: V.P.	DATE: MARCH 2019	FIGURE No.: 2
SCALE: H 1:750		

File: P:\Projects\06-233-Phase 2\FSR\F2-FSR GRADING.dwg - Revised by <DFAN> : Tue, Apr 09 2019 - 9:36am



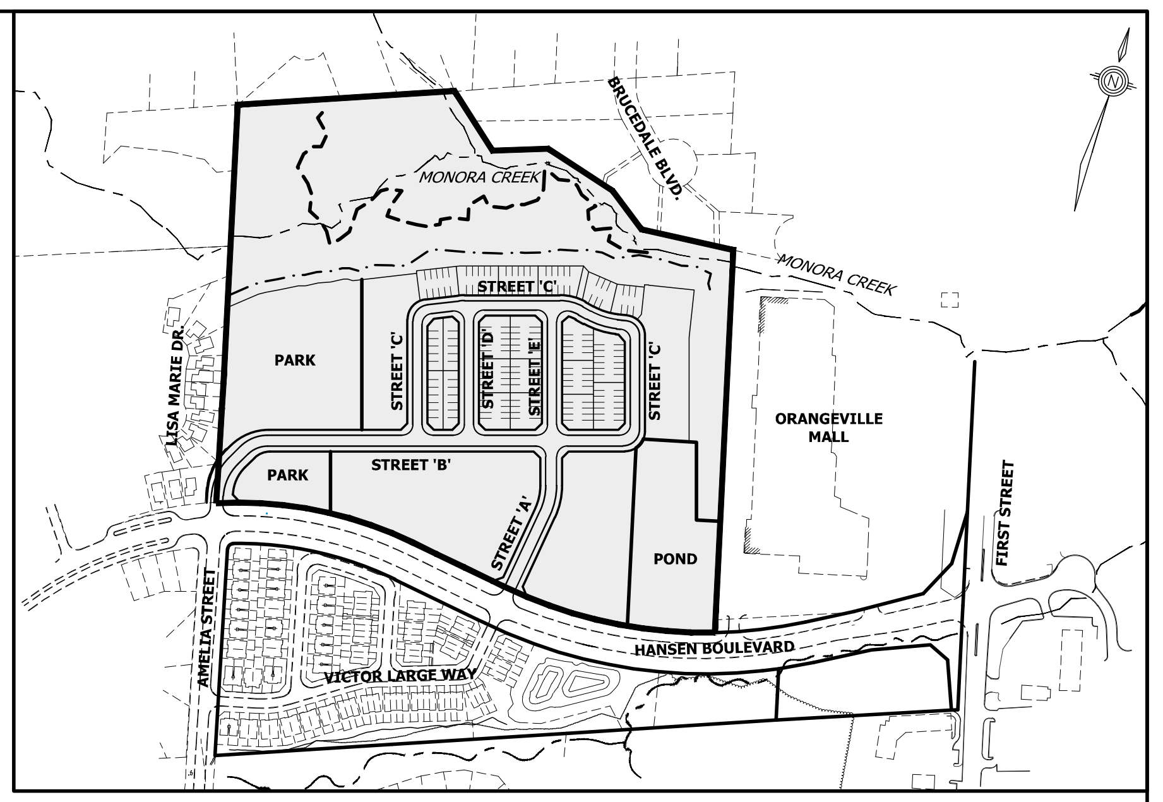
SECTION A-A

SCALE H =1: 250 V =1: 25

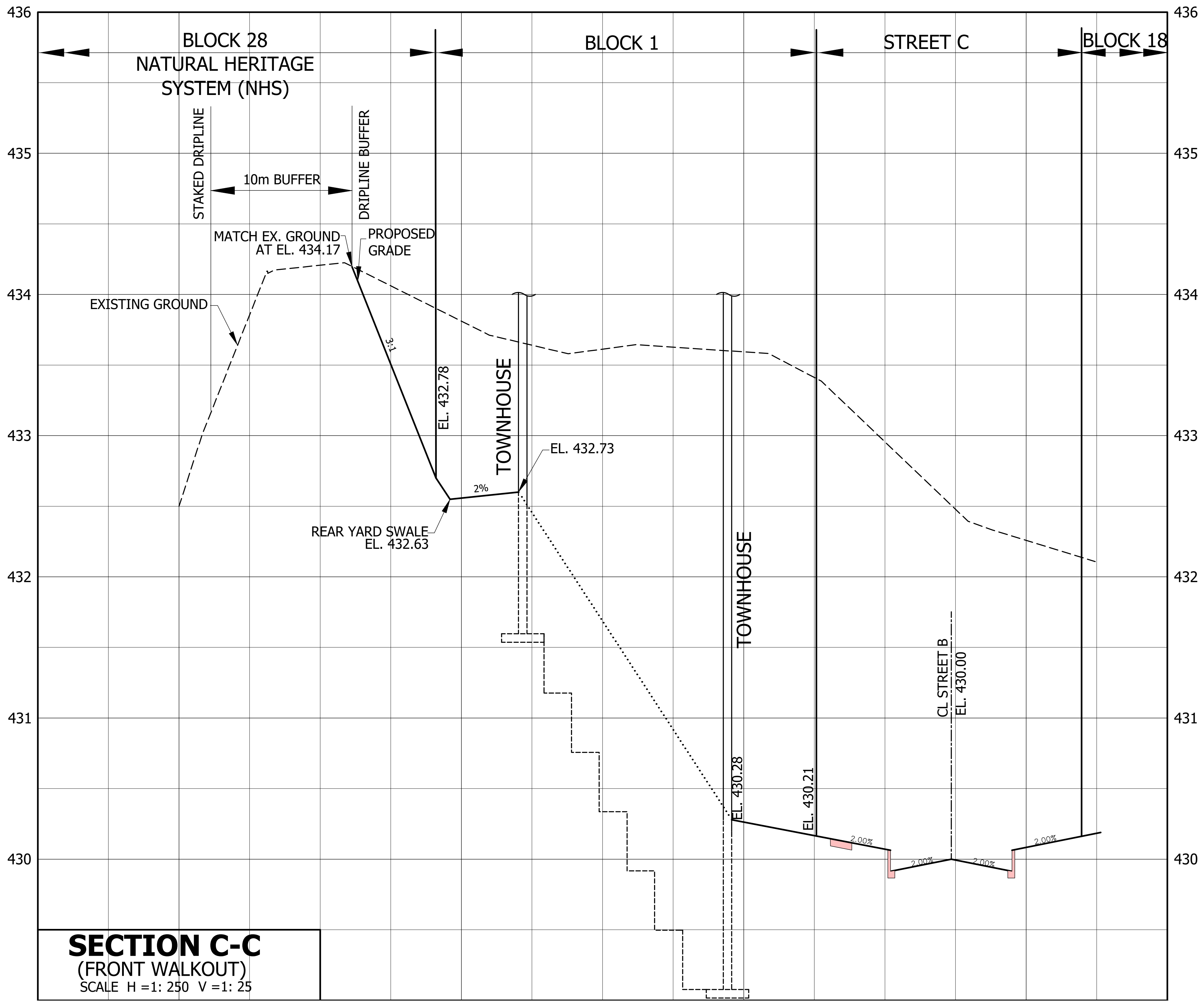


SECTION B-B

SCALE H =1: 250 V =1: 25



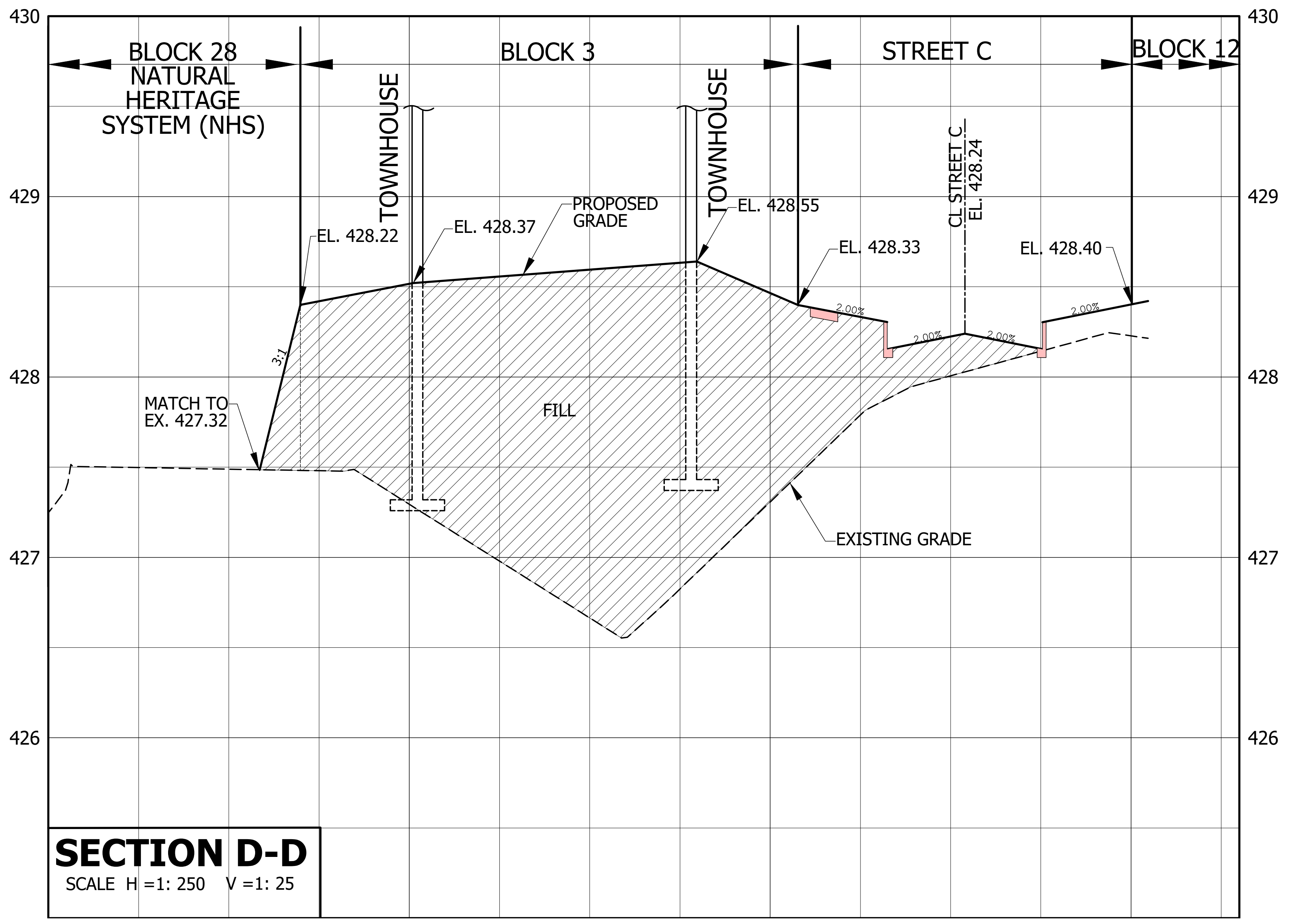
KEY PLAN
NTS



SECTION C-C

(FRONT WALKOUT)

SCALE H =1: 250 V =1: 25



SECTION D-D

SCALE H =1: 250 V =1: 25

NOTES:

1. REFER TO FIG 2 FOR CROSS SECTIONS LOCATIONS
2. LANDSCAPING CONSULTANT TO PROVIDE ENHANCED RESTORATION DETAILS FOR TRANSITION GRADING IN THE OPEN SPACE BLOCKS BEYOND THE REAR LOT LINE.

BENCHMARK

STATION: 00819688502 ELEVATION: 417.719
502-68: ONE STOREY BROWN BRICK MORTUARY (FOREST LAWN MORTUARY) ON EAST SIDE OF HWY 10 AND 24, 1.9 KM NORTH OF NORTH JCT OF HWYS 9, 10 AND 24 AT ORANGEVILLE. 1.4 KM SOUTH OF MONO TWP SIDEROAD 5 (DUFFERIN CTY RD 7) AND 301.8 M EAST OF CENTERLINE OF HWY 10 AND 24 ALONG CEMETERY RD. TABLET IS SET HORIZONTALLY IN NORTH FACE OF CONCRETE FOUNDATION, 2.59 M EAST OF N.W. CORNER AND 43 CM BELOW BRICKWORK.

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No.	REVISION	DATE

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FUNCTIONAL SERVICING

Orangeville
Historic Charm Dynamic Future

Corporation of the
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THE TOWN OF
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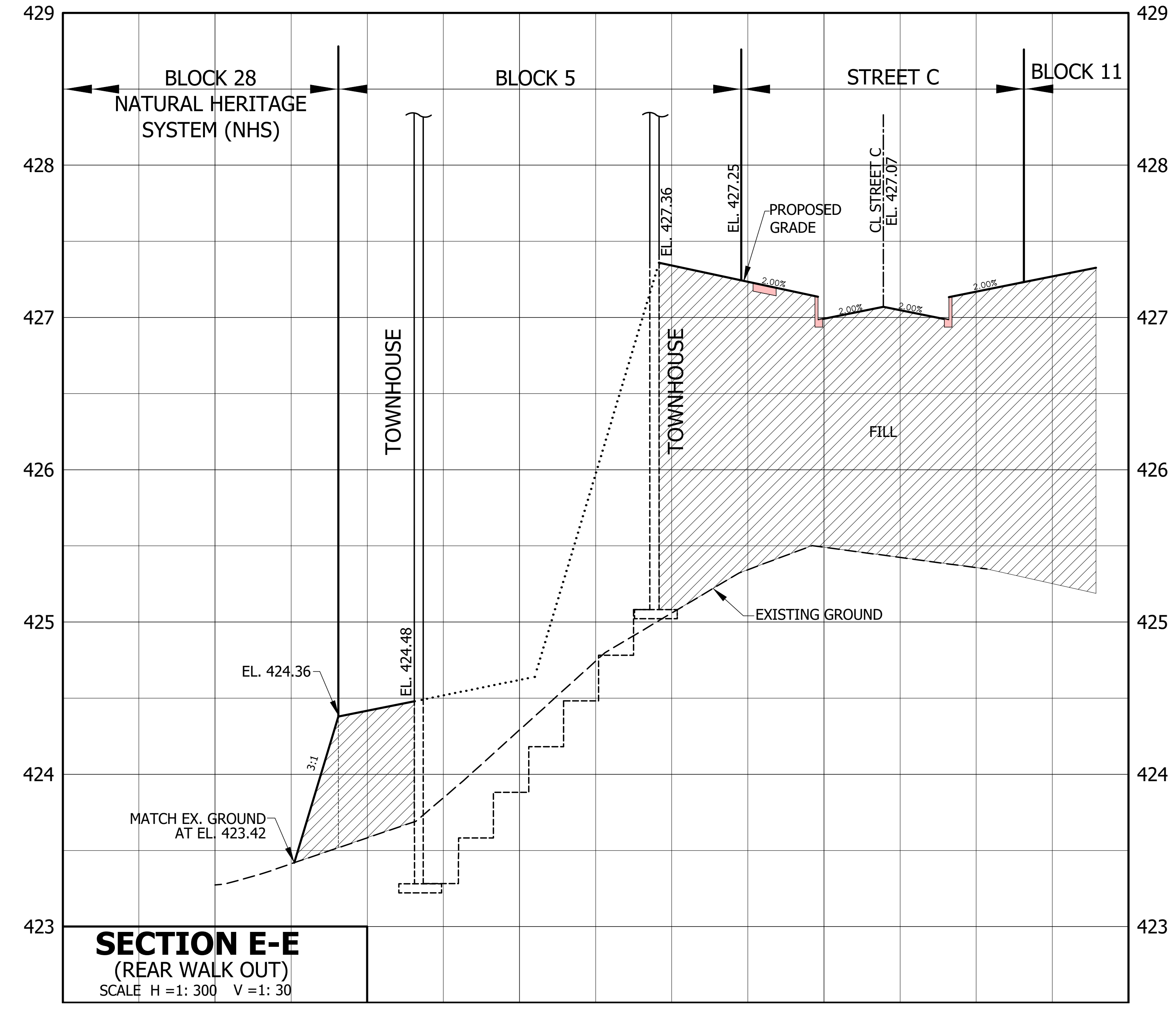
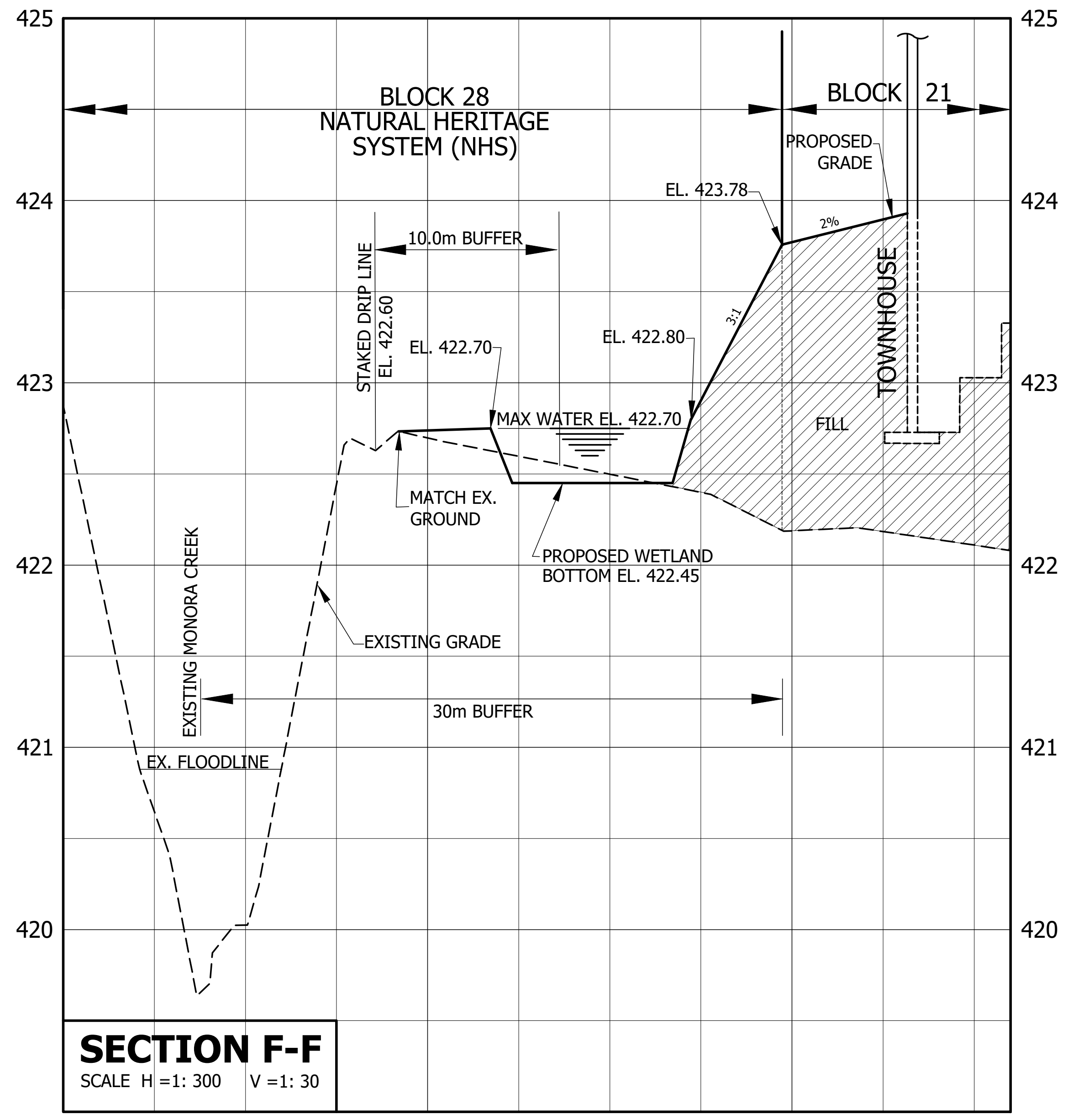
LICENSED PROFESSIONAL ENGINEER
S.B. RIEMER
100214712
APRIL 2019
PROVINCE OF ONTARIO

DESIGNED:	D.Z.	CHECKED:	D.Z.	PROJECT No.:	06-233-PH2
DRAWN:	V.P.	DATE:	MARCH 2019	FIGURE No.:	3A
SCALE:					

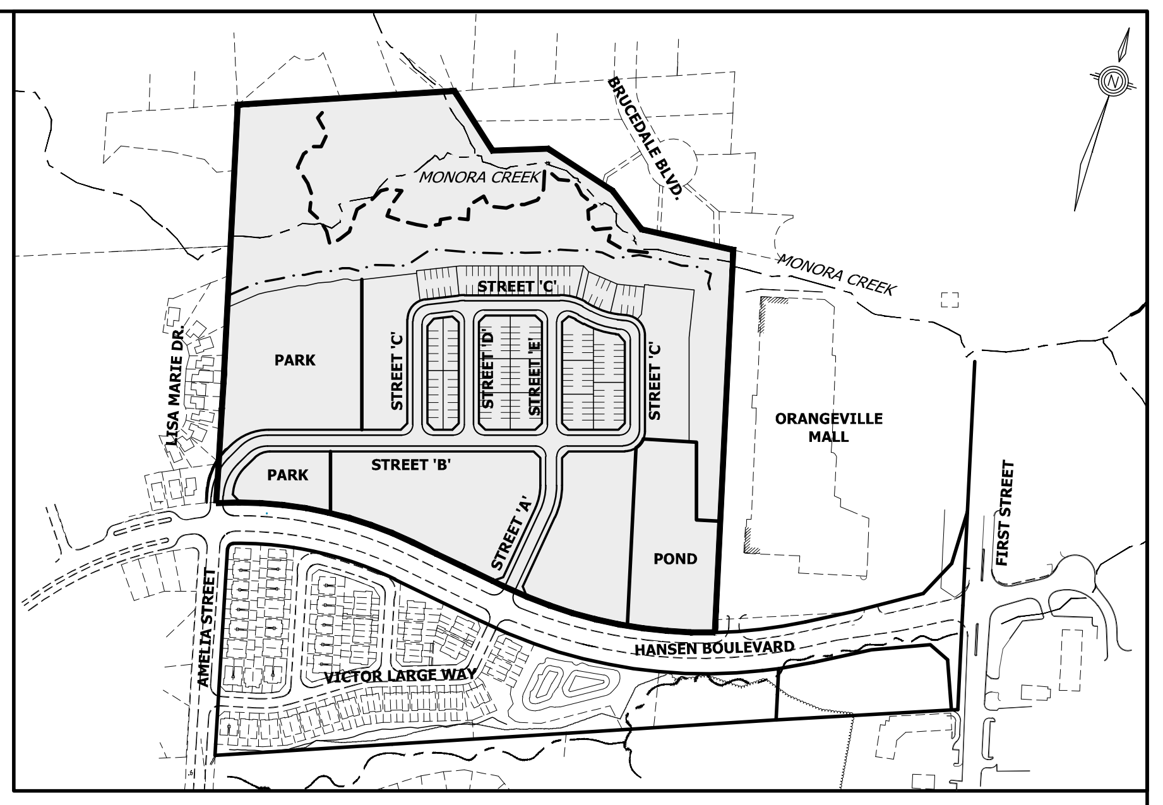
File: P:\Projects\06-233-Phase 2\FSR\F3-FSR GRADING SECTIONS.dwg - Revised by <DFAN> : Tue, Apr 09 2019 - 9:29am



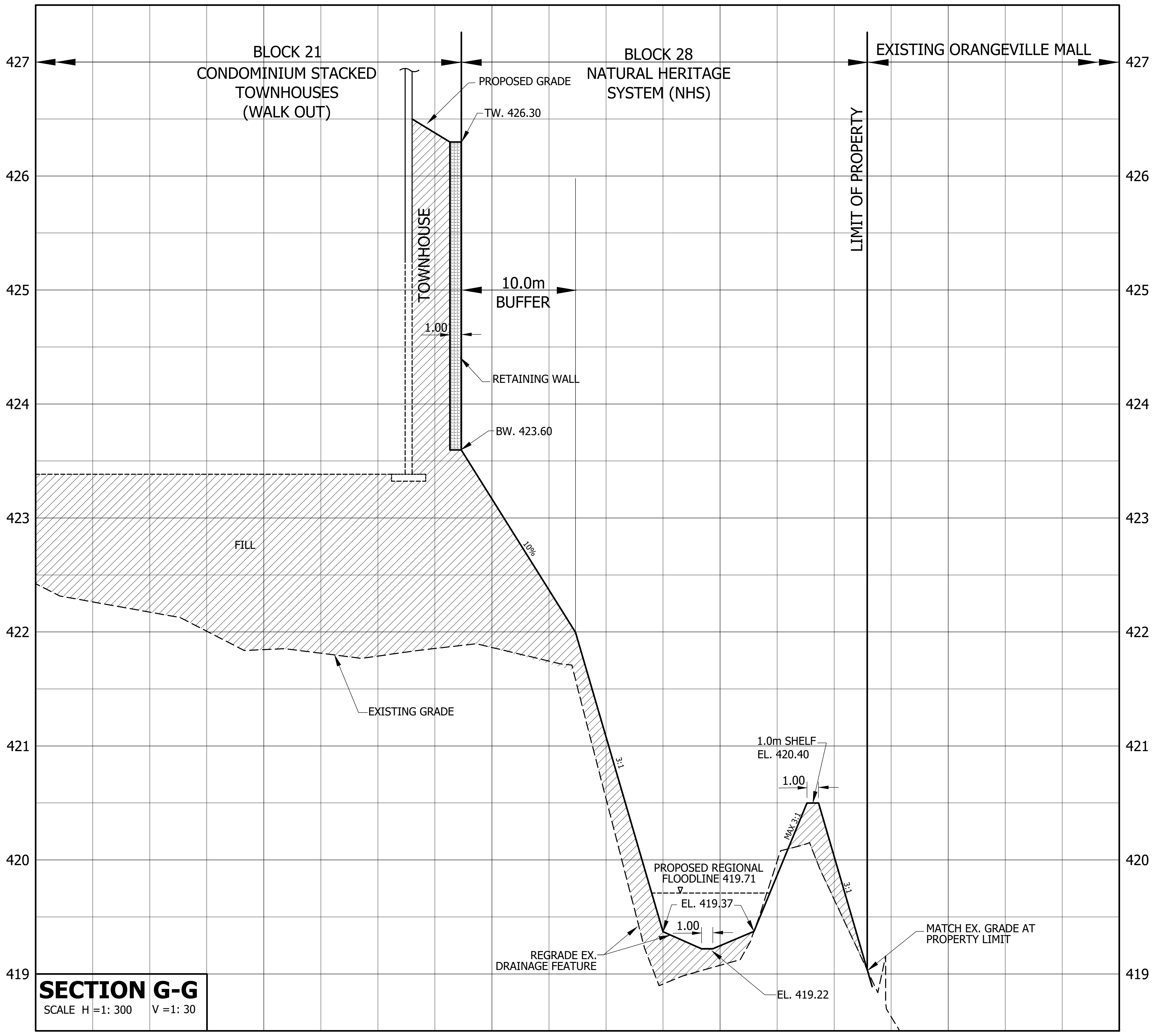
SECTION E-E
(REAR WALK OUT)
SCALE H =1: 300 V =1: 30



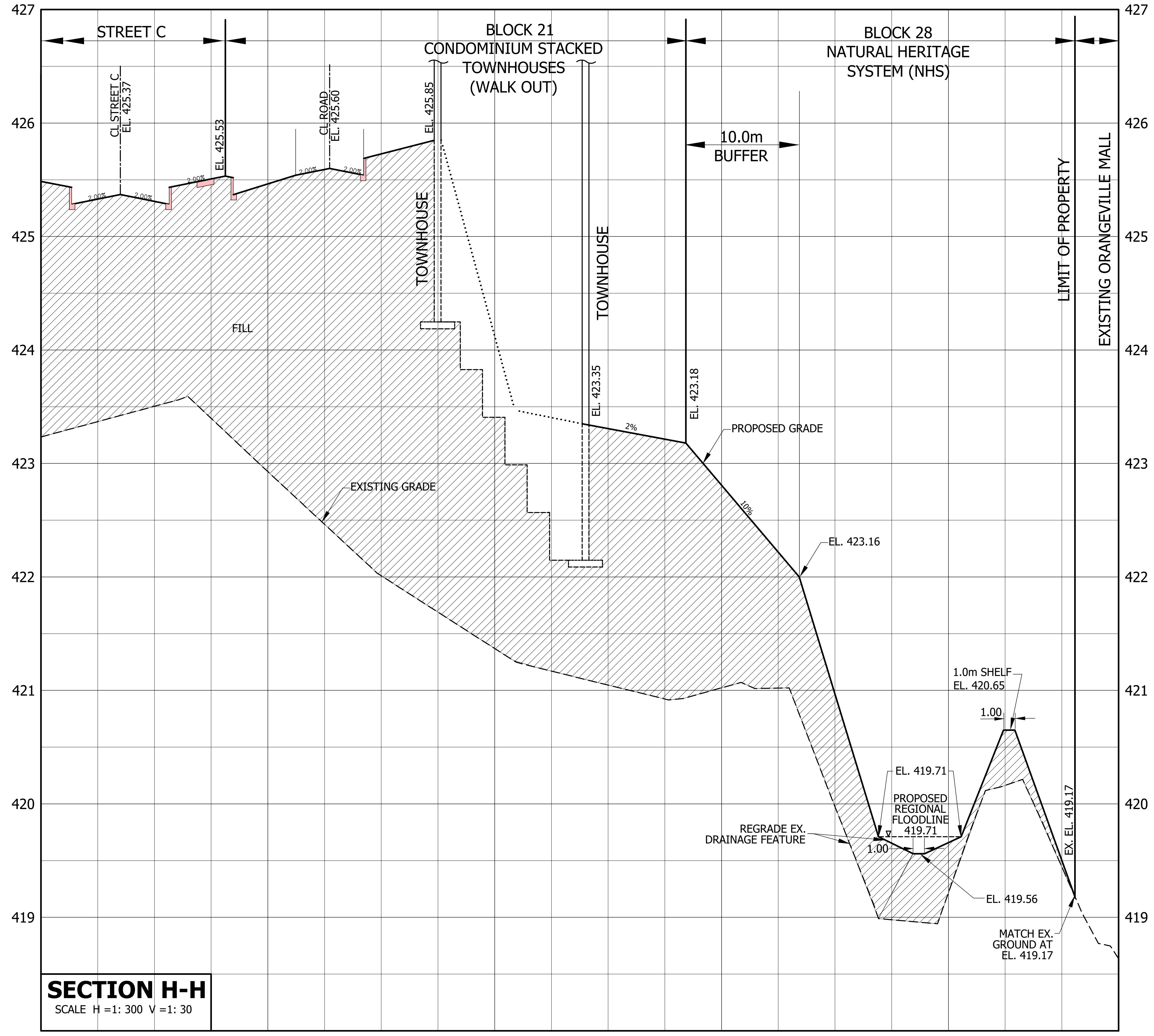
SECTION F-F
SCALE H =1: 300 V =1: 30



KEY PLAN
NTS



SECTION G-G
SCALE H =1: 300 V =1: 30



SECTION H-H
SCALE H =1: 300 V =1: 30

NOTES:

1. REFER TO FIG 2 FOR CROSS SECTIONS LOCATIONS
2. LANDSCAPING CONSULTANT TO PROVIDE ENHANCED RESTORATION DETAILS FOR TRANSITION GRADING IN THE OPEN SPACE BLOCKS BEYOND THE REAR LOT LINE.

BENCHMARK

STATION: 00819688502 ELEVATION: 417.719
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ORANGEVILLE HIGHLANDS PHASE 2 FUNCTIONAL SERVICING

Orangeville
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**REVIEWED BY
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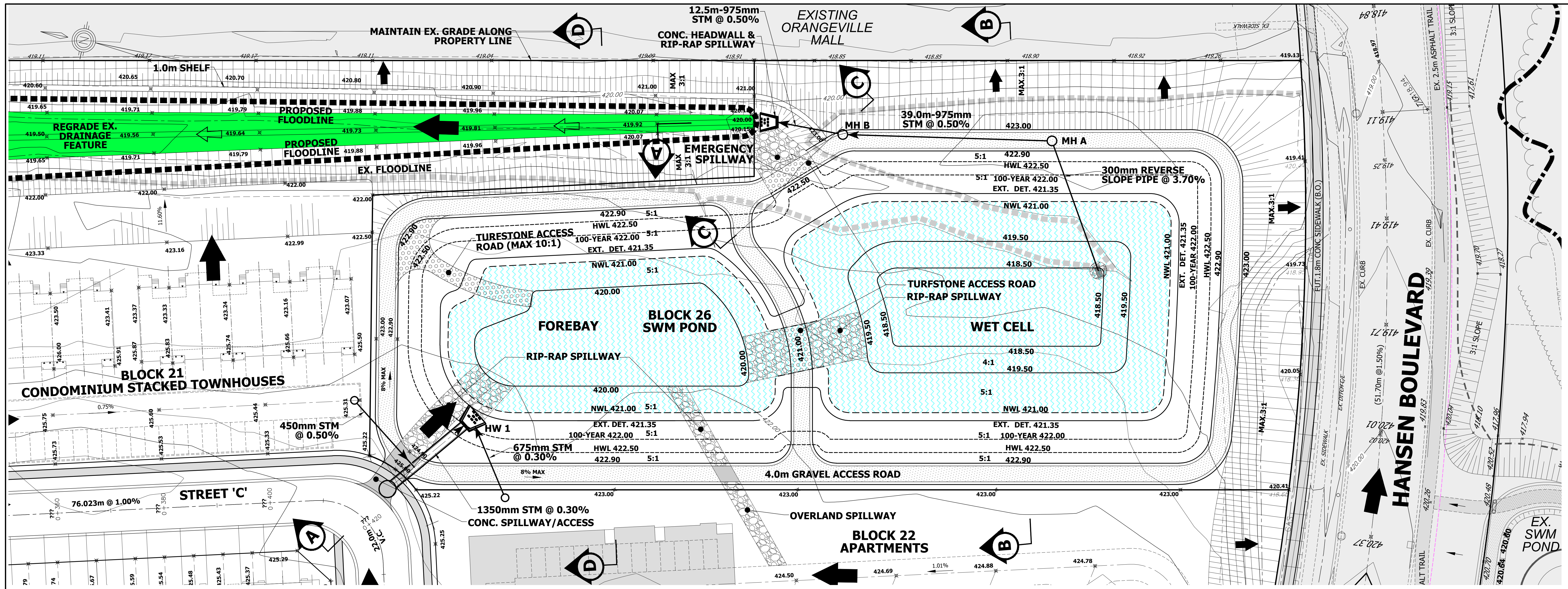
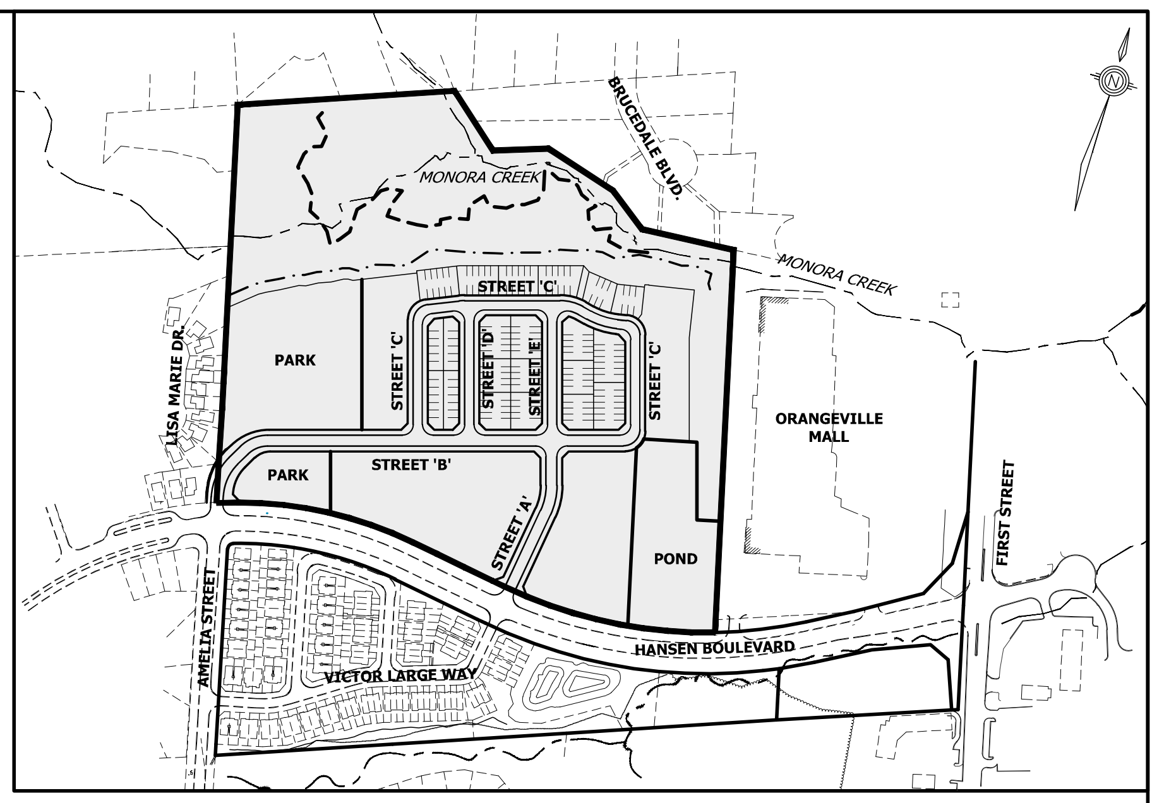
LICENSED PROFESSIONAL ENGINEER
S.B. RIEMER
100214712
APRIL 2019
PROVINCE OF ONTARIO

DESIGNED:	D.Z.	CHECKED:	D.Z.	PROJECT No.:	06-233-PH2
DRAWN:	V.P.	DATE:	MARCH 2019	FIGURE No.:	3B
SCALE:					

File: P:\Projects\06-233-Phase 2\FSR\F3-FSR GRADING SECTIONS.dwg - Revised by <DFAN> : Tue, Apr 09 2019 - 9:29am



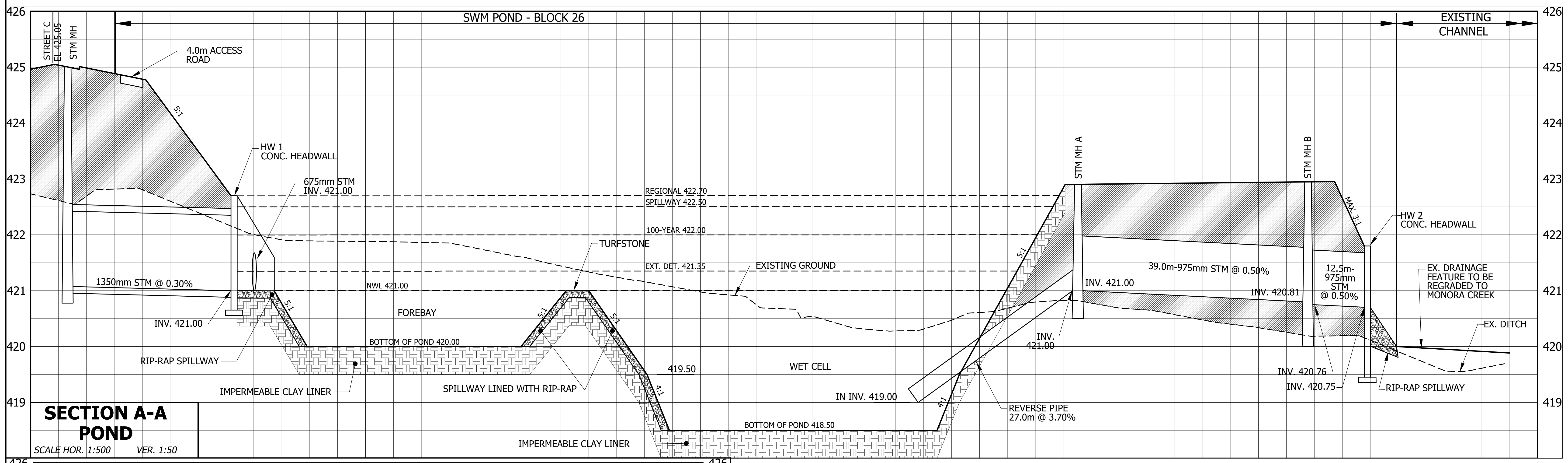
PLAN VIEW
SCALE 1:500



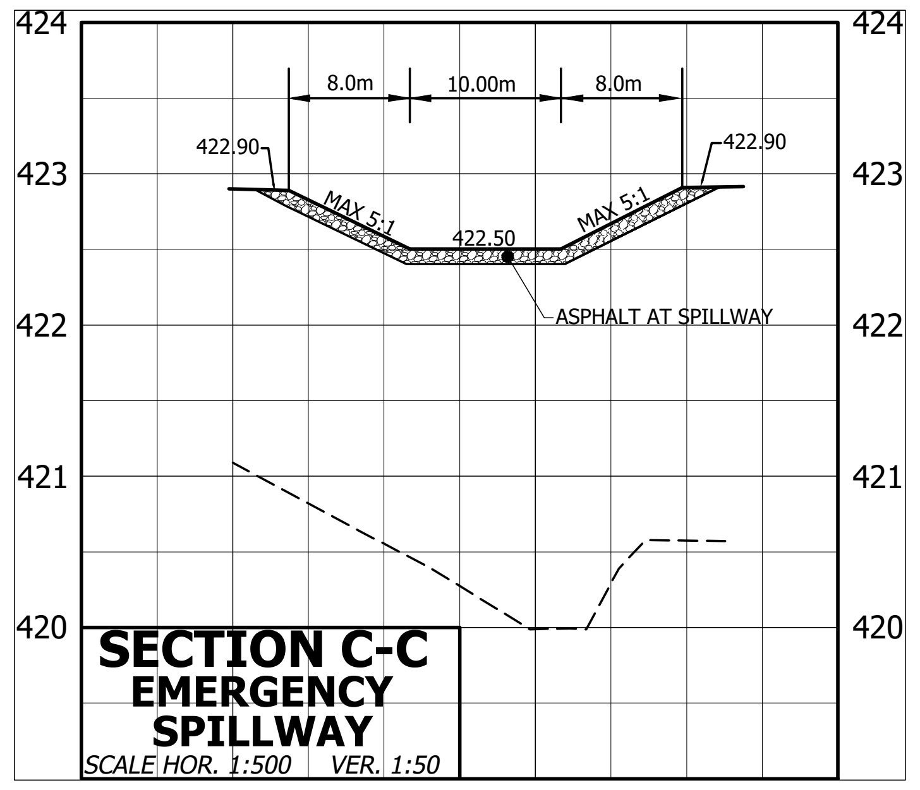
KEY PLAN
NTS

LEGEND

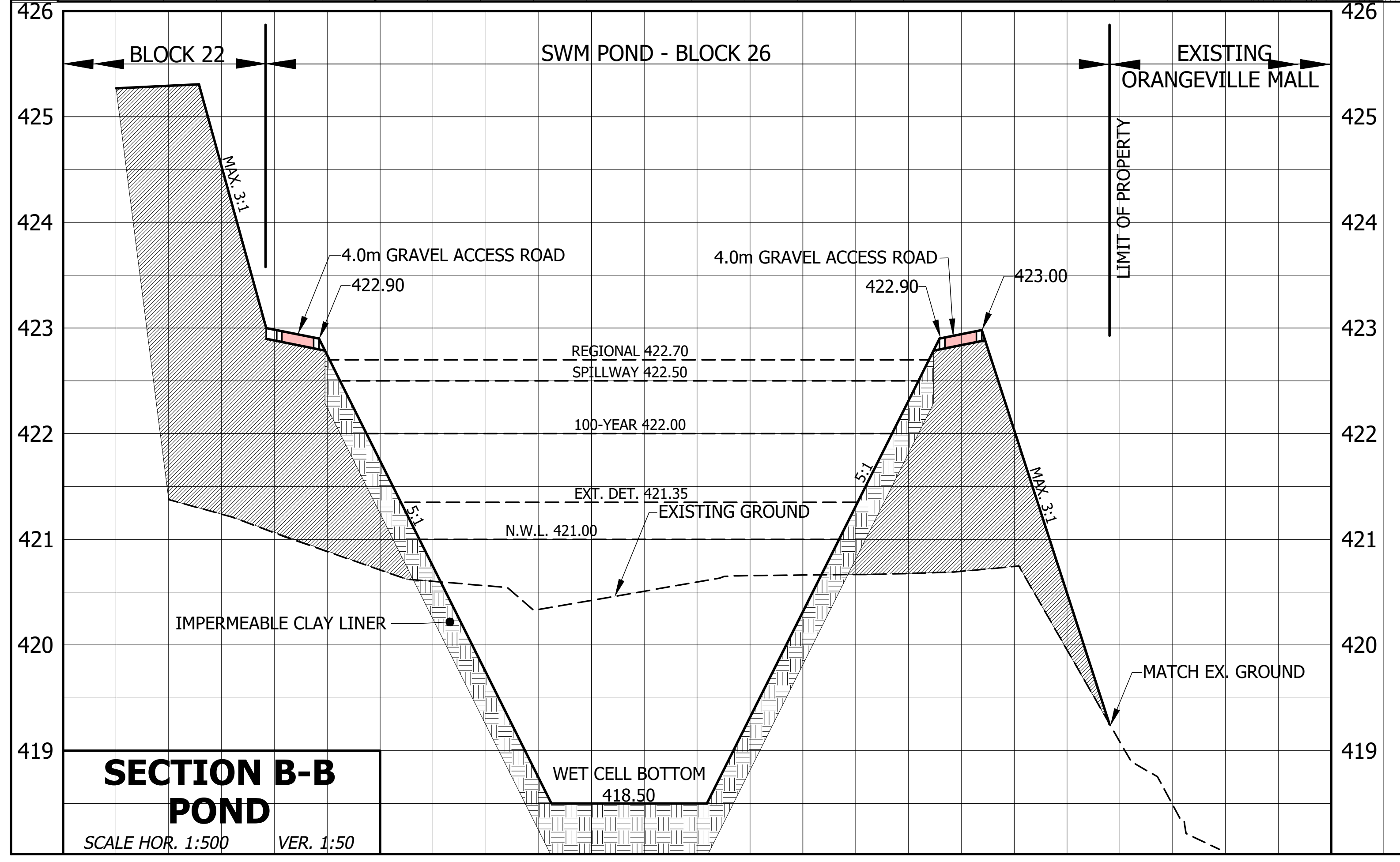
x 425.89	PROPOSED GRADE (m)
426.24	EXISTING ELEVATION (m)
421.50	EXISTING CONTOUR (m)
422.00	HIGH GROUND WATER TABLE CONTOUR (m)
⬅	OVERLAND FLOW ROUTE
⇦	EXISTING OVERLAND FLOW ROUTE



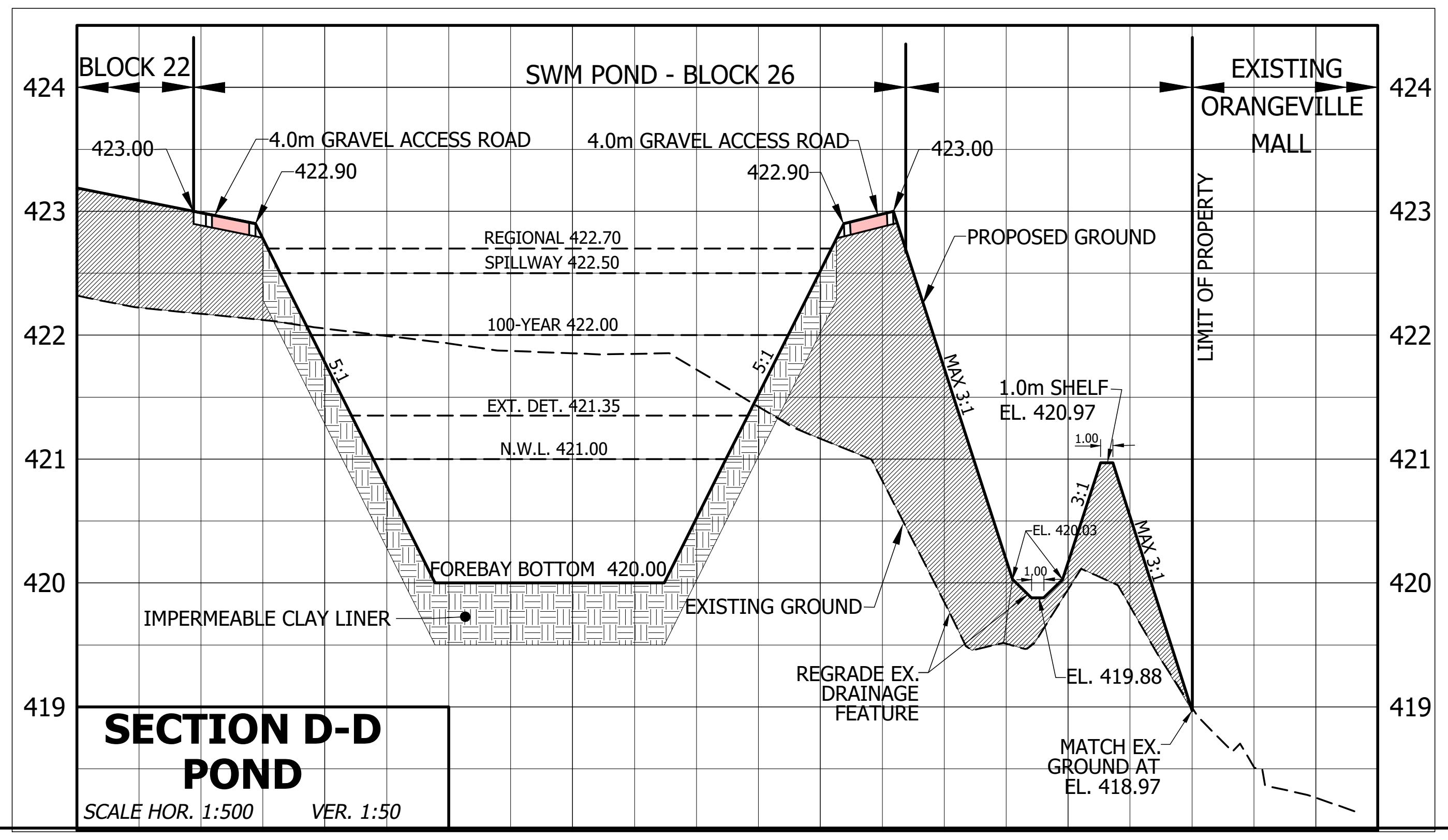
SECTION A-A
POND
SCALE HOR. 1:500 VER. 1:50



SECTION C-C
EMERGENCY SPILLWAY
SCALE HOR. 1:500 VER. 1:50



SECTION B-B
POND
SCALE HOR. 1:500 VER. 1:50



SECTION D-D
POND
SCALE HOR. 1:500 VER. 1:50

POND COMPONENTS	WATER SURFACE ELEVATION (m)	STORAGE VOLUME (m^3)		TARGET RELEASE RATE (m^3/s)
		REQUIRED	PROVIDED	
PERM POOL	421.00	1902	5049	-
25mm (EXT DET)	421.35	1722	1882	0.007
2-YEAR	421.50	2475	2762	0.241
5-YEAR	421.60	3304	3349	0.312
10-YEAR	421.70	3826	3936	0.379
25-YEAR	421.80	4539	4523	0.444
50-YEAR	421.90	5100	5109	0.492
100-YEAR	422.00	5408	5696	0.735
SPILLWAY	422.50	-	8673	-
EMERGENCY (REGIONAL)	422.70	10048	10170	1.400

NOTE: REFER TO GEOTECHNICAL REPORT FOR POND CONSTRUCTION RECOMMENDATIONS. ADDITIONAL DETAILS TO BE PROVIDED AT DETAILED DESIGN.

BENCHMARK

STATION: 00819688502 ELEVATION: 417.719
502-68: ONE STOREY BROWN BRICK MORTUARY (FOREST LAWN MORTUARY) ON EAST SIDE OF HWY 10 AND 24, 1.9 KM NORTH OF NORTH JCT OF HWYS 9, 10 AND 24 AT ORANGEVILLE. 1.4 KM SOUTH OF MONO TWP SIDEROAD 5 (DUFFERIN CTY RD 7) AND 301.8 M EAST OF CENTERLINE OF HWY 10 AND 24 ALONG CEMETERY RD. TABLET IS SET HORIZONTALLY IN NORTH FACE OF CONCRETE FOUNDATION, 2.59 M EAST OF N.W. CORNER AND 43 CM BELOW BRICKWORK.

No.	REVISION	DATE
4		
3		
2	2nd SUBMISSION	APRIL 2019
1	1st SUBMISSION	APRIL 2018

ORANGEVILLE HIGHLANDS PHASE 2
FUNCTIONAL SERVICING

Corporation of the
Town of Orangeville
Ontario, Canada

REVIEWED BY
THE TOWN OF
ORANGEVILLE

DATE

DIRECTOR OF PUBLIC WORKS

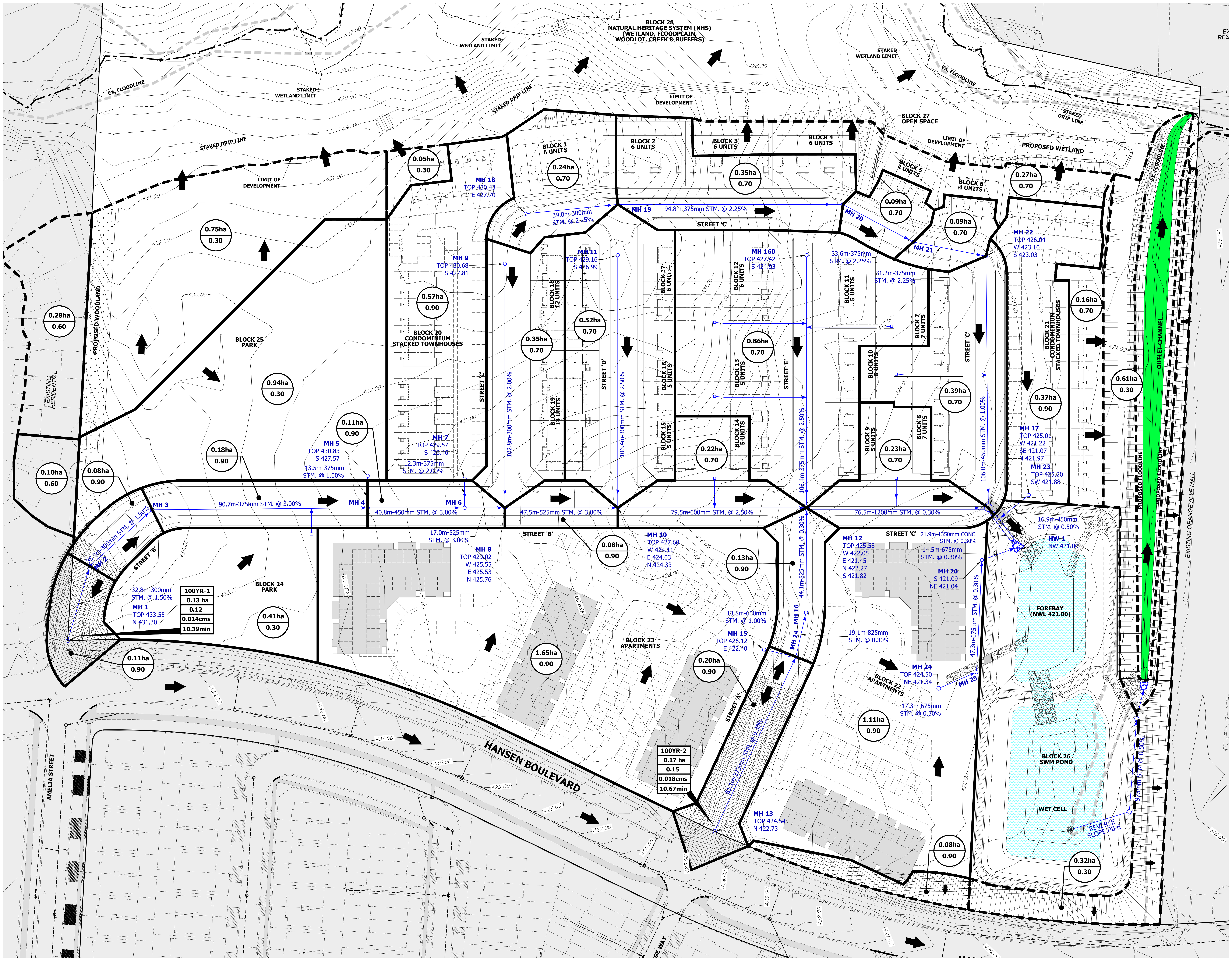
urbantech
Urbantech Consulting, A Division of Leighton-Zec Ltd.
25 Royal Crest Court, Suite 201, Markham, Ontario L3R 9X4
tel: 905.946.9461 fax: 905.946.9595
www.urbantech.com

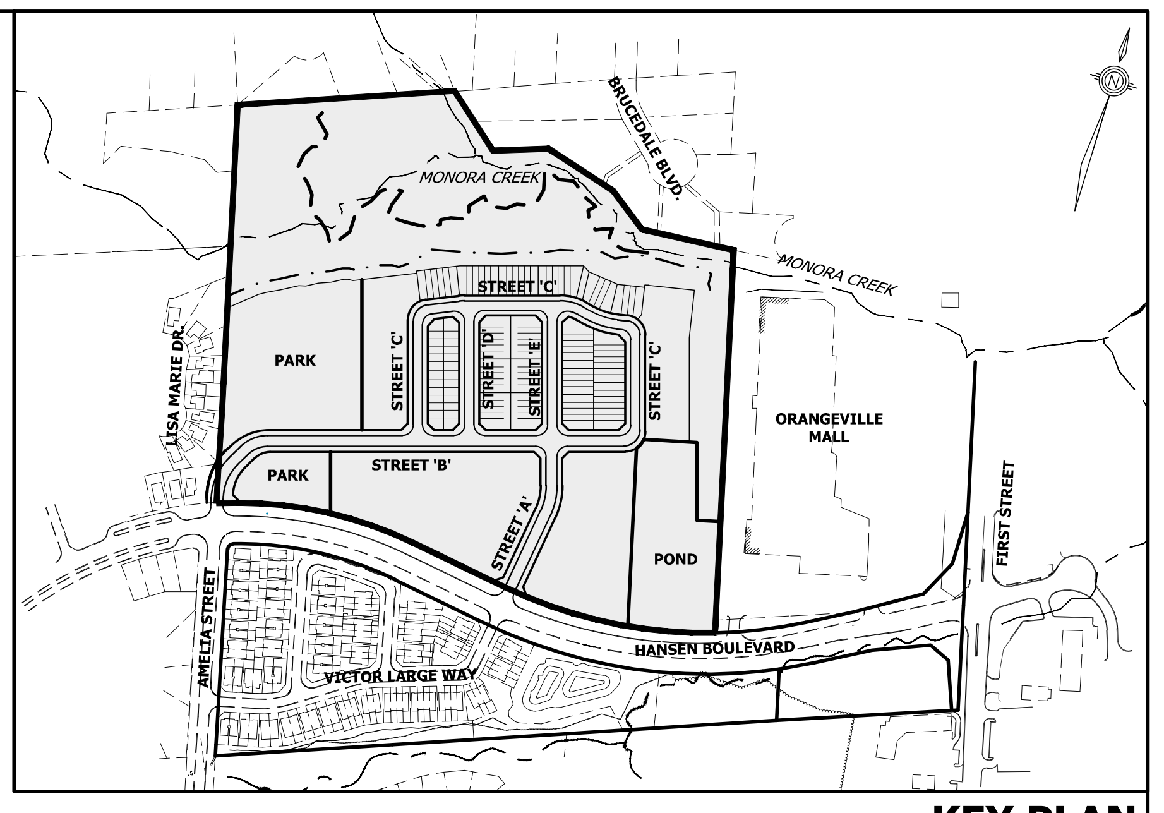
S.B. RIEMER
100214712
APRIL 2019

PRELIMINARY
SWM POND LAYOUT AND
CROSS SECTIONS

DESIGNED: D.Z.
CHECKED: D.Z.
PROJECT No.: 06-233-PH2
DRAWN: V.P.
DATE: MARCH 2019
FIGURE No.: 4
SCALE: AS SHOWN

File: P:\Projects\06-233-Phase 2\FSR\F4-FSR POND.dwg – Revised by <DFAN> : Thu, Apr 11 2019 – 3:54pm





KEY PLAN
NTS

LEGEND

256.00	EXISTING CONTOUR
→○	STORM SEWER & FLOW DIRECTION
- - →○- -	EXISTING STORM SEWER & FLOW DIRECTION
□	CATCHBASIN / REAR LOT CATCH BASIN
0.11ha	MINOR SYSTEM DRAINAGE AREA (10 YEAR STORM)
0.70	RUNOFF COEFFICIENT
□	MINOR SYSTEM DRAINAGE AREA BOUNDARY (10 YEAR)
⬚	EXTERNAL DRAINAGE BOUNDARY (NOT CAPTURED IN POND)
▨	MAJOR SYSTEM CAPTURE BOUNDARY (100-10 YEAR STORM)
←	OVERLAND FLOW ROUTE
100YR-2	MAJOR SYSTEM CAPTURE ID
0.17 ha	MAJOR SYSTEM CAPTURE AREA
0.15	AREA X RUNOFF COEFFICIENT
0.018cms	100-10 YEAR CONSTANT FLOW (m3/s)
10.67min	TIME OF CONCENTRATION (MINUTES)
▢	EXTERNAL/EXISTING AREA
MH1	MH NUMBER
TOP ###	MH TOP ELEVATION (m)
N ###	CONNECTED PIPE INVERT AND DIRECTION

NOTES

REFER TO FIGURE 5B FOR LID DETAILS

BENCHMARK

STATION: 00819688502 ELEVATION: 417.719
502-68: ONE STOREY BROWN BRICK MORTUARY (FOREST LAWN MORTUARY) ON EAST SIDE OF HWY 10 AND 24, 1.9 KM NORTH OF NORTH JCT OF HWYS 9, 10 AND 24 AT ORANGEVILLE. 1.4 KM SOUTH OF MONO TWP SIDEROAD 5 (DUFFERIN CTY RD 7) AND 301.8 M EAST OF CENTERLINE OF HWY 10 AND 24 ALONG CEMETERY RD. TABLET IS SET HORIZONTALLY IN NORTH FACE OF CONCRETE FOUNDATION, 2.59 M EAST OF N.W. CORNER AND 43 CM BELOW BRICKWORK.

No.	REVISION	DATE
4		
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2	2nd SUBMISSION	APRIL 2019
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ORANGEVILLE HIGHLANDS PHASE 2
FUNCTIONAL SERVICING

Orangeville
Historic Charm Dynamic Future

Corporation of the
Town of Orangeville
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THE TOWN OF
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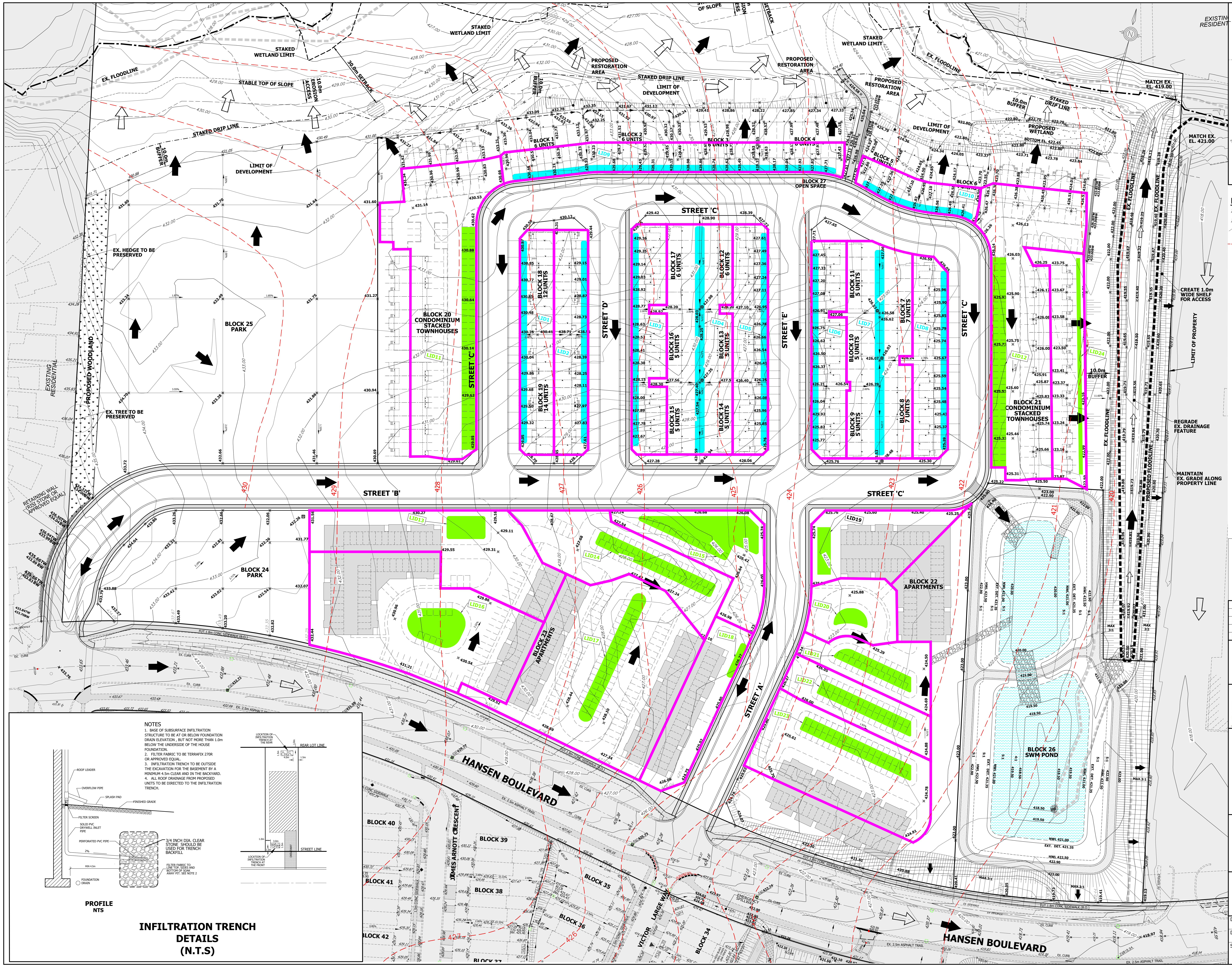
tel: 905.946.9461 fax: 905.946.9595
www.urbantech.com

S.B. RIEMER
100214712
APRIL 2019

STORM DRAINAGE PLAN

DESIGNED:	D.Z.	CHECKED:	D.Z.	PROJECT No.:	06-233-PH2
DRAWN:	V.P.	DATE:	MARCH 2019	FIGURE No.:	5A
SCALE:	H 1:750				

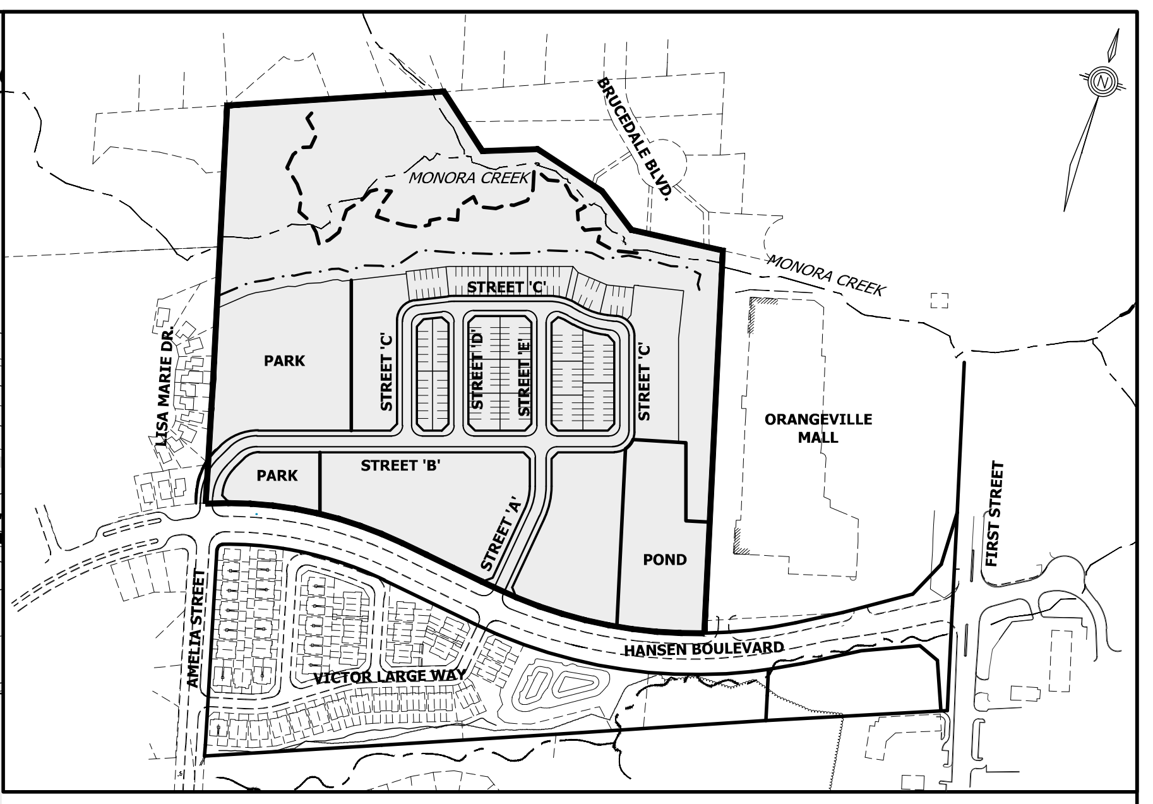
File: P:\Projects\06-233-Phase 2\FSR\F5A-FSR STM DRAINAGE.dwg - Revised by <DFAN> : Thu, Apr 04 2019 - 4:01pm



INFILTRATION TRENCH DETAILS (N.T.S)

NOTES
1. BASE OF SUBSURFACE INFILTRATION STRUCTURE TO BE AT OR BELOW FOUNDATION DRAIN ELEVATION , BUT NOT MORE THAN 1.0m BELOW THE UNDERSIDE OF THE HOUSE FOUNDATION.
2. FILTER FABRIC TO BE TERRAFIX 270R OR APPROVED EQUAL.
3. INFILTRATION TRENCH TO BE OUTSIDE THE EXCAVATION FOR THE BASEMENT BY A MINIMUM 4.5m CLEAR AND IN THE BACKYARD.
4. ALL ROOF DRAINAGE FROM PROPOSED UNITS TO BE DIRECTED TO THE INFILTRATION TRENCH.

PROFILE
NTS



KEY PLAN
NTS

LEGEND

⌧ **429.03**	PROPOSED GRADE (m)
⌧ *426.24*	EXISTING ELEVATION (m)
421.50	GROUND ELEVATION (m)
422.00	HIGH GROUND WATER ELEVATION CONTOUR (m)
⇦	EXISTING OVERLAND FLOW ROUTE
⬅	PROPOSED OVERLAND FLOW ROUTE
🟦	INFILTRATION TRENCH LOCATED IN PRIVATE FRONT/REAR YARD (REFER TO DETAIL, THIS DWG)
🟩	POTENTIAL LOCATION OF PRIVATE LID FEATURE (TO BE DETERMINED THROUGH FUTURE SITE PLAN APPLICATION)
▭	CONTRIBUTION DRAINAGE AREA TO LID FEATURE

LID#	DRAINAGE AREA (m^2)	STORAGE VOL (m^3)
LID1	1378	35.1
LID2	1384	35.1
LID3	1410	40.3
LID4	2778	86.4
LID5	1484	43.2
LID6	1363	40.5
LID7	2532	108.0
LID8	1283	50.4
LID9	1842	108.0
LID10	694	36.0
LID11	3959	207.7
LID12	3582	392.0
LID13	2624	15.6
LID14	2043	32.4
LID15	1575	57.0
LID16	4166	65.1
LID17	4784	41.9
LID18	1336	4.6
LID19	1489	66.0
LID20	943	47.8
LID21	994	80.2
LID22	1085	102.8
LID23	2665	121.8
LID24	1483	55.2

BENCHMARK

STATION: 00819688502 ELEVATION: 417.719
502-68: ONE STOREY BROWN BRICK MORTUARY (FOREST LAWN MORTUARY) ON EAST SIDE OF HWY 10 AND 24, 1.9 KM NORTH OF NORTH JCT OF HWYS 9, 10 AND 24 AT ORANGEVILLE. 1.4 KM SOUTH OF MONO TWP SIDEROAD 5 (DUFFERIN CTY RD 7) AND 301.8 M EAST OF CENTERLINE OF HWY 10 AND 24 ALONG CEMETERY RD. TABLET IS SET HORIZONTALLY IN NORTH FACE OF CONCRETE FOUNDATION, 2.59 M EAST OF N.W. CORNER AND 43 CM BELOW BRICKWORK.

