Functional Servicing and Stormwater Management Report, Storybrook Subdivision

Township of Centre Wellington, North West Fergus Secondary Planning Area

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December 2016 - Revised February 2018
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Record of Revisions

Revision	Date	Description
0	December 2016	Initial Submission for Draft Plan Application
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1.0 Introduction

1.1 General

R. J. Burnside & Associates Limited (Burnside) has been retained by Nigus Fergus Joint Venture Inc. (Nigus) to prepare the Functional Servicing Report (FSR) in support of the Draft Plan of Subdivision Application for the Storybrook West Development which includes the remainder of the North West Fergus Secondary Plan Area (NWFSPA), outside the Storybrook Subdivision Phase 1 limits. The NWFSPA is located in the Community of Fergus, Township of Centre Wellington.

1.2 Study Area

The North West Fergus Secondary Plan Area encompasses approximately 99 ha within the Township of Centre Wellington. The legal description is part of Lots 18, 19 and 20, Concession 14 in the former Nichol Township, and includes Parts 1 and 2 of Plan 61R-11272. The location of the subject lands is illustrated on Figure 1.

The Secondary Planning Area is bounded by Colborne Street to the south and west, Beatty Line to the east and an abandoned railway line to the north and east, with open space areas to the west marked by lot lines.

Agricultural and rural residential estate properties surround the subject property. A subdivision development within the Fergus Urban Centre encompasses some of the lands to the east of Beatty Line. The Keating Church property, approved for residential development, is located on the other side of the former rail corridor along the north-east boundary of the site. To the south of the subject property is a Wellington County Planning Policy Area (Wellington Place) that includes the existing Wellington County Museum and Archives and the site for the Groves Memorial Hospital. The Phase 1 Draft Plan encompassed 28.6 ha of the Secondary Planning Area, largely located in the north-east quadrant. The Storybrook West Development includes 70.64 ha area covering the entire southern portion of the lands and the remaining northwest quadrant of the Secondary Planning Area.

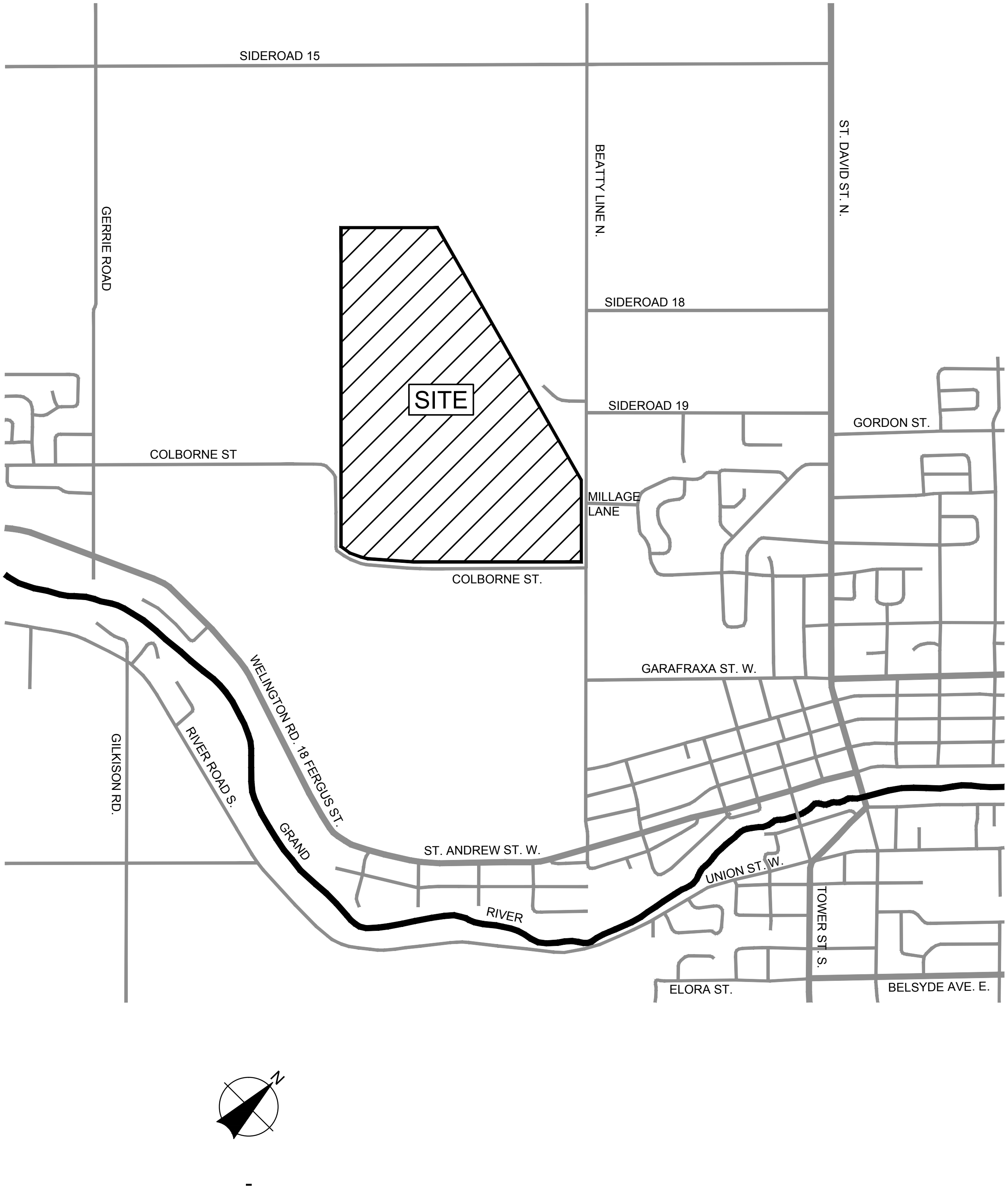
1.3 Land Uses

The Secondary Plan for the subject property was presented to Council on April 21, 2015 with recommendation for approval of the Secondary Plan. The Phase 1 Draft Plan was presented to Council on July 25, 2015 and is currently in the detailed design process. The proposed Storybrook West Development consists primarily of agricultural lands. One (1) residence and several farm related buildings and barns are located near the center of the Plan Area. Nichol Drain No. 1 runs westward through the center of the Secondary Plan Area. A smaller intermittent unnamed drain flows from the northern boundary of the Secondary Plan Area southward and converges with the Nichol Drain

No. 1 in the central western portion of the subject lands. The Nichol Drain No. 1 was included as part of the Phase 1 Draft Plan area, the unnamed watercourse, and adjacent woodlot/open space are included within the Storybrook West Draft Plan Area.

1.4 Scope of Work

The purpose of this report is to provide servicing information in support of the Draft Plan of Subdivision application by Nigus Fergus Joint Venture with specific focus on the Storybrook West Develoment currently under application. It will demonstrate how the subject lands can be serviced in accordance with Township of Centre Wellington standards and is an extension of the information provided as part of the Secondary Plan Application. The review includes a more detailed assessment of water, sanitary and storm servicing, including stormwater management implementation. Preliminary sizing and identification of drainage corridors through the site (major and trunk minor system), is also included as applicable.



BURNSIDE

Figure Title

NW FERGUS SECONDARY PLANNING AREA
DRAFT PLAN APPLICATION
SUBJECT SITE LOCATION PLAN

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NIGUS FERGUS JOINT VENTURE INC.

Drawn	Checked	Date	Figure No.
PAG	LN	2016-11-30	**FIG 1**
Scale		Project No.	
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File: \\MONTY\Shared Work Areas\031145 - Storybrook Ph1\07_Figures\FSR\05_Figures\031145 FSR FIG1.dwg   Date Plotted: December 13, 2016 - 3:56 PM

2.0 Background

2.1 Planning Context

The proposed North West Fergus Secondary Plan was approved with a mix of residential, parks and green space areas. The North West Fergus Secondary Plan, prepared by The Planning Partnership is shown on Figure 2. The Draft Plan of Subdivision is an extension of the land use approved for the Secondary Plan. The proposed Phase 1 Draft Plan is included as Figure 3 and the proposed Storybrook West Development Draft Plan is included as Figure 4.

2.2 Population Data and Projections

The Draft Plan of Subdivision, prepared by GSP Group, includes identification of the specific unit breakdown for Phase 1 of the proposed site as this is currently in detailed design. The remainder of the plan includes a potential range of units, in keeping with the population projections established as part of the Secondary Plan. The population projections have been developed based on the proposed unit count and the following unit densities taken from the *Township of Centre Wellington – 2009 Development Charge Background Study* completed for the Township of Centre Wellington by Watson and Associates Economists Ltd. in November 2009.

Table 1: Residential Unit Densities

	No. of Units		**Density***	**Population**	
	(Scenario A)	***(Scenario B)***	***(ppu)***	***(Scenario A)***	***(Scenario B)***
Phase 1 Low Density	176		3.08	543	
Storybrook West Low Density	674	772		2076	2378
Phase 1 Med. Density	40		2.47	99	
Storybrook West Med. Density	162			400	
Storybrook West Mixed Use	40		2.47	99	
Total	**1092**	**1190**		**3217**	**3519**

Municipal services for the subject property will be designed to comply with the latest standards and criteria prepared by the Township of Centre Wellington and Wellington County including road, grading, storm, sanitary and watermain design. Calculations relating to servicing requirements will be based on the calculated population of 3,519 to ensure sufficient capacity within the servicing components.

2.3 Previous Studies, Reports and Planning Documents

The development concepts contained in this report are a reflection of, and in accordance with, the information and findings contained in the following reports:

- Nichol Drain No. 1 Subwatershed Study – Phase 1 Existing Conditions, Aquafor Beech Limited, October 2008.
- Hydrogeological Study Proposed Residential Subdivision Nigus Property, Terraprobe Limited, January 2009.
- Traffic Impact Study North West Fergus Secondary Plan Area, R.J. Burnside & Associated Limited, July 2014.
- Environmental Implementation Report, North West Fergus Secondary Plan Area, R.J. Burnside & Associates Limited, June 2014.
- Functional Servicing Report, North West Fergus Secondary Plan Area, R.J. Burnside & Associates Limited, July 2014.
- NW Fergus Secondary Plan Area Scoped Environmental Impact Study, R.J. Burnside & Associates Limited, June 2014.
- Geotechnical Investigation Storybrook Subdivision, V.A. Wood (Guelph) Incorporated, May 2016.
- NW Fergus Secondary Plan Area Scoped Environmental Impact Study, Phase 2, R.J. Burnside & Associates Limited, ongoing.
- Traffic Impact Study – Draft Plans – North West Fergus Secondary Plan Area, Phase 2, ongoing.
- Hydrogeological Assessment in Support of Draft Plan, November 2016.

These studies have provided input into the recommended servicing and stormwater management scheme for the proposed site. The studies noted above as “ongoing” are part of the studies associated with the Storybrook West Draft Plan Application currently underway. These reports are being completed concurrently with the Functional Servicing and Stormwater Management Report contained herein.

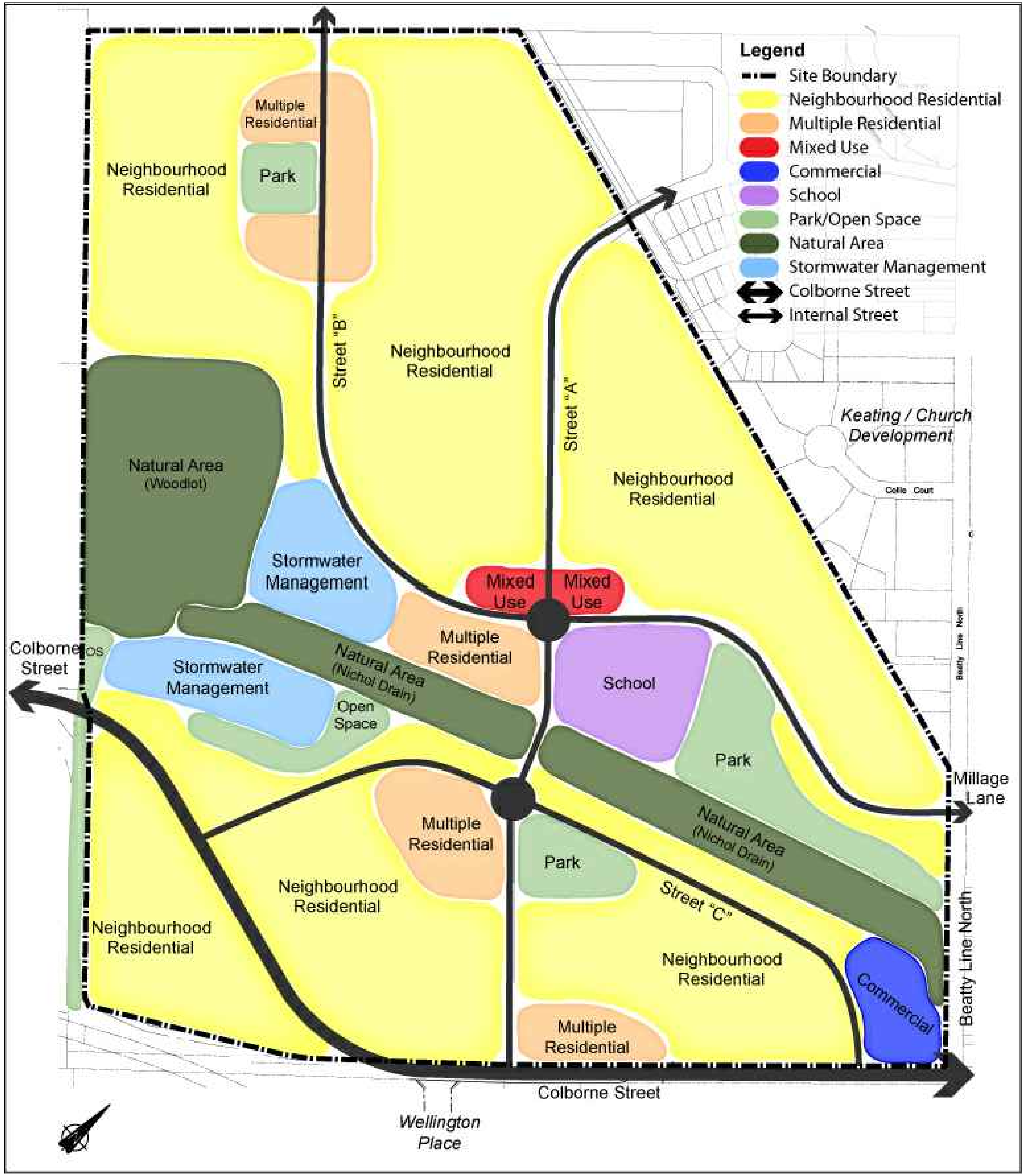

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Figure Title

NW FERGUS SECONDARY PLANNING AREA
DRAFT PLAN APPLICATION
APPROVED SECONDARY PLAN

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PAG	LN	2016-11-30	**FIG2**
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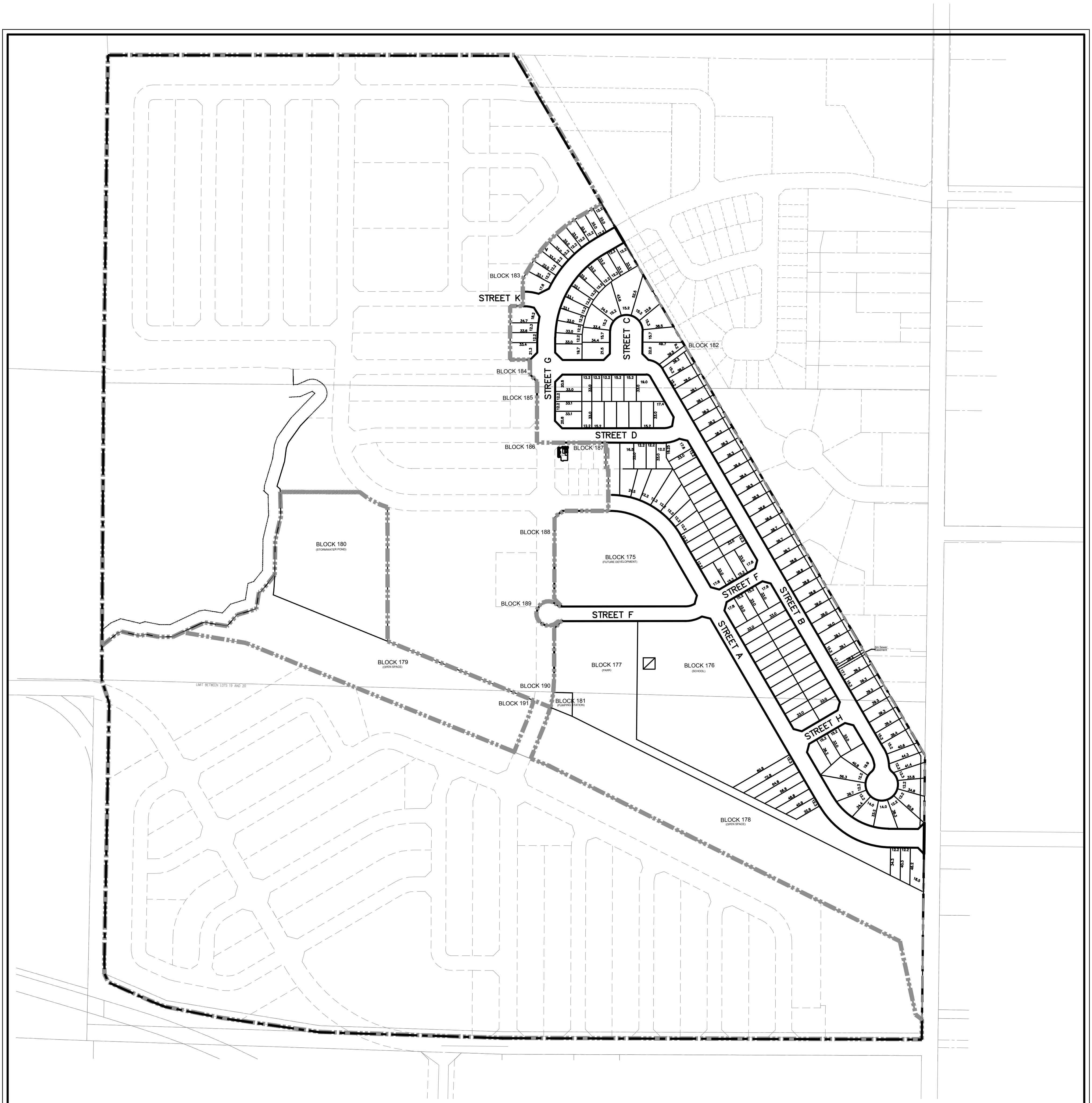

LAND USE SCHEDULE

PHASE 1	LOTS/BLKS.	UNITS	AREA (ha.)
Single Detached Residential	1-172	172	9.38
Medium Density Residential	173	46	1.69
School	174		2.58
Park	175		1.82
Nichol Drain (open space)	176,177		6.29
Stormwater Management	178		2.09
Pumping Station	179		0.06
Walkway / Emergency Access	180		0.02
0.3m Reserve	181-192		0.02
Roads			4.76
Total Phase 1		218	28.56
Total Subdivision			99.50

LEGEND

NORTH WEST FERGUS SECONDARY PLANNING AREA BOUNDARY

PROPOSED PHASING LIMITS

0 200 400 600 800
Metres

Prepared By:

GSP group
PLANNING I URBAN DESIGN I LANDSCAPE ARCHITECTURE
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Figure Title
NW FERGUS SECONDARY PLANNING AREA
DRAFT PLAN APPLICATION
PHASE 1 DRAFT PLAN

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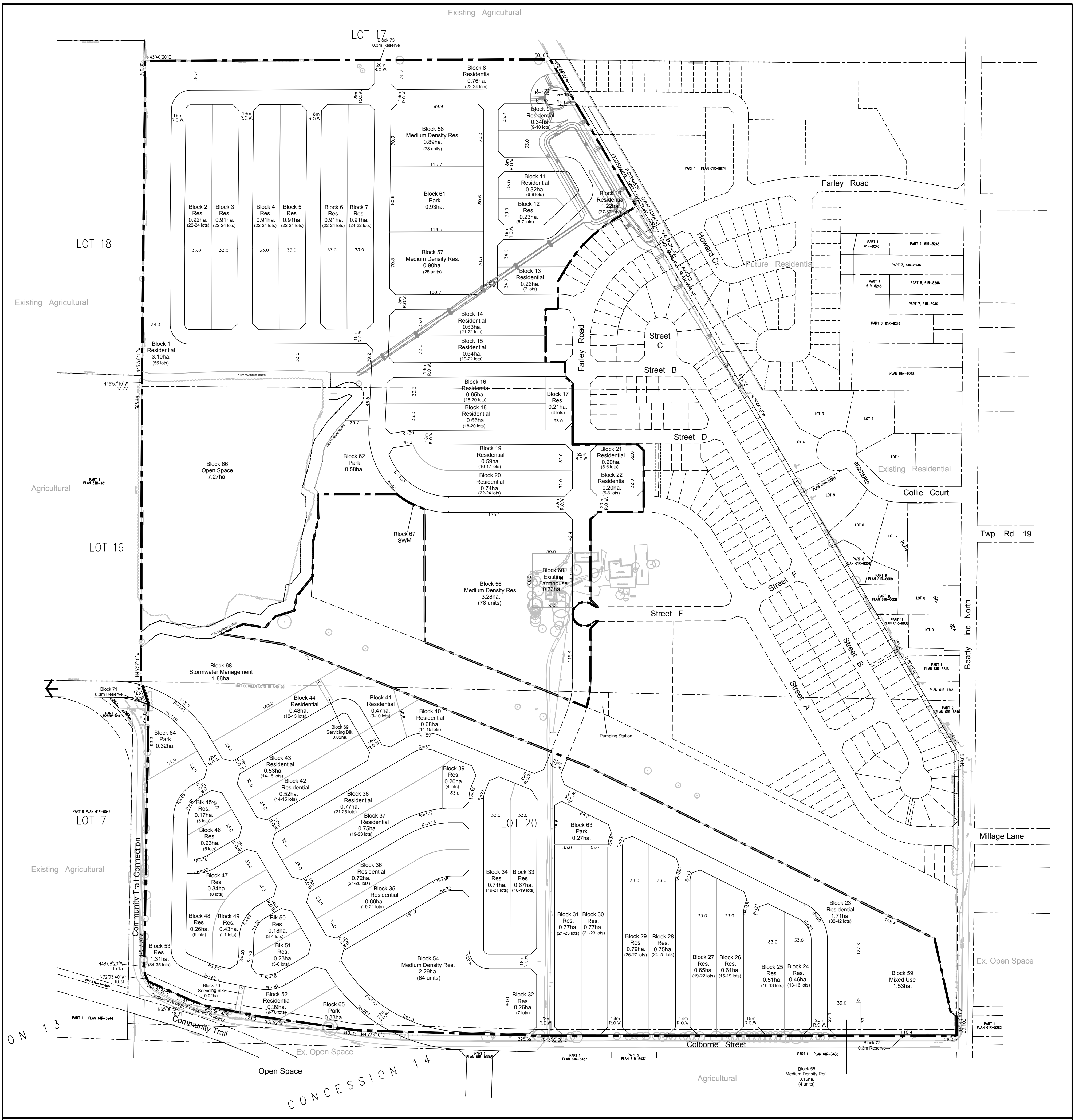

AREA SCHEDULE

DESCRIPTION	LOTS/BLKS.	UNITS	AREA (ha.)
Single Detached Residential	1-58	845-927	34.64
Medium Density Residential	59-63	202	7.50
Mixed Use	64	40	1.52
Existing Farmhouse	65		0.33
Park	66,67		11.83
Open Space	68-70		7.48
Stormwater Management	71		1.91
0.3m Reserve	72,73		0.00
Roads			15.24
Total		1087-1169	70.64

LEGEND

━ ▪ ━ ▪ ━	STORYBROOK WEST DEVELOPMENT

0 200 400 600 800
Metres

Prepared By:

GSP group
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gspgroup.ca

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Figure Title
NW FERGUS SECONDARY PLANNING AREA DRAFT PLAN APPLICATION
STORYBROOK WEST DRAFT PLAN

Client
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RS	LN	2016-11-30	**FIG 4**
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3.0 Existing Site Conditions

The study area is comprised largely of agricultural lands. Nichol Drain No. 1 runs westward through the center of the Secondary Plan Area. A smaller, intermittent unnamed drain flows from the northern boundary of the site and converges with the Nichol Drain. The site slopes gently towards both the Nichol and unnamed drain with an average slope of 3% in the areas draining directly to Nichol Drain and a shallower sloping of approximately 1.5% towards the unnamed drain. There is an existing dwelling located centrally on the site with access off Colborne Street from the south. There is an existing woodlot, bounded by both the Nichol and the unnamed drain, located on the western boundary of the subject lands. The remainder of the site is open field. Refer to Figure 5 for existing site conditions and contours.

3.1 Soil Conditions

Based on the Ontario Soils Mapping database, the subject property is located within three (3) different soil formations. The Nichol Drain is located within the Parkhill Loam Formation. These soils are described as poor draining as they are generally wet throughout the year. North of the Nichol Drain, soils are located within the Listowel Loam Formation; these soils are established from a Loam Till and are considered imperfectly draining. South of the Nichol Drain the soils are located within the Harriston Loam Formation; these soils are considered well-draining.

An initial geotechnical investigation for the study area was completed by Terraprobe Limited in 2009 (see Appendix A). Based on the findings, the site is covered by a surficial layer of topsoil underlain by glacial till materials, comprising of a low permeability sandy silt to clayey silt. Layers of sand and gravel were encountered along the Nichol Drain and in the north-east corner of the site. The topsoil thickness generally ranges from about 200 mm to 300 mm in depth.

A detailed geotechnical investigation for the Phase 1 Storybrook Subdivision area was completed by V.A. Wood Incorporated (see Appendix A). Based on the findings of this report, the site is covered by a surficial layer of topsoil ranging in depths from 150 mm to 410 mm thick, underlain by loose to compact silty sand and/or sand underlain by loose to very dense clayey sandy silt till with seams of company sand and very stiff to hard silty clay.

3.2 Groundwater Conditions

As part of the initial geotechnical investigation conducted by Terraprobe, groundwater conditions were monitored using standpipe piezometers, which were installed at each borehole location. The water levels were recorded on three (3) separate occasions, at the time of the Geotechnical Report; these piezometers continue to be monitored by Burnside. As last recorded, groundwater was found in all 20 boreholes.

The groundwater levels were generally found to be within two (2) metres of the ground surface. The shallow ground water flow generally follows site topography and generally flows to the downstream portion of the Nichol Drain. The only exception is the northern portion, which generally flows to the north-west [ref. p. 8, Geotechnical Report, 2009].

As part of the geotechnical investigation conducted by VA Wood, groundwater conditions were monitored at each borehole location. The water levels were recorded using monitoring wells at five (5) of the boreholes. Based on the field work that was completed, the groundwater table is considered to be located at elevations ranging from 408.1 m to 415.3 m.

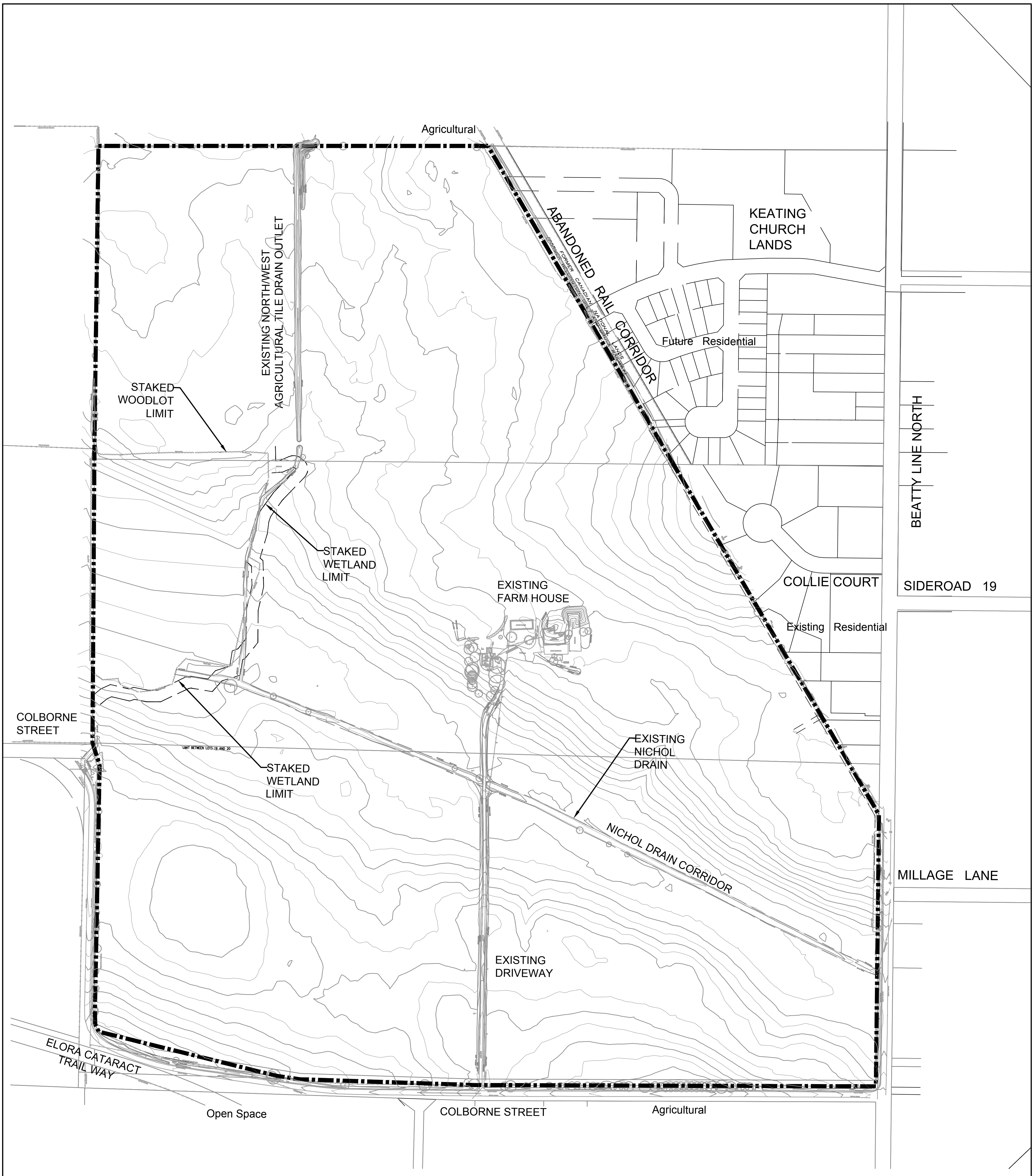
Further hydrogeological assessment and monitoring has been completed by Burnside as part of the Phase 1 Draft Plan Application, and the ongoing works supporting the current Storybrook West Draft Planning process. A more detailed assessment of seasonal high groundwater contours has been completed. It is noted that the groundwater elevations within the Phase 1 development area range from 410 m to 419 m. Where the foundation elevations of the dwellings are located within 0.60 m of the SHGW, a separate Foundation Drain Collector system will be required as part of the subdivision design.

3.3 Environmental Features

The subject property has been historically used for agricultural purposes. There is an existing woodlot and wetland located in the west central portion of the site.
This woodlot / wetland feature was staked on site with GRCA in 2014. In accordance with the Phase 1 Subwatershed study, the woodlot buffer requirement is 15 m and the wetland buffer requirements is 30 m. As part of the Draft Plan studies, a scoped Environmental Impact Study (EIS) is being completed under separate cover, to establish reduced buffers on both the woodlot and wetland. The Draft Plan includes the application of a 15 m buffer on the wetland, specific to the areas adjacent to the stormwater management facilities, a 30 m wetland buffer adjacent to other land uses and a 10 m buffer on the woodlot. The buffer reduction was approved for the Phase 1 only area where the environmental feature abuts the North Stormwater Management Pond. The remainder of the buffer reduction remains under review. Consultation with GRCA indicates that minor encroachment within the 30 m wetland buffer may be permitted, subject to appropriate restoration and protection measures. The current Draft Plan includes a very minor encroachment within the buffer to allow for an efficient and safe alignment of proposed Street A.

The Nichol Drain bisects the property and flows in an east to west direction. The current floodplain extends well beyond the top of bank of the existing Nichol Drain. The approved Secondary Plan included the proposal for ‘terracing’ of the Nichol Drain, which results in channelizing the drain corridor and provide reconnection of the channel with its floodplain, as specified in the Phase 1 Subwatershed Study.

A 30 metre buffer on either side of the 7 m low flow channel of the Nichol Drain is provided, resulting in a 67 m wide channel corridor through the property. The proposed drain terracing was approved as part of the Phase 1 subdivision design.



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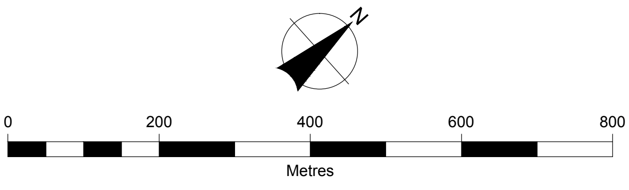

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Figure Title

NW FERGUS SECONDARY PLANNING AREA DRAFT PLAN APPLICATION

EXISTING SITE CONDITIONS

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PAG	LN	2016-11-30	**FIG 5**
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4.0 Sanitary Servicing

4.1 Sanitary Design Criteria

The proposed sanitary sewers will be designed and constructed to current Township and MOE criteria and specifications.

The sanitary design criterions are as follows:

- Residential Flow Rate – 250 litres per capita per day
- Infiltration – 0.15 litres per second per hectare
- Inflow – 0.028 litres per second per m pipe
- Peaking Factor – Hammon Peaking Factor Formula
- Population Density – Varies:
  - Low Density Residential – 3.08 ppu
  - Medium Density Residential – 2.47 ppu
- Institutional / Commercial / Industrial Loading – 28 m^3/ha/day

4.2 External Sanitary Services

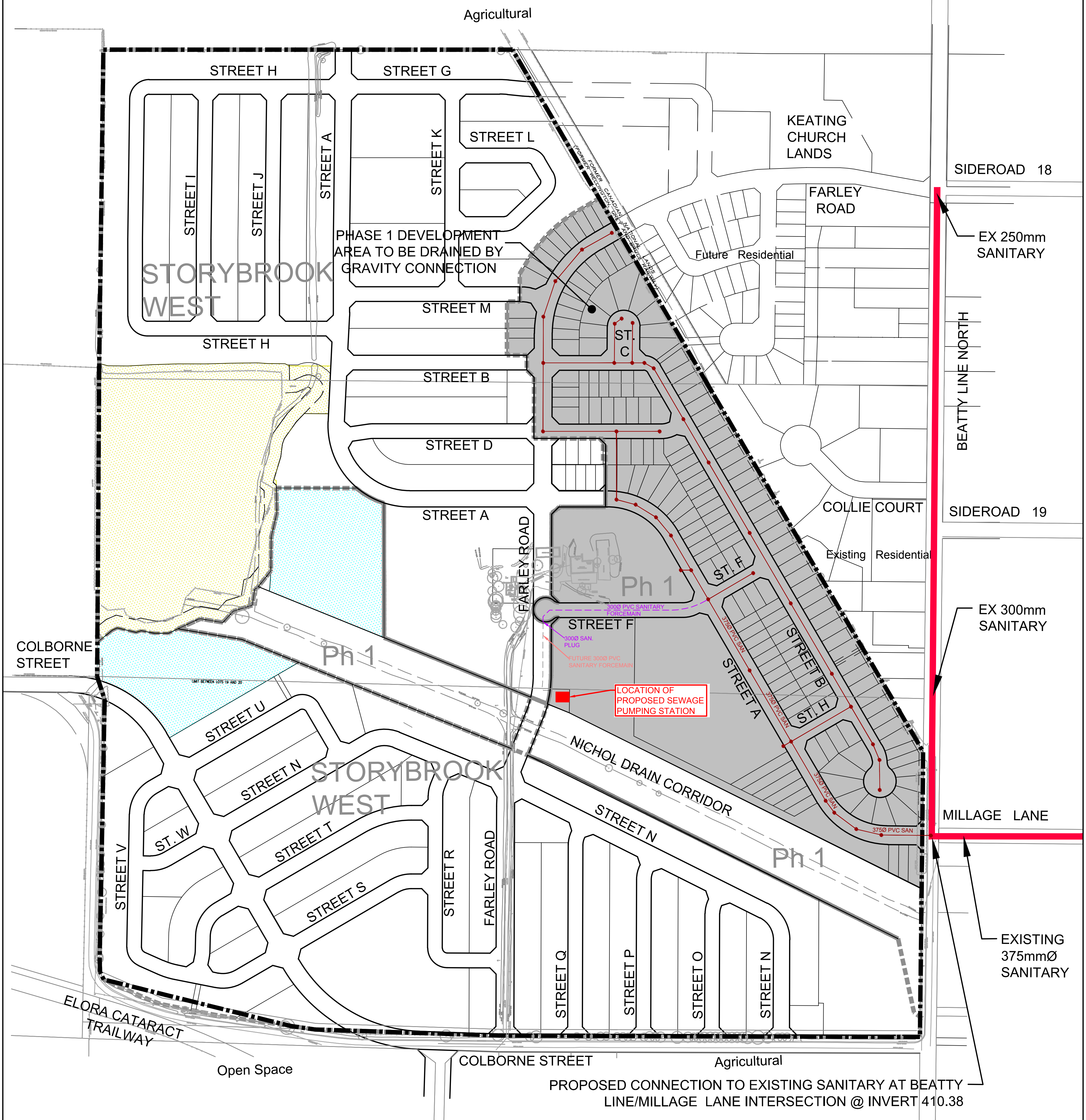
The subject property is located in the North West Trunk Sanitary drainage shed in Fergus, within the Township of Centre Wellington. The area ultimately drains to the Fergus Water Pollution Control Plant (WPCP).

As established as part of the Secondary Plan, the preferred alternative for providing sanitary servicing to the NWFSPA is through a combination of gravity and pumping station connection to the Beatty Line Sub-Trunk Sewer that connects to the Millage Lane Sewer. The sewer subsequently flows to the Black Street, Holman Crescent, Perry Street and Provost Lane sanitary sewers and ultimately discharges to the Fergus WPCP on Union Street south of the Grand River.

Due to grading constraints associated with the existing site topography and the Nichol Drain Corridor, a sewage pumping station within the subject property is proposed to reduce the fill and alleviate the outlet elevation constraints.

Phase 1 of the Draft Plan of Subdivision was established on the basis of the area of the site that can be serviced by gravity without significant fill. The location of the pumping station was identified within the Phase 1 Draft Plan, based on the anticipated future phasing of the property as well as minimizing the proposed infrastructure crossings of the Nichol Drain. As noted on Figure 6, the sanitary pump station site is to be located at the north-west intersection of Farley Road and the Nichol Drain Corridor, in the south- west corner of the Phase 1 park block.

As part of the Phase 1 design, the gravity system will be designed in accordance to Municipal standards, within the proposed ROW. Additionally, the Phase 1 work will include the extension of a forcemain along Street F to provide connection to the Storybrook West Draft Plan area. The proposed Phase 1 infrastructure is included for reference on Figure 6.



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━ · ━ · ━	NORTH WEST FERGUS SECONDARY PLANNING AREA BOUNDARY	▨	EXISTING WOODLOT	▨	PROPOSED SWM FACILITY
▬ ▬ ▬	PROPOSED PHASING LIMITS	━●━	PHASE 1 SANITARY SEWER		
━━━	EXISTING SANITARY SEWER				

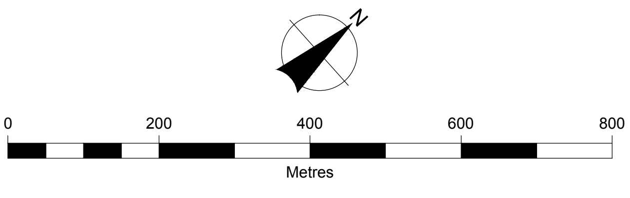

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Figure Title
NW FERGUS SECONDARY PLANNING AREA
DRAFT PLAN APPLICATION
PROPOSED SANITARY CONNECTION

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PAG	LN	2016-11-30	**FIG 6**
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4.3 Planned Sanitary Services

The Township of Centre Wellington has completed updates to the Water, Wastewater and Road sections of the Development Charges by-law. The Township, through its updates (2006 and 2008), has identified a strategy for the construction of new wastewater infrastructure within the current urban boundary based on projected growth rates and ultimate population estimates. The plan incorporates the expansion of the treatment capacity at the Fergus Waste Water Treatment Plan (WWTP).

4.3.1 Treatment Plant Capacity

The Fergus WPCP treats raw effluent from within the Fergus Urban Boundary and has a current design capacity of 8,000 m^3/d. A further expansion of the WPCP is planned that will increase overall capacity of the WPCP to 12,000 m^3/d. The current 10-year Capital Forecast includes a budget allowance for that work to be completed in 2019.

Based on recent capacity reports and committed allocation, the current WPCP can accommodate flows from the development. Currently, 2,023 units of uncommitted capacity representing a potential serviced population of approximately 6,300 people exist within the plant. The NWFSPA will require approximately 1,190 units of capacity at complete build-out based on the upper end of the planning range for the site. The Phase 1 requirement is 216 units including 176 low density units and 40 medium density units as identified on the proposed Draft Plan. Based on the available capacity and the proposed Phase 1 and Storybrook West development, the WPCP expansion will not be required to support the development.

4.4 Internal Sanitary Services

As identified above, the Beatty Line sewer has sufficient capacity to accept the sanitary flows from the development area. The existing Beatty Line sanitary sewer is a 375 mm diameter sewer having an invert elevation of 410.33 m at the proposed connection location, causing the requirement of a pumping station and forcemain in order to service the entire development area.

The initial phase of development includes the land which can drain by gravity to the Beatty Line Sewer. The Phase 1 area identified on the Draft Plan was established based on the preliminary sanitary sewer design for the gravity system. Drawing SAN1 depicts the sanitary sewer system design including; alignments of key sanitary infrastructure and elevation and cover information. The information is consistent with the Phase 1 detailed design currently in process with the Township. The gravity drainage area is calculated to be 18.25 hectares discharging to the sanitary sewer system.

The Storybrook West property, approximately 61.1 hectares will drain to a pumping station identified on the north side of the Nichol Drain.

The proposed siting of the pumping station results in only a single crossing of the Nichol Drain with sanitary infrastructure. The invert of the pumping station wet well will be set sufficiently deep to accommodate gravity sanitary drainage beneath the Nichol Drain. Preliminary elevation information is included on the drawing SAN1. A forcemain was included in the Phase 1 design, extending to the limits of Street F for future connection to the gravity drainage system.

As identified on the drawing, local trunk sewers servicing the NWFSPA will follow the alignment of roads within the NWFSPA. These local trunks will collect flows from local sewers extending through the Secondary Planning Area.

4.4.1 Preliminary Sewer Design

A preliminary sanitary sewer design sheet has been generated for the proposed Draft Planning Area to determine the calculated flow from the property for both the gravity drainage area and the sanitary pumping station. The design sheet also assists in establishing the potential capacity available within the system for accommodation of the lands located immediately north of the subject property.

The table below summarizes the preliminary flow calculations for the proposed Draft Plan Area. The design sheet is included in Appendix B. The design sheet is based on utilization of minimum pipe slopes of 0.30% within the entire area. At detailed design the sloping of the pipes will need to be refined to reflect the municipal standards associated with upstream legs of sewer and minimum velocity.

Table 2: Preliminary Sanitary Flow Calculations

Phase	Drainage Area / Unit Count	Calc. Flow (L/s)	Req. Pipe Size (mm)
Phase 1 Low Density	176 units	8.60	
Phase 1 Medium Density	40 units	1.1	
Phase 1 School	2.70 ha	1.3	
Sub Total Phase 1		**10.9**	**200**
Storybrook West Low Density	772 units	35.0	
Storybrook West Medium Density	162 units	5.8	
Storybrook West Commercial	1.53 ha	0.7	
Sub Total Storybrook West		**38.7**	**300**
Sub Total Development Area		**49.6**	**375**
Future External Flow	51.3 ha *	39.6	300
Total to Ex. Connection		**82.1**	**375**

* Note: External drainage area is based on a blended density of 63 ppha

As noted in the above table, if the connection at Millage Lane is maximized to the existing pipe size, the internal system can be sized to accommodate approximately 54.3 ha of development north of the subject lands.

It should be noted that all of the above flows and pipes sizes are based on conservative values associated with per capita flow rate as well as estimate density. There is an additional 10% flow allowance within the system to account for inflow. As the site proceeds through detailed design and development additional refinements will be made the capacity calculations to assess the system and maximize the drainage area.

4.4.2 Sanitary Forcemain Connection Point

As identified on drawing SAN1, and established through the Phase 1 Draft Plan process, the proposed connection point for the sanitary forecemain is taken at the closest point of extension of the gravity sanitary drainage system situated at the Phase 1 construction limits of Street F.

This option was selected on the basis of keeping the forcemain infrastructure within the road right-of-way from the pumping station to the gravity connection.

4.4.3 Phasing Implications

The construction of the sanitary sewer network drives the initial phasing or staging of the development in that the lands which can be serviced without the need of the pumping station and forcemain will be constructed first. As these lands are adjacent to Beatty Line which provides access to the NWFSPA, the initial phase will be constructed without any need to cross the Nichol Drain.

All phases beyond the initial phase are dependent on the sanitary pumping station for service. As such, construction of the pumping station will occur within the initial Phase of the Storybrook West development. Beyond these initial phases, the development of the site may occur through the logical extension of the sanitary sewer network through the site. Other factors such as transportation and road network completion or the desire to complete specific community features may dictate phasing after the second phase of development.

The timing of the expansion of the Fergus WPCP has the potential to impact the schedule of the construction of the remainder of the development lands. The current uncommitted capacity in units exceeds those proposed within the Secondary Planning Area. The pace of buildout of the NWFSPA as well as that of other portion do the urban area will determine whether a future expansion of the plant is required prior to full buildout. The expansion of the Fergus WPCP is currently shown for 2018-2026 according to the current to the Development Charge By-Law with a budget for the works identified in the current 10-year Capital Forecast for 2019.

Current uncommitted reserve capacity within the existing treatment plan will need to be confirmed with the Township.

The existing 375 mm trunk sewer at Beatty Line and Millage Lane has an allocated capacity for approximately 4,000 persons for the NWFSPA, as confirmed by the Township Engineer. The upper end of the projected population range for the NWFSPA is 3,519 persons. Given that the upper range is below the confirmed capacity allocation, the trunk sewer capacity will not impact the proposed phasing or timing of the development of the NWFSPA.

5.0 Water Servicing

5.1 Water Design Criteria

Water servicing for the subject lands will be designed in accordance with the latest Township standards and specifications to ensure that adequate pressures and flows are achieved. Watermain design flows will be based on the following criteria:

- Average Daily Demand – 250 litres per capita per day
- Population Density – per wastewater standards
- Peaking Factor – per MOE criteria (max. 4.0)
- Design Flow – greater of Max. Day plus Fire or Peak.

5.2 External Water Services

Water supply servicing is provided by the Township water system, a combined system serving the communities of Elora and Fergus and includes a series of wells and interconnecting feedermains. Storage for peak flow and fire flow is provided by elevated storage tanks in both Elora and Fergus. The topographic elevations of the NWFSPA are such that the entire site is within existing Zone 1 of the Township of Centre Wellington water system.

As identified in the Secondary Plan Servicing Study, the existing 300 mm diameter watermains along Beatty Line across the frontage of the subject lands as well as the 300 mm diameter watermain along a portion of Colborne Street provide a looped connection to the existing water system for the full development area. Additionally, the proposed residential development of the Beatty Hollow Subdivision includes a 200 mm diameter watermain within the extension of Farley Road, providing a looped supply system to Phase 1 development area.

The Fergus / Elora system currently has an uncommitted reserve capacity of 2,451 units (approximately 7,550 people) based on the most recent capacity reports prepared by the Township. The NWFSPA would require approximately 1,190 units of capacity based on the upper end of the planning range for the site. As such, sufficient uncommitted capacity exists to service the entire NWFSPA area. As the community expands, additional wells and storage facilities will be brought online as necessary. The need for additional wells and/or storage necessary to service the NWFSPA will be dependent on the phasing of the NWFSPA as well as growth in the balance of the urban area in Centre Wellington.

It was confirmed as part of the Secondary Planning Process that the existing watermains along Colborne Street and Beatty Line have sufficient pressure and capacity to accommodate the full development of the NWFSPA.

5.3 Planned Water Infrastructure

A review of the 2008 Background Study for the Development Charge By-Law for the Township of Centre Wellington identified the construction of an Elevated Water Tower and new Municipal Wells between 2008 and 2028. This indicates that the Township acknowledges that as development continues within the Township, the water supply and distribution will need to be expanded to meet the requirements of the new developments. Currently, there is excess supply capacity and some storage is available within the current system. The watermains adjacent to the development are able to provide the service required for the NWFSPA development and no new watermain infrastructure will be required to provide service to the area.

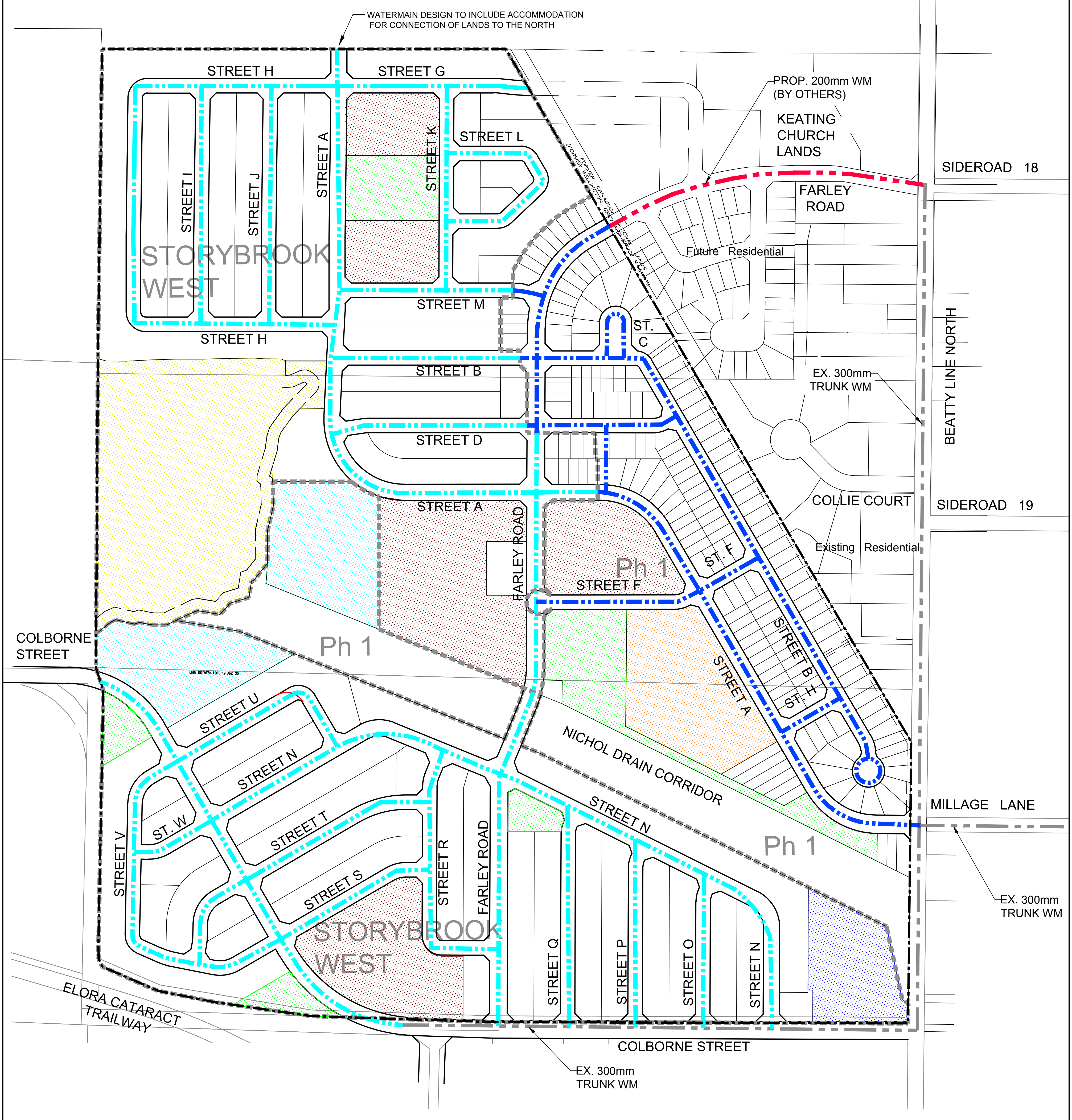
5.4 Internal Water Services

Figure 7 depicts the proposed water servicing distribution network for the Draft Plan Area. As part of the Phase 1 design, the internal watermain distribution will be designed in accordance to Municipal standards, within the proposed ROW. The Phase 1 work includes both the connection to Beatty Line as well as the connection to the Beatty Hollow Subdivision at Farley Road. The proposed Phase 1 infrastructure is included for reference on Figure 7. The Storybrook West area will be serviced through additional connections to the existing main on Colborne Street.

A network of feedermains is proposed to follow the alignment of the internal road system. Based on the Draft Plan configuration, the preliminary design results in five (5) connections to the existing watermain on Colborne Street and includes the extension of the existing main along the realignment of Colborne Street.

5.4.1 Phasing Implications

Lands within the NWFSPA are able to be immediately serviced by the existing watermain infrastructure adjacent to the development. No further upgrades to the existing distribution network serving the NWFSPA are required. Sufficient supply capacity currently exists to meet the needs of the entire NWFSPA. As additional population growth occurs throughout the Fergus and Elora urban boundary, additional supply and elevated storage infrastructure may be required and is planned as described in the Development Charges By-Law Background Study Update (2008). The need for additional water infrastructure to service the NWFSPA will be determined by the rate of build-out of the Secondary Plan Area, as well as that of other urban areas within the community.



LEGEND:

- ▬ · ▬ NORTH WEST FERGUS SECONDARY PLANNING AREA BOUNDARY
- ▬ ▬ ▬ PROPOSED PHASING LIMITS
- ▬ · ▬ EXISTING WATERMAIN
- ▬ · ▬ PROPOSED BEATTY HOLLOW SUBDIVISION WATERMAIN
- ▬ · ▬ PROPOSED WATERMAIN LAYOUT STORYBROOK WEST
- ▬ · ▬ PROPOSED WATERMAIN LAYOUT STORYBROOK PHASE 1
- 🟩 PROPOSED PARK BLOCK
- 🟥 PROPOSED MEDIUM DENSITY BLOCK
- 🟨 EXISTING WOODLOT
- 🟧 PROPOSED SCHOOL BLOCK
- 🟦 PROPOSED COMMERCIAL BLOCK
- ▨ PROPOSED SWM FACILITY

0 200 400 600 800
Metres

BURNSIDE

Figure Title
NW FERGUS SECONDARY PLANNING AREA DRAFT PLAN APPLICATION
PROPOSED INTERNAL WATERMAIN LAYOUT

Client
NIGUS FERGUS JOINT VENTURE INC.

Drawn	Checked	Date	Figure No.
PAG	LN	2016-11-30	**FIG 7**
Scale		Project No.	
1:5000		300031145	

6.0 Grading and Storm Drainage

6.1 Site Grading

The site grading design will take into consideration the following requirements and constraints:

- Conform to the Township's grading criteria.
- Match existing boundary grading conditions.
- Match proposed grading along interface of Beatty Hollow subdivision.
- Minimize required earthworks.
- Provide minimum cover on proposed servicing.
- Provide overland flow conveyance for major storm conditions.

Proposed road grades will meet the Township of Centre Wellington's minimum of 0.5% and will not exceed 8.0%. Proposed preliminary road centreline grades and overland flow routes are shown on Figure 8.

