Barrie Lockhart Road LP

Functional Servicing Report

October 2018

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SUBMISSION HISTORY

Submission	Date	In Support Of	Distributed To
1st	October 2018	Draft Plan Approval	City of Barrie, Lake Simcoe Region Conservation Authority

1.0 INTRODUCTION

SCS Consulting Group Ltd. has been retained by Barrie Lockhart Road LP to prepare a Functional Servicing Report for a proposed development within the Hewitt's Secondary Plan, located in the City of Barrie.

1.1 Purpose of the Functional Servicing Report

The Functional Servicing Report (FSR) has been prepared in support of the Draft Plan of Subdivision for the proposed development. The Draft Plan of Subdivision is provided in **Appendix A**. The proposed development consists of the following land uses:

- low density residential,
- mixed-use,
- institutional,
- parks,
- open space,
- SWM pond block, and
- proposed roads.

The purpose of this report is to demonstrate that the proposed development can be graded and serviced in accordance with the City of Barrie, LSRCA and the Ministry of Environment Conservation and Parks (MOECP) design criteria.

1.2 Study Area

The study area is approximately 23.47 ha in size and is bound by an environmental protection area to the north, an existing residential subdivision to the west, Lockhart Road to the south and future residential lands to the east which are also part of the Hewitt's Secondary Plan Area (see **Figure 1.1**).

The existing lands are comprised of agricultural land and open space areas. The study area is located within the Lover's Creek subwatershed in the Lake Simcoe watershed.

1.3 Background Servicing Information

In preparation of the site servicing and SWM strategies, the following design guidelines and standards were used:

- Stormwater Management Policies and Design Guidelines, City of Barrie (November 2009);
- Sanitary Sewer Collection System Policies and Design Guidelines, City of Barrie (September 2012);
- Water Transmission and Distribution Policies and Design Guidelines, City of Barrie (May 2015);
- Low Impact Development, Interim Guidance Document, City of Barrie (September 2017);

- Lot Grading and Drainage Standards and Design Manual, City of Barrie (June 2016);
- Lake Simcoe Region Conservation Authority (LSRCA) Technical Guidelines for Stormwater Management Submissions (September 2016);
- Lake Simcoe Protection Plan (July 2009);
- LSRCA Phosphorus Offsetting Policy (September 2017);
- Ministry of Environment (MOECP) Stormwater Management Planning and Design Manual (March 2003); and
- Ministry of Transportation (MTO) Drainage Management Manual (1997).

The site servicing and SWM strategies in this report are based on the following reports:

- Geotechnical Investigation, prepared by Peto MacCallum Ltd., dated May 2017;
- Hydrogeological Study in Support of Draft Plan, RJ Burnside, dated October 2018;
- Water Distribution Analysis, Laughlen Municipal Consulting, dated October 2018, and
- Hewitt's Secondary Plan Area Subwatershed Impact Study (SIS) Lover's, Hewitt's, and Sandy Cove Creeks prepared by R.J. Burnside November 2017;

Excerpts from the above listed documents are included in **Appendix B** or as noted in the following sections.

2.0 STORMWATER MANAGEMENT

2.1 Stormwater Runoff Control Criteria

The following stormwater runoff control criteria have been established based on the design guidelines and standards listed in **Section 1.3,** predominantly in reference to the approved SIS. The stormwater runoff criteria are summarized below in **Table 2.1**:

Table 2.1 – Stormwater Runoff Control Criteria

Criteria	Control Measure
Quantity Control	Proposed peak flow controls are to match approved unitary discharge rates as determined through the SIS. Proposed runoff volume controls shall capture and infiltrate/filtrate runoff from a 25 mm rainfall event over all new impervious areas.
Quality Control	MOECP Enhanced Level Protection (80% TSS Removal).
Erosion Control	Detention of the runoff volume from a 25 mm 4-hour Chicago storm for a minimum of 24 hours.
Water Balance	Maintain existing groundwater recharge rates and appropriate distribution, to the extent feasible, ensuring the protection of related hydrology ecologic functions.
Phosphorus Budget	A best effort shall be employed such that any increase in loading is kept to a minimum with the target of “zero” increase in loading. Regardless of existing loading, the removal of 80% of the proposed annual Total Phosphorus load is required. The remaining proposed phosphorus loading conveyed offsite (if any) is to be offset per the LSRCA Phosphorus Offsetting Policy.

2.2 Existing Drainage

As shown on **Figure 2.1**, runoff from the majority of the site (Catchment 1000, 22.84 ha) is conveyed as overland flow to the existing environmental area to the north. Runoff from the remainder of the site (Catchment 1001, 3.05 ha) is conveyed as overland flow to the existing ditch on the north side of Lockhart Road.

2.3 Best Management Practices

In accordance with the MOECP Stormwater Management Planning and Design Manual (2003), a review of stormwater management best practices was completed using a treatment train approach, which evaluated lot level, conveyance system and end-of-pipe alternatives.

The following site characteristics were taken into consideration:

- The topography varies considerably from the high point located in the southern central portion of the site at slopes ranging from approximately 5 to 15%;

- Based on the geotechnical investigation, site soils consist of clayey silt, overlain by silty sand/sandy silt and sand/silt till soils;
- An in-situ percolation test was completed and indicates that the native soils generally have a percolation rate ranging from 1.3 x 10^{-5} to 2.2 x 10^{-4} mm/hr;
- Within the installed site wells, groundwater was observed predominantly within 1.0 m from the surface with depths ranging between 0.0 m to 7.4 m below existing grade; and
- The proposed subdivision development is approximately 23 ha and consists of a residential subdivision with associated parks and an institutional block.

2.3.1 Lot Level Controls

Lot-level controls are private at-source measures that reduce runoff prior to stormwater entering the conveyance system. These controls are proposed on private properties. Incorporating controls with minimal maintenance requirements can be an effective method in the treatment train approach to SWM. There is no municipal operation or maintenance associated with these SWM facilities. The following lot level controls have been considered:

Increased Topsoil Depth – An increase in the restored topsoil depth on lots can be used to promote lot level infiltration and evapotranspiration. Increased topsoil depth will contribute to lot level quality and water balance control. A minimum depth of 0.3 m is proposed in all landscaped areas.

Passive Landscaping – Planting of gardens and other vegetation designed to minimize local runoff or use rainwater as a watering source can be used to reduce rainwater runoff by increasing evaporation, transpiration, and infiltration. By promoting infiltration through passive landscaping, water quality and quantity control is provided for the volume of water retained. Passive landscaping can provide significant SWM benefits as part of the overall treatment train approach for the subject development. While encouraged, benefits are not quantified as part of the design

Roof Runoff to Soak-away Pits – Directing roof runoff to subsurface soak-away pits can be used to promote infiltration. By promoting infiltration water quality and quantity control is provided for the volume of water retained. Infiltration of roof runoff can provide a significant SWM benefit as part of the overall treatment train approach for the subject development. Due to potential concerns with maintenance on private property and due to generally high groundwater, it has not been considered.

Roof Runoff to Retention Cisterns – Directing roof runoff to rainwater retention cisterns (i.e. rain barrels or greywater re-use) can contribute to water quality and water balance control. The retained rainwater can be harvested for re-use such as irrigation and/or greywater use. A typical rain barrels ranges in size from 190 to 400 liters. Feasibility of retention cisterns will be determined by the home builder and while encouraged, is not quantified as part of the design.

Green Roofs – Best suited for flat roofs, greenroofs provide rainwater retention in the growing medium where it is evaporated, evapotranspirated, or slowly drains away after the rainfall event. The subject development will have peaked roofs within the residential portion and are thereby not suitable. Feasibility of green roofs for the institutional block is to be confirmed at the site plan application stage.

Rooftop and/or Parking Lot Detention Storage – Often utilized with large rooftop or parking lot footprints, flow attenuation for quantity or extended detention control can be provided via a flow restriction with stormwater storage provided via ponding either on rooftops or parking lots. The subject development does not have any flat rooftops or parking lots, within its residential portion therefore this is not suitable. Feasibility of rooftop and parking lot storage for the institutional block is to be confirmed at the site plan application stage.

Roof overflow to Grassed Areas – Directing roof leaders to grassed areas will contribute to water quality and water balance control by encouraging stormwater retention. Roof leaders can be directed to grassed areas where there is grass, however, if there is no grass , roof leaders should be connected to the storm sewer to eliminate the hazard of ice accumulation. It is recommended to direct roof leaders to the front or rear yards where possible to promote infiltration and to avoid discharging to impervious areas directly connected to the storm sewer per City of Barrie guidelines.

Pervious Pavement – By encouraging infiltration and filtration, pervious pavement within the proposed driveways can contribute to water quality, balance and erosion control. Due to potential maintenance issues and potential for removal, permeable pavers are not recommended for the residential portion of the site. Feasibility of permeable pavers for the institutional block and village squares are to be confirmed at the site plan application stage.

Vegetated Filter Strip – At source filtration and infiltration may be encouraged through the use of vegetated filter strips by directing sheet flow from impermeable areas to the strip prior to being collected via the storm system. Vegetated filter strips are best suited to parking lot areas with landscaped borders or islands or within buffer areas. There are none of these areas on the residential portion of the subject development. The potential use of vegetated filter strips in the institutional block will be evaluated at the site plan application stage.

A summary of the suitability of potential lot level controls for the subject developments is provided in **Table 2.2**.

2.3.2 Conveyance Controls

Conveyance controls provide treatment of stormwater during the transport of runoff from individual lots to the receiving watercourse or end-of-pipe facility and present opportunities to distribute stormwater management techniques throughout a development. The following conveyance controls have been considered:

Grassed Swales – A grassed swale will promote infiltration, filtration, and evapotranspiration, contributing to water quality and quantity control. It is noted that smaller grassed swales will potentially be used at the individual lot grading level. Feasibility of grassed swales for the institutional block will be confirmed at the site plan application stage.

Bioretention - To meet LSRCA criteria for water balance, bioswales/rain gardens are feasible for non-frontage boulevards or within open space/buffer areas. A portion of the required water balance volume for the residential portion of the subject development is proposed to be accommodated with bioretention as discussed further in **Section 2.6**.

Exfiltration at Rear Lot Catchbasins – Where rear lot catchbasins are required due to grading constraints, a perforated pipe system can be incorporated into the rear lot catchbasin design to promote infiltration of 'clean' stormwater runoff. By promoting infiltration, water quality and quantity control is provided for the volume of water retained. As it is preferred by the City of Barrie that parks and SWM blocks be utilized to promote infiltration over rear lot catch basins, this is not recommended.

A summary of the suitability of potential conveyance controls for the subject developments is provided in **Table 2.2**.

2.3.3 End-of-Pipe Controls

Stormwater management facilities at the end of pipe receive stormwater flows from a conveyance system and provide treatment of stormwater prior to discharging flows to the receiving watercourse. While lot level and conveyance system controls are valuable components of the overall SWM plan, on their own they are not sufficient to meet the quantity and quality control objectives for the subject development. The following end of pipe controls have been considered:

Wet Ponds, Wetlands, Dry Ponds – Sized in accordance with the MOECP criteria, these end of pipe facilities can provide water quality, quantity, and erosion control treatment. As outlined in the SIS, an end of pipe wet pond is proposed to provide water quality, quantity, and erosion control treatment for the subject development. The SIS also notes that the wet pond facility could be designed as a constructed wetland should the block accommodate it as discussed further in **Section 2.5**.

Underground Stormwater Detention Facility – To meet quantity control targets, flow restrictors can be used to control stormwater release rates. To accommodate the reduced release rate, stormwater detention facilities are required to store stormwater runoff. Stormwater storage can be provided by oversized storm sewers and controlled with flow restrictors prior to discharging to the receiving infrastructure. As quantity control will be provided by downstream SWM facilities, additional stormwater detention facilities are not proposed.

Manufactured Treatment Device – A properly sized manufactured treatment device (MTD) can provide MOECP Enhanced (Level 1) treatment and contribute to the treatment train approach for water quality control. The unit specified, whether an oil-grit separator or filter based system is required to have Canadian ETV program verification. MTD's will be utilized where required as pre-treatment for LID's.

2.3.4 Selection of Low Impact Development Practices

Table 2.2 summarizes the suitability of the various stormwater management controls identified for the subject developments.

Table 2.2 - Recommended Stormwater LID Practices

STORMWATER MANAGEMENT PRACTICE	FEASIBLE (Yes/No)	RECOMMENDED (Yes/No)
Increased Topsoil Depth	Yes	Yes
Passive Landscaping	Yes	Yes
Roof Leader to Soak-away Pits	No	No
Roof Runoff to Retention Cisterns	Yes	Yes
Green Roofs	Yes (Institutional Block)	Yes (Optional)
Rooftop and/or Parking Lot Detention Storage	Yes (Institutional Block)	Yes (Optional)
Roof overflow to Grassed Areas	Yes	Yes
Pervious Pavement	Yes (Institutional Block)	Yes (Optional)
Vegetated Filter Strips	Yes (Institutional Block)	Yes (Optional)
Grassed Swales	Yes	Yes
Bioretention	Yes	Yes
Exfiltration at Rear Lot Catchbasins	Limited	No
Wet Ponds, Wetlands, Dry Ponds	Yes	Yes
Underground Stormwater Detention Facility	Yes (Institutional Block)	No
Manufactured Treatment Device	Yes	Yes (pre-treatment)

The potential LID practices that are proposed to be utilized to assist with volume control, water balance and phosphorus removal are discussed in greater detail in **Section 2.6**.

2.4 Proposed Storm Drainage

As shown on **Figure 2.2**, minor system runoff (storm events up to and including the 5 year storm event) from the majority of the proposed development (Catchment 401, 21.34 ha), will be conveyed via the proposed storm sewer system to the proposed SWMF #2 (SWM pond) to the northeast. Major system runoff (storm events greater than the 5 year up to and including the 100 year storm event) from Catchment 401 will be conveyed as overland flow to the proposed SWM pond via the proposed right-of-ways.

Runoff from external Catchments 402 (2.87 ha), and a portion of external Catchment 405 will be conveyed through Catchment 401 and ultimately to the proposed SWM pond to the northeast. Runoff from Lockhart Road, consisting of Catchments 403 (1.77 ha) & 404 (0.40 ha), has the potential to be conveyed to the SWM pond. It is noted that through the design of the Lockhart Road widening, major system flows may not have the opportunity to be conveyed to the proposed SWM pond and no storm sewer upsizing to accommodate major system flows from Lockhart road are proposed.

Runoff from Catchment 406 (0.41 ha of rear roofs and adjacent park) will be conveyed to the proposed hybrid bioswale, discussed in **Section 2.7.3**) to the north.

Runoff from Catchment 501 (1.32 ha) will be conveyed to the existing Thicketwood Avenue right-of-way to the west via the proposed lined bioswale in the adjacent buffer area (**Section 2.6**). In addition, a small portion of Street A, west of Street C/D will be conveyed to the existing Fenchurch Manor right-of-way and associated storm infrastructure. The capacity of the existing storm sewer system is described below in **Section 2.5.1**.

An interim storm sewer design is illustrated on **Figure 2.2** should the external lands to the south not move forward at the time of the construction of Street ‘M’. The interim storm sewer would extend from the southwest corner of Street ‘M’, through frozen future residential lots, connecting to the proposed Street ‘K’ storm sewer. It is noted that should this be required, the storm sewers downstream of Street ‘K’ need to be designed both for depth and size to accommodate this area.

2.5 Proposed Stormwater Management Plan

2.5.1 Quantity Control

The proposed SWM pond will control proposed flows to the unitary discharge rates outlined in the SIS. As the majority of the SWM pond is located on adjacent lands, the functional SWM pond design will be completed by others in support of the future application for the adjacent lands.

As outlined in the SIS a 1.82 ha area was contemplated to be directed to the existing 300 mm storm sewer on Thicketwood Avenue. Through revisions to the Draft Plan and proposed site grading (per **Section 5.0**), the proposed drainage area to Thicketwood Avenue (Catchment 501, **Figure 2.2**) has been reduced to 1.32 ha. As discussed further in **Section 2.7**, minor system flows will be controlled via LID’s with major system drainage being conveyed via the right-of-way, ultimately being controlled by the existing downstream SWM facility.

As shown on **Figure 2.2**, there is also a 0.11 ha area (Catchment 502) that will be conveyed to the existing storm infrastructure on Fenchurch Manor due to grading constraints. This area, when combined with the drainage area to Thicketwood Avenue is still less than what was contemplated in the SIS and will ultimately be controlled via existing infrastructure.

2.5.2 Quality Control

As outlined in the SIS, the permanent pool of the SWM pond will provide 80% TSS removal per MOECP criteria. In addition, the proposed LID’s, as discussed in **Section 2.7**, will provide additional quality control via a treatment train approach. While not contemplated in the calculations provided in **Appendix C**, the proposed LID’s will dramatically reduce the TSS removal requirements of the proposed SWM pond in comparison to what was assumed in the SIS.

2.5.3 Erosion Control

The erosion control criteria is to provide a minimum of 24 hour extended detention of the runoff from a 25 mm rainfall event and will be provided in the proposed SWM pond. Further discussion of the preliminary design requirements of the proposed SWM pond are available in the SIS and will ultimately be provided as part of the future application for the lands to the east.

2.6 Volume Control

As detailed in the SIS, the target filtration and infiltration rates have been set based on-site soils and LSRCA guidelines. More specifically, the site lies within SIS Catchments 2, 201 and 2-EXT area directed to SWMF#2. The infiltration target for these lands is “best efforts” and the filtration target is 25 mm.

As shown in the calculations included in **Appendix C**, the 25 mm target corresponds to a volume of 6,196 m^3 for the area proposed to convey runoff to the proposed SWM pond to the northeast.

As detailed in the following sections, LIDs have been explored to maximize filtration and to utilize infiltration as a best efforts approach.

2.7 Design Charrette

A design charrette was completed on June 28, 2018 at the City of Barrie in conjunction with the conformity review process. Meeting minutes from the design charrette are included in **Appendix C** and the following LID measures were discussed and agreed to in principle at the meeting.

As confirmed through the design charrette, centralized LID facilities were preferred and therefore have been proposed in the parks and buffer areas, in addition to the SWM pond and are shown on **Figure 2.3**. Based on preliminary calculations included in **Appendix C**, the proposed LIDs will have sufficient capacity to provide filtration for the required 6,196 m^3.

While not necessary to achieve the volume control criteria, ROW based LIDs have been explored and their potential locations are shown on **Figure 2.3**. ROW based LIDs are shown as optional should they be required to achieve phosphorus criteria or supplement centralized LIDs should the anticipated capacity be reduced through detailed design.

The institutional block is required to provide 25 mm of filtration on-site, but as this block could potentially be converted to residential lands, it has not been included in the overall calculations.

2.7.1 Catchbasin Exfiltration Trenches in ROW

Catchbasin exfiltration trenches are feasible within a portion of the proposed 18 m municipal ROWs in areas with a sufficient depth of groundwater. The potential locations are shown on **Figure 2.3**. Runoff captured by the street catchbasins will be conveyed to the exfiltration trench located in the boulevard. Catchbasins will be provided with a deep sump and pre-treatment device (Goss Trap, CB Sheild, etc.) to prevent floatables and sediment from entering the exfiltration trench. Runoff in excess of the capacity of the exfiltration trench will overflow to the mainline storm sewer. A preliminary detail of the potential catchbasin exfiltration system contemplated within an 18 m ROW is shown on **Figure 2.4**.

Catchbasin exfiltration trenches have not been included in the 25 mm filtration calculations. However, it is noted that these LIDs are feasible and could be utilized to provide additional filtration and quality controlled if required at detailed design.

2.7.2 Rain Gardens in ROW

Rain gardens are feasible throughout the development adjacent to side residential lot flankages within municipal ROWs. The potential locations are shown on **Figure 2.3**. Curb cuts are proposed to be located upstream of regular street catchbasins to collect and convey low flows to the rain gardens. When runoff enters the rain garden, it filters through an engineered soil media sized to achieve water filtration targets. An underdrain, located at the bottom of the rain garden will collect the filtered water and convey the water to the proposed storm sewer. In areas with sufficiently deep groundwater, the rain gardens are to be unlined and equipped with a raised discharge pipe to the proposed storm sewer to promote infiltration. In areas of high groundwater, the potential rain gardens would be lined and equipped with a discharge pipe at the subdrain to allow for filtration and discharge to the proposed storm sewer. A preliminary detail of the potential rain garden layout within the 18 m ROW is shown on **Figure 2.5.**

Boulevard based rain gardens have not been included in the 25 mm filtration calculations. However, it is noted that these LIDs are feasible and could be utilized to provide additional filtration and quality control if required at detailed design.

2.7.3 Hybrid Bioswales in Buffer

As shown on **Figure 2.3**, bioswales are proposed within the first 15 m of the 30 m Environmental Protection (EP) buffer along the north limit of the site.

As shown, a hybrid bioswale is proposed along the buffer from the village square at the north end of Street H and around the proposed SWM pond. The proposed hybrid bioswale accepts flows from Catchments 107, 201, 102 and 103 via the Street H storm sewer as well as flows from a portion of Catchments 204 and 106 via overland flow. A portion of flows form Catchment 204 will also be directed to the hybrid bioswale via future storm sewer. An MTD is provided as a pre-treatment device for flows entering the hybrid bioswale via the Street H and future storm sewers.

A lined bioswale is proposed within the buffer west along Street B from the Village Square to Thicketwood Avenue. This bioswale is sized to provide 25 mm of filtration for Catchment 104.

Preliminary sizing of the proposed bioswale is provided in **Appendix C**.

2.7.4 Filtration Galleries

As shown on **Figure 2.3** filtration galleries are proposed in the southwest and north village squares as well as in the downstream SWM facility. Flows will enter the proposed filtration galleries via the proposed storm sewers and will provide filtration via an engineered soil media sized to achieve the required filtration targets. Pre-treatment for flows entering the proposed

filtration galleries will be provided via proposed MTDs as shown on **Figure 2.3**. As outlined in **Section 2.8** the proposed MTD's are filter based units to achieve the required phosphorus removal efficiencies.
Preliminary sizing of the proposed galleries is provided in **Appendix C**. Filtration galleries proposed in park blocks will be designed in conjunction with the City of Barrie parks department to ensure that the location and configuration of the facility is in compliance with the proposed park facility fit.

2.7.5 SWM Pond

The proposed SWM pond was contemplated as a wet SWM pond in the approved SIS. To provide better filtration and phosphorus removal, the SWM pond has been contemplated in this report to be a hybrid wetland facility. It is noted that the SIS also states that there is potential for SWMF 2 to be a constructed wetland.

The hybrid wetland facility has been contemplated with standard forebays providing primary treatment followed by a main wetland cell. Although, based on the size and effectiveness of proposed upstream LIDs the overall quality requirements for the hybrid wetland facility will be reduced when compared to what was contemplated in the SIS. This may allow for a reduction in the overall SWM pond block, removal of pre-treatment requirements, or alternative treatment options as to be confirmed by the future application for the lands to the west. It is noted that due to the groundwater information provided in the Hydrogeological Report in **Appendix B**, the SWM pond in any configuration will likely need to be lined.

The wetland cell can provide a filtration volume via the associated vegetation. As shown in the preliminary sizing calculations provided in **Appendix C**, the volume provided in the wetland is greater than the required 25 mm filtration from contributing catchments.

2.8 Phosphorus Budget

Under the Lake Simcoe Protection Plan, a stormwater management plan must demonstrate how phosphorus loadings are minimized between existing and proposed. In addition, 80% Total Phosphorus load from all major development areas is required per LSRCA criteria. The MOECP database application *Lake Simcoe Phosphorus Loading Development Tool* (v2, 01-April-2012 update) was used to complete the phosphorus budget for the residential portion of the proposed development.

<u>Existing Phosphorus Loadings</u>

The existing phosphorus loading was calculated based on the existing conditions land use interpreted from satellite imagery and on-site reconnaissance. The existing land use consists of 35.82 ha of cropland within the Lover's Creek subwatershed with an annual phosphorus loading coefficient of 0.16 kg/ha.

<u>Proposed Phosphorus Loadings</u>

The proposed residential lots (singles and townhomes) are considered high intensity development according to the Phosphorus Tool. The proposed SWM pond is considered low intensity development. The proposed phosphorus loading with no mitigation was calculated to be 43.62 kg/yr (**Appendix C**).

The proposed phosphorus loading with mitigation via the proposed LID's discussed in **Section 2.7.3**, was calculated to be 3.86 kg/yr (see **Appendix C**). The LIDs utilized throughout the site comprise of a variety of sand or media filters including: subsurface exfiltration trenches, lined bioswales, unlined rain gardens, lined rain gardens, hybrid bioswales, and below grade filtration gallery complete with pre-treatment devices in addition to the proposed hybrid wetland facility. For further information on how each catchment associates with its respective BMP, please refer to the "Project Development Summary" in **Appendix C**. **Table 2.3** provides a summary of the phosphorus removal efficiencies for the existing and proposed conditions.

Table 2.3: Phosphorus Budget Summary

Phosphorus Loading (kg/yr)			
Existing	**Proposed with 80% Removal**	**Proposed (unmitigated)**	**Proposed with BMPs**
5.73	8.72	43.62	3.86

As shown in **Table 2.3**, based on the proposed LID's there is a decrease in phosphorus loading when compared to existing, while still removing more than 80% of proposed phosphorus loading. As the overall annual phosphorus loading is required to be offset per the Lake Simcoe Phosphorus Offset Program, all efforts will be explored at detailed design to further minimize phosphorus loadings.

2.9 Water Balance

Due to high groundwater elevations on site, a best efforts approach will be implemented to maintain existing groundwater recharge. It is noted that per the Hydrogeological Assessment (**Appendix B**), that it is anticipated that the proposed LIDs will provide adequate control to offset the infiltration deficit, to be confirmed at detailed design.

It is noted that the proposed development is not located in a wellhead protection area or an area of significant groundwater recharge as shown on the Simcoe County mapping included in **Appendix B**. The northwest corner of the site, adjacent to the existing Thicketwood Avenue ROW is mapped as highly vulnerable aquifer and as such LID's are proposed to treat stormwater in this location.

2.10 Storm Servicing

The storm sewer system (minor system) will be designed for the 5 year return period storm per City of Barrie standards.

The major system drainage will generally be conveyed overland along the proposed ROW's. Per the City of Barrie standards, flow depth on roads shall not exceed 0.20 m above the crown of any local road or 0.10 m above the crown on any collector road.

The storm sewer system will typically be designed with grades between 0.5% and 5%. Throughout the proposed development, the storm sewer will be constructed at a minimum depth of 1.5 m to obvert to provide frost protection and 3.0 m where basement connections are required per City of Barrie standard drawing BSD-75B. The preliminary layout for the proposed storm sewer within the subject lands is provided on **Figure 2.2**. There are no anticipated crossing conflicts with the sanitary sewer as per City of Barrie standards, basements are not to be connected to the storm sewer, unless directed by City staff. It is anticipated that through crossings with the watermain connections, the storm sewer will typically be at a depth of 2.5 m. Due to the overall site grading and proposed SWM pond NWL, it is noted that the storm sewer network could be designed to connect all residential connections to the storm sewer via gravity.

The storm sewer system will be designed in accordance with the City of Barrie and MOECP guidelines, including the following:

- Pipes to be sized to accommodate runoff from a 5 year storm event,
- Minimum Pipe Slope 0.5 %
- Maximum Flow Velocity: 4.0 m/s,
- Minimum Flow Velocity: 0.75 m/s,
- Minimum Pipe Depth: 1.5 m to obvert (per City Standard BSD-76 or BSD-75A), 3.0 m where basement connections are required (per City Standard BSD-75B).

The rainfall intensity will be calculated using A, B, and C values per **Table 2.4**:

Table 2.4: Rainfall Intensity Parameters

Return Period Storm	A	B	C
2 Year	678.085	4.699	0.781
5 Year	853.608	4.699	0.766
10 Year	975.865	4.699	0.760
25 Year	1146.275	4.922	0.757
50 Year	1236.152	4.699	0.751
100 Year	1426.408	5.273	0.759

2.11 Overland Flow

Major system flows will be conveyed within the ROWs to the proposed SWM pond. Overland flow capacity calculations are provided in **Appendix C** and show that the major system flows can be safely conveyed within the proposed ROW and overland flow block to the proposed SWM pond per City of Barrie criteria. It is noted that as shown in the calculations, boulevards are to be sloped at 5% to accommodate overland flow within the Street B ROW adjacent to the SMW pond and institutional block, to be confirmed at detailed design.

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3.0 SANITARY SERVICING

3.1 Existing Sanitary Sewer System

As illustrated in the SIS, the existing sanitary sewers adjacent to the subject development include a stub for a 375 mm diameter pipe flowing west located on the east limit of Thicketwood Avenue (connection E2) in addition to a stub for a 250 mm diameter pipe flowing west located at the east limit of Fenchurch Avenue (connection E1).

The existing sanitary infrastructure adjacent to the Hewitt's SPA was investigated as part of the SIS. Excerpts relevant to the subject development are included in **Appendix B**.

3.2 Proposed Sanitary Sewer System

As outlined in the SIS, the subject development will be serviced at two connection points to existing sanitary sewers. Sanitary flows from the north portion of the subject development in addition to flows from external lands to the east will be serviced by the existing 375 mm diameter sewer located at connection point E2. The remaining portion of the subject development in addition to the external lands to the south will be serviced by the existing 250 mm diameter sewer located at connection point E1.

As shown on **Figure 3.1**, the subject development as well as the external lands to the east will contribute sanitary drainage to the E2 connection point from a total area of 32.64 ha. These flows will be generated via 405 residential units within the proposed development, 480 residential units from the external development to the east as well as the proposed institutional block within the drainageshed.

The remainder of the subject development in addition to the external lands to the south will contribute flows from a total area of 9.87 ha. These flows will be generated via 189 residential units within the proposed development and 56 residential units from the future development to the south, and will be serviced by an existing 250 mm diameter sewer located at connection point E1.

The preliminary layout for the proposed sanitary sewers within the subject development is provided on **Figure 3.1**.

The sanitary sewer system will be designed in accordance with the City of Barrie and MOECP criteria, including but not limited to:

- Residential Sanitary Generation Rate: 225 l/c/d,
- Population Density: 3.13 people/unit for single detatched dwellings, and 2.34 people/unit for townhomes and walk-up apartments,
- Institutional/Commercial Demand 28 m^3/day/ha,
- Design capacity: maximum 85% full flow,
- Peaking Factor: Harmon (1.5-4),
- Infiltration Rate: 0.1 L/s/ha,
- Minimum Pipe Size: 250 mm diameter,
- Minimum Pipe Cover: 2.5 m,

- Minimum Actual Velocity: 0.75 m/s, and
- Maximum Velocity: 3.0 m/s.

As shown in the calculations provided in **Appendix D**, the total sanitary flow to connection points E1 and E2 has increased from 28.1 L/s as proposed in the SIS to 33.9 L/s due to an increase in proposed density. However, as stated in the SIS, the existing downstream infrastructure has sufficient capacity to convey this increase. In addition it is noted that the calculations were completed assuming the maximum population density of 120 units per hectare for the internal and external mixed use blocks.

Similar to the interim storm sewer design as discussed in **Section 2.**4, an interim sanitary sewer design is illustrated on **Figure 3.1. S**hould the external lands to the south not move forward at the time of the construction of Street ‘M’ the interim sanitary sewer would extend from the southwest corner of Street ‘M’, through frozen future residential lots, connecting to the proposed Street ‘K’ sanitary sewer. It is noted that should this be required, the sanitary sewers downstream of Street ‘K’ need to be designed both for depth and size to accommodate this area. It is noted that this would not have a negative impact on existing downstream infrastructure as this option diverts sanitary flow from the more restricted connection E1 to E2.

4.0 WATER SUPPLY AND DISTRIBUTION

4.1 External Water Supply

As indicated in the Watermain Analysis, completed by Municipal Engineering Solutions, and on **Figure 4.1** the following existing watermains are located to the west of the proposed development:

- 300 mm diameter watermain on Lockhart Road, terminating at the existing hydrant east of Priscilla's Place;
- 150 mm diameter watermain at the termination of Fenchurch Manor;
- 150 mm diameter watermain at the termination of Thicketwood Avenue; and
- 200 mm diameter watermain at the intersection of the pedestrian pathway and Thicketwood Avenue.

4.2 Internal Water Distribution

The preliminary layout for the proposed watermain system, as outlined in the watermain analysis, is provided on **Figure 4.1.**

As described in the watermain analysis, the existing 150 mm diameter watermain from the existing pedestrian pathway to the eastern limit of Thicketwood Avenue will need to be replaced with a 200 mm diameter watermain. In addition, the watermain analysis indicates that ultimately the existing 300 mm diameter watermain on Lockhart Road will need to be extended to service the proposed development.

As noted in the watermain analysis, the extension of external watermain could be phased with development. The analysis notes that to provide adequate fire protection to the proposed townhouse units the 300 mm diameter watermain will need to be extended to the property boundary.

The watermain system will be designed in accordance with the City of Barrie and MOECP criteria including:

- Residential water usage rate: 57 L/s,
- Schools: 91 L/s,
- Minimum Pipe Size: 150 mm diameter,
- Minimum Pipe Depth: 1.7 m, and
- Maximum Hydrant Spacing: 152 m.

At detailed design, efficiencies will be explored based on timing and phasing to limit the extent of external infrastructure required within Lockhart Road.

5.0 SITE GRADING

5.1 Existing Grading Conditions

As illustrated on **Figure 2.1** under existing conditions, the site is generally sloped down at five to fifteen percent from a high point located in the central south portion of the site.

5.2 Proposed Grading Concept

In general, the subject development will be graded in a manner which will satisfy the following goals:

- Satisfy the Municipality lot and road grading criteria including:
    - Minimum Road Grade: 0.5%
    - Maximum Road Grade: 7.0%
    - Minimum Lot Grade: 2%
    - Maximum Lot Grade: 5%
- Provide continuous road grades for overland flow conveyance;
- Minimize the need for retaining walls;
- Minimize the volume of earth to be moved and minimize cut/fill differential;
- Minimize the need for rear lot catchbasins
- Underside of the floor slab should be set 0.5 m higher than seasonal groundwater level (where feasible); and
- Achieve the SWM objectives required for the subject development.

A preliminary grading plan is provided on **Figure 5.1**.

It is noted that the groundwater levels adjacent to the existing environmental protection lands, as well as at Thicketwood Avenue eliminate the potential for 0.5 m separation of the underside of floor slab and the seasonally high groundwater elevation. As shown on **Figure 5.1**, every effort has been made to raise the elevations of the road and lots to limit this condition to as few lots as possible. The critical grading path is from the low point on Street ‘B’ at the SWM pond access block to the elbow on Street ‘D’. As shown on **Figure 5.1**, centerline road grading has been contemplated at 0.5% but could be further raised should the City accept saw-tooth grading within this alignment.

In addition, single loaded boulevards adjacent to Lockhart Road to the south and the environmental buffer to the north have been designed to be reverse graded at max 3:1, 0.5 m behind the back of curb. As shown on **Figure 5.1**, there is a minor grading encroachment of 5.0 m max adjacent to Street ‘B’. Regarding Lockhart Road, the proposed elevations at the extent of the future road widening are 0-0.5 m than existing, which is typically below existing and assumed to be able to be achieved through the future design of Lockhart Road.

At the detailed design stage, the preliminary grading shown on **Figure 5.1** will be subject to a more in-depth analysis in an attempt to limit the export of material and minimize slopes.

6.0 RIGHT-OF-WAYS AND SIDEWALKS

The majority of the subject development is composed of 18 m and 24 m ROWs for which cross-sections will be in accordance with the City of Barrie Standard Drawing BSD-43 and BSD-303 respectively (**Appendix B**).

Should ROW LIDs be proposed at detailed design, the standard ROW sections will be replaced with the modified standards proposed on **Figures 2.4** & **2.5.**

The proposed sidewalk location plan is provided on **Figure 6.1**.

7.0 COST-SHARING

The cost of infrastructure which benefits multiple properties, such as trunk storm sewers, trunk sanitary sewers, sanitary pumping stations, watermains, collector roads, and stormwater management facilities, should be shared by the benefiting landowners. The landowners within the Hewitt's Creek Secondary Plan (including Barrie Lockhart Road LP) have established a cost sharing agreement which sets out the principles in which these costs will be equitably shared.

8.0 EROSION AND SEDIMENT CONTROL DURING CONSTRUCTION

During the detailed design stage, erosion and sediment control measures will be designed with a focus on erosion control practices (such as stabilization, track walking, staged earthworks, etc.) as well as sediment controls (such as fencing, mud mats, catchbasin sediment control devices, rock check dams and temporary sediment control ponds). These measures will be designed and constructed as per the "Erosion and Sediment Control Guideline for Urban Construction" document (December 2006). A detailed erosion and sediment control plan will be prepared for review and approval by the Municipality and Conservation Authority prior to any site grading being undertaken. This plan will address phasing, inspection and monitoring aspects of erosion and sediment control. All reasonable measures will be taken to ensure sediment loading to the adjacent watercourses and properties are minimized both during and following construction.

9.0 UTILITY CONSIDERATIONS

Utility coordination for the overall Hewitt’s Secondary Plan Area has been undertaken by the Hewitt’s Land Owner Group. Specific servicing details will be provided with the detailed engineering submissions. We note that the utility providers for the proposed development are as follows:

- Hydro – InnPower
- Gas – Enbridge Gas
- Communications – Rogers & Bell

10.0 SUMMARY

This Functional Servicing Report has been prepared in support of the Draft Plan of Subdivision application for the proposed development in the City of Barrie. This report outlines the means by which the proposed development can be graded and serviced in accordance with previously approved reports and the City of Barrie, Lake Simcoe Region Conservation Authority, and Ministry of Environment, Conversation and Parks design criteria and policies.

<u>General Information</u>

- The existing land use is cropland;
- The subject development is located in the Lover's Creek subwatershed in the Lake Simcoe watershed; and
- The proposed development consists of;
  - low density residential,
  - mixed-use,
  - institutional,
  - parks,
  - open space,
  - SWM pond block, and
  - proposed roads.

<u>Stormwater Management</u>

- Quantity Control: Peak Flow Control – will be provided via the proposed downstream SWM pond;
- Quantity Control: Volume Control – will be provided by centralized municipal LIDs with the optional incorporation of ROW based LIDs should they be required at detailed design;
- Quality Control: MOECP Enhanced (Level 1) water quality protection can be provided through the use of LIDs and the proposed SWM pond;
- Erosion Control: The runoff volume from a 25 mm rainfall event will be detained over a period of 24 hours by the downstream SWM pond;
- Water Balance: A best efforts approach has been contemplated, and the proposed LID's are anticipated provide adequate mitigation as indicated in the Hydrogeological Assessment;
- Phosphorus Budget: A phosphorus budget analysis was completed using the MOECP phosphorus budget tool, which shows that the proposed phosphorus export meets the applicable criteria. The remaining phosphorus loading will be offset per the LSRCA Phosphorus Offsetting Policy.

<u>Storm Servicing</u>

- Storm runoff will be conveyed by storm sewers designed in accordance with City of Barrie and MOECP criteria;
- Storm sewers will be designed for the 5 year storm event; and
- Adequate 100 year overland flow routes will be provided.

<u>Sanitary Servicing</u>

- Sanitary servicing is to be provided for the subject development via two connection points, E1 & E2, to the existing downstream infrastructure in conformity with the SIS.

Water Supply

- Water servicing is proposed per the Watermain Assessment, the staging of which is to be assessed further at detailed design.

Site Grading

- The preliminary site grading has been developed to match to the existing surrounding grades in addition to the proposed grades of adjacent development, and provide conveyance of stormwater runoff, including external drainage; and
- The preliminary lot grading will be subject to further grading design at the detailed design stage

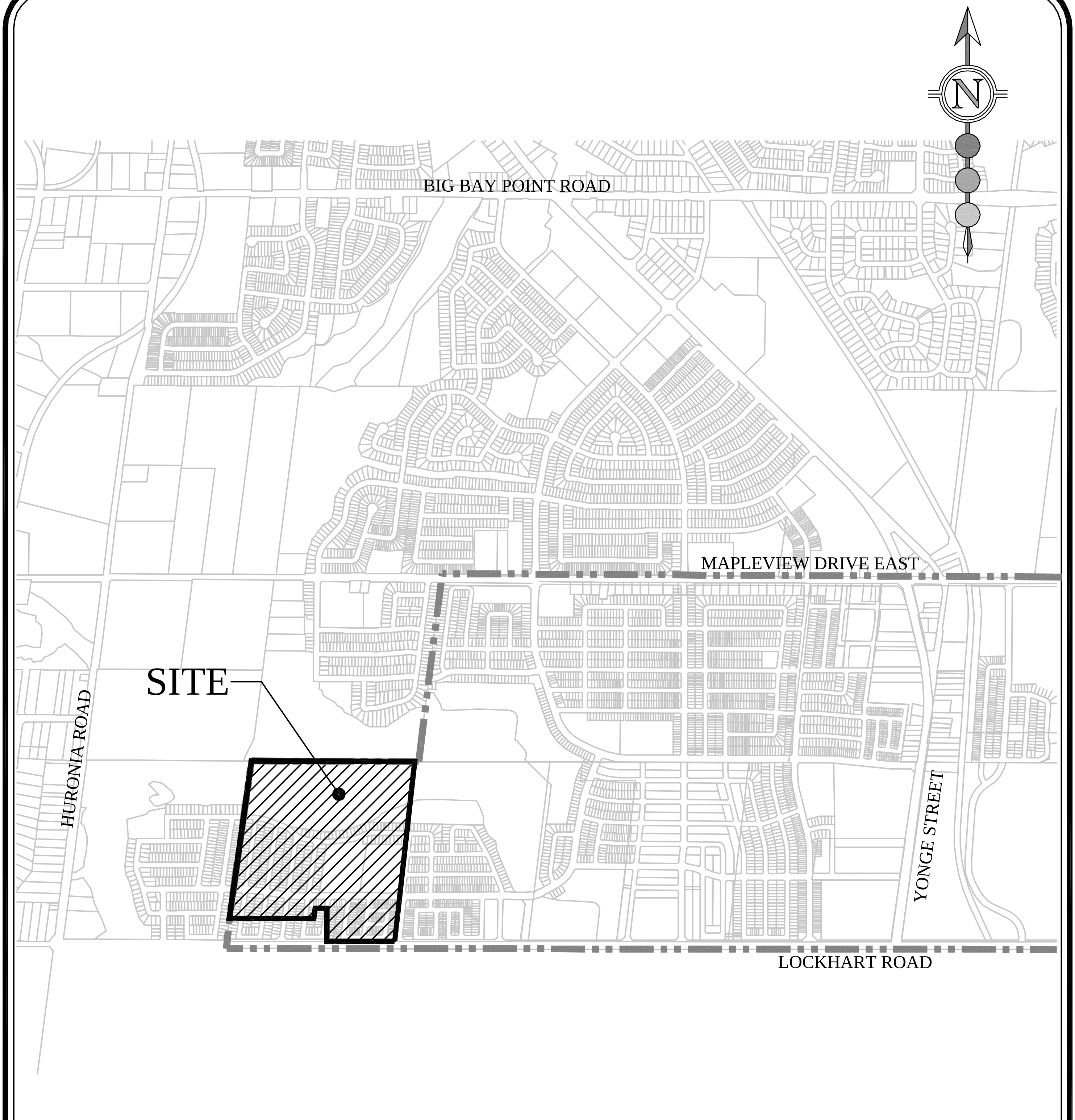
Respectfully Submitted:

SCS Consulting Group Ltd.

LICENSED PROFESSIONAL ENGINEER
J. M. PRIAMO
100126893
Oct 22 2018
PROVINCE OF ONTARIO

Marc Tremblay
mtremblay@scsconsultinggroup.com

John Priamo, P.Eng.
jpriamo@scsconsultinggroup.com



*NOTE: LAYOUT IS SCHEMATIC ONLY, DETAILS TO BE PROVIDED AT DETAILED DESIGN STAGE.

SITE LOCATION PLAN

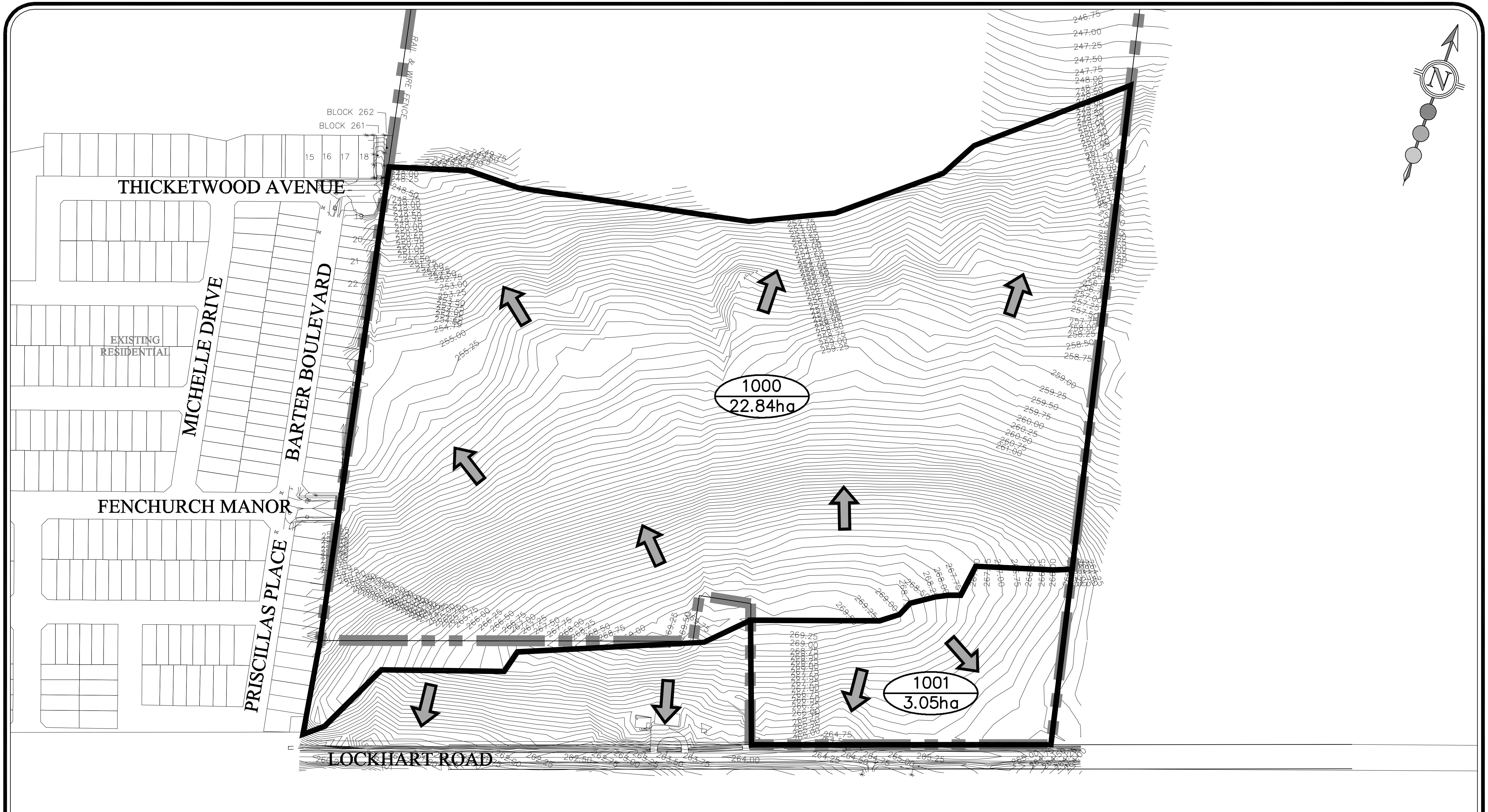
— · · —	HEWIT'S CREEK SECONDARY PLAN AREA
▨	SUBJECT DEVELOPMENT - PHASE 1

BARRIE LOCKHART ROAD-SORBARA

DRAWN BY:	L.G.	CHECKED BY:	J.M.P.
SCALE:	N.T.S.	DATE:	OCTOBER 2018
PROJECT No:	2000	FIGURE No:	1.1

SCS consulting group ltd

30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335



*NOTE: LAYOUT IS SCHEMATIC ONLY, DETAILS TO BE PROVIDED AT DETAILED DESIGN STAGE.

LEGEND:

▬ ▬ ▬	LIMIT OF DEVELOPMENT	➡	EXISTING OVERLAND FLOW
▬▬▬	STORM DRAINAGE BOUNDARY	0.50	CATCHMENT ID
270.25	EXISTING CONTOUR	0.20ha	DRAINAGE AREA (HECTARES)

SCS consulting group ltd
30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

BARRIE LOCKHART ROAD - SORBARA

EXISTING STORM DRAINAGE PLAN

DESIGNED BY:	M.T.T.	CHECKED BY:	J.M.P.
SCALE:	1:3000	DATE:	OCTOBER 2018

PROJECT No: 2000

FIGURE No: 2.1

File: P:\2000 Barrie Lockhart Road – Sorbara\Drawings\FSP\Fig\Report Figures\2000P–STRM–EXST–X.X.dwg – Revised by <FBISDA> : Fri, Aug 10 2018 – 9:03am

*NOTE: LAYOUT IS SCHEMATIC ONLY, DETAILS TO BE PROVIDED AT DETAILED DESIGN STAGE.

LEGEND:

▬ ▪ ▪ ▬	PROPERTY LIMIT
━━━	PROPOSED STORM DRAINAGE BOUNDARY
━▶━○━	PROPOSED STORM SEWER
-·▶·○·-	INTERIM STORM SEWER
‑ ‑▶‑○‑ ‑	FUTURE STORM SEWER
⇨	OVERLAND FLOW ROUTE
270.25	EXISTING CONTOUR
1.20ha	DRAINAGE AREA (HECTARES)
72%	PERCENT (%) IMPERVIOUS
202	CATCHMENT ID
1.77ha	EXTERNAL STORM DRAINAGE AREA (HECTARES)
72%	PERCENT (%) IMPERVIOUS
404	CATCHMENT ID

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30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

BARRIE LOCKHART ROAD - SORBARA

PROPOSED STORM DRAINAGE PLAN

DESIGNED BY:	M.T.T.	CHECKED BY:	J.M.P.
SCALE:	1:1500	DATE:	OCTOBER 2018

PROJECT No: 2000

FIGURE No: 2.2

File: P:\2000 Barrie Lockhart Road – Sorbara\Drawings\FSP\Fig\Report Figures\2000P–STRM–PROP–2.2.dwg – Revised by <HDUNNINGS> : Tue, Oct 23 2018 – 10:19am

*NOTE: LAYOUT IS SCHEMATIC ONLY, DETAILS TO BE PROVIDED AT DETAILED DESIGN STAGE.

LEGEND:

▬ ▬ ▬	LIMIT OF PROPERTY
▬	STORM DRAINAGE BOUNDARY
🟩	PROPOSED HYBRID BIOSWALE
🟪	PROPOSED LINED BIOSWALE
🟦	OPTIONAL SUBSURFACE EXFILTRATION TRENCH
🟧	OPTIONAL UNLINED RAIN GARDEN
🟥	OPTIONAL LINED RAIN GARDEN
➡	OVERLAND FLOW ROUTE
▨	PROPOSED BELOW GRADE FILTRATION GALLERY
▨	PROPOSED WETLAND
◎	FILTRATION BASED PRE-TREATMENT DEVICE

1.20ha — DRAINAGE AREA (HECTARES)
72% — PERCENT (%) IMPERVIOUS
202 — CATCHMENT ID

0.31ha — EXTERNAL STORM DRAINAGE AREA (HECTARES)
72% — PERCENT (%) IMPERVIOUS
202 — CATCHMENT ID

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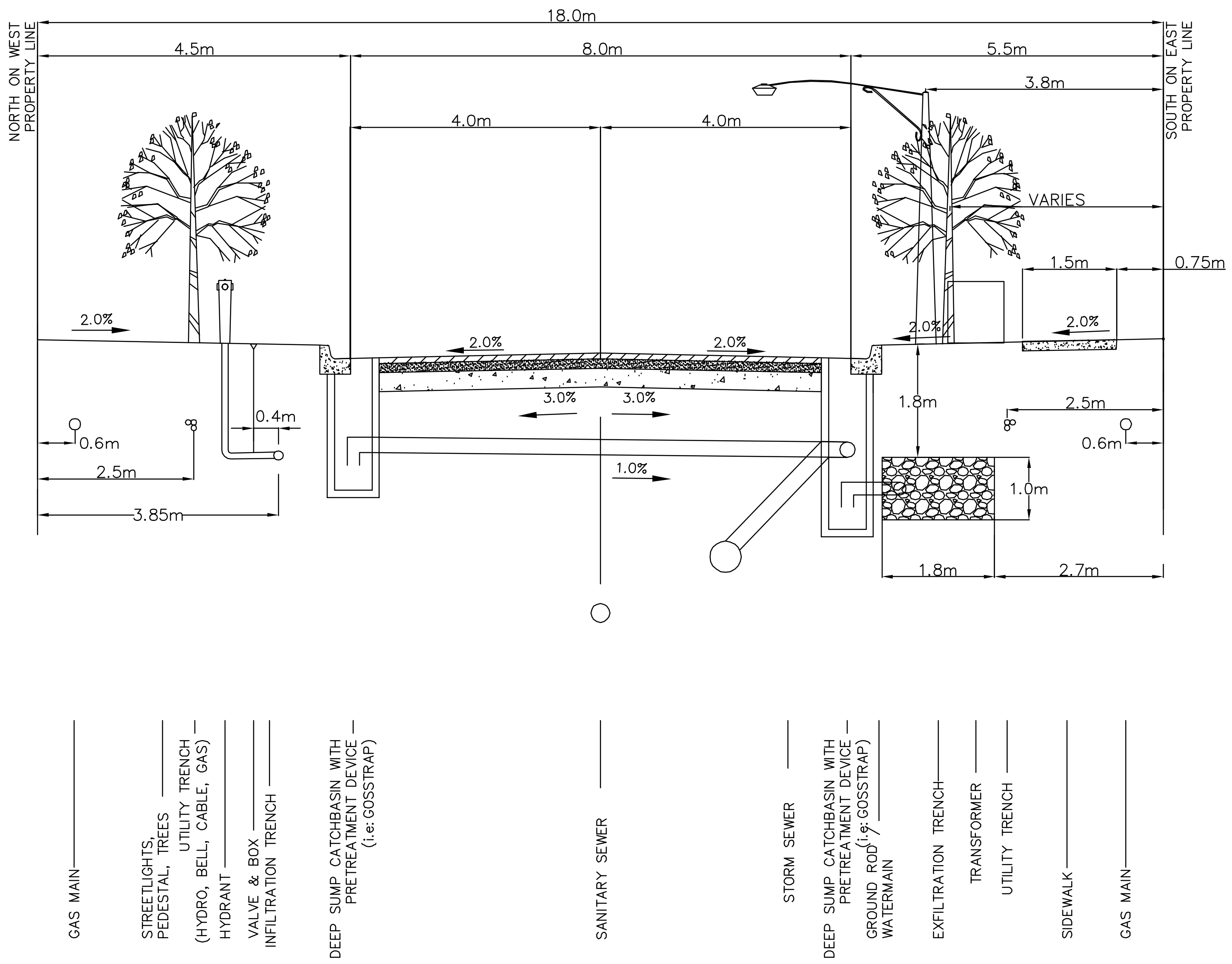
TEL: (905) 475-1900
FAX: (905) 475-8335

BARRIE LOCKHART ROAD - SORBARA

POTENTIAL AND PROPOSED L.I.D. LOCATIONS

DESIGNED BY: M.T.T.
CHECKED BY: J.M.P.
SCALE: 1:1500
DATE: OCTOBER 2018
PROJECT No: 2000
FIGURE No: 2.3

File: P:\2000 Barrie Lockhart Road – Sorbara\Drawings\FSP\Fig\Report Figures\2000P-LIDS-2.3.dwg – Revised by <HDUNNINGS> : Tue, Oct 23 2018 – 10:36am



*NOTE: LAYOUT IS SCHEMATIC ONLY, DETAILS TO BE PROVIDED AT DETAILED DESIGN STAGE.

BARRIE LOCKHART
ROAD - SORBARA

FSR

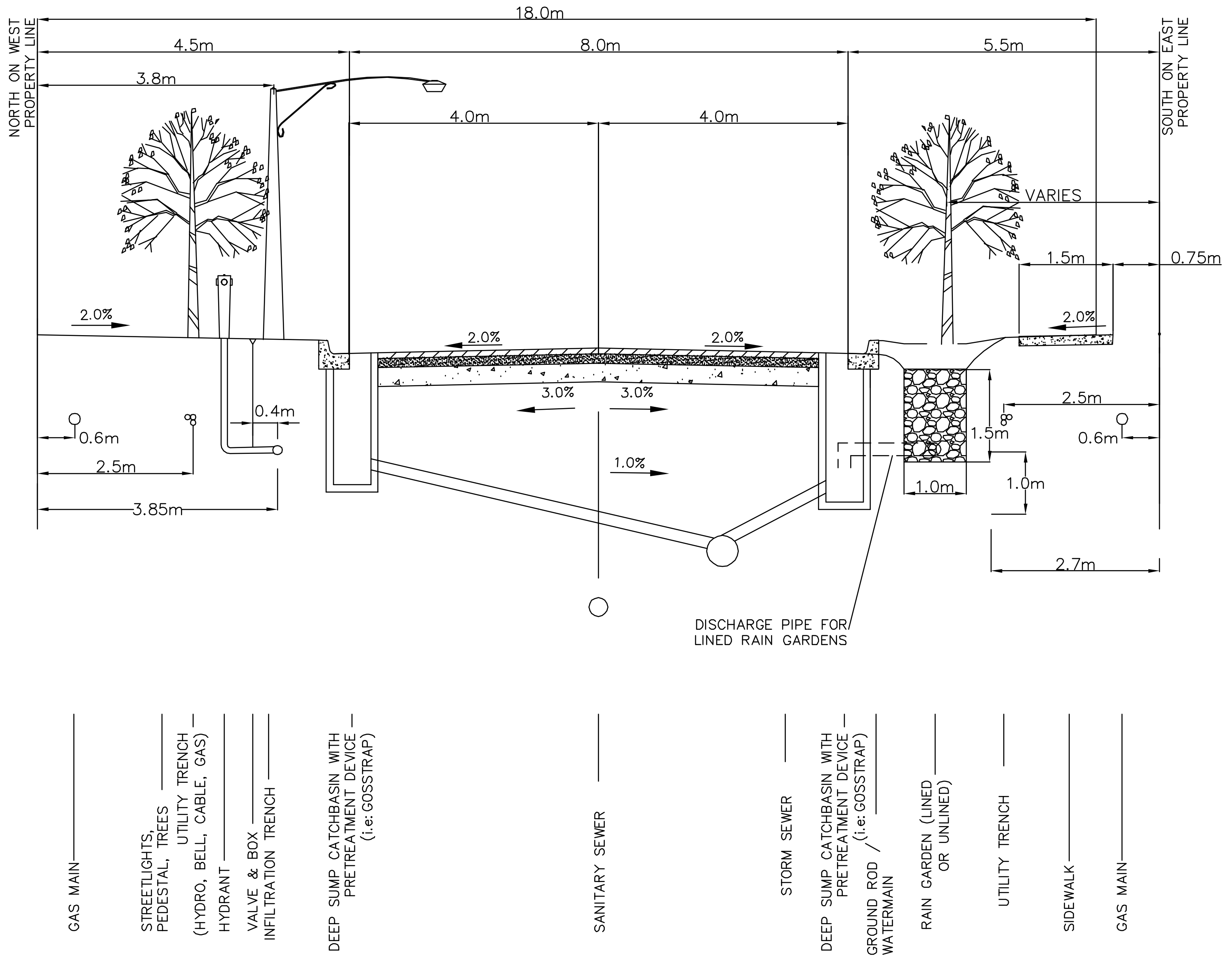
PRELIMINARY EXFILTRATION
TRENCH LAYOUT IN 18m R.O.W.

SCS consulting group ltd
30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

DESIGNED BY: M.T.
CHECKED BY: J.M.P.
SCALE: 1:1000
DATE: OCTOBER 2018

PROJECT No: 2000
FIGURE No: 2.4

File: P:\2000 Barrie Lockhart Road - Sorbara\Drawings\FSP\Fig\Report Figures\2000P-SWMN-ROWS-2.4-(C3D).dwg - Revised by <NPOLITIS> : Mon, Oct 22 2018 - 11:00am



*NOTE: LAYOUT IS SCHEMATIC ONLY, DETAILS TO BE PROVIDED AT DETAILED DESIGN STAGE.

BARRIE LOCKHART ROAD - SORBARA	FSR	PRELIMINARY RAIN GARDEN LAYOUT IN 18m R.O.W.

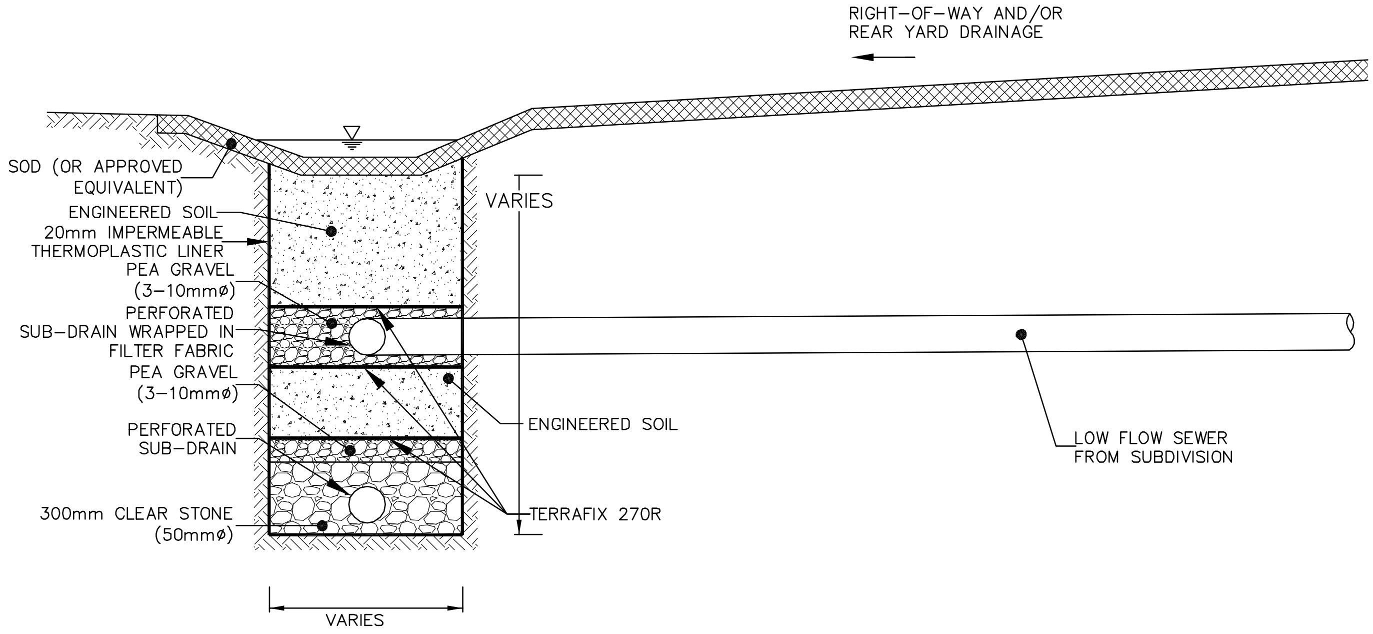
SCS consulting group ltd
30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

DESIGNED BY:	M.T.	CHECKED BY:	J.M.P.
SCALE:	1:1000	DATE:	OCTOBER 2018

PROJECT No: 2000

FIGURE No: 2.5

File: P:\2000 Barrie Lockhart Road – Sorbara\Drawings\FSP\Fig\Report Figures\2000P-SWMN-ROWS-2.5-(C3D).dwg – Revised by <NPOLITIS> : Mon, Oct 22 2018 – 10:59am



*NOTE: LAYOUT IS SCHEMATIC ONLY, DETAILS TO BE PROVIDED AT DETAILED DESIGN STAGE.