No.	REVISION	DATE
4		
3		
2	2nd SUBMISSION	APRIL 2019
1	1st SUBMISSION	APRIL 2018

ORANGEVILLE HIGHLANDS PHASE 2
FUNCTIONAL SERVICING

Orangeville
Historic Charm Dynamic Future

**Corporation of the
Town of Orangeville
Ontario, Canada**

**REVIEWED BY
THE TOWN OF
ORANGEVILLE**

DATE

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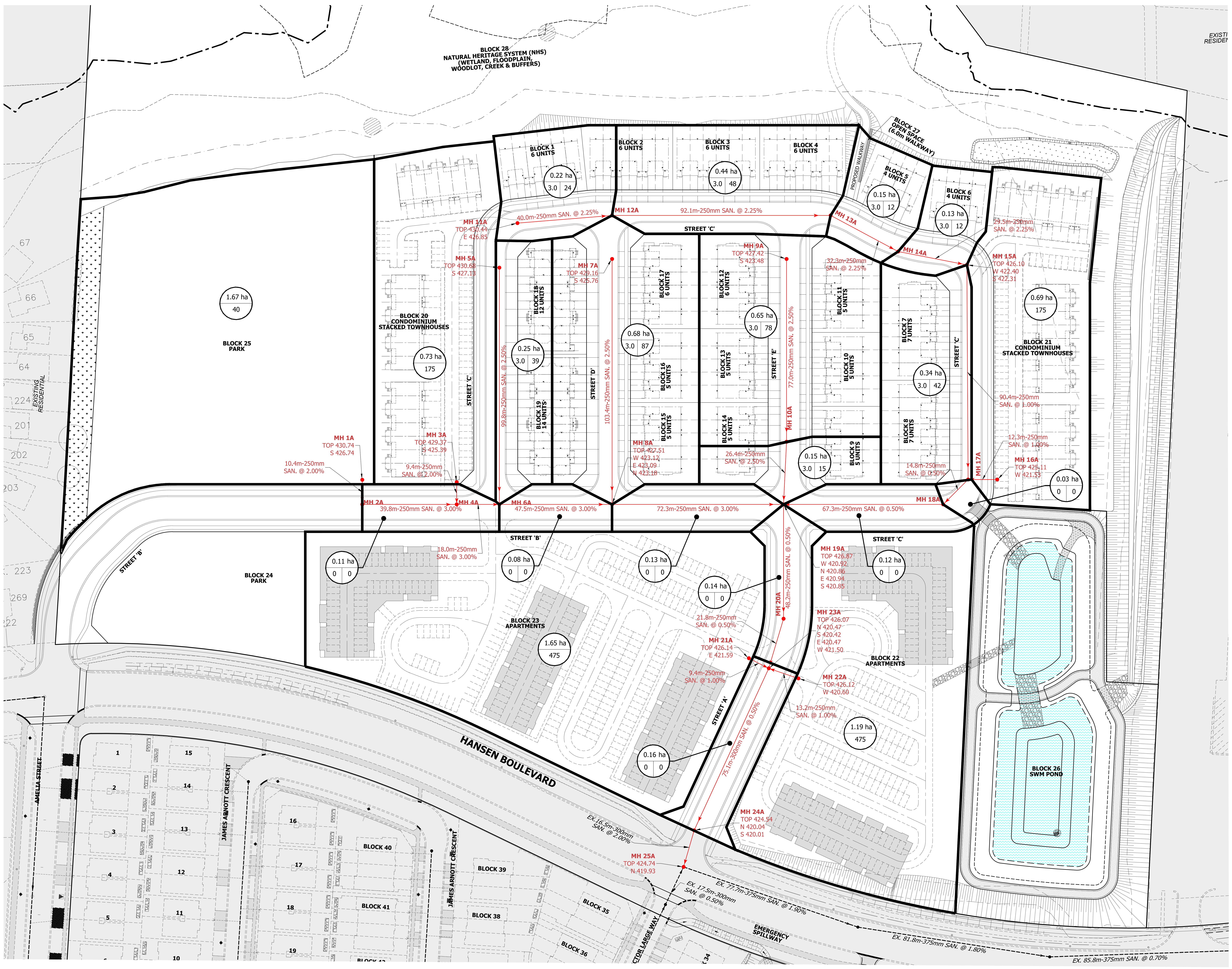
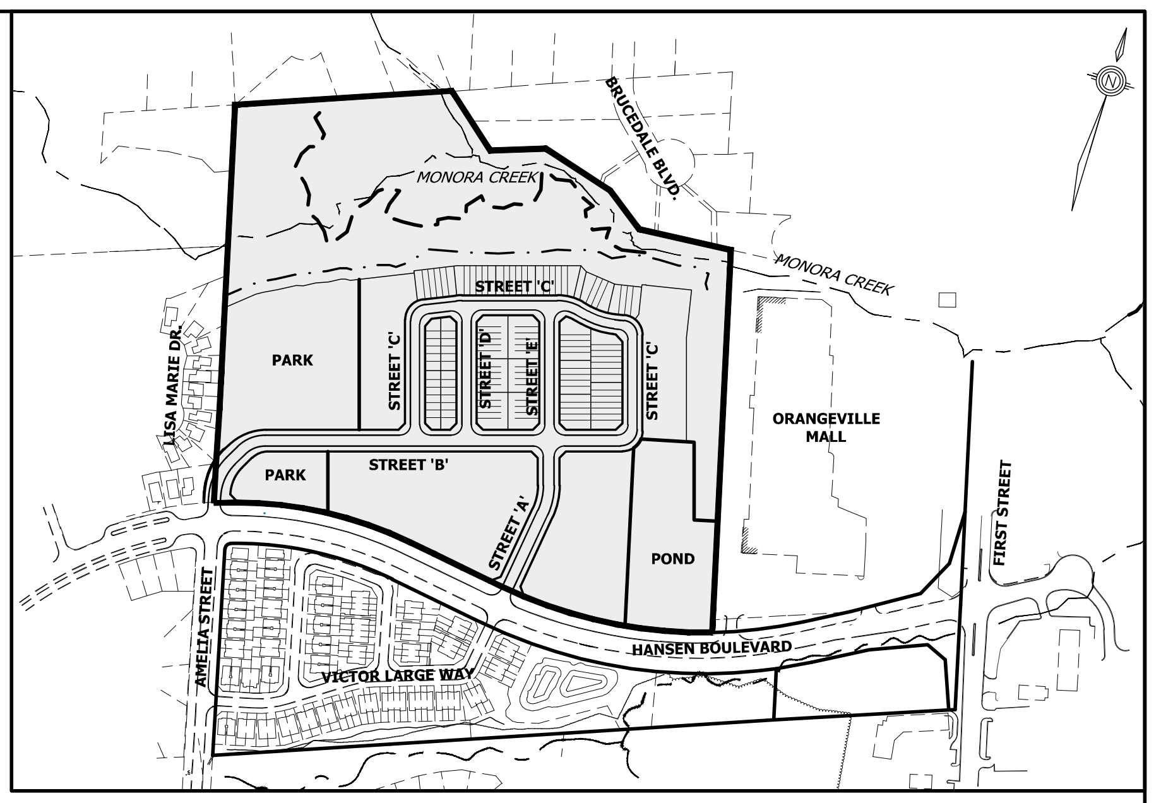
tel: 905.946.9461 fax: 905.946.9595
www.urbantech.com

LICENSED PROFESSIONAL ENGINEER
S.B. RIEMER
100214712
APRIL 2019
PROVINCE OF ONTARIO

LID DRAINAGE PLAN

DESIGNED: D.Z.	CHECKED: D.Z.	PROJECT No.: 06-233-PH2
DRAWN: V.P.	DATE: MARCH 2019	FIGURE No.: 5B
SCALE: H 1:750		





KEY PLAN
NTS

LEGEND

- ●→ SANITARY SEWER & FLOW DIRECTION
- - -●- - EX. SANITARY SEWER & FLOW DIRECTION
- ▬ SANITARY DRAINAGE AREA BOUNDARY
- 0.16 ha — SANITARY DRAINAGE AREA; 0 — POPULATIION; 0 — POPULATION PER UNITS
- 1.65 ha — SANITARY DRAINAGE AREA; 475 — POPULATION PER HECTARE

MH1	MH NUMBER
TOP ###	MH TOP ELEVATION (m)
N ###	CONNECTED PIPE INVERT AND DIRECTION

BENCHMARK

STATION: 00819688502 ELEVATION: 417.719
502-68: ONE STOREY BROWN BRICK MORTUARY (FOREST LAWN MORTUARY) ON EAST SIDE OF HWY 10 AND 24, 1.9 KM NORTH OF NORTH JCT OF HWYS 9, 10 AND 24 AT ORANGEVILLE. 1.4 KM SOUTH OF MONO TWP SIDEROAD 5 (DUFFERIN CTY RD 7) AND 301.8 M EAST OF CENTERLINE OF HWY 10 AND 24 ALONG CEMETERY RD. TABLET IS SET HORIZONTALLY IN NORTH FACE OF CONCRETE FOUNDATION, 2.59 M EAST OF N.W. CORNER AND 43 CM BELOW BRICKWORK.

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2	2nd SUBMISSION	APRIL 2019
1	1st SUBMISSION	APRIL 2018
No.	REVISION	DATE

ORANGEVILLE HIGHLANDS PHASE 2
FUNCTIONAL SERVICING

Orangeville
Historic Charm Dynamic Future

Corporation of the
Town of Orangeville
Ontario, Canada

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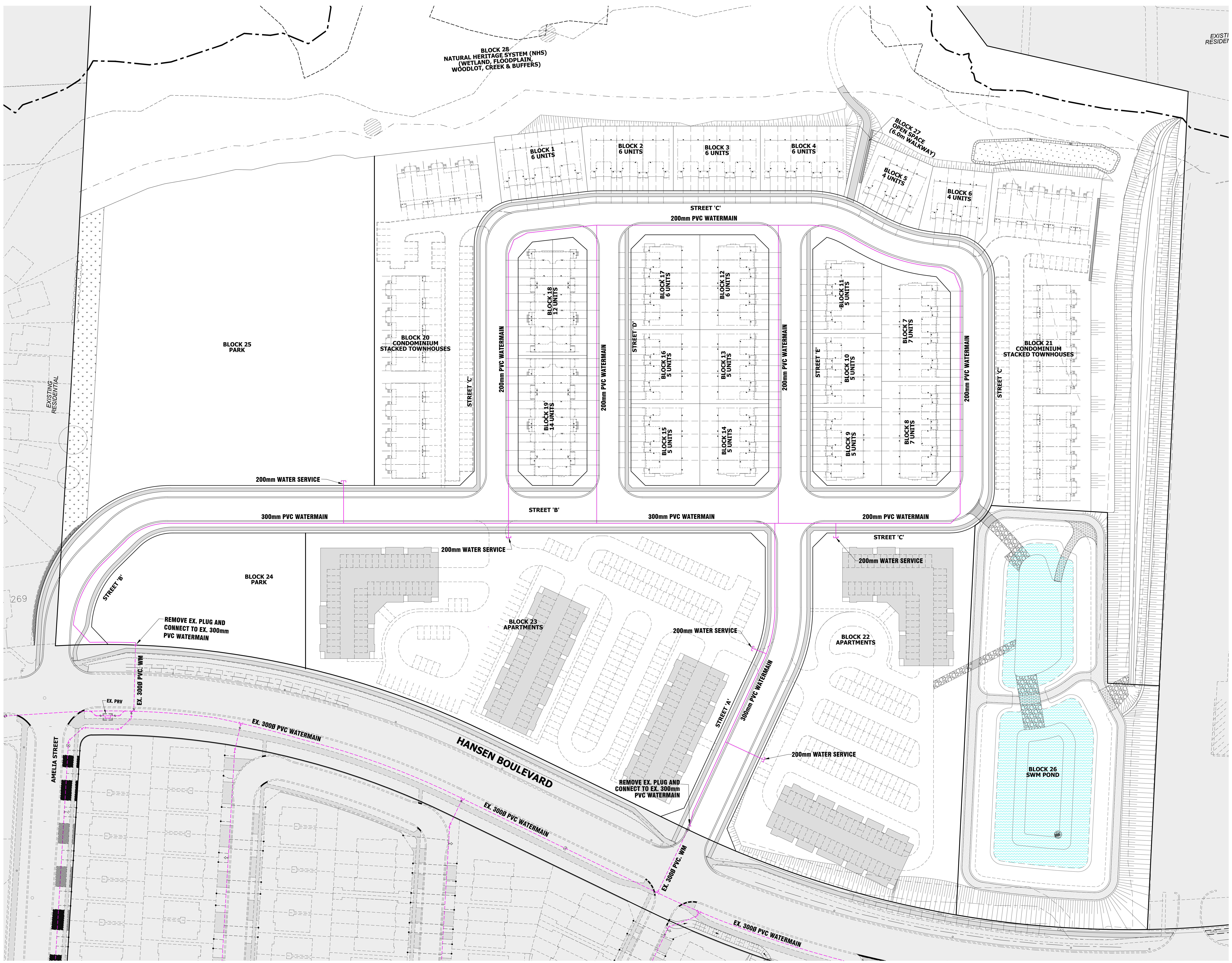
25 Royal Crest Court, Suite 201, Markham, Ontario L3R 9X4
tel: 905.946.9461 fax: 905.946.9595
www.urbantech.com

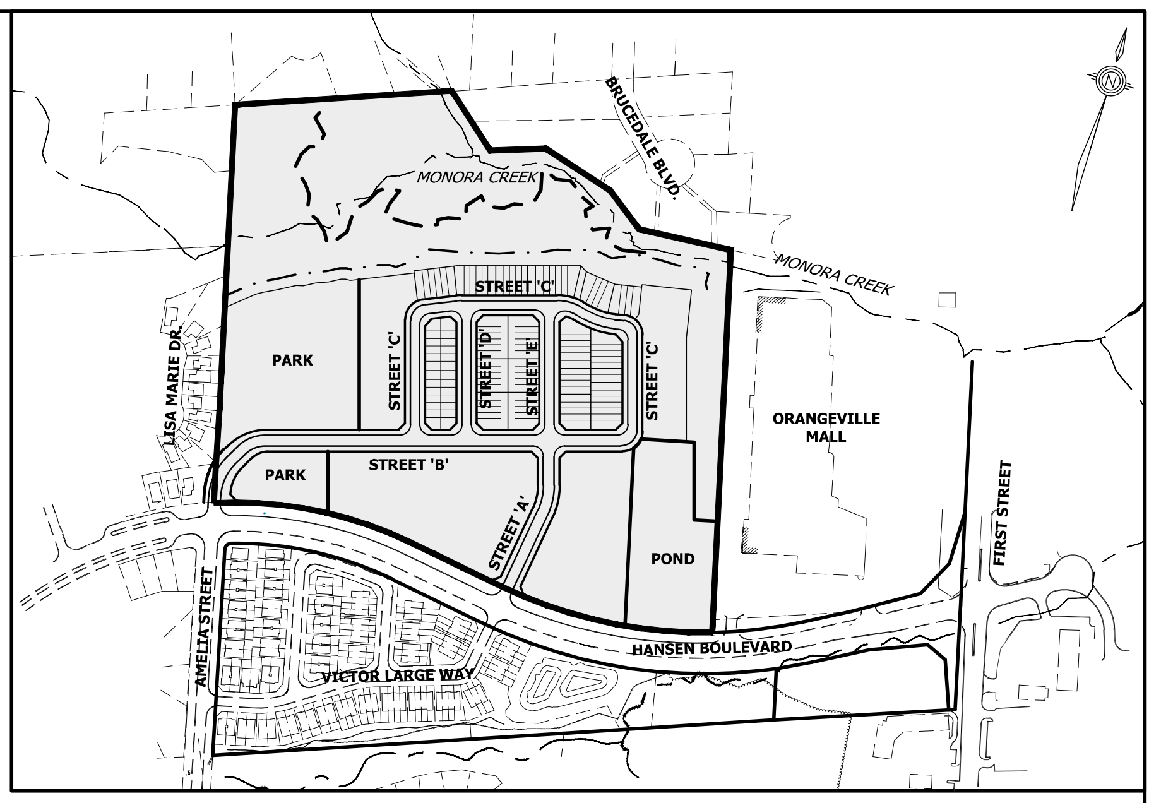
LICENSED PROFESSIONAL ENGINEER
S.B. RIEMER
100214712
APRIL 2019
PROVINCE OF ONTARIO

SANITARY SERVICING PLAN

DESIGNED:	D.Z.	CHECKED:	D.Z.	PROJECT No.:	06-233-PH2
DRAWN:	V.P.	DATE:	MARCH 2019	FIGURE No.:	6
SCALE:	H 1:750				

File: P:\Projects\06-233-Phase 2\FSR\F6-FSR SAN DRAINAGE.dwg - Revised by <DFAN> : Mon, Apr 08 2019 - 11:10am





KEY PLAN
NTS

LEGEND

PROPOSED WATERMAIN

EXISTING WATERMAIN

NOTES:

1. UNITS TO BE PROVIDED WITH INDIVIDUAL WATER SERVICE CONNECTIONS.
2. INTERNAL WATERMAIN SIZES TO BE CONFIRMED AT DETAIL DESIGN
3. VALVE BOX AND CHAMBER LOCATIONS AND DETAILS TO BE DETERMINED AT DETAILED DESIGN.
4. BLOCK CONNECTION LOCATIONS AND SIZES TO BE CONFIRMED AT DETAILED DESIGN.

BENCHMARK

STATION: 00819688502 ELEVATION: 417.719

502-68: ONE STOREY BROWN BRICK MORTUARY (FOREST LAWN MORTUARY) ON EAST SIDE OF HWY 10 AND 24, 1.9 KM NORTH OF NORTH JCT OF HWYS 9, 10 AND 24 AT ORANGEVILLE. 1.4 KM SOUTH OF MONO TWP SIDEROAD 5 (DUFFERIN CTY RD 7) AND 301.8 M EAST OF CENTERLINE OF HWY 10 AND 24 ALONG CEMETERY RD. TABLET IS SET HORIZONTALLY IN NORTH FACE OF CONCRETE FOUNDATION, 2.59 M EAST OF N.W. CORNER AND 43 CM BELOW BRICKWORK.

4		
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2	2nd SUBMISSION	APRIL 2019
1	1st SUBMISSION	APRIL 2018
No.	REVISION	DATE

ORANGEVILLE HIGHLANDS PHASE 2
FUNCTIONAL SERVICING

Orangeville
Historic Charm Dynamic Future

**Corporation of the
Town of Orangeville
Ontario, Canada**

**REVIEWED BY
THE TOWN OF
ORANGEVILLE**

DATE ____________

DIRECTOR OF PUBLIC WORKS ____________

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LICENSED PROFESSIONAL ENGINEER
S.B. RIEMER
100214712
APRIL 2019
PROVINCE OF ONTARIO

WATERMAIN
DISTRIBUTION PLAN

DESIGNED:	D.Z.	CHECKED:	D.Z.	PROJECT No.:	06-233-PH2
DRAWN:	V.P.	DATE:	MARCH 2019	FIGURE No.:	7
SCALE:	H 1:750				

File: P:\Projects\06-233-Phase 2\FSR\F7-FSR WM DISTRIBUTION.dwg - Revised by <DZEC> : Thu, Apr 26 2018 - 5:26pm

APPENDIX B
SWM Design Calculations & Storm Sewer Design Sheets

urbantech

STORM SEWER DESIGN SHEET

10 Year Storm

Orangeville Highlands Phase 2

Town of Orangeville

PROJECT DETAILS

Project No: 06-233-Ph2
Date: 29-Mar-19
Designed by: DY
Checked by: SR

DESIGN CRITERIA

Min. Diameter = 300 mm
Mannings 'n'= 0.013
Starting Tc = 10 min
Factor of Safety = 20 %

Rainfall Intensity = $\frac{A}{(Tc+B)^c}$
A = 1763.886
B = 16.056
c = 0.852

🟨 Shading indicates sewers conveying 100-year flow

NOMINAL PIPE SIZE USED

STREET	FROM MH	TO MH	AREA (ha)	RUNOFF COEFFICIENT "R"	'AR'	ACCUM. 'AR'	RAINFALL INTENSITY (mm/hr)	FLOW (m3/s)	CONSTANT FLOW (m3/s)	ACCUM. CONSTANT FLOW (m3/s)	TOTAL FLOW (m3/s)	LENGTH (m)	SLOPE (%)	PIPE DIAMETER (mm)	FULL FLOW CAPACITY (m3/s)	FULL FLOW VELOCITY (m/s)	INITIAL Tc (min)	TIME OF CONCENTRATION (min)	ACC. TIME OF CONCENTRATION (min)	PERCENT FULL (%)
STREET 'B'	1	2	0.11	0.90	0.10	0.10	109.7	0.030	0.014	0.014	0.044	32.8	1.50	300	0.118	1.68	10.00	0.33	10.33	37%
STREET 'B'	2	3	0.08	0.90	0.07	0.17	108.5	0.052	0.000	0.014	0.066	35.4	1.50	300	0.118	1.68	10.33	0.35	10.68	55%
BLOCK 24		3	0.41	0.30	0.12	0.12														
STREET 'B'	3	4	0.18	0.90	0.16	0.46	107.3	0.136	0.000	0.014	0.150	90.7	3.00	375	0.304	2.75	10.68	0.55	11.23	49%
EXTERNAL		5	0.10	0.60	0.06	0.06														
BLOCK 25	5	4	0.94	0.30	0.28	0.34	109.7	0.104			0.104	13.5	1.00	375	0.175	1.59	10.00	0.14	10.14	59%
STREET 'B'	4	6	0.11	0.90	0.10	0.90	105.5	0.263	0.000	0.014	0.277	40.8	3.00	450	0.494	3.10	11.23	0.22	11.45	56%
BLOCK 20	7	6	0.57	0.90	0.51	0.51	109.7	0.156			0.156	12.3	2.00	375	0.248	2.25	10.00	0.09	10.09	63%
STREET 'B'	6	8	0.00	0.00	0.00	1.41	104.7	0.410	0.000	0.014	0.424	17.0	3.00	525	0.745	3.44	11.45	0.08	11.53	57%
STREET 'C'	9	8	0.35	0.70	0.25	0.25	109.7	0.075			0.075	102.8	2.00	300	0.137	1.93	10.00	0.89	10.89	55%
STREET 'B'	8	10	0.08	0.90	0.07	1.73	104.5	0.501	0.000	0.014	0.515	47.5	3.00	525	0.745	3.44	11.53	0.23	11.76	69%
STREET 'D'	11	10	0.52	0.70	0.36	0.36	109.7	0.111			0.111	106.4	2.50	300	0.153	2.16	10.00	0.82	10.82	73%
STREET 'B'	10	12	0.22	0.70	0.15	2.25	103.7	0.647	0.000	0.014	0.661	79.5	2.50	600	0.971	3.43	11.76	0.39	12.15	68%
STREET 'A'	13	14	0.20	0.90	0.18	0.18	109.7	0.055	0.018	0.018	0.073	81.1	0.30	375	0.096	0.87	10.00	1.55	11.55	76%
BLOCK 23	15	14	1.65	0.90	1.49	1.49	109.7	0.452			0.452	13.8	1.00	600	0.614	2.17	10.00	0.11	10.11	74%
STREET 'A'	14	16	0.00	0.00	0.00	1.67	104.4	0.483	0.000	0.018	0.501	19.1	0.30	825	0.786	1.47	11.55	0.22	11.77	64%
STREET 'A'	16	12	0.00	0.90	0.00	1.67	103.7	0.480	0.000	0.018	0.498	44.1	0.30	825	0.786	1.47	11.77	0.50	12.27	63%
STREET 'E'	160	12	0.86	0.70	0.60	0.60	109.7	0.183			0.183	106.4	2.50	375	0.277	2.51	10.00	0.71	10.71	66%
STREET 'C'	12	17	0.23	0.70	0.16	4.67	102.1	1.326	0.000	0.032	1.358	76.5	0.30	1200	2.135	1.89	12.27	0.68	12.95	64%
STREET 'C'	18	19	0.24	0.70	0.17	0.17	109.7	0.051			0.051	39.0	2.25	300	0.145	2.05	10.00	0.32	10.32	35%
STREET 'C'	19	20	0.35	0.70	0.25	0.41	108.6	0.125			0.125	94.8	2.25	375	0.263	2.38	10.32	0.66	10.98	47%
STREET 'C'	20	21	0.09	0.70	0.06	0.48	106.3	0.141			0.141	33.6	2.25	375	0.263	2.38	10.98	0.24	11.22	53%
STREET 'C'	21	22	0.09	0.70	0.06	0.54	105.5	0.158			0.158	31.2	2.25	375	0.263	2.38	11.22	0.22	11.43	60%
STREET 'C'	22	17	0.39	0.70	0.27	0.81	104.8	0.236			0.236	106.0	1.00	450	0.285	1.79	11.43	0.99	12.42	83%

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3760 14th Avenue, Suite 301   Markham, Ontario   L3R 3T7
TEL: 905.946.9461   FAX: 905.946.9595
www.urbantech.com

STORM SEWER DESIGN SHEET

10 Year Storm

Orangeville Highlands Phase 2

Town of Orangeville

PROJECT DETAILS

Project No: 06-233-Ph2
Date: 29-Mar-19
Designed by: DY
Checked by: SR

DESIGN CRITERIA

Min. Diameter = 300 mm
Mannings 'n'= 0.013
Starting Tc = 10 min
Factor of Safety = 20 %

Rainfall Intensity = $\frac{A}{(Tc+B)^c}$

A = 1763.886
B = 16.056
c = 0.852

🟨 Shading indicates sewers conveying 100-year flow

NOMINAL PIPE SIZE USED

STREET	FROM MH	TO MH	AREA (ha)	RUNOFF COEFFICIENT "R"	'AR'	ACCUM. 'AR'	RAINFALL INTENSITY (mm/hr)	FLOW (m3/s)	CONSTANT FLOW (m3/s)	ACCUM. CONSTANT FLOW (m3/s)	TOTAL FLOW (m3/s)	LENGTH (m)	SLOPE (%)	PIPE DIAMETER (mm)	FULL FLOW CAPACITY (m3/s)	FULL FLOW VELOCITY (m/s)	INITIAL Tc (min)	TIME OF CONCENTRATION (min)	ACC. TIME OF CONCENTRATION (min)	PERCENT FULL (%)
BLOCK 21	23	17	0.37	0.90	0.33	0.33	109.7	0.101			0.101	16.9	0.50	450	0.202	1.27	10.00	0.22	10.22	50%
BLOCK 26-SWM POND	17	HW 1	0.00	0.00	0.00	5.82	100.1	1.618	0.000	0.032	1.650	21.9	0.30	1350	2.923	2.04	12.95	0.18	13.12	56%
BLOCK 22	24	25	1.11	0.90	1.00	1.00	109.7	0.304			0.304	17.3	0.30	675	0.460	1.29	10.00	0.22	10.22	66%
	25	26				1.00	108.9	0.302			0.302	47.3	0.30	675	0.460	1.29	10.22	0.61	10.84	66%
	26	HW1				1.00	106.8	0.296			0.296	14.5	0.30	675	0.460	1.29	10.84	0.19	11.02	64%

PROJECT DETAILS

Title1: **STORM SEWER DESIGN SHEET**
Title2: **Constant Flow Calculations**
Project Name: **Orangeville Highlands Phase 2**
Municipality: **Town of Orangeville**
Project No: **06-233**
Date: **22-Mar-19**
Designed by: **SR**
Checked by: **DZ**

IDF Parameters for Orangeville			
$I=A/(T+b)^c$		10-yr	100-yr
	A	1763.886	4338.383
	B	16.056	27.408
	C	0.852	0.925

ID	**MH**	**A** *ha*	**R**	**AR**	**L** *m*	**Tc** *min*	**I10** *mm/hr*	**I100** *mm/hr*	**Q10** *m3/s*	**Q100** *m3/s*	**Q100-Q10** *m3/s*	**Const. flow** *m3/s*
100YR-1	1	0.13	0.90	0.12	35	10.39	108.3	150.7	0.035	0.049	0.014	0.014
100YR-2	10	0.17	0.90	0.15	60	10.67	107.3	149.7	0.046	0.064	0.018	0.018

Tc calcs *where Tc = starting Tc + length/velocity*
Starting Tc (min) = 10
Velocity (m/s) = 1.5

P:\Projects\06-233-Phase 2\FSR\Design\Storm\[06-233 STM (Constant Flow).xls]100yr capture calcs

SWM POND DESIGN CALCULATION
SWMF-1 TARGET SUMMARY

Project Name: ORANGEVILLE HIGHLANDS PHASE 2
Municipality: Town of Orangeville
Project No.: 06-233
Date: 23-Jan-18

Prepared by: D.L.
Checked by: A.F.
Submission #:

POND

Pond Layout

Head Wall

Number of Headwall:	1
Drainage Area to Headwall E [ha]:	0.00
Drainage Area to Headwall W [ha]:	11.57

Elevation (m)	Storm Event	Surface Area (m^2)	Total Storage Volume (m^3)	Active Storage Volume (m^3)
419.50	BOTTOM WET CELL	1238	0	
420.00	BOTTOM FOREBAY	308	0	0
421.00	PERM POOL	3654	3509	0
421.05	--	3747	3694	185
421.10	--	3841	3949	440
421.15	--	3934	4204	695
421.20	--	4027	4459	950
421.25	--	4120	4713	1205
421.30	--	4213	4968	1460
421.35	--	4307	5223	1715
421.40	--	4400	5478	1970
421.45	EXT DET	4493	5733	2225
421.50	--	4586	5988	2480
421.55	--	4680	6243	2735
421.60	2-YR	4773	6498	2989
421.65	--	4866	6753	3244
421.70	--	4959	7008	3499
421.75	5-YR	5052	7263	3754
421.80	10-YR	5146	7518	4009
421.85	--	5239	7773	4264
421.90	--	5332	8028	4519
421.95	25-YR	5425	8283	4774
422.00	50-YR	5518	8538	5029
422.05	--	5612	8793	5284
422.10	--	5705	9048	5539
422.15	--	5798	9303	5794
422.20	--	5891	9557	6049
422.25	--	5984	9812	6304
422.30	--	6078	10067	6559
422.35	--	6171	10322	6814
422.40	--	6264	10577	7069
422.45	--	6357	10832	7324
422.50	100-YR	6451	11087	7579

Note: Surface area and storage volume are generated from AutoCAD

Design Target

Event	Volume	Discharge	Description
PERM POOL	185 m^3/ha	-	(Modified for 70% imperviousness)
EXT DET	0 m^3/imp ha	0 m^3/s/ha	(VO5)
25 YR	0 m^3/imp ha	0 m^3/s/ha	(VO5)
100 YR	0 m^3/imp ha	0 m^3/s/ha	(VO5)
REGIONAL	0 m^3/imp ha	-	-

**** Quantity storage tagets include extended detention storage.**

Wet Pond *(REFER: MOECC Stormwater Management Planning and Design Manual 2003, Table 3.2)*

Impervious Level	Water Quality Storage Vol	Extended Detention	Permanent Pool
(%)	**m^3/ha**	**m^3/ha**	**m^3/ha**
35%	140	40	100
55%	190	40	150
70%	225	40	185
85%	250	40	210
Interpolated Storage Requirement			
70%	225	40	**185**

	Area [ha]	IMP%
Total Contributing Area	11.57	70.00%
Quantity Control Only	11.57	70.00%
Quality Control Only	11.57	70.00%

Return Period	Stage [m]	Required Volume [m^3]	Target Discharge [m^3/s]
PERM POOL	421.00	2140	-
EXT DET	421.45	2000	0.007
2-YR	421.60	2750	0.320
5-YR	421.75	3500	0.580
10-YR	421.80	3950	0.750
25-YR	421.95	4600	1.010
50-YR	422.00	5000	1.220
100-YR	422.50	5340	1.440
REGIONAL	0.00	-	-
EMERGENCY *	0.00	-	-

Note: 2-YR, 5-Yr, 10-Yr, 50-YR and 100-Yr levels are interpolated from target rates.

*Emergency flow target is the uncontrolled 100-year flow

HW#	**Minor System Uncontrolled Flow (m^3/s)**	**100-Yr Uncontrolled Flow (m^3/s)**
HW-W	-	3.567
HW-E	-	-

Drawdown Time Target = 48 Hours

Forebay L:W Ratio = 3 : 1

SWM DESIGN CALCULATIONS

Project Name: ORANGEVILLE HIGHLANDS PHASE 2
Municipality: Town of Orangeville
Project No.: 06-233
Date: 23-Jan-18

Prepared by: D.L.
Checked by: A.F.
Last Revised:

POND

Input Parameters:

Side Slope, S_1	5	:1 (5%)
Side Slope, S_2	5	:1 (5%)
Spillway Invert	422.5	m
Water Level	422.9	m
Flow Depth, H	0.40	m
Bottom Width, B:	10.0	m

Weir equation: $Q = BxC_dxH^{3/2} + SxC_dxH^{5/2}$

$C_d = 1.5$

where:
Q=flow rate (m3/s)
H= head on the weir (m)
B=width of the weir (m)
S = side slopes of weir (H:V)

Computed Values:

Capacity, Q at 422.9m	**4.55**	m^3/s
Emergency Flow via Spillway	**3.57**	m^3/s

Uncontrolled 100-year: 3.567 m^3/s
Regional Event: - m^3/s

The proposed emergency spillway provides sufficient capacity.

```
===========================================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
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                   *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 5.0\VO2\voin.dat
  Output  filename: C:\Users\dlee\AppData\Local\Civica\VH5\5adcd22e-1633-4416-b3c0-53190c2640b0\9c34a859-9a02-
  Summary filename: C:\Users\dlee\AppData\Local\Civica\VH5\5adcd22e-1633-4416-b3c0-53190c2640b0\9c34a859-9a02-


DATE: 04/26/2018                         TIME: 05:30:06

USER:



COMMENTS: ____________________________________________________________


-----------------------------------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   0 **
  ****************************


--------------------
|    READ STORM    |    Filename: C:\Users\dlee\AppD
|                  |              ata\Local\Temp\
|                  |              ab3f5c2f-d020-4fa4-903a-45cde12d5781\1bfbd2d8
| Ptotal=122.60 mm |    Comments: 24 hour
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.17    0.00 |  6.33    2.21 | 12.50   17.65 | 18.67    2.21
                 0.33    1.47 |  6.50    2.21 | 12.67   13.24 | 18.83    1.47
                 0.50    0.74 |  6.67    2.21 | 12.83   10.30 | 19.00    2.21
                 0.67    1.47 |  6.83    2.21 | 13.00    8.83 | 19.17    2.21
                 0.83    1.47 |  7.00    2.94 | 13.17    8.09 | 19.33    1.47
                 1.00    1.47 |  7.17    2.21 | 13.33    7.36 | 19.50    2.21
                 1.17    0.74 |  7.33    2.21 | 13.50    6.62 | 19.67    1.47
                 1.33    1.47 |  7.50    2.94 | 13.67    5.88 | 19.83    2.21
                 1.50    1.47 |  7.67    2.21 | 13.83    5.88 | 20.00    1.47
                 1.67    1.47 |  7.83    2.94 | 14.00    5.15 | 20.17    1.47
                 1.83    1.47 |  8.00    2.21 | 14.17    4.41 | 20.33    1.47
                 2.00    1.47 |  8.17    2.94 | 14.33    4.41 | 20.50    1.47
                 2.17    1.47 |  8.33    2.94 | 14.50    4.41 | 20.67    1.47
                 2.33    1.47 |  8.50    2.94 | 14.67    4.41 | 20.83    2.21
                 2.50    1.47 |  8.67    2.94 | 14.83    3.68 | 21.00    1.47
                 2.67    1.47 |  8.83    3.68 | 15.00    3.68 | 21.17    1.47
                 2.83    1.47 |  9.00    3.68 | 15.17    4.41 | 21.33    1.47
                 3.00    1.47 |  9.17    3.68 | 15.33    2.94 | 21.50    1.47
                 3.17    1.47 |  9.33    3.68 | 15.50    3.68 | 21.67    1.47
                 3.33    2.21 |  9.50    4.41 | 15.67    3.68 | 21.83    1.47
                 3.50    1.47 |  9.67    3.68 | 15.83    2.94 | 22.00    1.47
                 3.67    1.47 |  9.83    4.41 | 16.00    2.94 | 22.17    1.47
                 3.83    1.47 | 10.00    4.41 | 16.17    2.94 | 22.33    1.47
                 4.00    2.21 | 10.17    4.41 | 16.33    2.94 | 22.50    1.47
                 4.17    1.47 | 10.33    5.15 | 16.50    2.94 | 22.67    1.47
                 4.33    1.47 | 10.50    5.88 | 16.67    2.21 | 22.83    1.47
                 4.50    2.21 | 10.67    5.88 | 16.83    2.94 | 23.00    1.47
                 4.67    1.47 | 10.83    6.62 | 17.00    2.21 | 23.17    1.47
                 4.83    2.21 | 11.00    8.09 | 17.17    2.94 | 23.33    1.47
                 5.00    1.47 | 11.17    8.09 | 17.33    2.21 | 23.50    1.47
                 5.17    2.21 | 11.33    9.56 | 17.50    2.21 | 23.67    0.74
                 5.33    2.21 | 11.50   11.77 | 17.67    2.94 | 23.83    1.47
                 5.50    1.47 | 11.67   13.98 | 17.83    2.21 | 24.00    1.47
                 5.67    2.21 | 11.83   39.72 | 18.00    2.21 | 24.17    1.47
                 5.83    2.21 | 12.00   98.57 | 18.17    2.21 |
                 6.00    2.21 | 12.17  141.23 | 18.33    2.21 |
```

```
                 6.17    2.21 | 12.33   22.07 | 18.50    2.21 |

-------------------------------------------------------------------------------

--------------------
| CALIB             |
| NASHYD   (  0008)|   Area    (ha)=  12.15   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                               ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 6.167    2.21 |12.250   22.08 | 18.33    2.21
                0.167    0.00 | 6.250    2.21 |12.333   22.07 | 18.42    2.21
                0.250    1.47 | 6.333    2.21 |12.417   17.65 | 18.50    2.21
                0.333    1.47 | 6.417    2.21 |12.500   17.65 | 18.58    2.21
                0.417    0.74 | 6.500    2.21 |12.583   13.24 | 18.67    2.21
                0.500    0.74 | 6.583    2.21 |12.667   13.24 | 18.75    1.47
                0.583    1.47 | 6.667    2.21 |12.750   10.30 | 18.83    1.47
                0.667    1.47 | 6.750    2.21 |12.833   10.30 | 18.92    2.21
                0.750    1.47 | 6.833    2.21 |12.917    8.83 | 19.00    2.21
                0.833    1.47 | 6.917    2.94 |13.000    8.83 | 19.08    2.21
                0.917    1.47 | 7.000    2.94 |13.083    8.09 | 19.17    2.21
                1.000    1.47 | 7.083    2.21 |13.167    8.09 | 19.25    1.47
                1.083    0.74 | 7.167    2.21 |13.250    7.36 | 19.33    1.47
                1.167    0.74 | 7.250    2.21 |13.333    7.36 | 19.42    2.21
                1.250    1.47 | 7.333    2.21 |13.417    6.62 | 19.50    2.21
                1.333    1.47 | 7.417    2.94 |13.500    6.62 | 19.58    1.47
                1.417    1.47 | 7.500    2.94 |13.583    5.88 | 19.67    1.47
                1.500    1.47 | 7.583    2.21 |13.667    5.88 | 19.75    2.21
                1.583    1.47 | 7.667    2.21 |13.750    5.88 | 19.83    2.21
                1.667    1.47 | 7.750    2.94 |13.833    5.88 | 19.92    1.47
                1.750    1.47 | 7.833    2.94 |13.917    5.15 | 20.00    1.47
                1.833    1.47 | 7.917    2.21 |14.000    5.15 | 20.08    1.47
                1.917    1.47 | 8.000    2.21 |14.083    4.41 | 20.17    1.47
                2.000    1.47 | 8.083    2.94 |14.167    4.41 | 20.25    1.47
                2.083    1.47 | 8.167    2.94 |14.250    4.41 | 20.33    1.47
                2.167    1.47 | 8.250    2.94 |14.333    4.41 | 20.42    1.47
                2.250    1.47 | 8.333    2.94 |14.417    4.41 | 20.50    1.47
                2.333    1.47 | 8.417    2.94 |14.500    4.41 | 20.58    1.47
                2.417    1.47 | 8.500    2.94 |14.583    4.41 | 20.67    1.47
                2.500    1.47 | 8.583    2.94 |14.667    4.41 | 20.75    2.21
                2.583    1.47 | 8.667    2.94 |14.750    3.68 | 20.83    2.21
                2.667    1.47 | 8.750    3.68 |14.833    3.68 | 20.92    1.47
                2.750    1.47 | 8.833    3.68 |14.917    3.68 | 21.00    1.47
                2.833    1.47 | 8.917    3.68 |15.000    3.68 | 21.08    1.47
                2.917    1.47 | 9.000    3.68 |15.083    4.41 | 21.17    1.47
                3.000    1.47 | 9.083    3.68 |15.167    4.41 | 21.25    1.47
                3.083    1.47 | 9.167    3.68 |15.250    2.94 | 21.33    1.47
                3.167    1.47 | 9.250    3.68 |15.333    2.94 | 21.42    1.47
                3.250    2.21 | 9.333    3.68 |15.417    3.68 | 21.50    1.47
                3.333    2.21 | 9.417    4.41 |15.500    3.68 | 21.58    1.47
                3.417    1.47 | 9.500    4.41 |15.583    3.68 | 21.67    1.47
                3.500    1.47 | 9.583    3.68 |15.667    3.68 | 21.75    1.47
                3.583    1.47 | 9.667    3.68 |15.750    2.94 | 21.83    1.47
                3.667    1.47 | 9.750    4.41 |15.833    2.94 | 21.92    1.47
                3.750    1.47 | 9.833    4.41 |15.917    2.94 | 22.00    1.47
                3.833    1.47 | 9.917    4.41 |16.000    2.94 | 22.08    1.47
                3.917    2.21 |10.000    4.41 |16.083    2.94 | 22.17    1.47
                4.000    2.21 |10.083    4.41 |16.167    2.94 | 22.25    1.47
                4.083    1.47 |10.167    4.41 |16.250    2.94 | 22.33    1.47
                4.167    1.47 |10.250    5.15 |16.333    2.94 | 22.42    1.47
                4.250    1.47 |10.333    5.15 |16.417    2.94 | 22.50    1.47
                4.333    1.47 |10.417    5.88 |16.500    2.94 | 22.58    1.47
                4.417    2.21 |10.500    5.88 |16.583    2.21 | 22.67    1.47
                4.500    2.21 |10.583    5.88 |16.667    2.21 | 22.75    1.47
                4.583    1.47 |10.667    5.88 |16.750    2.94 | 22.83    1.47
                4.667    1.47 |10.750    6.62 |16.833    2.94 | 22.92    1.47
                4.750    2.21 |10.833    6.62 |16.917    2.21 | 23.00    1.47
                4.833    2.21 |10.917    8.09 |17.000    2.21 | 23.08    1.47
                4.917    1.47 |11.000    8.09 |17.083    2.94 | 23.17    1.47
                5.000    1.47 |11.083    8.09 |17.167    2.94 | 23.25    1.47
                5.083    2.21 |11.167    8.09 |17.250    2.21 | 23.33    1.47
                5.167    2.21 |11.250    9.56 |17.333    2.21 | 23.42    1.47
                5.250    2.21 |11.333    9.56 |17.417    2.21 | 23.50    1.47
                5.333    2.21 |11.417   11.77 |17.500    2.21 | 23.58    0.74
                5.417    1.47 |11.500   11.77 |17.583    2.94 | 23.67    0.74
                5.500    1.47 |11.583   13.98 |17.667    2.94 | 23.75    1.47
                5.583    2.21 |11.667   13.98 |17.750    2.21 | 23.83    1.47
                5.667    2.21 |11.750   39.72 |17.833    2.21 | 23.92    1.47
```

```
                5.750    2.21 |11.833   39.72 |17.917    2.21 | 24.00    1.47
                5.833    2.21 |11.917   98.56 |18.000    2.21 | 24.08    1.47
                5.917    2.21 |12.000   98.57 |18.083    2.21 | 24.17    1.47
                6.000    2.21 |12.083  141.22 |18.167    2.21 |
                6.083    2.21 |12.167  141.23 |18.250    2.21 |

     Unit Hyd Qpeak  (cms)=   2.344

     PEAK FLOW       (cms)=   1.471 (i)
     TIME TO PEAK    (hrs)=  12.250
     RUNOFF VOLUME    (mm)=  49.293
     TOTAL RAINFALL   (mm)= 122.597
     RUNOFF COEFFICIENT   =   0.402

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0012)|   Area    (ha)=  10.20   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

     Unit Hyd Qpeak  (cms)=   1.968

     PEAK FLOW       (cms)=   1.235 (i)
     TIME TO PEAK    (hrs)=  12.250
     RUNOFF VOLUME    (mm)=  49.293
     TOTAL RAINFALL   (mm)= 122.597
     RUNOFF COEFFICIENT   =   0.402

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0013)|   Area    (ha)=   1.98   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.06

     Unit Hyd Qpeak  (cms)=   1.282

     PEAK FLOW       (cms)=   0.328 (i)
     TIME TO PEAK    (hrs)=  12.167
     RUNOFF VOLUME    (mm)=  42.023
     TOTAL RAINFALL   (mm)= 122.597
     RUNOFF COEFFICIENT   =   0.343

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0014)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0012):    10.20   1.235    12.25    49.29
      + ID2= 2 (  0013):     1.98   0.328    12.17    42.02
        ===================================================
        ID = 3 (  0014):    12.18   1.481    12.17    48.11

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0025)|   Area    (ha)=   0.23
|ID= 1 DT= 5.0 min |   Total Imp(%)=  30.00   Dir. Conn.(%)=  30.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.07         0.16
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      39.16        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     141.23        68.69
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.27 (ii)    9.47 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.33         0.12
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.03         0.02          0.049 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.17          12.17
```

```
     RUNOFF VOLUME    (mm)=     121.60        49.39          71.03
     TOTAL RAINFALL   (mm)=     122.60       122.60         122.60
     RUNOFF COEFFICIENT   =       0.99         0.40           0.58

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0026)|   Area    (ha)=   0.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29         0.13
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      52.92        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     141.23        68.69
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.52 (ii)    5.90 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.33         0.15
                                                              *TOTALS*
     PEAK FLOW       (cms)=       0.12         0.02            0.135 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.17            12.17
     RUNOFF VOLUME    (mm)=     121.60        49.39            99.93
     TOTAL RAINFALL   (mm)=     122.60       122.60           122.60
     RUNOFF COEFFICIENT   =       0.99         0.40             0.82

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB              |
| STANDHYD (  0029)|   Area    (ha)=  11.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.10         3.47
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     277.73        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     141.23        68.69
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.11 (ii)    8.49 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.24         0.12
                                                              *TOTALS*
     PEAK FLOW       (cms)=       3.08         0.48            3.567 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.17            12.17
     RUNOFF VOLUME    (mm)=     121.60        49.39            99.93
     TOTAL RAINFALL   (mm)=     122.60       122.60           122.60
     RUNOFF COEFFICIENT   =       0.99         0.40             0.82

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR(  0027)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
```

```
                          0.0000     0.0000   |   0.7500      0.3950
                          0.0070     0.2000   |   1.0100      0.4600
                          0.3200     0.2750   |   1.2200      0.5000
                          0.5800     0.3500   |   1.4400      0.5340

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0029)     11.570      3.567     12.17      99.93
   OUTFLOW: ID= 1 (  0027)     11.570      1.394     12.25      97.02

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 39.09
                   TIME SHIFT OF PEAK FLOW         (min)=  5.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.5321

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--------------------
| ADD HYD  (  0028)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0025):     0.23   0.049    12.17    71.03
      + ID2= 2 (  0026):     0.42   0.135    12.17    99.93
        ====================================================
        ID = 3 (  0028):     0.65   0.184    12.17    89.70

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD  (  0028)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0028):     0.65   0.184    12.17    89.70
      + ID2= 2 (  0027):    11.57   1.394    12.25    97.02
        ====================================================
        ID = 1 (  0028):    12.22   1.460    12.25    96.63

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD (  0030)|   Area    (ha)=   0.23
|ID= 1 DT= 5.0 min |   Total Imp(%)=  30.00   Dir. Conn.(%)=  30.00
--------------------
                                 IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=         0.07          0.16
     Dep. Storage     (mm)=         1.00          5.00
     Average Slope     (%)=         1.00          2.00
     Length            (m)=        39.16         40.00
     Mannings n           =        0.013         0.250

     Max.Eff.Inten.(mm/hr)=       141.23         68.69
                over (min)          5.00         10.00
     Storage Coeff.  (min)=         1.27 (ii)     9.47 (ii)
     Unit Hyd. Tpeak (min)=         5.00         10.00
     Unit Hyd. peak  (cms)=         0.33          0.12
                                                              *TOTALS*
     PEAK FLOW       (cms)=         0.03          0.02          0.049 (iii)
     TIME TO PEAK    (hrs)=        12.17         12.17          12.17
     RUNOFF VOLUME    (mm)=       121.60         49.39          71.03
     TOTAL RAINFALL   (mm)=       122.60        122.60         122.60
     RUNOFF COEFFICIENT   =         0.99          0.40           0.58

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD (  0031)|   Area    (ha)=  11.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                                 IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=         8.10          3.47
     Dep. Storage     (mm)=         1.00          5.00
     Average Slope     (%)=         1.00          2.00
     Length            (m)=       277.73         40.00
```

```
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     141.23        68.69
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.11 (ii)    8.49 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.24         0.12
                                                           *TOTALS*
     PEAK FLOW       (cms)=       3.08         0.48          3.567 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.17          12.17
     RUNOFF VOLUME    (mm)=     121.60        49.39          99.93
     TOTAL RAINFALL   (mm)=     122.60       122.60         122.60
     RUNOFF COEFFICIENT   =       0.99         0.40           0.82

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB             |
| STANDHYD (  0033)|   Area    (ha)=   0.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29         0.13
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      52.92        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     141.23        68.69
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.52 (ii)    5.90 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.33         0.15
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.12         0.02          0.135 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.17          12.17
     RUNOFF VOLUME    (mm)=     121.60        49.39          99.93
     TOTAL RAINFALL   (mm)=     122.60       122.60         122.60
     RUNOFF COEFFICIENT   =       0.99         0.40           0.82

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0034)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0030):     0.23   0.049    12.17    71.03
      + ID2= 2 (  0031):    11.57   3.567    12.17    99.93
        ====================================================
        ID = 3 (  0034):    11.80   3.616    12.17    99.37

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD  (  0034)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0034):    11.80   3.616    12.17    99.37
      + ID2= 2 (  0033):     0.42   0.135    12.17    99.93
        ====================================================
        ID = 1 (  0034):    12.22   3.751    12.17    99.39

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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===========================================================================================================
```

```
       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I      SS   U   U  AAAAA  L
        V  V    I        SS U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO     TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
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                   *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 5.0\VO2\voin.dat
  Output  filename: C:\Users\dlee\AppData\Local\Civica\VH5\5adcd22e-1633-4416-b3c0-53190c2640b0\0cf49570-59fc-
  Summary filename: C:\Users\dlee\AppData\Local\Civica\VH5\5adcd22e-1633-4416-b3c0-53190c2640b0\0cf49570-59fc-


DATE: 04/26/2018                          TIME: 05:30:05

USER:



COMMENTS: ____________________________________________________________


--------------------------------------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   0 **
  ****************************


--------------------
|    READ STORM    |    Filename: C:\Users\dlee\AppD
|                  |              ata\Local\Temp\
|                  |              ab3f5c2f-d020-4fa4-903a-45cde12d5781\2fed91df
| Ptotal= 85.49 mm |    Comments: 24 hour
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.17    0.00 |  6.33    1.54 | 12.50   12.30 | 18.67    1.54
                 0.33    1.03 |  6.50    1.54 | 12.67    9.23 | 18.83    1.03
                 0.50    0.51 |  6.67    1.54 | 12.83    7.18 | 19.00    1.54
                 0.67    1.03 |  6.83    1.54 | 13.00    6.15 | 19.17    1.54
                 0.83    1.03 |  7.00    2.05 | 13.17    5.64 | 19.33    1.03
                 1.00    1.03 |  7.17    1.54 | 13.33    5.13 | 19.50    1.54
                 1.17    0.51 |  7.33    1.54 | 13.50    4.61 | 19.67    1.03
                 1.33    1.03 |  7.50    2.05 | 13.67    4.10 | 19.83    1.54
                 1.50    1.03 |  7.67    1.54 | 13.83    4.10 | 20.00    1.03
                 1.67    1.03 |  7.83    2.05 | 14.00    3.59 | 20.17    1.03
                 1.83    1.03 |  8.00    1.54 | 14.17    3.08 | 20.33    1.03
                 2.00    1.03 |  8.17    2.05 | 14.33    3.08 | 20.50    1.03
                 2.17    1.03 |  8.33    2.05 | 14.50    3.08 | 20.67    1.03
                 2.33    1.03 |  8.50    2.05 | 14.67    3.08 | 20.83    1.54
                 2.50    1.03 |  8.67    2.05 | 14.83    2.56 | 21.00    1.03
                 2.67    1.03 |  8.83    2.56 | 15.00    2.56 | 21.17    1.03
                 2.83    1.03 |  9.00    2.56 | 15.17    3.08 | 21.33    1.03
                 3.00    1.03 |  9.17    2.56 | 15.33    2.05 | 21.50    1.03
                 3.17    1.03 |  9.33    2.56 | 15.50    2.56 | 21.67    1.03
                 3.33    1.54 |  9.50    3.08 | 15.67    2.56 | 21.83    1.03
                 3.50    1.03 |  9.67    2.56 | 15.83    2.05 | 22.00    1.03
                 3.67    1.03 |  9.83    3.08 | 16.00    2.05 | 22.17    1.03
                 3.83    1.03 | 10.00    3.08 | 16.17    2.05 | 22.33    1.03
                 4.00    1.54 | 10.17    3.08 | 16.33    2.05 | 22.50    1.03
                 4.17    1.03 | 10.33    3.59 | 16.50    2.05 | 22.67    1.03
                 4.33    1.03 | 10.50    4.10 | 16.67    1.54 | 22.83    1.03
                 4.50    1.54 | 10.67    4.10 | 16.83    2.05 | 23.00    1.03
                 4.67    1.03 | 10.83    4.61 | 17.00    1.54 | 23.17    1.03
                 4.83    1.54 | 11.00    5.64 | 17.17    2.05 | 23.33    1.03
                 5.00    1.03 | 11.17    5.64 | 17.33    1.54 | 23.50    1.03
                 5.17    1.54 | 11.33    6.66 | 17.50    1.54 | 23.67    0.51
                 5.33    1.54 | 11.50    8.20 | 17.67    2.05 | 23.83    1.03
                 5.50    1.03 | 11.67    9.74 | 17.83    1.54 | 24.00    1.03
                 5.67    1.54 | 11.83   27.68 | 18.00    1.54 | 24.17    1.03
                 5.83    1.54 | 12.00   68.69 | 18.17    1.54 |
                 6.00    1.54 | 12.17   98.43 | 18.33    1.54 |
                 6.17    1.54 | 12.33   15.38 | 18.50    1.54 |
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| CALIB             |
| NASHYD   (  0008)|   Area    (ha)=  12.15   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                ---- TRANSFORMED HYETOGRAPH ----
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.083    0.00 | 6.167    1.54 |12.250   15.39 | 18.33    1.54
                 0.167    0.00 | 6.250    1.54 |12.333   15.38 | 18.42    1.54
                 0.250    1.03 | 6.333    1.54 |12.417   12.30 | 18.50    1.54
                 0.333    1.03 | 6.417    1.54 |12.500   12.30 | 18.58    1.54
                 0.417    0.51 | 6.500    1.54 |12.583    9.23 | 18.67    1.54
                 0.500    0.51 | 6.583    1.54 |12.667    9.23 | 18.75    1.03
                 0.583    1.03 | 6.667    1.54 |12.750    7.18 | 18.83    1.03
                 0.667    1.03 | 6.750    1.54 |12.833    7.18 | 18.92    1.54
                 0.750    1.03 | 6.833    1.54 |12.917    6.15 | 19.00    1.54
                 0.833    1.03 | 6.917    2.05 |13.000    6.15 | 19.08    1.54
                 0.917    1.03 | 7.000    2.05 |13.083    5.64 | 19.17    1.54
                 1.000    1.03 | 7.083    1.54 |13.167    5.64 | 19.25    1.03
                 1.083    0.51 | 7.167    1.54 |13.250    5.13 | 19.33    1.03
                 1.167    0.51 | 7.250    1.54 |13.333    5.13 | 19.42    1.54
                 1.250    1.03 | 7.333    1.54 |13.417    4.61 | 19.50    1.54
                 1.333    1.03 | 7.417    2.05 |13.500    4.61 | 19.58    1.03
                 1.417    1.03 | 7.500    2.05 |13.583    4.10 | 19.67    1.03
                 1.500    1.03 | 7.583    1.54 |13.667    4.10 | 19.75    1.54
                 1.583    1.03 | 7.667    1.54 |13.750    4.10 | 19.83    1.54
                 1.667    1.03 | 7.750    2.05 |13.833    4.10 | 19.92    1.03
                 1.750    1.03 | 7.833    2.05 |13.917    3.59 | 20.00    1.03
                 1.833    1.03 | 7.917    1.54 |14.000    3.59 | 20.08    1.03
                 1.917    1.03 | 8.000    1.54 |14.083    3.08 | 20.17    1.03
                 2.000    1.03 | 8.083    2.05 |14.167    3.08 | 20.25    1.03
                 2.083    1.03 | 8.167    2.05 |14.250    3.08 | 20.33    1.03
                 2.167    1.03 | 8.250    2.05 |14.333    3.08 | 20.42    1.03
                 2.250    1.03 | 8.333    2.05 |14.417    3.08 | 20.50    1.03
                 2.333    1.03 | 8.417    2.05 |14.500    3.08 | 20.58    1.03
                 2.417    1.03 | 8.500    2.05 |14.583    3.08 | 20.67    1.03
                 2.500    1.03 | 8.583    2.05 |14.667    3.08 | 20.75    1.54
                 2.583    1.03 | 8.667    2.05 |14.750    2.56 | 20.83    1.54
                 2.667    1.03 | 8.750    2.56 |14.833    2.56 | 20.92    1.03
                 2.750    1.03 | 8.833    2.56 |14.917    2.56 | 21.00    1.03
                 2.833    1.03 | 8.917    2.56 |15.000    2.56 | 21.08    1.03
                 2.917    1.03 | 9.000    2.56 |15.083    3.08 | 21.17    1.03
                 3.000    1.03 | 9.083    2.56 |15.167    3.08 | 21.25    1.03
                 3.083    1.03 | 9.167    2.56 |15.250    2.05 | 21.33    1.03
                 3.167    1.03 | 9.250    2.56 |15.333    2.05 | 21.42    1.03
                 3.250    1.54 | 9.333    2.56 |15.417    2.56 | 21.50    1.03
                 3.333    1.54 | 9.417    3.08 |15.500    2.56 | 21.58    1.03
                 3.417    1.03 | 9.500    3.08 |15.583    2.56 | 21.67    1.03
                 3.500    1.03 | 9.583    2.56 |15.667    2.56 | 21.75    1.03
                 3.583    1.03 | 9.667    2.56 |15.750    2.05 | 21.83    1.03
                 3.667    1.03 | 9.750    3.08 |15.833    2.05 | 21.92    1.03
                 3.750    1.03 | 9.833    3.08 |15.917    2.05 | 22.00    1.03
                 3.833    1.03 | 9.917    3.08 |16.000    2.05 | 22.08    1.03
                 3.917    1.54 |10.000    3.08 |16.083    2.05 | 22.17    1.03
                 4.000    1.54 |10.083    3.08 |16.167    2.05 | 22.25    1.03
                 4.083    1.03 |10.167    3.08 |16.250    2.05 | 22.33    1.03
                 4.167    1.03 |10.250    3.59 |16.333    2.05 | 22.42    1.03
                 4.250    1.03 |10.333    3.59 |16.417    2.05 | 22.50    1.03
                 4.333    1.03 |10.417    4.10 |16.500    2.05 | 22.58    1.03
                 4.417    1.54 |10.500    4.10 |16.583    1.54 | 22.67    1.03
                 4.500    1.54 |10.583    4.10 |16.667    1.54 | 22.75    1.03
                 4.583    1.03 |10.667    4.10 |16.750    2.05 | 22.83    1.03
                 4.667    1.03 |10.750    4.61 |16.833    2.05 | 22.92    1.03
                 4.750    1.54 |10.833    4.61 |16.917    1.54 | 23.00    1.03
                 4.833    1.54 |10.917    5.64 |17.000    1.54 | 23.08    1.03
                 4.917    1.03 |11.000    5.64 |17.083    2.05 | 23.17    1.03
                 5.000    1.03 |11.083    5.64 |17.167    2.05 | 23.25    1.03
                 5.083    1.54 |11.167    5.64 |17.250    1.54 | 23.33    1.03
                 5.167    1.54 |11.250    6.66 |17.333    1.54 | 23.42    1.03
                 5.250    1.54 |11.333    6.66 |17.417    1.54 | 23.50    1.03
                 5.333    1.54 |11.417    8.20 |17.500    1.54 | 23.58    0.51
                 5.417    1.03 |11.500    8.20 |17.583    2.05 | 23.67    0.51
                 5.500    1.03 |11.583    9.74 |17.667    2.05 | 23.75    1.03
                 5.583    1.54 |11.667    9.74 |17.750    1.54 | 23.83    1.03
                 5.667    1.54 |11.750   27.68 |17.833    1.54 | 23.92    1.03
                 5.750    1.54 |11.833   27.68 |17.917    1.54 | 24.00    1.03
                 5.833    1.54 |11.917   68.69 |18.000    1.54 | 24.08    1.03
```

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                5.917    1.54 |12.000   68.69 |18.083    1.54 | 24.17    1.03
                6.000    1.54 |12.083   98.43 |18.167    1.54 |
                6.083    1.54 |12.167   98.43 |18.250    1.54 |

     Unit Hyd Qpeak  (cms)=   2.344

     PEAK FLOW       (cms)=   0.784 (i)
     TIME TO PEAK    (hrs)=  12.250
     RUNOFF VOLUME    (mm)=  26.620
     TOTAL RAINFALL   (mm)=  85.488
     RUNOFF COEFFICIENT   =   0.311

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0012)|   Area    (ha)=  10.20   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

     Unit Hyd Qpeak  (cms)=   1.968

     PEAK FLOW       (cms)=   0.659 (i)
     TIME TO PEAK    (hrs)=  12.250
     RUNOFF VOLUME    (mm)=  26.620
     TOTAL RAINFALL   (mm)=  85.488
     RUNOFF COEFFICIENT   =   0.311

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0013)|   Area    (ha)=   1.98   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.06

     Unit Hyd Qpeak  (cms)=   1.282

     PEAK FLOW       (cms)=   0.178 (i)
     TIME TO PEAK    (hrs)=  12.167
     RUNOFF VOLUME    (mm)=  22.694
     TOTAL RAINFALL   (mm)=  85.488
     RUNOFF COEFFICIENT   =   0.265

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0014)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK      R.V.
--------------------         (ha)    (cms)    (hrs)      (mm)
        ID1= 1 (  0012):    10.20   0.659    12.25    26.62
      + ID2= 2 (  0013):     1.98   0.178    12.17    22.69
        =====================================================
        ID = 3 (  0014):    12.18   0.787    12.17    25.98

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0025)|   Area    (ha)=   0.23
|ID= 1 DT= 5.0 min |   Total Imp(%)=  30.00   Dir. Conn.(%)=  30.00
--------------------
                                 IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.07         0.16
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      39.16        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      98.43        31.70
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.46 (ii)   12.64 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.33         0.08
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.01          0.027 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.25          12.17
     RUNOFF VOLUME    (mm)=      84.49        26.67          43.98
     TOTAL RAINFALL   (mm)=      85.49        85.49          85.49
```

```
     RUNOFF COEFFICIENT   =       0.99         0.31           0.51

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0026)|   Area    (ha)=   0.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29         0.13
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      52.92        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      98.43        31.70
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.75 (ii)   12.93 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.32         0.08
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.08         0.01          0.087 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.25          12.17
     RUNOFF VOLUME    (mm)=      84.49        26.67          67.12
     TOTAL RAINFALL   (mm)=      85.49        85.49          85.49
     RUNOFF COEFFICIENT   =       0.99         0.31           0.79

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0029)|   Area    (ha)=  11.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.10         3.47
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     277.73        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      98.43        31.70
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       4.75 (ii)   15.92 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.22         0.07
                                                           *TOTALS*
     PEAK FLOW       (cms)=       2.12         0.18          2.250 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.33          12.17
     RUNOFF VOLUME    (mm)=      84.49        26.67          67.14
     TOTAL RAINFALL   (mm)=      85.49        85.49          85.49
     RUNOFF COEFFICIENT   =       0.99         0.31           0.79

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0027)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.7500      0.3950
                          0.0070     0.2000   |   1.0100      0.4600
```

```
                          0.3200     0.2750   |   1.2200      0.5000
                          0.5800     0.3500   |   1.4400      0.5340

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0029)     11.570      2.250     12.17      67.14
   OUTFLOW: ID= 1 (  0027)     11.570      0.741     12.33      64.23

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 32.93
                   TIME SHIFT OF PEAK FLOW         (min)= 10.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.3926

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0028)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0025):     0.23   0.027    12.17    43.98
      + ID2= 2 (  0026):     0.42   0.087    12.17    67.12
        =======================================================
        ID = 3 (  0028):     0.65   0.114    12.17    58.93

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD  (  0028)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0028):     0.65   0.114    12.17    58.93
      + ID2= 2 (  0027):    11.57   0.741    12.33    64.23
        =======================================================
        ID = 1 (  0028):    12.22   0.774    12.33    63.95

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0030)|   Area    (ha)=   0.23
|ID= 1 DT= 5.0 min |   Total Imp(%)=  30.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.07         0.16
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      39.16        40.00
     Mannings n          =       0.013        0.250

     Max.Eff.Inten.(mm/hr)=      98.43        31.70
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.46 (ii)   12.64 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.33         0.08
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.01          0.027 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.25          12.17
     RUNOFF VOLUME    (mm)=      84.49        26.67          43.98
     TOTAL RAINFALL   (mm)=      85.49        85.49          85.49
     RUNOFF COEFFICIENT   =       0.99         0.31           0.51

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0031)|   Area    (ha)=  11.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.10         3.47
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     277.73        40.00
     Mannings n          =       0.013        0.250
```

```
     Max.Eff.Inten.(mm/hr)=      98.43        31.70
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       4.75 (ii)   15.92 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.22         0.07
                                                           *TOTALS*
     PEAK FLOW       (cms)=       2.12         0.18          2.250 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.33          12.17
     RUNOFF VOLUME    (mm)=      84.49        26.67          67.14
     TOTAL RAINFALL   (mm)=      85.49        85.49          85.49
     RUNOFF COEFFICIENT   =       0.99         0.31           0.79

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0033)|   Area    (ha)=   0.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29         0.13
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      52.92        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      98.43        31.70
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.75 (ii)   12.93 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.32         0.08
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.08         0.01          0.087 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.25          12.17
     RUNOFF VOLUME    (mm)=      84.49        26.67          67.12
     TOTAL RAINFALL   (mm)=      85.49        85.49          85.49
     RUNOFF COEFFICIENT   =       0.99         0.31           0.79

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0034)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0030):     0.23   0.027    12.17    43.98
      + ID2= 2 (  0031):    11.57   2.250    12.17    67.14
        ====================================================
        ID = 3 (  0034):    11.80   2.277    12.17    66.69

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0034)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0034):    11.80   2.277    12.17    66.69
      + ID2= 2 (  0033):     0.42   0.087    12.17    67.12
        ====================================================
        ID = 1 (  0034):    12.22   2.364    12.17    66.71

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
===========================================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
```

```
        V   V    I     SS    U   U  AAAAA  L
        V   V    I      SS   U   U  A   A  L
         VV      I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO     TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
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                  *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 5.0\VO2\voin.dat
  Output  filename: C:\Users\dlee\AppData\Local\Civica\VH5\5adcd22e-1633-4416-b3c0-53190c2640b0\0a44177c-665a-
  Summary filename: C:\Users\dlee\AppData\Local\Civica\VH5\5adcd22e-1633-4416-b3c0-53190c2640b0\0a44177c-665a-


DATE: 04/26/2018                           TIME: 05:30:05

USER:



COMMENTS: ____________________________________________________________


--------------------------------------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   0 **
  ****************************


--------------------
|    READ STORM    |    Filename: C:\Users\dlee\AppD
|                  |              ata\Local\Temp\
|                  |              ab3f5c2f-d020-4fa4-903a-45cde12d5781\cddc4a9d
| Ptotal= 25.00 mm |    Comments:
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.17    2.07 | 1.17     5.70 |  2.17     5.19 |  3.17    2.80
                 0.33    2.27 | 1.33    10.78 |  2.33     4.47 |  3.33    2.62
                 0.50    2.52 | 1.50    50.21 |  2.50     3.95 |  3.50    2.48
                 0.67    2.88 | 1.67    13.37 |  2.67     3.56 |  3.67    2.35
                 0.83    3.38 | 1.83     8.29 |  2.83     3.25 |  3.83    2.23
                 1.00    4.18 | 2.00     6.30 |  3.00     3.01 |  4.00    2.14

----------------------------------------------------------------------------------


--------------------
| CALIB            |
| NASHYD   (  0008)|   Area    (ha)=  12.15   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                  ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    2.07 | 1.083    5.70 | 2.083     5.19 |  3.08    2.80
                0.167    2.07 | 1.167    5.70 | 2.167     5.19 |  3.17    2.80
                0.250    2.27 | 1.250   10.78 | 2.250     4.47 |  3.25    2.62
                0.333    2.27 | 1.333   10.78 | 2.333     4.47 |  3.33    2.62
                0.417    2.52 | 1.417   50.21 | 2.417     3.95 |  3.42    2.48
                0.500    2.52 | 1.500   50.21 | 2.500     3.95 |  3.50    2.48
                0.583    2.88 | 1.583   13.37 | 2.583     3.56 |  3.58    2.35
                0.667    2.88 | 1.667   13.37 | 2.667     3.56 |  3.67    2.35
                0.750    3.38 | 1.750    8.29 | 2.750     3.25 |  3.75    2.23
                0.833    3.38 | 1.833    8.29 | 2.833     3.25 |  3.83    2.23
                0.917    4.17 | 1.917    6.30 | 2.917     3.01 |  3.92    2.14
                1.000    4.18 | 2.000    6.29 | 3.000     3.01 |  4.00    2.14

     Unit Hyd Qpeak  (cms)=   2.344

     PEAK FLOW       (cms)=   0.056 (i)
     TIME TO PEAK    (hrs)=   1.667
     RUNOFF VOLUME    (mm)=   2.188
     TOTAL RAINFALL   (mm)=  24.996
```