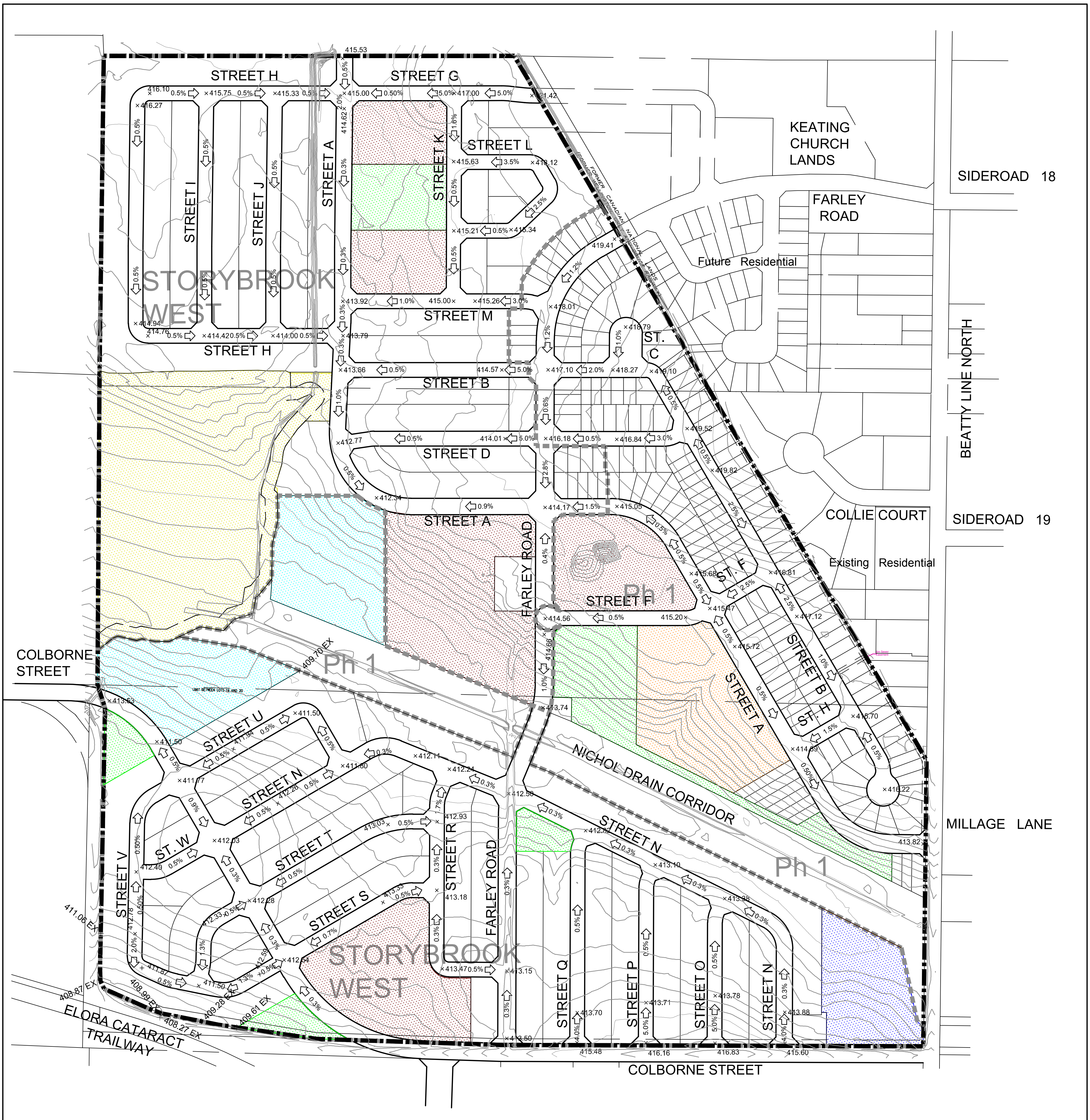
The site has been designed to match the existing topography where possible, while ensuring positive drainage towards the two (2) proposed stormwater management facilities. As identified on the figure, sawtooth grading is currently proposed along portions of the Street A and portions of Streets N, R and Farley Road, along the drain corridor. The implementation of sawtooth grading helps to minimize the earthworks and to tie into grading constraints surrounding the site.

Road grades are proposed such that the right-of-ways can be utilized as overland flow routes to direct the major storm events to the proposed stormwater management facilities. Sawtooth road grading conforms to the Town's minimum 0.50% road grade; however, the net grade over an extended length of road is reduced by introducing sections of road reverse graded at 0.50%. The net slope is typically 0.3% and will not be less than 0.20% in this scenario and will provide a positive outlet / flow route to accommodate major system flow conveyance. During detailed design, flow capacity calculations will be completed to ensure the overland flow route is sufficiently sized to accommodate the flow.

A portion of the south drainage area will drain to the stormwater management facility via a proposed easement that will accommodate the overland flow from Street U for conveyance to the pond. Additionally, a portion of the overland flow drainage from Street V will be directed to the proposed outlet via an easement graded to accommodate the overland flow route.

The proposed Beatty Hollow Subdivision to the northeast of the property currently has a detailed subdivision design in process with the Township.

The proposed grading design for the site involves the drainage of storm flows from a significant portion of the development through the subject lands. The proposed grading of the Beatty Hollow Subdivision is incorporated in the preliminary design for the Draft Plan.



LEGEND:

—·—·— NORTH WEST FERGUS SECONDARY PLANNING AREA BOUNDARY

- - - - PROPOSED PHASING LIMITS

412.67 EXISTING GRADE

0.5%⇨ PROPOSED ROAD SLOPE

× 412.260 PROPOSED GRADE

🟩 PROPOSED PARK BLOCK

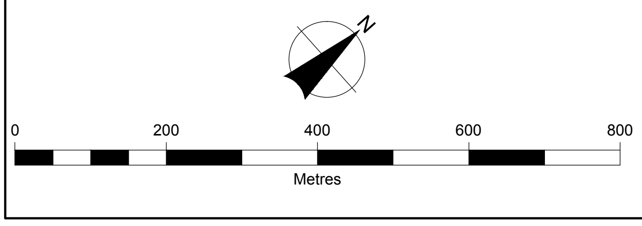
🟥 PROPOSED MEDIUM DENSITY BLOCK

🟨 EXISTING WOODLOT

🟧 PROPOSED SCHOOL BLOCK

🟦 PROPOSED COMMERCIAL BLOCK

▨ PROPOSED SWM FACILITY



BURNSIDE

Figure Title

NW FERGUS SECONDARY PLANNING AREA DRAFT PLAN APPLICATION

PROPOSED ROAD GRADING PLAN

Client

NIGUS FERGUS JOINT VENTURE INC.

Drawn	Checked	Date	Figure No.
EDT	LN	2016-11-30	**FIG 8**
Scale		Project No.	
1:5000		300031145	

6.2 Existing Storm Drainage

The existing site topography slopes gently towards both the Nichol and unnamed drain with an average slope of 3% in the areas draining directly to the Nichol Drain and a shallower sloping of approximately 1.5% towards the unnamed drain. The unnamed drain collects drainage from a large external catchment area and conveys it through the property to the Nichol Drain. This catchment area totals approximately 42.09 ha and is largely agricultural land.

There are pockets of land in the south and north-west corners of the study area that drain directly off site. Approximately 7.13 ha of land in the south-west corner of the site drains to the existing Colborne Street ditch and ultimately to the woodlot south of the subject lands. In the north-west portion of the property approximately 2.92 ha of the subject lands drain towards the western limits of the woodlot.

A small external area, totaling 2.14 ha, located south of the existing Colborne Street drains directly onto the south-east corner of the property via an existing culvert. The existing drainage areas are highlighted on Figures 9 and 10.

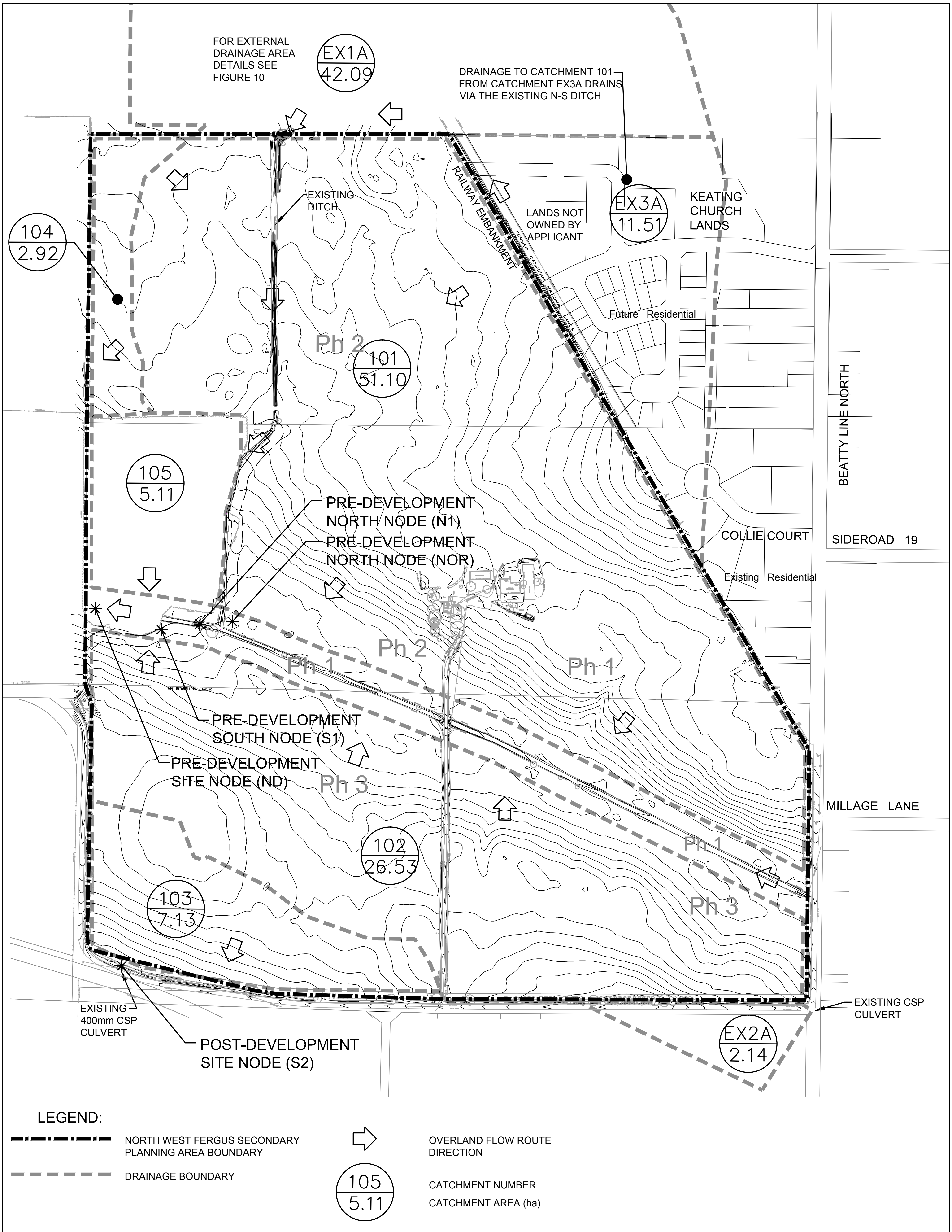
6.3 Proposed Storm Drainage

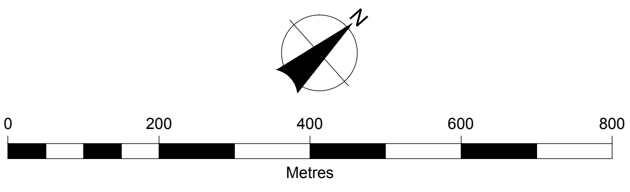
The post-development drainage scheme generally follows the existing drainage patterns. As identified in the Secondary Planning Process, two (2) stormwater management facilities are proposed for the site. The facilities are sited on the north and south limits of the Nichol Drain at the eastern limits of the proposed development. Both of the facilities, detailed in the sections following, will discharge to the Nichol Drain.

The proposed tile drain outlet will be enclosed, as part of the development of the land, from the northern limit of the Draft Plan to the north-east corner of the buffers established for the existing wetland / woodlot area. The flow from the area tributary to the drain will be conveyed within a separate pipe system which will be located within the proposed rights-of-way in the future phase. The preliminary alignment of the cleanwater system is depicted along Street A to the proposed discharge point. The elevations of the infrastructure have been reviewed to confirm that there will be no crossing conflict.

As much as possible, minor system post-development flows for the site will be directed to the stormwater management facilities via a local storm sewer network. Major system flows will be routed to the stormwater management facilities via roads and overland flow routes as required. There is a small portion of the south-west corner of the property which will drain directly to the existing Colborne Street ditch. Draining this area to the SWM pond causes significant grading challenges. Additionally, it is proposed that the multi-use block will be serviced through an on-site system with direct discharge to the Nichol Drain. The proposed stormwater treatment details for each of these areas are included in the sections following.

The storm drainage infrastructure for the development is highlighted on Drawing STM1, the proposed general drainage areas are highlighted on Figure 11.





BURNSIDE

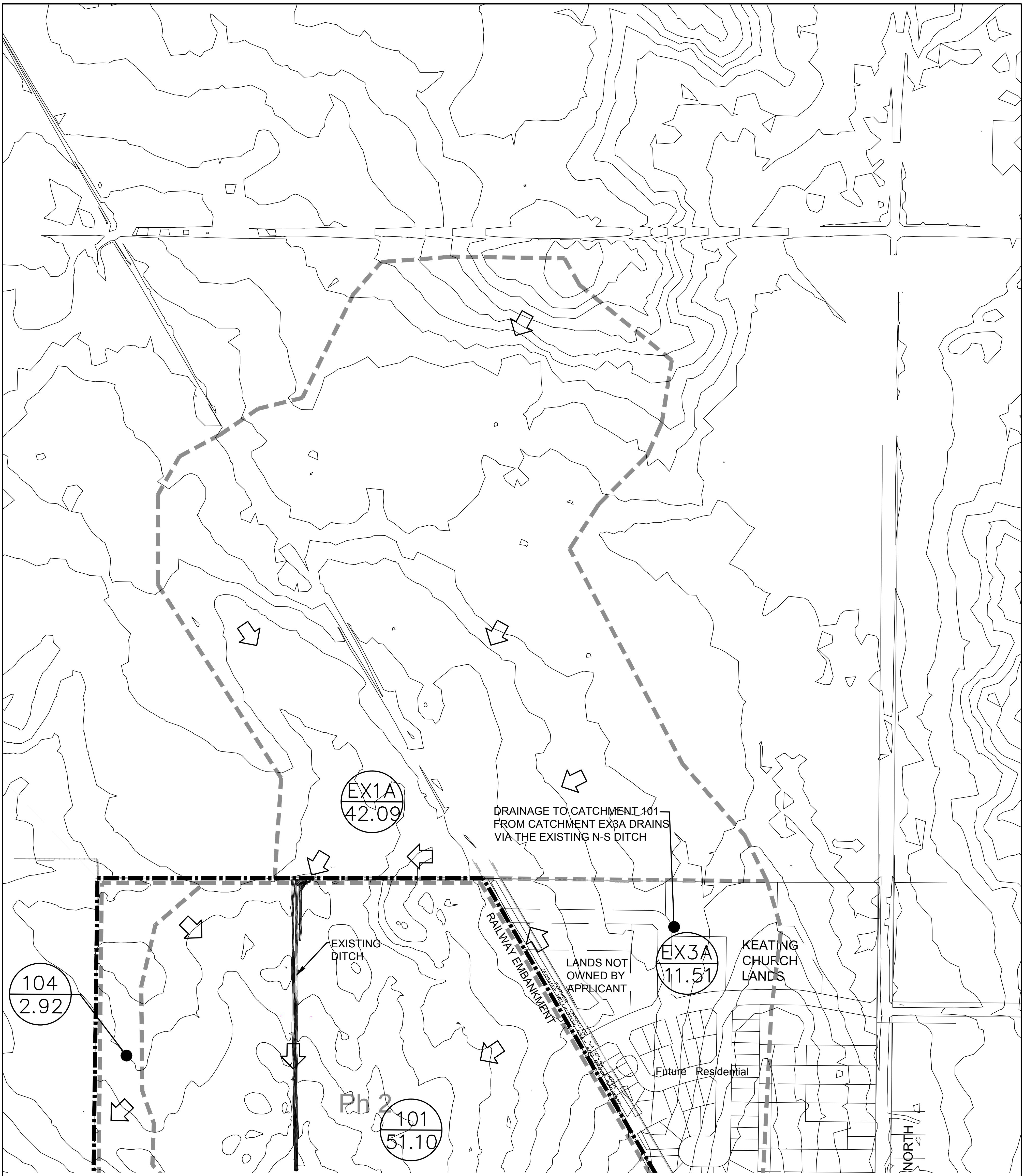
Figure Title

NW FERGUS SECONDARY PLANNING AREA
DRAFT PLAN APPLICATION
EXISTING DRAINAGE BOUNDARIES

Client

NIGUS FERGUS JOINT VENTURE INC.

Drawn	Checked	Date	Figure No.
PAG	LN	2016-11-30	**FIG 9**
Scale		Project No.	
1:5000		300031145	



LEGEND:

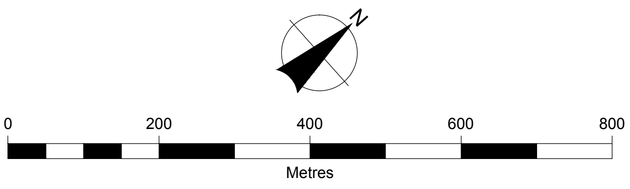
▬ · ▬ · ▬ NORTH WEST FERGUS SECONDARY PLANNING AREA BOUNDARY

– – – – DRAINAGE BOUNDARY

⇨ OVERLAND FLOW ROUTE DIRECTION

105 CATCHMENT NUMBER

5.11 CATCHMENT AREA (ha)



BURNSIDE

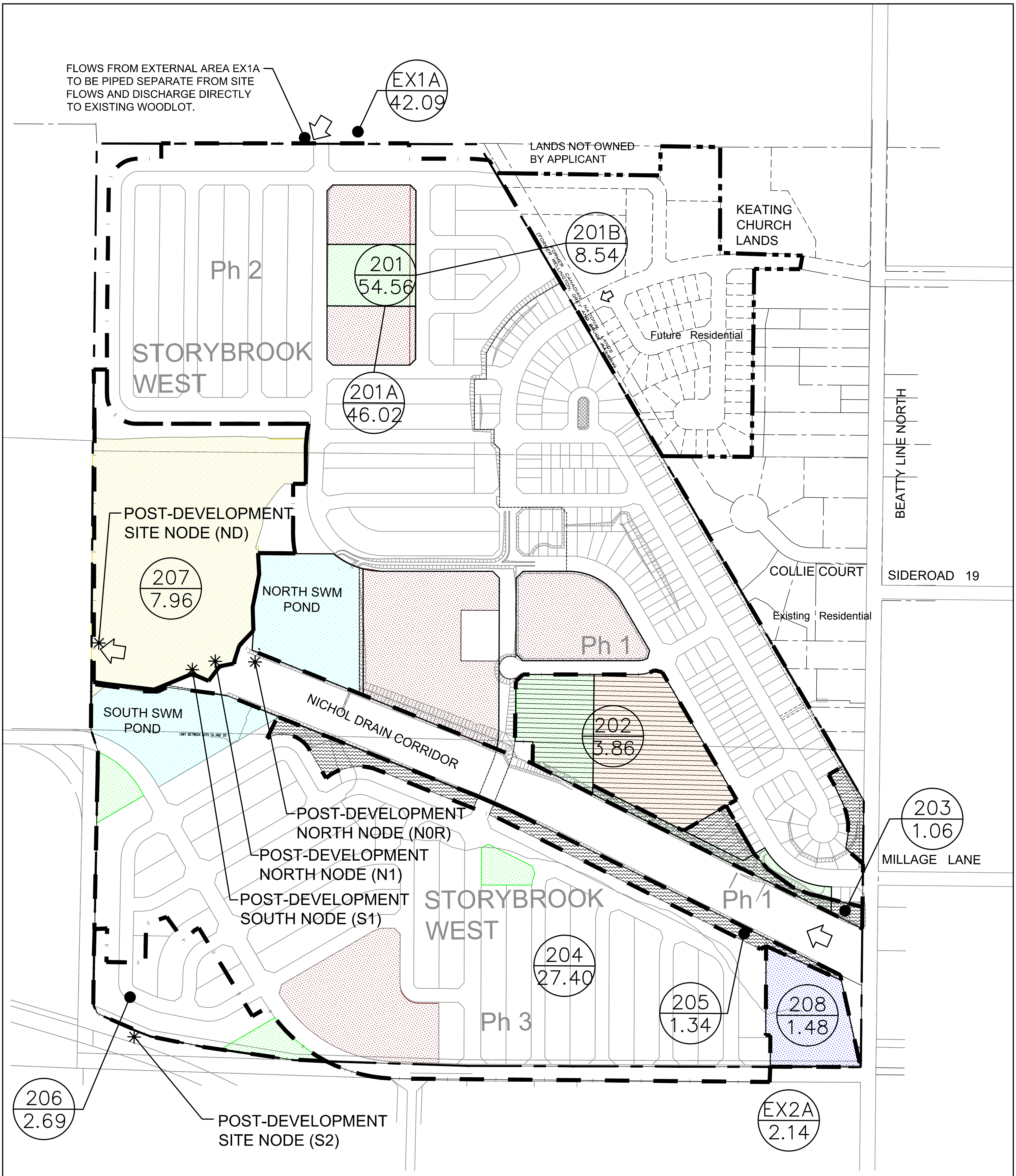
Figure Title

NW FERGUS SECONDARY PLANNING AREA
DRAFT PLAN APPLICATION
EXISTING EXTERNAL DRAINAGE BOUNDARIES

Client

NIGUS FERGUS JOINT VENTURE INC.

Drawn	Checked	Date	Figure No.
RS	LN	2016-11-30	**FIG 10**
Scale		Project No.	
1:5000		300031145	



LEGEND:

STORYBROOK SUBDIVISION BOUNDARY

PROPOSED PHASING LIMITS

DRAINAGE BOUNDARY

EXTERNAL AREA BYPASS STORM SEWER

⇨ OVERLAND FLOW ROUTE DIRECTION

▤ MINOR FLOW CONTROLLED, MAJOR FLOW UNCONTROLLED

▨ MINOR FLOW UNCONTROLLED, MAJOR FLOW UNCONTROLLED

202 / 24.01 — CATCHMENT NUMBER / CATCHMENT AREA (ha)

🟧 PROPOSED SCHOOL BLOCK

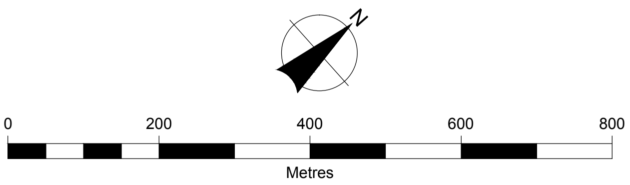
🟦 PROPOSED SWM FACILITY

🟩 PROPOSED PARK BLOCK

🟥 PROPOSED MEDIUM DENSITY BLOCK

🟨 EXISTING WOODLOT

🟦 PROPOSED COMMERCIAL BLOCK



BURNSIDE

Figure Title

STORYBROOK SUBDIVISION
PHASE 1
PROPOSED DRAINAGE BOUNDARIES

Client	Drawn	Checked	Date	Figure No.
NIGUS FERGUS JOINT VENTURE INC.	PAG	LN	2016-11-30	**FIG 11**
	Scale		Project No.	
	H 1:5000		300031145	

6.3.1 Minor Storm Conveyance

The minor storm system will be a series of storm sewers sized to convey the 5-year return period storm as per the Township of Centre Wellington standard. The storm sewers will follow the right-of-ways and easements within the proposed development and ultimately outlet to the stormwater management ponds or proposed discharge points. There will be two (2) stormwater management facilities as noted above. The preliminary sizing of the storm sewers is included in Appendix C.

Phase 1 of the proposed development does not include the extension of the public road to the stormwater management facility. As part of this phase of Draft Plan development, a series of stormwater conveyance easements / blocks will be required in order to connect the development to the storm pond. At final build-out of the Draft Plan, the minor storm conveyance system will follow the right-of-way or permanent easement / block as identified below.

The storm sewer network is designed to convey storm flows for the proposed secondary planning area as well as the adjacent Beatty Hollow subdivision as noted above. The storm sewers are not designed to accommodate the development of the lands to the north of the property. Based on current grading conditions, it is anticipated that this area will be developed with standalone stormwater conveyance and management. The northern area drains entirely to the existing tile drain outlet, as further outlined below the proposed enclosure of the drain will be sufficiently designed to accommodate the existing 100-year flows from the upstream drainage area. The proposed design will allow for the future development of this area to connect to the drain enclosure with post to pre stormwater management controls.

The proposed northern stormwater management pond and drainage system has been designed to accommodate multiple storm sewer sub-trunks and pond inlets. As identified on Drawing STM1, there are two (2) pipes proposed to inlet to the stormwater management facility from Street A. The two (2) pipes will be accommodated with a single headwall into the forebay of the pond. This approach minimizes the inlet sewer sizing by dividing the flows within the northern catchment into two (2) individual systems. The result of the multiple pipes is a significant reduction in the earthworks required to provide sufficient cover over the proposed storm sewers.

An additional inlet is proposed into the northern stormwater management facility to be located along the north limits of the Nichol Drain. This storm sewer is required in order to drain the southern length of Street B, the eastern limits of Street A and Street H. Due to the existing elevations at the connection with Millage Lane, there would be inadequate cover on a storm sewer located entirely within the right-of-way. The proposed storm sewer will be located within the block, coincident with the proposed trail connection to the park. The park block pipe has also been sized sufficiently to convey the flows from the existing Collie Court subdivision, if required.

Through the Colborne Street EA and Secondary Planning process, landowners on Collie Court and Beatty Line have identified concern with the existing drainage at the rear of their properties, which back onto the rail corridor abutting the Nigus lands. Discussions with the Township Engineers have led to the identification of the rear of these lots as being subject to a drainage / stormwater management control easement. The initial conclusion is that the facility is functioning as designed. Preliminary discussions have taken place with the Municipality to review options with respect to the Collie Court Drainage and a proposed approach has not yet been determined. Given that this matter is currently under review, the preliminary sizing of the minor flow conveyance system includes an allowance for the input of the 100-year flows from the existing facility. Further discussion and agreements between the Municipality, the Collie Court Residents and Nigus will be required with respect to construction and cost sharing if this solution is carried forward.

The proposed southern stormwater management pond and drainage system has been designed to accommodate multiple storm sewer sub-trunks and pond inlets. As identified on Drawing STM1, there are two (2) proposed forebays for the stormwater management facility. The inlet into the forebay within the southern portion of the pond conveys drainage from the southwestern part of the site to the pond with discharge into the pond at the Colborne Street / Street U intersection. The second inlet is proposed to be located at the north-east corner of the pond block, along the south limits of the Nichol Drain. The north forebay inlet will discharge to the pond block via an easement through the residential lots separating Street U and the pond block. The two (2) inlets are proposed in order to ensure the provision of sufficient cover on the proposed storm sewers and appropriate interface with existing grades around the perimeter of the proposed draft plan.

Within the southern catchment, a small drainage area is proposed to be conveyed to the existing Colborne Street ditch/culvert. The majority of this area is park and rear yards with a minor portion of proposed road and storm sewer that will also be directed to the outlet. This outlet will serve to maintain the conveyance of flow to the southern wetland per existing conditions. The table below identifies the proposed drainage areas, discharge points and associated flow and pipe size requirements.

Table 3: Preliminary Storm Sewer Flow Calculations

Phase	Drainage Area (ha)	Calc. Flow (m^3/s)	Req. Pipe Size (mm)
North of Nichol Drain			
External Keating Lands	8.54	1.025	
North East Catchment	12.90	1.050	
Sub Total North-East Inlet	**21.46**	**2.075**	**1050**
North West Catchment	22.35	1.911	

Sub Total North-West Inlet	**22.35**	**1.911**	**1200**
Collie Court	1.60	0.192	
Easement Catchment	11.93	1.028	
Sub Total South Inlet	**13.23**	**1.028**	**1050**
Total North Pond	**57.04**	**5.194**	
South of Nichol Drain			
South East Catchment	16.19	1.164	900x1800 Box
South West Catchment	9.66	0.986	975
Total South Pond	**26.15**	**2.150**	
Colborne St. Ex. Culvert	2.69	0.223	525
Total Colborne St. Ex. Culvert	**2.69**	**0.145**	**525**

6.3.2 Major Storm Conveyance

The major system flow route will follow a combination of proposed right-of-ways and overland flow blocks to convey overland flows from major storm events, up to and including the 100-year storm event. The major system flows will be directed to the proposed stormwater management facilities. The entire 100-year flow will be contained within the major system flow route. During detailed design, flow capacity calculations will be completed to ensure the overland flow route is sufficiently sized to accommodate the flow. As the grading becomes more refined during detailed design, if the major flow exceeds the capacity of the right-of-way, there may be some oversize piping required to ensure containment of the flow within the right-of-way limits. As noted previously, the overland flow route to the north inlet of the south stormwater management facility will be accommodated within the proposed easement connecting Street U and the pond block. In addition, the overland flow route to the south culvert will be accommodated within the easement connecting the existing ditch to Street V.

As part of the Phase 1 development, multiple overland flow routes will be required and designed specifically to convey both the overland and minor system flows from the developed roads to the proposed facility. For the most part, the overland flow routes will be located adjacent to the ultimate location of the right-of-way to be developed in future phases. This approach will limit constraints during installation of future services within the right-of-way.

6.3.3 External Drainage Conveyance

As noted previously, the majority of the adjacent Keating subdivision will drain through the site and be accommodated within the north stormwater management facility.

Under existing conditions, the tile drain outlet conveys flows from an upstream drainage area of approximately 42.09 ha to the Nichol Drain. As identified on Drawing STM1, under post-development conditions it is proposed that this drainage will be accommodated and conveyed within a dedicated pipe to the northern limits of the existing woodlot / wetland feature. The proposed pipe is sized to accommodate the existing 100-year storm flow from the drainage area as identified in the table below (Appendix C). During detailed design, or at future Draft Plan stages, the proposed conveyance of the upstream flow can be reviewed and further refined as more detailed grading and servicing information is available.

Table 4: Tile Drain Outlet Conveyance System

Drainage Area (ha)	Calculated 100-Year Flow (m^3/s)	Pipe Size	Pipe Slope
42.09	2.546	900 mm x 1800 mm box culvert	0.30%

The sizing noted above will allow for the future development of the northern catchment through provision of a discharge system.

The development of the northern property will require the implementation of stand-alone treatment for both stormwater quality and quantity control including post- to pre- quantity for the 100-year storm event.

The preliminary alignment of the tile drain outlet conveyance system is depicted along Streets A and N to the proposed discharge point to avoid crossing conflict with the proposed storm sewer system. During detailed design the final profile and alignment of the proposed conveyance system will be established. The preliminary design, including inverts and sizing, is identified on Drawing STM1.

6.3.4 Foundation Drain Collector System

A foundation drain collector (FDC) system is required for portions of the Phase 1 and Storybrook West development areas where the foundations will be sited within 0.6 m of the Seasonal High Groundwater Elevation. Based on the previous hydrogeological studies and the ongoing works being completed by Burnside, a contour plan of the SHGW elevations has been established and was used to determine the anticipated location of the required FDC system.

Within the Phase 1 area, the FDC is located largely in the south-east portion of the development and is routed with direct discharge to the Nichol Drain. Within the Storybrook West development area, the portion of the property north of the Nichol Drain requiring an FDC is in close proximity to the Phase 1 area and entirely east of the extension of Street A. The north portion of the Storybrook West Development will be serviced by a separate FDC system than Phase 1. The Storybrook West FDC will be routed through the Municipal ROW and along the North Pond limit, with direct discharge to Nicol Drain, via the stormwater management block.

Within the south portion of the Storybrook West Development Area, three (3) separate FDC systems are proposed. For the area east of, and including Farley Street, and portion of Streets R, S and T, the FDC will be routed for discharge to Nichol Drain in proximity to the proposed road crossing. For the remainder of Streets S and T as well as Streets V, the FDC will discharge directly to the Colborne Street ditch, along with the proposed storm sewer. A third FDC system will be routed along the eastern limit of the south SWM Pond to service Streets U, W and portions of N and will discharge into the Nichol Drain. Based on the preliminary grading plan for this area, the majority of the units will be sited within the SHGW elevation and will be below the 100-year flood elevation within the drain at the discharge location. For this specific area it is proposed that the units will be fitted with both a gravity connection with back flow preventer draining to the FDC, with discharge to the Nichol Drain, as well as a back-up sump pump system that will pump to grade. The sump pump would only be operating during conditions where the Nichol Drain floodline elevation is at, or above the elevation of the gravity connection to the FDC. This condition will only occur during period of less frequent flow within the Nichol Drain at or exceeding, at minimum, the 5-year floodline event. The preliminary design, including inverts, drainage areas and sizing, is identified on Drawing FDC1.

7.0 Stormwater Management

7.1 Background

The guidelines and criteria for stormwater management within the study area are set out in the Nichol Drain No. 1 Subwatershed Study, completed in 2008 by Aquafor Beech Limited and were confirmed as part of the Secondary Planning process. The stormwater management for the proposed Draft Plan will be achieved through the use of two (2) off-line stormwater management wet ponds, located on either side of the Nichol Drain. The design of these stormwater management facilities will be based on Township of Centre Wellington, MOE and Grand River Conservation Authority design criteria.

7.2 Existing Hydrologic Conditions

The computer model SWMHYMO was used to simulate peak flow rates for different design storms based on the existing conditions of the site. The Chicago 4-hour rainfall distribution from the Fergus Shand Dam IDF values was used to generate each storm event. As the Nichol Drain bisects the property, the simulation is split into two (2) catchments, the North and South catchments. These catchments are further divided into a number of sub-catchments based on the localized drainage. The existing drainage areas and flow directions are outlined on Figures 9 and 10.

7.2.1 South Catchment

The south catchment area covers approximately 33.66 ha of the SPA located south of the Nichol Drain. Approximately 26.53 ha, of this area drains via sheet flow directly to the Nichol Drain while the remaining 7.13 ha drains via sheet flow to a wetland complex located south of Colborne Street via a 400 mm diameter CSP culvert. There is an external area of approximately 2.14 ha which flows into the site in the south-west corner via an existing CSP culvert under Colborne Street. This area drains via the Beatty Line roadside ditch and drains directly to the Nichol Drain.

7.2.2 North Catchment

The catchment area within the SPA to the north of the Nichol Drain totals approximately 59.13 ha. The area is comprised of 51.10 ha which drains into the Nichol Drain either directly or via the unnamed tile drain outlet (TDO) and 8.03 ha, located along the west boundary of the site, which contributes directly to the Nichol Drain via the woodlot / wetland area.

A total of approximately 53.60 ha of external drainage are directed through the subject property via the tile drain outlet. Approximately 42.09 ha of the external area comes from the agricultural fields to the north of the subject site with an additional 11.51 ha of area contributing from the adjacent Beatty Hollow Subdivision, to the north-east of the

SPA. The Beatty Hollow Subdivision enter the system via a DICB which outlets to the TDO.

7.3 Proposed Hydrologic Conditions

Based on the location of the Nichol Drain, the proposed Draft Plan area is divided into two (2) distinct catchments, each requiring a separate stormwater management facility.

A hydrologic model has been created to simulate the anticipated post-development peak stormwater runoff rates for all design storm events. This model takes into account development type for each sub-catchment. The assumed impervious values are shown below:

- School – 65%
- Low Density Residential Area – 55%
- Medium Density Residential Area – 65%
- Parks – 10%
- Pond Block – 50%
- Commercial – 90%
- Beatty Hollow Subdivision – 47%

A composite percent impervious for both catchments was calculated at 53.5% for the north catchment and 54.5% for the south catchment area draining to the pond. Post-development sub-catchment areas and corresponding drainage areas are shown on Figure 11.

7.3.1 North Catchment

The north catchment includes all development land located on the north side of the Nichol Drain. The function of the existing TDO that conveys the runoff from the external area (sub-catchment EX1A) north of the Secondary Planning Area to the Nichol Drain must be maintained. It is proposed to maintain the function of the TDO drain via by-pass piping which will follow the North-South Collector Road and outlet directly into the existing TDO at the northeast corner of the woodlot. This allows the external area(s) to by-pass the proposed stormwater management facility and also allows for the area west of the existing alignment of the TDO to be conveyed to the proposed stormwater management facility.

An agreement is in place between Nigus Fergus Joint Venture Inc. and the adjacent property owner (Keating) that the majority of the drainage from the Beatty Hollow Subdivision will be conveyed through the subject property to the proposed north stormwater management facility. Based on the current design prepared by GM Blue Plan for the subdivision, the drainage area from the Beatty Hollow Subdivision lands that will be directed to the north SWM facility totals 8.54 ha (sub-catchment 201B).

7.3.2 South Catchment

The south catchment includes the majority of the development located on the south side of the Nichol Drain with the exception of the park block, and a small portion of residential development in the south west corner of the site as well as the Mixed Use/Commercial Block in the north-east corner of the south catchment. Sub-catchment 204, which represents the majority of the south catchment, is approximately 27.40 ha in area. This is generally the area which currently drains to the Nichol Drain and the overall grading pattern will be maintained under post-development conditions with all stormwater runoff being directed to the SWM facility.

Sub-catchment 206 is approximately 2.69 ha. This area falls within the catchment that currently drains in a southerly direction, away from the Nichol Drain and off the Secondary Planning Area property to a wetland complex on the south side of Colborne Street. Under post-development conditions the flow from catchment 206 will continue to be conveyed toward the wetland complex on the south side of the existing Colborne Street alignment. Given that the proposed land use includes portions of residential development, alternate stormwater management quality control will be required prior to discharge to the wetland. There is no required quantity treatment for the runoff from this catchment because the post-development flows to the existing wetland are maintained below the pre-development levels for all storm events.

Sub-catchment 207 is approximately 1.48 ha in size. This area currently drains to the Nichol Drain under existing conditions. Due to the grading and servicing limitations of the site, it is proposed that this development area will provide on-site controls to achieve both quantity and quality treatment for the post-development runoff, with proposed direct discharge to the Nichol Drain.

7.4 Proposed Stormwater Management Ponds

As noted, the stormwater management approach for the SPA requires two (2) stormwater management wet ponds to ensure adequate quality and quantity control of the post-development runoff. Criteria for the stormwater management pond design were established as part of the Secondary Planning Process with the Township and GRCA and are consistent with MOE requirements. The following criteria are required:

- Quality Control: Level 1 (Enhanced).
- Erosion Control: 24-hour retention of 25 mm runoff event.
- Quantity Control: Post- to Pre-Control for 2- through 100-year storm events.
- Thermal Mitigation measures associated with cold water receiver for discharge to the Nichol Drain.

7.4.1 Quantity Control

The pre-development peak flow rates for the 2- through 100-year events are summarized in Table 5 below. The flow rates have been calculated at specific nodes for comparison purposes under post-development conditions. The nodes, as identified on Figure 11, represent the flows entering the Nichol Drain from the North Catchment (Node N1) and the South Catchment (Node S1). The total site contributions to the Nichol Drain, including the external flows within the TDO are reflected by Node ND. Flows leaving the site under Colborne Street via the South Culvert are identified at Node S2. The hydrologic flow charts and SWMHYMO runs for all storms are included as Appendix D.

Table 5: Pre-Development Peak Flow Rates

Storm Event	Pre-Development Peak Flows (cms)			
	Node N1	Node S1	Node S2	Node ND
2-Year	1.083	0.283	0.138	1.443
5-Year	2.282	0.586	0.277	3.030
10-Year	3.246	0.828	0.387	4.307
25-Year	4.631	1.174	0.543	6.142
50-Year	5.777	1.461	0.671	7.663
100-Year	6.985	1.762	0.804	9.265

7.4.2 Quality Control

The two (2) stormwater management facilities will be sized in accordance to the MOE requirements for the provision of Level 1 Quantity Control.

Extended Detention volume for each facility will be provided to meet the greater of the 40 m^3/ha noted in the MOE manual or the equivalent runoff from the 25 mm storm event. The extended detention will be released over a minimum 24 hour period.

For the proposed catchments that are not being directed to the stormwater management facilities for quality control a combination of treatment measures will be incorporated to ensure the provision of the 80% TSS removal associated with Level 1 quality control.

The commercial/mixed use site will require a combination of an Oil Grit Separator (OGS) along with surface flow over vegetated area to ensure sufficient sediment removal/filtration. Either the vegetated area immediately east of the parcel or the 30 m Nichol Drain corridor provides opportunity for planting enhancements downstream of the OGS discharge.

Similarly, the proposed portion of the development in the south west corner which drains to the existing Colborne Street Ditch/Culvert and ultimately the off-site wetland to the south, will require Level 1 quality control treatment. A portion of this drainage area is rear yard and park block, both of which are considered “clean runoff” sources. The portion of the area which drains towards the storm sewer, including driveways and roads, will require quality control measures.

The proposed approach for achieving the required quality control for this area includes the provision of an OGS at the downstream limits of the storm sewer system. The OGS will discharge to the existing Colborne Street ditch which will provide additional treatment prior to release into the wetland. Extended detention is not proposed for this receiver as the post-development flows are lower than the existing pre-development flows as detailed in the sections below.

7.4.3 Pond Locations

The stormwater management ponds have been located at the lowest points and on either side of the Nichol Drain; these locations will adequately service the Nigus lands. The pond outlets will be directed into the Nichol Drain. The flood outlets will be above the 100-year floodline within the drain to allow for free discharge of stormwater from the pond during 2- through 100-year storm events.

7.4.4 North Pond Design

The North Pond stormwater management facility is located on the north side of the Nichol Drain adjacent to the existing woodlot. The following table summarizes the operating characteristics for the North Pond and the storage volumes required to meet the design criteria.

Table 6: Summary Table for North Pond

Drainage Area = 58.43 ha | % IMP= 53.5

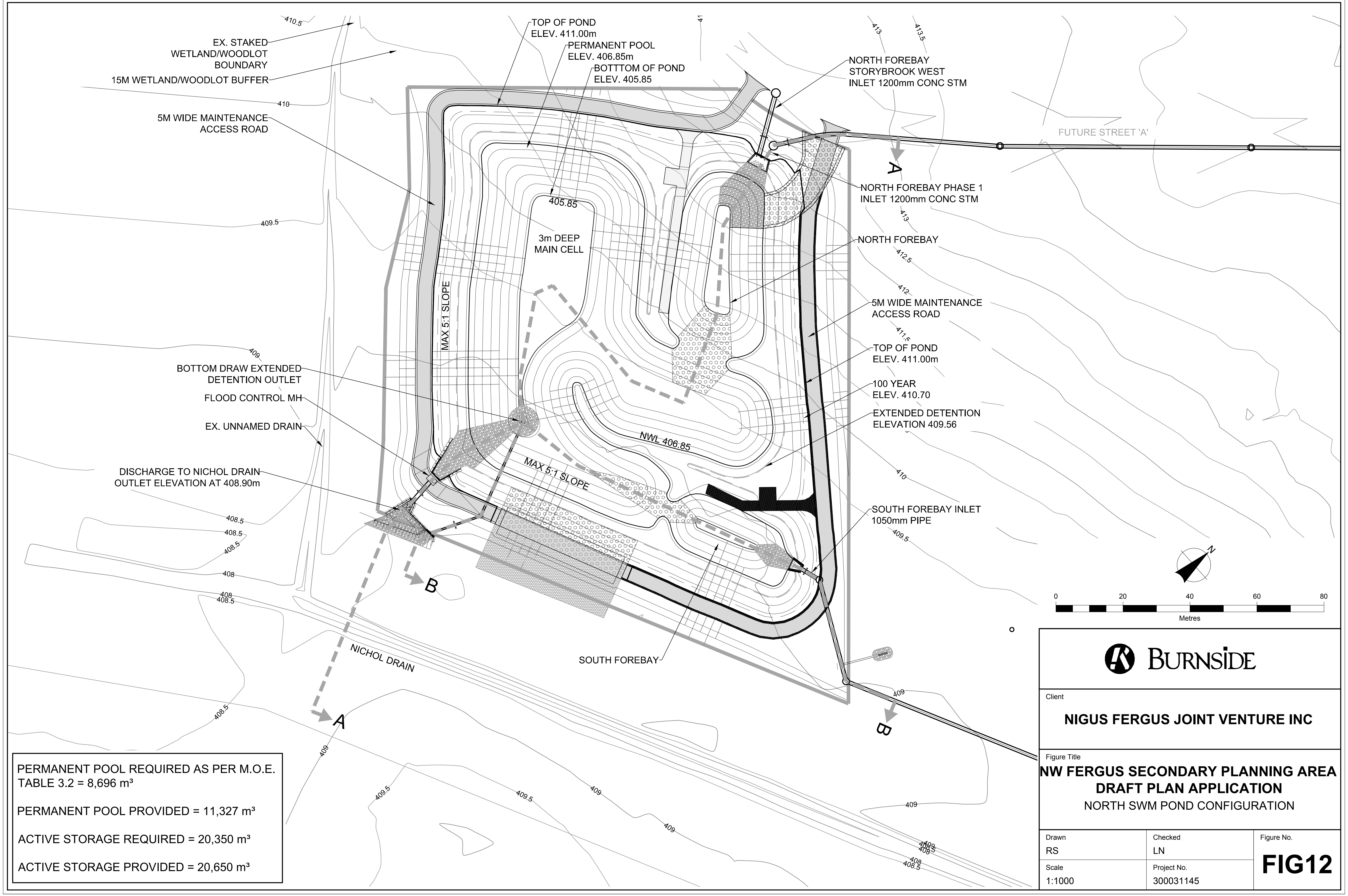
Pond Block Area = 2.17 ha

Permanent Pool Required = 146 m^3/ha x 59.49 ha = 8,696 m^3
Permanent Pool Provided = 11,327 m^3
Max Depth = 3.0 m
Permanent Pool Elevation = 408.85 m

Erosion Control
SCS Method – Extended Detention (ED) Required = 6,803 m^3
ED Active Storage Provided = 6,850 m^3
Depth = 0.71 m

Return Event	Pond Out-Flow (m^3/s)	Storage Volume (m^3)	Water Elevation (m)
2-Year	0.328	8,100	409.68
5-Year	1.086	11,200	409.95
10-Year	1.773	13,350	410.13
25-Year	2.783	16,150	410.35
50-Year	3.632	18,250	410.52
100-Year	4.497	20,350	410.70

Calculations associated with the stormwater management pond sizing are included in Appendix D. Figures 12 and 13 illustrate the proposed North Pond configuration and section including minor grading around the pond.



PERMANENT POOL REQUIRED AS PER M.O.E. TABLE 3.2 = 8,696 m³

PERMANENT POOL PROVIDED = 11,327 m³

ACTIVE STORAGE REQUIRED = 20,350 m³

ACTIVE STORAGE PROVIDED = 20,650 m³

BURNSIDE

Client

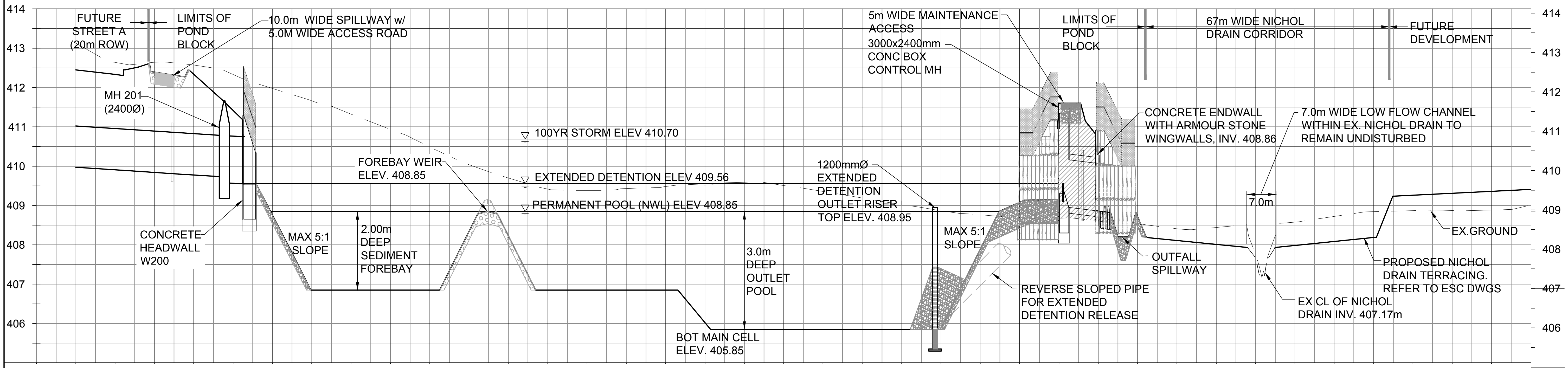
NIGUS FERGUS JOINT VENTURE INC

Figure Title

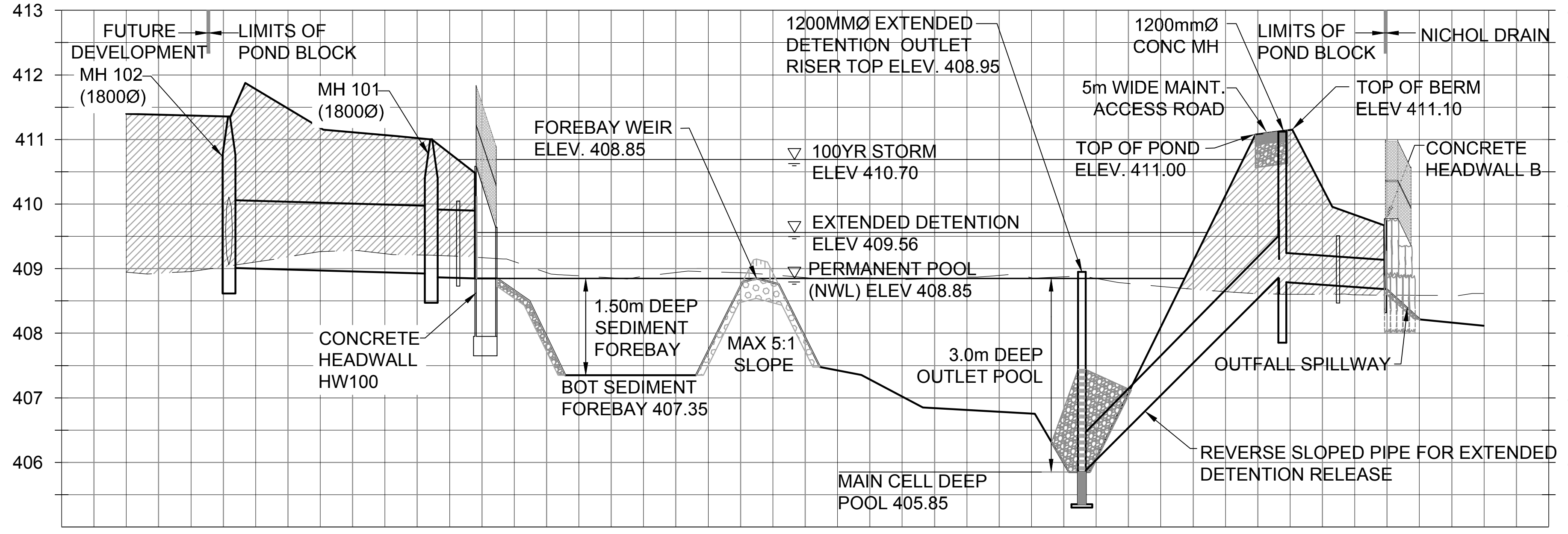
NW FERGUS SECONDARY PLANNING AREA
DRAFT PLAN APPLICATION
NORTH SWM POND CONFIGURATION

Drawn RS	Checked LN	Figure No. FIG12
Scale 1:1000	Project No. 300031145	

File Name: 031145 FSR FIG12.dwg Date Plotted: December 14, 2016 - 4:12 PM



SECTION A-A



SECTION B-B

BURNSIDE

Client

NIGUS FERGUS JOINT VENTURE INC

Figure Title

NW FERGUS SECONDARY PLANNING AREA
DRAFT PLAN APPLICATION
NORTH SWM POND SECTIONS
(WITH KEATING FLOWS)

Drawn	Checked	Date	Figure No.
R.S.	L.N.	2015-07-08	**FIG13**
Scale		Project No.	
H 1:1000 V 1:100		300031145	

File Name: 031145 FSR FIG13.dwg Date Plotted: December 14, 2016 - 4:17 PM

7.4.5 South Pond Design

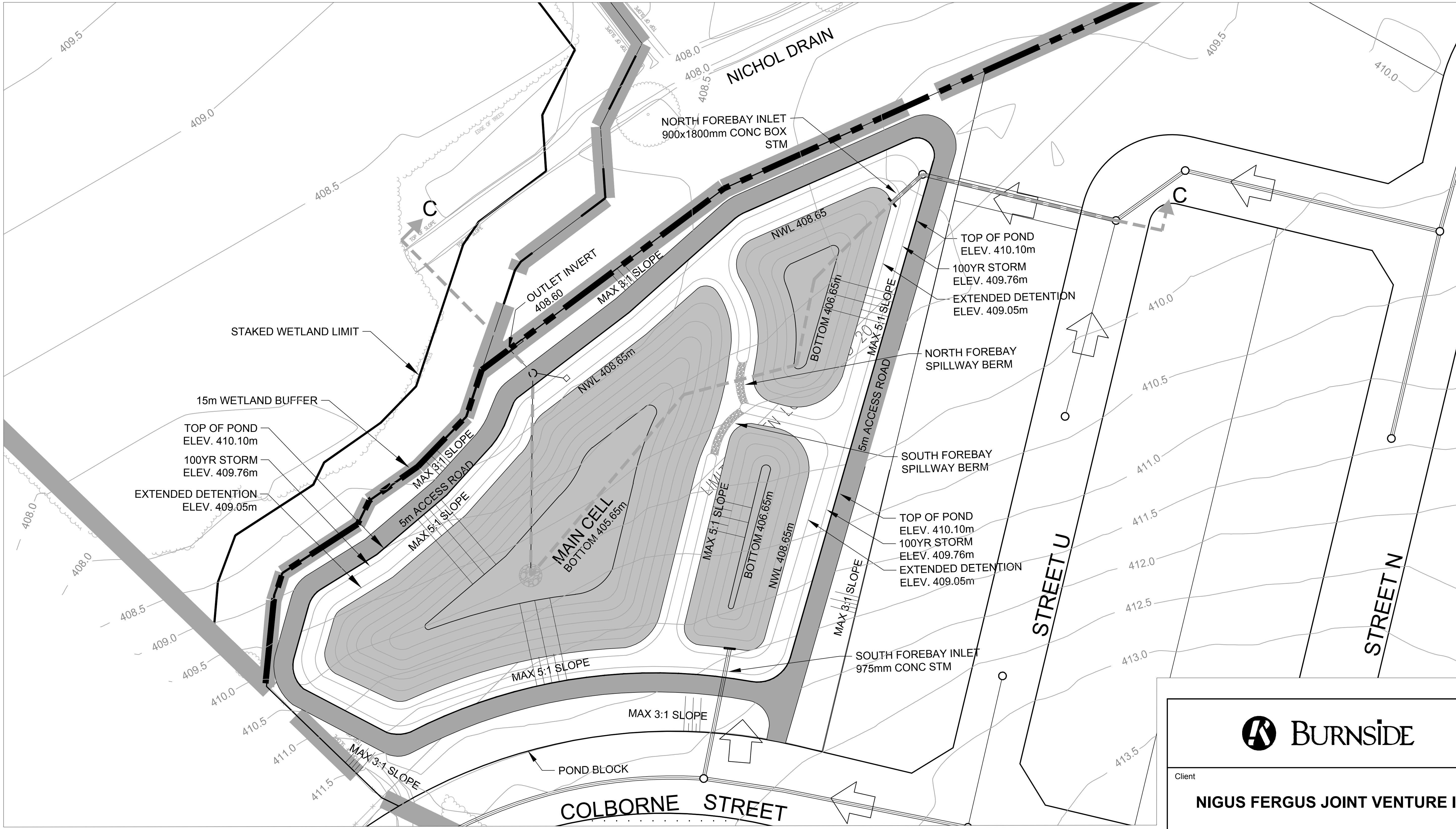
The south stormwater management pond is located on the south side of the Nichol Drain, adjacent to the western property boundary. The following table summarizes the operating characteristics for the South Pond and the required volumes to meet the design criteria.

Table 7: Summary Table for South Pond

Drainage Area	=	27.40 ha	% IMP = 54.5
Pond Block Area	=	1.88 ha	
Permanent Pool Required	=	149.9 m^3/ha	x 27.37 ha = 4,077 m^3
Permanent Pool Provided	=	11,486 m^3	
Max Depth	=	3.0 m	
Permanent Pool Elevation	=	408.65 m	
Erosion Control			
SCS Method – Extended Detention (ED) Required	=	3,232 m^3	
ED Active Storage Provided	=	3,506 m^3	
Depth	=	0.40 m	

Return Event	**Pond Out-Flow (m^3/s)**	**Storage Volume (m^3)**	**Water Elevation (m)**
2-Year	0.212	3,612	409.06
5-Year	0.523	5,149	409.20
10-Year	0.765	6,387	409.32
25-Year	1.068	8,089	409.48
50-Year	1.352	9,447	409.61
100-Year	1.628	10,790	409.76

Figures 14 and 15 illustrate the South Pond configuration and sections, including minor grading around the pond.