BARRIE LOCKHART
ROAD - SORBARA

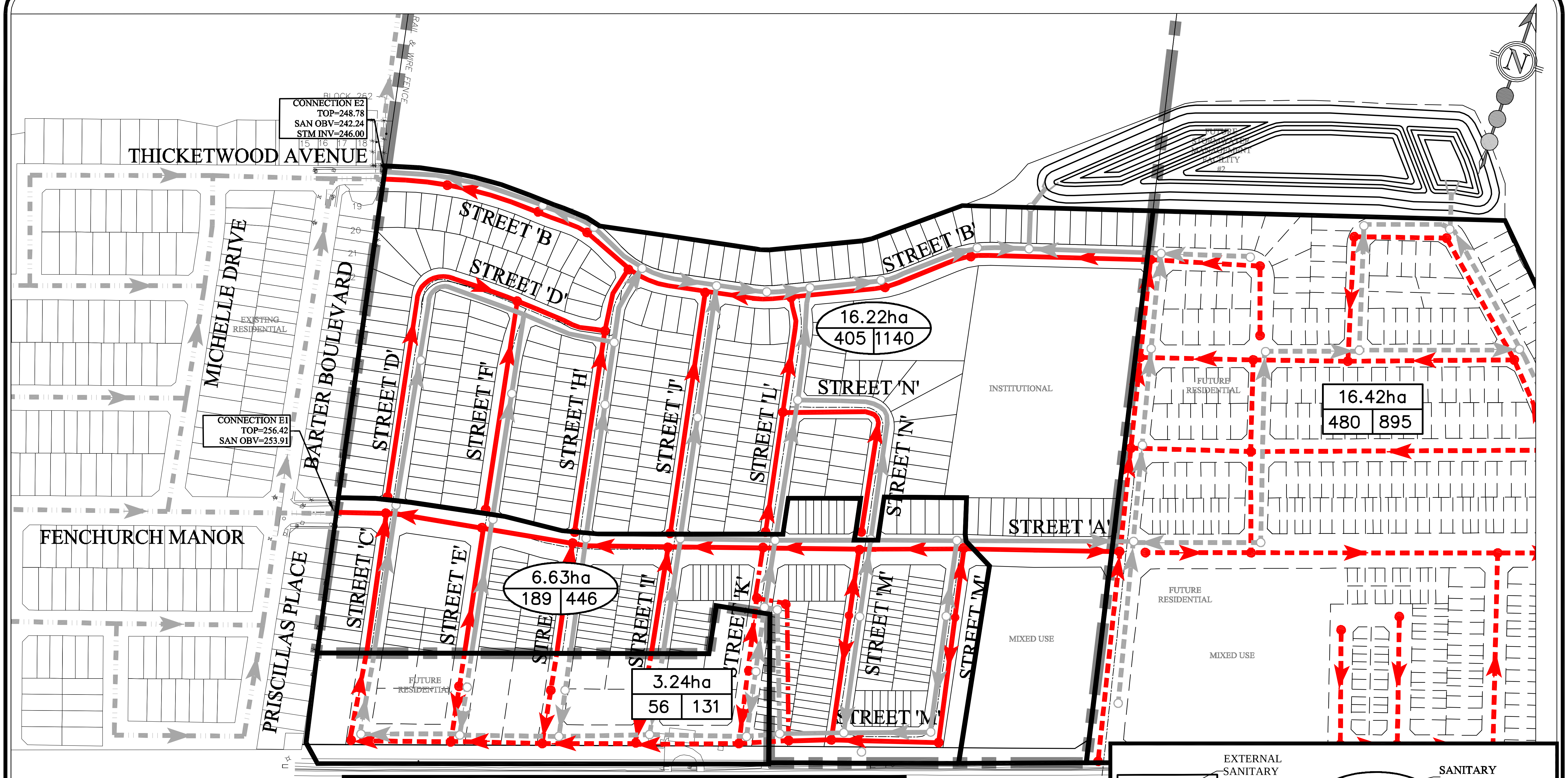
FSR

PRELIMINARY HYBRID
BIOSWALE LAYOUT

SCS consulting group ltd
30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

DESIGNED BY: M.T.
CHECKED BY: J.M.P.
SCALE: NTS
DATE: OCTOBER 2018
PROJECT No: 2000
FIGURE No: 2.6

File: P:\1900 Rainsong Development - Barrie\Drawings\FSP - Phase 1\Fig\Report Figures\1900P-SWMN-ROWS-2.6-(C3D).dwg - Revised by <CMAIER-DOWNING> : Fri, Apr 07 2017 - 11:48am



*NOTE: LAYOUT IS SCHEMATIC ONLY, DETAILS TO BE PROVIDED AT DETAILED DESIGN STAGE.

LEGEND:

▬	SANITARY DRAINAGE BOUNDARY
▬ ▬ ▬	LIMIT OF DEVELOPMENT
270.25	EXISTING CONTOUR
➤○	PROPOSED STORM SEWER
➤●	POTENTIAL INTERIM SANITARY SEWER
➤●	EXISTING SANITARY SEWER
➤●	PROPOSED SANITARY SEWER
➤●	FUTURE SANITARY SEWER
➤○	FUTURE STORM SEWER
➤○	POTENTIAL INTERIM STORM SEWER

SCS consulting group ltd

30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

BARRIE LOCKHART ROAD - SORBARA

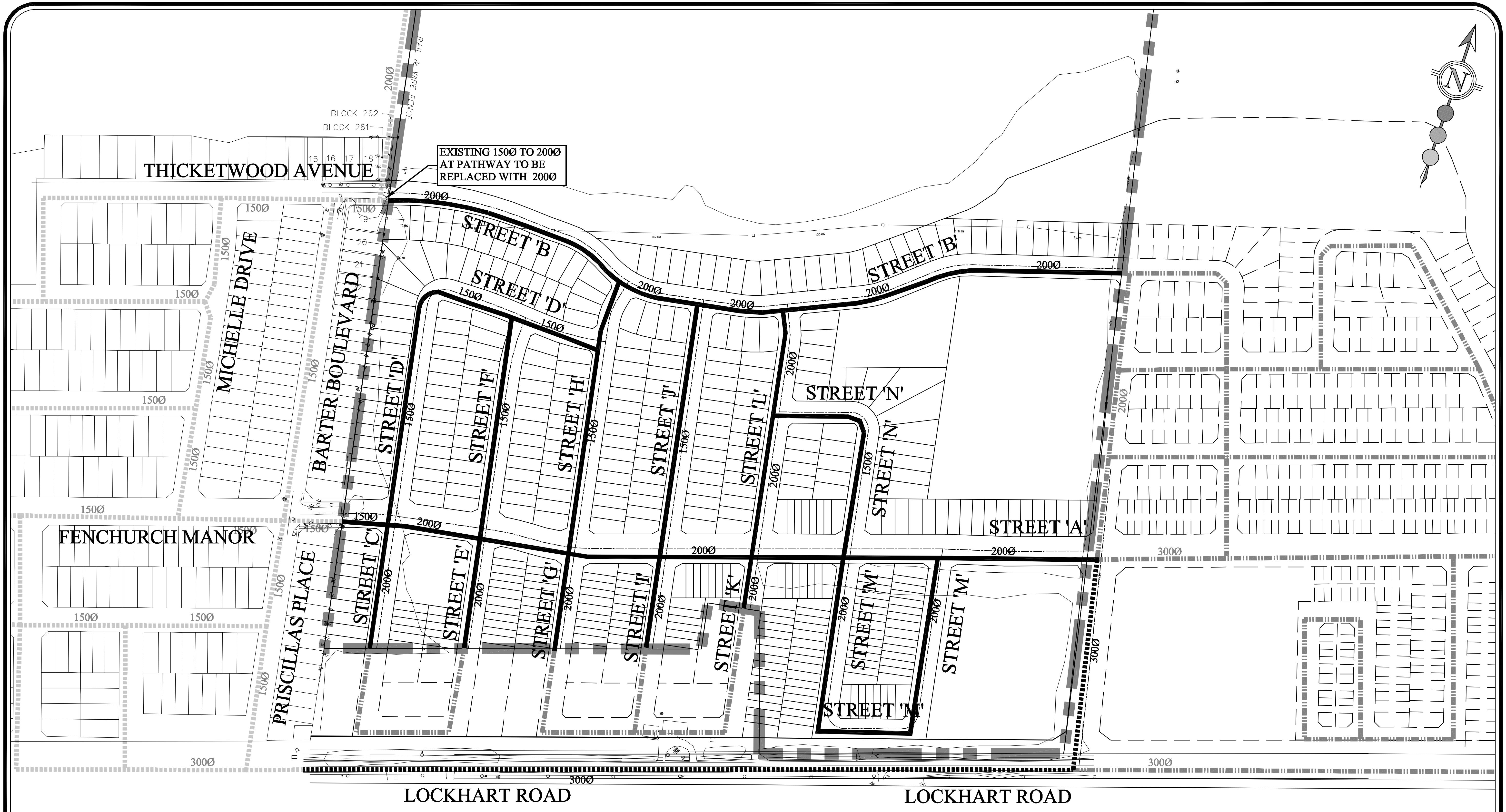
PRELIMINARY SANITARY SERVICING PLAN

DESIGNED BY:	M.T.T.	CHECKED BY:	J.M.P.
SCALE:	1:3000	DATE:	OCTOBER 2018

PROJECT No: 2000

FIGURE No: 3.1

File: P:\2000 Barrie Lockhart Road – Sorbara\Drawings\FSP\Fig\Report Figures\2000P–Preliminary Sanitary Servicing Plan.dwg – Revised by <NPOLITIS> : Thu, Oct 18 2018 – 11:41am



*NOTE: LAYOUT IS SCHEMATIC ONLY, DETAILS TO BE PROVIDED AT DETAILED DESIGN STAGE.

LEGEND:

270.25	EXISTING CONTOUR	┈┈┈┈	EXISTING WATERMAIN
━━━━	LOCAL WATERMAIN	━ ━ ━	FUTURE WATERMAIN
▮▮▮▮▮▮	LOCAL TRUNK WATERMAIN		
▬ ▬ ▬	LIMIT OF DEVELOPMENT		

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30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

BARRIE LOCKHART ROAD - SORBARA

PROPOSED WATER DISTRIBUTION SYSTEM

DESIGNED BY:	M.T.T.	CHECKED BY:	J.M.P.
SCALE:	1:3000	DATE:	OCTOBER 2018

PROJECT No: 2000

FIGURE No: 4.1

File: P:\2000 Barrie Lockhart Road – Sorbara\Drawings\FSP\Fig\Report Figures\2000P–WTRM–4.1.dwg – Revised by <CMCCARTHY> : Tue, Oct 23 2018 – 10:23am

NORTH BOULEVARD OF 'STREET B' ADJACENT TO ENVIRONMENTAL AREA TO BE REVERSE GRADED AT MAX 3:1 TO MINIMIZE ENCROACHMENT. MAXIMUM GRADING IN BUFFER IS 5.0m

SOUTH BOULEVARD OF ALL WINDOW ROADS PROPOSED TO BE REVERSE GRADED TO MAX 3:1 TO ACCOMMODATE FUTURE LOCKHART ROAD WIDENING

SOUTH BOULEVARD OF ALL WINDOW ROADS PROPOSED TO BE REVERSE GRADED TO MAX 3:1 TO ACCOMMODATE FUTURE LOCKHART ROAD WIDENING

*NOTE: LAYOUT IS SCHEMATIC ONLY, DETAILS TO BE PROVIDED AT DETAILED DESIGN STAGE.

LEGEND:

▬ ▬ ▬	LIMIT OF DEVELOPMENT
270.25	LIMIT OF PHASE
× 223.91	PROPOSED ELEVATION
× 224.35 EX	EXISTING ELEVATION
× 223.91 FUT	FUTURE ELEVATION
3.5% →	MAXIMUM CENTRELINE GRADIENT
◀	PROP. ROAD FLAG (LOW POINT)
▶	PROP. ROAD FLAG (HIGH POINT)
S	SPLIT DRAINING LOT
F	FRONT DRAINING LOT
W/O	WALKOUT LOT TYPES
B/S	BACK SPLIT DRAINING LOT

SCS consulting group ltd

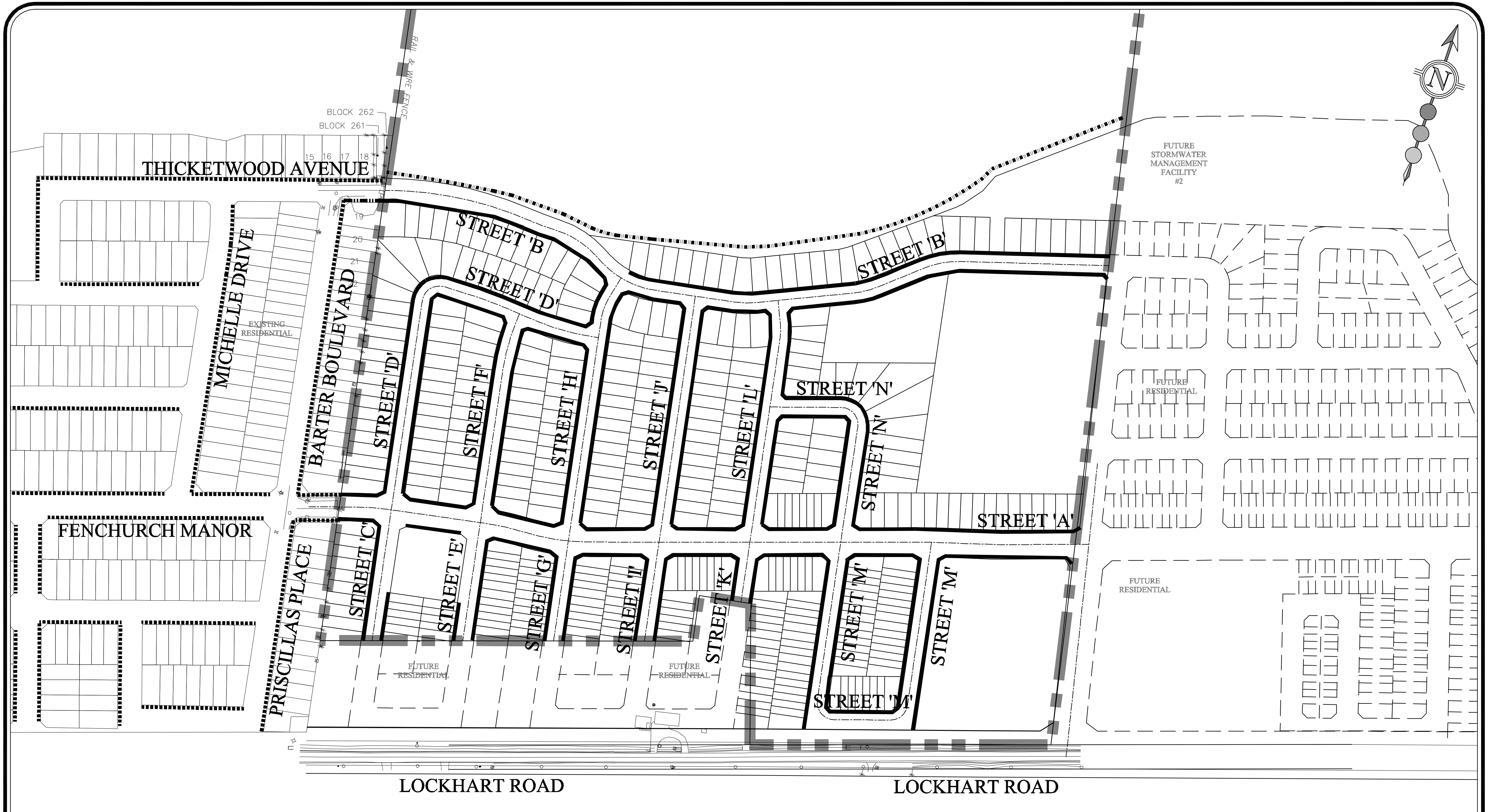
30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

BARRIE LOCKHART ROAD - SORBARA

PRELIMINARY GRADING PLAN

DESIGNED BY: M.T.T.
CHECKED BY: J.M.P.
SCALE: 1:1000
DATE: OCTOBER 2018
PROJECT No: 2000
FIGURE No: 5.1

File: P:\2000 Barrie Lockhart Road – Sorbara\Drawings\FSP\Fig\Report Figures\2000R–GRAD–5.1.dwg – Revised by <HDUNNINGS> : Tue, Oct 23 2018 – 10:37am



*NOTE: LAYOUT IS SCHEMATIC ONLY, DETAILS TO BE PROVIDED AT DETAILED DESIGN STAGE.

LEGEND:

SIDEWALK

EXISTING SIDEWALK

POTENTIAL TRAIL LOCATION

LIMIT OF DEVELOPMENT

270.25 EXISTING CONTOUR

SCS consulting group ltd
30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

BARRIE LOCKHART ROAD - SORBARA

PRELIMINARY SIDEWALK LAYOUT

DESIGNED BY:	M.T.T.	CHECKED BY:	J.M.P.
SCALE:	1:3000	DATE:	OCTOBER 2018

PROJECT No: 2000

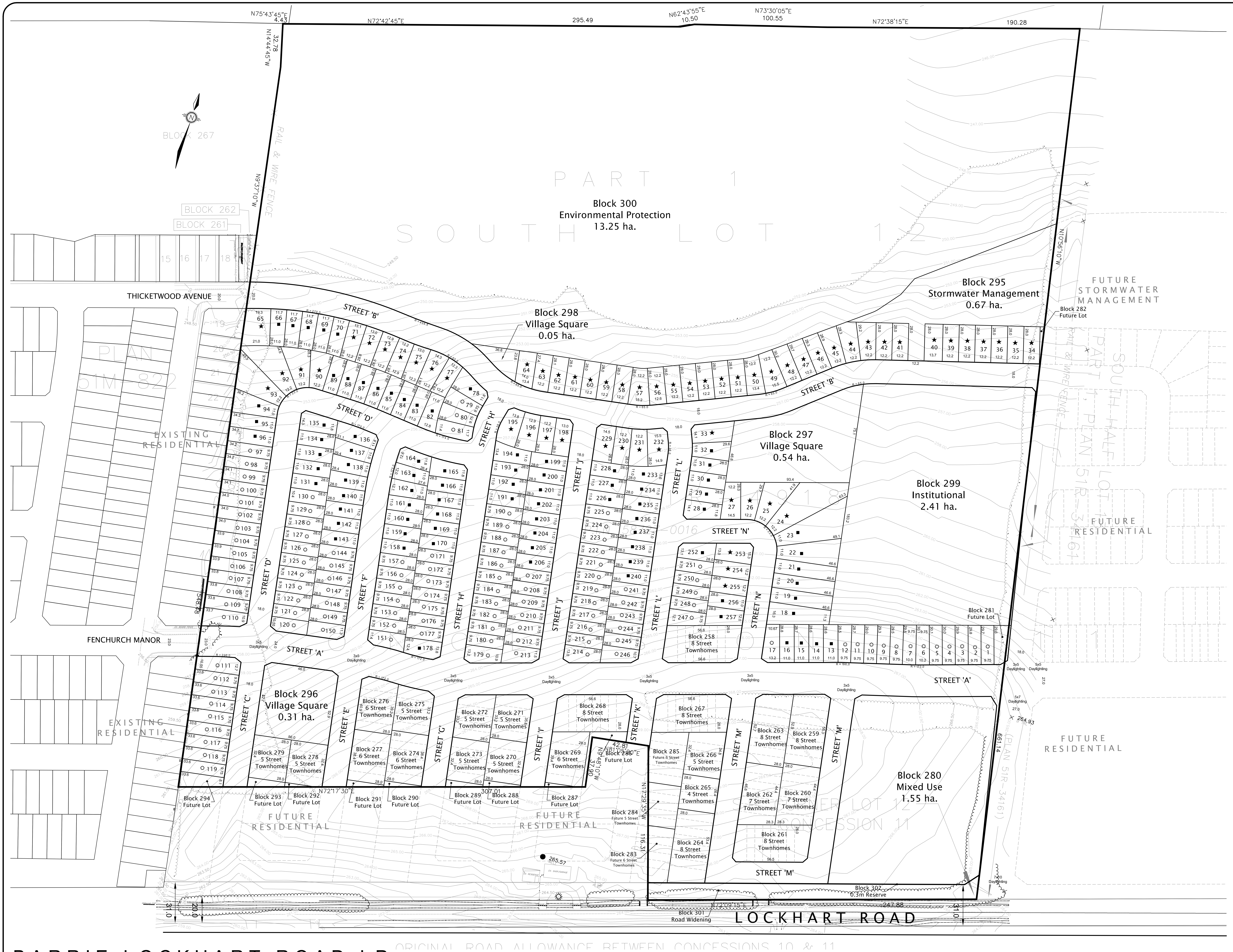
FIGURE No: 6.1

File: P:\2000 Barrie Lockhart Road – Sorbara\Drawings\FSP\Fig\Report Figures\2000P–SIDEWALKS – 6.1.dwg – Revised by <NPOLITIS> : Thu, Oct 18 2018 – 11:42am

APPENDIX A

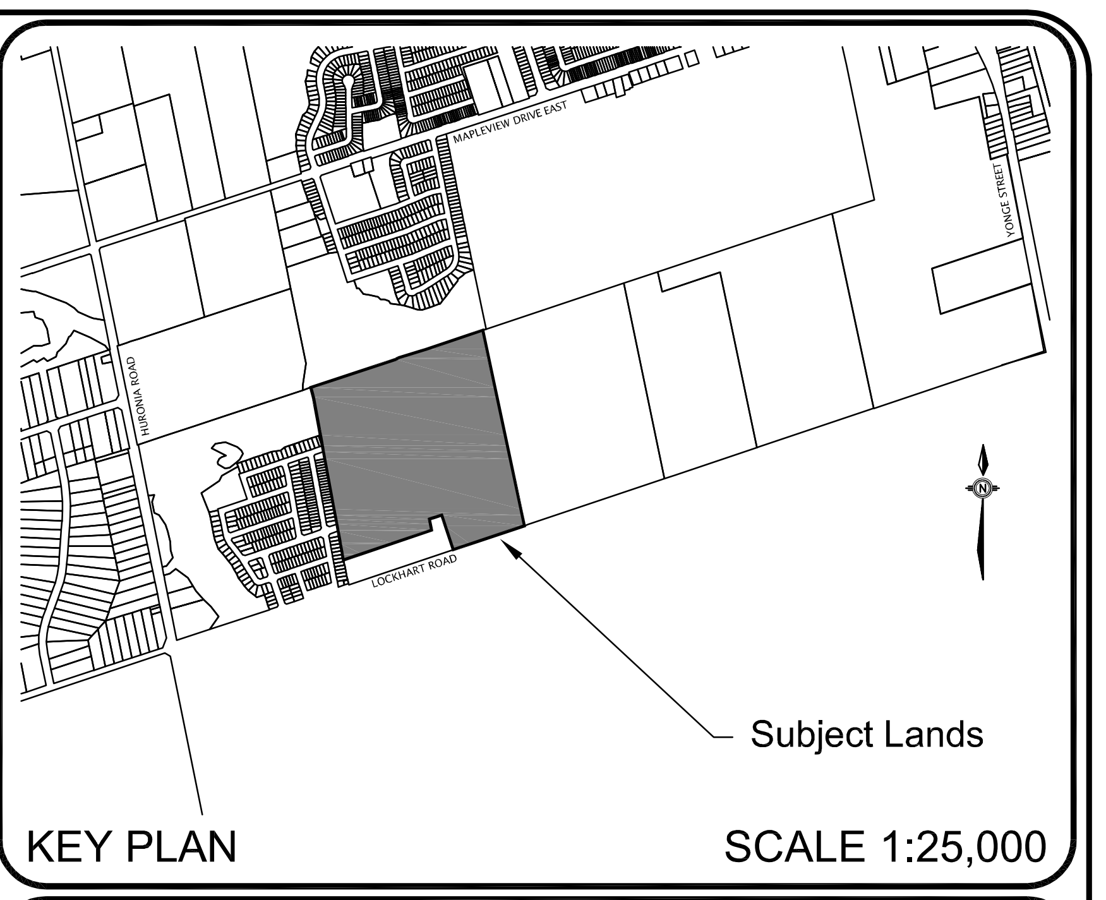
DRAFT PLAN

SCS consulting group ltd



BARRIE LOCKHART ROAD LP

CITY OF BARRIE



KEY PLAN SCALE 1:25,000

Draft Plan of Subdivision

Part of the South Half of Lot 12, Concession 11
Former Township of Innisfil, Now in the

City of Barrie

2018

OWNER'S CERTIFICATE

I, THE UNDERSIGNED, BEING THE REGISTERED OWNER OF THE SUBJECT LANDS, HEREBY AUTHORIZE THE JONES CONSULTING GROUP LTD., TO PREPARE THIS DRAFT PLAN OF SUBDIVISION AND TO SUBMIT SAME TO THE CITY OF BARRIE FOR APPROVAL.

DATE ______ OWNER ______

SURVEYOR'S CERTIFICATE

I CERTIFY THAT THE BOUNDARIES OF THE LANDS TO BE SUBDIVIDED AND THEIR RELATIONSHIP TO ADJACENT LANDS ARE ACCURATELY AND CORRECTLY SHOWN.

DATE ______ ONTARIO LAND SURVEYORS ______

ADDITIONAL INFORMATION REQUIRED UNDER SECTION 51(17) OF THE PLANNING ACT

a) SHOWN ON DRAFT PLAN
b) SHOWN ON DRAFT PLAN
c) SHOWN ON KEY PLAN
d) RESIDENTIAL, SWM, MIXED USE, OPEN SPACE, INSTITUTIONAL & EP
e) SHOWN ON DRAFT PLAN
f) SHOWN ON DRAFT PLAN
g) SHOWN ON DRAFT PLAN
h) MUNICIPAL PIPED WATER TO BE PROVIDED
i) SANDY/CLAY LOAM
j) SHOWN ON DRAFT PLAN
k) ALL MUNICIPAL SERVICES TO BE PROVIDED
l) SHOWN ON DRAFT PLAN

STATISTICS

RESIDENTIAL LOT BREAKDOWN

★ 12.2 m Singles		59 units
■ 11.0 m Singles		85 units
☼ 9.75 m Singles (LOTS 1 - 257)		113 units
SUB TOTAL	8.61 ha.	257 units
Street Townhomes (6.0 m/each) (BLOCKS 258 - 279)	2.60 ha.	138 units
Mixed Use (40 - 120 uph) (BLOCKS 280)	1.55 ha.	62 - 186 units
Future Lots/Blocks (BLOCKS 281 - 294)	0.40 ha.	13 units
Stormwater Management Pond (BLOCK 295)	0.67 ha.	
Village Square Open Spaces (BLOCKS 296 - 298)	0.90 ha.	
Institutional (BLOCK 299)	2.41 ha.	
Environmental Protection (BLOCK 300)	13.25 ha.	
Widening & Reserve (BLOCKS 301 & 302)	0.31 ha.	
Roads (MINOR COLLECTOR, STREET 'A') (LOCAL STREETS 'B' - 'N')	6.04 ha.	
TOTAL	36.72 ha.	470 - 594 units

20 0 20 40 60 80 100 120m

SCALE = 1:1250 (A1)

BARRIE LOCKHART ROAD LP

DRAFT PLAN OF SUBDIVISION

Raymond J. Duhamel
R.P.P.

Date Issued:	SEPT. 26, 2018
Checked By:	RD
Project No.:	SOR-17045
Drawn By:	m.c.r.
Drawing Name:	SOR-17045-DP-1.dwg

JONES
CONSULTING GROUP LTD.
PLANNERS & ENGINEERS
229 Mapleview Drive East, Unit 1, Barrie, Ontario, L4N 0W5
Phone: 705-734-2538 Fax: 705-734-1056
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APPENDIX B

BACKGROUND INFORMATION

SCS consulting group ltd

Point	**Identification**	**Master Plan**	**SIS**	**Pipe Capacity**
		Discharge Flow (L/s)	Discharge Flow (L/s)	(L/s)
E1	SAP09044	5	7.3	59.5
E2	SAP09067	77	20.8	96.0
E3	SAP09006A	66	79.8	156.2
E4A	6940	24	34.5	40.3
E4B	SAP25122	11	n/a	n/a
E4C	SAP25121	1	n/a	n/a
E5	SAH08044	129	157.7	1435.4
E6	SAH09043	2	2.3	229.3
E7	SAH08021	8	1.0	40.8
E8	SAH08063	16	14.6	53.0
E9	SAH08066	14	15.5	37.6

The proposed sanitary flows and areas based on the revised conceptual plan vary (in some cases significantly) from the proposed Master Plan flows, however the proposed flows are less than the capacity of the receiving pipe. The full downstream pipe network should be reviewed with the City to confirm capacity to the discharge point.

In the case of connection point E4A, which includes the sanitary discharge from the Sobey’s lands, the downstream pipe capacity may limit development. At detailed design, the pipe discharge should not exceed 85% capacity of the receiving pipe, which may limit the number of units within this parcel. Additional detailed analysis will be required to confirm pipe sizing and the distribution of the proposed units within the development area.

6.4 Water Distribution

6.4.1 External Water Supply

The municipal water supply for the City of Barrie is currently obtained from twelve groundwater wells as well as several surface water sources, with a total combined capacity of 81.3 million liters per day (MLD), with an additional two wells at design stage. The City is divided into five major pressure zones, with the two southern zones (2S and 3S) being serviced by surface water sources, and the remaining three northern zones (1, 2N and 3N) being serviced by groundwater sources.

The Hewitt’s SPA lies within pressure zone 2S, which is serviced by a surface water treatment plant (SWTP) located on the shore of Kempenfelt Bay. The ultimate capacity of the plant is 240 MLD, however it is being implemented in phases, with the initial capacity at 60 MLD.

Table 6 Lover's Creek, Existing Condition Modelling Results

			24 Hour SCS Type II Storm						
	Catchment	**Area (ha)**	**2 Year**	**5 Year**	**10 Year**	**25 Year**	**50 Year**	**100 Year**	**Regional**
Lover's Creek									
	101	0.10	0.01	0.02	0.03	0.03	0.04	0.04	0.01
	102	0.22	0.01	0.03	0.04	0.05	0.06	0.07	0.02
	103	0.77	0.02	0.05	0.07	0.1	0.13	0.15	0.07
	104	0.62	0.01	0.03	0.05	0.07	0.09	0.11	0.05
	105	0.96	0.02	0.05	0.08	0.11	0.14	0.17	0.09
	106	0.69	0.02	0.04	0.06	0.09	0.11	0.13	0.07
	107	0.39	0.02	0.04	0.06	0.08	0.1	0.12	0.04
	108	0.12	0.01	0.02	0.02	0.03	0.04	0.04	0.01
	109	3.91	0.21	0.46	0.64	0.87	1.05	1.24	0.39
	110	1.28	0.04	0.11	0.15	0.21	0.26	0.32	0.12
	111	4.31	0.03	0.08	0.13	0.19	0.24	0.3	0.25
	112	207.62	0.94	2.14	3.13	4.59	5.95	7.44	8.74
	113	24.75	0.25	0.45	0.61	0.83	1.02	1.22	0.77
Total		245.7	1.59	3.52	5.07	7.25	9.23	11.35	10.63
SIS Unitary Discharge Rates (m^3/s/ha)			**0.006**	**0.014**	**0.021**	**0.030**	**0.038**	**0.046**	**n/a**
DSWMMP Unitary Discharge Rates (m^3/s/ha)			0.010	0.019	0.026	0.036	0.044	0.052	n/a

The overall unitary discharge rates determined above are less than those calculated in the DSWMMP and represent a more conservative discharge rate. These results are consistent with the comparison results presented in Appendix E between OTTHYMO and PCSWMM, where in general PCSWMM results will produce lower peak flows and volumes for non-urban catchments.

5.3.3.2 Hewitt's Creek

The following Table provides a summary of the 2-100 year SCS Type II PCSWMM existing condition peak runoff results for the Hewitt's Creek watershed.

Catchment 18 & 18A/SWMF#18

SWMF#18 is the fourth of four SWMF which are to be located within post-2031 development lands but is required to service pre-2031 development. The SWMF block is to be located on the south of the main channel of Sandy Cove Creek, on the north side of the tributary. The SWMF is intended to provide controls for primarily Phase 4 Dorsay lands, however there may be an opportunity to direct runoff from the 20th Sideroad ROW into the facility. This option has not been modelled at this time.

A small portion of the drainage area bypasses the facility; however the majority of this area is anticipated to be pervious rear yards draining directly to the tributary of Sandy Cove Creek. There is sufficient volume in the facility to provide over control for this area that bypasses the facility.

This facility may also be required to be expanded post-2031 to accommodate additional Dorsay development lands

The SWMF is to be located adjacent to 20th Sideroad adjacent to an area identified within the Master Plan as being within floodplain. There may be opportunity in to refine the floodplain extents and relocate the proposed SWMF further south.

The current configuration of the facility meets the required length to width and volume requirements set out by the MOECC and the Master Plan.

Catchment 206

A small (1.39 ha) catchment along the west edge of the NHS in the northeast corner of the SPA will discharge runoff to the NHS and ultimately to Big Bay Point Road. This area which consists largely of proposed pervious rear yards will require additional LID controls to bring the peak discharge below pre development levels. Alternatively over control within SWMF#14 could be provided.

5.5 Low Impact Design (LID)

Low Impact Design (or Development) (LID) is the concept of reducing stormwater runoff by the implementation of a more holistic approach to stormwater design. It is integration of stormwater design at all stages of design and construction to preserve natural areas, reduce impervious cover, and distributes runoff throughout a much larger area. Essentially it is dealing with rainfall as soon as it hits the ground rather than relying conveyance systems and traditional end-of-pipe or centralized SWM facilities.

5.5.1 LID Background & Guidance

There are a number of guiding documents with respect to LID in general and to LID specifically related to the Hewitt's SPA including the following:

DSWMMP October 2013 – The Master DSWMMP report provided a number of recommendations with respect to the implementation of LID throughout the Hewitt's SPA. LID practices were proposed for all development lands within the SPA for mitigation of water balance impacts and to help attain water quality targets. The DSWMMP did not provide specific recommendations for LID design as it was believed to be too detailed for a Master Plan level document.

LSRCA Stormwater Management Design Guidelines, June 24 2016 – The revised and updated LSRCA SWM Guidelines place a greater emphasis on site design to protect existing natural areas, elimination of impervious surfaces and implementation of a distributed stormwater management strategy including lot level, conveyance and as a final measure end-of-pipe stormwater controls.

The current target is to not only provide peak flow attenuation to pre development levels but to also detain/retain on site 25 mm of rainfall through the widespread implementation of LID. Reduced targets under the LSRCA Flexible Treatment Alternative of 12.5 mm and 5 mm have been proposed for sites with restrictions. Filtration of 25 mm of runoff from all new impervious areas will also be required.

The LSRCA (through the TRCA/CVC LID Manual), recommended methods for SWM quantity/quality control including LID are as follows:

- **Planning Level Design –** Use of alternative road design in the development of a subdivision plan to maximize the natural/pervious area and minimize the amount of impervious area. The use of cul-de-sacs and looped roads provide the greatest opportunity for reduction in impervious areas. Additional design selection such as reduction in road widths, adoption of cul-de-sac design with vegetated islands and elimination of sidewalks on both sides of the streets are all viable options to greatly improve infiltration.
- **Lot Level Controls –** Rooftop detention, parking lot storage, rear yard storage, reduced lot grading, downspout disconnection, porous pavement, rain gardens and water reuse systems. These measures could apply to either residential development lots (provided the City is agreeable) or to site plan control developments. Typically the MOECC will not provide credit or issue an ECA for lot level stormwater controls for residential development.
- **Conveyance Controls –** Grassed swales, pervious (third) pipe systems, pervious catch basins, bio-swales, filtration systems and infiltration systems. Subsurface conveyance controls typically require a linear implementation which makes providing quality control prior to infiltration difficult on a subdivision scale.

- **End of Pipe –** filter strips, buffer strips, infiltration basins, infiltration trenches, OGS, sand filters, dry ponds, wet ponds, wetlands, hybrid ponds, filtration devices and adsorptive materials. The LSRCA ideally wants to reduce the dependence on end-of-pipe controls, requiring a greater adoption of the other methods (listed above) to provide quality and quantity control.

Specific design guidance has generally not been provided for any of the above measures within the LSRCA Guidelines, rather the document points to the design guidance provided in the CVC/TRCA Low Impact Development Stormwater Management Planning and Design Guide (2010).

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Draft City of Barrie LID Policy and Standards (January 2016) – The City of Barrie is currently in the process of updating policies and standards for LID including modifications to the existing Stormwater Management Policies and Design Guidelines. The City of Barrie is considering the following LID techniques, however further review is ongoing and the list is subject to change:

- Perforated pipe system
- Infiltration trenches
- Dry Swales
- Enhanced Grass Swales
- Soakaway Pits
- Infiltration chambers
- Silva Cell
- Rain Harvesting
- Green Roof systems
- Permeable pavers
- Vegetated filter strip
- Bio-retention swales

In general, the City of Barrie has recommended that LID measures within Public Lands should be focused on roadways that receive lower amounts of de-icing salts, and within soils with higher infiltration rates such as Type A & B Soils, perforated third-pipe systems and infiltration trenches being the initial preferred alternatives. Other means, such as enhanced grass swales and soakaway pits could be utilized in soils with lower infiltration rates.

The Draft (95%) submission City of Barrie Transportation Design Manual (August 2016) provides a series of ROW cross sections which include the preferred location of LID. The City is currently proposing LID on the east and south sides of the road between the back of curb and the edge of sidewalk. No additional details have been provided at this time.

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Catchment 2 & 2a

A summary of LID considerations and recommendations for the catchment are outlined below.

Table 15 LID Considerations – Catchment 2 & 2a

Catchment ID	**2**	**2A**	**2-EXT**
Catchment Area	33.83	0.69	0.75
Impervious %	51%	50%	51%
Dominant Soil Type	Silty Clay	Silty Clay	Silty Clay
Effective Soil Type	Silty Clay	Silty Clay	Silty Clay
Hydraulic Conductivity	1 mm/hr	1 mm/hr	1 mm/hr
LSRCA Hydraulic Conductivity[A]	0.4 mm/hr	0.4 mm/hr	0.4 mm/hr
25 mm Runoff Volume (m^3)	4337	86	96
Required Infiltration Storage Volume[B]			
25 mm Runoff	228270	4550	N/C
12.5 mm Runoff	136950	2750	N/C
5 mm Runoff	45650	900	N/C
Recommended Infiltration Target			
	Best Effort	Best Effort	N/C
Recommended Filtration Target			
	25 mm	25 mm	N/C
LID Opportunities			
Park Block	26800	None	None
School/Community Centre	25900	None	None
Accessible NHS Buffer (Linear m)	259	259	None
ROW (Linear m)	4514	None	367
Pervious Area available for Additional Topsoil (m^2)	113067	3450	None
SWM Control	LID/SWMF 2	LID/Compensation in SWMF 2	LID/ SWMF 2
Discharge Point	Lover's Creek	Lover's Creek	Lover's Creek

Notes

[A] LSRCA Factor of Safety Required = 2.5 (Divide measured Hydraulic Conductivity by 2.5)

[B] Assumes 24 hr drawdown, 1.0 m tall stone trench with bottom set at 1.2 m below grade, 0.4 void ratio

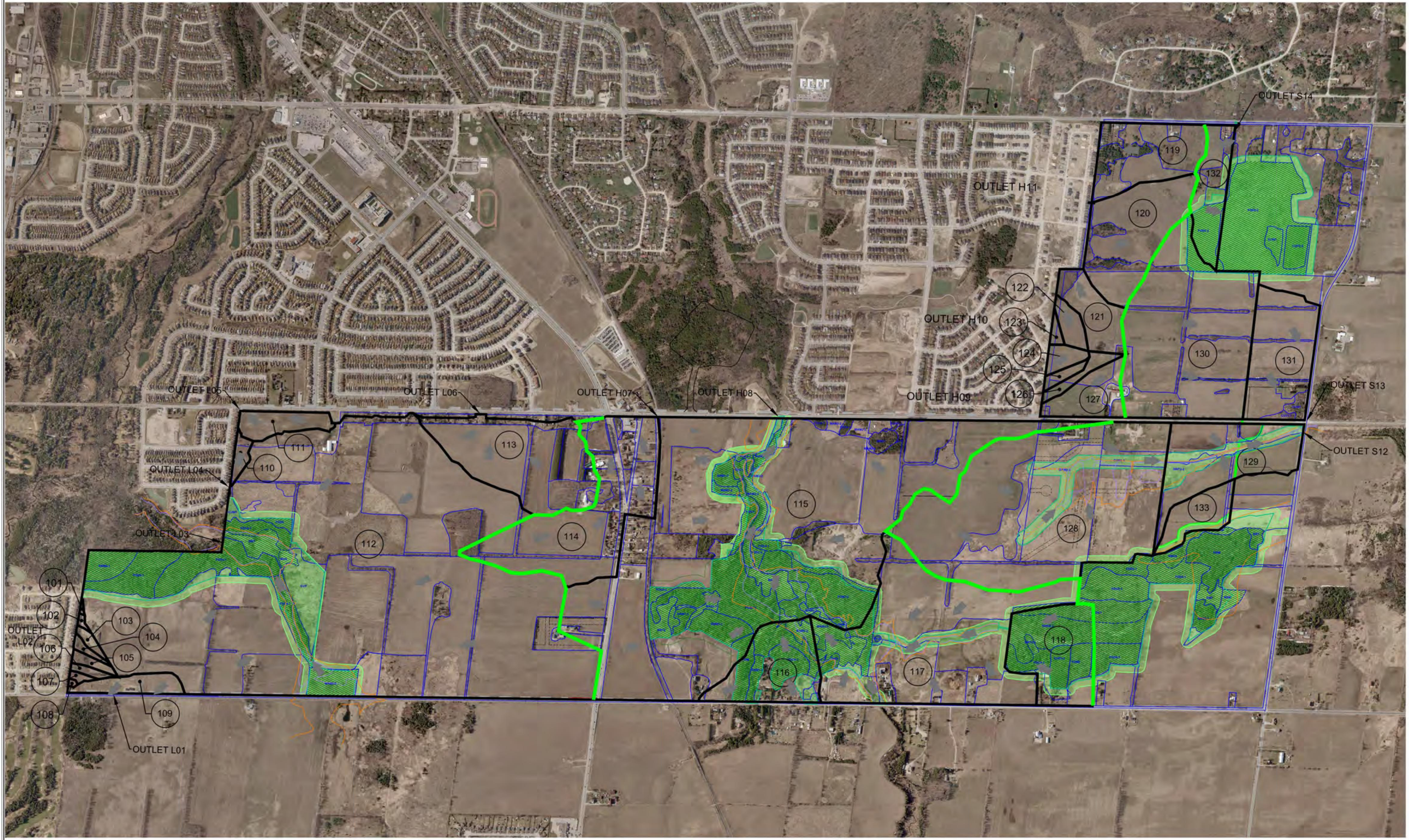
Catchments 2 and 2a provide limited opportunities for infiltration LID due to low hydraulic conductivity. However, there are locations within the catchment where opportunities could exist for the installation of LID measures including within window streets, unconstrained NHS buffers (336 m of the total 518 m), park and school blocks (which between 40-50% of the drainage area could be routed), and 3661 m (of the total 5081 m) of unconstrained ROW.

In order to achieve even the 5 mm target (46,550 cu.m of storage volume required) through infiltration measures only, the following is an example of a LID system that would be required:

- A 3.0 m wide x 2.0 m deep(1.5 m on both sides of the road perforated pipe/ /trench in all unconstrained ROWs (3661 m of ROW within the catchment) totaling 14,644 cu.m, plus
- A 5.0 m wide x 2.0 m deep infiltration trench in all unconstrained buffer areas totaling 3,360 cu.m, plus
- An infiltration system encompassing 40% of the school block totaling 10,360 cu.m
- An infiltration system encompassing 40% of the park block totaling 10,720 cu.m

Due to the low hydraulic conductivity of this catchment and resulting impractical and economically unfeasible infiltration system requirements to achieve even the 5mm target as noted above, the following are the LID recommendations for Catchment 2/2a:

- Best efforts to achieve the minimum 5 mm infiltration target, with remaining 25 mm of target achieved through filtration and attenuation measures.
- Use of park and school blocks for infiltration and filtration measures to the extent permitted by proposed surface uses.
- Placement of LID measures where feasible within NHS buffers where buffers are 30 m wide and void of significant vegetation. Filling of buffers to achieve groundwater clearance may be required. LID and fill placement not to extend more than 50% (15 m) into buffer.
- Use of CB inserts and deepened sumps where ROW infiltration measures are to be implemented.
- Use of shallow LID measures such as increased topsoil depth on private and public pervious areas (located all or partially above the frost line) to increase infiltration opportunities.
- Integration of LID measures with Lockhart Road at window streets.
- LIDs are to be provided to achieve groundwater balance volumes as outlined in Section 4.6.3 to the extent possible.



110	DRAINAGE AREA ID
▬	DRAINAGE BOUNDARY
〰	EXISTING CONTOURS
─	ELC BOUNDARIES
🟩	WATERSHED BOUNDARY
🟩	STAKED 2015 NHS LIMITS
🟩	NHS BUFFER LIMITS
▨	COB GENERATED NHS BUFFER LIMITS (2013)
─	EXISTING 100yr STORM FLOOD LIMIT
─	EXISTING REGIONAL STORM FLOOD LIMIT
➡	OVERLAND FLOW ROUTE

DASHED FLOOD LINES ARE APPROXIMATE ONLY, BASED ON INTERPOLATED DATA BETWEEN FINGERLAKES AND 1091369 ONTARIO INC. DETAILED TOPOGRAPHIC DATA. FLOODLINES ARE SUBJECT TO CHANGE BASED ON ADDITION OF DETAILED TOPOGRAPHIC SURVEY.

N

0 100 200 400 600

Metres

NOTE: "SCALE ONLY VALID FOR 24" x 36" SIZED PLOTS"

BURNSIDE

Figure Title

HEWITT'S SECONDARY PLAN AREA
SUBWATERSHED IMPACT STUDY
EXISTING CONDITIONS DRAINAGE PLAN

Client

HEWITT'S CREEK LANDOWNERS GROUP INC.

Drawn	Checked	Date	Figure No.
BH	MZ	16/09/07	**FIG 5**
Scale		Project No.	
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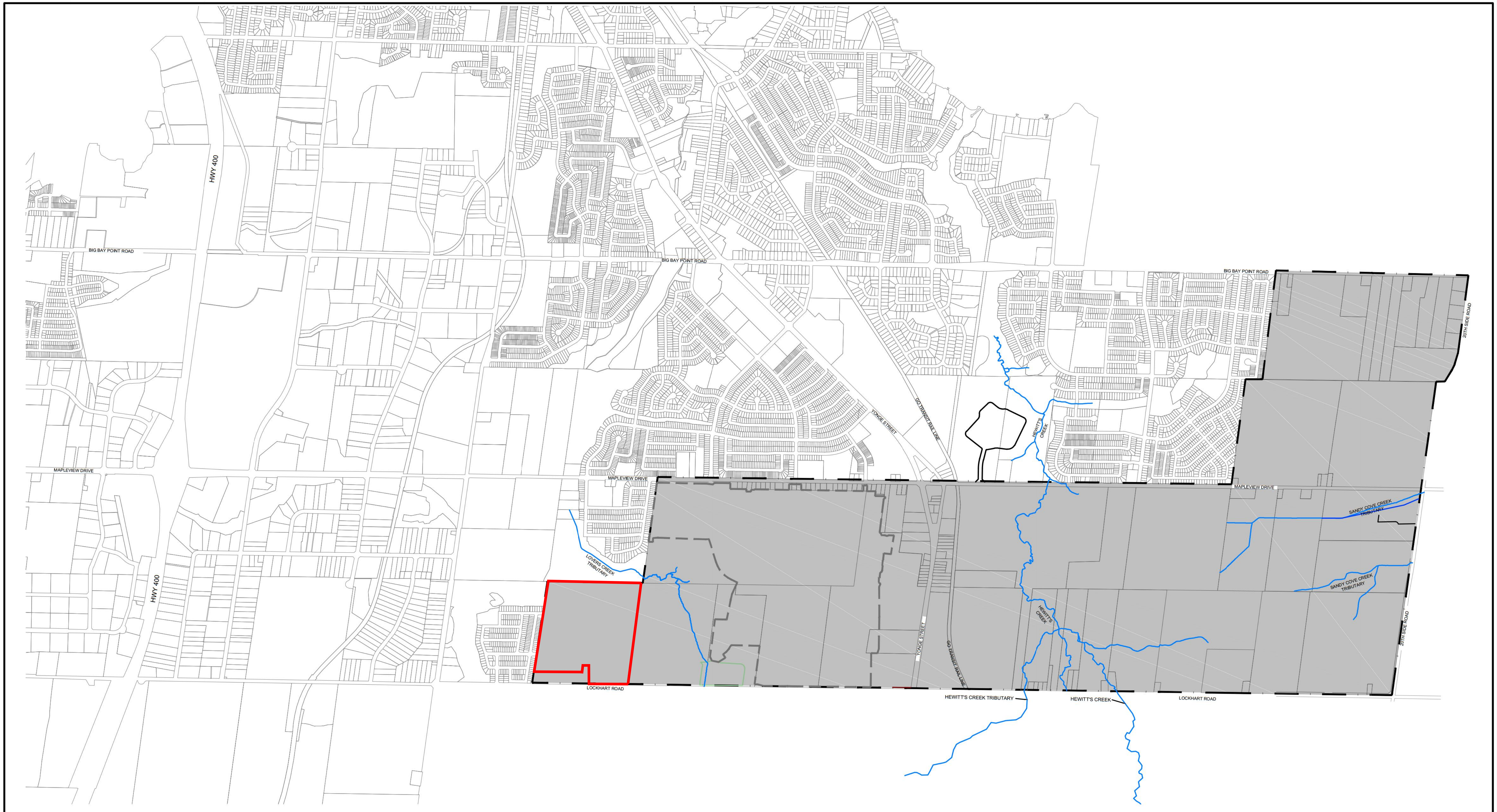

▨ LIMIT OF HEWITT'S CREEK SECONDARY PLAN

BURNSIDE

Figure Title

HEWITT'S SECONDARY PLAN AREA
SUBWATERSHED IMPACT STUDY
LOCATION AND BOUNDARY PLAN

Client

HEWITT'S CREEK LANDOWNERS GROUP INC.

Drawn	Checked	Date	Figure No.
BH	CC	16/09/07	**FIG 1**
Scale		Project No.	
NOT TO SCALE		300032860	

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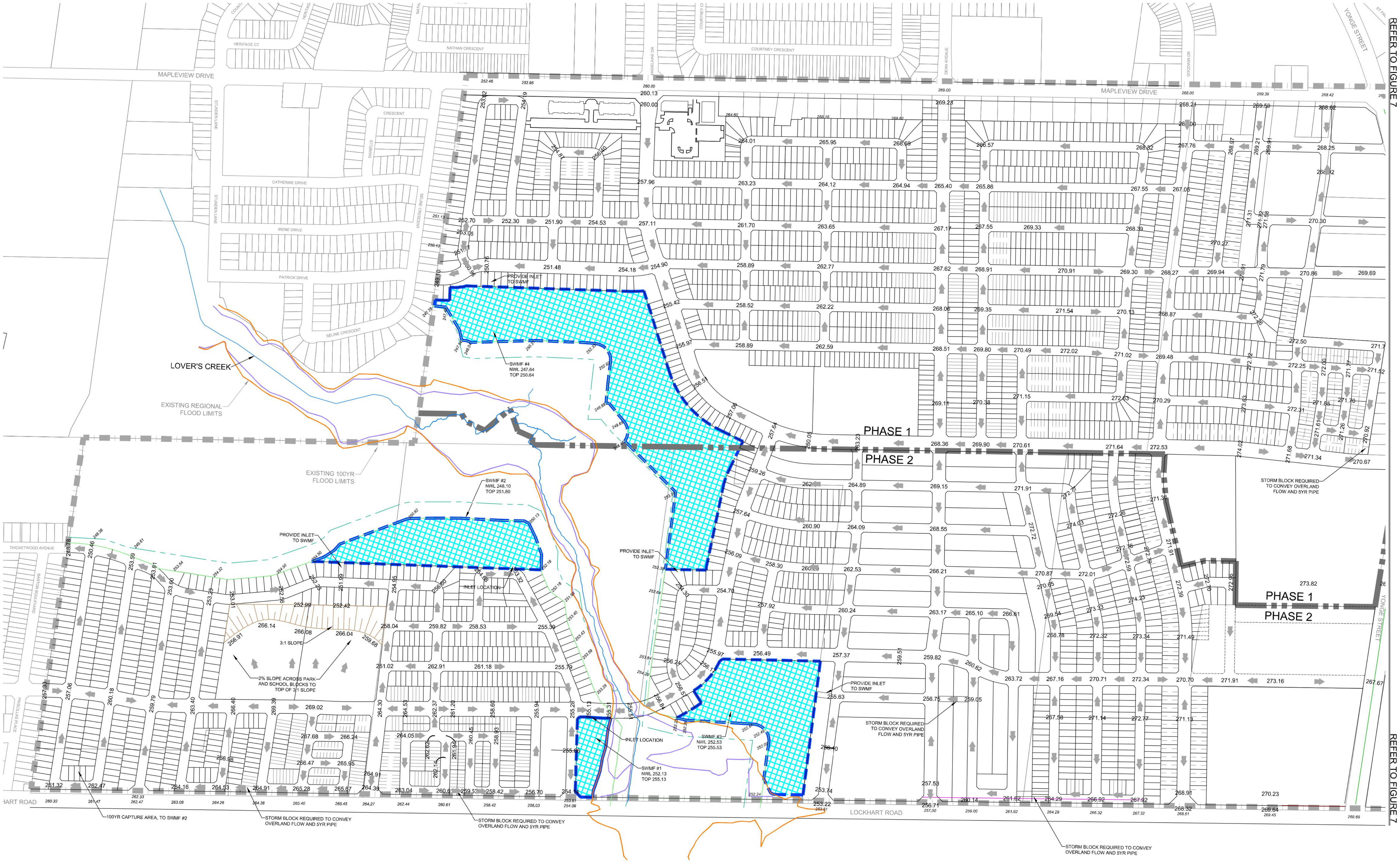

LEGEND

— — —	STAKED NHS LIMITS (2015)
——	NHS BUFFER LIMITS
— — —	CoB GENERATED BUFFER LIMITS (2013)
🟩	2031 BOUNDARY
🟪	EXISTING 100 YR FLOOD LIMITS
🟧	EXISTING REGIONAL FLOOD LIMITS
——	PROPOSED 100 YR FLOOD LIMITS
🟥	PROPOSED REGIONAL FLOOD LIMITS
263.99	EXISTING ELEVATION
263.99	PROPOSED ELEVATION
◀	PROPOSED OVERLAND FLOW ROUTE

DASHED FLOOD LINES ARE APPROXIMATE ONLY, BASED ON INTERPOLATED DATA BETWEEN FINGERLAKES AND 1091369 ONTARIO INC. DETAILED TOPOGRAPHIC DATA. FLOODLINES ARE SUBJECT TO CHANGE BASED ON ADDITION OF DETAILED TOPOGRAPHIC SURVEY.

BURNSIDE

Figure Title

HEWITT'S SECONDARY PLAN AREA SUBWATERSHED IMPACT STUDY

PROPOSED CONDITION GRADING PLAN (1 OF 3)

Client

HEWITT'S CREEK LANDOWNERS GROUP INC.

Drawn	Checked	Date	Figure No.
AD	BH	16/09/07	**FIG 6**
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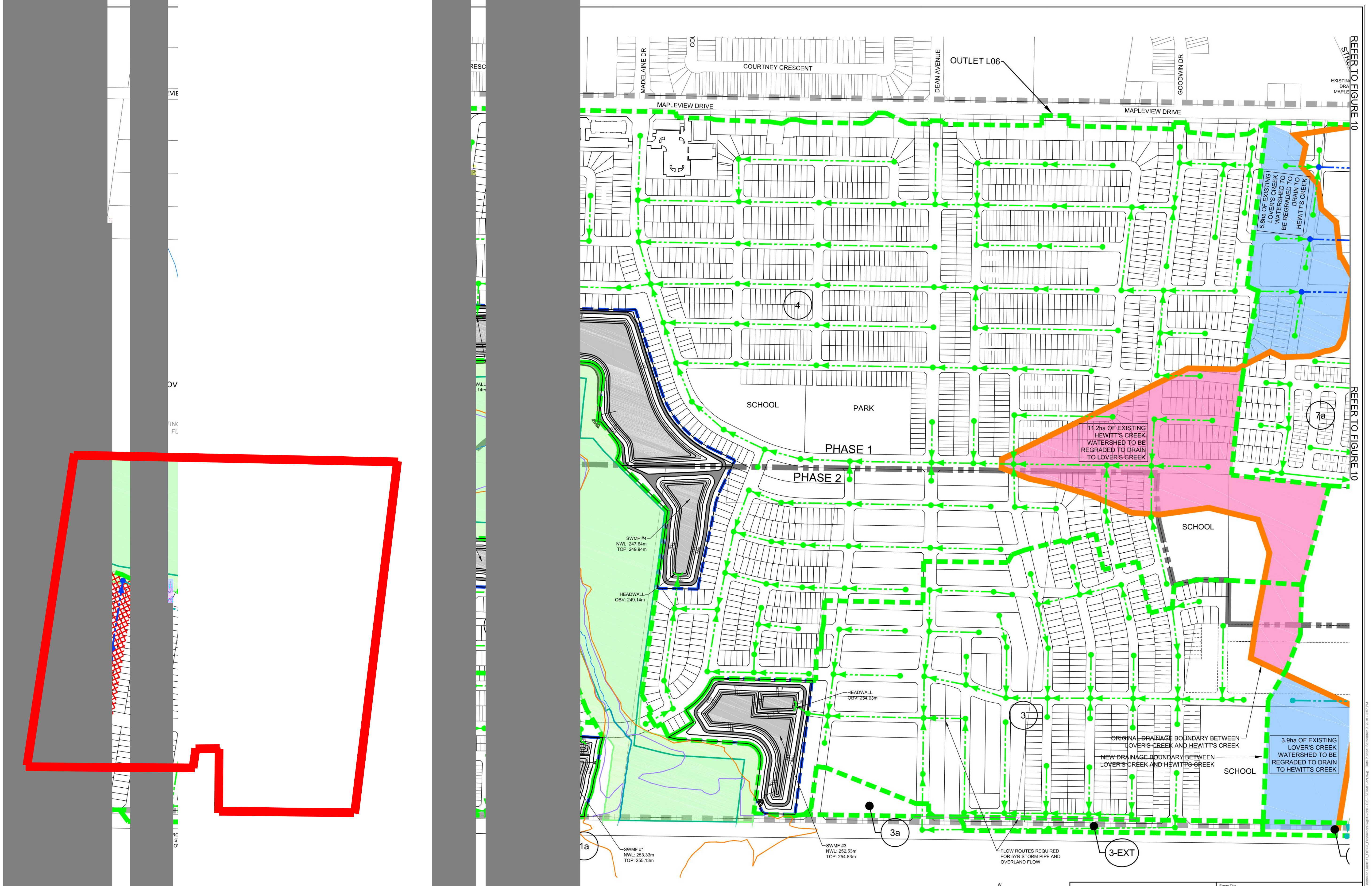

RE SEWER, MANHOLE

YANCE SYSTEM WITH 5YR CAPTURE

SEWER, MANHOLE

M SEWER, MANHOLE

NOTE: *SCALE ONLY VALID FOR 24" x 36" SIZED PLOTS*

BURNSIDE

Figure Title
HEWITT'S SECONDARY PLAN AREA
SUBWATERSHED IMPACT STUDY
PROPOSED STORM SEWER PLAN (1 OF 3)

Client
HEWITT'S CREEK LANDOWNERS GROUP INC.

Drawn	Checked	Date	Figure No.
BH	CC	16/09/07	**FIG 9**
Scale		Project No.	
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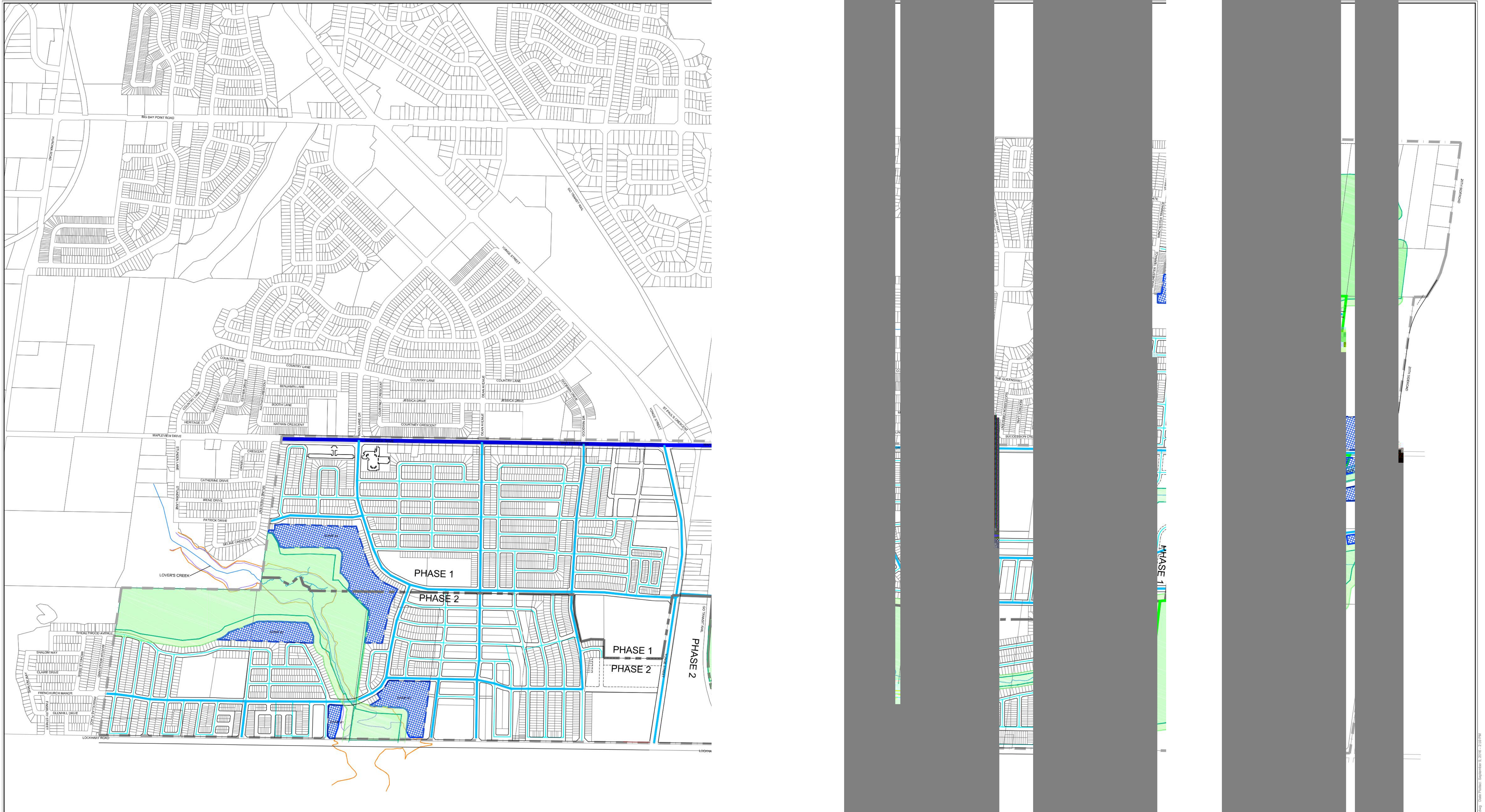

LEGEND

DC TRUNK WATERMAIN	2031 PHASE LINE
LOCAL TRUNK WATERMAIN	PHASING LIMITS
LOCAL WATERMAIN	LIMIT OF HEWITT'S CREEK SECONDARY PLAN
SURVEYED NHS LIMITS (2015)	STAKED 2015 NHS LIMITS
NHS BUFFER LIMITS	NHS BUFFER LIMITS

NC

WI ARY PLAN AREA
UB IMPACT STUDY
ROF STRIBUTION PLAN

Figure No.
FIG 12

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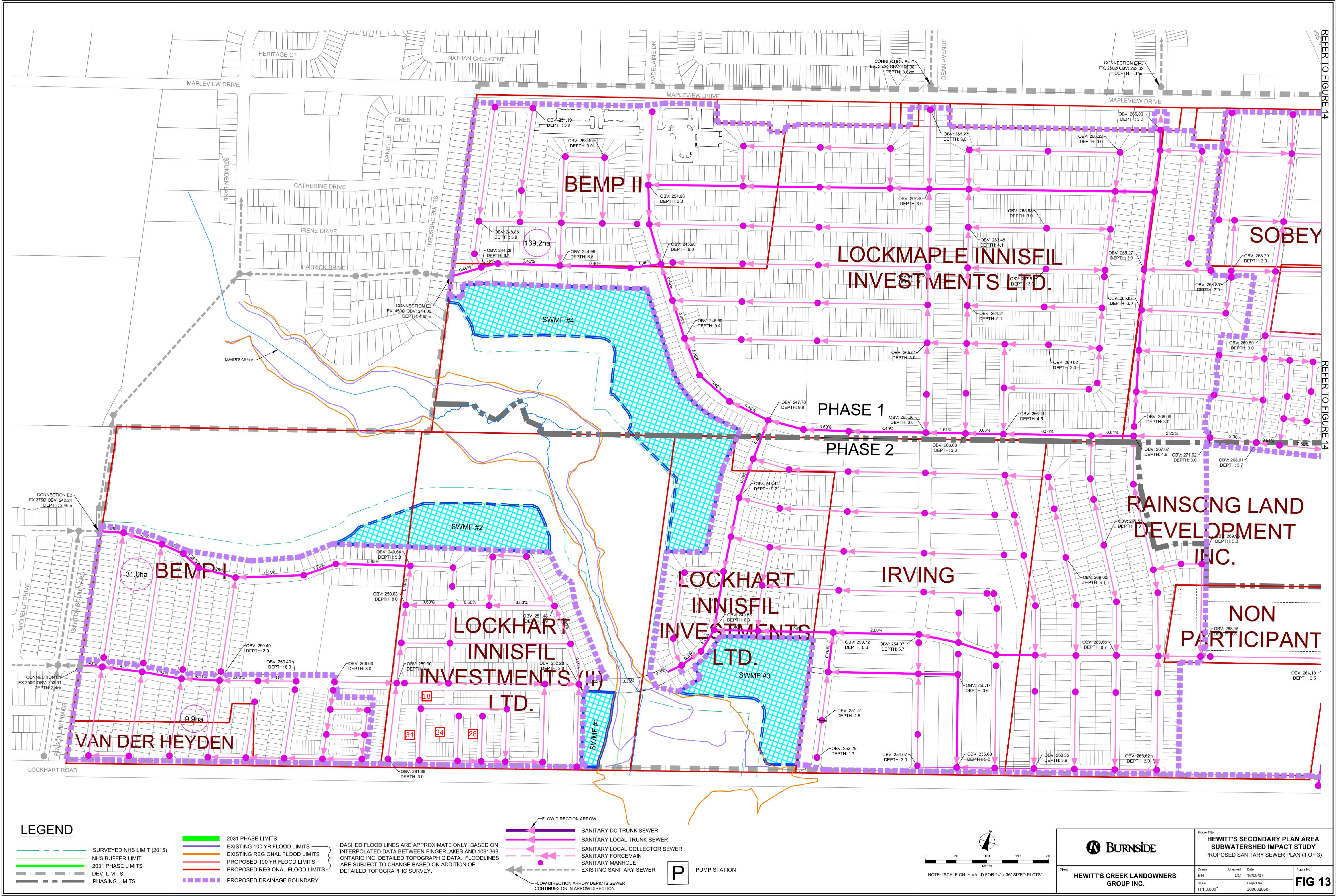

BURNSIDE

Figure Title

HEWITT'S SECONDARY PLAN AREA
SUBWATERSHED IMPACT STUDY
PROPOSED SANITARY SEWER PLAN (1 OF 3)

Client

HEWITT'S CREEK LANDOWNERS GROUP INC.