```
     RUNOFF COEFFICIENT   =   0.088

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0012)|   Area    (ha)=  10.20   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

     Unit Hyd Qpeak  (cms)=   1.968

     PEAK FLOW       (cms)=   0.047 (i)
     TIME TO PEAK    (hrs)=   1.667
     RUNOFF VOLUME    (mm)=   2.188
     TOTAL RAINFALL   (mm)=  24.996
     RUNOFF COEFFICIENT   =   0.088

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0013)|   Area    (ha)=   1.98   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.06

     Unit Hyd Qpeak  (cms)=   1.282

     PEAK FLOW       (cms)=   0.016 (i)
     TIME TO PEAK    (hrs)=   1.500
     RUNOFF VOLUME    (mm)=   1.865
     TOTAL RAINFALL   (mm)=  24.996
     RUNOFF COEFFICIENT   =   0.075

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0014)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0012):    10.20   0.047     1.67     2.19
      + ID2= 2 (  0013):     1.98   0.016     1.50     1.87
        ===================================================
        ID = 3 (  0014):    12.18   0.055     1.67     2.14

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0025)|   Area    (ha)=   0.23
|ID= 1 DT= 5.0 min |   Total Imp(%)=  30.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.07         0.16
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      39.16        40.00
     Mannings n          =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      50.21         1.59
                over (min)        5.00        40.00
     Storage Coeff.  (min)=       1.92 (ii)   38.95 (ii)
     Unit Hyd. Tpeak (min)=       5.00        40.00
     Unit Hyd. peak  (cms)=       0.31         0.03
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.01         0.00          0.010 (iii)
     TIME TO PEAK    (hrs)=       1.50         2.33           1.50
     RUNOFF VOLUME    (mm)=      24.00         2.19           8.63
     TOTAL RAINFALL   (mm)=      25.00        25.00          25.00
     RUNOFF COEFFICIENT   =       0.96         0.09           0.35

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
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--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0026)|   Area    (ha)=   0.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29         0.13
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      52.92        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      50.21         1.59
                over (min)        5.00        40.00
     Storage Coeff.  (min)=       2.30 (ii)   39.33 (ii)
     Unit Hyd. Tpeak (min)=       5.00        40.00
     Unit Hyd. peak  (cms)=       0.30         0.03
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.04         0.00          0.041 (iii)
     TIME TO PEAK    (hrs)=       1.50         2.33           1.50
     RUNOFF VOLUME    (mm)=      24.00         2.19          17.40
     TOTAL RAINFALL   (mm)=      25.00        25.00          25.00
     RUNOFF COEFFICIENT   =       0.96         0.09           0.70

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0029)|   Area    (ha)=  11.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.10         3.47
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     277.73        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      50.21         1.59
                over (min)        5.00        45.00
     Storage Coeff.  (min)=       6.21 (ii)   43.25 (ii)
     Unit Hyd. Tpeak (min)=       5.00        45.00
     Unit Hyd. peak  (cms)=       0.19         0.03
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.95         0.01          0.948 (iii)
     TIME TO PEAK    (hrs)=       1.50         2.42           1.50
     RUNOFF VOLUME    (mm)=      24.00         2.19          17.45
     TOTAL RAINFALL   (mm)=      25.00        25.00          25.00
     RUNOFF COEFFICIENT   =       0.96         0.09           0.70


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0027)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.7500      0.3950
                          0.0070     0.2000   |   1.0100      0.4600
                          0.3200     0.2750   |   1.2200      0.5000
                          0.5800     0.3500   |   1.4400      0.5340

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0029)     11.570      0.948      1.50      17.45
   OUTFLOW: ID= 1 (  0027)     11.570      0.007      4.33      15.26

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  0.72
                   TIME SHIFT OF PEAK FLOW         (min)=170.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.1945
```

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--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0028)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0025):     0.23   0.010     1.50     8.63
      + ID2= 2 (  0026):     0.42   0.041     1.50    17.40
        ===================================================
        ID = 3 (  0028):     0.65   0.050     1.50    14.29

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD  (  0028)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0028):     0.65   0.050     1.50    14.29
      + ID2= 2 (  0027):    11.57   0.007     4.33    15.26
        ===================================================
        ID = 1 (  0028):    12.22   0.053     1.50    15.21

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0030)|   Area    (ha)=   0.23
|ID= 1 DT= 5.0 min |   Total Imp(%)=  30.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.07          0.16
     Dep. Storage     (mm)=       1.00          5.00
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      39.16         40.00
     Mannings n          =       0.013         0.250

     Max.Eff.Inten.(mm/hr)=      50.21          1.59
                over (min)        5.00         40.00
     Storage Coeff.  (min)=       1.92 (ii)    38.95 (ii)
     Unit Hyd. Tpeak (min)=       5.00         40.00
     Unit Hyd. peak  (cms)=       0.31          0.03
                                                              *TOTALS*
     PEAK FLOW       (cms)=       0.01          0.00            0.010 (iii)
     TIME TO PEAK    (hrs)=       1.50          2.33             1.50
     RUNOFF VOLUME    (mm)=      24.00          2.19             8.63
     TOTAL RAINFALL   (mm)=      25.00         25.00            25.00
     RUNOFF COEFFICIENT   =       0.96          0.09             0.35

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0031)|   Area    (ha)=  11.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.10          3.47
     Dep. Storage     (mm)=       1.00          5.00
     Average Slope     (%)=       1.00          2.00
     Length            (m)=     277.73         40.00
     Mannings n          =       0.013         0.250

     Max.Eff.Inten.(mm/hr)=      50.21          1.59
                over (min)        5.00         45.00
     Storage Coeff.  (min)=       6.21 (ii)    43.25 (ii)
     Unit Hyd. Tpeak (min)=       5.00         45.00
     Unit Hyd. peak  (cms)=       0.19          0.03
                                                              *TOTALS*
     PEAK FLOW       (cms)=       0.95          0.01            0.948 (iii)
     TIME TO PEAK    (hrs)=       1.50          2.42             1.50
     RUNOFF VOLUME    (mm)=      24.00          2.19            17.45
     TOTAL RAINFALL   (mm)=      25.00         25.00            25.00
     RUNOFF COEFFICIENT   =       0.96          0.09             0.70
```

```
       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0033)|   Area    (ha)=   0.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29         0.13
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      52.92        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      50.21         1.59
                over (min)        5.00        40.00
     Storage Coeff.  (min)=       2.30 (ii)   39.33 (ii)
     Unit Hyd. Tpeak (min)=       5.00        40.00
     Unit Hyd. peak  (cms)=       0.30         0.03
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.04         0.00          0.041 (iii)
     TIME TO PEAK    (hrs)=       1.50         2.33           1.50
     RUNOFF VOLUME    (mm)=      24.00         2.19          17.40
     TOTAL RAINFALL   (mm)=      25.00        25.00          25.00
     RUNOFF COEFFICIENT   =       0.96         0.09           0.70

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0034)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0030):     0.23   0.010     1.50     8.63
      + ID2= 2 (  0031):    11.57   0.948     1.50    17.45
        ====================================================
        ID = 3 (  0034):    11.80   0.958     1.50    17.28

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0034)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0034):    11.80   0.958     1.50    17.28
      + ID2= 2 (  0033):     0.42   0.041     1.50    17.40
        ====================================================
        ID = 1 (  0034):    12.22   0.998     1.50    17.28

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
===========================================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO     TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
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```
                  *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 5.0\VO2\voin.dat
  Output  filename: C:\Users\dlee\AppData\Local\Civica\VH5\5adcd22e-1633-4416-b3c0-53190c2640b0\db7690aa-9c4a-
  Summary filename: C:\Users\dlee\AppData\Local\Civica\VH5\5adcd22e-1633-4416-b3c0-53190c2640b0\db7690aa-9c4a-


DATE: 04/26/2018                          TIME: 05:30:06

USER:



COMMENTS: ____________________________________________________________


--------------------------------------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   0 **
  ****************************


--------------------
|    READ STORM    |    Filename: C:\Users\dlee\AppD
|                  |              ata\Local\Temp\
|                  |              ab3f5c2f-d020-4fa4-903a-45cde12d5781\9e70dc18
| Ptotal= 99.63 mm |    Comments: 24 hour
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.17    0.00 |  6.33    1.79 | 12.50   14.34 | 18.67    1.79
                 0.33    1.20 |  6.50    1.79 | 12.67   10.76 | 18.83    1.20
                 0.50    0.60 |  6.67    1.79 | 12.83    8.37 | 19.00    1.79
                 0.67    1.20 |  6.83    1.79 | 13.00    7.17 | 19.17    1.79
                 0.83    1.20 |  7.00    2.39 | 13.17    6.57 | 19.33    1.20
                 1.00    1.20 |  7.17    1.79 | 13.33    5.98 | 19.50    1.79
                 1.17    0.60 |  7.33    1.79 | 13.50    5.38 | 19.67    1.20
                 1.33    1.20 |  7.50    2.39 | 13.67    4.78 | 19.83    1.79
                 1.50    1.20 |  7.67    1.79 | 13.83    4.78 | 20.00    1.20
                 1.67    1.20 |  7.83    2.39 | 14.00    4.18 | 20.17    1.20
                 1.83    1.20 |  8.00    1.79 | 14.17    3.59 | 20.33    1.20
                 2.00    1.20 |  8.17    2.39 | 14.33    3.59 | 20.50    1.20
                 2.17    1.20 |  8.33    2.39 | 14.50    3.59 | 20.67    1.20
                 2.33    1.20 |  8.50    2.39 | 14.67    3.59 | 20.83    1.79
                 2.50    1.20 |  8.67    2.39 | 14.83    2.99 | 21.00    1.20
                 2.67    1.20 |  8.83    2.99 | 15.00    2.99 | 21.17    1.20
                 2.83    1.20 |  9.00    2.99 | 15.17    3.59 | 21.33    1.20
                 3.00    1.20 |  9.17    2.99 | 15.33    2.39 | 21.50    1.20
                 3.17    1.20 |  9.33    2.99 | 15.50    2.99 | 21.67    1.20
                 3.33    1.79 |  9.50    3.59 | 15.67    2.99 | 21.83    1.20
                 3.50    1.20 |  9.67    2.99 | 15.83    2.39 | 22.00    1.20
                 3.67    1.20 |  9.83    3.59 | 16.00    2.39 | 22.17    1.20
                 3.83    1.20 | 10.00    3.59 | 16.17    2.39 | 22.33    1.20
                 4.00    1.79 | 10.17    3.59 | 16.33    2.39 | 22.50    1.20
                 4.17    1.20 | 10.33    4.18 | 16.50    2.39 | 22.67    1.20
                 4.33    1.20 | 10.50    4.78 | 16.67    1.79 | 22.83    1.20
                 4.50    1.79 | 10.67    4.78 | 16.83    2.39 | 23.00    1.20
                 4.67    1.20 | 10.83    5.38 | 17.00    1.79 | 23.17    1.20
                 4.83    1.79 | 11.00    6.57 | 17.17    2.39 | 23.33    1.20
                 5.00    1.20 | 11.17    6.57 | 17.33    1.79 | 23.50    1.20
                 5.17    1.79 | 11.33    7.77 | 17.50    1.79 | 23.67    0.60
                 5.33    1.79 | 11.50    9.56 | 17.67    2.39 | 23.83    1.20
                 5.50    1.20 | 11.67   11.35 | 17.83    1.79 | 24.00    1.20
                 5.67    1.79 | 11.83   32.27 | 18.00    1.79 | 24.17    1.20
                 5.83    1.79 | 12.00   80.07 | 18.17    1.79 |
                 6.00    1.79 | 12.17  114.73 | 18.33    1.79 |
                 6.17    1.79 | 12.33   17.93 | 18.50    1.79 |

---------------------------------------------------------------------------------

--------------------
| CALIB            |
| NASHYD   (  0008)|   Area    (ha)=  12.15   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                  ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
```

```
           0.083    0.00 | 6.167    1.79 |12.250   17.94 | 18.33    1.79
           0.167    0.00 | 6.250    1.79 |12.333   17.93 | 18.42    1.79
           0.250    1.20 | 6.333    1.79 |12.417   14.34 | 18.50    1.79
           0.333    1.20 | 6.417    1.79 |12.500   14.34 | 18.58    1.79
           0.417    0.60 | 6.500    1.79 |12.583   10.76 | 18.67    1.79
           0.500    0.60 | 6.583    1.79 |12.667   10.76 | 18.75    1.20
           0.583    1.20 | 6.667    1.79 |12.750    8.37 | 18.83    1.20
           0.667    1.20 | 6.750    1.79 |12.833    8.37 | 18.92    1.79
           0.750    1.20 | 6.833    1.79 |12.917    7.17 | 19.00    1.79
           0.833    1.20 | 6.917    2.39 |13.000    7.17 | 19.08    1.79
           0.917    1.20 | 7.000    2.39 |13.083    6.57 | 19.17    1.79
           1.000    1.20 | 7.083    1.79 |13.167    6.57 | 19.25    1.20
           1.083    0.60 | 7.167    1.79 |13.250    5.98 | 19.33    1.20
           1.167    0.60 | 7.250    1.79 |13.333    5.98 | 19.42    1.79
           1.250    1.20 | 7.333    1.79 |13.417    5.38 | 19.50    1.79
           1.333    1.20 | 7.417    2.39 |13.500    5.38 | 19.58    1.20
           1.417    1.20 | 7.500    2.39 |13.583    4.78 | 19.67    1.20
           1.500    1.20 | 7.583    1.79 |13.667    4.78 | 19.75    1.79
           1.583    1.20 | 7.667    1.79 |13.750    4.78 | 19.83    1.79
           1.667    1.20 | 7.750    2.39 |13.833    4.78 | 19.92    1.20
           1.750    1.20 | 7.833    2.39 |13.917    4.18 | 20.00    1.20
           1.833    1.20 | 7.917    1.79 |14.000    4.18 | 20.08    1.20
           1.917    1.20 | 8.000    1.79 |14.083    3.59 | 20.17    1.20
           2.000    1.20 | 8.083    2.39 |14.167    3.59 | 20.25    1.20
           2.083    1.20 | 8.167    2.39 |14.250    3.59 | 20.33    1.20
           2.167    1.20 | 8.250    2.39 |14.333    3.59 | 20.42    1.20
           2.250    1.20 | 8.333    2.39 |14.417    3.59 | 20.50    1.20
           2.333    1.20 | 8.417    2.39 |14.500    3.59 | 20.58    1.20
           2.417    1.20 | 8.500    2.39 |14.583    3.59 | 20.67    1.20
           2.500    1.20 | 8.583    2.39 |14.667    3.59 | 20.75    1.79
           2.583    1.20 | 8.667    2.39 |14.750    2.99 | 20.83    1.79
           2.667    1.20 | 8.750    2.99 |14.833    2.99 | 20.92    1.20
           2.750    1.20 | 8.833    2.99 |14.917    2.99 | 21.00    1.20
           2.833    1.20 | 8.917    2.99 |15.000    2.99 | 21.08    1.20
           2.917    1.20 | 9.000    2.99 |15.083    3.59 | 21.17    1.20
           3.000    1.20 | 9.083    2.99 |15.167    3.59 | 21.25    1.20
           3.083    1.20 | 9.167    2.99 |15.250    2.39 | 21.33    1.20
           3.167    1.20 | 9.250    2.99 |15.333    2.39 | 21.42    1.20
           3.250    1.79 | 9.333    2.99 |15.417    2.99 | 21.50    1.20
           3.333    1.79 | 9.417    3.59 |15.500    2.99 | 21.58    1.20
           3.417    1.20 | 9.500    3.59 |15.583    2.99 | 21.67    1.20
           3.500    1.20 | 9.583    2.99 |15.667    2.99 | 21.75    1.20
           3.583    1.20 | 9.667    2.99 |15.750    2.39 | 21.83    1.20
           3.667    1.20 | 9.750    3.59 |15.833    2.39 | 21.92    1.20
           3.750    1.20 | 9.833    3.59 |15.917    2.39 | 22.00    1.20
           3.833    1.20 | 9.917    3.59 |16.000    2.39 | 22.08    1.20
           3.917    1.79 |10.000    3.59 |16.083    2.39 | 22.17    1.20
           4.000    1.79 |10.083    3.59 |16.167    2.39 | 22.25    1.20
           4.083    1.20 |10.167    3.59 |16.250    2.39 | 22.33    1.20
           4.167    1.20 |10.250    4.18 |16.333    2.39 | 22.42    1.20
           4.250    1.20 |10.333    4.18 |16.417    2.39 | 22.50    1.20
           4.333    1.20 |10.417    4.78 |16.500    2.39 | 22.58    1.20
           4.417    1.79 |10.500    4.78 |16.583    1.79 | 22.67    1.20
           4.500    1.79 |10.583    4.78 |16.667    1.79 | 22.75    1.20
           4.583    1.20 |10.667    4.78 |16.750    2.39 | 22.83    1.20
           4.667    1.20 |10.750    5.38 |16.833    2.39 | 22.92    1.20
           4.750    1.79 |10.833    5.38 |16.917    1.79 | 23.00    1.20
           4.833    1.79 |10.917    6.57 |17.000    1.79 | 23.08    1.20
           4.917    1.20 |11.000    6.57 |17.083    2.39 | 23.17    1.20
           5.000    1.20 |11.083    6.57 |17.167    2.39 | 23.25    1.20
           5.083    1.79 |11.167    6.57 |17.250    1.79 | 23.33    1.20
           5.167    1.79 |11.250    7.77 |17.333    1.79 | 23.42    1.20
           5.250    1.79 |11.333    7.77 |17.417    1.79 | 23.50    1.20
           5.333    1.79 |11.417    9.56 |17.500    1.79 | 23.58    0.60
           5.417    1.20 |11.500    9.56 |17.583    2.39 | 23.67    0.60
           5.500    1.20 |11.583   11.35 |17.667    2.39 | 23.75    1.20
           5.583    1.79 |11.667   11.35 |17.750    1.79 | 23.83    1.20
           5.667    1.79 |11.750   32.27 |17.833    1.79 | 23.92    1.20
           5.750    1.79 |11.833   32.27 |17.917    1.79 | 24.00    1.20
           5.833    1.79 |11.917   80.06 |18.000    1.79 | 24.08    1.20
           5.917    1.79 |12.000   80.07 |18.083    1.79 | 24.17    1.20
           6.000    1.79 |12.083  114.73 |18.167    1.79 |
           6.083    1.79 |12.167  114.73 |18.250    1.79 |

Unit Hyd Qpeak  (cms)=   2.344

PEAK FLOW       (cms)=   1.030 (i)
TIME TO PEAK    (hrs)=  12.250
RUNOFF VOLUME    (mm)=  34.772
TOTAL RAINFALL   (mm)=  99.630
RUNOFF COEFFICIENT   =   0.349

(i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
```

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--------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0012)|   Area    (ha)=  10.20   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

     Unit Hyd Qpeak  (cms)=   1.968

     PEAK FLOW       (cms)=   0.865 (i)
     TIME TO PEAK    (hrs)=  12.250
     RUNOFF VOLUME    (mm)=  34.772
     TOTAL RAINFALL   (mm)=  99.630
     RUNOFF COEFFICIENT   =   0.349

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD   (  0013)|   Area    (ha)=   1.98   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.06

     Unit Hyd Qpeak  (cms)=   1.282

     PEAK FLOW       (cms)=   0.232 (i)
     TIME TO PEAK    (hrs)=  12.167
     RUNOFF VOLUME    (mm)=  29.643
     TOTAL RAINFALL   (mm)=  99.630
     RUNOFF COEFFICIENT   =   0.298

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0014)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0012):    10.20   0.865    12.25    34.77
      + ID2= 2 (  0013):     1.98   0.232    12.17    29.64
        ===============================================
        ID = 3 (  0014):    12.18   1.035    12.17    33.94

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0025)|   Area    (ha)=   0.23
|ID= 1 DT= 5.0 min |   Total Imp(%)=  30.00   Dir. Conn.(%)=  30.00
--------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.07         0.16
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      39.16        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     114.73        48.45
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.38 (ii)   10.81 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.33         0.09
                                                              *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.01           0.034 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.25           12.17
     RUNOFF VOLUME    (mm)=      98.63        34.84           53.95
     TOTAL RAINFALL   (mm)=      99.63        99.63           99.63
     RUNOFF COEFFICIENT   =       0.99         0.35            0.54

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0026)|   Area    (ha)=   0.42
```

```
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29         0.13
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      52.92        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     114.73        48.45
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.65 (ii)    6.41 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.32         0.14
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.09         0.01           0.107 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.17           12.17
     RUNOFF VOLUME    (mm)=      98.63        34.84           79.48
     TOTAL RAINFALL   (mm)=      99.63        99.63           99.63
     RUNOFF COEFFICIENT   =       0.99         0.35            0.80

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0029)|   Area    (ha)=  11.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.10         3.47
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     277.73        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     114.73        48.45
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       4.46 (ii)    9.22 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.23         0.12
                                                            *TOTALS*
     PEAK FLOW       (cms)=       2.49         0.33           2.814 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.17           12.17
     RUNOFF VOLUME    (mm)=      98.63        34.84           79.49
     TOTAL RAINFALL   (mm)=      99.63        99.63           99.63
     RUNOFF COEFFICIENT   =       0.99         0.35            0.80

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| RESERVOIR(  0027)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.7500      0.3950
                          0.0070     0.2000   |   1.0100      0.4600
                          0.3200     0.2750   |   1.2200      0.5000
                          0.5800     0.3500   |   1.4400      0.5340

                                AREA     QPEAK      TPEAK        R.V.
                                (ha)     (cms)      (hrs)        (mm)
   INFLOW : ID= 2 (  0029)     11.570      2.814     12.17      79.49
   OUTFLOW: ID= 1 (  0027)     11.570      0.988     12.33      76.58

                    PEAK   FLOW   REDUCTION [Qout/Qin](%)= 35.12
                    TIME SHIFT OF PEAK FLOW        (min)= 10.00
                    MAXIMUM  STORAGE   USED       (ha.m.)=  0.4566

--------------------------------------------------------------------------------
```

```
--------------------
| ADD HYD  (  0028)|
|   1 +  2 =  3    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0025):      0.23   0.034    12.17    53.95
      + ID2= 2 (  0026):      0.42   0.107    12.17    79.48
        ====================================================
        ID = 3 (  0028):      0.65   0.141    12.17    70.45

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD  (  0028)|
|   3 +  2 =  1    |          AREA    QPEAK    TPEAK     R.V.
--------------------          (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0028):      0.65   0.141    12.17    70.45
      + ID2= 2 (  0027):     11.57   0.988    12.33    76.58
        ====================================================
        ID = 1 (  0028):     12.22   1.027    12.33    76.25

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0030)|   Area    (ha)=   0.23
|ID= 1 DT= 5.0 min |   Total Imp(%)=  30.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.07         0.16
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      39.16        40.00
     Mannings n          =       0.013        0.250

     Max.Eff.Inten.(mm/hr)=     114.73        48.45
                over (min)       5.00        15.00
     Storage Coeff.  (min)=       1.38 (ii)   10.81 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.33         0.09
                                                              *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.01             0.034 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.25             12.17
     RUNOFF VOLUME    (mm)=      98.63        34.84             53.95
     TOTAL RAINFALL   (mm)=      99.63        99.63             99.63
     RUNOFF COEFFICIENT   =       0.99         0.35              0.54

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0031)|   Area    (ha)=  11.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.10         3.47
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     277.73        40.00
     Mannings n          =       0.013        0.250

     Max.Eff.Inten.(mm/hr)=     114.73        48.45
                over (min)       5.00        10.00
     Storage Coeff.  (min)=       4.46 (ii)    9.22 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.23         0.12
                                                              *TOTALS*
     PEAK FLOW       (cms)=       2.49         0.33             2.814 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.17             12.17
     RUNOFF VOLUME    (mm)=      98.63        34.84             79.49
     TOTAL RAINFALL   (mm)=      99.63        99.63             99.63
     RUNOFF COEFFICIENT   =       0.99         0.35              0.80

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
```

```
       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0033)|   Area    (ha)=   0.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29         0.13
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      52.92        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     114.73        48.45
                over (min)        5.00        10.00
     Storage Coeff.  (min)=       1.65 (ii)    6.41 (ii)
     Unit Hyd. Tpeak (min)=       5.00        10.00
     Unit Hyd. peak  (cms)=       0.32         0.14
                                                              *TOTALS*
     PEAK FLOW       (cms)=       0.09         0.01             0.107 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.17             12.17
     RUNOFF VOLUME    (mm)=      98.63        34.84             79.48
     TOTAL RAINFALL   (mm)=      99.63        99.63             99.63
     RUNOFF COEFFICIENT   =       0.99         0.35              0.80

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0034)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0030):     0.23   0.034    12.17    53.95
      + ID2= 2 (  0031):    11.57   2.814    12.17    79.49
        =====================================================
        ID = 3 (  0034):    11.80   2.848    12.17    78.99

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0034)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0034):    11.80   2.848    12.17    78.99
      + ID2= 2 (  0033):     0.42   0.107    12.17    79.48
        =====================================================
        ID = 1 (  0034):    12.22   2.955    12.17    79.01

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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 FINISH
============================================================================================================

============================================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO     TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
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```
                   *****  D E T A I L E D   O U T P U T *****


  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 5.0\VO2\voin.dat
  Output  filename: C:\Users\dlee\AppData\Local\Civica\VH5\5adcd22e-1633-4416-b3c0-53190c2640b0\2f34f1e0-d51b-
  Summary filename: C:\Users\dlee\AppData\Local\Civica\VH5\5adcd22e-1633-4416-b3c0-53190c2640b0\2f34f1e0-d51b-


DATE: 04/26/2018                          TIME: 05:30:05

USER:



COMMENTS: ____________________________________________________________


-------------------------------------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   0 **
  ****************************


--------------------
|    READ STORM    |    Filename: C:\Users\dlee\AppD
|                  |              ata\Local\Temp\
|                  |              ab3f5c2f-d020-4fa4-903a-45cde12d5781\c460be6c
| Ptotal= 54.99 mm |    Comments: 24 hour
--------------------
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                  0.17    0.00 |  6.33    0.99 | 12.50    7.92 | 18.67    0.99
                  0.33    0.66 |  6.50    0.99 | 12.67    5.94 | 18.83    0.66
                  0.50    0.33 |  6.67    0.99 | 12.83    4.62 | 19.00    0.99
                  0.67    0.66 |  6.83    0.99 | 13.00    3.96 | 19.17    0.99
                  0.83    0.66 |  7.00    1.32 | 13.17    3.63 | 19.33    0.66
                  1.00    0.66 |  7.17    0.99 | 13.33    3.30 | 19.50    0.99
                  1.17    0.33 |  7.33    0.99 | 13.50    2.97 | 19.67    0.66
                  1.33    0.66 |  7.50    1.32 | 13.67    2.64 | 19.83    0.99
                  1.50    0.66 |  7.67    0.99 | 13.83    2.64 | 20.00    0.66
                  1.67    0.66 |  7.83    1.32 | 14.00    2.31 | 20.17    0.66
                  1.83    0.66 |  8.00    0.99 | 14.17    1.98 | 20.33    0.66
                  2.00    0.66 |  8.17    1.32 | 14.33    1.98 | 20.50    0.66
                  2.17    0.66 |  8.33    1.32 | 14.50    1.98 | 20.67    0.66
                  2.33    0.66 |  8.50    1.32 | 14.67    1.98 | 20.83    0.99
                  2.50    0.66 |  8.67    1.32 | 14.83    1.65 | 21.00    0.66
                  2.67    0.66 |  8.83    1.65 | 15.00    1.65 | 21.17    0.66
                  2.83    0.66 |  9.00    1.65 | 15.17    1.98 | 21.33    0.66
                  3.00    0.66 |  9.17    1.65 | 15.33    1.32 | 21.50    0.66
                  3.17    0.66 |  9.33    1.65 | 15.50    1.65 | 21.67    0.66
                  3.33    0.99 |  9.50    1.98 | 15.67    1.65 | 21.83    0.66
                  3.50    0.66 |  9.67    1.65 | 15.83    1.32 | 22.00    0.66
                  3.67    0.66 |  9.83    1.98 | 16.00    1.32 | 22.17    0.66
                  3.83    0.66 | 10.00    1.98 | 16.17    1.32 | 22.33    0.66
                  4.00    0.99 | 10.17    1.98 | 16.33    1.32 | 22.50    0.66
                  4.17    0.66 | 10.33    2.31 | 16.50    1.32 | 22.67    0.66
                  4.33    0.66 | 10.50    2.64 | 16.67    0.99 | 22.83    0.66
                  4.50    0.99 | 10.67    2.64 | 16.83    1.32 | 23.00    0.66
                  4.67    0.66 | 10.83    2.97 | 17.00    0.99 | 23.17    0.66
                  4.83    0.99 | 11.00    3.63 | 17.17    1.32 | 23.33    0.66
                  5.00    0.66 | 11.17    3.63 | 17.33    0.99 | 23.50    0.66
                  5.17    0.99 | 11.33    4.29 | 17.50    0.99 | 23.67    0.33
                  5.33    0.99 | 11.50    5.28 | 17.67    1.32 | 23.83    0.66
                  5.50    0.66 | 11.67    6.27 | 17.83    0.99 | 24.00    0.66
                  5.67    0.99 | 11.83   17.81 | 18.00    0.99 | 24.17    0.66
                  5.83    0.99 | 12.00   44.20 | 18.17    0.99 |
                  6.00    0.99 | 12.17   63.33 | 18.33    0.99 |
                  6.17    0.99 | 12.33    9.90 | 18.50    0.99 |

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--------------------
| CALIB            |
| NASHYD   (  0008)|   Area    (ha)=  12.15   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.

                                  ---- TRANSFORMED HYETOGRAPH ----
```

```
            TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
             hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
           0.083    0.00 | 6.167    0.99 |12.250    9.91 | 18.33    0.99
           0.167    0.00 | 6.250    0.99 |12.333    9.90 | 18.42    0.99
           0.250    0.66 | 6.333    0.99 |12.417    7.92 | 18.50    0.99
           0.333    0.66 | 6.417    0.99 |12.500    7.92 | 18.58    0.99
           0.417    0.33 | 6.500    0.99 |12.583    5.94 | 18.67    0.99
           0.500    0.33 | 6.583    0.99 |12.667    5.94 | 18.75    0.66
           0.583    0.66 | 6.667    0.99 |12.750    4.62 | 18.83    0.66
           0.667    0.66 | 6.750    0.99 |12.833    4.62 | 18.92    0.99
           0.750    0.66 | 6.833    0.99 |12.917    3.96 | 19.00    0.99
           0.833    0.66 | 6.917    1.32 |13.000    3.96 | 19.08    0.99
           0.917    0.66 | 7.000    1.32 |13.083    3.63 | 19.17    0.99
           1.000    0.66 | 7.083    0.99 |13.167    3.63 | 19.25    0.66
           1.083    0.33 | 7.167    0.99 |13.250    3.30 | 19.33    0.66
           1.167    0.33 | 7.250    0.99 |13.333    3.30 | 19.42    0.99
           1.250    0.66 | 7.333    0.99 |13.417    2.97 | 19.50    0.99
           1.333    0.66 | 7.417    1.32 |13.500    2.97 | 19.58    0.66
           1.417    0.66 | 7.500    1.32 |13.583    2.64 | 19.67    0.66
           1.500    0.66 | 7.583    0.99 |13.667    2.64 | 19.75    0.99
           1.583    0.66 | 7.667    0.99 |13.750    2.64 | 19.83    0.99
           1.667    0.66 | 7.750    1.32 |13.833    2.64 | 19.92    0.66
           1.750    0.66 | 7.833    1.32 |13.917    2.31 | 20.00    0.66
           1.833    0.66 | 7.917    0.99 |14.000    2.31 | 20.08    0.66
           1.917    0.66 | 8.000    0.99 |14.083    1.98 | 20.17    0.66
           2.000    0.66 | 8.083    1.32 |14.167    1.98 | 20.25    0.66
           2.083    0.66 | 8.167    1.32 |14.250    1.98 | 20.33    0.66
           2.167    0.66 | 8.250    1.32 |14.333    1.98 | 20.42    0.66
           2.250    0.66 | 8.333    1.32 |14.417    1.98 | 20.50    0.66
           2.333    0.66 | 8.417    1.32 |14.500    1.98 | 20.58    0.66
           2.417    0.66 | 8.500    1.32 |14.583    1.98 | 20.67    0.66
           2.500    0.66 | 8.583    1.32 |14.667    1.98 | 20.75    0.99
           2.583    0.66 | 8.667    1.32 |14.750    1.65 | 20.83    0.99
           2.667    0.66 | 8.750    1.65 |14.833    1.65 | 20.92    0.66
           2.750    0.66 | 8.833    1.65 |14.917    1.65 | 21.00    0.66
           2.833    0.66 | 8.917    1.65 |15.000    1.65 | 21.08    0.66
           2.917    0.66 | 9.000    1.65 |15.083    1.98 | 21.17    0.66
           3.000    0.66 | 9.083    1.65 |15.167    1.98 | 21.25    0.66
           3.083    0.66 | 9.167    1.65 |15.250    1.32 | 21.33    0.66
           3.167    0.66 | 9.250    1.65 |15.333    1.32 | 21.42    0.66
           3.250    0.99 | 9.333    1.65 |15.417    1.65 | 21.50    0.66
           3.333    0.99 | 9.417    1.98 |15.500    1.65 | 21.58    0.66
           3.417    0.66 | 9.500    1.98 |15.583    1.65 | 21.67    0.66
           3.500    0.66 | 9.583    1.65 |15.667    1.65 | 21.75    0.66
           3.583    0.66 | 9.667    1.65 |15.750    1.32 | 21.83    0.66
           3.667    0.66 | 9.750    1.98 |15.833    1.32 | 21.92    0.66
           3.750    0.66 | 9.833    1.98 |15.917    1.32 | 22.00    0.66
           3.833    0.66 | 9.917    1.98 |16.000    1.32 | 22.08    0.66
           3.917    0.99 |10.000    1.98 |16.083    1.32 | 22.17    0.66
           4.000    0.99 |10.083    1.98 |16.167    1.32 | 22.25    0.66
           4.083    0.66 |10.167    1.98 |16.250    1.32 | 22.33    0.66
           4.167    0.66 |10.250    2.31 |16.333    1.32 | 22.42    0.66
           4.250    0.66 |10.333    2.31 |16.417    1.32 | 22.50    0.66
           4.333    0.66 |10.417    2.64 |16.500    1.32 | 22.58    0.66
           4.417    0.99 |10.500    2.64 |16.583    0.99 | 22.67    0.66
           4.500    0.99 |10.583    2.64 |16.667    0.99 | 22.75    0.66
           4.583    0.66 |10.667    2.64 |16.750    1.32 | 22.83    0.66
           4.667    0.66 |10.750    2.97 |16.833    1.32 | 22.92    0.66
           4.750    0.99 |10.833    2.97 |16.917    0.99 | 23.00    0.66
           4.833    0.99 |10.917    3.63 |17.000    0.99 | 23.08    0.66
           4.917    0.66 |11.000    3.63 |17.083    1.32 | 23.17    0.66
           5.000    0.66 |11.083    3.63 |17.167    1.32 | 23.25    0.66
           5.083    0.99 |11.167    3.63 |17.250    0.99 | 23.33    0.66
           5.167    0.99 |11.250    4.29 |17.333    0.99 | 23.42    0.66
           5.250    0.99 |11.333    4.29 |17.417    0.99 | 23.50    0.66
           5.333    0.99 |11.417    5.28 |17.500    0.99 | 23.58    0.33
           5.417    0.66 |11.500    5.28 |17.583    1.32 | 23.67    0.33
           5.500    0.66 |11.583    6.27 |17.667    1.32 | 23.75    0.66
           5.583    0.99 |11.667    6.27 |17.750    0.99 | 23.83    0.66
           5.667    0.99 |11.750   17.81 |17.833    0.99 | 23.92    0.66
           5.750    0.99 |11.833   17.81 |17.917    0.99 | 24.00    0.66
           5.833    0.99 |11.917   44.20 |18.000    0.99 | 24.08    0.66
           5.917    0.99 |12.000   44.20 |18.083    0.99 | 24.17    0.66
           6.000    0.99 |12.083   63.33 |18.167    0.99 |
           6.083    0.99 |12.167   63.33 |18.250    0.99 |

Unit Hyd Qpeak  (cms)=   2.344

PEAK FLOW       (cms)=   0.340 (i)
TIME TO PEAK    (hrs)=  12.250
RUNOFF VOLUME    (mm)=  11.743
TOTAL RAINFALL   (mm)=  54.990
RUNOFF COEFFICIENT   =   0.214
```

```
     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB             |
| NASHYD   (  0012)|   Area    (ha)=  10.20   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

     Unit Hyd Qpeak  (cms)=   1.968

     PEAK FLOW       (cms)=   0.285 (i)
     TIME TO PEAK    (hrs)=  12.250
     RUNOFF VOLUME    (mm)=  11.743
     TOTAL RAINFALL   (mm)=  54.990
     RUNOFF COEFFICIENT   =   0.214

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB             |
| NASHYD   (  0013)|   Area    (ha)=   1.98   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.06

     Unit Hyd Qpeak  (cms)=   1.282

     PEAK FLOW       (cms)=   0.079 (i)
     TIME TO PEAK    (hrs)=  12.167
     RUNOFF VOLUME    (mm)=  10.011
     TOTAL RAINFALL   (mm)=  54.990
     RUNOFF COEFFICIENT   =   0.182

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0014)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0012):    10.20   0.285    12.25    11.74
      + ID2= 2 (  0013):     1.98   0.079    12.17    10.01
        ====================================================
        ID = 3 (  0014):    12.18   0.339    12.17    11.46

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB             |
| STANDHYD (  0025)|   Area    (ha)=   0.23
|ID= 1 DT= 5.0 min |   Total Imp(%)=  30.00   Dir. Conn.(%)=  30.00
--------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.07         0.16
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      39.16        40.00
     Mannings n          =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      63.33        12.19
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       1.75 (ii)   18.13 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.32         0.06
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.01         0.00          0.015 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.33          12.17
     RUNOFF VOLUME    (mm)=      53.99        11.77          24.39
     TOTAL RAINFALL   (mm)=      54.99        54.99          54.99
     RUNOFF COEFFICIENT   =       0.98         0.21           0.44

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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| CALIB            |
| STANDHYD (  0026)|   Area    (ha)=   0.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29         0.13
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      52.92        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      63.33        12.19
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       2.09 (ii)   18.47 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.31         0.06
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.05         0.00          0.053 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.33          12.17
     RUNOFF VOLUME    (mm)=      53.99        11.77          41.30
     TOTAL RAINFALL   (mm)=      54.99        54.99          54.99
     RUNOFF COEFFICIENT   =       0.98         0.21           0.75

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0029)|   Area    (ha)=  11.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.10         3.47
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     277.73        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      63.33        12.19
                over (min)        5.00        25.00
     Storage Coeff.  (min)=       5.66 (ii)   22.04 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=       0.20         0.05
                                                           *TOTALS*
     PEAK FLOW       (cms)=       1.33         0.07          1.369 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.42          12.17
     RUNOFF VOLUME    (mm)=      53.99        11.77          41.32
     TOTAL RAINFALL   (mm)=      54.99        54.99          54.99
     RUNOFF COEFFICIENT   =       0.98         0.21           0.75


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR(  0027)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.7500      0.3950
                          0.0070     0.2000   |   1.0100      0.4600
                          0.3200     0.2750   |   1.2200      0.5000
                          0.5800     0.3500   |   1.4400      0.5340

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0029)     11.570     1.369     12.17      41.32
   OUTFLOW: ID= 1 (  0027)     11.570     0.312     12.50      38.42

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 22.78
                   TIME SHIFT OF PEAK FLOW         (min)= 20.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.2735

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--------------------
| ADD HYD  (  0028)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0025):     0.23   0.015    12.17    24.39
      + ID2= 2 (  0026):     0.42   0.053    12.17    41.30
        ====================================================
        ID = 3 (  0028):     0.65   0.068    12.17    35.31

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD  (  0028)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0028):     0.65   0.068    12.17    35.31
      + ID2= 2 (  0027):    11.57   0.312    12.50    38.42
        ====================================================
        ID = 1 (  0028):    12.22   0.326    12.42    38.26

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0030)|   Area    (ha)=   0.23
|ID= 1 DT= 5.0 min |   Total Imp(%)=  30.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.07         0.16
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      39.16        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      63.33        12.19
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       1.75 (ii)   18.13 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.32         0.06
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.01         0.00         0.015 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.33         12.17
     RUNOFF VOLUME    (mm)=      53.99        11.77         24.39
     TOTAL RAINFALL   (mm)=      54.99        54.99         54.99
     RUNOFF COEFFICIENT   =       0.98         0.21          0.44

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0031)|   Area    (ha)=  11.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.10         3.47
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     277.73        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      63.33        12.19
                over (min)        5.00        25.00
     Storage Coeff.  (min)=       5.66 (ii)   22.04 (ii)
     Unit Hyd. Tpeak (min)=       5.00        25.00
     Unit Hyd. peak  (cms)=       0.20         0.05
                                                          *TOTALS*
     PEAK FLOW       (cms)=       1.33         0.07         1.369 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.42         12.17
     RUNOFF VOLUME    (mm)=      53.99        11.77         41.32
     TOTAL RAINFALL   (mm)=      54.99        54.99         54.99
     RUNOFF COEFFICIENT   =       0.98         0.21          0.75
```

```
       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0033)|   Area    (ha)=   0.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29         0.13
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      52.92        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      63.33        12.19
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       2.09 (ii)   18.47 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.31         0.06
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.05         0.00           0.053 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.33           12.17
     RUNOFF VOLUME    (mm)=      53.99        11.77           41.30
     TOTAL RAINFALL   (mm)=      54.99        54.99           54.99
     RUNOFF COEFFICIENT   =       0.98         0.21            0.75

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0034)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 1 (  0030):     0.23   0.015    12.17    24.39
        + ID2= 2 (  0031):    11.57   1.369    12.17    41.32
          ==================================================
          ID = 3 (  0034):    11.80   1.384    12.17    40.99

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0034)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
          ID1= 3 (  0034):    11.80   1.384    12.17    40.99
        + ID2= 2 (  0033):     0.42   0.053    12.17    41.30
          ==================================================
          ID = 1 (  0034):    12.22   1.437    12.17    41.00

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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===============================================================================================

       V    V   I    SSSSS  U   U    A    L
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
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                   *****  D E T A I L E D   O U T P U T *****
```

```
  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 5.0\VO2\voin.dat
  Output  filename: C:\Users\dlee\AppData\Local\Civica\VH5\5adcd22e-1633-4416-b3c0-53190c2640b0\2c2303d4-b000-
  Summary filename: C:\Users\dlee\AppData\Local\Civica\VH5\5adcd22e-1633-4416-b3c0-53190c2640b0\2c2303d4-b000-


DATE: 04/26/2018                           TIME: 05:30:05

USER:



COMMENTS: ____________________________________________________________


--------------------------------------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   0 **
  ****************************


--------------------
|    READ STORM    |    Filename: C:\Users\dlee\AppD
|                  |              ata\Local\Temp\
|                  |              ab3f5c2f-d020-4fa4-903a-45cde12d5781\ff56d5e4
| Ptotal=110.79 mm |    Comments: 24 hour
--------------------
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.17    0.00 |  6.33    1.99 | 12.50   15.96 | 18.67    1.99
                 0.33    1.33 |  6.50    1.99 | 12.67   11.97 | 18.83    1.33
                 0.50    0.66 |  6.67    1.99 | 12.83    9.31 | 19.00    1.99
                 0.67    1.33 |  6.83    1.99 | 13.00    7.98 | 19.17    1.99
                 0.83    1.33 |  7.00    2.66 | 13.17    7.31 | 19.33    1.33
                 1.00    1.33 |  7.17    1.99 | 13.33    6.65 | 19.50    1.99
                 1.17    0.66 |  7.33    1.99 | 13.50    5.98 | 19.67    1.33
                 1.33    1.33 |  7.50    2.66 | 13.67    5.32 | 19.83    1.99
                 1.50    1.33 |  7.67    1.99 | 13.83    5.32 | 20.00    1.33
                 1.67    1.33 |  7.83    2.66 | 14.00    4.65 | 20.17    1.33
                 1.83    1.33 |  8.00    1.99 | 14.17    3.99 | 20.33    1.33
                 2.00    1.33 |  8.17    2.66 | 14.33    3.99 | 20.50    1.33
                 2.17    1.33 |  8.33    2.66 | 14.50    3.99 | 20.67    1.33
                 2.33    1.33 |  8.50    2.66 | 14.67    3.99 | 20.83    1.99
                 2.50    1.33 |  8.67    2.66 | 14.83    3.32 | 21.00    1.33
                 2.67    1.33 |  8.83    3.32 | 15.00    3.32 | 21.17    1.33
                 2.83    1.33 |  9.00    3.32 | 15.17    3.99 | 21.33    1.33
                 3.00    1.33 |  9.17    3.32 | 15.33    2.66 | 21.50    1.33
                 3.17    1.33 |  9.33    3.32 | 15.50    3.32 | 21.67    1.33
                 3.33    1.99 |  9.50    3.99 | 15.67    3.32 | 21.83    1.33
                 3.50    1.33 |  9.67    3.32 | 15.83    2.66 | 22.00    1.33
                 3.67    1.33 |  9.83    3.99 | 16.00    2.66 | 22.17    1.33
                 3.83    1.33 | 10.00    3.99 | 16.17    2.66 | 22.33    1.33
                 4.00    1.99 | 10.17    3.99 | 16.33    2.66 | 22.50    1.33
                 4.17    1.33 | 10.33    4.65 | 16.50    2.66 | 22.67    1.33
                 4.33    1.33 | 10.50    5.32 | 16.67    1.99 | 22.83    1.33
                 4.50    1.99 | 10.67    5.32 | 16.83    2.66 | 23.00    1.33
                 4.67    1.33 | 10.83    5.98 | 17.00    1.99 | 23.17    1.33
                 4.83    1.99 | 11.00    7.31 | 17.17    2.66 | 23.33    1.33
                 5.00    1.33 | 11.17    7.31 | 17.33    1.99 | 23.50    1.33
                 5.17    1.99 | 11.33    8.64 | 17.50    1.99 | 23.67    0.66
                 5.33    1.99 | 11.50   10.64 | 17.67    2.66 | 23.83    1.33
                 5.50    1.33 | 11.67   12.63 | 17.83    1.99 | 24.00    1.33
                 5.67    1.99 | 11.83   35.91 | 18.00    1.99 | 24.17    1.33
                 5.83    1.99 | 12.00   89.10 | 18.17    1.99 |
                 6.00    1.99 | 12.17  127.67 | 18.33    1.99 |
                 6.17    1.99 | 12.33   19.95 | 18.50    1.99 |

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--------------------
| CALIB            |
| NASHYD   (  0008)|   Area    (ha)=  12.15   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                  ---- TRANSFORMED HYETOGRAPH ----
                 TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                  hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                0.083    0.00 | 6.167    1.99 |12.250   19.96 | 18.33    1.99
                0.167    0.00 | 6.250    1.99 |12.333   19.95 | 18.42    1.99
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                0.250    1.33 | 6.333    1.99 |12.417   15.96 | 18.50    1.99
                0.333    1.33 | 6.417    1.99 |12.500   15.96 | 18.58    1.99
                0.417    0.66 | 6.500    1.99 |12.583   11.97 | 18.67    1.99
                0.500    0.66 | 6.583    1.99 |12.667   11.97 | 18.75    1.33
                0.583    1.33 | 6.667    1.99 |12.750    9.31 | 18.83    1.33
                0.667    1.33 | 6.750    1.99 |12.833    9.31 | 18.92    1.99
                0.750    1.33 | 6.833    1.99 |12.917    7.98 | 19.00    1.99
                0.833    1.33 | 6.917    2.66 |13.000    7.98 | 19.08    1.99
                0.917    1.33 | 7.000    2.66 |13.083    7.31 | 19.17    1.99
                1.000    1.33 | 7.083    1.99 |13.167    7.31 | 19.25    1.33
                1.083    0.66 | 7.167    1.99 |13.250    6.65 | 19.33    1.33
                1.167    0.66 | 7.250    1.99 |13.333    6.65 | 19.42    1.99
                1.250    1.33 | 7.333    1.99 |13.417    5.98 | 19.50    1.99
                1.333    1.33 | 7.417    2.66 |13.500    5.98 | 19.58    1.33
                1.417    1.33 | 7.500    2.66 |13.583    5.32 | 19.67    1.33
                1.500    1.33 | 7.583    1.99 |13.667    5.32 | 19.75    1.99
                1.583    1.33 | 7.667    1.99 |13.750    5.32 | 19.83    1.99
                1.667    1.33 | 7.750    2.66 |13.833    5.32 | 19.92    1.33
                1.750    1.33 | 7.833    2.66 |13.917    4.65 | 20.00    1.33
                1.833    1.33 | 7.917    1.99 |14.000    4.65 | 20.08    1.33
                1.917    1.33 | 8.000    1.99 |14.083    3.99 | 20.17    1.33
                2.000    1.33 | 8.083    2.66 |14.167    3.99 | 20.25    1.33
                2.083    1.33 | 8.167    2.66 |14.250    3.99 | 20.33    1.33
                2.167    1.33 | 8.250    2.66 |14.333    3.99 | 20.42    1.33
                2.250    1.33 | 8.333    2.66 |14.417    3.99 | 20.50    1.33
                2.333    1.33 | 8.417    2.66 |14.500    3.99 | 20.58    1.33
                2.417    1.33 | 8.500    2.66 |14.583    3.99 | 20.67    1.33
                2.500    1.33 | 8.583    2.66 |14.667    3.99 | 20.75    1.99
                2.583    1.33 | 8.667    2.66 |14.750    3.32 | 20.83    1.99
                2.667    1.33 | 8.750    3.32 |14.833    3.32 | 20.92    1.33
                2.750    1.33 | 8.833    3.32 |14.917    3.32 | 21.00    1.33
                2.833    1.33 | 8.917    3.32 |15.000    3.32 | 21.08    1.33
                2.917    1.33 | 9.000    3.32 |15.083    3.99 | 21.17    1.33
                3.000    1.33 | 9.083    3.32 |15.167    3.99 | 21.25    1.33
                3.083    1.33 | 9.167    3.32 |15.250    2.66 | 21.33    1.33
                3.167    1.33 | 9.250    3.32 |15.333    2.66 | 21.42    1.33
                3.250    1.99 | 9.333    3.32 |15.417    3.32 | 21.50    1.33
                3.333    1.99 | 9.417    3.99 |15.500    3.32 | 21.58    1.33
                3.417    1.33 | 9.500    3.99 |15.583    3.32 | 21.67    1.33
                3.500    1.33 | 9.583    3.32 |15.667    3.32 | 21.75    1.33
                3.583    1.33 | 9.667    3.32 |15.750    2.66 | 21.83    1.33
                3.667    1.33 | 9.750    3.99 |15.833    2.66 | 21.92    1.33
                3.750    1.33 | 9.833    3.99 |15.917    2.66 | 22.00    1.33
                3.833    1.33 | 9.917    3.99 |16.000    2.66 | 22.08    1.33
                3.917    1.99 |10.000    3.99 |16.083    2.66 | 22.17    1.33
                4.000    1.99 |10.083    3.99 |16.167    2.66 | 22.25    1.33
                4.083    1.33 |10.167    3.99 |16.250    2.66 | 22.33    1.33
                4.167    1.33 |10.250    4.65 |16.333    2.66 | 22.42    1.33
                4.250    1.33 |10.333    4.65 |16.417    2.66 | 22.50    1.33
                4.333    1.33 |10.417    5.32 |16.500    2.66 | 22.58    1.33
                4.417    1.99 |10.500    5.32 |16.583    1.99 | 22.67    1.33
                4.500    1.99 |10.583    5.32 |16.667    1.99 | 22.75    1.33
                4.583    1.33 |10.667    5.32 |16.750    2.66 | 22.83    1.33
                4.667    1.33 |10.750    5.98 |16.833    2.66 | 22.92    1.33
                4.750    1.99 |10.833    5.98 |16.917    1.99 | 23.00    1.33
                4.833    1.99 |10.917    7.31 |17.000    1.99 | 23.08    1.33
                4.917    1.33 |11.000    7.31 |17.083    2.66 | 23.17    1.33
                5.000    1.33 |11.083    7.31 |17.167    2.66 | 23.25    1.33
                5.083    1.99 |11.167    7.31 |17.250    1.99 | 23.33    1.33
                5.167    1.99 |11.250    8.64 |17.333    1.99 | 23.42    1.33
                5.250    1.99 |11.333    8.64 |17.417    1.99 | 23.50    1.33
                5.333    1.99 |11.417   10.64 |17.500    1.99 | 23.58    0.66
                5.417    1.33 |11.500   10.64 |17.583    2.66 | 23.67    0.66
                5.500    1.33 |11.583   12.63 |17.667    2.66 | 23.75    1.33
                5.583    1.99 |11.667   12.63 |17.750    1.99 | 23.83    1.33
                5.667    1.99 |11.750   35.91 |17.833    1.99 | 23.92    1.33
                5.750    1.99 |11.833   35.91 |17.917    1.99 | 24.00    1.33
                5.833    1.99 |11.917   89.09 |18.000    1.99 | 24.08    1.33
                5.917    1.99 |12.000   89.10 |18.083    1.99 | 24.17    1.33
                6.000    1.99 |12.083  127.67 |18.167    1.99 |
                6.083    1.99 |12.167  127.67 |18.250    1.99 |

     Unit Hyd Qpeak  (cms)=   2.344

     PEAK FLOW       (cms)=   1.239 (i)
     TIME TO PEAK    (hrs)=  12.250
     RUNOFF VOLUME    (mm)=  41.645
     TOTAL RAINFALL   (mm)= 110.785
     RUNOFF COEFFICIENT   =   0.376

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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```
| CALIB              |
| NASHYD   (  0012)|   Area    (ha)=  10.20   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

     Unit Hyd Qpeak  (cms)=   1.968

     PEAK FLOW       (cms)=   1.040 (i)
     TIME TO PEAK    (hrs)=  12.250
     RUNOFF VOLUME    (mm)=  41.645
     TOTAL RAINFALL   (mm)= 110.785
     RUNOFF COEFFICIENT   =   0.376

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB              |
| NASHYD   (  0013)|   Area    (ha)=   1.98   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.06

     Unit Hyd Qpeak  (cms)=   1.282

     PEAK FLOW       (cms)=   0.278 (i)
     TIME TO PEAK    (hrs)=  12.167
     RUNOFF VOLUME    (mm)=  35.503
     TOTAL RAINFALL   (mm)= 110.785
     RUNOFF COEFFICIENT   =   0.320

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0014)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0012):    10.20   1.040    12.25    41.65
      + ID2= 2 (  0013):     1.98   0.278    12.17    35.50
        ===================================================
        ID = 3 (  0014):    12.18   1.246    12.17    40.65

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0025)|   Area    (ha)=   0.23
|ID= 1 DT= 5.0 min |   Total Imp(%)=  30.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.07         0.16
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      39.16        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=     127.67        58.07
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.32 (ii)   10.09 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.33         0.10
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.02          0.039 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.25          12.17
     RUNOFF VOLUME    (mm)=     109.79        41.73          62.11
     TOTAL RAINFALL   (mm)=     110.79       110.79         110.79
     RUNOFF COEFFICIENT   =       0.99         0.38           0.56

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0026)|   Area    (ha)=   0.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
```

```
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29          0.13
     Dep. Storage     (mm)=       1.00          5.00
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      52.92         40.00
     Mannings n           =      0.013         0.250

     Max.Eff.Inten.(mm/hr)=     127.67         58.07
                over (min)        5.00         10.00
     Storage Coeff.  (min)=       1.58 (ii)     6.14 (ii)
     Unit Hyd. Tpeak (min)=       5.00         10.00
     Unit Hyd. peak  (cms)=       0.33          0.15
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.10          0.02          0.121 (iii)
     TIME TO PEAK    (hrs)=      12.17         12.17          12.17
     RUNOFF VOLUME    (mm)=     109.78         41.73          89.36
     TOTAL RAINFALL   (mm)=     110.79        110.79         110.79
     RUNOFF COEFFICIENT   =       0.99          0.38           0.81

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0029)|   Area    (ha)=  11.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.10          3.47
     Dep. Storage     (mm)=       1.00          5.00
     Average Slope     (%)=       1.00          2.00
     Length            (m)=     277.73         40.00
     Mannings n           =      0.013         0.250

     Max.Eff.Inten.(mm/hr)=     127.67         58.07
                over (min)        5.00         10.00
     Storage Coeff.  (min)=       4.28 (ii)     8.84 (ii)
     Unit Hyd. Tpeak (min)=       5.00         10.00
     Unit Hyd. peak  (cms)=       0.23          0.12
                                                            *TOTALS*
     PEAK FLOW       (cms)=       2.78          0.40          3.179 (iii)
     TIME TO PEAK    (hrs)=      12.17         12.17          12.17
     RUNOFF VOLUME    (mm)=     109.79         41.73          89.37
     TOTAL RAINFALL   (mm)=     110.79        110.79         110.79
     RUNOFF COEFFICIENT   =       0.99          0.38           0.81

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR(  0027)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE    |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)    |   (cms)     (ha.m.)
                          0.0000     0.0000    |   0.7500      0.3950
                          0.0070     0.2000    |   1.0100      0.4600
                          0.3200     0.2750    |   1.2200      0.5000
                          0.5800     0.3500    |   1.4400      0.5340

                                AREA     QPEAK      TPEAK       R.V.
                                (ha)     (cms)      (hrs)       (mm)
   INFLOW : ID= 2 (  0029)     11.570      3.179      12.17      89.37
   OUTFLOW: ID= 1 (  0027)     11.570      1.177      12.33      86.45

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 37.02
                   TIME SHIFT OF PEAK FLOW         (min)= 10.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.4953

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--------------------
| ADD HYD  (  0028)|
```

```
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0025):     0.23   0.039    12.17    62.11
      + ID2= 2 (  0026):     0.42   0.121    12.17    89.36
        ====================================================
        ID = 3 (  0028):     0.65   0.160    12.17    79.72

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD  (  0028)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0028):     0.65   0.160    12.17    79.72
      + ID2= 2 (  0027):    11.57   1.177    12.33    86.45
        ====================================================
        ID = 1 (  0028):    12.22   1.222    12.33    86.09

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0030)|   Area    (ha)=   0.23
|ID= 1 DT= 5.0 min |   Total Imp(%)=  30.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.07          0.16
     Dep. Storage     (mm)=       1.00          5.00
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      39.16         40.00
     Mannings n          =       0.013         0.250

     Max.Eff.Inten.(mm/hr)=     127.67         58.07
                over (min)        5.00         15.00
     Storage Coeff.  (min)=       1.32 (ii)    10.09 (ii)
     Unit Hyd. Tpeak (min)=       5.00         15.00
     Unit Hyd. peak  (cms)=       0.33          0.10
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.02          0.02          0.039 (iii)
     TIME TO PEAK    (hrs)=      12.17         12.25          12.17
     RUNOFF VOLUME    (mm)=     109.79         41.73          62.11
     TOTAL RAINFALL   (mm)=     110.79        110.79         110.79
     RUNOFF COEFFICIENT   =       0.99          0.38           0.56

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0031)|   Area    (ha)=  11.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.10          3.47
     Dep. Storage     (mm)=       1.00          5.00
     Average Slope     (%)=       1.00          2.00
     Length            (m)=     277.73         40.00
     Mannings n          =       0.013         0.250

     Max.Eff.Inten.(mm/hr)=     127.67         58.07
                over (min)        5.00         10.00
     Storage Coeff.  (min)=       4.28 (ii)     8.84 (ii)
     Unit Hyd. Tpeak (min)=       5.00         10.00
     Unit Hyd. peak  (cms)=       0.23          0.12
                                                           *TOTALS*
     PEAK FLOW       (cms)=       2.78          0.40          3.179 (iii)
     TIME TO PEAK    (hrs)=      12.17         12.17          12.17
     RUNOFF VOLUME    (mm)=     109.79         41.73          89.37
     TOTAL RAINFALL   (mm)=     110.79        110.79         110.79
     RUNOFF COEFFICIENT   =       0.99          0.38           0.81

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
```

```
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD (  0033)|   Area    (ha)=   0.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29          0.13
     Dep. Storage     (mm)=       1.00          5.00
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      52.92         40.00
     Mannings n           =      0.013         0.250

     Max.Eff.Inten.(mm/hr)=     127.67         58.07
                over (min)        5.00         10.00
     Storage Coeff.  (min)=       1.58 (ii)     6.14 (ii)
     Unit Hyd. Tpeak (min)=       5.00         10.00
     Unit Hyd. peak  (cms)=       0.33          0.15
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.10          0.02          0.121 (iii)
     TIME TO PEAK    (hrs)=      12.17         12.17          12.17
     RUNOFF VOLUME    (mm)=     109.78         41.73          89.36
     TOTAL RAINFALL   (mm)=     110.79        110.79         110.79
     RUNOFF COEFFICIENT   =       0.99          0.38           0.81

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0034)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0030):     0.23   0.039    12.17    62.11
      + ID2= 2 (  0031):    11.57   3.179    12.17    89.37
        =====================================================
        ID = 3 (  0034):    11.80   3.218    12.17    88.84

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0034)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0034):    11.80   3.218    12.17    88.84
      + ID2= 2 (  0033):     0.42   0.121    12.17    89.36
        =====================================================
        ID = 1 (  0034):    12.22   3.339    12.17    88.85

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

--------------------------------------------------------------------------------
============================================================================================================

       V    V   I   SSSSS   U   U    A    L
       V    V   I   SS      U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I   SSSSS   UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO
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                   *****  D E T A I L E D   O U T P U T *****
```

```
  Input   filename: C:\Program Files (x86)\Visual OTTHYMO 5.0\VO2\voin.dat
  Output  filename: C:\Users\dlee\AppData\Local\Civica\VH5\5adcd22e-1633-4416-b3c0-53190c2640b0\aa0759b8-b502-
  Summary filename: C:\Users\dlee\AppData\Local\Civica\VH5\5adcd22e-1633-4416-b3c0-53190c2640b0\aa0759b8-b502-


DATE: 04/26/2018                          TIME: 05:30:06

USER:



COMMENTS: ____________________________________________________________


--------------------------------------------------------------------------------------------------------------
  ****************************
  ** SIMULATION NUMBER:   0 **
  ****************************


--------------------
|    READ STORM    |    Filename: C:\Users\dlee\AppD
|                  |              ata\Local\Temp\
|                  |              ab3f5c2f-d020-4fa4-903a-45cde12d5781\ec633eed
| Ptotal= 73.65 mm |    Comments: 24 hour
--------------------
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                  0.17    0.00 |  6.33    1.33 | 12.50   10.61 | 18.67    1.33
                  0.33    0.88 |  6.50    1.33 | 12.67    7.95 | 18.83    0.88
                  0.50    0.44 |  6.67    1.33 | 12.83    6.19 | 19.00    1.33
                  0.67    0.88 |  6.83    1.33 | 13.00    5.30 | 19.17    1.33
                  0.83    0.88 |  7.00    1.77 | 13.17    4.86 | 19.33    0.88
                  1.00    0.88 |  7.17    1.33 | 13.33    4.42 | 19.50    1.33
                  1.17    0.44 |  7.33    1.33 | 13.50    3.98 | 19.67    0.88
                  1.33    0.88 |  7.50    1.77 | 13.67    3.54 | 19.83    1.33
                  1.50    0.88 |  7.67    1.33 | 13.83    3.54 | 20.00    0.88
                  1.67    0.88 |  7.83    1.77 | 14.00    3.09 | 20.17    0.88
                  1.83    0.88 |  8.00    1.33 | 14.17    2.65 | 20.33    0.88
                  2.00    0.88 |  8.17    1.77 | 14.33    2.65 | 20.50    0.88
                  2.17    0.88 |  8.33    1.77 | 14.50    2.65 | 20.67    0.88
                  2.33    0.88 |  8.50    1.77 | 14.67    2.65 | 20.83    1.33
                  2.50    0.88 |  8.67    1.77 | 14.83    2.21 | 21.00    0.88
                  2.67    0.88 |  8.83    2.21 | 15.00    2.21 | 21.17    0.88
                  2.83    0.88 |  9.00    2.21 | 15.17    2.65 | 21.33    0.88
                  3.00    0.88 |  9.17    2.21 | 15.33    1.77 | 21.50    0.88
                  3.17    0.88 |  9.33    2.21 | 15.50    2.21 | 21.67    0.88
                  3.33    1.33 |  9.50    2.65 | 15.67    2.21 | 21.83    0.88
                  3.50    0.88 |  9.67    2.21 | 15.83    1.77 | 22.00    0.88
                  3.67    0.88 |  9.83    2.65 | 16.00    1.77 | 22.17    0.88
                  3.83    0.88 | 10.00    2.65 | 16.17    1.77 | 22.33    0.88
                  4.00    1.33 | 10.17    2.65 | 16.33    1.77 | 22.50    0.88
                  4.17    0.88 | 10.33    3.09 | 16.50    1.77 | 22.67    0.88
                  4.33    0.88 | 10.50    3.54 | 16.67    1.33 | 22.83    0.88
                  4.50    1.33 | 10.67    3.54 | 16.83    1.77 | 23.00    0.88
                  4.67    0.88 | 10.83    3.98 | 17.00    1.33 | 23.17    0.88
                  4.83    1.33 | 11.00    4.86 | 17.17    1.77 | 23.33    0.88
                  5.00    0.88 | 11.17    4.86 | 17.33    1.33 | 23.50    0.88
                  5.17    1.33 | 11.33    5.75 | 17.50    1.33 | 23.67    0.44
                  5.33    1.33 | 11.50    7.07 | 17.67    1.77 | 23.83    0.88
                  5.50    0.88 | 11.67    8.40 | 17.83    1.33 | 24.00    0.88
                  5.67    1.33 | 11.83   23.86 | 18.00    1.33 | 24.17    0.88
                  5.83    1.33 | 12.00   59.22 | 18.17    1.33 |
                  6.00    1.33 | 12.17   84.85 | 18.33    1.33 |
                  6.17    1.33 | 12.33   13.26 | 18.50    1.33 |

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| CALIB            |
| NASHYD   (  0008)|   Area    (ha)=  12.15   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

         NOTE:  RAINFALL WAS TRANSFORMED TO   5.0 MIN. TIME STEP.