LEGEND

DEVELOPMENT LIMITS

MAJOR OVERLAND FLOW ROUTE

412.0 EXISTING CONTOUR

PERMANENT POOL REQUIRED AS PER M.O.E. TABLE 3.2 = 4,077 m³

PERMANENT POOL PROVIDED = 12,095 m³

ACTIVE STORAGE REQUIRED = 10,790 m³

ACTIVE STORAGE PROVIDED = 11,486 m³

N

0 20 40 60 80
Meters

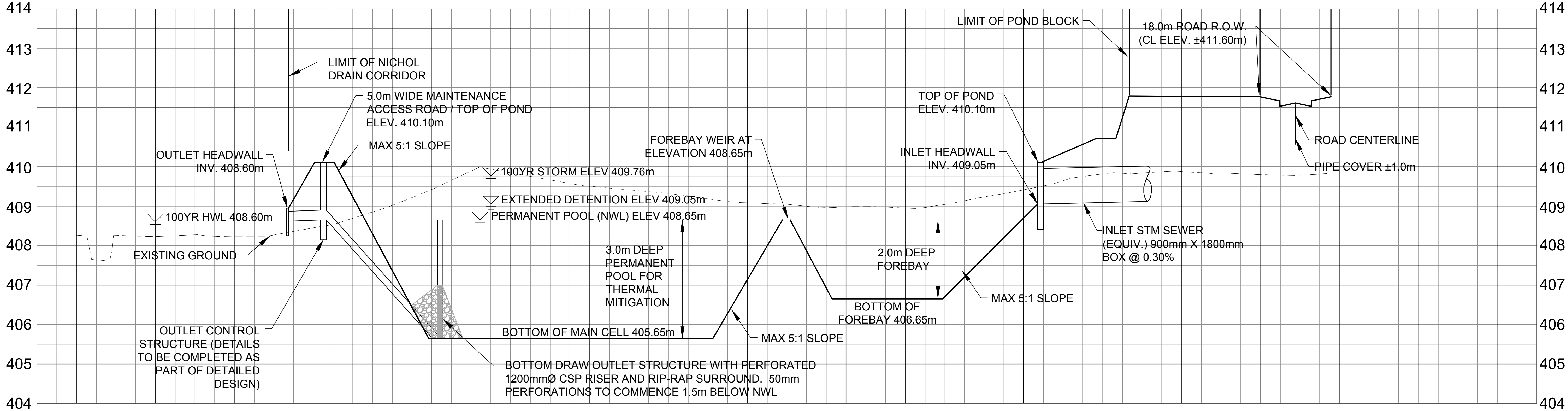
BURNSIDE

Client
NIGUS FERGUS JOINT VENTURE INC

Figure Title
NW FERGUS SECONDARY PLANNING AREA
DRAFT PLAN APPLICATION
SOUTH SWM POND CONFIGURATION

Drawn	Checked	Date	Figure No.
PAG	LN	2016-11-30	FIG14
Scale		Project No.	
1:1000		300031145	

File Name: 031145 FSR FIG14.dwg Date Plotted: February 21, 2018 - 2:22 PM



SECTION C-C
SOUTH POND SECTION

SCALE HOR 1:1000
VER 1:100

BURNSIDE

Client

NIGUS FERGUS JOINT VENTURE INC

Figure Title

NW FERGUS SECONDARY PLANNING AREA
DRAFT PLAN APPLICATION
SOUTH SWM POND SECTION

Drawn	Checked	Date	Figure No.
PAG	LN	2016-11-30	**FIG15**
Scale		Project No.	
AS SHOWN		300031145	

File Name: 031145 FSR FIG15.dwg Date Plotted: February 21, 2018 - 2:11 PM

7.4.6 Total Post-Development Flows

The following table summarizes the net storm flows from the subject property under both pre and post-development conditions. Based on the configurations outlined above, the controlled rates leaving the site will be below the pre-development rates for all storms from the 2-through 100-year storm events to all outlets.

Table 8: Flow Rate Summary

Storm Event	Flow Rates (m^3/s)							
	Node N1		Node S1		Node S2		Node ND	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
2-Year	1.083	0.697	0.283	0.218	0.138	0.107	1.443	0.951
5-Year	2.282	1.966	0.586	0.545	0.277	0.226	3.030	2.620
10-Year	3.246	2.949	0.828	0.802	0.387	0.287	4.307	3.938
25-Year	4.631	4.372	1.174	1.126	0.543	0.360	6.142	5.808
50-Year	5.777	5.526	1.461	1.430	0.671	0.439	7.663	7.368
100-Year	6.985	6.727	1.762	1.725	0.804	0.517	9.265	8.967

As per the above table, the area that is conveyed toward the wetland complex (Catchment 206) on the south side of the existing Colborne Street alignment does not require quantity control. The post development flows are less than pre-development flows.

The proposed detailed design for the Commercial Mixed-Use Block will need to include on-site quantity control measures such that the post development flow rates are controlled to the pre-development levels per the table below. The post development controlled rates documented above, for Node S1 and ND are calculated based on the requirement for post to pre-development controls for the commercial block.

Table 9: Commercial/Mixed Use Block Flow Summary

Storm Event	Drainage Area (ha)	Flow Rates (m^3/s)		
		Pre	Uncontrolled Post	Max. Allowable Post
2-Year	1.48	0.029	0.096	0.029
5-Year	1.48	0.059	0.176	0.059
10-Year	1.48	0.083	0.237	0.083
25-Year	1.48	0.116	0.324	0.116
50-Year	1.48	0.143	0.391	0.143
100-Year	1.48	0.172	0.632	0.172

7.5 Water Balance / Infiltration

A preliminary water balance was completed as part of the Secondary Planning process. It was concluded, on a site wide basis, that the rooftop runoff can be directed to the surface or to an infiltration facility to maintain the groundwater recharge.

As part of the Scoped Environmental Impact Study, a more detailed water balance has been undertaken with specific focus on the woodlot / wetland feature and the maintenance of water balance to that feature. The details of that assessment are included under separate cover. It was determined that a post-development water balance can be maintained to the feature through lot grading and roof leader discharge in combination with additional LID measures.

7.6 Low Impact Development

As identified in the Secondary Planning documentation and above, based on Terraprobe’s analysis of soil and groundwater conditions, the water balance, under post-development conditions, can be partially maintained through discharge of roof leaders. The at grade discharge of roof leaders ensures that downspouts outlet to grassed swales within the rear yard or side yard, as opposed to outletting to the driveway and entering the storm sewer system.

To ensure the water balance is fully maintained under post-development conditions, LIDs measures will be implemented. LIDs such as bioswales implemented within the buffers and trails will be investigated at the detailed design stage. Roof water will be directed to the bioswale to allow for infiltration and provide a storage depression for the water.

A more refined hydrogeological assessment and study is currently underway. As additional details become available, the impact of the LID measures on the stormwater management design and modelling will be determined. The preliminary stormwater management blocks identified within the EIR currently do not reflect any reductions in runoff volume to the facility as a result of the use of LID techniques.

7.7 Nichol Drain Corridor

As part of the Subwatershed Study and the subsequent Secondary Planning process it was established that the Nichol Drain within the subject lands will be terraced within a 67m corridor, to reconnect the existing low flow watercourse to the floodplain. The approved terracing design incorporates the maintenance of a 7 m wide low flow channel along the existing alignment. The terrace will be formed at a minimum slope of 1% extended from the top of the revised low flow channel banks and 4:1 side slopes will form the corridor banks. The design maintains the 7 m wide low flow channel and a 30 metre buffer on each side of the channel for a total channel corridor width of 67 m. The corridor terracing was included as part of the Phase 1 Draft Plan and detailed design work and approved through the Site Alteration Permit process. Drain Capacity confirmation will be required, based on as-constructed information, upon completion of the drain work.

7.8 Implementation of the Terracing of the Nichol Drain

As noted above, the proposed terracing design will incorporate the maintenance of a 7 m wide low flow channel along the existing alignment. The terrace will be formed at a minimum slope of 1% extended from the top of the revised low flow channel banks and 4:1 side slopes will form the corridor banks up to existing grades. During Phase 1 of the development, the proposed banks will extend above existing grade in some locations within the SPA. However, the proposed grades will be designed to connect into the proposed drain at the limits of the corridor with the maintenance of positive drainage towards the corridor.

A preliminary staging plan was identified within the Secondary Planning documentation. It should be noted that the proposed timing for the proposed works is limited to April 1 to September 30 based on the fisheries window. A detailed staging plan and erosion sediment control plan will be established at detailed design.

8.0 Erosion and Sediment Control.

The following general Erosion and Sediment Control (ESC) measures will be implemented as part of the proposed construction works associated with the proposed draft plan. A detailed Erosion Sediment Control Plan will be established during the detailed design approvals process. The ESC measures noted below are intended to mitigate the impacts associated with the construction activities on the surrounding environment. The ESC measures listed below are applicable to all construction activities within the subject property:

a) Erosion and Sediment Control (ESC) measures will be implemented prior to, and maintained during the construction phases, to prevent entry of sediment into the water.

b) Sediment control fence consisting of non-woven material shall be installed and maintained to prevent sediment from leaving the proposed construction areas. Location of fencing will be established based on the site staging and proposed construction work.

c) The contractor shall maintain a supply of silt fence, clear stone, straw bales and filter fabric on-site for emergency use.

d) All in-water and near water works will be conducted in the dry, with appropriate erosion and sediment controls.

e) No equipment or vehicles are permitted to cross through the watercourse, unless approved by Grand River Conservation Authority.

f) No sediment-laden water or deleterious substances will be released to the adjacent waterbody at any time. Dewatering discharge containing sediment laden water must be discharged to a sediment bag positioned in a vegetated area and allowed to discharge into existing established vegetation at least 30 m from any watercourse or existing storm catchbasin.

g) Removal of vegetative cover will be staged and restricted to a period immediately preceding the commencement of earth works in each stage.

h) Disturbed areas will be temporarily or permanently stabilized or restored as the work progresses.

i) If site construction activities are interrupted, and/or inactivity exceeds 30 days, all stripped and/or bare soil areas are to be stabilized using either erosion control matting (e.g. jute), sodding/seeding/mulching or other approved methods to the satisfaction of the site inspector.

j) Equipment, stockpiled material or construction material will be stored outside watercourse and buffer areas and in a manner that prevents sediment or deleterious substances from entering the Nichol Drain.

k) Vehicular refueling and maintenance will be conducted a minimum of 30 metres from the water.

l) An ESC monitoring program will be used as detailed below in Section 9. Erosion and sediment control methods are to be continuously monitored, evaluated, and upgraded when necessary (see further details below in Section 9.0).

m) All damaged erosion and sediment control measures should be repaired and/or replaced within 48 hours of the inspection.

n) After hours contact numbers are to be posted on-site for emergencies.

9.0 Effectiveness Monitoring

The intention of effectiveness monitoring is to provide environmental protection and compliance with all applicable legislation, while contributing to the overall success of a project. As a basis of monitoring a proposed project, it is essential to ensure that the erosion and sediment control measures are properly installed, well maintained, and functioning as intended on a daily basis. A designated ESC inspector should be assigned to assist the Contract Administrator to ensure that all environmental protection measures are appropriately addressed. In general, the primary roles of the designated inspector are to:

a) Ensure compliance with environmental deliverables.

b) Ensure effectiveness of project environmental protection and erosion and sediment control measures.

c) Ensure compliance with environmental regulatory instruments, such as permits and authorizations.

The following monitoring measures will be implemented to ensure that appropriate actions are taken to minimize the effects of the activity on the surrounding environment:

a) Contract administrator shall verify that the ESC controls are intact on a daily basis and after all rainfall events. Deficiencies shall be reported to the contractor and repaired immediately.

b) A specific ESC measures review/inspection shall be completed weekly and in advance of, and within 24 hours following significant rain/snowmelt events to monitor all environmental protection measures and in particular works related to erosion and sediment controls, dewatering, restoration and in- or near- water works.

c) During inactive construction periods, where the site is left alone for 30 days or longer, a monthly inspection should be conducted as a minimum. Inspections should be conducted in advance of, and within 24 hours following significant rainfall events (i.e. events greater than 10 mm of rainfall).

d) The ESC Inspector shall inspect sediment and erosion control works and prepare an inspection record, as required for review and discussion with the Contract Administrator.

Should concerns arise on site; the Environmental Monitor will contact the relevant parties including the Grand River Conservation Authority Enforcement Officer, the Municipality as well as the proponent.

10.0 Conclusions and Recommendations

This Functional Servicing and Stormwater Management Report is intended to satisfy Township of Centre Wellington and Grand River Conservation Authority requirements for a review of site servicing and stormwater management in support of Draft Plan Approval for Phase 1 and the Storybrook West development of the North West Fergus Secondary Planning Area. Based on a review of all the materials available, the following conclusions and/or recommendations are made:

- The ultimate sanitary infrastructure needed to service NWFSPA includes the existing 375 mm trunk sewer along Millage Lane, at the intersection of Beatty Line and Millage Lane across the frontage of the subject lands which conveys flows through the Fergus Urban Area to the Fergus Water Pollution Control Plant.
- The land holdings within the NWFSPA will be serviced through a combination of gravity sanitary drainage and a sanitary pumping station with ultimate connection to the Beatty Line trunk sewer. Phase 1 of the development will be serviced entirely by an internal gravity system. The Storybrook West development will be serviced though the sanitary pump station.
- Based on recent capacity reports, the site may be accommodated within the existing Fergus WPCP. A planned expansion is included in the Development Charge Background Study for 2018-2026. The need for expansion of the WPCP to service the entire North West Fergus Secondary Plan Area will be dependent on the phasing of the NWFSPA as well as growth pressures in other areas of the community within the urban boundary.

- Trunk distribution watermains exist along both Beatty Line and Colborne Street, adjacent to the development. The Township has confirmed that sufficient capacity and pressure exists within these mains to service development within the NWFSPA. Trunk distributions mains extended via the collector roads within the NWFSPA will supply local distribution mains extended throughout the area via the local road network.
- Sufficient supply capacity currently exists to meet the needs of the entire NWFSPA. As additional population growth occurs throughout the Fergus and Elora urban boundary, additional supply and elevated storage infrastructure may be required and is planned as described in the Development Charges By-Law Background Study Update (2008).
- The proposed storm drainage system will be sized in accordance with Township requirements. The system north of the Nichol Drain will accommodate flows from the Beatty Hollow Subdivision located along the north-east boundary of the secondary planning area and has been sufficiently sized to accommodate the Collie Court residents, should an agreement be reached in that regard.
- A tile drain outlet conveyance system has been including in the design which will serve to convey the existing major system drainage from the property north of the subject lands to the existing receiver adjacent to the woodlot. Future development of the lands to the north will require stand-alone stormwater treatment.
- Two (2) SWM facilities will be required to service the subject lands located on the north and south sides of Nichol Drain towards the western edge of the development. The stormwater management ponds will be sized in accordance with Township and GRCA criteria as detailed in the Stage 2 Subwatershed Study (EIR) completed as part of the Secondary Planning Area application.
- Site specific controls will be provided, during detailed design for the Mixed Use/Commercial Block with the provision of quality and quantity control consistent with the requirements identified through the Subwatershed Study and Secondary Planning process.
- A site wide water balance can be achieved through implementation of a combination of roof leader discharge and LID measures.
- The Nichol Drain will be terraced through the subject lands as part of the Phase 1 development and in accordance with the approved approach outlined in the Stage 2 Subwatershed Study (EIR) completed as part of the Secondary Planning Area application.
- An effectiveness monitoring plan will be implemented during construction to ensure all works are in conformance to the required Erosion Sediment Control Plan for the site.

11.0 References

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BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix A

Geotechnical Investigation

V.A. WOOD (GUELPH) INCORPORATED
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
TELEPHONE: 519-763-3101

GEOTECHNICAL INVESTIGATION
STORYBROOK SUBDIVISION
PART OF LOTS 18, 19 AND 20, CONCESSION 14
(GEOGRAPHIC TOWNSHIP OF MITCHELL)
TOWNSHIP OF CENTRE WELLINGTON (FERGUS), ONTARIO

Ref. No. G3719-6-5
May, 2016

Prepared for:

Nigus Fergus Joint Venture
c/o Sorbara Group of Companies
3700 Steeles Avenue West
Suite 800
Vaughan, Ontario
L4L 8M9

Attention: Mr. Colin Eden

Distribution:

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(1) Copy - R.J. Bumside & Associates Ltd. (Mississauga)
(1) Copy - R.J. Bumside & Associates Ltd. (Guelph)
(2) Copies - V.A. Wood (Guelph) Inc.

CONTENTS

APPENDIX

ENCLOSURES

1.0 INTRODUCTION:

V. A. Wood (Guelph) Inc. was retained by Nigus Fergus Joint Venture to carry out a geotechnical investigation for a proposed residential subdivision on Part of Lots 18, 19 & 20, Concession 14 in the Township of Centre Wellington (Fergus), Ontario.

The purpose of the investigation was to reveal the subsurface conditions and to determine the relevant soil properties for recommendations concerning the design and construction of the site services, houses, pavement areas and storm water management systems.

2.0 FIELD WORK:

The fieldwork was carried out April 18 to 22 of 2016 and consisted of twenty-eight (28) boreholes at the locations shown on Enclosure 1. The boreholes were advanced to the sampling depths by means of a track-mounted, power-auger machine equipped for soil sampling. Standard Penetration tests were carried out at frequent intervals of depth and the results are shown on the Borehole Logs as N-values. The subsurface soils were visually inspected, logged and sampled at the borehole locations.

The boreholes were laid out by personnel from V.A. Wood (Guelph) Inc. and a soils technician supervised the fieldwork program. The ground elevation at each borehole was interpolated from a topographic survey produced by J.D. Barnes Ltd. dated April 27, 2007.

3.0 SUBSURFACE CONDITIONS:

Full details of the soils encountered in each borehole are given on the Borehole Logs, Enclosures 2 to 29, inclusive and the following notes are intended to summarize this data.

The boreholes encountered a surficial deposit of ***topsoil*** *ranging between 150mm and 410mm thick.*

The topsoil at Boreholes 1, 2, 3, 5, 7, 8, 10 to 23, and 25 to 28, inclusive was underlain by a deposit of brown or grey ***silty sand*** *to depths ranging between 0.8 and 3.0 metres below grade. Standard Penetration tests in this material gave N-values ranging between 3 and 48 blows/300mm and the natural moisture content was found to range between 10 and 25%. A typical grain size distribution curve for this material can be found on Enclosure 30.*

Based on the test results, the deposit of silty sand is considered to have a generally very loose to dense relative density, however the presence of occasional gravel and/or cobble in this deposit may have resulted in high N-values and these may not accurately represent the relative density of the soil.

A deposit of brown ***clayey sandy silt*** *were encountered below the silty sand at Borehole 2 and the topsoil at Borehole 24 to a depth of about 2.3 metres below grade. Standard Penetration tests in this material gave N-values ranging between 5 and 18 blows/300mm and the natural moisture was found to range from 14 to 19%.*

Based on the test results, the deposit of silty sand is considered to have a generally loose to compact relative density.

A deposit of brown ***sand and gravel*** *was encountered below the silty sand at Borehole 19 to a depth of 1.7 metres below grade.*

A deposit of brown or grey ***sand*** *were encountered below the silty sand at Boreholes 3, 9, 12, 16, 18, 22, 23, 25, 26 and 28 and below the clayey sandy silt at Borehole 2. This material extended to depths ranging between 2.3 and 6.1 metres below grade and the full depth of investigation (i.e. 6.6 metres below grade). Standard Penetration tests in this material gave N-values ranging between 5 and greater than 100 blows/300mm and the natural moisture was found range between 7 and 23%.*

Based on the test results, the deposits of sand and gravel and sand are considered to have generally very loose to very dense relative densities, however the presence of gravel and/or cobble in these deposits may have resulted in high N-values and these may not accurately represent the relative density of the soil.

A deposit of brown ***silty sand and gravel*** *was encountered below the sand at Borehole 16 to a depth of 4.6 metres below grade. Standard Penetration tests in this material gave N-values of 21 to 43 blows/300mm and the natural moisture was found to be about 11%.*

Based on the test results, the deposit of silty sand and gravel is considered to have a generally compact to dense relative density, however the presence of gravel and/or cobble in this deposit may have resulted in high N-values and these may not accurately represent the relative density of the soil.

A deposit of brown or grey ***clayey sandy silt till*** *was encountered below the silty sand at Boreholes 1, 7, 8, 10, 11, 13, 14, 15, 17, 20, 21, and 27, below the sand at Boreholes 2, 3, 9, 18, 22, 23, 25, 26, and 28, topsoil at Boreholes 4 and 6, silty sand and gravel at Borehole 16, sand and gravel at Borehole 19, and clayey sandy silt at Borehole 24. This deposit extended to depths ranging between 3.0 metres below grade and the full depth of investigation (i.e. 6.6 metres below grade). Standard Penetration tests in this material gave N-values ranging between 4 and greater than 100 blows/300mm and the natural moisture content was found to range between 6 and 22%. Pocket penetrometer tests indicated it has an undrained shear strength varying from 50 to 450 kPa. A typical grain size distribution curve for this material can be found on Enclosure 31.*

Based on the test results, the deposit of clayey sandy silt till is considered to have a generally loose to very dense relative density, although the presence of occasional gravel and/or cobble in this deposit may have resulted in high N-values and these may not accurately represent the relative density of the soil.

A deposit of grey ***sand*** *was encountered below the clayey sandy silt till at Borehole 19 to a depth of 4.6 metres below grade. A Standard Penetration test in this material gave an N-value of 49 blows/300mm and the natural moisture content was found to be about 12%*

Based on the test results, the deposit of sand is considered to have a generally dense relative density.

The silty sand at Borehole 5 and the clayey sandy silt till at Boreholes 21 and 23 was underlain by a deposit of brown ***silty clay*** *to depths ranging between 4.6 metres below grade and the full depth of the investigation (i.e. 6.6 metres below grade). Standard Penetration tests in this material gave N-values ranging between 12 and 60 blows/300mm and the natural moisture content was found to range between 11 and 31%. Pocket penetrometer tests indicated it has an undrained shear strength varying from 150 to 450 kPa.*

Based on the test results, the deposit of silty clay is considered to have a generally stiff to very stiff consistency.

The silty clay at Boreholes 5 and 23 and the sand at Borehole 19 were underlain by a deposit of ***clayey sandy silt till*** *to the full depth of the investigation (i.e. 6.6 metres below grade). Standard Penetration tests in this material gave N-values ranging between 78 and greater than 100 blows/300mm and the natural moisture content was found to range between 6 and 13%. Pocket penetrometer tests indicated it has an undrained shear strength varying from 300 to 450 kPa.*

Based on the test results, the deposit of clayey sandy silt till is considered to have a generally very dense relative density.

3.0 GROUNDWATER CONDITIONS:

Boreholes 1, 4, 6, 8, 10, 15, 21, 22 were dry and open to the full depth of the investigation on completion of the fieldwork program. Boreholes 18, 19, 25 and 28 encountered dry cave-in at elevations ranging between 407.6m± and 410.4± (i.e. 4.9± to 5.5± metres below grade) on completion of the fieldwork program. Boreholes 12, 13, 23 and 26 encountered wet cave-in at elevations ranging between 407.2m± and 413.2m± (i.e. 1.8± to 3.7± metres below grade) on completion of the fieldwork program. Free water surfaces were encountered at Boreholes 2, 3, 5, 9, 11, 16 and 17 at elevations ranging between 404.9m± to 411.5m± (i.e. 1.2± to 5.5± metres below grade) on completion of the fieldwork program.

Monitoring wells were installed in Boreholes 7, 14, 20, 24 and 27 and water levels were measured at the elevations noted in the following chart.

Location	*Ground El. (m±)*	*May 5, 2016*	
		Depth Below Existing Grade (m±)	*Water Level El. (m±)*
BH 7	*414.8*	*0.9*	*413.9*
BH 14	*416.5*	*1.2*	*415.3*
BH 20	*413.9*	*5.8*	*408.1*
BH 24	*415.8*	*4.3*	*411.5*
BH 27	*414.1*	*5.6*	*408.5*

An examination of the soil samples indicated that they were generally moist to saturated.

It is noted that no sub-artesian water pressures were encountered in any of the boreholes.

A colour change from brown to grey was noted in all the boreholes at elevations ranging between 404.7m± and 415.3± (i.e. 0.2 to 6.1 metres below grade.

Based on the foregoing, the groundwater table is considered to be located at elevations ranging between 408.1m± to 415.3m±, although perched groundwater conditions can be expected in the looser upper zones underlain by the less permeable till.

5.0 *DISCUSSION AND RECOMMENDATIONS:*

5.1 General:

The boreholes generally encountered surficial deposits of topsoil underlain by loose to compact silty sand and/or sand underlain by loose to very dense clayey sandy silt till with seams of compact sand and very stiff to hard silty clay.

The groundwater table is considered to be located at elevations ranging between 408.1m± to 415.3m±, although perched groundwater conditions can be expected in the looser upper zones underlain by the less permeable till.

Full details concerning the proposed development, and in particular, the grading plan was not available at the time of this report which should therefore be reviewed when this information is available. Therefore, the following discussion is considered preliminary.

5.2 Sewers:

It is assumed that the sewer inverts will be located at depths ranging between 3 and 4 metres below the existing grades.

Reference to the Borehole Logs indicates that the subgrade will generally consist of competent deposits of clayey sandy silt till, sand, sand and gravel and/or silty clay which will generally provide adequate support for the pipes and allow the use of normal Class 'B' bedding using Granular 'A' material. Clear crushed stone should not be used as bedding otherwise fines may migrate into the voids of the stone and cause undesirable settlements. Where the exposed subgrade is less competent than the materials identified in the Borehole Logs, the bedding thickness may have to be increased and it may be necessary to protect the excavation with a skim coat of concrete immediately after it has been exposed.

Where sewer trench grades are below the groundwater table, provisions may be required to lower the groundwater table through pumping from local sumps as and where required or through the use of well points. The sides of the excavation to a depth of more than 1.2 metres (and above the water table) should either be cut back at a side slope of 1 to 1 or supported using adequately braced closed sheeting.

The excavated materials will be generally suitable for use as trench backfill provided that they are free of topsoil and boulders. If the on-site materials become wet, they should be air dried prior to re-use as trench backfill. The trench backfill should be placed in 150 to 200mm thick layers and uniformly compacted to at least 95% of its Standard Proctor maximum dry density.

The backfill around manholes should consist of well-graded and well-compacted granular material.

To minimize potential problems and wetting of the subgrade material, backfilling operations should follow closely after excavations, so that only a minimal length of trench is exposed at a time. Should construction be carried out in the winter season, particular attention should be given to make sure no frozen material is used for backfill.

5.3 Foundations:

The boreholes encountered deposits of topsoil and loose, wet upper soils which are not considered to be a suitable bearing strata. Therefore, the foundations for the proposed structures should extend to below the surface to more competent soils. It is anticipated that an adequate stratum for Housing and Small Buildings in accordance with Part 9 of the 2012 Building Code Compendium will be located at the elevations indicated in the following charts:

Borehole No.	Borehole Ground Elev. (m±)	Bearing Stratum	Suitable Bearing Stratum Elev. (m±)	Depth to Suitable Bearing Stratum (m±)	Allowable Bearing Pressure (kPa)
1	413.7	Clayey Silty Sand Till	412.2	1.5	100
2	412.9	Clayey Silty Sand	412.1	0.8	100
3	413.5	Sand	412.0	1.5	100
4	413.1	Clayey Silty Sand Till	412.3	0.8	100
5	409.3	Silty Clay	407.0	2.3	100
6	411.7	Clayey Silty Sand Till	410.2	1.5	100
7	414.8	Clayey Silty Sand Till	413.3	1.5	50
8	413.8	Clayey Silty Sand Till	412.3	1.5	50
9	410.2	Sand	409.4	0.8	50
10	409.6	Clayey Silty Sand Till	408.1	1.5	100
11	410.8	Clayey Silty Sand Till	408.5	2.3	100
12	409.0	Sand	406.0	3.0	100
13	409.0	Clayey Silty Sand Till	406.7	2.3	50
14	416.5	Clayey Silty Sand Till	415.0	1.5	50
15	415.0	Clayey Silty Sand Till	413.5	1.5	50
16	413.5	Sand	412.0	1.5	50
17	411.7	Clayey Silty Sand Till	409.4	2.3	75
18	414.5	Clayey Silty Sand Till	413.0	1.5	100
19	413.1	Clayey Silty Sand Till	411.4	1.7	100
20	413.9	Clayey Silty Sand Till	411.6	2.3	100

Borehole No.	Borehole Ground Elev. (m±)	Bearing Stratum	Suitable Bearing Stratum Elev. (m±)	Depth to Suitable Bearing Stratum (m±)	Allowable Bearing Pressure (kPa)
21	414.6	Clayey Silty Sand Till	413.1	1.5	100
22	414.1	Sand	413.3	0.8	50
23	414.9	Sand	413.4	1.5	100
24	415.8	Clayey Silty Sand Till	413.5	2.3	100
25	415.6	Sand	414.1	1.5	50
26	415.0	Sand	414.2	0.8	50
27	414.1	Clayey Silty Sand Till	412.6	1.5	100
28	414.8	Clayey Silty Sand Till	413.3	1.5	100

If basements are constructed, the basement floors should be located at least 0.5 metres above the observed high groundwater level (i.e. El. 408.1m to 415.3m) otherwise sub-floor drainage systems together with continual pumping from the drainage systems will be required.

If there are requirements for cut and fill grading, the foundation grade could be raised using "engineered fill", which would be suitable for supporting normal spread footings designed to an allowable bearing pressure of up to 150 kPa.

The procedure for "engineered fill pad" construction would consist of the following:

1. The total removal of topsoil and loose, wet material from beneath the proposed development envelopes.

2. Geotechnical personnel from V.A. Wood (Guelph) Inc. prior to placement of "engineered fill" should inspect the exposed subgrade. Any loose or soft zones which are encountered should be removed and replaced with approved on-site or approved imported granular material, compacted to at least 98% Standard Proctor maximum dry density.

3. The areas should then be brought up to the final subgrade level with approved on-site or approved imported granular material placed in maximum 200mm thick lifts and compacted to at least 98% Standard Proctor maximum dry density.

4. The "engineered fill" under all structures to be supported should extend to at least 0.6 metres laterally beyond the edge of their perimeter at the founding level and at least a distance equal to the depths of the fill pad, at the level of the approved subgrade.

The "engineered fill" should be in place at least one month prior to loading it to minimize settlement.

This "engineered fill" will satisfy the raising of the founding levels to the proposed grades and provide a suitable subgrade for the proposed structures.

All exterior house footings or footings in unheated areas should be located at least 1.2 metres below finished grade for adequate frost protection.

Elevation differences between adjacent footings should not be more than a half of the horizontal distance between them.

It is estimated that the total and differential settlements of the footings designed to the above stated bearing pressures will be less than 25 and 20mm respectively, which are normally considered to be acceptable for the proposed structures.

It is recommended that all foundation excavations be inspected by geotechnical personnel from V.A. Wood (Guelph) Inc. to ensure that the founding soils are similar to those identified in the Borehole Logs and that the founding soils are capable of supporting the design loads.

5.4 Excavation and Groundwater Control:

No major construction problems due to water are anticipated with excavations above El. 404.7m±. However, provision should be made for the control of any surface water run-off and minor seepage from any wet sand seams by pumping from local sumps on an as and where required basis. If, however, excavations are extended below the groundwater table, then provisions may be required to lower the groundwater table through more extensive pumping from local sumps as and where required or through the use of well-points.

Excavations to a depth of more than 1.2 metres below grade should be cut back to a side slope of 1 to 1 or, supported using adequately braced sheeting.

Sub-drains will probably be required for basements less than 0.5m above the water table.

5.5 Floor Slabs:

All topsoil should be stripped from the building areas and the proposed subgrade should be re-compacted from the surface to at least 95% of its Standard Proctor maximum dry density. Any loose/wet material encountered should be sub-excavated and replaced with approved fill.

The fill may consist of approved on-site materials free of cobbles/boulders or approved imported fill. All fill materials should be placed in 150 to 200mm thick lifts and compacted to at least 95% of its Standard Proctor maximum dry density. It is recommended the underfloor fill be placed at least one month prior to floor construction in order to minimize settlement.

A layer of well-graded, free-draining material, at least 150mm thick and compacted to at least 98% of it Standard Proctor maximum dry density, should be placed under the floor slabs to provide a uniform bearing surface and to act as a vapour barrier.

Frequent inspections by geotechnical personnel from V.A. Wood (Guelph) Inc. should be carried out during construction to verify compaction of the subgrade and base courses by in-situ density testing using nuclear gauges.

5.6 Storm Water Management:

The grain size distribution curves prepared for the representative soil samples obtained at the boreholes were compared to the family of curves presented in the Supplementary Standard SB-6 of the 2012 Building Code Compendium. Based on the Unified Soils Classification System, the soils are considered to have the following properties:

Material	Unified Soils Classification Group	Estimated Co-efficient of Permeability (k) (cm/sec)
Silty Sand	(SM)	10^{-3} - 10^{-5}
Clayey Sandy Silt Till	(CL)	10^{-6} and less
Silty Clay	(CL)	10^{-6} and less

5.7 Pavement Designs:

All topsoil should be stripped from the paved areas. The proposed subgrade should then be re-compacted from the surface to at least 98% of its Standard Proctor maximum dry density prior to the road construction. Any loose areas which are detected should be sub-excavated and backfilled with suitable on-site material or approved imported fill. All fill should be placed in 150 to 200mm thick lifts and compacted to at least 98% of its Standard Proctor maximum dry density.

Considering the probable traffic requirements and subsoil conditions, the following pavement designs are recommended:

	Passenger Car Parking (Light Duty) (mm)	Access Road (Medium Duty) (mm)
Asphaltic Concrete	50	90
Granular 'A' Base Course	150	175
Granular 'B' Sub-base Course	200	350

The base and sub-base granular materials should be compacted to at least 100% Standard Proctor maximum dry density. The asphalt should be compacted to OPS Specifications.

Frequent inspections by geotechnical personnel from V. A. Wood (Guelph) Inc. should be carried out during construction to verify the compaction of the subgrade, base courses and asphaltic concrete by in-situ density testing using nuclear gauges.

6.0 STATEMENT OF LIMITATIONS:

The Statement of Limitations presented on Appendix 'A' is an integral part of this report.

V. A. WOOD (GUELPH) INC.

V. WOOD

J. Broad, B.A.
President & General Manager

V. Wood, M.Eng., P. Eng.
Chief Engineer

JB:sm

Encls.

2 copies

APPENDIX

STATEMENT OF LIMITATIONS:

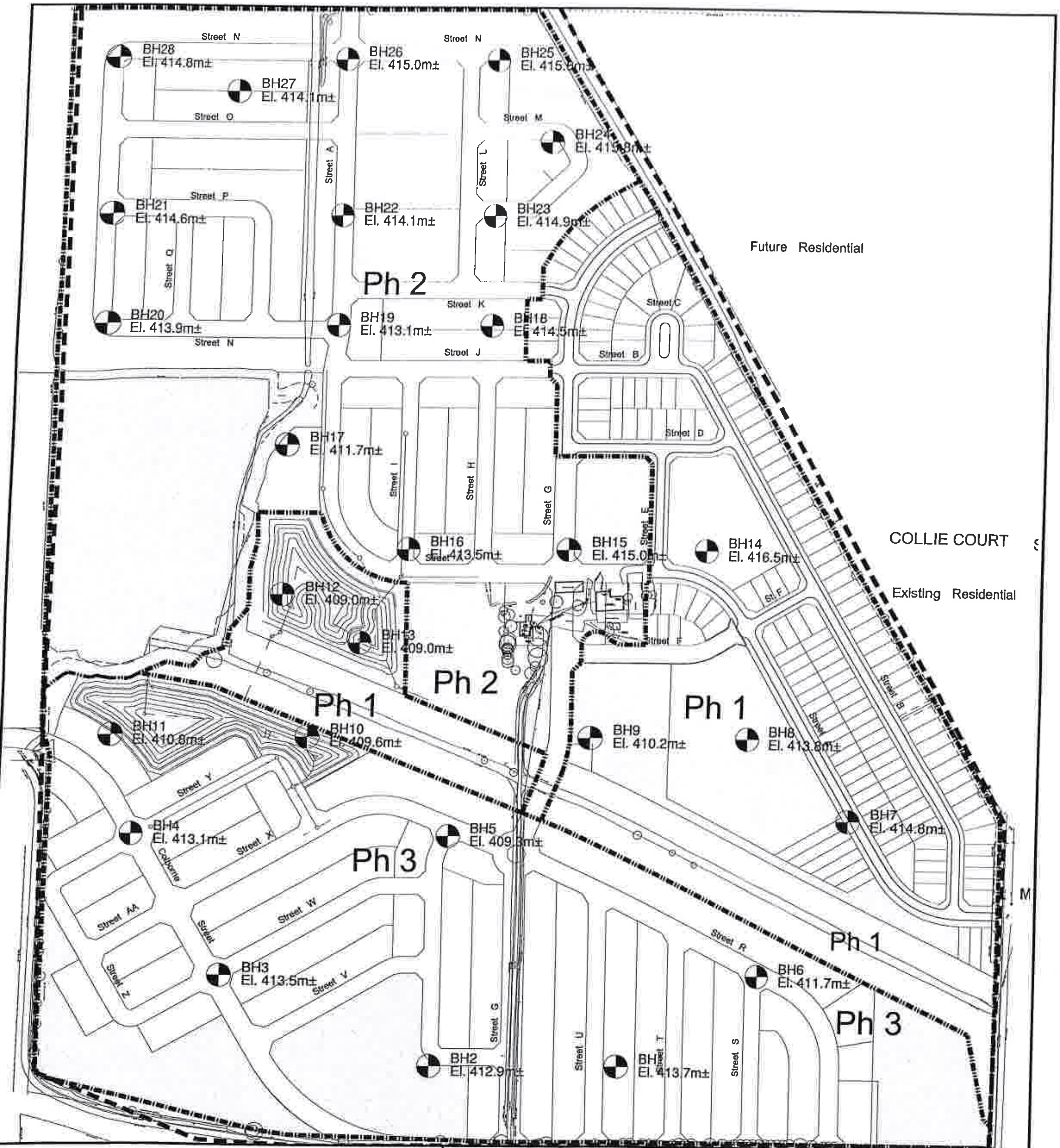
The conclusions and recommendations in this report are based on information determined at the borehole locations and on geological data of a general nature, which may be available, for the area investigated. Soil and groundwater conditions between and beyond the boreholes may differ from those encountered at the borehole locations and conditions may become apparent during construction, which would not be detected or anticipated at the time of the soil investigation.

We recommend that we be retained to ensure that all necessary stripping, subgrade preparation and compaction requirements are met, and to confirm that the soil conditions do not deviate materially from those encountered in the boreholes. ***In cases where this recommendation is not followed the company's responsibility is limited to interpreting accurately the information encountered at the boreholes.***

This report is applicable only to the project described in the introduction, constructed substantially in accordance with details of alignment and elevations quoted in the text.

This report was prepared by V. A. Wood (Guelph) Inc. for Nigus Fergus Joint Venture. The material in it reflects V.A. Wood (Guelph) Inc. judgment in light of the information available to it at the time of preparation. Any use which a Third Party makes of this report, or any reliance on decisions to be made based on it, is the responsibility of such Third Parties. V. A. Wood (Guelph) Inc. accepts no responsibility for damages, if any, suffered by any Third Party as a result of decisions made or actions based on this report.

ENCLOSURES



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Consulting Geotechnical Engineers
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405 York Road, Guelph, Ontario N1E 3H3

Borehole Location Plan
Part of Lot 18, 19, 20, Concession 14
(Geographic Township of Mitchell)
Township of Centre Wellington, Ontario

Scale: NTS	Ref. No. G3719-6-4
Date: April 27, 2016	Enclosure 1

REFERENCE No: G3719-6-5

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

BOREHOLE No: 1

ENCLOSURE No: 2

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
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SUBSURFACE PROFILE					SAMPLE					
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	PENETRATION RESISTANCE BLOWS/0.3m 20 40 60 80	WATER CONTENT % 5 10 15 20 25	UNIT WEIGHT
0.0	Ground Surface	413.7								
0.3	280mm Topsoil	413.4		DRY (18-Apr-2016)	1	SS	4	○		
	brown, loose SILTY SAND some clay, trace gravel, moist				1	SS	10	○	●	
					2	SS	7	○		
1.5		412.2								
	brown, compact to very dense CLAYEY SANDY SILT TILL trace gravel, moist				3	SS	18	○	●	
					4	SS	41	○		
					5	SS	50	○	●	
	grey with limestone fragments @ 4.6m				6	SS	50	○75mm		
5.6		408.1			7	SS	50	○75mm	●	
	Probable Boulder/Bedrock Refusal									

DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 18, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

BOREHOLE No: 2

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

ENCLOSURE No: 3

LOCATION: Township of Centre Wellington, ON

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

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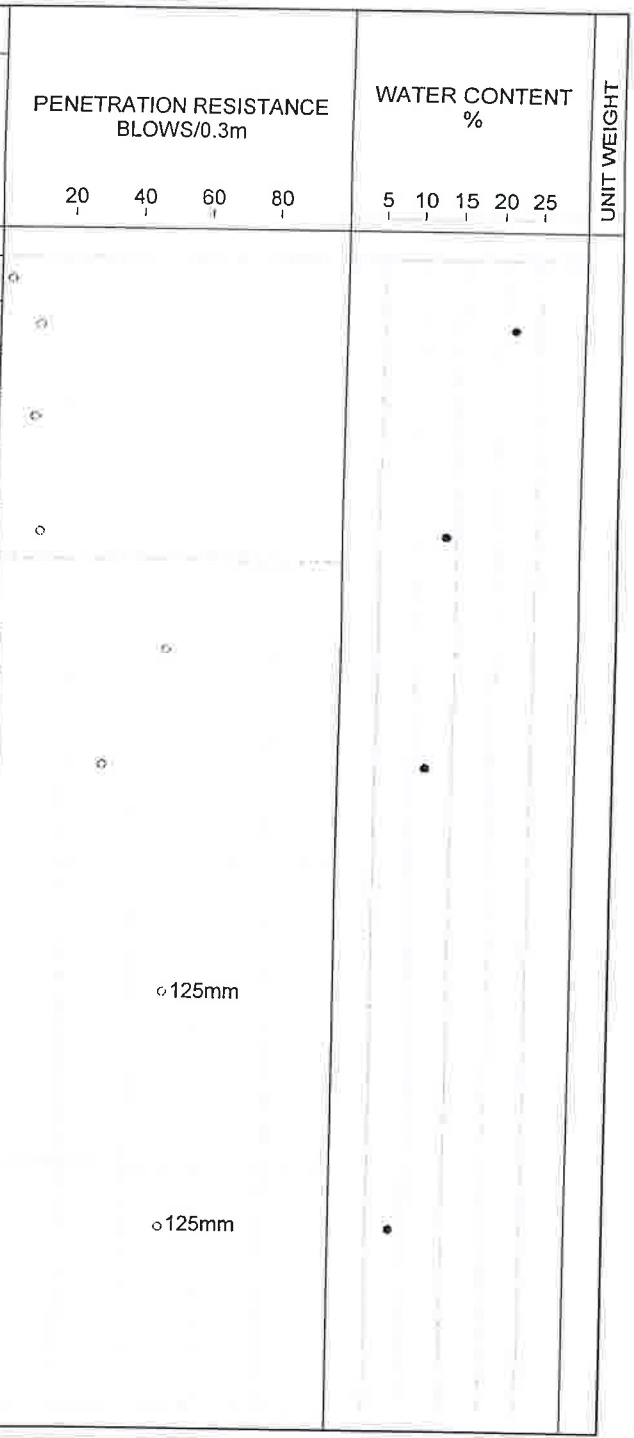
SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	412.9					
0.2	175mm Topsoil	412.7			1	SS	3
0.8	brown, compact SILTY SAND some clay, trace gravel, trace organics and wood, moist	412.1			1	SS	11
2.3	brown, compact CLAYEY SANDY SILT trace gravel, moist	410.6			2 3	SS SS	10 12
3.0	brown, dense SAND wet	409.9		W.L. @ El. 409.9m± (18-Apr-2016)	4	SS	49
6.6	grey, dense to very dense CLAYEY SANDY SILT TILL trace gravel, moist	406.3			5 6 7	SS SS SS	31 50 50
	End of Borehole						



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 18, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

BOREHOLE No: 3

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CLIENT: Nigus Fergus Joint Venture

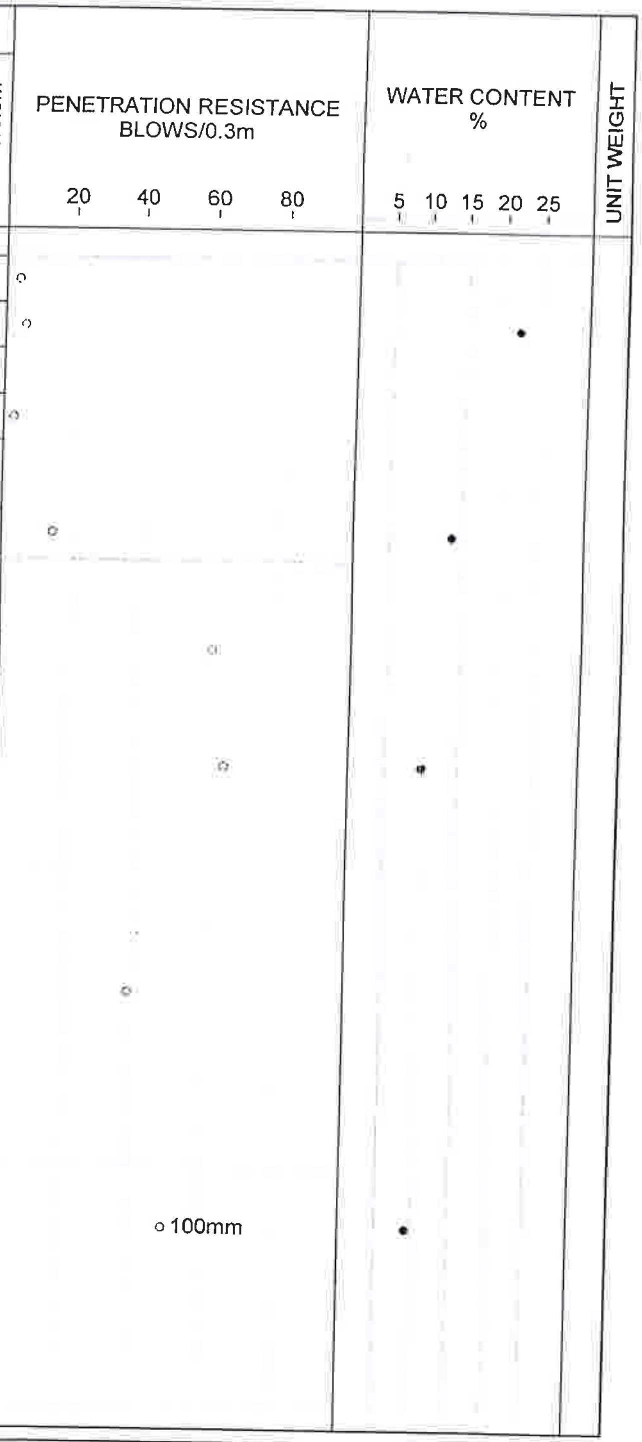
PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

ENCLOSURE No: 4

SUPERVISOR: M.P.

SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	413.5					
0.2	200mm Topsoil	413.3			1	SS	4
	brown, loose to very loose SILTY SAND moist to wet				1	SS	6
					2	SS	3
1.5		412.0					
	brown, compact SAND wet				3	SS	15
2.3		411.2					
	brown, dense to very dense CLAYEY SANDY SILT TILL trace gravel, moist			W.L. @ El. 409.8m± (18-Apr-2016)	4	SS	61
					5	SS	65
	grey @ 4.6m				6	SS	39
6.6		407.0			7	SS	50
	End of Borehole						



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 18, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

BOREHOLE No: 4

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

ENCLOSURE No: 5

LOCATION: Township of Centre Wellington, ON

SUPERVISOR: M.P.

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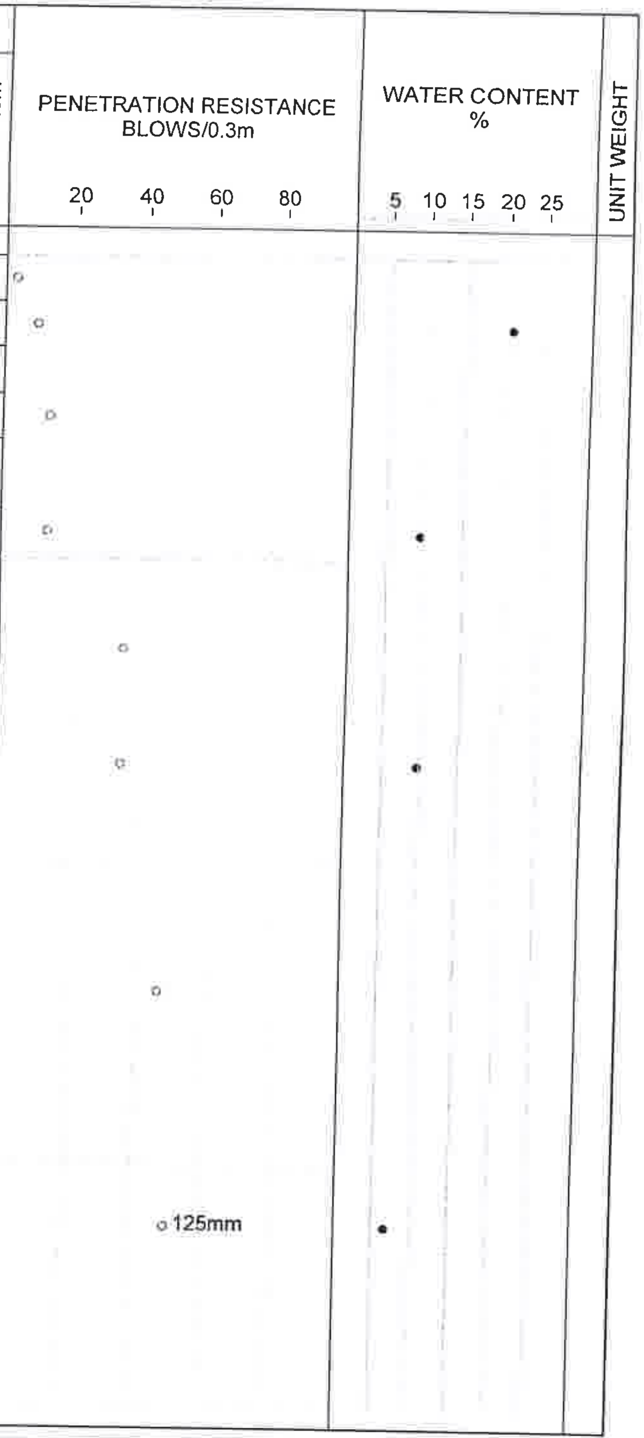
SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	413.1					
0.2	225mm Topsoil	412.9		DRY (19-Apr-2016)	1	SS	3
	brown, loose to very dense CLAYEY SANDY SILT TILL trace gravel, moist				1	SS	9
					2	SS	13
					3	SS	13
					4	SS	35
					5	SS	35
					6	SS	47
6.6	grey @ 6.1m	406.6			7	SS	50
	End of Borehole						



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 19, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

BOREHOLE No: 5

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CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

ENCLOSURE No: 6

LOCATION: Township of Centre Wellington, ON

SUPERVISOR: M.P.

SUBSURFACE PROFILE					SAMPLE					
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	PENETRATION RESISTANCE BLOWS/0.3m (20 40 60 80)	WATER CONTENT % (5 10 15 20 25)	UNIT WEIGHT
0.0	Ground Surface	409.3								
0.2	225mm Topsoil	409.1			1	SS	6			
	grey, loose to compact SILTY SAND some clay, trace gravel, moist				1	SS	9			
					2	SS	19			
					3	GS	17			
2.3		407.0								
	grey, stiff SILTY CLAY some sand, moist			W.L. @ El. 404.9m± (19-Apr-2016)	4	SS	12			
					5	SS	13		31.3%	
4.6		404.7								
	grey, very dense SILTY SAND some clay, trace gravel, moist				6	SS	81			
6.6		402.8			7	SS	50	50mm		
	End of Borehole									

DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 19, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

BOREHOLE No: 6

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

ENCLOSURE No: 7

LOCATION: Township of Centre Wellington, ON

SUPERVISOR: M.P.

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PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	411.7		DRY (18-Apr-2016)						
0.2	150mm Topsoil	411.6			1	SS	5	○		
	brown, loose to very dense CLAYEY SANDY SILT TILL trace gravel, moist trace organics @ 0.8m				1	SS	6	○	●	
					2	SS	4	○		
					3	GS	16	○	●	
					4	SS	50	○ 150mm		
	grey @ 3.0m				5	SS	50	○ 150mm	●	
					6	SS	50	○ 75mm		
6.6		405.2			7	SS	50	○ 75mm	●	
	End of Borehole									

DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 18, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

BOREHOLE No: 7

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

ENCLOSURE No: 8

LOCATION: Township of Centre Wellington, ON

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

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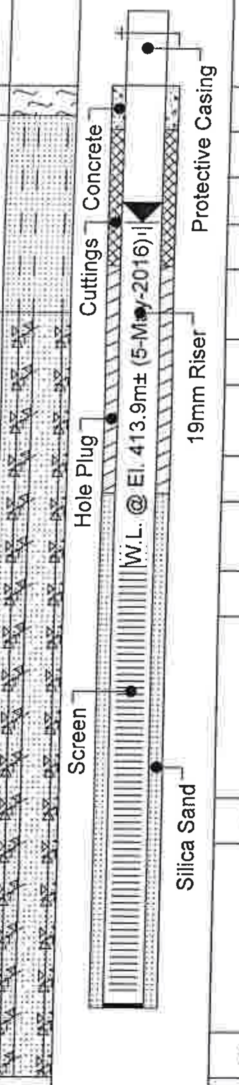
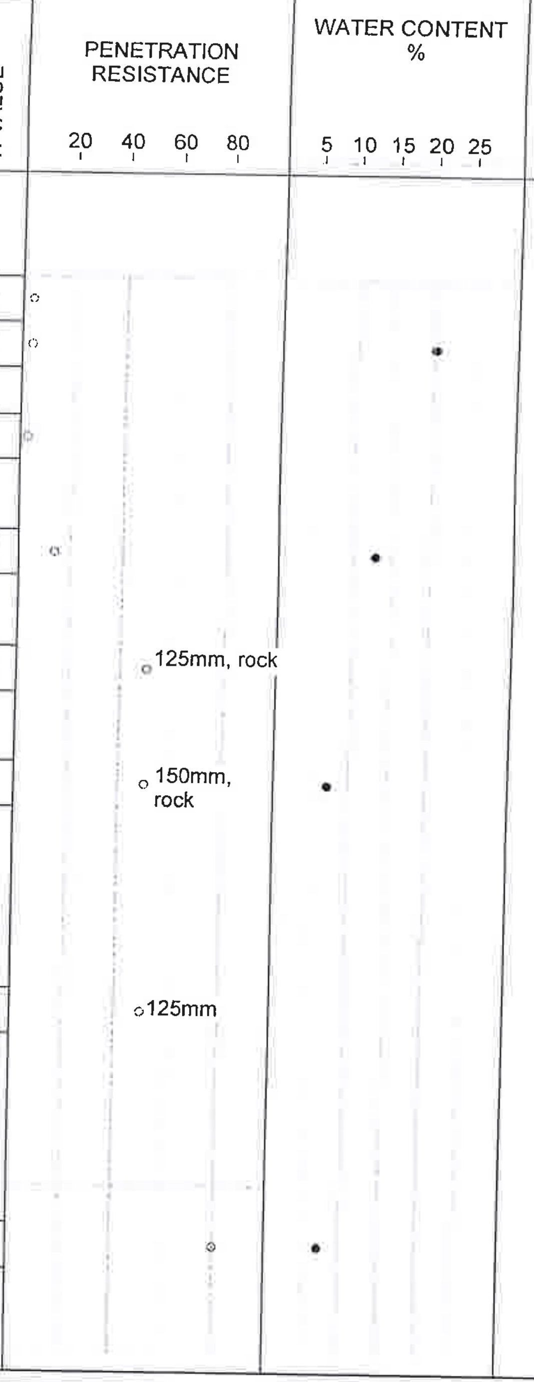
SUBSURFACE PROFILE

DEPTH (m)	DESCRIPTION	ELEVATION
0.0	Ground Surface	414.8
0.2	200mm Topsoil	414.6
	brown, very loose SILTY SAND some clay, trace gravel, moist	
1.5	brown, compact to very dense CLAYEY SANDY SILT TILL trace gravel, moist grey @ 4.6m	413.3
6.6	End of Borehole	408.3



SAMPLE

NUMBER	TYPE	N-VALUE
1	SS	4
1	SS	4
2	SS	3
3	SS	14
4	SS	50
5	SS	50
6	SS	50
7	SS	80



UNIT WEIGHT

DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 20, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

BOREHOLE No: 8

ENCLOSURE No: 9

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
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SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	413.8					
0.2	150mm Topsoil	413.7			1	SS	4
	brown, loose to compact SILTY SAND some clay, trace gravel, moist				1	SS	6
					2	SS	11
1.5		412.3					
	brown, compact to very dense CLAYEY SANDY SILT TILL trace gravel, moist grey @ 2.3m			DRY (20-Apr-2016)	3	SS	25
					4	SS	45
					5	SS	41
					6	SS	41
6.6		407.3			7	SS	50
	End of Borehole						

DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 150mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 20, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

BOREHOLE No: 9

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

ENCLOSURE No: 10

LOCATION: Township of Centre Wellington, ON

SUPERVISOR: M.P.