Drawn	Checked	Date	Figure No.
BH	CC	16/09/07	FIG 13
Scale		Project No.	
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Lake Simcoe Region
conservation authority

Scale 1: 14,154

Features

- 🟥 Regulation Map Index
- 🟩 LSRCA Watershed Boundary
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- Roads
  - Hwy 400 Series
  - Highway, Arterials
  - Local Road
- Railway

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10/21/2018

WGS_1984_Web_Mercator_
Auxiliary_Sphere

Mapped By:

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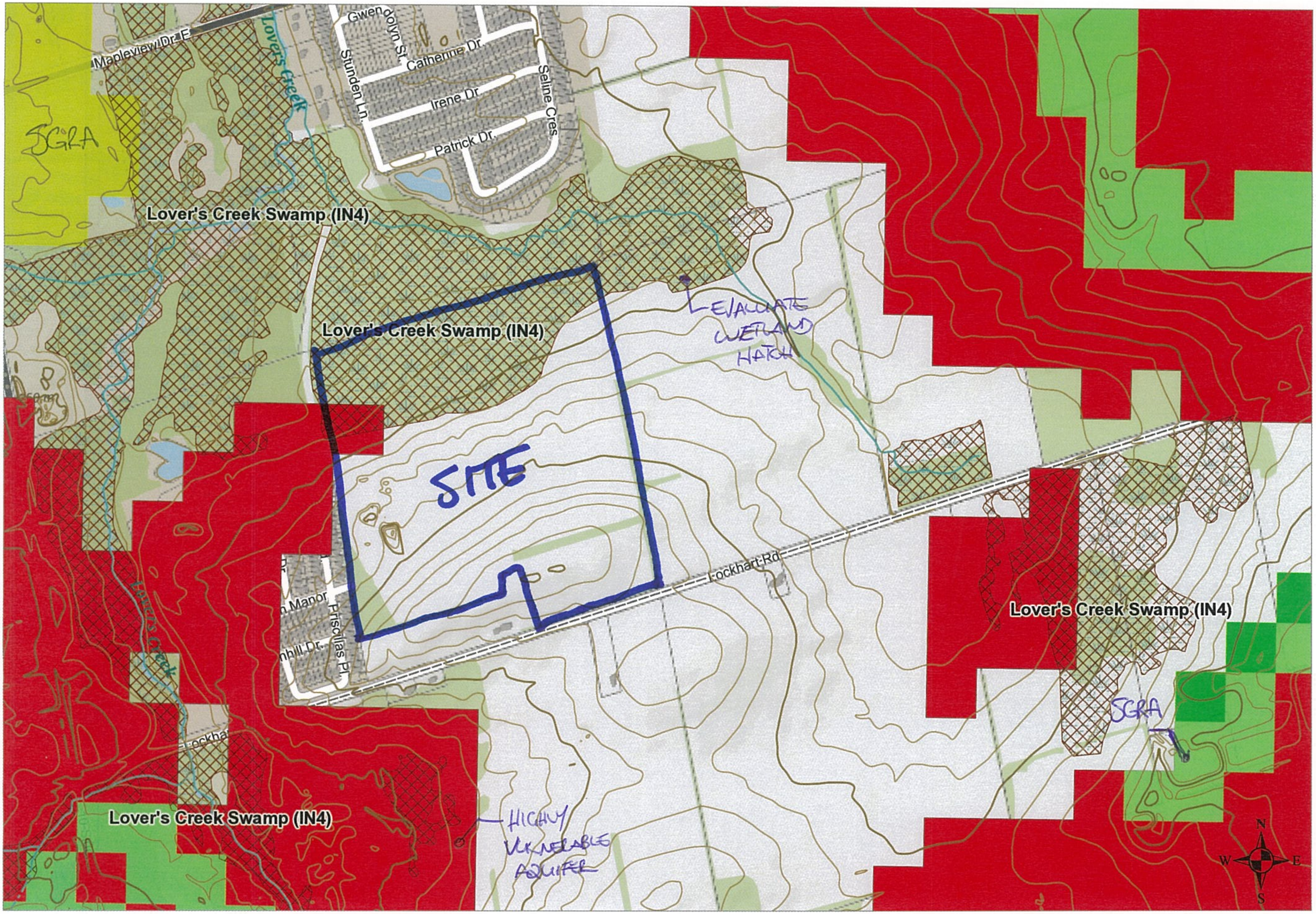
Sorbara Barrie



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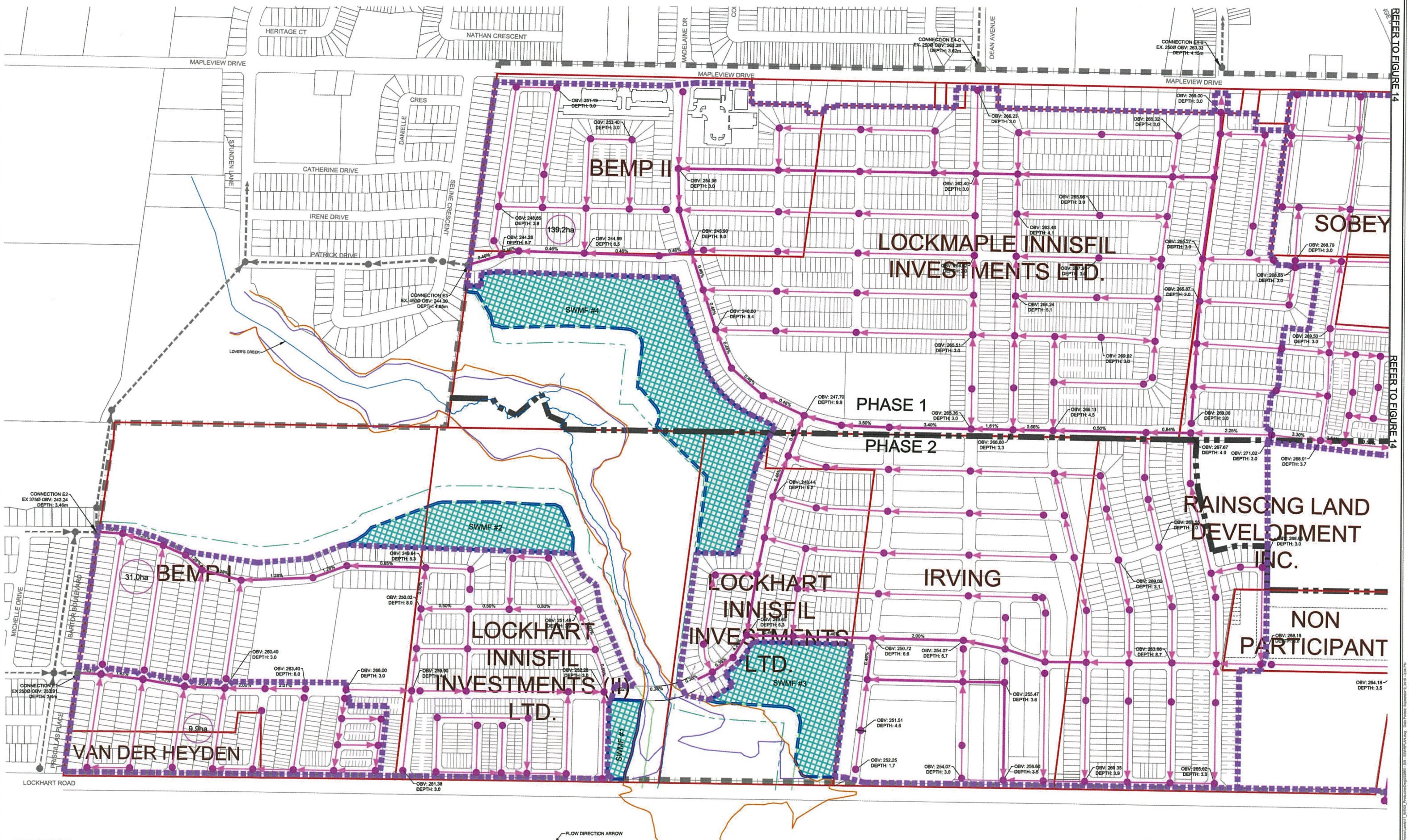
October 21, 2018



LEGEND

- SURVEYED NHS LIMIT (2015)
- NHS BUFFER LIMIT
- 2031 PHASE LIMITS
- DEV. LIMITS
- PHASING LIMITS
- 2031 PHASE LIMITS
- EXISTING 100 YR FLOOD LIMITS
- EXISTING REGIONAL FLOOD LIMITS
- PROPOSED 100 YR FLOOD LIMITS
- PROPOSED REGIONAL FLOOD LIMITS
- PROPOSED DRAINAGE BOUNDARY

DASHED FLOOD LINES ARE APPROXIMATE ONLY, BASED ON INTERPOLATED DATA BETWEEN FINGERLAKES AND 1091369 ONTARIO INC. DETAILED TOPOGRAPHIC DATA. FLOODLINES ARE SUBJECT TO CHANGE BASED ON ADDITION OF DETAILED TOPOGRAPHIC SURVEY.

- FLOW DIRECTION ARROW
- SANITARY DC TRUNK SEWER
- SANITARY LOCAL TRUNK SEWER
- SANITARY LOCAL COLLECTOR SEWER
- SANITARY FORCEMAIN
- SANITARY MANHOLE
- EXISTING SANITARY SEWER
- FLOW DIRECTION ARROW DEPICTS SEWER CONTINUES ON IN ARROW DIRECTION
- P PUMP STATION

0 60 120 180 240
Metres

NOTE: "SCALE ONLY VALID FOR 24" x 36" SIZED PLOTS"

BURNSIDE

Client
HEWITT'S CREEK LANDOWNERS GROUP INC.

Figure Title
HEWITT'S SECONDARY PLAN AREA
SUBWATERSHED IMPACT STUDY
PROPOSED SANITARY SEWER PLAN (1 OF 3)

Drawn	Checked	Date	Figure No.
BH	CC	16/09/07	FIG 13
Scale		Project No.	
H 1:3,000*		300032860	

Hydrogeological Study in Support of Draft Plan

Barrie Lockhart Road LP
Barrie, Ontario

R.J. Burnside & Associates Limited
292 Speedvale Avenue West Unit 20
Guelph ON   N1H 1C4 CANADA

October 2018
300041514.0000

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0	Yes	Yes	Scott Young, Sorbara
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Record of Revisions

Revision	Date	Description
-	October 10, 2018	Submission to Sorbara and The Jones Consulting Group Ltd.

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1.0 Introduction

R.J. Burnside & Associates Limited (Burnside) has been retained by Barrie Lockhart Road LP (part of the Sorbara Group) to complete a hydrogeological assessment for lands located within the Hewitt's Secondary Plan Area in Barrie. The lands associated with the assessment, herein referred to as the subject lands are located north of Lockhart Road and east of Huronia Road in the City of Barrie, Ontario (Figure 1). The subject lands are located within the Barrie Annexed Lands and the OPA 39 Hewitt's Secondary Plan Area (SPA) located on the southern boundary of the City of Barrie. In 2016, a Subwatershed Impact Study (SIS) for the Hewitt's SPA was completed for the Hewitt's Creek Landowners Group that included an assessment of regional hydrogeology (Burnside, 2016). The current assessment is aimed at updating information contained in the regional hydrogeological assessment and providing more detailed site-specific information for the subject lands in support of an application for draft plan approval.

1.1 Scope of Work

The scope of work completed for the hydrogeological study was developed to build upon the more regional work completed for the Hewitt's SPA (Burnside, 2016) and to address requirements for hydrogeological studies in support of draft plan approval. The scope of work for the hydrogeological assessment included the review of available regional information as well as the completion of the following site-specific tasks:

1. Review of published geological and hydrogeological information: A review of background material for the area, including topography, surficial geology and bedrock geology mapping and existing geotechnical and hydrogeological reports was completed to assess the regional hydrogeological setting.

2. Review of the Ministry of the Environment, Conservation and Parks (MECP) water well records: The MECP maintains a database that provides geological records of water supply wells drilled in the province. A list of the available MECP water well records for local wells is provided in Appendix A and the well locations are plotted on Figure 5. It is noted that the well locations listed in the MECP records are approximations only and may not be representative of the precise well locations in the field. These well data were compiled and mapped to characterize the local groundwater resources.

3. Establish groundwater monitoring network: Groundwater monitoring locations were established to characterize seasonal variations in the water table in both the shallow and deep aquifers. Existing wells (MW11) and piezometers (PZ4) from previous studies were selected for inclusion in the monitoring program. Fifteen new monitoring wells (SB-1 to SB-15) were completed on the subject

lands as part of a geotechnical assessment and were incorporated into the current assessment. One piezometer nest (one shallow and one deep piezometer) was installed near a wetland feature (SB-PZ1s/d) to determine the nature of potential groundwater/surface water interactions in the vicinity of this feature. The locations of the monitoring wells and piezometers are shown on Figure 2. The monitoring well construction details are provided on the borehole logs in Appendix B.

4. Hydraulic conductivity testing: Burnside conducted single well response tests in order to determine hydraulic conductivity. Single well response tests were completed at four groundwater monitoring wells (MW11, SB-3, SB-4, and SB-6) in 2018. The hydraulic conductivity field testing results are provided in Appendix C.

5. Monitoring of groundwater levels: Monitoring has been completed to measure the depth to the water table and assess the horizontal and vertical groundwater flow conditions. Groundwater level monitoring was completed monthly since November 2017 in monitoring wells and piezometers. Automatic water level recorders (dataloggers) were installed in one monitoring well (MW11) and two piezometers (SB-PZ1d and PZ4) to document the range of groundwater fluctuations and the response of the groundwater table to precipitation events. Barometric data from a barologger installed in the vicinity of the subject lands was used for calibration of the datalogger results. The groundwater monitoring data and hydrographs are provided in Appendix D.

6. Water quality testing: Water quality data was collected from selected monitoring locations to typify the groundwater and surface water quality in the vicinity of the subject lands. Samples were collected in 2018 from two monitoring wells: SB-3 and SB-4 and one surface water sample SB-SW1. The water samples were submitted to a qualified laboratory for analyses of general water quality indicators (e.g., pH, hardness, and conductivity), basic ions (including chloride and nitrate) and selected metals to characterize the background water quality at the property. The laboratory water quality data are provided in Appendix E.

7. Water balance calculations: Pre-development water balance calculations have been completed to assess the groundwater infiltration volumes for the subject lands. The local climate data and detailed water balance calculations are provided in Appendix F.

8. Data compilation, assessment of site conditions and reporting: The above data were all compiled reviewed and assessed to develop an understanding of the site specific hydrogeological conditions. The results of the assessment are presented in the current report.

2.0 Physical Setting

2.1 Topography and Drainage

The topography of the subject lands slopes in a northern direction towards Lover's Creek Swamp with elevations ranging from 269 masl, at the south portion of the subject lands, to 247 masl within Lover's Creek Swamp on the north portion of the subject lands (Figure 3).

The subject lands are located within the Lake Simcoe watershed and Lovers Creek subwatershed. Lover's Creek Swamp, a provincially significant wetland is located in the north portion of the subject lands. A tributary of Lover's Creek crosses the extreme northeast corner of the subject lands (Figure 3).

2.2 Geology

The subject lands are located in the physiographic region known as the Peterborough Drumlin Field. The region is characterized as a rolling drumlinized till plain. The drumlins through the region are comprised of highly calcareous till (Chapman & Putnam, 1984).

The overburden within the Peterborough Drumlin Field was deposited as a series of advances and retreats of the Simcoe glacial ice lobe. This has resulted in drumlinized sheets of glacial till (Newmarket till), stratified glaciolacustrine deposits of sand and gravel, littoral-foreshore deposits and massive-well laminated deposits of sand and gravel being common in this area. A review of the quaternary geology mapping for the area (OGS, 2003) indicates that the overburden sediments of the subject lands consist primarily of silty to sandy glacial till with bands of coarse-textured glaciolacustrine deposits located on the northern and central portion of the site (Figure 4). The bedrock underlying the subject lands is mapped as the Lindsay Formation of the Simcoe Group, which consists of limestone and shale (OGS, 2007).

2.3 Regional Hydrostratigraphy

The overburden deposits of the subject lands influence groundwater occurrence and flow. The overburden has been interpreted by regional studies such as the Tier 3 Water Balance (AquaResource, 2011) and Source Water Protection Assessment Report (LSRCA, 2012) to consist of alternating sequences of coarser-grained permeable layers (aquifers) and finer-grained less permeable areas (aquitards) of varying thicknesses. The basic hydrostratigraphic sequence that was modelled in the regional studies (AquaResource, 2011) consists of four main aquifer areas (A1-A4) and four main aquitards (C1 to C4) with a confining layer (UC) over the uppermost aquifer (A1).

A description of the interpreted regional hydrostratigraphic framework is provided below (LSRCA, 2012):

- Surficial Geology Layer – This layer represents coarse grained sediments in stream beds and at surface surficial geology areas that overly the UC. The thickness ranges from 0.1 m to 3 m.
- UC – Upper Confining Layer – Represents smaller areas of less permeable surficial material. The upper confining layer has been mapped as coarse-grained lacustrine deposits which are part of a regionally extensive sand plain (LSRCA, 2012). Regional studies such as the AquaResource (2011) report indicate that the confining layer (UC) is patchy in the area of the study area.
- A1 – Represents the uppermost aquifer. Frequently exists as a surficial unconfined aquifer and is stratigraphically equivalent to the Oak Ridges Moraine. It is generally associated with coarse grained glacial and interglacial sediments mapped as ice contact stratified drift. The majority of the local domestic wells are completed within this area. The upper aquifer A1 is reported to be present throughout the larger Barrie area, and has been interpreted to occur extensively in the study area.
- C1 – Upper aquitard. Described as varved clay and silt (LRSCA, 2012).
- A2 – Intermediate aquifer which is stratigraphically equivalent to areas within the Northern Till. The aquifer is generally described as being composed of sand with some clast rich portions (LRSCA, 2012). This area is used for the Innisfil Heights water supply.
- C2 – Intermediate aquitard.
- A3 – This area constitutes the main Barrie municipal aquifer and is the source of the Stroud water supply; it is stratigraphically equivalent to the Thorncliffe deposits in the Upland regions.
- C3 – Lower aquitard.
- A4 – Lower aquifer, thin and sometimes combined with A3 where C3 is thin or absent.
- C4 – Lower aquitard but may also represent weathered bedrock.

2.4 Local Stratigraphy

Boreholes were drilled across the subject lands as part of a geotechnical investigation conducted by Peto MacCallum in 2017. The investigation included the completion of 15 boreholes that were constructed as monitoring wells. The locations of the boreholes/monitoring wells are shown on Figure 5 and the borehole logs are provided in Appendix B.

The geological information from the boreholes indicated that the overburden is generally composed of layers of glacial till and sand. The till deposits were generally composed of sandy silt to silty sand with varying amounts of clay and gravel. Some lenses of finer grained sediments were encountered in the boreholes and these lenses were interpreted to be discontinuous. Clayey silt was encountered below the surficial layer or topsoil at SB-1, SB-3 and MW11. The clayey silt extended to depths of about 2.0 m. The information provided by the borehole logs confirms the surficial geology mapping for the area.

To illustrate the shallow hydrostratigraphic sequence of the subject lands, schematic geologic cross-sections have been prepared (Figures 6 and 7) using the MECP well records (Appendix A) and the soils information collected during drilling of boreholes (Appendix B). The locations of the cross sections are illustrated on Figure 5 along with the locations of water wells and boreholes used in the construction of the cross-sections.

The cross-sections illustrate that the subject lands are underlain by a layer of sandy silt till with a thickness ranging from 5 m to 24 m. The sandy silt till has occasional layers of sand and gravel. Underlying the sandy silt till layer is a layer of sand and gravel. The sand layer is interpreted to form the local aquifer where private supply wells are completed (Figures 6 and 7). Based on cross-sections produced in the Hewitt's SIS (Burnside, 2015), the sand layer is interpreted to be underlain by a low permeability clay silt till at elevations between 210 masl and 230 masl.

2.5 Hydraulic Conductivity

There are various methods that can be used to assess soil hydraulic conductivity, i.e., the ability of the soil to transmit groundwater. Grainsize data and soil characteristics can be used to provide a general estimate of hydraulic conductivity. In situ bail-down or slug-testing methods are used in groundwater monitoring wells to assess site-specific hydraulic conductivity. These methods have been used to estimate the hydraulic conductivity of the soils encountered on the subject lands as discussed below.

2.5.1 Grainsize Analysis

Grainsize analysis from the geotechnical investigations on the subject lands (Peto MacCallum, 2017) were reviewed (data provided in Appendix C).

Table 1: Summary of Grainsize Analyses and Hydraulic Conductivity

Sample ID	Depth of Sample (mbgs)	Soil Classification	Hydraulic Conductivity (cm/s)
SB-6 SS6	4.6	Till: Sand and Silt, trace clay, trace gravel	6.3×10^{-5}
SB-8 SS3	1.5	Till: Silty Sand, trace gravel	3.6×10^{-4}
SB-11 SS5	3.0	Till: Sand and Silt, trace clay, trace gravel	6.3×10^{-5}
SB-3 SS8	7.6	Silty Sand, trace gravel	2.3×10^{-3}

To estimate hydraulic conductivity based on grainsize analysis, an empirical formula method known as the Hazen estimation is used. This method is an approximation of hydraulic conductivity based on grainsize curves for sandy soils. The approximation does not strictly apply to finer grained materials, however, it is still considered useful to provide a general indication of the range of the hydraulic conductivity values. Hydraulic conductivity values were derived empirically using the Hazen method for eight of the samples. The grainsize distribution graphs are provided in Appendix C and the calculated hydraulic conductivity values are provided in Table 1.

2.5.2 Single Well Response Tests

To assess the in-situ hydraulic conductivity of the sediments, single well response tests (bail-down tests) were conducted at four monitoring wells. The results from the tests were plotted (Appendix C) and analyzed to calculate hydraulic conductivity of the sediments screened. A summary the calculated hydraulic conductivities is provided below in Table 2.

Table 2: Single Well Response Testing Results

Monitoring Well	Screen Interval (mbgs)*	Formation Screened	Hydraulic Conductivity (cm/sec)
SB-3	8.4	Silty Sand	1.3×10^{-5}
SB-4	3.9	Sand/Silt Till	1.3×10^{-4}
SB-6	3.3	Sand/Silt Till	2.2×10^{-4}
MW11	7.7	Sandy Silt	2.1×10^{-4}

*metres below ground surface

2.5.3 Hydraulic Conductivity Discussion

Grainsize analyses results indicate that the sediments within the overburden range in composition from silty sand with trace gravel (27% fines) to sand and silt (47% fines). The greater amount of fines within a deposit impacts the ability of the material to transmit water and generally lowers the overall hydraulic conductivity. Groundwater flow is generally limited by fine grained sediments with lower hydraulic conductivity.

Grainsize analysis completed for the subject lands indicate that the overburden sediments in this area generally consist of varying amounts of sand and silt. The hydraulic conductivities based on grainsize analyses for the majority of the sediments is estimated in the range of 10^{-3} to 10^{-5} cm/sec.

The single well response test analyses resulted in similar hydraulic conductivities ranging from 10^{-4} to 10^{-5} cm/sec. The wells tested were all screened in the surficial sandy silt layer which forms the area to be impacted by development and is interpreted to be a low yielding aquifer (aquitard). Overall, the hydraulic conductivity of the overburden sediments on the subject lands consisting of sand and silt till is interpreted to range from 10^{-3} cm/sec (high) to 10^{-5} cm/sec (moderate).

3.0 Hydrogeology

3.1 Local Groundwater Use

The City of Barrie obtains its water from a combination of groundwater and surface water based supplies. Municipal servicing is assumed to be available for lands within the municipal city boundary which includes lands north of Mapleview Drive (Figure 1). It is also assumed that the subdivisions west of the subject lands and north of the subject lands (see Figure 2) are municipally serviced. Older homes (along Lockhart Road) outside of the previous municipal limits however are likely to have private water supply wells.

A review of the MECP water well records indicated that there are approximately 15 water supply well records within 500 m of the subject lands. Based on the well records and interpreted hydrostratigraphy, most of these wells are completed in the overburden with depths ranging from 4 m to 44 m. The locations of the MECP water well records are shown on Figure 5. Based on our interpretation of local stratigraphy and the interpreted geological cross-sections it is interpreted that water supply wells are most likely completed into the underlying sand and gravel layer that occurs at elevations approximately between 210 masl and 250 masl. These wells are assumed to be completed below the low hydraulic conductivity sandy silt layer that is at surface across most of the subject lands (Figure 6 and Figure 7).

The City of Barrie groundwater supply wells are located in deep aquifers (A3 and A4 in the regional hydrostratigraphy). These aquifers are interpreted to be found at elevations of 150 masl to 195 masl and 115 masl to 160 masl respectively and are therefore significantly below the surficial layer found on the subject lands and separated from any potential impact due to the proposed development (AquaResource et al., 2011). There are no municipal water supply wells located close to the subject lands; the municipal water supply wells are located on the west and northern sides of the City more than 5 kilometres from the subject lands. The subject lands do not fall within any wellhead protection areas or intake protection zones associated with the City of Barrie water supply systems (LSRCA, 2012).

3.2 Water Level Monitoring Results

Groundwater levels were monitored at the on-site monitoring wells on a monthly basis between November 2017 and August 2018. Groundwater level data is provided in tables and hydrographs in Appendix D. Groundwater elevations are plotted with daily precipitation data obtained from a nearby climate station – Barrie-Oro (Climate Station ID# 6117700) – which is the closest station with daily precipitation values for 2017 and 2018. In addition to the manual water level measurements recorded at each location, automatic water level recorders (dataloggers) collected hourly water level data at MW11, SB-PZ1d and PZ4. To prevent freezing and potential malfunctioning of dataloggers, they are not installed in piezometers during winter months. The loggers in SB-PZ1d and PZ4 were installed in April 2018 and these data are also included in the project record. The datalogger data collected are included on the hydrographs provided in Appendix D.

Hydrographs were not created for wells where water elevations were not available such as wells that were dry or flowing during the monitoring period.

The groundwater monitoring data show the following (refer to Figure 2 for the monitoring locations and the data tables and hydrographs in Appendix D):

- Typically, in shallow wells in southern Ontario, a seasonal groundwater level pattern is apparent with highest levels occurring in the spring, declining throughout the summer and early fall and then rising again in the late fall/early winter. This pattern was observed in the on-site wells with seasonal variations ranging from 0.7 m to 4.2 m (Figures D-1 to D-10).

- Continuous water level data at MW11 is plotted against precipitation to determine if there is a correlation between changes in water level and the occurrence of precipitation events (Figures D-10). The logger data shows some correlation with variation in water levels and precipitation events. For example, in July 2018 a rain event of 37 m over two days resulted in an increase of 0.3 m.

- The groundwater table is interpreted to generally reflect the topography of the area. From November 2017 to August 2018, groundwater elevations in the monitoring wells ranged from 251.2 masl to 262.3 masl. Groundwater was measured at surface or above ground in monitoring wells in the lower topographic areas (MW11, SB-1, SB-3, SB-11) while groundwater was greater than 9 meters deep at SB-9 and SB-10 in the upper topographic areas.

- Several monitoring wells were seasonally dry only measuring water levels during the spring when the water table is the highest. These wells included SB-4, SB-8, SB-9, SB-10, SB-14 and SB-15.

- Water levels in piezometer nest SB-PZ1s/d were consistently within 0.05 m of ground surface. Water levels in the deep piezometer were higher than the shallow well during the summer months indicating discharge conditions (Figure D-11, Appendix D).

- Piezometer PZ4 showed typical seasonal variations in the shallow groundwater table with levels lowest during the summer and highest in the spring (Figure D-12).

3.3 Interpreted Groundwater Flow Pattern

Groundwater flow within the shallow overburden (water table) is interpreted to be influenced by the surface topography with groundwater flow from the topographically higher areas towards topographically lower areas and surface water features. Groundwater elevation data (May 2018) obtained from the monitoring wells are shown on Figure 8, along with the interpreted groundwater elevation contours for the area. Arrows perpendicular to the groundwater elevation contours shown on Figure 8 illustrate the interpreted direction of the groundwater movement. Groundwater is interpreted to move in a north and west direction towards Lover’s Creek Swamp.

3.4 Recharge and Discharge Conditions

Areas where water from precipitation infiltrates into the ground and moves downward (i.e., areas of downward hydraulic gradients) are known as recharge areas. These areas are generally found at relatively higher topographic elevation. Areas where groundwater moves upward (i.e., areas of upward hydraulic gradients) are discharge areas and these generally occur in areas of relatively lower topographic elevation, such as along watercourses.

When evaluating groundwater recharge or discharge conditions, nested wells (two wells screened at different depths at the same location) can be used to determine vertical hydraulic gradients in the subsurface.

Piezometer nest SB-PZ1s/d is located at the edge of Lover’s Creek Swamp (Figure 2). The hydrograph of SB-PZ1s/d (Figure D-11) indicates discharge condition at this location with water levels in the deep piezometer higher than the shallow piezometer.

There were no other nested wells on the subject property however, artesian conditions at monitoring wells MW11, SB-1 and SB-3 suggest discharge conditions occur in the lower elevations of the subject lands. In the higher elevations of the subject lands there were several wells that were dry or seasonally dry wells (SB-4, SB-5, SB-8, SB-9, SB-10, SB-14 and SB-15) indicating that recharge conditions are present.

3.5 Significant Groundwater Recharge Areas and Ecologically Significant Groundwater Recharge Areas

Significant Groundwater Recharge Areas (SGRAs) can be described as areas that can effectively move water from the surface through the unsaturated soil zone to replenish available groundwater resources (LSRCA, 2012). SGRAs were mapped by the Source Water Protection Assessment Report (LSRCA, 2012) as a requirement of the Clean Water Act, 2006 and based on guidance provided by the MECP. The delineation of these areas was completed using numerical models and analyses that included the evaluations of numerous factors including precipitation, temperature and other climate data along with land use, soil type, topography and vegetation to predict groundwater recharge, runoff and evapotranspiration.

SGRAs represent areas where the annual recharge rate is greater than 115% of the average recharge of 164 mm/year across the Lake Simcoe watershed (or greater than the threshold recharge rate of 189 mm/year) (LSRCA, 2012). There are no SGRAs mapped within the subject lands (Figure 9).

Ecologically Significant Groundwater Recharge Areas (ESGRAs) were delineated for the Barrie Creek, Lover's Creek and Hewitt's Creek subwatersheds by Earthfx (2012) using the groundwater model developed by AquaResources for the Source Protection studies. ESGRAs were identified as areas of land that are assumed to support groundwater systems or environmentally sensitive features like lakes, cold water streams and wetlands (Earthfx, 2012). ESGRAs were delineated by identifying pathways in which recharge, if it occurred, would reach an ecologically significant feature. Ecologically significant features used for the delineation of the ESRGAs included headwater streams, cold water fisheries, wetlands, and brook trout and sculpin capture sites.

An ESGRA is mapped within the area of the Lover's Creek Swamp in the subject lands (Figure 9). The groundwater flow map completed as part of this assessment (Figure 8) indicates that groundwater is moving towards the wetland and creek. Groundwater monitoring data however as discussed in Section 3.4 indicates discharge conditions within this area.

4.0 Water Quality

4.1 Groundwater Quality

Water quality data was collected from selected monitoring wells to typify the groundwater quality on the subject lands. Groundwater sampling was completed on May 22, 2018 at two groundwater monitoring wells (SB-3 and SB-4). The water samples were submitted to a certified laboratory for analyses of general water quality indicators (e.g., pH, hardness, and conductivity), basic ions (including chloride and nitrate) and selected metals to characterize the background water quality. The groundwater testing results from the analytical laboratory are provided in Table E-1, Appendix E and discussed below.

- The results showed that the water generally met the Ontario Drinking Water Quality Standards (ODWQS).
- Both samples exceeded the ODWQS for total hardness (100 mg/L) with values ranging of 271 mg/L (SB-3) and 337 mg/L (SB-4). Hardness in groundwater is caused by dissolved calcium and magnesium and is typically related to the geologic material of the subsurface.
- Samples exceeded the ODWQS for turbidity (5 NTU) with values of 12 NTU (SB-3) and 15500 NTU (SB-4). This is likely a result of high silt content in the samples caused by a lack of well development. Groundwater is not intended for potable uses as part of the development and hence this exceedance is not regarded as an issue of concern.
- Nitrate was detected in both of the samples with values of 5.47 mg/L (SB-3) and 6.9 mg/L (SB-4). Nitrate in shallow groundwater is typically associated with areas where agricultural land use results in elevated nitrates in groundwater. Current land use on the subject lands is agricultural and is interpreted to be the cause of the elevated nitrates. The removal of agricultural land use as part of the development process is expected to alleviate this issue. It is however noted that both samples were below the ODWQS for nitrate, 10 mg/L.
- Total phosphorus was reported in the samples at 0.03 mg/L (SB-3) and 1.97 mg/L (SB-4). Total phosphorus is a measure of all forms of phosphorus (dissolved or particulate) that are found in the water sample. There was no dissolved phosphorus (ortho-phosphate) reported in the groundwater samples suggesting the reported concentrations are particulate.

4.2 Surface Water Quality

To typify the surface water quality on the subject lands, a surface water sample (SW1) was collected on May 22, 2018 from the tributary of Lover's Creek that crosses the northeast corner of the subject lands. The water sample was submitted to a certified laboratory for analyses of general water quality indicators (e.g., pH, hardness, and conductivity), basic ions (including chloride and nitrate) and selected metals to characterize the background water quality. The surface water quality testing results from the analytical laboratory are provided in Table E-2, Appendix E and discussed below.

- The results show that the surface water sample met all of the Provincial Water Quality Standards (PWQS).

- The sample had similar levels of hardness, total dissolved solids and chloride to the groundwater sample from SB-3. This supports the interpretation that there is groundwater discharge in the wetland area and along Lover's Creek.

- Nitrate was not detected in the surface water sample. This may indicate that nitrate is being attenuated in the groundwater flow path and is not moving off site.

- Total phosphorus was reported in the samples at 0.03 mg/L. Total phosphorus is a measure of all forms of phosphorus (dissolved or particulate) that are found in the water sample. There was no dissolved phosphorus (ortho-phosphate) reported in the surface water sample suggesting the reported concentration was due to particulate.

5.0 Water Balance

In order to assess potential land development impacts on the local groundwater conditions, a detailed water balance analysis has been completed to determine the pre-development recharge volumes (based on existing land use conditions). The detailed water balance calculations are provided in Appendix F.

5.1 Water Balance Components

A water balance is an accounting of the water resources within a given area. As a concept, the water balance is relatively simple and may be estimated from the following equation:

$$P = S + ET + R + I$$

Where:
P = precipitation
S = change in groundwater storage
ET = evapotranspiration/evaporation
R = surface water runoff
I = infiltration

The components of the water balance vary in space and time and depend on climatic conditions as well as the soil and land cover conditions (i.e., rainfall intensity, land slope, soil hydraulic conductivity and vegetation). Runoff, for example, occurs particularly during periods of snowmelt when the ground is frozen, or during intense rainfall events.

Precise measurement of the water balance components is difficult and as such, approximations and simplifications are made to characterize the water balance of a property. Field observations of the drainage conditions, land cover and soil types, groundwater levels and local climatic records are important input considerations for the water balance calculations.

The groundwater balance components for the subject area are discussed below:

Precipitation (P)

The long-term average annual precipitation for the area is 933 mm based on data from the Environment Canada Barrie WPCC (Station 6110557, 44°22'33.012" N, 79°41'23.010" W, elevation 221.0 masl) for the period between 1981 and 2010. The climate station is located 5.2 km northwest of the subject lands. Average monthly records of precipitation and temperature from this station have been used for the water balance calculations in this study (Appendix F).

Storage (S)

Although there are groundwater storage gains and losses on a short-term basis, the net change in groundwater storage on a long-term basis is assumed to be zero so this term is dropped from the equation.

Evapotranspiration (ET)

Evapotranspiration and evaporation components vary based on the characteristics of the land surface cover (i.e., type of vegetation, soil moisture conditions, perviousness of surfaces, etc.). Potential evapotranspiration (PET) refers to the water loss from a vegetated surface to the atmosphere under conditions of an unlimited water supply. The actual rate of evapotranspiration (AET) is generally less than the PET under dry conditions (i.e., during the summer when there is a soil moisture deficit). In this report, the PET and AET have been calculated using a soil-moisture balance approach.

Water Surplus (R + I)

The difference between the mean annual P and the mean annual ET is referred to as the water surplus. Part of the water surplus travels across the surface of the soil as surface or overland runoff (R) and the remainder infiltrates the surficial soil (I). The infiltration is comprised of two end member components: one component that moves vertically downward to the groundwater table (referred to as recharge) and a second component that moves laterally through the topsoil profile or shallow soils as interflow that re-emerges locally to surface (i.e., as runoff) at some short time following cessation of precipitation. As opposed to the “direct” component of surface runoff that occurs during precipitation or snowmelt events, interflow becomes an “indirect” component of runoff.

The interflow component of surface runoff is not accounted for in the water balance equation cited above since it is often difficult to distinguish between interflow and direct (overland) runoff, however both interflow and direct runoff together form the total surface water runoff component.

5.2 Approach and Methodology

The analytical approach to calculate the water balance involves monthly soil-moisture balance calculations to determine the pre-development (based on existing land use) infiltration volumes. A soil-moisture balance approach assumes that soils do not release water as potential recharge while a soil moisture deficit exists. During wetter periods, any excess of precipitation over evapotranspiration first goes to restore soil moisture. Once the soil moisture deficit is overcome, any further excess water can then pass through the soil as infiltration and either become interflow (indirect runoff) or recharge (deep infiltration).

A soil moisture storage capacity of 150 mm was used for the agricultural lands with predominantly short to moderate-rooted vegetation (Table F-1, Appendix F). A soil moisture storage capacity of 300 mm was used for wooded areas within the subject lands (Table F-2, Appendix F). Tables F-1 and F-2 in Appendix F detail the monthly potential evapotranspiration calculations accounting for latitude and climate, and then calculate the actual evapotranspiration and water surplus components of the water balance based on the monthly precipitation and soil moisture conditions.

The MECP SWM Planning and Design Manual (2003) methodology for calculating total infiltration based on topography, soil type and land cover was used and a corresponding runoff component was calculated for the soil moisture storage conditions. The calculated water balance components from this table are then used to assess the pre-development volumes for runoff and infiltration as presented on Table F-3 in Appendix F.

5.3 Water Balance Component Values

The detailed monthly calculations of the water balance components are provided in Tables F-1 and F-2 in Appendix F. For these calculations, it has been assumed that sandy loam soils are representative for the subject lands for estimating the soil infiltration factor. The calculations show that a water surplus is generally available from November to May. The monthly water balance calculations illustrate how infiltration occurs during periods when there is sufficient water available to overcome the soil moisture storage requirements. The monthly calculations are summed to provide estimates of the annual water balance component values (Tables F-1 and F-2, Appendix F). A summary of these values is provided in Table 3.

Table 3: Water Balance Component Values

Water Balance Component	Agricultural Lands	Wooded Areas
Average Precipitation	933 mm/year	933 mm/year
Actual Evapotranspiration	593 mm/year	593 mm/year
Water Surplus	340 mm/year	340 mm/year
Infiltration	238 mm/year	272 mm/year
Runoff	102 mm/year	68 mm/year

5.4 Pre-Development Water Balance (Existing Conditions)

The pre-development water balance calculations are presented in Table F-3 in Appendix F. As summarized on Table F-3, the total area of the subject lands is about 36.6 ha. The water balance component values from Table F-1 and Table F-2 were used to calculate the average annual volume of infiltration across the subject lands. Based on these component values, the pre-development infiltration volume for the subject lands is calculated to be about 64,100 m^3/year (Table F-3, Appendix F).

5.5 Potential Urban Development Impacts to Water Balance

Development of an area affects the natural water balance. The most significant difference is the addition of impervious surfaces as a type of surface cover (i.e., roads, parking lots, driveways, and rooftops). Impervious surfaces prevent infiltration of water into the soils and the removal of the vegetation removes the evapotranspiration component of the natural water balance. The evaporation component from impervious surfaces is relatively minor (estimated to be 10% to 20% of precipitation) compared to the evapotranspiration component that occurs with vegetation in this area (about 64% of precipitation across the subject lands). The net effect of the construction of impervious surfaces is that most of the precipitation that falls onto impervious surfaces becomes surplus water and direct runoff. The natural infiltration components (interflow and deep recharge) are reduced.

A water balance calculation of the potential water surplus for impervious areas is shown at the bottom of Table F-1 in Appendix F. There is an evaporation component from impervious surfaces and this is typically estimated to be between about 10% and 20% of the total precipitation. For the purposes of the calculations in this study, the evaporation has been estimated to be 15% of precipitation. The remaining 85% of the precipitation that falls on impervious surfaces is assumed to become runoff. Therefore, assuming an evaporation/loss from impervious surfaces of 15% of the precipitation, there is a potential water surplus from impervious areas of 793 mm/year.

It is noted that the proposed development will be serviced by municipal water supply and waste water services. Therefore, there will be no impact on the water balance and local groundwater or surface water quantity and quality conditions related to any on-site groundwater supply pumping or disposal of septic effluent.

5.6 Post-Development Water Balance with No Mitigation

To assess potential development impacts on infiltration, the post-development infiltration volumes have been calculated for the subject lands on Table F-3 in Appendix F. The total areas for the proposed land uses and the associated percentage impervious factors were provided by SCS Consulting Group.

The infiltration and runoff components for the post-development land uses have been calculated using the MOECC SWM Planning and Design Manual (2003) methodology based on topography, soil type and land cover as shown on Tables F-1 and F-2 in Appendix F. In summary from these appendix tables, the average calculated post-development infiltration volume (without mitigation) is about 48,500 m^3/year.

Comparing the pre- and post-development infiltration volumes, shows that development has the potential to reduce the average infiltration on the subject lands from 64,500 m^3/year to 48,500 m^3/year, i.e., a reduction of about 16,000 m^3/year or 25%. These calculations assume no low impact development (LID) measures for stormwater management are in place.

5.7 Recommended Mitigation Strategies for Infiltration

The water balance calculations suggest that, without mitigation, the subject lands will receive about 75% of the current amount of average annual groundwater infiltration after development. It is recommended to minimize the potential development impacts to infiltration through the use of 'low impact development' (LID) measures for stormwater management to ensure the post-development groundwater infiltration volume is maintained as close to the pre-development infiltration volume as possible.

Where feasible, measures to promote infiltration and minimize development impacts on the water balance should be incorporated into the development design. There, as outlined in the MOECC SWM Design Manual (2003), a number of mitigation techniques that can be used to increase the potential for post-development infiltration and mitigate the reductions in infiltration that occur with land development. Techniques to maximize the water availability in pervious areas such as designing grades to direct roof runoff towards lawns, side and rear yard swales, boulevards, parks, and other open space areas throughout the development where possible and increasing the topsoil thickness (i.e., from typical thicknesses of about 15 cm up to 20 cm or 30 cm) can increase the potential for infiltration in developed areas. These types of surface LID techniques promote natural infiltration by providing additional water volumes in the pervious areas. This may be particularly effective in the summer months, when natural infiltration would not generally occur because the additional water overcomes the natural soil moisture deficit. Other LID measures that may be considered to reduce runoff volumes include bioswales, rain gardens, perforated pipe systems, infiltration trenches and facilities, permeable pavements, tree boxes, and rainwater harvesting techniques, such as cisterns and rain barrels.

It is our understanding that subsurface exfiltration trenches, rain gardens and a below grade filtration gallery are being considered by the projects' engineers for LIDs on the subject lands (SCS, 2018). It is expected that these measures will provide adequate water to offset the infiltration deficit, however the impact of LID measures on infiltration should be confirmed at detailed design.

6.0 Development Considerations

6.1 Construction Below the Water Table

Based on groundwater level data collected as part of this study water table on the subject lands ranges from 0 m to 9 m below ground surface. Should excavations during construction of servicing extend below the water table the local soils may need to be dewatered. Significant groundwater flows may be encountered in areas where high permeability sand and gravel layers are encountered.

The construction of buried services below the water table has the potential to capture and redirect groundwater flow through more permeable fill materials typically placed in the base of excavations. Groundwater may also infiltrate into joints in storm sewers and manholes. Over the long-term, these impacts can lower the groundwater table across the development area. To mitigate this effect, services to be installed below the water table should be constructed to prevent redirection of groundwater flow. This will involve the use of anti-seepage collars or clay plugs surrounding the pipes to provide barriers to flow and prevent groundwater flow along granular bedding material and erosion of the backfill materials.

Due to the potential for encountering the water table during construction, the dewatering of local aquifers may be required in order for services to be installed below the water table. The undertaking of dewatering according to industry standards and in accordance with a MECP processes will ensure that adequate attention is paid to potential adverse impacts to the environment. Currently the MECP allows for construction dewatering of less than 400,000 L/d to proceed under the Environmental Activity Sector Registry (EASR) process. If dewatering is to be above this threshold, then the standard Permit to Take Water (PTTW) process applies. In both cases, a scientific study is required in support of EASR registration or PTTW application. This scientific study must review the potential for environmental impacts and provide mitigation and monitoring measures to the satisfaction of the MECP or other review agency. The requirements for construction dewatering will be confirmed by geotechnical/hydrogeological investigations completed in support of detailed design.

6.2 Local Groundwater Supply Wells

The area surrounding the subject lands is not currently serviced and residences are supplied by private wells. A water well survey has been completed on behalf of the Hewitt's Land Owners Group to identify private water supply wells within 300 m of the Hewitt's SPA area. The survey confirmed the location of private wells along Lockhart Road. The private wells are assumed to be completed in the local sand and gravel layer that underlies the shallow sandy silt till zone which may be subject to impacts during construction. The low permeability of the shallow sandy silt till is expected to restrict the potential zone of influence due to construction activities. Dewatering of the subject lands will result in short-term removal of water from the subsurface however this impact is expected to be limited to the shallow sandy silt layer that is above and separated from the sand and gravel layer in which most of the private domestic wells are completed.

As noted in Section 6.1, the PTTW and EASR processes require a detailed hydrogeological study to be completed that evaluates the potential impacts of dewatering and looks at the area of potential impact from this activity. It is expected that the report will set out any domestic well monitoring requirements as well as a contingency and mitigation response plan. It is recommended that, prior to the completion of any dewatering activities, local residents be advised of the activity and that an impact response procedure be established. The impact response procedure will include a contact for any resident who notes an impact at their well. Impacts will also be reported to the MECP and replacement water supplied until the impact has dissipated.

6.3 Well Decommissioning

Prior to or during construction, it is necessary to ensure that all inactive wells within the development footprint have been located and properly decommissioned by a licensed water well contractor according to Ontario Regulation 903. This regulation applies private domestic wells and to the groundwater observation wells installed for this study unless they are maintained throughout the construction for monitoring purposes.

7.0 References

AquaResource et al. 2011. City of Barrie Tier Three Water Balance and Local Area Risk Assessment Groundwater Flow Model, AquaResource, Golder and IWC, 2011.

Burnside, 2016. Hewitt's Secondary Plan Area Hydrogeological Assessment, Hewitt's Landowners Group, R.J. Burnside & Associates Limited, June 2016.

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Peto MacCallum, 2017. Geotechnical Investigation Proposed Lockhart Road Residential Subdivision, Barrie, Ontario. Peto MacCallum Ltd., May 2017.

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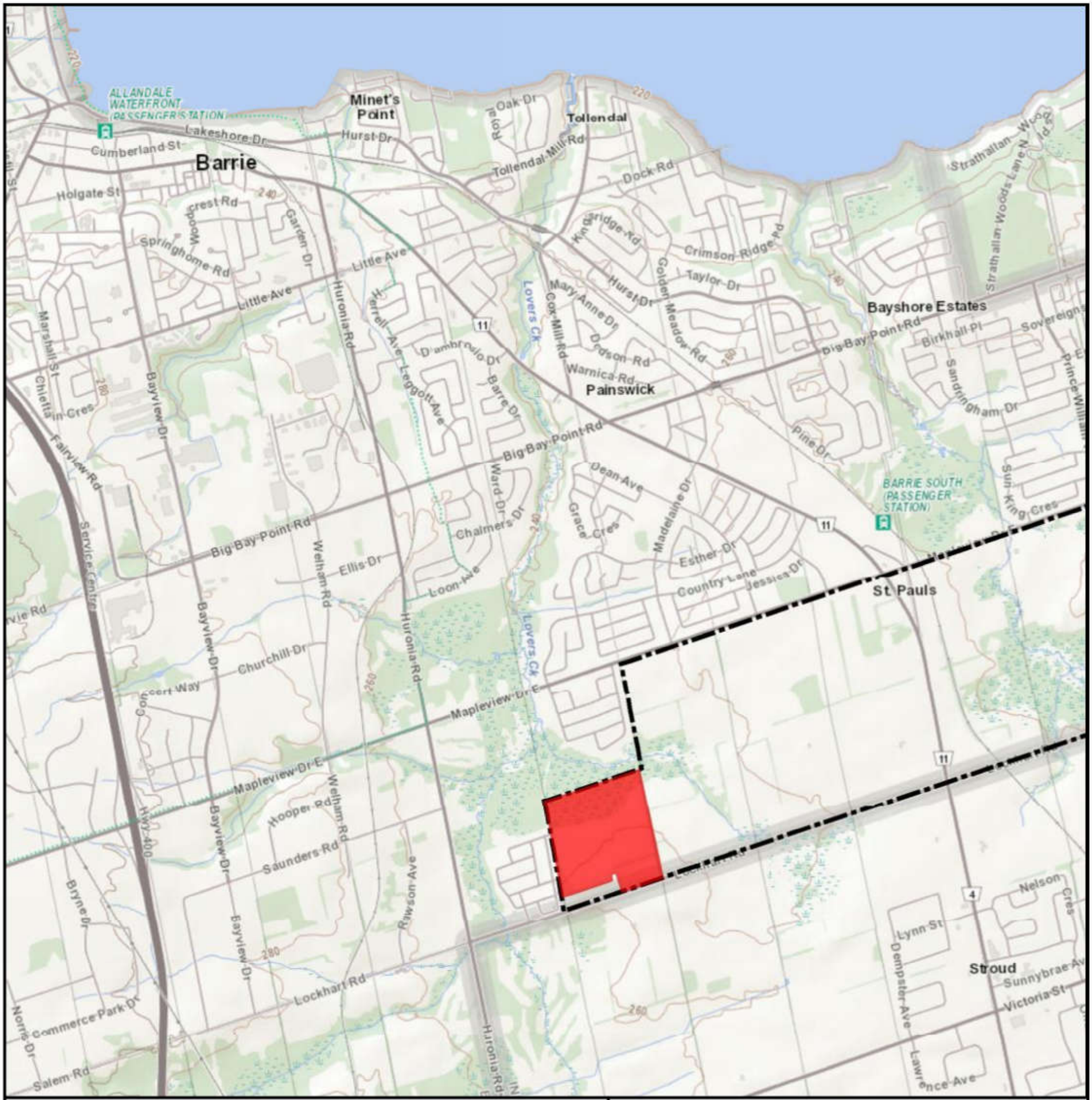
Figures



LEGEND

🟥 SUBJECT LANDS

⬚ HEWITT'S SECONDARY PLAN AREA

0 500 1,000 2,000
Meters

N

BURNSIDE

Client / Report

BARRIE LOCKHART ROAD LP
BARRIE, ONTARIO

HYDROGEOLOGICAL STUDY
IN SUPPORT OF DRAFT PLAN

Figure Title:

SITE LOCATION

Drawn	Checked	Date	Figure No.
SK	SC	August 2018	1
Scale		Project No.	
1:35,000		300041514	

File Path: Nigel/Shared Work Areas/041514 Lockhart Road LPA:\041514 Lockhart Rd LP\041514 Site Location.mxd Print Date: 2018/08/22 Time: 11:04 AM

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

LEGEND

- 🟥 SUBJECT LANDS
- ▭ HEWITT'S SECONDARY PLAN
- ⊕ MONITORING WELL (PETO, 2017)
- ⊕ MONITORING WELL (RJB, 2014)
- ● DRIVE POINT PIEZOMETER

0 50 100 200 300 400
Meters

N

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BARRIE LOCKHART ROAD LP
BARRIE, ONTARIO

HYDROGEOLOGICAL STUDY
IN SUPPORT OF DRAFT PLAN

Figure Title:

SITE PLAN

Drawn	Checked	Date	Figure No.
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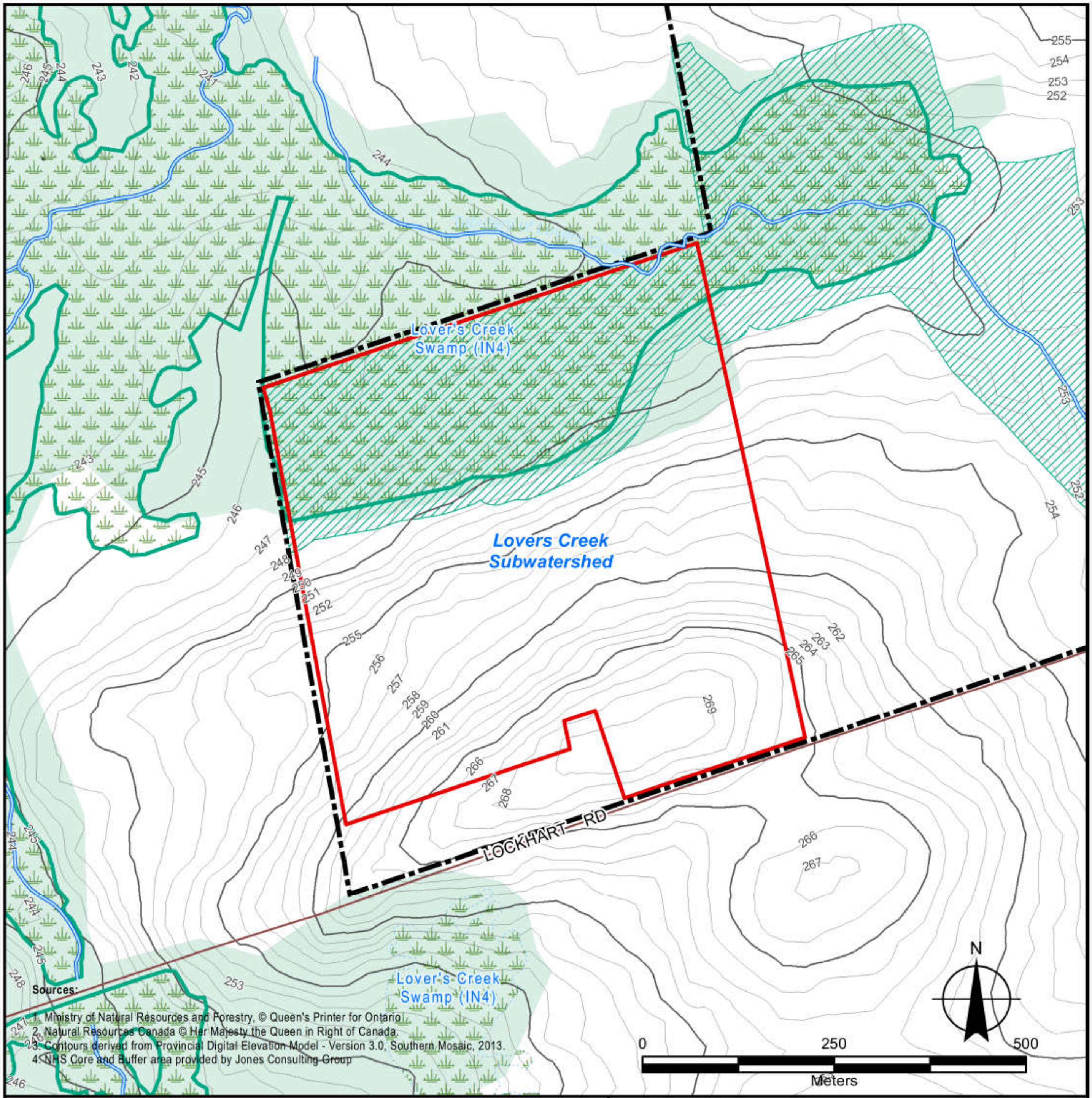

Sources:
1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario.
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. Contours derived from Provincial Digital Elevation Model - Version 3.0, Southern Mosaic, 2013.
4. NHS Core and Buffer area provided by Jones Consulting Group

LEGEND

🟥 SUBJECT LANDS
▭ HEWITT'S SECONDARY AREA
═ WATERCOURSE
— CONTOUR (5m intervals - masl)
— CONTOUR (1m intervals - masl)
— ROADWAY
▨ WETLAND
▭ PROVINCIALLY SIGNIFICANT WETLAND
▨ NHS CORE AND BUFFER
🟩 WOODS / FOREST

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Client / Report

BARRIE LOCKHART ROAD LP
BARRIE, ONTARIO

HYDROGEOLOGICAL STUDY
IN SUPPORT OF DRAFT PLAN

Figure Title:

TOPOGRAPHY AND DRAINAGE

Drawn	Checked	Date	Figure No.
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Scale		Project No.	
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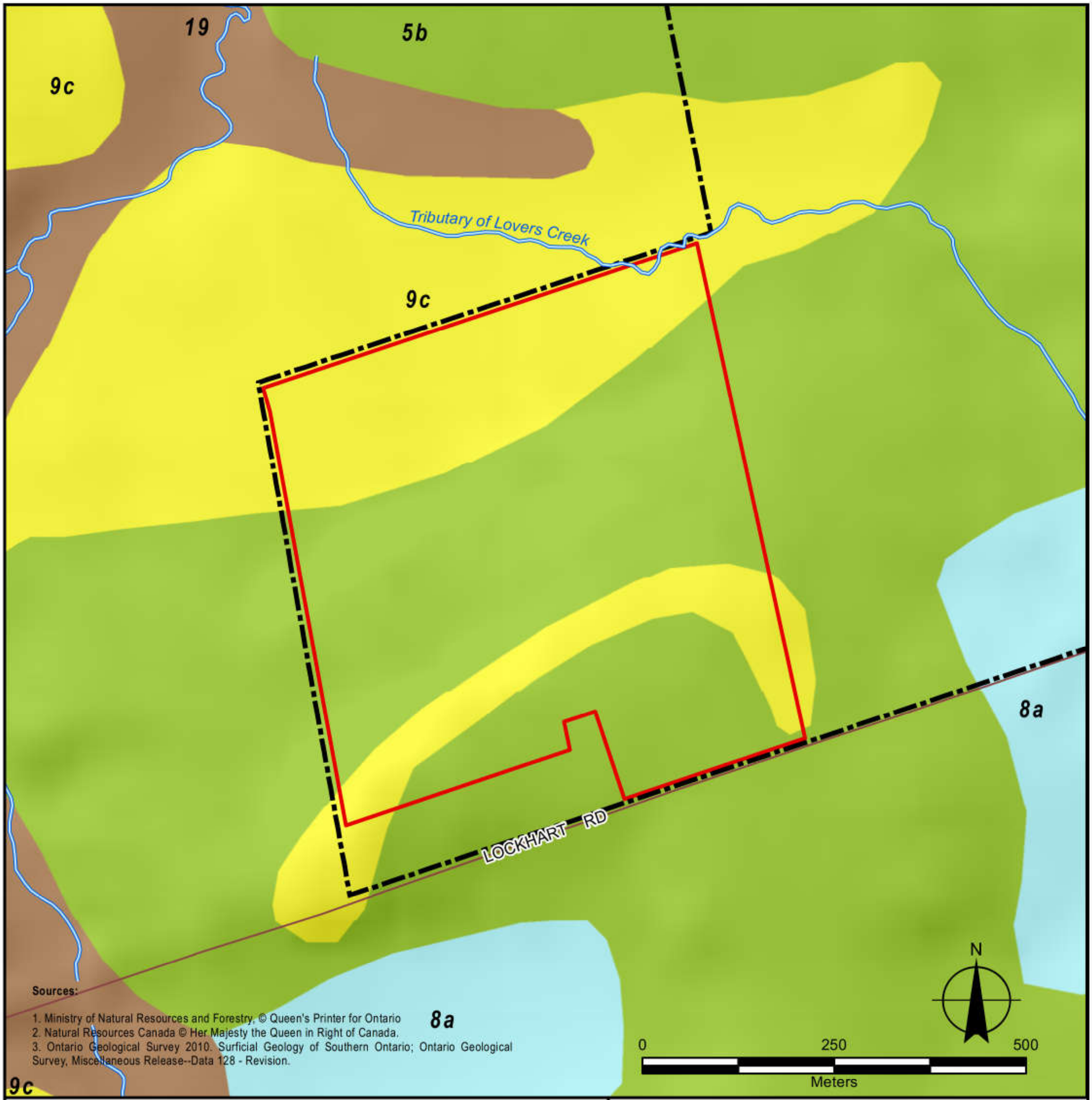

Sources:
1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. Ontario Geological Survey 2010. Surficial Geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128 - Revision.