                                  ---- TRANSFORMED HYETOGRAPH ----
                  TIME    RAIN |  TIME    RAIN |'  TIME    RAIN |  TIME    RAIN
                   hrs   mm/hr |   hrs   mm/hr |'   hrs   mm/hr |   hrs   mm/hr
                 0.083    0.00 | 6.167    1.33 |12.250   13.27 | 18.33    1.33
                 0.167    0.00 | 6.250    1.33 |12.333   13.26 | 18.42    1.33
                 0.250    0.88 | 6.333    1.33 |12.417   10.61 | 18.50    1.33
                 0.333    0.88 | 6.417    1.33 |12.500   10.61 | 18.58    1.33
```

```
            0.417    0.44 | 6.500    1.33 |12.583    7.95 | 18.67    1.33
            0.500    0.44 | 6.583    1.33 |12.667    7.95 | 18.75    0.88
            0.583    0.88 | 6.667    1.33 |12.750    6.19 | 18.83    0.88
            0.667    0.88 | 6.750    1.33 |12.833    6.19 | 18.92    1.33
            0.750    0.88 | 6.833    1.33 |12.917    5.30 | 19.00    1.33
            0.833    0.88 | 6.917    1.77 |13.000    5.30 | 19.08    1.33
            0.917    0.88 | 7.000    1.77 |13.083    4.86 | 19.17    1.33
            1.000    0.88 | 7.083    1.33 |13.167    4.86 | 19.25    0.88
            1.083    0.44 | 7.167    1.33 |13.250    4.42 | 19.33    0.88
            1.167    0.44 | 7.250    1.33 |13.333    4.42 | 19.42    1.33
            1.250    0.88 | 7.333    1.33 |13.417    3.98 | 19.50    1.33
            1.333    0.88 | 7.417    1.77 |13.500    3.98 | 19.58    0.88
            1.417    0.88 | 7.500    1.77 |13.583    3.54 | 19.67    0.88
            1.500    0.88 | 7.583    1.33 |13.667    3.54 | 19.75    1.33
            1.583    0.88 | 7.667    1.33 |13.750    3.54 | 19.83    1.33
            1.667    0.88 | 7.750    1.77 |13.833    3.54 | 19.92    0.88
            1.750    0.88 | 7.833    1.77 |13.917    3.09 | 20.00    0.88
            1.833    0.88 | 7.917    1.33 |14.000    3.09 | 20.08    0.88
            1.917    0.88 | 8.000    1.33 |14.083    2.65 | 20.17    0.88
            2.000    0.88 | 8.083    1.77 |14.167    2.65 | 20.25    0.88
            2.083    0.88 | 8.167    1.77 |14.250    2.65 | 20.33    0.88
            2.167    0.88 | 8.250    1.77 |14.333    2.65 | 20.42    0.88
            2.250    0.88 | 8.333    1.77 |14.417    2.65 | 20.50    0.88
            2.333    0.88 | 8.417    1.77 |14.500    2.65 | 20.58    0.88
            2.417    0.88 | 8.500    1.77 |14.583    2.65 | 20.67    0.88
            2.500    0.88 | 8.583    1.77 |14.667    2.65 | 20.75    1.33
            2.583    0.88 | 8.667    1.77 |14.750    2.21 | 20.83    1.33
            2.667    0.88 | 8.750    2.21 |14.833    2.21 | 20.92    0.88
            2.750    0.88 | 8.833    2.21 |14.917    2.21 | 21.00    0.88
            2.833    0.88 | 8.917    2.21 |15.000    2.21 | 21.08    0.88
            2.917    0.88 | 9.000    2.21 |15.083    2.65 | 21.17    0.88
            3.000    0.88 | 9.083    2.21 |15.167    2.65 | 21.25    0.88
            3.083    0.88 | 9.167    2.21 |15.250    1.77 | 21.33    0.88
            3.167    0.88 | 9.250    2.21 |15.333    1.77 | 21.42    0.88
            3.250    1.33 | 9.333    2.21 |15.417    2.21 | 21.50    0.88
            3.333    1.33 | 9.417    2.65 |15.500    2.21 | 21.58    0.88
            3.417    0.88 | 9.500    2.65 |15.583    2.21 | 21.67    0.88
            3.500    0.88 | 9.583    2.21 |15.667    2.21 | 21.75    0.88
            3.583    0.88 | 9.667    2.21 |15.750    1.77 | 21.83    0.88
            3.667    0.88 | 9.750    2.65 |15.833    1.77 | 21.92    0.88
            3.750    0.88 | 9.833    2.65 |15.917    1.77 | 22.00    0.88
            3.833    0.88 | 9.917    2.65 |16.000    1.77 | 22.08    0.88
            3.917    1.33 |10.000    2.65 |16.083    1.77 | 22.17    0.88
            4.000    1.33 |10.083    2.65 |16.167    1.77 | 22.25    0.88
            4.083    0.88 |10.167    2.65 |16.250    1.77 | 22.33    0.88
            4.167    0.88 |10.250    3.09 |16.333    1.77 | 22.42    0.88
            4.250    0.88 |10.333    3.09 |16.417    1.77 | 22.50    0.88
            4.333    0.88 |10.417    3.54 |16.500    1.77 | 22.58    0.88
            4.417    1.33 |10.500    3.54 |16.583    1.33 | 22.67    0.88
            4.500    1.33 |10.583    3.54 |16.667    1.33 | 22.75    0.88
            4.583    0.88 |10.667    3.54 |16.750    1.77 | 22.83    0.88
            4.667    0.88 |10.750    3.98 |16.833    1.77 | 22.92    0.88
            4.750    1.33 |10.833    3.98 |16.917    1.33 | 23.00    0.88
            4.833    1.33 |10.917    4.86 |17.000    1.33 | 23.08    0.88
            4.917    0.88 |11.000    4.86 |17.083    1.77 | 23.17    0.88
            5.000    0.88 |11.083    4.86 |17.167    1.77 | 23.25    0.88
            5.083    1.33 |11.167    4.86 |17.250    1.33 | 23.33    0.88
            5.167    1.33 |11.250    5.75 |17.333    1.33 | 23.42    0.88
            5.250    1.33 |11.333    5.75 |17.417    1.33 | 23.50    0.88
            5.333    1.33 |11.417    7.07 |17.500    1.33 | 23.58    0.44
            5.417    0.88 |11.500    7.07 |17.583    1.77 | 23.67    0.44
            5.500    0.88 |11.583    8.40 |17.667    1.77 | 23.75    0.88
            5.583    1.33 |11.667    8.40 |17.750    1.33 | 23.83    0.88
            5.667    1.33 |11.750   23.86 |17.833    1.33 | 23.92    0.88
            5.750    1.33 |11.833   23.86 |17.917    1.33 | 24.00    0.88
            5.833    1.33 |11.917   59.22 |18.000    1.33 | 24.08    0.88
            5.917    1.33 |12.000   59.22 |18.083    1.33 | 24.17    0.88
            6.000    1.33 |12.083   84.85 |18.167    1.33 |
            6.083    1.33 |12.167   84.85 |18.250    1.33 |

     Unit Hyd Qpeak  (cms)=   2.344

     PEAK FLOW       (cms)=   0.597 (i)
     TIME TO PEAK    (hrs)=  12.250
     RUNOFF VOLUME    (mm)=  20.359
     TOTAL RAINFALL   (mm)=  73.652
     RUNOFF COEFFICIENT   =   0.276

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB             |
| NASHYD   (  0012)|   Area    (ha)=  10.20   Curve Number   (CN)= 61.0
```

```
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.20

     Unit Hyd Qpeak  (cms)=   1.968

     PEAK FLOW       (cms)=   0.501 (i)
     TIME TO PEAK    (hrs)=  12.250
     RUNOFF VOLUME    (mm)=  20.359
     TOTAL RAINFALL   (mm)=  73.652
     RUNOFF COEFFICIENT   =   0.276

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB            |
| NASHYD   (  0013)|   Area    (ha)=   1.98   Curve Number   (CN)= 61.0
|ID= 1 DT= 5.0 min |   Ia      (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------   U.H. Tp(hrs)=   0.06

     Unit Hyd Qpeak  (cms)=   1.282

     PEAK FLOW       (cms)=   0.137 (i)
     TIME TO PEAK    (hrs)=  12.167
     RUNOFF VOLUME    (mm)=  17.356
     TOTAL RAINFALL   (mm)=  73.652
     RUNOFF COEFFICIENT   =   0.236

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| ADD HYD  (  0014)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0012):    10.20   0.501    12.25    20.36
      + ID2= 2 (  0013):     1.98   0.137    12.17    17.36
        ==================================================
        ID = 3 (  0014):    12.18   0.598    12.17    19.87

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD (  0025)|   Area    (ha)=   0.23
|ID= 1 DT= 5.0 min |   Total Imp(%)=  30.00   Dir. Conn.(%)=  30.00
--------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.07          0.16
     Dep. Storage     (mm)=       1.00          5.00
     Average Slope     (%)=       1.00          2.00
     Length            (m)=      39.16         40.00
     Mannings n           =      0.013         0.250

     Max.Eff.Inten.(mm/hr)=      84.85         24.17
                over (min)        5.00         15.00
     Storage Coeff.  (min)=       1.55 (ii)    14.01 (ii)
     Unit Hyd. Tpeak (min)=       5.00         15.00
     Unit Hyd. peak  (cms)=       0.33          0.08
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.02          0.01          0.022 (iii)
     TIME TO PEAK    (hrs)=      12.17         12.25          12.17
     RUNOFF VOLUME    (mm)=      72.65         20.40          36.04
     TOTAL RAINFALL   (mm)=      73.65         73.65          73.65
     RUNOFF COEFFICIENT   =       0.99          0.28           0.49

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| CALIB            |
| STANDHYD (  0026)|   Area    (ha)=   0.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                                IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29          0.13
```

```
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      52.92        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      84.85        24.17
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.86 (ii)   14.32 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.32         0.08
                                                           *TOTALS*
     PEAK FLOW       (cms)=       0.07         0.01          0.074 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.25          12.17
     RUNOFF VOLUME    (mm)=      72.65        20.40          56.96
     TOTAL RAINFALL   (mm)=      73.65        73.65          73.65
     RUNOFF COEFFICIENT   =       0.99         0.28           0.77

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0029)|   Area    (ha)=  11.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.10         3.47
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     277.73        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      84.85        24.17
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       5.04 (ii)   17.49 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.21         0.06
                                                           *TOTALS*
     PEAK FLOW       (cms)=       1.81         0.13          1.908 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.33          12.17
     RUNOFF VOLUME    (mm)=      72.65        20.40          56.97
     TOTAL RAINFALL   (mm)=      73.65        73.65          73.65
     RUNOFF COEFFICIENT   =       0.99         0.28           0.77


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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--------------------
| RESERVOIR(  0027)|
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.7500      0.3950
                          0.0070     0.2000   |   1.0100      0.4600
                          0.3200     0.2750   |   1.2200      0.5000
                          0.5800     0.3500   |   1.4400      0.5340

                                AREA     QPEAK      TPEAK        R.V.
                                (ha)     (cms)      (hrs)        (mm)
   INFLOW : ID= 2 (  0029)     11.570      1.908     12.17       56.97
   OUTFLOW: ID= 1 (  0027)     11.570      0.570     12.33       54.07

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 29.88
                   TIME SHIFT OF PEAK FLOW         (min)= 10.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.3482

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--------------------
| ADD HYD  (  0028)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0025):     0.23   0.022    12.17    36.04
```

```
      + ID2= 2 (  0026):     0.42   0.074    12.17    56.96
        ====================================================
        ID = 3 (  0028):     0.65   0.096    12.17    49.56

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| ADD HYD  (  0028)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0028):     0.65   0.096    12.17    49.56
      + ID2= 2 (  0027):    11.57   0.570    12.33    54.07
        ====================================================
        ID = 1 (  0028):    12.22   0.596    12.33    53.83

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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--------------------
| CALIB            |
| STANDHYD (  0030)|   Area    (ha)=   0.23
|ID= 1 DT= 5.0 min |   Total Imp(%)=  30.00   Dir. Conn.(%)=  30.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.07         0.16
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      39.16        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      84.85        24.17
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.55 (ii)   14.01 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.33         0.08
                                                          *TOTALS*
     PEAK FLOW       (cms)=       0.02         0.01          0.022 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.25          12.17
     RUNOFF VOLUME    (mm)=      72.65        20.40          36.04
     TOTAL RAINFALL   (mm)=      73.65        73.65          73.65
     RUNOFF COEFFICIENT   =       0.99         0.28           0.49

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------
--------------------
| CALIB            |
| STANDHYD (  0031)|   Area    (ha)=  11.57
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       8.10         3.47
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=     277.73        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      84.85        24.17
                over (min)        5.00        20.00
     Storage Coeff.  (min)=       5.04 (ii)   17.49 (ii)
     Unit Hyd. Tpeak (min)=       5.00        20.00
     Unit Hyd. peak  (cms)=       0.21         0.06
                                                          *TOTALS*
     PEAK FLOW       (cms)=       1.81         0.13          1.908 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.33          12.17
     RUNOFF VOLUME    (mm)=      72.65        20.40          56.97
     TOTAL RAINFALL   (mm)=      73.65        73.65          73.65
     RUNOFF COEFFICIENT   =       0.99         0.28           0.77


       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.
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--------------------
| CALIB            |
| STANDHYD (  0033)|   Area    (ha)=   0.42
|ID= 1 DT= 5.0 min |   Total Imp(%)=  70.00   Dir. Conn.(%)=  70.00
--------------------
                              IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=       0.29         0.13
     Dep. Storage     (mm)=       1.00         5.00
     Average Slope     (%)=       1.00         2.00
     Length            (m)=      52.92        40.00
     Mannings n           =      0.013        0.250

     Max.Eff.Inten.(mm/hr)=      84.85        24.17
                over (min)        5.00        15.00
     Storage Coeff.  (min)=       1.86 (ii)   14.32 (ii)
     Unit Hyd. Tpeak (min)=       5.00        15.00
     Unit Hyd. peak  (cms)=       0.32         0.08
                                                            *TOTALS*
     PEAK FLOW       (cms)=       0.07         0.01          0.074 (iii)
     TIME TO PEAK    (hrs)=      12.17        12.25          12.17
     RUNOFF VOLUME    (mm)=      72.65        20.40          56.96
     TOTAL RAINFALL   (mm)=      73.65        73.65          73.65
     RUNOFF COEFFICIENT   =       0.99         0.28           0.77

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
            CN*  =  61.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0034)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0030):     0.23   0.022    12.17    36.04
      + ID2= 2 (  0031):    11.57   1.908    12.17    56.97
        ====================================================
        ID = 3 (  0034):    11.80   1.930    12.17    56.57

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

-------------------------------------------------------------------------------

--------------------
| ADD HYD  (  0034)|
|   3 +  2 =  1    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 3 (  0034):    11.80   1.930    12.17    56.57
      + ID2= 2 (  0033):     0.42   0.074    12.17    56.96
        ====================================================
        ID = 1 (  0034):    12.22   2.004    12.17    56.58

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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APPENDIX C
Sanitary Servicing Calculations

STORM SEWER DESIGN SHEET

10 Year Storm
Orangeville Highlands Phase 2

Town of Orangeville

PROJECT DETAILS

Project No: 06-233-Phase 2
Date: 26-Mar-19
Designed by: D.L.
Checked by: A.F.

DESIGN CRITERIA

Min. Flow = 13 l/s
Min Diameter = 250 mm
Mannings 'n'= 0.013
Min. Velocity = 0.75 m/s
Max. Velocity = 3.50 m/s
Factor of Safety = 20 %

Avg. Domestic Flow = 302.8 l/c/d
Infiltration = 0.200 l/s/ha
Max. Peaking Factor = 4.00
Min. Peaking Factor= 1.50
Domestic Sewage flow for < 1000 ppl = 0.013m^3/s
(Region of Peel Std. 2-5-2)

NOMINAL PIPE SIZE USED

			RESIDENTIAL							COMMERCIAL/INDUSTRIAL/INSTITUTIONAL						FLOW CALCULATIONS								PIPE DATA						
STREET	FROM MH	TO MH	AREA (ha)	ACC. AREA (ha)	UNITS (#)	DENSITY (P/ha)	DENSITY (P/unit)	POP	ACCUM. RES. POP.	AREA (ha)	ACC. AREA (ha)	EQUIV. POP. (p/ha)	FLOW RATE (l/s/ha)	EQUIV. POP.	ACCUM. EQUIV. POP.	INFILTRATION (l/s)	TOTAL ACCUM. POP.	PEAKING FACTOR	RES. FLOW (l/s)	MIN. RES. FLOW (l/s)	COMM. FLOW (l/s)	ACCUM. COMM. FLOW (l/s)	TOTAL FLOW (l/s)	SLOPE (%)	PIPE DIAMETER (mm)	PIPE LENGTH (m)	FULL FLOW CAPACITY (l/s)	FULL FLOW VELOCITY (m/s)	ACTUAL VELOCITY (m/s)	PERCENT FULL (%)
BLOCK 25			1.67	1.67		40		67	67							0.3	67	4.00	0.9	13.0			13.3	2.00	250	10.4	84.1	1.71	1.25	16%
STREET 'B'	2A	4A	0.11	0.11												0.0							0.0	3.00	250	39.8	103.0	2.10	0.55	0%
BLOCK 20	3A	4A	0.73	0.73		175		128	128							0.1	128	4.00	1.8	13.0			13.1	2.00	250	9.4	84.1	1.71	1.25	16%
STREET 'B'	4A	6A		0.84					128							0.2	128	4.00	1.8	13.0			13.2	3.00	250	18.0	103.0	2.10	1.45	13%
STREET 'C'	5A	6A	0.25	0.25	13		3	39	39							0.1	39	4.00	0.5	13.0			13.1	2.50	250	99.8	94.0	1.92	1.34	14%
STREET 'B'	6A	8A	0.08	1.17					167							0.2	167	4.00	2.3	13.0			13.2	3.00	250	47.5	103.0	2.10	1.45	13%
STREET 'D'	7A	8A	0.68	0.68	29		3	87	87							0.1	87	4.00	1.2	13.0			13.1	2.50	250	103.4	94.0	1.92	1.34	14%
STREET 'B'	8A	19A	0.13	1.98					254							0.4	254	4.00	3.6	13.0			13.4	3.00	250	72.3	103.0	2.10	1.45	13%
STREET 'E'	9A	10A	0.65	0.65	26		3	78	78							0.1	78	4.00	1.1	13.0			13.1	2.50	250	77.0	94.0	1.92	1.34	14%
STREET 'E'	10A	19A	0.15	0.80	5		3	15	93							0.2	93	4.00	1.3	13.0			13.2	2.50	250	26.4	94.0	1.92	1.34	14%
STREET 'C'	11A	12A	0.22	0.22	8		3	24	24							0.0	24	4.00	0.3	13.0			13.0	2.25	250	40.0	89.2	1.82	1.31	15%
STREET 'C'	12A	13A	0.44	0.66	16		3	48	72							0.1	72	4.00	1.0	13.0			13.1	2.25	250	92.1	89.2	1.82	1.31	15%
STREET 'C'	13A	14A	0.15	0.81	4		3	12	84							0.2	84	4.00	1.2	13.0			13.2	2.25	250	32.3	89.2	1.82	1.31	15%
STREET 'C'	14A	15A	0.13	0.94	4		3	12	96							0.2	96	4.00	1.3	13.0			13.2	2.25	250	29.5	89.2	1.82	1.31	15%
STREET 'C'	15A	17A	0.34	1.28	14		3	42	138							0.3	138	4.00	1.9	13.0			13.3	1.00	250	90.4	59.5	1.21	0.96	22%
BLOCK 21	16A	17A	0.69	0.69		175		121	121							0.1	121	4.00	1.7	13.0			13.1	1.00	250	12.3	59.5	1.21	0.96	22%
STREET 'C'	17A	18A	0.03	2.00					259							0.4	259	4.00	3.6	13.0			13.4	0.50	250	14.8	42.0	0.86	0.75	32%
STREET 'C'	18A	19A	0.12	2.12					259							0.4	259	4.00	3.6	13.0			13.4	0.50	250	67.3	42.0	0.86	0.75	32%
STREET 'C'	19A	20A	0.14	5.04					606							1.0	606	3.93	8.3	13.0			14.0	0.50	250	48.2	42.0	0.86	0.75	33%
STREET 'C'	20A	23A		5.04					606							1.0	606	3.93	8.3	13.0			14.0	0.50	250	21.8	42.0	0.86	0.75	33%
BLOCK 23	21A	23A	1.65	1.65		475		784	784							0.3	784	3.87	10.6	13.0			13.3	1.00	250	9.4	59.5	1.21	0.96	22%
BLOCK 22	22A	23A	1.19	1.19		475		566	566							0.2	566	3.95	7.8	13.0			13.2	1.00	250	13.2	59.5	1.21	0.96	22%
STREET 'C'	23A	24A	0.16	8.04					1956							1.6	1956	3.59	24.6	24.6			26.2	0.50	250	75.1	42.0	0.86	0.88	62%
EX. HANSEN BLVD	24A	25A		8.04					1956							1.6	1956	3.59	24.6	24.6			26.2	2.00	250	16.5	84.1	1.71	1.49	31%

APPENDIX D
Geotechnical and Hydrogeological Studies

SOIL-MAT ENGINEERS & CONSULTANTS LTD.

www.soil-mat.ca info@soil-mat.ca TF: 800.243.1922

Hamilton: 130 Lancing Drive L8W 3A1 T: 905.318.7440 F: 905.318.7455
Milton: PO Box 40012 Derry Heights PO L9T 7W4 T: 905.875.3228

PROJECT NO.: SM 190167-G April 12, 2019

URBANTECH CONSULTING
3760 14th Avenue – Suite 301
Markham, Ontario
L3R 3T7

Attention: Scott Reimer, P.Eng.
Project Engineer

SUPPLEMENTAL SWM POND CONSIDERATIONS
ORANGEVILLE HIGHLANDS-PHASE II SUBDIVISION
ORANGEVILLE, ONTARIO

Dear Mr. Reimer,

Further to your request, SOIL-MAT ENGINEERS has prepared the following comments with respect to the construction of the stormwater management (SWM) pond within the proposed Orangeview Highlands development in Orangeville, Ontario. This letter report should be read in conjunction with our initial geotechnical investigation report SM 165031-G, dated August 1, 2013.

We understand that the proposed development will include the construction of a SWM pond in the southeast corner of the development. Based on the proposed cross-section drawings provided to our office, the SWM pond will have a permanent pool elevation of 421.00 metres, and a bottom of pond elevation ranging from 418.50 to 420.00 metres. Where the permanent pool elevation is below the static groundwater elevation, it will be necessary to provide a low permeability layer over the base of the pond to resist the infiltration of natural groundwater, and of sufficient weight to resist the hydrostatic uplift pressures. This could be accomplished through the use of a compacted clay liner, or with a weighed down proprietary liner system, etc. The weight of the liner system would have to exceed the uplift pressure of the ground water during the most severe periods of the year, likely when maximum storage is required. In approximate terms for example, one metre of clay liner, or equivalent, would be required for about every two meters of water storage below static ground water level, i.e., when the water level in the pond is 2 metres below the static ground water table, the clay liner would have to be at least one metre thick; if 3 metres below the static level, then 1.5 metres thick, etc.

An impermeable compacted clay liner would consist of a sufficiently plastic clay soil, with a recommended minimum clay content of 20 per cent and plasticity index of 7. The fine-grained sand to silty sand soils encountered during our geotechnical investigation would not be considered suitable for use in construction a compacted clay liner. A suitable off-site source could be located for importation to the site, and the clay liner should be placed in nominal lifts of 300 millimetres, sufficiently worked to destroy any natural layering or soil structure, and compacted to 95 per cent of its standard Proctor maximum dry density [SPMDD].

Alternatively, weighed down proprietary liners could be considered, however the material suppliers of such materials (such as Layfield, Terrafix, Suprema) would have to be consulted for recommendations on the appropriate product and installation methods for the site conditions. Such artificial liners would not require compaction efforts and could be weighed down with practically any available soil or granular material.

The provided drawings indicate interior pond slopes beneath the permanent pond elevation of 4 to 5 horizontal to 1 vertical, with interior slopes above permanent pond elevation and exterior slopes no steeper than 3 horizontal to 1 vertical. It is understood that the use of coarse 'rip rap' and filter cloth will be provided for some interior slopes under water to maintain stability of some of the submerged slopes. In general, it is recommended that all interior pond slopes be provide with at least some form of stabilisation/protection.

The proposed pond slopes would be considered to remain stable at the proposed inclinations of between 3 to 5 horizontal to 1 vertical, provided the material utilised is free of significant organic deposits, construction debris, or any other deleterious materials which would affect stability of the pond slopes. Our office should be retained to review any imported material to the site, as well as to provide quality control services during construction.

Additional stabilization efforts such as biaxial geogrid layers within the fill mass may also be considered. The product supplier [such as Terrafix or Maccaferri] should be consulted on the most appropriate products and design details, given the proposed slope and soil conditions. Such reinforced earth embankments should also incorporate suitable drainage, such as 'wick drains', or layers of granular material encased in heavy geofabric, in order to prevent excess pore water pressure, which would impact the stability of the constructed slope.

We trust that this information meets with your requirements. Should you have any queries or require additional information, please do not hesitate to contact the undersigned.

Yours very truly,
SOIL-MAT ENGINEERS & CONSULTANTS LTD.

Kyle Richardson, P.Eng.
Project Engineer

Ap-12/19
S. K. RICHARDSON
100179716

Distribution: Urbantech Consulting [1, plus pdf]

PROJECT NO: SM 135031-G

AUGUST 1, 2013

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
ORANGEVILLE HIGHLANDS-PHASE II SUBDIVISION
ORANGEVILLE, ONTARIO

PREPARED FOR:

VENTAWOOD MANAGEMENT INC.

Soil-Mat

BY

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 LANCING DRIVE
HAMILTON, ONTARIO
L8W 3A1

PROJECT NO: **SM 135031-G**

AUGUST 1, 2013

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
ORANGEVILLE HIGHLANDS-PHASE II SUBDIVISION
ORANGEVILLE, ONTARIO

PREPARED FOR:

VENTAWOOD MANAGEMENT INC.

BY

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 LANCING DRIVE
HAMILTON, ONTARIO
L8W 3A1

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 LANCING DRIVE, HAMILTON, ONTARIO L8W 3A1
PHONE (905) 318-7440 TOLL FREE (800) 243-1922 FAX (905) 318-7455
E-MAIL: info@soil-mat.on.ca WEB SITE: www.soil-mat.on.ca

PROJECT NO.: **SM 135031-G** August 1, 2013

VENTAWOOD MANAGEMENT INC.
2458 Dundas Street West
Mississauga, Ontario
L5K 1R8

Attention: Ms. Carmen Jandu, MCIP RPP

GEOTECHNICAL INVESTIGATION
PROPOSED RESIDENTIAL DEVELOPMENT
ORANGEVILLE HIGHLANDS-PHASE II SUBDIVISION
ORANGEVILLE, ONTARIO

Dear Ms. Jandu,

The fieldwork, laboratory testing, and report preparation corresponding to the above noted project, have been undertaken in general accordance with proposal P5010, dated March 26, 2013, including the requested additional boreholes and groundwater monitoring wells. Our comments and recommendations, based on our findings at the fifteen borehole locations are presented in the following paragraphs.

1. INTRODUCTION

We understand that the proposed project will consist of the construction of multiple residential structures primarily consisting of townhouse buildings, along with asphalt paved roadways. These structures are to compose the second phase of the Orangeville Highlands residential subdivision development. The construction will also include the installation of the associated underground municipal services for these residential units. We understand that the proposed roadway configuration and design site grades had not been finalised at the time of this report. At the time of preparing this report the concept site configuration consisted of three roadways and the SWM facility along the eastern limit. The purpose of this geotechnical investigation was to determine the subsurface conditions at fifteen borehole locations and to interpret the results of this investigation with respect to the design and construction of the foundations and related earthworks for this project.

This report is based on the above summarised project description, and on the assumption that the design and construction will be performed in accordance with applicable codes and standards. Any significant deviations from the proposed project design may void the recommendations given in this report. If significant changes are made to the proposed design, this office must be consulted to review the new design with respect to the results of this investigation. The information contained in this report does not reflect upon the environmental aspects of the site and therefore have not been addressed in this document.

2. PROCEDURE

A total of fifteen [15] sampled boreholes were advanced at the locations illustrated on the attached Drawing No. 1, Borehole Location Plan. The boreholes were advanced using solid-stem continuous flight power auger equipment on April 25 and 26, 2013, under the supervision of SOIL-MAT ENGINEERS. The boreholes were terminated at depths of approximately 5.0 to 9.8 metres below the present grade. Representative samples of the subsoils were recovered from the borings at selected depth intervals using split barrel sampling equipment driven in accordance with ASTM test specification D1586, Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils. After undergoing a general field examination, the soil samples were preserved and transported to the SOIL-MAT laboratory for visual, tactile, and olfactory classifications. Routine moisture content tests were performed on all soil samples recovered from the borings.

Groundwater observations were made in each borehole during the drilling operations. At the completion of drilling groundwater monitoring wells with protective 'stick up' casings were installed in Borehole Nos. 12 [MW-1], 13 [MW-2] and 14 [MW-3]. The remaining boreholes were backfilled with granular bentonite in general accordance with Ontario Regulation 903 of the Ontario Water Resources Act. Our groundwater observations, together with those provided by Azimuth Environmental Consulting Inc., have been shown as footnotes on the enclosed borehole logs.

The boreholes were located in the field by a representative of SOIL-MAT ENGINEERS within the proposed area of the roadway and townhouse blocks. The elevation of the ground surface at each of the borehole locations was referenced to a temporary benchmark described as the top of the sanitary manhole in Hansen Boulevard roughly at the midpoint of the south side of the site. The elevation of this temporary benchmark is assumed to be 100.00 metres.

The results of this investigation and that of our corresponding lab testing are detailed in Borehole Log Nos. 1 through 15, inclusive, which can be found appended to the end of this report. It is noted that the boundaries of soil types indicated on the borehole logs are inferred from non-continuous soil sampling and observations made during drilling. These boundaries are intended to reflect transition zones for the purpose of geotechnical design and therefore should not be construed as the exact planes of geological change.

3. SITE DESCRIPTION

The project site is located northeast of the intersection of Amelia Street and Hansen Boulevard in Orangeville, Ontario. The Phase II site is immediately east of the Phase I development and is bound to the north by woodland, to the east by the Orangeville Mall, and to the south by Hansen Boulevard. Vegetation on the site is defined by wild grass and scrub vegetation with sparse clusters of mature trees throughout the property. There is a small drainage course and ponded water found in the northeast quadrant, together with some topsoil stockpiles. The topography of the site rises from east to west with a maximum topographic relief across the site of approximately 11.5 metres. There is a fenced 'dog' park located in the southeast corner of the property. There is a gravel roadway off Hanson Boulevard near the centre of the site and the remnants of a sales pavilion located to the west of the roadway.

Topsoil

A topsoil layer with a thickness of approximately 150 to 200 millimetres was encountered at the borehole locations, with a thickness of about 450 to 700 millimetres in Borehole Nos. 3, 14 and 15. We were informed that the topsoil material 'stripped' from the adjacent Mall property was deposited on the subject site. Therefore, variable thicknesses of topsoil must be expected in the northeast portion of the site during the course of construction. A series of test pits could be advanced to delineate the areas of increased thickness of topsoil as part of the tender preparation.

It should be noted that the term 'topsoil' has been interpreted in this report from a geotechnical engineering point of view. If it is to be used for landscaping purposes, its suitability should be confirmed by tests on representative samples for organic and nutrient content and therefore its ability to support plant growth.

Fine Sand/ Fine Sandy Silt

Native interbedded Fine Sand/Fine Sandy Silt was encountered below the topsoil layer at the borehole locations. This brown to greyish brown fine granular soil contained traces of fine gravel, occasional silt seams, and organic staining at shallower depths. Some boreholes were found to contain seams of coarse gravel or cobbles resulting in sample intervals with higher 'N' values. The Fine Sand/ Fine Sandy Silt was generally found to be in a loose to compact state. The Fine Sand/ Fine Sandy Silt soils are generally in a moist to wet condition, with natural moisture content typically on the order of 20 percent. The 'lower' 'N' values obtained during split-spoon sampling are expected to have been influenced by soil disturbance ['suction' during removal of the auger flights]. The Fine Sand/ Fine Sandy Silt was proven to termination at all borehole locations.

Groundwater Observations

At the completion of drilling, 'free' groundwater and/or soil 'cave' was generally encountered at the borehole locations at depths of between about 1.5 to 5.3 metres below the surrounding ground surface level. Borehole Nos. 5 and 11 were found to be 'dry' on completion. These levels are not considered to be reflective of the static groundwater as insufficient time would have passed for the water level to stabilise in the open boreholes. Groundwater monitoring wells were installed in Borehole Nos. 12 [MW-1], 13 [MW-2] and 14 [MW-3] to allow for long term monitoring of the groundwater levels. Groundwater readings were taken by a representative of Azimuth Environmental Consulting Inc. on April 29, May 24 and June 26, 2013 and provided to this office. The groundwater monitoring information has been provided in the following table.

TABLE A
GROUNDWATER OBSERVATIONS

Borehole	BH No. 12 [MW-1]	BH No. 13 [MW-2]	BH No. 14 [MW-3]
Ground Surface Elevation [m]	93.57	93.97	93.97
Date	Depth / Elevation [m]	Depth / Elevation [m]	Depth / Elevation [m]
April 29, 2013	5.75/87.82	1.57/92.10	1.35/92.32
May 24, 2013	5.81/87.76	1.77/91.90	1.54/92.13
June 26, 2013	5.86/87.71	1.93/91.74	1.56/92.11

4. EXCAVATIONS

As previously noted the final design grades for this subdivision project had not been finalised at the time of this report. We would recommend that Soil-Mat Engineers be afforded the opportunity to review the final design grades, which may result in supplemental comments pertaining to the excavation operations. It is anticipated that the proposed foundations, sewers and other underground services for the residential development will extend to depths of up to approximately 1.5 to 5.5 metres below the present grade, into the native Fine Sand/Fine Sandy Silt. If possible the grade in 'low' areas of the site should be raised in order to reduce the effect of the relatively shallow groundwater conditions on the construction of services and roadways.

The side slopes in excavations above the groundwater level should remain stable for the short construction period at slopes of 45 degrees to the horizontal. Where 'wet' seams are encountered or for deeper excavations, the sides of excavations will have a tendency to 'cave in' to slopes a flat as 3 horizontal to 1 vertical, or flatter. Some minor infiltration of groundwater through more permeable seams and from surface runoff should be anticipated. However any such infiltration should be readily controlled with typical construction dewatering methods, i.e. pumping from sumps in the base of excavations. Occasional cobbles and boulders should be anticipated during excavation. Depending on the size and quantity of these cobbles/boulders, the rate of excavation may be slowed.

Where deeper excavations are required, extending to within perhaps 0.5 metres to slightly below the static groundwater level, difficulties should be anticipated with base and side slope stability, groundwater control, etc. The sides of excavations will tend to 'slump in' to as flat as 3 horizontal to 1 vertical, or flatter. The base of excavations will have a tendency to become unstable, requiring the placement of coarse ballast stone material 'punched' into the underlying wet fine grained granular soils, additional bedding material, etc. Additional sumps will be required to control groundwater infiltration, and the use of more sophisticated groundwater control methods may be considered necessary for excavations deeper than about 0.5 to 1.0 metres below the groundwater level. In this regard it is recommended that a number of test pit excavations be advanced to allow tendering contractors to observe the conditions first hand to assess the requirements of their excavation operations during the installation of underground services.

With a firm and stable excavation base, stabilised as required, standard pipe bedding may be provided, as typically specified by the Ontario Provincial Standard Specification [OPSS] or the local municipality will be satisfactory. Special attention should be paid to compaction under the pipe haunches.

At certain locations the contractor may choose to undertake the excavations in the 'wet', which would result in wider trenches/excavations, requirements to stabilise the base of the trenches along certain sections of the pipe lines where they extend below the ground water table at the time of construction, and additional backfill requirements. The excavations would require continuous pumping from constructed sumps. The excavations could begin at the 'low-end' of the site to allow drainage away from the working areas. Time will be of the essence and any section of pipe must therefore be installed and backfilled as expeditiously as possible. It might be necessary to install 'sand' filter pressure relief wells in the base of the trenches along certain severe ground water condition sections to reduce disturbance and uplift of the excavation base.

The alternative to the 'open-trench' excavation technique would be the installation of more sophisticated 'dewatering' schemes. This would require estimates of the coefficient of permeability of the native fine graded soils although for preliminary design purposes values in the 10^{-2} to 10^{-4} cm/sec range would seem reasonable. It is recommended that tendering

contractors undertake a number of test excavations in order to observe firsthand how the conditions with affect their operations.
Notwithstanding the above, all excavations must comply with the current Occupational Health and Safety Act and Regulations for Construction Projects. Excavation slopes steeper than those required in the Safety Act much be supported or a trench box provided, and a senior geotechnical engineer from this office should be retained to monitor the work. More water should be expected when connections are made with existing services. Surface water should be directed away from the excavations.

We would recommend that the invert elevations of any storm sewer pipes for rear yard catch basins be located above the proposed underside of footing elevations of adjacent to the townhouse structures, or that the trench excavations should be filled with 'lean mix' concrete to the proposed underside of footing level where the excavations extend below an imaginary one horizontal to one vertical line extending outwards and down from the proposed residential foundations.

5. BACKFILL CONSIDERATIONS

The majority of the excavated material will consist of Fine Sand/Fine Sandy Silt as described above. This material is generally considered suitable for use as engineered fill and service trench backfill, provided the moisture content can be controlled within 3 per cent of standard Proctor optimum value. The Fine Sand/Fine Sandy Silt is noted to range from slightly 'dry' to well 'wet' of optimum moisture content. As such some selective sorting based on moisture content may be required. Depending on the weather at the time of construction, some moisture content conditioning of the excavated materials may be required to achieve acceptable compaction densities and minimise long-term settlement. The Fine Sand/Fine Sandy Silt soils are not considered to be free-draining and should not be used as backfill where this characteristic is necessary.

Proper handling of the on-site soils based on groundwater and weather conditions during construction will be important to achieving a successful compaction operation. The Fine Sand/Fine Sandy Silt is sensitive to moisture absorption and will become practically impossible to compact using conventional compaction equipment if they become wet during extended periods of precipitation. The 'drier' excavated materials should therefore undergo minimal exposure to the elements in order to minimize the absorption of precipitation, prior to their use as backfill. The wet to saturated fine sand/fine sandy silt soils will need to be spread out and allowed to air dry if they will not drain sufficiently 'fast' to allow for adequate compaction operations. After a period of heavy precipitation, any near-surface softened material should be allowed to dry or be removed from the fill surface and discarded. Dust could a problem during the dry months of the year. The soils encountered on site are also considered to be highly frost susceptible and will have a tendency to 'heave' significantly under sub-freezing weather conditions.

It is noted that where the backfill material is placed and compacted near or slightly above its optimum moisture content the potential for long-term settlement due to ingress of groundwater and collapse of the fill structure is reduced. Correspondingly, the shear strength of the 'wet' backfill material is also lowered, thereby reducing its ability to support construction traffic and therefore impacting roadway construction. If the soil is well dry of its optimum value, it will appear to ery strong when compacted, but will tend to settle with time as the moisture content in the fill increases to equilibrium condition. Therefore, it is very important that the moisture content of the fill at the time of placement and compaction is within 3 per cent of its standard Proctor optimum moisture content. Any imported fill required in service trenches or to raise the subgrade elevation should exhibit respective moisture contents within 3 per cent of its optimum moisture content and meet the necessary environmental guidelines.

As noted above, occasional cobbles and boulders should be anticipated in the excavations. It is recommendebe vd that care be taken to avoid including large cobbles and boulders in backfill materials that will be placed in areas where settlement is critical.

A representative of SOIL-MAT ENGINEERS should monitor the backfilling and compaction operations to confirm uniform compaction of the backfill material to project specification requirements. Close supervision is prudent in areas that are not readily accessible to compaction equipment, for instance near the end of compaction 'runs', and around manholes and catch basins. The service trench backfill should be compacted to a minimum of 95 per cent standard Proctor density, with the upper one metre of roadway subgrade material compacted to 100 per cent standard Proctor density. The appropriate compaction equipment should be employed based on soil type. A method should be developed to assess compaction efficiency employing the on-site compaction equipment and backfill materials during construction.

6. MANHOLES, CATCH BASINS, AND THRUST BLOCKS

Where manholes, catch basins, valve chambers, etc. are founded on the native Fine Sand/Fine Sandy Silt or suitable engineered fill, and the founding surfaces are carefully prepared to remove all loose and disturbed material, the bearing surfaces will be practically non-yielding under the anticipated loads. Proper preparation of the founding soils may accentuate the protrusion of these structures above the pavement surface if compaction of the fill around these structures is not adequate, causing settlement of the surrounding paved surfaces. Conversely, the pavement surfaces may rise above valve chambers under frost action. To alleviate the potential for these various types of movements, free-draining, non-frost susceptible material should be employed as backfill around the structures located within the paved roadway limits, and compacted to 100 per cent of its standard Proctor density.

Thrust blocks placed in the native soils may be sized as recommended by the applicable Ontario Provincial Standard Specification [OPSD 1103.010, Nov 2006 Rev 1]. A design allowable bearing pressure of 100kPa [~2,000 psf] may conservatively be used in the design of the thrust blocks in the native Fine Sand/Fine Sandy Silt. Any backfill required behind the blocks should be granular and should be compacted to 100 per cent of their standard Proctor density.

7. PAVEMENT CONSIDERATIONS

The roadway areas should be stripped of any existing topsoil in addition to any other organic or unsuitable materials. The exposed subgrade should be proofrolled with 3 to 4 passes of a loaded tandem truck or large smooth drum roller in the presence of a representative of this office immediately prior to the placement of the sub-base material. Any areas of distress revealed by this or other means must be sub-excavated and replaced with suitable backfill material. Alternatively, the soft areas may be stabilised by placing coarse crushed stone and 'punching' it into these areas. As noted above the fine grained granular soils are generally 'wet' and sensitive to moisture conditions making effective compaction difficult. As such it should be anticipated that subgrade in instability will be experienced, requiring the use of additional depth of Granular B and/or coarse 'rip rap' stone materials.

The need for the treatment of softened subgrade will be reduced if construction is undertaken during the dry summer months and if careful attention is paid to the compaction operations. The fill overlying shallow utilities cut into or across subdivision streets [i.e. telephone lines, hydro, gas, etc.] must also be compacted to 100 per cent of its standard Proctor maximum dry density.

Good drainage provisions will optimise the long-term performance of the pavement structure. The subgrade must be properly crowned and shaped to promote drainage to the subdrain system. Subdrains should be installed to intercept excess subsurface water and prevent softening of the subgrade material. Surface water should not be allowed to pond adjacent to paved areas.

The most severe loading conditions on the subgrade typically occur during the course of construction; therefore precautionary measures should be taken to ensure that the subgrade is not unduly disturbed by construction traffic. These measures would include minimising the

amount of heavy traffic travelling over the subgrade, such as during the placement of granular base layers.
If construction is conducted under adverse weather conditions, it should be anticipated that additional subgrade preparation will be required, such as additional depth of Granular B, Type II sub-base course material. It is also important that the sub-base and base course granular layers of the pavement structure be placed as soon after exposure and preparation of the subgrade as practical.

The proposed pavement structure would be required to adequately support cars, trucks and the intermittent delivery and garbage trucks. For this project we would recommend a pavement structure of 350mm of OPSS Granular 'B' sub-base course [Type II], 150mm of OPSS Granular 'A' base course, 80 millimetres of OPSS HL8 binder course asphaltic concrete, and 40 millimetres of OPSS HL3 surface course asphaltic concrete. Nevertheless the pavement structure should conform to the relevant Town of Orangeville requirements. It is our opinion, that this design is suitable for use on a residential roadway section, provided that the subgrade has been prepared as specified and is good and firm before the sub-base course material is placed. If the subgrade is soft, remedial measures as discussed above may have to be implemented and/or the sub-base thickness may have to be increased. The granular sub-base and base courses and asphaltic concrete layers should be compacted to OPSS or the Town of Orangeville requirements. A program of in-place density testing must be carried out to monitor that compaction requirements are being met. We note that this provided pavement structure is not to be considered as a construction roadway design.

To minimise segregation of the finished asphalt mat, a uniform asphalt temperature must be maintained throughout the mat during placement and compaction. Frequently, significant temperature gradients exist in the delivered and placed asphalt with cooler portions of the mat resisting compaction and presenting a 'honey combed' surface. As the spreader moves forward, a responsible member of the paving crew should monitor the pavement surface, to ensure smoothness and uniformity. The contractor can mitigate the surface segregation by 'back-casting' or scattering shovels of the full mix material over the segregated areas and raking out the coarse particles during compaction operations. Of course, the above assumes that the asphalt mix is sufficiently hot to allow the 'back-casting' to be performed.

8. HOUSE AND RESIDENTIAL TOWNHOUSE FOUNDATION CONSIDERATIONS

The native soils are considered capable of supporting the loads typically associated with single family dwellings and residential townhouse structures, typically taken as 75 kPa [~1,500 psf], provided they have not been unduly disturbed by construction activities and/or by groundwater conditions prevailing at the time of construction. Foot traffic within the footing beds should be kept to a minimum to prevent disturbance of the founding soils. The footing beds must be hand cleaned of all loose or disturbed soil immediately prior to the placement of concrete. It would be prudent to place a concrete mud slab following excavation as part of the foundation construction operation.

Where engineered fill is required in site grading operations the fill material should be placed and compacted consistent with the recommendations noted in the Backfill Considerations comments above. As noted above it is very important that the placement moisture content of any fill material be within 3 percent of its optimum value to ensure efficient compaction and minimise long-term settlement potential. The fill material should be placed in lifts of no more than 300 millimetres depending on the size of the compaction equipment and each lift should be uniformly compacted to 100 percent of its standard Proctor maximum dry density. If there is a short fall in the volume of fill required, then the source of imported fill should be assessed for gradation, Proctor value, compatibility with existing fill, environmental analysis and be approved by this office prior to use.

The support conditions afforded by the native soils, and/or engineered fill are generally not uniform across the building footprint, nor are the loads on the various foundations elements. As such it is recommended that nominal reinforcement be provided in the footings and foundation walls to account for these variable support and loading conditions. The use of nominal reinforcement is considered good construction practice as it will act to reduce the potential for cracking in the foundation walls due to minor settlements, heaving, shrinkage, etc. and will assist in resisting the pressures generated against the foundation walls by the backfill. Such nominal reinforcement is an economical approach to the reduction and prevention of costly foundation repairs after completion and later in the life of the buildings. This reinforcement would typically consist of two continuous 15M rods placed in the footings [directly below the foundation wall] and similarly, two steel rods placed approximately 300 millimeters from the top of the foundation walls, depending on ground conditions exposed during construction. These reinforcement bars would be bent to reinforce all corners and under basement windows, and be provided with sufficient overlap at staggered splice locations. At 'steps' in the foundations and at window locations, the reinforcing steel should transition diagonally, rather than at 90 degrees, to maintain the continuous tensile capacity of the reinforcement. Where footings are founded on, or partially on, engineered fill the above provision for nominal reinforcement would be required.

All basement foundation walls should be suitably damp proofed, including the provision of a 'dimple board' type drainage product, and provided with a perimeter drainage tile system outlet to a gravity sewer connection or positive sump pit a minimum of 150 millimetres below the basement floor slab. The clear stone material surrounding the weeping tile should be encased with a geotextile material to prevent the migration of fines from the foundation wall backfill into the clear stone product. In the event that sump pit systems are required we would recommend that the sump pump system should be constructed with a 'back-flow' prevention valve so that the sump pump will not cycle repeatedly within short time periods. In the areas of a 'higher' groundwater level we would recommend that an underfloor drainage system be incorporated into the building construction and that this system be connected separately, from the exterior perimeter drainage system, to the discharge sump pit. In areas where severe disturbance issues become apparent, it may be prudent to place a geotextile filter cloth [e.g., Mirafi 140NC] over the exposed subgrade material prior to the construction of the footing formwork and the underfloor granular base product.

All footings exposed to the environment must be provided with a minimum of 1.2 meters of earth or equivalent insulation to protect against frost penetration. This frost protection would also be required if construction were undertaken during the winter months. All footings must be proportioned to satisfy the requirements of the Ontario Provincial Building Code.

It is imperative that a soils engineer be retained from this office to provide geotechnical engineering services during the excavation and foundation construction phases of the project. This is to observe compliance with the design concepts and recommendations of this report and to allow changes to be made in the event that subsurface conditions differ from the conditions identified at the Borehole locations.

9. GENERAL COMMENTS

The comments provided in this document are intended only for the guidance of the design team. The subsoil descriptions and borehole information are only intended to describe conditions at the borehole locations. Contractors placing bids or undertaking this project should carry out due diligence in order to verify the results of this investigation and to determine how the subsurface conditions will affect their operations.

We trust that this geotechnical report is sufficient for your present requirements. Should you require any additional information or clarification as to the contents of this document, please do not hesitate to contact the undersigned.

Yours very truly,
SOIL-MAT ENGINEERS & CONSULTANTS LTD.

Michael Brown
Michael Brown, B. Sci. Eng., EIT

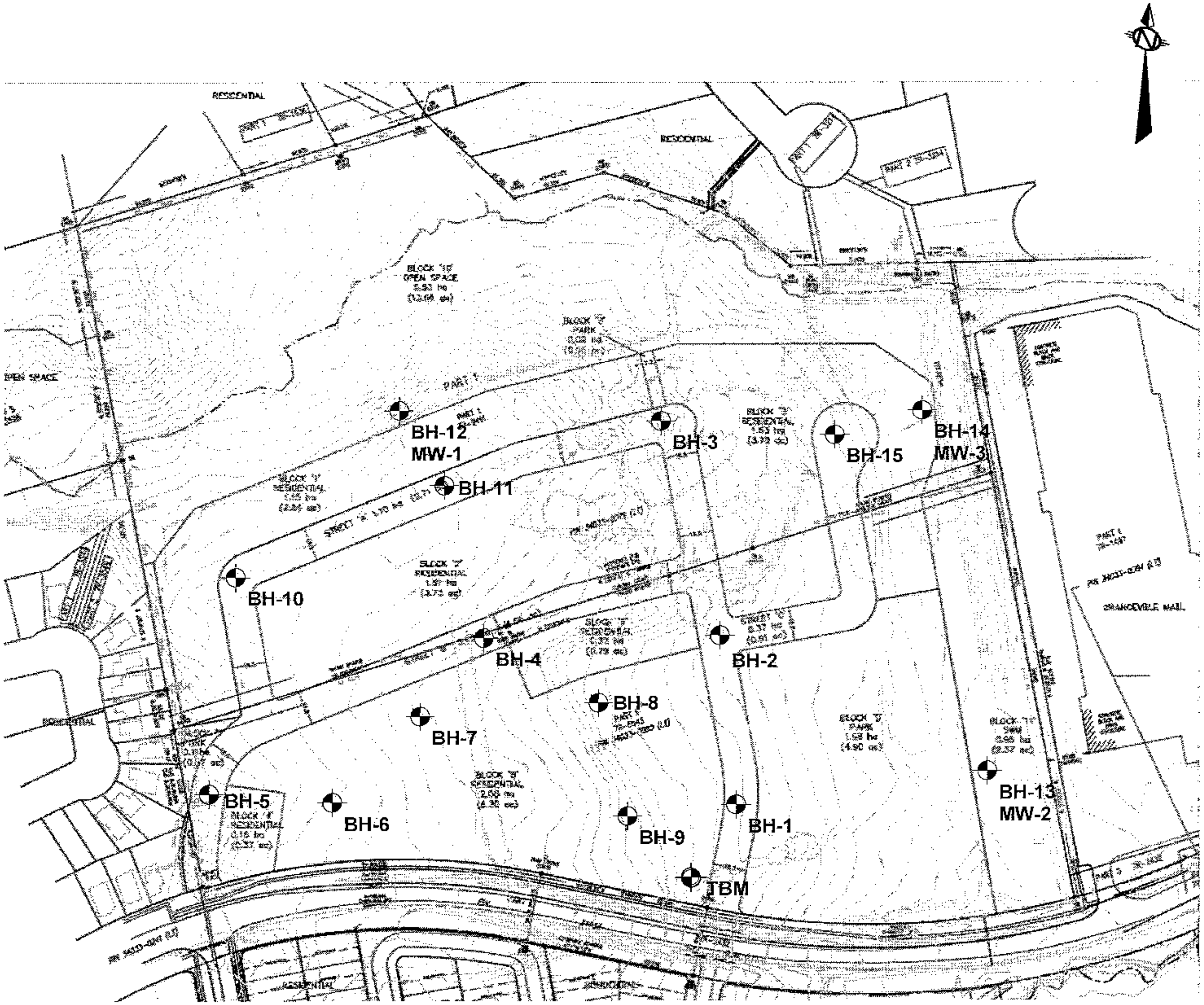
John Monkman, P.Eng.
Project Engineer

for: Ian Shaw, P. Eng.
Review Engineer

LICENSED PROFESSIONAL ENGINEER
Aug 29/13
J. D. MONKMAN
PROVINCE OF ONTARIO

Enclosures: Drawing No. 1, Borehole Location Plan
Borehole Log Nos. 1 to 15, inclusive

Distribution: Ventawood Management Inc. [2, plus pdf]



LEGEND

BH-# Borehole

TBM Temporary Benchmark
[Described as the top of the sanitary manhole near the eastern intersection of development and Hansen Blvd. Assumed elevation of 100.00 m]

NOTES:

1. This drawing should be read in conjunction with Soil-Mat Engineers & Consultants Ltd. report number SM 135031-G.
2. Soil samples will be discarded after 3 months unless directed otherwise by client.
3. Borehole locations are approximate.

Soil-Mat
Engineers & Consultants Ltd.

CLIENT
Country Green Homes Ltd.

PROJECT TITLE
Geotechnical Investigation
Orangeville Highlands Phase II
Hansen Blvd., Orangeville

DRAWING TITLE
Borehole Location Plan

PROJECT No.	SM 135031-G
SCALE	N.T.S.
DATE	April 2013
CHECKED	IS
DRAWN	KR

FILENAME
135031 - Borehole Location Plan.kcw

DRAWING No. 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 1

Project Manager: John Monkman, P. Eng.

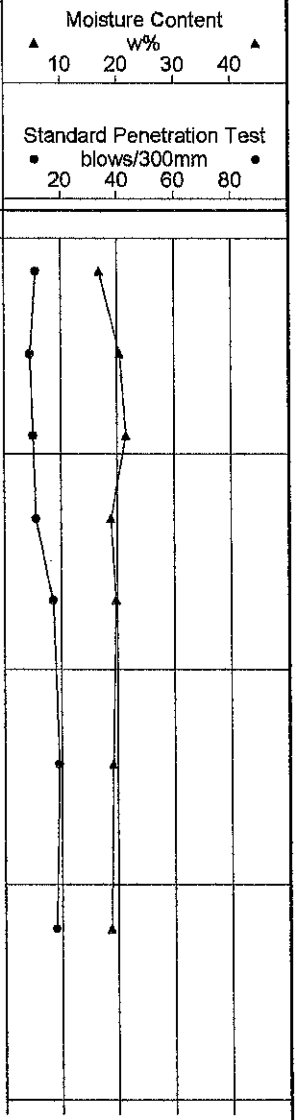
Borehole Location: See Drawing No. 1

: ::

Soil-Mat

SUBSURFACE PROFILE					SAMPLE						
Depth	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
ft 0 m 0	98.35		Ground Surface								
			Topsoil Approximately 150 millimetres of topsoil.		SS	1	5,5,6,7	11	■		
			Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, occasional silt seams, loose to compact		SS	2	3,3,6,8	9	■		
					SS	3	4,5,5,8	10	■		
					SS	4	4,5,6,8	11	■		
					SS	5	4,7,10,12	17	■		
					SS	6	5,7,12,17	19	■		
					SS	7	3,4,4,5	8	■		
	91.65		End of Borehole								

Depth (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32
Depth (m): 0, 2, 4, 6, 8



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 6.7 metres.
2. Borehole was recorded as 'caved' at a depth of 2.0 metres upon completion of drilling and backfilled as per Ontario Regulation 903.
3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 2

Project Manager: John Monkman, P. Eng.

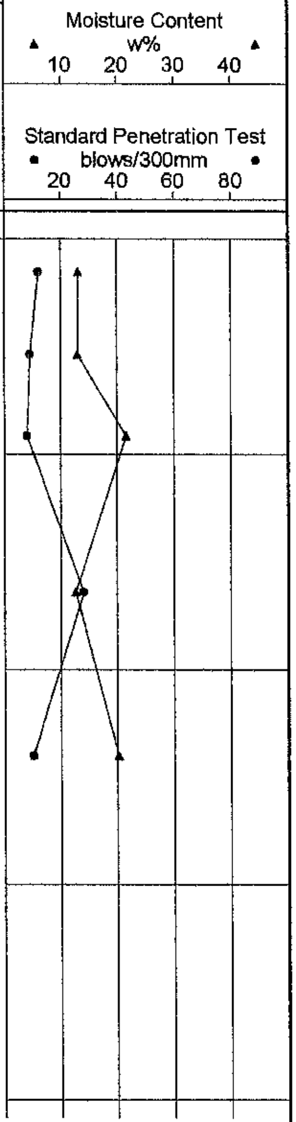
Borehole Location: See Drawing No. 1

: ::

Soil-Mat

SUBSURFACE PROFILE / SAMPLE

Depth (ft / m)	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	98.75		Ground Surface								
			Topsoil Approximately 150 millimetres of topsoil.		SS	1	3,5,7,8	12	■		
			Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, traces of organic staining at shallower depths, loose to compact		SS	2	5,4,5,8	9	■		
					SS	3	2,2,6,9	8	■		
					SS	4	9,10,18	28	■		
	95.25		Coarse layer at approximately 3.5 meters								
					SS	5	4,4,6	10	■		
	92.05		End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 6.7 metres.
2. Borehole was recorded as 'wet' at a depth of 2.3 metres upon completion of drilling and backfilled as per Ontario Regulation 903.
3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 3

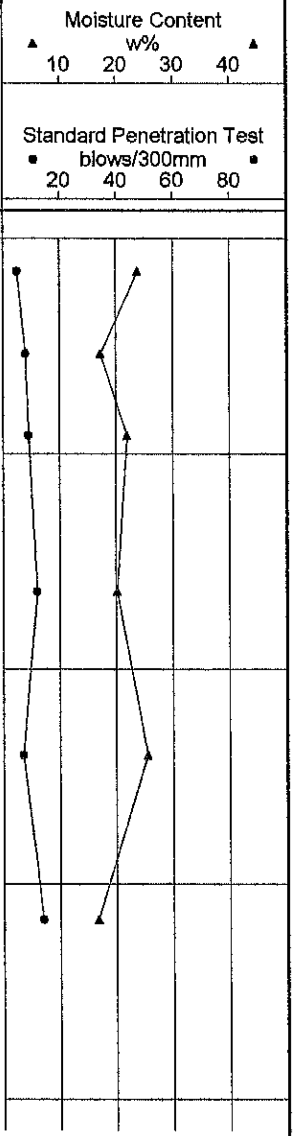
Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: ::

Soil-Mat

SUBSURFACE PROFILE					SAMPLE						
Depth (ft / m)	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	97.78		Ground Surface								
	97.08		**_Topsoil_** Approximately 700 millimetres of topsoil.		SS	1	3,2,3,5	5	■		
			Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, organic staining at shallower depths, loose to compact		SS	2	2,3,5,8	8	■		
					SS	3	2,4,5,6	9	■		
					SS	4	3,4,8	12	■		
					SS	5	2,2,5	7	■		
	91.18				SS	6	6,7,7	14	■		
			End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 6.6 metres.
2. Borehole was recorded as 'wet' at a depth of 1.5 metres upon completion of drilling and backfilled as per Ontario Regulation 903.
3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 4

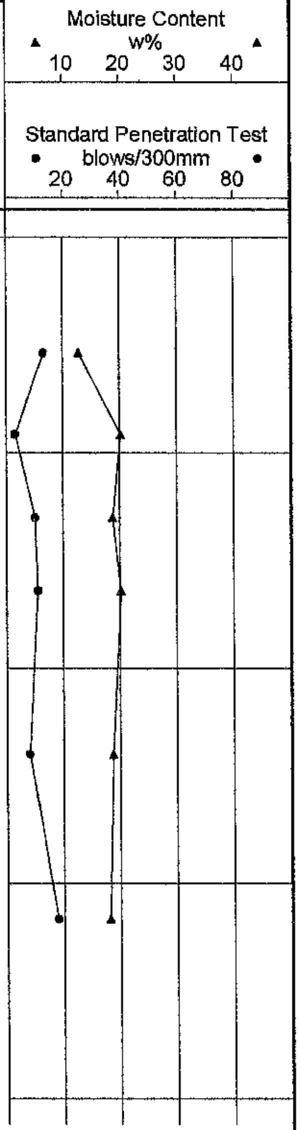
Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: ::

Soil-Mat

SUBSURFACE PROFILE					SAMPLE						
Depth (ft / m)	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	102.71		Ground Surface								
			Topsoil Approximately 150 millimetres of topsoil.								
			Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, traces of oxidation at shallower depths, very loose to compact		SS	1	5,7,6,5	13	■		
					SS	2	1,1,2,3	3	■		
					SS	3	2,4,6,6	10	■		
					SS	4	4,5,6	11	■		
					SS	5	2,3,3	8	■		
	96.11				SS	6	5,7,11	18	■		
			End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 6.6 metres.
2. Borehole was recorded as 'caved' at a depth of 1.8 metres upon completion of drilling and backfilled as per Ontario Regulation 903.
3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 5

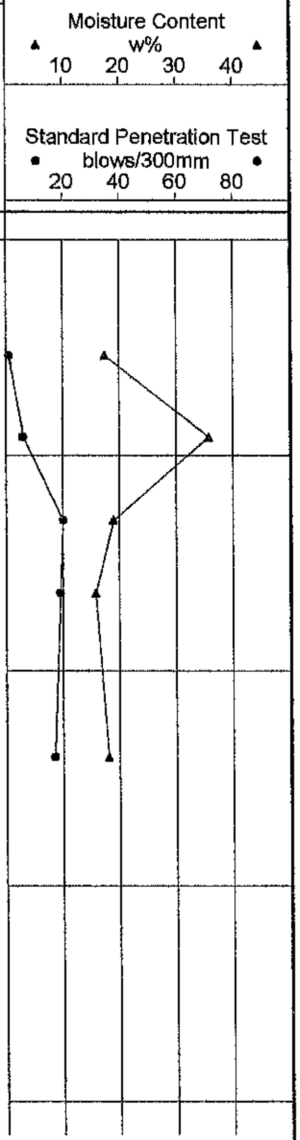
Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: ::

Soil-Mat

SUBSURFACE PROFILE					SAMPLE						
Depth (ft / m)	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	104.46		Ground Surface								
	104.26	~	**Topsoil** Approximately 200 millimetres of topsoil.								
			Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, occasional silt seams, very loose to compact		SS	1	1,0,1,1	1	■		
	102.64		Clay-rich layer at approximately 1.8 meters		SS	2	0,1,2,4	6	■		
					SS	3	3,5,9,11	20	■		
					SS	4	4,8,11	19	■		
	99.46				SS	5	5,8,9	17	■		
			End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 5.0 metres.
2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.
3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 6

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

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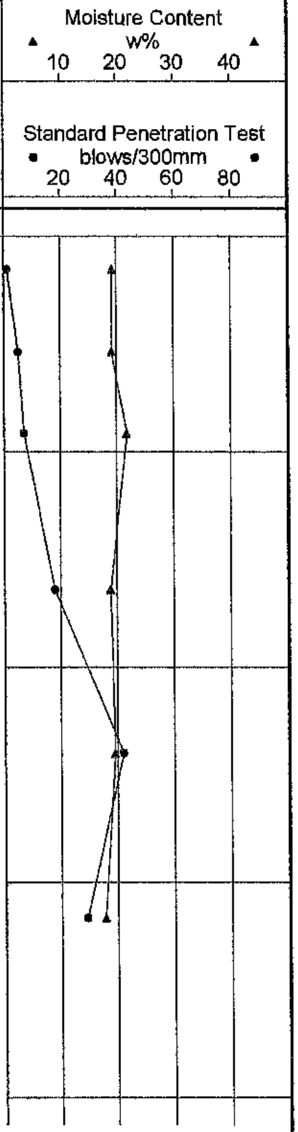
Soil-Mat

SUBSURFACE PROFILE					SAMPLE						
Depth (ft / m)	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	105.69		Ground Surface								
	105.49	~	**Topsoil** Approximately 200 millimetres of topsoil.		SS	1	0,1,0,0	1	■		
		▒	**Fine Sand/ Fine Sandy Silt** Brown to greyish brown, interbedded, traces of fine to coarse gravel, organic staining at shallower depths, very loose to dense		SS	2	2,3,2,3	5	■		
					SS	3	2,3,4,7	7	■		
					SS	4	6,8,10	18	■		
					SS	5	11,18,24	42	■		
					SS	6	7,12,17	29	■		
	99.09		End of Borehole								



Depth scale: ft 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32; m 0 2 4 6 8

NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 6.6 metres.
2. Borehole was recorded as 'wet' at a depth of 5.3 meters upon completion of drilling and backfilled as per Ontario Regulation 903.
3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

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e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 7

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

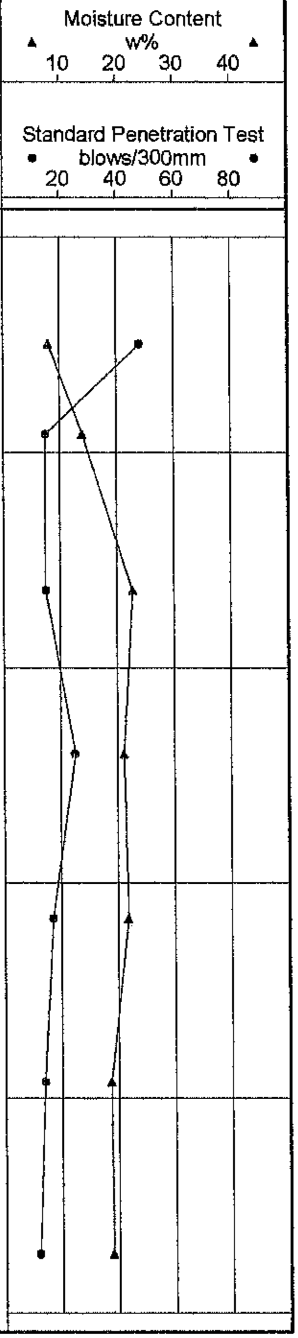
: ::

Soil-Mat

SUBSURFACE PROFILE / SAMPLE

Depth (ft / m)	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt. (kN/m3)
0 / 0	103.77		Ground Surface								
	103.57		**Topsoil** Approximately 200 millimetres of topsoil.								
			Fine Sand/ Fine Silty Sand Brown to greyish brown, interbedded, traces of fine gravel throughout, some coarse gravel at shallower depths, assumed cobble at approximately 0.9 meters, compact to dense		SS	1	6,20,28	48	■		
					SS	2	3,7,8,8	15	■		
					SS	3	4,7,8	15	■		
					SS	4	4,11,14	25	■		
					SS	5	0,1,5,12	17	■		
					SS	6	2,4,10	14	■		
					SS	7	2,4,8,12	12	■		
	93.97		End of Borehole								

Depth scale: ft 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32; m 0, 2, 4, 6, 8



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 9.8 metres.

2. Borehole was recorded as 'wet' at a depth of 3.5 meters upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Log of Borehole No. 8

Project: Orangeville Highlands Phase II

Project Manager: John Monkman, P. Eng.

Location: Hansen Bvld., Orangeville, ON

Borehole Location: See Drawing No. 1

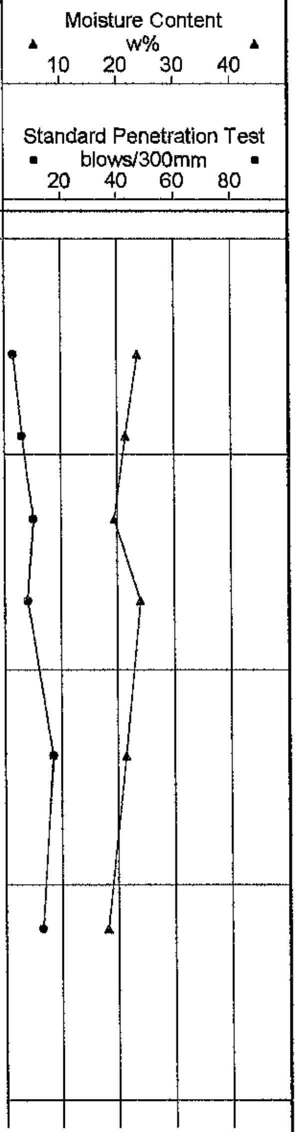
Client: Country Green Homes Ltd.

: ::

Soil-Mat

SUBSURFACE PROFILE / SAMPLE

Depth	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
ft 0 / m 0	102.15		Ground Surface								
		~	***Topsoil*** Approximately 150 millimetres of topsoil.								
		▨	***Fine Sand/ Fine Sandy Silt*** Brown to greyish brown, interbedded, traces of fine gravel, occasional silt seams, loose to compact		SS	1	1,1,2,3	3	■		
					SS	2	2,2,4,8	6	■		
					SS	3	3,4,6,6	10	■		
					SS	4	3,3,5,7	8	■		
					SS	5	4,7,10	17	■		
					SS	6	2,5,8,11	13	■		
	95.45		End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 6.7 metres.

2. Borehole was recorded as 'wet' at a depth of 1.8 meters upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Log of Borehole No. 9

Project: Orangeville Highlands Phase II

Project Manager: John Monkman, P. Eng.

Location: Hansen Bvld., Orangeville, ON

Borehole Location: See Drawing No. 1

Client: Country Green Homes Ltd.

:	::

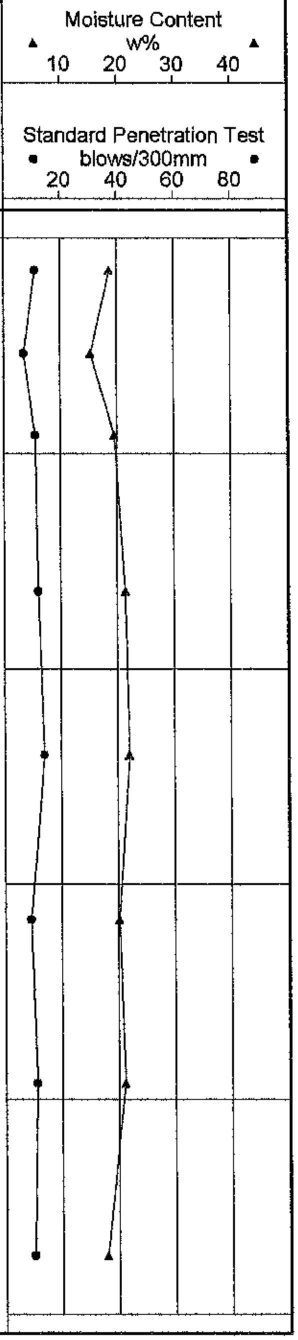
Soil-Mat

SUBSURFACE PROFILE

Depth (ft / m)	Elevation [m]	Symbol	Description	Well Data
0 / 0	99.42		Ground Surface	
			Topsoil Approximately 150 millimetres of topsoil.	
			Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, occasional silt seams, loose to compact	
32	89.67		End of Borehole	

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	4,4,7	11			
SS	2	2,3,4,5	7			
SS	3	3,5,6,10	11			
SS	4	3,5,7	12			
SS	5	3,5,9	14			
SS	6	4,3,6	9			
SS	7	4,5,6	11			
SS	8	5,6,4,6	10			



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 26, 2013 to termination at a depth of 9.8 metres.

2. Borehole was recorded as 'caved' at a depth of 1.8 meters upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 26, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 10

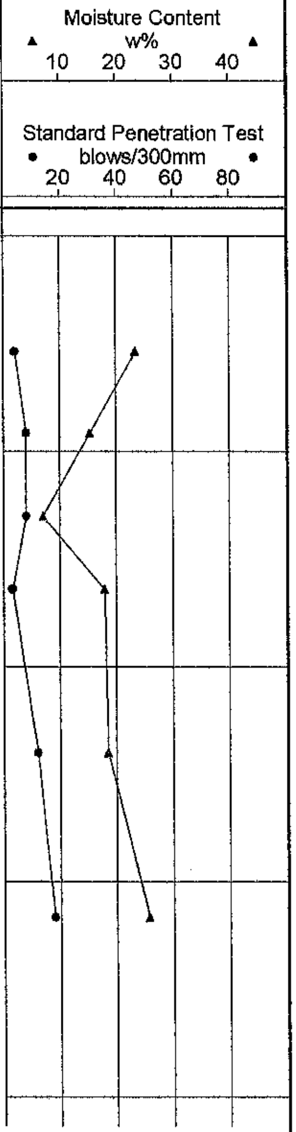
Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: ::

Soil-Mat

SUBSURFACE PROFILE						SAMPLE						
Depth ft	Depth m	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0	0	104.29		Ground Surface								
		104.09	~	**Topsoil** Approximately 200 millimetres of topsoil.								
			▒	**Fine Sand/ Fine Sandy Silt** Brown to greyish brown, traces of fine gravel, occasional silt seams, very loose to compact		SS	1	2,2,2,3	4	■		
			▒			SS	2	2,4,4,6	8	■		
			▒			SS	3	3,4,4,5	8	■		
			▒			SS	4	3,2,1	3	■		
			▒			SS	5	2,4,8	12	■		
		97.69	▒			SS	6	4,7,11	18	■		
				End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 26, 2013 to termination at a depth of 6.6 metres.
2. Borehole was recorded as 'caved' at a depth of 3.7 meters and 'wet' at a depth of 3.5 meters upon completion of drilling and backfilled as per Ontario Regulation 903.
3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 26, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 11

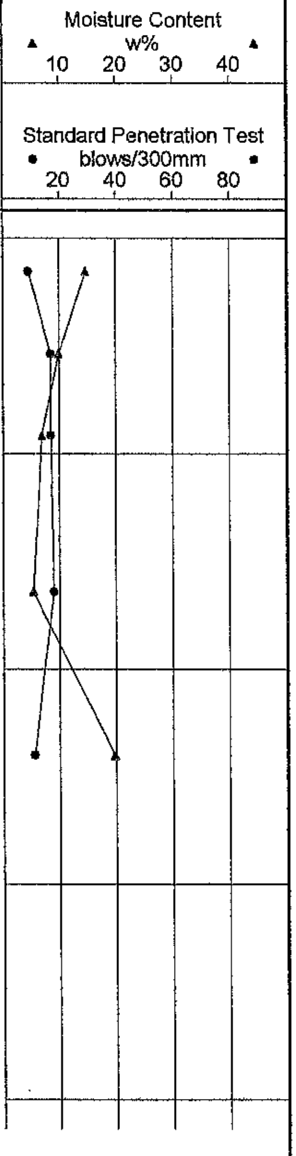
Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: ::

Soil-Mat

SUBSURFACE PROFILE					SAMPLE						
Depth	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 ft / 0 m	104.56		Ground Surface								
	104.36	~	***Topsoil*** Approximately 200 millimetres of topsoil.		SS	1	1,2,7,10	9	■		
		▒	***Fine Sand/ Fine Sandy Silt*** Brown to greyish brown, interbedded, traces of fine gravel throughout, some coarse gravel at shallower depths, loose to compact		SS	2	9,10,7,12	17	■		
		▒			SS	3	4,8,9,10	17	■		
		▒			SS	4	6,8,10	18	■		
		▒			SS	5	6,5,6	11	■		
	99.56		End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 26, 2013 to termination at a depth of 5.0 metres.
2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.
3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 26, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 12 [MW-1]

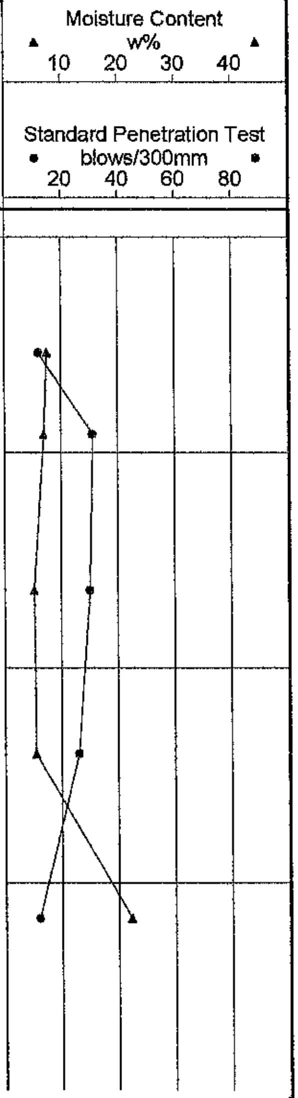
Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: ::

Soil-Mat

SUBSURFACE PROFILE					SAMPLE						
Depth (ft / m)	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
0 / 0	104.68		Ground Surface								
	104.48	~	***Topsoil*** Approximately 200 millimetres of topsoil.								
			Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, compact to dense								
					SS	1	2,5,7,8	12	■		
					SS	2	10,14,17, 12	31	■		
					SS	3	9,16,14	30	■		
					SS	4	5,10,16	26	■		
					SS	5	4,6,6	12	■		
	97.08		End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 26, 2013 to termination at a depth of 7.6 metres.