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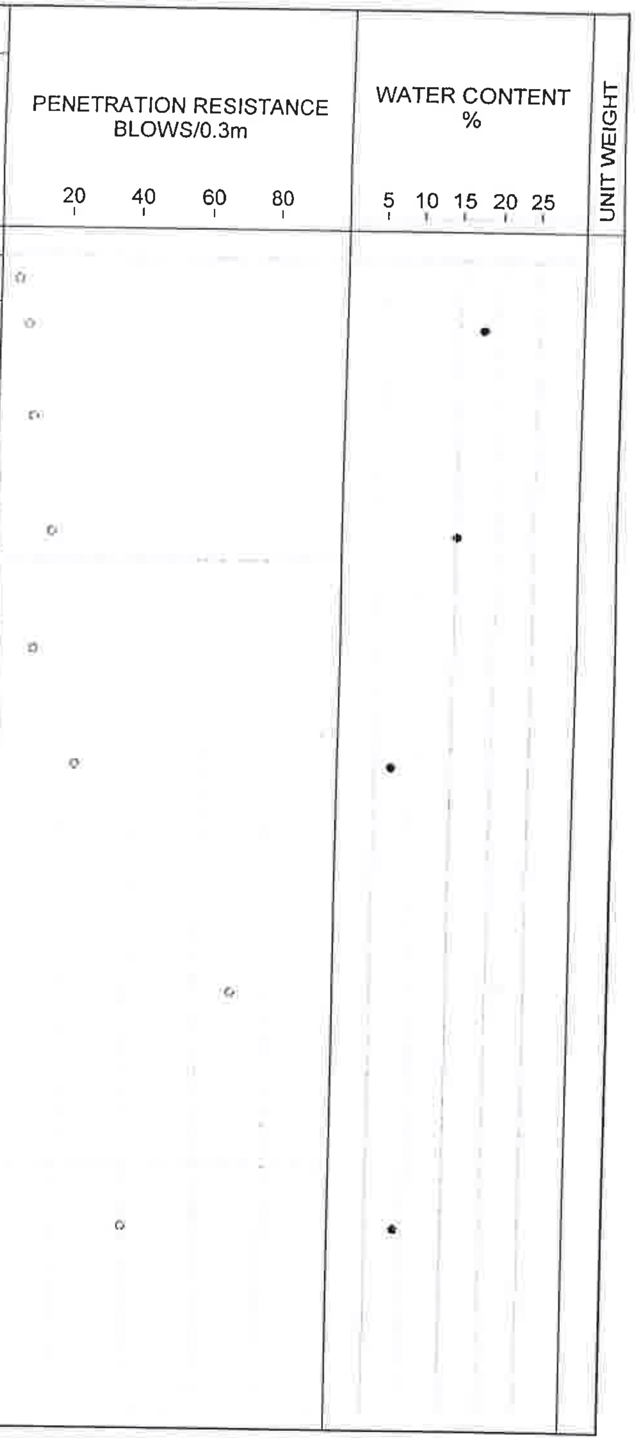
SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	410.2					
	410mm Topsoil				1	SS	5
0.4		409.8					
	brown, loose to compact SAND some silt, moist to wet,				1	SS	8
					2	SS	10
					3	SS	16
				▼ W.L. @ El. 408.1m± (20-Apr-2016)	4	SS	11
	wet gravel seam @ 3.0m				5	SS	24
4.6		405.6					
	grey, very dense CLAYEY SANDY SILT TILL trace gravel, moist				6	SS	70
					7	SS	40
6.6		403.7					
	End of Borehole						



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 150mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 20, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

BOREHOLE No: 10

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

ENCLOSURE No: 11

LOCATION: Township of Centre Wellington, ON

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

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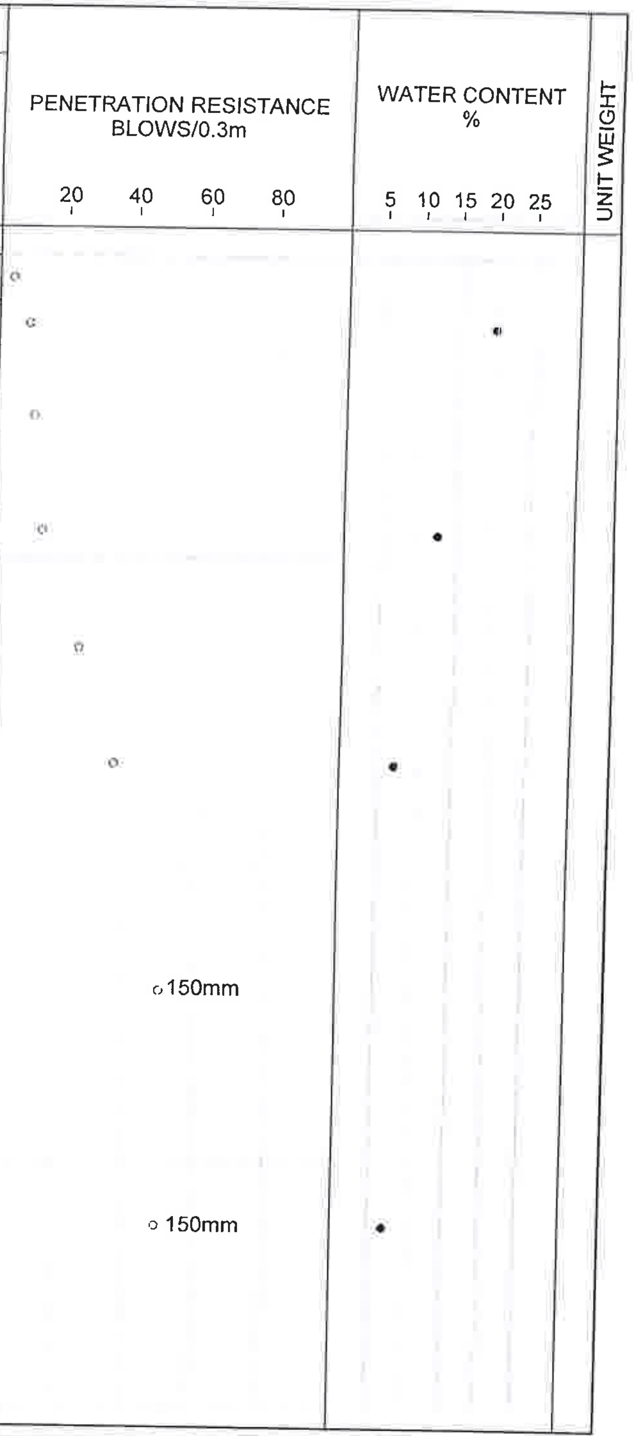
SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	409.6					
0.2	175mm Topsoil	409.4		DRY (19-Apr-2016)	1	SS	4
	brown, loose to compact SILTY SAND some clay, trace gravel, moist				1	SS	9
					2	SS	11
1.5		408.1					
	brown, compact to very dense CLAYEY SANDY SILT TILL trace gravel, moist grey @ 2.3m				3	SS	14
					4	SS	25
					5	SS	36
					6	SS	50
6.6		403.1			7	SS	50
	End of Borehole						



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 19, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

BOREHOLE No: 11

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

ENCLOSURE No: 12

LOCATION: Township of Centre Wellington, ON

SUPERVISOR: M.P.

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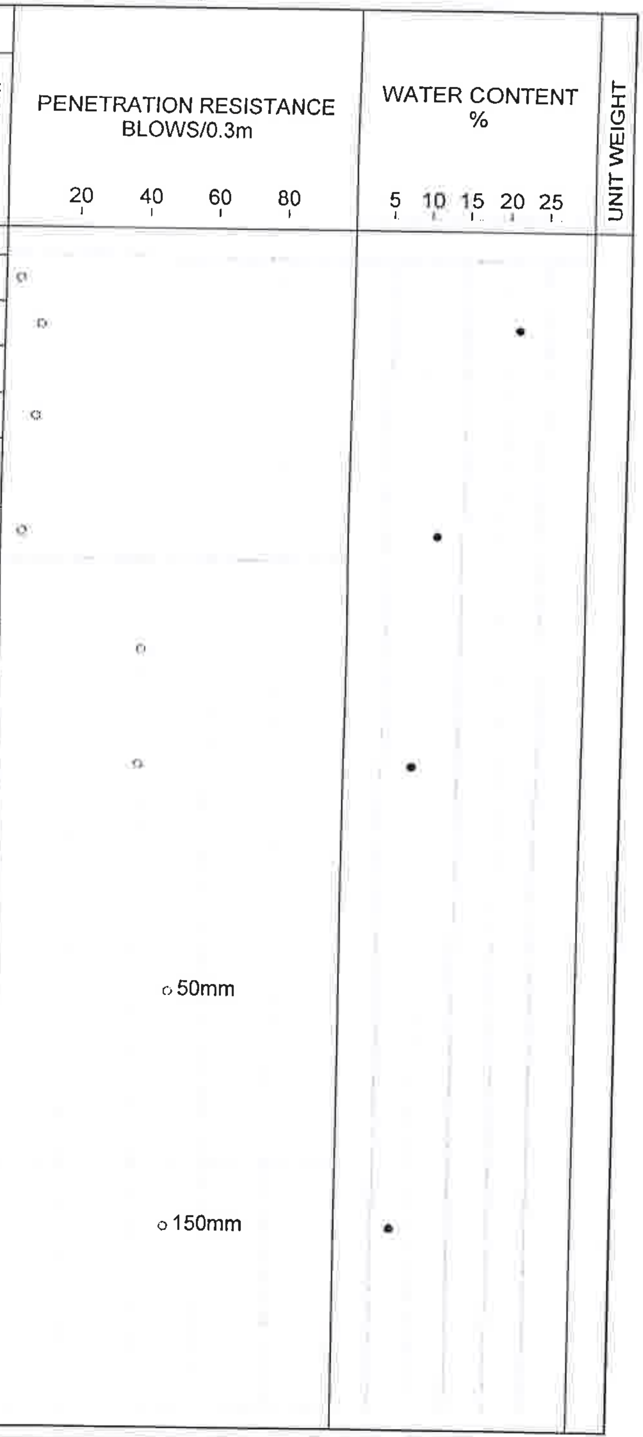
SUBSURFACE PROFILE

DEPTH (m)	DESCRIPTION	ELEVATION	GROUND WATER
0.0	Ground Surface	410.8	
0.2	175mm Topsoil	410.6	
0.8	brown, compact SILTY SAND some clay, trace gravel, moist	410.0	
6.6	brown, loose to very dense CLAYEY SANDY SILT TILL trace gravel, moist grey @ 6.1m	404.3	W.L. @ El. 405.3m± (19-Apr-2016)
	End of Borehole		

SAMPLE

NUMBER	TYPE	'N' BLOWS/0.3m
1	SS	4
1	SS	10
2	SS	9
3	SS	6
4	SS	40
5	SS	40
6	SS	50
7	SS	50



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 19, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

BOREHOLE No: 12

ENCLOSURE No: 13

SUPERVISOR: M.P.

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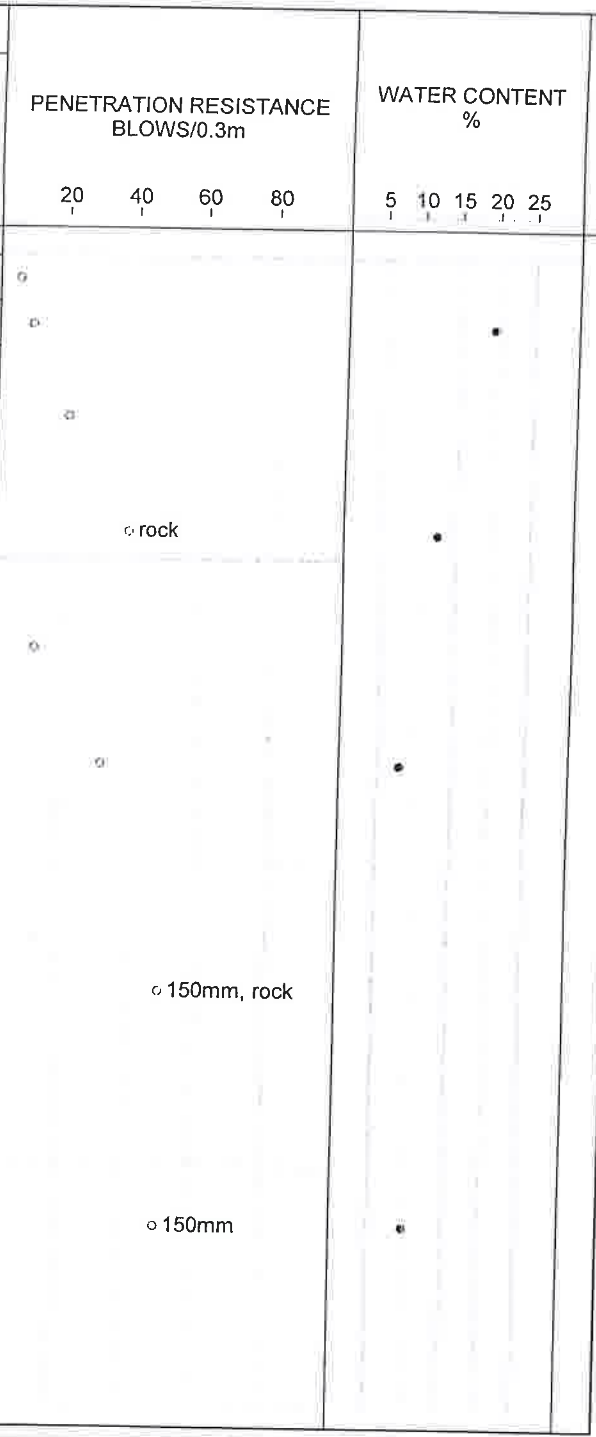
SUBSURFACE PROFILE					SAMPLE					
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
0.0	Ground Surface	409.0								
0.2	175mm Topsoil	408.8			1	SS	6			
	brown, compact to dense SILTY SAND some clay, trace gravel, moist				1	SS	10			
	boulder @ 1.2m				2	SS	21			
	cobbles @ 1.5m									
				WET C.I. @ El. 407.2m± (19-Apr-2016)	3	SS	39	rock		
					4	GS	12			
3.0		406.0								
	grey, dense to very dense SAND some silt, moist				5	SS	32			
					6	SS	50	150mm, rock		
6.6	some gravel @ 6.1m	402.5			7	SS	50	150mm		
	End of Borehole									



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 19, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

BOREHOLE No: 13

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

ENCLOSURE No: 14

LOCATION: Township of Centre Wellington, ON

SUPERVISOR: M.P.

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CONSULTING GEOTECHNICAL ENGINEERS

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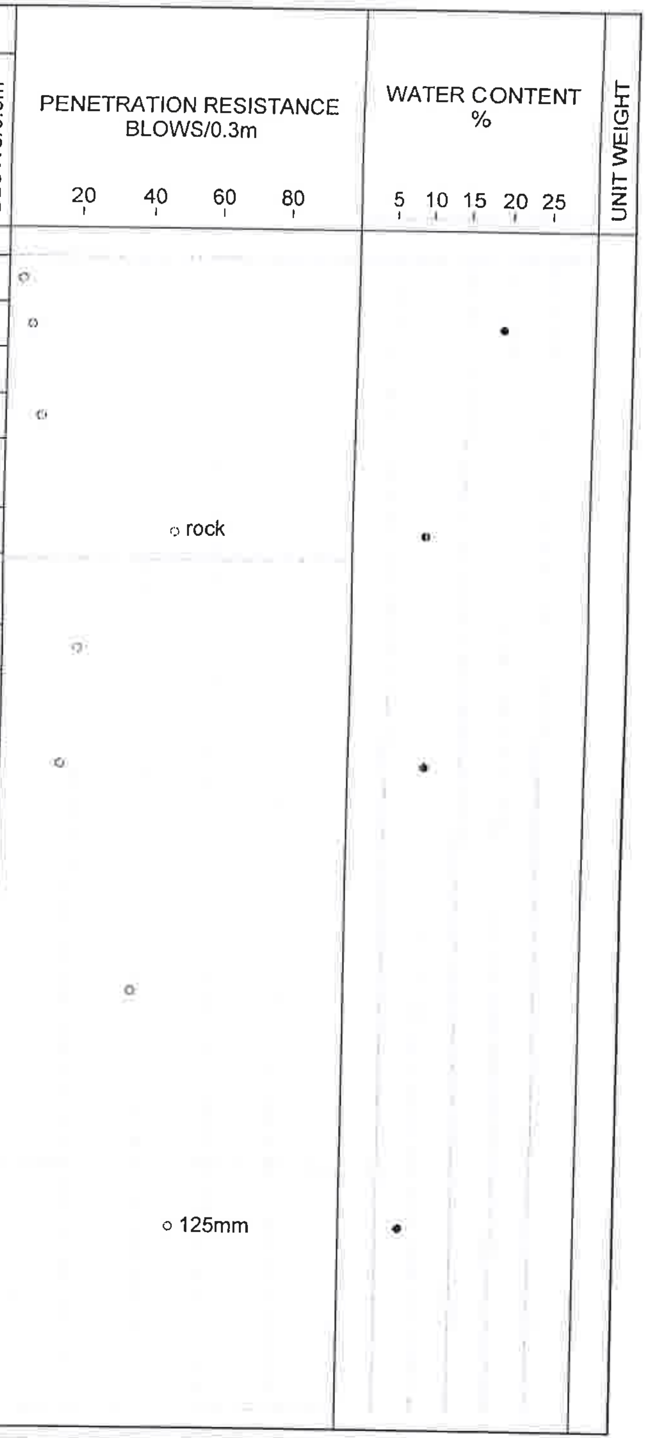
SUBSURFACE PROFILE					SAMPLE					
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
0.0	Ground Surface	409.0								
0.2	175mm Topsoil	408.8			1	SS	4			
	brown, loose to dense SILTY SAND some clay, trace gravel, moist				1	SS	7			
					2	SS	10			
				WET C.I. @ El. 407.2m± (19-Apr-2016)	3	SS	48	rock		
2.3		406.7								
	grey, compact to very dense CLAYEY SANDY SILT TILL trace gravel, moist				4	SS	21			
					5	SS	17			
					6	SS	38			
6.6		402.5			7	SS	50	125mm		
	End of Borehole									



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 19, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

BOREHOLE No: 14

ENCLOSURE No: 15

SUPERVISOR: M.P.

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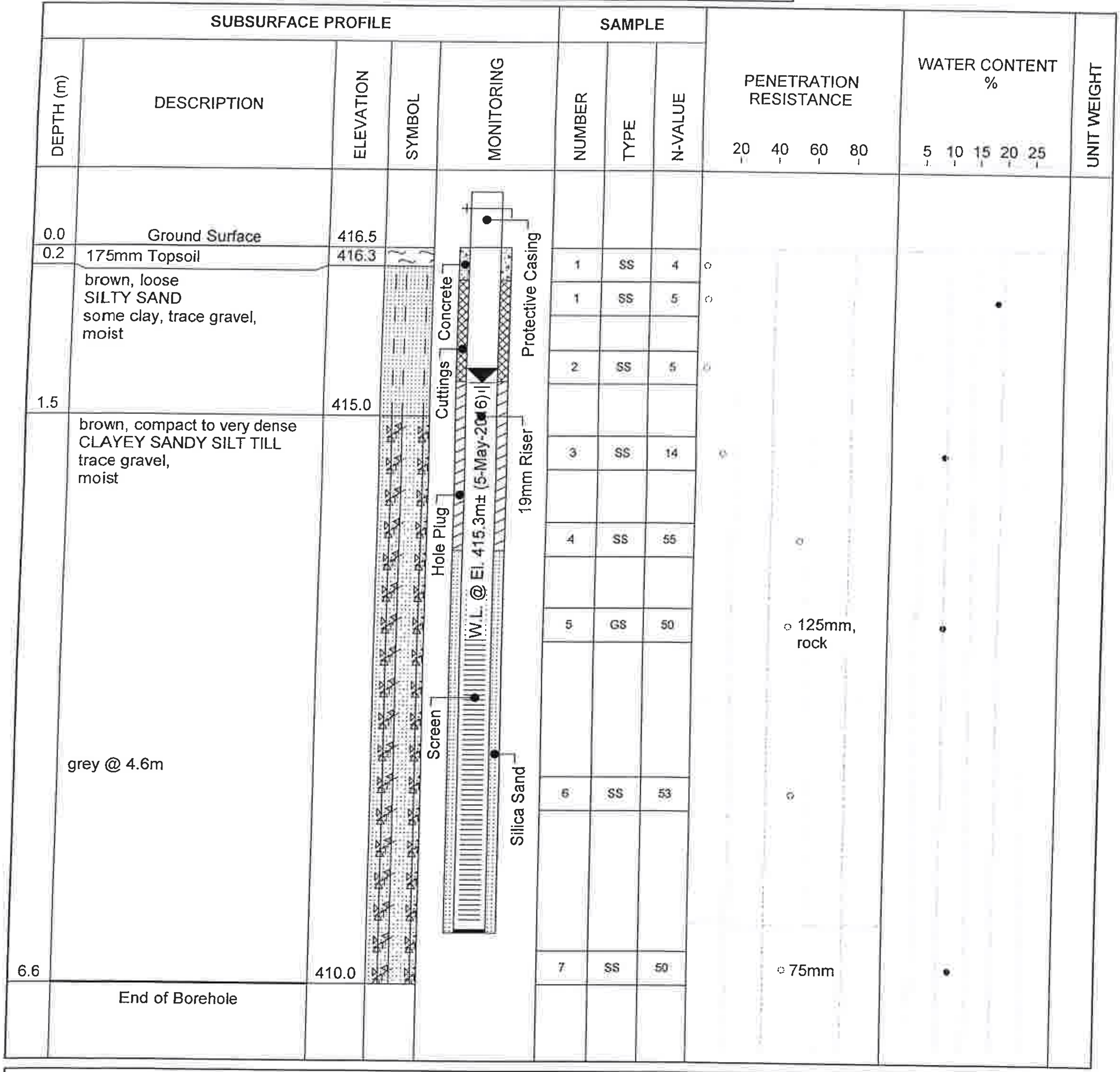

DEPTH (m)	DESCRIPTION	ELEVATION	NUMBER	TYPE	N-VALUE
0.0	Ground Surface	416.5			
0.2	175mm Topsoil	416.3			
	brown, loose SILTY SAND some clay, trace gravel, moist		1	SS	4
			1	SS	5
			2	SS	5
1.5	brown, compact to very dense CLAYEY SANDY SILT TILL trace gravel, moist	415.0	3	SS	14
			4	SS	55
			5	GS	50
	grey @ 4.6m		6	SS	53
6.6		410.0	7	SS	50
	End of Borehole				

DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 20, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

BOREHOLE No: 15

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

ENCLOSURE No: 16

LOCATION: Township of Centre Wellington, ON

SUPERVISOR: M.P.

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CONSULTING GEOTECHNICAL ENGINEERS

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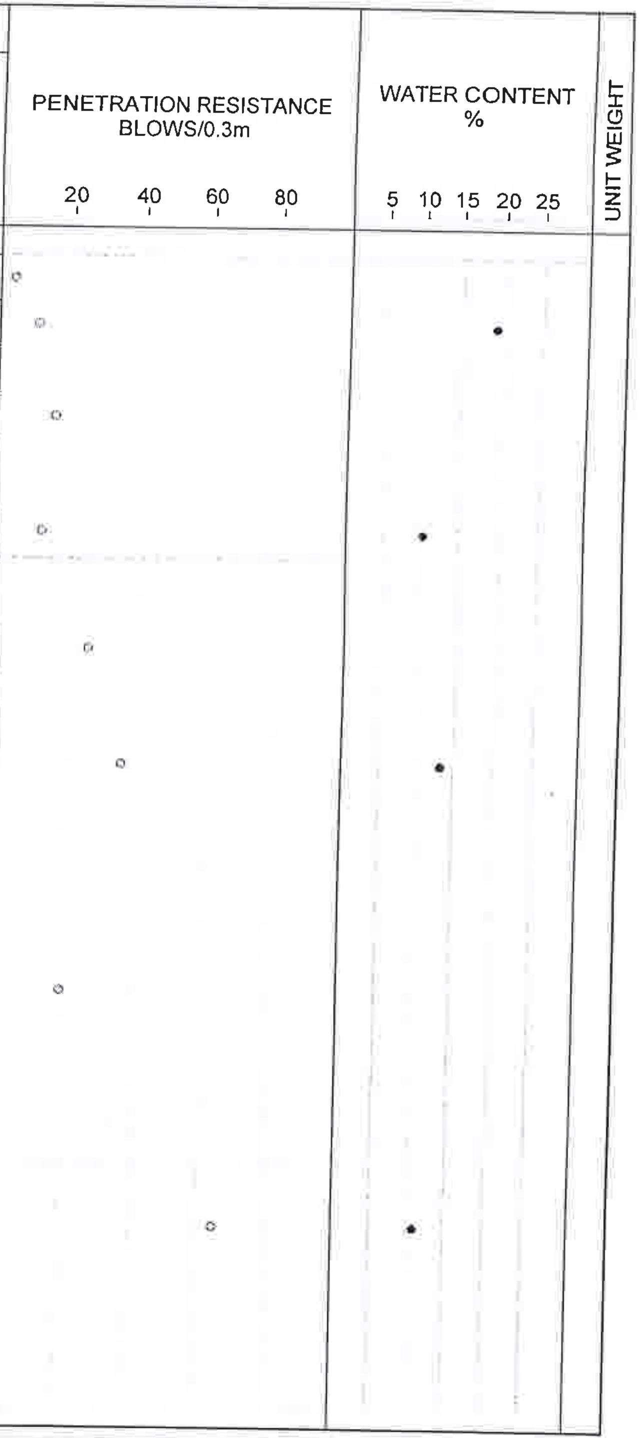
SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	415.0					
0.3	250mm Topsoil	414.8		DRY (20-Apr-2016)	1	SS	4
	brown, compact SILTY SAND some clay, trace gravel, moist				1	SS	11
					2	SS	16
1.5		413.5					
	brown, compact to very dense CLAYEY SANDY SILT TILL trace gravel, moist				3	SS	13
					4	SS	26
					5	SS	36
	grey @ 4.6m						
					6	SS	20
6.6		408.5			7	SS	65
	End of Borehole						



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 150mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 20, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

BOREHOLE No: 16

ENCLOSURE No: 17

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

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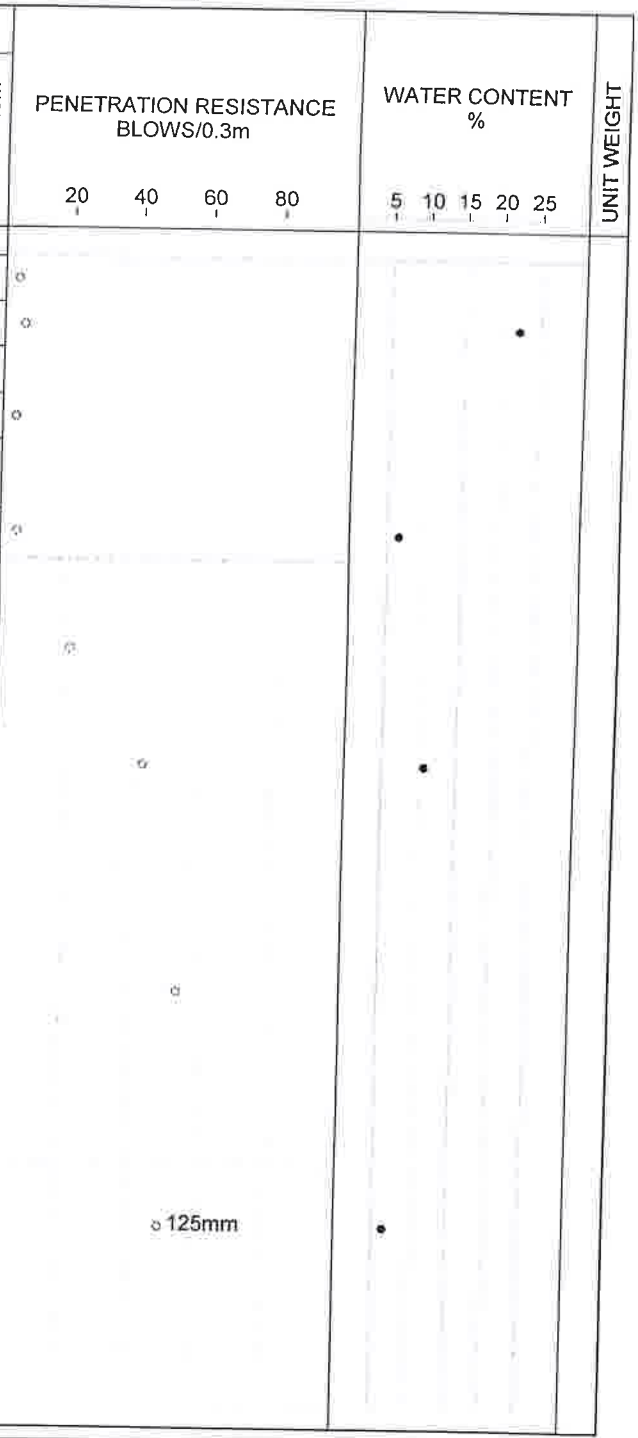
SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	413.5					
0.2	225mm Topsoil	413.3			1	SS	4
1.5	brown, loose SILTY SAND some clay, trace gravel, some organics, moist	412.0			1 2	SS SS	6 4
2.3	brown, loose SAND moist	411.2			3	SS	5
4.6	brown, compact to dense SILTY SAND AND GRAVEL moist	408.9		W.L. @ El. 411.1m± (20-Apr-2016)	4 5	SS SS	21 43
6.6	grey, very dense CLAYEY SANDY SILT TILL trace gravel, moist	407.0			6 7	SS SS	54 50
	End of Borehole						



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 20, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

BOREHOLE No: 17

ENCLOSURE No: 18

SUPERVISOR: M.P.

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CONSULTING GEOTECHNICAL ENGINEERS

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SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	411.7								
0.3	280mm Topsoil	411.4			1	SS	3			
	brown, loose SILTY SAND some clay, trace gravel, moist				1	SS	9			
				W.L. @ El. 410.5m± (20-Apr-2016)	2	SS	4			
1.5		410.2								
	brown, loose to very dense CLAYEY SANDY SILT TILL trace gravel, moist				3	SS	7			
					4	SS	22			
	grey @ 3.0m				5	SS	44			
					6	SS	80			
6.6		405.2			7	SS	50	125mm		
	End of Borehole									

DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 20, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

BOREHOLE No: 18

ENCLOSURE No: 19

SUPERVISOR: M.P.

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SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m (20 40 60 80)	WATER CONTENT % (5 10 15 20 25)	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m			
0.0	Ground Surface	414.5								
0.2	175mm Topsoil	414.3			1	SS	4	○		
0.8	brown, compact SILTY SAND some clay, trace gravel, moist	413.7			1	SS	11	○	●	
1.5	brown, loose SAND moist	413.0			2	SS	6	○		
	brown, compact to very dense CLAYEY SANDY SILT TILL trace gravel, moist			DRY C.I. @ El. 409.6m± (22-Apr-2016)	3	SS	11	○	●	
	sand seam @ 2.3m				4	SS	19	○		
	grey @ 3.0m				5	SS	54	○rock	●	
					6	SS	50	○ 125mm, rock		
6.6		408.0			7	SS	50	○ 150mm	●	
	End of Borehole									

DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 22, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

BOREHOLE No: 19

ENCLOSURE No: 20

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

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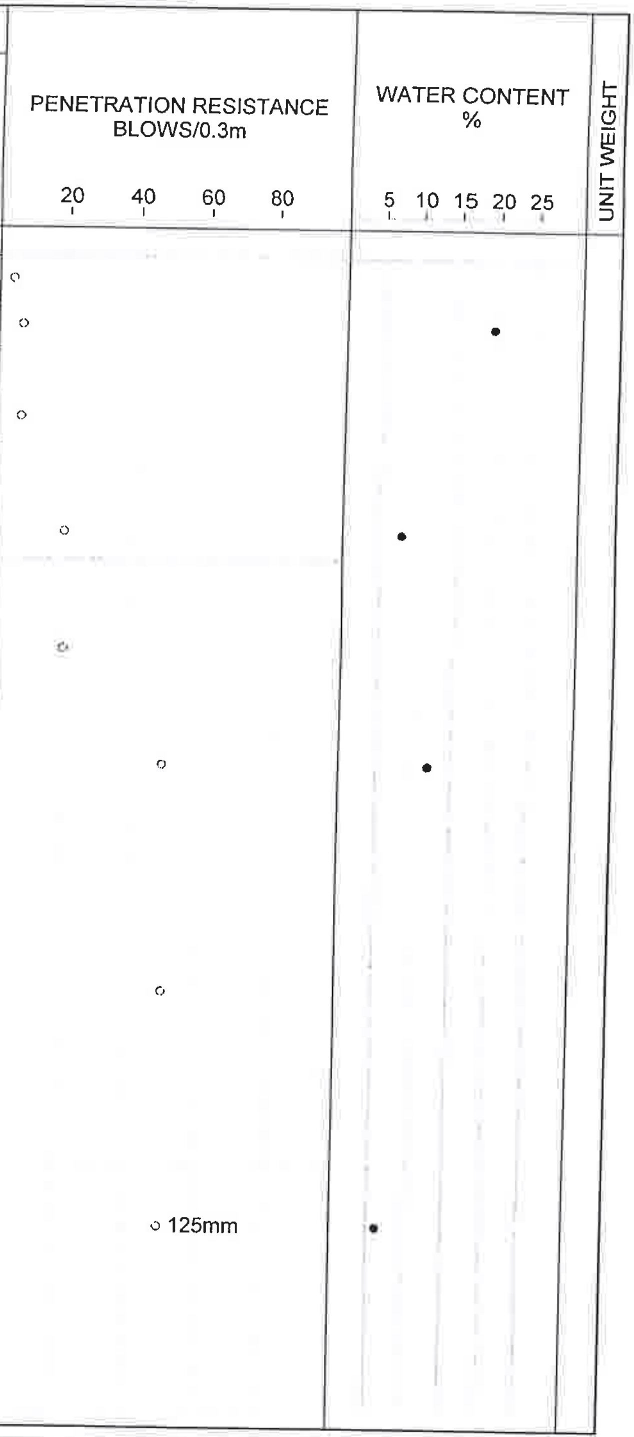
SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	413.1					
0.4	410mm Topsoil	412.7			1	SS	4
1.5	brown, loose SILTY SAND some clay, trace gravel, moist	411.6			1 2	SS SS	7 7
1.7	grey, compact SAND AND GRAVEL moist	411.4					
3.0	grey, compact CLAYEY SANDY SILT TILL trace gravel, moist	410.1			3 4	SS SS	20 20
4.6	grey, dense SAND some silt, moist	408.5			5	SS	49
6.6	grey, very dense CLAYEY SANDY SILT TILL trace gravel, moist	406.6			6 7	SS SS	50 50
	End of Borehole						

DRY C.I. @ El. 407.6m± (21-Apr-2016)



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 21, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

BOREHOLE No: 20

ENCLOSURE No: 21

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

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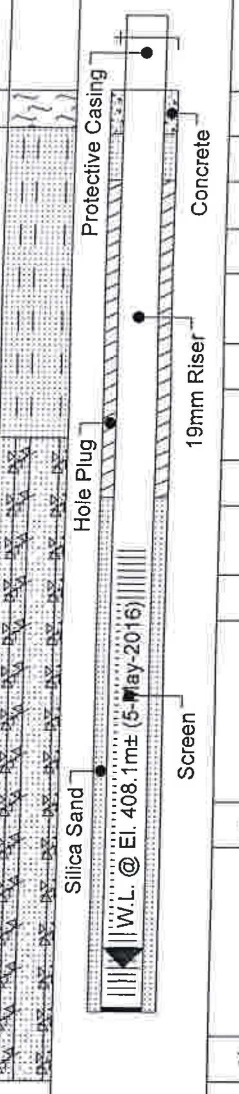
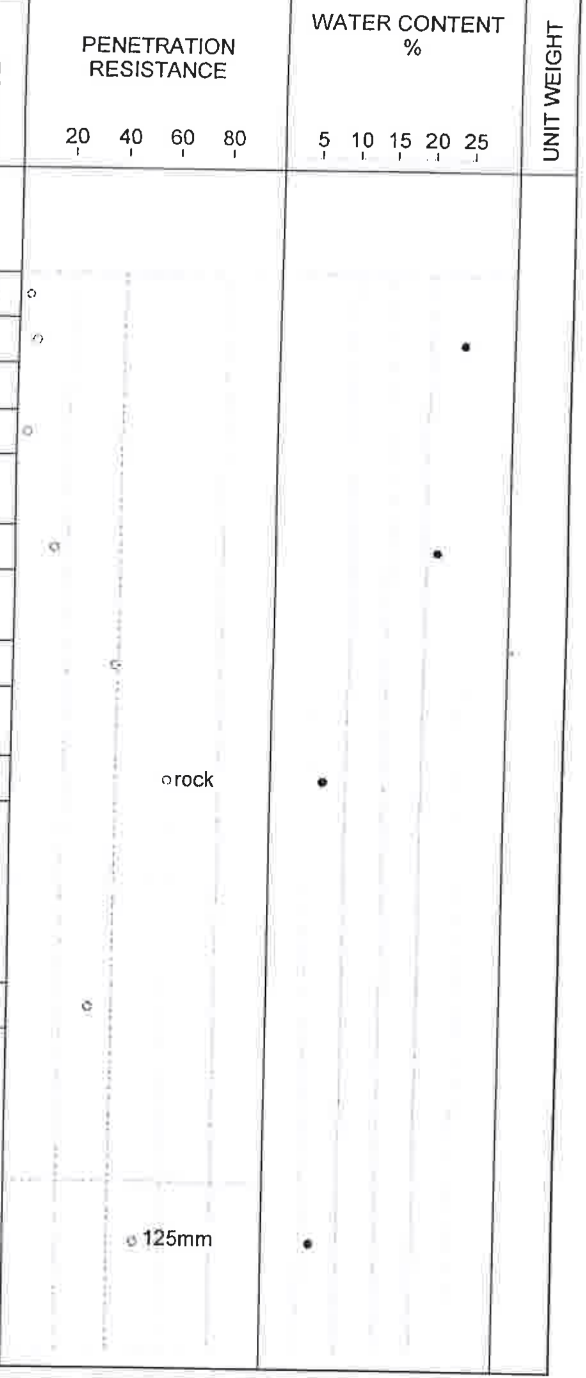
SUBSURFACE PROFILE

DEPTH (m)	DESCRIPTION	ELEVATION
0.0	Ground Surface	413.9
0.3	250mm Topsoil	413.7
	brown, loose to compact SILTY SAND some clay, trace gravel, moist to wet	
2.3		411.6
	brown, dense to very dense CLAYEY SANDY SILT TILL trace gravel, moist grey @ 4.6m	
6.6		407.3
	End of Borehole	



SAMPLE

NUMBER	TYPE	N-VALUE
1	SS	4
1	SS	7
2	SS	4
3	SS	15
4	SS	39
5	SS	60
6	SS	31
7	SS	50



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 21, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

BOREHOLE No: 21

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

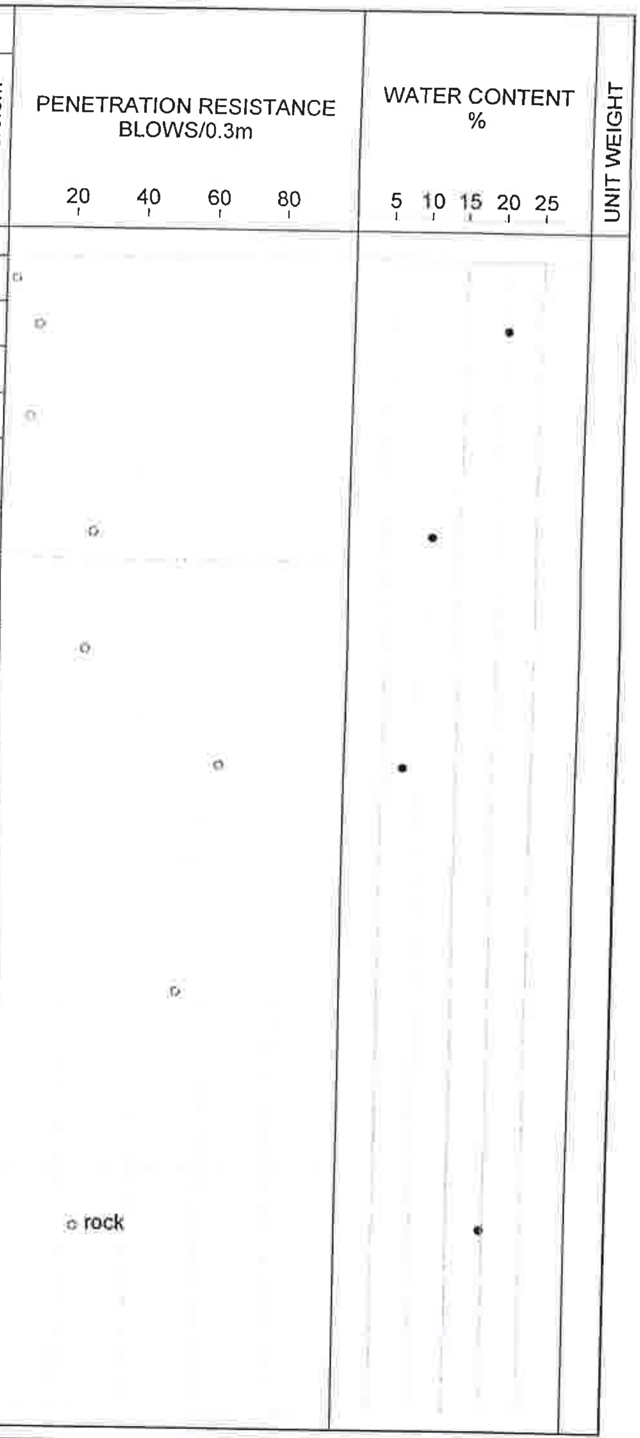
ENCLOSURE No: 22

LOCATION: Township of Centre Wellington, ON

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS
405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	414.6		DRY (21-Apr-2016)			
0.2	200mm Topsoil	414.4			1	SS	3
0.8	brown, compact SILTY SAND some clay, trace gravel, moist	413.8			1	SS	10
	brown, loose to very dense CLAYEY SANDY SILT TILL trace gravel, moist				2	SS	8
					3	SS	27
					4	SS	25
					5	SS	64
	grey @ 4.6m				6	SS	53
6.1		408.5					
	grey, very stiff SILTY CLAY some sand, moist				7	SS	25
6.6		408.1					
	End of Borehole						



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 21, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

BOREHOLE No: 22

ENCLOSURE No: 23

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

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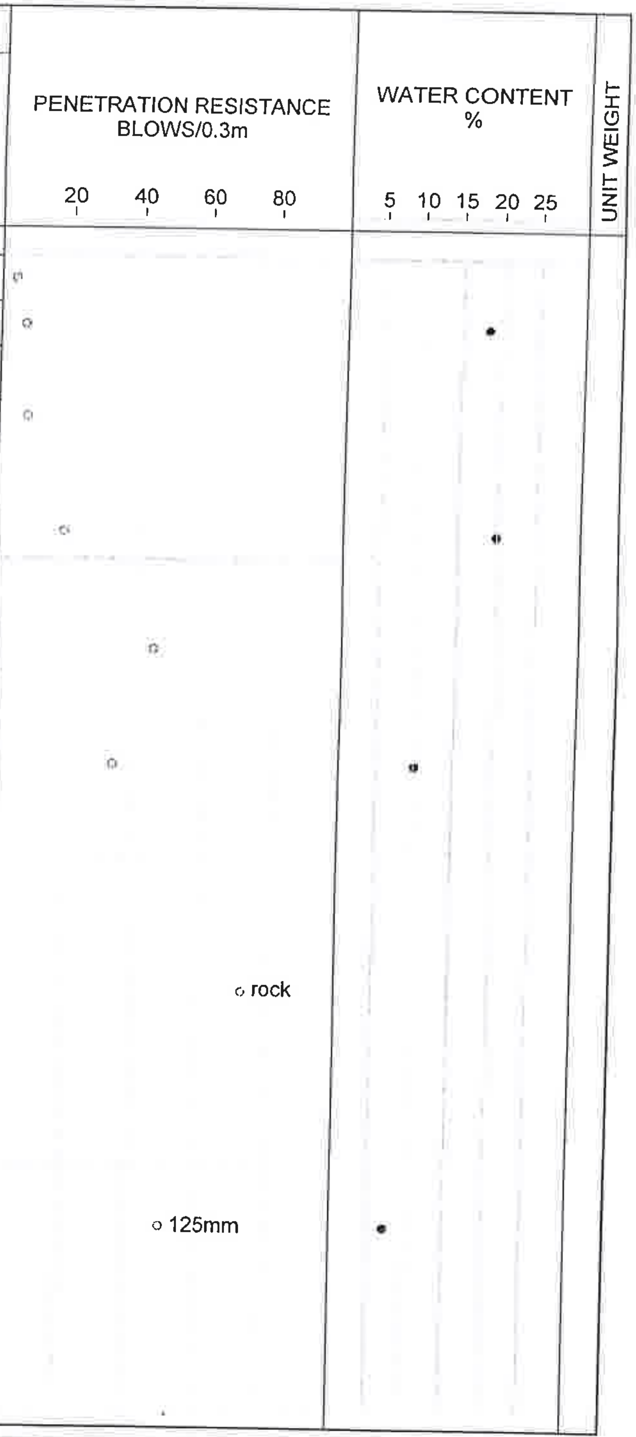
SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	414.1		DRY (21-Apr-2016)			
0.3	280mm Topsoil	413.8			1	SS	4
0.8	brown, loose SILTY SAND some clay, trace gravel, moist	413.3			1	SS	7
	brown, loose to compact SAND moist to wet				2 3	SS SS	8 19
2.3		411.8					
	grey, dense to very dense CLAYEY SANDY SILT TILL trace gravel, moist				4 5 6 7	SS SS SS SS	45 34 73 50
6.6		407.6					
	End of Borehole						



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 21, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

BOREHOLE No: 23

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

ENCLOSURE No: 24

LOCATION: Township of Centre Wellington, ON

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

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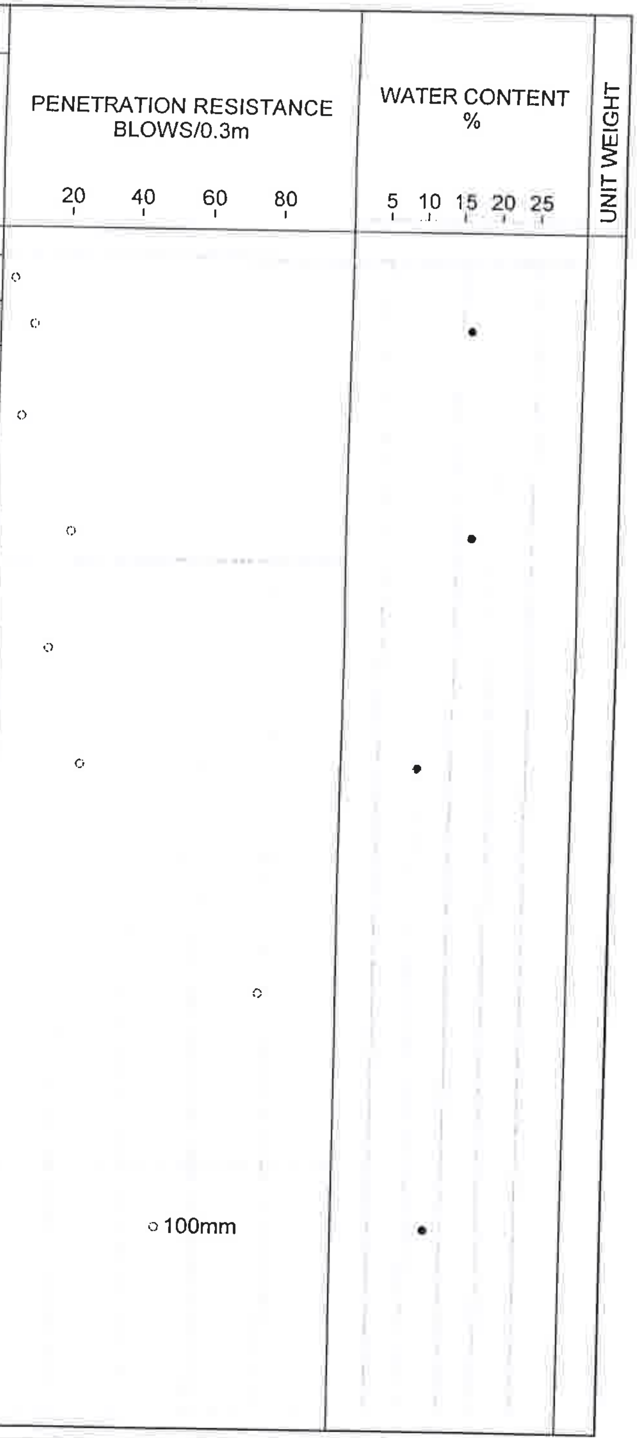
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	414.9					
0.2	225mm Tosoil	414.7			1	SS	4
1.5	brown, loose to compact SANDY SILT trace clay, moist	413.4		WET C.I. @ El. 411.2m± (22-Apr-2016)	1 2	SS SS	10 7
2.3	brown, compact SAND some silt, some gravel, wet	412.6			3	SS	22
3.0	brown, compact CLAYEY SANDY SILT TILL trace gravel, moist	411.9			4	SS	16
4.6	grey, very stiff SILTY CLAY some sand, moist	410.3			5	SS	26
6.6	grey, very dense CLAYEY SANDY SILT TILL trace gravel, moist	408.3			6 7	SS SS	78 50
	End of Borehole						



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 22, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

BOREHOLE No: 24

ENCLOSURE No: 25

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
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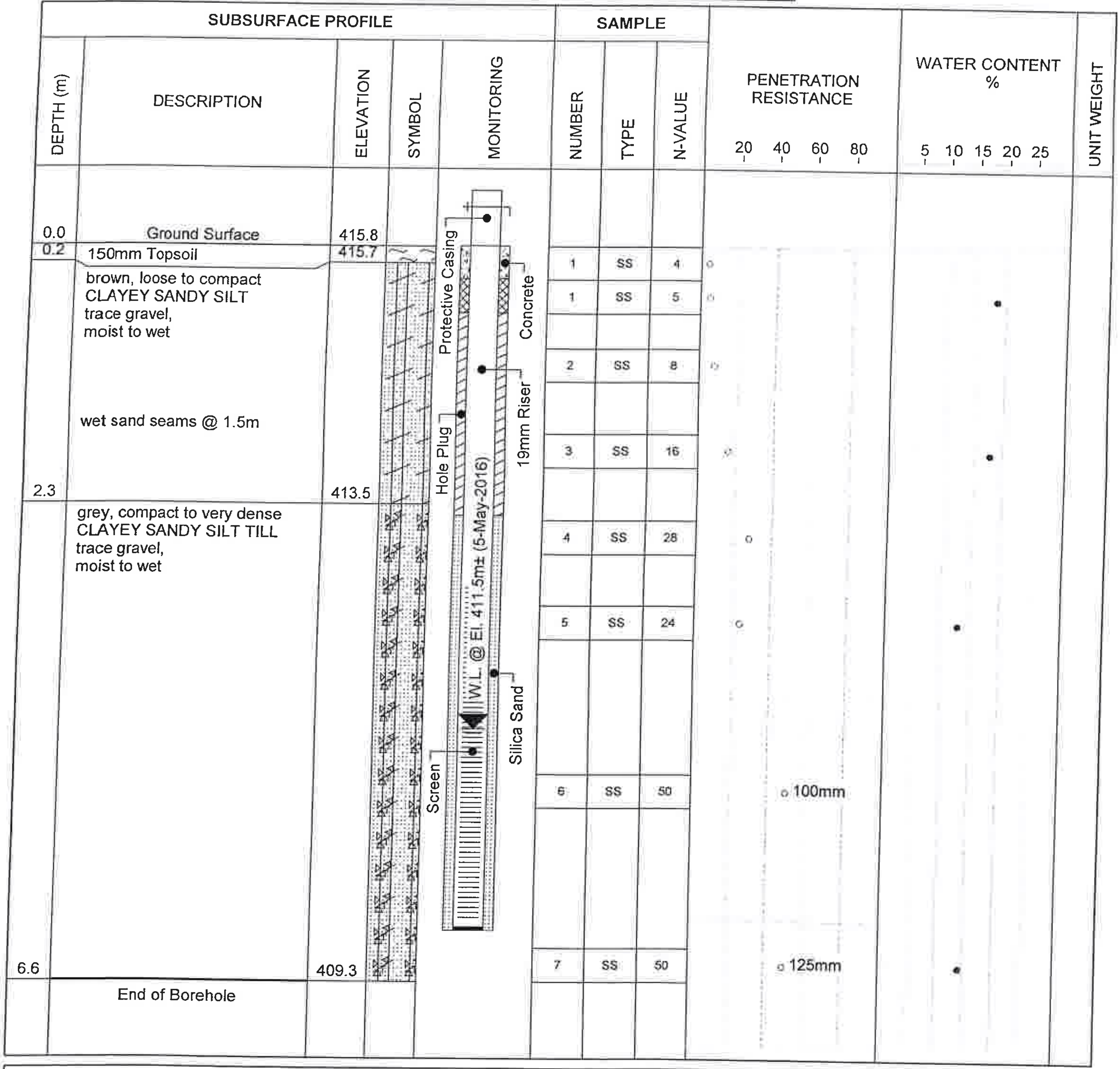

DEPTH (m)	DESCRIPTION	ELEVATION
0.0	Ground Surface	415.8
0.2	150mm Topsoil	415.7
	brown, loose to compact CLAYEY SANDY SILT trace gravel, moist to wet wet sand seams @ 1.5m	
2.3	grey, compact to very dense CLAYEY SANDY SILT TILL trace gravel, moist to wet	413.5
6.6	End of Borehole	409.3

NUMBER	TYPE	N-VALUE
1	SS	4
1	SS	5
2	SS	8
3	SS	16
4	SS	28
5	SS	24
6	SS	50
7	SS	50

DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 22, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