LEGEND

🟥	SUBJECT LANDS
▭	HEWITT'S SECONDARY AREA PLAN
═	WATERCOURSE
—	ROADWAY
🟩	5b: Stone-poor, carbonate-derived silty to sandy till
🟦	8a: Fine-textured glaciolacustrine deposits: Massive-well laminated
🟨	9b: Coarse-textured glaciolacustrine deposits: Littoral-foreshore deposits
🟨	9c: Coarse-textured glaciolacustrine deposits: Foreshore-basinal deposits
🟫	19: Modern alluvial deposits

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BARRIE LOCKHART ROAD LP
BARRIE, ONTARIO

HYDROGEOLOGICAL STUDY
IN SUPPORT OF DRAFT PLAN

Figure Title:

SURFICIAL GEOLOGY

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Scale		Project No.	
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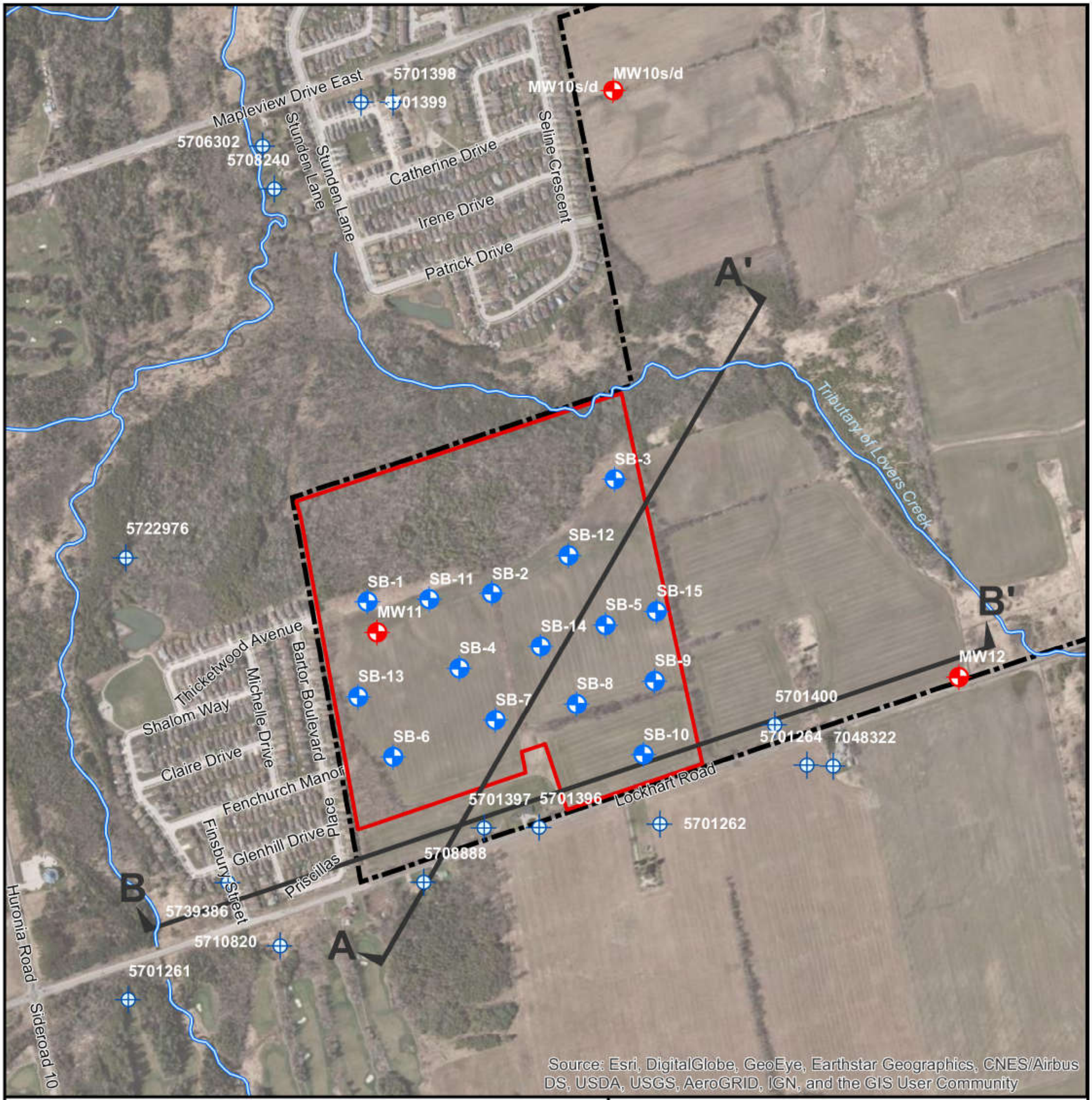

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

LEGEND

🟥	SUBJECT LANDS
▭	HEWITT'S SECONDARY PLAN AREA
●	MONITORING WELL (PETO, 2017)
●	MONITORING WELL (RJB, 2014)
⊕	MECP WELL RECORD LOCATION
⌴	CROSS SECTION LOCATION KEY

0 50 100 200 300 400 500 600 700 800

Meters

N

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Client / Report

BARRIE LOCKHART ROAD LP
BARRIE, ONTARIO
HYDROGEOLOGICAL STUDY
IN SUPPORT OF DRAFT PLAN

Figure Title:

WELL PLAN

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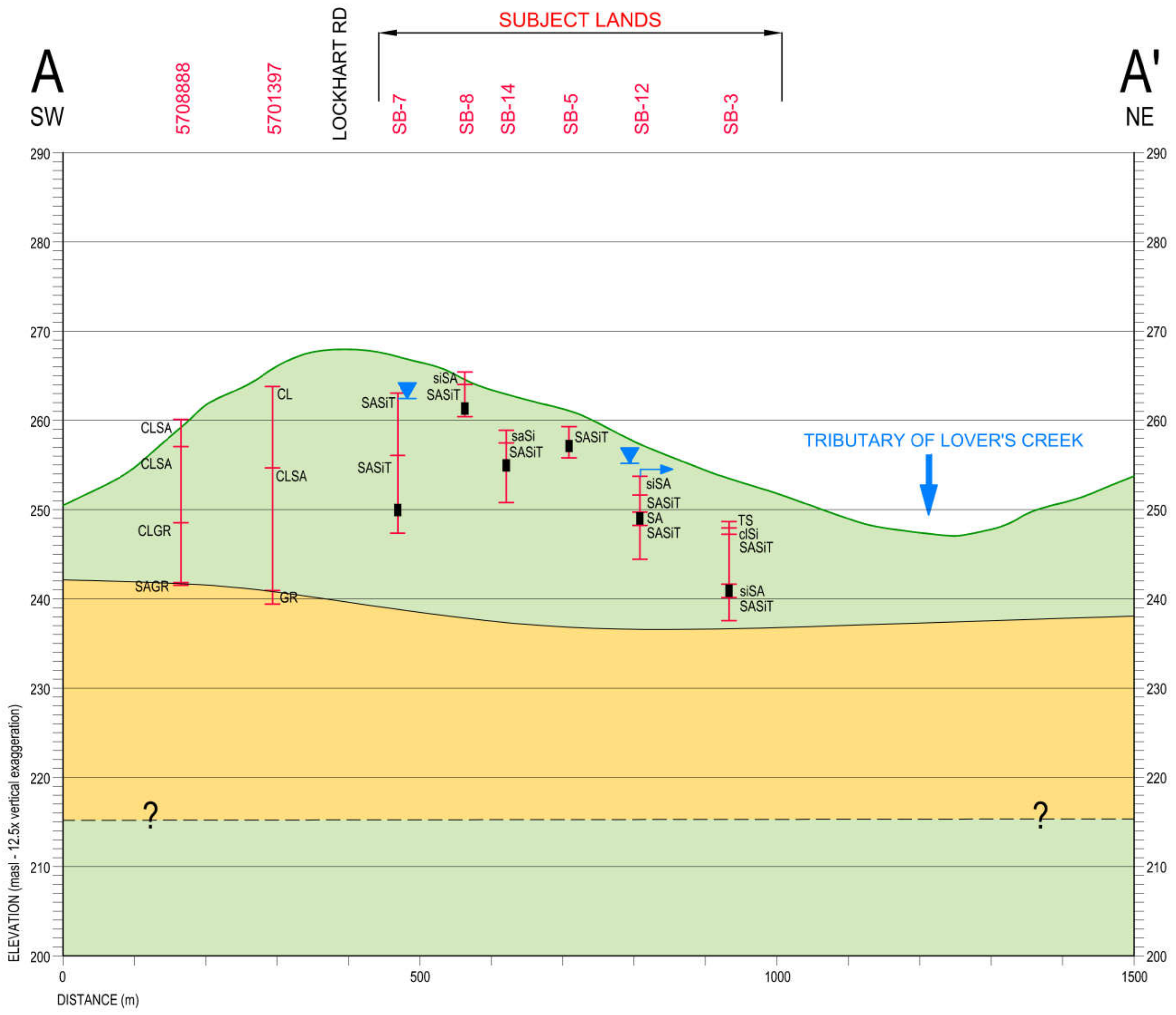

LEGEND

- 4901807 — MOE WELL RECORD NUMBER
- MW10 — WELL / BOREHOLE ID
- WELL
- CLGR — GEOLOGICAL STRATIGRAPHY
- ▽ — STATIC WATER LEVEL (REPORTED ON MOE WELL RECORD)
- ▼ — MEASURED WATER LEVEL (MAY, 2018)
- ▮ — WELL SCREEN

- 🟩 CLAY / SILT / TILL
- 🟨 SAND / GRAVEL
- – – – INTERPRETED GEOLOGICAL CONTACT
- ↓ WATERCOURSE CROSSING
- ↱ INDICATES FLOWING WELL

si	SILTY
cl	CLAYEY
sa	SANDY
F	FILL
T	TILL
SA	SAND
Si	SILT
GR	GRAVEL
CL	CLAY
PRDG	PREDUG

Client / Report

BARRIE LOCKHART ROAD LP
BARRIE, ONTARIO
HYDROGEOLOGICAL STUDY
IN SUPPORT OF DRAFT PLAN

Figure Title

INTERPRETED GEOLOGICAL CROSS-SECTION A-A'

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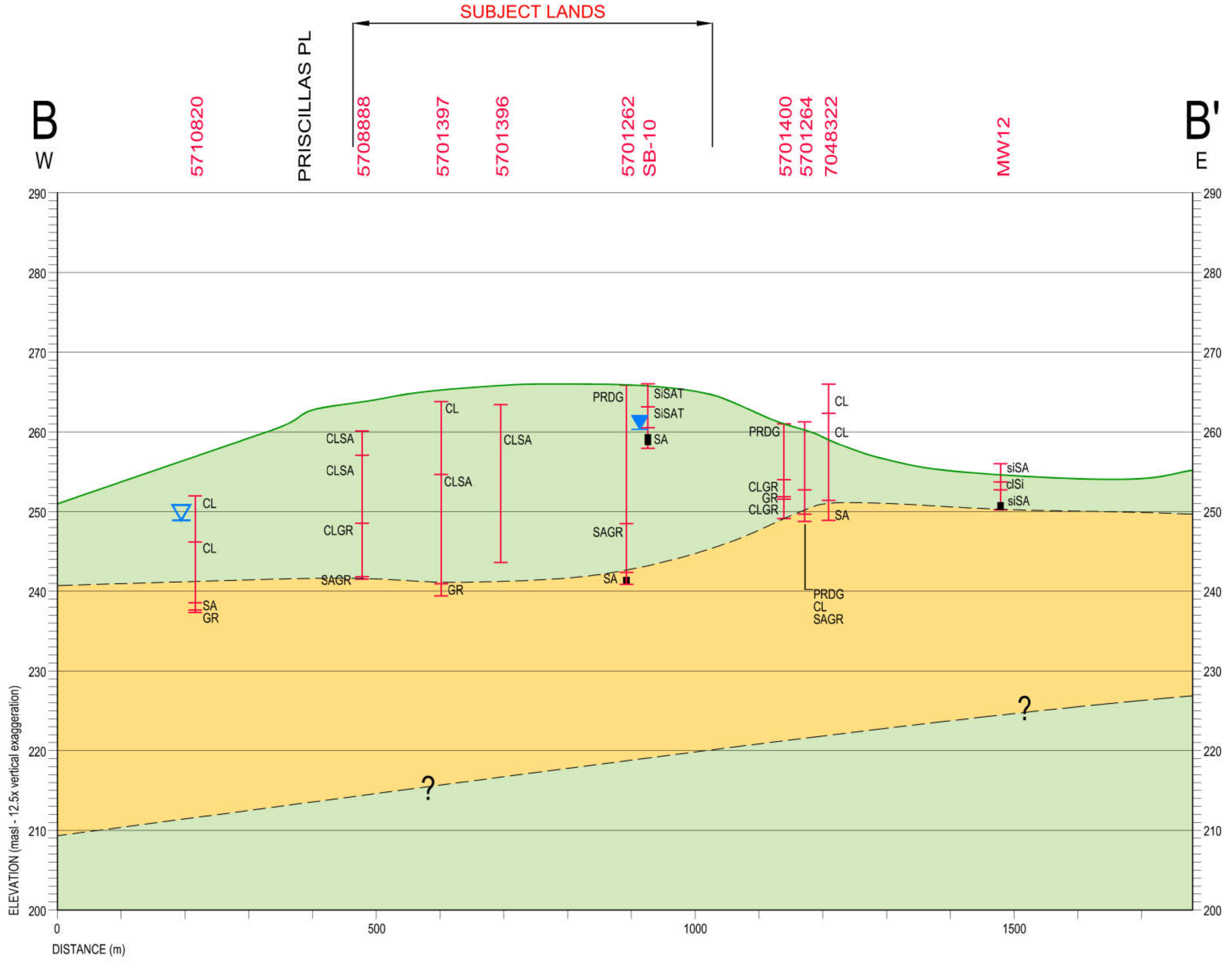

LEGEND

4901807 MW10
- WELL / BOREHOLE ID
- MOE WELL RECORD NUMBER
- WELL
- CLGR — GEOLOGICAL STRATIGRAPHY
- ▽ STATIC WATER LEVEL (REPORTED ON MOE WELL RECORD)
- ▼ MEASURED WATER LEVEL (MAY, 2018)
- ▮ WELL SCREEN

- 🟩 CLAY / SILT / TILL
- 🟨 SAND / GRAVEL
- – – – INTERPRETED GEOLOGICAL CONTACT
- ↓ WATERCOURSE CROSSING

si	SILTY
cl	CLAYEY
sa	SANDY
F	FILL
T	TILL
SA	SAND
Si	SILT
GR	GRAVEL
CL	CLAY
PRDG	PREDUG

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BARRIE LOCKHART ROAD LP
BARRIE, ONTARIO
HYDROGEOLOGICAL STUDY
IN SUPPORT OF DRAFT PLAN

Figure Title

INTERPRETED GEOLOGICAL CROSS-SECTION B-B'

Drawn	Checked	Date	Figure No.
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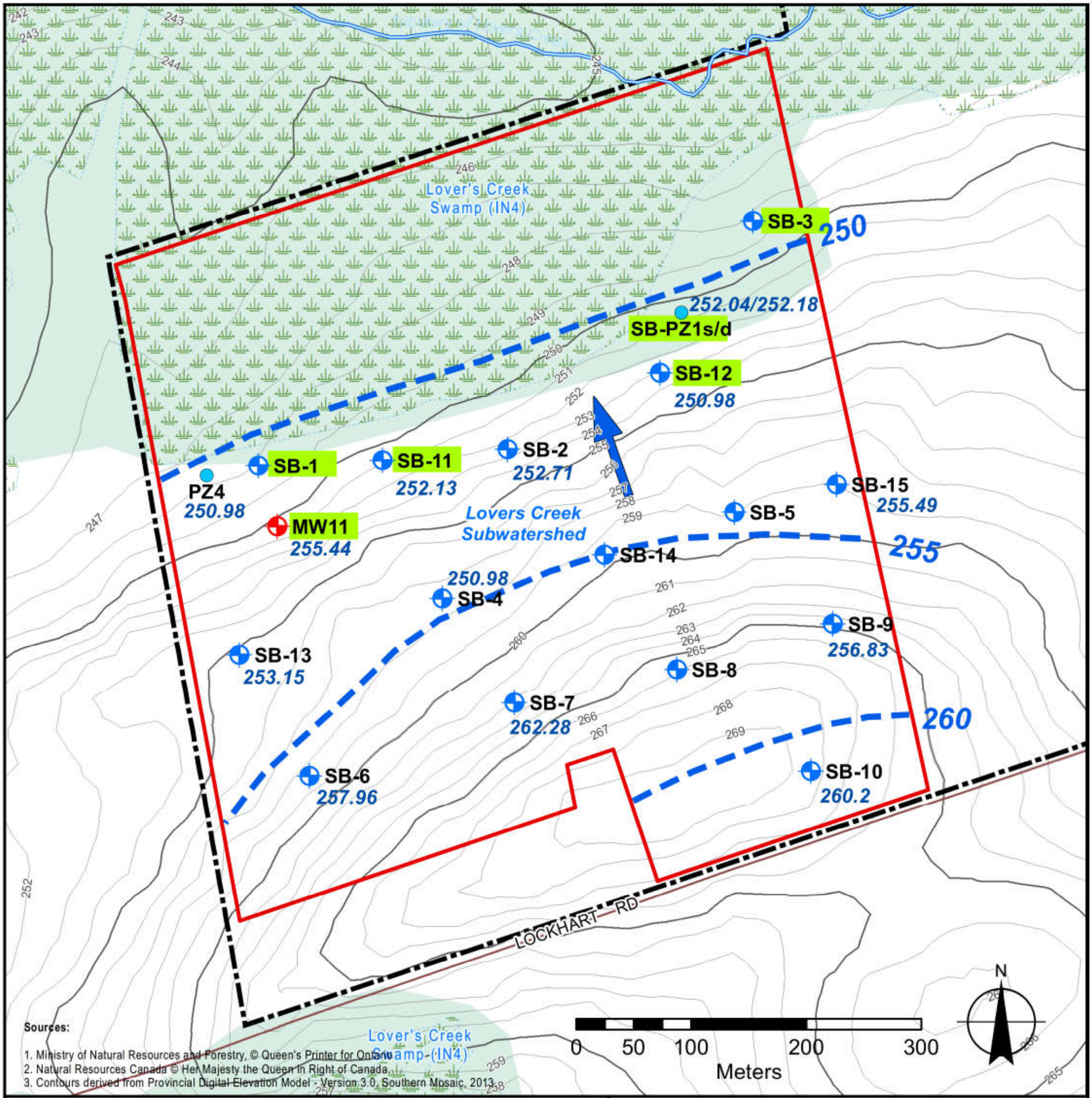

Sources:

1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. Contours derived from Provincial Digital Elevation Model - Version 3.0, Southern Mosaic, 2013.

LEGEND

- ▭ SUBJECT LANDS
- ▭ HEWITT'S SECONDARY AREA PLAN
- ⊕ MONITORING WELL (RJB, 2014)
- ⊕ MONITORING WELL (PETO, 2017)
- ● DRIVE POINT PIEZOMETER
- ═ WATERCOURSE
- — CONTOUR (5m intervals - masl)
- — CONTOUR (1m intervals - masl)
- — ROADWAY
- ▨ WETLAND
- 🟩 WOODS / FOREST
- 🟩 INDICATES WATER LEVELS ABOVE GROUND SURFACE
- – – INTERPRETED GROUNDWATER CONTOUR (masl)
- *255.49* MEASURED WATER LEVEL (masl - May 2018)
- → INTERPRETED GROUNDWATER FLOW DIRECTION

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BARRIE LOCKHART ROAD LP
BARRIE, ONTARIO

HYDROGEOLOGICAL STUDY
IN SUPPORT OF DRAFT PLAN

Figure Title:

INTERPRETED GROUNDWATER FLOW

Drawn	Checked	Date	Figure No.
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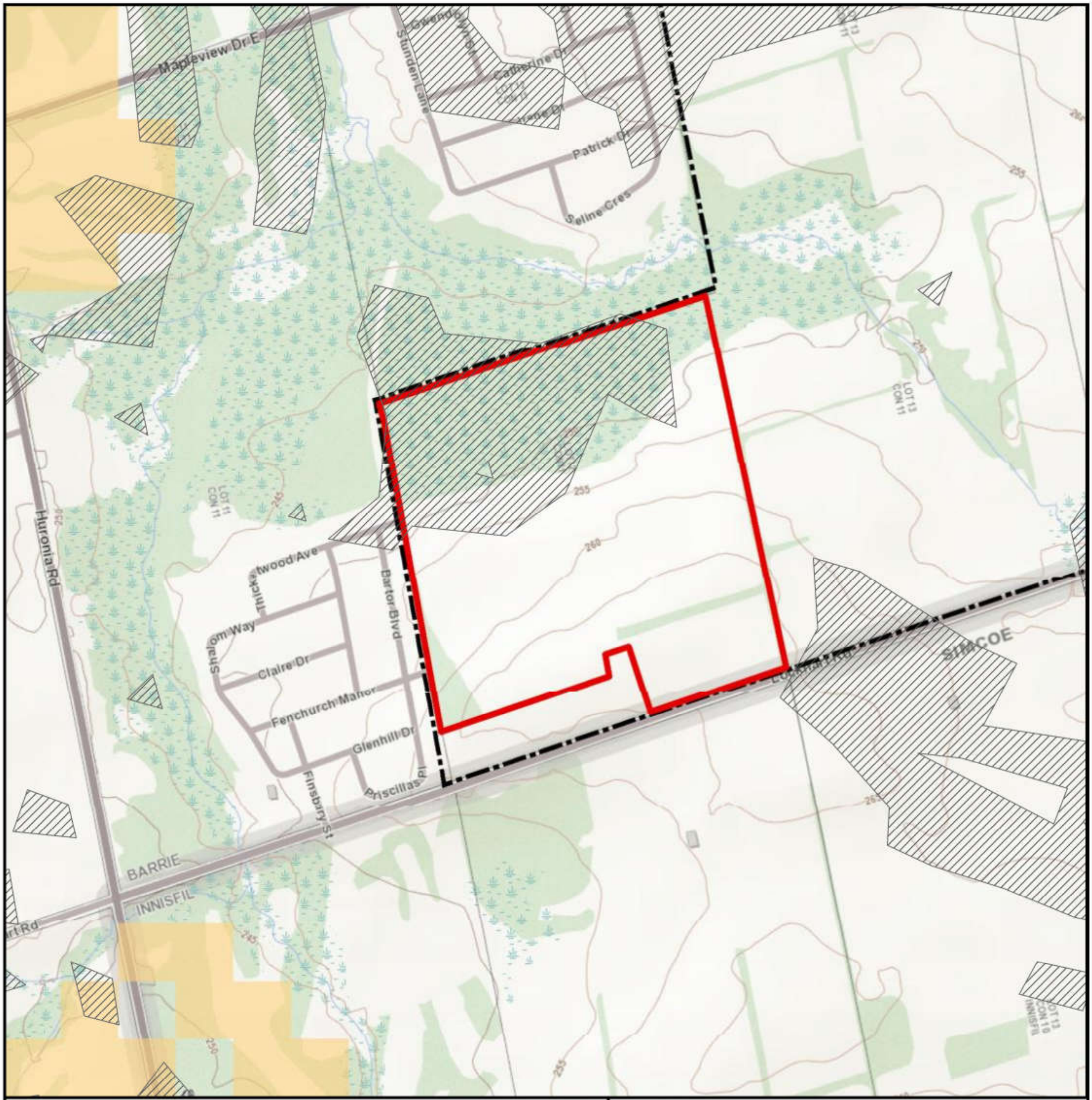

LEGEND

🟥 SUBJECT LANDS

▭ HEWITT'S SECONDARY PLAN AREA

▨ ECOLOGICALLY SIGNIFICANT GROUNDWATER RECHARGE AREAS (ESGRA, LSRCA)

🟧 SIGNIFICANT GROUNDWATER RECHARGE AREAS (SGRA, LSRCA)

0 100 200 400 600 800

Meters

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Client / Report

BARRIE LOCKHART ROAD LP
BARRIE, ONTARIO
HYDROGEOLOGICAL STUDY
IN SUPPORT OF DRAFT PLAN

Figure Title:

RECHARGE AREAS

Drawn	Checked	Date	Figure No.
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Scale		Project No.	
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BURNSIDE

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Appendix A

MECP Water Well Records

Water Well Records

Thursday, March 01, 2018

10:51:45 AM

TOWNSHIP CON LOT	UTM	DATE CNTR	CASING DIA	WATER	PUMP TEST	WELL USE	SCREEN	WELL	FORMATION
INNISFIL TOWNSHIP CON 10 011	17 607060 4909238 W	1957/06 1637	4	FR 0111	34/38/6/2:0	DO	0139 6	5701261 ()	CLAY STNS 0047 STNS 0068 GRVL 0145
INNISFIL TOWNSHIP CON 10 012	17 607985 4909544 W	1961/09 2514	6	FR 0080	43/55/25/2:30	ST DO	0079 3	5701262 ()	PRDG 0057 MSND GRVL CLAY 0077 CSND 0082
INNISFIL TOWNSHIP CON 10 012	17 607574 4909443 W	1969/12 3203	5	FR 0060	24/45/2/2:0	DO		5708888 ()	BLCK LOAM 0002 BRWN CLAY MSND 0010 BRWN CLAY MSND STNS 0038 GREY CLAY GRVL 0060 GREY MSND GRVL 0061
INNISFIL TOWNSHIP CON 10 013	17 608286 4909644 W	2007/08 3413	6		15/42/10/2:	PS		7048322 (Z63967) A058559	BRWN CLAY 0012 GREY CLAY 0048 GREY SAND 0056
INNISFIL TOWNSHIP CON 10 013	17 608240 4909646 W	1960/11 2514	6	FR 0041	18/40/2/2:0	DO		5701264 ()	PRDG 0028 BRWN CLAY 0038 MSND GRVL 0041
INNISFIL TOWNSHIP CON 11 011	17 607234 4909442 W	2004/12 2513						5739386 (Z14909) A014862 A	
INNISFIL TOWNSHIP CON 11 011	17 607056 4910007 L	1987/11 2514	6	FR 0119	50/75/15/1:30	DO	0122 3	5722976 (NA)	BRWN CLAY 0034 GREY CLAY GVLY 0119 YLLW SAND 0125
INNISFIL TOWNSHIP CON 11 012	17 607294 4910723 W	1969/06 4608	30	FR 0008	8/13//1:0	DO		5706302 ()	BRWN CLAY STNS 0005 GREY GRVL 0010 GREY GRVL STNS 0015
INNISFIL TOWNSHIP CON 11 012	17 607775 4909538 W	1959/12 4102	30	FR 0065	20//1/:	ST DO		5701396 ()	BLUE CLAY MSND 0065
INNISFIL TOWNSHIP CON 11 012	17 607679 4909537 W	1964/09 3109	30	FR 0075	57//2/:	ST DO		5701397 ()	LOAM 0002 BLUE CLAY 0030 CLAY MSND STNS 0075 GRVL 0080
INNISFIL TOWNSHIP CON 11 012	17 607521 4910799 W	1966/09 3203	5	FR 0078	30/68/2/2:0	DO		5701398 ()	LOAM 0001 BRWN CLAY 0019 BRWN CLAY STNS 0030 GRVL CLAY MSND 0078 GRVL MSND 0079 GRVL MSND CLAY 0085
INNISFIL TOWNSHIP CON 11 012	17 607465 4910799 W	1966/12 3109	30	FR 0064	32//2/:	DO		5701399 ()	LOAM 0002 BRWN CLAY 0027 BLUE CLAY STNS 0062 GRVL 0070
INNISFIL TOWNSHIP CON 11 012	17 607314 4910648 W	1971/08 3203	6	FR 0048	6/45/4/2:30	DO	0048 4	5708240 ()	BRWN CLAY GRVL 0013 GREY CLAY STNS 0028 GREY CLAY SAND 0048 SAND 0052
INNISFIL TOWNSHIP CON 11 013	17 608514 4909816 W	2014/03 6809						7239311 (C25733) A152308 P	
INNISFIL TOWNSHIP CON 11 013	17 608220 4910394 L	1989/09 3030	36	UK 0006	6///:	DO		5725687 (61061)	BRWN LOAM 0001 BRWN SAND 0006 BRWN SAND 0023
INNISFIL TOWNSHIP CON 11 013	17 608184 4909716 W	1964/11 2514	6	FR 0030	18/30/4/2:0	ST DO		5701400 ()	PRDG 0023 BLUE CLAY GRVL BLDR 0030 GRVL 0031 BLUE CLAY GRVL BLDR 0039

TOWNSHIP CON LOT UTM DATE CNTR CASING DIA WATER PUMP TEST WELL USE SCREEN WELL FORMATION

Notes:
UTM: UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
DATE CNTR: Date Work Completedand Well Contractor Licence Number
CASING DIA: .Casing diameter in inches
WATER: Unit of Depth in Fee. See Table 4 for Meaning of Code

PUMP TEST: Static Water Level in Feet / Water Level After Pumping in Feet / Pump Test Rate in GPM / Pump Test Duration in Hour : Minutes
WELL USE: See Table 3 for Meaning of Code
SCREEN: Screen Depth and Length in feet
WELL: WEL (AUDIT #) Well Tag . A: Abandonment; P: Partial Data Entry Only
FORMATION: See Table 1 and 2 for Meaning of Code

1. Core Material and Descriptive terms

Code	Description	Code	Description	Code	Description	Code	Description	Code	Description
BLDR	BOULDERS	FCRD	FRACTURED	IRFM	IRON FORMATION	PORS	POROUS	SOFT	SOFT
BSLT	BASALT	FGRD	FINE-GRAINED	LIMY	LIMY	PRDG	PREVIOUSLY DUG	SPST	SOAPSTONE
CGRD	COARSE-GRAINED	FGVL	FINE GRAVEL	LMSN	LIMESTONE	PRDR	PREV. DRILLED	STKY	STICKY
CGVL	COARSE GRAVEL	FILL	FILL	LOAM	TOPSOIL	QRTZ	QUARTZITE	STNS	STONES
CHRT	CHERT	FLDS	FELDSPAR	LOOS	LOOSE	QSND	QUICKSAND	STNY	STONEY
CLAY	CLAY	FLNT	FLINT	LTCL	LIGHT-COLOURED	QTZ	QUARTZ	THIK	THICK
CLN	CLEAN	FOSS	FOSILIFEROUS	LYRD	LAYERED	ROCK	ROCK	THIN	THIN
CLYY	CLAYEY	FSND	FINE SAND	MARL	MARL	SAND	SAND	TILL	TILL
CMTD	CEMENTED	GNIS	GNEISS	MGRD	MEDIUM-GRAINED	SHLE	SHALE	UNKN	UNKNOWN TYPE
CONG	CONGLOMERATE	GRNT	GRANITE	MGVL	MEDIUM GRAVEL	SHLY	SHALY	VERY	VERY
CRYS	CRYSTALLINE	GRSN	GREENSTONE	MRBL	MARBLE	SHRP	SHARP	WBRG	WATER-BEARING
CSND	COARSE SAND	GRVL	GRAVEL	MSND	MEDIUM SAND	SHST	SCHIST	WDFR	WOOD FRAGMENTS
DKCL	DARK-COLOURED	GRWK	GREYWACKE	MUCK	MUCK	SILT	SILT	WTHD	WEATHERED
DLMT	DOLOMITE	GVLY	GRAVELLY	OBDN	OVERBURDEN	SLTE	SLATE		
DNSE	DENSE	GYPS	GYPSUM	PCKD	PACKED	SLTY	SILTY		
DRTY	DIRTY	HARD	HARD	PEAT	PEAT	SNDS	SANDSTONE		
DRY	DRY	HPAN	HARDPAN	PGVL	PEA GRAVEL	SNDY	SANDYOAPSTONE		

2. Core Color

Code	Description
WHIT	WHITE
GREY	GREY
BLUE	BLUE
GREN	GREEN
YLLW	YELLOW
BRWN	BROWN
RED	RED
BLCK	BLACK
BLGY	BLUE-GREY

3. Well Use

Code	Description	Code	Description
DO	Domestic	OT	Other
ST	Livestock	TH	Test Hole
IR	Irrigation	DE	Dewatering
IN	Industrial	MO	Monitoring
CO	Commercial	MT	Monitoring TestHole
MN	Municipal		
PS	Public		
AC	Cooling And A/C		
NU	Not Used		

4. Water Detail

Code	Description	Code	Description
FR	Fresh	GS	Gas
SA	Salty	IR	Iron
SU	Sulphur		
MN	Mineral		
UK	Unknown		

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix B

Borehole Logs

Appendix B

LOG OF BOREHOLE NO. 1

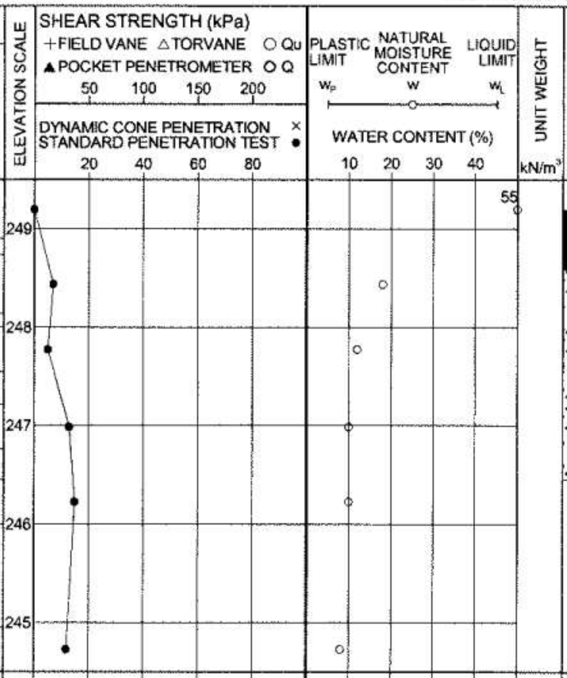
1 of 1

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 14, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

DEPTH / ELEV (metres)	SOIL PROFILE DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER OBSERVATIONS AND REMARKS
	SURFACE ELEVATION 249.50				
0.14 249.36	TOPSOIL: Brown, silty sand, trace gravel, frozen	1	SS	0	Stick-up cover Concrete
	CLAYEY SILT: Very soft to firm, brown, clayey silt, trace sand, frozen	2	SS	7	Bentonite seal
1.4 248.1	SAND/SILT TILL: Loose to compact, brown, sandy silt/silty sand, trace gravel, cobbles and boulders, very moist to moist	3	SS	5	
		4	SS	13	19 mm slotted pipe Filter sand
		5	SS	15	First water strike at 2.7 m
5.0		6	SS	12	
244.5	BOREHOLE TERMINATED AT 5.0 m				Upon completion of augering No water No cave Water Level Readings:

Date	Depth	Elev.
2017-03-28	+1.0	250.5

(Water above existing grade)

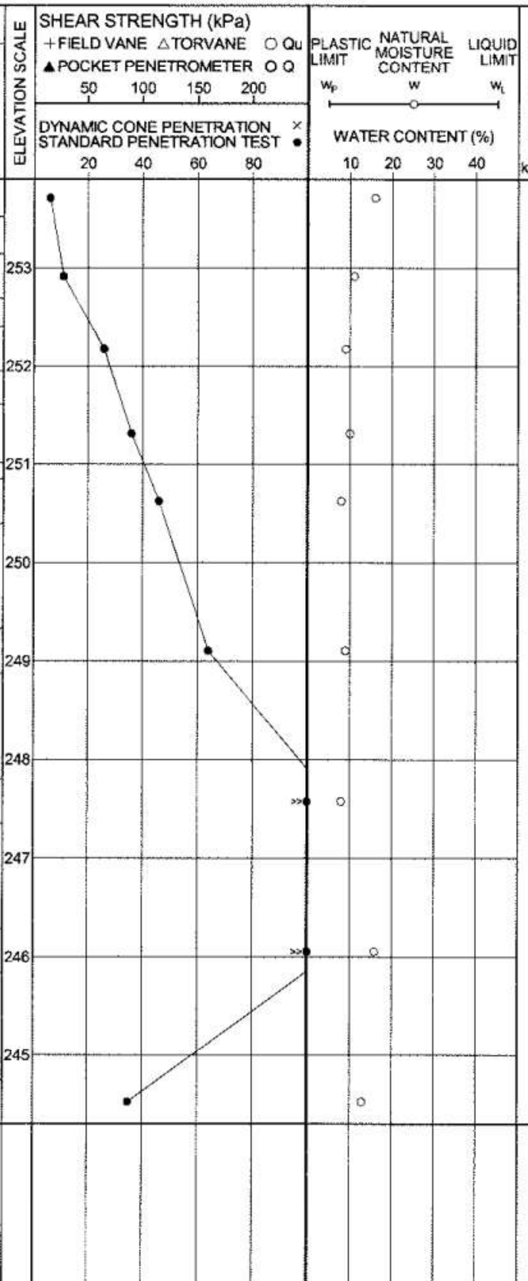


NOTES

LOG OF BOREHOLE NO. 2

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 21, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

SOIL PROFILE			SAMPLES		
DEPTH ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
	SURFACE ELEVATION 253.90				
	TOPSOIL: Dark brown, silt, roots, moist		1	SS	6
0.70 253.20	SAND/SILT TILL: Compact to very dense, brown to grey, silty sand/sandy silt, trace gravel, cobbles and boulders, moist; with wet seams/layers		2	SS	11
			3	SS	26
			4	SS	36
			5	SS	46
			6	SS	64
			7	SS	91/280 mm
7.0 246.9	SAND: Very dense to dense, brown, sand, trace silt to silty sand, trace gravel, wet		8	SS	93/280 mm
			9	SS	35
9.6 244.3	BOREHOLE TERMINATED AT 9.6 m				



GROUND WATER OBSERVATIONS AND REMARKS

GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Stick-up cover
Concrete

First water strike at 2.1 m

Bentonite seal

19 mm slotted pipe
Filter sand

Upon completion of augering
Water at 2.4 m
Cave at 8.5 m
Water Level Readings:

Date	Depth	Elev.
2017-03-28	0.8	253.1

NOTES

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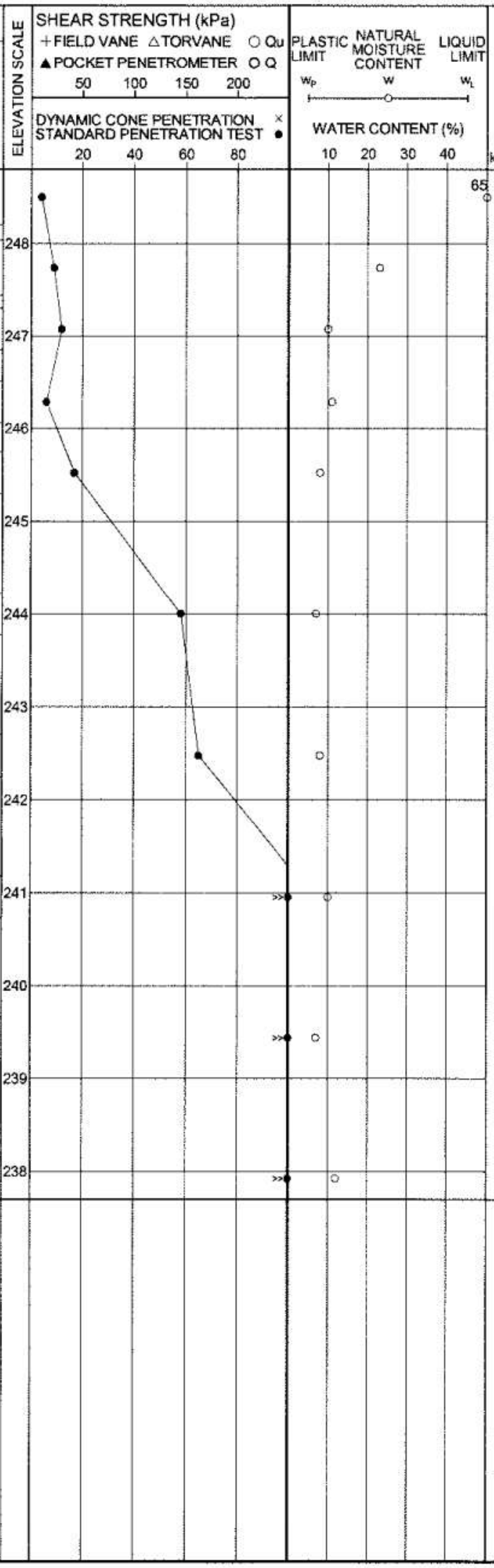
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 3

1 of 1

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 16, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

DEPTH / ELEV (metres)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES
	SURFACE ELEVATION 248.80			
0.0	TOPSOIL: Dark brown, silt some sand, roots, frozen	1	SS	4
0.70 248.10	CLAYEY SILT: Stiff, brown, clayey silt, trace sand, frozen	2	SS	9
1.4 247.4	SAND/SILT TILL: Loose to compact, grey, silty sand/sandy silt, trace gravel, cobbles and boulders, moist to very moist	3 4 5 6 7	SS SS SS SS SS	12 6 17 58 65
7.0 241.8	SILTY SAND: Very dense, grey, silty sand, trace gravel, wet	8	SS	83/280 mm
8.5 240.3	SAND/SILT TILL: Very dense, grey, silty sand/sandy silt, trace gravel, cobbles and boulders, moist to very moist; with wet seams/layers	9 10	SS SS	83/280 mm 50/150 mm
11.1 237.7	BOREHOLE TERMINATED AT 11.1 m			



GROUND WATER OBSERVATIONS AND REMARKS

Stick-up cover
Concrete

First water strike at 3.1 m
Bentonite seal

50 mm slotted pipe
Filter sand

GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
8	67	25	

Upon completion of augering
Water at 1.4 m
Cave at 2.9 m
Water Level Readings:

Date	Depth	Elev.
2017-03-28	+1.0	249.8

(Water above existing grade)

NOTES

PML Peto MacCallum Ltd.
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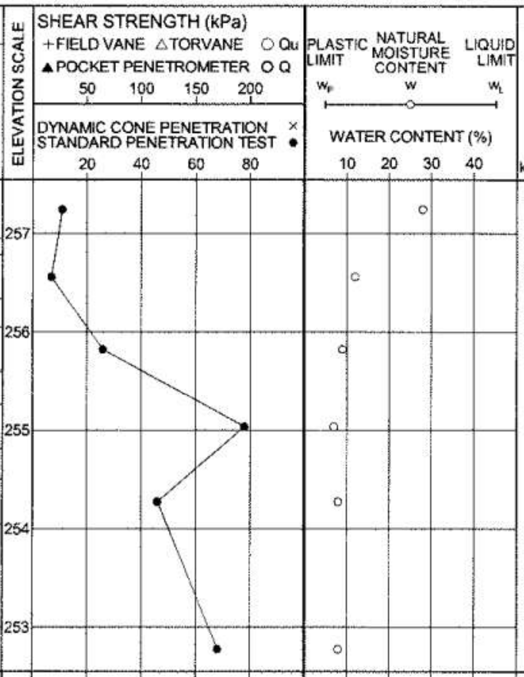
LOG OF BOREHOLE NO. 4

1 of 1

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 14, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

DEPTH ELEV (metres)	DESCRIPTION	NUMBER	TYPE	"N" VALUES
0.0	SURFACE ELEVATION 257.55			
	TOPSOIL: Dark brown, sandy silt, trace gravel, frozen	1	GS	11
0.70 256.85	SAND/SILT TILL: Loose, brown, silty sand/sandy silt, trace gravel, cobbles and boulders, frozen	2	SS	7
1.4 256.2	SILTY SAND: Compact, brown, silty sand, trace gravel, very moist	3	SS	26
2.1 255.5	SAND/SILT TILL: Dense to very dense, brown, silty sand to sandy silt, trace gravel, cobbles and boulders, moist; with wet seams/layers	4	SS	78
		5	SS	46
		6	SS	68
5.0 252.6	BOREHOLE TERMINATED AT 5.0 m			



GROUND WATER OBSERVATIONS AND REMARKS

GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

First water strike at 4.3 m

Upon completion of augering
No water
No cave
Water Level Readings:

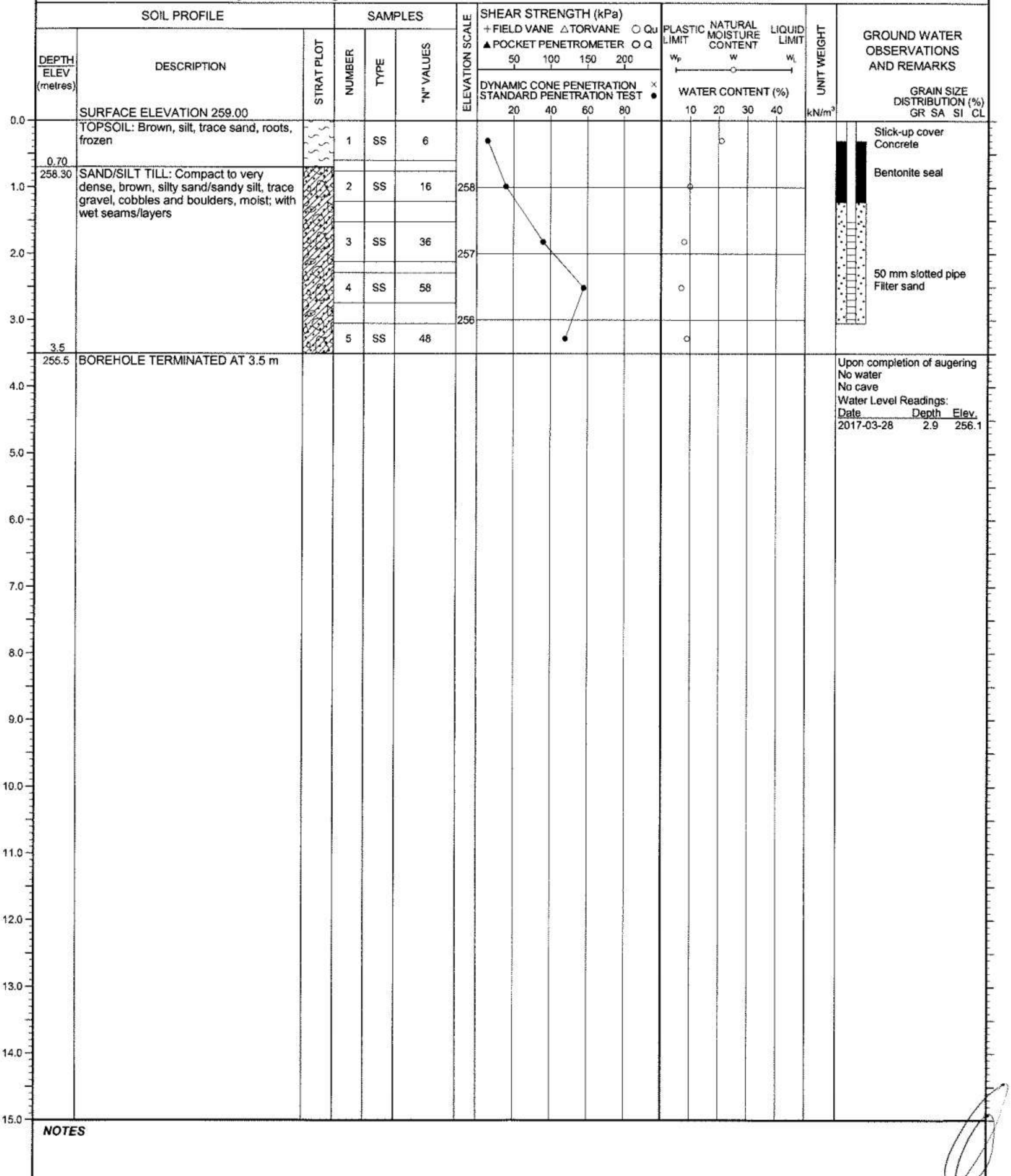
Date	Depth	Elev.
2017-03-28	1.7	255.9

NOTES

LOG OF BOREHOLE NO. 5

1 of 1

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 16, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM



SURFACE ELEVATION 259.00

DEPTH ELEV (metres)	DESCRIPTION
	TOPSOIL: Brown, silt, trace sand, roots, frozen
0.70 258.30	SAND/SILT TILL: Compact to very dense, brown, silty sand/sandy silt, trace gravel, cobbles and boulders, moist; with wet seams/layers
3.5 255.5	BOREHOLE TERMINATED AT 3.5 m

NUMBER	TYPE	"N" VALUES
1	SS	6
2	SS	16
3	SS	36
4	SS	58
5	SS	48

Upon completion of augering
No water
No cave
Water Level Readings:

Date	Depth	Elev.
2017-03-28	2.9	256.1

NOTES

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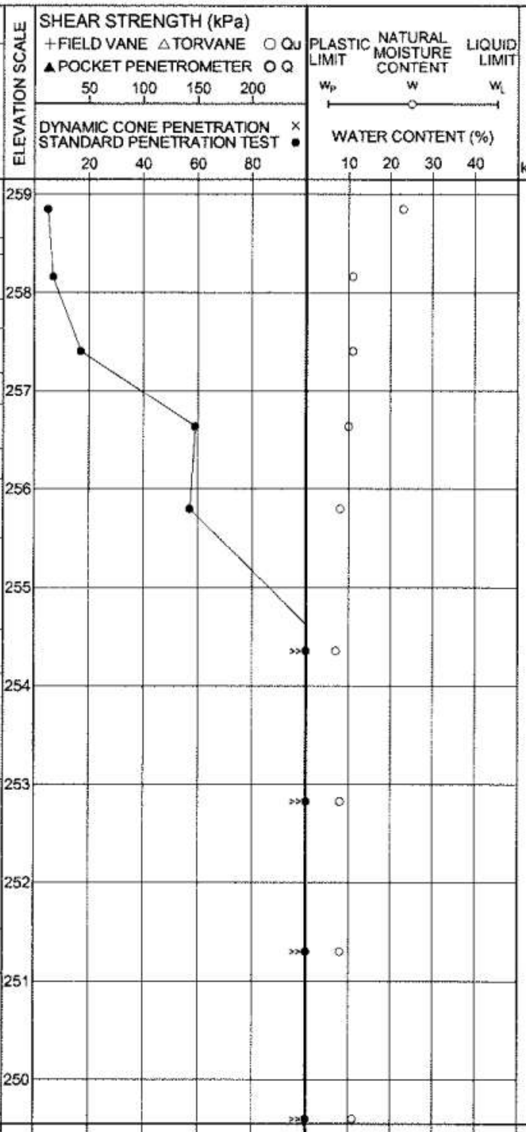
LOG OF BOREHOLE NO. 6

1 of 1

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING DATE March 14, 2017
BORING METHOD Continuous Flight Solid Stem Augers
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

SOIL PROFILE		SAMPLES		
DEPTH ELEV (metres)	DESCRIPTION	NUMBER	TYPE	"N" VALUES
	SURFACE ELEVATION 259.15			
0.70	TOPSOIL: Brown, sandy silt, trace gravel, frozen	1	SS	5
258.45	SAND/SILT TILL: Loose to very dense, brown, silty sand/sandy silt, trace gravel, cobbles and boulders, very moist to moist; with wet seams/layers	2	SS	7
		3	SS	17
		4	SS	59
		5	SS	57
		6	SS	72/290 mm
		7	SS	81/270 mm
		8	SS	50/140 mm
9.6		9	SS	50/100 mm
249.6	BOREHOLE TERMINATED AT 9.6 m			



GROUND WATER OBSERVATIONS AND REMARKS

GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Stick-up cover
Concrete

First water strike at 0.9 m

Bentonite seal

6 56 38

19 mm slotted pipe
Filter sand

Upon completion of augering
Water at 1.8 m
Cave at 2.1 m
Water Level Readings:

Date	Depth	Elev.
2017-03-28	2.8	256.4

NOTES

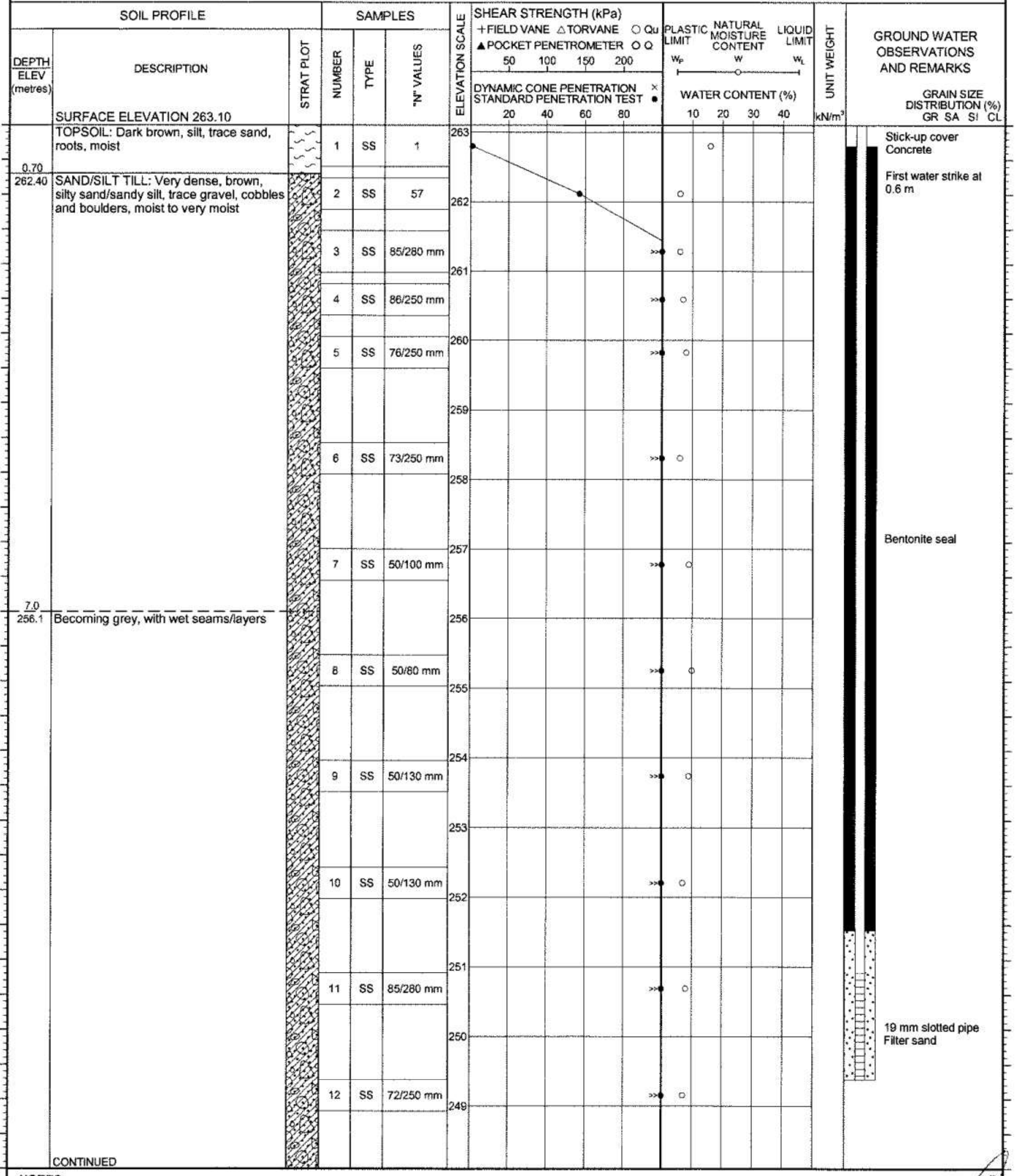
9

LOG OF BOREHOLE NO. 7

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 20, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

DEPTH ELEV (metres)	SOIL PROFILE DESCRIPTION
0.0	SURFACE ELEVATION 263.10
	TOPSOIL: Dark brown, silt, trace sand, roots, moist
0.70 262.40	SAND/SILT TILL: Very dense, brown, silty sand/sandy silt, trace gravel, cobbles and boulders, moist to very moist
7.0 256.1	Becoming grey, with wet seams/layers
15.0	CONTINUED

NUMBER	TYPE	"N" VALUES
1	SS	1
2	SS	57
3	SS	85/280 mm
4	SS	86/250 mm
5	SS	76/250 mm
6	SS	73/250 mm
7	SS	50/100 mm
8	SS	50/80 mm
9	SS	50/130 mm
10	SS	50/130 mm
11	SS	85/280 mm
12	SS	72/250 mm



NOTES

LOG OF BOREHOLE NO. 7

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 20, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

SOIL PROFILE			SAMPLES			ELEVATION SCALE	SHEAR STRENGTH (kPa) +FIELD VANE △TORVANE ○ Qu ▲POCKET PENETROMETER ○ Q 50 100 150 200 / DYNAMIC CONE PENETRATION × STANDARD PENETRATION TEST ● 20 40 60 80	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L / WATER CONTENT (%) 10 20 30 40	UNIT WEIGHT kN/m³	GROUND WATER OBSERVATIONS AND REMARKS / GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
DEPTH / ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES					
15.0	CONTINUED FROM PREVIOUS PAGE									
	SAND/SILT TILL: Very dense, grey, silty sand/sandy silt, trace gravel, cobbles and boulders, moist to very moist; with wet seams/layers	▨	13	SS	50/130 mm	248	>>●	○		
15.7 247.4	BOREHOLE TERMINATED AT 15.7 m									Upon completion of augering Water at 3.0 No cave Water Level Readings: Date Depth Elev. 2017-03-28 4.8 258.3

15.0 16.0 17.0 18.0 19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0 30.0

NOTES

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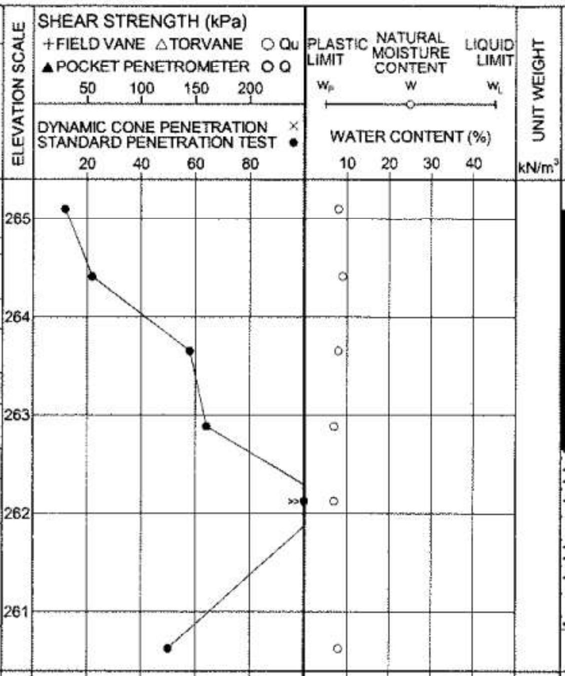
LOG OF BOREHOLE NO. 8

1 of 1

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 16, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

SURFACE ELEVATION 265.40

DEPTH / ELEV (metres)	DESCRIPTION	SAMPLES NUMBER	TYPE	"N" VALUES	GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
0.0 / 265.40	TOPSOIL: Dark brown, sand, trace silt, roots, frozen	1	SS	12	
0.70 / 264.70	SILTY SAND: Compact, brown, silty sand, moist	2	SS	22	
1.4 / 264.0	SAND/SILT TILL: Very dense, brown, silty sand/sandy silt, trace gravel, cobbles and boulders, moist	3	SS	58	5 63 32
		4	SS	64	
		5	SS	87/280 mm	
		6	SS	50	
5.0 / 260.4	BOREHOLE TERMINATED AT 5.0 m				



GROUND WATER OBSERVATIONS AND REMARKS

Upon completion of augering
No water
No cave
Water Level Readings:

Date	Depth	Elev.
2017-03-28	Dry	----

NOTES

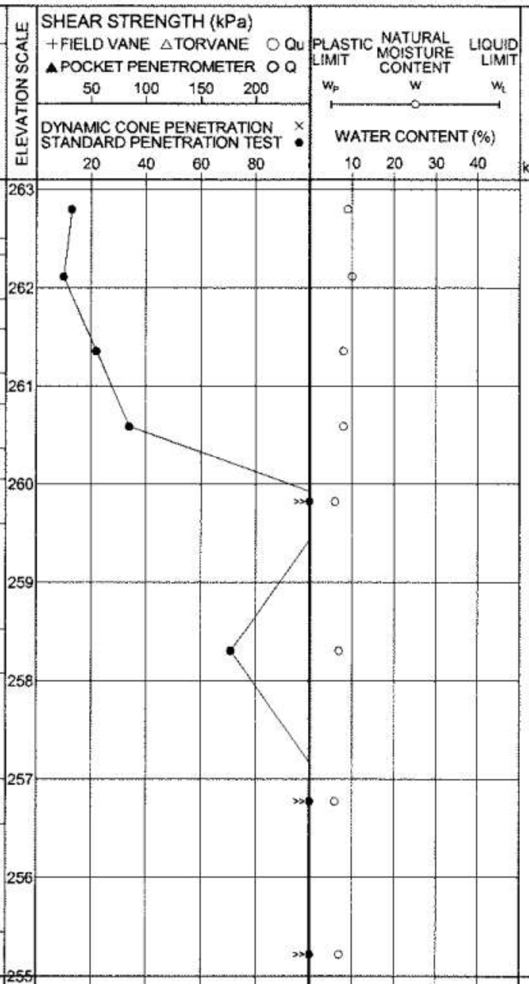
LOG OF BOREHOLE NO. 9

1 of 1

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 17, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

DEPTH ELEV (metres)	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER OBSERVATIONS AND REMARKS
	SURFACE ELEVATION 263.10				
	TOPSOIL: Brown, sand, trace to some silt, frozen	1	SS	13	Stick-up cover Concrete
0.70 262.40	SANDY SILT: Compact, brown to grey, sandy silt, moist	2	SS	10	
1.4 261.7	SAND/SILT TILL: Compact to very dense, brown to grey, silty sand/sandy silt, trace gravel, cobbles and boulders, moist; with with seams/layers	3	SS	22	
		4	SS	34	
		5	SS	65/250 mm	Bentonite seal
		6	SS	71	
		7	SS	77/250 mm	19 mm slotted pipe Filter sand
		8	SS	84/200 mm	
8.1 255.0	BOREHOLE TERMINATED AT 8.1 m				Upon completion of augering No water No cave Water Level Readings:

Date	Depth	Elev.
2017-03-28	5.2	257.9



GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

NOTES

Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 10

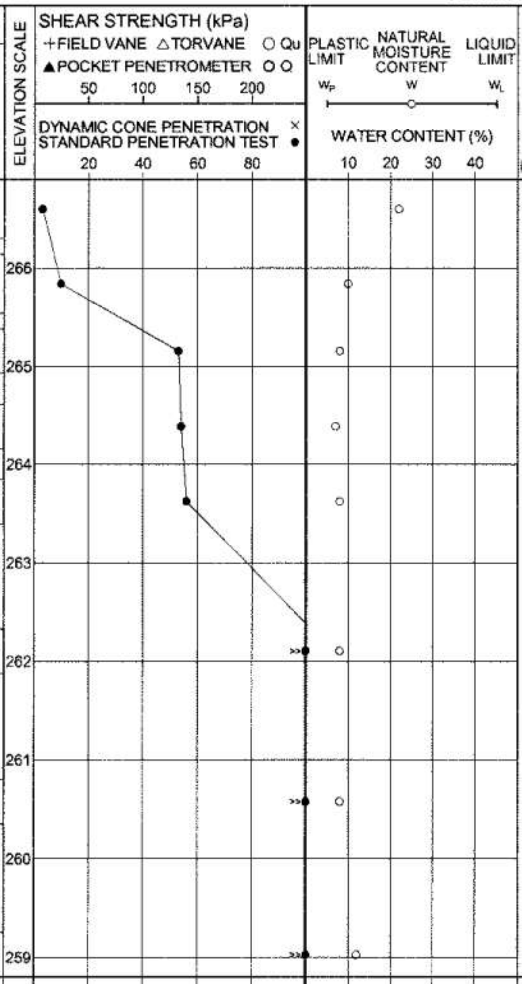
1 of 1

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 21, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

SURFACE ELEVATION 266.90

DEPTH / ELEV (metres)	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER OBSERVATIONS AND REMARKS
	TOPSOIL: Dark brown, silt, trace sand, moist	1	SS	3	Stick-up cover Concrete
0.70 266.20	SILT/SAND TILL: Compact to very dense, brown, silty sand/sandy silt, trace gravel, cobbles and boulders, moist	2	SS	10	
		3	SS	53	
		4	SS	54	
2.9 264.0	Becoming grey	5	SS	56	Bentonite seal
		6	SS	70/280 mm	
5.5 261.4	SAND: Very dense, brown, sand, some silt, wet	7	SS	72/250 mm	First water strike at 6.1 m 50 mm slotted pipe Filter sand
		8	SS	50/130 mm	
8.1 258.8	BOREHOLE TERMINATED AT 8.1 m				Upon completion of augering Water at 6.7 m Cave at 7.0 m Water Level Readings:

Date	Depth	Elev.
2017-03-28	5.4	261.5



GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

NOTES

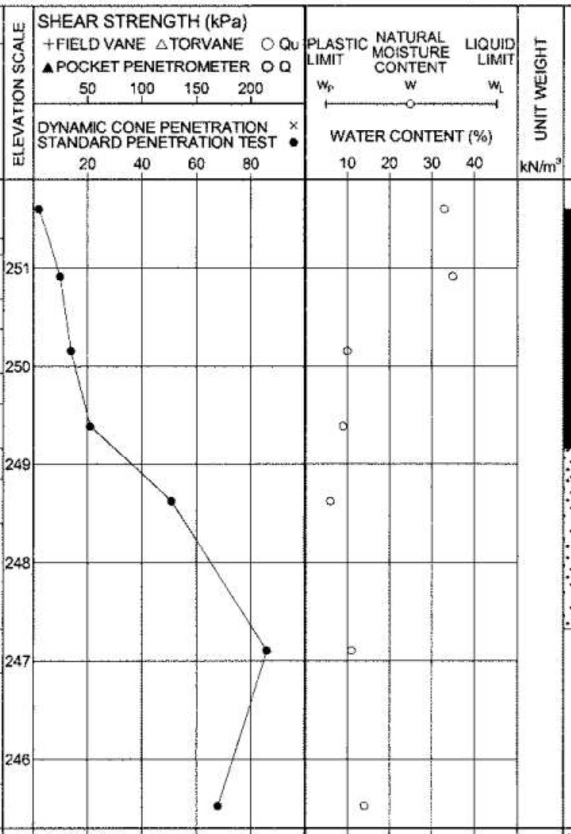
PML Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 11

1 of 1

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 17, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

DEPTH / ELEV (metres)	SOIL PROFILE – DESCRIPTION	SAMPLES – NUMBER	TYPE	"N" VALUES	GROUND WATER OBSERVATIONS AND REMARKS (GRAIN SIZE DISTRIBUTION (%) GR SA SI CL)
0.0	SURFACE ELEVATION 251.90				Stick-up cover Concrete
	TOPSOIL: Dark brown, silt, trace sand, roots, frozen	1	SS	2	
0.70 251.20	SILTY SAND: Compact, brown, silty sand, trace organics, wet	2	SS	10	
1.4 250.5	SAND/SILT TILL: Compact to very dense, brown, silty sand/sandy silt, trace gravel, cobbles and boulders, moist	3	SS	14	Bentonite seal First water strike at 1.5 m
		4	SS	21	
		5	SS	51	2 52 46
4.0 247.9	Becoming wet				19 mm slotted pipe Filter sand
		6	SS	86	
5.5 246.4	SAND: Very dense, grey, sand, some silt, trace gravel, wet	7	SS	68	
6.6 245.3	BOREHOLE TERMINATED AT 6.6 m				Upon completion of augering Water at 0.8 m Cave at 0.9 m Water Level Readings: Date Depth Elev. 2017-03-28 0.4 251.5



Depth scale (m): 0.0, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0

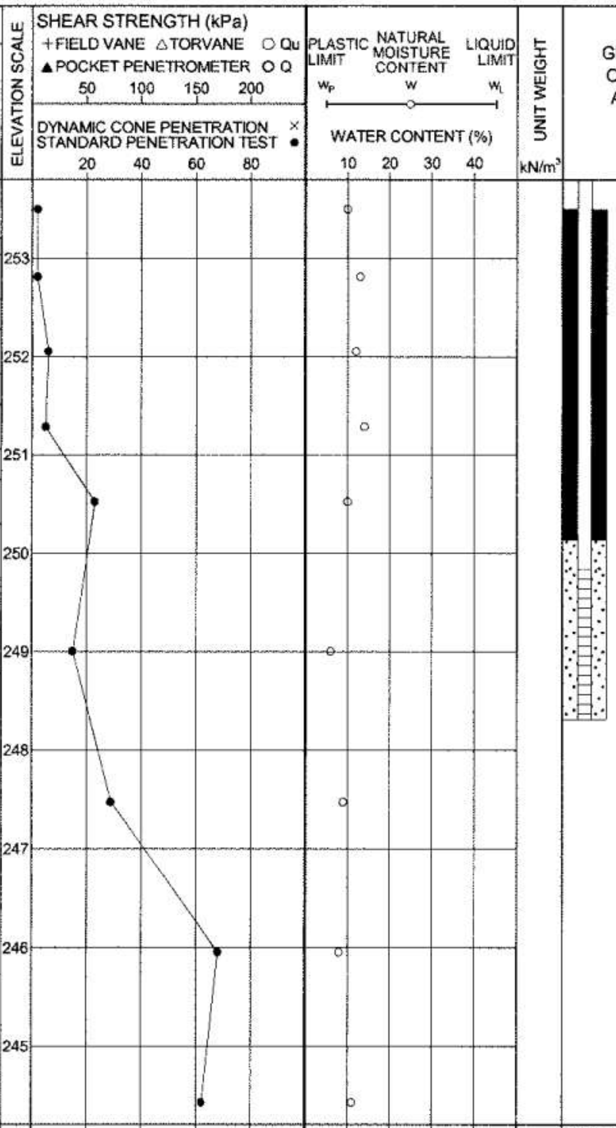
NOTES

LOG OF BOREHOLE NO. 12

1 of 1

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 17, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

DEPTH / ELEV (metres)	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES
	SURFACE ELEVATION 253.80			
	TOPSOIL: Brown, silty sand, roots, frozen	1	SS	2
0.70 253.10	SILTY SAND: Very loose to loose, brown, silty sand, wet	2	SS	2
		3	SS	6
2.1 251.7	SAND/SILT TILL: Loose to compact, brown, silty sand/sandy silt, trace gravel, cobbles and boulders, wet to moist	4	SS	5
		5	SS	23
4.0 249.8	SAND: Compact, brown, sand, some silt, trace gravel, wet	6	SS	15
5.5 248.3	SAND/SILT TILL: Compact to very dense, grey, silty sand/sandy silt, trace gravel, cobbles and boulders, moist	7	SS	29
		8	SS	68
		9	SS	62
9.6 244.2	BOREHOLE TERMINATED AT 9.6 m			



GROUND WATER OBSERVATIONS AND REMARKS

GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

Stick-up cover
Concrete

First water strike at 1.5 m
Bentonite seal

19 mm slotted pipe
Filter sand

Upon completion of augering
Water at 1.5 m
Cave at 6.1 m
Water Level Readings:

Date	Depth	Elev.
2017-03-28	0.5	253.3

NOTES

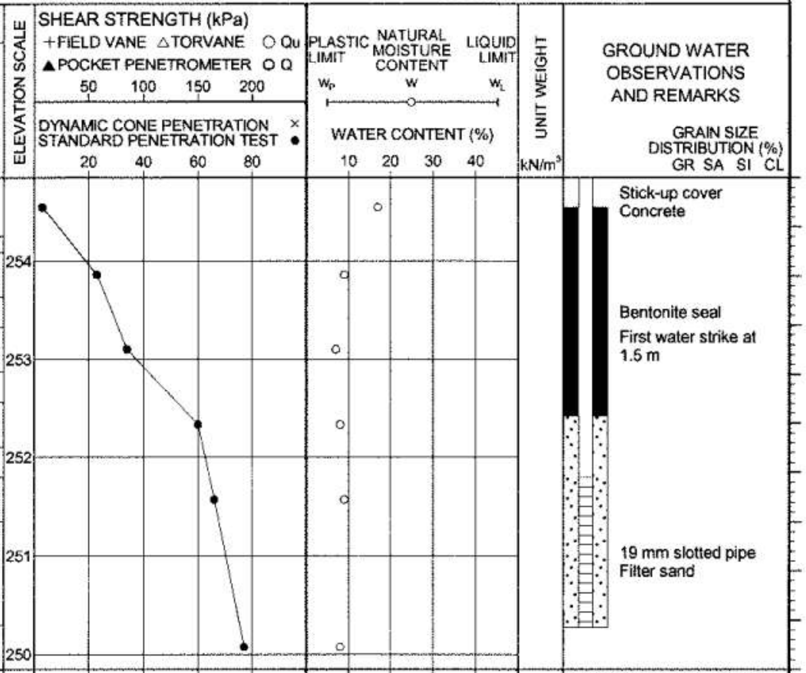
Peto MacCallum Ltd.
CONSULTING ENGINEERS

LOG OF BOREHOLE NO. 13

1 of 1

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 21, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

SOIL PROFILE			SAMPLES		
DEPTH / ELEV (metres)	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
	SURFACE ELEVATION 254.85				
0.0	TOPSOIL: Dark brown, silty sand, moist		1	SS	3
0.70 254.15	SAND/SILT TILL: Compact to very dense, brown, silty sand/sandy silt, trace gravel, cobbles and boulders, very moist to moist		2	SS	23
			3	SS	34
			4	SS	60
			5	SS	66
			6	SS	77
5.0 249.9	BOREHOLE TERMINATED AT 5.0 m				



Upon completion of augering
Water at 0.9 m
Cave at 1.4 m
Water Level Readings:

Date	Depth	Elev.
2017-03-28	0.6	254.3

NOTES

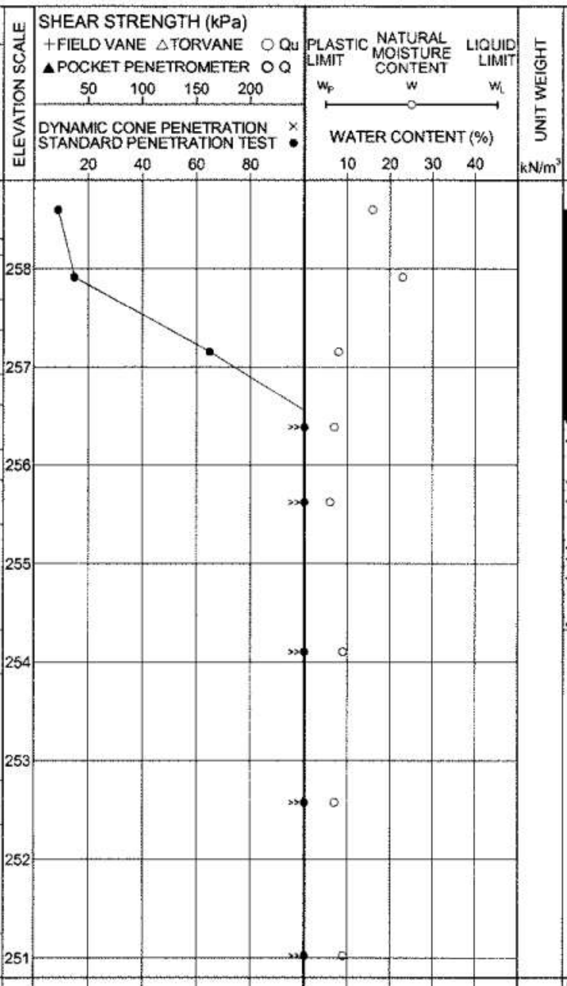
LOG OF BOREHOLE NO. 14

1 of 1

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 21, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

DEPTH ELEV (metres)	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER OBSERVATIONS AND REMARKS
	SURFACE ELEVATION 258.90				
0.0	TOPSOIL: Dark brown, silt, trace clay, roots, moist	1	SS	9	Stick-up cover Concrete
0.70 258.20	SANDY SILT: Compact, brown, sandy silt, trace organics, wet	2	SS	15	
1.4 257.5	SAND/SILT TILL: Very dense, brown to grey, silty sand/sandy silt, trace gravel, cobbles and boulders, moist; with wet seams/layers	3	SS	65	Bentonite seal
		4	SS	73/250 mm	
		5	SS	90/250 mm	19 mm slotted pipe Filter sand
		6	SS	80/250 mm	First water strike at 5.5 m
		7	SS	83/250 mm	
		8	SS	80/250 mm	
8.1 250.8	BOREHOLE TERMINATED AT 8.1 m				Upon completion of augering Water at 5.5 m Cave at 6.1 m Water Level Readings:

Date	Depth	Elev.
2017-03-28	3.4	255.5



GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL

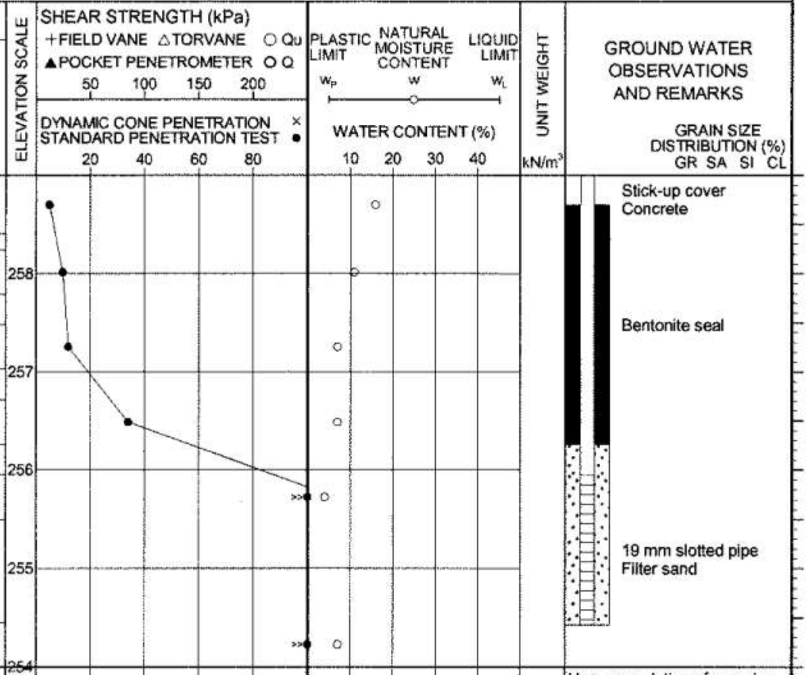
NOTES

LOG OF BOREHOLE NO. 15

1 of 1

PROJECT Proposed Lockhart Road Residential Subdivision
LOCATION Barrie, Ontario
BORING METHOD Continuous Flight Solid Stem Augers
BORING DATE March 16, 2017
PML REF. 17BF005
ENGINEER GW
TECHNICIAN RM

DEPTH / ELEV (metres)	DESCRIPTION	NUMBER	TYPE	"N" VALUES
	SURFACE ELEVATION 259.00			
	TOPSOIL: Dark brown, sand, trace silt, roots and twigs, frozen	1	SS	5
0.70 258.30	SANDY SILT: Compact, brown, sandy silt, moist	2	SS	10
1.4 257.6	SAND/SILT TILL: Compact to very dense, brown, silty sand/sandy silt, trace gravel, cobbles and boulders, very moist to moist	3	SS	12
		4	SS	34
		5	SS	80/280 mm
		6	SS	84/280 mm
5.0 254.0	BOREHOLE TERMINATED AT 5.0 m			



Upon completion of augering
No water
No cave
Water Level Readings:

Date	Depth	Elev.
2017-03-28	Dry	----

NOTES

LOG OF DRILLING OPERATIONS

MW11

BURNSIDE

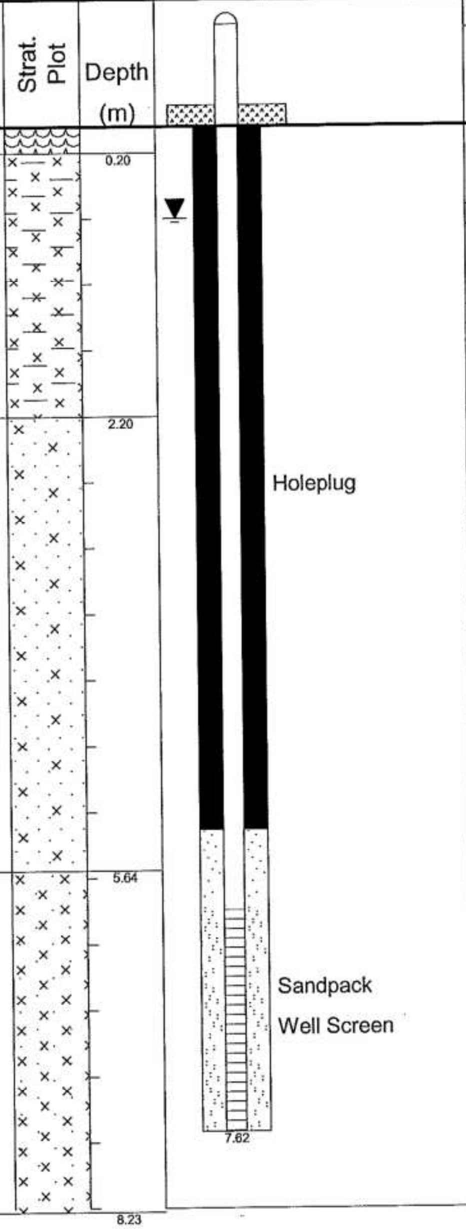
R.J. Burnside & Associates Limited
292 Speedvale Avenue West, Guelph, Ontario N1H 1C4
telephone (519) 823-4995 fax (519) 836-5477

Page 1 of 1

Client: **Hewitt's Creek Landowners Group**	Project Name: **Hewitt's Secondary Plan Area**	Logged by: **C. Dinulescu**
Project No.: **300033110**	Location: **Barrie, ON**	Ground (m amsl): **254.20**
Drilling Co.: **Lantech Drilling**	Date Started: **3/26/2014**	Static Water Level Depth (m):
Drilling Method: **Hollow Stem Auger**	Date Completed: **3/26/2014**	Sand Pack Depth (m) : **5.33-7.62**

Surface Elevation (m): **254.20**

Stratigraphic Description	Depth (m)
TOPSOIL Black clayey silt.	0.20
Clayey SILT to Silty CLAY Light brown, very soft, saturated, some sand, trace gravel (rounded, < 2 cm diameter), iron staining, weakly plastic. More clay with depth. Turns grey at 2.10 m.	2.20
Silty SAND Brown-grey, fine to medium, compact, saturated, uniform, trace gravel (subrounded, <2 cm diameter), trace clay, occasional cobbles and iron staining. With depth, siltier, dense, wet	5.64
Sandy SILT Brown, stiff, wet, trace gravel, trace clay, weakly plastic. Between 5.8 - 6.1 m - hard/noisy drilling suggesting a layer of gravel and cobbles.	8.23



SAMPLE

Num.	Type	Int.	N.Val.
	SS	☒	12
1	SS	☒	11
2	SS	☒	8
3	SS	☒	67
4	SS	☒	76/10"
5	SS	☒	84/10"
6	SS	☒	50/4"
7	SS	☒	50/4"
8	SS	☒	50/3"

Prepared By: **C. Dinulescu** Checked By: **D. Smikle** Date Prepared: **7/14/2014**

This borehole log was prepared for hydrogeological and/or environmental purposes and does not necessarily contain information suitable for a geotechnical assessment of the subsurface conditions. Borehole data requires interpretation by R. J. Burnside & Associates Limited personnel before use by others.

LEGEND	MONITORING WELL DATA	SAMPLE TYPE			
▼ Water found @ time of drilling	Pipe: **51 mm dia. PVC**	AC	Auger Cutting	SS ☒	Split Spoon
▽ Static Water Level -	Screen: **51 mm dia. PVC #10 slot**	CS	Continuous	AR ▨	Air Rotary
		RC	Rock Core	WC	Wash Cuttings

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix C

Hydraulic Conductivity Data

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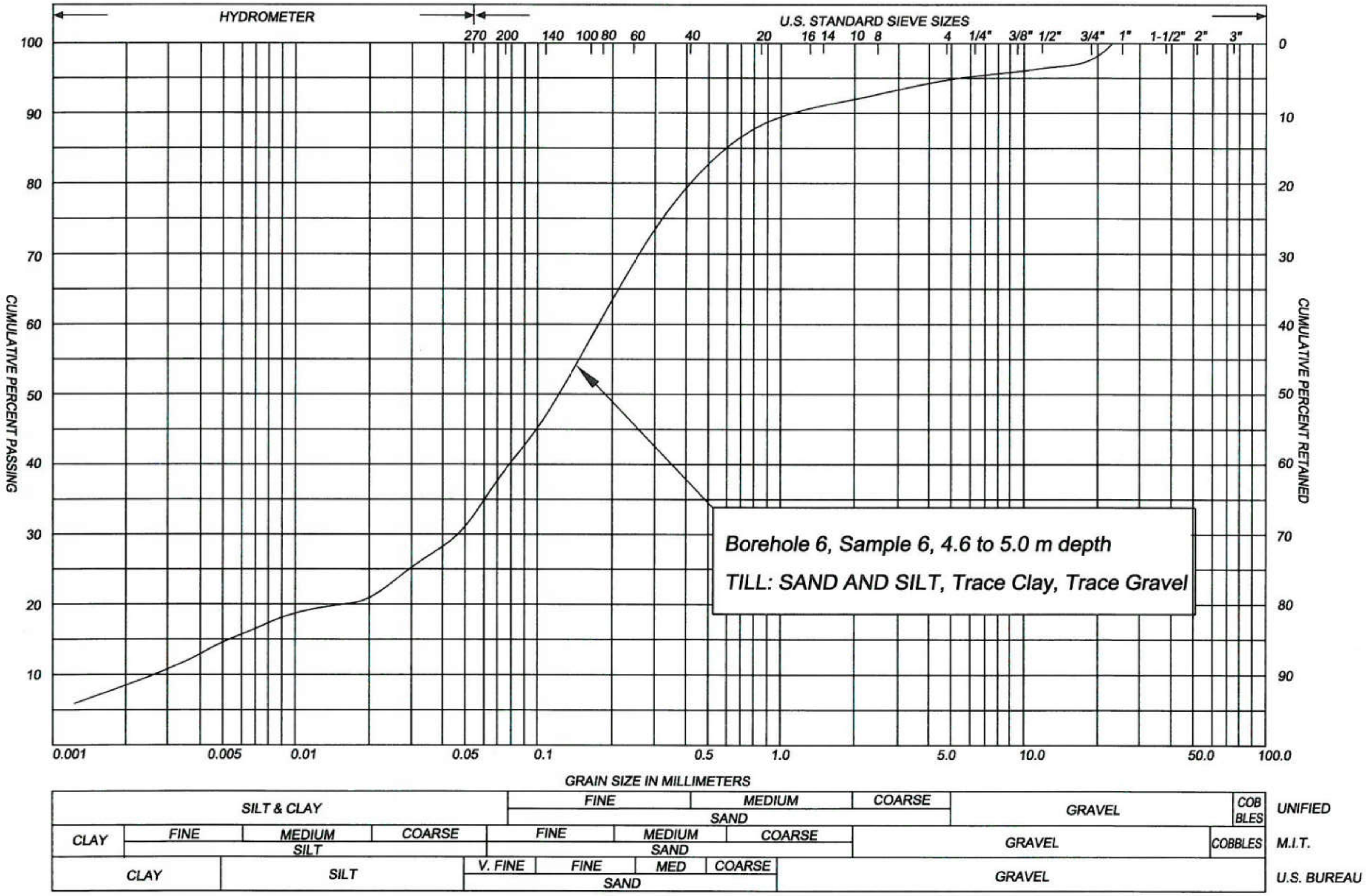
CONSULTING ENGINEERS

PARTICLE SIZE DISTRIBUTION CHART

PML Ref.: 17BF005
Figure No.: 1



Borehole 6, Sample 6, 4.6 to 5.0 m depth

TILL: SAND AND SILT, Trace Clay, Trace Gravel

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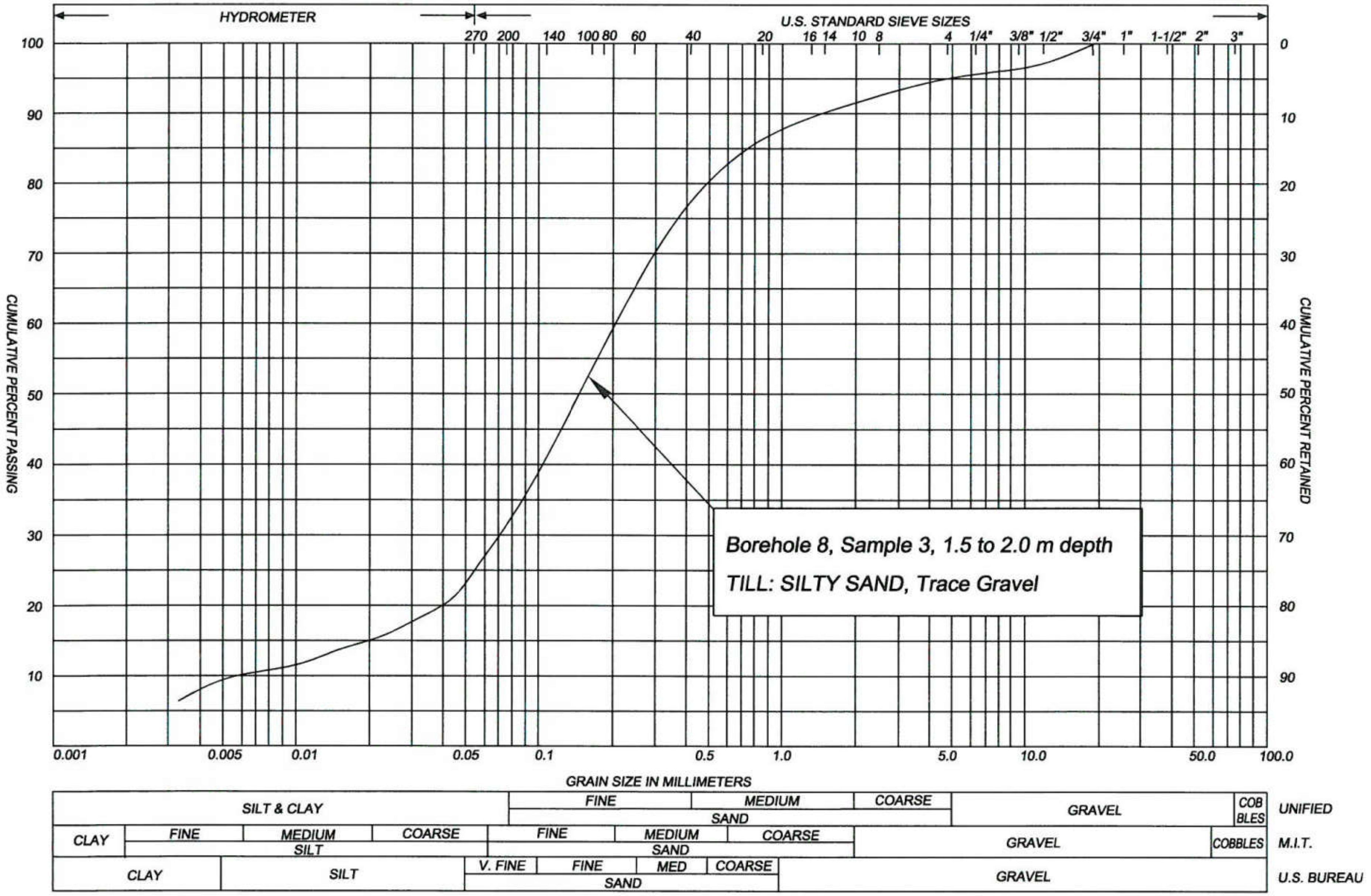
CONSULTING ENGINEERS

PARTICLE SIZE DISTRIBUTION CHART

PML Ref.: 17BF005
Figure No.: 2



Borehole 8, Sample 3, 1.5 to 2.0 m depth

TILL: SILTY SAND, Trace Gravel

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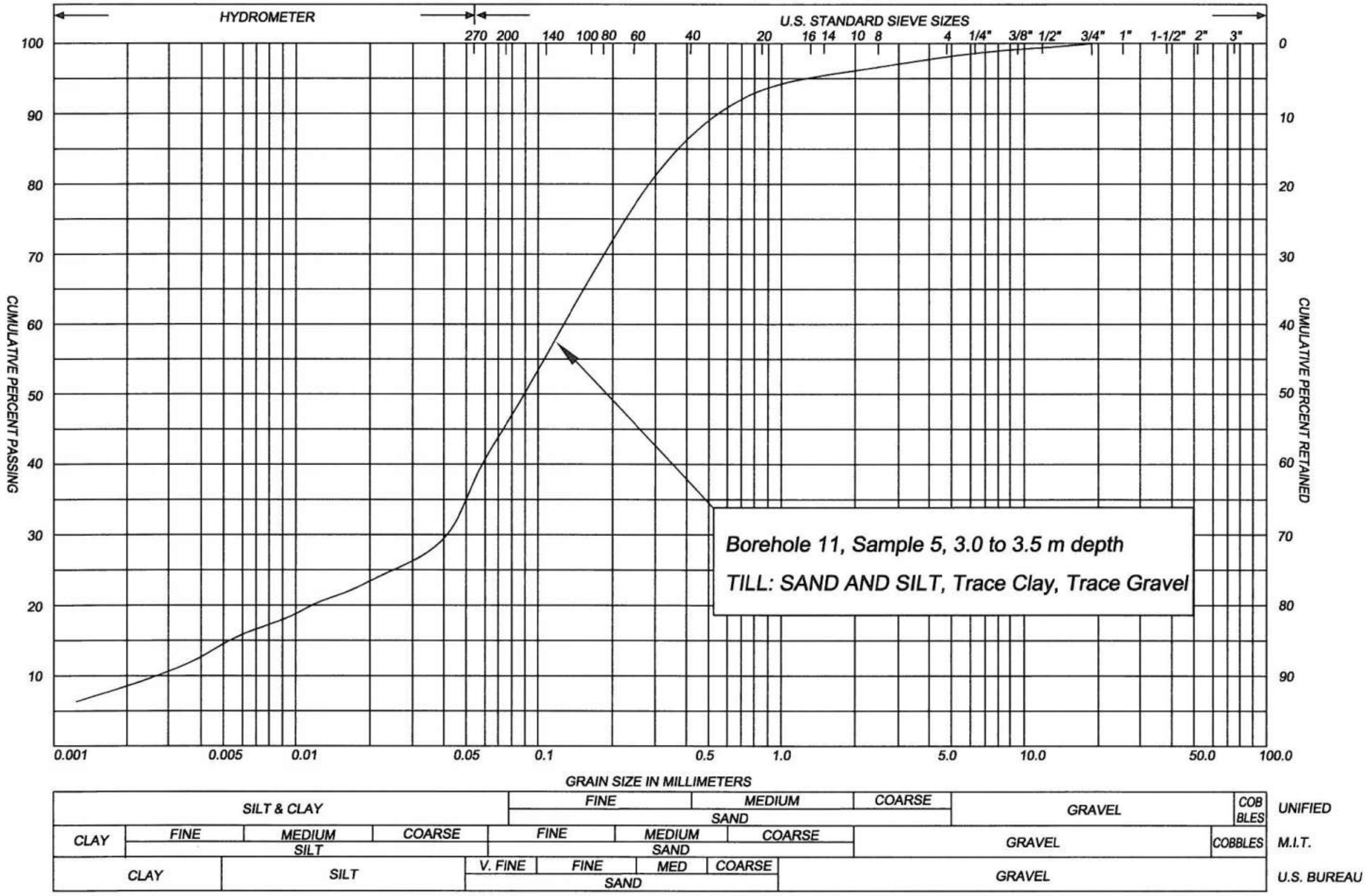
PARTICLE SIZE DISTRIBUTION CHART

PML Ref.: 17BF005
Figure No.: 3


Borehole 11, Sample 5, 3.0 to 3.5 m depth

TILL: SAND AND SILT, Trace Clay, Trace Gravel

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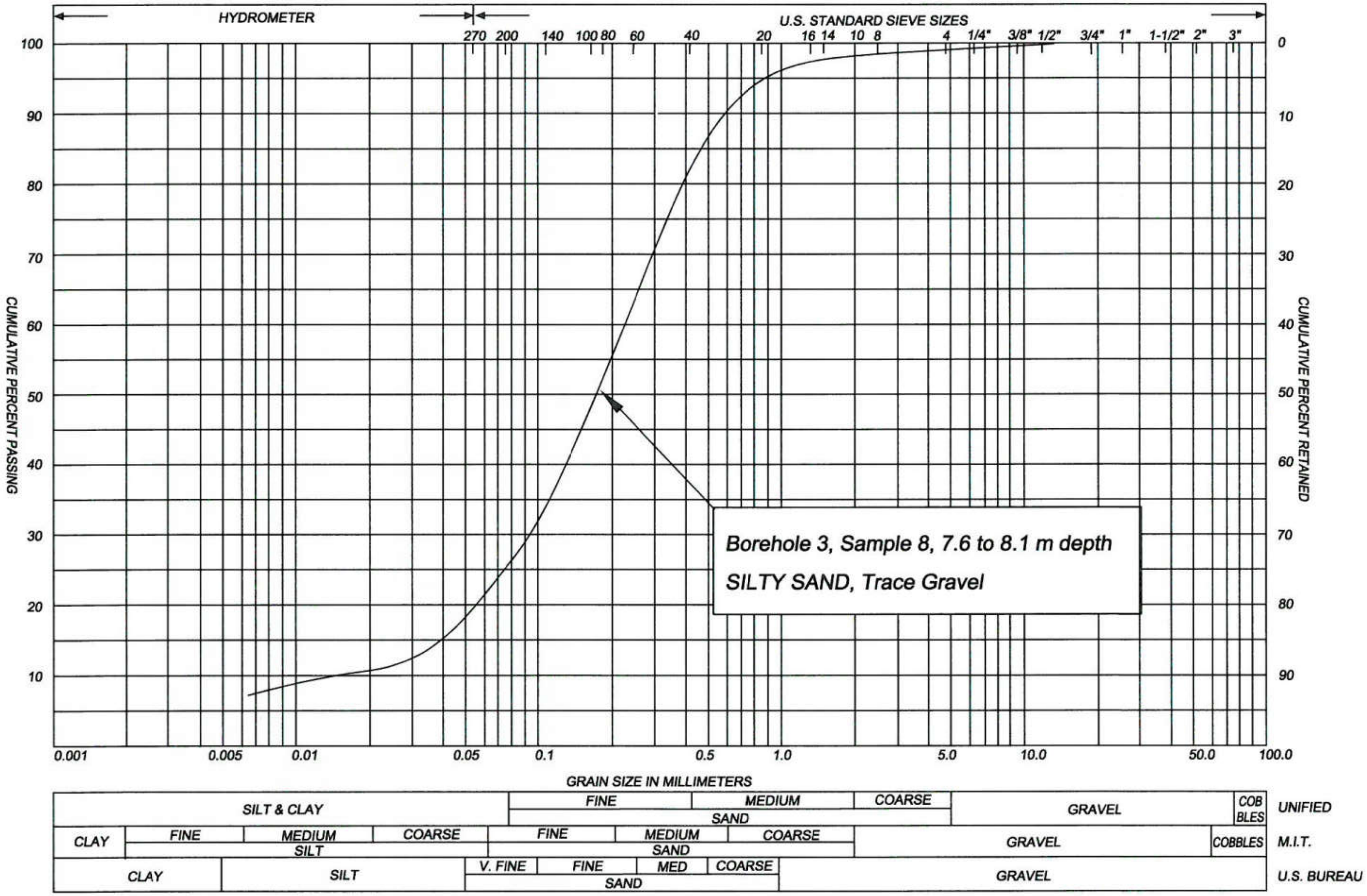
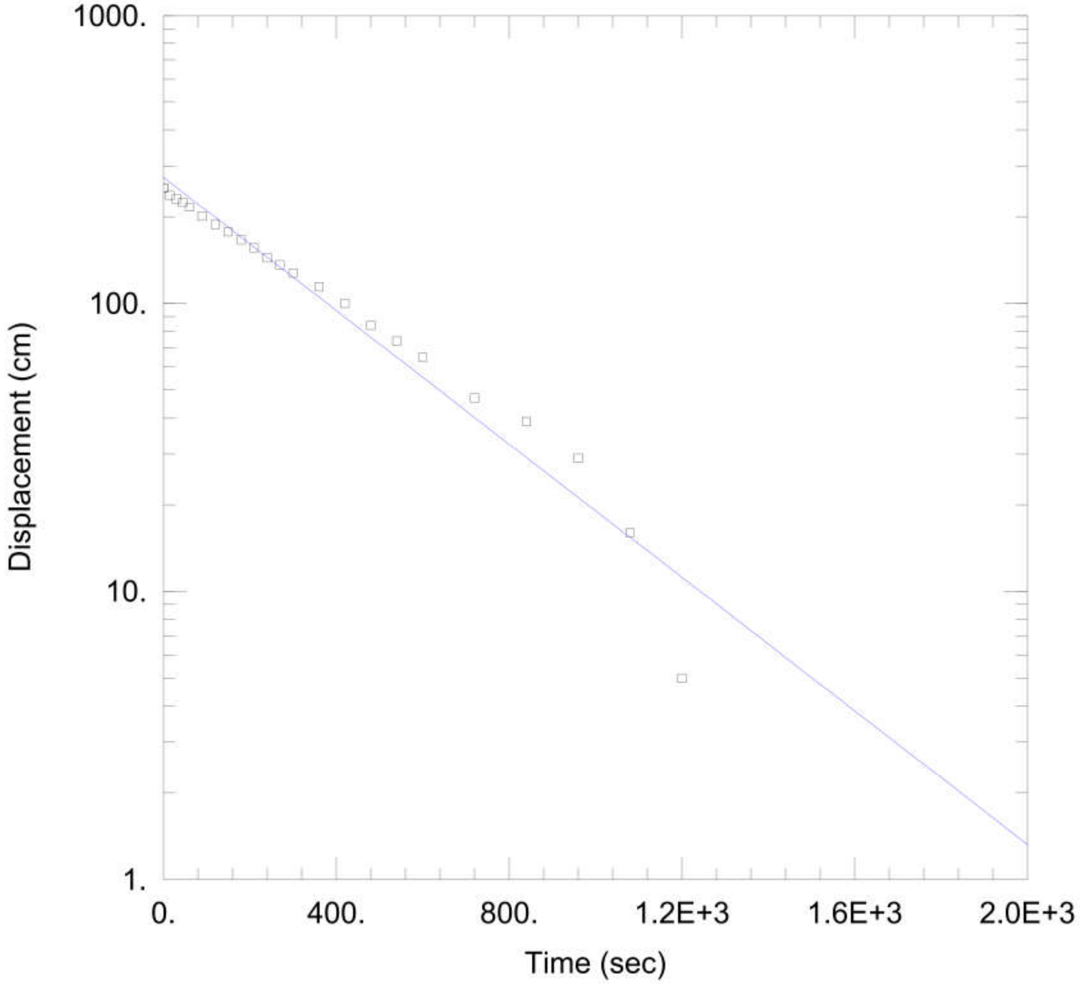
CONSULTING ENGINEERS

PARTICLE SIZE DISTRIBUTION CHART

PML Ref.: 17BF005
Figure No.: 4


Borehole 3, Sample 8, 7.6 to 8.1 m depth
SILTY SAND, Trace Gravel



HYDRAULIC CONDUCTIVITY TEST AT MW11

PROJECT INFORMATION

Company: R.J Burnside
Client: Sobara
Project: 300041514
Location: Barrie
Test Well: MW11
Test Date: May 22, 2018

AQUIFER DATA

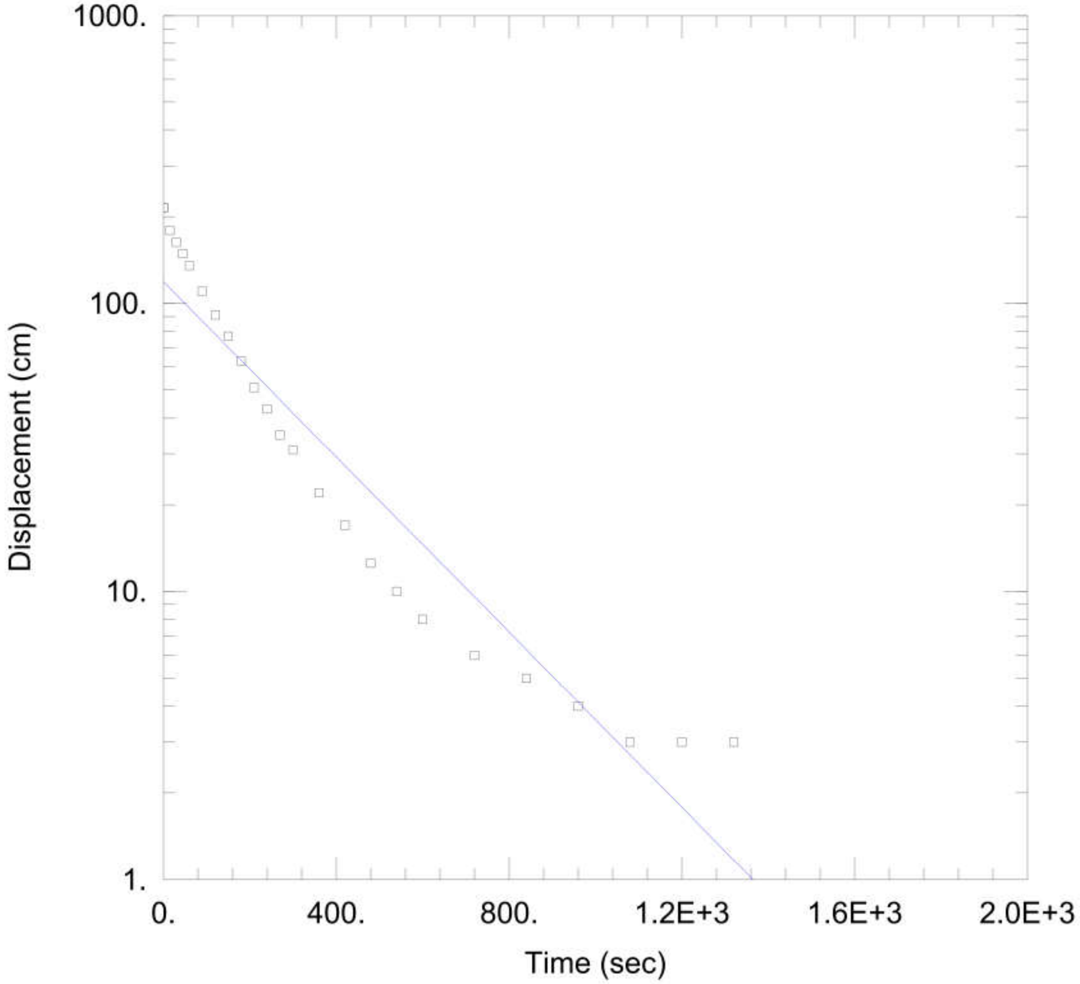
Saturated Thickness: 837. cm
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MW11)

Initial Displacement: 252. cm
Total Well Penetration Depth: 837. cm
Casing Radius: 2.54 cm
Static Water Column Height: 837. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.0002086 cm/sec
y0 = 274.1 cm



HYDRAULIC CONDUCTIVITY TEST AT SB-6

PROJECT INFORMATION

Company: R.J Burnside
Client: Sobara
Project: 300041514
Location: Barrie
Test Well: SB-6
Test Date: May 22, 2018

AQUIFER DATA

Saturated Thickness: 212. cm

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (SB-6)

Initial Displacement: 215. cm
Total Well Penetration Depth: 152. cm
Casing Radius: 2.54 cm

Static Water Column Height: 212. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

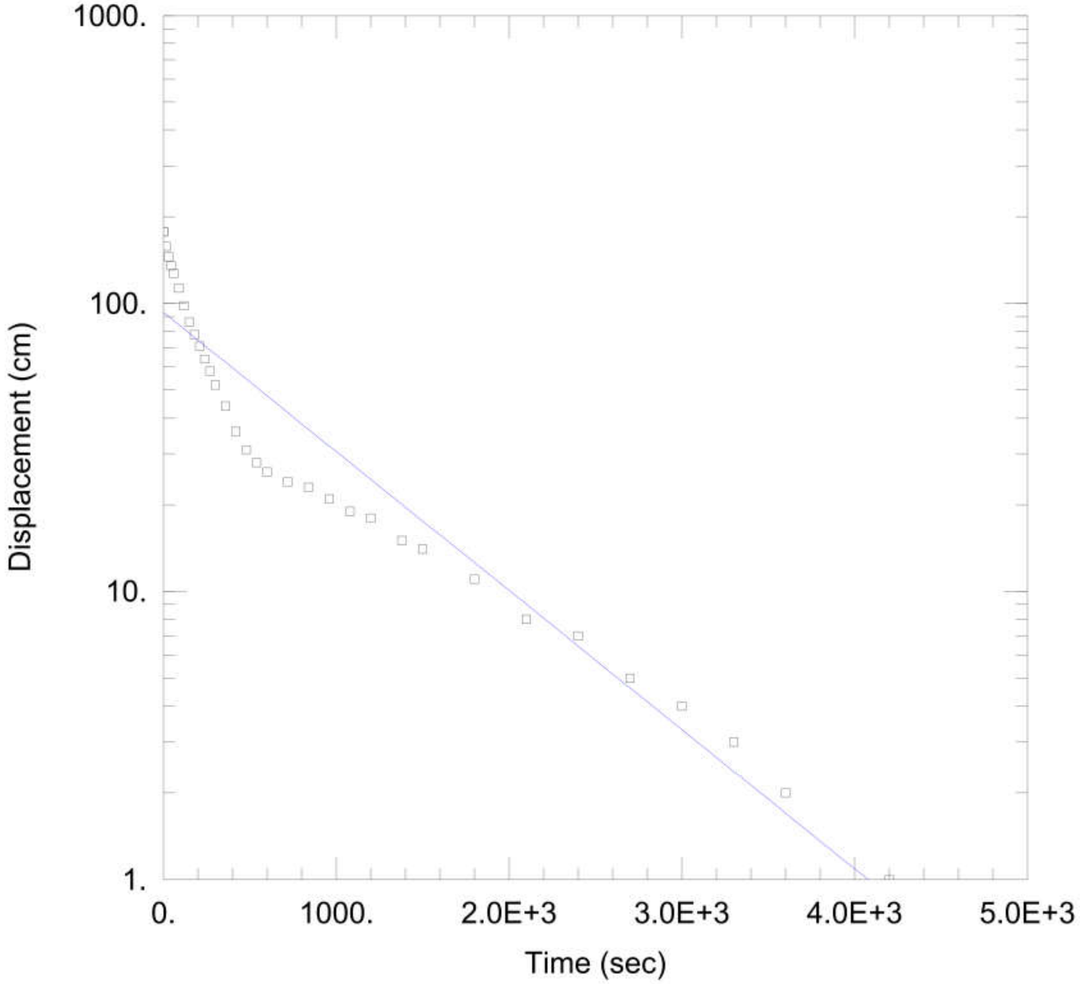
SOLUTION

Aquifer Model: Unconfined

Solution Method: Hvorslev

K = 0.0002225 cm/sec

y0 = 118.8 cm



HYDRAULIC CONDUCTIVITY TEST AT SB-4

PROJECT INFORMATION

Company: R.J Burnside
Client: Sobara
Project: 300041514
Location: Barrie
Test Well: SB-4
Test Date: May 22, 2018

AQUIFER DATA

Saturated Thickness: 150. cm
Anisotropy Ratio (Kz/Kr): 1.

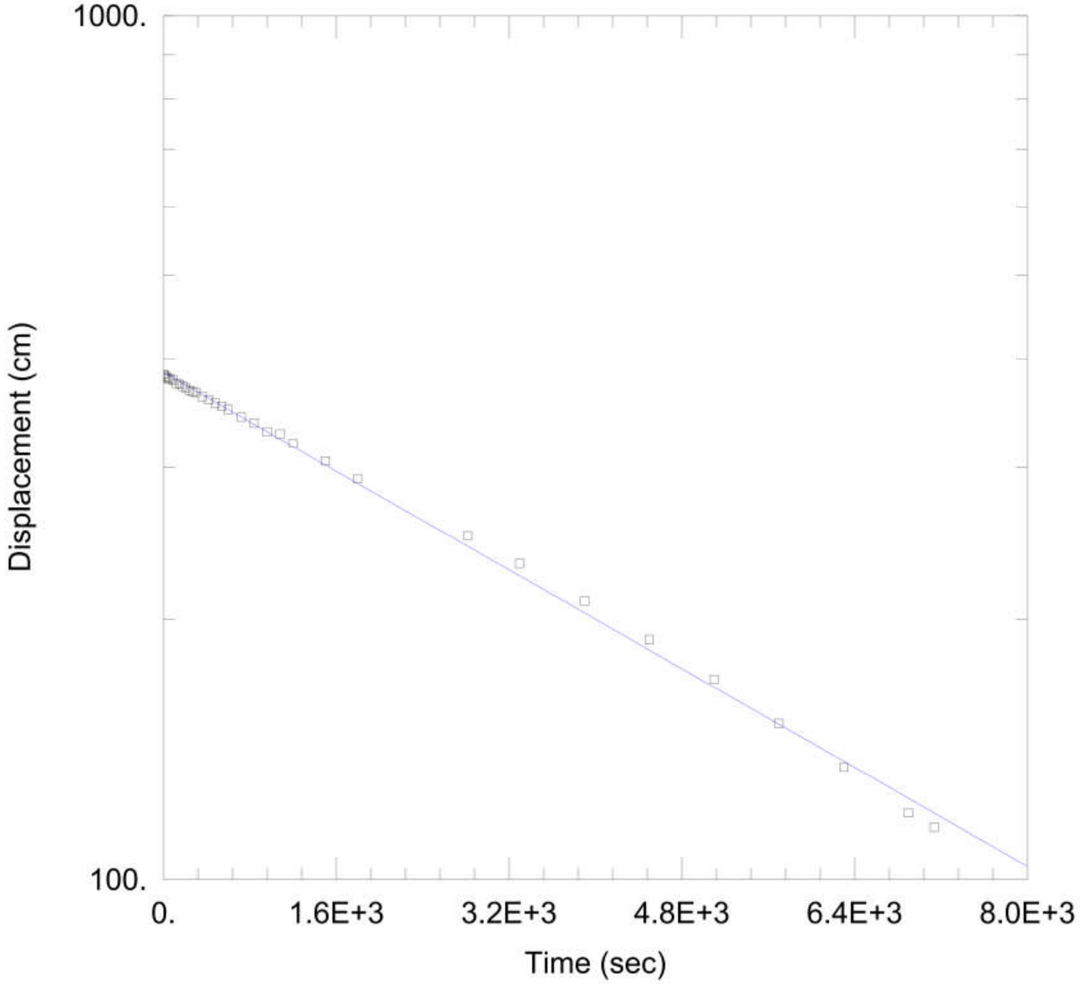
WELL DATA (SB-4)

Initial Displacement: 177. cm
Total Well Penetration Depth: 152. cm
Casing Radius: 2.54 cm
Static Water Column Height: 150. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev

K = 0.0001266 cm/sec
y0 = 92.96 cm



HYDRAULIC CONDUCTIVITY TEST AT SB-3

PROJECT INFORMATION

Company: R.J Burnside
Client: Sobara
Project: 300041514
Location: Barrie
Test Well: SB-3
Test Date: May 22, 2018

AQUIFER DATA

Saturated Thickness: 936. cm
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (SB-3)

Initial Displacement: 384. cm
Total Well Penetration Depth: 936. cm
Casing Radius: 2.54 cm
Static Water Column Height: 936. cm
Screen Length: 152. cm
Well Radius: 7.62 cm

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 1.287E-5 cm/sec
y0 = 386.1 cm

Appendix D

Groundwater Level Data

Appendix D

Table D-1

Groundwater Elevations

	Well Depth (mbgl)	Ground Surface Elevation (masl)	24-Nov-2017		19-Dec-2017		25-Jan-2018		23-Feb-2018		23-Mar-2018	
			Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
SB-1	**4.31**	**249.50**	-0.19	249.69	Frozen	Frozen	-	-	Dry	Dry	Dry	Dry
SB-2	**4.38**	**253.90**	2.39	251.51	2.55	251.35	2.30	251.60	1.65	252.25	1.85	252.05
SB-3	**8.36**	**248.80**	Flowing	Flowing	Flowing	Flowing	-	-	Frozen	Frozen	Flowing	Flowing
SB-4	**3.88**	**257.55**	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
SB-5	**2.98**	**259.00**	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
SB-6	**6.10**	**259.15**	-	-	-	-	2.02	257.13	2.34	256.81	2.31	256.84
SB-7	**12.74**	**263.10**	-	-	-	-	Dry	Dry	Dry	Dry	2.83	260.27
SB-8	**4.33**	**265.40**	Dry	Dry	-	-	Dry	Dry	Dry	Dry	Dry	Dry
SB-9	**7.36**	**263.10**	Dry	Dry	-	-	Dry	Dry	Dry	Dry	Dry	Dry
SB-10	**9.24**	**266.90**	Dry	Dry	-	-	Dry	Dry	Dry	Dry	Dry	Dry
SB-11	**4.60**	**251.90**	0.68	251.23	0.79	251.11	0.39	251.51	0.58	251.32	0.39	251.51
SB-12	**5.50**	**253.80**	1.74	252.07	1.97	251.83	1.52	252.28	1.07	252.73	1.42	252.38
SB-13	**4.50**	**254.85**	1.91	252.94	2.50	252.36	2.09	252.76	2.00	252.85	1.95	252.90
SB-14	**3.71**	**258.90**	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
SB-15	**4.46**	**259.00**	Dry	Dry	4.31	254.69	Dry	Dry	Dry	Dry	Dry	Dry
MW11	**7.67**	**254.20**	-	-	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen
SB-PZ1s	**1.27**	**252.00**	-0.03	252.03	0.02	251.98	Frozen	Frozen	0.00	252.00	0.03	251.97
SB-PZ1d	**1.81**	**252.00**	0.30	251.70	0.05	251.95	Frozen	Frozen	0.04	251.96	Frozen	Frozen
PZ4	**1.87**	**251.00**	-	-	0.00	251.00	Frozen	Frozen	Frozen	Frozen	Frozen	Frozen

"-" denotes data unavailable

Table D-1

Groundwater Elevations

			27-Apr-2018		22-May-2018		28-Jun-2018		27-Jul-2018		14-Aug-2018	
	Well Depth (mbgl)	Ground Surface Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)	Water Level (mbgs)	Water Elevation (masl)
SB-1	**4.31**	**249.50**	Flowing	Flowing	Flowing	Flowing	Flowing	Flowing	-	-	-	-
SB-2	**4.38**	**253.90**	0.58	253.32	1.19	252.71	1.73	252.17	0.50	253.40	0.71	253.19
SB-3	**8.36**	**248.80**	Flowing	Flowing	Flowing	Flowing	Flowing	Flowing	Flowing	Flowing	Flowing	Flowing
SB-4	**3.88**	**257.55**	0.47	257.08	2.36	255.19	0.44	257.11	Dry	Dry	Dry	Dry
SB-5	**2.98**	**259.00**	Dry	Dry	Dry	Dry	Dry	Dry	-	-	Dry	Dry
SB-6	**6.10**	**259.15**	0.34	258.81	1.19	257.96	2.08	257.07	-	-	4.54	254.61
SB-7	**12.74**	**263.10**	0.80	262.30	0.82	262.28	2.62	260.48	-	-	4.74	258.36
SB-8	**4.33**	**265.40**	3.84	261.56	Dry	Dry	Dry	Dry	-	-	Dry	Dry
SB-9	**7.36**	**263.10**	6.20	256.90	6.27	256.83	7.22	255.88	-	-	Dry	Dry
SB-10	**9.24**	**266.90**	7.39	259.51	6.70	260.20	-	-	-	-	Dry	Dry
SB-11	**4.60**	**251.90**	-0.65	252.55	-0.23	252.13	0.18	251.72	-	-	-	-
SB-12	**5.50**	**253.80**	0.39	253.41	-0.23	254.03	1.15	252.65	1.65	252.15	1.87	251.93
SB-13	**4.50**	**254.85**	0.52	254.33	1.70	253.15	2.45	252.40	3.35	251.50	3.68	251.17
SB-14	**3.71**	**258.90**	1.34	257.56	Dry	Dry	Dry	Dry	Dry	Dry	Dry	Dry
SB-15	**4.46**	**259.00**	3.23	255.77	3.51	255.49	4.20	254.80	4.30	254.70	4.30	254.70
MW11	**7.67**	**254.20**	Flowing	Flowing	-1.24	255.44	-1.02	255.22	-0.70	254.90	-0.56	254.76
SB-PZ1s	**1.27**	**252.00**	-0.06	252.06	-0.04	252.04	0.02	251.98	0.09	251.91	0.04	251.96
SB-PZ1d	**1.81**	**252.00**	-0.18	252.18	-0.14	252.14	-0.11	252.11	-0.01	252.01	0.01	251.99
PZ4	**1.87**	**251.00**	-0.07	251.07	0.02	250.98	0.15	250.85	0.23	250.77	0.19	250.81

"-" denotes data unavailable

SB-2 (Well Depth: 4.4 m, Screened in Sand/Silt Till, Sand)
Groundwater Elevations

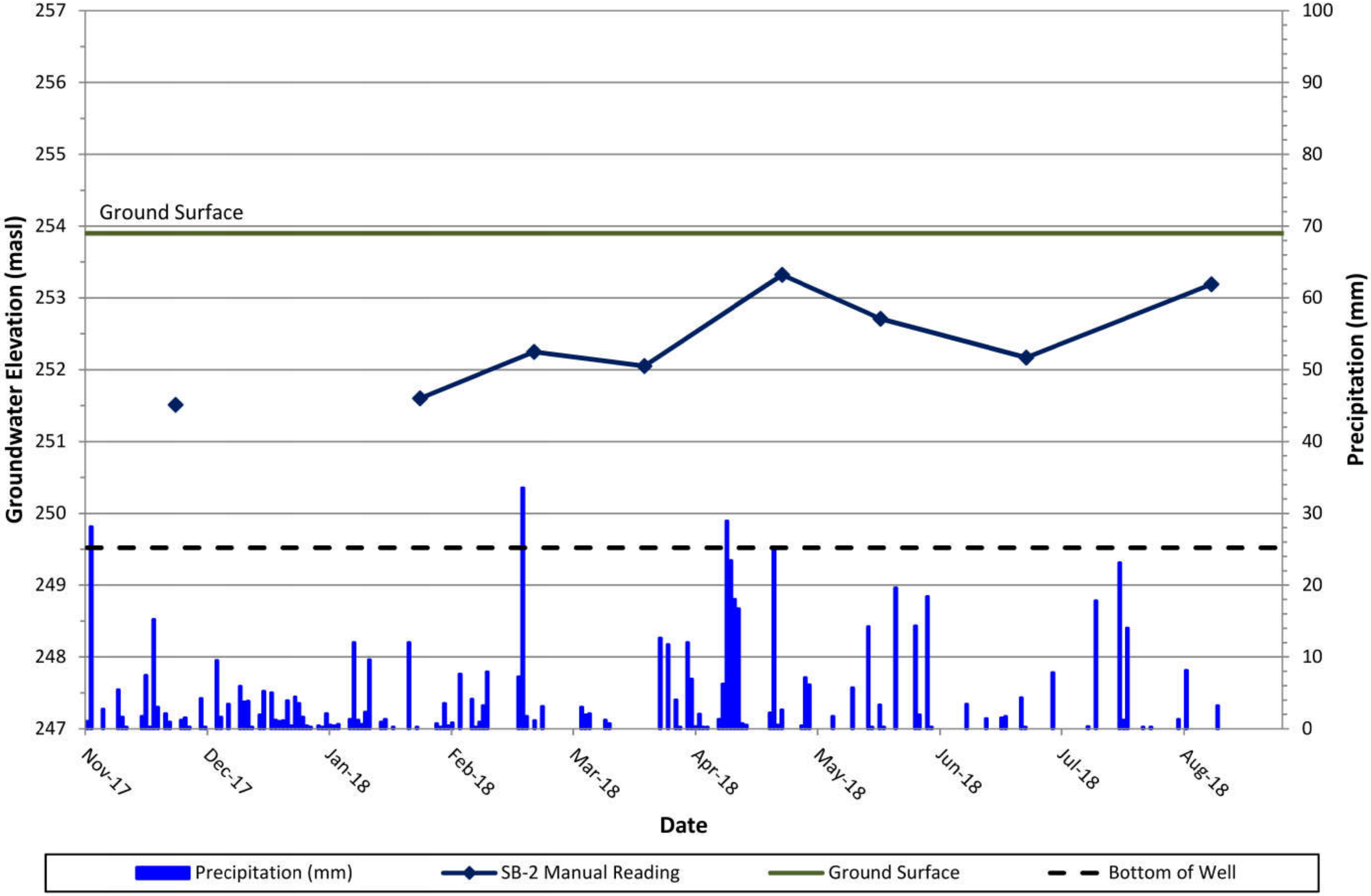
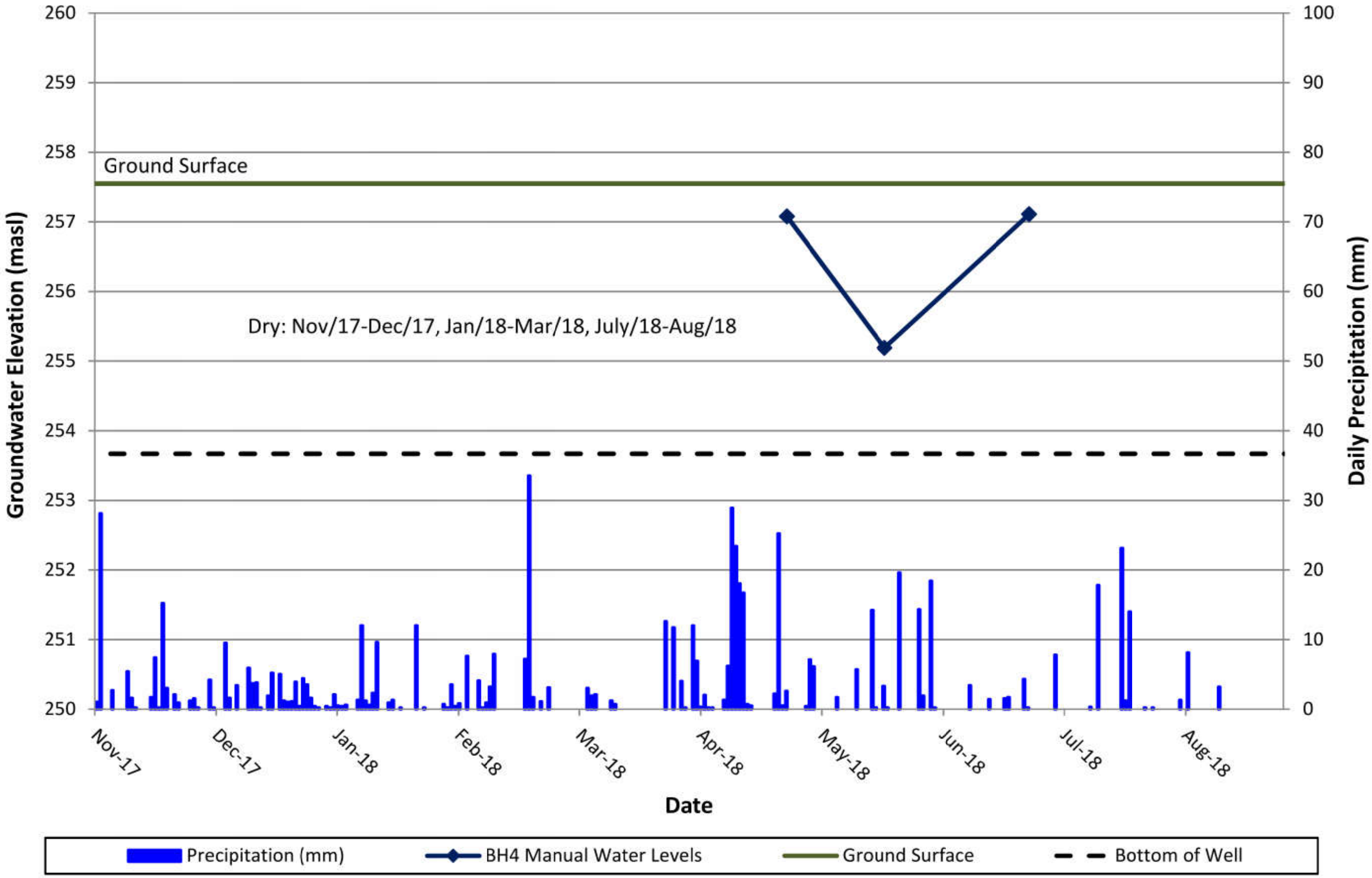