2. A monitoring well was installed upon the completion of drilling and the following groundwater levels were measured by a representative of Azimuth Environmental Consults Inc.:

April 29, 2013 - 5.75 metres May 24, 2013 - 5.81 metres June 26, 2013 - 5.86 metres

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Hollow-Stem Auger
Drill Date: April 26, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 13 [MW-2]

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: ::

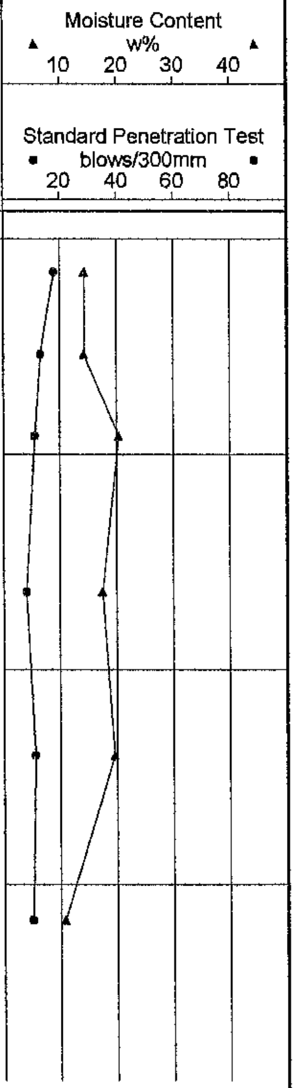
Soil-Mat

SUBSURFACE PROFILE

Depth	Elevation [m]	Description
0 ft / 0 m	93.97	Ground Surface
	93.77	***Topsoil*** Approximately 200 millimetres of topsoil.
		Fine Sand/ Fine Sandy Silt Brown to greyish, interbedded, traces of fine gravel, traces of organic staining at shallower depths, occasional silt seams, loose to compact
	87.27	End of Borehole

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	5,6,12,12	18	■		
SS	2	5,8,5,6	13	■		
SS	3	3,4,7,10	11	■		
SS	4	2,3,5	8	■		
SS	5	4,5,6	11	■		
SS	6	3,4,4,6	10	■		



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 26, 2013 to termination at a depth of 6.7 metres.

2. A monitoring well was installed upon the completion of drilling and the following groundwater levels were measured by a representative of Azimuth Environmental Consults Inc.:

April 29, 2013 - 1.57 metres May 24, 2013 - 1.77 metres June 26, 2013 - 1.93 metres

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Hollow-Stem Auger
Drill Date: April 26, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 14 [MW-3]

Project Manager: John Monkman, P. Eng.

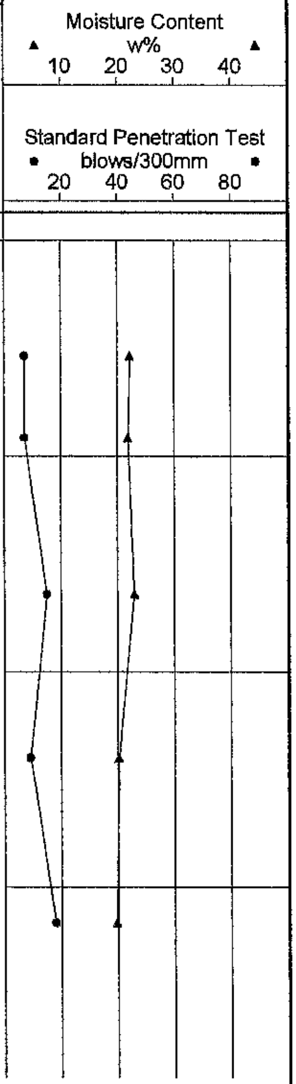
Borehole Location: See Drawing No. 1

:   ::

Soil-Mat

SUBSURFACE PROFILE / SAMPLE

Depth ft	Depth m	Elevation [m]	Description	Type	Number	Blow Counts	Blows/300mm	PP (kgf/cm2)	U.Wt.(kN/m3)
0	0	94.78	Ground Surface						
		94.28	***Topsoil*** Approximately 500 millimetres of topsoil.						
			Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, traces of organic staining at shallower depths, loose to compact	SS	1	5,8,5,6	7		
				SS	2	3,4,7,10	7		
				SS	3	2,3,5	15		
				SS	4	4,5,6	9		
		88.18		SS	5	3,4,4,6	18		
			End of Borehole						



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 26, 2013 to termination at a depth of 6.6 metres.

2. A monitoring well was installed upon the completion of drilling and the following groundwater levels were measured by a representative of Azimuth Environmental Consults Inc.:

April 29, 2013 - 1.35 metres   May 24, 2013 - 1.54 metres   June 26, 2013 - 1.56 metres

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Hollow-Stem Auger
Drill Date: April 26, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Log of Borehole No. 15

Project: Orangeville Highlands Phase II

Project Manager: John Monkman, P. Eng.

Location: Hansen Bvld., Orangeville, ON

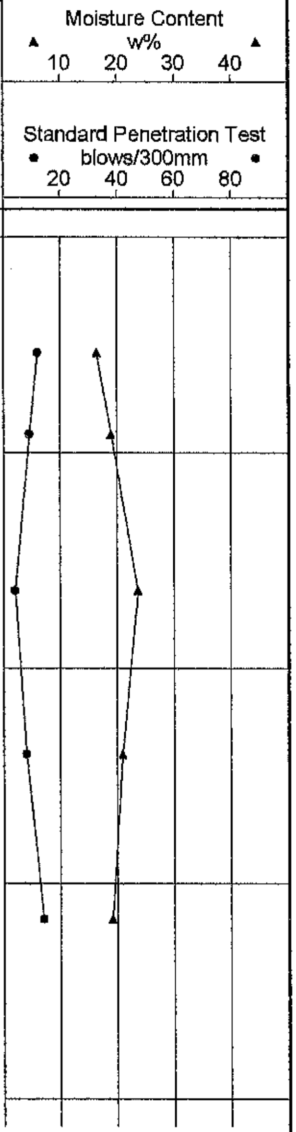
Borehole Location: See Drawing No. 1

: ::

Client: Country Green Homes Ltd.

Soil-Mat

SUBSURFACE PROFILE					SAMPLE						
Depth	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
ft 0 / m 0	96.19		Ground Surface								
	95.74		***Topsoil*** Approximately 450 millimetres of topsoil.								
			Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, organic staining at shallower depths, very loose to compact		SS	1	4,5,7,7	12	■		
					SS	2	4,5,4,5	9	■		
					SS	3	1,1,3,5	4	■		
					SS	4	2,3,5	8	■		
	90.99				SS	5	4,7,7,9	14	■		
			End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 26, 2013 to termination at a depth of 5.2 metres.
2. Borehole was recorded as 'caved' at a depth of 1.5 metres upon completion of drilling and backfilled as per Ontario Regulation 903.
3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 26, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Temporary Benchmark
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Hydrogeological Addendum Report for the East Half of Lot 3, Concession 2, Orangeville, ON

Revised Report

Prepared for:
Orangeville Highlands Ltd.
c/o Venta Investments Limited

Prepared by:
Azimuth Environmental
Consulting, Inc.

April 2019

AEC 11-237b

AZIMUTH ENVIRONMENTAL
CONSULTING, INC.
Environmental Assessments & Approvals

April 10, 2019 AEC 11-237b

Orangeville Highlands Ltd.
c/o Venta Investments Limited
9-2458 Dundas Street West
Mississauga, ON
L5K 1R8

Attention: Carmen Jandu

Re: **Revised Hydrogeological Addendum Report for the East Half of Lot 3, Concession 2, West of Hurontario Street, Geographic Township of Mono, in the Town of Orangeville, County of Dufferin**

Dear Ms. Jandu:

Azimuth Environmental Consulting (Azimuth) is pleased to submit our updated and revised Hydrogeological Report for the property described above. This report was prepared in order to address a number of outstanding issues identified in the September 23, 2011 letter from the Credit Valley Conservation Authority (CVC) as well as subsequent comments from a previous submission of this report which was submitted in May 2018. These include comments from the Town of Orangeville, Town of Mono and the Credit Valley Conservation Authority (CVC). Overall, the report summarizes newly collected water level and stream flow data in addition to providing an updated assessment based on that initially presented in the Jagger Hims in 2007 (***Supplemental Monitoring & Hydrogeological Assessment - Proposed Orangeville Highlands Development, Phase II***), utilizing the most recent development plan.

We would like to thank you for opportunity to complete this project. Please contact me if you have any questions or comments.

Yours truly,
AZIMUTH ENVIRONMENTAL CONSULTING, INC.

PROFESSIONAL GEOSCIENTIST
COLIN ROSS
PRACTISING MEMBER
2055
ONTARIO

PROFESSIONAL GEOSCIENTIST
MICHAEL G. JONES
PRACTISING MEMBER
0595
ONTARIO

Colin Ross, B.Sc., P.Geo.
Hydrogeologist

Mike Jones, M.Sc., P.Geo.
President

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List of In-Text Tables

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List of Appendices

1.0 INTRODUCTION

The purpose of this report is to summarize newly acquired hydrogeological data to satisfy some remaining issues presented by Michael Crechiolo of the Credit Valley Conservation Authority (CVC) in a September 23, 2011 letter to the Director of Planning with the City of Orangeville, as well as comments received by the CVC, Town of Orangeville and Town of Mono from a previous submission of this report in May 2018. The subject property has previously been referred to as the ***Orangeville Highland Development – Phase 2*** and is located on Part of East Half Lot 3, Concession 2, W.H.S, Formerly in the Township of Mono, currently the Town of Orangeville, County of Dufferin.

Specifically, the following issues were raised and have been addressed in subsequent sections of this report.

- Measurement of high ground water levels in the areas of the proposed SWMP and retaining walls. New monitoring wells are to target these areas and be monitored in conjunction with the existing monitoring network;
- Seasonal contributions of ground water discharge to terrestrial features and Middle Monora Creek are to be characterized. Describe how those features will be maintained post-development;
- Updated feature based water balance incorporating the ground water level monitoring;
- Clarification of the description of the highest measured water levels presented by Jagger Hims;
- Presentation of ground water elevation and flow mapping in relation to site grading, subsurface infrastructure, retaining wall depths, SWMP / outlets and basement depths;
- A discussion of the implications of site grading on recharge potential of the site;
- Proposed construction and post construction monitoring program;
- Discussion regarding the quality and quantity impacts resulting from increased impermeable area and mitigation measures proposed to address these potential impacts such that impacts to adjacent private wells are prevented.

It should be noted that this report represents an addendum to the previous Hydrogeological Investigation completed by Jagger Hims Ltd in 2007. As such, for reference the reader is directed to review this report (Appendix E) for a more detailed description of the geological and hydrogeological conditions at the site.

2.0 2013 & 2017 FIELD WORK

In order to address a few of the items noted above, field work upon at the site was undertaken beginning in April 2013 where a number of geotechnical boreholes (14) were constructed by Soil-Mat Engineers and Consultants (Soil Mat). Three of these boreholes (MW-1, 2 & 3) were equipped with monitoring wells in accordance with O. Reg. 903 to establish water table elevations in the areas of the proposed SWMP and proposed retaining walls (Figure 2).

A review of the borehole logs (Appendix C) indicates the shallow soils encountered (>7 mbgs) were described as fine sand / fine sandy silt across the site, which is generally similar to what was observed in the original boreholes installed in 2005 as part of the Jagger Hims original Hydrogeological Investigation. However, it is noted that the historic logs provide slightly more detailed descriptions which include a greater degree of stratification with sand at surface, transitioning into a silt till at most of the locations. The fact the Soil Mat logs indicate finer grained sand and silt is likely a function of these wells being located at lower elevations at the Site such that they are intersecting the glacial till found deeper as noted in the Jagger Hims logs.

As these new monitoring wells were installed to determine water table elevations, including establishment of high water table conditions at the site, water level monitoring began immediately following the installation of the new wells and included supplemental water level monitoring of the historical monitoring wells at the Site. In order to correlate the ground water elevation data between the new constructed and historical monitoring wells, the new wells were surveyed by Soil-Mat and Azimuth tied these elevations into the existing monitoring well network.

In addition to the monitoring wells discussed above, one additional ground water monitoring point (MW-10) was installed adjacent to the south branch of the Middle Monora Creek (Figure 2). This monitoring well was a shallow standpipe installed by hand to a depth of 1.8 mbgs. The purpose of this monitoring point was to establish shallow ground water levels relative to ground surface to establish whether the area adjacent to the creek represents a ground water discharge area. The soils observed during this installation were mainly fine grained sand, similar to what is described in Site borehole logs.

This water level monitoring program also included the installation of two dataloggers at MW-2 and MW-10 to provide continuous (30 minute interval) water level measurements for the monitoring period, which are illustrated in Appendix B.

The monitoring program also included measurement of stream flow at both the Middle Monora Creek to the north of the Site and the Lower Monora Creek to the south. Stream flow measurements were completed on three separate dates during 2013 in conjunction with the water level monitoring program and included collection of both up and downstream flows for both water courses, with the purpose of establishing potential variability in baseflow. Follow-up measurements of both flow and water levels were also completed in 2017 in order to update the database.

3.0 RESULTS

3.1 Ground Water Elevations

As illustrated in Table 1 (Appendix B), the recent ground water elevations within the historical wells show similar results to those measured historically and although only three measurements were collected, similar seasonal trending is observed with ground water levels declining at all locations following the spring freshet. However, it was noted that the springtime ground water elevations measured during April 2013 were lower than those observed during 2005 and 2006 with the exception of BH05-F I/II which indicated elevations similar during both periods. Given this location showed limited seasonal variability compared to the other locations, the lack of variance is not surprising.

Based on the difference in seasonal data between the 2013 /2017 and historical data, a comparison was completed between these two data sets to estimate a high ground water elevation mark for the three new monitoring wells. This was done by looking at the variance at the closest historical monitoring well to each of the new monitoring wells. The following table summarizes this comparison for each location. It is noted that the historical high elevation utilized the values on May 8, 2006 as this represented the monitoring event with the most locations with a maximum value.

MW-1

Closest Historical Monitoring Well	**BH05-A-I**
Historical GW Elevation at closest well	429.2 (May, 2006)
2013 GW Elevation	428.43 (May, 2013)
Difference	0.77 m
2013 MW-1 GW Elevation	426.66 (April, 2013)
Estimated GW Elevation High at MW-1	**427.43**

* - All elevations in masl

MW-3

Closest Historical Monitoring Well	**BH05-E-I**
Historical GW Elevation at closest well	421.75 (May, 2006)
2013 GW Elevation	421.55 (April, 2013)
Difference	0.20 m
2013 MW-3 GW Elevation	420.35 (April, 2013)
Estimated GW Elevation High at MW-3	**420.55**

* - All elevations in masl

No estimate was calculated for MW-2 as the 2013 ground water elevations at MW05-F-I (closest historical monitoring well) were more elevated during 2013 than in 2005/06.

Ground water elevations have been plotted on Figure 3 to establish ground water flow direction. As expected, ground water flow direction generally follows the topography of the Site towards the east, which matches historical representations of ground water flow patterns. It is noted that the contours were generated with AutoCAD using point ground water elevation data for each monitoring well. These contours were reviewed to ensure appropriateness given the local topography and environmental setting.

As indicated in the review comments, some clarification was requested with respect to the discussion on highest measured ground water levels as it was indicated that the report focused on the 2005 data, while the most elevated levels were noted during 2006. A review of the historical and more recent ground water elevation data indicates that there is some variability in seasonal ground water elevations. The wells located at lower elevations to the east of the property were shown to be more elevated in 2006 while the western locations are topographically higher and indicated higher ground water elevations in 2005. It is likely this variance is a function of climatic response and timing of the measurements following rainfall events. This variance is illustrated in the hydrograph for the continuous water level monitoring at BH05-E (Figure 9, Jagger Hims, 2006) (Appendix E) and Figure 3 which illustrates continuous ground water elevations at MW-2.

The high water table elevation contours were also presented on the Site grading plan completed by Urbantech as part of their FSR. Proposed grading ensures that basements and retaining walls will be situated at minimum 0.5 m above the maximum observed water table. Similarly, all proposed LID's have been proposed to be constructed at an elevation of greater than 1.0 m above the water table (Appendix D). In addition, the wet portion of the storm water management pond and forebay are designed to be below the water table, while the remaining components are near the high water table elevation. As such, the pond and forebay are proposed to be lined, which would limit the hydraulic connection between the pond and underlying aquifer. The servicing details for the property are not known to date, however, may intersect the water table in certain areas of the property depending on the elevations required. Temporary dewatering may be required in these areas to create a dry working area during installation, or may be possibly avoided if the work is completed during the summer when the water table is depressed. No permanent alterations will be expected as a result of these installations; however, it is recommended that trench plugs could be used to eliminate permanent dewatering along these servicing trenches in the areas where the utility trenches are below the high water table. Similarly, as the wet portion of the pond and forebay are designed to be below the water table, temporary dewatering may be required to facilitate construction of the facility.

Although not surveyed, water levels in MW-10 were measured to establish whether the area adjacent to the stream represents a ground water discharge area. The continuous water level measurements (Appendix B) indicated much more consistent water levels than those observed within the upland area of the property. Despite saturated ground conditions noted in the area, upward (artesian) vertical gradients were not observed with the water levels remaining consistent approximately 0.2 mbgs. These measurements support field observations made during this monitoring period that no pooled areas with outflow or other flow channels were observed during these Site visits indicating no specific ground water seep or springs are present in the valley. Despite this, the shallow water levels at MW10 would indicate that there likely is a hydraulic connection between the shallow water table and creek, which would support the creek as a potential ground water discharge feature. However, it is also noted that the differential between the fluctuation in ground water levels in the upland sections of the Site (up to 0.7 m during 2013) and the valley area (<0.1 m) indicates that contributions beyond the Site area likely have more influence than that from the Site itself, which is supported by the fact the developable area of the Site is approximately 40 times smaller than the watershed area for adjacent creeks.

3.2 Stream Flow

Stream flow measurements were collected at both the middle and lower Monora Creek at both upstream and downstream locations to establish whether an increase in baseflow is observed in the area of the subject property as a result of ground water discharge. Flow measurements were determined through the use of a Global Water Flow Probe meter to establish velocity over a measured cross-section of the watercourse at a location where turbulence or eddy effects would be minimal (i.e. relatively uniform streambed and free of debris).

The stream flow measurements are summarized in the following table and indicate that there is an increase in baseflow downstream of the subject property, which would be attributable to ground water discharge as the small additional tributaries (SW1a & SW2a) measured during the 2017 field measurements do not contribute a meaningful amount of flow to these features. Of the two features, the Middle Monora Creek is interpreted to represent a more dominant ground water receptor than Lower Monora Creek due to both the elevated flows and downstream differential. It is also noted that the degree of baseflow contribution is seasonal as the there is a decline in both overall flow, as well as the increase in downstream flow during the summer. It is noted that these results contradict those collected by Jagger Hims in 2005, which indicated more consistent flows between up and downstream locations (Section 4.8, Appendix E). As the Jagger Hims measurements were collected in the spring time (April), the degree of baseflow may have been muted by higher flows derived from upstream sources. This is supported by the fact the recent flow measurements indicated a seasonal increase in baseflow in June, 2013 & 2017.

Table 1: Stream Flow Measurements

Location	Stream Flow Measurements (m^3/sec)							
	29-Apr-13		24-May-13		26-Jun-13		7-Jun-17	
SW-1 (Upstream)	0.0082		0.0038		0.0010		0.0048	
SW-1a (mid location)	Not Measured		Not Measured		Not Measured		0.0005	
SW-1 (Downstream)	0.0202		0.0126		0.0051		0.0208	
Difference	***0.0120***	***145%***	***0.0088***	***232%***	***0.0041***	***410%***	***0.0165***	***343%***
SW-2 (Upstream)	0.0399		0.0280		0.0218		0.0638	
SW-2a (mid location)	Not Measured		Not Measured		Not Measured		0.0127	
SW-2 (Downstream)	0.0590		0.0372		0.0305		0.0833	
Difference	***0.0191***	***48%***	***0.0092***	***33%***	***0.0087***	***40%***	***0.0322***	***50%***

* - Locations identified on Figure 2

4.0 WATER BALANCE

In order to determine the potential changes to the natural ground water recharge conditions, a pre- and post-development water balance assessment has been completed using the Thornthwaite and Mather method (1957). It is noted that the approach and variables have generally been maintained from the previous submission as the approach was endorsed by the CVC in their review comments. The "pre-development" case is based on the existing conditions, i.e. undeveloped. This method evaluated evapotranspiration based on precipitation and temperature. Residual soil saturation is a function of topography and soil type. Monthly data are tabulated from daily average temperature and precipitation, and the water budget is a continuous calculation over the period of record. To clarify, the method and approach used by many individuals in examining infiltration resets the annual conditions (moisture deficit, snow storage, etc.) over the winter months because of the general lack of infiltration during the frost period. However, we maintain those records and carry them forward from month to month during the entire period of record.

Values were determined on a monthly basis, compiled from daily Environment Canada meteorological data station located in Orangeville, Ontario between 1969 and 2015 (Orangeville Climate Station – Station ID 6155790). The calculations are based on the average conditions during this period. The average precipitation was 896 millimeters (mm), rainfall was 675 mm, evapotranspiration was 502 mm, and the surplus was 393 mm per year. It is noted that this climate station was closed at the end of 2015, as such; the dataset is as complete as can be with the available data. Despite a lack of more recent data, the extended period of record makes it appropriate when looking at long term climate averages.

Infiltration rates for the Site were estimated taking into account site specific soils data collected during both the Jagger Hims Hydrogeological Assessment and Soil Mat Geotechnical Investigation (borehole logs in Appendix C & E), local topography and ground cover. These variables for the infiltration factor were based on Table 2 of the Ministry of Environment, Conservation & Parks (MECP) Hydrogeological Technical Information Requirements for Land Development Applications (1995). The infiltration factors utilized in this assessment are 0.70 and 0.75 and are based on the following.

Table 2: Infiltration Factors

Factor	**Classification**	**Value of Factor**			
		Pre-Development		**Post-Development**	
		Cultivated / Grasslands	**Forested**	**Cultivated / Grasslands**	**Forested**
Topography	Flat Land, <0.6m per km	0.25	0.25	0.25	0.25
Soils	Med. / Fine Sand to Silty Sand	0.30	0.30	0.30	0.30
Cover	Forested		0.20		0.20
	Cultivated / Grasslands	0.15		0.15	
Total		**0.70**	**0.75**	**0.70**	**0.75**

By multiplying the annual average surplus amount (393 mm) by the soil infiltration rates (70 & 75%), infiltration is estimated to be approximately 275 & 295 mm/year for the

Site. It is noted that infiltration factors between pre and post development will be kept consistent as the Site is currently cultivated / grasslands, while the post-development scenario will maintain this in all pervious sections within the developed portion of the site. Similarly, grading will not significantly alter the overall Site topography such that the infiltration factor has not been adjusted in the post-development scenario; however, from a ground water infiltration perspective, the reduction in overall relief across the site to facilitate construction would enhance the potential for infiltration.

As this water balance is being presented as a feature based assessment, the areas were divided into three catchments which are based on topography, ground water flow direction as well as the presence of a *Wellhead Protection Area (WHPA Q1/2)* at the eastern end of the property. It is noted that these areas were established in communication with the CVC in December 2018. More discussion related to the WHPA area is provided in Section 5.0, although it is noted that the WHPA area catchment matches the boundary established in the Source Water Protection Area mapping. The second catchment area represents the area interpreted to contribute to the water course and associated wetland feature at the north end of the Site and is based more on the localized topographic relief in the northern section of the Site. The final area is the remainder of the which based on ground water flow mapping (Figure 3) indicates a defined easterly flow path generally correlating to the easterly slope of the Site. For reference, these catchment areas are illustrated on Figure 2.

The 2018 water balance submission included informal ground water infiltration mitigation measures such as discharge of rooftop runoff to adjacent yards. However, with additional information provided by Urbantech as part of their 2019 Functional Servicing Report (FSR), the majority of ground water infiltration mitigation will be completed as part of formal LID's (infiltration trenches). The details relating to these features are provided in the following section, while design information can be referenced in the FSR.

4.1 Low Impact Design (LID) Mitigation Measures

Based on previous comments received by the CVC, it is understood that previously provided ground water infiltration deficits (38%) did not meet requirements established by the CVC and that the deficit needs to be reduced through the creation of additional mitigation measures. As presented in the FSR, as well as illustrated in the LID drainage plan provided in Appendix D, Urbantech has identified a number of locations for potential LID features as well as their associated sizing details. As a result, the water balance has incorporated these volumes in order to show the potential for a much closer match in each of the catchments / features summarized in the following sections.

In order to correlate event based rainfall data, for which the LID's are designed (i.e. 25 mm rainfall event), to annual averages, as is what is utilized in water balances, an event based assessment has been completed for the Orangeville Climate station. Rainfall events over the past 6 years (2010 – 2015) were broken down by event size, such that total volumes for each of these events could be calculated. These totals were then related to the total volume over the same period to obtain a percentage. This percentage is then multiplied by the annual average value (675 mm) utilized in the overall water balance to obtain an annual average amount / depth for the various intervals.

Table 3: Rainfall Frequency Evaluation

	Total	25 mm	20mm	15mm	12mm	10mm	9mm	8mm	7mm	6mm	5mm	4mm
Total Depth (mm)	4,446	4,065	3,904	3,594	3,307	3,063	2,914	2,748	2,551	2,326	2,072	1,789
Percent of Total Rainfall	100%	91%	88%	81%	74%	69%	66%	62%	57%	52%	47%	40%
Rainfall Depth (mm)	**675**	**617**	**593**	**546**	**502**	**465**	**442**	**417**	**387**	**353**	**315**	**272**

* - Rainfall depths are cumulative with increasing rainfall event size.

It is noted that the above breakdown does not extend beyond the 25 mm event, although some of the LID's are proposed to capture larger events. As the annual amount for the larger (>25 MM) storm events represent only 9% of the total rainfall, a more detailed breakdown was not completed and the 25 mm event was utilized for all sizing above this threshold. As such, it is noted that this does add a level of conservancy to the evaluation.

As each of the LID's have different rainfall event sizing (Appendix D), infiltration values were established for each LID independently and totaled for each feature / catchment. It is noted that these boundaries are based on topographic relief and policy boundaries (WHPA Q1/Q2) area such that ground water recharge and flow would not follow these exact boundaries. As such, variance associated with this overlap is not seen as significant enough to provide a meaningful enough change in the values, such that the infiltration volumes have been assumed to be incorporated into the feature / catchment where the LID is located. In the case of LID 9 and LID 10, a percentage of the total for each was taken to represent a portion going to both the Middle Medora Creek and Tableland catchment / feature areas.

In order to quantify the annual infiltration volumes for each LID, the annual rainfall depth discussed above is multiplied by the catchment area for that specific LID, while a 20% evaporation loss factor was employed for runoff collected on all impervious surfaces. It is noted that this factor is a common assumption in water balance assessments and is based on standards presented in *Conservation Guidelines for Hydrogeological Assessments* (Cuddy & Chan, 2013). For capture of runoff from pervious surfaces, infiltration and evapotranspiration were considered such that the runoff was calculated as a percentage of surplus (17% or 118 mm/year).

Finally, it is noted that added conservancy is reflected in these numbers through discounting of snow melt. Although difficult to quantify due to seasonal storage and movement (i.e. snow banks, snow dumps), it can provide a potential meaningful contribution as it represents ~31% of total precipitation.

4.2 Feature Based Water Balance Assessment

Using the climate model data, calculations and LID measures mentioned above, the following pre- and post-development infiltration values have been determined for each of the feature catchments.

Table 4: Water Balance Summary – WHPA Q1/Q2 Area

Parameter		Pre-Development	Post-Development No Mitigation	Post-Development With Mitigation
Annual Rainfall (mm)		675	675	675
Annual Surplus (mm)		393	393	393
Infiltration Factor (Grassland)*		0.7	0.7	0.7
Infiltration Factor (Forest)*		0.75	0.75	0.75
Feature Area (m^2)		38,400	38,400	38,400
Total Non-Hard Surface Area (pervious) (m^2)		38,400	25,400	25,400
Total Hard Surface Area (impervious) (m^2)		0	13,000	13,000
Infiltration Gain From LID's		0	0	1,705
Annual Infiltration (m^3/year)		10,758	7,116	8,821
Infiltration Reduction	m^3/year	0	3,642	1,937
	%	0%	34%	18%
	mm/m^2	0	95	50

* - infiltration factor for non-hard surface areas

The results for this feature indicate a 34% (3,642 m^3) loss in ground water infiltration post development, with no mitigation measures employed. However, with the inclusion of LID's, this loss is reduced to 18% (1,937 m^3). Further, it is noted that the eastern boundary intersects LID 13, such that if infiltration from this LID were to be accounted for in this feature, the deficit would be reduced to 12% or 1,242 m^3/year. Overall, this deficit is not viewed as significant given the conservancy factors utilized in this assessment, such that this deficit would likely be overcome through snowmelt contributions to the LID.

Table 5: Water Balance Summary – Middle Medora Creek Area

Parameter		Pre-Development	Post-Development No Mitigation	Post-Development With Mitigation
Annual Rainfall (mm)		675	675	675
Annual Surplus (mm)		393	393	393
Infiltration Factor (Grassland)*		0.7	0.7	0.7
Infiltration Factor (Forest)*		0.75	0.75	0.75
Feature Area (m^2)		56,000	56,000	56,000
Total Non-Hard Surface Area (pervious) (m^2)		56,000	50,700	50,700
Total Hard Surface Area (impervious) (m^2)		0	5,300	5,300
Infiltration Gain From LID's		0	0	758
Annual Infiltration (m^3/year)		16,300	14,757	15,515
Infiltration Reduction	m^3/year	0	1,543	784
	%	0%	9%	5%
	mm/m^2	0	28	14

* - infiltration factor for non-hard surface areas

The results for this feature indicate a 9% (1,543 m^3) loss in ground water infiltration post development with no mitigation measures employed. However, with the inclusion of LID’s, this loss is reduced to 5% (784 m^3). Overall, this deficit is not viewed as significant given the conservancy factors utilized in this assessment, such that this deficit would likely be overcome through snowmelt contributions the LID.

Table 6: Water Balance Summary – Tableland (remaining) Area

Parameter		Pre-Development	Post-Development No Mitigation	Post-Development With Mitigation
Annual Rainfall (mm)		675	675	675
Annual Surplus (mm)		393	393	393
Infiltration Factor (Grassland)*		0.7	0.7	0.7
Infiltration Factor (Forest)*		0.75	0.75	0.75
Feature Area (m^2)		85,300	85,300	85,300
Total Non-Hard Surface Area (pervious) (m^2)		85,300	23,900	23,900
Total Hard Surface Area (impervious) (m^2)		0	61,400	61,400
Infiltration Gain From LID's		0	0	16,998
Annual Infiltration (m^3/year)		23,466	6,575	23,573
Infiltration Reduction	m^3/year	0	16,891	-107
	%	0%	72%	0%
	mm/m^2	0	198	-1

* - infiltration factor for non-hard surface areas
negative value indicates increase

The results for this feature indicate a 72% (16,891 m^3) loss in ground water infiltration post development with no mitigation measures employed. However, with the inclusion of LID’s, reduced surplus is generated to create an overall increase of 107 m^3. However, it is noted that if LID 13 is removed from this catchment and added to the WHPA catchment, the actual reduction would be 3% (588 m^3). Regardless of the inclusion of LID 13, this deficit is not viewed as significant given the conservancy factors utilized in this assessment, such that this deficit would likely be overcome through snowmelt contributions to the LID.

Table 7: Water Balance Summary – Total Site

Parameter		Pre-Development	Post-Development No Mitigation	Post-Development With Mitigation
Annual Rainfall (mm)		675	675	675
Annual Surplus (mm)		393	393	393
Infiltration Factor (Grassland)*		0.70	0.7	0.7
Infiltration Factor (Forest)*		0.75	0.75	0.75
Total Non-Hard Surface Area (pervious) (m^2)		179,700	100,000	100,000
Total Hard Surface Area (impervious) (m^2)		0	79,700	79,700
Infiltration Gain From LID's (m^3/year)		0	0	19,461
Annual Infiltration (m^3/year)		50,524	28,448	47,909
Infiltration Change	m^3/year	0	22,076	2,615
	%	0%	44%	5%
	mm/m^2	0	123	15

* - infiltration factor for non-hard surface areas

Despite the feature based assessment which was required by the CVC, it is still important to look at the water balance at a site level as entire site is ultimately contributing to the Middle Medora Creek through ground water discharge.

Post-development infiltration rates will be affected by the presence of impervious surfaces (i.e., building rooftops and asphalt roads/driveways), which based on the proposed development plan will comprise approximately 64% of the development area of the property or 44% of the entire property. Upon completion of the site development, it is estimated that there will be a loss of approximately 44% in ground water infiltration between the pre-development and post-development conditions, assuming no mitigation strategies are employed. If LID mitigation measures are employed as outlined in the Urbantech FSR, an overall recovery in ground water infiltration of approximately 19,461 m^3/year would be expected, for a net loss of approximately 5%. The deficit is re-directed to Middle Monora Creek so that it remains within the same watershed. As the deficit mainly occurs during spring and fall (periods of high water), the net effect is minimized. Finally, this deficit equates to only approximately 15 mm/year/m^2, which is insignificant relative to pre-development infiltration rate of 275 mm. A reduction of infiltration by this amount will theoretically reduce the on-site water table elevation by 0.005 to 0.015 metre, which is within the existing seasonal fluctuations, which have been shown at some monitoring wells to vary between 1.5 to 2 m, therefore is not considered to be significant.

5.0 SOURCE WATER PROTECTION

A review of the Source Water Protection Areas as identified on the MOECC Source Protection Information Atlas website indicates that the Site is not located within a *Wellhead Protection Area [WHPA (A, B, C or D)]* for quality threats or within a *Significant Groundwater Recharge Area (SGRA)*. However, the Site is situated within a *High Vulnerability Aquifer Area,* as well as partially within a *Wellhead Protection Area (WHPA Q1/2)* for quantity threat. Despite this, it is noted that only a small area of the property intersects the *WHPA Q1/2* boundary, which as illustrated on Figure 2 is mostly being maintained as parkland such that only a very small (5%) developable area encroaches in this area, which only a portion of would represent hard surface area. As stated previously, mitigation measures are proposed to help compensate for any infiltration loss resulting from the proposed development.

6.0 LOCAL PRIVATE WELL WATER SUPPLIES

It is noted that much of the surrounding area is municipally serviced through the Town of Orangeville's municipal water supply. Similarly, the proposed development will be municipally serviced for both water and sewage such that no supply wells and sewage treatment facilities are being proposed at the Site. The closest private water well supplies are noted to the north of the property along Starview Cres., Brucedale Blvd., Victoria Heights Ave., and Dodd's Crt. Most of these properties are more than 200 m from the development limits; however, some properties along Brucedale Blvd. and Victoria Heights Ave. are noted to be as close as 70 m. A detailed well survey was not completed as part of this report; however, a review of local water well records indicate that the majority of these wells target the underlying bedrock with depths of approximately 20 m. The fact the majority of wells target this deeper unit would provide protection from surficial influences or localized ground water recharge. Despite this, there were some more shallow well constructions targeting shallower depths within the overburden (~12 m) noted in the area, but do not represent the primary target aquifer.

Impacts from the proposed development are limited due to the fact the proposed development is municipally serviced such that no permanent water taking will be occurring to facilitate water supply to the new residential units. Similarly, as noted in the above water balance, the LID measures proposed in the FSR (i.e. infiltration trenches) will provide mitigation to the loss of infiltration on the impervious surfaces (i.e. roads, rooftops) created as part of the development. Finally, the entire development is located south of Middle Monora Creek, which provides a hydraulic separation between the development and the private wells to the north.

With respect to water quality, the proposed development would have limited sources of contaminants which would contribute to the impairment of the shallow ground water in the area. Potential influences would be limited to road salt application along the roads servicing the Site properties. However, as these roadways are not main arterial roads, the winter maintenance is more limited than what would be applied locally on roads such as Highway 10 or Hansen Blvd. As indicated in the FSR, all surface runoff from the main Site roadways will be directed into the lined storm water management pond such that it would be released to the adjacent surface water feature rather than infiltrated. The only LID areas which potentially will receive road salt application will be the access laneways and parking area in the southern apartment blocks. Overall, exclusively "clean" or non roadway runoff will represent 50% of the LID capture volume (8,432 m^3) (LID's 1 – 10), while the remaining LID's represent approximately 50% capture from roadway or parking areas. As such, the overall ground water infiltration from roadway or parking areas is estimated to represent approximately 10% of the overall post development infiltration. Given this limited contribution, it is not expected that road salt would create a meaningful contribution to the ground water quality beneath the Site compared to what is already being applied within the entire watershed for the adjacent creeks, which is approximately 40 times larger than the developable area of the Site.

Finally, there would be similar protection to the private wells to the north due to the hydraulic separation of the creek and the upslope / upgradient location of these private wells from the creek. It is also noted that the predominant ground water flow path at the Site, as illustrated in Figure 3 is to the east. This is further supported by the more regional topographic dip in this direction. As a result, any water quality impairments as a result of the development would be directed east within a municipally serviced area and not north towards the private water wells.

7.0 CONCLUSIONS

Based upon our interpretation of the available data, the proposed development will not have a significant impact on the existing hydrogeological conditions of the area, including the adjacent wetland features associated with Middle Monora Creek. It has been determined that these features are likely ground water discharge areas. Although no defined seeps or springs were identified in the field, saturated ground conditions within the wetland areas and measured increases in baseflow downstream of the site indicate base flow contributions to the wetlands.

The water balance assessment completed for the proposed development plan indicates that approximately 2,615 m^3/year, or 5% of pre-development infiltration would be re-directed from infiltration to runoff, assuming that all proposed LID's in the FSR are developed. This equates to an average of approximately 15 mm/year over the development property. A reduction of infiltration by this amount will theoretically reduce the on-site water table elevation by less than 0.5 metre, which is within the existing seasonal fluctuations, which have been shown at some monitoring wells to vary between 1.5 to 2 m, therefore is not considered to be significant.

Finally, it is also noted that the development, as well the existing surrounding development is municipally serviced, such that there are no potential for impairment of local water wells. Private wells are noted to be present along and off of Starview Crescent to the North of the Site; however, given the limited impacts to the water table resulting from the proposed development and these wells being hydraulically separated from the development by the Middle Monora Creek, a more detailed assessment of these private wells was not completed and is not proposed to be completed given the monitoring program outlined below will provide ground water level data during and post construction.

8.0 PROPOSED MONITORING PROGRAM

As required by the CVC in their review comments of the previous submission, a monitoring program is being proposed to allow for the collection of ground water and base flow data prior to, during and post construction.

This monitoring program is proposed to align with the monitoring program already completed, but with focus on Middle Medora Creek and understanding that monitoring wells will be decommissioned over much of the site to facilitate construction. It is recommended that ground water levels be monitored at MW-1, MW-3 (if monitor can be retained) as well as a replacement drivepoint peizometer in the area of MW-10 as this monitor was noted to have been destroyed. Even with the potential absence of MW-3 post construction, MW-1 and MW-10 provide strategic monitoring locations to assess ground water conditions closest to the creek such that would be most reflective of the contributions to this feature. It is proposed that dataloggers could be installed to obtain continuous data thus reducing the need for more frequent site visits to seasonal (spring, summer, fall).

In addition to the ground water monitoring, stream flow and creek water levels could be monitored with installation of stilling wells at an upstream and downstream location with installation of dataloggers at both to record continuous water level data similar to the monitoring wells. Seasonal stream flow measurements could be collected in conjunction with the manual ground water level measurements.

Implementation of this monitoring program will be scheduled prior to construction and continue throughout construction and for one year following the completion of construction.

9.0 REFERENCES

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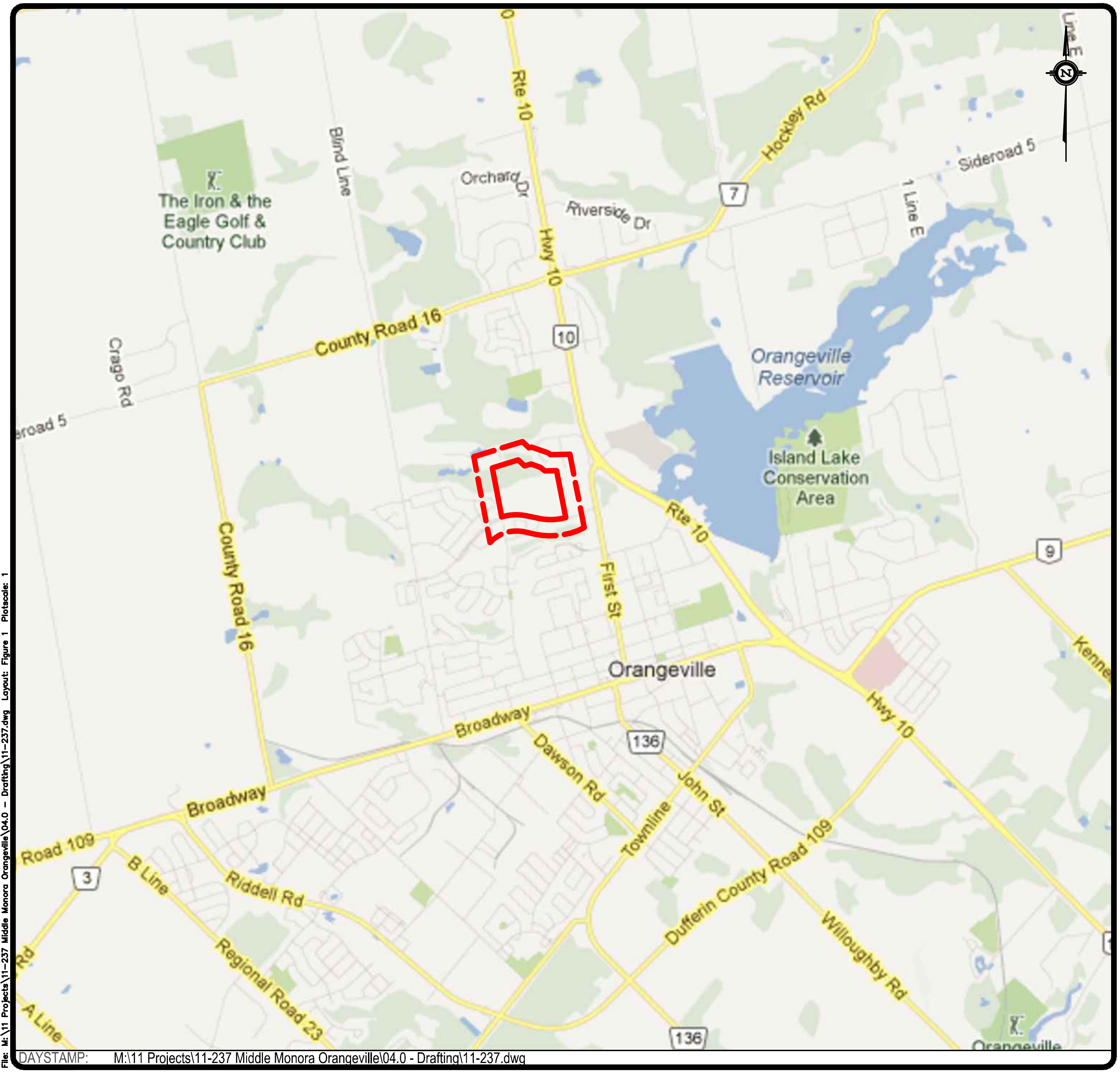
APPENDICES

APPENDIX A

Figures



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LEGEND:

- Approx. Property Boundary
- Study Area

600m 0 1200m

HORIZONTAL SCALE 1: 40,000

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

Study Area

Orangeville Highlands Phase 2
Orangeville, ON

DATE ISSUED: March 2018	Figure No.
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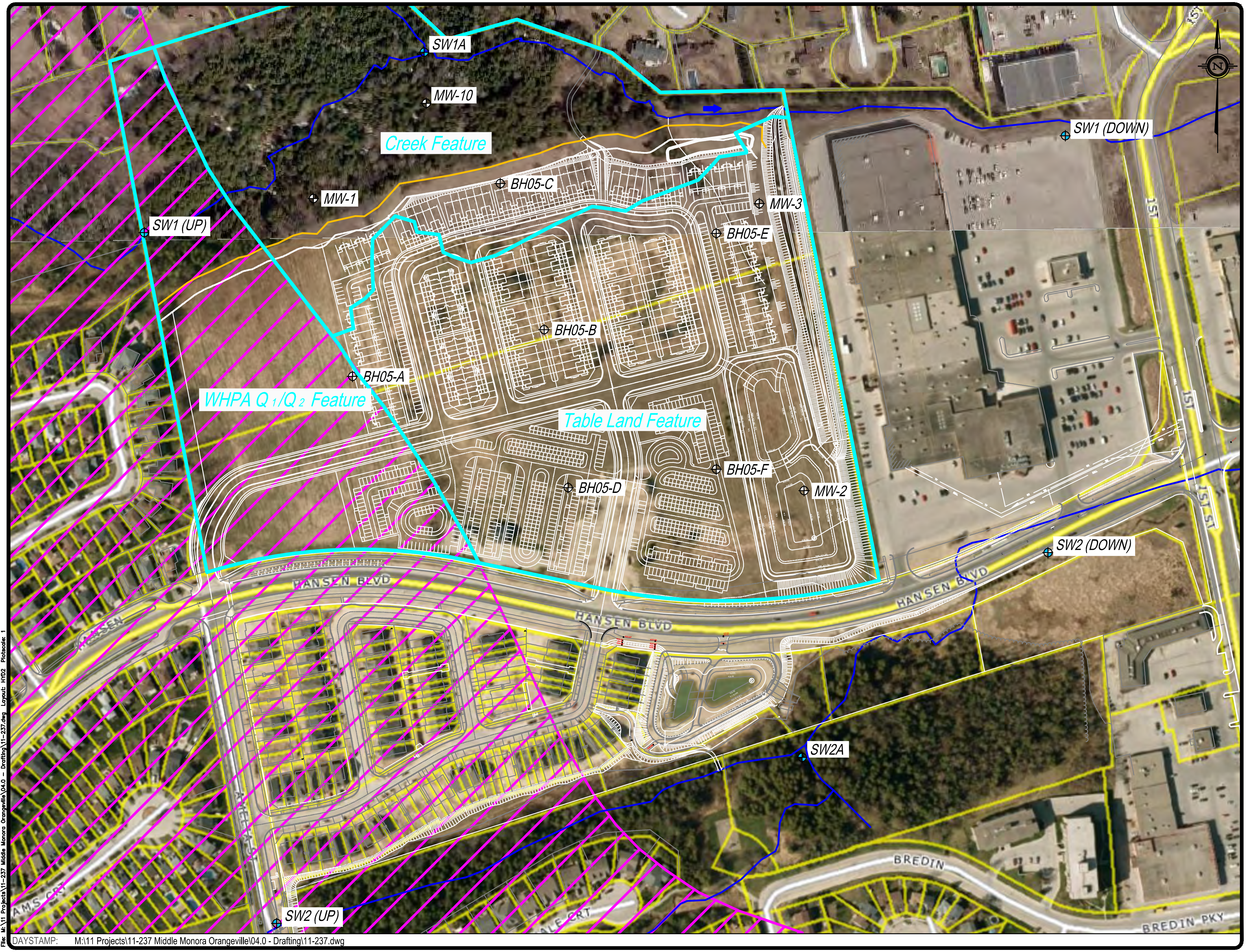
PROJECT NO.: 11-237	
REFERENCE: Google Maps	



LEGEND:

- Approx. Property Boundary
- Watercourse
- 2011 Dripline
- Catchment Feature/Boundaries
- ▨ WHPA Q1/2
- ⊕ Monitoring Well Locations
- ⊕ Surface Water Sample Locations

25m 0 75m

HORIZONTAL SCALE 1:2,500

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

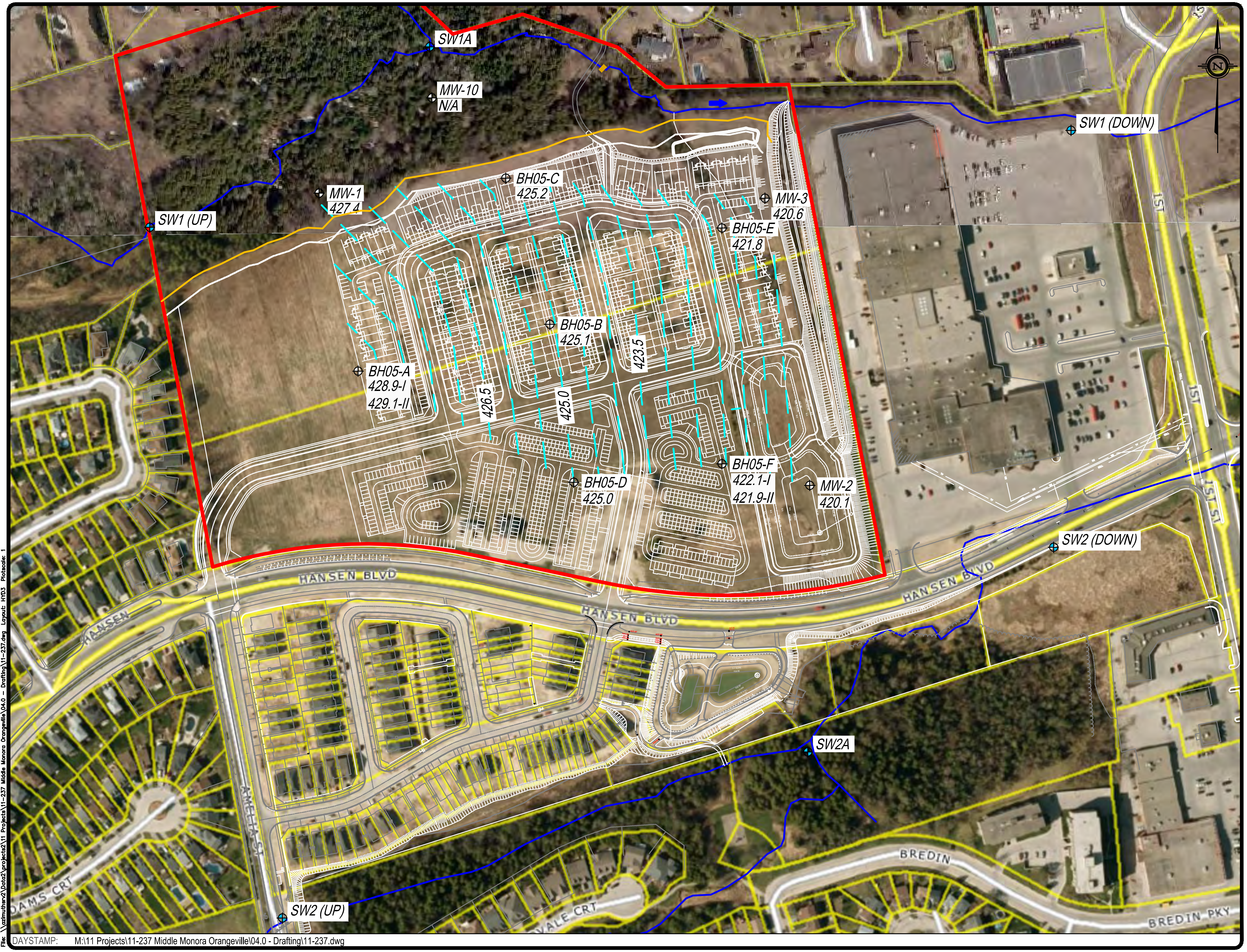
Monitoring Wells

Orangeville Highlands Phase 2
Orangeville, ON

DATE ISSUED:	March 2019	Figure No.
CREATED BY:	JLM	2
PROJECT NO.:	11-237	
REFERENCE:	First Base Solutions	

DAYSTAMP: M:\11 Projects\11-237 Middle Monora Orangeville\04.0 - Drafting\11-237.dwg

Plotted by: JMCCARTNEY on April 8, 2019 at 11:39am Layout: HYD2 Plotscale: 1
File: M:\11 Projects\11-237 Middle Monora Orangeville\04.0 - Drafting\11-237.dwg



LEGEND:

- 🟥 *Approx. Property Boundary*
- 🟦 *Watercourse*
- 🟧 *2011 Dripline*
- ⊕ *Monitoring Well Locations*
- ⊕ *Surface Water Sample Locations*
- *421.55* *Ground Water Elevation* (May 2006)*
- — *Inferred Ground Water Contours*

** MW-1, MW-2, MW-3 ground water elevations extrapolated from difference between May 2016, and June 2013 at adjacent locations.*

25m 0 75m

HORIZONTAL SCALE 1:2,500

AZIMUTH ENVIRONMENTAL CONSULTING, INC.

Ground Water Elevations and Contours (High Water Table Conditions)

Orangeville Highlands Phase 2
Orangeville, ON

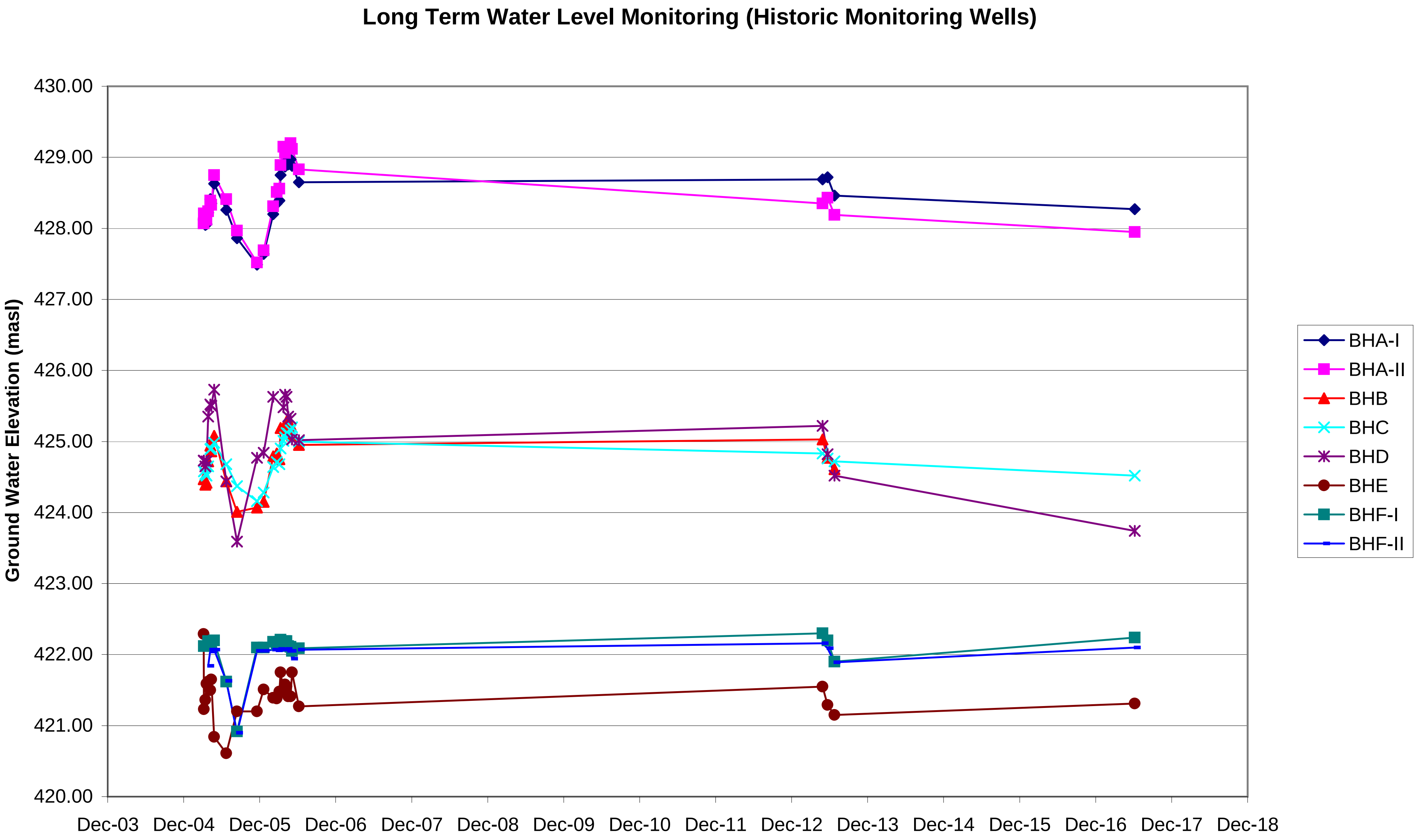
DATE ISSUED:	March 2019	Figure No.
CREATED BY:	JLM	3
PROJECT NO.:	11-237	
REFERENCE:	First Base Solutions	

DAYSTAMP: M:\11 Projects\11-237 Middle Monora Orangeville\04.0 - Drafting\11-237.dwg

Plotted by: JMCCARTNEY on April 4, 2019 at 11:13am
File: \\azimuthsrv2\Data2\projects2\11 Projects\11-237 Middle Monora Orangeville\04.0 – Drafting\11-237.dwg Layout: HYD3 Plotscale: 1

APPENDIX B

Ground Water Elevations



Long Term Water Level Monitoring (Historic Monitoring Wells)

Continuous Water Levels

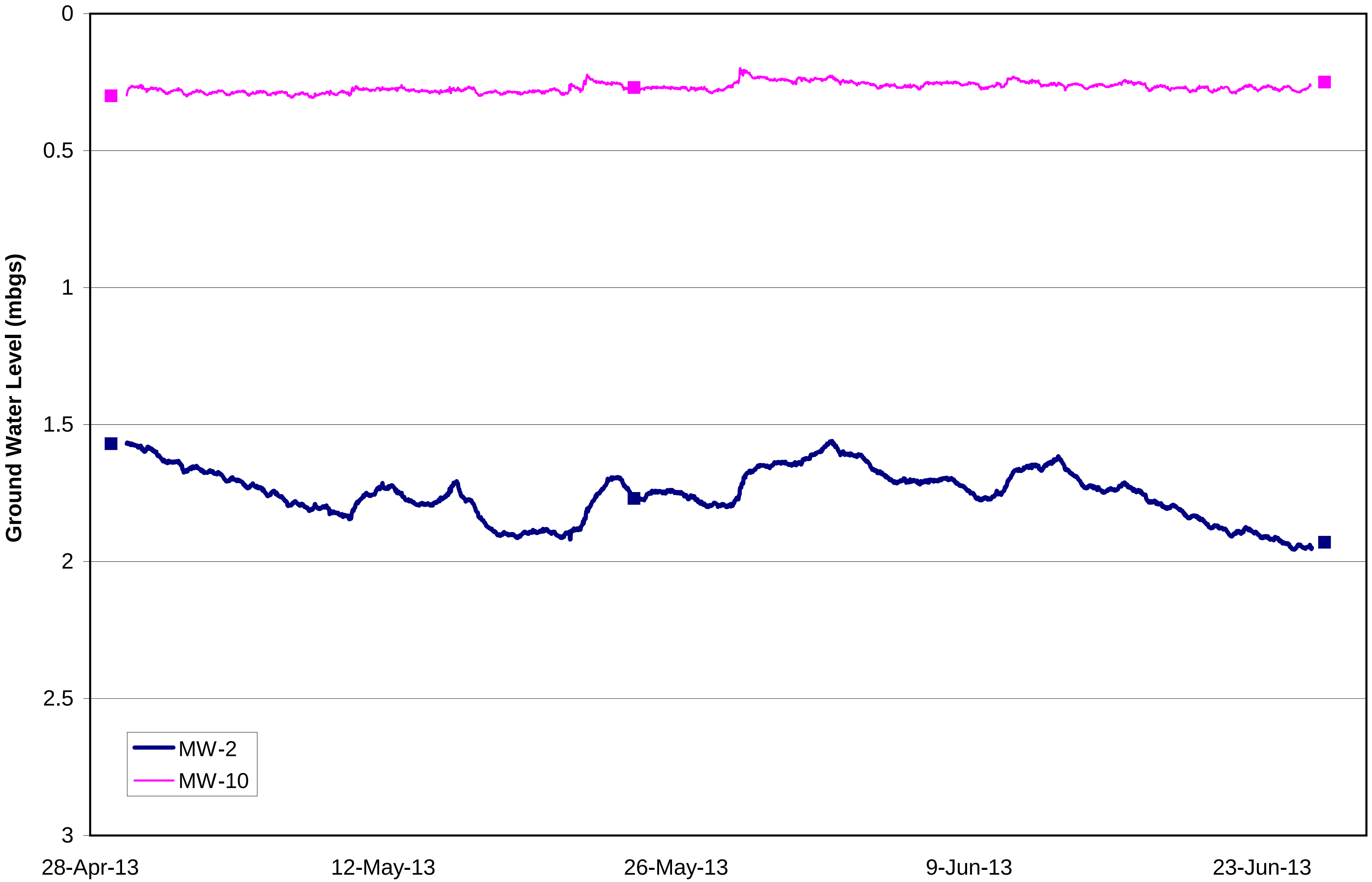


Table 2 - Historical Ground Water Elevations

BH-A-I		BH-A-II		BH-B		BH-C		BH-D		BH-E		BH-F-I		BH-F-II	
Date	Ground Water Elevation (masl)	Date	Ground Water Elevation (masl)	Date	Ground Water Elevation (masl)	Date	Ground Water Elevation (masl)	Date	Ground Water Elevation (masl)	Date	Ground Water Elevation (masl)	Date	Ground Water Elevation (masl)	Date	Ground Water Elevation (masl)
10-Mar-05	428.12	10-Mar-05	428.07	10-Mar-05	424.47	11-Mar-05	424.58	10-Mar-05	424.73	10-Mar-05	422.29	11-Mar-05	422.12	11-Mar-05	
11-Mar-05	428.14	11-Mar-05	428.21	11-Mar-05	424.47	18-Mar-05	424.54	11-Mar-05	424.73	11-Mar-05	421.23	18-Mar-05		18-Mar-05	
18-Mar-05	428.05	18-Mar-05	428.14	18-Mar-05	424.39	24-Mar-05	424.52	18-Mar-05	424.65	18-Mar-05	421.36	24-Mar-05		24-Mar-05	
24-Mar-05	428.06	24-Mar-05	428.12	24-Mar-05	424.42	1-Apr-05	424.65	24-Mar-05	424.72	24-Mar-05	421.59	1-Apr-05	422.19	1-Apr-05	421.84
1-Apr-05	428.22	1-Apr-05	428.24	1-Apr-05	424.72	11-Apr-05	424.89	1-Apr-05	425.35	1-Apr-05	421.62	11-Apr-05	422.18	11-Apr-05	422.07
11-Apr-05	428.41	11-Apr-05	428.39	11-Apr-05	424.94	15-Apr-05	424.90	11-Apr-05	425.52	11-Apr-05	421.50	15-Apr-05	422.14	15-Apr-05	422.04
15-Apr-05	428.35	15-Apr-05	428.33	15-Apr-05	424.86	29-Apr-05	424.98	15-Apr-05	425.50	15-Apr-05	421.65	29-Apr-05	422.20	29-Apr-05	422.07
29-Apr-05	428.63	29-Apr-05	428.75	29-Apr-05	425.08	27-Jun-05	424.68	29-Apr-05	425.73	29-Apr-05	420.84	27-Jun-05	421.62	27-Jun-05	421.63
27-Jun-05	428.26	27-Jun-05	428.41	27-Jun-05	424.44	17-Aug-05	424.37	27-Jun-05	424.44	27-Jun-05	420.61	17-Aug-05	420.92	17-Aug-05	420.90
17-Aug-05	427.86	17-Aug-05	427.97	17-Aug-05	424.01	21-Nov-05	424.16	17-Aug-05	423.59	17-Aug-05	421.20	21-Nov-05	422.10	21-Nov-05	422.05
21-Nov-05	427.49	21-Nov-05	427.52	21-Nov-05	424.07	23-Dec-05	424.28	21-Nov-05	424.77	21-Nov-05	421.20	23-Dec-05	422.10	23-Dec-05	422.05
23-Dec-05	427.64	23-Dec-05	427.69	23-Dec-05	424.15	7-Feb-06	424.64	23-Dec-05	424.84	23-Dec-05	421.51	7-Feb-06	422.18	7-Feb-06	422.07
7-Feb-06	428.20	7-Feb-06	428.31	7-Feb-06	424.79	24-Feb-06	424.71	7-Feb-06	425.63	7-Feb-06	421.39	24-Feb-06	422.14	24-Feb-06	422.06
24-Feb-06	428.35	24-Feb-06	428.51	24-Feb-06	424.83	9-Mar-06	424.68	24-Feb-06		24-Feb-06	421.38	9-Mar-06	422.18	9-Mar-06	422.08
9-Mar-06	428.39	9-Mar-06	428.56	9-Mar-06	424.75	14-Mar-06	424.90	9-Mar-06		9-Mar-06	421.48	14-Mar-06	422.21	14-Mar-06	422.07
14-Mar-06	428.75	14-Mar-06	428.89	14-Mar-06	425.19	28-Mar-06	425.01	14-Mar-06		14-Mar-06	421.75	28-Mar-06	422.16	28-Mar-06	422.07
28-Mar-06	428.90	28-Mar-06	429.15	28-Mar-06	425.19	5-Apr-06	425.06	28-Mar-06	425.48	28-Mar-06	421.48	5-Apr-06	422.19	5-Apr-06	422.07
5-Apr-06	428.87	5-Apr-06	429.06	5-Apr-06	425.23	12-Apr-06	425.12	5-Apr-06	425.66	5-Apr-06	421.58	12-Apr-06	422.19	12-Apr-06	422.08
12-Apr-06	428.94	12-Apr-06	429.13	12-Apr-06	425.28	20-Apr-06	425.11	12-Apr-06	425.63	12-Apr-06	421.55	20-Apr-06	422.12	20-Apr-06	422.05
20-Apr-06	428.90	20-Apr-06	429.13	20-Apr-06	425.19	1-May-06	425.16	20-Apr-06	425.35	20-Apr-06	421.41	1-May-06	422.11	1-May-06	422.05
1-May-06	428.97	1-May-06	429.20	1-May-06	425.23	8-May-06	425.20	1-May-06	425.32	1-May-06	421.41	8-May-06	422.05	8-May-06	421.94
8-May-06	428.88	8-May-06	429.12	8-May-06	425.09	10-Jun-06	425.00	8-May-06	425.03	8-May-06	421.75	10-Jun-06	422.09	10-Jun-06	422.07
10-Jun-06	428.65	10-Jun-06	428.83	10-Jun-06	424.95	29-Apr-13	424.83	10-Jun-06	425.02	10-Jun-06	421.27	29-Apr-13	422.30	29-Apr-13	422.16
29-Apr-13	428.69	29-Apr-13	428.35	29-Apr-13	425.03	24-May-13	424.76	29-Apr-13	425.22	29-Apr-13	421.55	24-May-13	422.20	24-May-13	422.09
24-May-13	428.72	24-May-13	428.43	24-May-13	424.77	26-Jun-13	424.72	24-May-13	424.82	24-May-13	421.29	26-Jun-13	421.90	26-Jun-13	421.89
26-Jun-13	428.46	26-Jun-13	428.19	26-Jun-13	424.61	7-Jun-17	424.52	26-Jun-13	424.52	26-Jun-13	421.15	7-Jun-17	422.24	7-Jun-17	422.10
7-Jun-17	428.27	7-Jun-17	427.95					7-Jun-17	423.74	7-Jun-17	421.31				

Table 1 - Ground Water Monitor Details and Elevations

Monitoring Well	Stickup (m)	Total Depth (mbtoc)	TOC Elevation (masl)	Ground Elevation (masl)	Ground Water Levels (mbtoc)				Ground Water Levels (mbgs)				Ground Water Elevation (masl)			
					29-Apr-13	**24-May-13**	**26-Jun-13**	**7-Jun-17**	**29-Apr-13**	**24-May-13**	**26-Jun-13**	**7-Jun-17**	**29-Apr-13**	**24-May-13**	**26-Jun-13**	**7-Jun-17**
MW-1	0.50	8.10	432.91	432.41	6.25	6.31	6.36	7.78	5.75	5.81	5.86	7.28	426.66	426.60	426.55	425.13
MW-2	0.66	7.36	422.36	421.70	2.23	2.43	2.59	NA	1.57	1.77	1.93	NA	420.13	419.93	419.77	NA
MW-3	0.65	7.25	422.35	421.70	2.00	2.19	2.21	2.17	1.35	1.54	1.56	1.52	420.35	420.16	420.14	420.18
MW-A-I	0.73	10.51	433.17	432.26	4.48	4.45	4.71	4.90	3.75	3.72	3.98	4.17	428.69	428.72	428.46	428.27
MW-A-II	0.68	6.22	433.15	432.26	4.80	4.72	4.96	5.20	4.12	4.04	4.28	4.52	428.35	428.43	428.19	427.95
MW-B	0.75	9.29	431.09	430.18	6.06	6.32	6.48	NA	5.31	5.57	5.73	NA	425.03	424.77	424.61	NA
MW-C	0.77	7.22	429.77	428.80	4.94	5.01	5.05	5.25	4.17	4.24	4.28	4.48	424.83	424.76	424.72	424.52
MW-D	0.59	4.36	426.74	425.88	1.52	1.92	2.22	3.00	0.93	1.33	1.63	2.41	425.22	424.82	424.52	423.74
MW-E	0.96	4.55	423.30	422.25	1.75	2.01	2.15	1.99	0.79	1.05	1.19	1.03	421.55	421.29	421.15	421.31
MW-F-I	0.80	8.68	423.10	422.19	0.80	0.90	1.20	0.86	0.00	0.10	0.40	0.06	422.30	422.20	421.90	422.24
MW-F-II	0.74	3.56	422.99	422.02	0.83	0.90	1.10	0.89	0.09	0.16	0.36	0.15	422.16	422.09	421.89	422.10
MW-10*	0.90	2.69	NA	NA	1.20	1.17	1.15	NA	0.30	0.27	0.25	NA	NA	NA	NA	NA

*MW-10 is piezometer installed by hand in wetland

Bold and Italics indicates new wells installed in 2013

NA - not accessible

APPENDIX C

Borehole Logs

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 1

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: ::

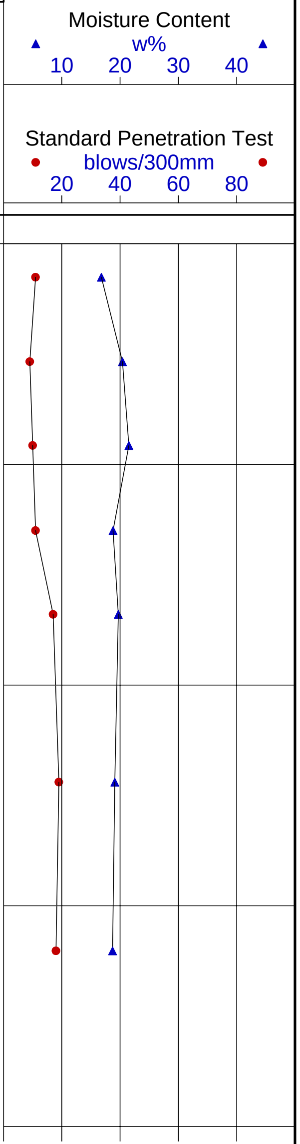
Soil-Mat

SUBSURFACE PROFILE

Depth (ft)	Depth (m)	Elevation [m]	Description
0	0	98.35	Ground Surface
0	0		**Topsoil** Approximately 150 millimetres of topsoil.
			Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, occasional silt seams, loose to compact
22		91.65	End of Borehole

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	5,5,6,7	11	▨		
SS	2	3,3,6,8	9	▨		
SS	3	4,5,5,8	10	▨		
SS	4	4,5,6,8	11	▨		
SS	5	4,7,10,12	17	▨		
SS	6	5,7,12,17	19	▨		
SS	7	3,4,4,5	8	▨		



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 6.7 metres.