BOREHOLE No: 25

ENCLOSURE No: 26

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS
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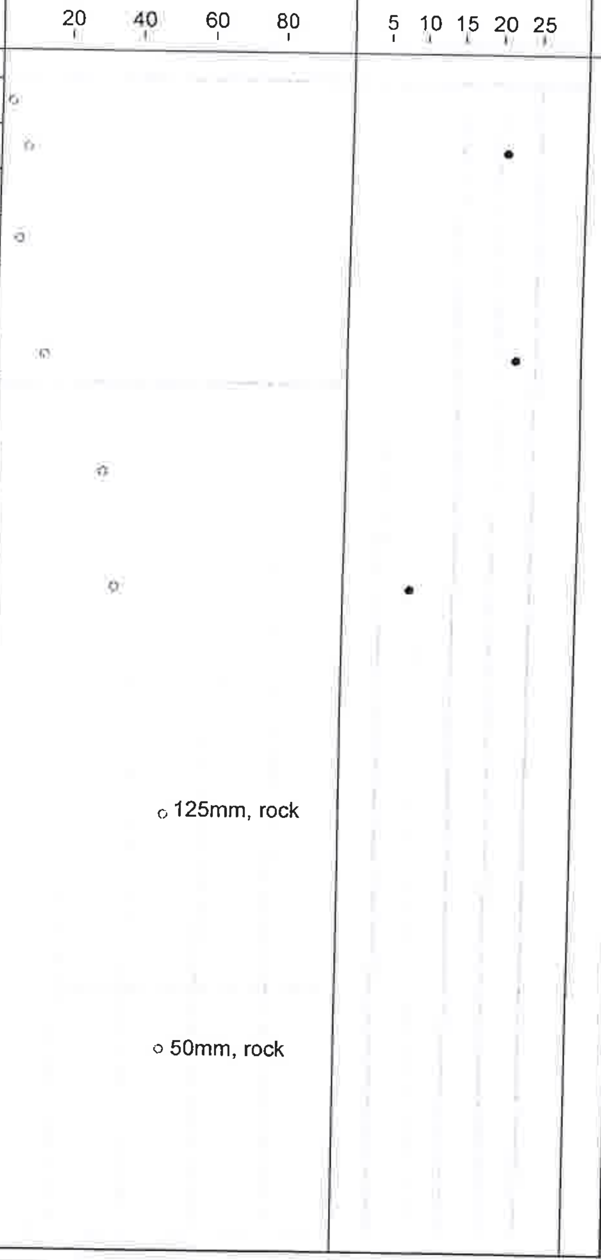
SUBSURFACE PROFILE					SAMPLE			PENETRATION RESISTANCE BLOWS/0.3m	WATER CONTENT %	UNIT WEIGHT
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m	20 40 60 80	5 10 15 20 25	
0.0	Ground Surface	415.6		DRY C.I. @ El. 410.4m± (22-Apr-2016)						
0.3	330mm Topsoil	415.3			1	SS	3			
	grey/mottled, loose SILTY SAND some clay, trace gravel, moist				1	SS	8			
1.5		414.1			2	SS	6			
2.3	grey, compact SAND wet	413.3			3	SS	14			
	grey, dense to very dense CLAYEY SANDY SILT TILL trace gravel, moist				4	SS	31			
					5	SS	35			
					6	SS	50	125mm, rock		
6.6		409.1			7	SS	50	50mm, rock		
	End of Borehole									



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 22, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

BOREHOLE No: 26

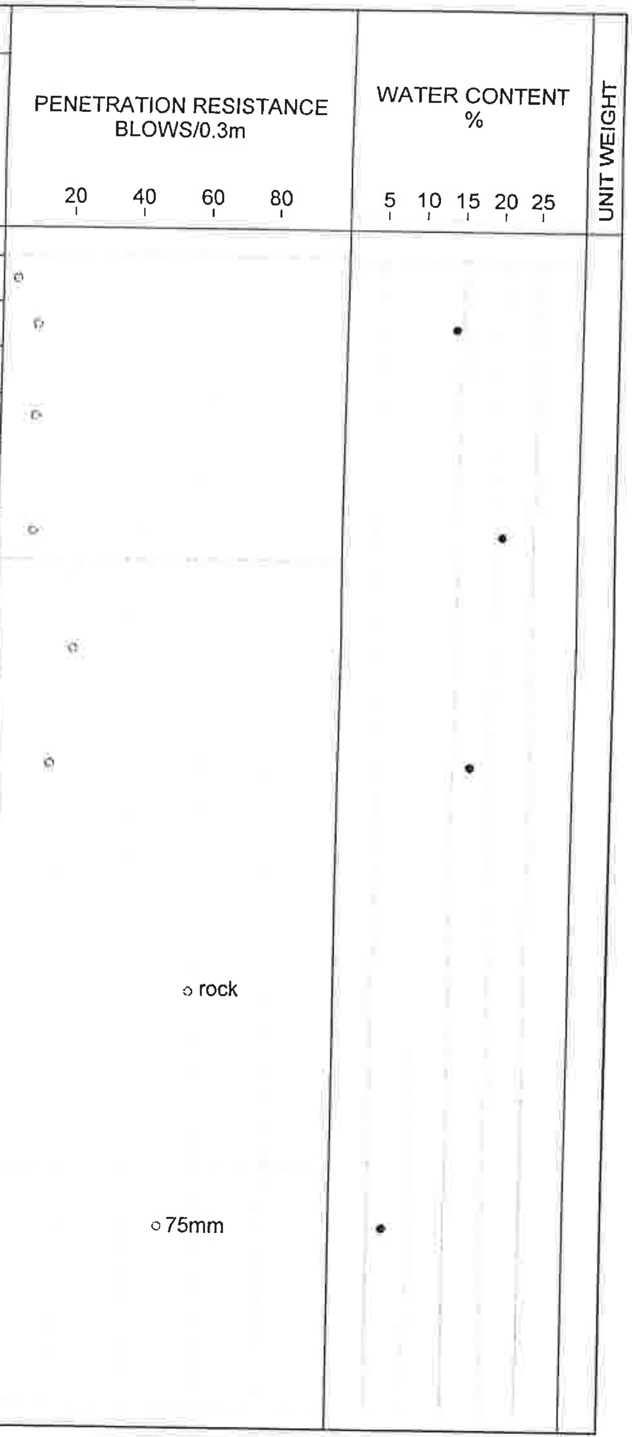
ENCLOSURE No: 27

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	415.0					
0.2	200mm Topsoil	414.8			1	SS	4
0.8	brown, compact SILTY SAND some clay, trace gravel, moist	414.2			1	SS	10
	brown, compact to very dense SAND some silt, wet				2	SS	10
				WET C.I. @ El. 413.2m± (21-Apr-2016)	3	SS	10
	grey @ 2.3m				4	SS	22
					5	SS	16
					6	SS	58
6.1		408.9					
6.6	grey, very dense CLAYEY SANDY SILT TILL trace gravel, moist	408.5			7	SS	50
	End of Borehole						



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 21, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

LOCATION: Township of Centre Wellington, ON

BOREHOLE No: 27

ENCLOSURE No: 28

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
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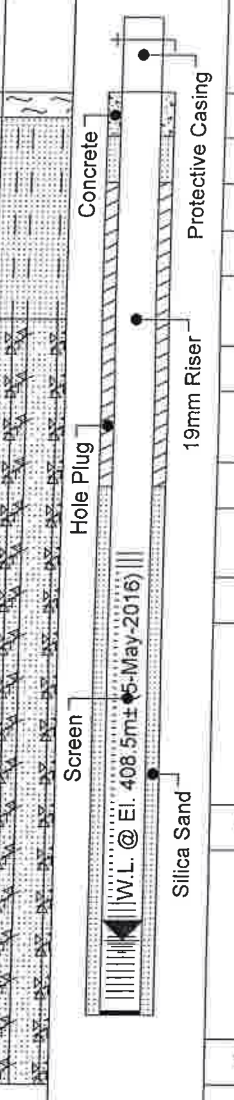
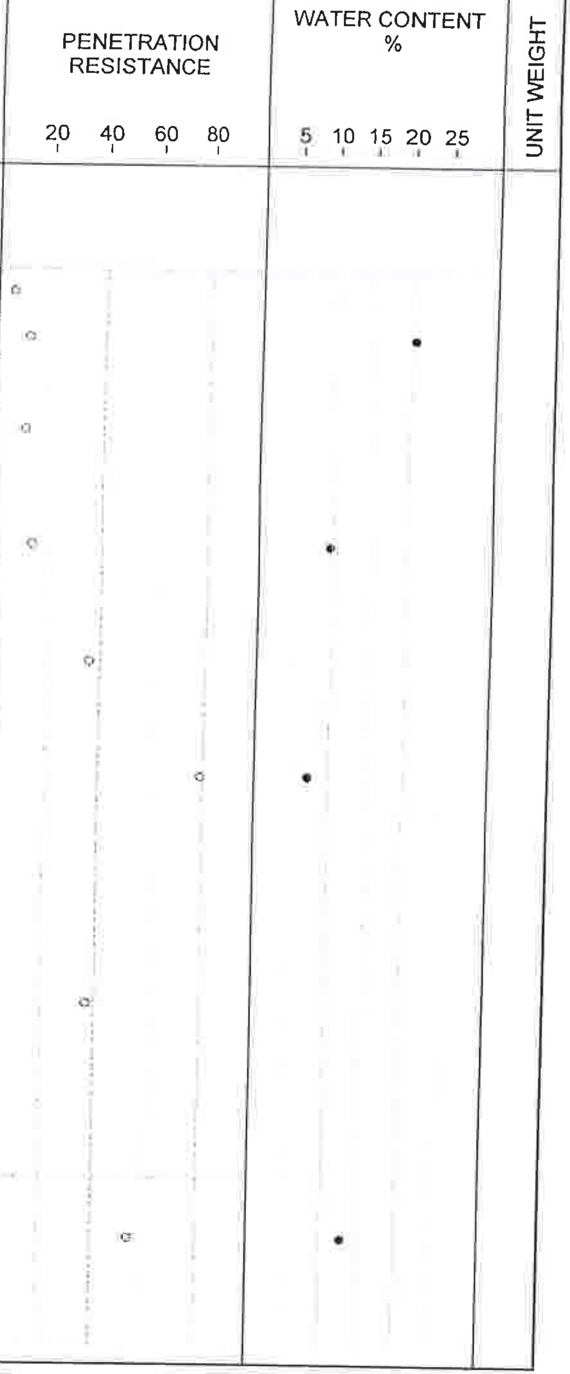
SUBSURFACE PROFILE			SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	NUMBER	TYPE	N-VALUE
0.0	Ground Surface	414.1			
0.2	175mm Topsoil	413.9	1	SS	6
	brown, compact SILTY SAND some clay, trace gravel, moist		1	SS	12
			2	SS	11
1.5	grey, compact to very dense CLAYEY SANDY SILT TILL trace gravel, moist	412.6	3	SS	14
			4	SS	36
			5	SS	79
			6	SS	37
6.6	End of Borehole	407.6	7	SS	54





DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

DATUM: Geodetic

DRILL DATE: April 21, 2016

SHEET: 1 of 1

REFERENCE No: G3719-6-5

BOREHOLE No: 28

CLIENT: Nigus Fergus Joint Venture

PROJECT: Storybrook Subdivision

ENCLOSURE No: 29

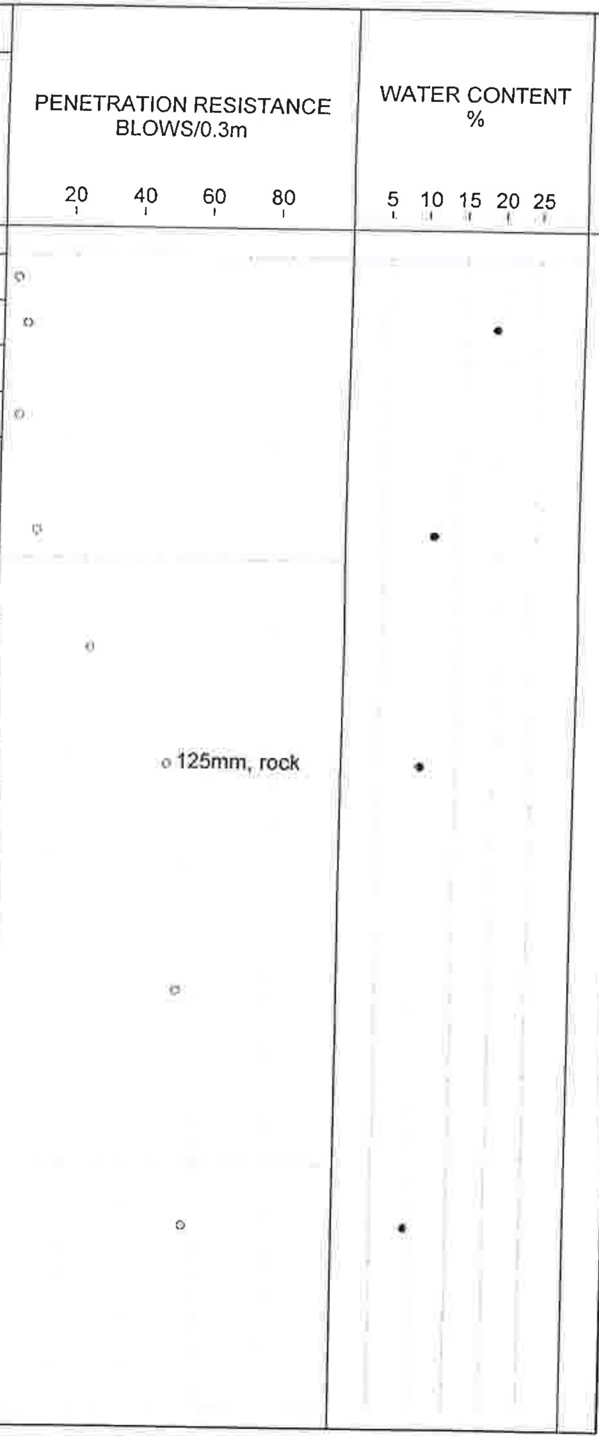
LOCATION: Township of Centre Wellington, ON

SUPERVISOR: M.P.

V.A. WOOD (GUELPH) INC.
CONSULTING GEOTECHNICAL ENGINEERS

405 YORK ROAD, GUELPH, ONTARIO N1E 3H3
PH. (519) 763-3101 FAX (519) 763-5912

SUBSURFACE PROFILE					SAMPLE		
DEPTH (m)	DESCRIPTION	ELEVATION	SYMBOL	GROUND WATER	NUMBER	TYPE	'N' BLOWS/0.3m
0.0	Ground Surface	414.8					
0.3	300mm Topsoil	414.5			1	SS	4
0.8	brown, loose SILTY SAND some clay, trace gravel, moist	414.0			1	SS	7
1.5	brown, loose SAND some silt, moist	413.3			2	SS	5
	brown, compact to very dense CLAYEY SANDY SILT TILL trace gravel, moist			DRY C.I. @ El. 409.3m± (21-Apr-2016)	3	SS	11
					4	SS	27
	cobbles @ 3.0m				5	SS	50
	grey @ 4.6m				6	SS	54
6.6		408.3			7	SS	57
	End of Borehole						



DRILLED BY: ALTECH Drilling and Investigative Services Ltd.

HOLE DIAMETER: 210mm

DRILL METHOD: Hollow Stem Auger

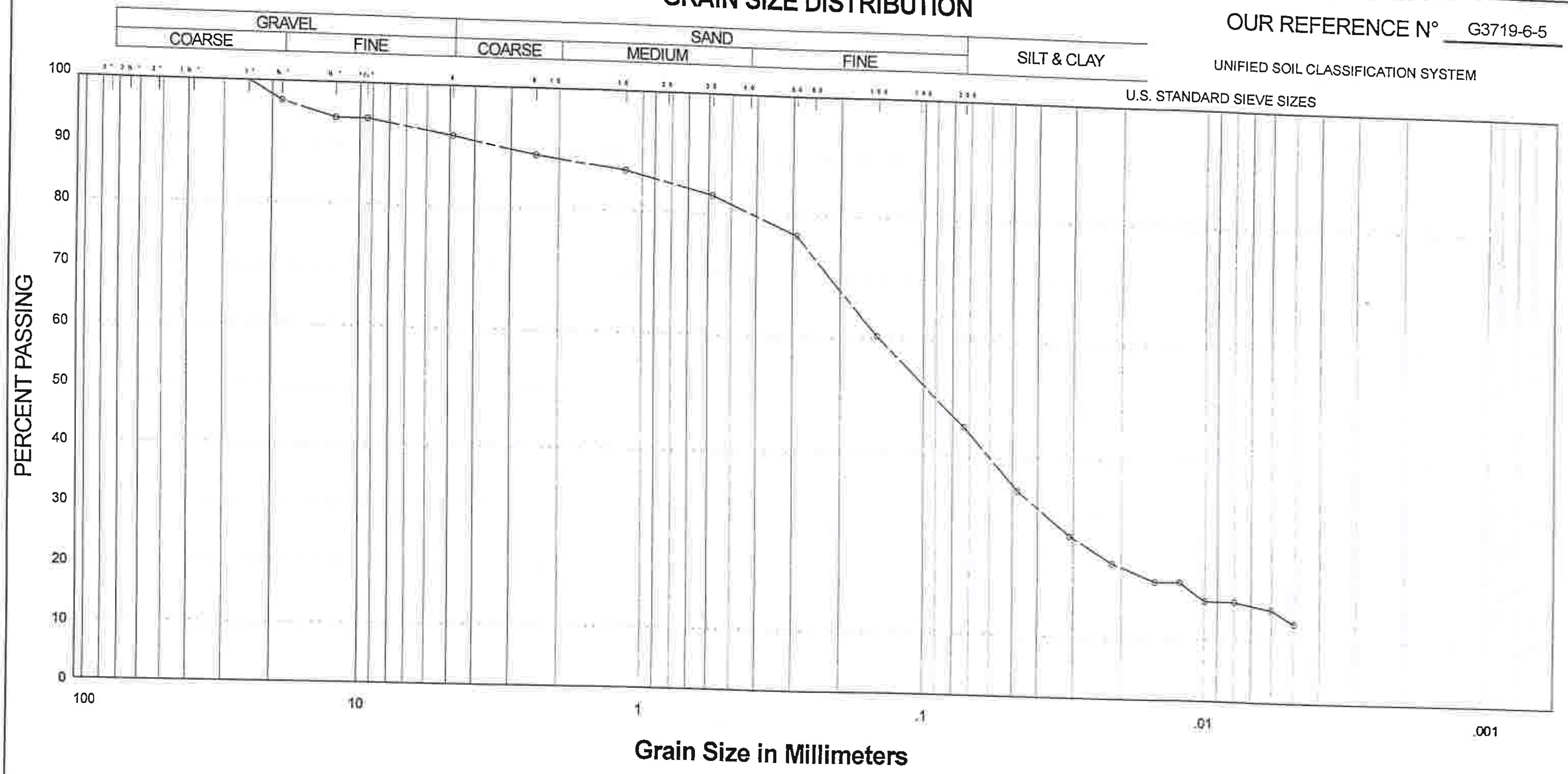
DATUM: Geodetic

DRILL DATE: April 21, 2016

SHEET: 1 of 1

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G3719-6-5



PROJECT: Storybrook Subdivision
LOCATION: Township of Centre Wellington, Ontario
BOREHOLE N°: 12
SAMPLE N°: 4
DEPTH: 2.3 - 2.6m±
ELEVATION: 410.8 - 410.5m±

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SILTY SAND, some clay, trace gravel (SM)

PLASTIC PROPERTIES

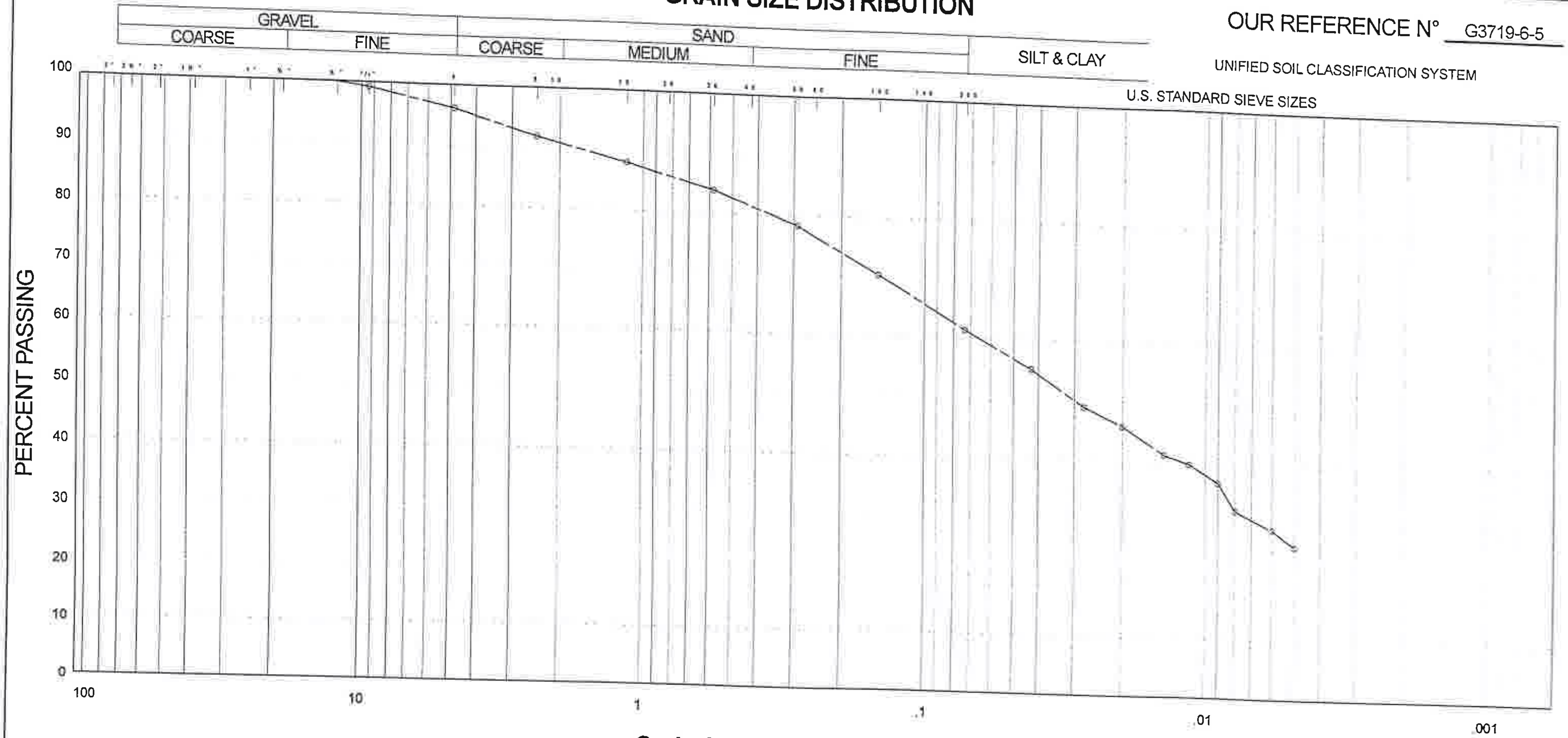
LIQUID LIMIT	% = 18.5
PLASTIC LIMIT	% = 14.2
PLASTICITY INDEX	% = 4.3
MOISTURE CONTENT	% = 17.6

ENCLOSURE N° 30

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G3719-6-5



Grain Size in Millimeters

PROJECT: Storybrook Subdivision
LOCATION: Township of Centre Wellington, Ontario
BOREHOLE N°: 4
SAMPLE N°: 6
DEPTH: 4.6 - 4.9m±
ELEVATION: 408.5 - 408.2m±

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

CLAYEY SANDY SILT TILL, trace gravel (CL)

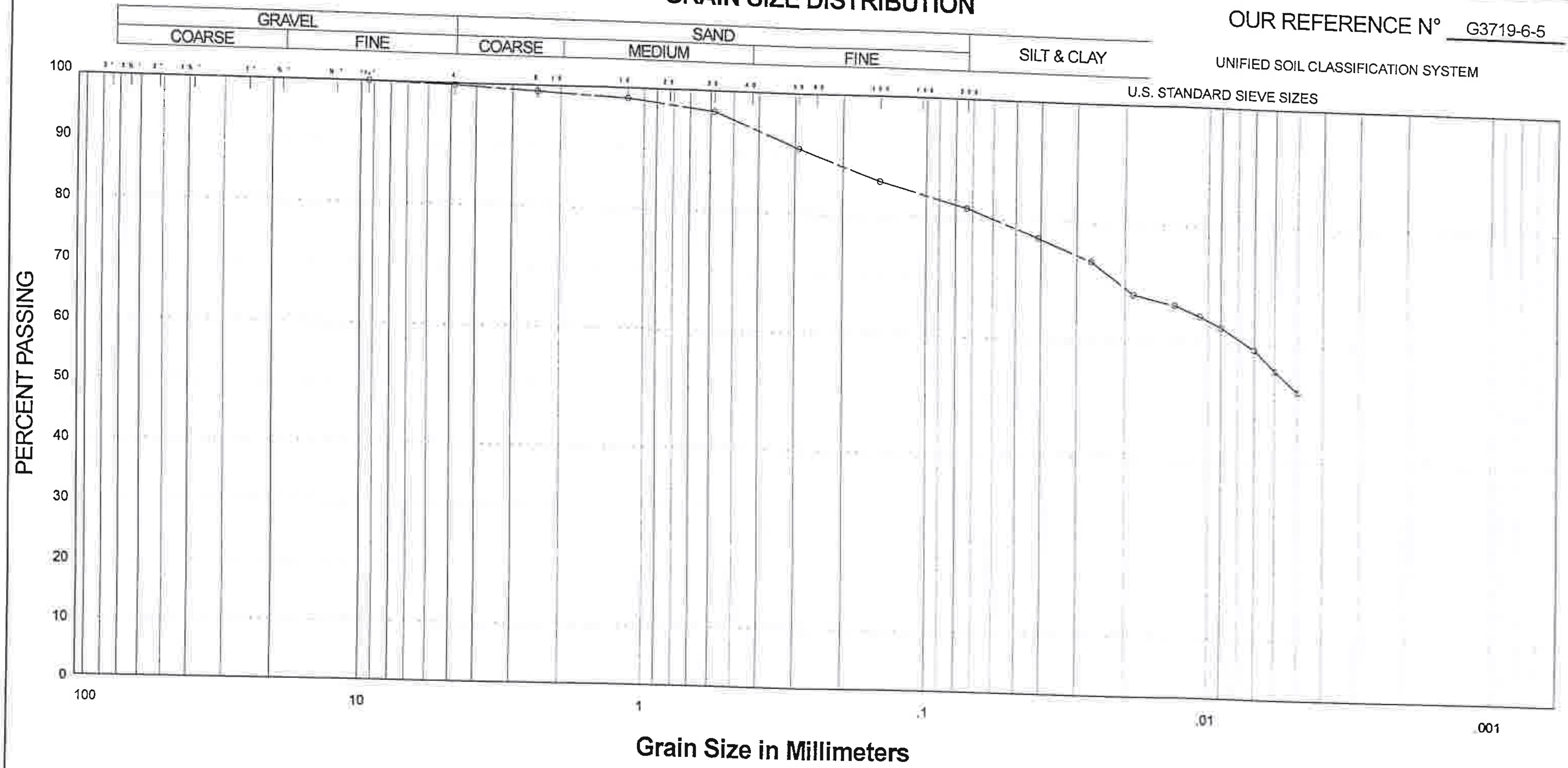
PLASTIC PROPERTIES	
LIQUID LIMIT	% = 20.8
PLASTIC LIMIT	% = 11.6
PLASTICITY INDEX	% = 9.2
MOISTURE CONTENT	% = 10.2

ENCLOSURE N° 31

V. A. WOOD (GUELPH) INCORPORATED

GRAIN SIZE DISTRIBUTION

OUR REFERENCE N° G3719-6-5



PROJECT: Storybrook Subdivision
LOCATION: Township of Centre Wellington, Ontario
BOREHOLE N°: 5
SAMPLE N°: 5
DEPTH: 3.0 - 3.3m±
ELEVATION: 406.3 - 406.0m±

COEFFICIENT OF UNIFORMITY:
COEFFICIENT OF CURVATURE:

Classification of Sample and Group Symbol:

SILTY CLAY, some sand (CL)

PLASTIC PROPERTIES	
LIQUID LIMIT	% = 30.8
PLASTIC LIMIT	% = 13.4
PLASTICITY INDEX	% = 17.4
MOISTURE CONTENT	% = 18.7

ENCLOSURE N° 32

V. A. WOOD (GUELPH) INCORPORATED

Terraprobe

Consulting Geotechnical & Environmental Engineering
Construction Materials Engineering, Inspection & Testing

HYDROGEOLOGICAL STUDY
PROPOSED RESIDENTIAL SUBDIVISION
NIGUS PROPERTY
TOWNSHIP OF CENTRE WELLINGTON, ONTARIO

Prepared For:
Sorbara Development Group
3700 Steeles Avenue West, Suite 800
Vaughan, Ontario
L4L 8M9

Attention: Mr. Andy Margaritis

File No.: 1-07-2438

January 6, 2009

Distribution of Report:

6 copies – Sorbara Development Group
1 copy – Terraprobe Limited

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1.0 INTRODUCTION

Terraprobe Limited was retained by the Sorbara Development Group to evaluate a proposed residential development in the Township of Centre Wellington, Ontario (Figures 1 & 2). The purpose of the evaluation was to provide information regarding the hydrogeological considerations for development of the property, including:

- hydrogeologic setting of the property;
- document existing ground water levels;
- identification of ground water recharge and discharge zones;
- contribution of the property to base flow in surrounding watercourses; and,
- requirements and design measures which can be used to maintain the ground water function of the site.

2.0 PROCEDURE

The scope of work for the study consists of the following:

- A review of available geologic and hydrogeologic information for the site including topographic mapping, geologic mapping, MOE well records, and the results of previous investigations conducted by Terraprobe and others in the area.

- A review of meteorological data to assess local climate and water balance.

- A detailed visual inspection of the site and surrounding areas to determine local topography and drainage. The presence of significant hydrogeologic features such as closed depressions (areas of ground water recharge), seeps, springs, or presence of phreatophytic vegetation was assessed.

- A subsurface investigation of the site consisting of drilling a series of twenty (20) boreholes. Standpipe piezometers were installed at each borehole location to assess shallow ground water levels. Nested piezometers were installed at two locations to determine the vertical gradient.

3.0 SITE AND PROJECT DESCRIPTION

3.1 Site Location and Project Description

The site is located north of Colborne Street and west of Beatty Line North, in the Township of Centre Wellington (Figure 1). The property to be developed is an irregular-shaped parcel of approximately 100 ha (250 acres) in total size. The property is bounded by Colborne Street to the south, Beatty Line North and a former rail line to the east, Colborne Street and agricultural lands to the west and agricultural lands to the north.

The property comprises agricultural fields and a rural dwelling is located in the central portion of the site. A woodlot is located in the west central portion of the site and a tributary to Irvine Creek, known as Nichol Drain No. 1, crosses through the site in an east-west direction. A drainage swale is located in the northwestern portion of the site, which drains to the south towards the woodlot.

The property is proposed to be developed as a residential subdivision. The proposed development (low and medium density) would include single family and town houses lots, open space blocks and internal roads. A school is proposed for the southeast corner of the property, and some commercial development in the central portion. The development will be serviced by sanitary and storm sewers and municipal water.

3.2 Site Drainage and Topography

The subject site consists of gently rolling lands, and generally slopes down to the north in the southern portion of the site (south of the Nichol Drain), to the south in the area immediately north of the Nichol Drain, and to the west in the north east portion of the site. Elevations on site range from approximately 409 m at the western portion of the Nichol Drain to about 420 m in the west central portion of the site.

Surface water drainage at the site is directed towards the Nichol Drain in the southern portion of the site and to the drainage swale in the north east portion of the site. A drainage ditch is located along the southern boundary of the property (along Colborne Street), which receives some surface water drainage from the southernmost portion of the site. The Nichol Drain flows to the west and discharges to Irvine Creek, a tributary to the Grand River.

3.3 Local Geology and Hydrogeology

Based on geologic mapping of the area, the overburden materials in the vicinity of the site generally consist of deposits of Wentworth Till, which comprises sandy glacial till. Lacustrine kame and outwash sand is located in the vicinity of the Nichol Drain which crosses through the property. A deposit of outwash gravel is located in the northeast corner of the property. The overburden materials are underlain by bedrock of the Guelph Formation, which consists of dolostone. The bedrock elevation in the vicinity of the subject site is approximately 400 masl, and the thickness of overburden is on the order of 20 to 25 m.

Local hydrogeologic conditions were assessed based on information obtained from Ministry of Environment well records (Appendix A). Selected well records are plotted on Figure 3. Geologic cross-sections were prepared using the well records and are presented in Figures 4 and 5.

A buried bedrock valley feature crosses through the area, beginning on the west side of Bellwood Lake, approximately 6 km northeast of the property, and extending in a southwest direction, crossing the Grand River at the Elora Gorge, approximately 1.5 km southwest of the subject property. Based on the MOE well records for the area, the bedrock valley is located immediately southeast of the subject property. Two wells in this area were drilled to depths of approximately 70 m and did not encountered bedrock, as shown on the attached Figure 4. The bedrock valley in this area is filled with glacial till, underlain by sand deposits.

A review of the MOE water well records was conducted for wells within 1 km of the site. The records indicate the majority of the wells in the vicinity of the site are drilled and completed in the deep confined system (bedrock aquifer). The pumping rates of the wells are generally less than 10 gpm. A summary of MOE water records is provided in the attached Table 1. It is noted that the urban portion of Fergus is serviced with municipal water obtained from wells completed in the bedrock aquifer.

In summary, two distinct zones of ground water transmission (aquifer zones) can be identified in the area:

- A shallow aquifer system, which is found at a depth of several metres or less. This system consists of an unconfined shallow water table. Perched water is noted in the sand and gravel deposits within the glacial till. The ground water flow rates within this unit will be slow as a result of the low permeability of the glacial till soils.

- A deep confined system that is typically found at depths of 20 to 25 m below ground surface. This system consists of dolostone bedrock found beneath the upper deposit of glacial till.

3.4 Site Inspection to Assess Hydrogeologic Features

A detailed site inspection was conducted to assess the presence of features which are significant from a hydrogeologic viewpoint. In particular, the site was inspected to assess the following:

- The presence of closed drainage features or depressions which may allow for ponding and significant infiltration of water.
- Inspection of swales and drainage courses for evidence of ground water seepage or springs.
- Assessment of the presence of phreatophytic vegetation, which may indicate seasonally high ground water levels and/or ground water discharge and seepage.

The results of the inspection performed in June 2008 indicate that there are no significant low-lying areas or closed depressions which allow for ponding and infiltration of ground water. The Nichol Drain crosses through the southern portion of the property, and flows to the west. The Nichol Drain has been channelized in the past, and has been used to convey drainage from the farm lands. This feature was flowing at the time of our site inspection. The ground and banks were wet due to recent rainfall. No seepage or springs were identified during our site inspection.

A woodlot in located in the west central portion of the site, which contains a wetland feature. This wetland feature appears to be partially fed by the drainage swale located in the northwestern portion of the site. This drainage swale receives flow from the discharge of tile drains from the neighbouring property to the north and surface water drainage. This feature was dry during our site inspection and it appears that it does not flow in the dry seasons. No seepage or springs were noted during our site inspection.

3.5 Local Climate

The site is situated in a climatic region known as Huron Slopes. The climate is characteristic of Southern Ontario, consisting of temperate conditions with an excess of rainfall (i.e., rainfall exceeds evaporation and evapotranspiration). Table 3.1 summarizes climatic conditions for the area based on Environment Canada weather records from 1950 to 1980 (Brown et al., 1980).

Table 3.1: Climate Data

Mean annual frost-free period	135 days
Mean annual total precipitation	890mm
Mean annual actual evapotranspiration	560 mm
Mean annual water surplus	330 mm

As noted above, there is a mean annual water surplus of approximately 330 mm. This represents the volume of water that is available for ground water recharge and runoff.

4.0 RESULTS OF INVESTIGATION

4.1 Subsurface Investigation

The subsurface investigation of the site was conducted between January 14 and 17, 2008. It consisted of drilling and sampling a total of twenty (20) exploratory boreholes extending to a depth of about 4.6 m to 9.3 m below ground surface. The ground surface elevations at borehole locations were estimated from the topographic information provided by the client, and are referenced to geodetic datum.

The drilling was conducted under the full time supervision of a Terraprobe field technician who logged the borings and examined the samples as they were obtained. The results of the investigation are provided in detail on the accompanying borehole logs (Appendix B).

Soil samples were obtained from the boreholes using a split-barrel sampler advanced by a 63.5 kg hammer dropping approximately 760 mm. The results of these Standard Penetration Tests are reported as "N" values on the borehole logs at the corresponding depths.

Samples obtained from the boreholes were inspected in the field immediately upon retrieval for type, texture, colour and odour. The samples obtained were then sealed in clean plastic containers and transferred to the Terraprobe laboratory where the samples were examined. Appropriate samples were selected for laboratory testing. Laboratory testing consisted of grain size analysis by sieve/hydrometer.

Ground water conditions were monitored during and at the completion of each borehole. Standpipe type piezometers comprising of 20 mm diameter PVC tubing were installed at each borehole location to facilitate shallow ground water monitoring. Nested piezometers were installed at two borehole locations (Borehole 12 and 17). The PVC tubing was slotted near its base and fitted with a bentonite clay seal as shown on the accompanying borehole logs. Water levels in the standpipes were measured on three occasions to determine seasonal variations in the ground water levels.

In summary, the boreholes generally encountered a topsoil layer at the ground surface underlain by glacial till materials, comprising clayey silt to sandy silt. Layers of sand and gravel were encountered along the Nichol Drain and in the northeast corner of the site.

A brief summary of the subsurface soils encountered at the site is presented below. The stratigraphic information is presented in detail on the enclosed borehole logs. It should be noted that the soil conditions are confirmed at the borehole locations only and may vary between and beyond the boreholes. The stratigraphic boundaries as shown on the logs are based on a non-continuous sampling. These boundaries represent an inferred transition between the various strata, rather than a precise plane of geologic change.

4.1.1 Topsoil

A topsoil layer varying in thickness from about 200 to 1170 mm was encountered at the ground surface at all borehole locations. The topsoil is dark brown to black in colour, and predominantly consists of a silt matrix.

It must be noted that the data provided here pertaining to the topsoil thickness is confirmed at the respective borehole locations only, and may vary between and beyond the boreholes. Further, the above data may not be sufficient for estimating the topsoil quantities and/or associated costs.

4.1.2 Disturbed/Weathered Soil Zone

A zone of weathered/disturbed soil was penetrated beneath the topsoil layer in Boreholes 2, 3, 4, 5, 9, 10, 11, 12, 14, 18 and 20. The disturbed/weathered soil zone extended to depths of about 0.7 m below ground surface. The composition of the soils encountered within this zone was similar to that of the underlying undisturbed native soils but included trace amounts of natural organic soil (topsoil).

4.1.3 Clayey Silt to Sandy Silt Till

Clayey silty and/or sandy silt glacial till deposits were encountered at each borehole location. In Boreholes 3, 5, 9, 10, 11, 12, 14, 16, 17, 18 and 20 the glacial till deposits were encountered beneath the topsoil and extended to the full depth of investigation. In Boreholes 1, 2, 4, 6, 7, 8, 13, 15 and 19 clayey to sandy silt till deposit was encountered at varying depths, interbedded with (above or below) sand deposits. The glacial till deposits extended to the full depth of investigation at each borehole location.

The grain size distribution curves of three samples obtained from this deposit (Borehole 5, Sample 4; Borehole 7, Sample 5; and, Borehole 16, Sample 3) are appended.

4.1.4 Sandy Silt

A layer of sandy silt was encountered beneath the topsoil in Boreholes 1, 6, 7, 8, 13, and 19. This layer extended to a depth of up to about 1.2 m below ground surface. This layer generally contained trace to some clay and trace organic soil (topsoil) and rootlets.

4.1.5 Sand and Gravel Deposits

Sand layers were encountered in Boreholes 1, 2, 4, 6, 7, 8, 13, 15 and 19. The sand deposits encountered in Boreholes 1, 4, 6, 7 and 19 were generally only about 0.4 to 0.7 m in thickness and were underlain by glacial till deposits.

Combinations of sand and gravel deposits ranging from approximately 2.4 to 3.2 m in thickness were encountered in Boreholes 8, 13 and 15, located along the Nichol Drain, and in Borehole 2, located in the northeast corner of the property. These sand and gravel deposits ranged from fine sand with trace silt to sandy gravel in composition. The sand and gravel deposits were fully penetrated at each of these boreholes locations, and were underlain by glacial till deposits.

The grain size distribution curves of two samples obtained from the sand and gravel deposits (Borehole 8, Sample 3 and Borehole 13, Sample 5) are appended.

4.1.6 Ground Water

Standpipe piezometers were installed at each borehole location to assess shallow ground water levels. Water levels measurements were obtained on January 28, 2008, March 28, 2008 and June 23, 2008. These water level measurements are provided in the attached Table 2. The ground water elevations from the June 23, 2008 measurements are shown on the attached Figure 6.

Shallow ground water flow at the site generally follows site topography and flows to the northwest in the areas to the south of the Nichol Drain, to the southwest in the areas immediately north of the Nichol Drain, and to the northwest in the northern portion of the site. The ground water levels were generally found to be within 2 m of ground surface.

Nested piezometers were installed at two locations (BH 12 and 17), in the order to determine the vertical gradient. The water level measurements from these wells are presented below:

Well No.	Depth	Ground Water Elevation		
		January 28, 2008	March 28, 2008	June 23, 2008
12S	4.6	407.8	407.7	407.9
12D	9.1	405.3	407.0	407.1
17S	4.6	408.5	408.4	408.2
17D	8.8	407.4	406.8	406.5

Generally, the water level in the shallow wells is at a higher elevation than the corresponding deep wells, indicating that there is a downward gradient.

5.0 DISCUSSION AND RECOMMENDATIONS

The following discussion and recommendations are based on the data gathered for this study. They are presented for site planning purposes. It is noted that further engineering consultation will be required during the final design and construction of the development.

5.1 Overview of Hydrogeologic Features of Site

The results of the study indicate that the site hydrogeologic characteristics can be summarized as follows:

- Generally, the site stratigraphy predominantly consists of low permeability sandy silt to clayey silt glacial till deposits. Sand and gravel deposits were noted in the vicinity of the Nichol Drain and the northeast corner of the property.

- The Nichol Drain crosses through the southern portion of the site and flows towards a woodlot located in the west central portion of the site. A drainage swale flows in the southerly direction from the north property boundary to the woodlot. A wetland feature is located in the woodlot, which appears to the partially fed by the drainage swale. The drainage swale receives its flow from the discharge of tile drains on the property to the north of the site, and surface water drainage.

- The water table was typically found within 2 m of ground surface. Shallow ground water flow at the site generally follows site topography and flows to the northwest in the areas to the south of the Nichol Drain, to the southwest in the areas immediately north of the Nichol Drain, and to the northwest in the northern portion of the site.

- The local water wells are typically drilled wells completed in the dolostone bedrock, which is typically encountered at a depth of 20 to 25 m below ground surface. A buried bedrock valley feature is located immediately southeast of the subject site.

Based on these factors, the primary considerations with respect to the hydrogeologic aspects of site development will be the following:

- Preservation or enhancement of ground water recharge across the property area (i.e., no net reduction in recharge to aquifers).

- Preservation of ground water flow and transmission pathways.

The above objectives should be considered in conjunction with the requirements for site development and, in particular, storm water management practices at the site.

5.2 Water Balance

A water balance was conducted to assess the infiltration recharge rates at the site for pre-development and post-development conditions. The water balance was conducted using Environment Canada data presented in Section 3.5 of this report.

The calculations are summarized in Table 3.

The results of the water balance calculations indicate the following:

- The development of the site, and coverage with hard-surfaced areas, will reduce ground water infiltration rates and increase run-off.
- The volume of roof run-off created following development exceeds the potential loss in infiltration (roof run-off = 265,242 m^3/a, while loss of infiltration = 78,019 m^3/a).
- Ground water infiltration rates at the site can be maintained or enhanced through the infiltration of roof run-off. The calculations indicate that approximately 29% of the roof runoff would be needed to maintain the pre-development infiltration rates.

5.3 Maintenance of Ground Water Recharge

The existing ground water recharge rates at the site are expected to be approximately 165 mm/a. This recharge occurs in a broad or diffuse manner over the entire site. There are no significant local depressions or zones of enhanced recharge.

The site will generally be developed as a residential subdivision, with some commercial development in the central portion of the site. The water balance presented in Table 3 should be revised as additional details become available when the development plans are finalized. In general, development of the site will result in creation of hard surfaced areas and will result in an increase in water available for runoff. It will also result in a considerable decrease in evapotranspiration. This net increase in runoff provides an opportunity for maintenance of ground water recharge through a variety of infiltration techniques.

Based on site conditions, there are a number of storm water management techniques which are available to maintain ground water recharge rates. Roof leaders for the buildings could be discharged to overland flow or to an infiltration facility. Infiltration facilities may be considered in the area of commercial development. This could include one or more of the following:

- Soak-away pits or gravel-filled trenches (to capture and store runoff to allow infiltration)
- An underground perforated pipe system (leaky pipe)

An assessment of an enhanced infiltration system design can be completed once plans for the development are finalized.

5.4 Maintenance of Ground Water Transmission Pathways

In general, the overall continuity of the ground water flow at the site should be maintained, where practical. Generally, the ground water transmission pathways can be maintained through the following means:

- If basements are constructed below the water table they will require foundation drains. Water collected in foundation drains could be pumped to an infiltration facility to allow the ground water to re-infiltrate. However, it is expected that a limited amount of water would be collected from foundation drains in areas underlain by glacial till as a results of the low permeability of this soil.

- The bedding materials for underground services may serve as a subdrain to collect and convey ground water away from existing ground water transmission zones. This effect can be mitigated by the provision of trench plugs to cutoff granular bedding at all manhole locations.

- The excavation of underground services across sand layers may interrupt ground water flow. Trench backfilling operations should be carried out with materials that are similar to the materials that have been excavated. In particular, sand zones must not be truncated by backfilling of the trench using lower permeability materials (such as the silt till identified across the bulk of the site). The continuity of sand zones can be ensured by backfilling with native sandy material as excavated.

As part of final design, proposed site grading, drainage, and servicing plans should be reviewed by this office. The review should specifically address the requirement to maintain the zones of ground water transmission, as noted above.

6.0 SUMMARY AND CONCLUSIONS

1. Generally, the site stratigraphy predominantly consists of low permeability sandy silt to clayey silt glacial till deposits. Sand and gravel deposits were noted in the vicinity of the Nichol Drain and in the northeast corner of the property.

2. The primary hydrogeologic function of the site is the provision of ground water recharge across the site and the maintenance of ground water flow or transmission pathways.

3. A wetland feature is located in the woodlot in the east central portion of the site, which appears to be fed by the drainage swale located in the northwestern portion of the site. This drainage swale receives its flow from the discharge of tile drains on the property to the north of the site, and surface water drainage.

4. A water balance has been prepared based on preliminary site plan details. The calculations confirm the feasibility of site development.

5. In general, site design should incorporate the following measures:
    - Infiltration rates at the site can generally be maintained by the direction of roof runoff to overland flow. Infiltration facilities may be considered in the commercial areas.
    - Trench plugs should be used at all manhole locations.
    - Trench backfilling operations should be carried out with materials that are similar to the materials that have been excavated. In particular, sand zones must not be truncated by backfilling of the trench using lower permeability materials.

We trust this report meets with your requirements. Should you have any questions regarding the information presented, please do not hesitate to contact our office.

Respectfully submitted,

Terraprobe Limited

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Associate

LICENSED PROFESSIONAL ENGINEER
8 Jan 2009
D.A.MacGILLIVRAY
PROVINCE OF ONTARIO

Paul W. Bowen, P.Geo., P.Eng.,
Principal

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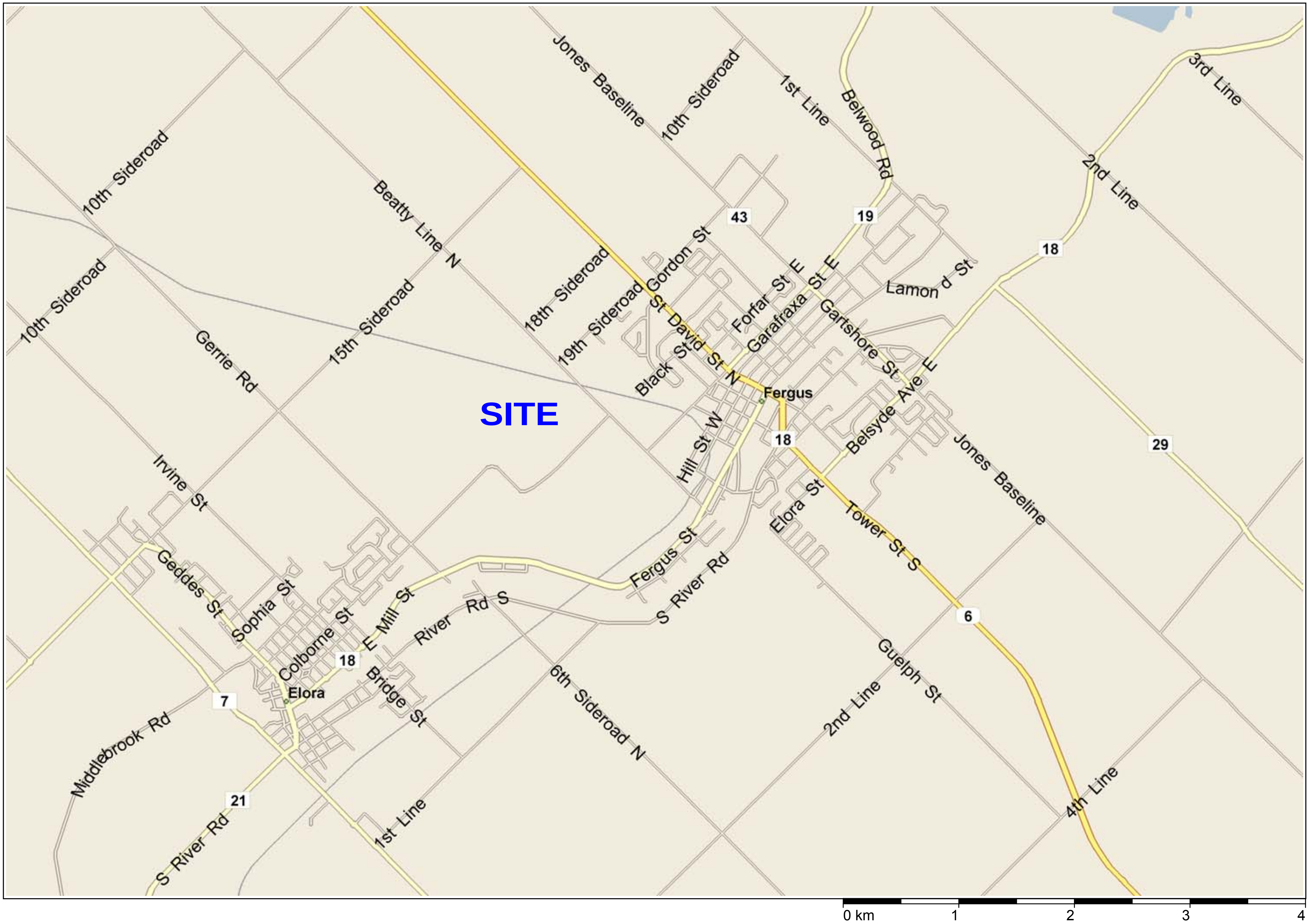
FIGURES

TERRAPROBE LIMITED

NIGUS PROPERTY, TOWNSHIP OF CENTRE WELLINGTON

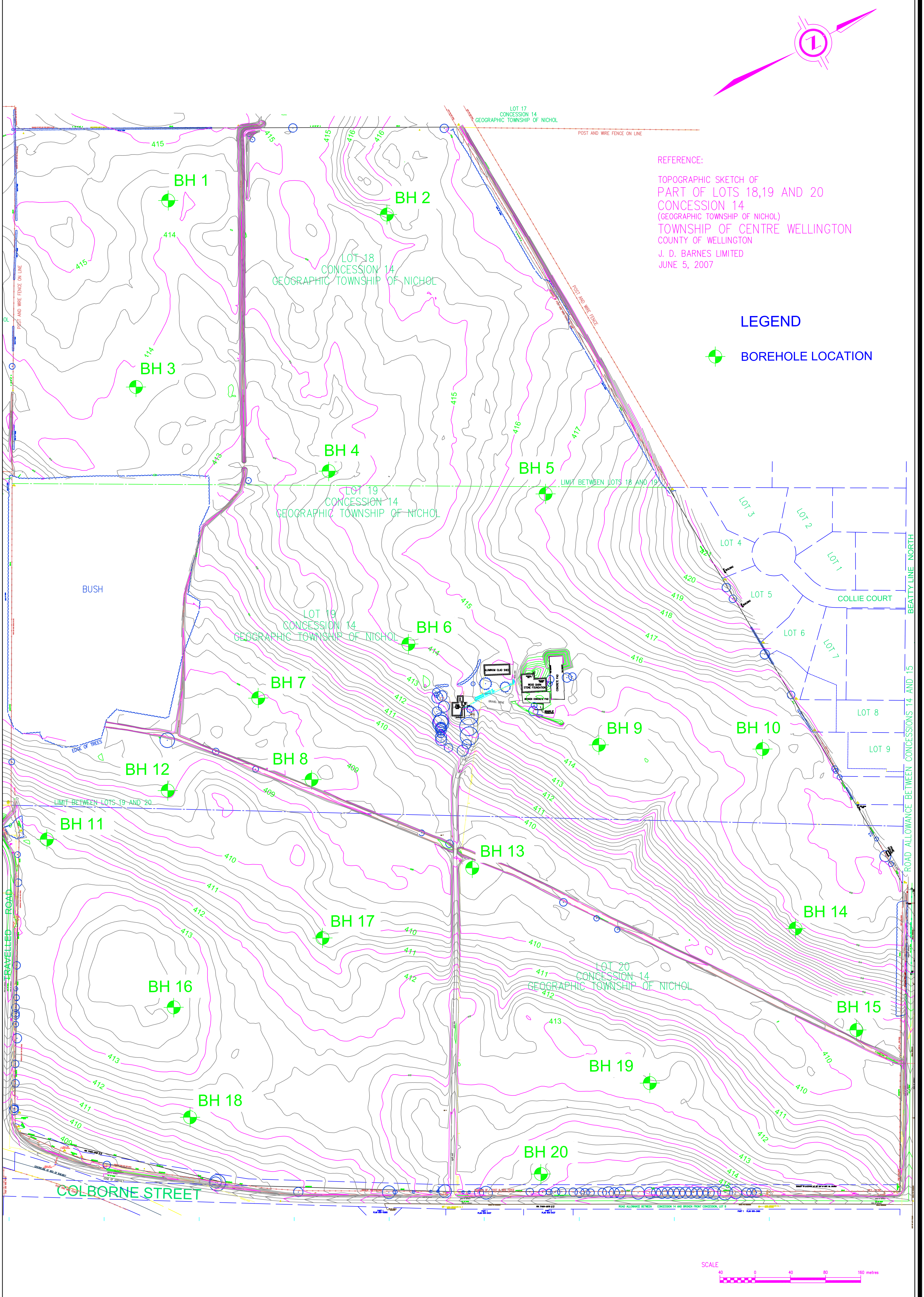


SITE LOCATION PLAN

TERRAPROBE

FILE No. 1-07-2438

FIGURE 1



REFERENCE:

TOPOGRAPHIC SKETCH OF
PART OF LOTS 18,19 AND 20
CONCESSION 14
(GEOGRAPHIC TOWNSHIP OF NICHOL)
TOWNSHIP OF CENTRE WELLINGTON
COUNTY OF WELLINGTON
J. D. BARNES LIMITED
JUNE 5, 2007