Figure D-1

SB-4 (Well Depth: 3.9 m, Screened in Sands/Silt Till)
Groundwater Elevations



SB-6 (Well Depth: 6.1 m, Screened in Sand, Silt Till.)
Groundwater Elevations

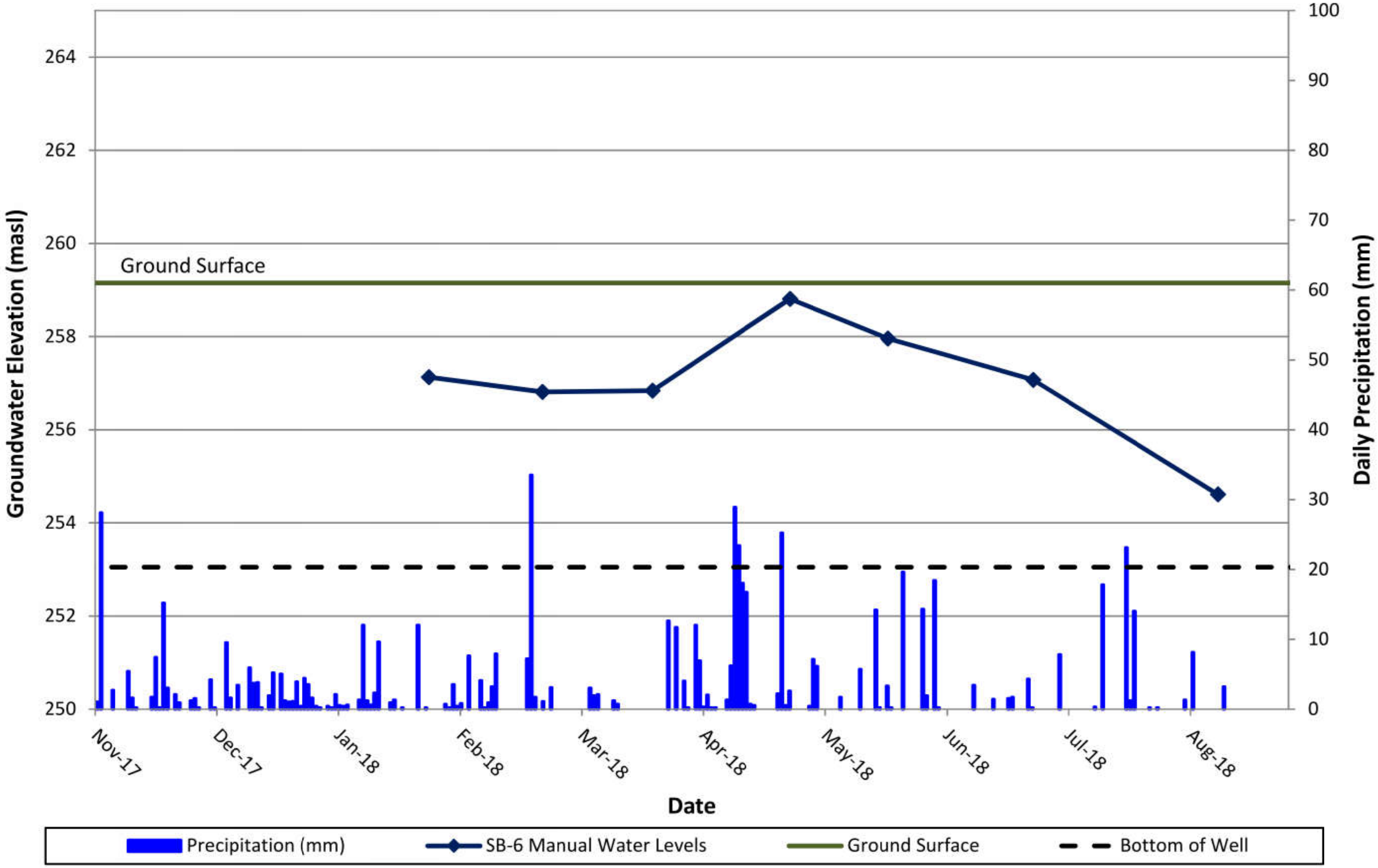
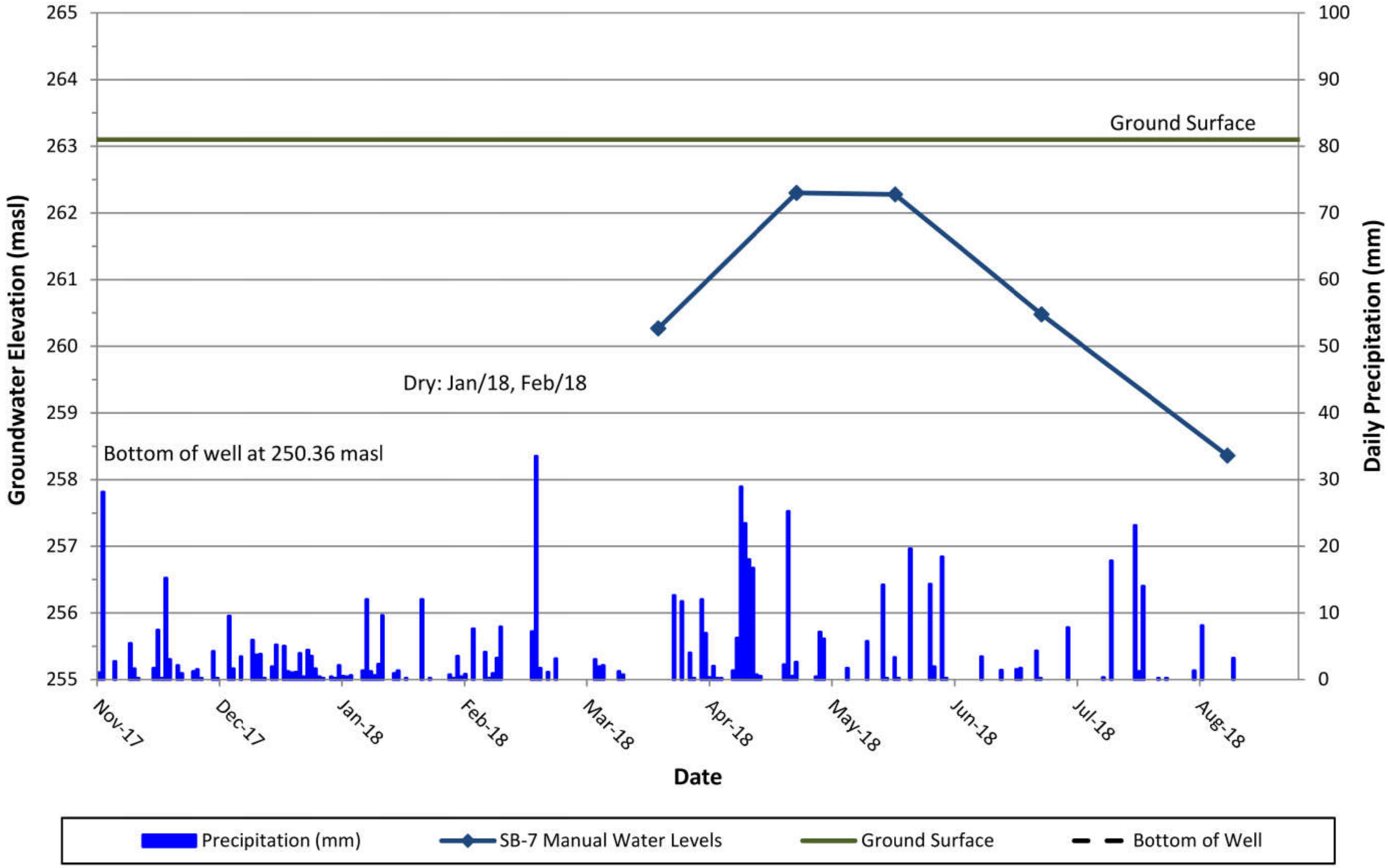


Figure D-3

SB-7 (Well Depth: 12.7 m, Screened in Sand/Silt Till)
Groundwater Elevations



SB-9 (Well Depth: 7.4 m, Screened in Sand/Silt Till)
Groundwater Elevations

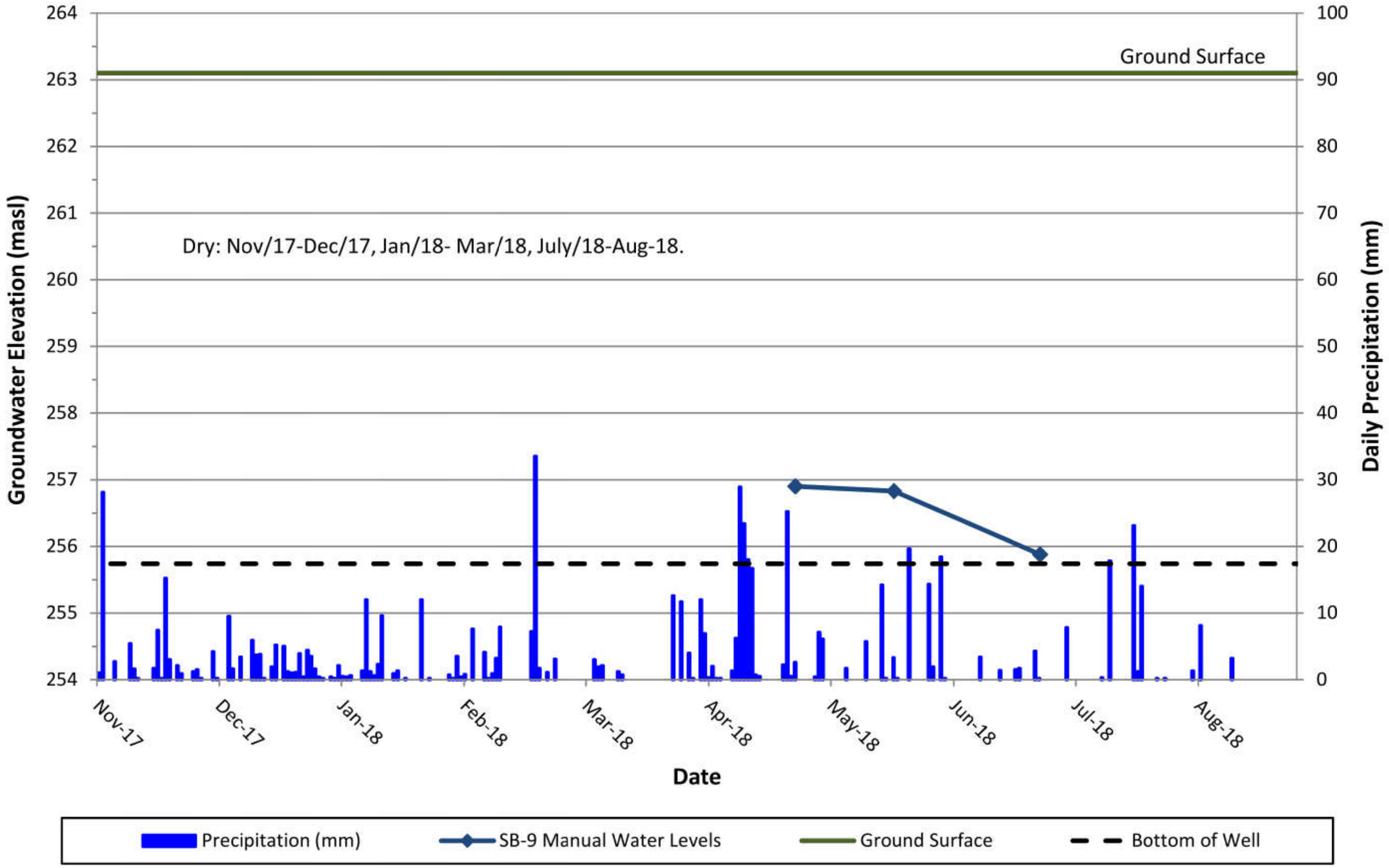


Figure D-5

SB-10 (Well Depth: 9.2 m, Screened in Sand)
Groundwater Elevations

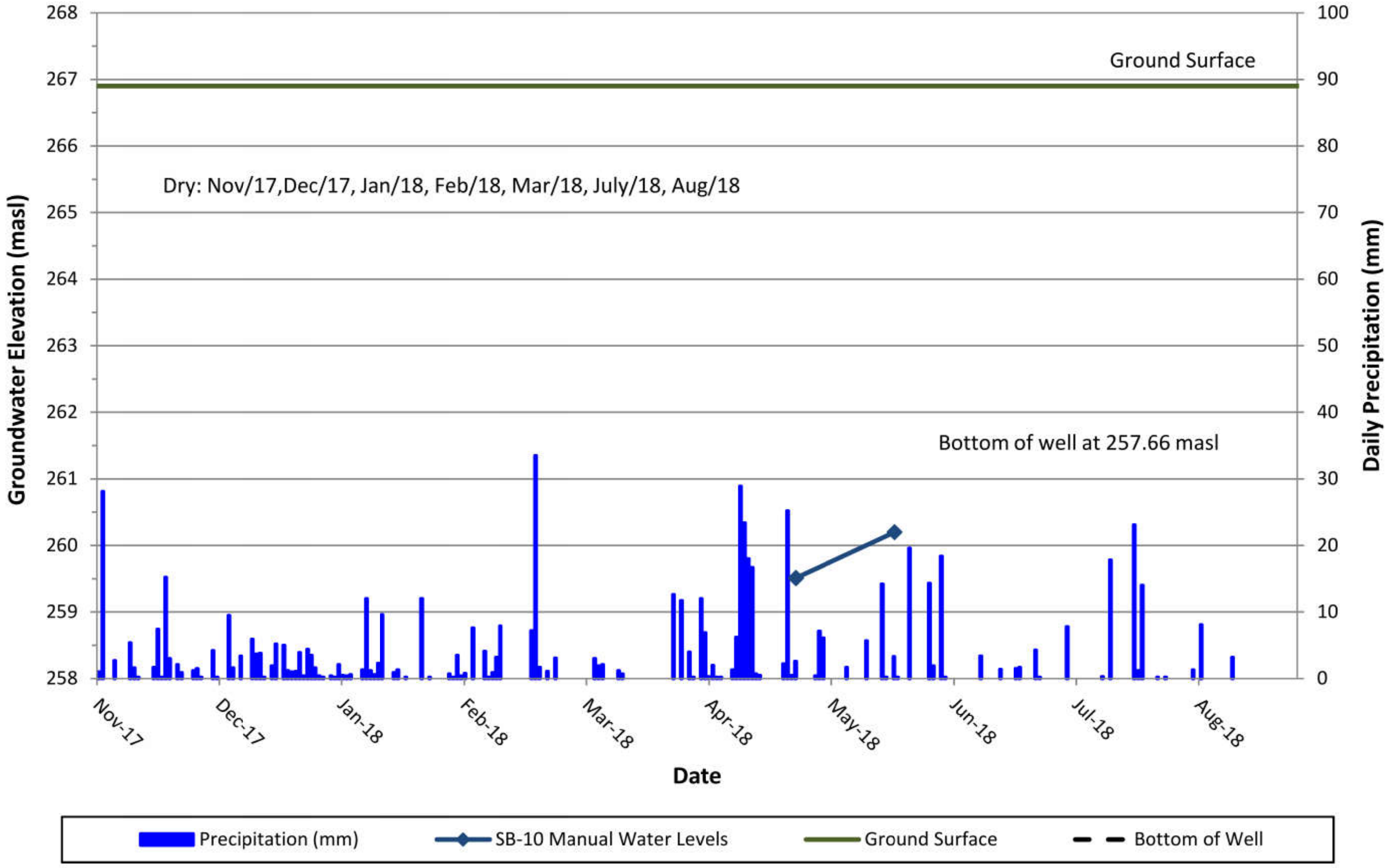


Figure D-6

SB-11 (Well Depth: 4.6 m, Screened in Sand/Silt Till)
Groundwater Elevations

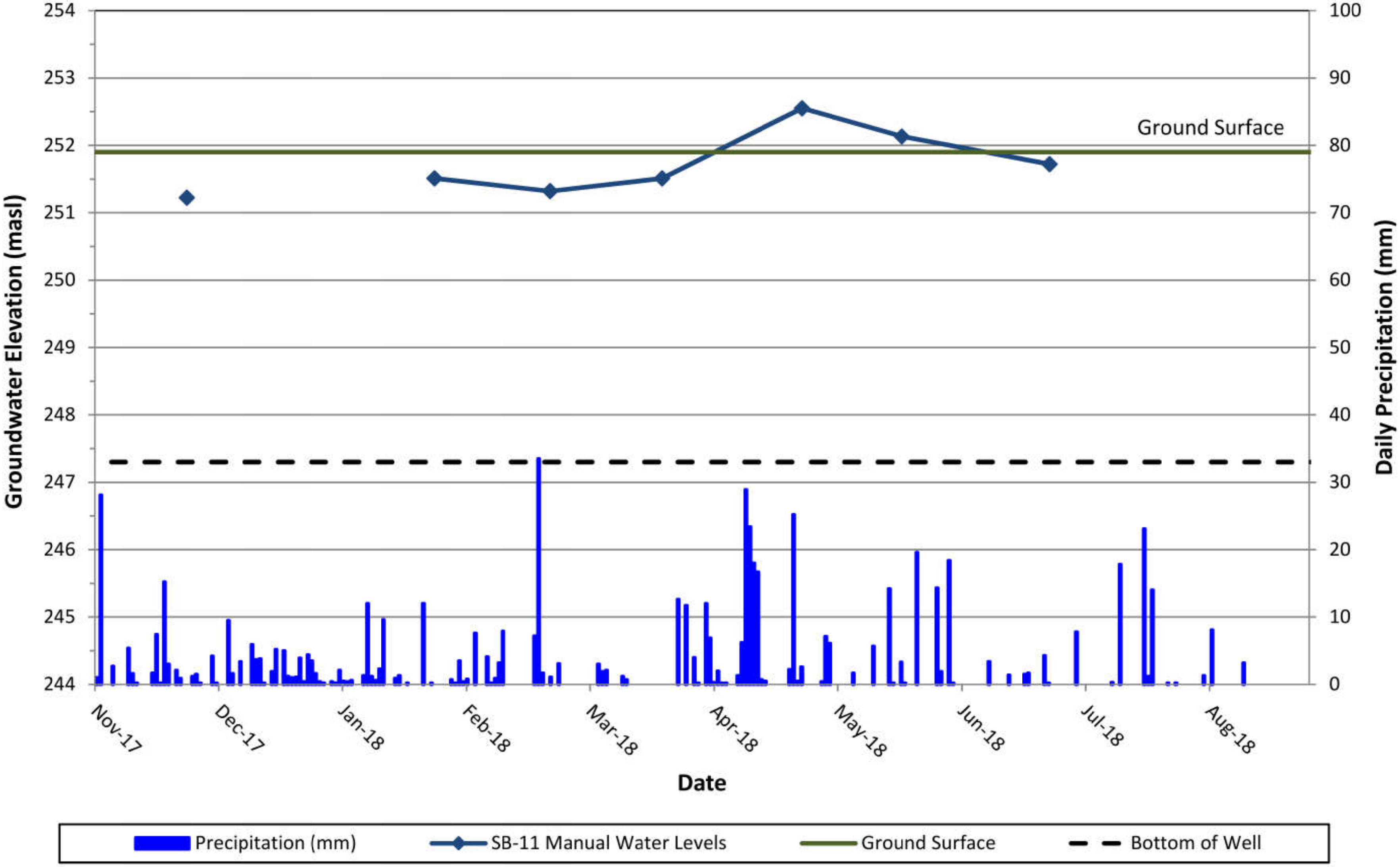


Figure D-7

SB-13 (Well Depth: 4.5 m, Screened in Sand/Silt Till)
Groundwater Elevations

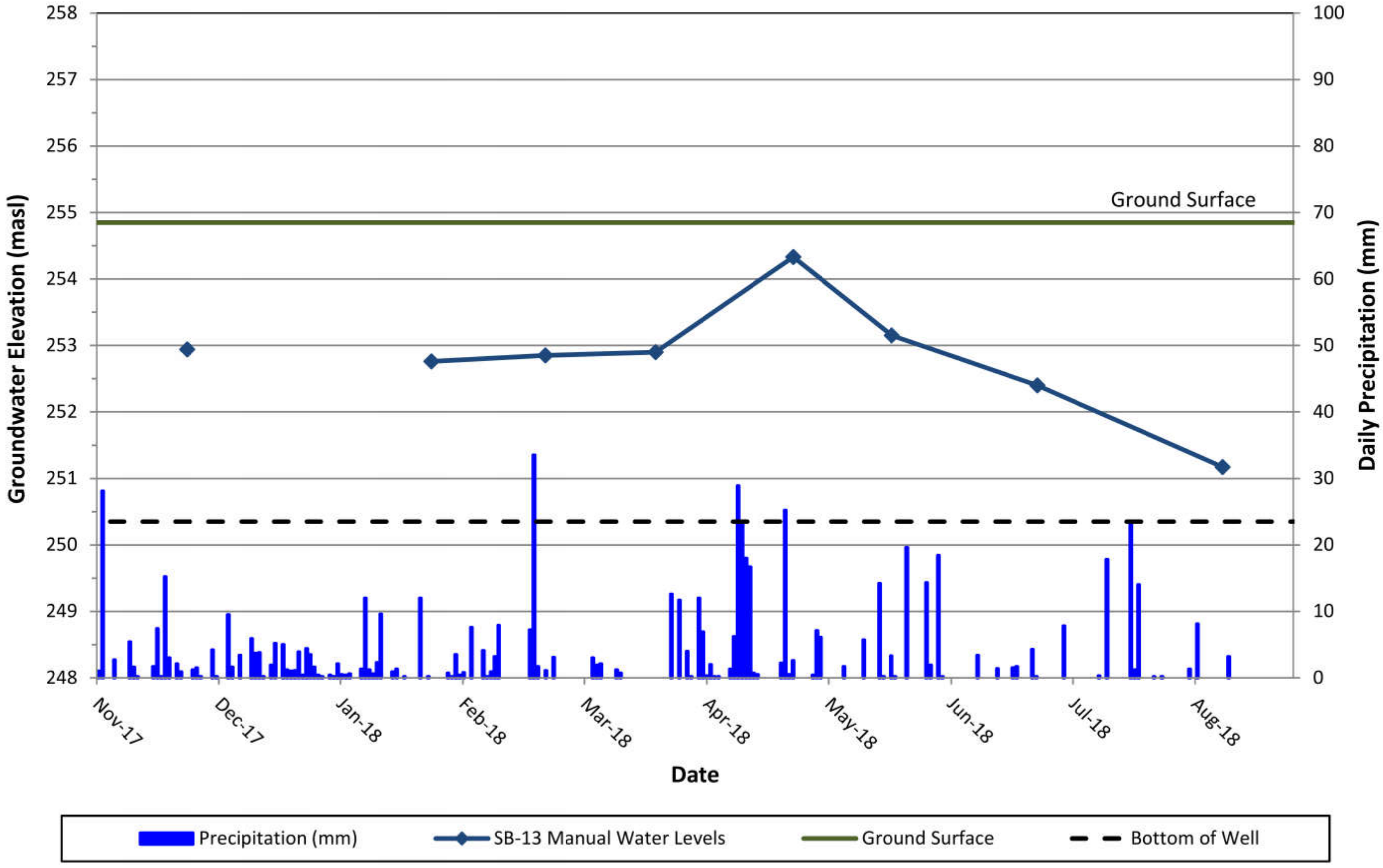


Figure D-8

SB-15 (Well Depth: 4.5 m, Screened in Sand/Silt Till)
Groundwater Elevations

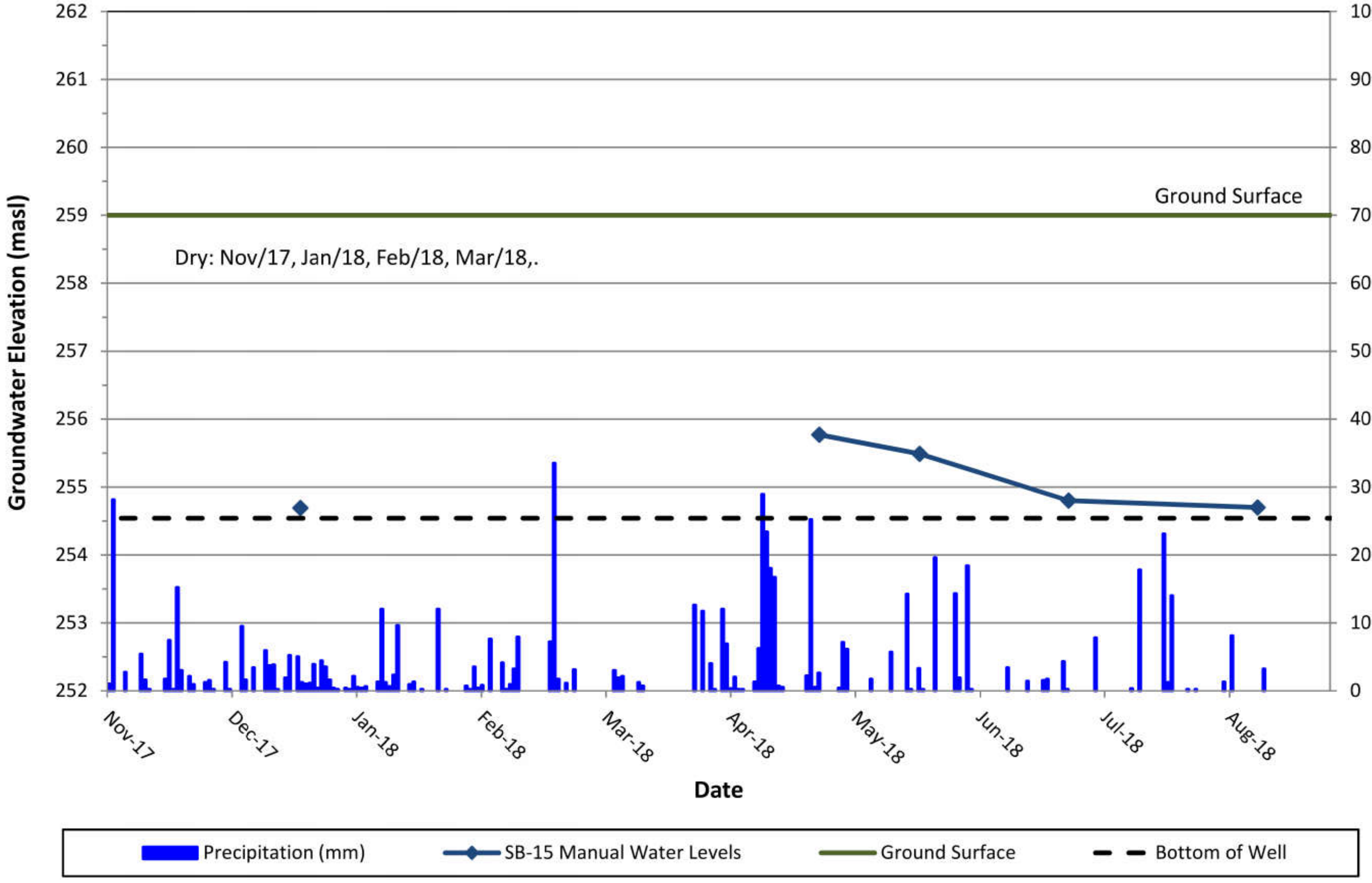


Figure D-9

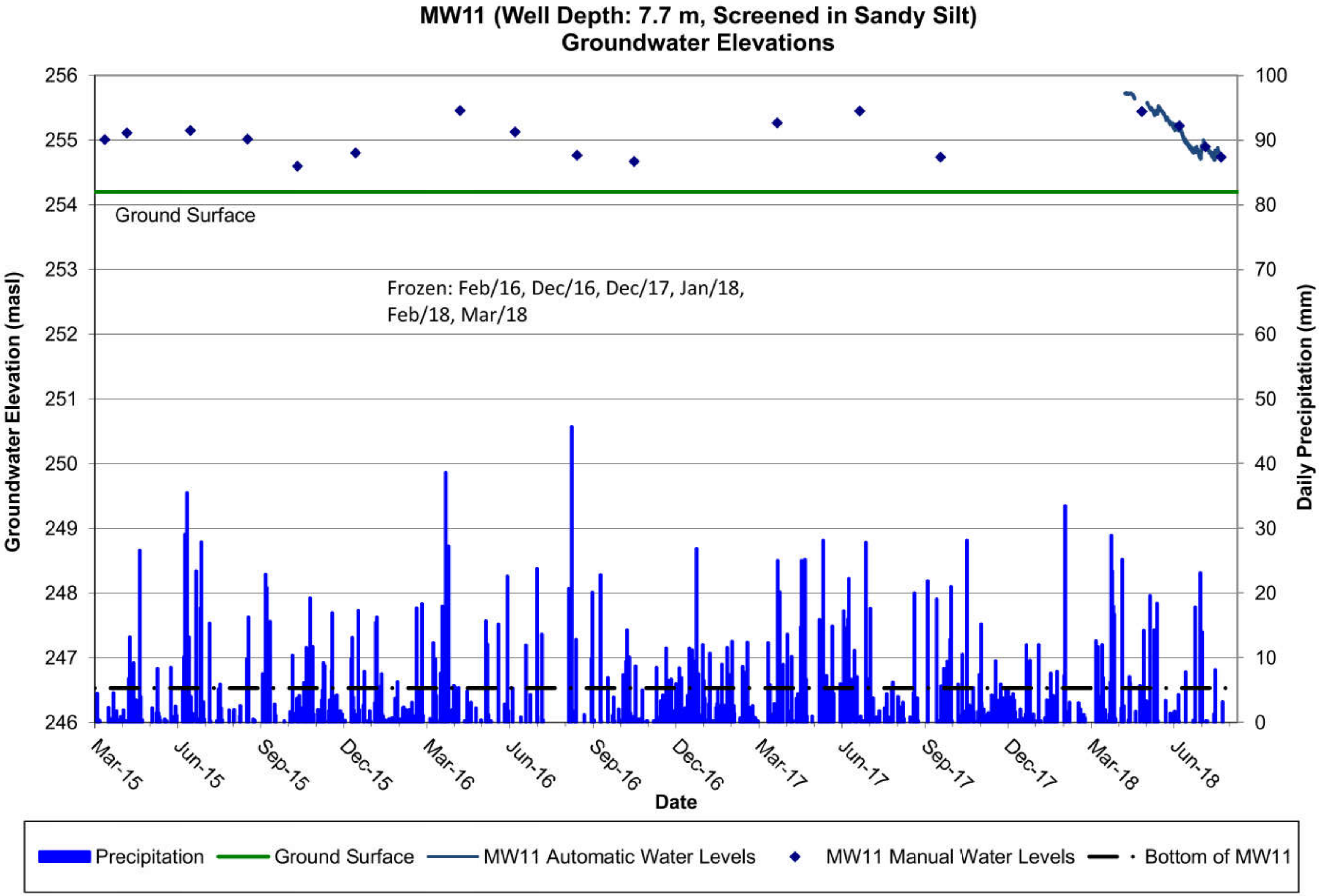

MW11 (Well Depth: 7.7 m, Screened in Sandy Silt)
Groundwater Elevations
Groundwater Elevation (masl)
256
255
254
253
252
251
250
249
248
247
246
Daily Precipitation (mm)
100
90
80
70
60
50
40
30
20
10
0
Ground Surface
Frozen: Feb/16, Dec/16, Dec/17, Jan/18, Feb/18, Mar/18
Mar-15
Jun-15
Sep-15
Dec-15
Mar-16
Jun-16
Sep-16
Dec-16
Mar-17
Jun-17
Sep-17
Dec-17
Mar-18
Jun-18
Date
Precipitation
Ground Surface
MW11 Automatic Water Levels
MW11 Manual Water Levels
Bottom of MW11

Figure D-10

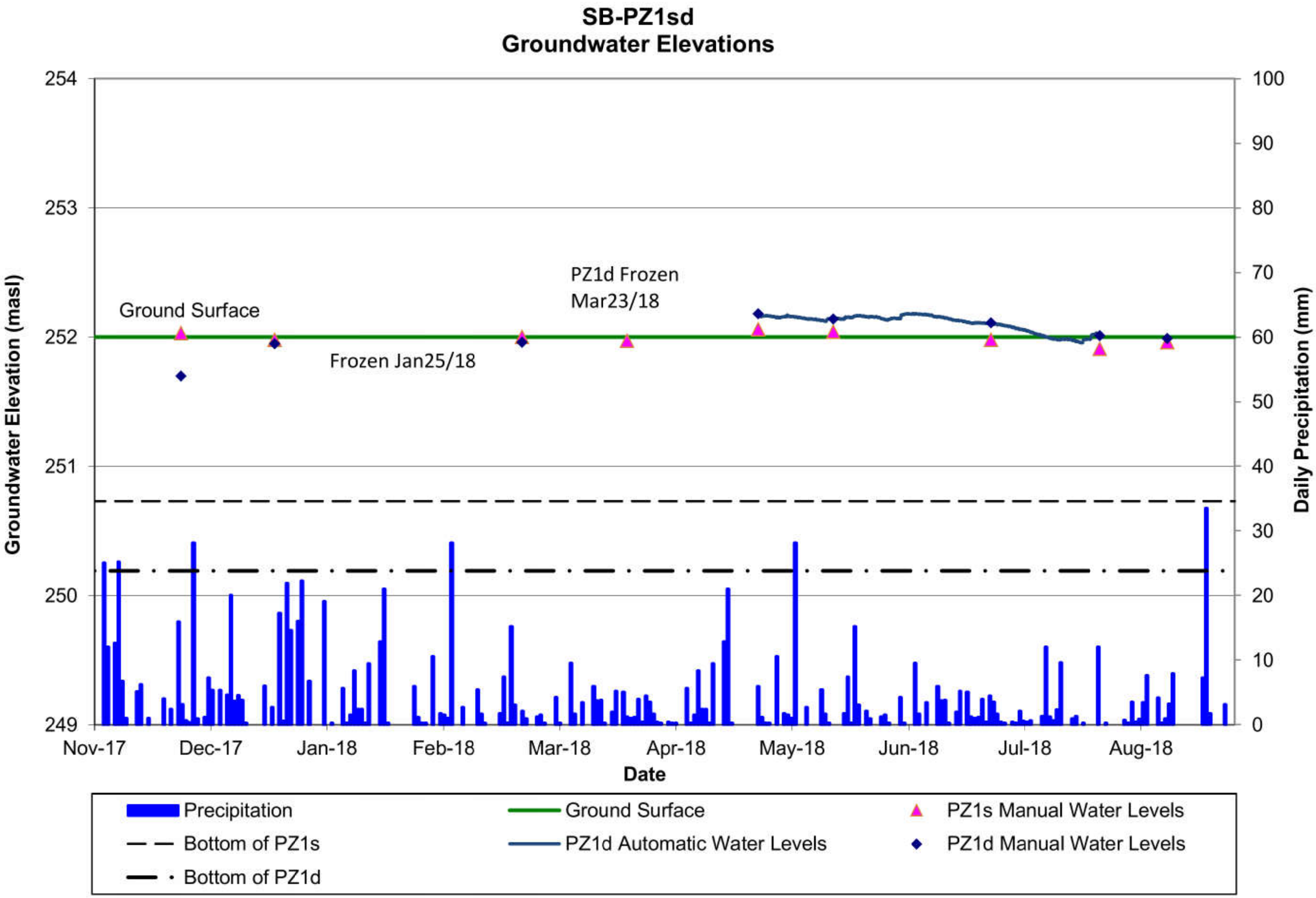

SB-PZ1sd
Groundwater Elevations
Groundwater Elevation (masl)
254
253
252
251
250
249
Daily Precipitation (mm)
100
90
80
70
60
50
40
30
20
10
0
Nov-17
Dec-17
Jan-18
Feb-18
Mar-18
Apr-18
May-18
Jun-18
Jul-18
Aug-18
Date
Ground Surface
Frozen Jan25/18
PZ1d Frozen
Mar23/18
Precipitation
Bottom of PZ1s
Bottom of PZ1d
Ground Surface
PZ1d Automatic Water Levels
PZ1s Manual Water Levels
PZ1d Manual Water Levels

Figure D-11

PZ4
Groundwater Elevations

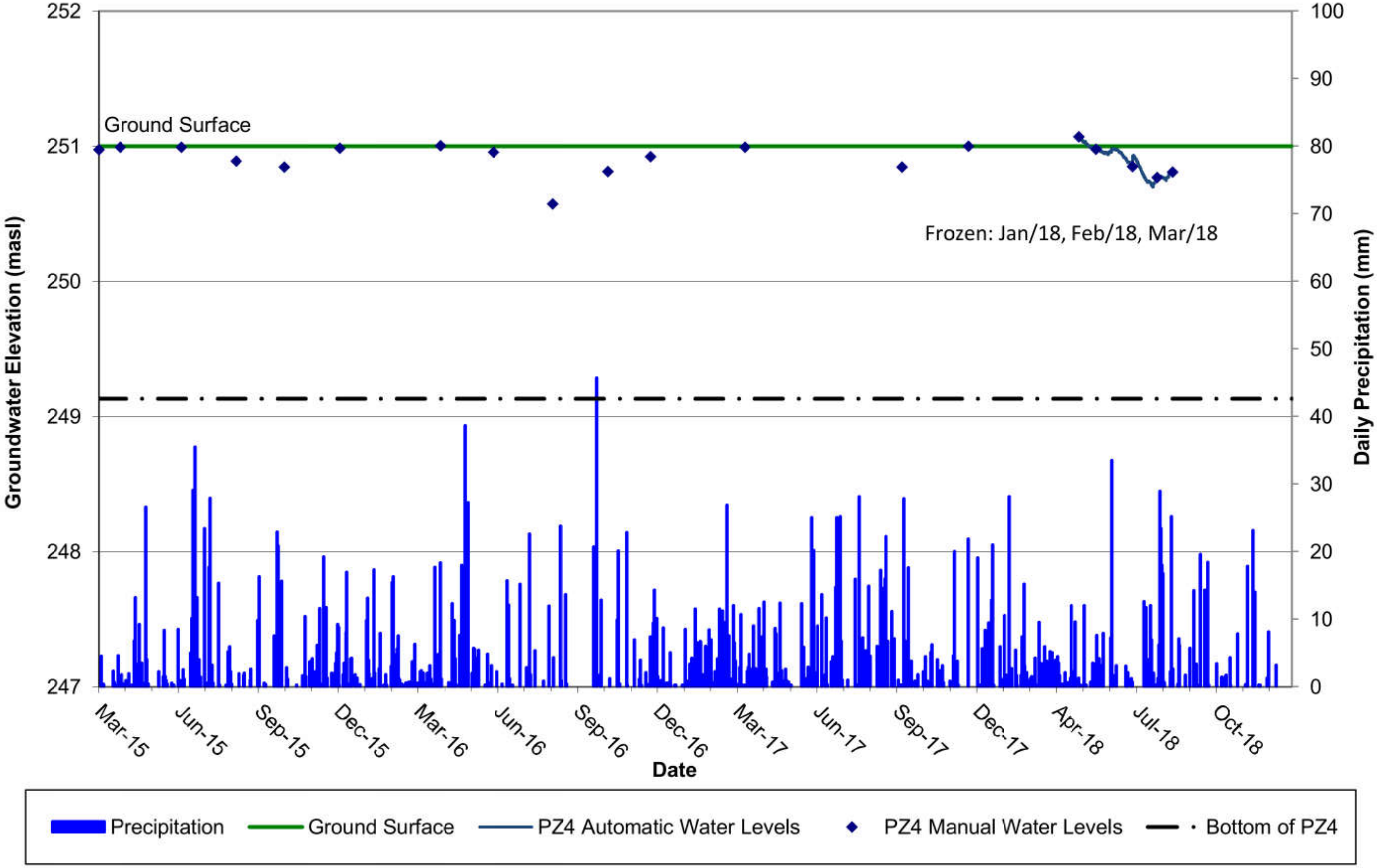


Figure D-12

BURNSIDE

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Appendix E

Water Quality Data

Table E-1
Groundwater Quality

Monitoring Well				**SB-3**	**SB-4**
Date Sampled				**22-May-18**	**22-May-18**
Parameter	**Unit**	**RDL**	**ODWQS**		
Electrical Conductivity	µS/cm	2		533	639
pH	pH Units	NA	(6.5-8.5)	7.89	7.75
Saturation pH				7.01	6.8
Langelier Index				0.88	0.95
Total Hardness (as CaCO3)	mg/L	0.5	(80-100)	**271**	**337**
Total Dissolved Solids	mg/L	20	500	298	402
Alkalinity (as CaCO3)	mg/L	5	(30-500)	246	338
Bicarbonate (as CaCO3)	mg/L	5		246	338
Carbonate (as CaCO3)	mg/L	5		<5	<5
Hydroxide (as CaCO3)	mg/L	5		<5	<5
Fluoride	mg/L	0.10	1.5	<0.10	<0.10
Chloride	mg/L	0.20	250	11.7	21.2
Nitrate as N	mg/L	0.10	10.0	5.47	6.9
Nitrite as N	mg/L	0.10	1.0	<0.10	<0.10
Bromide	mg/L	0.10		<0.10	<0.10
Sulphate	mg/L	0.20	500	30.1	15
Ortho Phosphate as P	mg/L	0.20		<0.20	<0.20
Reactive Silica	mg/L	0.10		17.4	16
Ammonia as N	mg/L	0.02		<0.02	0.02
Total Phosphorus	mg/L	0.02		0.03	1.97
Total Organic Carbon	mg/L	1.0		0.7	5.2
Colour	TCU	5	5	<5	<5
Turbidity	NTU	15	5	**12.4**	**15500**
Calcium	mg/L	0.05		69.7	114
Magnesium	mg/L	0.05		23.5	12.6
Sodium	mg/L	0.05	20 (200)	5.48	4.92
Potassium	mg/L	0.05		1.81	0.97
Aluminum (Dissolved)	mg/L	0.004	0.1	<0.004	<0.004
Antimony	mg/L	0.003	0.006	<0.003	<0.003
Arsenic	mg/L	0.003	0.025	<0.003	<0.003
Barium	mg/L	0.002	1	0.054	0.033
Beryllium	mg/L	0.001		<0.001	<0.001
Boron	mg/L	0.010	5	<0.010	0.013
Cadmium	mg/L	0.001	0.005	<0.0001	<0.001
Chromium	mg/L	0.003	0.05	<0.003	<0.003
Cobalt	mg/L	0.001		<0.0005	<0.001
Copper	mg/L	0.003	1	0.001	<0.003
Iron	mg/L	0.010	0.3	<0.01	<0.010
Lead	mg/L	0.001	0.01	<0.001	<0.001
Manganese	mg/L	0.002	0.05	<0.002	<0.002
Mercury (Dissolved)	mg/L	0.0001	0.001	<0.0001	<0.0001
Molybdenum	mg/L	0.002		0.003	<0.002
Nickel	mg/L	0.003		<0.003	<0.003
Selenium	mg/L	0.004	0.01	<0.004	<0.004
Silver	mg/L	0.002		<0.0001	<0.002
Strontium	mg/L	0.005		0.267	0.212
Thallium	mg/L	0.006		<0.0003	<0.006
Tin	mg/L	0.002		<0.002	<0.002
Titanium	mg/L	0.002		<0.002	<0.002
Tungsten	mg/L	0.010		<0.010	<0.010
Uranium	mg/L	0.002	0.02	<0.002	<0.002
Vanadium	mg/L	0.002	3	<0.002	<0.002
Zinc	mg/L	0.005	5	0.005	<0.005
Zirconium	mg/L	0.004		<0.004	<0.004
% Difference/ Ion Balance	%	NA		4.78	7.86

ODWQS - Ontario Drinking Water Quality Standards

RDL - Reported Detection Limit

Bold indicates an exceedence of the ODWQS

Table E-2
Surface Water Quality

Sample Location				**SB-SW1**
Date Sampled				**22-May-18**
Parameter	**Unit**	**RDL**	**PWQO**	
Electrical Conductivity	µS/cm	2		497
pH	pH Units	NA	(6.5-8.5)	7.91
Saturation pH				6.95
Langelier Index				0.96
Total Hardness (as CaCO3)	mg/L	0.5		275
Total Dissolved Solids	mg/L	20		282
Alkalinity (as CaCO3)	mg/L	5		276
Bicarbonate (as CaCO3)	mg/L	5		276
Carbonate (as CaCO3)	mg/L	5		<5
Hydroxide (as CaCO3)	mg/L	5		<5
Fluoride	mg/L	0.05		<0.05
Chloride	mg/L	0.1		10.6
Nitrate as N	mg/L	0.05		<0.05
Nitrite as N	mg/L	0.05		<0.05
Bromide	mg/L	0.05		<0.05
Sulphate	mg/L	0.1		12.1
Ortho Phosphate as P	mg/L	0.1		<0.10
Reactive Silica	mg/L	0.05		10.5
Ammonia as N	mg/L	0.02		<0.02
Total Phosphorus	mg/L	0.02	0.03	0.03
Total Organic Carbon	mg/L	0.5		6.5
Colour	TCU	5		<5
Turbidity	NTU	0.5		0.9
Calcium	mg/L	0.05		86.9
Magnesium	mg/L	0.05		14
Sodium	mg/L	0.05		5.2
Potassium	mg/L	0.05		1.18
Aluminum (dissolved)	mg/L	0.004	0.075	<0.004
Antimony	mg/L	0.003		<0.003
Arsenic	mg/L	0.003	1	<0.003
Barium	mg/L	0.002		0.07
Beryllium	mg/L	0.001		<0.001
Boron	mg/L	0.01	2	0.011
Cadmium	mg/L	0.0001	0.0002	<0.0001
Chromium	mg/L	0.003	0.009	<0.003
Cobalt	mg/L	0.0005		<0.0005
Copper	mg/L	0.001	0.005	<0.001
Iron	mg/L	0.01	0.3	<0.01
Lead	mg/L	0.001	0.001	<0.001
Manganese	mg/L	0.002		0.009
Dissolved Mercury	mg/L	0.0001	0.0002	<0.0001
Molybdenum	mg/L	0.002	0.04	<0.002
Nickel	mg/L	0.003	0.025	<0.003
Selenium	mg/L	0.004	0.01	<0.004
Silver	mg/L	0.0001		<0.0001
Strontium	mg/L	0.005		0.225
Thallium	mg/L	0.0003	0.0003	<0.0003
Tin	mg/L	0.002		<0.002
Titanium	mg/L	0.002		<0.002
Tungsten	mg/L	0.01		<0.010
Uranium	mg/L	0.002	0.005	0.002
Vanadium	mg/L	0.002		<0.002
Zinc	mg/L	0.005	0.03	<0.005
Zirconium	mg/L	0.004		<0.004
Cation Sum	meq/L	NA		5.75
Anion Sum	meq/L			6.07
% Difference/ Ion Balance	%	NA		2.72

PWQS - Provincial Water Quality Standards

RDL - Reported Detection Limit

Bold indicates an exceedence of the PWQO

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Appendix F

Water Balance Calculations

Appendix F

WATER BALANCE CALCULATIONS
Barrie Lockhart Road LP
Barrie, ON

PROJECT No.300041514

TABLE F-1

Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 150 mm (moderate rooted crops in sandy loam soils)

Precipitation data from Barrie WPCC Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	**6.9**
Heat index: i = $(t/5)^{1.514}$	0.00	0.00	0.00	1.19	3.91	6.90	8.66	7.97	5.44	2.31	0.39	0.00	**36.8**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	25.18	58.76	88.02	103.48	97.59	74.33	40.47	11.47	0.00	**499**
Adjusting Factor for U (Latitude 44° 20' N)	0.81	0.82	1.02	1.13	1.27	1.29	1.3	1.2	1.04	0.95	0.8	0.76	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
WATER BALANCE COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	83	62	58	62	82	85	77	90	94	78	89	74	**933**
Potential Evapotranspiration (PET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
P - PET	83	62	58	34	8	-29	-57	-27	17	39	80	74	**340**
Change in Soil Moisture Storage	0	0	0	0	0	-29	-57	-27	17	39	58	0	**0**
Soil Moisture Storage max 150 mm	150	150	150	150	150	121	64	37	53	92	150	150	
Actual Evapotranspiration (AET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
Soil Moisture Deficit max 150 mm	0	0	0	0	0	29	86	113	97	58	0	0	
Water Surplus - available for infiltration or runoff	83	62	58	34	8	0	0	0	0	0	22	74	**340**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	58	43	41	24	5	0	0	0	0	0	16	52	**238**
Potential Direct Surface Water Runoff (independent of temperature)	25	19	17	10	2	0	0	0	0	0	7	22	**102**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	933	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	140	mm/year											
P-PE (surplus available for runoff from impervious areas)	793	mm/year											

Assume January storage is 100% of Soil Moisture Storage

Soil Moisture Storage	150 mm	<-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003
*MOE SWM infiltration calculations		
topography - rolling to hilly land	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - sandy loam	0.4	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - predominantly cultivated land	0.1	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.7**	
Latitude of site (or climate station)	44 ° N.	

WATER BALANCE CALCULATIONS
Barrie Lockhart Road LP
Barrie, ON

PROJECT No.300041514

TABLE F-2

Water Balance Components

Based on Thornthwaite's Soil Moisture Balance Approach with a Soil Moisture Retention of 300 mm (wooded areas in sandy loam soils)

Precipitation data from Barrie WPCC Climate Station (1981 - 2010)

Potential Evapotranspiration Calculation	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Average Temperature (Degree C)	-7.7	-6.6	-2.1	5.6	12.3	17.9	20.8	19.7	15.3	8.7	2.7	-3.5	**6.9**
Heat index: $i = (t/5)^{1.514}$	0.00	0.00	0.00	1.19	3.91	6.90	8.66	7.97	5.44	2.31	0.39	0.00	**36.8**
Unadjusted Daily Potential Evapotranspiration U (mm)	0.00	0.00	0.00	25.18	58.76	88.02	103.48	97.59	74.33	40.47	11.47	0.00	**499**
Adjusting Factor for U (Latitude 43° 52' N)	0.81	0.82	1.02	1.13	1.27	1.29	1.3	1.2	1.04	0.95	0.8	0.76	
Adjusted Potential Evapotranspiration PET (mm)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
WATER BALANCE COMPONENTS	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**YEAR**
Precipitation (P)	83	62	58	62	82	85	77	90	94	78	89	74	**933**
Potential Evapotranspiration (PET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
P - PET	83	62	58	34	8	-29	-57	-27	17	39	80	74	**340**
Change in Soil Moisture Storage	0	0	0	0	0	-29	-57	-27	17	39	58	0	**0**
Soil Moisture Storage max 300 mm	300	300	300	300	300	271	214	187	203	242	300	300	
Actual Evapotranspiration (AET)	0	0	0	28	75	114	135	117	77	38	9	0	**593**
Soil Moisture Deficit max 300 mm	0	0	0	0	0	29	86	113	97	58	0	0	
Water Surplus - available for infiltration or runoff	83	62	58	34	8	0	0	0	0	0	22	74	**340**
Potential Infiltration (based on MOE metholodogy*; independent of temperature)	66	49	46	27	6	0	0	0	0	0	18	59	**272**
Potential Direct Surface Water Runoff (independent of temperature)	17	12	12	7	2	0	0	0	0	0	4	15	**68**
IMPERVIOUS AREA WATER SURPLUS													
Precipitation (P)	933	mm/year											
Potential Evaporation (PE) from impervious areas (assume 15%)	140	mm/year											
P-PE (surplus available for runoff from impervious areas)	793	mm/year											

Assume January storage is 100% of Soil Moisture Storage

Soil Moisture Storage	300 mm	<-- See "Water Holding Capacity" values in Table 3.1, MOE SWMPDM, 2003
*MOE SWM infiltration calculations		
topography - rolling to hilly land	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
soils - sandy loam	0.4	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
cover - woodlands	0.2	<-- Infiltration Factors from the bottom section of Table 3.1, MOE SWMPDM, 2003
Infiltration factor	**0.8**	
Latitude of site (or climate station)	44 ° N.	

WATER BALANCE CALCULATIONS
Barrie Lockhart Road LP
Barrie, ON

PROJECT No.300041514

TABLE F-3

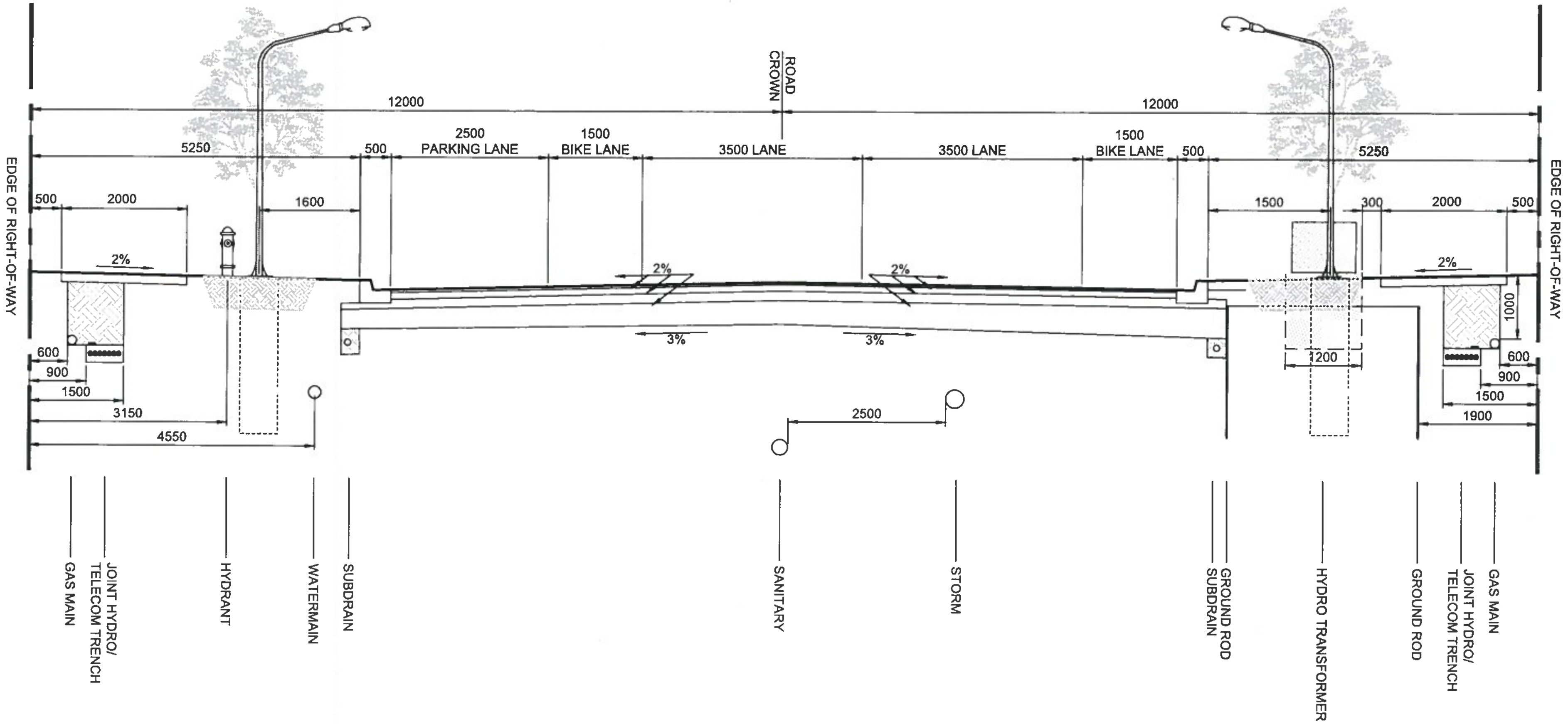
Water Balance for Pre- and Post-Development Land Use Conditions (with no SWM/LID measures in place)

Land Use Description	Approx. Land Area* (m^2)	Estimated Impervious Fraction for Land Use*	Estimated Impervious Area (m^2)	Runoff from Impervious Area** (m/a)	Runoff Volume from Impervious Area (m^3/a)	Estimated Pervious Area (m^2)	Runoff from Pervious Area** (m/a)	Runoff Volume from Pervious Area (m^3/a)	Infiltration from Pervious Area** (m/a)	Infiltration Volume from Pervious Area (m^3/a)	Total Runoff Volume (m^3/a)	Total Infiltration Volume (m^3/a)
Exising Land Use												
Rural Forest	56,200	0.00	0	0.793	0	56,200	0.068	3,818	0.272	15,274	3,818	15,274
Wetlands	104,000	1.00	104,000	0.793	82,468	0	0.102	0	0.238	0	82,468	0
Agricultural	207,200	0.00	0	0.793	0	207,200	0.102	21,117	0.238	49,272	21,117	49,272
TOTAL PRE-DEVELOPMENT	**367,400**		**104,000**		**82,468**	**263,400**		**24,935**		**64,546**	**107,404**	**64,546**
Post-Development Land Use (with no LID measures in place)												
Residential (Single Detached)	90,100	0.74	66,674	0.793	52,870	23,426	0.102	2,387	0.238	5,571	55,258	5,571
Residential (Townhouse)	26,000	0.72	18,720	0.793	14,844	7,280	0.068	495	0.238	1,731	15,339	1,731
Mixed Use	15,500	0.75	11,625	0.793	9,218	3,875	0.068	263	0.238	921	9,481	921
Stormwater Management Pond	6,700	0.50	3,350	0.793	2,656	3,350	0.068	228	0.238	797	2,884	797
Village Square	9,000	0.25	2,250	0.793	1,784	6,750	0.068	459	0.238	1,605	2,243	1,605
Institutional	24,100	0.75	18,075	0.793	14,333	6,025	0.068	409	0.238	1,433	14,742	1,433
Roads	60,400	0.67	40,468	0.793	32,090	19,932	0.068	1,354	0.238	4,740	33,444	4,740
Environmental Heitage System	132,500	0.00	0	0.793	0	132,500	0.068	9,002	0.238	31,509	9,002	31,509
Widening and Reserve	3,100	0.74	2,294	0.793	1,819	806	0.102	82	0.238	192	1,901	192
TOTAL POST-DEVELOPMENT	**367,400**		**163,456**		**129,615**	**203,944**		**14,680**		**48,498**	**144,295**	**48,498**
										% Change from Pre to Post	134	25
										Effect of development (with no mitigation)	1.3 times increase in runoff	25% reduction of infiltration

* data provided by SCS Consulting Group Inc.

** figures from Tables F-1 and F-2

To balance pre- to post-,
the infiltration target (m^3/a)= **16,048**



NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
2. WASTEWATER SYSTEMS, STORMWATER SYSTEMS, INCLUDING LOW IMPACT DEVELOPMENT FACILITIES, AND WATER DISTRIBUTION AND TRANSMISSION SYSTEMS TO BE DESIGNED IN ACCORDANCE WITH CITY OF BARRIE ENGINEERING GUIDELINES AND STANDARDS.
4. REFER TO THE CITY OF BARRIE ROADWAY ILLUMINATION POLICIES AND DESIGN GUIDELINES AND ASSOCIATED BSD'S FOR LIGHT STANDARD AND POLE BASE LOCATION AND DEPTH.
5. REFER TO TRANSPORTATION DESIGN MANUAL FOR PAVEMENT DESIGN METHODOLOGY.
6. TREES TO BE PLACED IN LOCATIONS APPROVED BY THE PARKS, PLANNING, AND DEVELOPMENT BRANCH. (SEE BSD-1315)
7. WIDENINGS MAY BE REQUIRED AT INTERSECTIONS TO ACCOMMODATE REQUIRED TURN-LANES

Barrie
STANDARD DETAIL

24.0 m MINOR COLLECTOR RESIDENTIAL ROAD ALLOWANCE 12.5 m ASPHALT

REV No.
1

DATE: OCT 2017

SCALE: N.T.S.

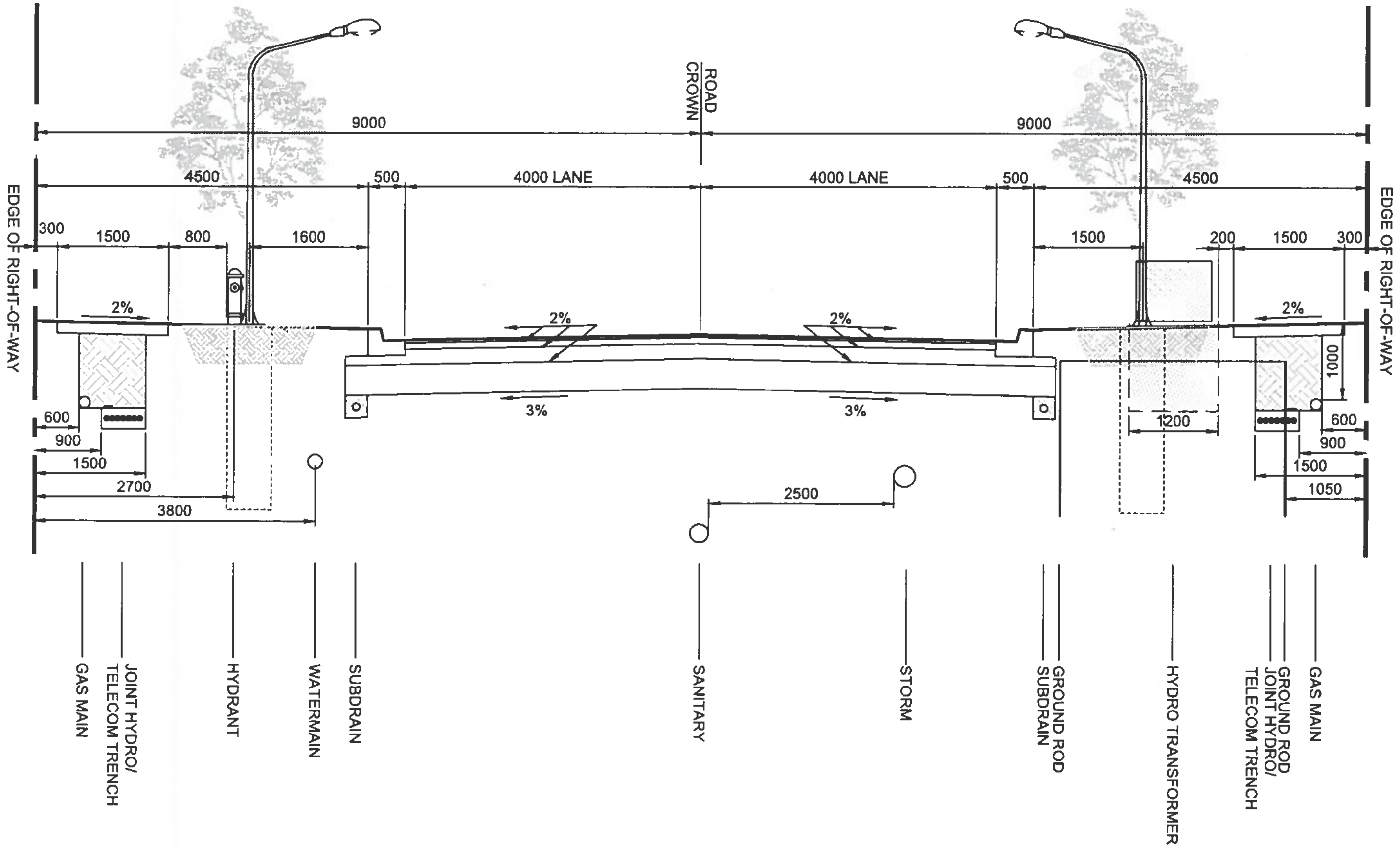
BSD-303

APPROVED

DATE Oct. 28/17

R. Sutton

DIRECTOR OF ENGINEERING



NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
2. WASTEWATER SYSTEMS, STORMWATER SYSTEMS, INCLUDING LOW IMPACT DEVELOPMENT FACILITIES, AND WATER DISTRIBUTION AND TRANSMISSION SYSTEMS TO BE DESIGNED IN ACCORDANCE WITH CITY OF BARRIE ENGINEERING GUIDELINES AND STANDARDS.
3. REFER TO THE CITY OF BARRIE ROADWAY ILLUMINATION POLICIES AND DESIGN GUIDELINES AND ASSOCIATED BSD'S FOR LIGHT STANDARD AND POLE BASE LOCATION AND DEPTH.
4. REFER TO TRANSPORTATION DESIGN MANUAL FOR PAVEMENT DESIGN METHODOLOGY.
5. TREES TO BE PLACED IN LOCATIONS APPROVED BY THE PARKS, PLANNING, AND DEVELOPMENT BRANCH. (SEE BSD-1315)

Barrie

STANDARD DETAIL

18.0 m LOCAL ROAD ALLOWANCE - RESIDENTIAL 8.0 m ASPHALT

REV No.
1

DATE: OCT 2017

SCALE: N.T.S.