2. Borehole was recorded as 'caved' at a depth of 2.0 metres upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 2

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

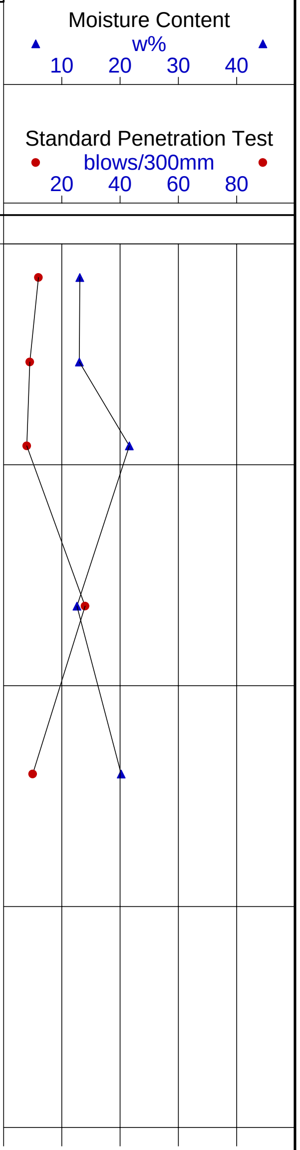
SUBSURFACE PROFILE

Depth: ft 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32; m 0, 2, 4, 6, 8

Elevation [m]	Symbol	Description	Well Data
98.75		Ground Surface	
		Topsoil Approximately 150 millimetres of topsoil.	
		Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, traces of organic staining at shallower depths, loose to compact	
95.25		Coarse layer at approximately 3.5 meters	
92.05		End of Borehole	

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	3,5,7,8	12			
SS	2	5,4,5,8	9			
SS	3	2,2,6,9	8			
SS	4	9,10,18	28			
SS	5	4,4,6	10			



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 6.7 metres.

2. Borehole was recorded as 'wet' at a depth of 2.3 metres upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 3

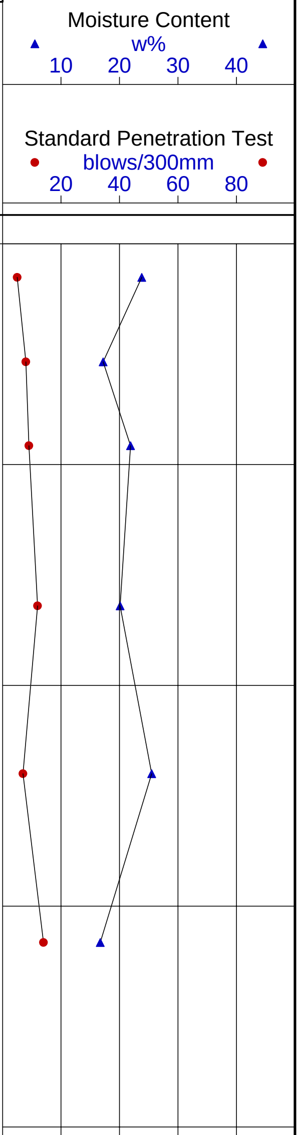
Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

Soil-Mat

SUBSURFACE PROFILE					SAMPLE						
Depth (ft / m)	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
	97.78		Ground Surface								
0 / 0			***Topsoil*** Approximately 700 millimetres of topsoil.		SS	1	3,2,3,5	5			
	97.08		***Fine Sand/ Fine Sandy Silt*** Brown to greyish brown, interbedded, traces of fine gravel, organic staining at shallower depths, loose to compact		SS	2	2,3,5,8	8			
					SS	3	2,4,5,6	9			
					SS	4	3,4,8	12			
					SS	5	2,2,5	7			
					SS	6	6,7,7	14			
	91.18		End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 6.6 metres.

2. Borehole was recorded as 'wet' at a depth of 1.5 metres upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 4

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

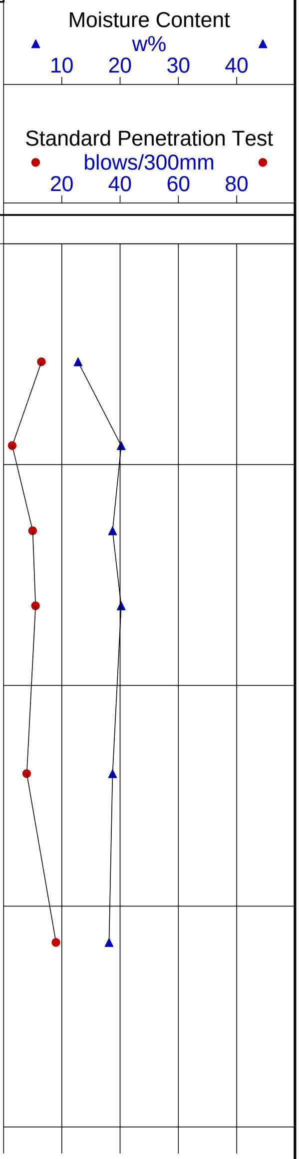
Soil-Mat

SUBSURFACE PROFILE

Elevation [m]	Description
102.71	Ground Surface
	Topsoil Approximately 150 millimetres of topsoil.
	Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, traces of oxidation at shallower depths, very loose to compact
96.11	End of Borehole

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	5,7,6,5	13	▨		
SS	2	1,1,2,3	3	▨		
SS	3	2,4,6,6	10	▨		
SS	4	4,5,6	11	▨		
SS	5	2,3,3	8	▨		
SS	6	5,7,11	18	▨		



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 6.6 metres.

2. Borehole was recorded as 'caved' at a depth of 1.8 metres upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 5

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

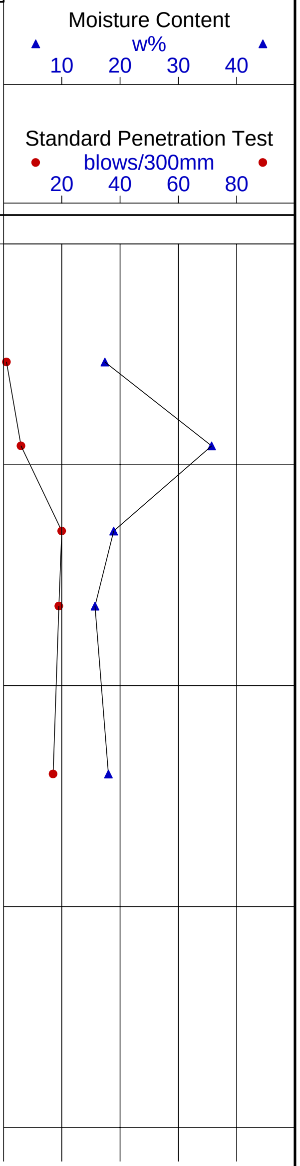
: **::**

SUBSURFACE PROFILE

Elevation [m]	Description
104.46	Ground Surface
104.26	***Topsoil*** Approximately 200 millimetres of topsoil.
	Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, occasional silt seams, very loose to compact
102.64	Clay-rich layer at approximately 1.8 meters
99.46	End of Borehole

SAMPLE

Type	Number	Blow Counts	Blows/300mm
SS	1	1,0,1,1	1
SS	2	0,1,2,4	6
SS	3	3,5,9,11	20
SS	4	4,8,11	19
SS	5	5,8,9	17



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 5.0 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 6

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

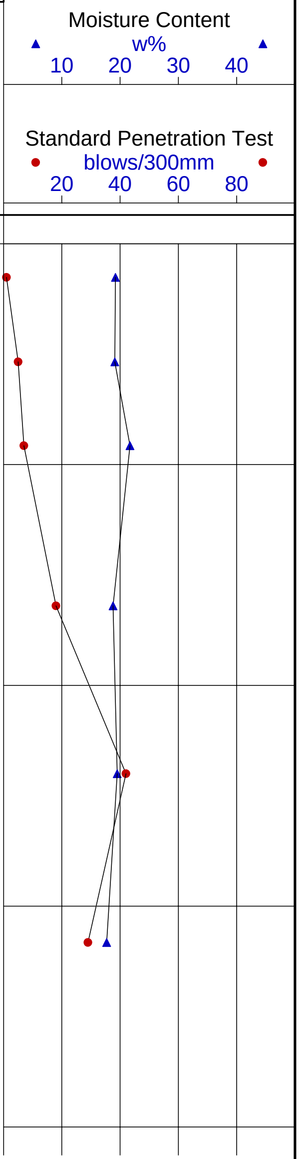
: **::**

Soil-Mat

SUBSURFACE PROFILE / SAMPLE

Depth: ft 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32; m 0, 2, 4, 6, 8

Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
105.69		Ground Surface								
105.49		**Topsoil** Approximately 200 millimetres of topsoil.		SS	1	0,1,0,0	1	▨		
		Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine to coarse gravel, organic staining at shallower depths, very loose to dense		SS	2	2,3,2,3	5	▨		
				SS	3	2,3,4,7	7	▨		
				SS	4	6,8,10	18	▨		
				SS	5	11,18,24	42	▨		
99.09				SS	6	7,12,17	29	▨		
		End of Borehole								



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 6.6 metres.

2. Borehole was recorded as 'wet' at a depth of 5.3 meters upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 7

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

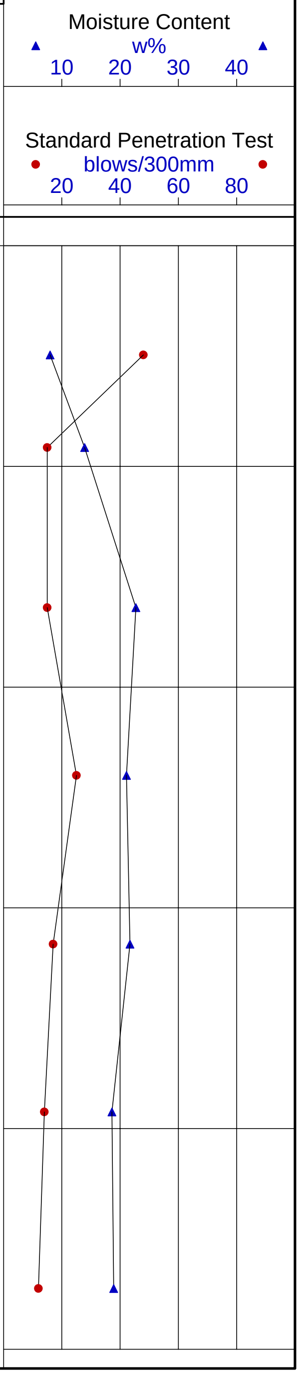
Soil-Mat

SUBSURFACE PROFILE

Depth (m)	Elevation [m]	Symbol	Description	Well Data
	103.77		Ground Surface	
0	103.57	~~	**Topsoil** Approximately 200 millimetres of topsoil.	
0.2		⋮	**Fine Sand/ Fine Silty Sand** Brown to greyish brown, interbedded, traces of fine gravel throughout, some coarse gravel at shallower depths, assumed cobble at approximately 0.9 meters, compact to dense	
9.8	93.97		End of Borehole	

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	6,20,28	48	▨		
SS	2	3,7,8,8	15	▨		
SS	3	4,7,8	15	▨		
SS	4	4,11,14	25	▨		
SS	5	0,1,5,12	17	▨		
SS	6	2,4,10	14	▨		
SS	7	2,4,8,12	12	▨		



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 9.8 metres.

2. Borehole was recorded as 'wet' at a depth of 3.5 meters upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

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130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 8

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

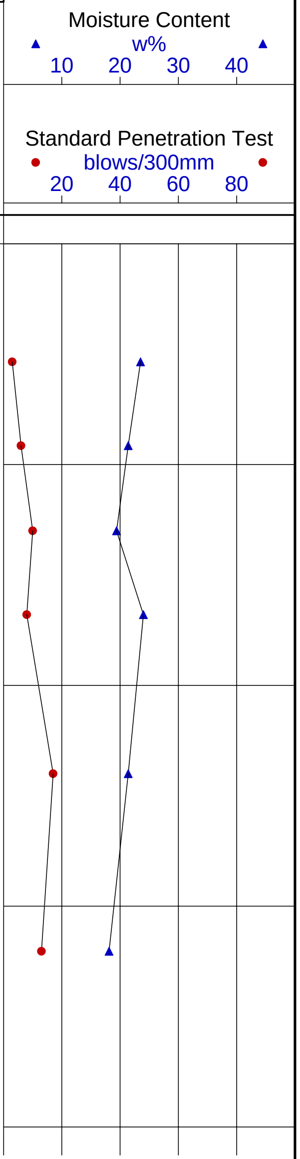
Soil-Mat

SUBSURFACE PROFILE

Depth	Elevation [m]	Description
0 ft / 0 m	102.15	Ground Surface
		Topsoil Approximately 150 millimetres of topsoil.
		Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, occasional silt seams, loose to compact
	95.45	End of Borehole

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	1,1,2,3	3	▨		
SS	2	2,2,4,8	6	▨		
SS	3	3,4,6,6	10	▨		
SS	4	3,3,5,7	8	▨		
SS	5	4,7,10	17	▨		
SS	6	2,5,8,11	13	▨		



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 25, 2013 to termination at a depth of 6.7 metres.

2. Borehole was recorded as 'wet' at a depth of 1.8 meters upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 25, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

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130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 9

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

Soil-Mat

SUBSURFACE PROFILE / SAMPLE

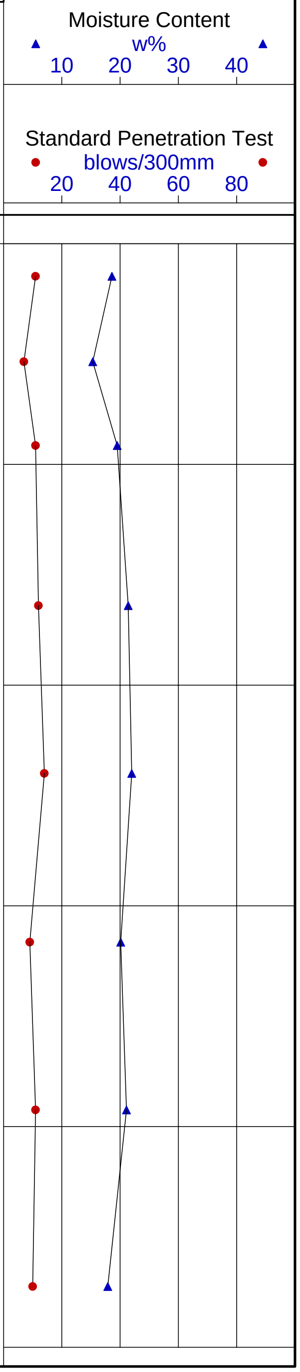
Depth	Elevation [m]	Symbol	Description	Well Data	Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
ft m 0 0	99.42		Ground Surface								
			Topsoil Approximately 150 millimetres of topsoil.		SS	1	4,4,7	11			
			Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, occasional silt seams, loose to compact		SS	2	2,3,4,5	7			
					SS	3	3,5,6,10	11			
					SS	4	3,5,7	12			
					SS	5	3,5,9	14			
					SS	6	4,3,6	9			
					SS	7	4,5,6	11			
					SS	8	5,6,4,6	10			
	89.67		End of Borehole								

NOTES:

1. Borehole was advanced using solid stem auger equipment on April 26, 2013 to termination at a depth of 9.8 metres.

2. Borehole was recorded as 'caved' at a depth of 1.8 meters upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.



Drill Method: Solid-Stem Auger
Drill Date: April 26, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 10

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

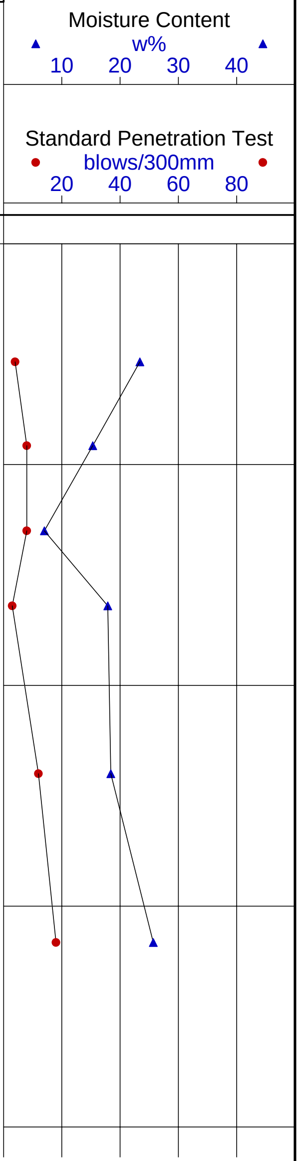
SUBSURFACE PROFILE

Depth
ft 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
m 0 2 4 6 8

Elevation [m]	Symbol	Description	Well Data
104.29		Ground Surface	
104.09		**Topsoil** Approximately 200 millimetres of topsoil.	
		Fine Sand/ Fine Sandy Silt Brown to greyish brown, traces of fine gravel, occasional silt seams, very loose to compact	
97.69		End of Borehole	

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	2,2,2,3	4	▨		
SS	2	2,4,4,6	8	▨		
SS	3	3,4,4,5	8	▨		
SS	4	3,2,1	3	▨		
SS	5	2,4,8	12	▨		
SS	6	4,7,11	18	▨		



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 26, 2013 to termination at a depth of 6.6 metres.

2. Borehole was recorded as 'caved' at a depth of 3.7 meters and 'wet' at a depth of 3.5 meters upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 26, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 11

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

SUBSURFACE PROFILE

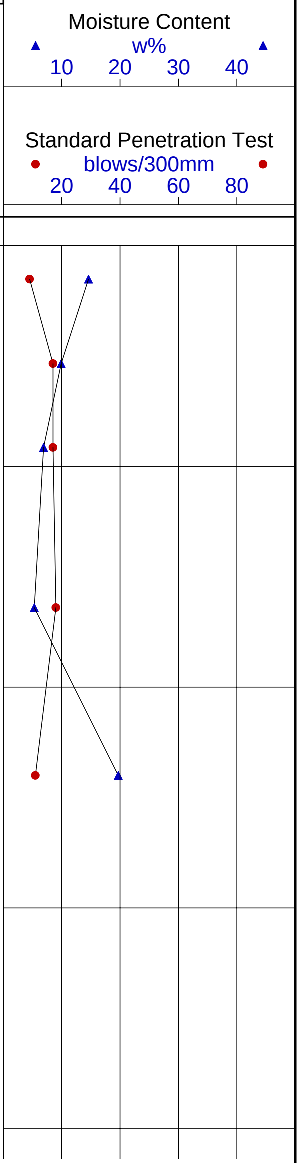
Depth (ft)	Depth (m)	Elevation [m]	Description
0	0	104.56	Ground Surface
		104.36	**Topsoil** Approximately 200 millimetres of topsoil.
			Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel throughout, some coarse gravel at shallower depths, loose to compact
16		99.56	End of Borehole

Depth scale: ft 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32; m 0, 2, 4, 6, 8

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	1,2,7,10	9	▨		
SS	2	9,10,7,12	17	▨		
SS	3	4,8,9,10	17	▨		
SS	4	6,8,10	18	▨		
SS	5	6,5,6	11	▨		

Well Data



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 26, 2013 to termination at a depth of 5.0 metres.

2. Borehole was recorded as 'dry' upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 26, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 12 [MW-1]

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

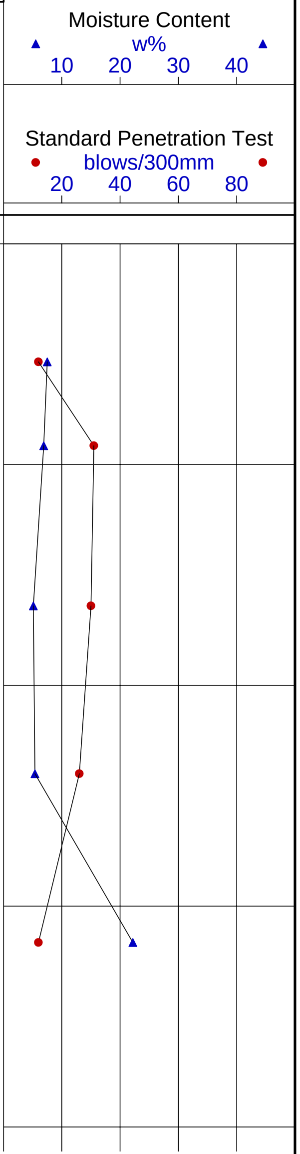
Soil-Mat

SUBSURFACE PROFILE

Depth (m)	Elevation [m]	Description
0	104.68	Ground Surface
0	104.48	**Topsoil** Approximately 200 millimetres of topsoil.
		Fine Sand/ Fine Sandy Silt Brown to greyish brown, interbedded, traces of fine gravel, compact to dense
	97.08	End of Borehole

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	2,5,7,8	12			
SS	2	10,14,17, 12	31			
SS	3	9,16,14	30			
SS	4	5,10,16	26			
SS	5	4,6,6	12			



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 26, 2013 to termination at a depth of 7.6 metres.

2. A monitoring well was installed upon the completion of drilling and a following free groundwater level of 5.75 metres was measured by a representative of Azimuth Environmental Consulting Inc. on April 29, 2013.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Hollow-Stem Auger
Drill Date: April 26, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 13 [MW-2]

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: **::**

Soil-Mat

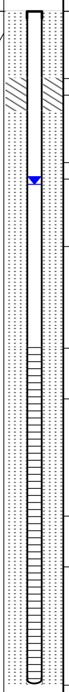
SUBSURFACE PROFILE

Depth	Elevation [m]	Symbol	Description
ft m 0 0	93.97		Ground Surface
	93.77	~~	**Topsoil** Approximately 200 millimetres of topsoil.
			Fine Sand/ Fine Sandy Silt Brown to greyish, interbedded, traces of fine gravel, traces of organic staining at shallower depths, occasional silt seams, loose to compact
	87.27		End of Borehole

Depth (ft): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32

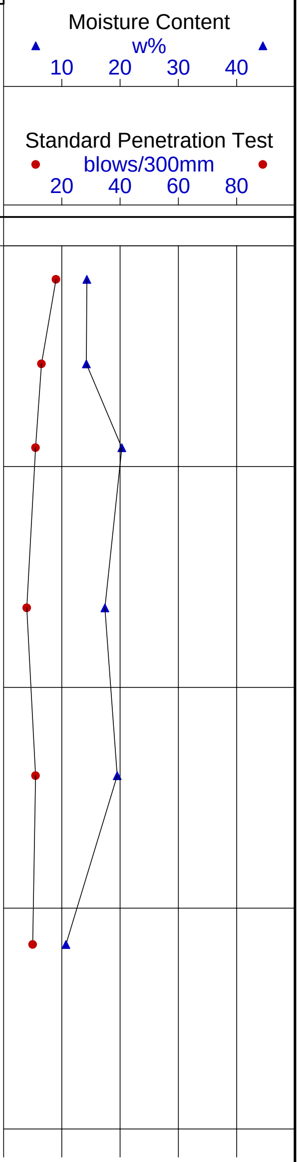
Depth (m): 0, 2, 4, 6, 8

Well Data



SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	5,6,12,12	18	▨		
SS	2	5,8,5,6	13	▨		
SS	3	3,4,7,10	11	▨		
SS	4	2,3,5	8	▨		
SS	5	4,5,6	11	▨		
SS	6	3,4,4,6	10	▨		



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 26, 2013 to termination at a depth of 6.7 metres.

2. A monitoring well was installed upon the completion of drilling and a following free groundwater level of 1.57 metres was measured by a representative of Azimuth Environmental Consulting Inc. on April 29, 2013.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Hollow-Stem Auger
Drill Date: April 26, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

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130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 14 [MW-3]

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

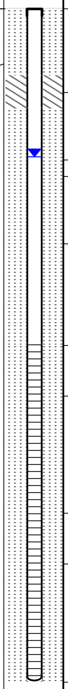
: **::**

Soil-Mat

SUBSURFACE PROFILE

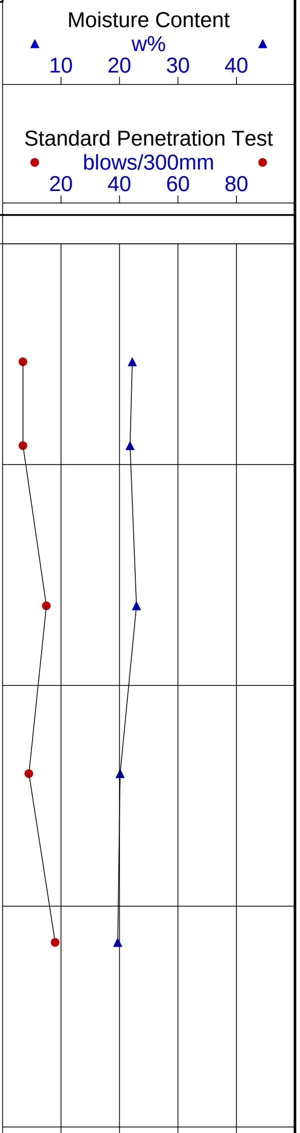
Depth (m)	Elevation [m]	Description
	93.97	Ground Surface
0		***Topsoil*** Approximately 500 millimetres of topsoil.
	93.47	***Fine Sand/ Fine Sandy Silt*** Brown to greyish brown, interbedded, traces of fine gravel, traces of organic staining at shallower depths, loose to compact
	87.37	End of Borehole

Depth scale: ft 0–32; m 0–8



SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	5,8,5,6	7			
SS	2	3,4,7,10	7			
SS	3	2,3,5	15			
SS	4	4,5,6	9			
SS	5	3,4,4,6	18			



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 26, 2013 to termination at a depth of 6.6 metres.

2. A monitoring well was installed upon the completion of drilling and a following free groundwater level of 1.35 metres was measured by a representative of Azimuth Environmental Consulting Inc. on April 29, 2013.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Hollow-Stem Auger
Drill Date: April 26, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

SOIL-MAT ENGINEERS & CONSULTANTS LTD.
130 Lancing Drive, Hamilton, ON L8W 3A1
Phone: (905) 318-7440 Fax: (905) 318-7455
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

Project No: SM135031-G

Project: Orangeville Highlands Phase II

Location: Hansen Bvld., Orangeville, ON

Client: Country Green Homes Ltd.

Log of Borehole No. 15

Project Manager: John Monkman, P. Eng.

Borehole Location: See Drawing No. 1

: ::

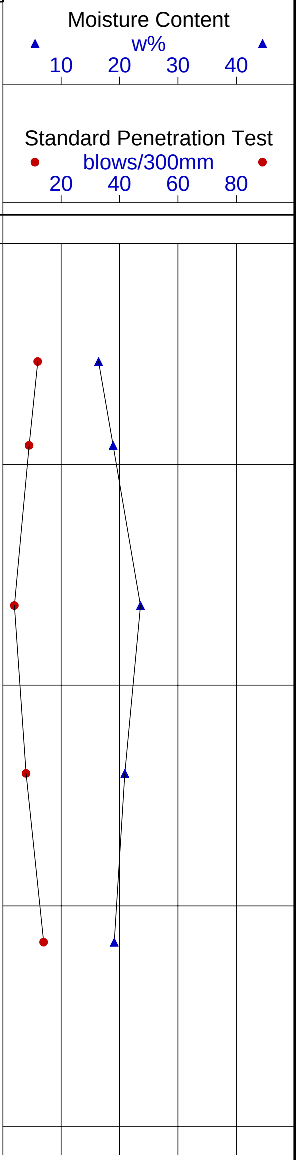
Soil-Mat

SUBSURFACE PROFILE

Depth (m)	Elevation [m]	Description
0	93.97	Ground Surface
0	93.97	**Topsoil** Approximately 450 millimetres of topsoil.
0.45	93.52	**Fine Sand/ Fine Sandy Silt** Brown to greyish brown, interbedded, traces of fine gravel, organic staining at shallower depths, very loose to compact
5.2	88.77	End of Borehole

SAMPLE

Type	Number	Blow Counts	Blows/300mm	Recovery	PP (kgf/cm2)	U.Wt.(kN/m3)
SS	1	4,5,7,7	12	▨		
SS	2	4,5,4,5	9	▨		
SS	3	1,1,3,5	4	▨		
SS	4	2,3,5	8	▨		
SS	5	4,7,7,9	14	▨		



NOTES:

1. Borehole was advanced using solid stem auger equipment on April 26, 2013 to termination at a depth of 5.2 metres.

2. Borehole was recorded as 'caved' at a depth of 1.5 metres upon completion of drilling and backfilled as per Ontario Regulation 903.

3. Soil samples will be discarded after 3 months unless otherwise directed by our client.

Drill Method: Solid-Stem Auger
Drill Date: April 26, 2013
Hole Size: 150mm
Drill Contractor: Geo Environmental

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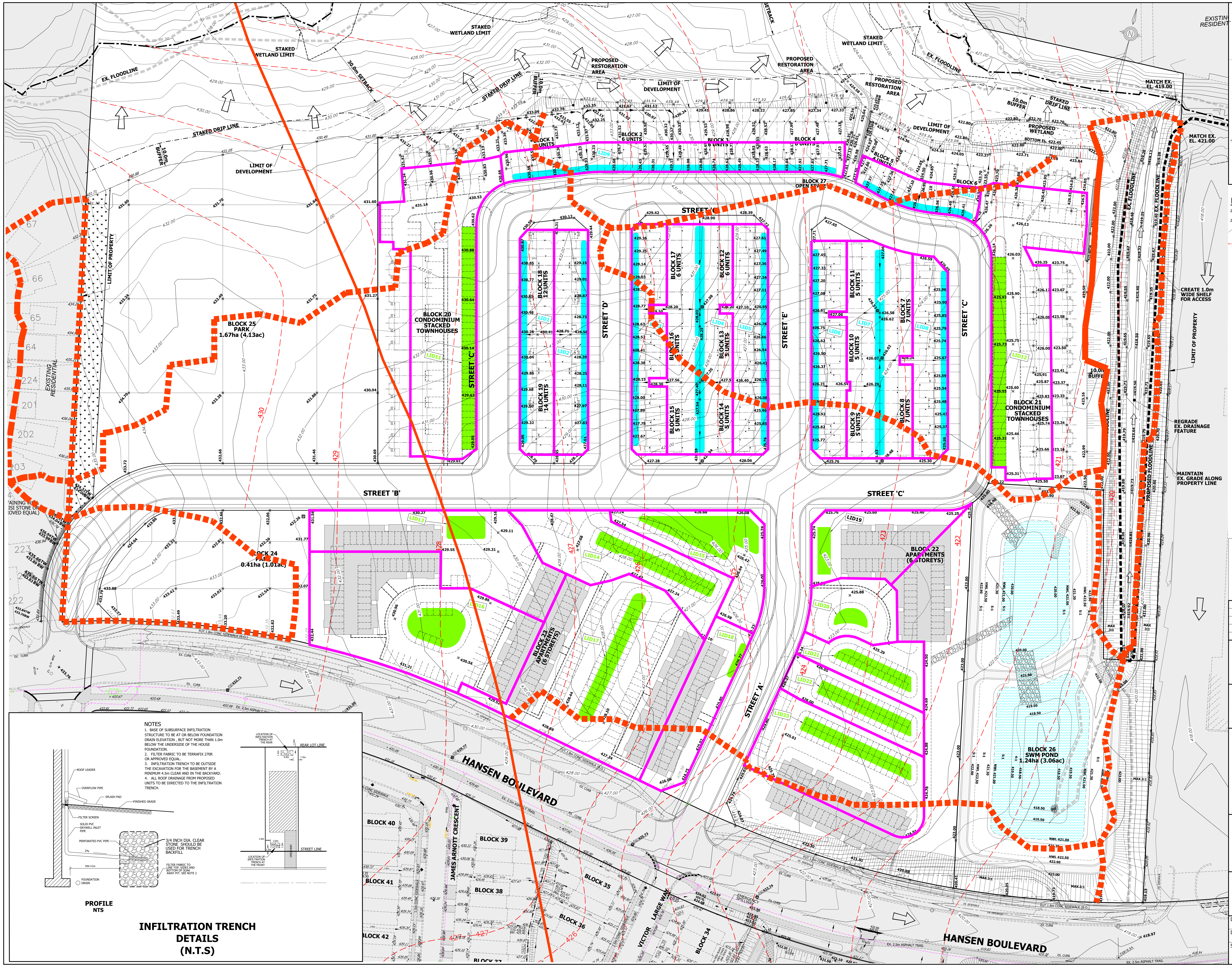
e-mail: info@soil-mat.on.ca

Datum: Ground Surface
Field Logged by: Kyle Fletcher
Checked by: JM
Sheet: 1 of 1

APPENDIX D

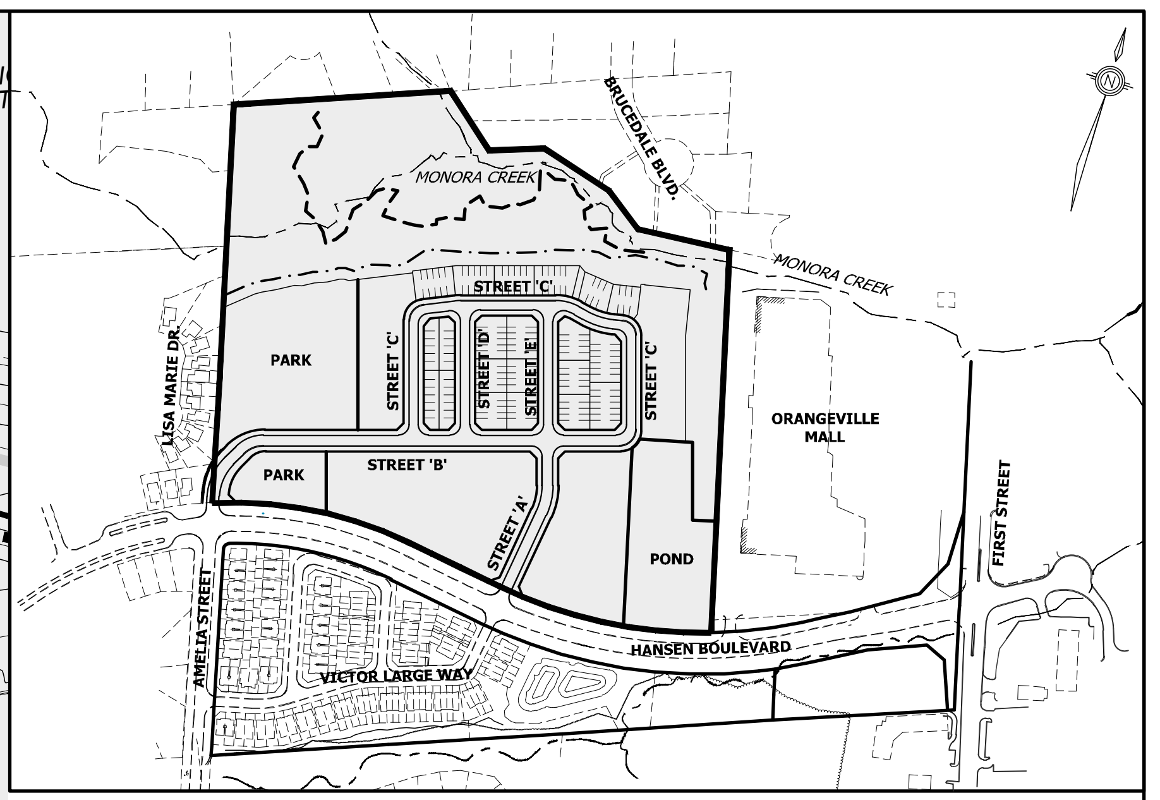
LID Plan and Details



PROFILE
NTS

NOTES
1. BASE OF SUBSURFACE INFILTRATION STRUCTURE TO BE AT OR BELOW FOUNDATION DRAIN ELEVATION , BUT NOT MORE THAN 1.0m BELOW THE UNDERSIDE OF THE HOUSE FOUNDATION.
2. FILTER FABRIC TO BE TERRAFIX 270R OR APPROVED EQUAL.
3. INFILTRATION TRENCH TO BE OUTSIDE THE EXCAVATION FOR THE BASEMENT BY A MINIMUM 4.5m CLEAR AND IN THE BACKYARD.
4. ALL ROOF DRAINAGE FROM PROPOSED UNITS TO BE DIRECTED TO THE INFILTRATION TRENCH.

INFILTRATION TRENCH DETAILS
(N.T.S)



KEY PLAN
NTS

LEGEND

⌧ 429.03	PROPOSED GRADE (m)
⌧ 426.24	EXISTING ELEVATION (m)
421.50	GROUND ELEVATION (m)
422.00	HIGH GROUND WATER ELEVATION CONTOUR (m)
⇦	EXISTING OVERLAND FLOW ROUTE
⬅	PROPOSED OVERLAND FLOW ROUTE
▨	INFILTRATION TRENCH LOCATED IN PRIVATE FRONT/REAR YARD (REFER TO DETAIL, THIS DWG)
🟦	POTENTIAL LOCATION OF PRIVATE LID FEATURE (TO BE DETERMINED THROUGH FUTURE SITE PLAN APPLICATION)
▭	CONTRIBUTION DRAINAGE AREA TO LID FEATURE

LID#	DRAINAGE AREA (m^2)	STORAGE VOL (m^3)
LID1	1378	35.1
LID2	1384	35.1
LID3	1410	40.3
LID4	2778	86.4
LID5	1484	43.2
LID6	1363	40.5
LID7	2532	108.0
LID8	1283	50.4
LID9	1842	108.0
LID10	694	36.0
LID11	3959	207.7
LID12	3582	392.0
LID13	2624	15.6
LID14	2043	32.4
LID15	1575	57.0
LID16	4166	65.1
LID17	4784	41.9
LID18	1336	4.6
LID19	1489	66.0
LID20	943	47.8
LID21	994	80.2
LID22	1085	102.8
LID23	2665	121.8

BENCHMARK

STATION: 00819688502 ELEVATION: 417.719
502-68: ONE STOREY BROWN BRICK MORTUARY (FOREST LAWN MORTUARY) ON EAST SIDE OF HWY 10 AND 24, 1.9 KM NORTH OF NORTH JCT OF HWYS 9, 10 AND 24 AT ORANGEVILLE. 1.4 KM SOUTH OF MONO TWP SIDEROAD 5 (DUFFERIN CTY RD 7) AND 301.8 M EAST OF CENTERLINE OF HWY 10 AND 24 ALONG CEMETERY RD. TABLET IS SET HORIZONTALLY IN NORTH FACE OF CONCRETE FOUNDATION, 2.59 M EAST OF N.W. CORNER AND 43 CM BELOW BRICKWORK.

No.	REVISION	DATE
4		
3		
2		
1		

ORANGEVILLE HIGHLANDS PHASE 2
FUNCTIONAL SERVICING

Corporation of the
Town of Orangeville
Ontario, Canada

REVIEWED BY
THE TOWN OF
ORANGEVILLE

DATE

DIRECTOR OF PUBLIC WORKS

urbantech
Urbantech® Consulting, A Division of Leighton-Zec Ltd.
3760 14th Avenue, Suite 301 Markham ON L3R 3T7
tel: 905.946.9461 fax: 905.946.9595
www.urbantech.com

LICENSED PROFESSIONAL ENGINEER
S.B. RIEMER
100214712
APRIL 2019
PROVINCE OF ONTARIO

LID DRAINAGE PLAN

DESIGNED: D.Z.	CHECKED: D.Z.	PROJECT No.:	06-233-PH2
DRAWN: V.P.	DATE: MARCH 2019	FIGURE No.:	FIG 5B
SCALE: H 1:750			

File: P:\Projects\06-233-Phase 2\FSR\F5B-FSR LID WATER BALANCE.dwg - Revised by <DFAN> : Mon, Apr 01 2019 - 4:36pm

TABLE: LID PERFORMANCE AND ON-SITE RETENTION

LID	TYPE	TOTAL DRAINAGE AREA (m^2)	IMPERVIOUS DRAINAGE AREA (m^2)	TOTAL LID SURFACE AREA (m^2)	AVG GROUNDWATER DEPTH (m)	AVERAGE LID DEPTH (m)	TOTAL LID VOL (m^3)	TOTAL STORAGE VOL (m^3)	EQUIV RAINFALL DEPTH (mm)
1	INFILTRATION TRENCH	1378	1034	58.5	2.5	1.50	87.8	35.1	25.5
2	INFILTRATION TRENCH	1384	1038	58.5	2.5	1.50	87.8	35.1	25.4
3	INFILTRATION TRENCH	1410	1058	72.0	2.4	1.40	100.8	40.3	28.6
4	INFILTRATION TRENCH	2778	2083	144.0	2.5	1.50	216.0	86.4	31.1
5	INFILTRATION TRENCH	1484	1113	72.0	2.5	1.50	108.0	43.2	29.1
6	INFILTRATION TRENCH	1363	1023	67.5	2.5	1.50	101.3	40.5	29.7
7	INFILTRATION TRENCH	2532	1899	135.0	3.0	2.00	270.0	108.0	42.7
8	INFILTRATION TRENCH	1283	962	63.0	3.0	2.00	126.0	50.4	39.3
9	INFILTRATION TRENCH	1842	1381	108.0	3.5	2.50	270.0	108.0	58.6
10	INFILTRATION TRENCH	694	520	36.0	3.5	2.50	90.0	36.0	51.9
11	TBD AT SITE PLAN DESIGN STAGE	3959	3563	519.3	2.0	1.00	519.3	207.7	52.5
12	TBD AT SITE PLAN DESIGN STAGE	3582	3224	490.1	3.0	2.00	980.1	392.0	109.4
13	TBD AT SITE PLAN DESIGN STAGE	2624	2362	155.7	1.3	0.25	38.9	15.6	5.9
14	TBD AT SITE PLAN DESIGN STAGE	2043	1839	324.0	1.3	0.25	81.0	32.4	15.9
15	TBD AT SITE PLAN DESIGN STAGE	1575	1418	570.0	1.3	0.25	142.5	57.0	36.2
16	TBD AT SITE PLAN DESIGN STAGE	4166	3749	325.7	1.5	0.50	162.8	65.1	15.6
17	TBD AT SITE PLAN DESIGN STAGE	4784	4306	349.1	1.3	0.30	104.7	41.9	8.8
18	TBD AT SITE PLAN DESIGN STAGE	1336	1202	38.1	1.3	0.30	11.4	4.6	3.4
19	TBD AT SITE PLAN DESIGN STAGE	1489	1340	110.0	2.5	1.50	165.0	66.0	44.3
20	TBD AT SITE PLAN DESIGN STAGE	943	849	79.6	2.5	1.50	119.4	47.8	50.6
21	TBD AT SITE PLAN DESIGN STAGE	994	894	200.5	2.0	1.00	200.5	80.2	80.7
22	TBD AT SITE PLAN DESIGN STAGE	1085	977	257.0	2.0	1.00	257.0	102.8	94.8
23	TBD AT SITE PLAN DESIGN STAGE	2665	2398	304.5	2.0	1.00	304.5	121.8	45.7
								1817.9	

APPENDIX E

2007 Jagger Hims Hydrogeological Assessment

SUPPLEMENTAL MONITORING AND HYDROGEOLOGIC ASSESSMENT PROPOSED ORANGEVILLE HIGHLANDS DEVELOPMENT, PHASE 2

PART OF EAST HALF OF LOT 3, CONCESSION 2 W.H.S
FORMERLY IN THE TOWNSHIP OF MONO
TOWN OF ORANGEVILLE, COUNTY OF DUFFERIN

Prepared for:
Orangeville Highlands Ltd.

January 2007

File 021508.03

Distribution:
8 c Urbantech
1 c File

This report contains recycled fibre.

JAGGER HIMS
LIMITED
Environmental Consulting Engineers

JAGGER HIMS
LIMITED
Environmental Consulting Engineers

1091 Gorham Street, Suite 301
Newmarket, Ontario
Canada L3Y 8X7

Tel 905 853-3303
800 263-7419
Fax 905 853-1759

January 8, 2007

Orangeville Highlands Ltd.
c/o Mr. Paul A. Sytsma, Principal
Urbantech
25 Royal Crest Court, Suite 201
Markham, Ontario
L3R 9X4

Dear Mr. Sytsma:

Re: Supplemental Monitoring and Hydrogeologic Assessment
Proposed Orangeville Highlands Development, Phase 2
Part of East Half of Lot 3, Concession 2 W.H.S
Formerly in the Township of Mono
Town of Orangeville, County of Dufferin
File 021508.03

As requested, Jagger Hims Limited is pleased to provide the supplemental hydrogeologic report on the Phase 2 area of the proposed Orangeville Highlands residential development, which expands upon our 2003 infiltration study. The fieldwork components included borehole drilling, groundwater monitor installation, groundwater level monitoring, and watercourse flow monitoring.

The information provided herein can be used in support of the design of the general development layout. We understand that a copy of this document will be provided to Credit Valley Conservation for their review and approval.

We understand that Urbantech has replaced Metropolitan Consulting for managing development at this site. We look forward to continuing to provide our services for this site under direction of Urbantech. If our firm can be of further assistance, please contact us.

Yours truly,
JAGGER HIMS LIMITED

AG Hims

Andrew G. Hims, P.Eng.
Consulting Engineer
BDT:nah

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1.0 BACKGROUND

1.1 PROPOSED DEVELOPMENT

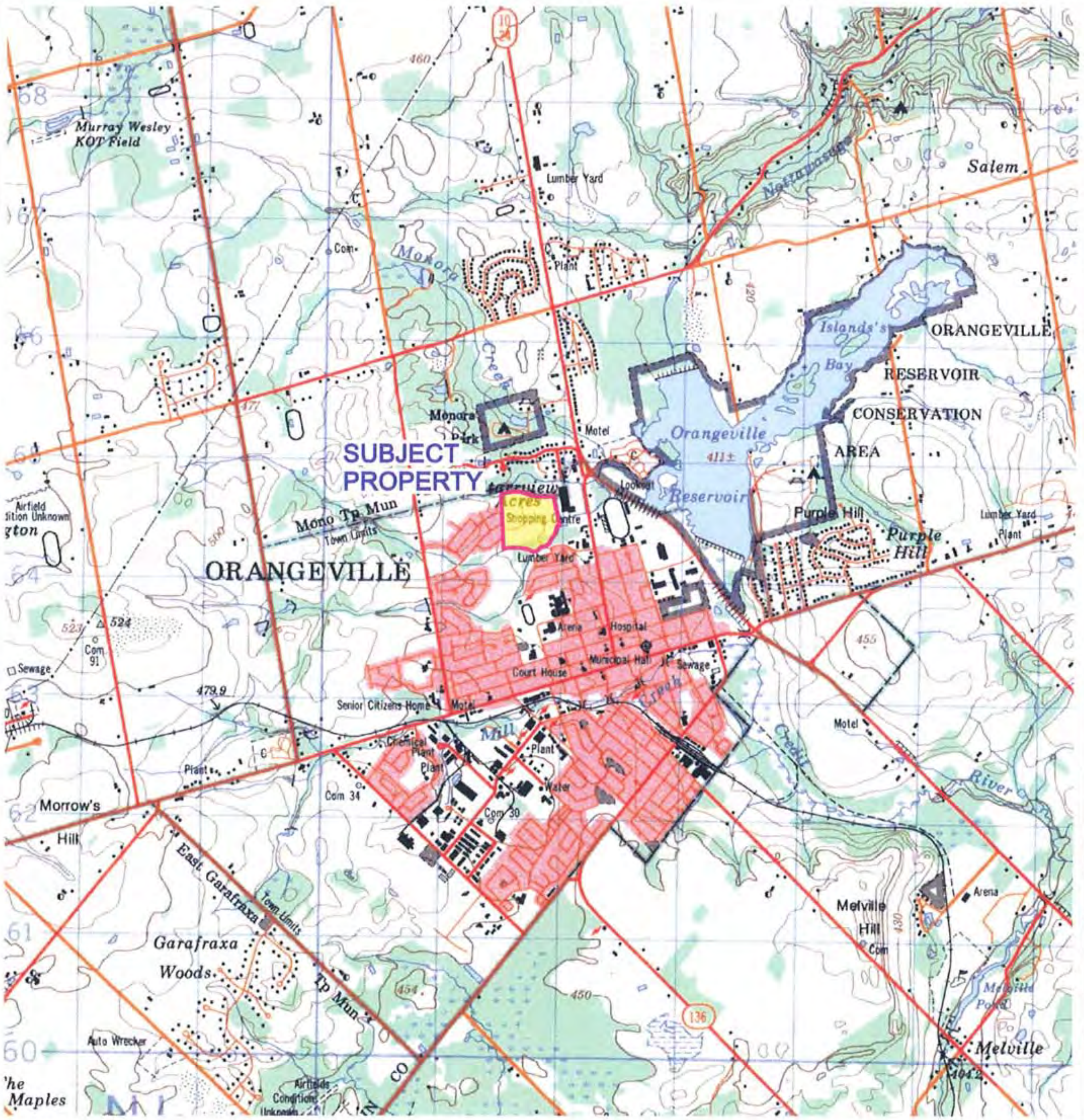
Orangeville Highlands Ltd. is proposing to construct a residential development in an area located in the northern part of the Town of Orangeville, in the County of Dufferin, as shown on Figure 1. The total property area is 22.39 ha (55.33 acres), which will be developed in two phases as follows, as illustrated in Figure 2.

- Phase 1 that is located south of Hansen Boulevard and east of Amelia Street, and extends over approximately 5.1 ha (12.6 acres).
- Phase 2 (site) that is located north of Hansen Boulevard, and extends over an area of approximately 18.01 ha (44.5 acres).

Phase 2 is the subject of this report and has a total area of 18 ha, of which approximately 13 ha (32.2 acres) is potentially available for development; the northern portion along the Middle Monora valley will be preserved. The development concept for Phase 2 will be prepared when the constraints, as partially determined from the results of this study, are finalized.

Jagger Hims Limited previously carried out a test pit investigation and infiltration study of the site (Jagger Hims Limited, 2003).

Full municipal services will be provided to the proposed development, including water supply and sewage disposal. It is proposed that stormwater will be collected by stormwater management systems to be directed to two stormwater management ponds on site, which will subsequently discharge to the Middle and Lower Monora Creeks.



LEGEND

🟨 APPROXIMATE LOCATION OF SUBJECT PROPERTY

MAP SOURCE:
NTS SHEET 40P/16 ORANGEVILLE

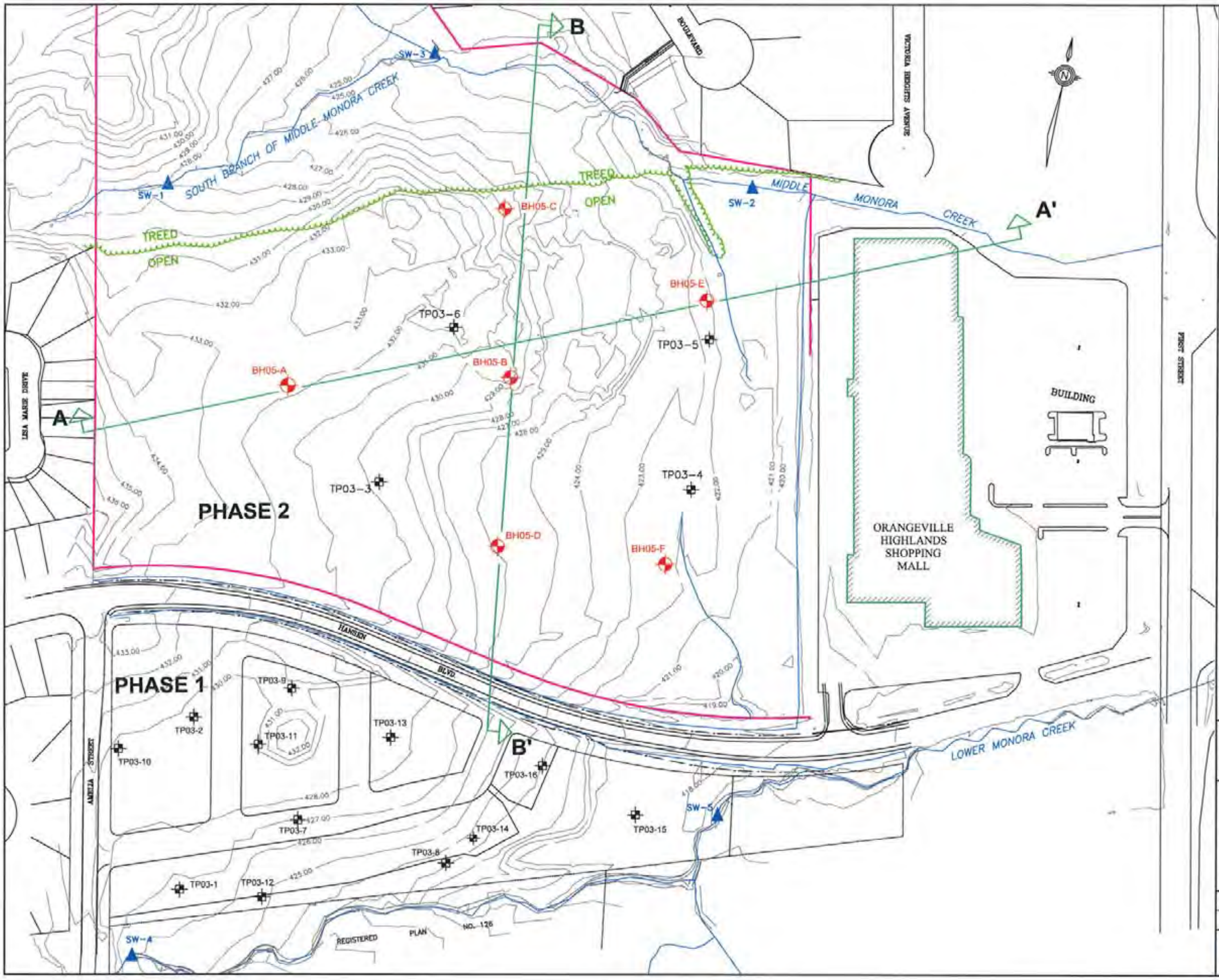
SITE LOCATION PLAN

SUPPLEMENTAL MONITORING
AND HYDROGEOLOGICAL ASSESSMENT
PROPOSED ORANGEVILLE HIGHLANDS
DEVELOPMENT, PHASE 2
for Orangeville Highlands Ltd.

DATE: JULY 2006	SCALE: 1:50,000
PROJECT: 021508.03	REF. NO.: 0-02150803F1-LM

JAGGER HIMS LIMITED
Environmental Consulting Engineers

FIGURE
1



Legend

	SITE PROPERTY BOUNDARY
BH05-A	JAGGER HIMS LIMITED BOREHOLE AND MONITOR, LOCATION AND DESIGNATION
TP03-16	JAGGER HIMS LIMITED TEST PIT LOCATION AND DESIGNATION
▲ SW-A	SURFACE WATER MONITORING STATION
423.00	TOPOGRAPHIC CONTOUR (mASL)
	SURFACE WATER COURSE
	BOUNDARY OF TREED AREA
A	LINE OF HYDROSTRATIGRAPHIC CROSS SECTION AS SHOWN ON FIGURE 4

10 0 20 metres

NOTES:

1. CONTOURS OF EXISTING GRADE PROVIDED BY METROPOLITAN CONSULTING INC.

2. LOCATIONS OF MONITORS SURVEYED BY METROPOLITAN CONSULTING INC. LOCATIONS OF TEST PITS IN PHASE 2 ARE ESTIMATED BASED ON GPS.

3. BASED ON MAP BY METROCON, N-05001 SURVEY, JUNE 2005 AND AERIAL PHOTOGRAPHY.

DETAILED SITE PLAN

SUPPLEMENTAL MONITORING AND
HYDROGEOLOGICAL ASSESSMENT
PROPOSED ORANGEVILLE HIGHLANDS
DEVELOPMENT, PHASE 2
for Orangeville Highlands Ltd.

DATE: JULY 2006	SCALE: 1:2,500
PROJECT: 021508.03	FILE NO.: 0-02150803F2-SP
JAGGER HIMS LIMITED Environmental Consulting Engineers	Figure 2

1.2 ENVIRONMENTAL OBJECTIVES

The site is situated within the catchments of two local watercourses that include (1) the north branch of Lower Monora Creek that is located to the south of Phase 1, and (2) the Middle Monora Creek that is located to the north of Phase 2. In the present undeveloped condition, on-site infiltration recharges the shallow groundwater regime through pervious soils exposed at surface over the entire area of the site. Discharges from the shallow groundwater regime contribute a portion of the base flow in both watercourses.

The proposed residential development will include construction of relatively impervious surfaces over pervious soils that are exposed in the present pre-construction condition. Examples of impervious surfaces include paved roads, driveways, and dwelling footprints. In post-construction, such impervious surfaces will intercept incident precipitation and that water will be conveyed to a stormwater management pond. Impervious surfaces reduce the total amount of recharge to the shallow groundwater regime that can consequently reduce the volume of base flow in receiving watercourses.

Several environmental studies were carried out on the site area for the Town of Orangeville, private developers, and Credit Valley Conservation (ESG International Inc. August, 2002; Aquafor Beech Ltd et al, 1997; Aquafor Beech Ltd., 2001). The following relevant conclusions and objectives were derived from those studies.

- Base flows in the adjacent watercourses are provided by shallow and deeper groundwater flow systems.
- The primary source of water to groundwater systems is recharge within the local and regional areas.
- Base flow is significant for supporting the ecological functions of those watercourses.

- Most of the Phase 2 property is designated as a "high" groundwater recharge area.
- The Lower and Middle Monora Creeks are Level One Riparian Corridors.
- It will be necessary to provide, "...emulation or enhancement of existing recharge, taking into account local groundwater divides" (Aquafor Beech, 1997).

In summary, environmental reviews of the site area indicate that development should proceed in a manner such that the rate of infiltration for post-construction conditions will be similar to the rate of infiltration that presently occurs for pre-construction conditions.

1.3 STUDY OBJECTIVES AND SCOPE

The objective of this study was to assess aspects of the relationship between the groundwater regime and the proposed development, which included the following components.

1) Determine the elevation of shallow groundwater.
2) Characterize temporal changes of groundwater elevations, including for peak annual conditions.
3) Interpret areas of groundwater recharge and discharge.
4) Assess the distribution of areas with shallower groundwater that could affect development design components.
5) Determine the direction of groundwater movement to assess contributions by the site to the local watercourses.
6) Assess subsurface conditions with respect to the capability to support artificial infiltration systems that will maintain local watercourse base flows.

This information will provide input to planning of the residential development, including the distribution of lots, artificial infiltration measures, and the design of subsurface municipal servicing infrastructure. We understand that the elevation of the groundwater level can constrain the design and placement of dwellings, basements, buried utility infrastructure, and artificial infiltration systems.

The scope of work included completion of the following tasks.

- Completion of drilling explorations to determine subsurface soil conditions at six locations.
- Installation of a network of groundwater monitors to assess groundwater levels, consisting of eight monitors at six locations.
- Performance of a monitoring program to observe seasonal groundwater level elevations and trends, including for two spring seasons.
- Measurement of base flows in local watercourses
- Assessment of hydrogeologic effects potentially resulting from development at the site.
- Provision of this report.

2.0 METHODOLOGY

2.1 BOREHOLE AND MONITOR INSTALLATION PROGRAM

A program of borehole drilling and groundwater monitor installation was carried out during March 7 to 11, 2005. Work was performed at six (6) locations on the site, with boreholes and groundwater monitors designated as BH05-A through BH05-F. The locations of boreholes and groundwater monitors are shown on Figure 2.

Borehole locations were selected to provide good areal coverage for the interpretation of soil and groundwater conditions across the site. The selection of locations also considered the probable presence of groundwater divides, including between the surface water catchments of Middle Monora Creek and Lower Monora Creek, a local swale, and a ridge. The drilling locations were submitted to and approved by Credit Valley Conservation prior to commencing the field program.

Lantech Drilling Services Inc. of Mount Albert, Ontario was the drilling contractor who provided the drilling equipment and operating crew. The work program was supervised in the field by a Jagger Hims Limited technician.

The depth of exploratory boreholes resulting from the drilling ranged from 4.4 to 11.3 metres below ground level (m bgl). Boreholes were drilled using the hollow stem auger method and soil samples were collected using a standard 0.6 metre (m) long split spoon sampler. Samples were generally collected every 0.76 m, with reduced sampling frequencies at less critical depths as determined by the project geoscientist.

A groundwater monitor was installed within the exploratory borehole at each location. At locations BH05-A and BH05-F, an adjacent, unsampled borehole was advanced and a relatively shallower monitor was installed to determine the position of the groundwater table and the vertical hydraulic gradient.

Each groundwater monitor was constructed using environmental grade, PVC, 51 millimetre (mm) diameter, thread-connected riser pipe. Each monitor was equipped with a machine-slotted well screen with an open length of 1.4 m. The bottom of the monitor was fitted with a slotted end cap. The annulus at the screened zone was backfilled with sand to provide a filter pack. The annulus above the screened zone was backfilled with a low permeability bentonite seal that continued to ground surface. Locked protective casings were installed over each riser pipe. Summaries of monitor construction details are provided in Tables A-1 and A-2 of Appendix A.

Groundwater monitors were surveyed for location and elevation by Metropolitan Consulting Inc. The elevation references were the rim of PVC riser casing and adjacent ground level at each monitor. Elevation data is provided on Table A-2 of Appendix A.

The Well Tag Number that is registered with the Ministry of the Environment for the monitors installed on this site is No. A011143.

Test pits were excavated on the site by Jagger Hims Limited (Jagger Hims Limited, 2003), with designations of TP03-3, TP03-4, TP03-5, and TP03-6. Locations are shown on Figure 2. Standpipes were installed in TP03-3 and TP03-4, and the standpipe at TP03-3 was functional and used for monitoring in 2005/2006.

2.2 GROUNDWATER LEVEL MONITORING

Groundwater levels were measured in the groundwater monitors and in the test pit standpipe using a Solinst® brand electric water level tape. The reference level at each monitor was the rim of the PVC casing.

Historic measurements of groundwater levels were obtained at test pits TP03-4 and TP03-5 in January and June 2003.

In 2005, groundwater levels were measured in groundwater monitors at locations BH05-A through BH05-F, and at TP03-4. Monitoring events were carried out on the dates indicated on Table 1, which are summarized as follows.

- Spring 2005, including 7 events from March 11 to April 29, 2005.
- Other 2005, including 4 events between June 27 and December 23, 2005.
- Spring 2006, including 11 events from February 7 to June 10, 2006.

TABLE 1
Record of Groundwater Levels
Orangeville Highlands, Phase 2, Supplemental Monitoring and Assessments

Monitor	Ground Surface	Top of Tube	Date	Static Water Levels		
	m ASL	m ASL		m bmp	m ASL	m bgl
BH05-A-i	432.26	433.17	10-Mar-05	5.055	428.12	4.14
			11-Mar-05	5.035	428.14	4.13
			18-Mar-05	5.12	428.05	4.21
			24-Mar-05	5.11	428.06	4.20
			1-Apr-05	4.95	428.22	4.04
			11-Apr-05	4.76	428.41	3.85
			15-Apr-05	4.82	428.35	3.91
			29-Apr-05	***4.54***	***428.63***	***3.63***
			27-Jun-05	4.91	428.26	4.00
			17-Aug-05	5.31	427.86	4.40
			21-Nov-05	5.68	427.49	4.77
			23-Dec-05	5.53	427.64	4.62
			7-Feb-06	4.97	428.20	4.06
			24-Feb-06	4.82	428.35	3.91
			9-Mar-06	4.78	428.39	3.87
			14-Mar-06	4.42	428.75	3.51
			28-Mar-06	4.27	428.90	3.36
			5-Apr-06	4.30	428.87	3.39
			12-Apr-06	4.23	428.94	3.32
			20-Apr-06	4.27	428.90	3.36
			1-May-06	***4.20***	***428.97***	***3.29***
			8-May-06	4.29	428.88	3.38
			10-Jun-06	4.53	428.65	3.61
BH05-A-ii	432.26	433.15	10-Mar-05	5.08	428.07	4.19
			11-Mar-05	4.94	428.21	4.05
			18-Mar-05	5.01	428.14	4.12
			24-Mar-05	5.03	428.12	4.14
			1-Apr-05	4.91	428.24	4.02
			11-Apr-05	4.76	428.39	3.87
			15-Apr-05	4.82	428.33	3.93
			29-Apr-05	***4.40***	***428.75***	***3.51***
			27-Jun-05	4.74	428.41	3.85
			17-Aug-05	5.18	427.97	4.29
			21-Nov-05	5.63	427.52	4.74
			23-Dec-05	5.46	427.69	4.57
			7-Feb-06	4.84	428.31	3.95
			24-Feb-06	4.64	428.51	3.75
			9-Mar-06	4.59	428.56	3.70
			14-Mar-06	4.26	428.89	3.37
			28-Mar-06	4.00	429.15	3.11
			5-Apr-06	4.09	429.06	3.20
			12-Apr-06	4.03	429.13	3.13
			20-Apr-06	4.02	429.13	3.13
			1-May-06	***3.95***	***429.20***	***3.06***
			8-May-06	4.03	429.12	3.14
			10-Jun-06	4.33	428.83	3.44

TABLE 1
Record of Groundwater Levels
Orangeville Highlands, Phase 2, Supplemental Monitoring and Assessments

Monitor	Ground Surface m ASL	Top of Tube m ASL	Date	Static Water Levels m bmp	m ASL	m bgl
BH05-B	430.18	431.09	10-Mar-05	6.62	424.47	5.71
			11-Mar-05	6.62	424.47	5.71
			18-Mar-05	6.70	424.39	5.79
			24-Mar-05	6.67	424.42	5.76
			1-Apr-05	6.37	424.72	5.46
			11-Apr-05	6.15	424.94	5.24
			15-Apr-05	6.23	424.86	5.32
			29-Apr-05	***6.01***	***425.08***	***5.10***
			27-Jun-05	6.65	424.44	5.74
			17-Aug-05	7.08	424.01	6.17
			21-Nov-05	7.02	424.07	6.11
			23-Dec-05	6.94	424.15	6.03
			7-Feb-06	6.30	424.79	5.39
			24-Feb-06	6.26	424.83	5.35
			9-Mar-06	6.34	424.75	5.43
			14-Mar-06	5.90	425.19	4.99
			28-Mar-06	5.90	425.19	4.99
			5-Apr-06	5.86	425.23	4.95
			12-Apr-06	***5.82***	***425.28***	***4.91***
			20-Apr-06	5.90	425.19	4.99
			1-May-06	5.86	425.23	4.95
			8-May-06	6.00	425.09	5.09
			10-Jun-06	6.15	424.95	5.24
BH05-C	428.80	429.77	11-Mar-05	5.195	424.58	4.23
			18-Mar-05	5.235	424.54	4.27
			24-Mar-05	5.25	424.52	4.28
			1-Apr-05	5.12	424.65	4.15
			11-Apr-05	4.88	424.89	3.91
			15-Apr-05	4.87	424.90	3.90
			29-Apr-05	***4.79***	***424.98***	***3.82***
			27-Jun-05	5.09	424.68	4.12
			17-Aug-05	5.40	424.37	4.43
			21-Nov-05	5.61	424.16	4.64
			23-Dec-05	5.49	424.28	4.52
			7-Feb-06	5.13	424.64	4.16
			24-Feb-06	5.06	424.71	4.09
			9-Mar-06	5.09	424.68	4.12
			14-Mar-06	4.87	424.90	3.90
			28-Mar-06	4.76	425.01	3.79
			5-Apr-06	4.71	425.06	3.74
			12-Apr-06	4.65	425.12	3.68
			20-Apr-06	4.66	425.11	3.69
			1-May-06	4.61	425.16	3.64
			8-May-06	***4.57***	***425.20***	***3.60***
			10-Jun-06	4.78	425.00	3.81

TABLE 1
Record of Groundwater Levels
Orangeville Highlands, Phase 2, Supplemental Monitoring and Assessments

Monitor	Ground Surface	Top of Tube	Date	Static Water Levels		
	m ASL	m ASL		m bmp	m ASL	m bgl
BH05-D	425.88	426.74	10-Mar-05	2.01	424.73	1.15
			11-Mar-05	2.01	424.73	1.15
			18-Mar-05	2.09	424.65	1.23
			24-Mar-05	2.02	424.72	1.16
			1-Apr-05	1.39	425.35	0.53
			11-Apr-05	1.22	425.52	0.36
			15-Apr-05	1.24	425.50	0.38
			29-Apr-05	***1.01***	***425.73***	***0.15***
			27-Jun-05	2.30	424.44	1.44
			17-Aug-05	3.15	423.59	2.29
			21-Nov-05	1.97	424.77	1.11
			23-Dec-05	1.90	424.84	1.04
			7-Feb-06	1.11	425.63	0.25
			24-Feb-06	0.90 to ice		
			9-Mar-06	0.90 to ice		
			14-Mar-06	0.85 to ice		
			28-Mar-06	1.26	425.48	0.40
			5-Apr-06	***1.08***	***425.66***	***0.22***
			12-Apr-06	1.11	425.63	0.25
			20-Apr-06	1.39	425.35	0.53
			1-May-06	1.42	425.32	0.56
			8-May-06	1.71	425.03	0.85
			10-Jun-06	1.73	425.02	0.87
BH05-E	422.25	423.30	11-Mar-05	1.015	422.29	-0.04
			18-Mar-05	2.07	421.23	1.02
			24-Mar-05	1.94	421.36	0.89
			1-Apr-05	1.71	421.59	0.66
			11-Apr-05	1.68	421.62	0.63
			15-Apr-05	1.80	421.50	0.75
			29-Apr-05	***1.65***	***421.65***	***0.60***
			27-Jun-05	2.46	420.84	1.41
			17-Aug-05	2.69	420.61	1.64
			21-Nov-05	2.10	421.20	1.05
			23-Dec-05	2.10	421.20	1.05
			7-Feb-06	1.79	421.51	0.74
			24-Feb-06	1.91	421.39	0.86
			9-Mar-06	1.92	421.38	0.87
			14-Mar-06	***1.55***	***421.75***	***0.50***
			28-Mar-06	1.82	421.48	0.77
			5-Apr-06	1.72	421.58	0.67
			12-Apr-06	1.76	421.55	0.70
			20-Apr-06	1.89	421.41	0.84
			1-May-06	1.89	421.41	0.84
			8-May-06	***1.55***	***421.75***	***0.50***
			10-Jun-06	2.03	421.27	0.98

TABLE 1
Record of Groundwater Levels
Orangeville Highlands, Phase 2, Supplemental Monitoring and Assessments

Monitor	Ground Surface	Top of Tube	Date	Static Water Levels		
	m ASL	m ASL		m bmp	m ASL	m bgl
BH05-F-i	422.19	423.10	11-Mar-05	0.985	422.12	0.07
			18-Mar-05	1.00 to ice		0.07 to ice
			24-Mar-05	1.07 to ice		0.14 to ice
			1-Apr-05	0.91	422.19	0.00
			11-Apr-05	0.92	422.18	0.01
			15-Apr-05	0.96	422.14	0.05
			29-Apr-05	***0.90***	***422.20***	***-0.01***
			27-Jun-05	1.48	421.62	0.57
			17-Aug-05	2.18	420.92	1.27
			21-Nov-05	1.00	422.10	0.09
			23-Dec-05	1.00	422.10	0.09
			7-Feb-06	0.92	422.18	0.01
			24-Feb-06	0.96	422.14	0.05
			9-Mar-06	0.92	422.18	0.01
			14-Mar-06	***0.89***	***422.21***	***-0.02***
			28-Mar-06	0.94	422.16	0.03
			5-Apr-06	0.91	422.19	0.00
			12-Apr-06	0.92	422.19	0.00
			20-Apr-06	0.98	422.12	0.07
			1-May-06	0.99	422.11	0.08
			8-May-06	1.05	422.05	0.14
			10-Jun-06	1.01	422.09	0.10
BH05-F-ii	422.02	422.99	11-Mar-05	Frozen		
			18-Mar-05	0.895 to ice		-0.08 to ice
			24-Mar-05	0.96 to ice		-0.01 to ice
			1-Apr-05	1.15	421.84	0.18
			11-Apr-05	***0.92***	***422.07***	***-0.05***
			15-Apr-05	0.95	422.04	-0.02
			29-Apr-05	***0.92***	***422.07***	***-0.05***
			27-Jun-05	1.36	421.63	0.39
			17-Aug-05	2.09	420.90	1.12
			21-Nov-05	0.94	422.05	-0.03
			23-Dec-05	0.94	422.05	-0.03
			7-Feb-06	0.92	422.07	-0.05
			24-Feb-06	0.93	422.06	-0.04
			9-Mar-06	***0.91***	***422.08***	***-0.06***
			14-Mar-06	0.92	422.07	-0.05
			28-Mar-06	0.92	422.07	-0.05
			5-Apr-06	0.92	422.07	-0.05
			12-Apr-06	***0.92***	***422.08***	***-0.06***
			20-Apr-06	0.94	422.05	-0.03
			1-May-06	0.94	422.05	-0.03
			8-May-06	1.05	421.94	0.08
			10-Jun-06	0.93	422.07	-0.05

Notes:

1. "m bmp" indicates metres below measurement point (top of PVC casing).
2. "m ASL" indicates metres above sea level.
3. "m bgl" indicates metres below ground level.
4. Shaded values are minimum observed for location.
5. Bold and italic values are maximum observed for location for year.