LEGEND

⊕	BOREHOLE LOCATION

BOREHOLE LOCATION PLAN

TERRAPROBE

File No. 1-07-2438

FIGURE 2

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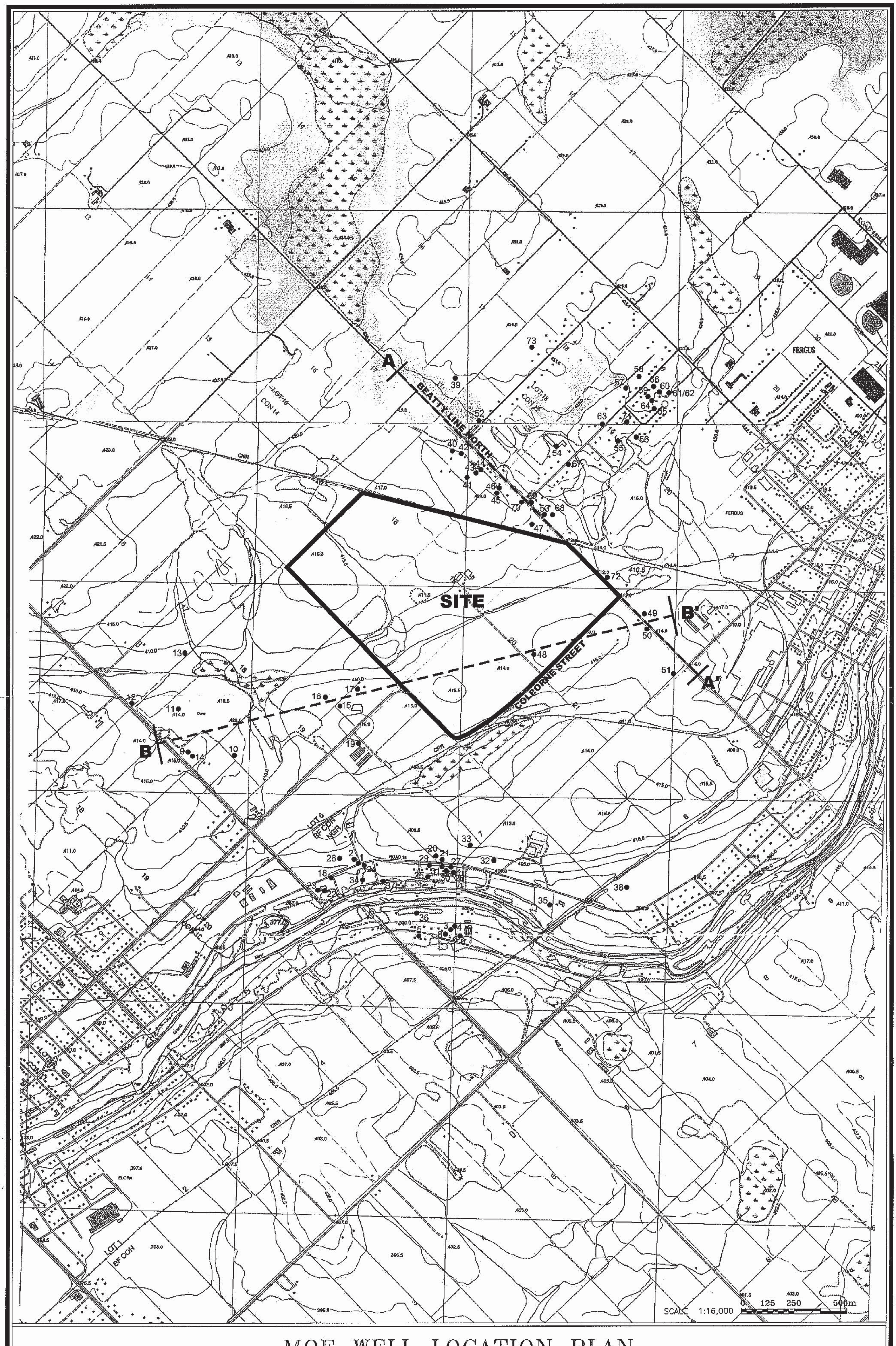
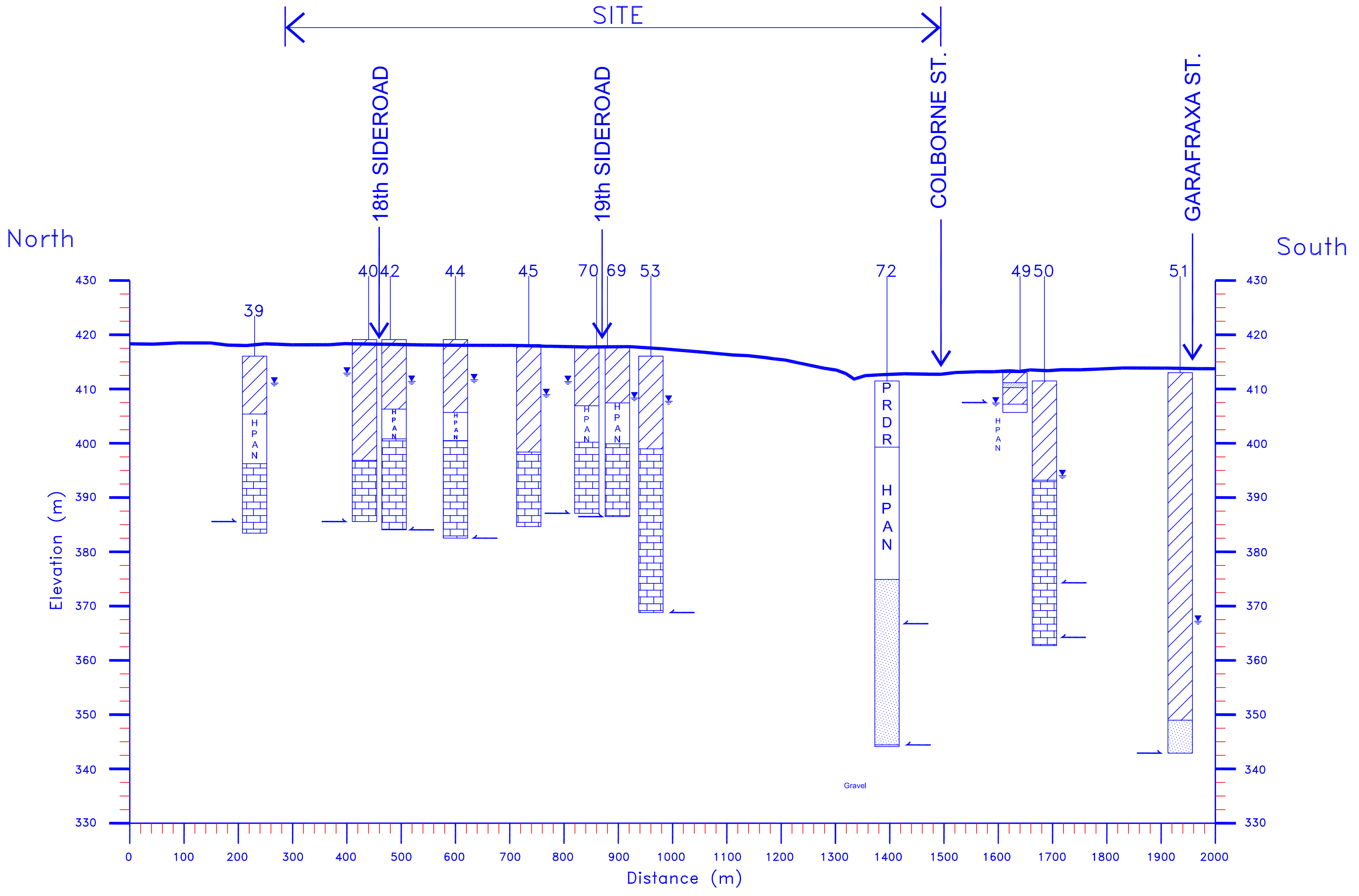


MOE WELL LOCATION PLAN

TERRAPROBE

File No. 1-07-2438

FIGURE 3



SCALES:

Horizontal 1 : 10000
Vertical 1 : 1000

LEGEND

░	SAND	▦	LIMESTONE	39	WELL NUMBER		
▨	CLAY	▼	STATIC WATER LEVEL	HPAN	HARDPAN		
▩	GRAVEL	→	WATER FOUND	PRDR	PREVIOUSLY DRILLED		
▥	SILT						

HYDROGEOLOGIC CROSS-SECTION A-A'

TERRAPROBE

File No. 1-07-2438

FIGURE 4

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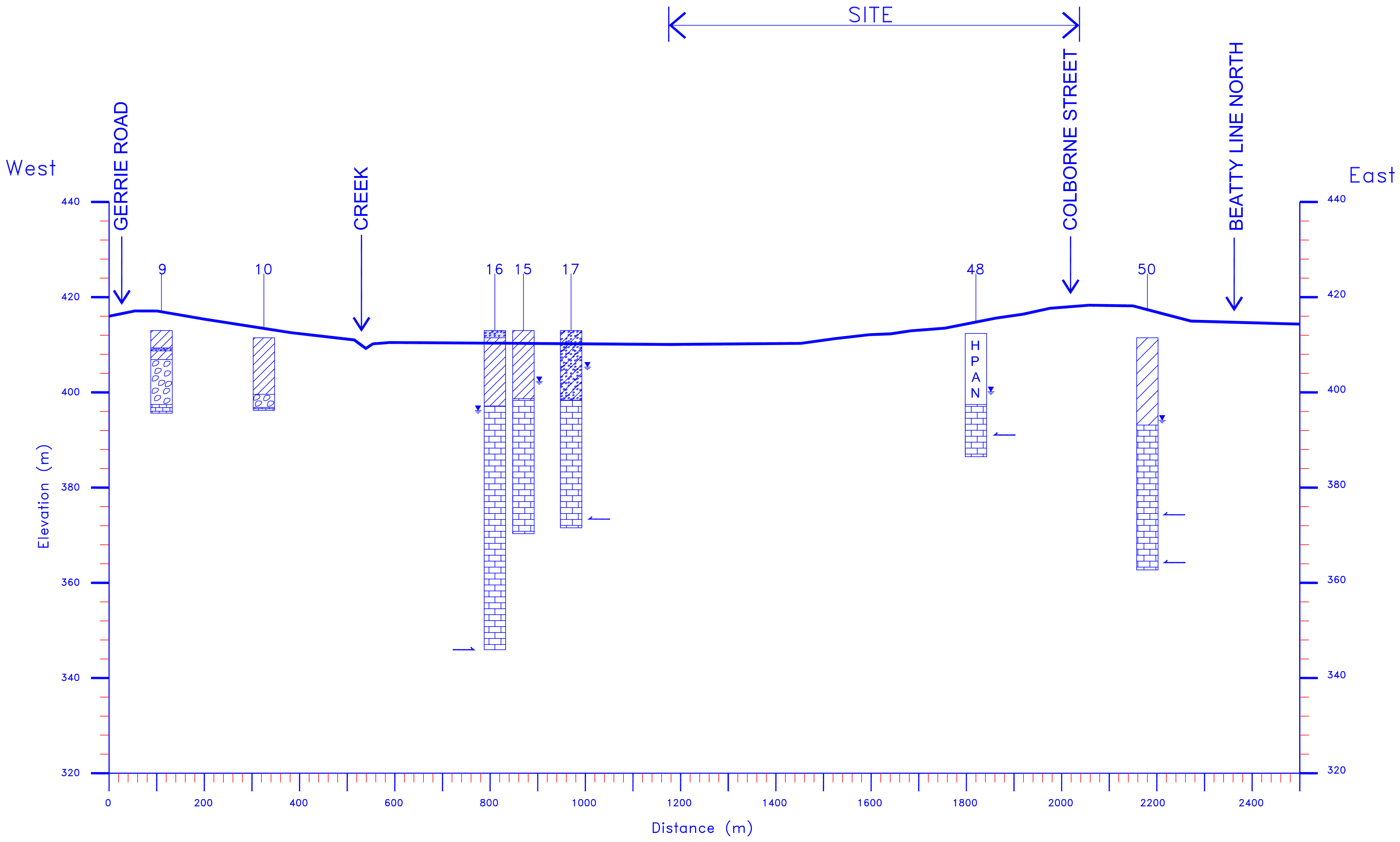
JACKIE\DRAWING\1-07-2438 Hydro Geological Section And Well Location Plan.dwg, LB



SCALES:

Horizontal 1 : 10000
Vertical 1 : 1000

LEGEND

░ SAND
▨ CLAY
▦ GRAVEL
▤ LIMESTONE
▼ STATIC WATER LEVEL
⟶ WATER FOUND
⁘ BOULDERS
9 WELL NUMBER
HPAN HARDPAN

HYDROGEOLOGIC CROSS-SECTION B-B'

TERRAPROBE

File No. 1-07-2438

FIGURE 5

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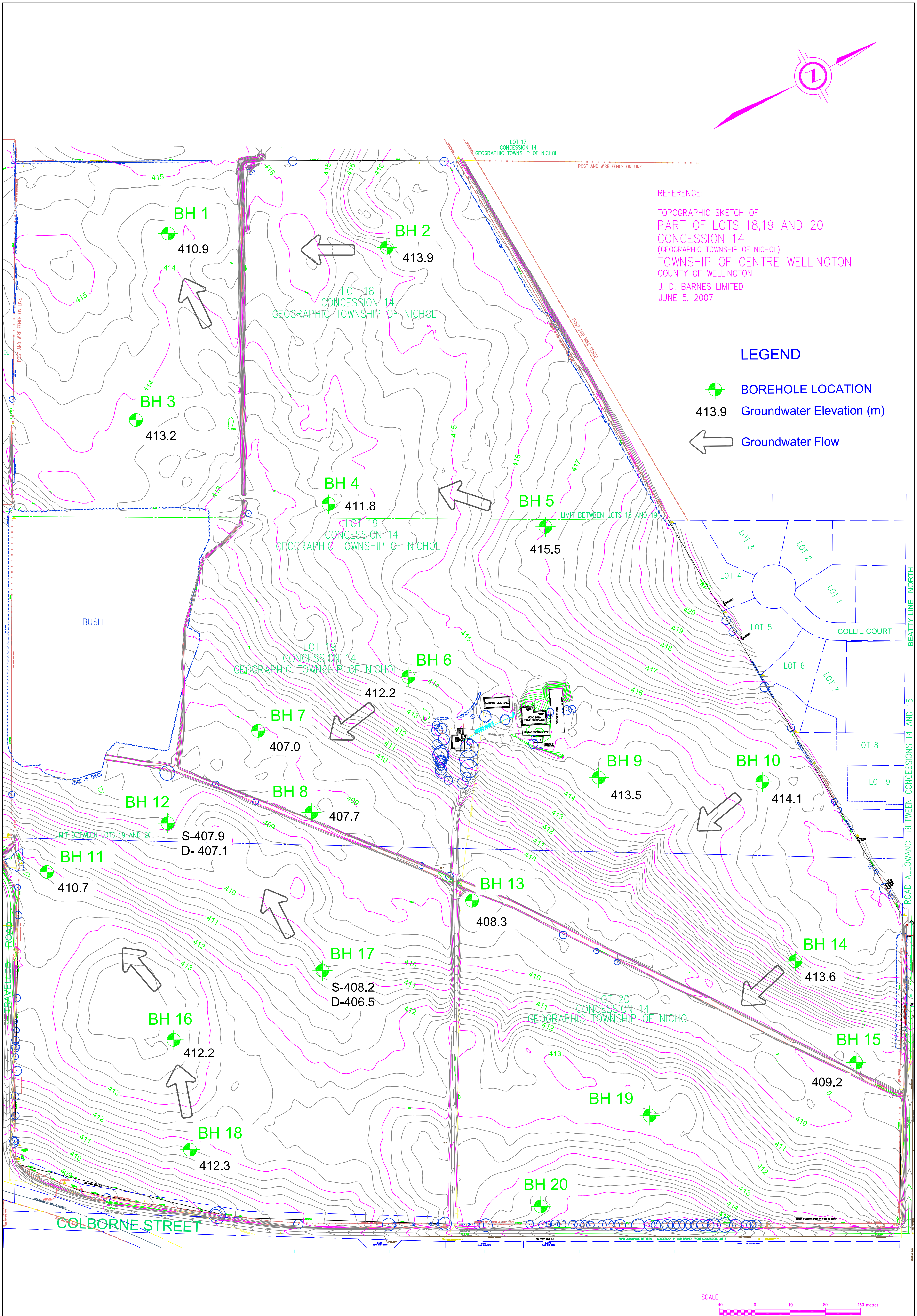
JACKIE\DRAWING\1-07-2438 Hydro Geological Section And Well Location Plan.dwg, LB



GROUNDWATER ELEVATIONS

TERRAPROBE

File No. 1-07-2438

FIGURE 6

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TABLES

TERRAPROBE LIMITED

TABLE 1: MOE Well Records Summary

Total # Wells	72	
Total number of wells completed in bedrock	54	75.0 %
Total number of wells completed in overburden	18	25.0 %
Total number of wells flowing artesian	2	2.8 %
Total number of wells with casing diameter greater than 12 inches	16	22.2 %
Total number of wells with casing diameter less than 12 inches	55	76.4 %
Total number of wells with an unknown casing diameter	1	1.4 %
Depth Ranges		
Less than 25 ft.	14	19.4 %
25 ft to 50 ft	5	6.9 %
51 ft. to 100 ft	8	11.1 %
101 ft to 150 ft	25	34.7 %
151 ft to 200 ft	14	19.4 %
Greater than 200 ft	6	8.3 %
Water Use		
Domestic or Stock	64	88.9 %
Commercial	0	0.0 %
Industrial	0	0.0 %
Public Supply	2	2.8 %
Irrigation	1	1.4 %
Unknown	5	6.9 %
Water Quality		
Fresh	65	90.3 %
Salty	0	0.0 %
Dry	0	0.0 %
Unknown	7	9.7 %
Range of Reported Pumping Rates		
0 to 23 lpm (0 to 5 igpm)	15	20.8 %
23 to 45 lpm (6 to 10 igpm)	36	50.0 %
45 to 68 lpm (11 to 15 igpm)	6	8.3 %
68 to 91 lpm (16 to 20 igpm)	3	4.2 %
91 to 454 lpm (20 to 100 igpm)	4	5.6 %
Greater than 454 lpm (greater than 100 igpm)	0	0.0 %
No data	8	11.1 %

TABLE 2:
Ground Water Elevations

Well No.	Depth (mbgl)	Ground Surface Elevation (m)	Water Level					
			28-Jan-08		28-Mar-08		23-Jun-08	
			mbgl	geodetic	mbgl	geodetic	mbgl	geodetic
1	4.9	414.1	3.01	411.1	N/A	N/A	3.22	410.9
2	5.0	415.4	1.47	413.9	N/A	N/A	1.55	413.9
3	5.0	414.1	0.95	413.2	N/A	N/A	0.87	413.2
4	4.7	413.4	1.56	411.8	N/A	N/A	1.63	411.8
5	4.8	417.0	1.60	415.4	N/A	N/A	1.54	415.5
6	4.8	414.1	1.62	412.5	1.69	412.4	1.86	412.2
7	4.8	409.0	1.60	407.4	N/A	N/A	2.01	407.0
8	5.0	408.8	1.20	407.6	1.30	407.5	1.15	407.7
9	5.0	414.7	1.07	413.6	1.00	413.7	1.17	413.5
10	4.6	415.4	1.03	414.4	0.65	414.8	1.29	414.1
11	4.6	412.1	1.21	410.9	1.30	410.8	1.37	410.7
12S	4.6	408.9	1.14	407.8	1.20	407.7	1.02	407.9
12D	9.1	408.9	3.62	405.3	1.90	407.0	1.84	407.1
13	4.9	409.1	0.73	408.4	0.95	408.2	0.84	408.3
14	4.8	414.5	0.90	413.6	0.93	413.6	0.91	413.6
15	4.7	410.4	1.36	409.0	1.20	409.2	1.2	409.2
16	5.0	413.7	0.93	412.8	frozen	frozen	1.47	412.2
17S	4.6	410.4	1.87	408.5	2.05	408.4	2.19	408.2
17D	8.8	410.4	3.05	407.4	3.65	406.8	3.91	406.5
18	4.7	411.7	N/A	N/A	0.60	411.1	-0.63	412.3
19	4.6	412.8	1.04	411.8	1.00	411.8	N/A	N/A
20	5.0	414.7	1.00	413.7	1.80	412.9	N/A	N/A

mbgl - metres below ground level

TABLE 3: WATER BALANCE

1. Climate Information

Precipitation	890	mm/a
Evapotranspiration	560	mm/a
Water Surplus	330	mm/a

2. Infiltration Rates

Table 2 Approach - Infiltration Factors

Rolling land	0.2
Medium combinations of clay and loam	0.2
Cultivated lands	0.1
TOTAL	0.5

Infiltration (0.5 x 330)	165	mm/a
Run-off (330-165)	165	mm/a

Table 3 Approach - Typical Recharge Rates

silty sand to sandy silt	150 - 200	mm/a
silt	125 - 150	mm/a
clayey silt	100 - 125	mm/a

Site development area is underlain primarily by clayey silt to sandy silt till soils

Based on the above, the recharge rate is 165 mm/a

with runoff of 165 mm/a

3. Property Statistics

Parks & Schools	63,600	m^2	6.36	ha
SWM	37,500	m^2	3.75	ha
Woodlot	58,100	m^2	5.81	ha
Nichol Drain Channel	65,500	m^2	6.55	ha
Roads	113,900	m^2	11.39	ha
Lots (Roof)	298,025	m^2	29.80	ha
Lots (Driveway, parking, sidewalks)	60,915	m^2	6.09	ha
Lots (Open space, lawns, gardens)	296,060	m^2	29.61	ha
TOTAL	**993,600**	**m^2**	**99.36**	**ha**

TABLE 3: WATER BALANCE

4. Annual Pre-Development Water Balance

Land Use	Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Undeveloped	993,600	884,304	556,416	163,944	163,944

5. Annual Post-Development Water Balance

Land Use	Area (m^2)	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Lawns, Parks, SWM, Openspace	520,760	463,476	291,626	85,925	85,925
Road, Sidewalk, Pavement	174,815	155,585	nil	nil	155,585
Residential Roof Area	298,025	265,242	nil	nil	265,242
TOTAL	**993,600**	**884,304**	**291,626**	**85,925**	**506,753**

6. Comparison of Pre-Development and Post-Development

	Precipitation (m^3)	Evapotranspiration (m^3)	Infiltration (m^3)	Run-Off (m^3)
Pre-Development	884,304	556,416	163,944	163,944
Post-Development	884,304	291,626	85,925	506,753

7. Infiltration of Roof Runoff

Volume of post-development infiltration	85,925	m^3
Volume of pre-development infiltration	163,944	m^3
Defecit from pre- to post- development infiltration	78,019	m^3
Volume of available roof runoff	265,242	m^3
Percentage of roof runoff required to match pre-development infiltration	29%	

APPENDIX A

TERRAPROBE LIMITED

WELL NUMBER	CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR/MN	WATER USE	OWNER/LOG/SCREEN DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
1	BF	6	67- 1944	547527 4837683	1300	07/58	1659		FR	100	20	40	7	3/00	DO	HUGHES E PRDG 0015 GREY LMSN 0100
2	BF	6	67- 1945	547522 4837688	1300	12/58	2521	4	FR	125	20	60	6	1/00	DO	HUGHES E GRVL CLAY 0011 GREY LMSN 0125
3	BF	6	67- 3104	547980 4837360	1285	06/68	2521	4	FR	142	23	70	10	1/00	DO	YULE KENNETH GRVL STNS 0007 GREY LMSN 0142
4	BF	6	67- 3482	547990 4837370	1285	12/69	1617	4	FR	123	18	60	4	2/30	DO	DEJEAN F O PRDG 0008 GREY LMSN 0123
5	BF	6	67- 5857	547830 4837340	1290	12/75	1906	4	FR	193	20	60	9	1/00	DO	YORK HOLDINGS CLAY STNS 0012 BRWN ROCK 0060 WHIT ROCK 0150 BRWN ROCK 0165 GREY ROCK 0195
6	BF	6	67- 6143	548020 4837350	1285	06/76	1669	4	FR	125	18	65	8	3/00	DO	BETTOIL PETER BLCK TPSL 0002 BRWN CLAY 0033 BRWN LMSN 0125
8	BF	6	67- 7020	547950 4837350	1290	04/79	1669	4	FR	75	15	60	9	3/00	DO	YUEL L BRWN CLAY STNS 0005 BRWN LMSN 0075
9	CON 13	18	67- 3755	546700 4838180	1355	09/70	1657	2								TOWN FLORA & FERGUS BRWN CLAY 0012 GRVL 0014 GREY CLAY 0020 BLDR CLAY MSND 0051 GRVL 0054 GREY CLAY 0055 ROCK 0057
10	CON 13	18	67- 3756	546940 4838450	1350	09/70	1657	2								TOWN FLORA & FERGUS BRWN CLAY STNS 0011 GREY CLAY STNS 0039 BLDR 0048 ROCK 0050
11	CON 13	18	67- 3757	546700 4838400	1350	09/70	1657	2								TOWN FLORA & FERGUS BRWN CLAY STNS 0020 GREY CLAY STNS 0040 BLDR CLAY 0055 ROCK 0056
12	CON 13	18	67- 3758	546450 4838420	1350	09/70	1657	2								TOWN FLORA & FERGUS BRWN CLAY STNS 0010 GREY CLAY 0039 BLDR 0048 ROCK 0049
13	CON 13	18	67- 3759	546680 4838650	1335	09/70	1657	2								TOWN FLORA FERGUS BRWN CLAY 0007 GREY CLAY STNS 0015 BLDR GRVL 0024 ROCK 0026
14	CON 13	19	67- 1913	546716 4838177	1350	07/65	2521	4	FR	107	25	80	6	1/00	IR DO	GILBERT W CLAY STNS 0052 GREY LMSN 0107
15	CON 13	19	67- 5240	547427 4838420	1355	08/74	2521	4	FR		35	80	10	1/00	DO	VELDMAN JOHN CLAY GVLY 0047 BRWN ROCK HARD 0140
16	CON 13	19	67- 6537	547350 4838450	1355	09/77	5469	6	FR	220	55	80	60	2/00	PS	PENTECOSTAL CHURCH TPSL 0001 SAND GRVL 0005 BRWN CLAY 0018 GREY CLAY STNS 0052 BRWN LMSN 0220
17	CON 13	19	67- 6558	547500 4838500	1355	10/77	2564	4	FR	130	25	50	9	2/00	ST DO	BOUWMAN JOHN GRVL CLAY 0048 BRWN LMSN 0136
18	CON 13	20	67- 1914	547389 4837861	1325	11/63	2521	4	FR	176	23	67	9	2/00	ST DO	ALLAN D CLAY STNS 0029 GREY LMSN 0176
19	CON 13	20	67- 3472	547550 4838250	1350	12/69	2521	4	FR	160	33	65	10	2/00	ST	CRAWFORD O CLAY MSND 0010 MSND 0052 GREY LMSN 0160
20	CON 13	21	67- 1915	547883 4837713	1300	02/64	2521	4	FR	120	30	80	5	2/00	PS	MARTIN T CLAY 0020 GREY LMSN 0120

WELL NUMBER	CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR/MN	WATER USE	OWNER/LOG/SCREEN DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
21	CON 13	21	67- 3661	547920 4837700	1300	04/70	1659	4	FR	175	33	55	8	2/00	DO	KELLEY GLEN YLLW CLAY STNS 0015 GREY LMSN 0177
22	CON 13	21	67- 3774	547370 4837550	1275	07/70	1659	4	FR	170	FLW	20	10	8/00	DO	DENYS JOSEP FILL 0006 GREY LMSN 0170
23	CON 13	21	67- 4125	547350 4837550	1275	12/71	2406	5	FR FR	170 188	8	15	12	2/00	DO	SMYTH T W GREY GRVL FILL 0005 BRWN ROCK 0064 GREY ROCK 0130 BRWN ROCK 0188
24	CON 13	21	67- 5017	547557 4837666	1285	01/74	2521	5	FR	153	FLW	10	20	/30	DO	WOLFE CECIL GREY LMSN 0153
25	CON 13	21	67- 5367	547848 4837627	1290	05/74	1659	4	FR	55	24			3/00	DO	MAC HARDY BRWN SAND CLAY 0004 WHIT LMSN 0055
26	CON 13	21	67- 5554	547450 4837700	1295	06/75	2521	4	FR	156	30	40	10	1/00	DO	DRIMME NORM CLAY 0003 GREY LMSN 0156
27	CON 13	21	67- 6168	547830 4837670	1300	06/76	4544	5	FR	160	18	35	22	1/30	DO	O P A DEVELOPMENTS BLCK TPSL STNS 0002 RED CLAY STNS 0020 GRVL DRY 0023 BRWN ROCK SOFT 0165
28	CON 13	21	67- 6169	547970 4837650	1300	06/76	4544	5	FR FR FR	175 180 200	25	40	30	1/00	DO	O P A DEVELOPMENTS BLCK TPSL 0003 RED CLAY SAND STNS 0024 GRVL 0025 BRWN ROCK 0205
29	CON 13	21	67- 6170	547870 4837670	1300	06/76	4544	5	FR	153	20	20	20	/30	DO	O P A DEVELOPMENTS RED CLAY STNS SAND 0021 GRVL FSND 0022 BRWN ROCK 0155
30	CON 13	21	67- 6171	547940 4837660	1300	06/76	4544	5	FR FR	150 197	12	21	25	/45	DO	O P A DEVELOPMENTS RED CLAY STNS SAND 0020 GRVL 0026 BRWN ROCK SOFT 0203
31	CON 13	21	67- 6172	547910 4837670	1300	06/76	4544	5	FR	138	22	22	18	/30	DO	O P A DEVELOPMENTS BLCK TPSL STNS 0002 RED CLAY STNS 0019 GRVL 0023 BRWN ROCK SOFT 0145
32	CON 13	22	67- 1916	548170 4837718	1320	07/64	2521	4	FR	151	25	80	5	2/00	DO	THEBER B GRVL CLAY 0005 GREY LMSN 0151
33	CON 13	22	67- 5076	548059 4837722	1300	04/74	5469	5	FR	168	18	32	12		DO	PAL MAR LTD BLCK TPSL 0002 BRWN CLAY ROCK 0017 BRWN ROCK 0024 BRWN ROCK 0035 GREY ROCK 0166 BRWN ROCK 0171
34	CON 13	22	67- 5313	547550 4837600	1280	10/74	1804	6	FR	137	12	12	10	1/00	DO	RICE I BLCK TPSL STNS FILL 0004 WHIT LMSN ROCK WBRG 0139
35	CON 13	22	67- 5326	548450 4837500	1300	05/74	1669	4	FR	122	31	40	8	1/30	DO	BAWMAN G BLCK TPSL 0005 BRWN CLAY 0008 WHIT LMSN 0122
36	CON 13	22	67- 5841	547800 4837450	1310	12/75	2521	4	FR	240	30	100	7	1/00	DO	DIPON ROOF TRUSSES PRDG 0004 GREY LMSN 0240
37	CON 13	22	67- 6844	547650 4837600	1280	09/78	4544	5	FR	114 127	40	51	8	1/00	DO	BRAKSFORD E BLCK ROCK 0040 BRWN LMSN 0125 UNKN 0127
38	CON 13	23	67- 1918	548825 4837557	1318	07/63	1659	4	FR	80	30	40	8	2/00	DO	KEEN G TPSL 0004 WHIT LMSN 0080

WELL NUMBER	CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR/MN	WATER USE	OWNER/LOG/SCREEN DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
39	CON 14	18	67- 3119	547960 4839650	1365	03/68	1617	4	FR	100	16	30	15		DO	NIXON SR MELVIN CLAY MSND 0006 CLAY STNS 0035 HPAN 0065 GREY LMSN 0107
40	CON 14	18	67- 4572	547930 4839650	1375	01/73	3406	4	FR	110	20	45	10	1/00	DO	ENGLAND J BRWN CLAY 0021 GREY CLAY GRVL 0073 WHIT LMSN 0110
41	CON 14	18	67- 4879	548000 4839570	1375	10/73	3737	4	FR	117	25	62	3	1/00	DO	VENTRY J BLCK TPSL 0001 GREY CLAY BLDR 0045 BRWN LMSN 0117
42	CON 14	18	67- 4880	547980 4839640	1375	10/73	3737	4	FR	115	25	62	3	1/00	DO	ARBUCKLE R BLCK TPSL 0002 GREY CLAY BLDR 0042 GREY HPAN BLDR 0060 BRWN LMSN 0115
43	CON 14	18	67- 4889	548040 4839550	1375	10/73	3737	4	FR	115	25	65	3	1/00	DO	FOSTER H BLCK TPSL 0001 GREY CLAY BLDR 0042 GREY HPAN BLDR 0063 BRWN LMSN 0115
44	CON 14	18	67- 5250	548050 4839550	1375	08/74	3740	4	FR	120	24	35	7	1/00	DO	MORABITO PAUL BLCK TPSL 0001 GREY CLAY BLDR 0044 GREY HPAN BLDR 0061 BRWN LMSN 0120
45	CON 14	19	67- 1924	548146 4839450	1372	10/61	1659	4			30	60	9	2/00	DO	ANDERSON C CLAY STNS 0065 GREY LMSN 0110
46	CON 14	19	67- 3342	548150 4839470	1370	04/69	1617	4	FR	129	28	60	5	2/00	DO	ANDERSON WM PRDG 0006 CLAY MSND 0030 CLAY STNS 0070 GREY LMSN 0129
47	CON 14	19	67- 3773	548320 4839300	1360	08/70	1659	4	FR	144	27	35	8	8/00	DO	HOOKER GORDEN CLAY MSND BLDR 0065 GREY LMSN 0144
48	CON 14	20	67- 1925	548336 4838709	1353	08/55	2414	4	FR	70	40	45	10		DO	PEARSON W TPSL 0001 HPAN STNS 0048 BRWN LMSN 0084
49	CON 14	21	67- 1926	548720 4838879	1355	06/62	2519	30	FR	18	18	24	1	/30	DO	MCHARDY G I TPSL 0001 BRWN CLAY MSND 0006 BRWN FSND 0009 GREY CLAY STNS 0018 GRVL MSND 0019 BLUE HPAN BLDR 0024
50	CON 14	21	67- 4174	548725 4838825	1350	02/72	3316	4	FR FR	122 155	57	85	9	2/00	ST DO	FERGUS FUR FARMS CLAY STNS SAND 0060 BRWN ROCK 0160
51	CON 14	22	67- 5843	549000 4838600	1355	12/75	2521	4		230	150	200	1	1/00	DO	BLAB HENRY CLAY 0210 FSND 0230
52	CON 15	18	67- 1931	548077 4839818	1375	08/66	2519	30	FR	12	12	18	3	2/00	ST	WHITTICK J TPSL 0001 BRWN CLAY 0006 BRWN MSND 0018
53	CON 15	19	67- 3120	548400 4839350	1365	04/68	1617	5	FR	155	27	40	15	3/30	DO	MILLAGE CHARLES CLAY STNS 0056 GREY LMSN 0155
54	CON 15	19	67- 3437	548420 4839670	1375	07/69	1617	4	FR	126	24	40			ST DO	JACKSON ROBERT PRDG 0016 SILT 0080 LMSN 0126
55	CON 15	19	67- 4003	548725 4839700	1375	08/71	3413	30	FR	10	10	10	10	2/00	DO	MEALING J BRWN CLAY 0010 CSND 0018
56	CON 15	19	67- 4017	548800 4839725	1375	09/71	3413	30	FR	10	10	10	10	2/00	DO	WHITE D BRWN CLAY 0010 CSND 0018
57	CON 15	19	67- 4053	548750 4839950	1375	01/71	3637	30	FR FR	12 17	10	17	12	2/00	DO	SANT BRWN FILL 0001 BRWN CLAY 0010 YLLW GRVL SAND 0012 BLCK CSND GRVL 0017

WELL NUMBER	CONCESSION ETC	LOT	WELL NO	UTM EASTING NORTHING	ELEV FEET	DATE	DRILLER	CSG DIA INS	KIND OF WATER	WATER FOUND FEET	STAT LVL FEET	PUMP LVL FEET	TEST RATE GPM	TEST TIME HR/MN	WATER USE	OWNER/LOG/SCREEN DEPTHS IN FEET TO WHICH FORMATIONS EXTEND
58	CON 15	19	67-4054	548800 4840000	1375	01/71	3637	30	FR	9	9	17	10	2/00	DO	SANT E BRWN FILL 0001 BRWN CLAY 0009 BLCK CSND GRVL STNS 0013 BLCK CSND GRVL 0017
59	CON 15	19	67-4374	548850 4839900	1375	09/72	3413	30	FR	6	6	14	3	4/00	DO	EXACTOR CONST BRWN CLAY 0006 GRVL 0008 BLUE CLAY 0018
60	CON 15	19	67-4746	548900 4839920	1375	07/73	2519	30	FR	7	7	15	6	1/00	DO	BELMONT BLDG CORP BRWN CLAY 0007 BRWN SAND GRVL 0009 GREY CLAY STNS 0023
61	CON 15	19	67-4747	548950 4839920	1575	08/73	2519	30	FR	6	6	19			DO	BELWOOD BLDG CORP BRWN CLAY 0002 GREY SAND 0006 BRWN SAND 0012 GREY CLAY BLDR 0020
62	CON 15	19	67-4748	548950 4839920	1375	08/73	2519	30	FR	6	6	20	6	/30	DO	BELMONT BLDG CORP BRWN TPSL 0002 GREY SAND 0006 BRWN SAND 0012 GREY CLAY STNS 0022
63	CON 15	19	67-4751	548660 4839800	1375	08/73	2519	30	FR	6	6	20	6	1/00	DO	BELMONT BLDG CORP BRWN CLAY 0004 GREY SAND GRVL 0016 GREY CLAY 0021
64	CON 15	19	67-4752	548850 4839900	1375	08/73	2519	30	FR	4	3	18	5	1/00	DO	BELMONT BLDG CORP BRWN CLAY TPSL 0002 GREY SAND GRVL 0012 GREY CLAY 0020
65	CON 15	19	67-4757	548880 4839850	1375	08/73	2510	30	FR	7	7	24	8	1/00	DO	CORP D BRWN CLAY 0005 BRWN CSND 0018 GREY GRVL 0019 GREY CLAY STNS 0025
66	CON 15	19	67-4780	548870 4839950	1375	09/73	2519	30	FR	5	4	14	8	1/00	DO	BELMONT BLDG CORP BRWN CLAY 0005 BRWN SAND GRVL 0012 GREY CLAY ROCK 0020
67	CON 15	19	67-5317	548470 4839584	1370	10/74	3740	4	FR	148	18	35	10	1/00	DO	BAKER ALUN BRWN FILL 0006 GREY CLAY 0018 GREY HPAN STNS 0059 BRWN LMSN 0068 GREY LMSN 0145 BRWN LMSN 0148
68	CON 15	19	67-5319	548350 4839350	1370	10/74	3740	4	FR	130	30	40	10	1/00	DO	HAMILTON NEIL CONTR BRWN CLAY 0034 GREY HPAN BLDR 0060 BRWN LMSN 0080 GREY LMSN 0130
69	CON 15	19	67-5528	548300 4839400	1370	05/75	3740	4	FR	102	30	40	12	1/00	DO	HAMILTON NEIL CONTR BRWN CLAY 0033 GREY HPAN BLDR 0058 BRWN LMSN 0102
70	CON 15	19	67-5531	548270 4839400	1370	05/75	3740	4	FR	100	20	40	8	1/00	DO	HAMILTON NEIL CONTR BRWN CLAY 0035 GREY HPAN 0057 BRWN LMSN 0100
71	CON 15	19	67-5699	548750 4839800	1375	09/75	2519	30	FR	6	6	24	3	1/00	DO	MCDONALD PERSEY BRWN CLAY 0003 GREY GRVL 0010 GREY CLAY 0025
72	CON 15	20	67-1932	548692 4839055	1350	12/54	2411	3	FR FR	150 220		100	5		DO	MACK H PRDR 0040 HPAN GRVL 0120 FSND 0220 GRVL 0221
73	CON 15	18	67-5142	548300 4840150	1395	06/74	2519	30	FR	10	10	18	5	1/00	DO	LARSON CONSTRUCTION BRWN CLAY 0005 BRWN SAND 0017 BLUE SAND 0020 BLUE HPAN CLAY 0021

APPENDIX B

TERRAPROBE LIMITED

Terraprobe

LOG OF BOREHOLE 1

PROJECT: Colborne Street & Beatty Line

DATE: 14 January 2008

LOCATION: Fergus, Ontario

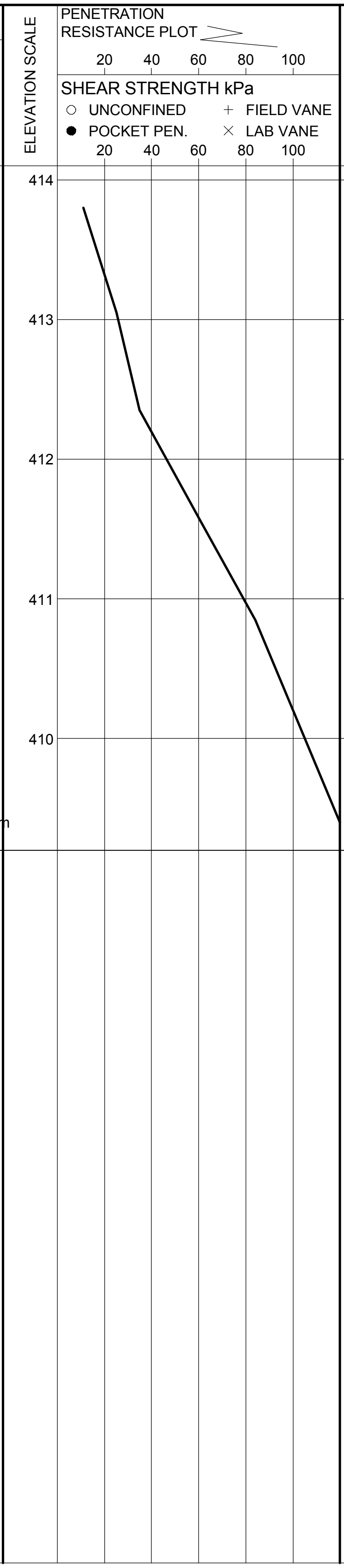
EQUIPMENT: Track-Mount - Hollow Stem Augers

CLIENT: Nigus Holdings Inc.

ELEVATION DATUM: Geodetic

FILE: 1-07-2438

SOIL PROFILE			SAMPLES		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
414.1	Ground Surface				
0.0 413.7	360mm TOPSOIL		1	SS	11
0.4 413.4	SANDY SILT - some clay, trace organics, stiff, brown, wet				
0.7 412.7	SAND - trace silt, compact, brown, wet		2	SS	25
1.4 411.2	CLAYEY SILT - some sand, trace gravel, hard, grey, moist (GLACIAL TILL)		3 4	SS SS	35 61
2.9 409.2	SANDY SILT - some clay, trace gravel, very dense, grey, damp, (GLACIAL TILL)		5 6	SS SS	84 93/23cm
4.9	End of Borehole				

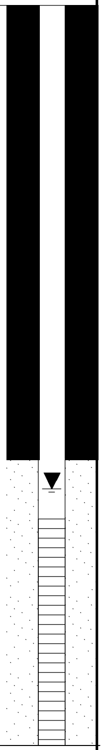


PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) 10 20 30

ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS



NOTES:
Borehole was open and dry upon completion of drilling. Water level in piezometer at 3.0m on January 28, 2008 and at 3.2m on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 2

PROJECT: Colborne Street & Beatty Line

LOCATION: Fergus, Ontario

CLIENT: Nigus Holdings Inc.

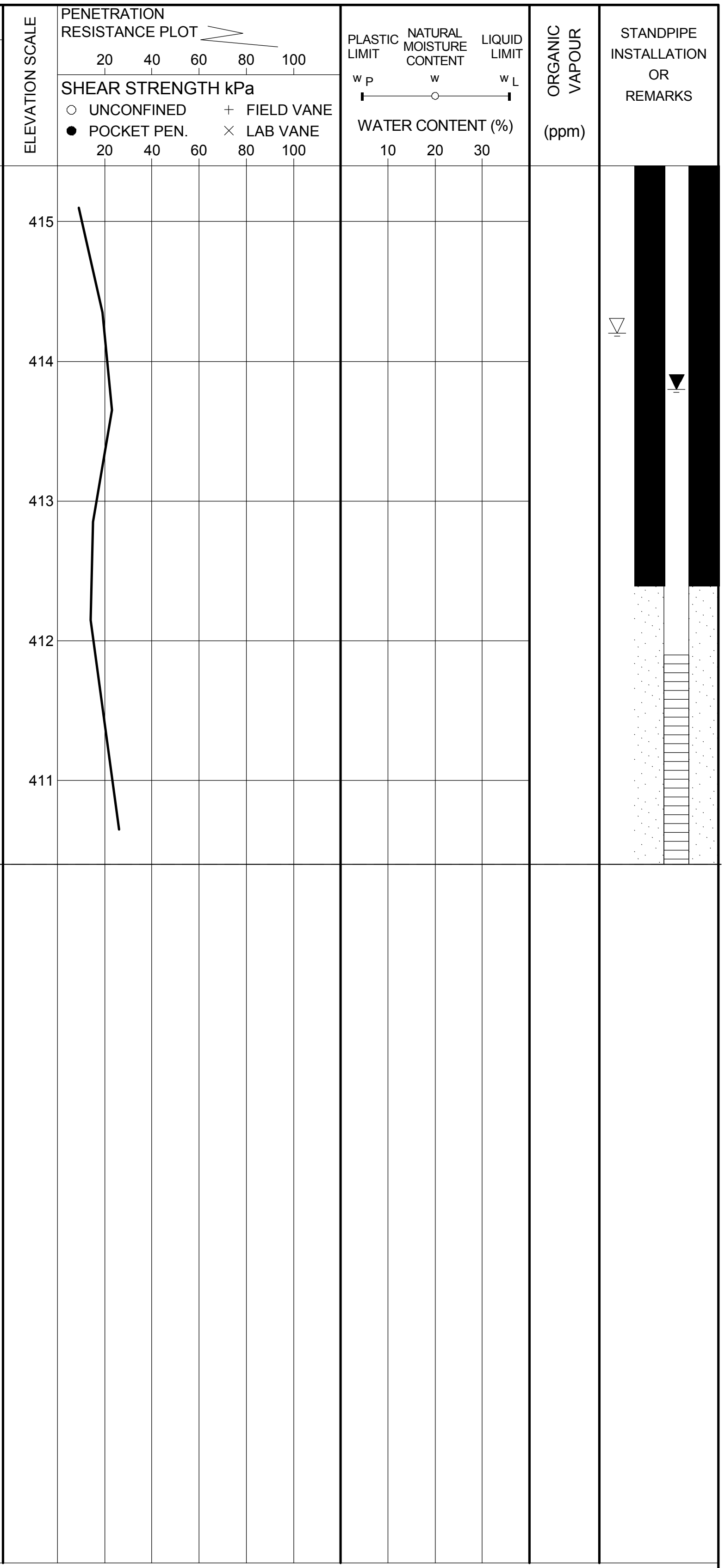
DATE: 14 January 2008

EQUIPMENT: Track-Mount - Hollow Stem Augers

ELEVATION DATUM: Geodetic

FILE: 1-07-2438

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
415.4	Ground Surface			
0.0 415.0	410mm TOPSOIL	1	SS	9
0.4 414.7	WEATHERED / DISTURBED trace organics			
0.7 414.2	SANDY SILT - some clay, trace gravel, compact, brown, moist (GLACIAL TILL)	2	SS	19
1.2 411.7	SAND - trace silt to silty, compact, brown, wet	3 4 5	SS SS SS	23 15 14
3.8 410.4	CLAYEY SILT - some sand, sand, trace gravel, very stiff, grey, moist, (GLACIAL TILL)	6	SS	26
5.0	End of Borehole			



NOTES:

Borehole was open and water level at 1.2m upon completion of drilling. Water level in piezometer at 1.5m on January 28, 2008 and at 1.6m on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 3

PROJECT: Colborne Street & Beatty Line

LOCATION: Fergus, Ontario

CLIENT: Nigus Holdings Inc.

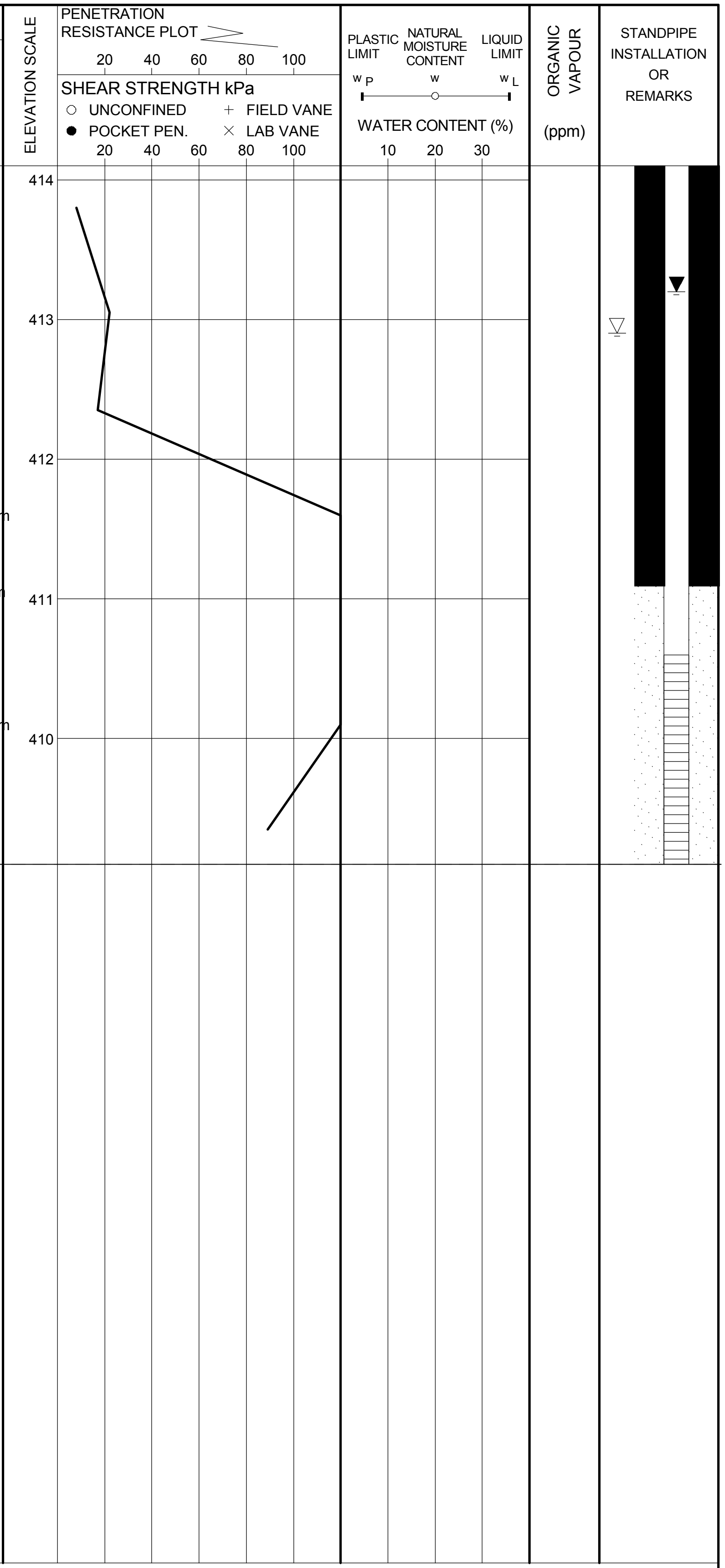
DATE: 14 January 2008

EQUIPMENT: Track-Mount - Hollow Stem Augers

ELEVATION DATUM: Geodetic

FILE: 1-07-2438

SOIL PROFILE			SAMPLES		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES
414.1	Ground Surface				
0.0	410mm TOPSOIL		1	SS	8
413.7 0.4	WEATHERED / DISTURBED trace organics				
413.4 0.7	SANDY SILT - trace clay, trace gravel, compact to very dense, brown, moist, (GLACIAL TILL)		2	SS	22
			3	SS	17
			4	SS	82/23cm
			5	SS	50/5cm
411.1 3.1	CLAYEY SILT some sand, trace gravel, hard, grey, damp (GLACIAL TILL)		6	SS	83/23cm
			7	SS	89
409.1 5.0	End of Borehole				



NOTES:
Borehole was open and water level at 1.2m upon completion of drilling. Water level in piezometer at 1.0m on January 28, 2008 and at 0.9m on June 23, 2008.

Sheet 1 of 1

Terraprobe

LOG OF BOREHOLE 4

PROJECT: Colborne Street & Beatty Line

LOCATION: Fergus, Ontario

CLIENT: Nigus Holdings Inc.

DATE: 14 January 2008

EQUIPMENT: Track-Mount - Hollow Stem Augers

ELEVATION DATUM: Geodetic

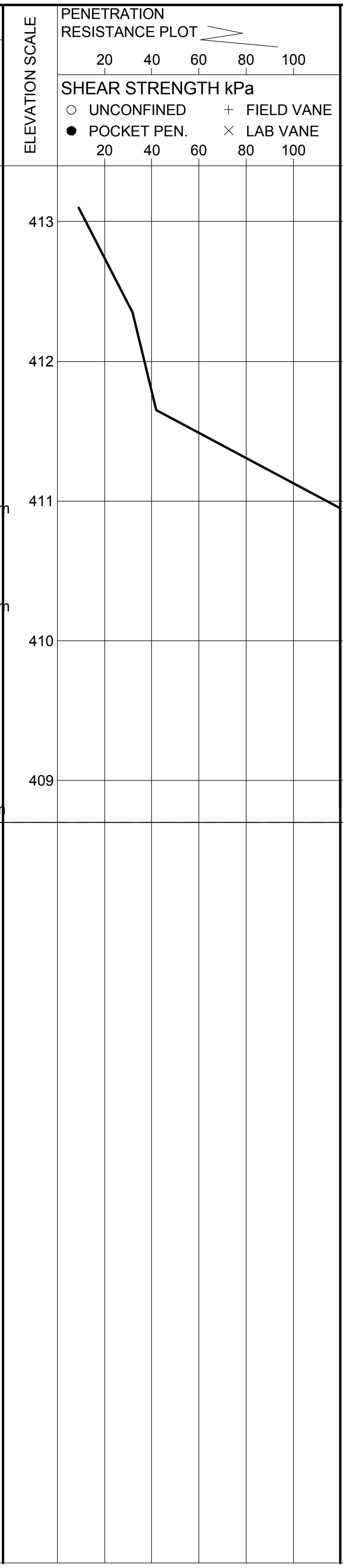
FILE: 1-07-2438

SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
413.4	Ground Surface
0.0	300mm TOPSOIL
413.1 0.3	WEATHERED / DISTURBED trace organics
412.7 0.7	SANDY SILT - trace clay, trace gravel, dense, brown, moist (GLACIAL TILL)
412.2 1.2	SAND - trace silt, trace gravel, dense, brown, wet
411.5 1.9	SANDY SILT - trace clay, trace gravel very dense, grey, damp, (GLACIAL TILL)
408.7 4.7	End of Borehole

SAMPLES

NUMBER	TYPE	"N" VALUES
1	SS	9
2	SS	32
3	SS	42
4	SS	50/13cm
5	SS	50/15cm
6	SS	50/8cm

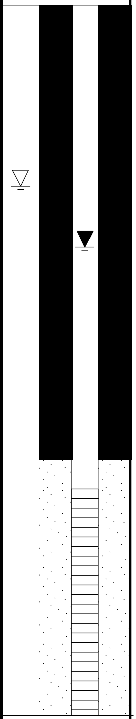


PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) 10 20 30

ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS



NOTES:

Borehole was open and water level at 1.2m upon completion of drilling. Water level in piezometer at 1.6m on January 28, 2008 and at 1.6m on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 5

PROJECT: Colborne Street & Beatty Line

DATE: 15 January 2008

LOCATION: Fergus, Ontario

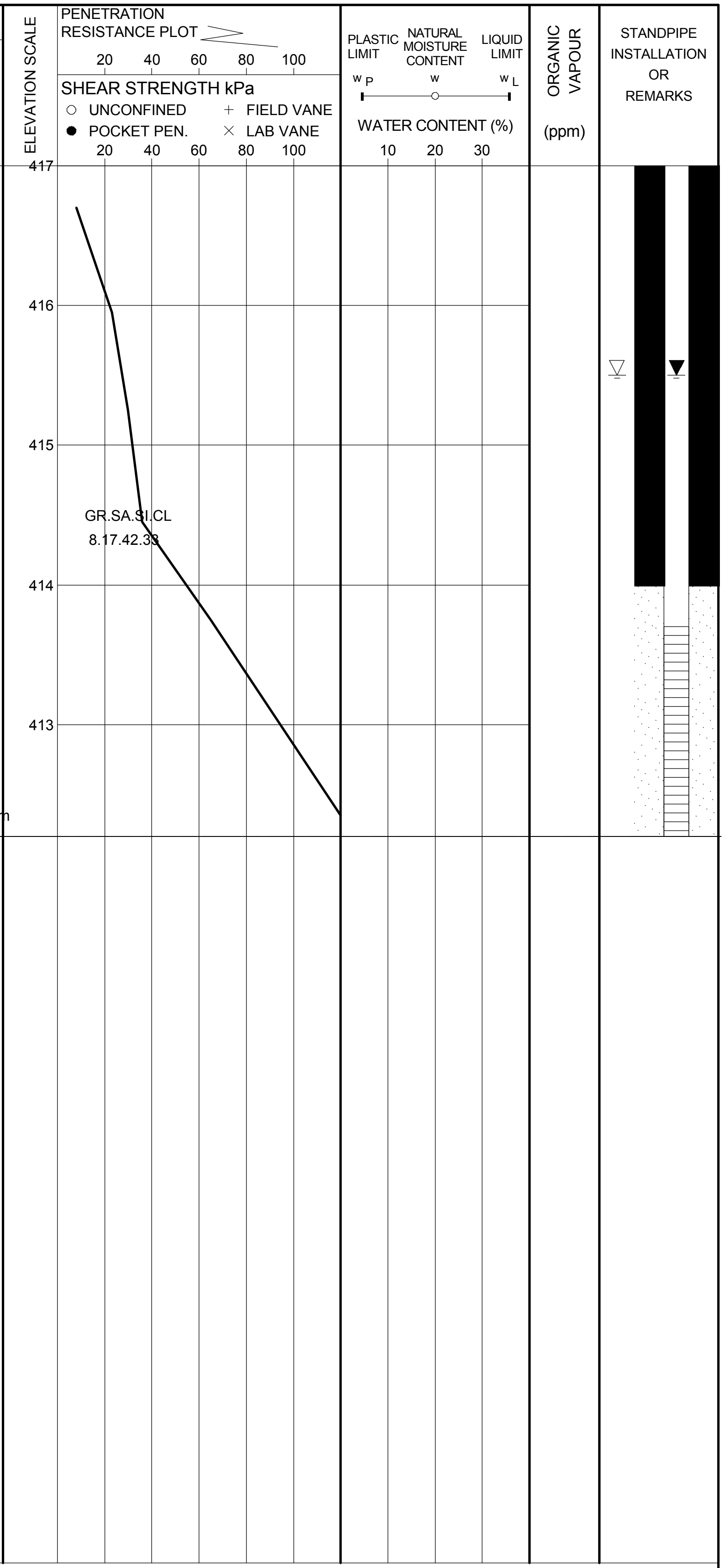
EQUIPMENT: Track-Mount - Hollow Stem Augers

CLIENT: Nigus Holdings Inc.