BSD-301

APPROVED

DATE Oct 28/17

R. Sutton

DIRECTOR OF ENGINEERING

14.5.4 Institutional Uses in Residential Zones

a) The Institutional Standards found in Section 8.3 of this By-law shall apply to the Institutional *uses* listed in Table 14.5.2; and 14.5.6 unless otherwise stated in Section 14 of this by-law.

b) The maximum *lot* area for a place of worship located in a Residential Zone shall be 0.6 ha;

c) Any group home permitted in Table 14.2 shall comply with the R2 standards contained in Section 5.2.1 and Table 5.3.

14.5.5 Commercial Uses within Apartment Buildings

A convenience store, *personal service store* and *dry cleaning or laundry depot* shall be permitted commercial uses within an *apartment building* provided that the commercial *uses* do not occupy in excess of 25% of the ground floor area of the *building*. All other standards of the *zone* in which the *building* is located shall be complied with.

14.5.6 Residential Standards

Table 14.5.6

	Zones						
	Neighbourhood Residential R5 Zone			**Neighbourhood Residential Multiple Zone RM3**			
	Single	**Semi**	**Street Townhouse**	**Back To Back Townhouse**	**Block/ Cluster/ Street Townhouse**	**Walk-Up Apartments**	**Apartments**
Lot Frontage (min)	9.0m	7.2m	4.5m	5.5m	11.0m	18.0m	24.0m
***Front Yard Setback* (min.)(1)**	3.0m	3.0m	3.0m	3.0m	3.0m	3.0m	3.0m
Exterior Side Yards *Setback* (min.)(1)	2.0m	2.0m	2.0m	2.0m	2.0m	2.0m	2.0m
Interior Side Yards *Setback* (min.) one side	1.2m	1.2m	0	0	0	1.2	5
Interior Side Yards *Setback* (min.) opposite side	0.6m	0	0	0		1.2	5
Interior Side Yard Setback s where balconies or terraces face the side property line						5m	5m
Rear Yard (min.)	5.0m	5.0m	5.0m	5.0m	5.0m	5.0m	5.0m

APPENDIX C

STORMWATER MANAGEMENT CALCULATIONS

scs consulting group ltd

SCS consulting group ltd

WEIGHTED IMPERVIOUSNESS
PROPOSED STORM DRAINAGE PLAN

Sorbara - Lockhart Road
Job Number: 2000
Date: October 2018
Designer Initials: M.T.T.

Catchment 401

	Imperviousness	Area (ha)	Weighted Imperviousness
Singles (on 18m R.O.W.)	0.72	9.82	0.33
Singles (on 25m R.O.W.)	0.74	0.82	0.03
Mixed Use	0.75	1.79	0.06
Towns (on 18m R.O.W.)	0.72	3.32	0.11
Towns (on 25m R.O.W.)	0.74	0.89	0.03
25m R.O.W.	0.74	0.76	0.03
School	0.75	2.41	0.08
Pond	0.50	0.68	0.02
Park	0.25	0.85	0.01
TOTAL		21.34	0.70

Catchment 402

	Imperviousness	Area (ha)	Weighted Imperviousness
Towns (on 18m R.O.W.)	0.72	2.58	0.65
Singles (on 18m R.O.W.)	0.72	0.29	0.07
TOTAL		2.87	0.72

Catchment 403

	Imperviousness	Area (ha)	Weighted Imperviousness
25m R.O.W.	0.74	1.77	0.74
TOTAL		1.77	0.74

Catchment 404

	Imperviousness	Area (ha)	Weighted Imperviousness
25m R.O.W.	0.74	0.40	0.74
TOTAL		0.40	0.74

Catchment 405

	Imperviousness	Area (ha)	Weighted Imperviousness
Singles (on 18m R.O.W.)	0.72	6.07	0.46
Mixed Use	0.75	0.66	0.05
18m R.O.W.	0.67	0.44	0.03
Pond	0.50	2.29	0.12
TOTAL		9.46	0.67

Catchment 406

	Imperviousness	Area (ha)	Weighted
Park	0.20	0.04	0.02
Rear Lot Singles	0.60	0.37	0.54
TOTAL		0.41	0.54

WEIGHTED IMPERVIOUSNESS
PROPOSED STORM DRAINAGE PLAN

Catchment 501

	Imperviousness	Area (ha)	Weighted Imperviousness
Singles (on 18m R.O.W.)	0.72	1.14	0.62
18 m ROW	0.67	0.18	0.09
TOTAL		1.32	0.71

Catchment 502

	Imperviousness	Area (ha)	Weighted Imperviousness
Singles (on 18m R.O.W.)	0.72	0.02	0.16
25m R.O.W.	0.74	0.09	0.58
TOTAL		0.11	0.74

WEIGHTED IMPERVIOUSNESS
PROPOSED MUNICIPAL LID LOCATIONS

Sorbara - Lockhart Road
Job Number: 2000
Date: October 2018
Designer Initials: M.T.T.

Catchment 101

	Imperviousness	Area (ha)	Weighted Imperviousness
Singles (on 18m R.O.W.)	0.72	4.28	0.42
Singles (on 25m R.O.W.)	0.74	0.31	0.03
Mixed Use	0.75	0.06	0.01
Towns (on 18m R.O.W.)	0.72	1.02	0.10
Towns (on 25m R.O.W.)	0.74	0.89	0.09
25m R.O.W.	0.74	0.28	0.03
Park	0.25	0.54	0.02
TOTAL		7.38	0.69

Catchment 102

	Imperviousness	Area (ha)	Weighted Imperviousness
Singles (on 18m R.O.W.)	0.72	0.50	0.14
25m R.O.W.	0.74	0.48	0.14
Towns (on 18m R.O.W.)	0.72	1.19	0.35
Park	0.25	0.31	0.03
TOTAL		2.48	0.66

Catchment 103

	Imperviousness	Area (ha)	Weighted Imperviousness
Singles (on 18m R.O.W.)	0.72	4.46	0.72
TOTAL		4.46	0.72

Catchment 104

	Imperviousness	Area (ha)	Weighted Imperviousness
Singles (on 18m R.O.W.)	0.72	1.13	0.62
18 m ROW	0.67	0.18	0.09
TOTAL		1.31	0.71

Catchment 105

	Imperviousness	Area (ha)	Weighted Imperviousness
Singles (on 25m R.O.W.)	0.74	0.52	0.08
Singles (on 18m R.O.W.)	0.72	0.61	0.09
Mixed Use	0.75	1.50	0.22
School	0.75	2.41	0.36
TOTAL		5.04	0.75

WEIGHTED IMPERVIOUSNESS
PROPOSED MUNICIPAL LID LOCATIONS

Sorbara - Lockhart Road
Job Number: 2000
Date: October 2018
Designer Initials: M.T.T.

Catchment 106

	Imperviousness	Area (ha)	Weighted Imperviousness
Park	0.25	0.04	0.03
Rear Lot Singles	0.60	0.37	0.54
TOTAL		0.42	0.54

Catchment 107

	Imperviousness	Area (ha)	Weighted Imperviousness
Mixed Use	0.75	0.23	0.13
Towns (on 18m R.O.W.)	0.72	1.11	0.60
TOTAL		1.34	0.73

Catchment 108

	Imperviousness	Area (ha)	Weighted Imperviousness
Pond	0.50	2.93	0.50
TOTAL		2.93	0.50

WEIGHTED IMPERVIOUSNESS
PROPOSED MUNICIPAL LID LOCATIONS

Sorbara - Lockhart Road
Job Number: 2000
Date: October 2018
Designer Initials: M.T.T.

Catchment 201

	Imperviousness	Area (ha)	Weighted Imperviousness
Towns (on 18m R.O.W.)	0.72	2.23	0.63
Singles (on 18m R.O.W.)	0.72	0.33	0.09
TOTAL		2.56	0.72

Catchment 202

	Imperviousness	Area (ha)	Weighted Imperviousness
Towns (on 18m R.O.W.)	0.72	0.31	0.72
TOTAL		0.31	0.72

Catchment 203

	Imperviousness	Area (ha)	Weighted Imperviousness
Singles (on 18m R.O.W.)	0.72	3.18	0.54
Mixed Use	0.75	1.05	0.19
TOTAL		4.23	0.73

Catchment 204

	Imperviousness	Area (ha)	Weighted Imperviousness
Singles (on 18m R.O.W.)	0.72	3.25	0.72
TOTAL		3.25	0.72

FILTRATION FACILITIES WEIGHTED IMPERVIOUSNESS

Sorbara - Lockhart Road
Job Number: 2000
Date: October 2018
Designer Initials: M.T.T.

Southwest Park Filtration Gallery

	Imperviousness	Total Area (ha)	Weighted Imperviousness
201	0.72	2.56	0.29
107	0.73	1.34	0.15
102	0.66	2.48	0.26
TOTAL		6.38	0.70

Volume Req'd in LID for Filtration = 1115 m^3

Hybrid Bioswale

	Imperviousness	Area (ha)	Weighted Imperviousness
103	0.72	4.46	0.40
106	0.54	0.42	0.03
204	0.72	3.25	0.29
TOTAL		8.13	0.71

Volume Req'd in LID for Filtration = 1444 m^3

North Park Filtration Gallery

	Imperviousness	Area (ha)	Weighted Imperviousness
101	0.69	7.38	0.66
202	0.72	0.31	0.03
TOTAL		7.69	0.69

Volume Req'd in LID for Filtration = 1329 m^3

SWM Pond

	Imperviousness	Area (ha)	Weighted Imperviousness
105	0.75	5.04	0.31
203	0.73	4.23	0.25
108	0.50	2.93	0.12
TOTAL		12.20	0.68

Volume Req'd in LID for Filtration = 2075 m^3

FILTRATION FACILITIES
WEIGHTED IMPERVIOUSNESS

Street B and Thicketwood

	Imperviousness	Area (ha)	Weighted Imperviousness
104	0.71	1.31	0.71
TOTAL		1.31	0.71

Volume Req'd in LID for Filtration = 233 m^3

WATER BALANCE LID SIZING

LID Sizing

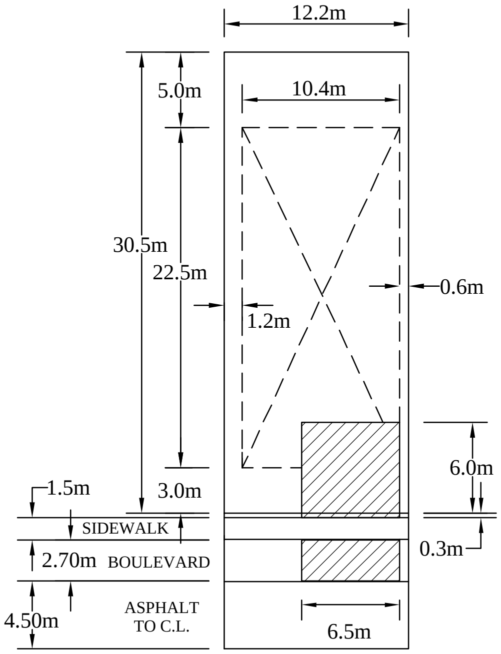
LID	Width (m)	Depth (m)	Porosity	Cross Sectional Area (m^2)
Hybrid Bioswale	4.4	1.2	0.4	2.10
Rain Garden in Buffer	2.8	1.0	0.4	1.12
Filtration Gallery	-	1.0	0.4	-

Preliminary LID Volume Calculation for 25 mm of Impervious Areas

Catchment Areas	Contributing Catchments	Remaining Volume to be Treated from Upstream Catchment (m^3)	Required Volume (m^3)	Length of Rain Garden (m)	Length of Exfiltration Trench (m)	Estimated Available Area of Filtration Gallery (m^2)	Estimated Available Volume of SWM Facility Wetland (m^2)	Volume Provided (m^3)	Remaining Volume to be Treated in Downstream Catchment (m^3)
Southwest Park Filtration Gallery	201, 107 & 102	-	1115			1463.8		**586**	**530**
North Park Filtration Gallery	202 & 101	-	1329			2739.6		**1096**	**233**
Hybrid Bioswale	103, 106 & 204	530	1444	938.0				**1974**	**0**
SWM Pond	105 & 203	233	2075				2708.0	**2708**	**0**
Street B and Thicketwood	104	-	233	208.4				**233**	**0**
TOTAL			**6196**					**6596**	

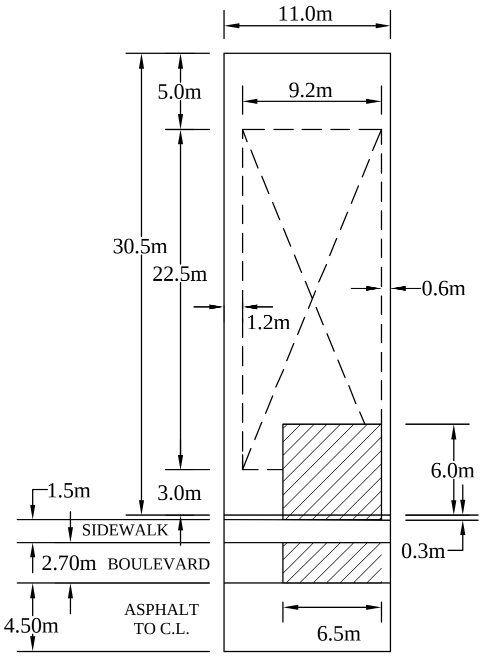
As shown, 25 mm of filtration can be achieved with the proposed LIDs. It is noted that the size and location of the proposed LIDs is to be confirmed at detailed design.

TYPICAL 12.2m x 30.5m SINGLE DETACHED DWELLING WITH 18.0m ROW



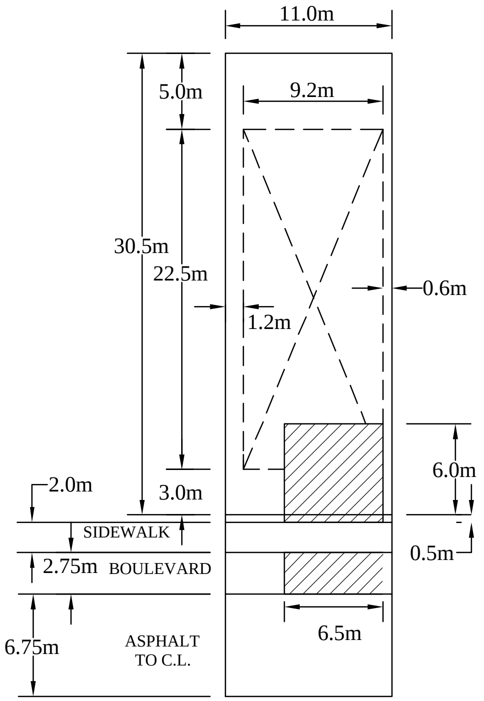
CALCULATED PERCENT IMPERVIOUS = 72%

TYPICAL 11.0m x 30.5m SINGLE DETACHED DWELLING WITH 18.0m ROW



CALCULATED PERCENT IMPERVIOUS = 72%

TYPICAL 11.0m x 30.5m SINGLE DETACHED DWELLING WITH 24m ROW



CALCULATED PERCENT IMPERVIOUS = 74%

NOTE: SETBACKS PER ZONING (APPENDIX B), MAX LOT COVERAGE = 60%

LEGEND:

▨	DRIVEWAY
⊠	BUILDING ENVELOPE

BARRIE LOCKHART ROAD - SORBARA

TYPICAL LAYOUT FOR SINGLE DETACHED DWELLING - 18m R.O.W.

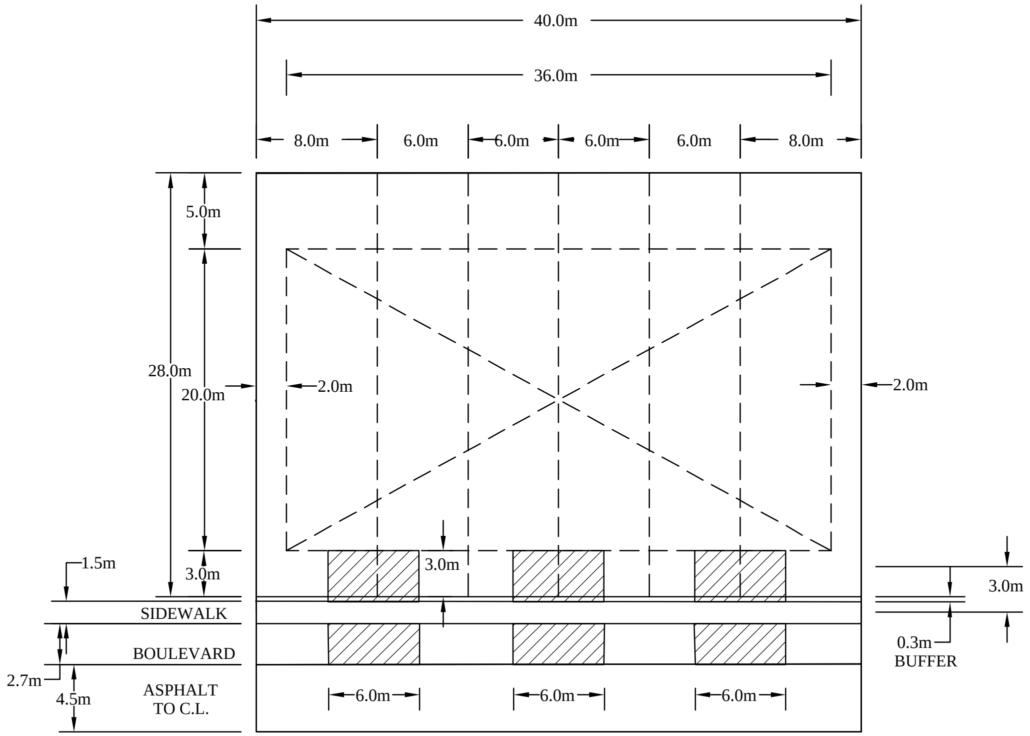
SCS consulting group ltd

30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

DRAWING BY: M.T.
CHECKED BY: J.M.P.
SCALE: 1:500
DATE: OCTOBER 2018
PROJECT No: 2000
FIGURE No: C-1

File: P:\2000 Barrie Lockhart Road - Sorbara\Drawings\FSP\Fig\Report Figures\2000P-LOTS-C-1-(C3D).dwg - Revised by <DLIAO> : Wed, Aug 22 2018 - 1:50pm

TYPICAL STREET
TOWNHOUSE DWELLING ON
A 18m ROW



*CALCULATED PERCENT IMPERVIOUS = 72%
NOTE: SETBACKS PER ZONING (APPENDIX B), MAX LOT COVERAGE = 70%

LEGEND:

▨ DRIVEWAY ☒ BUILDING ENVELOPE

BARRIE LOCKHART ROAD - SORBARA

TYPICAL LAYOUT FOR TOWNHOUSE - 18m R.O.W.

SCS consulting group ltd

30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

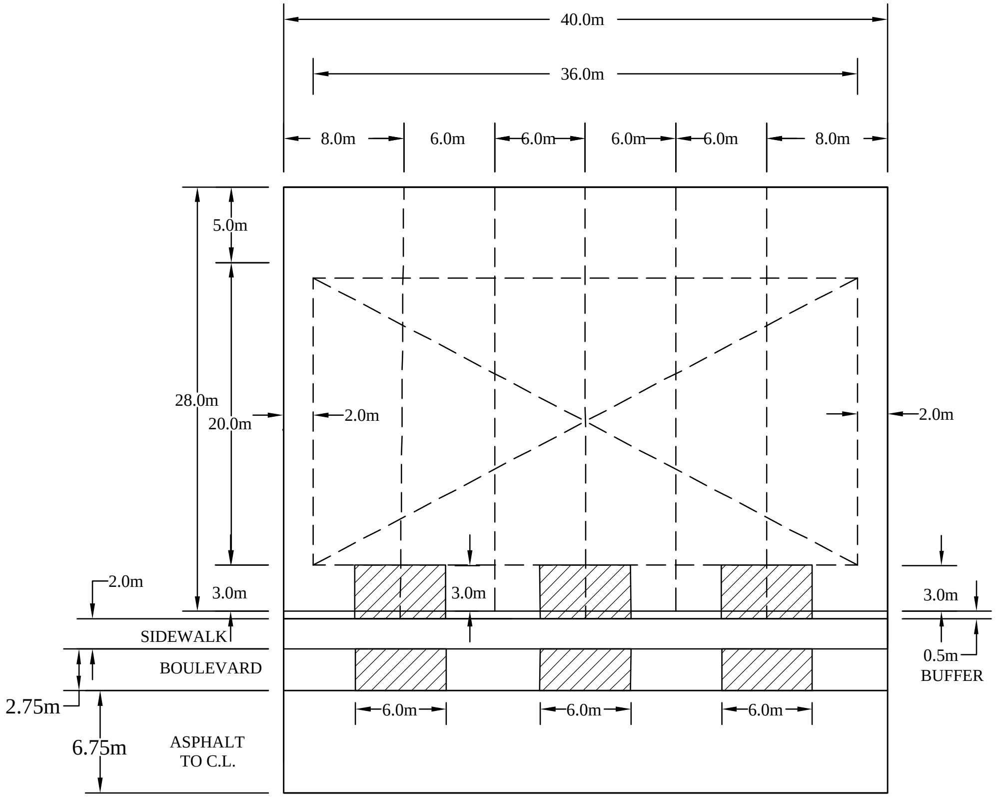
DRAWING BY:	M.T.	CHECKED BY:	J.M.P.
SCALE:	1:500	DATE:	OCTOBER 2018

PROJECT No: 2000

FIGURE No: C-2

File: P:\2000 Barrie Lockhart Road – Sorbara\Drawings\FSP\Fig\Report Figures\2000P-LOTS-C-2.dwg – Revised by <DLIAO> : Wed, Aug 22 2018 – 5:19pm

TYPICAL STREET TOWNHOUSE DWELLING ON A 24m ROW



*CALCULATED PERCENT IMPERVIOUS = 74%

NOTE: SETBACKS PER ZONING (APPENDIX B), MAX LOT COVERAGE = 70%

LEGEND:

▨ DRIVEWAY

☒ BUILDING ENVELOPE

BARRIE LOCKHART ROAD - SORBARA

TYPICAL LAYOUT FOR TOWNHOUSE - 24m R.O.W.

SCS consulting group ltd

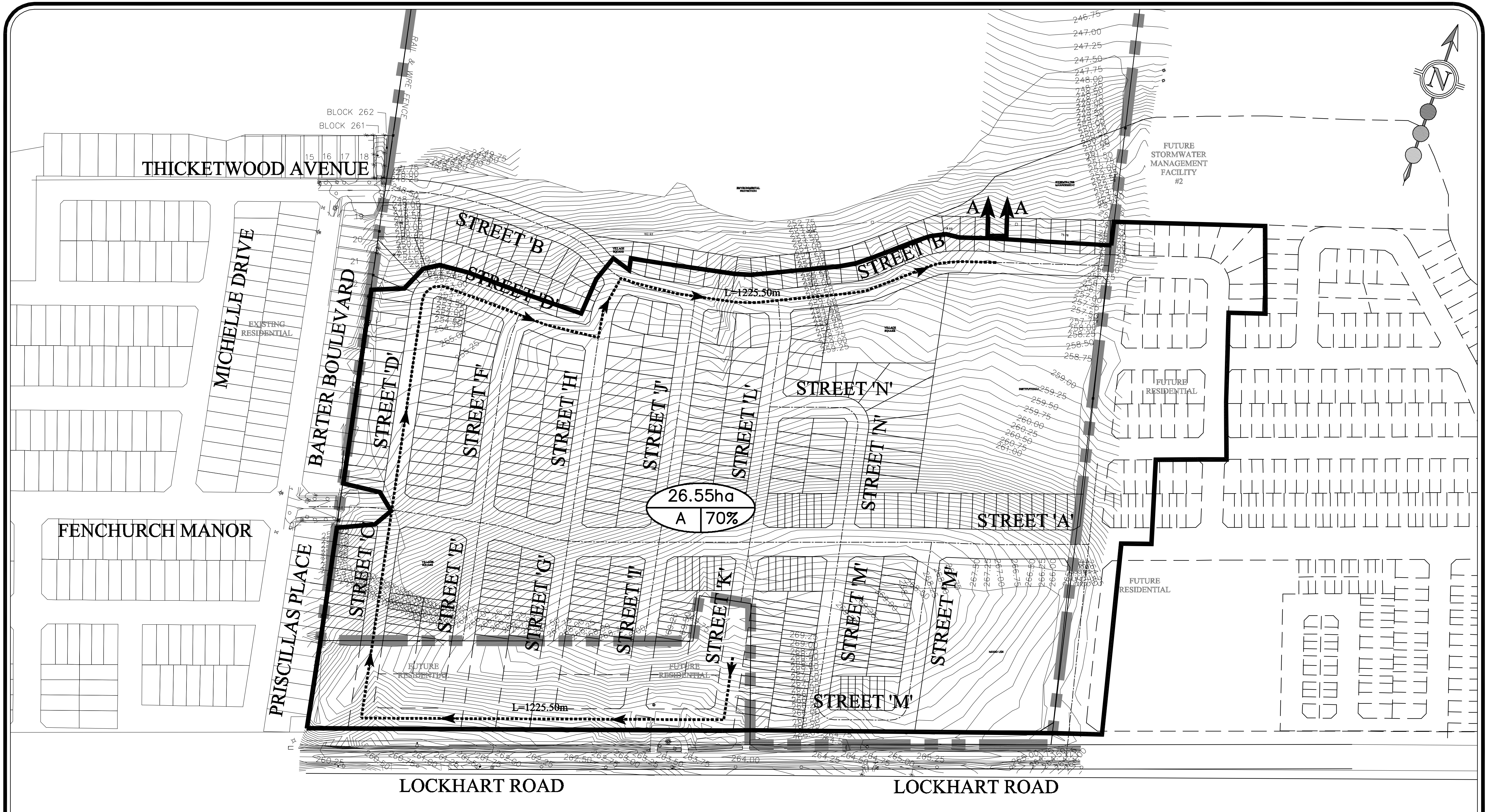
30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

DRAWING BY:	M.T.	CHECKED BY:	J.M.P.
SCALE:	1:500	DATE:	OCTOBER 2018

PROJECT No: 2000

FIGURE No: C-3

File: P:\2000 Barrie Lockhart Road - Sorbara\Drawings\FSP\Fig\Report Figures\2000P-LOTS-C-2.dwg - Revised by <DLIAO> : Wed, Aug 22 2018 - 5:19pm



*NOTE: LAYOUT IS SCHEMATIC ONLY, DETAILS TO BE PROVIDED AT DETAILED DESIGN STAGE.

LEGEND:

▬ ▬ ▬ LIMIT OF DEVELOPMENT

23.84ha / A / 70%
DRAINAGE AREA (HECTARES)
PERCENT (%) IMPERVIOUS
CATCHMENT ID

A ↑↑ A OVERLAND FLOW CROSS SECTION LOCATION

270.25 EXISTING CONTOUR

DRAINAGE BOUNDARY

WATER FLOW PATH

SCS consulting group ltd
30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

BARRIE LOCKHART ROAD - SORBARA

100 YEAR OVERLAND FLOW

DESIGNED BY:	M.T.T.	CHECKED BY:	J.M.P.
SCALE:	1:3000	DATE:	OCTOBER 2018

PROJECT No: 2000

FIGURE No: C-4

File: P:\2000 Barrie Lockhart Road – Sorbara\Drawings\FSP\Fig\Report Figures\2000P–100 Year Overland Flow.dwg – Revised by <MTREMBLAY> : Mon, Oct 01 2018 – 6:02pm

OVERLAND FLOW CALCULATIONS

Catchment A	**Return Period**
	5 Year
Area (ha)=	26.55
Return Period Factor =	1.00
Runoff Coeff. =	0.71
T_c (min)=	20.21
a =	**853.608**
b =	**4.70**
c =	**0.766**
Intensity (mm/hr) =	72.71
Runoff (m^3/s) =	**3.780**

(Assumes initial Tc of 10 minutes and 1225.5m flowing at 2 m/s)

Catchment A	**Return Period**
	100 Year
Area (ha)=	26.55
Return Period Factor =	1.25
Runoff Coeff. =	0.88
T_c (min)=	20.21
a =	**1426**
b =	**5.3**
c =	**0.759**
Intensity (mm/hr) =	122.14
Runoff (m^3/s) =	**7.937**

*Area and Runoff coefficient per **Figure C-4**
*IDF parameters per City of Barrie

5 Year Flow (Catchment A)

Q_{5yr} (m^3/s) = 3.780

100 Year Flow(Catchment A)

Q_{100yr} (m^3/s) = 7.937

Required 100 Year Capture Capacity

$Q_{100-5yr}$ (m^3/s) = 4.157

Section A-A

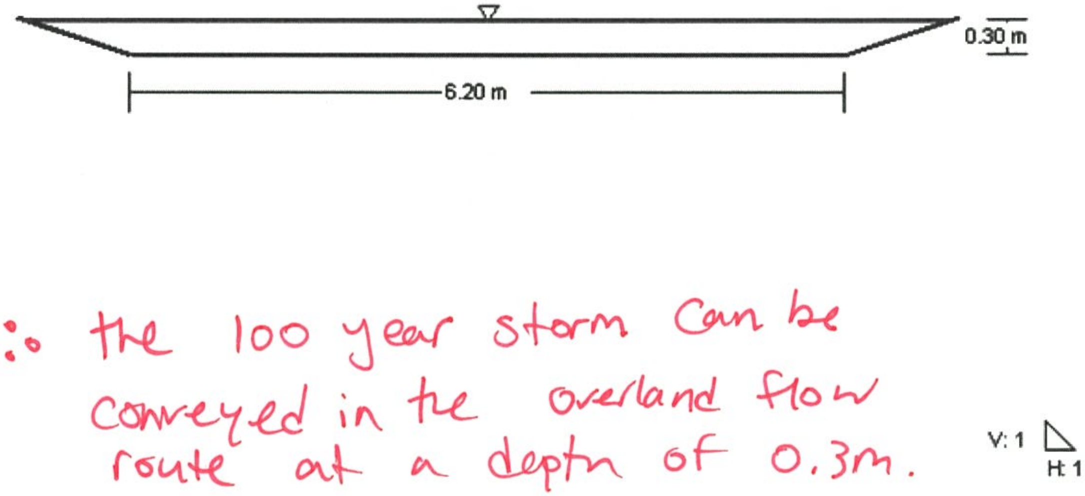
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	2.00	%
Normal Depth	0.30	m
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Bottom Width	6.20	m
Discharge	4.157	m³/s

Cross Section Image



∴ the 100 year storm can be conveyed in the overland flow route at a depth of 0.3m.

Section A-A

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030	
Channel Slope	2.00	%
Left Side Slope	3.00	m/m (H:V)
Right Side Slope	3.00	m/m (H:V)
Bottom Width	6.20	m
Discharge	4.157	m³/s

Results

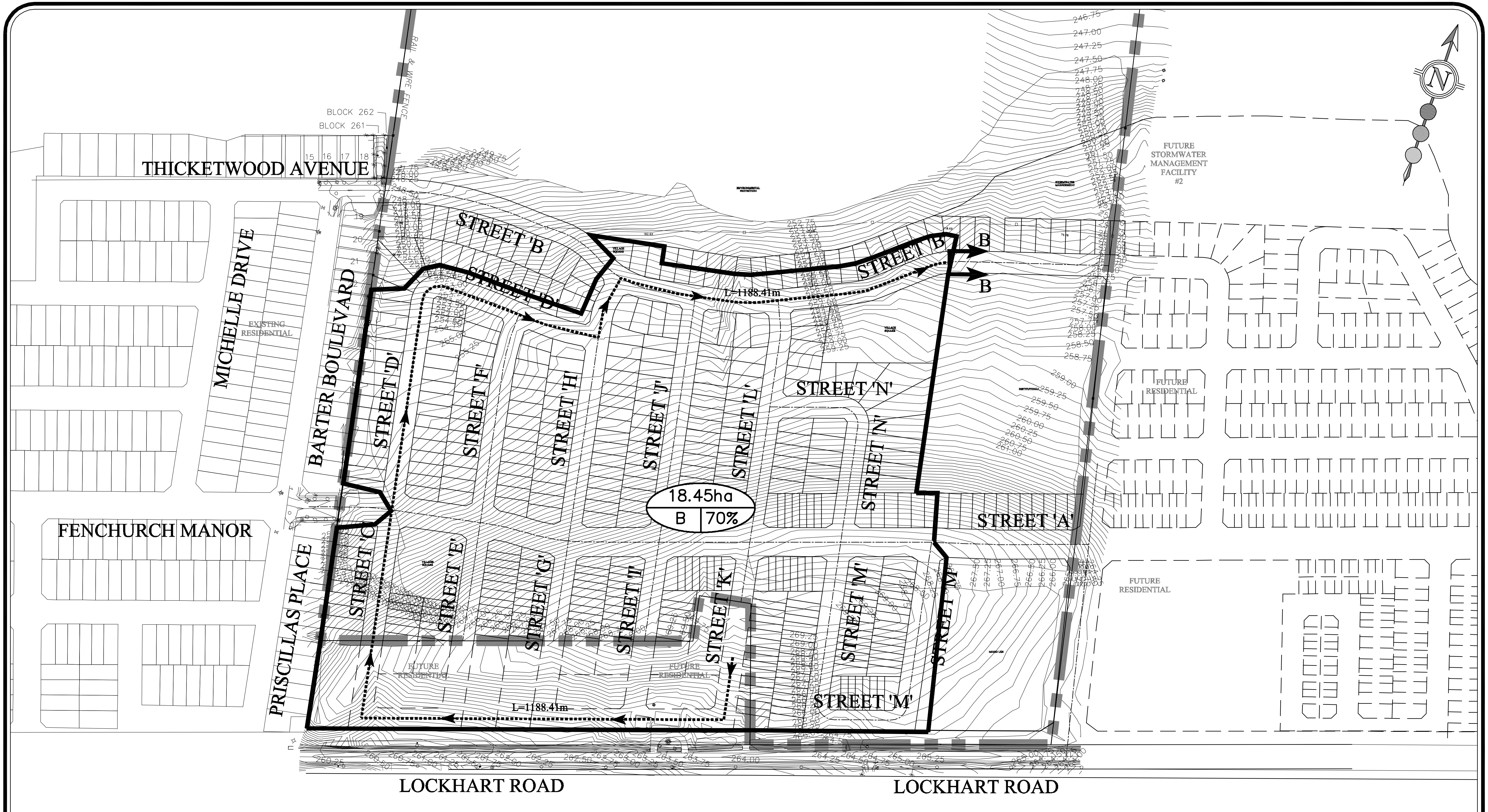
Normal Depth	0.30	m
Flow Area	2.14	m²
Wetted Perimeter	8.11	m
Top Width	8.01	m
Critical Depth	0.34	m
Critical Slope	0.01347	m/m
Velocity	1.94	m/s
Velocity Head	0.19	m
Specific Energy	0.49	m
Froude Number	1.20	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.000	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.30	m
Critical Depth	0.34	m
Channel Slope	0.02000	m/m
Critical Slope	0.01347	m/m



*NOTE: LAYOUT IS SCHEMATIC ONLY, DETAILS TO BE PROVIDED AT DETAILED DESIGN STAGE.

LEGEND:

LIMIT OF DEVELOPMENT

23.84ha
A | 70%

DRAINAGE AREA (HECTARES)
PERCENT (%) IMPERVIOUS
CATCHMENT ID

OVERLAND FLOW CROSS SECTION LOCATION

270.25 EXISTING CONTOUR

DRAINAGE BOUNDARY

WATER FLOW PATH

SCS consulting group ltd
30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

BARRIE LOCKHART ROAD - SORBARA

100 YEAR OVERLAND FLOW

DESIGNED BY:	M.T.T.	CHECKED BY:	J.M.P.
SCALE:	1:3000	DATE:	OCTOBER 2018

PROJECT No: 2000

FIGURE No: C-5

File: P:\2000 Barrie Lockhart Road - Sorbara\Drawings\FSP\Fig\Report Figures\2000P-100 Year Overland Flow.dwg - Revised by <MTREMBLAY> : Mon, Oct 01 2018 - 6:02pm

OVERLAND FLOW CALCULATIONS

Catchment B	**Return Period**
	5 Year
Area (ha)=	18.45
Return Period Factor =	1.00
Runoff Coeff. =	0.71
T_c (min)=	19.90
a =	**853.608**
b =	**4.70**
c =	**0.766**
Intensity (mm/hr) =	73.41
Runoff (m^3/s) =	**2.652**

(Assumes initial Tc of 10 minutes and 1188.41m flowing at 2 m/s)

Catchment B	**Return Period**
	100 Year
Area (ha)=	18.45
Return Period Factor =	1.25
Runoff Coeff. =	0.88
T_c (min)=	19.90
a =	**1426**
b =	**5.3**
c =	**0.759**
Intensity (mm/hr) =	123.28
Runoff (m^3/s) =	**5.568**

*Area and Runoff coefficient per **Figure C-5**
*IDF parameters per City of Barrie

5 Year Flow (Catchment A)
Q_{5yr} (m^3/s) = 2.652

100 Year Flow(Catchment A)
Q_{100yr} (m^3/s) = 5.568

Required 100 Year Capture Capacity
$Q_{100-5yr}$ (m^3/s) = 2.915

Section B-B

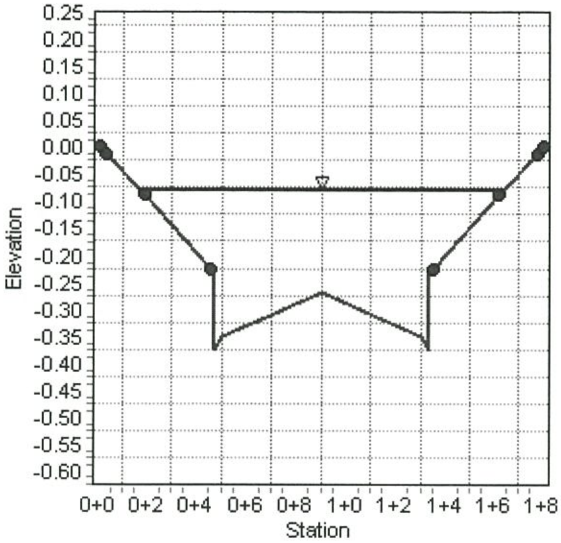
Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.50	%
Normal Depth	0.29	m
Discharge	2.915	m³/s

Cross Section Image



∴ The overland flow for the 100 year storm can be conveyed in the right-of-way at a depth of 0.2m. It is noted that the boulevard is sloped at 5%.

Section B-B

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.50	%
Discharge	2.915	m³/s

Section Definitions

Station (m)	Elevation (m)
0+0.000	0.00
0+0.300	-0.02
0+1.800	-0.09
0+4.500	-0.23
0+4.650	-0.23
0+4.700	-0.38
0+5.000	-0.35
0+9.000	-0.27
1+3.000	-0.35
1+3.300	-0.38
1+3.350	-0.23
1+3.500	-0.23
1+6.200	-0.09
1+7.700	-0.02
1+8.000	0.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+0.000, 0.00)	(0+0.300, -0.02)	0.025
(0+0.300, -0.02)	(0+1.800, -0.09)	0.013
(0+1.800, -0.09)	(0+4.500, -0.23)	0.025
(0+4.500, -0.23)	(1+3.500, -0.23)	0.013
(1+3.500, -0.23)	(1+6.200, -0.09)	0.025
(1+6.200, -0.09)	(1+7.700, -0.02)	0.013

Section B-B

Input Data

Start Station	Ending Station	Roughness Coefficient
(1+7.700, -0.02)	(1+8.000, 0.00)	0.025

Results

Normal Depth	0.29	m
Elevation Range	-0.375 to 0.000 m	
Flow Area	2.49	m²
Wetted Perimeter	15.015	m
Top Width	14.788	m
Normal Depth	0.29	m
Critical Depth	0.28	m
Critical Slope	0.00612	m/m
Velocity	1.17	m/s
Velocity Head	0.07	m
Specific Energy	0.36	m
Froude Number	0.91	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	m
Length	0.000	m
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	m
Profile Description		
Profile Headloss	0.00	m
Downstream Velocity	Infinity	m/s
Upstream Velocity	Infinity	m/s
Normal Depth	0.29	m
Critical Depth	0.28	m
Channel Slope	0.00500	m/m
Critical Slope	0.00612	m/m

SCS consulting group ltd

MEETING MINUTES

File #:	**2000**
Date:	**July 6, 2018**

Project:	**400 Lockhart Road (Barrie Lockhart Road GP Inc.)**
Purpose:	**Design Charrette**
Date/Time of Meeting:	**June 28, 2018/10:00 AM**
Location:	**City of Barrie**

	Recipient(s):	Email:
Attendees:	Frank Palka, City of Barrie	frank.palka@barrie.ca
	Andrew Gameiro, City of Barrie	andrew.gameiro@barrie
	Bill McGregor, City of Barrie	bill.mcgregor@barrie.ca
	Barb Perrault, City of Barrie	barb.perreault@barrie.ca
	Caroline Hawson, LSRCA	c.hawson@LSRCA.on.ca
	Rob Baldwin, LSRCA	r.baldwin@LSRCA.on.ca
	Melinda Bessey, LSRCA	m.bessey@LSRCA.on.ca
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	Scott Young, Sorbara Group	syoung@sorbara.com
	Ray Duhamel, Jones Consulting Group	rduhamel@jonesconsulting.com
	Marc Tremblay, SCS Consulting Group	mtremblay@scsconsultinggroup.com
	John Priamo, SCS Consulting Group	jpriamo@scsconsultinggroup.com
Absentees:	Mr. Dwight Smikle, R.J. Burnside	dwight.smikle@rjburnside.com

The following is considered to be a true and accurate record of the items discussed. Any errors or omissions in these minutes should be provided in writing to the author immediately.

Item:

1.0 Existing Site Conditions

1.1 Site generally slopes down at 2-5% from a high point located in the south.

1.2 Soils consist of clayey silt, to sand/silt till with hydraulic conductivity ranging from 35 to 69 mm/hr.

1.3 Groundwater ranges from 7 m below existing grade to at grade.

2.0 Sub-watershed Impact Study (SIS) Criteria

Item:

2.1 School block assumed to provide best efforts infiltration on-site.

2.2 25 mm of filtration over impervious areas is required.

2.3 Best efforts are required for infiltration.

2.4 "Enhanced" TSS Protection

2.5 Phosphorus – Greater of:

- Match existing loading rates
- 80% Reduction in Phosphorus Loading Rates
- Goal is "zero" export

3.0 Proposed Conditions

3.1 Grading to conform generally to SIS. Majority of site to drain to SWMF#2 with a portion of Street B draining to Thicketwood Avenue.

3.2 Proposed elevations generally more than 2 metres above groundwater elevation in the southeast corner of the development and between zero to 2 metres above proposed groundwater elevations on the majority of the development. A figure was presented showing groundwater elevations vs proposed elevation.

4.0 Potential Low Impact Developments (LIDs)

4.1 Rain Garden/Bioswale – Can be lined or unlined. Accept surface drainage. Appropriate for open space blocks, side flankages and single loaded roads.

4.2 Catchbasin Exfiltration trench – Below ground trench where soils can support infiltration and groundwater. City staff noted that issues exist as these systems are more difficult to maintain than those accepting drainage at the surface drainage.

5.0 Stormwater Management Solutions

5.1 A suite of potential LIDs was presented illustrating all possible locations for LIDs throughout the development. As shown, potential infiltration-based LIDs are present on the southeast corner of the development where groundwater is sufficiently low. The park, pond and buffer area show filtration galleries below grade with pre-treatment to be provided via an MTD (OGS or filter based). Potential bioswale/rain gardens are present on side flankages throughout the development as well.

5.2 Potential filtration volume to be required/provided in SWMF #2 ranges from 4,000 to 6,000 m^3.

5.3 Three options discussed for SWMF #2:

- Constructed Wetland (required permanent pool = 2,880 m3)
- Dry Pond with Below Grade Lined, Biofiltration or Sand Filter
- Hybrid of Options 1 and 2

6.0	**Stormwater Management Solution Discussions**
6.1	Design of LIDs proposed in park areas to be coordinated with Landscape Architect at the FSR stage to ensure any proposed LIDs in park do not conflict with proposed park infrastructure.
6.2	Any pre-treatment unit (i.e. OGS) to be located in roadway rather than in park land.
6.3	Backwater analysis to be provided at detailed design to show no issues associated with Lover's Creek and any potential pond block – based LIDs.
6.4	No opposition posed to LIDS based in the municipal ROW. However, it is understood that centralized facilities and LID's in buffer areas are preferred.
6.5	The preferred LID location is in the buffer running along the north limit of the development. This LID to be directly connected to storm sewers and will provide filtration rather than infiltration due to high groundwater and depth of required treatment.
6.6	LID design to be coordinated with landscape architect to ensure a natural esthetic in the buffer, incorporating buffer plantings and potential trail.
6.7	Surface drainage will also be maximized to LID in the buffer. It was noted that the LID in the buffer immediately east of Thicketwood would provide all required stormwater control for the small area not being conveyed to SWMF #2.
6.8	The area in the southeast should be maximized for water balance where feasible as groundwater conditions are favorable. However, it is noted that this is the high point of the site and will therefore receive minimal drainage.

It is noted that at the conclusion of the Design Charrette, all parties agreed to the potential for SWMF to be a hybrid or constructed wetland. In addition, the combination of wetland, linear LID's in the buffer and LID's in park blocks was the preferred alternative for providing volume control.

SCS Consulting Group Ltd.

John Priamo, P.Eng.
jpriamo@scsconsultinggroup.com

Attachments: Presentation and Supporting Materials as Attached

P:\2000 Barrie Lockhart Road - Sorbara\Correspondence\Minutes of Meetings\2018 07(Jul)06 - Meeting Minutes\2000 - Design Charrette Minutes _ MT.docx

APPENDIX D

SANITARY FLOW CALCULATIONS

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Sanitary Design Sheet
Sorbara
Lockhart Road
Barrie

Project: Sorbara
Project No. 2000
Date: October 10 2018
Designed By: M.T.
Reviewed By: J.M.P.

Minimum Sewer Diameter (mm) = 200
Mannings n = 0.013
Minimum Velocity (m/s) = 0.75
Maximum Velocity (m/s) = 3

Avg. Domestic Flow (l/cap/day) = 225
Infiltration Rate (l/s/ha) = 0.1
Max. Harmon Peaking Factor = 3.8
Min. Harmon Peaking Factor = 1.5

LOCATION			RESIDENTIAL						INDUSTRIAL/COMMERCIAL/INSTITUTIONAL				FLOW CALCULATIONS							
STREET	MANHOLE		AREA	ACCUM. AREA	UNITS	DENSITY		RESIDENTIAL POPULATION	AREA	POPULATION DENSITY	FLOW RATE	ACCUM. EQUIV. POPULATION	INFILTRATION	TOTAL ACCUM. POPULATION	AVG. DOMESTIC FLOW	ACCUM. AVG. DOMESTIC FLOW	PEAKING FACTOR	PEAKED RESIDENTIAL FLOW	ICI FLOW	TOTAL FLOW
	FROM	TO	(ha)	(ha)	(#)	PER UNIT (p/unit)	PER HA (p/ha)		(ha)	(p/ha)	(l/s/ha)		(L/s)		(L/s)	(L/s)		(L/s)	(L/s)	(L/s)
External to E2 - Singles			8.04		95	3.13		297	0	0	0	0	0.8	297	0.8	0.8	3.80	2.9	0.0	3.7
External to E2 - Mixed Use			2.18		262	2.34		613	0	0	0	0	0.2	613	1.6	1.6	3.80	6.1	0.0	6.3
External to E2 - Townhomes			6.2		123	2.34		288	0	0	0	0	0.6	288	0.7	0.7	3.80	2.8	0.0	3.5
Singles to E2			12.45		243	3.13		761	0	0	0	0	1.2	761	2.0	2.0	3.80	7.5	0.0	8.8
Mixed Use to E2			1.36		162	2.34		379	0	0	0	0	0.1	379	1.0	1.0	3.80	3.8	0.0	3.9
Institutional to E2			0		0			0	2.41	0	0.32	0	0.2	0	0.0	0.0	3.80	0.0	0.8	1.0
TOTAL			**30.23**		**885**			**2338**	**2.41**		**0.32**		**3.3**	**2338**	**6**	**6**	**23**	**23**	**0.8**	**27.2**
External to E1 - Townhomes			3.24		56	2.34		131	0	0	0	0	0.3	131	0.3	0.3	3.80	1.3	0.0	1.6
Towns and Future Towns to E1			5.68		151	2.3		347	0	0	0	0	0.6	347	0.9	0.9	3.80	3.4	0.0	4.0
Mixed Use to E1			0.21		24	2.3		55	0	0	0	0	0.0	55	0.1	0.1	3.80	0.5	0.0	0.6
Singles to E1			0.74		14	3.13		44	0	0	0	0	0.1	44	0.1	0.1	3.80	0.4	0.0	0.5
TOTAL			**9.87**		**245**			**577**					**1.0**	**577**	**1.5**	**1.5**	**15.2**	**5.7**		**6.7**

APPENDIX E

WATER DISTRIBUTION ANALYSIS

M E S
Municipal Engineering
Solutions

October 22, 2018 Project No. 17002-40

Sent via email
Mr. John Priamo
SCS Consulting Group
30 Centurian Drive, Suite 100
Markham ON
L3R 8B8

Subject: Sobara Barrie Watermain Analysis
City of Barrie

Dear Mr. Priamo,

We are pleased to submit our report entitled "Sobara Barrie Watermain Analysis" outlining the results of our water distribution analysis for a residential development in the City of Barrie.

This development was incorporated into an Infowater sub-model of the development site and modeled utilizing the design information provided to Municipal Engineering Solutions. The findings of our analysis are summarized in the following report.

We trust you find this report satisfactory. Should you have any questions or require further clarification, please call.

Yours truly,

Municipal Engineering Solutions

John C. Bourrie

Per: John C. Bourrie, P.Eng.

/LMC

File Location: D:\Projects\2018\18-020 Barrie FSR 17002-40\3.0 Report\Draft Report\17002-40_Barrie Watermain Analysis_20180925.docx

55 Gilbank Drive, Aurora, Ontario L4G 6H9
Tel: 905.726.1016 Cell: 416.434.0186 Fax: 905.726.1225

SOBARA BARRIE

WATERMAIN ANALYSIS

PREPARED BY:

MUNICIPAL ENGINEERING SOLUTIONS

FOR:

SCS CONSULTING GROUP
October 2018

Project Number: 17002-40

TABLE OF CONTENTS

APPENDICES

Appendix A	Demands
Appendix B	Model Results

Section 1 – INTRODUCTION

Municipal Engineering Solutions ("MES") was retained by SCS Consulting Group to conduct a hydraulic water analysis for the proposed Sobara Barrie Development located in the City of Barrie. As part of this hydraulic assessment MES was requested to undertake the following:

1. Calculate/verify water demands for the proposed development using City of Barrie, provincial and industry design standards;
2. Add the subject watermains/development/boundary information to development water model;
3. Run the model to size the subject mains to achieve service criteria during Average Day, and fire flow during Maximum Day demand; and
4. Prepare a Report summarizing the modeling results for agency review and design purposes.

1.1 Development Background

The Sobara Barrie site is located on the north side of Lockhart Road, east of Huronia Road in the City of Barrie. The residential development consists of 257 detached homes, 138 townhomes, a mixed use block and an institutional block. The demands for the site are shown in **Appendix A**. The proposed development is shown below on **Figure 1**.

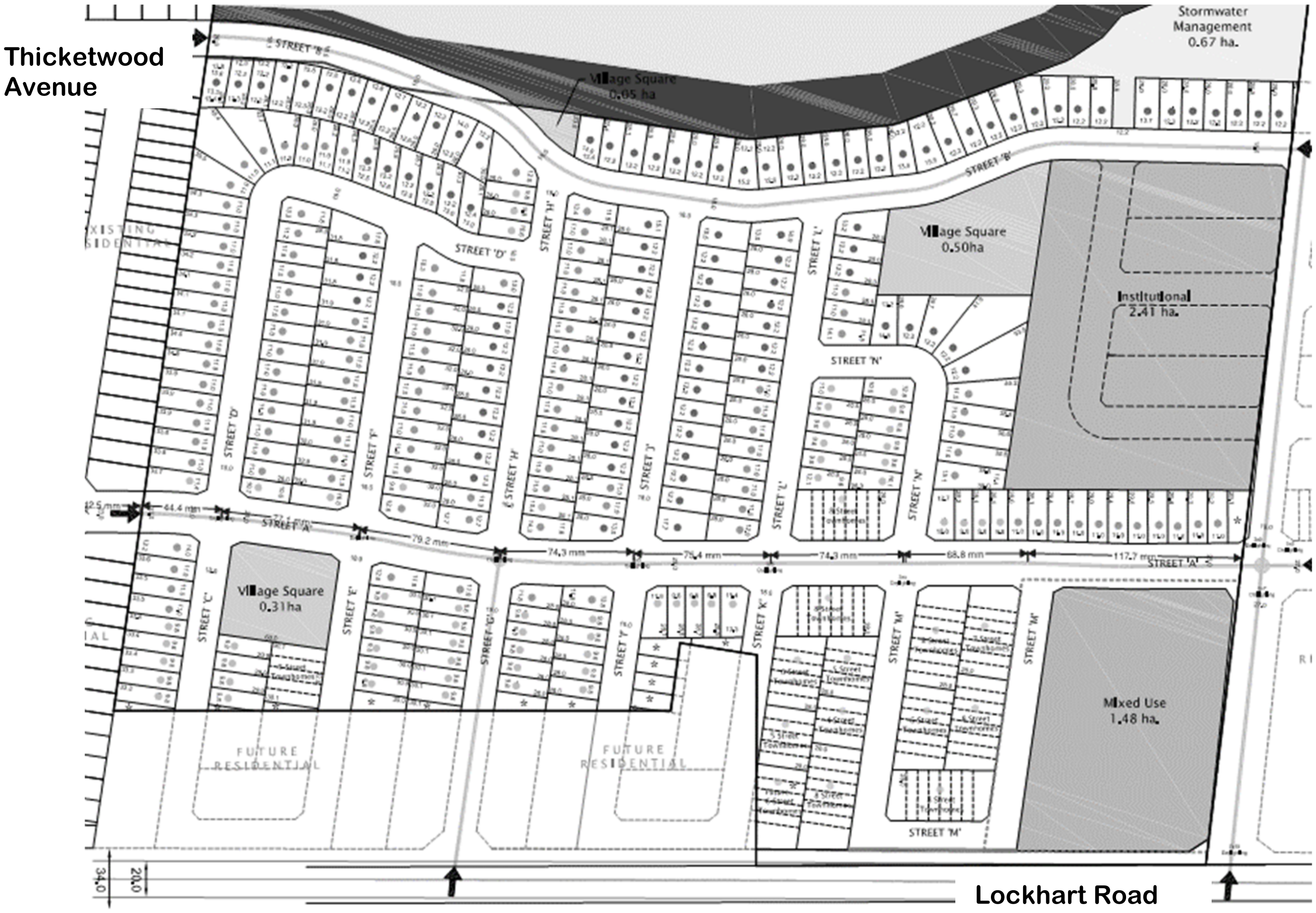


Figure 1 - Proposed Sobara Barrie Development

Section 2 – WATERMAIN DESIGN CRITERIA

The design criteria utilized to estimate the water demands for the hydraulic water model follows general industry standards and is calculated using the design criteria and guidelines outlined in the City of Barrie Water Transmission & Distribution Policies Design Guidelines, the Ministry of the Environment Conservation and Parks (MECP) Watermain Design Criteria, and the Fire Underwriters Survey.

The following sections summarize the specific design criteria used to carry out the hydraulic watermain assessment for this development.

2.1 Equivalent Population Densities & Water Design Factors

To calculate the equivalent population and water design factors for this development MES used City of Barrie standard population densities as noted in the *"Water Transmission & Distribution Policies Design Guidelines Dec 2017* and *"Sanitary Sewage Collection System Policies and Design Guidelines Oct 2017"*. **Table 1** summarizes the population densities and **Table 2** summarizes the average daily demand and peaking factors used for this analysis.

Table 1 – Equivalent Population Density

Type of Development	Equivalent Population (Persons/Unit)
Single Family	**3.13**
Townhouse	**2.34**
Apartment	**1.67**

Source: Sanitary Sewage Collection System Policies & Design Guidelines Oct 2017

Table 2 - Water Design Factors

Type of Development	Average Daily Demand (L per capita)	Maximum Daily Demand Peaking Factor
Residential & ICI	**225**	**2.5**

Source: Water Transmission & Distribution Policies & Design Guidelines Dec 2017, Sanitary Sewage Collection System Policies & Design Guidelines Oct 2017 and MECP

Section 3 –FLOW DEMANDS

Utilizing the equivalent population data from Table 1 and the corresponding Average Day, Maximum Day and Peak Hour data from Table 2 the water demands for this development were calculated.

3.1 Equivalent Population Flow Demands

The calculated demands for the development are summarized in **Table 3**. For additional details on the development water demands and assigned demand nodes used in the water model see **Appendix A**.

Table 3 – Water Demand for Sobara Barrie Development

	Average Day Demand (L/S)	Maximum Day Demand (L/S)
Sobara Barrie	**4.35**	**10.88**

3.2 Fire Flow Demands

The fire demands for this development based on the City of Barrie Engineering Design Standards & Criteria, December 2017. The City's 'Preferred' fire flows are shown in **Table 4**.

Table 4 - Fire Flow Requirements

Type of Development	Fire Flow (L/S)
Single Family Homes	76
Townhomes	None
Institutional/Convenience Commercial	114
Industrial/ Commercial	152
Downtown Commercial	189

Source: City of Barrie Engineering Design Standards & Criteria, December 2017

It should be noted that the site will comprise of single family, townhomes, mixed use and institutional buildings and the City's criteria does not have values for townhomes or mixed use units. Many municipalities are moving towards using the Fire Underwriters Survey ("FUS") formula for calculating the fire flow requirements but the formula requires building details that may not be available at the early stages of planning. In the absence of building design information, the FUS does have some minimum flow recommendations based on exposure distances between homes. The most recent City of Barrie "*Water Storage and Distribution Master Plan Oct 2013*" reviewed the City's fire flows. While the report did breakdown the types of land use differently and increased the flows for ICI developments, there still was no value for townhomes so the minimum FUS values have been used within this report for townhomes and mixed use.

In the absence of complete City fire flow requirements, the following fire flows have been assumed for this report are shown in **Table 5** with the source noted.

Table 5 - Fire Flow Requirements

Type of Development	Fire Flow (L/S)
Single Family Homes – Design Criteria	76
Townhomes - FUS	133*
Institutional – Master Plan	167
Commercial/Mixed Use – Master Plan	283*

*value assumed for modeling purposes, required flow to be confirmed when additional building information known.

Source: Engineering Design Standards & Criteria, December 2017, Fire Underwriters Survey, Water Storage and Distribution Master Plan, Oct 2013

3.3 External Demands

The EPANET models provided by the City contained external demands.

Section 4 – OTHER SYSTEM REQUIREMENTS

4.1 System Pressure Requirements

In addition to meeting the various flow requirements, the system must also satisfy minimum and maximum pressure requirements as outlined by the City of Barrie. The City's pressure requirements are outlined in the Design Criteria and stipulate the following:

1. The minimum system pressure shall not be less than 140 kPa (20 psi) at any point in the water system under fire flow conditions.
2. The minimum pressure shall be 350 kPa (50 psi).

3. The maximum pressure shall be 550 kPa (80 psi). Pressure reducing valves may need to be installed on individual services.

4.2 Watermain Sizing

The City of Barrie also stipulates that all watermains are adequately sized to maintain demand flows at the required pressures without causing excessive energy loss or result in water quality decay. The watermain system must therefore be designed to accommodate the Maximum day plus fire demand.

For distribution systems providing fire protection the minimum pipe size shall be 150 mm diameter in accordance with Ministry of the Environment Conservation and Parks (MECP) and NFPA requirements.

To provide appropriate fire protection, reliable supply and pressures the water distribution system should be looped wherever possible to improve supply security and water quality and also have two connections to the existing system where possible.

4.3 Watermain C-Factor

In designing and modeling of the pipes the Coefficient of Roughness (C-Factor) factors are not mentioned in the design criteria. All pipe sizes in the provided water model were assigned the same C-Factor of 130. As all of the pipe in the new development will be PVC, this C-Factor was used for the new pipes. The Coefficient of Roughness assigned to each pipe size in summarized in **Table 6** below.

Table 6 - Hazen-Williams Coefficient of Roughness (C-Factors)

Size of Pipe (Diameter in mm)	Coefficient of Roughness (C)
150 mm	130
200 mm to 250 mm	130
Greater Than 300 mm	130

Source: City of Barrie Water Model

Section 5 – ANALYSIS & MODELING RESULTS

To conduct the hydraulic water analysis for the proposed development the water demands were estimated by MES using the design criteria previously discussed and incorporated the demands into an InfoWater model created for the development using EPANet files provided by the City. The following sections discusses the model setup and results.

5.1 Model Setup

The City of Barrie provided four (4) EPANet models – existing and future planning scenarios for average day and maximum day demands – for the 2S and 3S zones combined. The provided models were imported into InfoWater so that all scenarios were in one model file. InfoWater was chosen as the City's overall water model is currently in InfoWater and it will allow for easier review by the City when the Sobara Barrie development model is forwarded to the City for review and approval.

The Sobara development is located within the City of Barrie water system in the 2S Zone that has top water elevation of 308 m. Elevations within the development range from 245 m to 268 m and should be adequately serviced by this zone.

The development was modeled under two planning scenarios – existing and future for average day and maximum day demands.

New nodes were created to add the flow demands and the elevation information from the development to an Infowater hydraulic water distribution model created for the development. Friction factor for the pipes were assigned according to Table 6.

5.2 Watermain Sizing and System Pressures

The analysis was conducted under existing and future servicing conditions for Average Day, Maximum Day and Maximum day plus Fire demands to size the watermains and meet the pressure requirements. The pipe size and layout are shown in **Appendix B**.

The Sobara Development is located on the north side of Lockhart Road. The existing watermains that could provide supply to the development are:

- 300 mm watermain on Lockhart Road;
- 200 mm watermain along the pedestrian pathway between Thicketwood Avenue and Patrick Drive;
- 150 mm watermains along Thicketwood Avenue and Fenchurch Manor.

The future model included, amongst other future upgrades, 300 mm watermains continuing along Lockhart Road and the future continuation of Fenchurch Manor.

The small section of 150 mm watermain on Thicketwood from the 200 mm watermain on the pedestrian walkway should be upsized to 200 mm. The site may be built out in phases. The phasing of the development should be reviewed to confirm the pipe sizes are appropriate if there are temporary dead end sections. It should be noted that the existing development to the west is comprised of only 150 mm pipes which will limit the amount of fire flow available. Initial phases may be limited to only single family homes. Also the future townhomes blocks and future residential development to the south on the continuation of Streets ‘C’, ‘E’, ‘G’, ‘I’ and ‘K’ were not included as the information is not currently available. The modeling must be reviewed as additional information and timing becomes available.

Modeled service pressures are summarized in **Table 7**. The pressures are higher than the required City of Barrie operating range maximum pressure under average day demands. It should be noted that the City does not request minimum hour or peak hour scenarios to be examined so pressure may be higher under low demand periods and lower during high demand periods. Individual pressure reducing valves will be needed to meet the maximum pressure of 550 kPa (80 psi). Pressures may also drop below 50 psi (345 kPa) during peak demand periods.

Fire flow demand can be met under maximum day conditions under future conditions. The fire flows achieved at the institutional and mixed use nodes are below the required under existing conditions when not all external future supply points are available. As the timing of these blocks is not known, those blocks may not be built until the future pipes are available. As additional building information becomes known, the fire flows can be calculated, and the appropriate design choices made to ensure the FUS flows suit the available flow if the sites are to be built before all external connections are completed.

Detailed pipe and node tables for the various scenarios modelled are attached to this report in **Appendix B**.

Table 7 - Modeled Service Pressures

Scenario	Average Day	Maximum Day	Max. Day + Fire
Existing	55.7 to 87.9 psi (384 to 606 kPa)	54.9 to 87.2 ps i(379 to 602 kPa)	128 to 237 L/s @ 140 kPa
Future	58.3 to 90.5 psi (402 to 624 kPa)	58.2 to 90.3 psi (401 to 623 kPa)	188 to 594 L/s @ 140 kPa

Section 6 – CONCLUSIONS/RECOMMENDATIONS

The proposed watermain layout for the Sobara Barrie development can achieve hydraulic requirements as prescribed by the City of Barrie watermain design criteria as summarized below.