The spring events were completed to observe water level trends during the spring freshet period, when groundwater levels were anticipated to correspond with maximum annual values. Other events in June to December were used to monitor seasonal variation.

In addition to manual measurements, shorter-term fluctuations of the groundwater level were measured by a computerized datalogger instrument that was installed in groundwater monitors. The instrument used was a Solinst® Levelogger® that includes an automated data logger and transducer. A Levelogger was installed in groundwater monitor BH05-D, which obtained readings at 10 minute intervals, between March 18 and April 29, 2005. A Levelogger was installed in groundwater monitor BH05-A-ii, which obtained readings at 10 minute intervals, between March 9 and May 1, 2006. The Solinst® Barologger®, which is a similar instrument to the Levelogger, was installed above ground on site, and its record was used to filter out barometric effects to the Levelogger record.

2.3 WATERCOURSE BASE FLOW MEASUREMENT

Base flows in the north branch of Lower Monora Creek and in the south branch of Middle Monora Creek were estimated using the stream profiling method. The cross-section of each watercourse was subdivided into segments, and the flow velocity and the sectional geometry within each segment was measured. Flow velocity was measured using the Marsh-McBirney Flo-mate instrument, which is an electromagnetic flow meter. One flow measurement event was completed on April 15, 2005, which was timed to occur several days after the most recent precipitation event.

2.4 CLIMATE MONITORING

Data for climate conditions for the duration of the field program were based on reports from local Environment Canada climate monitoring stations. Long-term monthly climatic averages of total precipitation and average daily temperature were based on the record for the Orangeville MOE Climate Station between 1971 and 2000. Assessment of effects during the spring monitoring periods required data of daily precipitation and daily temperature, most of which were obtained from the Orangeville MOE Climate Station (80°5' W, 43°55' N, Elevation = 411 metres above sea level (m ASL)).

Due to incomplete monitoring at the Orangeville MOE climate station that is located nearest to the site, supplemental data were required from other stations. Missing daily precipitation data were obtained from the Sandhill Climate Station (79°49' W, 43°49' N, Elevation = 274 m ASL), and missing daily temperature data were obtained from the Borden AWOS Climate Station (79°54' W, 44°16' N, Elevation = 222 m ASL).

2.5 HYDRAULIC CONDUCTIVITY

The in-situ hydraulic conductivity of soil was determined using rising-head tests at the two deeper groundwater monitors of BH05-A and BH05-F on December 23, 2005.

The rising head tests involved the removal of standing water within the groundwater monitors which was followed by measurement of the recovery of the water level over time. Hydraulic conductivity was interpreted from the water level versus time data using the Bouwer-Rice analytical method. Graphical presentations of the tests are provided in Appendix A.

3.0 SITE CONDITIONS

3.1 EXISTING FEATURES

The southern and central portions of Phase 2, at the times of inspection in 2003 and 2005, consisted for the most part of fallow pasture lands vegetated with wild grass and isolated trees. The northern portion consisted of the watercourse and adjacent wooded area. Buildings or other structures were absent from the site.

The land usage immediately surrounding Phase 2 consists of the following types, as shown on Figure 2:

- North: A woodlot along the valley containing the south branch of Middle Monora Creek, and further north was a neighbourhood of single-family residential dwellings.
- East: Commercial development consisting of a shopping mall with an extensive paved parking area.
- South: Hansen Boulevard, which is a two-lane asphalt paved road. Further south is the yet-to-be-developed Phase 1 land that consists primarily of grassy pasture.
- West: A neighourhood of single-family residential dwellings, including residences with addresses along Lisa Marie Drive and Hansen Boulevard.

Residential and commercial areas that are located downgradient of the proposed development are on municipal servicing, and there are no identified water supply wells that could be affected by infiltration at the site.

3.2 TOPOGRAPHY AND GRADE

The maximum elevation within the Phase 2 property is above 437.7 m ASL at a location near the southwest corner, and the minimum elevation is below 419 m ASL at a location in a ditch near the northeast corner at Middle Monora Creek, indicating a vertical range for the site of about 18 m.

Phase 2 can be divided into five topographic features, as follows.

- Western upland, which extends from the western property line to approximately 180 m eastward, and from Hansen Boulevard to approximately 180 m northward. In general, the western upland includes lands higher than approximately 430 m ASL. Existing grades are toward the east and northeast.
- Northern valley, which is a portion of a wooded valley that contains the south branch of Middle Monora Creek and its floodplain, with existing grades on site sloping northward to the watercourse.
- Broad swale, which is located in the south-central portion of the site. Existing grades are toward the west-to-east trending axis of the swale.
- Fill stockpile, which forms a hummocky hill in the central area of the site. The stockpile hill generally grades towards the east and to the northeast. The topography of native ground beneath the fill is not known.
- Eastern lowland, which is a relatively flatter area with grades less than approximately 5%, with steeper slopes that grade toward internal ditches or to the adjacent shopping mall. In general, the eastern lowland includes lands lower than an elevation of 423 m ASL.

The origin of the soil stockpile is believed to be from development of the Orangeville Highlands Mall property that is located to the east of the site. Site mapping shows the presence of the soil stockpile on-site in 1991.

3.3 DRAINAGE

The site is situated within the surface water catchments of two local watercourses. In pre-construction conditions, the majority of the site is located within the catchment of the south branch of Middle Monora Creek and connecting ditches. A minor portion of the site is located within the catchment of the north branch of Lower Monora Creek. The watercourses and the catchment divide between them are indicated on Figure 3.

Middle Monora Creek and Lower Monora Creek flow eastward and confluence east of First Street, and then discharge into the Orangeville Reservoir. The reservoir drains both to the Credit River (south) and to the Nottawasaga River (north). Both Lower Monora Creek and Middle Monora Creek are considered tributaries of the Credit River, within Subwatershed 19 of the Credit Valley Conservation plan (Aquafor Beech Ltd., 1997).

The north branch of Middle Monora Creek confluences with the south branch of Middle Monora Creek on the site, at a location that is approximately 250 m east of the western property line.

A 250 m long south-to-north trending ditch, designated herein as "Ditch #1", is located within the eastern portion of the eastern lowland and discharges to the south branch of Middle Monora Creek.

A 180 m long south-to-north trending constructed ditch, designated herein as "Ditch #2", is located within the northern portion of the eastern lowland, between the soil stockpile and Ditch #1, and discharges to the south branch of Middle Monora Creek.

A 120 m long west-to-east trending ditch, designated herein as "Ditch #3", is located north of the sidewalk adjacent to Hansen Boulevard, and discharges to a 0.91 m diameter culvert that is located near the intersection of Hansen Boulevard and the western driveway entrance to the Orangeville Highlands Mall.

A 450 m long west-to-east trending constructed swale, designated herein as "Ditch #4", is located between the sidewalk and the paved asphalt of Hansen Boulevard, and discharges to a catchbasin located near the intersection of Hansen Boulevard and the western driveway entrance to the Orangeville Highlands Mall.

A 170 m long north-to-south trending ditch, designated as "Ditch #5", is located within the southern portion of the eastern lowland, and discharges to Ditch #3.

Water from Ditch #3 and Ditch #4 is conveyed through storm sewers that include a culvert at Hansen Boulevard that eventually is conveyed to discharge at Lower Monora Creek.

Water flow in site ditches is seasonal and in response to antecedent precipitation events.

3.4 SURFICIAL GEOLOGIC MAPPING

Surficial geologic mapping characterizes the site and area as being dominated by overburden soils. Bedrock beneath the proposed development is located approximately 15 metres below ground level (m bgl) or deeper (Ontario Department of Mines, 1969) and is not a significant influence with respect to infiltration or watercourse base flow aspects.

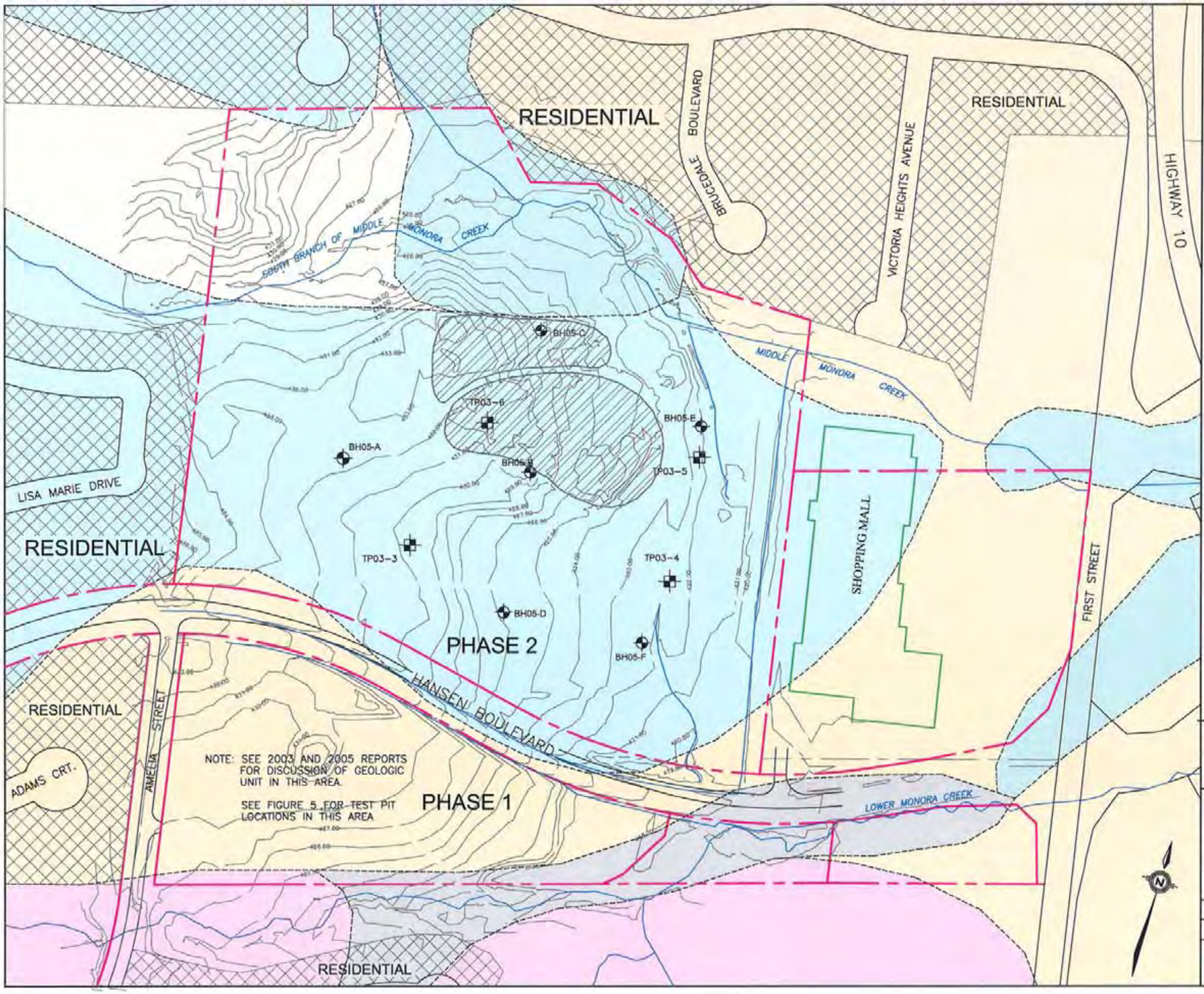
Published mapping indicates that surficial geology at the site is generally complex, as shown on Figure 4. The proposed development is located within the Orangeville Moraine landform (ESG International Inc, 2002; Aquafor Beech, 2001). The surficial geology map that covers this area (Ontario Department of Mines, 1973) indicates that the units at the site include the following.

- Ice-contact stratified drift, comprised of sand and gravel, and also including some glacial till or silt soils. This unit covers the vast majority of the site.

- Glaciofluvial outwash, comprised of gravel and gravelly sand, frequently overlain by several metres of sand or silt. This unit is exposed in the extreme northeast and southeast corners of the site.

- Glaciofluvial outwash, comprised of sand, with minor gravel. This unit is exposed in the northwest corner of the site.

- Bog deposits, comprised of peat, muck, and marl. This unit is exposed in the north-central portion of the site.



Legend

— · —	SUBJECT PROPERTY BOUNDARY
☒	RESIDENTIAL AREA
	MAPPED SURFICIAL GEOLOGIC UNITS:
☐	MODERN ALLUVIUM: SILT, SAND, GRAVEL
☐	BOG DEPOSITS: PEAT, MUCK, MARL
☐	GLACIOLACUSTRINE OR LOCAL POND SEDIMENTS: MAINLY FINE TO VERY FINE SAND
☐	GLACIOFLUVIAL OUTWASH SAND, MINOR GRAVEL
☐	GLACIOFLUVIAL OUTWASH GRAVEL AND GRAVELLY SAND, FREQUENTLY OVERLAIN BY SEVERAL FEET OF SAND OR SILT
☐	ICE-CONTACT STRATIFIED DRIFT: SAND AND GRAVEL INCLUDING SOME TILL OR SILT
▨	TOPSOIL STOCKPILE
● BH05-E	BOREHOLE AND MONITOR LOCATION AND DESIGNATION (JAGGER HIMS LIMITED)
✚ TP03-5	TEST PIT LOCATION AND DESIGNATION (JAGGER HIMS LIMITED)
—	TOPOGRAPHIC ELEVATION CONTOUR (mASL)

50 0 100 metres

NOTES:
1. LOCATIONS OF TEST PITS ARE APPROXIMATE, BASED ON GPS, LOCATIONS OF BOREHOLES WERE SURVEYED BY METROPOLITAN CONSULTING.
2. LOCATION OF TOPSOIL STOCKPILE IS ESTIMATED FROM YARDUN ENGINEERING (1991).
3. GEOLOGY FROM QUATERNARY GEOLOGY ORANGEVILLE AREA, PRELIMINARY MAP P.848, ONTARIO DIVISION OF MINES, MINISTRY OF NATURAL RESOURCES.

SURFICIAL GEOLOGY

SUPPLEMENTAL MONITORING AND HYDROGEOLOGICAL ASSESSMENT
PROPOSED ORANGEVILLE HIGHLANDS DEVELOPMENT, PHASE 2
for Orangeville Highlands Ltd.

DATE: JULY 2006	SCALE: 1:3,000
PROJECT: 021508.03	FILE NO.: 0-02150803F4-GE
JAGGER HIMS LIMITED Environmental Consulting Engineers	Figure 4

With the exception of the bog deposits, the surficial geologic materials present on site consist of granular soil materials that are anticipated to be well drained. Glacial till and silt materials, where present at depth, would be relatively poorly drained.

Site mapping indicates the presence of the fill stockpile with a reported volume of approximately 50,000 m^3 (Yardun Engineering Inc, 1991) at the approximate location shown on Figure 4.

4.0 OBSERVATIONS

4.1 CLIMATE

The source of infiltration and surface runoff is from climatic moisture surplus, which is the remainder of precipitation minus the evapotranspiration component. The average moisture surplus for the site was calculated based on long-term climate averages as recorded at the Orangeville MOE Climate Station, for the time period between 1971 and 2000; this station is the nearest Environment Canada station to the proposed development. Evapotranspiration losses were estimated from average monthly temperatures as input to the Thornthwaite method, with a daylight correction for latitude. Long-term averages of monthly climate data are provided on Table C-1 of Appendix C. The calculations indicate that the long-term average annual moisture surplus is 0.322 m/year. The moisture surplus is available for either infiltration or surface runoff, depending on site conditions.

A key objective for the monitoring program was to characterize the response of the shallow groundwater regime in the Phase 2 area to the spring snowmelt, also known as the spring freshet. Groundwater elevations are anticipated to be at or close to annual maximums during the freshet. Spring freshet usually occurs when the ambient air temperature ascends above the freezing point, the ground surface thaws, and the snow pack melts. Graphs of daily temperatures, including maximums, minimums, and averages for the spring monitoring periods of 2005 and 2006, are presented as Figures C-1 and C-2 of Appendix C, respectively. Graphs of daily precipitation for the spring monitoring period of 2005 and 2006 are presented as Figure C-3 and C-4, respectively. Tables of snow pack data for spring 2005 and 2006 are provided as Table C-2 and C-3, respectively.

4.1.1 Spring Freshet of 2005

The climatic record for 2005 indicates that the spring freshet occurred during late March to early April, as indicated by several climate parameters.

- "Snow on Ground" observations indicated that the main winter snow pack had completely melted by March 23 to 27, with a brief snow pack accumulation between April 2 and 5.
- Temperature was above the freezing point for some period of the day from at least March 19 onwards as indicated in the barometric logger air temperature data.
- The average daily temperature remained mainly above the freezing point from March 29 onwards according to Environment Canada climate stations, and from March 24 onwards as indicated in the barometric logger air temperature data. Most thawing of the frozen ground surface probably occurred after this date.

The precipitation record indicated that two periods of more-significant precipitation activity occurred during the monitoring period between mid-March and late April. The first significant period of precipitation occurred between March 31 to April 3, with a total of 49.8 mm provided during those days; the peak of 22 mm occurred on April 2. The second significant period of precipitation occurred between April 20 and April 29, with a total of at least 42.9 mm provided during those days; the peak of 21 mm occurred on April 23. Note precipitation data were not reported for the Orangeville or Sandhill climate stations for April 25. Other smaller events also occurred, as shown on Figure C-3, Appendix C.

4.1.2 Spring Freshet of 2006

The climatic record for 2006 indicates that the spring freshet occurred during late March, as indicated by several climate parameters.

- "Snow on Ground" observations indicated that the main winter snow pack had completely melted by March 12.
- Temperature was above the freezing point for some period of the day from at least March 23.
- The average daily temperature remained mainly above the freezing point from March 27 onwards. Most thawing of the frozen ground surface probably occurred after this date.

The precipitation record indicated that three periods of more significant precipitation activity occurred during the datalogger monitoring period between early-March and the start of May. There were cumulative precipitations on March 8 to 14, April 2 to 5 and April 21 to 24 of 56.3, 30.3 and 40.8 mm, respectively. Other single-day events also occurred, as shown on Figure C-4, Appendix C.

4.2 SITE GEOLOGY

Surficial geologic mapping indicates that the site is situated upon primarily granular sand and gravel textured soil units.

Subsurface geology of the site was investigated using boreholes and test pits. Detailed soil information at boreholes is provided in the borehole records of Appendix A, and details of test pits excavated are provided on Table B-1 of Appendix B and are also reported in Jagger Hims Limited (2003).

The borehole and test pits advanced on site indicate that the subsurface consists of two primary native soil layers, as follows.

- Sand - A fine to medium sand layer occurs across most of the drilled area of the site. The thickness of the sand layer ranges from 1.2 m at BH05-D to 4.0 m at BH05-E. At most locations the sand layer is the upper layer that overlies a lower layer of glacial till. At some locations the sand layer was buried beneath fill.

- Silt Till - A layer of glacial till, with dominant grain size texture ranging from "sand and silt" to "silt with some sand", including a trace clay component, was intercepted at most boreholes. The observed depth to till ranges from 1.8 to 8.2 m bgl, depending on location. The unit was not encountered at BH05-C to the depth of exploration at 6.0 m bgl.

In addition to the above units, other units were encountered at specific locations, including the following layers.

- Native topsoil - This layer occurs sporadically across the site. This unit was encountered at BH05-A and BH05-D with an approximate thickness of 0.6 m. This unit was absent at other locations and is likely buried beneath the fill at some locations.

- Fill, including organic soil fill and sandy silt fill - This layer is located within the central area of the site. This layer was encountered at BH05-B and BH05-C, with thicknesses of 3.0 and 2.1 m, respectively. These boreholes were located nearer to the edges of the topsoil stockpile as indicated on provided mapping, and a greater thickness of fill may be anticipated toward the centre of the stockpile. Also, test pit TP03-5 indicated granular fill with brick pieces with a layer thickness of 1.2 m, indicating that fill extends beyond the indicated stockpile perimeter to occur on portions of the eastern lowland.

- Sand with Silt - A layer of sand with some silt to silty fine sand was present at BH05-F. The layer was 2.2 m thick and occurred beneath the sand layer and above the silt till.

- Layered Sand and Silt - A layered sequence of dominantly silt and dominantly sand units was encountered at BH05-A and BH05-B. The thickness of the sequence was 6.7 m and 2.2 m, respectively. The layer is located above the silt till in the western area of the site.

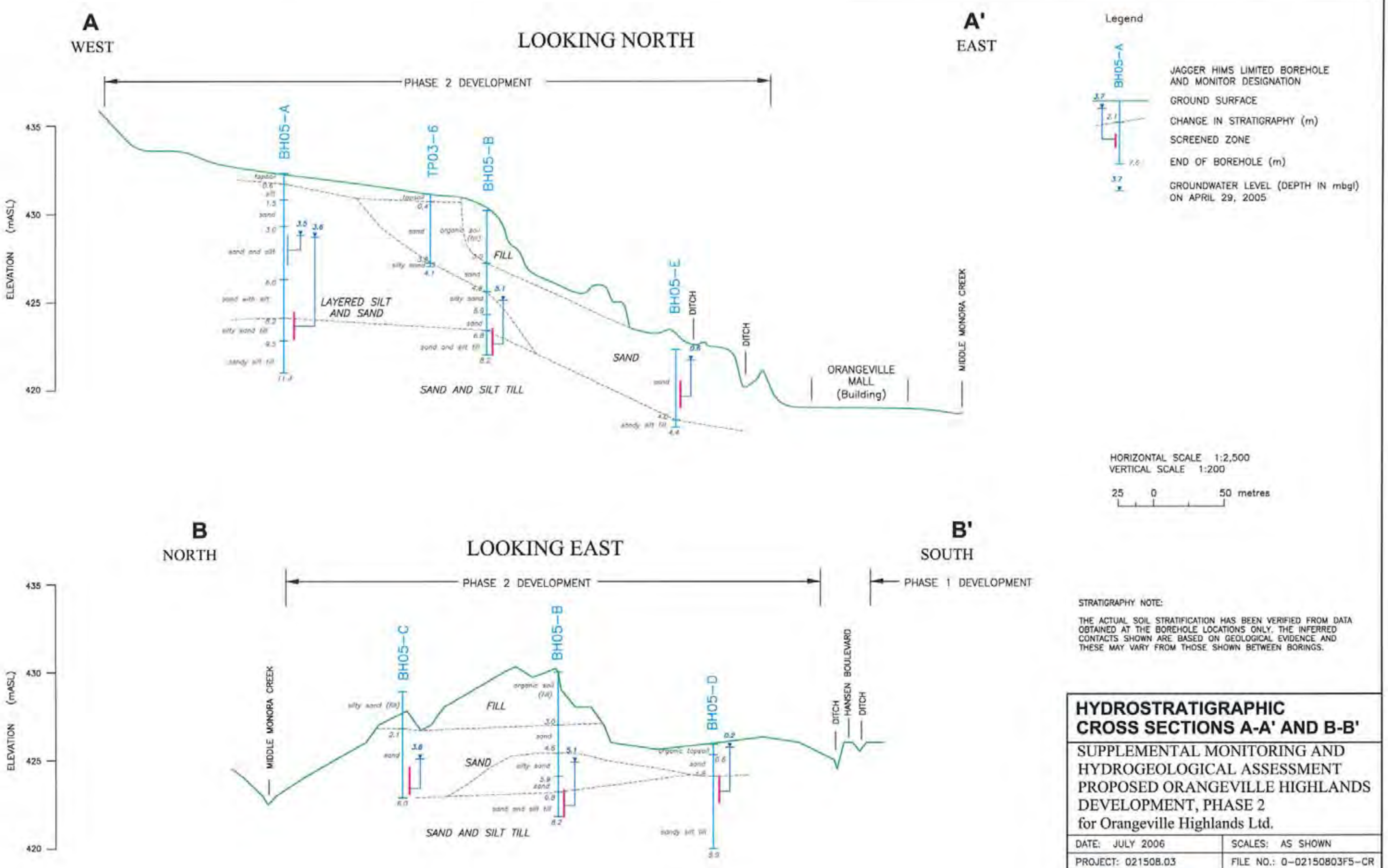
Two hydrostratigraphic cross sections were prepared that show the general relationship between these layers, based on available borehole and test pit data, as shown on Figure 5.

Two soil samples from the 2003 test pit program were submitted for laboratory analysis of the particle size distribution. Particle size distribution curves are provided as Figures B-1 and B-2 of Appendix B. The curves indicate fine sand with trace silt occurs at TP03-4 and TP03-6.

4.3 SHALLOW GROUNDWATER REGIME

Observations of groundwater levels at the site are provided on Table 1, for the measurement dates indicated in Section 2.2.

The following discussion focuses on the shallow groundwater levels that were observed on April 29, 2005, which provide the maximum observed elevation for Phase 2 during spring



STRATIGRAPHY NOTE:

THE ACTUAL SOIL STRATIFICATION HAS BEEN VERIFIED FROM DATA OBTAINED AT THE BOREHOLE LOCATIONS ONLY. THE INFERRED CONTACTS SHOWN ARE BASED ON GEOLOGICAL EVIDENCE AND THESE MAY VARY FROM THOSE SHOWN BETWEEN BORINGS.

HYDROSTRATIGRAPHIC CROSS SECTIONS A-A' AND B-B'

SUPPLEMENTAL MONITORING AND HYDROGEOLOGICAL ASSESSMENT PROPOSED ORANGEVILLE HIGHLANDS DEVELOPMENT, PHASE 2
for Orangeville Highlands Ltd.

DATE: JULY 2006	SCALES: AS SHOWN
PROJECT: 021508.03	FILE NO.: 0-02150803F5-CR

JAGGER HIMS LIMITED
Environmental Consulting Engineers

Figure
5

freshet of 2005. Comments on the groundwater response to the spring freshet 2006 are provided at the end of this section. The observed groundwater levels for April 29, 2005 are posted on Figure 3.

Contours for the maximum groundwater elevation condition were interpreted based on observations at monitors, an estimated "surface" computed with the Golden Software "Surfer" program, and interpretations by a Professional Geoscientist. The Surfer program used observations at Phase 1 standpipes and Phase 2 monitors for April 29, 2005, and also assumed that groundwater elevations were similar to grade at Middle Monora Creek. Note that groundwater contours shown are considered as established at groundwater monitor locations only, and conditions in between groundwater monitors and beyond the network are estimated.

The maximum elevation of shallow groundwater directly observed at the site was 428.75 m ASL at shallow monitor BH05-A-ii that is located in the western area of the site. It is probable that the groundwater elevations increase at lands west of this monitor, based on the general correlation of site topography and groundwater elevation trends.

The minimum elevation of shallow groundwater directly observed at the site was 421.65 m ASL at monitor BH05-E that is located in the eastern lowland. It is probable that the shallow groundwater occurs at lower elevations in the area east of this monitor, which is toward Ditch #1 and Ditch #5, based on the general correlation of site topography and groundwater elevation trends.

The depth to shallow groundwater level below existing grade varies across the site. The maximum observed depth was 5.10 m bgl at BH05-B in the central area. The minimum observed depth was 0.05 m above ground level at BH05-F, indicating sufficient hydrostatic pressure at the screen to raise the water above existing grade (artesian conditions).

Depths to maximum groundwater level were interpreted for the site based on a comparison of a maximum groundwater surface and the existing pre-construction grade. The maximum groundwater surface was estimated as described above. The surface for the existing ground elevation was generated by the Surfer program using the 1-m contours of Phases 1 and 2, as provided by Metropolitan Consulting Inc. The depth to maximum groundwater level was calculated by subtracting the maximum groundwater level surface from the ground elevation surface. A colour-classified map of the results is presented on Figure 5. Various depth ranges are highlighted that may be relevant to different requirements for infrastructure components with respect to the maximum groundwater level. Shaded areas indicate the following ranges of maximum groundwater level: greater than 2.0 m bgl, between 0.5 and 2.0 m bgl, between 0.0 and 0.5 m bgl grade, and above grade.

The findings indicate that maximum groundwater levels occurs in relatively close proximity to pre-construction existing grade within the eastern portion of Phase 2, particularly at the eastern lowland, the broad swale, and adjacent to watercourses. In the eastern lowland, groundwater levels that are less than 1.0 m bgl probably occur on a year-round basis. Hydrophilic vegetation and surface water at the base of ditches in the eastern lowland are interpreted to indicate a shallow water table in that area. The construction of ditches suggests the requirement for water management near to grade.

In general, the depth to water table or shallow groundwater will vary naturally with position across the proposed development, with season, and in response to constructed drainage measures and proposed artificial infiltration systems.

4.4 DISCHARGE AND RECHARGE AREAS

Discharge areas occur where the water table intersects the ground surface, and where the vertical hydraulic gradient and groundwater movement are upward. Discharge areas may be expressed as springs, seeps, or direct discharge to surface water bodies. If sufficient permeability is available in weathered soils that are near-to-surface and the discharge rate is relatively low, the discharge may move horizontally in soils below ground surface, with no surface expression.

Recharge areas occur where the vertical hydraulic gradient and groundwater movement is downward. In general, infiltration at grade does not contribute to groundwater systems in a discharge area, but it does contribute in a recharge area.

Areas of the site where the depths to maximum groundwater were at or higher than existing grade are interpreted to be discharge areas, as shown on Figure 5. Discharge areas occur in the eastern lowland, the broad swale, and likely at the base of Middle Monora Creek valley. The discharge areas are expressed by relatively denser vegetation and relatively wetter soils, with inundated conditions in ditches.

Localized springs and seeps of groundwater, as expressed by a wet area with continuous drainage away from the wet area that would suggest continuous discharge, were not observed in the areas of the site with shallow groundwater. Some areas of wet ground or small shallow ponds less than 20 cm deep without inflow and outflow drainage were present in some areas of the eastern lowland, the broad swale, and the valley floor of Middle Monora Creek. Some shallow ponds may be due to containment by micro-topography. Observed areas of wet ground are shown on Figure 5 as observed at the site in Spring 2006, based on reconnaissance mapping of Phase 1 and 2 areas. Other areas of wet ground could conceivably be present in portions of the site that were not visited, and wet conditions at some areas may have been obscured beneath the thick grass vegetation. The areas of wet ground and shallow ponds are temporary seasonal seeps. Those discharges are likely seasonal as they were not observed during site visits of the summer and late fall.

At Phase 2, the areas mapped on Figure 5 that have a maximum groundwater level that is deeper than 0.5 m below grade will likely function as perennial recharge areas. Perennial recharge areas occur at the soil stockpile and western upland areas.

Areas where the maximum shallow groundwater is located between ground surface and 0.5 m below are uncertain with respect to discharge and recharge conditions. The areal extent of discharge areas and recharge areas at a site can vary in response to seasonal climatic conditions, relatively wetter or drier years, and other factors. Seasonal conditions and minor topographic variations will be more significant in this zone.

The boundary between recharge areas and discharge areas will shift in response to seasonal conditions. As example, as the groundwater level declines through the summer/fall period, the extent of discharge areas will decrease and possible temporarily cease. There are areas where there is seasonal conversion from recharge area to discharge area and back, depending on the fluctuating water table elevation.

The amount of recharge that can occur per unit area depends on the presence of a downward hydraulic gradient, climatic moisture surplus, soil type, ground slope, vegetation, proportion of impervious cover, and other factors. Under pre-construction conditions, the proposed development portion of the site has variable ground slopes and soil types and the rate of infiltration will vary with location.

4.5 GROUNDWATER LEVEL TEMPORAL FLUCTUATIONS

The elevation of shallow groundwater will vary seasonally in response to moisture received at the overlying ground surface. Shallow groundwater usually increases in elevation in response to additions of moisture, such as from incident precipitation, runoff from upland areas, and/or a melting snow pack. During drier periods, when there is little or no surplus moisture available, the elevation of shallow groundwater decreases as the groundwater regime loses water to discharges at adjacent local watercourses.

The observed water levels during the 2005 and 2006 monitoring periods are graphed on Figures 6, 7, and 8, respectively. The water levels are presented as elevations and metres below existing grade on Table 1.

Figure 6: Hydrograph for Monitors BH05-A AND BH05-B
Orangeville Highlands, Phase 2 Area

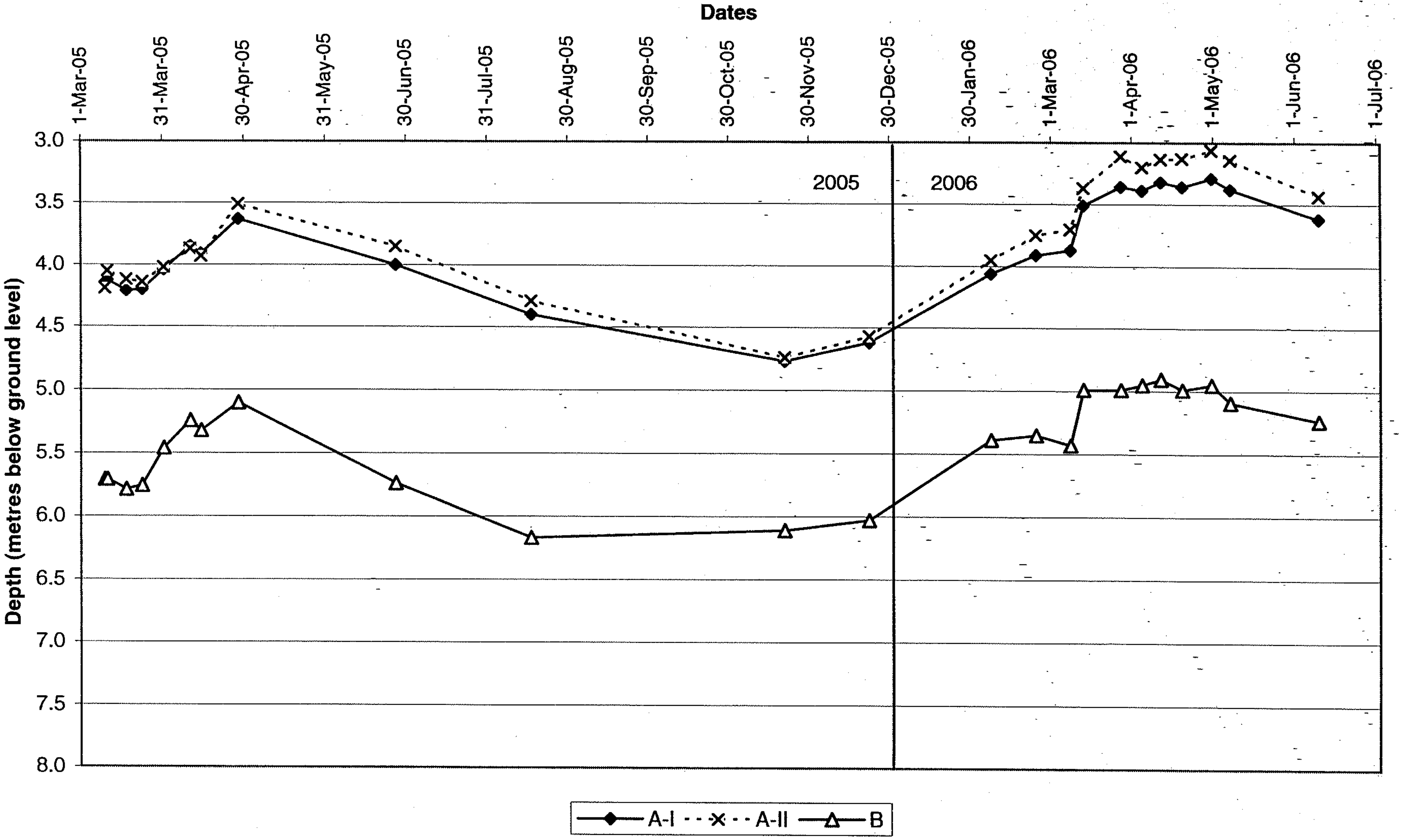


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Figure 7: Hydrograph for Monitors BH05-C AND BH05-D
Orangeville Highlands, Phase 2 Area

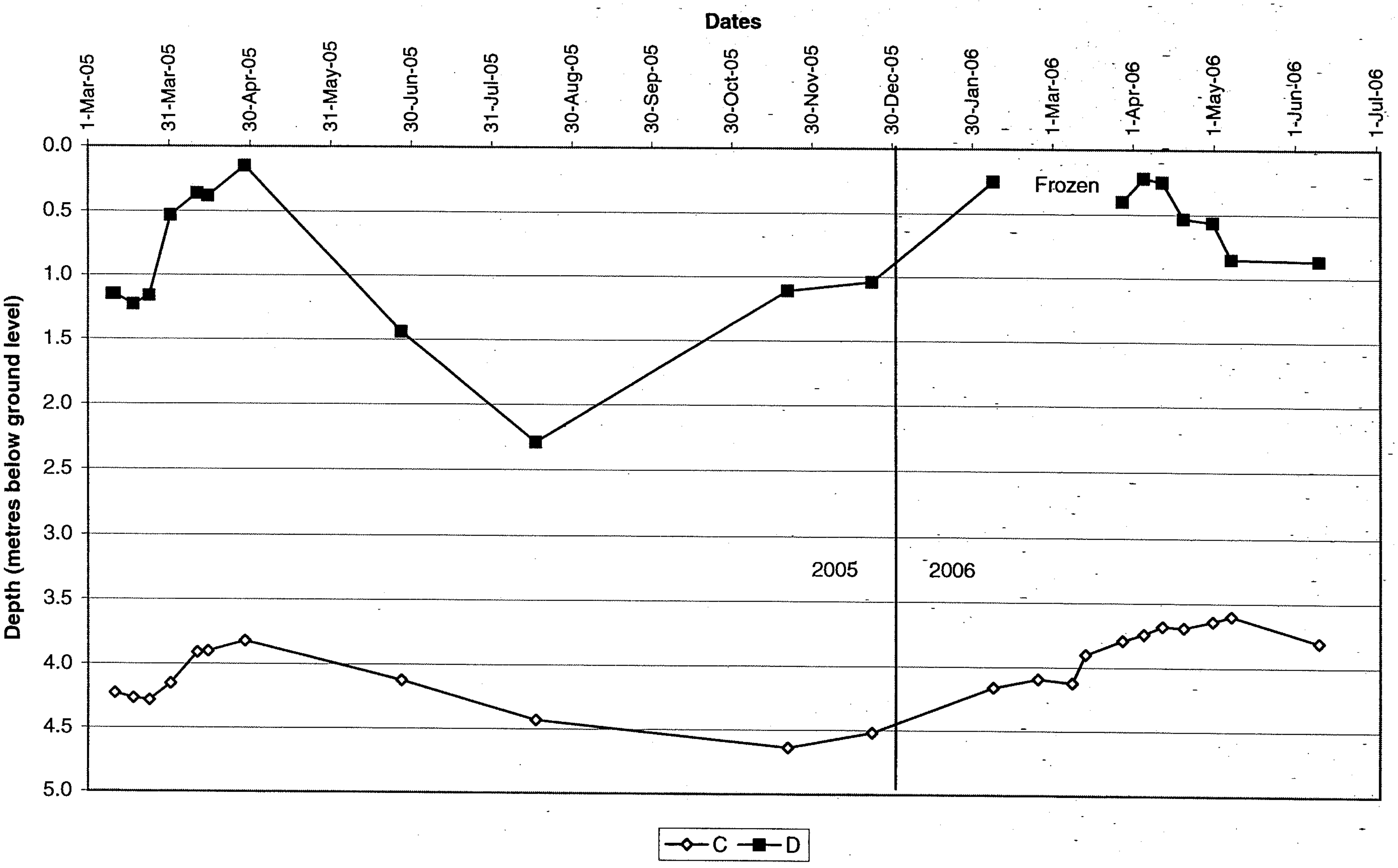

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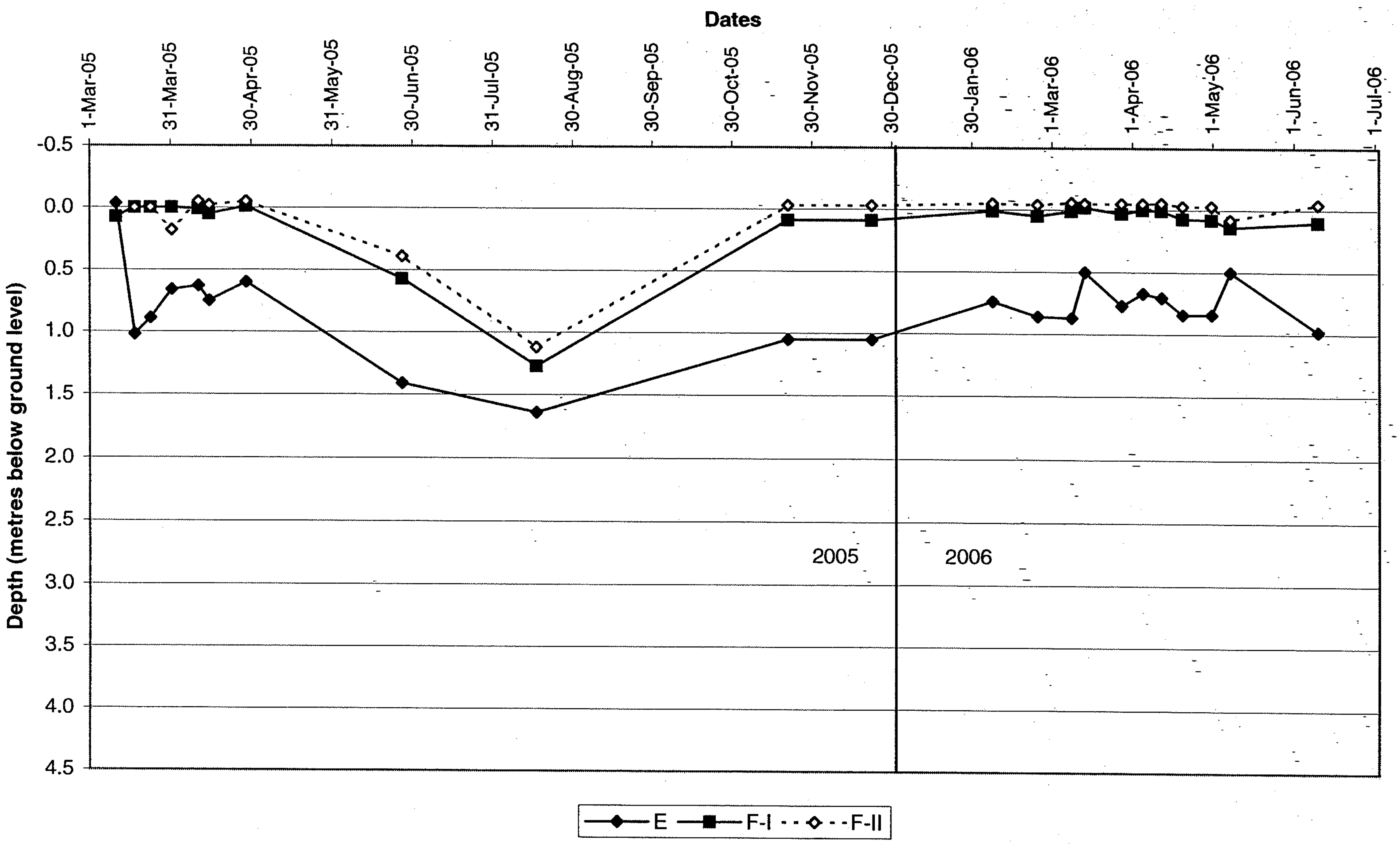
Figure 8: Hydrograph for Monitors BH05-E AND BH05-F Orangeville Highlands, Phase 2 Area



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4.5.1 Data Logger Observations at Eastern Lowland, 2005

As described in Section 2.2, an automated water level recorder was installed in BH05-E between March 18 and April 29, 2005 to monitor response of the groundwater level to the spring freshet in the Eastern Lowland area. The recorded hydrograph is provided on Figure 9. For comparison, temperature and precipitation data for that observation period are provided on Figures C-1 and C-3 of Appendix C, respectively.

The hydrograph for BH05-E indicates that the groundwater level elevation exhibited the following trends during the period of observation.

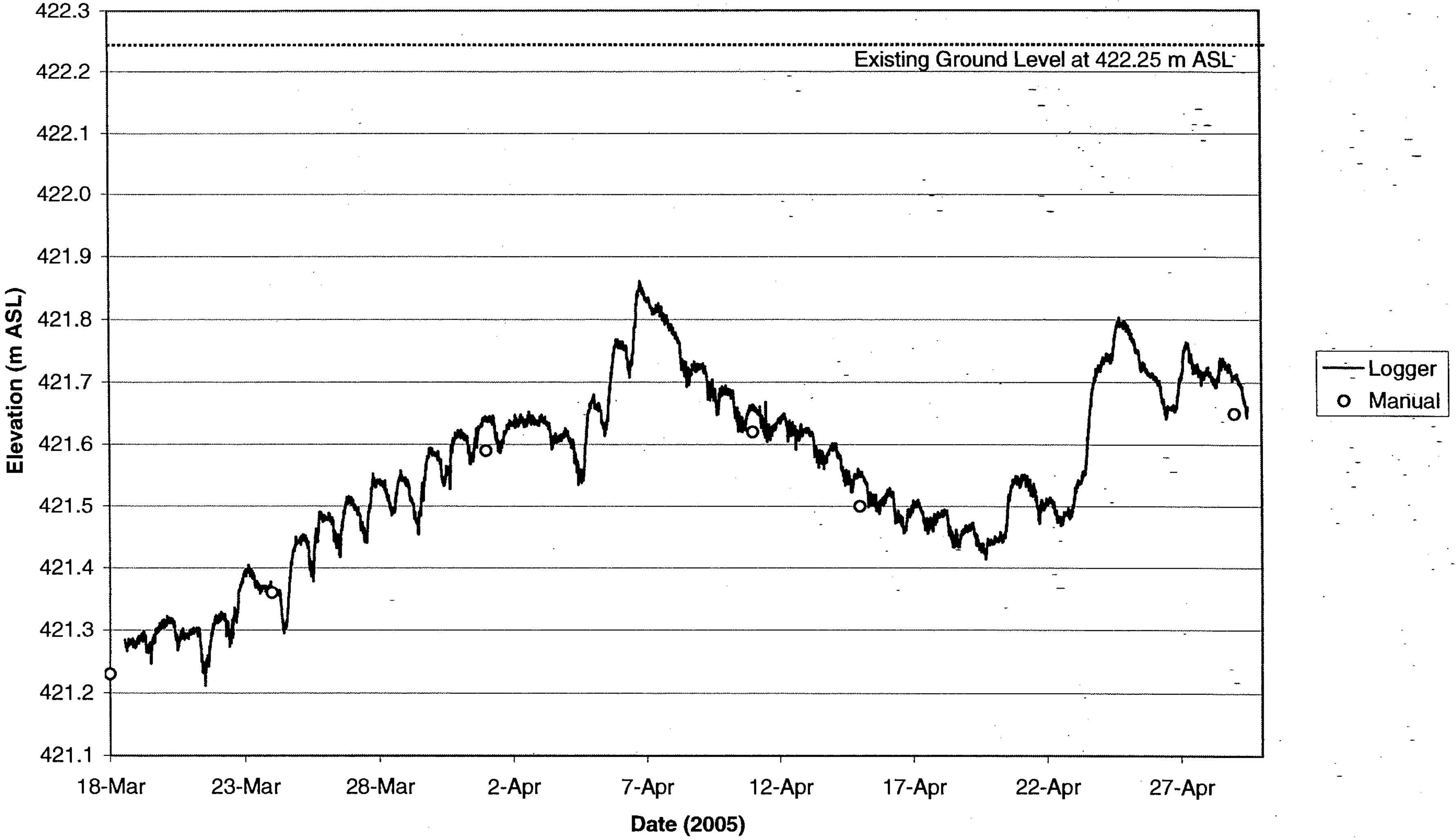
- The groundwater level has a regular diurnal fluctuation, with a magnitude on the order of 0.05 to 0.1 m. Within the cycle, the groundwater level usually increases to its highest elevation by mid-morning. This cyclical effect is negligible in magnitude and should have not any effects on the development.

- The groundwater level varied in elevation by 0.65 m during the logger monitoring period. Manual observations at this groundwater monitor indicate a historic elevation range of 1.6 m.

- The groundwater level elevation increased by approximately 0.3 m between March 19 and April 1, 2005. The increase likely was in response to partial melting of the overlying snow pack, thawing of ground frost, and some contribution by the total 10 mm of precipitation that fell during March 19 and 20.

- The groundwater level elevation increased by 0.3 m between April 4 and April 6. That increase is interpreted to be a result of the April 2 to 5 snow melt that resulted from warmer air temperatures during that period. No precipitation events occurred during that period. The peak groundwater elevation in response to the spring freshet occurred during this period, on April 6, 2005.

FIGURE 9: Logger Hydrograph of Monitor BHO5-E
Orangeville Highlands, Phase 2, Supplemental Monitoring and Assessments



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- No increase occurred in response to the total 48.6 mm of precipitation that fell during April 1 to 3. The lack of response to the relatively large amount of precipitation is attributed to a frozen ground surface at the time of precipitation, which would be relatively impermeable to recharge. The precipitation may have been temporarily stored in the snow pack and released during April 4 to 6.

- The groundwater level gradually declined between April 7 and 20. This decline occurred during a dry period and after the snow pack had melted, 'such that there were no sources to recharge the shallow groundwater. The groundwater level elevation declined at a rate of approximately 26 mm/day.

- The groundwater level increased by 0.4 m between April 20 and 24, with peaks on April 27 and 28. This marked increase is attributed to the total 35.7 mm of precipitation that fell during that period. The groundwater level elevation was sustained over the next few days as precipitation events of approximately 2 mm/day continued. At that time the ground surface would probably have thawed, allowing recharge of the underlying groundwater. The observations indicate that the groundwater level can increase by at least 0.3 m over a few days in response to a wetter climatic period.

It is noted that the magnitude of response to freshet observed at BH05-E is probably close to the maximum response for the site, as this monitor is located within a low area that receives runoff and snowmelt water from higher areas. Upland areas are anticipated to exhibit a lesser magnitude of responses to additions of moisture, as discussed in Section 4.5.2.

4.5.2 Data Logger Observations at Western Upland, 2006

As described in Section 2.2, an automated water level recorder was installed in BH05-A-ii between March 9 and May 1, 2006 to monitor response of the groundwater level to the spring freshet in the Western Upland area. The recorded hydrograph is provided on Figure 10. For comparison, temperature and precipitation data for that observation period are provided on Figures C-2 and C-4 of Appendix C, respectively.

The hydrograph for BH05-A-ii indicates that the groundwater level elevation exhibited the following events and patterns during the period of observation:

- The groundwater level has a regular fluctuation with a magnitude of about 0.01 m. This cyclical pattern is negligible in magnitude and is less than the diurnal fluctuation observed at BH05-E.

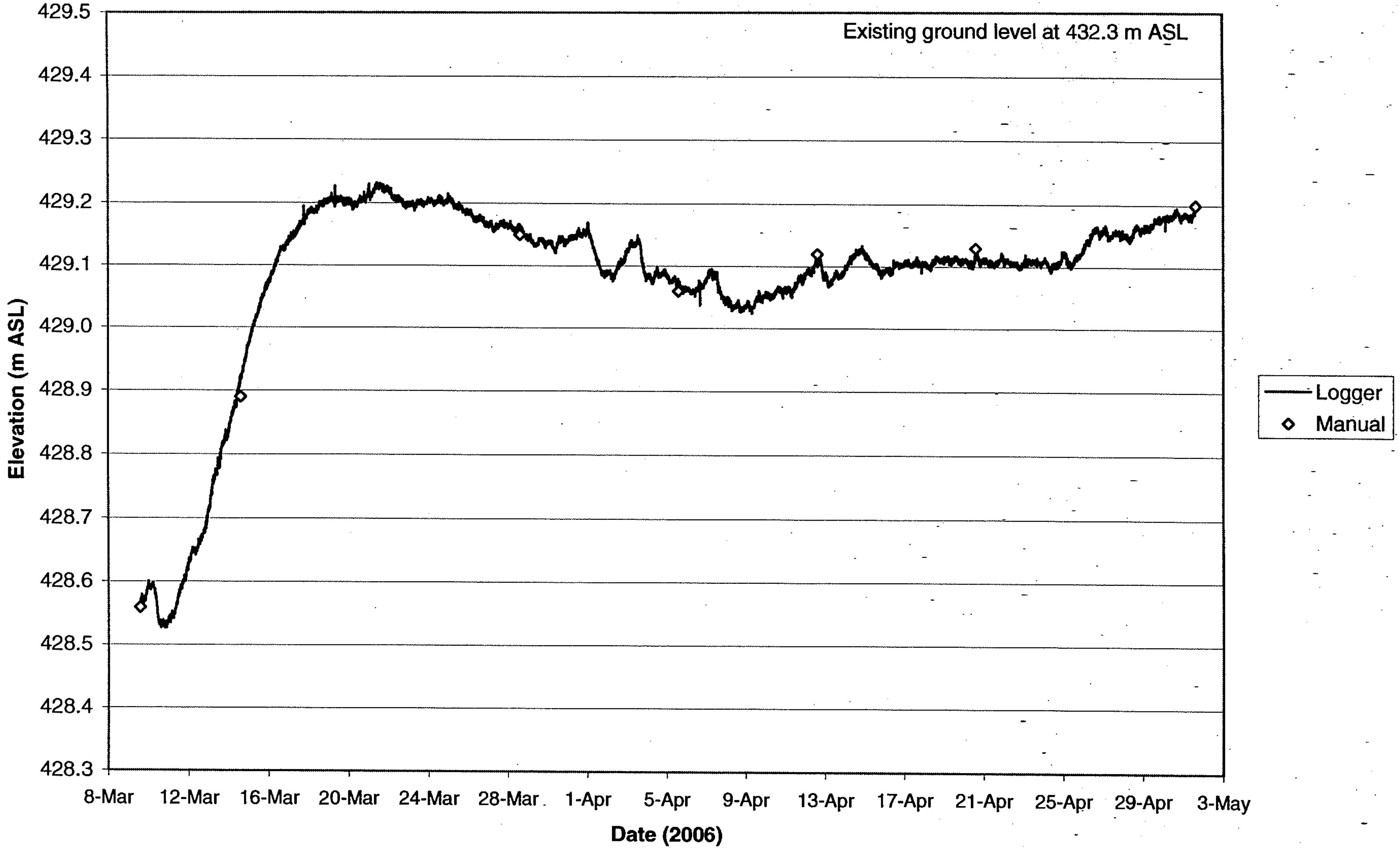
- The groundwater level varied in elevation by 0.70 m during the logger monitoring period. Manual observations at this groundwater monitor indicate a historic elevation range of 1.7 m.

- The groundwater level elevation increased by approximately 0.68 m between March 10 and March 19, 2006. Some of the increase likely was in response to melting of the overlying snow pack between March 9 and 11 and the cumulative 56.3 mm of precipitation that fell during March 8 and 14, 2006.

- The groundwater level elevation reached its highest value of 429.23 m ASL on March 21, 2006.

- The groundwater level generally decreased from March 21 to April 9, 2006. The snow pack had melted, precipitation events were fewer, and temperatures were

FIGURE 10: Logger Hydrograph of Monitor BH05-A-II
Orangeville Highlands, Phase 2, Supplemental Monitoring and Hydrogeologic Assessment



7/5/2006 2:49 PM h:\proj\02\1508\02\Loggers\A-II Mar9-May1 06 Comp.xls relatively cold to maintain partially frozen ground conditions, indicating fewer sources of moisture to groundwater.

- The groundwater level generally increased from April 9 to May 1, 2006. The temperature was relatively warmer during this period, which would have promoted thawing of the ground and thus infiltration of precipitation to groundwater. A second peak groundwater elevation in response to the spring freshet occurred close to May 1, 2006, as indicated by manual measurements and the levelogger record.

- The response to precipitation events generally is less than about 0.1 m above the general trend. This magnitude of response in BH05-A-ii is less than in BH05-E, as indicated by leveloggers. The location of BH05-A-ii in the western uplands area receives less runoff from upgrade areas than does BH05-E the eastern lowland area, as discussed in Section 4.5.1.

4.5.3 Manual Measurement Observations

As described in Section 2.2, a series of groundwater level measurement events were performed at Phase 2 groundwater monitors to measure the response to the spring freshet and the maximum groundwater level during 2005 and 2006. Observations are provided in Table 1.

The observations indicate that the groundwater level at each monitor varies over time. The vertical range between maximum and minimum groundwater levels at Phase 2 monitors varies between 1.0 m (at BH05-C) and 2.1 m (at BH05-D), with an average range of about 1.5 m. There is no apparent spatial pattern with respect to areas of the site that exhibited a consistent lower or higher range of shallow groundwater fluctuations.

During some monitoring events, some groundwater monitors developed a frozen ice plug that prevented measurement of the water level. The depth to ice indicates the water level at the time it was frozen. It is possible that groundwater pressure at the time of measurement was at a higher or lower elevation than the ice plug.

In southern Ontario, the maximum shallow groundwater elevation commonly occurs during the spring freshet. The leveloggers in BH05-E indicated that the 2005 maximum groundwater elevation occurred on April 6. The maximum groundwater elevation in 2005 as observed in Phase 2 monitors by manual measurements occurred towards the end of April. The elevated groundwater on that date was in response to a series of precipitation events that provided at least 42.9 mm in late April and those events were superimposed on relatively higher groundwater base level due to spring freshet conditions.

In southern Ontario, the minimum groundwater level elevation commonly occurs in late summer to early fall. The lowest observed groundwater level elevation at the site occurred for the August or November 2005 measurement events, depending on location. The lowest elevation of the groundwater elevation cycle is not a controlling factor with respect to construction design of the proposed residential development.

The monitoring record for 2006 suggests that the timing of maximum shallow groundwater elevation can vary by location across the site. As example, the peak elevation was as early as March 9 in BH05-F-ii and as late as May 8 in BH05-C and BH05-E. It is noted that the 2006 peak groundwater elevations ranged from 0.07 m deeper at BH05-D than in 2005 to 0.45 m higher at BH05-A-ii than in 2005, with most elevations being slightly higher in 2006.

4.5.4 Interpretations

The information presented indicates the following patterns can be anticipated with respect to the shallow groundwater elevation at Phase 2.

- Shallow groundwater elevation increases in response to the spring melt and sustained precipitation events. The increase in elevation generally is in proportion to the magnitude of the precipitation events, with some variation to be expected resulting from antecedent moisture conditions and the occurrence of frozen soils. Shallow groundwater elevations generally do not increase in response to a snowfall event, or to a precipitation event on frozen ground.
- The maximum shallow groundwater elevation occurs at the time of spring freshet, commonly occurring in March to April.
- The combination of a relatively high shallow groundwater elevation due to spring freshet and a heavier rainfall period can result in similar or higher groundwater level elevations than occur for the response to freshet alone.
- Shallow groundwater declines in elevation between rainfall events, at a rate that ranges from to 11 mm/day at BH05-A to approximately 26 mm/day at BH05-E.
- The lowest shallow groundwater is anticipated to occur in late summer to early fall, after a sustained period when natural recharge is limited.
- The elevation of the shallow groundwater gradually increases during the late-fall through to spring during months with positive moisture surplus.

4.6 HYDRAULIC CONDUCTIVITY

Hydraulic conductivity is a measure of the ability of a soil to transmit water. Higher values of hydraulic conductivity indicate that a relatively higher amount of water can be transmitted under the same hydraulic gradient conditions, and these soils will allow greater infiltration from incident precipitation or artificial infiltration systems. Hydraulic conductivity in a soil is controlled by the grain size texture of constituent particles, compaction of soils, degree of weathering, and other factors.

Hydraulic conductivity values determined from in-situ rising head tests in groundwater monitors provide properties of soils that are immediately adjacent to the monitors tested.

In situ hydraulic conductivity results at two locations on site are provided in Appendix B. The test completed at BH05-A, which was screened across two units that were dominantly sand with silt, indicated a hydraulic conductivity of 3 x 10^{-6} m/s. The test completed at BH05-F, which was screened across a glacial silt till, indicated a hydraulic conductivity of 2 x 10^{-7} m/s.

A grain-size distribution curve can be used with the Hazen formula to estimate the hydraulic conductivity. This method applies to soils where the finest 10% of the soil particles (the D10 value) are within the sand size range. Grain-size distribution tests were performed on two samples from Phase 2, with results provided as Figures B-1 and B-2 of Appendix B. The D10 value for those samples was approximately 0.09 mm, for which the Hazen formula estimates a hydraulic conductivity of approximately $8x10^{-5}$ m/s. This result represents conditions in shallower soil units than were tested by the rising head tests.

The data logger record at monitors BH05-A-ii BH05-E indicates that the average rates of decline during a dry period were approximately 11 and 26 mm/day, respectively. This is a similar magnitude to the infiltration rate for Phase 1 observed in the 2003 study, which was an average of 28 mm/day. The rate suggests that drainage from the shallow groundwater system in portions of Phase 2 may be partially controlled by deeper, less permeable materials.

Drilling and other information indicates variable soils at the site, with different fine particle content and density with location and depth. Thus, a range of hydraulic conductivity values will occur with depth and location at the site. The variability in permeability that occurs on site indicates that design of artificial infiltration systems, if required, should include tests of infiltration capacity at the elevations and locations of proposed infiltration systems.

4.7 GROUNDWATER MOVEMENT

4.7.1 Horizontal Groundwater Movement

A review of the direction of movement of shallow groundwater is pertinent since it demonstrates connection between the groundwater regime on site with adjacent watercourses. Such a connection also demonstrates that groundwater recharged by artificial infiltration systems on site would move to contribute base flow in local watercourses.

The surface of shallow groundwater that is shown on Figure 3 was used to interpret directions of groundwater movement. Groundwater tends to move in a direction that is perpendicular and downward from groundwater elevation contours. The results indicate that groundwater within the site moves within two main groundwater subcatchments, with divides shown on Figure 3 and as discussed below.

- A northern groundwater subcatchment that is located from along a broad ridge to Middle Monora Creek, and occupies approximately 28% of the site. Much of this catchment is covered by treed areas that will be conserved following construction of the site. Shallow groundwater in this area is higher than the adjacent Middle Monora Creek, such that some recharge within this area discharges to that watercourse. Interpreted groundwater contours indicate a slight northeast direction of movement in this area. The measurement of base flow in the watercourse, as discussed in Section 4.8, indicates that the contribution is relatively low.

- A central groundwater subcatchment that is located south of the northern groundwater subcatchment, and occupies approximately 65% of the site. Interpreted groundwater contours indicate an eastward direction of movement in this area. A portion of shallow groundwater is seasonally captured by Ditches #1, #2, and #5 that are tributaries to Lower Monora Creek, and Middle Monora Creek. It is considered probable that the majority of shallow groundwater in this subcatchment moves eastward off site toward the Orangeville Highlands Mall property.

The above areas account for about 93% of the site. Shallow groundwater movement in the remaining minor portion the site includes the following.

- Approximately 4% of the site, located in the extreme southeast corner, is eastward toward the Orangeville Highlands Mall property.
- Approximately 2% of the site, located in the extreme southwest corner, is toward Lower Monora Creek.
- Less than 1% of the site, located along the southern property line, is eastward toward Ditches #3 and #4.

Some local complexities in groundwater movement may occur from those shown, such as adjacent to the broad swale, the hummocky fill area, and near to ditches.

It is expected that the Orangeville Highlands Mall is equipped to manage shallow groundwater. The mall is located lower than eastern lowlands of the site that has shallow depth to groundwater, and it is probable that the mall area also has shallow depth to groundwater. The mall is also located near to watercourses, where groundwater will also tend to be shallow. The groundwater control measures at the mall may include foundation drains, sump pumps, and/or other mechanisms. These systems must have an outlet. Thus, it is probable that most groundwater moving off site is captured by groundwater control measures and discharges to a local watercourse and/or storm sewer system that discharge to other surface water features.

The magnitude of the horizontal gradient of shallow groundwater is relatively consistent over most of the site, with a range of approximately 0.02 to 0.03 m/m.

The rate of groundwater movement can be estimated using the Darcy approach. The groundwater observations indicate a horizontal hydraulic gradient of approximately 0.025 m/m. The rising head tests indicated a hydraulic conductivity of 2 x 10^{-7} m/s in the glacial till to 3 x 10^{-6} m/s in the sand and silt layer. The probable porosity is about 0.35. These input parameters indicate that the rates of horizontal movement are about 0.5 m/year within the glacial till to about 7 m/year within the sand with silt layer. Rates of movement will vary along the flow path depending on changes in gradient, soil material, and other factors.

In summary, infiltration within the recharge areas of the site replenishes the shallow groundwater. Recharge at the northern and southern groundwater subcatchments moves through the groundwater system and eventually discharges to watercourses. Recharge at the central groundwater subcatchment moves eastward, with a portion discharging at ditches that drain to Middle Monora Creek or Lower Monora Creek, while a significant portion likely moves further east of the site. A portion of shallow groundwater may move downward to recharge deeper groundwater systems that discharge at distance from the site.

4.7.2 Vertical Groundwater Movement

The vertical movement of groundwater is indicated by the relative difference in groundwater elevations between the shallow and deep groundwater monitors at an individual monitoring location. A higher groundwater elevation in a shallow monitor indicates downward groundwater movement, while a lower elevation in the shallow monitor indicates upward movement.

The vertical hydraulic gradient was measured at groundwater monitor nest BH05-A. The observations to date indicated a fluctuating gradient, ranging from a minimum of -0.010 m/m in an upward direction to a maximum of 0.044 m/m in a downward direction. The average condition is downward and the groundwater level is consistently several metres below grade, indicating the location of BH05-A, and by inference the western uplands and central area, can be classified as a recharge area.

The vertical hydraulic gradient was measured at groundwater monitor nest BH05-F. The observations to date indicated a fluctuating gradient, ranging from a minimum of -0.053 m/m in an upward direction to a maximum of 0.002 m/m in a downward direction. The average condition is upward and the groundwater level is consistently close to existing grade, indicating that the location of BH05-F, and by inference the eastern lowland, can be classified as a discharge area. Seasonal recharge conditions may occur.

Vertical hydraulic gradients were not determined at other locations. Based on topographic relationships, it is expected that the soil stockpile area is a recharge area and that the broad swale and Middle Monora Creek valley are discharge areas.

4.8 WATERCOURSE BASE FLOW OBSERVATIONS

Phase 2 is located within the catchments of two watercourses, the north branch of Lower Monora Creek and the south branch of Middle Monora Creek. Development on the property has the potential to affect base flow rates in those watercourses.

Flow rates were measured near upstream and downstream locations of the site boundaries adjacent to both watercourses, such that the difference would indicate base flow contributions by the site, within the accuracy of the measurement method. In addition, the flow rate was measured at the north branch of the Middle Monora Creek to account for contributions by this tributary to the south branch. The locations of stations, designated as “SW-# “, are shown on Figure 2.

Flow measurements at each station were obtained on April 15, 2005. That event was timed to occur after a relatively dry climatic period such that flow in the watercourses was comprised primarily of base flow, without a significant component of response to a recent precipitation event, nor to snowmelt. The most recent precipitation event antecedent to the flow measurement event was a rainfall of 1.6 mm that occurred on April 7, 2005, which was 8 days previous.

For the north branch of Lower Monora Creek, the calculated flow rates for the upstream station SW-4 and downstream station SW-5 were 33.4 and 39.0 L/s, respectively. Thus, assuming similar accuracy of flow measurements, the flow rate increased by 5.6 L/s across the Phase 1 site. The increased flow was likely a result of groundwater discharge adjacent to Phase 1, which would have originated from recharge in portions of the catchment area that are located to the south and north of the watercourse. The results confirm that recharge at Phase 1 and a portion of Phase 2 probably contributes to discharge that is received by the north branch of Lower Monora Creek.

For the south branch of Middle Monora Creek, the measured flow rates for the upstream station SW-1 at the south branch and the pre-confluence station SW-2 at the north branch were 9.4 and 0.5 L/s, respectively. The flow rate measured at the downstream station SW-3 was 10.0 L/s. Thus, assuming similar accuracy of flow measurements, the flow rate increased by 0.1 L/s across the Phase 2 site. This difference is probably less than the accuracy of the measurement method. Due to the configuration of higher groundwater levels to the south of the watercourse and general hydrogeologic principles, some groundwater discharge toward Middle Monora Creek that originates from on-site recharge is probable. Based on the one flow measurement, discharges from the catchment areas north and south of the watercourse along the site have a volume that is less than 1% of the base flow carried in this watercourse, which is negligible. This measurement was performed during seasonal high groundwater level conditions when base flow values would be anticipated to be close to annual maximum.

5.0 CONSIDERATIONS FOR CONSTRUCTION

5.1 WATER TABLE EFFECTS TO INFRASTRUCTURE

Effects to dwellings, buried servicing, and other infrastructure are possible if these components are constructed below the perennial water table, or are temporarily affected by vertical fluctuations of the water table.

As an example of an effect to a dwelling, if the high groundwater level ascends to the elevation of the foundation, wet basement conditions may result. Also, susceptibility to frost heave may result if high groundwater levels freeze. Wet seepage conditions are possible in lawn areas. Therefore dwellings should be constructed above the maximum groundwater level.

As an example of an effect to buried piped municipal servicing, such as water mains and sanitary sewage lines, a high groundwater level condition may require dewatering during construction and/or design of special drainage measures, among other requirements.

High groundwater levels can affect the vertical position of individual lot soakaway chambers, if installed to supplement recharge that is reduced due to development

The backfilled portions of buried utility trenches are often more permeable than adjacent native soils and if the utility trenches and lines are located below the water table, drainage of adjacent formations is possible with water moving down the utility alignment. To reduce this effect, trench plugs should be installed at adequate spacing. With trench plugs installed, shallow groundwater will be able to move laterally across trenches and so the shallow groundwater elevation and direction will be maintained similar to pre-construction conditions. Plugs can be constructed of compacted low permeability materials, such as local clayey soils or bentonite.

Construction of buried services, basements, and site grading should consider the potential for temporary inundation and artesian water pressures at some areas of the site.

It is possible that a pattern of warming and larger individual precipitation events could occur that may result in higher groundwater level elevations than observed to date. For the purpose of draft design planning, the highest annual shallow groundwater elevation for Phase 2 should be assumed as being 0.5 m above the maximum elevations indicated on Figure 5 and as observed at groundwater monitors.

Metropolitan Consulting Inc. indicated that all proposed dwellings or other buildings will be constructed with foundations and foundation drains that are located above the maximum annual groundwater elevation. Buried trenches should be equipped with trench plugs to inhibit movement of groundwater along the trenches. With the measures of foundations above the maximum groundwater level and trench plugs, the direction of groundwater movement will be similar for pre-construction and post-construction conditions at Phase 2.

While the elevations of building foundations will be designed to be above the water table, drains should be installed. Drains for foundations and subsurface walls must be properly designed, sized, and constructed. The drains must be able to accommodate and convey away from the structure the surplus moisture resulting from surface runoff, and rare and short-term "spike" elevation increases in shallow groundwater elevations that are conceivable, with no effects to the residences. Drainage infrastructure should be installed in compliance with the Ontario Building Code.

5.2 GROUNDWATER RECHARGE

Under pre-construction conditions, the Phase 2 area has perennial and seasonal recharge areas that contribute to base flows of the adjacent watercourses. Under the proposed development plan, impervious surfaces will be constructed that will occlude a portion of existing permeable surfaces and thereby reduce the total volume of recharge occurring on site (Jagger Hims Limited, 2003). Reduction of infiltration/recharge will similarly reduce the total volume of groundwater discharges that contribute to base flow in the creek, unless mitigation measures are implemented.