ELEVATION DATUM: Geodetic

FILE: 1-07-2438

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
417.0	Ground Surface			
0.0	300mm TOPSOIL			
416.7 0.3	WEATHERED / DISTURBED trace organics	1	SS	8
416.3 0.7	SANDY SILT - some clay, trace gravel, occassional sand lenses, compact, brown, moist (GLACIAL TILL)	2 3	SS SS	23 30
415.1 1.9	SILT AND CLAY - some sand, trace gravel, hard, brown, damp (GLACIAL TILL)	4 5	SS SS	36 65
413.3 3.8	SANDY SILT - trace clay, trace gravel, very dense, grey, moist (GLACIAL TILL)	6	SS	50/13cm
412.2 4.8	End of Borehole			



NOTES:
Borehole was open and water level at 1.5m upon completion of drilling. Water level in piezometer at 1.6m on January 28, 2008 and at 1.5m on June 23, 2008.

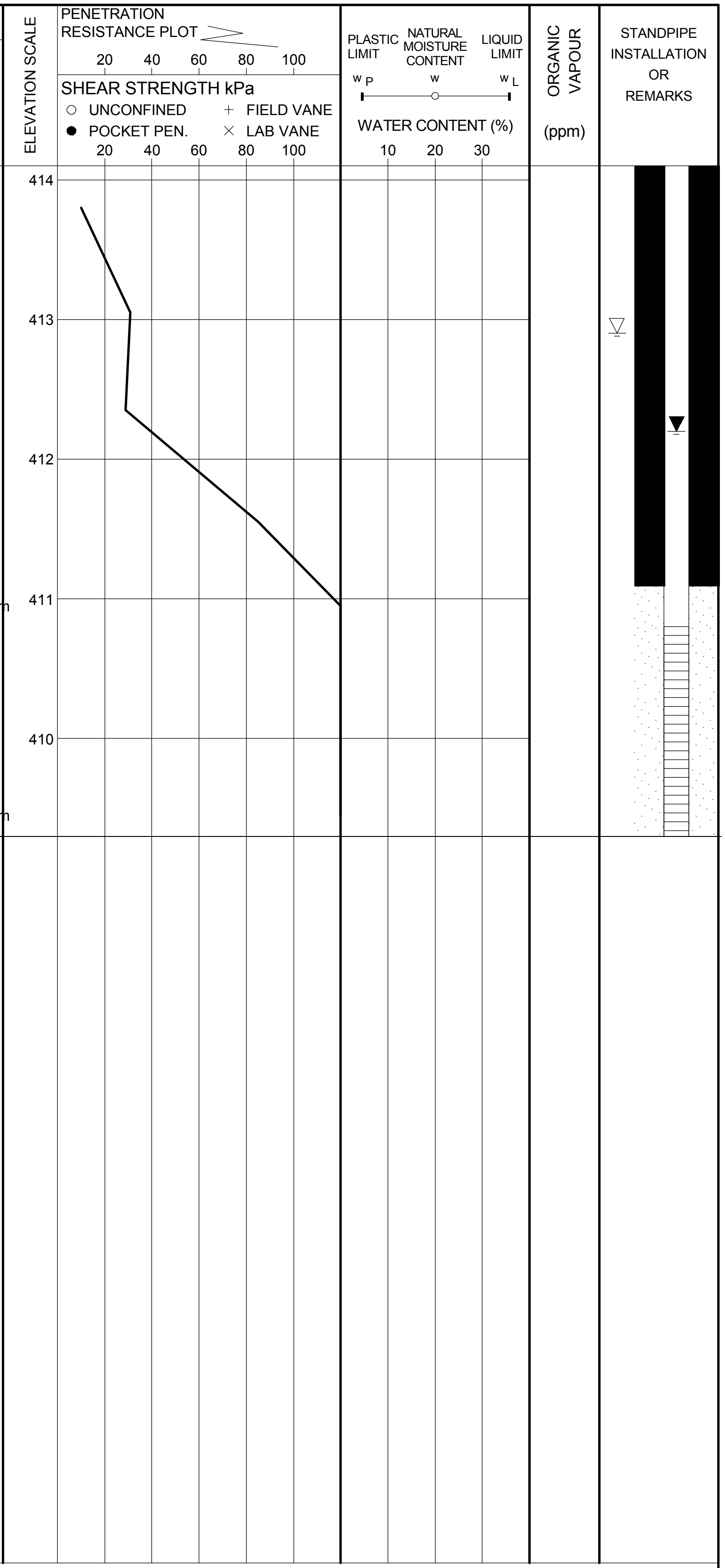
Terraprobe

LOG OF BOREHOLE 6

PROJECT: Colborne Street & Beatty Line
DATE: 14 January 2008
LOCATION: Fergus, Ontario
EQUIPMENT: Track-Mount - Solid Stem Augers
CLIENT: Nigus Holdings Inc.
ELEVATION DATUM: Geodetic
FILE: 1-07-2438

SOIL PROFILE	
ELEV DEPTH	DESCRIPTION
414.1	Ground Surface
413.9 0.0	200mm TOPSOIL
0.2	SANDY SILT trace to some clay, trace organics, loose to compact, brown, moist
413.4 0.7	SAND - trace silt, dense, brown, moist
412.9 1.2	CLAYEY SILT - some sand, trace gravel, very stiff to hard, brown, damp (GLACIAL TILL) ---- grey
409.3 4.8	End of Borehole

SAMPLES		
NUMBER	TYPE	"N" VALUES
1	SS	10
2	SS	31
3	SS	29
4	SS	85
5	SS	50/13cm
6	SS	50/13cm



NOTES:
Borehole was caving at 3.0m and water level at 1.2m upon completion of drilling. Water level in piezometer at 1.6m on January 28, 2008, at 1.7m on March 28, 20008 and at 1.9m on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 7

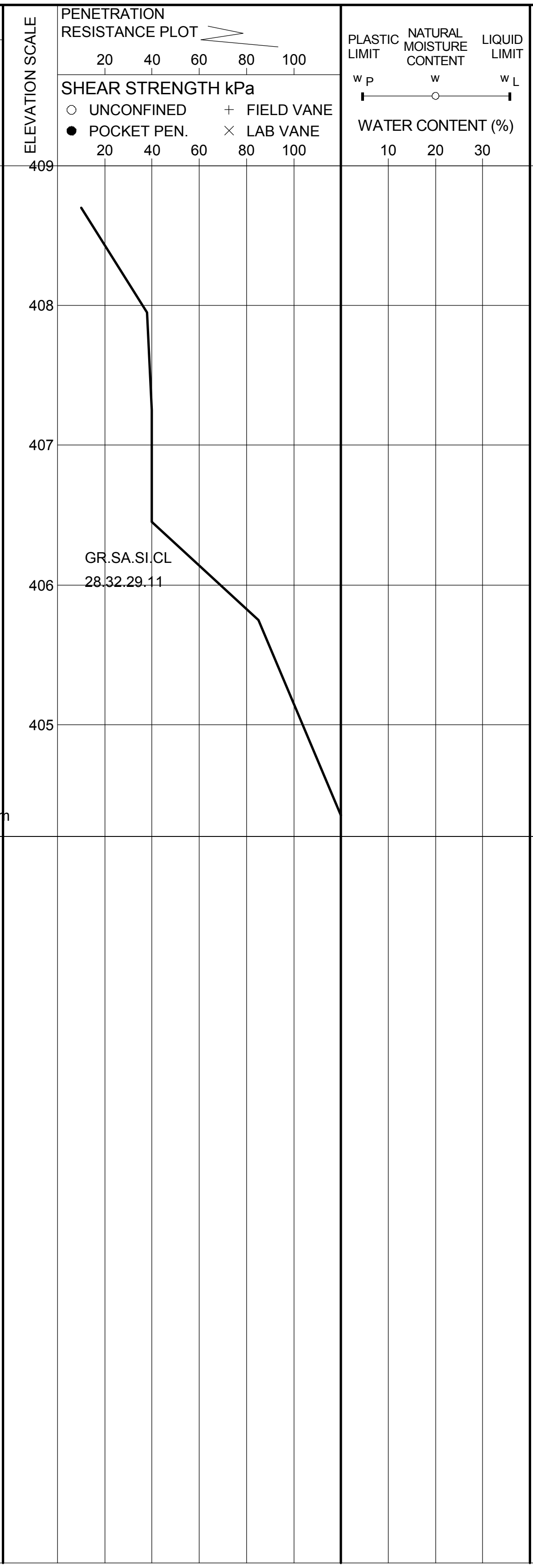
PROJECT: Colborne Street & Beatty Line
LOCATION: Fergus, Ontario
CLIENT: Nigus Holdings Inc.
DATE: 15 January 2008
EQUIPMENT: Track-Mount - Hollow Stem Augers
ELEVATION DATUM: Geodetic
FILE: 1-07-2438

SOIL PROFILE

ELEV DEPTH	DESCRIPTION
409.0	Ground Surface
0.0	360mm TOPSOIL
408.6 0.4	SANDY SILT some clay, trace organics, loose to compact, brown, moist
408.3 0.7	SAND - some silt, trace gravel, dense, brown, wet
407.8 1.2	SILTY SAND TO SANDY SILT gravelly, some clay, dense to very dense, brown, moist (GLACIAL TILL) ---grey
404.2 4.8	End of Borehole

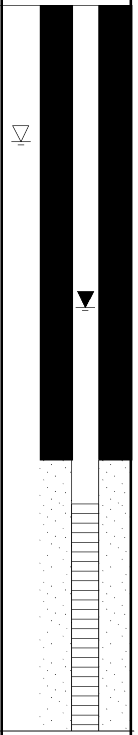
SAMPLES

NUMBER	TYPE	"N" VALUES
1	SS	10
2	SS	38
3	SS	40
4	SS	40
5	SS	85
6	SS	50/13cm



ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS



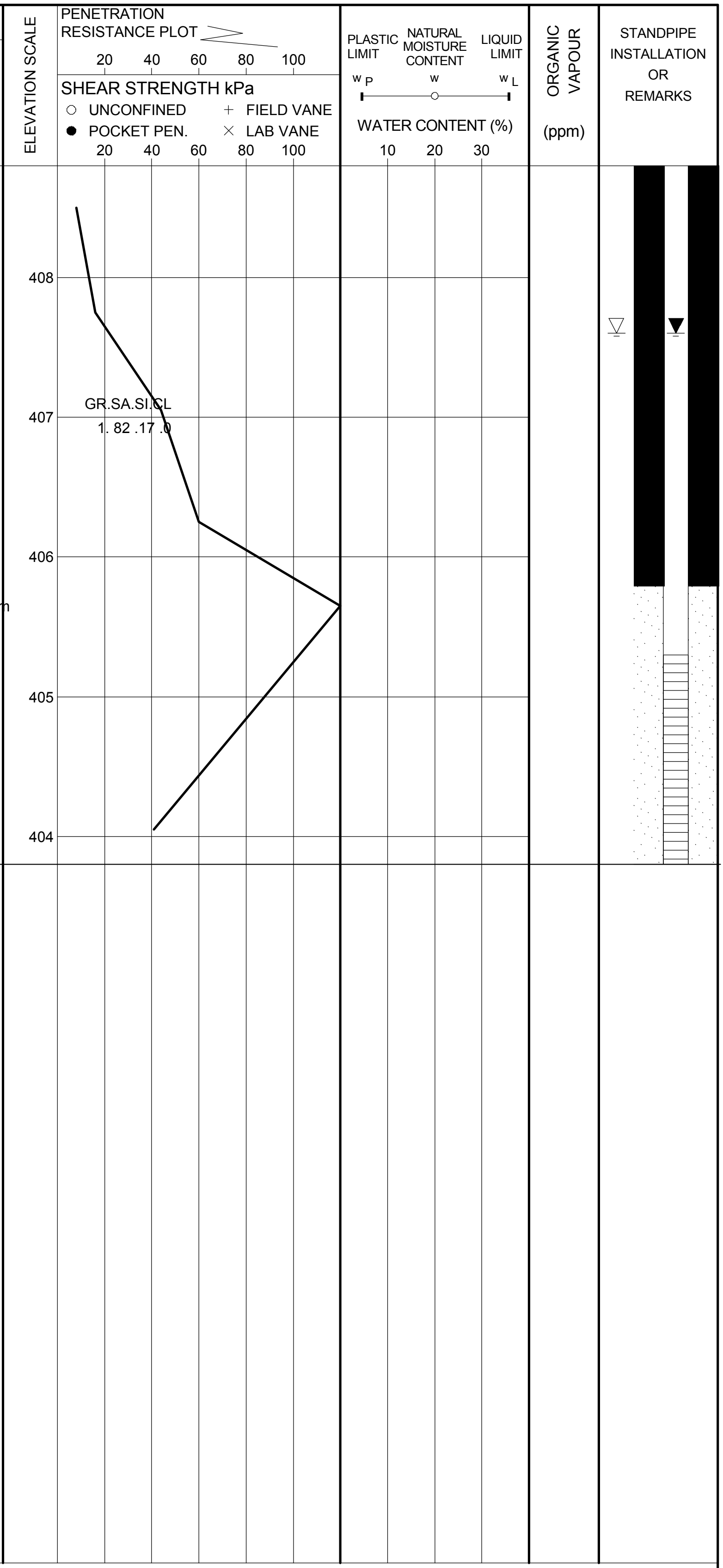
NOTES:
Borehole was open and water level at 0.9m upon completion of drilling. Water level in piezometer at 1.6m on January 28, 2008 and at 2.0m on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 8

PROJECT: Colborne Street & Beatty Line
LOCATION: Fergus, Ontario
CLIENT: Nigus Holdings Inc.
DATE: 15 January 2008
EQUIPMENT: Track-Mount - Hollow Stem Augers
ELEVATION DATUM: Geodetic
FILE: 1-07-2438

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
408.8	Ground Surface			
0.0	600mm TOPSOIL	1	SS	8
408.2 0.6	SANDY SILT trace clay, trace gravel, compact, brown, wet	2	SS	16
407.6 1.2	SAND some silt and clay, trace gravel, dense to very dense, brown, wet ---- gravelly ----	3	SS	44
		4	SS	60
		5	SS	50/13cm
405.1 3.8	CLAYEY SILT some sand, trace gravel, hard, grey, moist (GLACIAL TILL)	6	SS	41
403.8 5.0	End of Borehole			



NOTES:
Borehole was open and water level at 1.2m upon completion of drilling. Water level in piezometer at 1.2m on January 28, 2008, at 1.3m on March 28, 2008 and at 1.2m on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 9

PROJECT: Colborne Street & Beatty Line

LOCATION: Fergus, Ontario

CLIENT: Nigus Holdings Inc.

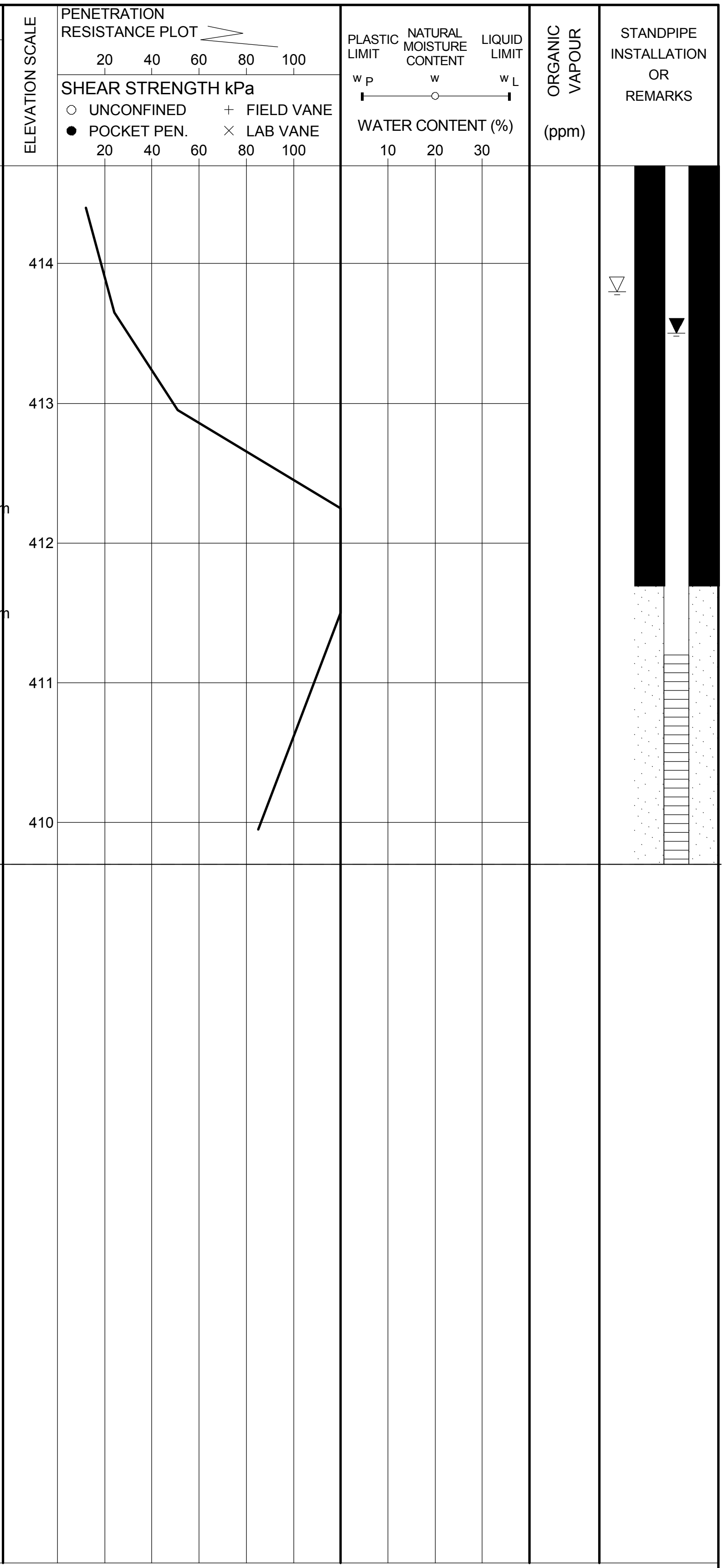
DATE: 15 January 2008

EQUIPMENT: Track-Mount - Hollow Stem Augers

ELEVATION DATUM: Geodetic

FILE: 1-07-2438

SOIL PROFILE		SAMPLES		
ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
414.7	Ground Surface			
0.0	410mm TOPSOIL	1	SS	12
414.3 0.4	WEATHERED / DISTURBED			
414.0 0.7	CLAYEY SILT - sandy, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)	2 3	SS SS	24 51
412.8 1.9	SANDY SILT trace clay, trace gravel, very dense, brown, damp, (GLACIAL TILL)	4 5	SS SS	50/15cm 94/28cm
	----grey	6	SS	85
409.7 5.0	End of Borehole			



NOTES:
Borehole was open and water level at 0.9m upon completion of drilling. Water level in piezometer at 1.1m on January 28, 2008, at 1.0m on March 28, 2008 and at 1.2m on June 23, 2008.

Sheet 1 of 1

Terraprobe

LOG OF BOREHOLE 10

PROJECT: Colborne Street & Beatty Line

LOCATION: Fergus, Ontario

CLIENT: Nigus Holdings Inc.

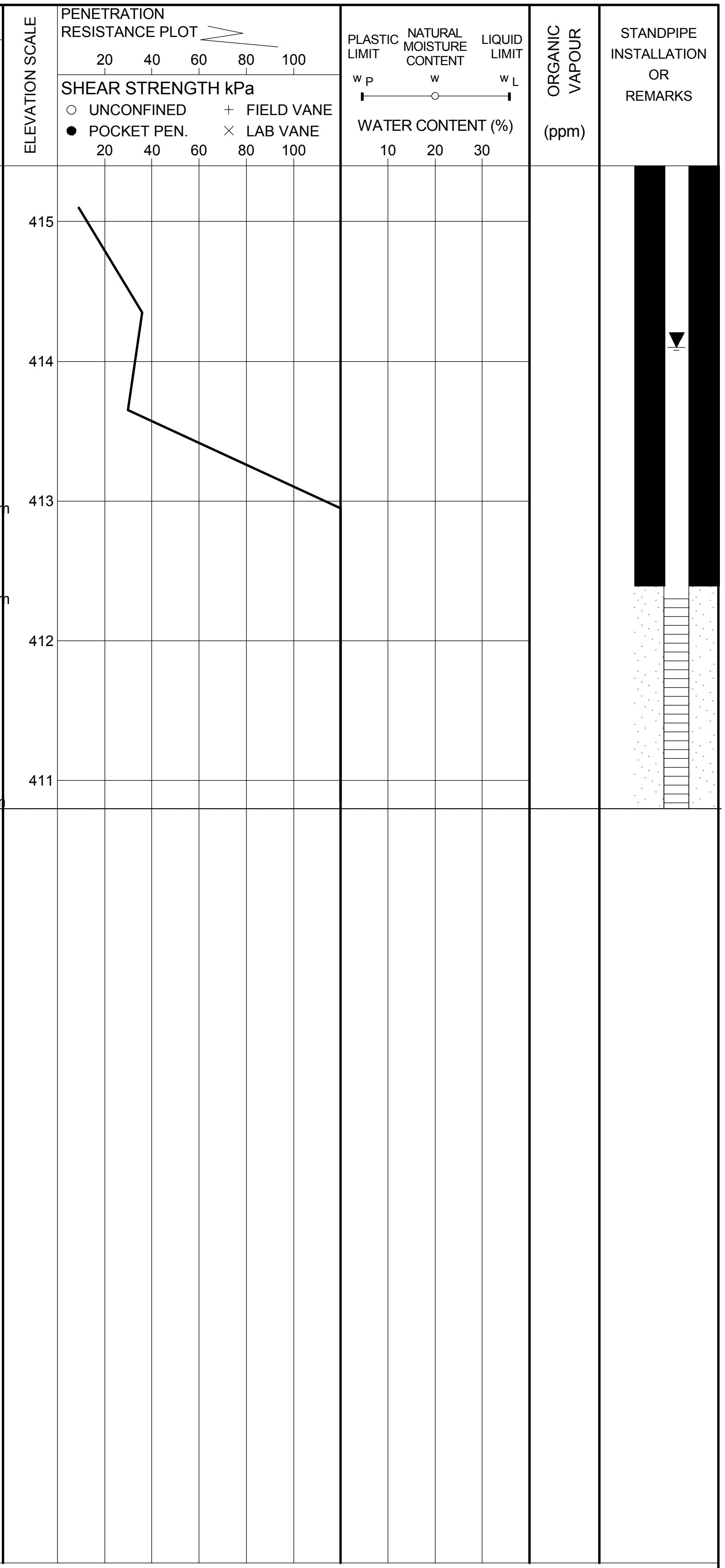
DATE: 15 January 2008

EQUIPMENT: Track-Mount - Hollow Stem Augers

ELEVATION DATUM: Geodetic

FILE: 1-07-2438

ELEV DEPTH	SOIL PROFILE DESCRIPTION	SAMPLES NUMBER	TYPE	"N" VALUES
415.4	Ground Surface			
0.0	360mm TOPSOIL			
415.0 0.4	WEATHERED / DISTURBED	1	SS	9
414.6 0.8	SANDY SILT, trace clay, trace gravel, compact, brown, moist (GLACIAL TILL)	2	SS	36
414.2 1.2	CLAYEY SILT some sand, trace gravel, very stiff, brown, moist (GLACIAL TILL)	3	SS	30
413.5 1.9	SANDY SILT trace clay, trace gravel, very dense, brown, damp (GLACIAL TILL)	4	SS	50/13cm
		5	SS	50/15cm
	----grey			
410.8 4.6	End of Borehole	6	SS	50/8cm



NOTES:
Borehole was open and dry upon completion of drilling. Water level in piezometer at 1.0m on January 28, 2008, at 0.7m on March 28, 2008 and at 1.3m on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 11

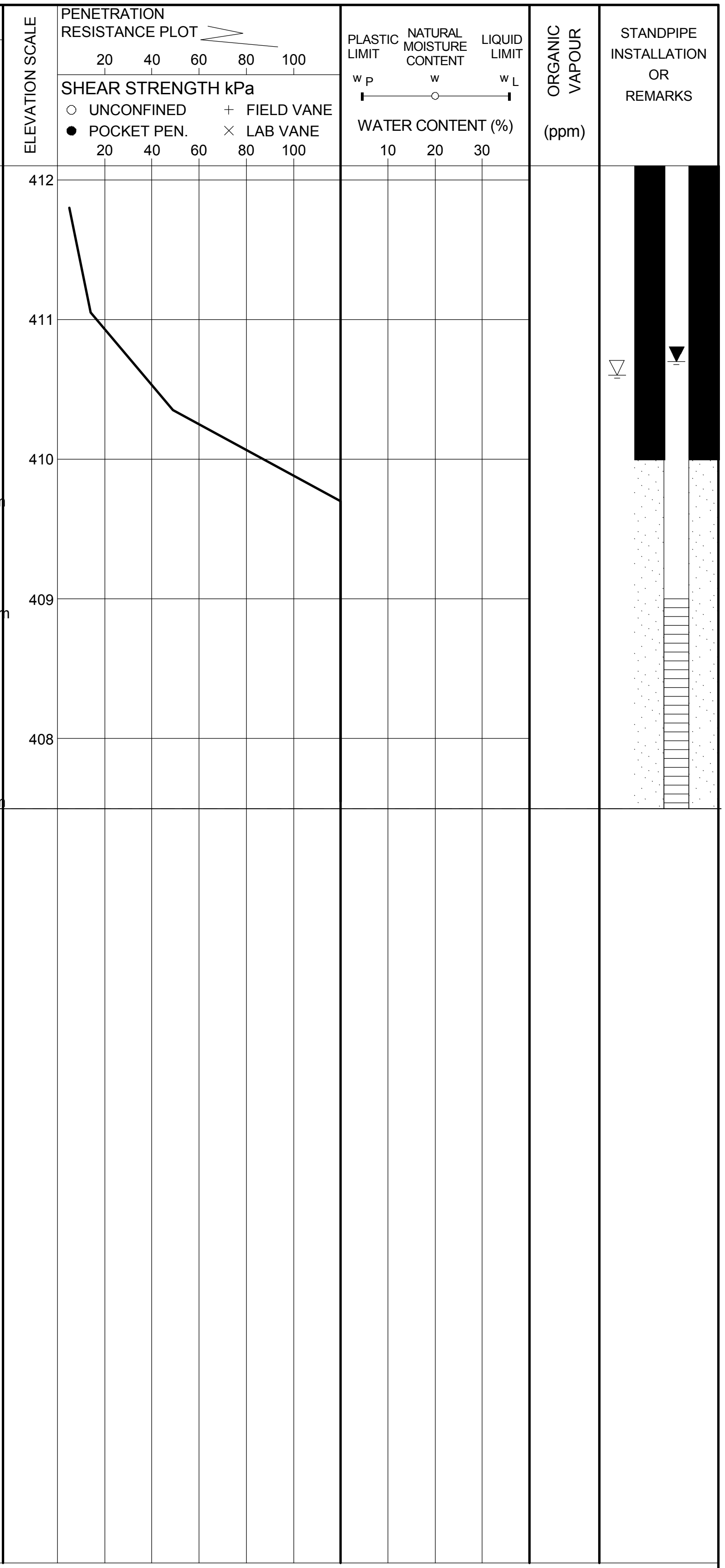
PROJECT: Colborne Street & Beatty Line
LOCATION: Fergus, Ontario
CLIENT: Nigus Holdings Inc.
DATE: 16 January 2008
EQUIPMENT: Track-Mount - Solid Stem Augers
ELEVATION DATUM: Geodetic
FILE: 1-07-2438

SOIL PROFILE

ELEV / DEPTH	DESCRIPTION
412.1	Ground Surface
0.0	360mm TOPSOIL
411.7 0.4	WEATHERED / DISTURBED
411.3 0.8	CLAYEY SILT - some sand to sandy, trace gravel, stiff to hard, brown, moist (GLACIAL TILL)
407.5 4.6	End of Borehole

SAMPLES

NUMBER	TYPE	"N" VALUES
1	SS	5
2	SS	14
3	SS	49
4	SS	50/8cm
5	SS	96/23cm
6	SS	50/8cm



NOTES:
Borehole was caving at 4.0m and water level at 1.5m upon completion of drilling. Water level in piezometer at 1.2m on January 28, 2008, at 1.3m on March 28, 2008 and at 1.4m on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 13

PROJECT: Colborne Street & Beatty Line

LOCATION: Fergus, Ontario

CLIENT: Nigus Holdings Inc.

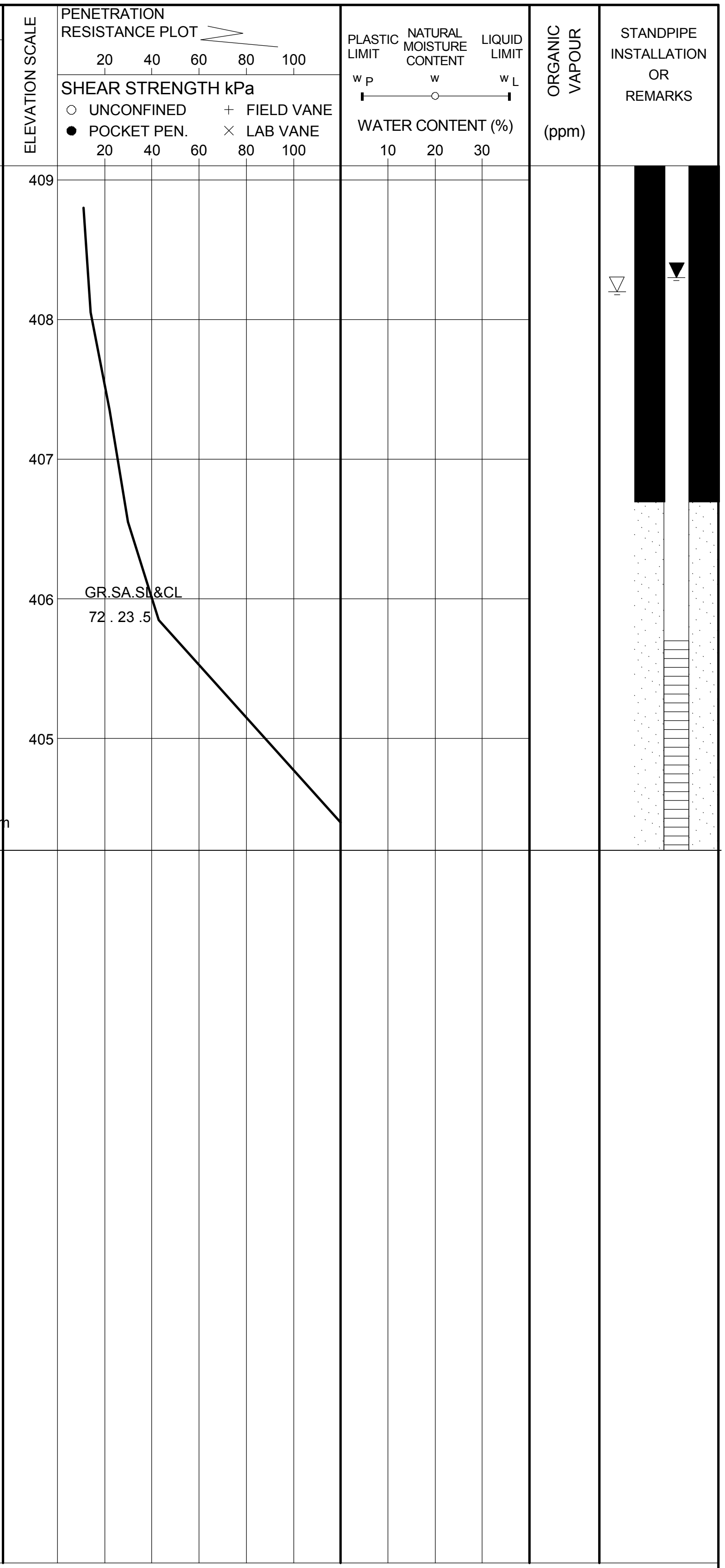
DATE: 17 January 2008

EQUIPMENT: Track-Mount - Solid Stem Augers

ELEVATION DATUM: Geodetic

FILE: 1-07-2438

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
409.1	Ground Surface			
0.0	430mm TOPSOIL	1	SS	11
408.7 0.4	SANDY SILT trace to some clay, trace rootlets, compact, brown, moist	2	SS	14
407.9 1.2	SAND some silt, brown, saturated, compact	3	SS	22
407.2 1.9	SANDY GRAVEL trace silt. compact to dense, brown, wet	4	SS	30
		5	SS	43
405.4 3.8	SANDY SILT trace clay, trace gravel, very dense, grey, damp (GLACIAL TILL)	6	SS	72/23cm
404.2 4.9	End of Borehole			



NOTES:

Borehole was caving at 3.7m and water level at 0.9m upon completion of drilling. Water level in piezometer at 0.7m on January 28, 2008, at 1.0m on March 28, 2008 and at 0.8m on June 23, 2008.

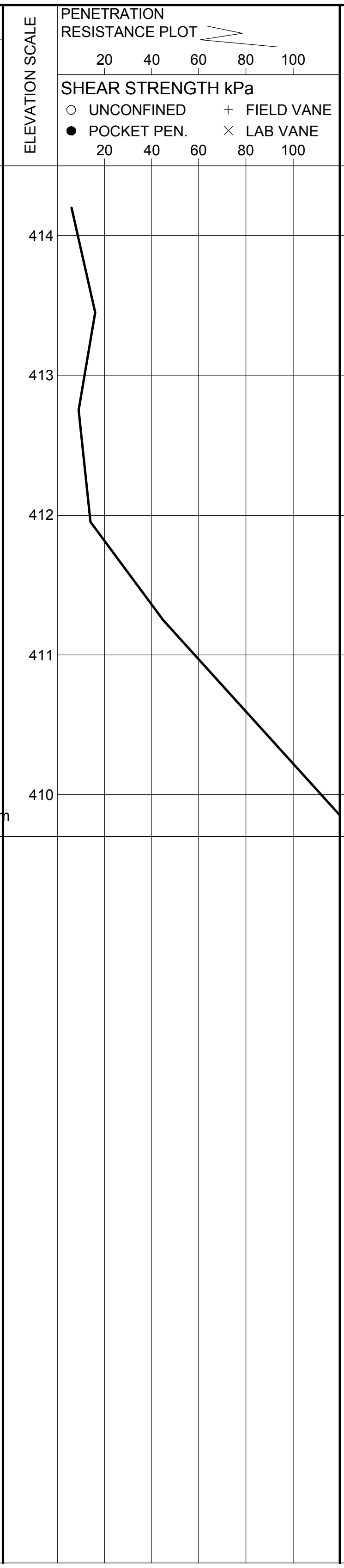
Sheet 1 of 1

Terraprobe

LOG OF BOREHOLE 14

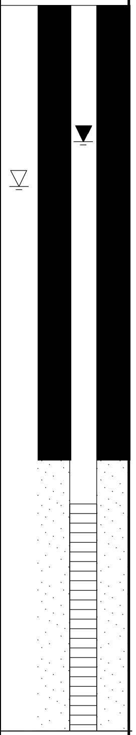
PROJECT: Colborne Street & Beatty Line
LOCATION: Fergus, Ontario
CLIENT: Nigus Holdings Inc.
DATE: 15 January 2008
EQUIPMENT: Track-Mount - Hollow Stem Augers
ELEVATION DATUM: Geodetic
FILE: 1-07-2438

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
414.5	Ground Surface			
0.0	380mm TOPSOIL	1	SS	6
414.1 0.4	WEATHERED / DISTURBED trace organics			
413.8 0.7	CLAYEY SILT some sand, trace gravel, firm to stiff, brown, moist (GLACIAL TILL)	2	SS	16
		3	SS	9
		4	SS	14
411.8 2.7	SANDY SILT trace clay, trace gravel, dense to very dense, brown, damp (GLACIAL TILL) ----grey	5	SS	45
		6	SS	50/10cm
409.7 4.8	End of Borehole			



PLASTIC LIMIT w_P	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w_L	ORGANIC VAPOUR (ppm)	STANDPIPE INSTALLATION OR REMARKS

WATER CONTENT (%) 10 20 30



NOTES:
Borehole was open and water level at 1.2m upon completion of drilling. Water level in piezometer at 0.9m on January 28, 2008, at 0.9m on March 28, 2008 and at 0.9m on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 15

PROJECT: Colborne Street & Beatty Line

LOCATION: Fergus, Ontario

CLIENT: Nigus Holdings Inc.

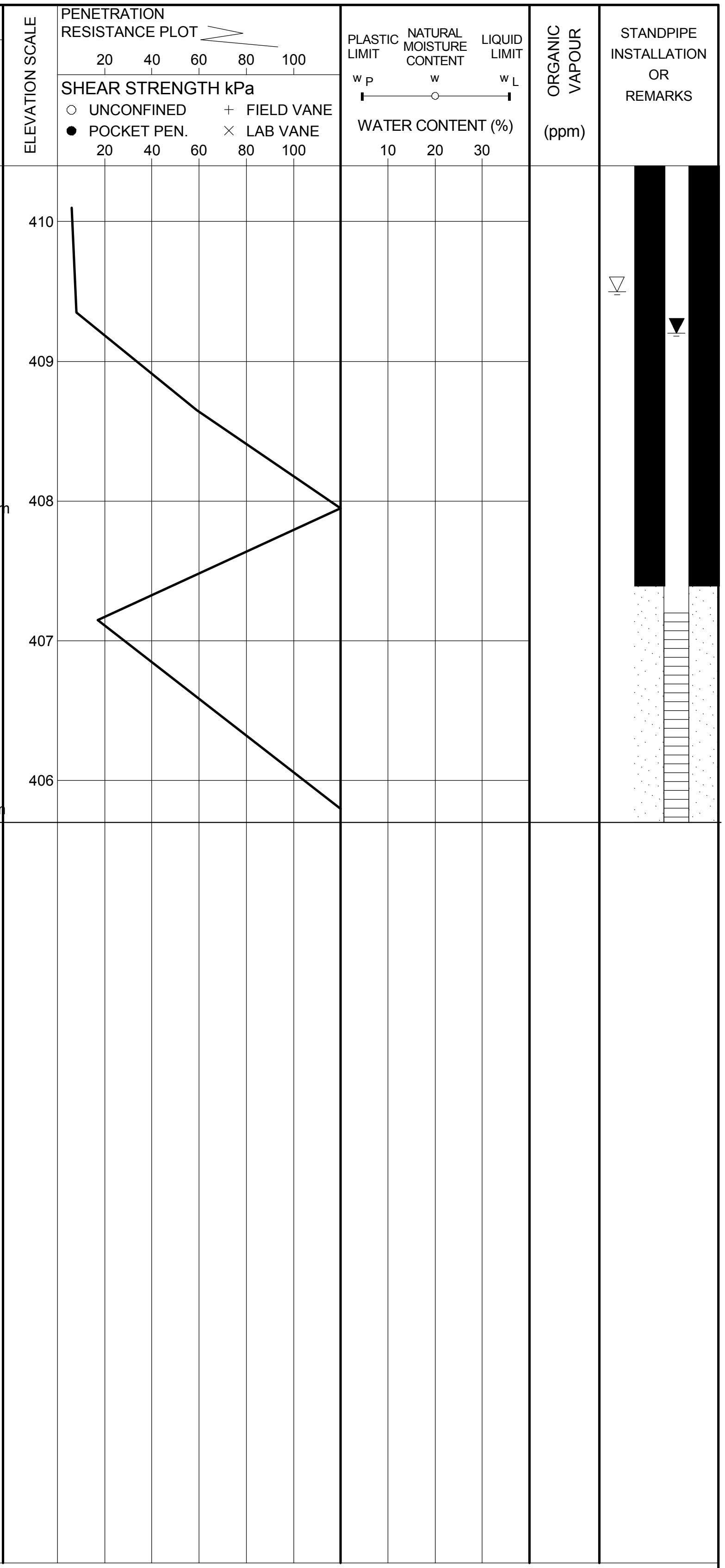
DATE: 15 January 2008

EQUIPMENT: Track-Mount - Hollow Stem Augers

ELEVATION DATUM: Geodetic

FILE: 1-07-2438

SOIL PROFILE		SAMPLES		
ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
410.4	Ground Surface			
0.0	1170mm TOPSOIL	1 2	SS SS	6 8
409.2 1.2	SAND - trace silt, loose, brown, moist			
409.0 1.4	GRAVEL AND SAND silty trace clay, very dense, brown, wet	3	SS	59
408.5 1.9	SAND some gravel, trace silt, trace clay, very dense, brown, wet	4	SS	50/13cm
407.7 2.7	FINE SAND trace silt, compact, brown, wet	5	SS	17
406.7 3.8	SANDY SILT - trace clay, trace gravel, hard, grey, moist, occasional sand seams (GLACIAL TILL)	6	SS	50/5cm
405.7 4.7	End of Borehole			



NOTES:
Borehole was open and water level at 0.9m upon completion of drilling. Water level in piezometer at 1.4m on January 28, 2008, at 1.2m on March 28, 2008, and at 1.2m on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 16

PROJECT: Colborne Street & Beatty Line

LOCATION: Fergus, Ontario

CLIENT: Nigus Holdings Inc.

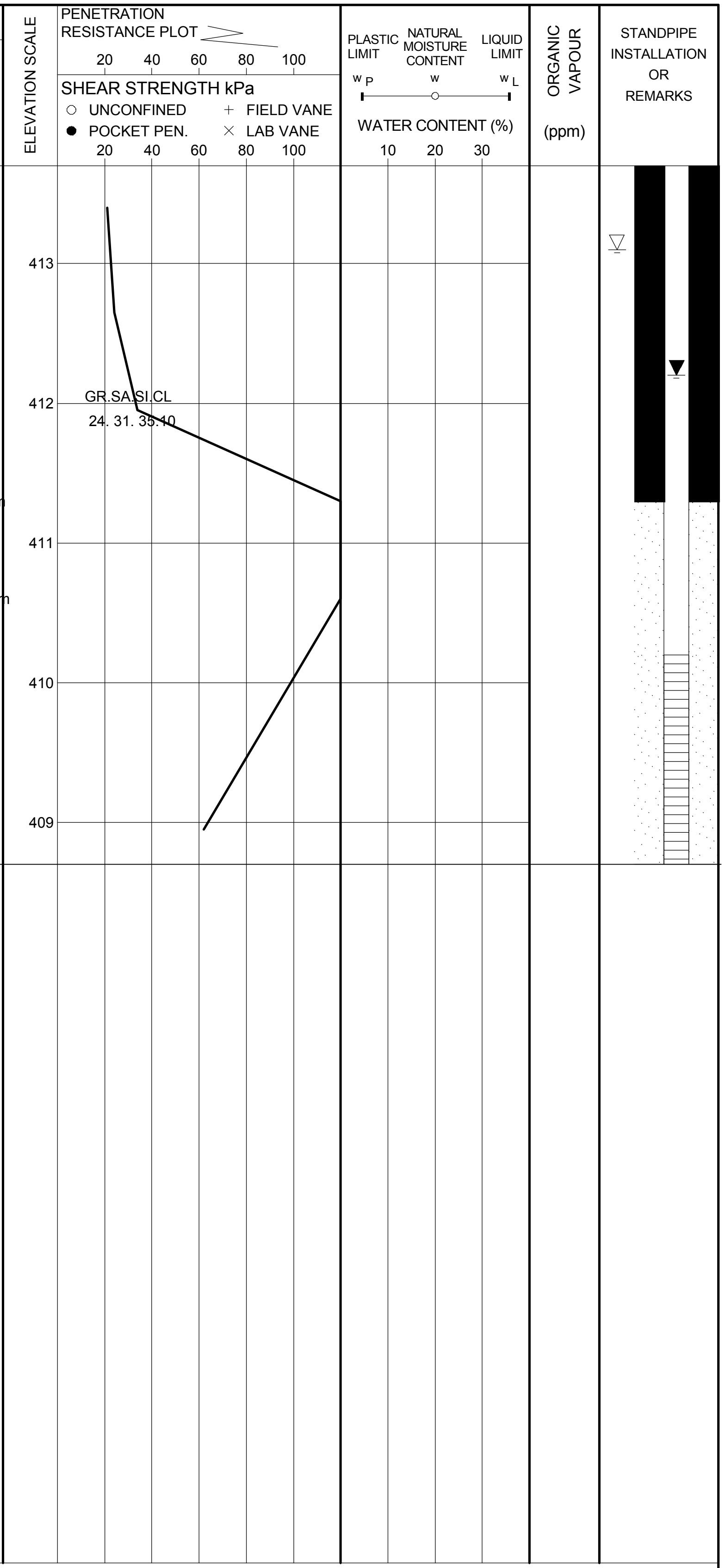
DATE: 16 January 2008

EQUIPMENT: Track-Mount - Solid Stem Augers

ELEVATION DATUM: Geodetic

FILE: 1-07-2438

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
413.7	Ground Surface			
0.0	300mm TOPSOIL			
413.4 0.3	SANDY SILT trace gravel to gravelly, trace clay, compact to very dense, brown, moist (GLACIAL TILL)	1	SS	21
		2	SS	24
		3	SS	34
		4	SS	50/8cm
		5	SS	50/15cm
	----grey			
408.7		6	SS	62
5.0	End of Borehole			



NOTES:

Borehole was caving at 4.3m and water level at 0.6m upon completion of drilling. Water level in piezometer at 0.9m on January 28, 2008, frozen on March 28, 2008 and at 1.5m on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 18

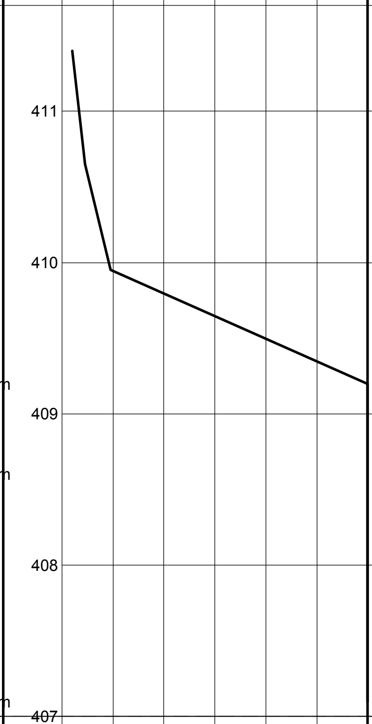
PROJECT: Colborne Street & Beatty Line
LOCATION: Fergus, Ontario
CLIENT: Nigus Holdings Inc.

DATE: 16 January 2008
EQUIPMENT: Track-Mount - Solid Stem Augers
ELEVATION DATUM: Geodetic
FILE: 1-07-2438

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
411.7	Ground Surface			
0.0	460mm TOPSOIL	1	SS	4
411.2 0.5	WEATHERED / DISTURBED trace organics	2	SS	9
410.7 1.1	SANDY SILT trace clay, trace gravel, loose to very dense, brown, moist, (GLACIAL TILL)	3	SS	19
		4	SS	74/23cm
		5	SS	50/15cm
	----grey			
407.0		6	SS	50/15cm
4.7	End of Borehole			

ELEVATION SCALE

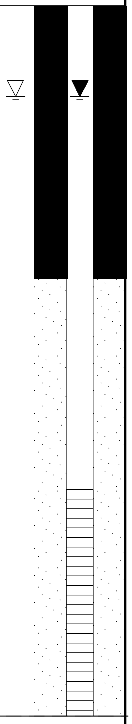
PENETRATION RESISTANCE PLOT
20 40 60 80 100
SHEAR STRENGTH kPa
○ UNCONFINED + FIELD VANE
● POCKET PEN. × LAB VANE
20 40 60 80 100



PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

ORGANIC VAPOUR (ppm)

STANDPIPE INSTALLATION OR REMARKS



NOTES:
Borehole was caving at 4.3m and water level at 0.6m upon completion of drilling. Water level in piezometer at 0.6m on March 28, 2008 and at 0.6m above ground on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 19

PROJECT: Colborne Street & Beatty Line

LOCATION: Fergus, Ontario

CLIENT: Nigus Holdings Inc.

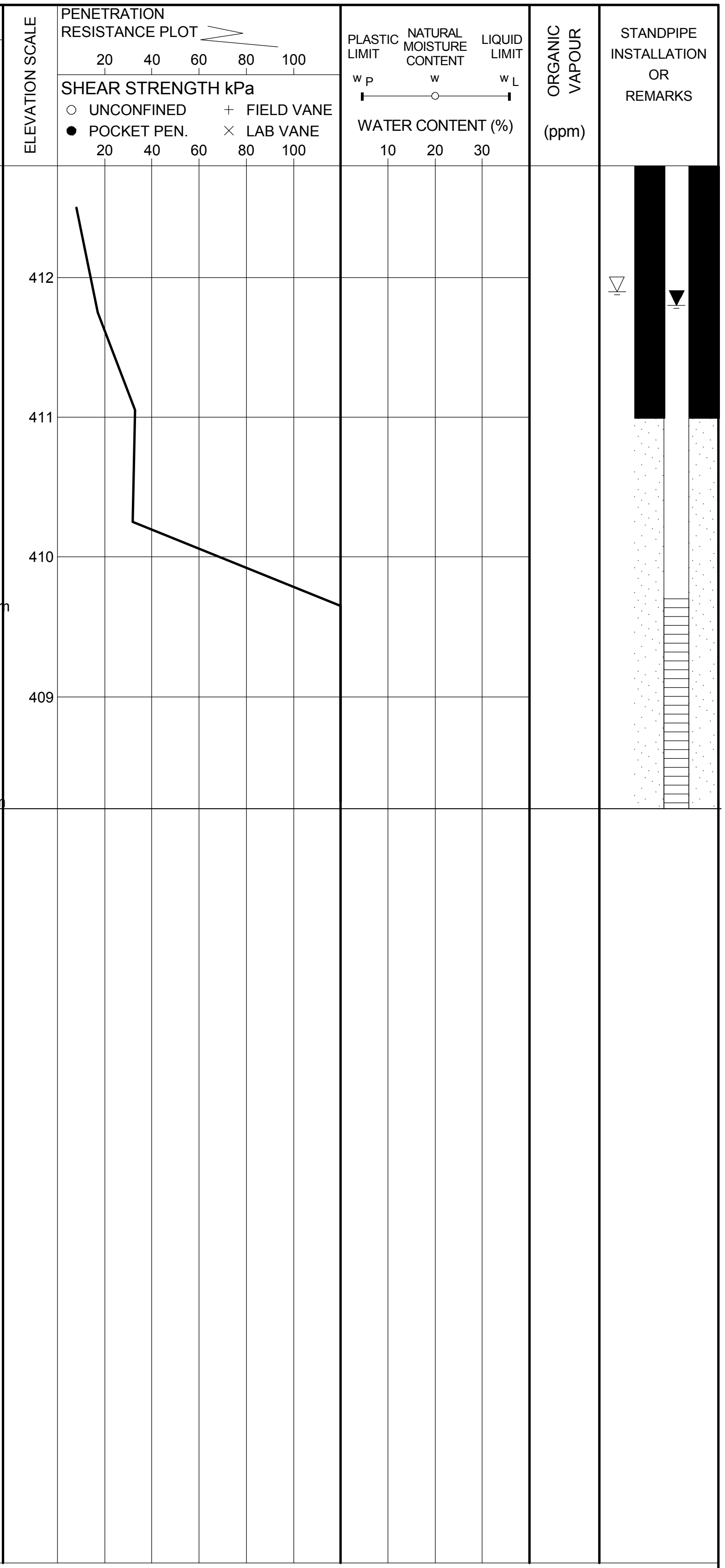
DATE: 17 January 2008

EQUIPMENT: Track-Mount - Solid Stem Augers

ELEVATION DATUM: Geodetic

FILE: 1-07-2438

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
412.8	Ground Surface			
0.0	300mm TOPSOIL			
412.5 0.3	SANDY SILT trace organics, trace clay, loose, brown, moist	1	SS	8
412.1 0.7	SAND - trace to some silt, trace gravel, compact to dense, brown, wet	2	AS	17
		3	SS	33
410.9 1.9	SANDY SILT trace clay, trace gravel, dense to very dense, brown, moist (GLACIAL TILL)	4	SS	32
		5	SS	50/13cm
	----grey			
408.2		6	SS	50/5cm
4.6	End of Borehole			



NOTES:
Borehole was caving at 3.7m and water level at 0.9m upon completion of drilling. Water level in piezometer at 1.0 m on January 28, 2008 and at 1.0m on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 20

PROJECT: Colborne Street & Beatty Line

LOCATION: Fergus, Ontario

CLIENT: Nigus Holdings Inc.

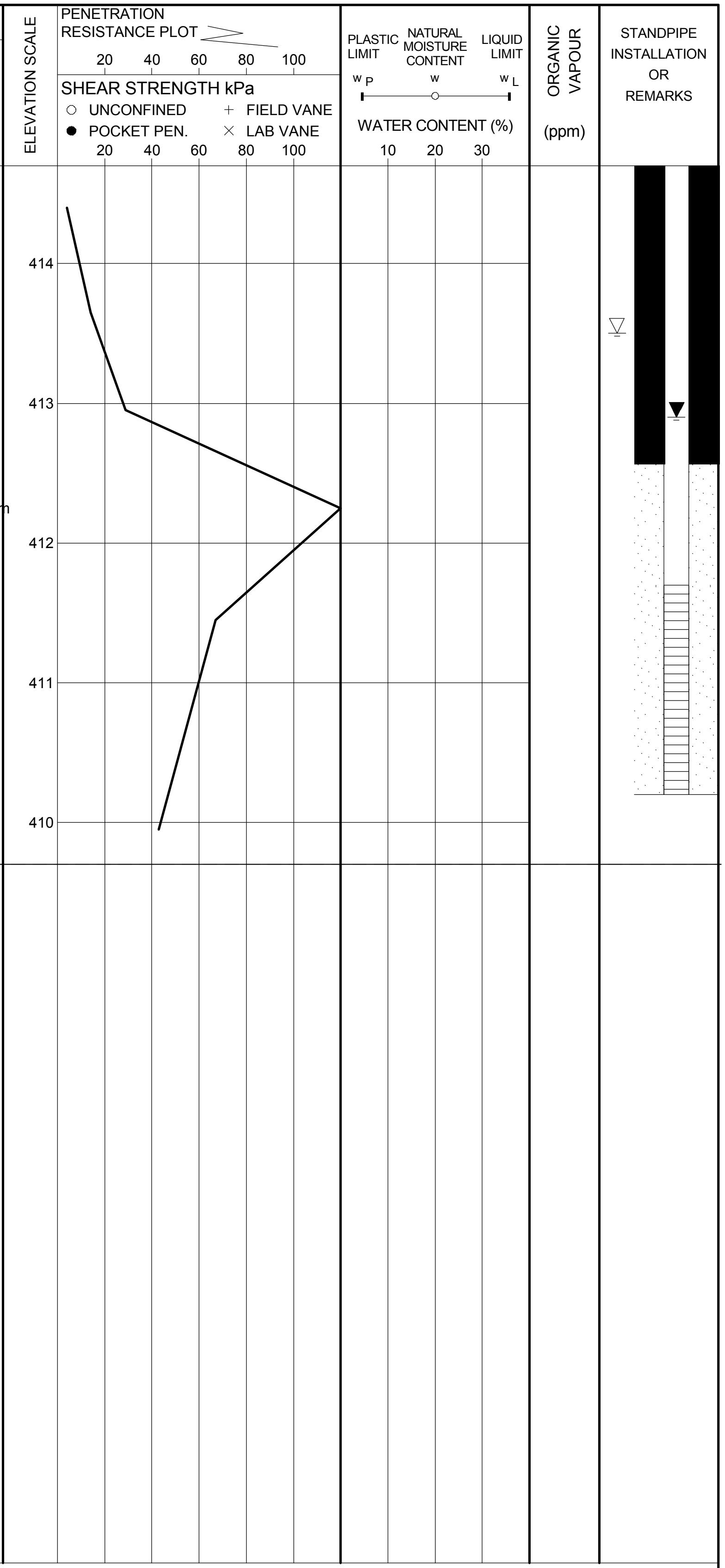
DATE: 17 January 2008

EQUIPMENT: Track-Mount - Solid Stem Augers

ELEVATION DATUM: Geodetic

FILE: 1-07-2438

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
414.7	Ground Surface			
0.0	410mm TOPSOIL	1	SS	4
414.3				
0.4	WEATHERED / DISTURBED			
414.0				
0.7	SANDY SILT trace clay, trace gravel, compact to very dense, brown, wet (GLACIAL TILL) ----moist	2	SS	14
		3	SS	29
		4	SS	50/13cm
412.0				
2.7	CLAYEY SILT some sand, trace gravel, hard, brown, moist (GLACIAL TILL)	5	SS	67
		6	SS	43
409.7				
5.0	End of Borehole			



NOTES:
Borehole was caving at 4.3m and water level at 1.2m upon completion of drilling. Water level in piezometer at 1.0m on January 28, 2008 and at 1.8m on March 28, 2008.