- The service pressures are expected to range from 54.9 to 87.9 psi (379 to 606 kPa) under existing conditions and 58.2 to 90.5 psi (401 to 624 kPa) under future conditions.
- Individual pressure reducing valves will be needed to meet the OBC maximum pressure of 550 kPa (80 psi) criteria.
- Pressures may be below 50 psi (345 kPa) during peak hour conditions.
- The modeling must be reviewed as additional information and timing becomes available for the future blocks and future residential properties to the south of the Sobara development.
- The available fire flow within the site meets or exceeds the fire flow demands as noted in Table 5 at the minimum pressure of 140 kPa based on the proposed watermain configuration under future conditions. Under existing conditions fire flows will not be met at the institutional and mixed use blocks. If the development is built in phases, the available fire flow will need to be confirmed and initial buildout may be limited to constructing only single family homes.
- Should it be determined, based on the final site, building design and discussions with the City, that greater fire flows than those noted in Table 5 are required or fire flows must be calculated using the Fire Underwriters survey formula, the fire flows must be reviewed and updated where necessary. Fire walls and/or sprinkler systems will likely be required for the FUS calculated flow for the townhomes, mixed use and institutional blocks to meet the available modeled flow.
- Required fire flows for all proposed buildings must be confirmed with the appropriate designer (architect or mechanical designer) as well as the City to determine the appropriate level of fire protection required.
- Confirmation and/or changes to the criteria should also be provided to and reviewed with MES prior to the finalization of the detailed design drawings and construction of the watermain system. Final design parameters are to be provided to MES prior to construction for further review to confirm that the actual (final) site conditions and building design(s) reflect those modeled by MES within this report.
- This report, including all modeling assumptions used, is to be submitted to and reviewed by the water operating authority (municipality) to confirm that the modeling parameters used are acceptable to the operating authority and/or confirm if modified domestic or fire flow requirements are required or should be implemented for this particular development.

Appendix A

Demands

Barrie Design Criteria

Water Transmission & Distribution Policies Design Guidelines Dec 2017 (unless otherwise stated)

Equivalent Population by Unit

(Sanitary Sewage Collection System Policies and Design Guidelines Oct 2017 for population and Average Day Demand)

Type of Development	Equivalent Population Density
	(Person/Unit)
Single Family or Semi-Detached	3.13
Townhouse	2.34
Apartment	1.67

Equivalent Population by Area

Type of Development	Equivalent Population Density	Average Day Demands
	(Person/Hectare)	*(m3/ha/day)*
Single Family, Duplex, Semis	78.25	
Triplex and 4-plex	81.9	
Townhouse	110	
Apartments (>6 stories)	500	
Light Commercial Areas	124	28.00
Community Services	124	28.00
Light Industrial Areas	155	35.00
Hospitals (persons/bed)		

Water Design Factors

Average Daily Demand (m3/capita)	0.225	
Maximum Daily Demand P.F.	2.5	MOECC
Maximum Hourly Demand P.F.		
Residential		
I/C/I		

Cofficient of Roughness

Size of Pipe (mm Dia.)	Coefficient of Roughness (C)
150	100
200-250	110
300-600	120
Over 600	130

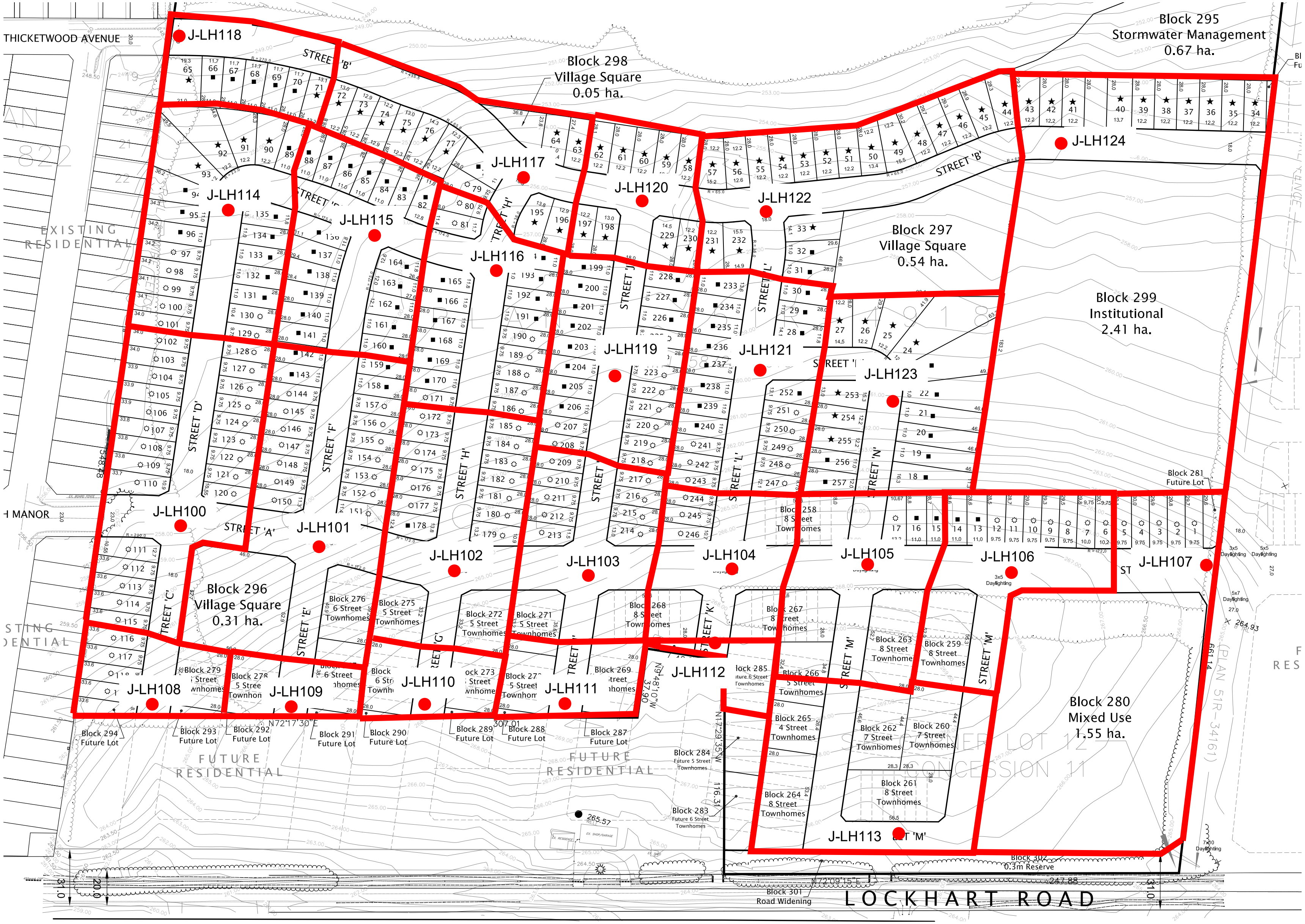
Minimum Pipe Size

Type of Development	Size of Pipe (mm Dia.)
Designed for Fire Protection	150
Domestic supply only	75

Working Pressures

Parameter	Pressure
Normal Condition	
Minimum Pressure	345kPa (50 psi)
Maximum (Building Code)	550 kPa (80 psi)
Maximum	620 kPa (90 psi)
Fire Flow Conditions	
Minimum Pressure	140 kPa (20 psi)

Demand Layout



Water Demand
Lockhart, Innisfil, ON
October 21, 2018

Municipal Engineering Solutions

Node	Phase	Elevation	Type of Development						Equivalent Population		Demands		
			Single Family	Townhouse	Apartments	Mixed Use	Commercial	Institutional	Total Population	Total Population	ADD	MDD	Fire Flow Demands
		(m)	*(units)*	*(units)*	*(units)*	(ha)	*(ha)*	*(ha)*	*(Residential)*	*(ICI)*	*(L/s)*	*(L/s)*	*(L/s)*
J-LH100		257.06	23						72	0	0.19	0.47	76
J-LH101		260.70	18	8					75	0	0.20	0.49	133
J-LH102		261.30	14	10					67	0	0.18	0.44	133
J-LH103		263.40	9	8					47	0	0.12	0.31	133
J-LH104		263.80	3	12					37	0	0.10	0.24	133
J-LH105		266.80	3	19					54	0	0.14	0.35	133
J-LH106		268.05	9	8					47	0	0.12	0.31	133
J-LH107		263.50	5			1.55			186	0	0.48	1.21	283
J-LH108		259.60	4	5					24	0	0.06	0.16	133
J-LH109		261.80		9					21	0	0.05	0.14	133
J-LH110		261.90		11					26	0	0.07	0.17	133
J-LH111		263.78		12					28	0	0.07	0.18	133
J-LH112		266.73							0	0	0.00	0.00	
J-LH113		265.75		36					84	0	0.22	0.55	133
J-LH114		256.00	20						63	0	0.16	0.41	76
J-LH115		255.30	18						56	0	0.15	0.37	76
J-LH116		254.85	18						56	0	0.15	0.37	76
J-LH117		245.40	12						38	0	0.10	0.24	76
J-LH118		249.78	7						22	0	0.06	0.14	76
J-LH119		258.70	21						66	0	0.17	0.43	76
J-LH120		254.00	9						28	0	0.07	0.18	76
J-LH121		258.15	20						63	0	0.16	0.41	76
J-LH122		253.65	19						59	0	0.15	0.39	76
J-LH123		261.15	15						47	0	0.12	0.31	76
J-LH124		252.85	10					2.41	31	374	1.05	2.64	167
J-LH125		255.00							0	0	0.00	0.00	
J-LH126		264.60							0	0	0.00	0.00	
Total			**257**	**138**	**0.00**	**1.55**	**0.00**	**2.41**	**1298**	**374**	**4.35**	**10.88**	

Appendix B

Model Results

Average Day

Node Table

ID	Demand (L/s)	Elevation (m)	Head (m)	Pressure (psi)
2S607	0.00	260.68	307.25	66.20
2S619	0.00	256.42	307.26	72.27
2S633	0.00	248.50	307.28	83.56
2S645	0.03	248.50	307.28	83.56
B36	0.00	263.00	307.25	62.91
B37	0.00	262.25	307.25	63.97
J-LH100	0.19	257.06	307.25	71.36
J-LH101	0.20	260.70	307.25	66.18
J-LH102	0.18	261.30	307.25	65.33
J-LH103	0.12	263.40	307.25	62.34
J-LH104	0.10	263.80	307.25	61.77
J-LH105	0.14	266.80	307.25	57.51
J-LH106	0.12	268.05	307.25	55.73
J-LH107	0.48	263.50	307.25	62.20
J-LH108	0.06	259.60	307.25	67.74
J-LH109	0.05	261.80	307.25	64.62
J-LH110	0.07	261.90	307.25	64.47
J-LH111	0.07	263.78	307.25	61.80
J-LH112	0.00	266.73	307.25	57.61
J-LH113	0.22	265.75	307.25	59.00
J-LH114	0.16	256.00	307.25	72.86
J-LH115	0.15	255.30	307.25	73.86
J-LH116	0.15	254.85	307.25	74.50
J-LH117	0.10	245.40	307.26	87.94
J-LH118	0.06	249.78	307.28	81.74
J-LH119	0.17	258.70	307.25	69.02
J-LH120	0.07	254.00	307.25	75.71
J-LH121	0.16	258.15	307.25	69.80
J-LH122	0.15	253.65	307.25	76.20
J-LH123	0.12	261.15	307.25	65.54
J-LH124	1.05	252.85	307.25	77.34
J-LH125	0.00	255.00	307.25	74.28
J-LH126	0.00	264.60	307.25	60.63

MIN		**245.40**		**55.73**
MAX		**268.05**		**87.94**

Pipe Table

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness (C)	Flow (ML/d)	Velocity (m/s)
ANNEX_12218	B36	B37	176.52	300	130	0.13	0.00
ANNEX_12220	B37	J-LH126	158.00	300	130	0.13	0.00
ANNEX_12221	2S619	J-LH100	44.40	150	130	0.93	0.05
L-3467-A	2S633	2S645	4.81	200	130	-3.54	0.11
P-LH100	J-LH100	J-LH101	77.88	200	130	0.64	0.02
P-LH101	J-LH101	J-LH102	79.47	200	130	0.62	0.02
P-LH102	J-LH102	J-LH103	74.10	200	130	0.85	0.03
P-LH103	J-LH103	J-LH104	75.22	200	130	0.97	0.03
P-LH104	J-LH104	J-LH105	74.79	200	130	0.87	0.03
P-LH105	J-LH105	J-LH106	61.63	200	130	0.62	0.02
P-LH106	J-LH106	J-LH107	112.94	200	130	0.61	0.02
P-LH107	J-LH107	B36	8.82	300	130	0.13	0.00
P-LH108	J-LH100	J-LH108	116.13	200	130	0.06	0.00
P-LH109	J-LH101	J-LH109	103.18	200	130	0.05	0.00
P-LH110	J-LH102	J-LH110	90.78	200	130	0.07	0.00
P-LH111	J-LH103	J-LH111	88.91	200	130	0.07	0.00
P-LH112	J-LH104	J-LH112	60.82	200	130	0.00	0.00
P-LH113	J-LH105	J-LH113	183.48	200	130	0.32	0.01
P-LH114	J-LH113	J-LH106	185.37	200	130	0.10	0.00
P-LH115	J-LH100	J-LH114	151.27	150	130	0.04	0.00
P-LH116	J-LH114	J-LH115	100.07	150	130	-0.12	0.01
P-LH117	J-LH115	J-LH101	159.89	150	130	0.23	0.01
P-LH118	J-LH102	J-LH116	152.18	150	130	-0.49	0.03
P-LH119	J-LH116	J-LH117	49.49	150	130	-1.14	0.06
P-LH120	J-LH118	J-LH117	212.43	200	130	3.48	0.11
P-LH121	J-LH118	2S633	6.40	200	130	-3.54	0.11
P-LH122	J-LH115	J-LH116	79.23	150	130	-0.50	0.03
P-LH123	J-LH103	J-LH119	90.21	150	130	-0.31	0.02
P-LH124	J-LH119	J-LH120	97.34	150	130	-0.48	0.03
P-LH125	J-LH117	J-LH120	74.66	200	130	2.24	0.07
P-LH126	J-LH104	J-LH121	110.29	200	130	0.00	0.00
P-LH127	J-LH121	J-LH122	75.96	200	130	-0.49	0.02
P-LH128	J-LH120	J-LH122	72.42	200	130	1.69	0.05
P-LH129	J-LH123	J-LH105	101.63	150	130	0.21	0.01
P-LH130	J-LH121	J-LH123	67.30	150	130	0.33	0.02
P-LH131	J-LH122	J-LH124	152.97	200	130	1.05	0.03
P-LH132	J-LH124	J-LH125	108.94	200	130	0.00	0.00
P-LH135	J-LH126	2S607	458.14	300	130	0.13	0.00

Maximum Day

Node Table

ID	Demand	Elevation	Head	Pressure
	(L/s)	*(m)*	*(m)*	*(psi)*
2S607	0.00	260.68	306.75	65.50
2S619	0.00	256.42	306.73	71.52
2S633	0.00	248.50	306.75	82.81
2S645	0.06	248.50	306.75	82.81
B36	0.00	263.00	306.74	62.18
B37	0.00	262.25	306.74	63.25
J-LH100	0.47	257.06	306.72	70.60
J-LH101	0.49	260.70	306.72	65.43
J-LH102	0.44	261.30	306.72	64.57
J-LH103	0.31	263.40	306.72	61.59
J-LH104	0.24	263.80	306.72	61.02
J-LH105	0.35	266.80	306.72	56.76
J-LH106	0.31	268.05	306.73	54.98
J-LH107	1.21	263.50	306.74	61.46
J-LH108	0.16	259.60	306.72	66.99
J-LH109	0.14	261.80	306.72	63.86
J-LH110	0.17	261.90	306.72	63.72
J-LH111	0.18	263.78	306.72	61.05
J-LH112	0.00	266.73	306.72	56.85
J-LH113	0.55	265.75	306.72	58.25
J-LH114	0.41	256.00	306.72	72.11
J-LH115	0.37	255.30	306.72	73.10
J-LH116	0.37	254.85	306.72	73.74
J-LH117	0.24	245.40	306.73	87.18
J-LH118	0.14	249.78	306.75	80.99
J-LH119	0.43	258.70	306.72	68.27
J-LH120	0.18	254.00	306.72	74.95
J-LH121	0.41	258.15	306.72	69.05
J-LH122	0.39	253.65	306.72	75.44
J-LH123	0.31	261.15	306.72	64.78
J-LH124	2.64	252.85	306.71	76.57
J-LH125	0.00	255.00	306.71	73.51
J-LH126	0.00	264.60	306.74	59.91

MIN		**245.40**		**54.98**
MAX		**268.05**		**87.18**

Pipe Table

ID	From Node	To Node	Length	Diameter	Roughness	Flow	Velocity
			(m)	*(mm)*	*(C)*	*(ML/d)*	*(m/s)*
ANNEX_12218	B36	B37	176.52	300	130	-4.69	0.07
ANNEX_12220	B37	J-LH126	158.00	300	130	-4.69	0.07
ANNEX_12221	2S619	J-LH100	44.40	150	130	2.26	0.13
L-3467-A	2S633	2S645	4.81	200	130	-3.96	0.13
P-LH100	J-LH100	J-LH101	77.88	200	130	1.23	0.04
P-LH101	J-LH101	J-LH102	79.47	200	130	0.66	0.02
P-LH102	J-LH102	J-LH103	74.10	200	130	0.44	0.01
P-LH103	J-LH103	J-LH104	75.22	200	130	-0.20	0.01
P-LH104	J-LH104	J-LH105	74.79	200	130	-1.53	0.05
P-LH105	J-LH105	J-LH106	61.63	200	130	-2.13	0.07
P-LH106	J-LH106	J-LH107	112.94	200	130	-3.48	0.11
P-LH107	J-LH107	B36	8.82	300	130	-4.69	0.07
P-LH108	J-LH100	J-LH108	116.13	200	130	0.16	0.01
P-LH109	J-LH101	J-LH109	103.18	200	130	0.14	0.00
P-LH110	J-LH102	J-LH110	90.78	200	130	0.17	0.01
P-LH111	J-LH103	J-LH111	88.91	200	130	0.18	0.01
P-LH112	J-LH104	J-LH112	60.82	200	130	0.00	0.00
P-LH113	J-LH105	J-LH113	183.48	200	130	-0.49	0.02
P-LH114	J-LH113	J-LH106	185.37	200	130	-1.04	0.03
P-LH115	J-LH100	J-LH114	151.27	150	130	0.40	0.02
P-LH116	J-LH114	J-LH115	100.07	150	130	-0.01	0.00
P-LH117	J-LH115	J-LH101	159.89	150	130	0.05	0.00
P-LH118	J-LH102	J-LH116	152.18	150	130	-0.39	0.02
P-LH119	J-LH116	J-LH117	49.49	150	130	-1.19	0.07
P-LH120	J-LH118	J-LH117	212.43	200	130	3.82	0.12
P-LH121	J-LH118	2S633	6.40	200	130	-3.96	0.13
P-LH122	J-LH115	J-LH116	79.23	150	130	-0.43	0.02
P-LH123	J-LH103	J-LH119	90.21	150	130	0.15	0.01
P-LH124	J-LH119	J-LH120	97.34	150	130	-0.28	0.02
P-LH125	J-LH117	J-LH120	74.66	200	130	2.39	0.08
P-LH126	J-LH104	J-LH121	110.29	200	130	1.09	0.03
P-LH127	J-LH121	J-LH122	75.96	200	130	1.11	0.04
P-LH128	J-LH120	J-LH122	72.42	200	130	1.92	0.06
P-LH129	J-LH123	J-LH105	101.63	150	130	-0.74	0.04
P-LH130	J-LH121	J-LH123	67.30	150	130	-0.43	0.02
P-LH131	J-LH122	J-LH124	152.97	200	130	2.64	0.08
P-LH132	J-LH124	J-LH125	108.94	200	130	0.00	0.00
P-LH135	J-LH126	2S607	458.14	300	130	-4.69	0.07

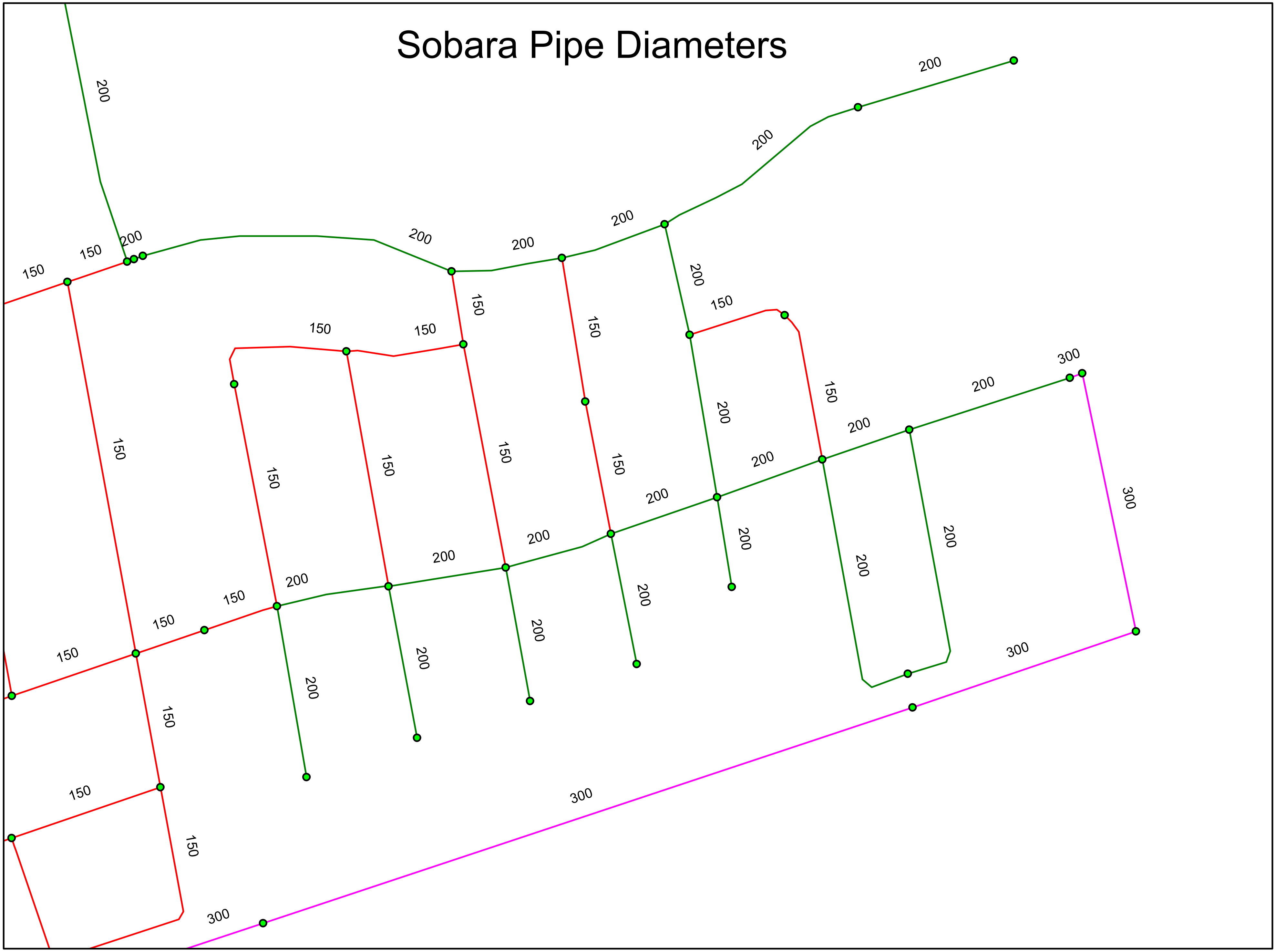
Existing Conditions
Lockhart Development, Innisfil, ON
October 21, 2018

Municipal Engineering
Solutions

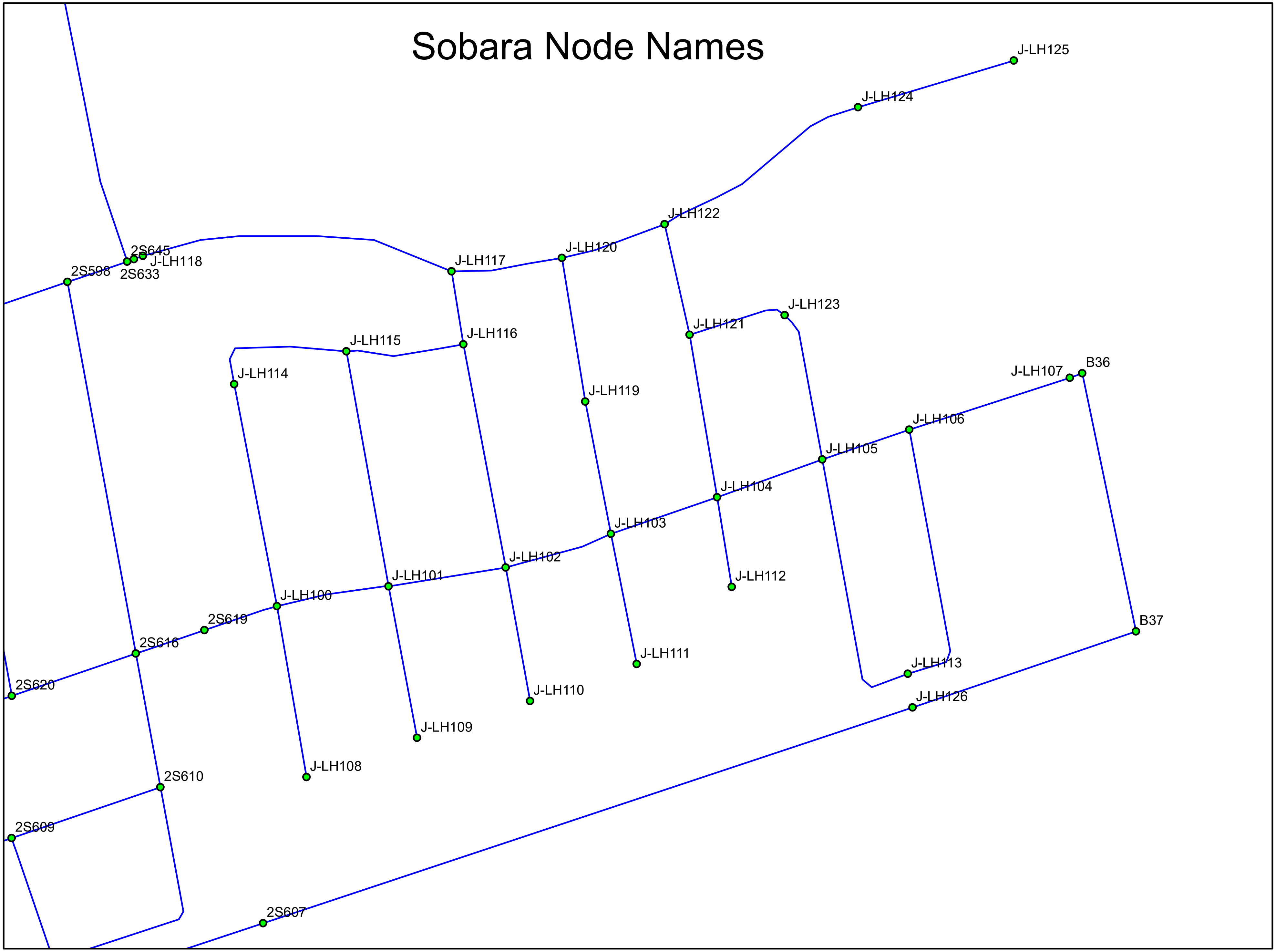
Fire Flow Table

ID	Total Demand	Available Flow	Fire Flow Met?
	(L/s)	*(L/s)*	
2S619	76.00	181.74	TRUE
2S633	76.00	235.24	TRUE
J-LH100	76.47	187.55	TRUE
J-LH101	133.49	179.67	TRUE
J-LH102	133.44	181.96	TRUE
J-LH103	133.31	178.08	TRUE
J-LH104	133.24	180.73	TRUE
J-LH105	133.35	170.95	TRUE
J-LH106	133.31	166.71	TRUE
J-LH107	284.21	193.21	FALSE
J-LH108	133.16	143.85	TRUE
J-LH109	133.14	142.98	TRUE
J-LH110	133.17	148.20	TRUE
J-LH111	133.18	145.36	TRUE
J-LH112	76.00	146.68	TRUE
J-LH113	133.55	156.12	TRUE
J-LH114	76.41	148.60	TRUE
J-LH115	76.37	173.83	TRUE
J-LH116	76.37	190.65	TRUE
J-LH117	76.24	237.42	TRUE
J-LH118	76.14	230.42	TRUE
J-LH119	76.43	158.88	TRUE
J-LH120	76.18	207.19	TRUE
J-LH121	76.41	192.75	TRUE
J-LH122	76.39	203.06	TRUE
J-LH123	76.31	156.08	TRUE
J-LH124	169.64	155.15	FALSE
J-LH125	76.00	128.79	TRUE
	MIN	**128.79**	
	MAX	**237.42**	

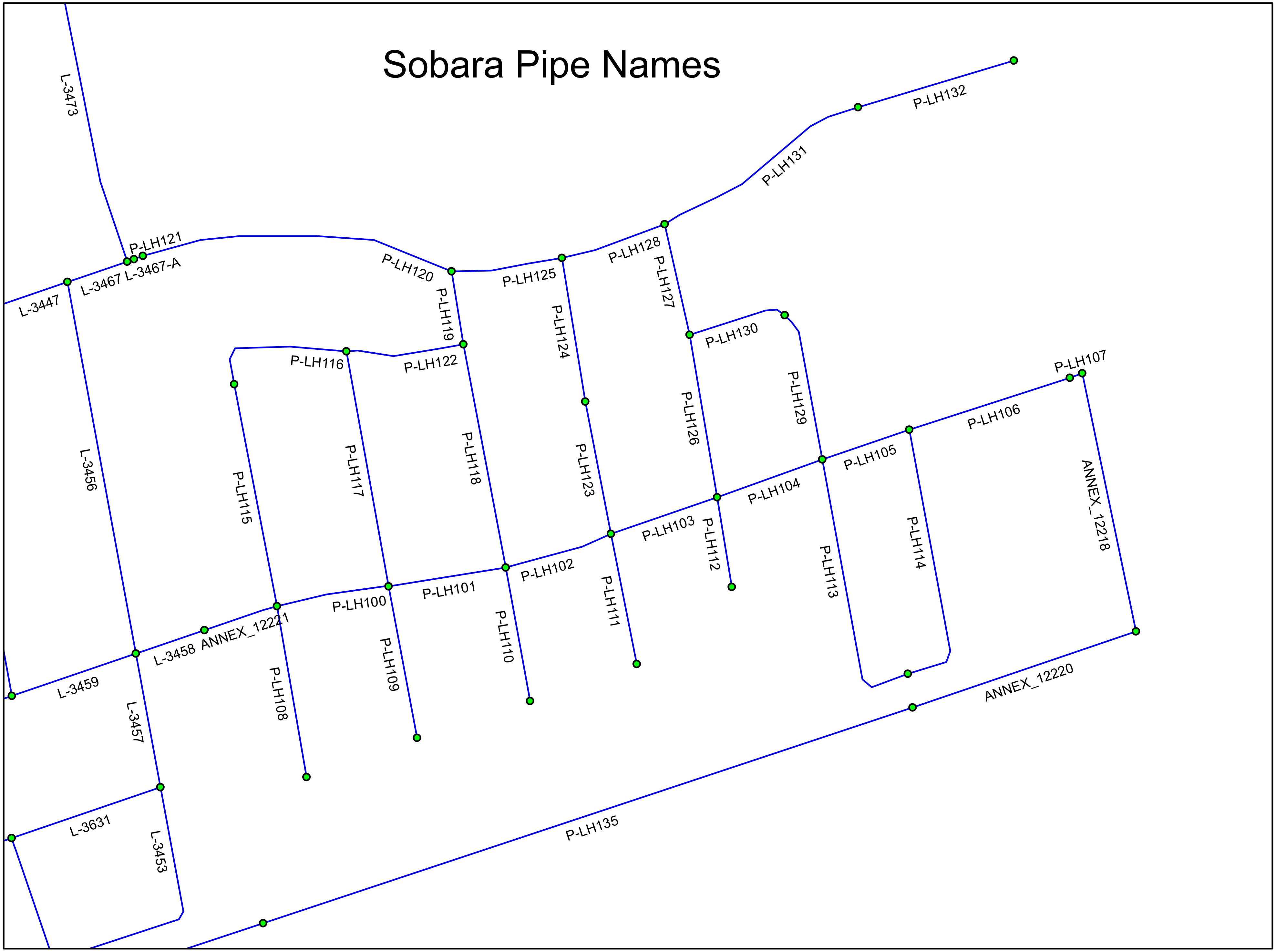
Sobara Pipe Diameters



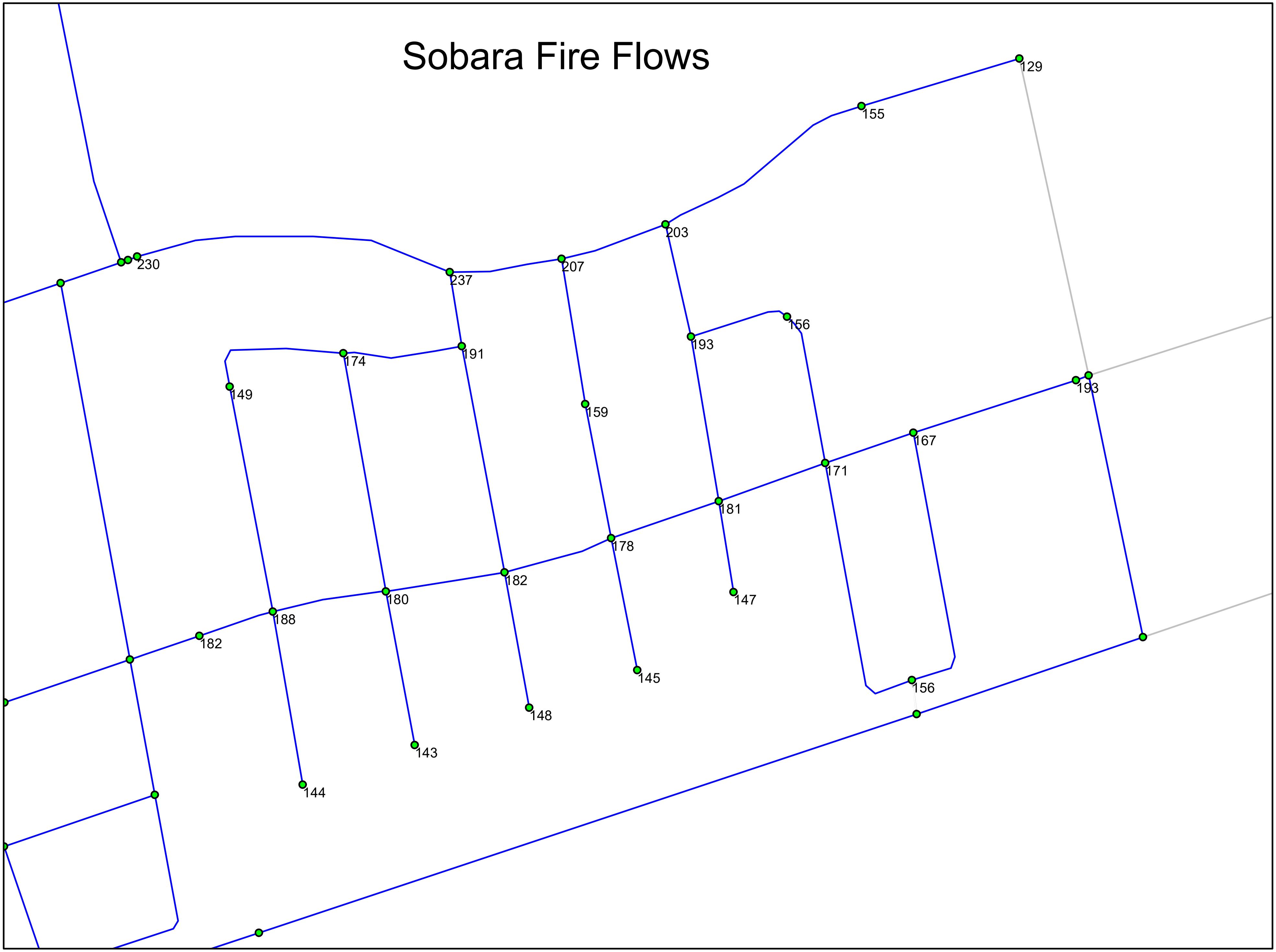
Sobara Node Names



Sobara Pipe Names



Sobara Fire Flows



Future Conditions
Lockhart Development, Innisfil, ON
October 21, 2018

Municipal Engineering Solutions

Average Day

Node Table

ID	Demand	Elevation	Head	Pressure
	(L/s)	*(m)*	*(m)*	*(psi)*
2S607	0.78	260.68	308.99	68.67
2S619	0.78	256.42	309.03	74.79
2S633	0.78	248.50	309.05	86.07
2S645	0.12	248.50	309.05	86.07
B36	1.18	263.00	309.07	65.49
B37	1.18	262.25	309.06	66.55
J-LH100	0.19	257.06	309.04	73.89
J-LH101	0.20	260.70	309.04	68.72
J-LH102	0.18	261.30	309.04	67.87
J-LH103	0.12	263.40	309.05	64.89
J-LH104	0.10	263.80	309.05	64.33
J-LH105	0.14	266.80	309.05	60.07
J-LH106	0.12	268.05	309.06	58.29
J-LH107	0.48	263.50	309.07	64.78
J-LH108	0.06	259.60	309.04	70.28
J-LH109	0.05	261.80	309.04	67.16
J-LH110	0.07	261.90	309.04	67.02
J-LH111	0.07	263.78	309.05	64.35
J-LH112	0.00	266.73	309.05	60.16
J-LH113	0.22	265.75	309.05	61.56
J-LH114	0.16	256.00	309.04	75.40
J-LH115	0.15	255.30	309.04	76.40
J-LH116	0.15	254.85	309.04	77.04
J-LH117	0.10	245.40	309.05	90.48
J-LH118	0.06	249.78	309.05	84.25
J-LH119	0.17	258.70	309.05	71.57
J-LH120	0.07	254.00	309.05	78.26
J-LH121	0.16	258.15	309.05	72.36
J-LH122	0.15	253.65	309.05	78.76
J-LH123	0.12	261.15	309.05	68.10
J-LH124	1.05	252.85	309.05	79.90
J-LH125	0.00	255.00	309.06	76.85
J-LH126	0.00	264.60	309.04	63.18

MIN		**245.40**		**58.29**
MAX		**268.05**		**90.48**

Pipe Table

ID	From Node	To Node	Length	Diameter	Roughness	Flow	Velocity
			(m)	*(mm)*	*(C)*	*(ML/d)*	*(m/s)*
ANNEX_12218	B36	B37	176.52	300	130	3.73	0.05
ANNEX_12220	B37	J-LH126	158.00	300	130	11.86	0.17
ANNEX_12221	2S619	J-LH100	44.40	150	130	-2.33	0.13
L-3467-A	2S633	2S645	4.81	200	130	-1.07	0.03
P-LH100	J-LH100	J-LH101	77.88	200	130	-2.10	0.07
P-LH101	J-LH101	J-LH102	79.47	200	130	-2.15	0.07
P-LH102	J-LH102	J-LH103	74.10	200	130	-2.24	0.07
P-LH103	J-LH103	J-LH104	75.22	200	130	-2.18	0.07
P-LH104	J-LH104	J-LH105	74.79	200	130	-2.30	0.07
P-LH105	J-LH105	J-LH106	61.63	200	130	-2.39	0.08
P-LH106	J-LH106	J-LH107	112.94	200	130	-3.52	0.11
P-LH107	J-LH107	B36	8.82	300	130	-4.00	0.06
P-LH108	J-LH100	J-LH108	116.13	200	130	0.06	0.00
P-LH109	J-LH101	J-LH109	103.18	200	130	0.05	0.00
P-LH110	J-LH102	J-LH110	90.78	200	130	0.07	0.00
P-LH111	J-LH103	J-LH111	88.91	200	130	0.07	0.00
P-LH112	J-LH104	J-LH112	60.82	200	130	0.00	0.00
P-LH113	J-LH105	J-LH113	183.48	200	130	-0.79	0.03
P-LH114	J-LH113	J-LH106	185.37	200	130	-1.01	0.03
P-LH115	J-LH100	J-LH114	151.27	150	130	-0.48	0.03
P-LH116	J-LH114	J-LH115	100.07	150	130	-0.64	0.04
P-LH117	J-LH115	J-LH101	159.89	150	130	0.20	0.01
P-LH118	J-LH102	J-LH116	152.18	150	130	-0.16	0.01
P-LH119	J-LH116	J-LH117	49.49	150	130	-1.29	0.07
P-LH120	J-LH118	J-LH117	212.43	200	130	0.23	0.01
P-LH121	J-LH118	2S633	6.40	200	130	-0.29	0.01
P-LH122	J-LH115	J-LH116	79.23	150	130	-0.99	0.06
P-LH123	J-LH103	J-LH119	90.21	150	130	-0.26	0.01
P-LH124	J-LH119	J-LH120	97.34	150	130	-0.43	0.02
P-LH125	J-LH117	J-LH120	74.66	200	130	-1.16	0.04
P-LH126	J-LH104	J-LH121	110.29	200	130	0.03	0.00
P-LH127	J-LH121	J-LH122	75.96	200	130	0.49	0.02
P-LH128	J-LH120	J-LH122	72.42	200	130	-1.66	0.05
P-LH129	J-LH123	J-LH105	101.63	150	130	-0.74	0.04
P-LH130	J-LH121	J-LH123	67.30	150	130	-0.62	0.04
P-LH131	J-LH122	J-LH124	152.97	200	130	-1.32	0.04
P-LH132	J-LH124	J-LH125	108.94	200	130	-2.37	0.08
P-LH133	J-LH125	B36	214.28	200	130	-2.37	0.08
P-LH135	J-LH126	2S607	458.14	300	130	11.86	0.17

Future Conditions
Lockhart Development, Innisfil, ON
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Maximum Day

Node Table

ID	Demand	Elevatio	Head	Pressure
	(L/s)	(m)	(m)	(psi)
2S607	0.78	260.68	308.93	68.59
2S619	0.78	256.42	308.94	74.66
2S633	0.78	248.50	308.96	85.94
2S645	0.12	248.50	308.96	85.94
B36	1.18	263.00	308.99	65.38
B37	1.18	262.25	308.99	66.45
J-LH100	0.47	257.06	308.94	73.75
J-LH101	0.49	260.70	308.94	68.58
J-LH102	0.44	261.30	308.95	67.73
J-LH103	0.31	263.40	308.95	64.75
J-LH104	0.24	263.80	308.95	64.19
J-LH105	0.35	266.80	308.96	59.93
J-LH106	0.31	268.05	308.97	58.16
J-LH107	1.21	263.50	308.99	64.67
J-LH108	0.16	259.60	308.94	70.14
J-LH109	0.14	261.80	308.94	67.02
J-LH110	0.17	261.90	308.95	66.88
J-LH111	0.18	263.78	308.95	64.21
J-LH112	0.00	266.73	308.95	60.02
J-LH113	0.55	265.75	308.96	61.43
J-LH114	0.41	256.00	308.94	75.26
J-LH115	0.37	255.30	308.94	76.26
J-LH116	0.37	254.85	308.95	76.90
J-LH117	0.24	245.40	308.95	90.34
J-LH118	0.14	249.78	308.96	84.12
J-LH119	0.43	258.70	308.95	71.43
J-LH120	0.18	254.00	308.95	78.12
J-LH121	0.41	258.15	308.95	72.22
J-LH122	0.39	253.65	308.95	78.62
J-LH123	0.31	261.15	308.95	67.96
J-LH124	2.64	252.85	308.95	79.76
J-LH125	0.00	255.00	308.97	76.72
J-LH126	0.00	264.60	308.97	63.08

MIN		**245.40**		**58.16**
MAX		**268.05**		**90.34**

Pipe Table

ID	From Node	To Node	Length	Diameter	Roughness	Flow	Velocity
			(m)	(mm)	(C)	(ML/d)	(m/s)
ANNEX_12218	B36	B37	176.52	300	130	1.19	0.02
ANNEX_12220	B37	J-LH126	158.00	300	130	10.54	0.15
ANNEX_12221	2S619	J-LH100	44.40	150	130	-1.31	0.07
L-3467-A	2S633	2S645	4.81	200	130	-2.41	0.08
P-LH100	J-LH100	J-LH101	77.88	200	130	-1.70	0.05
P-LH101	J-LH101	J-LH102	79.47	200	130	-2.22	0.07
P-LH102	J-LH102	J-LH103	74.10	200	130	-2.53	0.08
P-LH103	J-LH103	J-LH104	75.22	200	130	-2.70	0.09
P-LH104	J-LH104	J-LH105	74.79	200	130	-3.24	0.10
P-LH105	J-LH105	J-LH106	61.63	200	130	-3.61	0.11
P-LH106	J-LH106	J-LH107	112.94	200	130	-5.55	0.18
P-LH107	J-LH107	B36	8.82	300	130	-6.76	0.10
P-LH108	J-LH100	J-LH108	116.13	200	130	0.16	0.01
P-LH109	J-LH101	J-LH109	103.18	200	130	0.14	0.00
P-LH110	J-LH102	J-LH110	90.78	200	130	0.17	0.01
P-LH111	J-LH103	J-LH111	88.91	200	130	0.18	0.01
P-LH112	J-LH104	J-LH112	60.82	200	130	0.00	0.00
P-LH113	J-LH105	J-LH113	183.48	200	130	-1.07	0.03
P-LH114	J-LH113	J-LH106	185.37	200	130	-1.62	0.05
P-LH115	J-LH100	J-LH114	151.27	150	130	-0.23	0.01
P-LH116	J-LH114	J-LH115	100.07	150	130	-0.64	0.04
P-LH117	J-LH115	J-LH101	159.89	150	130	0.12	0.01
P-LH118	J-LH102	J-LH116	152.18	150	130	-0.30	0.02
P-LH119	J-LH116	J-LH117	49.49	150	130	-1.80	0.10
P-LH120	J-LH118	J-LH117	212.43	200	130	1.48	0.05
P-LH121	J-LH118	2S633	6.40	200	130	-1.62	0.05
P-LH122	J-LH115	J-LH116	79.23	150	130	-1.13	0.06
P-LH123	J-LH103	J-LH119	90.21	150	130	-0.32	0.02
P-LH124	J-LH119	J-LH120	97.34	150	130	-0.75	0.04
P-LH125	J-LH117	J-LH120	74.66	200	130	-0.56	0.02
P-LH126	J-LH104	J-LH121	110.29	200	130	0.30	0.01
P-LH127	J-LH121	J-LH122	75.96	200	130	0.68	0.02
P-LH128	J-LH120	J-LH122	72.42	200	130	-1.48	0.05
P-LH129	J-LH123	J-LH105	101.63	150	130	-1.10	0.06
P-LH130	J-LH121	J-LH123	67.30	150	130	-0.79	0.04
P-LH131	J-LH122	J-LH124	152.97	200	130	-1.20	0.04
P-LH132	J-LH124	J-LH125	108.94	200	130	-3.84	0.12
P-LH133	J-LH125	B36	214.28	200	130	-3.84	0.12
P-LH135	J-LH126	2S607	458.14	300	130	10.54	0.15

Future Conditions
Lockhart Development, Innisfil, ON
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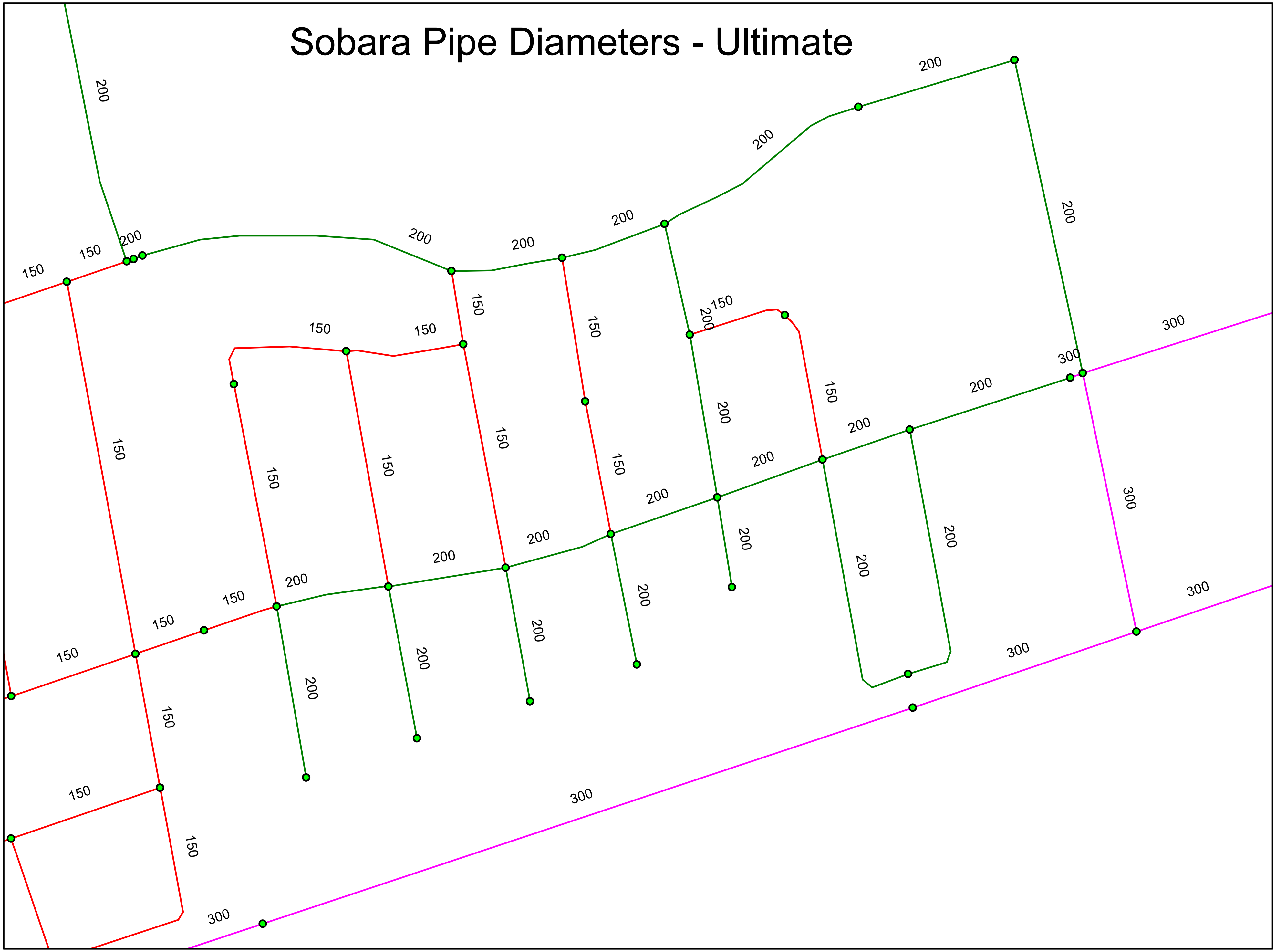
Municipal Engineering
Solutions

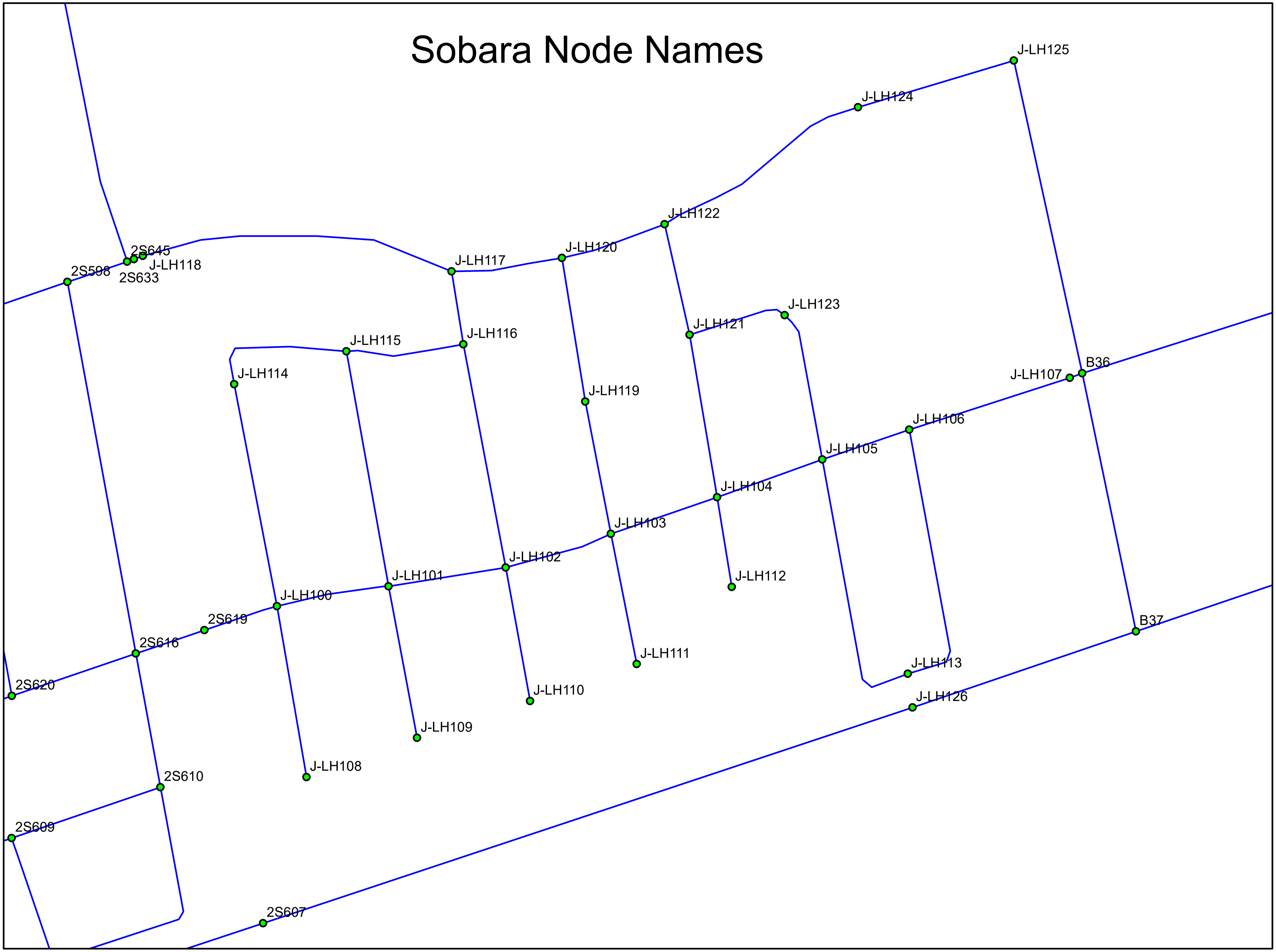
Fire Flow Table

ID	Total Demand	Available Flow	Fire Flow Met?
	(L/s)	*(L/s)*	
2S619	76.78	261.14	TRUE
2S633	76.78	360.47	TRUE
J-LH100	76.47	287.75	TRUE
J-LH101	133.49	287.79	TRUE
J-LH102	133.44	307.26	TRUE
J-LH103	133.31	318.55	TRUE
J-LH104	133.24	345.13	TRUE
J-LH105	133.35	333.70	TRUE
J-LH106	133.31	331.17	TRUE
J-LH107	284.21	594.10	TRUE
J-LH108	133.16	188.31	TRUE
J-LH109	133.14	192.90	TRUE
J-LH110	133.17	206.94	TRUE
J-LH111	133.18	208.55	TRUE
J-LH112	76.00	228.29	TRUE
J-LH113	133.55	253.23	TRUE
J-LH114	76.41	192.33	TRUE
J-LH115	76.37	247.07	TRUE
J-LH116	76.37	294.88	TRUE
J-LH117	76.24	411.18	TRUE
J-LH118	76.14	352.38	TRUE
J-LH119	76.43	226.92	TRUE
J-LH120	76.18	379.31	TRUE
J-LH121	76.41	358.40	TRUE
J-LH122	76.39	399.41	TRUE
J-LH123	76.31	231.25	TRUE
J-LH124	169.64	331.23	TRUE
J-LH125	76.00	322.64	TRUE
	MIN	**188.31**	
	MAX	**594.10**	

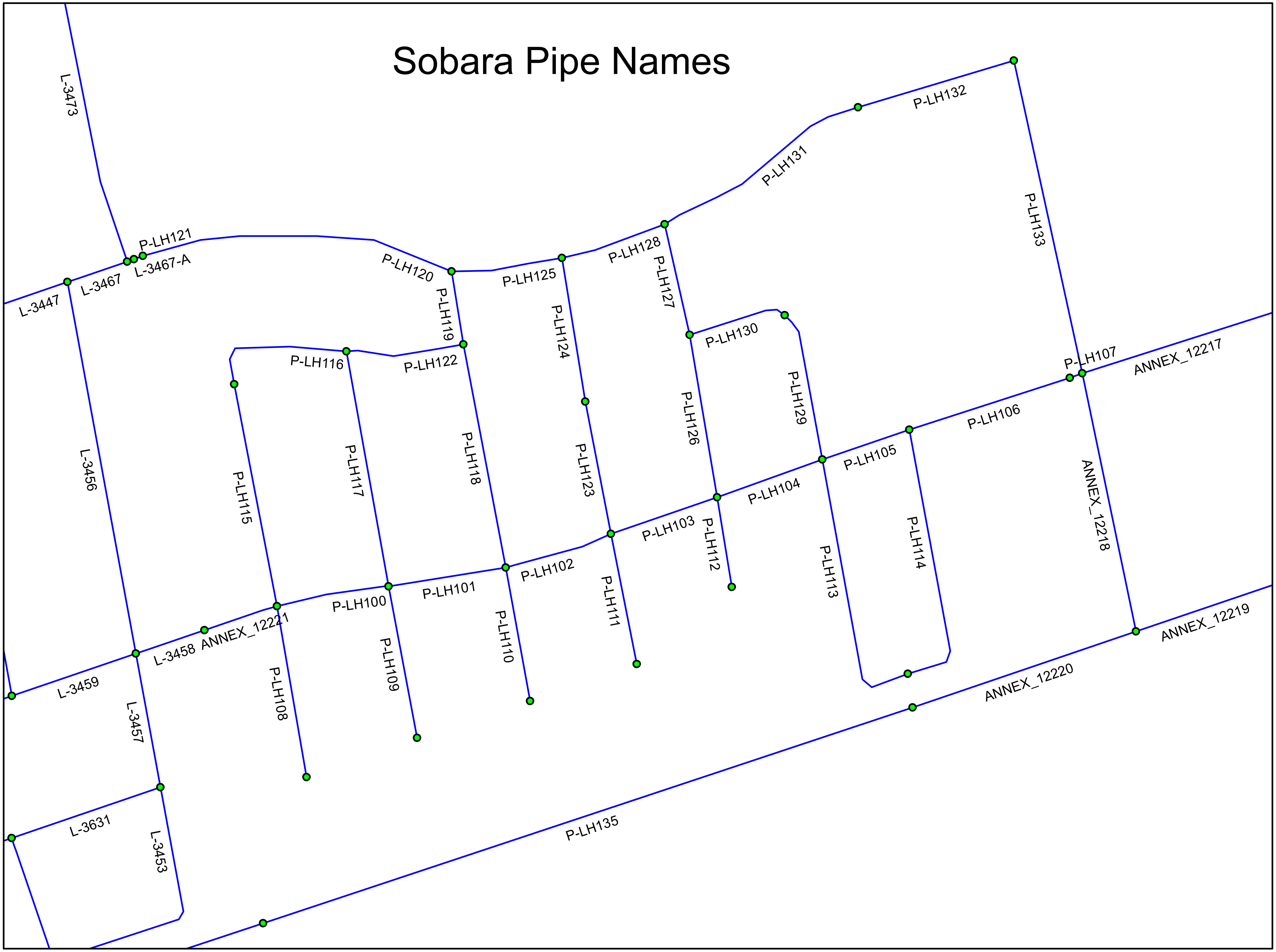
Sobara Pipe Diameters - Ultimate



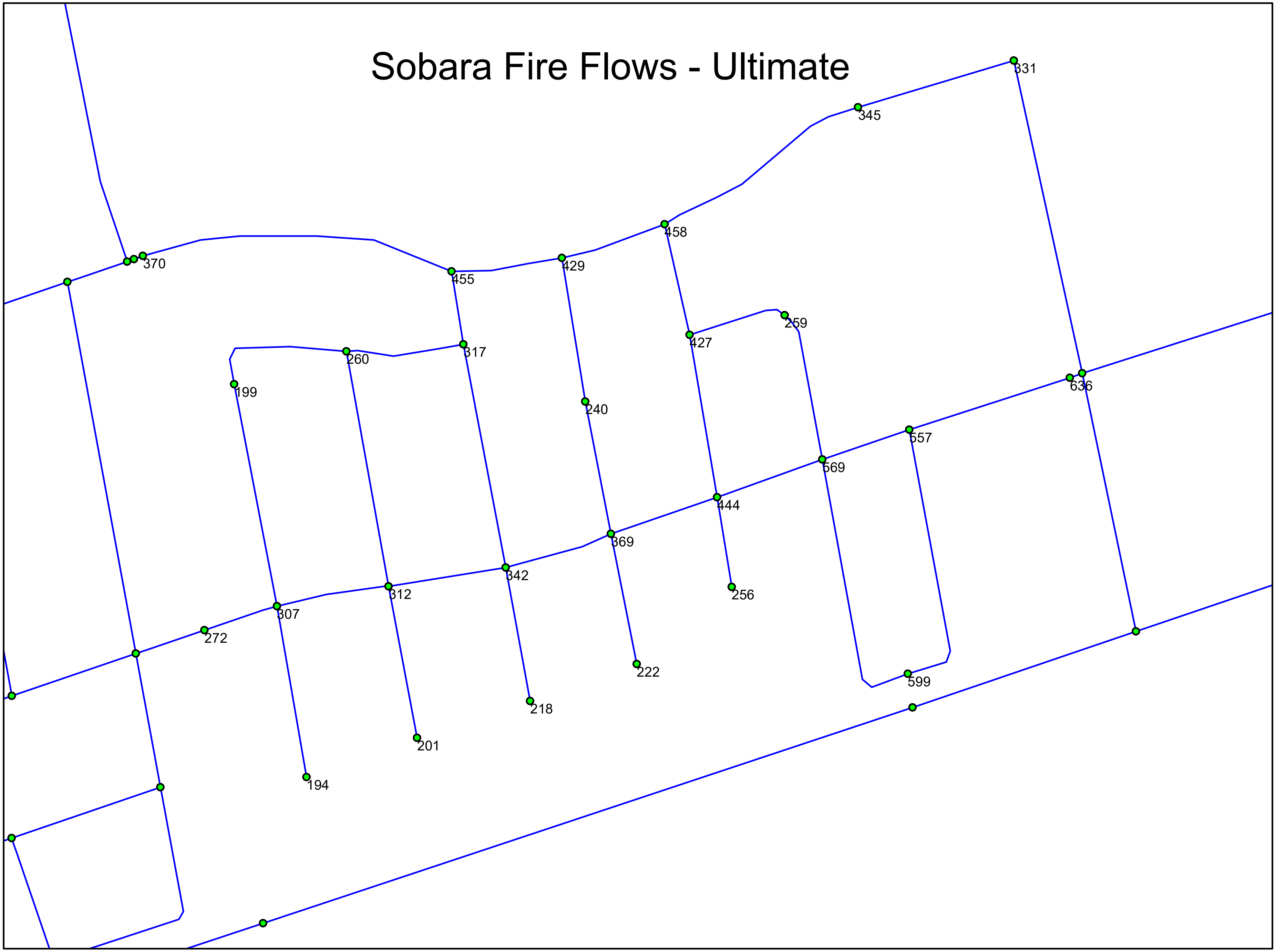
Sobara Node Names



Sobara Pipe Names



Sobara Fire Flows - Ultimate



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