On-site flow measurements indicate that contributions by the site to the base flow of the Middle Monora Creek are negligible, as discussed in Section 4.8. It is recommended studies for the draft design phase include additional monitoring of base flow to confirm the interpretation of a negligible contribution. If contributions to base flow are negligible, then mitigation measures for compensating base flow in some parts of the site probably are not necessary, subject to discussion with the Conservation Authority.

The proposed development will result in construction of relatively impervious surfaces that, if left unmitigated, would reduce the amount of groundwater recharge, which could translate into a decrease in the base flow of adjacent surface water courses. Previous reports have discussed the feasibility of using artificial infiltration options (Jagger Hims Limited, 2003) to promote recharge to post-construction rates that are similar to pre-construction rates. The likely preferred option for implementation at Phase 2 is a soakaway pit system for roof rainwater leaders.

5.3 EFFECTS OF CUTTING AND FILLING

As we understand, re-grading of the site is a probable step for construction, including cutting and filling. The cutting and filling will affect the permeability of soils in which artificial infiltration systems will be placed. Cutting and filling will also affect the proximity to the maximum water table that affects the location of artificial infiltration systems, the design of buried utilities, house basements, and other infrastructure.

Re-grading by cutting will affect the infiltration rate that is available for artificial infiltration systems. The site generally has more-permeable granular soils at shallow depth under pre-construction conditions. Cutting will reduce the depth to soils that are denser and finer grained, such as the glacial till layer, which will provide less permeability. Cutting will also decrease the depth to the shallow groundwater level and the proportion of site area with shallow depth to groundwater, if being considered.

Re-grading by filling will increase the distance between the constructed ground elevation and the maximum groundwater level, at the fill areas. The fill thickness should be designed for sufficient vertical distance to allow installation of artificial infiltration systems and other infrastructure considerations. It is recommended that fill thickness be sufficient to raise foundation grades to elevations above the maximum water table elevations, where required. Fills will decrease the proportion of site area with shallow depth to groundwater.

Areas of filling where the pre-construction ground surface is perennially above the maximum groundwater level would continue to function as perennial recharge areas after construction. Areas of filling where there are pre-construction discharge areas will result in a groundwater level within the fill layer as a water table in post-construction. Filling of pre-construction discharge areas will increase the amount of recharge area at the site in post-construction. Groundwater that would have discharged in the discharge area will instead remain as groundwater as it moves toward the watercourse, where it will then discharge. Filling will not reduce the total amount of water reaching the watercourses.

The topography of the proposed development should be designed to maintain surface grades in the same general directions as pre-construction existing conditions, to maintain a similar direction of shallow groundwater movement.

Re-grading by filling will affect the infiltration rate that is available for artificial infiltration systems. If the fill material has a higher proportion of fine grained silt and clay, and/or is compacted to higher density than occurs in soils at surface in pre-construction conditions, then the fill will be less permeable in post-construction conditions. To prevent reduced permeability in post-construction, fill at this site should be sourced and placed in a manner that maintains or increases the groundwater recharge rate that occurs during pre-construction conditions. The permeability of fill will be significantly controlled by the finer grained components of the soil texture, thus the fill source for use at this site should be equivalent to or coarser than the native material. The texture of native soils at this site should be characterized by sampling of at least eight widely separated locations within Phase 2 that are within areas proposed to be filled. Those samples should be submitted to a laboratory for grain-size and hydrometer analysis. The results should be analysed to determine the average D10 and D50 values. The D10 value represents the grain size for which 10 percent is finer, and the D50 represents the median 50% passing grain size. Fill materials for Phase 2 should be sourced from soils that have D10 and D50 values that are equal or coarser than the average D10 and D50 of native soils.

5.4 PREFERRED GREEN SPACE DEVELOPMENT

As we understand, the Town of Orangeville Official Plan designates part of the western upland area of the site as parkland (green space). Based on the interpreted hydrogeologic conditions at the site, we recommend consideration of the eastern lowland area as the preferred location of green space, due to the following factors.

- Vegetation tends to grow more rapidly in areas of shallow water table, which is the condition at the eastern lowland and does not occur at the western upland.
- Green space along the eastern lowland could be directly connected to the wooded area along Middle Monora Creek valley.
- Green space along the eastern lowland would provide a visual buffer between the mall and residences in Phase 2.
- The eastern lowland currently has three ditches. The ditch system could be re-constructed to permit improved continuous drainage to watercourses, increasing the volume of base flow. Re-alignment of ditches could also result in aesthetic improvement and increases in ecologic habitat.

- The western upland is a preferred area for development because of reduced costs associated for construction in areas of deep water table. Areas with shallow water table will likely require the importation of fill.

6.0 MAINTENANCE OF GROUNDWATER MONITOR NETWORK

The location and number of monitors in the groundwater monitor network was considered to be sufficient for draft level planning for the proposed development. Significant re-grading of the site is probable, including removal of the soil stockpile. Groundwater information should be reviewed in comparison to the proposed final design grade elevations and additional monitors should be installed, if necessary.

The existing groundwater monitoring network should remain in functional condition until the final design of the development is approved. Once the network is no longer required, the monitors should be abandoned by a licensed water well contractor in accordance with Regulation 903 as amended by Regulation 128.

7.0 CONCLUSIONS

Detailed monitoring of the groundwater was completed for Phase 2 groundwater monitors. The shallow groundwater response to spring freshets over two years was observed.

The depth to maximum annual shallow groundwater elevation was mapped for the Phase 2 area.

Shallow groundwater generally moves toward the east, a portion of which seasonally discharges to ditches that are a tributary to either the south branch of Middle Monora Creek or the north branch of Lower Monora Creek.

The depth of the shallow groundwater below existing grade varies with location. The observed depth of the maximum groundwater level ranged from about 5 metres below ground surface, to portions of the site where artesian conditions are present at shallow depth. Groundwater levels will vary seasonally and in response to climatic events.

During pre-construction conditions, areas with relatively shallow groundwater conditions were prevalent over approximately one-third of the property, with some seasonal variation. During post-construction, areas with relatively shallow groundwater conditions will depend on grading plans, including cuts and fills.

The maximum shallow groundwater elevation occurs at the time of spring freshet, commonly occurring in March or April.

A combination of high shallow groundwater due to spring freshet and a wet rainfall period can result in similar or higher shallow groundwater elevations than occur for the response to the freshet itself.

Measurements indicate that recharge from Phase 2 is not a significant contributor to the base flow volume in Middle Monora Creek. Analysis of interpreted groundwater subcatchments suggest that Phase 2 is not a significant contributor to the base flow volume of Lower Monora Creek.

The maximum elevation of the shallow groundwater should be assumed to be 0.5 m above that indicated by the maximum groundwater level contours that are shown on Figure 5.

We trust that this information is satisfactory to your requirements. Should you have any questions please call our office.

Yours truly,
JAGGER HIMS LIMITED

Brian D. Theimer

Brian D. Theimer, M.Sc., P.Geo
Project Hydrogeologist

BDTjec

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APPENDICES

APPENDIX A

JAGGER HIMS LIMITED BOREHOLE RECORDS

TABLE A-1
Groundwater Monitor Construction Details: Depths
Orangeville Highlands, Phase 2, Supplemental Monitoring and Assessments

Monitor Designation	Stick Up	Bottom of Borehole	Bottom of Monitor	Length of Monitor	Screen		Sand Pack		Bentonite Seals	
					Bottom of	Top of	Bottom of	Top of	Bottom of	Top of
	m agl	m bgl	m bgl	m	m bgl	m bgl	m bgl	m bgl	m bgl	m bgl
BH05-A-i	0.91	11.28	9.60	10.51	9.45	8.08	9.60	7.62	7.62	0.00
BH05-A-ii	0.89	5.49	5.33	6.22	5.18	3.81	5.33	3.35	3.35	0.00
BH05-B	0.91	8.38	8.38	9.29	8.23	6.86	8.38	6.40	6.40	0.00
BH05-C	0.97	6.25	6.25	7.22	6.10	4.73	6.25	3.96	3.96	0.00
BH05-D	0.86	5.94	3.50	4.36	3.35	1.98	3.50	1.37	1.37	0.00
BH05-E	1.05	4.42	3.50	4.55	3.35	1.98	3.50	1.52	1.52	0.00
BH05-F-i	0.91	7.77	7.77	8.68	7.62	6.25	7.77	5.79	5.79	0.00
BH05-F-ii	0.97	3.05	2.59	3.56	2.44	1.07	2.59	0.61	0.61	0.00

Notes:

1) "m agl" indicates metres above ground level. 2) "m bgl" indicates metres below ground level. 3) "m" indicates metres

TABLE A-2
Groundwater Monitor Construction Details: Elevations
Orangeville Highlands, Phase 2, Supplemental Monitoring and Assessments

Monitor Designation	Top of Pipe	Existing Grade	Bottom of Borehole	Bottom of Monitor	Screen		Sand Pack		Bentonite Seals	
					Bottom of	Top of	Bottom of	Top of	Bottom of	Top of
	m ASL	m ASL	m ASL	m ASL	m ASL	m ASL	m ASL	m ASL	m ASL	m ASL
BH05-A-i	433.17	432.26	420.98	422.66	422.81	424.18	422.66	424.64	424.64	432.26
BH05-A-ii	433.15	432.26	426.77	426.93	427.08	428.45	426.93	428.91	428.91	432.26
BH05-B	431.09	430.18	421.80	421.80	421.95	423.32	421.80	423.78	423.78	430.18
BH05-C	429.77	428.80	422.55	422.55	422.70	424.07	422.55	424.84	424.84	428.80
BH05-D	426.74	425.88	419.94	422.38	422.53	423.90	422.38	424.51	424.51	425.88
BH05-E	423.30	422.25	417.83	418.75	418.90	420.27	418.75	420.73	420.73	422.25
BH05-F-i	423.10	422.19	414.42	414.42	414.57	415.94	414.42	416.40	416.40	422.19
BH05-F-ii	422.99	422.02	418.97	419.43	419.58	420.95	419.43	421.41	421.41	422.02

Notes:

1) "m ASL" indicates metres above sea level.

7/5/2006 3:00 PM h:\proj\02\1508\03\tech\Monitor Construction Details.xls

BOREHOLE LOG EXPLANATION FORM

This explanatory section provides the background to assist in the use of the borehole logs. Each of the headings used on the borehole log, is briefly explained.

DEPTH

This column gives the depth of interpreted geologic contacts in metres below ground surface.

STRATIGRAPHIC DESCRIPTION

This column gives a description of the soil based on a tactile examination of the samples and/or laboratory test results. Each stratum is described according to the following classification and terminology.

Soil Classification *	
Clay	<0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2 mm
Gravel	2 to 60 mm
Cobbles	60 to 200 mm
Boulders	>200 mm

Terminology	Proportion
"trace" (eg. trace sand)	<10%
"some" (eg. some sand)	10% - 20%
adjective (eg. sandy)	20% - 35%
"and" (eg. and sand)	35% - 50%
noun (eg. sand)	>50%

* Extension of MIT Classification system unless otherwise noted.

The use of the geologic term "till" implies that both disseminated coarser grained (sand, gravel, cobbles or boulders) particles and finer grained (silt and clay) particles may occur within the described matrix.

The compactness of cohesionless soils and the consistency of cohesive soils are defined by the following:

COHESIONLESS SOIL		COHESIVE SOIL	
Compactness	Standard Penetration Resistance "N", Blows / 0.3 m	Consistency	Standard Penetration Resistance "N", Blows / 0.3 m
Very Loose	0 to 4	Very Soft	0 to 2
Loose	4 to 10	Soft	2 to 4
Compact	10 to 30	Firm	4 to 8
Dense	30 to 50	Stiff	8 to 15
Very Dense	Over 50	Very Stiff	15 to 30
		Hard	Over 30

The moisture conditions of cohesionless and cohesive soils are defined as follows.

COHESIONLESS SOILS

Dry
Moist
Wet
Saturated

COHESIVE SOILS

DTPL - Drier Than Plastic Limit
APL - About Plastic Limit
WTPL - Wetter Than Plastic Limit
MWTPL - Much Wetter Than Plastic Limit

STRATIGRAPHY

Symbols may be used to pictorially identify the interpreted stratigraphy of the soil and rock strata.

MONITOR DETAILS

This column shows the position and designation of standpipe and/or piezometer ground water monitors installed in the borehole. Also the water level may be shown for the date indicated.

▲	Standpipe and Designation	▧	Cement Seal
●	Piezometer and Designation	░	Granular Pack
■	Gas Monitor and Designation	▒	Granular Backfill
▨	Borehole Seal (Peltonite, Bentonite or Hole Plug)	☐	Native Soil Backfill/Cave

Where monitors are placed in separate boreholes, these are shown individually in the "Monitor Details" column. Otherwise, monitors are in the same borehole. For further data regarding seals, screens, etc., the reader is referred to the summary of monitor details table.

SAMPLE

These columns describe the sample type and number, the "N" value, the water content, the percentage recovery, and Rock Quality Designation (RQD), of each sample obtained from the borehole where applicable. The information is recorded at the approximate depth at which the sample was obtained. The legend for sample type is explained below.

SS = Split Spoon
ST = Thin Walled Shelby Tube
AS = Auger Flight Sample
CC = Continuous Core

GS = Grab Sample
CS = Channel Sample
WS = Wash Sample
RC = Rock Core

$$\%\ \text{Recovery} = \frac{\text{Length of Core Recovered Per Run}}{\text{Total Length of Run}} \times 100$$

Where rock drilling was carried out, the term RQD (Rock Quality Designation) is used. The RQD is an indirect measure of the number of fractures and soundness of the rock mass. It is obtained from the rock cores by summing the length of core recovered, counting only those pieces of sound core that are 100 mm or more in length. The RQD value is expressed as a percentage and is the ratio of the summed core lengths to the total length of core run. The classification based on the RQD value is given below.

RQD Classification	RQD (%)
Very poor quality	< 25
Poor quality	25 - 50
Fair quality	50 - 75
Good quality	75 - 90
Excellent quality	90 - 100

TEST DATA

The central section of the log provides graphs which are used to plot selected field and laboratory test results at the depth at which they were carried out. The plotting scales are shown at the head of the column.

Dynamic Penetration Resistance - The number of blows required to advance a 51 mm diameter, 60° steel cone fitted to the end of 45 mm OD drill rods, 0.3 m into the subsoil. The cone is driven with a 63.5 kg hammer over a fall of 750 mm.

Standard Penetration Resistance - Standard Penetration Test (SPT) "N" Value - The number of blows required to advance a 51 mm diameter standard split-spoon sampler 300 mm into the subsoil, driven by means of a 63.5 kg hammer falling freely a distance of 750 mm. In cases where the split spoon does not penetrate 300 mm, the number of blows over the distance of actual penetration in millimetres is shown as $\frac{x \text{ Blows}}{\text{mm}}$

Water Content -	The ratio of the mass of water to the mass of oven-dry solids in the soil expressed as a percentage.
w_P -	Plastic Limit of a fine-grained soil expressed as a percentage as determined from the Atterberg Limit Test.
w_L -	Liquid Limit of a fine-grained soil expressed as a percentage as determined from the Atterberg Limit Test.

REMARKS

The last column describes pertinent drilling details, field observations and/or provides an indication of other field or laboratory tests that were performed.

BOREHOLE NO. BH05-A

PAGE 1 OF 1

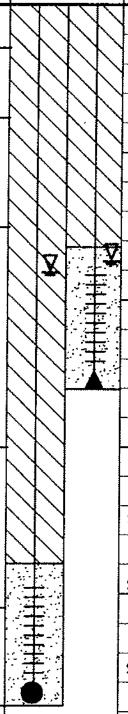
PROJECT NAME: ORANGEVILLE HIGHLANDS, PHASE 2
PROJECT NO.: 021508.03
CLIENT: ORANGEVILLE HIGHLANDS LTD.
DATE: MARCH 10, 2005
BOREHOLE TYPE: HOLLOW STEM AUGER
SUPERVISOR: BTC
GROUND ELEVATION: 432.26 m ASL
REVIEWER: BDT

DEPTH (m)	STRATIGRAPHIC DESCRIPTION	REMARKS
0.6	<u>TOPSOIL:</u> DARK BROWN ORGANIC SOIL WITH SILT, TRACE MEDIUM SAND, DAMP TO WET.	FROZEN SOILS NEAR SURFACE
1.5	<u>SILT:</u> MEDIUM TO DARK BROWN SILT, TRACE MEDIUM SAND, TRACE GRAVEL, SATURATED, COMPACT.	
3.0	<u>SAND:</u> MEDIUM BROWN FINE TO MEDIUM SAND, TRACE TO SOME SILT, DAMP. LOOSE TO DENSE.	STATIC WATER LEVELS ON APRIL 29, 2005 WERE: i 3.63 mBGL ii 3.51 mBGL
6.0	<u>SILT AND SAND:</u> MEDIUM BROWN SILT AND FINE SAND TO FINE TO MEDIUM SANDY SILT, DAMP, SATURATED BELOW 3.8 m, COMPACT TO DENSE.	
8.2	<u>SAND WITH SILT:</u> MEDIUM BROWN MEDIUM SAND SOME SILT, SATURATED, LOOSE TO DENSE.	
9.5	<u>SILTY SAND:</u> BROWN SILTY FINE TO COARSE SAND, SATURATED, VERY DENSE. LENS OF DARK RUSTY BROWN COARSE SAND AT 9.3 m.	
11.3	<u>SANDY SILT TILL:</u> GREY SANDY SILT TILL, TRACE CLAY, COMPACT.	
	BOREHOLE TERMINATED IN SANDY SILT TILL AT 11.3 m.	

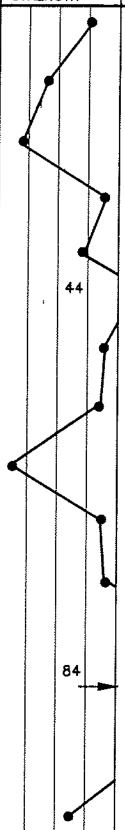
SAMPLE

TYPE	'N' VALUE	% WATER	% RECOVERY	RQD (%)
SS1	30		58	
SS2	17		29	
SS3	9		54	
SS4	34		67	
SS5	29		63	
SS6	44		88	
SS7	36		100	
SS8	34		100	
SS9	5		92	
SS10	34		67	
SS11	36		92	
SS12	84		92	
SS13	24		67	

MONITOR DETAILS



"N" VALUE



WATER CONTENT %

10 20 30

W_P W_L

Revision 2/ Aug 2003

BOREHOLE NO. BH05-B

PAGE 1 OF 1

PROJECT NAME: ORANGEVILLE HIGHLANDS, PHASE 2
PROJECT NO.: 021508.03
CLIENT: ORANGEVILLE HIGHLANDS LTD.
DATE: MARCH 9, 2005
BOREHOLE TYPE: HOLLOW STEM AUGER
SUPERVISOR: BTC
GROUND ELEVATION: 430.18 mASL
REVIEWER: BDT

DEPTH (m)	STRATIGRAPHIC DESCRIPTION	SAMPLE TYPE	'N' VALUE	% WATER	% RECOVERY	RQD (%)	"N" VALUE 10 20 30 / SHEAR STRENGTH	WATER CONTENT % 10 20 30 / WP WL	REMARKS
0 – 3.0	ORGANIC SOIL FILL: DARK BROWN ORGANIC SOIL FILL WITH TRACE FINE TO MEDIUM SAND, TRACE TO SOME SILT, ROOTS, MOIST, COMPACT.	SS1	16		17				
		SS2	15		17				
		SS3	15		50				
3.0 – 4.6	SAND: MOTTLED DARK BROWN TO YELLOW FINE TO MEDIUM SAND, SOME GRAVEL, SOME SILT, DAMP TO MOIST, DENSE. –SILTY ORGANIC SOIL AT 3.8 m.	SS4	49		54		49		
		SS5	30		75				
4.6 – 5.9	UNKNOWN: NO SAMPLE RECOVERED, HARD, TRACE OF SILTY SAND ON SPOON.	SS6	58		0		58		STATIC WATER LEVEL ON APRIL 29, 2005 WAS 5.10 mBGL.
		SS7	43		0		43		
5.9 – 6.8	SAND: MEDIUM BROWN FINE TO MEDIUM SAND, TRACE SILT, DAMP, VERY DENSE.	SS8	65		88		65		
6.8 – 8.2	SAND AND SILT TILL: MEDIUM BROWN FINE SAND AND SILT TILL, SATURATED, DENSE.	SS9	33		92				
		SS10	39		96				
8.2	BOREHOLE TERMINATED IN SAND AND SILT TILL AT 8.2 m.								

Revision 2/ Aug 2003

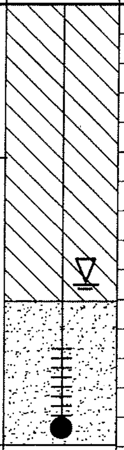
JAGGER HIMS LIMITED

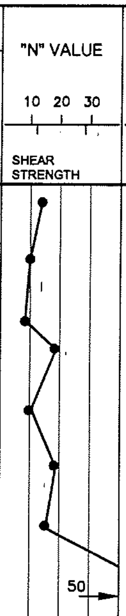
BOREHOLE NO. BH05-C

PAGE 1 OF 1

PROJECT NAME: ORANGEVILLE HIGHLANDS, PHASE 2
PROJECT NO.: 021508.03
CLIENT: ORANGEVILLE HIGHLANDS LTD.
DATE: MARCH 11, 2005
BOREHOLE TYPE: HOLLOW STEM AUGER
SUPERVISOR: BTC
GROUND ELEVATION: 428.80 mASL
REVIEWER: BDT

DEPTH (m)	STRATIGRAPHIC DESCRIPTION	STRATIGRAPHY	MONITOR DETAILS	SAMPLE TYPE	SAMPLE 'N' VALUE	SAMPLE % WATER	SAMPLE % RECOVERY	SAMPLE RQD (%)	REMARKS
0	SILTY SAND FILL: MOTTLED GREY SILTY MEDIUM SAND FILL MIXED WITH DARK BROWN ORGANIC SOIL, OCCASIONAL GRAVEL, DRY TO WET, LOOSE TO COMPACT.			SS1	13		33		
				SS2	10		58		
2				SS3	8		54		
2.1	SAND: BROWN FINE TO MEDIUM SAND, TRACE SILT, ROOTS TO 2.9 m, DRY TO DAMP, LOOSE TO DENSE. –SATURATED BELOW 4.1 m.			SS4	17		54		
				SS5	10		63		STATIC WATER LEVEL ON APRIL 29, 2005 WAS 3.82 mBGL.
4				SS6	18		88		
				SS7	15		92		
				SS8	50		100		
6.0	BOREHOLE TERMINATED IN SAND AT 6.0 m.								
8									
10									
12									
14									
16									
18									
20									





WATER CONTENT %
10 20 30
WP WL

BOREHOLE NO. BH05-D

PAGE 1 OF 1

PROJECT NAME: ORANGEVILLE HIGHLANDS, PHASE 2

PROJECT NO.: 021508.03

CLIENT: ORANGEVILLE HIGHLANDS LTD.

DATE: MARCH 9, 2005

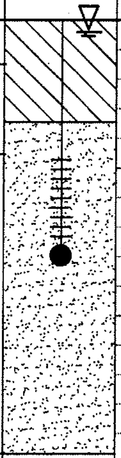
BOREHOLE TYPE: HOLLOW STEM AUGER

SUPERVISOR: BTC

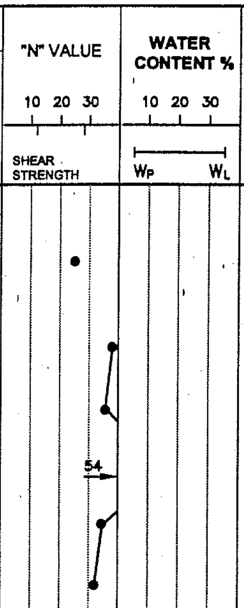
GROUND ELEVATION: 425.88 mASL

REVIEWER: BDT

DEPTH (m)	STRATIGRAPHIC DESCRIPTION
0 – 0.6	ORGANIC TOPSOIL: DARK BROWN ORGANIC TOPSOIL WITH MEDIUM TO COARSE SAND, GRAVEL, ROOTS, MOIST.
0.6 – 1.8	SAND: BROWN COARSE SAND, TRACE TO SOME FINE TO COARSE GRAVEL, MOIST.
1.8 – 5.9	SANDY SILT TILL: MEDIUM BROWN FINE TO MEDIUM SANDY SILT TO SILT WITH SOME FINE SAND, WET TO SATURATED, DENSE.
5.9	BOREHOLE TERMINATED IN SANDY SILT AT 5.9 m.



TYPE	'N' VALUE	% WATER	% RECOVERY	RQD (%)
SS9	46		63	
SS10	48		71	
SS1	25+		20	
SS11	120		83	
SS2	–		0	
SS3	37		67	
SS4	36		67	
SS5	54		75	
SS6	34		100	
SS7	32		67	



REMARKS

STATIC WATER LEVEL ON APRIL 29, 2005 WAS 0.15 m BGL

FROZEN SOIL NEAR SURFACE

SS9 TO SS11 OBTAINED IN AN ADJACENT HOLE

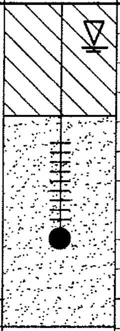
BOREHOLE NO. BH05-E

PAGE 1 OF 1

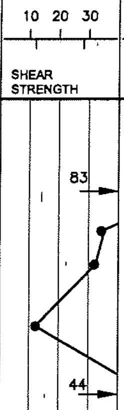
PROJECT NAME: ORANGEVILLE HIGHLANDS, PHASE 2
PROJECT NO.: 021508.03
CLIENT: ORANGEVILLE HIGHLANDS LTD.
DATE: MARCH 8, 2005
BOREHOLE TYPE: HOLLOW STEM AUGER
SUPERVISOR: BTC
GROUND ELEVATION: 422.25 mBGL
REVIEWER: BDT

DEPTH (m)	STRATIGRAPHIC DESCRIPTION	SAMPLE TYPE	'N' VALUE	% WATER	% RECOVERY	RQD (%)	REMARKS
0	SAND: BROWN FINE TO MEDIUM SAND, TRACE TO SOME SILT, DAMP, SATURATED BELOW 1.6 m, COMPACT TO DENSE.						FROZEN NEAR SURFACE
		SS1	83		29		STATIC WATER LEVEL ON APRIL 29, 2005 WAS 0.60 mBGL.
2		SS2	34		58		
		SS3	31		83		
		SS4	12		71		
4.0	SANDY SILT TILL: BROWNISH GREY SANDY SILT, TRACE CLAY, WTPL, HARD.	SS5	44		92		
4.4	BOREHOLE TERMINATED IN SANDY SILT TILL AT 4.4 m.						

MONITOR DETAILS



"N" VALUE / SHEAR STRENGTH



WATER CONTENT %: 10 20 30; WP WL

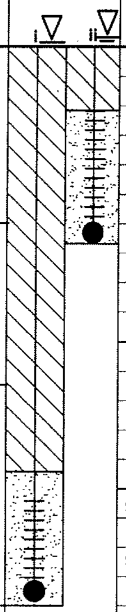
BOREHOLE NO. BH05-F

PAGE 1 OF 1

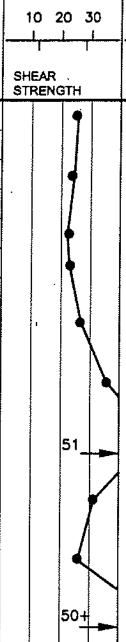
PROJECT NAME: ORANGEVILLE HIGHLANDS, PHASE 2
PROJECT NO.: 021508.03
CLIENT: ORANGEVILLE HIGHLANDS LTD.
DATE: MARCH 7, 2005
BOREHOLE TYPE: HOLLOW STEM AUGER
SUPERVISOR: BTC
GROUND ELEVATION: 422.10 mASL
REVIEWER: BDT

DEPTH (m)	STRATIGRAPHIC DESCRIPTION	SAMPLE TYPE	'N' VALUE	% WATER	% RECOVERY	RQD (%)
0	SAND: BROWN FINE TO MEDIUM SAND, TRACE TO SOME SILT, MOIST, WET TO SATURATED, COMPACT.	SS1	24		46	
		SS2	23		83	
2		SS3	22		91	
2.4		SS4	22		71	
	SAND WITH SILT: BROWN TO GREY BROWN FINE SAND, SOME SILT TO SILTY FINE SAND, TRACE CLAY, WTPL, VERY STIFF TO HARD.	SS5	26		–	
4		SS6	35		92	
4.6	SILT TILL: GREY-BROWN SILT TILL, SOME FINE SAND TO SANDY, TRACE TO SOME CLAY, WTPL, VERY STIFF TO HARD.	SS7	51		83	
		SS8	31		83	
6		SS9	26		79	
7.6		SS10	50+		71	
8	BOREHOLE TERMINATED IN SILT TILL AT 7.6 m.					

MONITOR DETAILS



"N" VALUE



WATER CONTENT %: 10 20 30; W_P W_L

REMARKS:

STATIC WATER LEVELS ON APRIL 29, 2005 WERE
i 0.01 mAGL
ii 0.05 mAGL

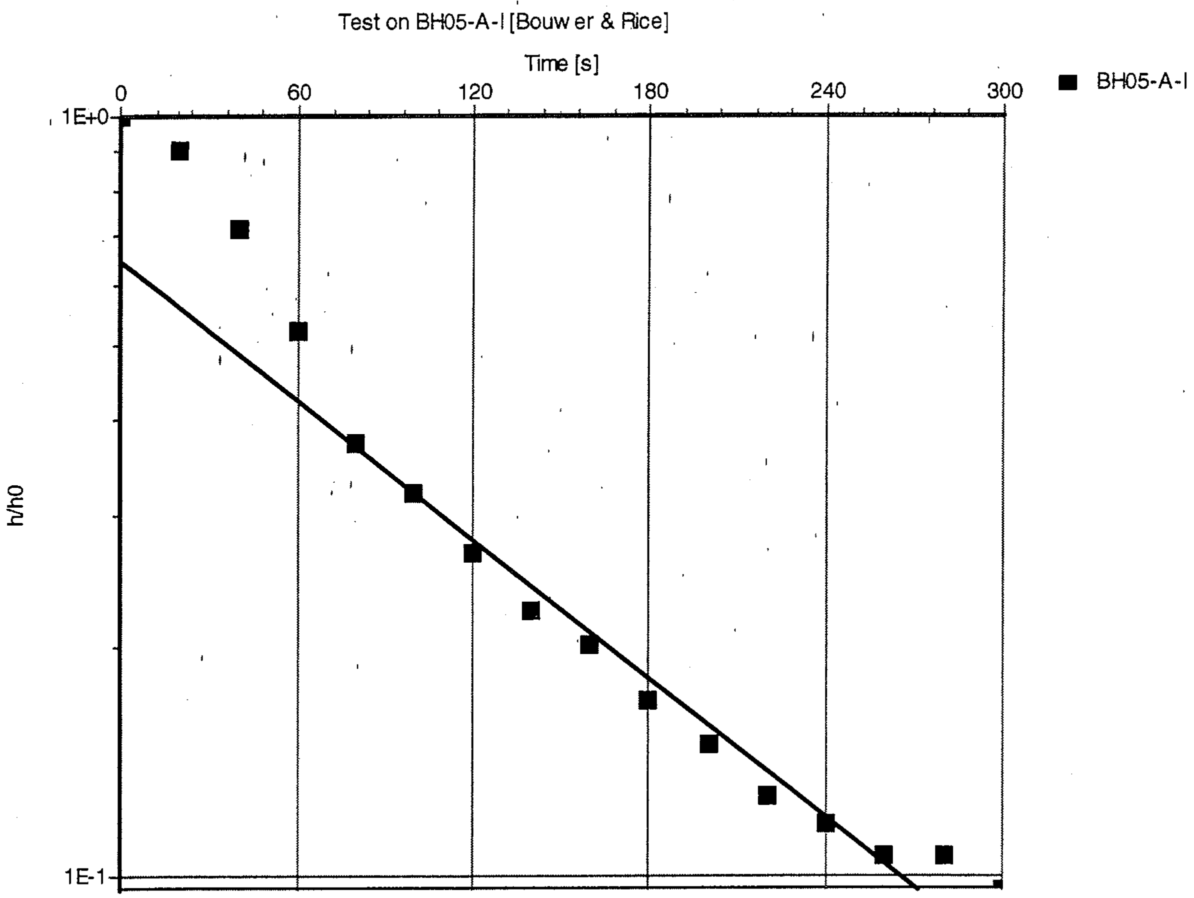
(ARTESIAN)

mAGL = METRES ABOVE GROUND LEVEL

Waterloo Hydrogeologic Inc.
180 Columbia St. Unit 1104
Waterloo, Ontario, Canada
Phone 519 746-1798

Slug Test Analysis Report

Project: Orangeville Highlands Phase 2
Number: 021508.02
Client: Orangeville Highlands Ltd.



<u>Slug Test:</u> **Test on BH05-A-I**

<u>Analysis Method:</u> **Bouwer & Rice**

Analysis Results:			Conductivity:	3.11E-6 [m/s]
Test parameters:	Test Well:	BH05-A-I	Aquifer Thickness:	8 [m]
	Casing radius:	0.0254 [m]	Gravel Pack Porosity (%)	25
	Screen length:	1.4 [m]		
	Boring radius:	0.105 [m]		
	r(eff):	0.057 [m]		

Comments:

Evaluated by: BDT
Evaluation Date: 2/6/2006

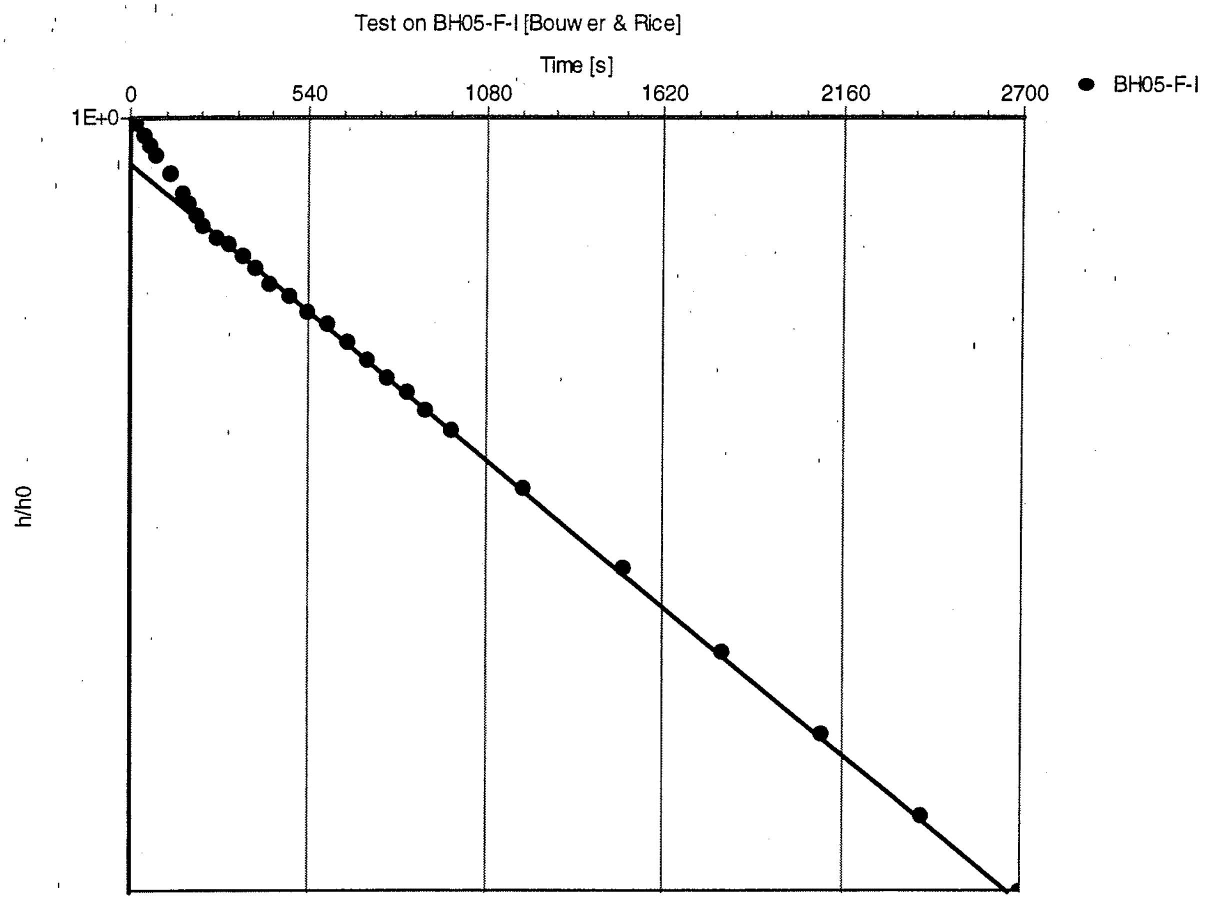
Waterloo Hydrogeologic Inc.
180 Columbia St. Unit 1104
Waterloo, Ontario, Canada
Phone 519 746-1798

Slug Test Analysis Report

Project: Orangeville Highlands Phase 2

Number: 021508.02

Client: Orangeville Highlands Ltd.



Slug Test: **Test on BH05-F-I**

Analysis Method: **Bouwer & Rice**

Analysis Results: Conductivity: 2.45E-7 [m/s]

Test parameters:

Test Well:	BH05-F-I	Aquifer Thickness:	10.6 [m]
Casing radius:	0.0245 [m]	Gravel Pack Porosity (%)	25
Screen length:	1.4 [m]		
Boring radius:	0.105 [m]		
r(eff):	0.057 [m]		

Comments:

Evaluated by: BDT

Evaluation Date: 2/6/2006

APPENDIX B

JAGGER HIMS LIMITED TEST PITS

TABLE B-1

TEST PIT LOGS

Depth Interval (m)	Soil Description
TP03-3	
0.0 – 0.25	Topsoil, with silt, organic silt, and fine sand. Dark brown to black. Grass roots. Frozen.
0.25 – 0.6	Fine Sand, trace organic silt. Dark brown. Damp.
0.6 – 1.4	Fine to Medium Sand, fine to coarse gravelly, occasional cobble and boulder. Grey brown. Dry to damp.
1.4 – 3.5	Silt, trace fine sand, trace clay, occasional rounded coarse gravel. Grading to medium grey brown Silt, some fine sand. Moist.
4.1 – 4.2	Silt, some fine sand, trace clay. Grey brown. Damp.
	➢ No seepage observed to base. ➢ No standpipe installed. ➢ Soil samples taken at 1.0, 2.5, and 4.2 m bgl.
TP03-4	
0.0 – 0.25	Topsoil, with silt, organic silt, and some fine sand. Dark brown to black. Grass roots. Frozen.
0.25 – 1.2	Fine Sand, trace silt. Well sorted. Medium grey brown. Moist.
1.2 – 2.5	Grading to Silt and Fine Sand to Silty Fine Sand. Grey-brown. Damp.
2.5 – 3.8	Grading to Silty Fine Sand. Grey-brown. Wet.
	➢ Seepage at 1.1 m. Seepage stopped below 1.3 metres. ➢ Standpipe installed. ➢ Standpipe stick up = 1.3 m agl. Base = 2.1 m bgl. ➢ Frequent collapse of pit walls. ➢ Soil samples taken at 0.7 and 2.5 m bgl. ➢ Static water level is 0.89 m bmp on June 26, 2003.

Depth Interval (m)	Soil Description
TP03-5	
0.0 – 0.2	Topsoil, with Organic Silt and Silt. Grass roots. Dark brown to black. Frozen.
0.2 – 0.3	Fill. Fine to Medium Sand. Roots. Grey-brown. Damp.
0.3 – 1.2	Fill. Fine Sand, some silt. With brick pieces, grass turf, occasional cobble and boulder. Mottled medium brown and dark brown. Moist.
1.2 – 4.0	Fine to Medium Sand, trace silt. Light grey brown, and medium grey brown below 3.0 m bgl. Moist, and wet to saturated below 3.0 m bgl. ➢ No seepage observed. ➢ Standpipe installed. ➢ Standpipe stick up = 0.6 m agl. Base = 3.4 m bgl. ➢ Soil samples taken at 0.9, 2.2, 3.2, and 4.0 m bgl. ➢ Static water level is 1.98 m bmp on June 26, 2003.
TP03-6	
0.0 – 0.4	Topsoil, with fine to medium sand, fine to medium gravel, organic silt. Black. Frozen.
0.4 – 0.7	Fine to Medium Sand, trace to some fine to coarse gravel, occasional cobble and boulder. Grey brown. Damp.
0.7 – 1.2	Fine Sand, trace fine gravel, trace silt. Light grey brown. Damp.
1.2 – 1.5	Sand and Gravel.
1.5 – 1.7	Fine to Medium Sand, trace fine gravel. Light grey brown. Damp.
1.7 – 2.4	Fine to Medium Sand, trace fine to coarse gravel, occasional boulder. Grey brown. Damp.
2.4 – 3.9	Fine to Medium Sand. Grey brown. Damp.
3.9 – 4.1	Fine Sand and Silt. Medium grey. Moist. ➢ No seepage observed to base. ➢ No standpipe installed. ➢ Soil samples taken at 0.9, 2.2, and 4.0 m bgl

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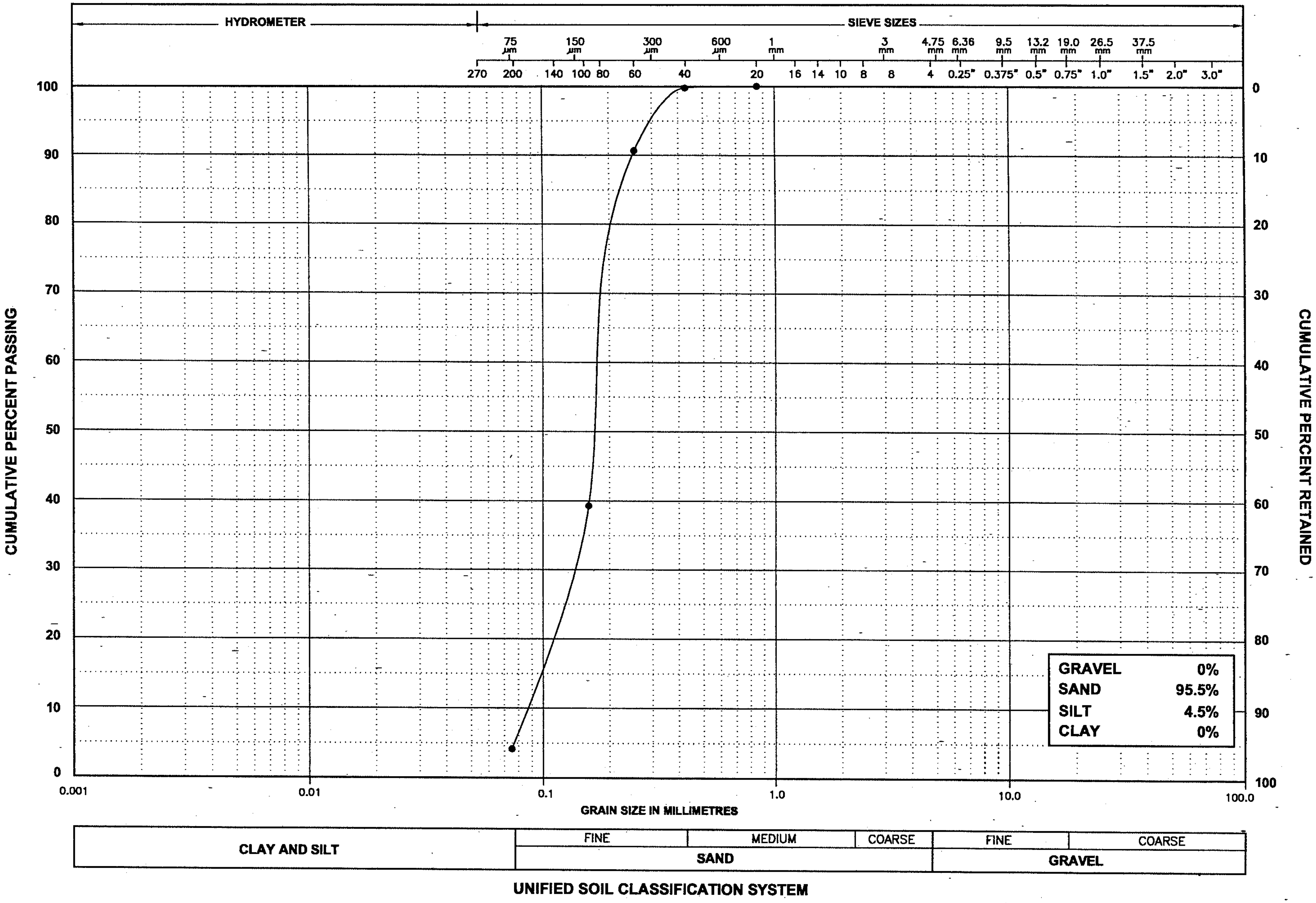
PARTICLE SIZE DISTRIBUTION



PROJECT: ORANGEVILLE HIGHLANDS **PROJECT No:** 021508.00 **HOLE No:** 03-4 **SAMPLE No:**

DEPTH: 0.7 m bgl **REMARKS:** Fine sand, trace silt **FIGURE:** B-1

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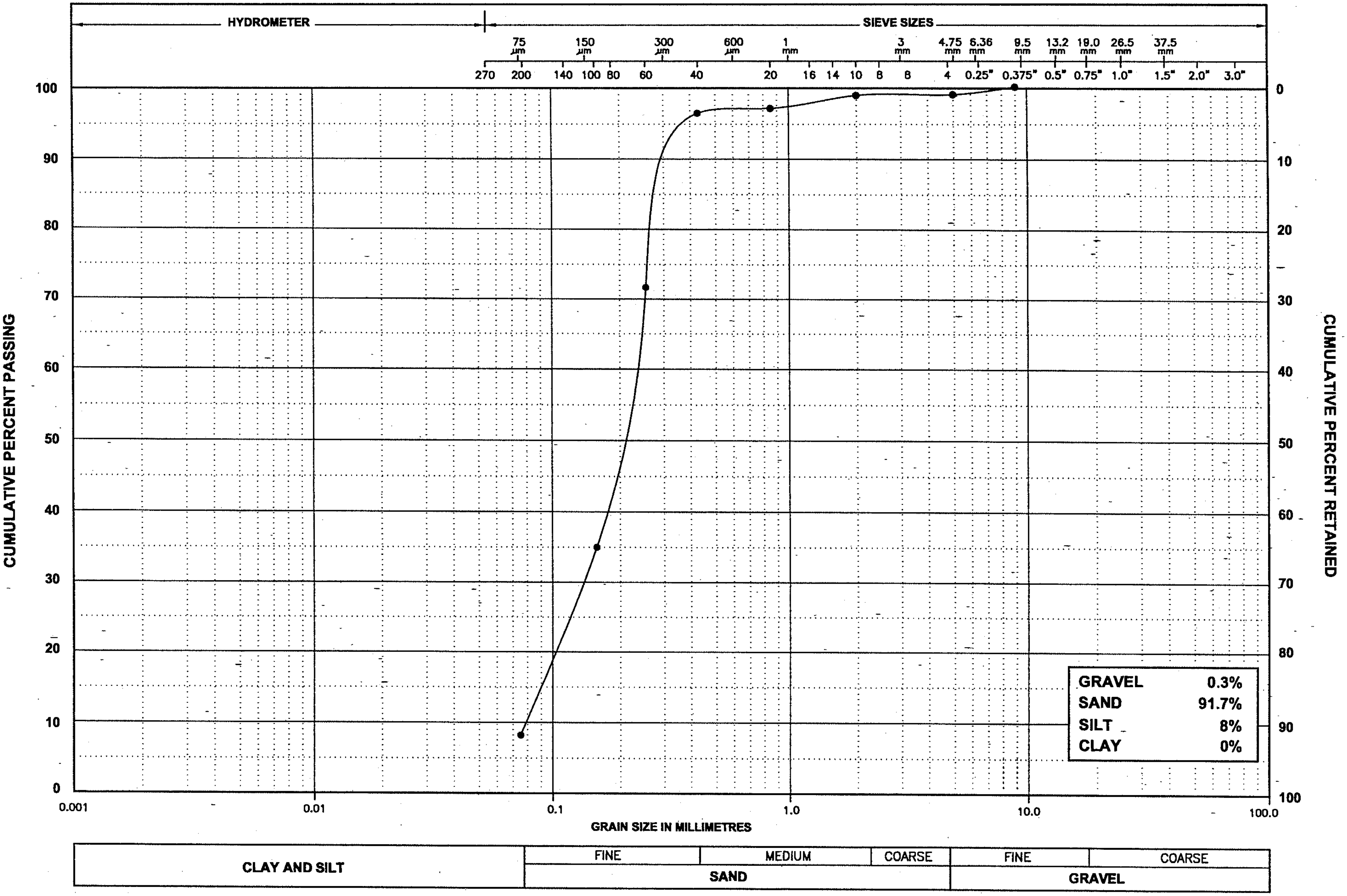

UNIFIED SOIL CLASSIFICATION SYSTEM

PROJECT: ORANGEVILLE HIGHLANDS **PROJECT No:** 021508.03 **HOLE No:** 03-6 **SAMPLE No:**

DEPTH: 1.0 m bgl **REMARKS:** Fine sand, trace silt **FIGURE:** B-2

APPENDIX C

CLIMATIC DATA

TABLE C-1
Climatic Water Budget: 1971 - 2000
Orangeville Highlands, Phase 2, Supplemental Monitoring and Assessments

MONTH	Mean Temperature (°C)	Heat Index	Evapo-trans. (mm)	Daylight Correction Factor	Adjusted Evap. (mm)	Total Precipitation (mm)	Surplus (mm)	Deficit (mm)
January	-8.0	0.0	0.0	0.73	0.0	65.2	65.2	0.0
February	-7.3	0.0	0.0	0.85	0.0	50.9	50.9	0.0
March	-2.3	0.0	0.0	0.98	0.0	65.8	65.8	0.0
April	4.9	1.0	24.7	1.13	27.9	69.9	42.0	0.0
May	11.8	3.7	59.8	1.26	75.4	79.3	3.9	0.0
June	16.5	6.1	83.8	1.33	111.7	83.9	0.0	27.8
July	19.1	7.6	97.1	1.31	126.7	75.3	0.0	51.4
August	18.3	7.1	93.0	1.20	111.1	95.6	0.0	15.5
September	14.0	4.7	71.0	1.06	74.9	83.7	8.8	0.0
October	7.8	2.0	39.4	0.91	35.8	71.0	35.2	0.0
November	1.6	0.2	8.0	0.78	6.2	81.8	75.6	0.0
December	-4.7	0.0	0.0	0.71	0.0	69.3	69.3	0.0
TOTALS (mm)					**569.8**	**891.7**	**416.7**	**94.7**
						569.8		
					Water Surplus	**321.9**	**mm**	

NOTES:
1) Evapotrans. = Evapotranspiration
2) Water budget based on Thornthwaite Method. Adjusted for latitude and daylight.
3) (°C) - Represents calculated mean of daily temperatures for the month.
4) Data from the Orangeville MOE Climatological Station located at latitude 43°55'N, longitude 80°5'W.
5) Water surplus is calculated as total precipitation minus adjusted evapotranspiration

TABLE C-2
Snow On Ground, 2005
Orangeville Highlands, Phase 2, Supplemental Monitoring and Assessments

Date	Snow Pack Depth (cm)	
	Orangeville MOE	Sandhill
1-Mar-05	15	25
2-Mar-05	13	30
3-Mar-05	16	31
4-Mar-05	12	30
5-Mar-05	NR	28
6-Mar-05	NR	22
7-Mar-05	12	19
8-Mar-05	9	11
9-Mar-05	NR	11
10-Mar-05	12	15
11-Mar-05	NR	16
12-Mar-05	NR	12
13-Mar-05	NR	17
14-Mar-05	12	15
15-Mar-05	12	12
16-Mar-05	11	10
17-Mar-05	7	13
18-Mar-05	3	10
19-Mar-05	NR	9
20-Mar-05	NR	8
21-Mar-05	13	10
22-Mar-05	3	7
23-Mar-05	NR	6
24-Mar-05	NR	8
25-Mar-05	NR	5
26-Mar-05	NR	3
27-Mar-05	NR	1
28-Mar-05	Trace	Trace
29-Mar-05	0	Trace
30-Mar-05	0	0
31-Mar-05	0	0

Date	Snow Pack Depth (cm)	
	Orangeville MOE	Sandhill
1-Apr-05	0	NR
2-Apr-05	20	Trace
3-Apr-05	NR	5
4-Apr-05	22	3
5-Apr-05	4	0
6-Apr-05	Trace	0
7-Apr-05	0	0
8-Apr-05	0	0
9-Apr-05	0	0
10-Apr-05	NR	0
11-Apr-05	0	0
12-Apr-05	0	0
13-Apr-05	0	0
14-Apr-05	0	0
15-Apr-05	0	0
16-Apr-05	NR	0
17-Apr-05	NR	0
18-Apr-05	0	0
19-Apr-05	0	0
20-Apr-05	0	0
21-Apr-05	0	0
22-Apr-05	0	0
23-Apr-05	0	0
24-Apr-05	NR	0
25-Apr-05	NR	NR
26-Apr-05	0	0
27-Apr-05	NR	0
28-Apr-05	NR	0
29-Apr-05	NR	0
30-Apr-05	NR	0

Note

NR = not recorded

TABLE C-3
Snow On Ground, 2006
Orangeville Highlands, Phase 2, Supplemental Monitoring and Assessments

Date	Snow Pack Depth (cm)	
	Orangeville MOE	Sandhill
1-Feb-06	0	0
2-Feb-06	0	0
3-Feb-06	2	0
4-Feb-06	NR	0
5-Feb-06	NR	17
6-Feb-06	25	17
7-Feb-06	41	19
8-Feb-06	35	17
9-Feb-06	31	17
10-Feb-06	28	16
11-Feb-06	NR	17
12-Feb-06	NR	17
13-Feb-06	25	15
14-Feb-06	29	14
15-Feb-06	23	12
16-Feb-06	23	22
17-Feb-06	22	15
18-Feb-06	NR	17
19-Feb-06	NR	16
20-Feb-06	22	16
21-Feb-06	21	16
22-Feb-06	24	16
23-Feb-06	23	12
24-Feb-06	30	13
25-Feb-06	NR	17
26-Feb-06	NR	17
27-Feb-06	37	16
28-Feb-06	36	16

Date	Snow Pack Depth (cm)	
	Orangeville MOE	Sandhill
1-Mar-06	36	15
2-Mar-06	37	15
3-Mar-06	37	15
4-Mar-06	NR	14
5-Mar-06	NR	14
6-Mar-06	25	12
7-Mar-06	25	12
8-Mar-06	NR	11
9-Mar-06	29	10
10-Mar-06	11	7
11-Mar-06	NR	2
12-Mar-06	NR	0
13-Mar-06	0	0
14-Mar-06	NR	0
15-Mar-06	1	1
16-Mar-06	NR	0
17-Mar-06	NR	0
18-Mar-06	NR	0
19-Mar-06	NR	0
20-Mar-06	0	0
21-Mar-06	0	0
22-Mar-06	0	0
23-Mar-06	0	0
24-Mar-06	NR	0
25-Mar-06	NR	1
26-Mar-06	NR	0
27-Mar-06	0	0
28-Mar-06	0	0
29-Mar-06	0	0
30-Mar-06	NR	0
31-Mar-06	NR	0

Date	Snow Pack Depth (cm)	
	Orangeville MOE	Sandhill
1-Apr-06	NR	0
2-Apr-06	NR	0
3-Apr-06	0	0
4-Apr-06	0	0
5-Apr-06	2	0
6-Apr-06	0	0
7-Apr-06	NR	0
8-Apr-06	NR	0
9-Apr-06	NR	0
10-Apr-06	0	0
11-Apr-06	0	0
12-Apr-06	0	0
13-Apr-06	0	0
14-Apr-06	NR	0
15-Apr-06	NR	0
16-Apr-06	NR	0
17-Apr-06	0	0
18-Apr-06	0	0
19-Apr-06	0	0
20-Apr-06	0	0
21-Apr-06	0	0
22-Apr-06	NR	0
23-Apr-06	NR	0
24-Apr-06	0	0
25-Apr-06	NR	0
26-Apr-06	0	0
27-Apr-06	0	0
28-Apr-06	NR	0
29-Apr-06	NR	0
30-Apr-06	NR	0

Note

NR = not recorded

FIGURE C-1, Air Temperatures for Spring Monitoring Period, 2005
Orangeville Highlands, Phase 2, Supplemental Monitoring and Assessments

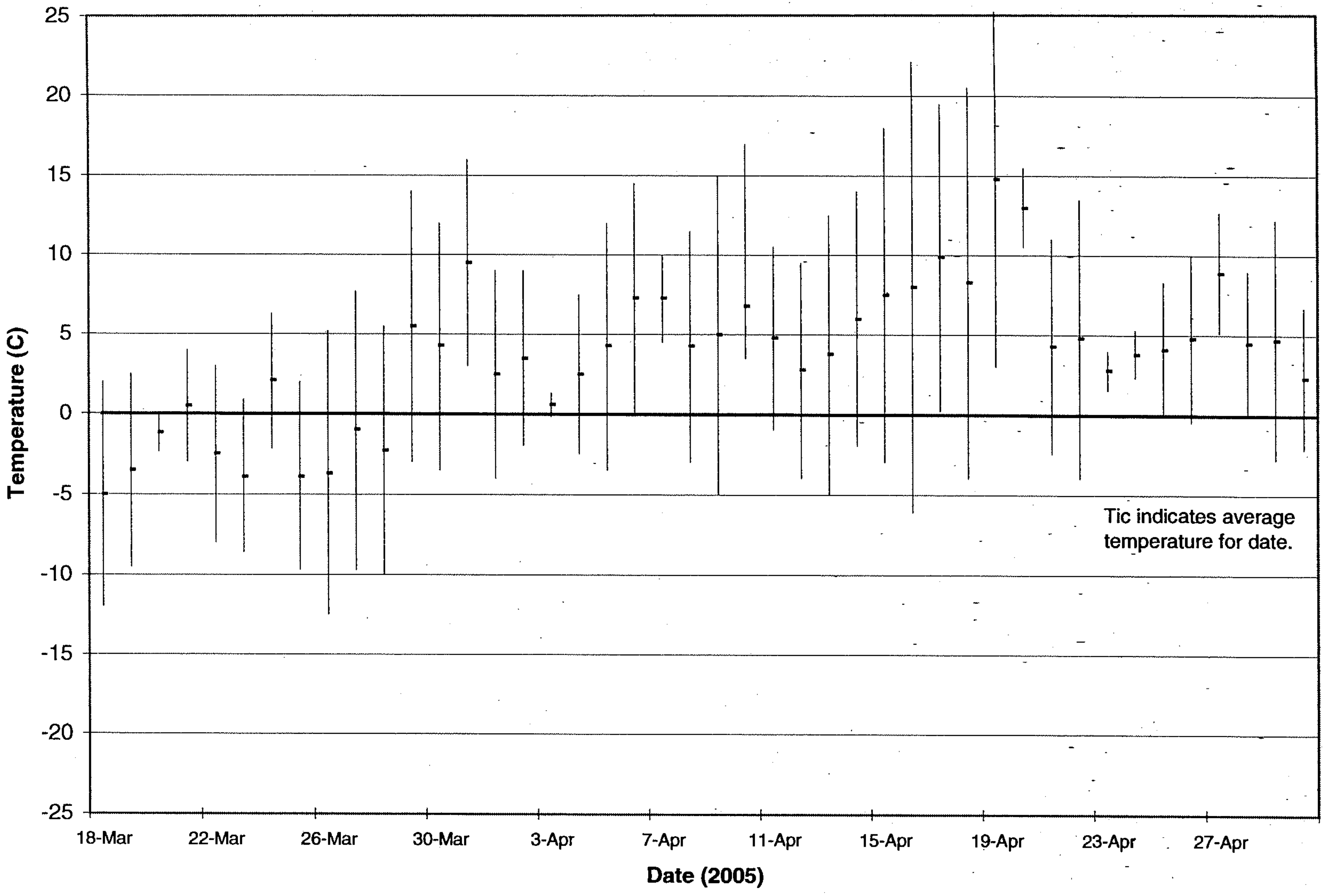

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FIGURE C-2, Air Temperatures for Spring Monitoring Period, 2006
Orangeville Highlands, Phase 2, Supplemental Monitoring and Assessments

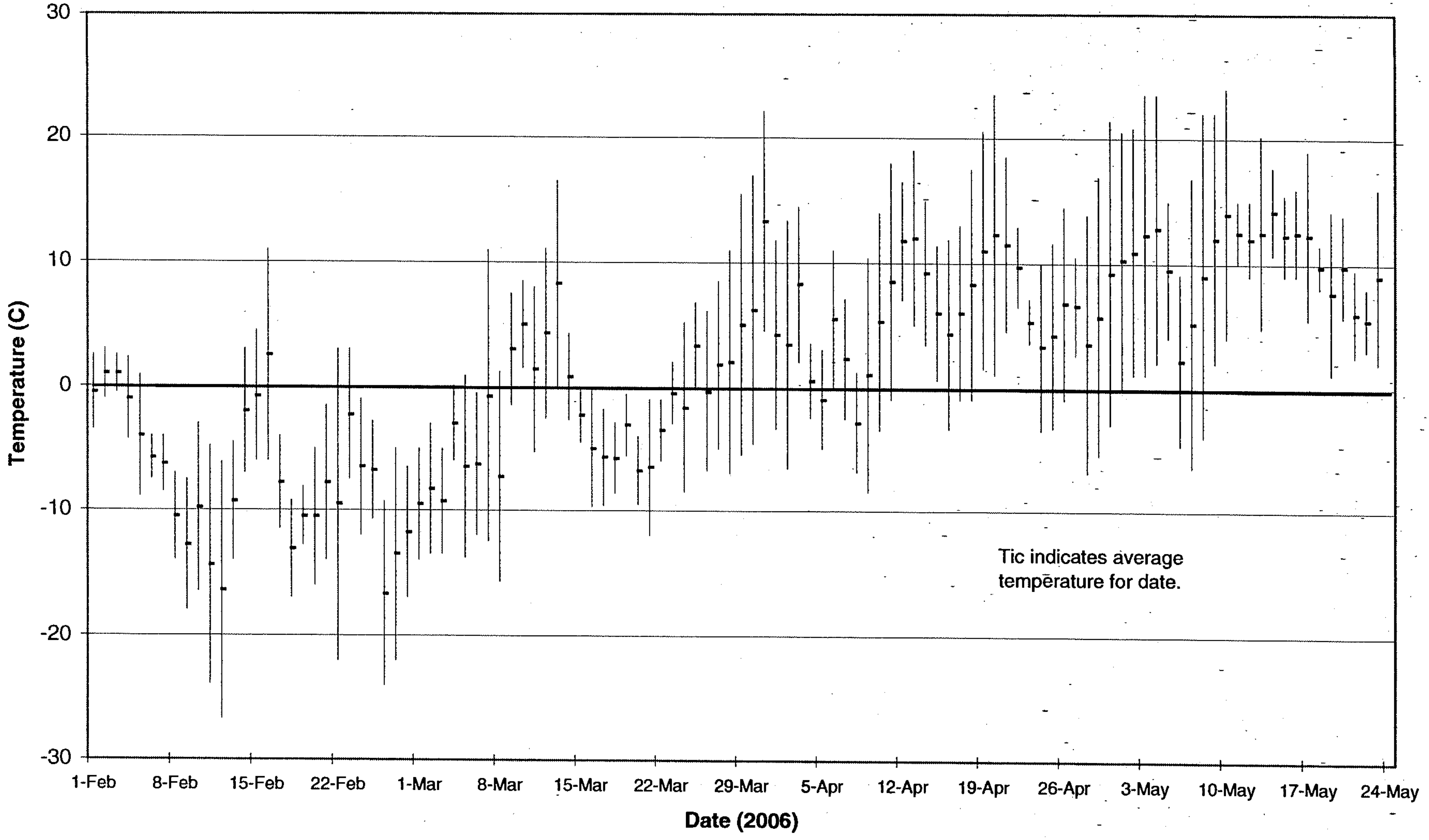

FIGURE C-3: Daily Precipitation for Spring Monitoring Period, 2005 Orangeville Highlands, Phase 2, Supplemental Monitoring and Assessments

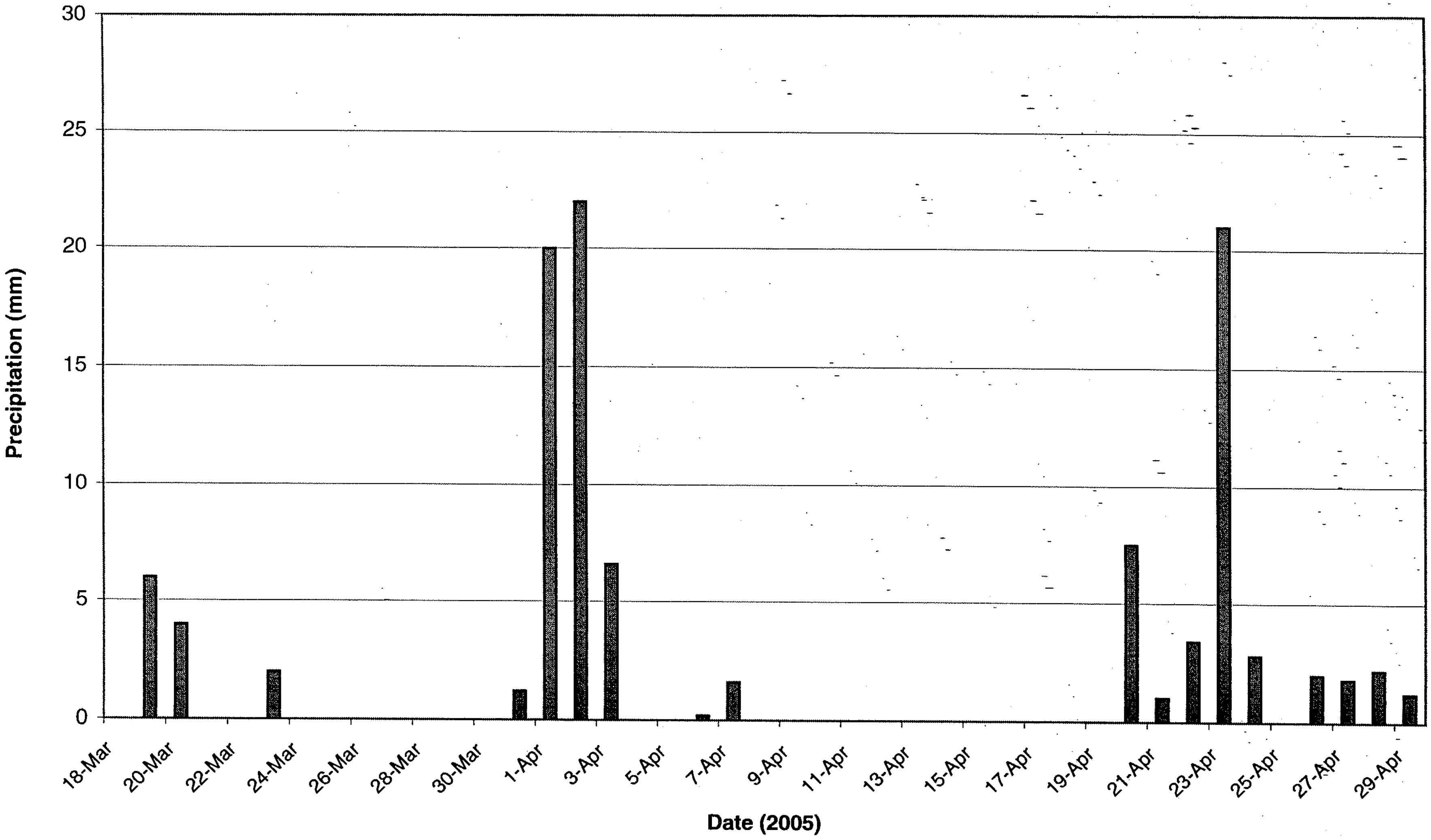

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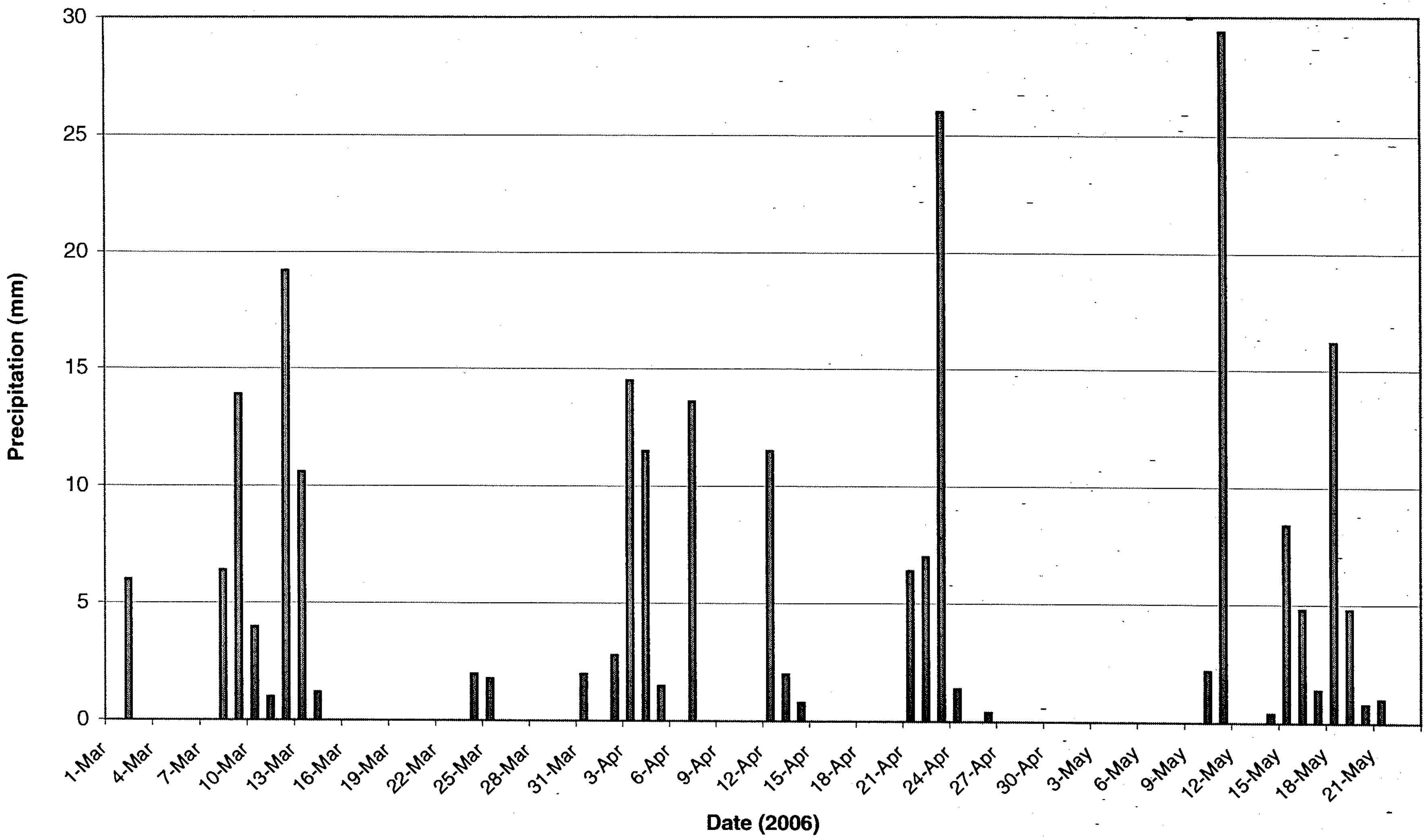
FIGURE C-4: Daily Precipitation for Spring Monitoring Period, 2006
Orangeville Highlands, Phase 2, Supplemental Monitoring and Assessments



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