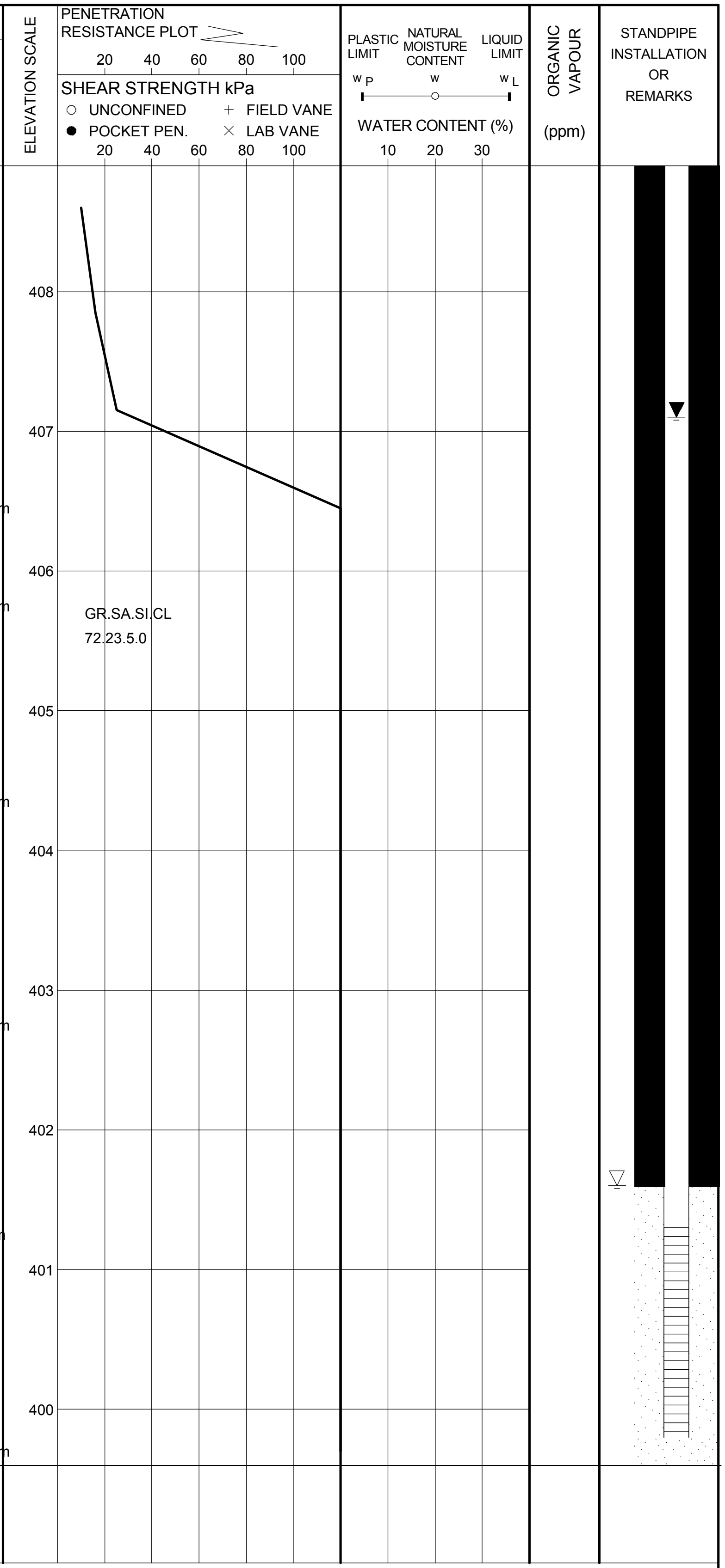
Terraprobe

LOG OF BOREHOLE 12D

PROJECT: Colborne Street & Beatty Line
LOCATION: Fergus, Ontario
CLIENT: Nigus Holdings Inc.

DATE: 16 January 2008
EQUIPMENT: Track-Mount - Solid Stem Augers
ELEVATION DATUM: Geodetic
FILE: 1-07-2438

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
408.9	Ground Surface			
0.0	360mm TOPSOIL	1	SS	10
408.5 0.4	WEATHERED / DISTURBED trace organics			
408.2 0.7	CLAYEY SILT some sand, trace gravel, stiff to very stiff, brown, moist	2	SS	16
		3	SS	25
407.0 1.9	SANDY SILT trace clay, trace gravel, very dense, brown, moist (GLACIAL TILL)	4	SS	50/13cm
		5	SS	50/13cm
	----grey	6	SS	50/10cm
		7	SS	50/10cm
		8	SS	50/8cm
		9	SS	50/15cm
399.6 9.3	End of Borehole			



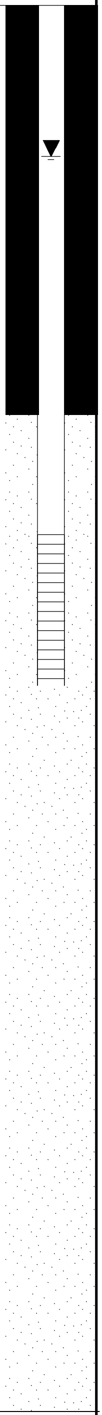
NOTES:
Borehole was caving at 8.8m and water level at 7.3m upon completion of drilling. Water level in piezometer at 3.6m on January 28, 2008, at 1.9m on March 28, 2008 and at 1.8m on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 12S

PROJECT: Colborne Street & Beatty Line
DATE: 16 January 2008
LOCATION: Fergus, Ontario
EQUIPMENT: Track-Mount - Solid Stem Augers
CLIENT: Nigus Holdings Inc.
ELEVATION DATUM: Geodetic
FILE: 1-07-2438

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● POCKET PEN. × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w L / WATER CONTENT (%) 10 20 30	ORGANIC VAPOUR (ppm)	STANDPIPE INSTALLATION OR REMARKS
408.9	Ground Surface									
0.0 408.5	360mm TOPSOIL									
0.4 408.2	WEATHERED / DISTURBED trace organics									
0.7	CLAYEY SILT some sand, trace gravel, stiff to very stiff, brown, moist					408				
407.0 1.9	SANDY SILT trace clay, trace gravel, very dense, brown, moist (GLACIAL TILL) ----grey					407 406 405				
404.4 4.5	End of Borehole					404 403 402 401 400				



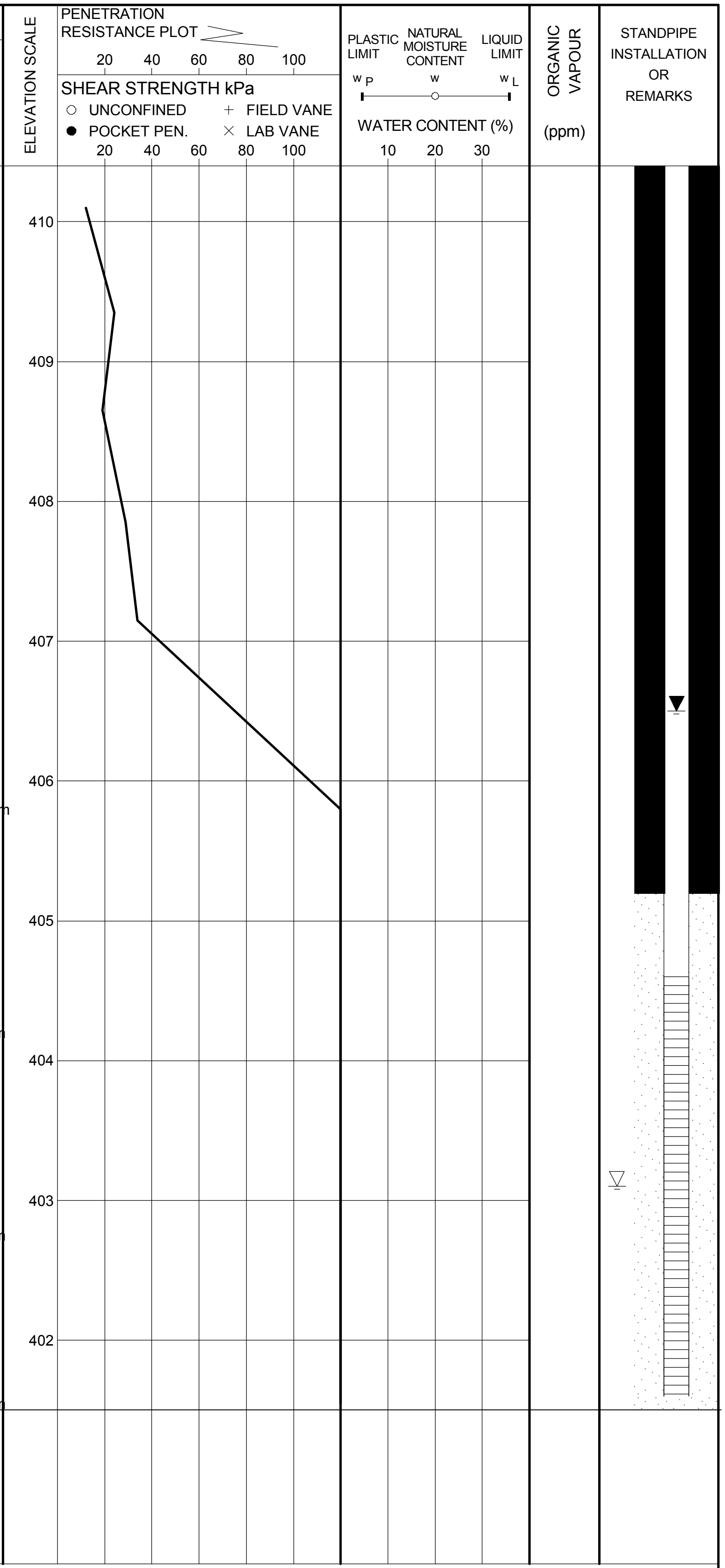
NOTES:
Water level in piezometer at 1.1m on January 28, 2008, at 1.2m on March 28, 2008 and at 1.0m on June 23, 2008.

Terraprobe

LOG OF BOREHOLE 17D

PROJECT: Colborne Street & Beatty Line
LOCATION: Fergus, Ontario
CLIENT: Nigus Holdings Inc.
DATE: 17 January 2008
EQUIPMENT: Track-Mount - Solid Stem Augers
ELEVATION DATUM: Geodetic
FILE: 1-07-2438

SOIL PROFILE		SAMPLES		
ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
410.4	Ground Surface			
0.0	460mm TOPSOIL	1	SS	12
409.9 0.5	SANDY SILT trace clay, trace gravel, compact, brown, moist (GLACIAL TILL)	2	SS	24
409.2 1.2	CLAYEY SILT some sand, trace gravel, stiff to hard, brown, moist (GLACIAL TILL)	3	SS	19
		4	SS	29
	----grey	5	SS	34
406.7 3.8	SANDY SILT trace clay, trace gravel, very dense, grey, moist (GLACIAL TILL)	6	SS	50/15cm
		7	SS	50/5cm
		8	SS	50/8cm
401.5		9	SS	50/5cm
8.9	End of Borehole			



NOTES:
Borehole was caving at 6.7m and water level at 7.3m upon completion of drilling. Water level in piezometer at 3.1m on January 28, 2008, at 3.7m on March 28, 2008 and at 3.9m on June 23, 2008.

Terraprobe

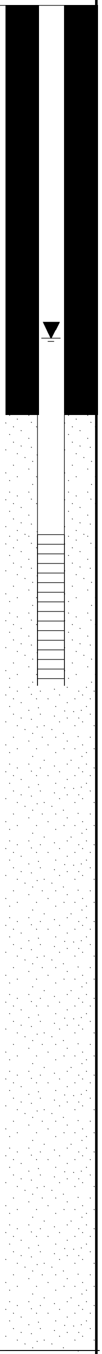
LOG OF BOREHOLE 17S

PROJECT: Colborne Street & Beatty Line
LOCATION: Fergus, Ontario
CLIENT: Nigus Holdings Inc.
DATE: 17 January 2008
EQUIPMENT: Track-Mount - Solid Stem Augers
ELEVATION DATUM: Geodetic
FILE: 1-07-2438

SOIL PROFILE | SAMPLES: NUMBER, TYPE, "N" VALUES | ELEVATION SCALE | PENETRATION RESISTANCE PLOT 20 40 60 80 100 | SHEAR STRENGTH kPa: ○ UNCONFINED, + FIELD VANE, ● POCKET PEN., × LAB VANE, 20 40 60 80 100 | PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 10 20 30 | ORGANIC VAPOUR (ppm) | STANDPIPE INSTALLATION OR REMARKS

ELEV DEPTH	DESCRIPTION
410.4	Ground Surface
0.0 409.9	460mm TOPSOIL
0.5 409.2	SANDY SILT trace clay, trace gravel, compact, brown, moist (GLACIAL TILL)
1.2 406.7	CLAYEY SILT some sand, trace gravel, stiff to hard, brown, moist (GLACIAL TILL) ----grey
3.8 405.9	SANDY SILT trace clay, trace gravel, very dense, grey, moist (GLACIAL TILL)
4.5	End of Borehole

ELEVATION SCALE: 410, 409, 408, 407, 406, 405, 404, 403, 402



NOTES:
Water level in piezometer at 1.9m on January 28, 2008, at 2.1m on March 28, 2008 and at 2.2m on June 23, 2008.

APPENDIX C

TERRAPROBE LIMITED

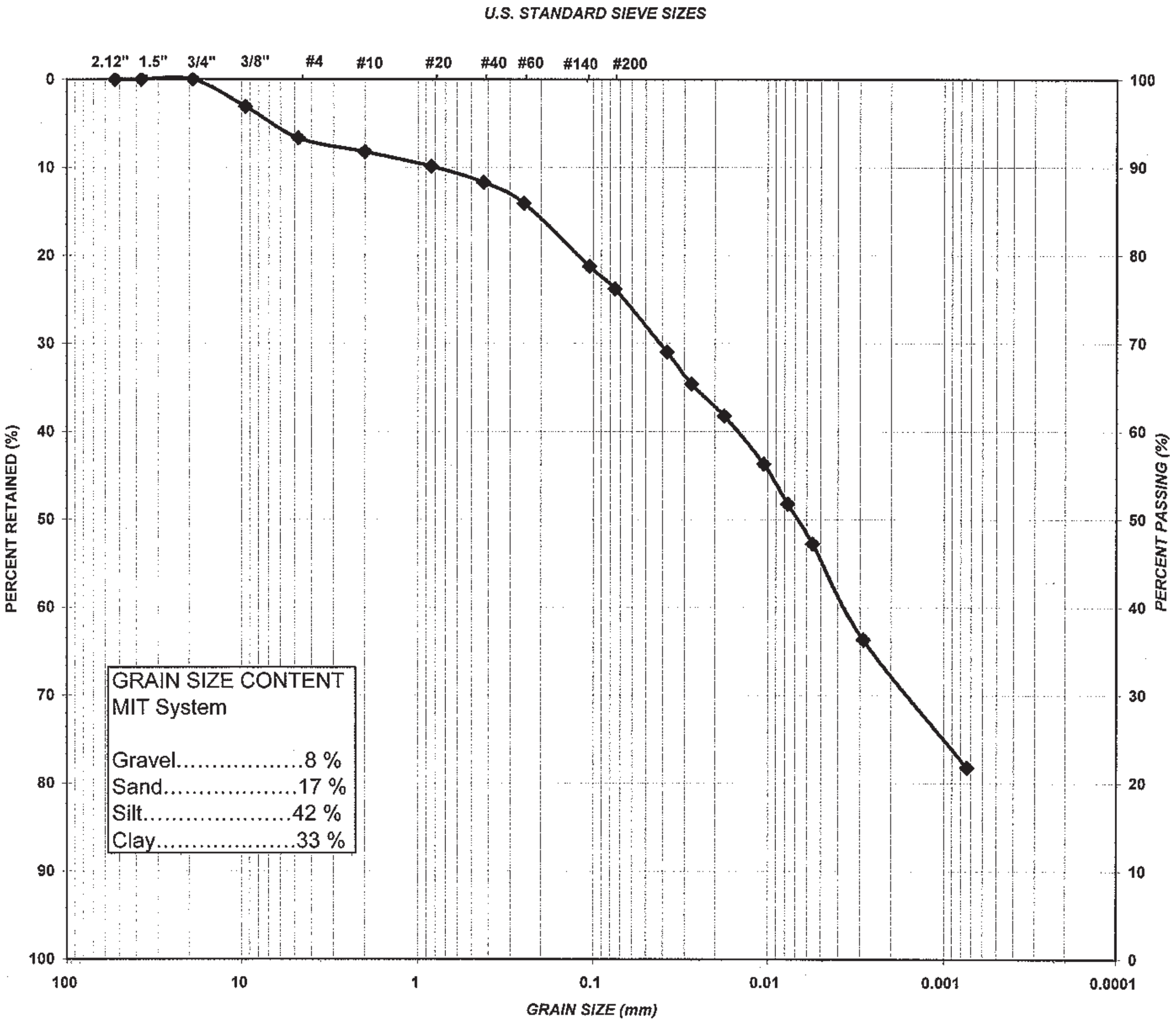
Terraprobe

SIEVE AND HYDROMETER ANALYSIS TEST REPORT

PROJECT: **Nigus Property**
LOCATION: **Fergus, Ontario**
CLIENT: **Nigus Holdings Inc.**
BOREHOLE: **5**
SAMPLE NUMBER: **4**
SAMPLE DEPTH: **2.3 - 2.7 m**
SAMPLE DESCRIPTION: **SILT and CLAY, some sand, trace gravel**

FILE NO.: **1-07-2438**
LAB NO.: **1031A**
SAMPLE DATE: **January 14, 2008**
SAMPLED BY: **L.H.**

GRAIN SIZE DISTRIBUTION



MIT SYSTEM	GRAVEL	SAND			SILT	CLAY
		COARSE	MEDIUM	FINE		

UNIFIED SYSTEM	GRAVEL		SAND			SILT AND CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

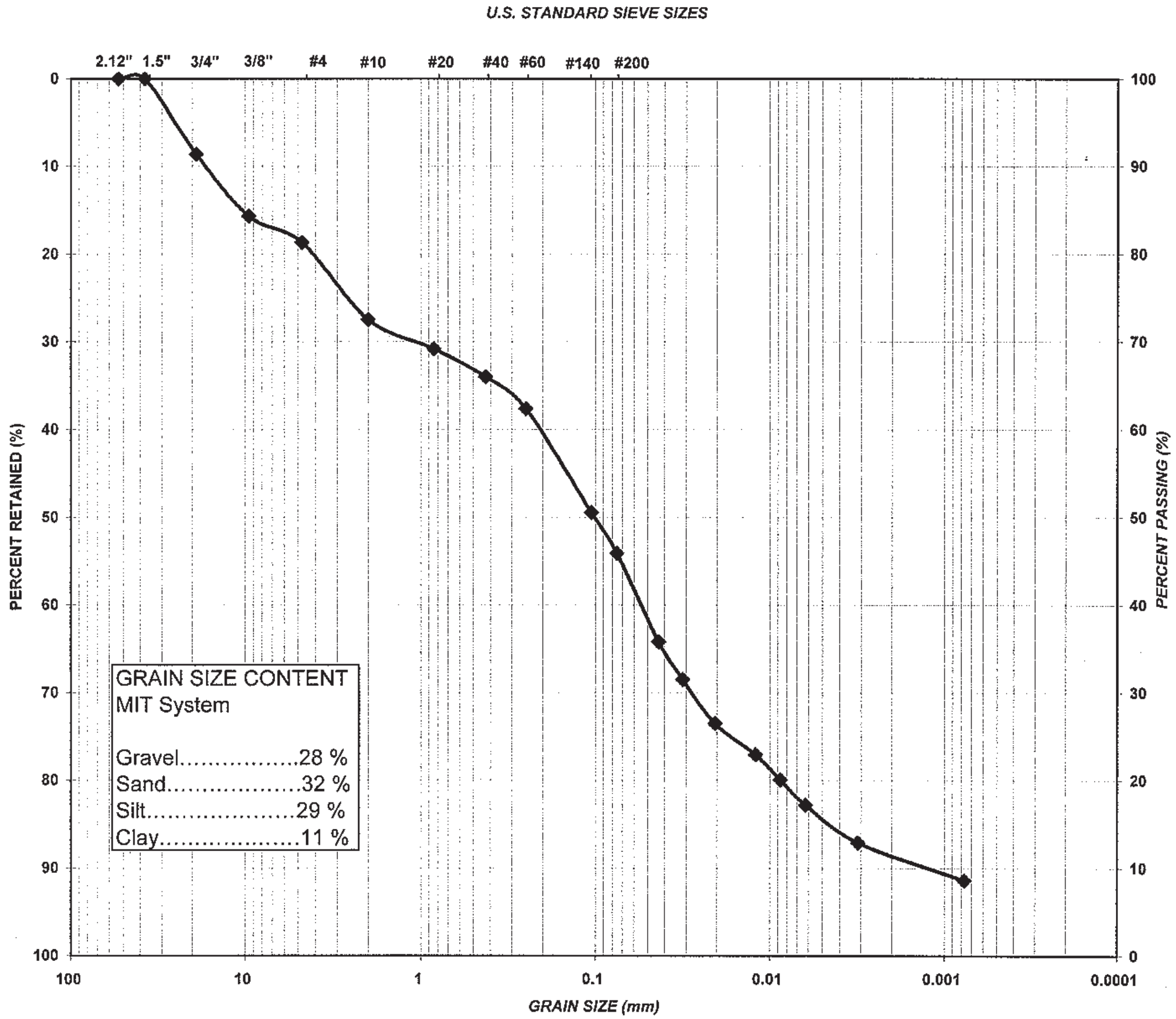
Terraprobe

SIEVE AND HYDROMETER ANALYSIS TEST REPORT

PROJECT: **Nigus Property**
LOCATION: **Fergus, Ontario**
CLIENT: **Nigus Holdings Inc.**
BOREHOLE: **7**
SAMPLE NUMBER: **5**
SAMPLE DEPTH: **3.0 - 3.5 m**
SAMPLE DESCRIPTION: **Silty, Gravelly, SAND, some clay**

FILE NO.: **1-07-2438**
LAB NO.: **1031B**
SAMPLE DATE: **January 14, 2008**
SAMPLED BY: **L.H.**

GRAIN SIZE DISTRIBUTION



		COARSE	MEDIUM	FINE		
MIT SYSTEM	GRAVEL	SAND			SILT	CLAY

	COARSE	FINE	COARSE	MEDIUM	FINE	
UNIFIED SYSTEM	GRAVEL		SAND			SILT AND CLAY

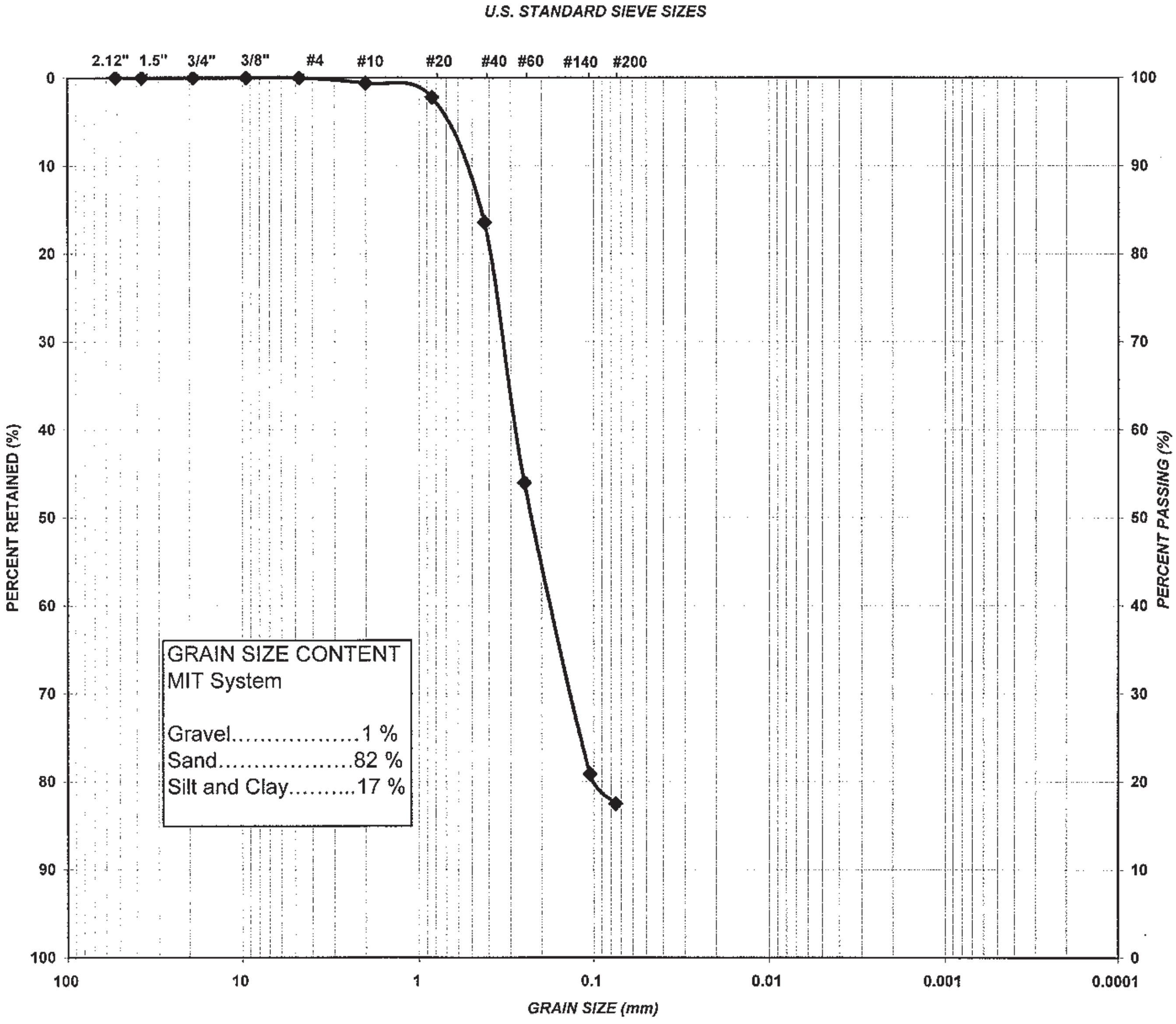
Terraprobe

SIEVE AND HYDROMETER ANALYSIS
TEST REPORT

PROJECT: **Nigus Holding Inc.**
LOCATION: **Fergus, Ontario**
CLIENT: **Nigus Holdings Inc.**
BOREHOLE NUMBER : **8**
SAMPLE NUMBER : **3**
SAMPLE DEPTH: **1.5 - 2.0 m**
SAMPLE DESCRIPTION: **SAND, some silt and clay, trace gravel**

FILE NO.: **1-07-2438**
LAB NO.: **1031C**
SAMPLE DATE: **January 15, 2008**
SAMPLED BY: **L.H.**

GRAIN SIZE DISTRIBUTION



MIT SYSTEM	GRAVEL	SAND			SILT	CLAY
		COARSE	MEDIUM	FINE		

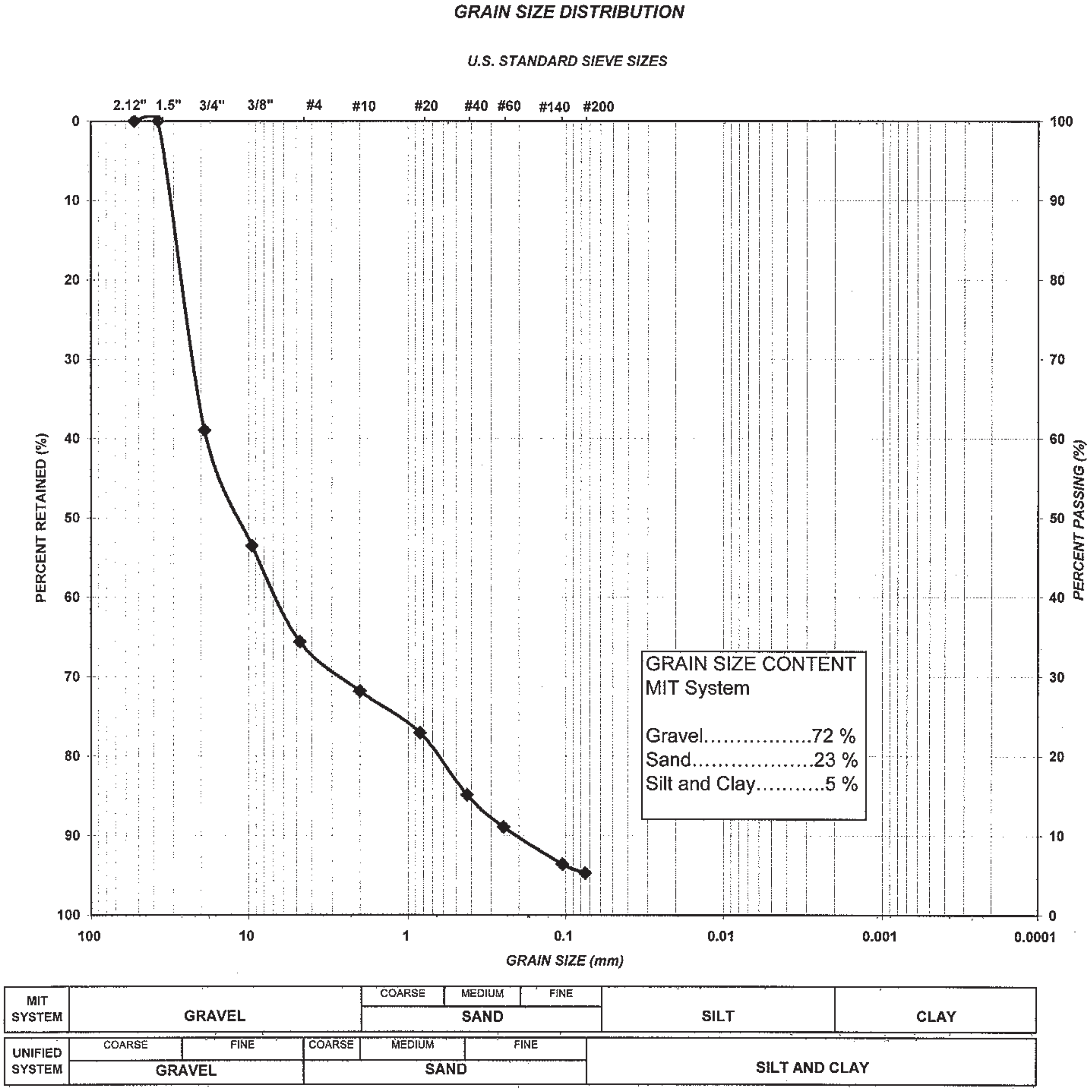
UNIFIED SYSTEM	GRAVEL		SAND			SILT AND CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Terraprobe

SIEVE AND HYDROMETER ANALYSIS
TEST REPORT

PROJECT: **Nigus Holding Inc.**
LOCATION: **Fergus, Ontario**
CLIENT: **Nigus Holdings Inc.**
BOREHOLE NUMBER : **13**
SAMPLE NUMBER : **5**
SAMPLE DEPTH: **3.0 - 3.5 m**
SAMPLE DESCRIPTION: **Sandy GRAVEL, trace silt**

FILE NO.: **1-07-2438**
LAB NO.: **1031D**
SAMPLE DATE: **January 15, 2008**
SAMPLED BY: **L.H.**

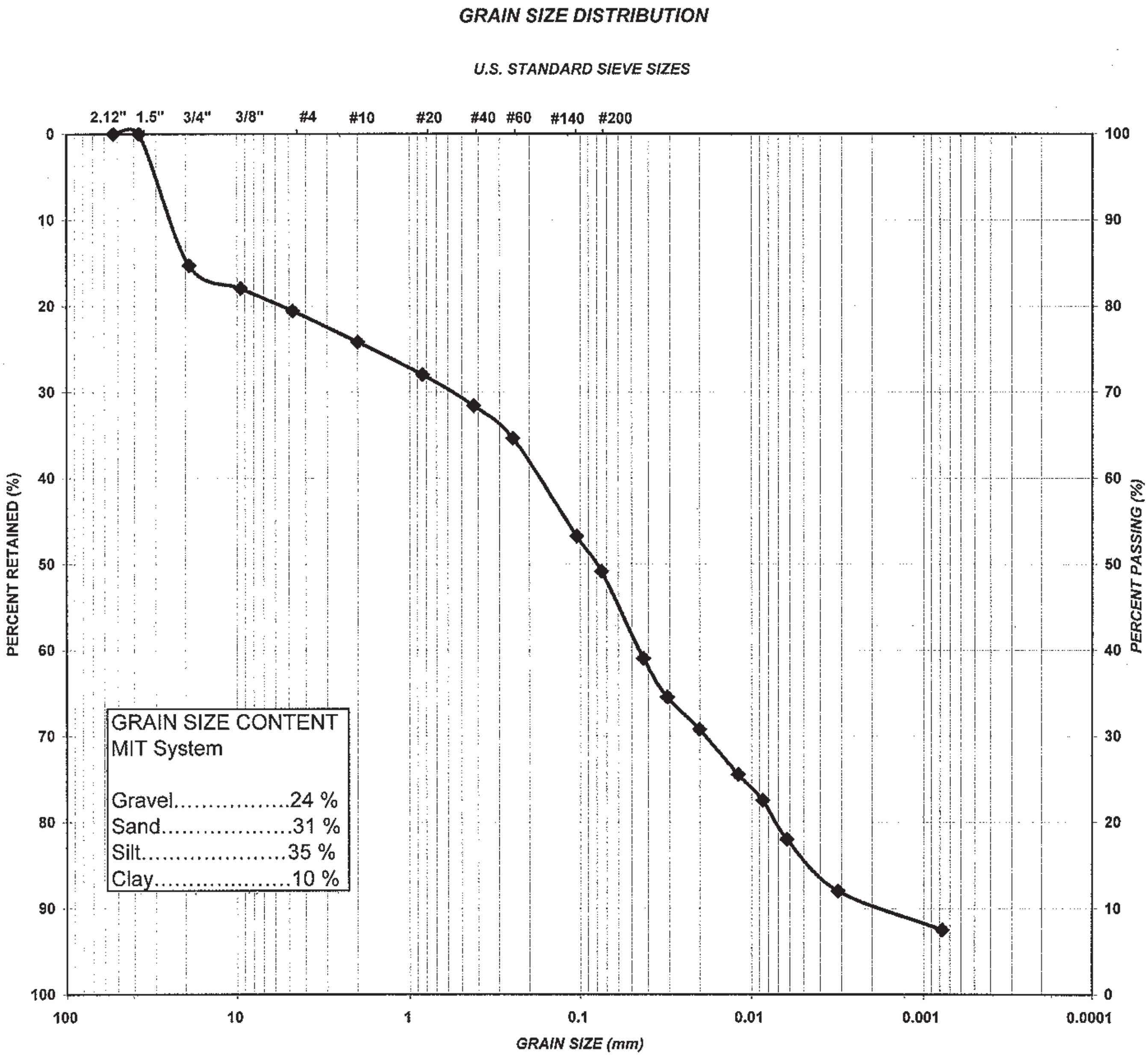


Terraprobe

SIEVE AND HYDROMETER ANALYSIS
TEST REPORT

PROJECT: **Nigus Property**
LOCATION: **Fergus, Ontario**
CLIENT: **Nigus Holdings Inc.**
BOREHOLE: **16**
SAMPLE NUMBER: **3**
SAMPLE DEPTH: **1.5 - 2.0 m**
SAMPLE DESCRIPTION: **Gravelly, Sandy, SILT, some clay**

FILE NO.: **1-07-2438**
LAB NO.: **1031E**
SAMPLE DATE: **January 14, 2008**
SAMPLED BY: **L.H.**



GRAIN SIZE CONTENT
MIT System

Gravel................24 %
Sand..................31 %
Silt....................35 %
Clay...................10 %

MIT SYSTEM		COARSE	MEDIUM	FINE		
	GRAVEL	SAND			SILT	CLAY

UNIFIED SYSTEM	COARSE	FINE	COARSE	MEDIUM	FINE	
	GRAVEL		SAND			SILT AND CLAY

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Appendix B

Sanitary Documents and Calculations

Fergus
Calculation of the Uncommitted Reserve Capacity - Wastewater

Summary of Units

Description	Total Units
Remaining Vacant Single, Semi & Townhouse Lots and Apartment Units By Registered Plan Of Subdivision	340
Remaining Vacant Single, Semi & Townhouse Lots and Apartment Units By Draft Approved Plan Of Subdivision	615
Zoned Multiple Units Outside Draft Plans of Subdivisions & Registered Plans of Subdivisions	55
Zoned Institutional - Allocation for Future Groves Memorial Hospital	153
Allowance for Infill and Redevelopment - residential/non-residential	712
FOR COMMITTED FIRM CAPACITY - Unconnected lots	1,875

URC Wastewater Calculation

Net 3 Yr Average Day	4,336	m^3/d
3 Yr Average Per Day Per Capita	305	litres/d/person

Typical Number of Building Units Constructed Annually	**130.00**

URC Firm Capacity - Available Actual Maximum Day Pumping Capacity

F =	**8,000**	**m^3/day**			
PPU =	**3.08**	**persons/unit**			
Avg. Day Flow /lot =	**0.94**	**m^3/day/unit**			
1	F = Design Capacity (m^3/day)			8,000	m^3/day
	Average Day Flow (3 Yr Average)			4,336	m^3/day
2	Committed Firm Capacity			1,763	m^3/day
				1,875	units
3	**Free Registered Dwelling Unit Capacity** **(Uncommitted Reserve Capacity)**			**1,902**	m^3/day
				2,023	units
4	Capacity Commitment Under Consideration			122	m^3/day
				130	units
5	CAPACITY AVAILABLE			**YES**	
6	Remaining Capacity			**1,780**	m^3/day
				1,893	units

SANITARY SEWER DESIGN SHEET

Preliminary Sewer Sizing
North West Fergus SPA Draft Plan, Township of Centre Wellington

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Project #: [300031145]
Date: 16-Feb-18
Designed: ET
Checked: LN

Min Diameter = 200 mm
Mannings 'n'= 0.013
Min. Velocity = 0.60 m/s
Max. Velocity = 3.00 m/s

Avg. Domestic Flow = 250.0 l/c/d
Infiltration = 0.150 l/s/ha
Max. Peaking Factor = 4.00
Min. Peaking Factor= 2.00

Factor of Safety = 10 %

NOMINAL PIPE SIZE USED

			RESIDENTIAL							COMMERCIAL/INDUSTRIAL/INSTITUTIONAL						FLOW CALCULATIONS							PIPE DATA				
DESCRIPTION	FROM MH	TO MH	AREA (ha)	ACC. AREA (ha)	UNITS (#)	DENISTY (P/ha)	DENSITY (P/unit)	POP	ACCUM. RES. POP.	AREA (ha)	ACC. AREA (ha)	EQUIV. POP. (p/ha)	FLOW RATE (l/s/ha)	EQUIV. POP.	ACCUM. EQUIV. POP.	INFILTRATION (l/s)	TOTAL ACCUM. POP.	PEAKING FACTOR	POP. FLOW (l/s)	CONSTANT COMM. FLOW (l/s)	ACCUM. COMM. FLOW (l/s)	TOTAL FLOW (l/s)	SLOPE (%)	PIPE DIAMETER (mm)	FULL FLOW CAPACITY (l/s)	FULL FLOW VELOCITY (m/s)	PERCENT FULL (%)
AREA TO PUMPSTATION																											
External (Low Density)	EXT1	E2	51.26	51.26		63		3230	3230							7.7	3230	3.41	31.9			39.6	0.50	300	68.4	0.97	58%
External (Medium Density)	EXT2	E2																					0.50	200	23.2	0.74	
External (Com/Inst/Ind)	EXT3	E2																					0.50	200	23.2	0.74	
Low Density	PH2_1	2	30.29	30.29	348		3.08	1072	1072							4.5	1072	3.78	11.7			16.3	0.50	200	23.2	0.74	70%
Medium Density	PH2_2	2			114		2.47	282	282								282	4.00	3.3			3.3	0.50	200	23.2	0.74	14%
Com/Inst/Ind	PH2_3	2								1.53	1.53		0.300			0.2				0.5	0.5	0.7	0.50	200	23.2	0.74	3%
Total Phase 2 Flow	**2**	**E1**		**30.29**					**1354**		**1.53**					**4.8**	**1354**	**3.71**	**14.5**		**0.5**	**19.8**		**200**			
Low Density	PH3_1	3	30.85	30.85	424		3.08	1306	1306							4.6	1306	3.72	14.1			18.7	0.50	200	23.2	0.74	81%
Medium Density	PH3_2	3			88		2.47	218	218								218	4.00	2.5			2.5	0.50	200	23.2	0.74	11%
Com/Inst. Ind	**PH3_3**	**3**																						**200**			
Total Phase 3 Flow	3	E1		30.85					1524							4.6	1524	3.67	16.2			20.8		200			
Total Phase 2 & 3 Flow	E1	E2		61.13					2878		1.53					9.4	2878	3.46	28.8		0.5	38.7	0.50	300	68.4	0.97	57%
Peak Flow into PS	E2	PS		112.39					6108		1.53					17.1	6108	3.16	55.9		0.5	73.5	0.50	375	124.0	1.12	59%
Peak Flow into PS	PS	100		112.39					6108		1.53					17.1	6108	3.16	55.9		0.5	73.5	0.50	375	124.0	1.12	59%
PHASE 1 AREA																											
Low Density	PH1_1	1	15.68	15.68	176		3.08	543	543							2.4	543	3.96	6.2			8.6	0.50	200	23.2	0.74	37%
Medium Density	PH1_2	1			40		2.47	99	99								99	4.00	1.1			1.1	0.50	200	23.2	0.74	5%
Com/Inst/Ind	PH1_3	1								2.70	2.70		0.320			0.4				0.9	0.9	1.3	0.50	200	23.2	0.74	5%
Total Phase 1 Flows	1	100		15.68					642		2.70					2.8	642	3.92	7.3		0.9	10.9	0.50	200	23.2	0.74	47%
	1	INT		15.68					642		2.70					2.8	642	3.92	7.3		0.9	10.9	0.50	200	23.2	0.74	47%
Int. Dev. Area Flow	INT	TotInt		15.68					642		2.70					2.8	642	3.92	7.3		0.9	10.9	0.50	200	23.2	0.74	47%
ALL FLOWS COMBINED	100	Ex		128.07					6750		4.23					19.8	6750	3.12	61.0		1.3	82.1	0.30	375	96.0	0.87	86%

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Appendix C

Storm Sewer Sizing

STORM SEWER DESIGN SHEET: (5 Year Storm)

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FSR
North West Fergus SPA, Township of Centre Wellington

Rainfall Intensity = $\frac{A}{(Tc+B)^c}$ *where Tc is in minutes*

A = 500
B = 0.24 *(5 Yr)*
C = 0.6877

Project #: 300031145
Date: 13-Dec-16
Designed: ET
Checked: LN

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

NOMINAL PIPE SIZE USED

DESCRIPTION	FROM MH	TO MH	AREA (ha)	RUNOFF COEFFICIENT "R"	'AR'	ACCUM. 'AR'	RAINFALL INTENSITY (mm/hr)	FLOW (m3/s)	CONSTANT FLOW (m3/s)	ACCUM. CONSTANT FLOW (m3/s)	TOTAL FLOW (m3/s)	LENGTH (m)	SLOPE (%)	PIPE DIAMETER (mm)	FULL FLOW CAPACITY (m3/s)	FULL FLOW VELOCITY (m/s)	INITIAL Tc (min)	TIME OF CONCENTRATION (min)	ACC. TIME OF CONCENTRATION (min)	PERCENT FULL (%)
Street G/H/A Intersection	1	2	2.35	0.45	1.06	1.06	101.0	0.297			0.297	235.0	0.30	600	0.336	1.19	10.00	3.29	13.29	88%
Street A/M Intersection	2	3	4.44	0.45	2.00	3.06	83.4	0.707			0.707	260.0	0.30	825	0.786	1.47	13.29	2.95	16.24	90%
Street A/M Intersection	4	3	4.17	0.45	1.88	1.88	101.0	0.526			0.526	380.0	0.30	750	0.610	1.38	10.00	4.59	14.59	86%
Street A/H Intersection	3	5	7.31	0.45	3.29	8.22	72.8	1.662			1.662	45.0	0.30	1200	2.135	1.89	16.24	0.40	16.64	78%
Street A/B Intersection	6	5	1.88	0.45	0.85	0.85	101.0	0.237			0.237	160.0	0.30	600	0.336	1.19	10.00	2.24	12.24	71%
Street A/D Intersection	5	7	0.19	0.90	0.17	9.24	71.6	1.838			1.838	132.0	0.30	1200	2.135	1.89	16.64	1.17	17.80	86%
Street A/D Intersection	8	7	1.86	0.45	0.84	0.84	101.0	0.235			0.235	165.0	0.30	600	0.336	1.19	10.00	2.31	12.31	70%
North Pond - West Inlet	7	HW1				10.08	68.4	1.914			1.914	95.0	0.30	1200	2.135	1.89	17.80	0.84	18.64	90%
External Area 1	EXT1	101	8.54	0.53	4.53	4.53	81.5	1.025			1.025									
Farley Road/Street B Intersection	101	102	1.35	0.45	0.61	5.13	101.0	1.440			1.440	200.0	0.90	900	1.717	2.70	10.00	1.23	11.23	84%
Farley Road/Street B Intersection	103	102	2.10	0.45	0.95	0.95	101.0	0.265			0.265	210.0	1.60	450	0.361	2.27	10.00	1.54	11.54	73%
Farley Road/Street D Intersection	102	104	0.32	0.45	0.14	6.22	91.7	1.585			1.585	82.0	0.50	1050	1.931	2.23	11.54	0.61	12.16	82%
Farley Road/Street D Intersection	105	104	1.18	0.45	0.53	0.53	101.0	0.149			0.149	92.0	0.50	450	0.202	1.27	10.00	1.21	11.21	74%
Farley Road/Street A Intersection	104	106	0.31	0.45	0.14	6.89	88.5	1.695			1.695	82.0	1.40	1050	3.231	3.73	12.16	0.37	12.52	52%
Farley Road/Street A Intersection	107	106	1.66	0.45	0.75	0.75	101.0	0.210			0.210	145.0	1.20	450	0.312	1.96	10.00	1.23	11.23	67%
Street A/Street F Intersection	108	109	2.08	0.45	0.94	0.94	101.0	0.263			0.263	155.0	2.00	450	0.403	2.54	10.00	1.02	11.02	65%
Farley Road/Street A Intersection	109	106	2.37	0.52	1.23	2.17	94.6	0.570			0.570	333.0	0.30	825	0.786	1.47	11.02	3.77	14.79	72%
North Pond - East Inlet	106	HW1	1.55	0.45	0.70	10.51	71.1	2.075			2.075	225.0	0.65	1050	2.202	2.54	16.81	1.47	18.28	94%
External Area 2	EXT2	201	1.60	0.43	0.68	0.68	101.0	0.192			0.192									
Street A/H Intersection	201	202	3.25	0.45	1.46	2.15	101.0	0.602			0.602	140.0	0.30	825	0.786	1.47	10.00	1.59	11.59	77%
Street A	202	203	0.51	0.45	0.23	2.38	91.4	0.603			0.603	80.0	0.30	825	0.786	1.47	11.59	0.91	12.49	77%
Street A	204	203	0.63	0.45	0.28	0.28	101.0	0.080			0.080	140.0	0.30	375	0.096	0.87	10.00	2.68	12.68	83%
Pond Easement	203	205	2.58	0.45	1.16	3.82	86.0	0.913			0.913	250.0	0.30	975	1.227	1.64	12.68	2.53	15.22	74%
Pond Easement	205	206	1.34	0.25	0.34	4.15	76.1	0.878			0.878	145.0	0.30	975	1.227	1.64	15.22	1.47	16.69	72%
Pond Easement	206	HW2	3.62	0.55	1.99	6.15	71.5	1.220			1.220	220.0	0.30	1050	1.496	1.73	16.69	2.12	18.81	82%
Colborne/Street S Intersection	1001	1002	3.46	0.59	2.03	2.03	101.0	0.570			0.570	200.0	0.30	825	0.786	1.47	10.00	2.27	12.27	72%
Colborne/Street T Intersection	1002	1003	1.89	0.45	0.85	2.88	88.0	0.704			0.704	85.0	0.30	825	0.786	1.47	12.27	0.96	13.23	90%
Colborne/Street N Intersection	1003	1004	1.49	0.45	0.67	3.55	83.6	0.825			0.825	85.0	0.30	900	0.992	1.56	13.23	0.91	14.14	83%
Colborne/Pond 2	1004	1005	2.34	0.45	1.05	4.61	79.9	1.023			1.023	135.0	0.30	975	1.227	1.64	14.14	1.37	15.51	83%
Colborne/Pond 2	1006	1005	0.48	0.25	0.12	0.12	101.0	0.034			0.034	90.0	0.30	300	0.053	0.75	10.00	2.00	12.00	64%
Pond 2	1005	HW3				4.73	75.1	0.986			0.986	45.0	0.30	975	1.227	1.64	15.51	0.46	15.96	80%
Street N/O Intersection	2001	2002	1.60	0.45	0.72	0.72	101.0	0.202			0.202	220.0	0.30	525	0.236	1.09	10.00	3.37	13.37	86%
Street N/P Intersection	2002	2003	1.83	0.45	0.82	1.54	83.0	0.356			0.356	90.0	0.30	675	0.460	1.29	13.37	1.17	14.54	77%
Street N/Q Intersection	2003	2004	2.25	0.45	1.01	2.56	78.5	0.557			0.557	100.0	0.30	825	0.786	1.47	14.54	1.13	15.67	71%
Farley Road/Street N Intersection	2004	2005	2.24	0.45	1.01	3.56	74.6	0.738			0.738	92.0	0.30	900	0.992	1.56	15.67	0.98	16.65	74%
Street N/R Intersection	2005	2006	4.44	0.45	2.00	5.56	71.6	1.106			1.106	80.0	0.30	900x1800 (BOX)	3.059	1.89	16.65	0.71	17.36	36%
Street N/R Intersection	2007	HW4	2.81	0.45	1.26	1.26	101.0	0.355			0.355	285.0	0.30	675	0.460	1.29	10.00	3.69	13.69	77%
Pond 2	2006	2008	1.02	0.45	0.46	6.02	69.6	1.164			1.164	305.0	0.30	900x1800 (BOX)	3.059	1.89	17.36	2.69	20.05	38%

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Appendix D

Stormwater Management Pond Calculations and Modelling

Appendix D

MODEL SCHEMATICS

PRE-DEVELOPMENT

$\text{N1} = \boxed{101} + \overset{\text{Route Channel}}{\boxed{\text{EX1A}}} + \overset{\text{Route Channel}}{\boxed{\text{EX3A}}}$

$\text{S1} = \boxed{102}$

$\text{S2} = \boxed{103}$

POST DEVELOPMENT

$\text{N.Pond} = \boxed{201} + \overset{\text{Minor}}{\boxed{202}}$

$\text{N1} = \overset{\text{Route Pipe}}{\boxed{\text{EX1A}}} + \boxed{\text{EX2A}} + \boxed{203} + \overset{\text{Major}}{\boxed{202}} + \text{N.Pond Outflow}$

$\text{S.Pond} = \boxed{204}$

$\text{S1} = \boxed{205} + \text{S.Pond Outflow}$

$\text{S2} = \boxed{206}$

MODELLING PARAMETERS

Pre-Development

Catchment	Area	TIMP	XIMP	TP	CN
	(ha)	(%)	(%)	(hr)	-
EX1A	42.09	-	-	0.92	74
EX2A	2.14	-	-	0.32	71
EX3A	11.51	-	-	0.56	71
101	51.10	-	-	0.52	71
102	26.53	-	-	0.71	71
103	7.13	-	-	0.28	71
104	2.92	-	-	0.60	65
105	5.11	-	-	0.41	65

Post Development

Catchment	Area	TIMP	XIMP	TP	CN
	(ha)	(%)	(%)	(hr)	-
EX1A	42.09	-	-	0.92	74
EX2A	2.14	-	-	0.32	71
201	54.56	53.9	29.6	-	71
202	3.86	46.7	28.3	-	71
203	1.06	38.2	19.4	-	71
204	27.40	55.0	29.8	-	71
205	1.34	-	-	0.33	71
206	2.69	55.0	28.0	-	71
207	1.48	-	-	0.41	65

```
2     Metric units
*#*******************************************************************************
*#  Project Name: [SB] Project Number: [300031145]
*#  Date        : 03-23-2017
*#  Modeller    : [JMS/AJC]
*#  Company     : R.J. Burnside & Associates
*#  License #   :  3245976
*#*******************************************************************************
*%
*%
*%
*%-----------------|----------------------------------------------------------|
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[1]
*%                   ["100Year.100"] <--storm filename
*%-----------------|----------------------------------------------------------|
READ STORM          STORM_FILENAME=["STORM.001"]
*%-----------------|----------------------------------------------------------|
*# ******************************************************************
*# North West Fergus Secondary Area (NWFSPA) Pre Development         *

*# ******************************************************************
*Pre-Development flows from the area north of Nichol Drain
*
*Note: For Time-To-Peak calculations refer to Appendix.
*%-----------------|----------------------------------------------------------|
*External area to the north of the NWFSPA (Catchment EX1A).
*The existing land use for this catchment is agricultural. The CN number
*was established based on Soils Mapping (Listowel Loam) at 74.
*This drainage will by-pass the SPA SWM ponds via the N-S realigned ditch.

DESIGN NASHYD       ID=[1], NHYD=["EX1A"], DT=[2]min, AREA=[42.09](ha),
                    DWF=[0](cms), CN/C=[74], TP=[0.92]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*%-----------------|----------------------------------------------------------|
*Routing of EX1A
*This is the routing of the External catchment to the north of the SPA
*through the N-S ditch which would ultimately outlets to the Nichol Drain

ROUTE CHANNEL       IDout=[2], NHYD=["EX1R"], IDin=[1],
                    RDT=[2](min),
                    CHLGTH=[700](m),  CHSLOPE=[0.7](%),
                                        FPSLOPE=[0.7](%),
                    SECNUM=[1.1],       NSEG=[1]
                    ( SEGROUGH, SEGDIST (m))=[0.035,8.2] NSEG times
                    ( DISTANCE (m), ELEVATION (m))=[0,414.2]
                                                  [4.3,412.7]
                                                  [8.2,414.2]
*%-----------------|----------------------------------------------------------|
*Catchment 101
*This catchment is the majority of the NWFSPA NORTH of the Nichol Drain.

DESIGN NASHYD       ID=[3], NHYD=["101"], DT=[5]min, AREA=[51.10](ha),
                    DWF=[0](cms), CN/C=[71], TP=[0.52]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*%-----------------|----------------------------------------------------------|
*Catchment EX3A
*This catchment refers to the Keating lands north-east of SPA.
*These land drain, via drains, to the N-S Ditch that runs through the SPA

DESIGN NASHYD       ID=[4], NHYD=["EX3A"], DT=[5]min, AREA=[11.51](ha),
                    DWF=[0](cms), CN/C=[71], TP=[0.56]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*%-----------------|----------------------------------------------------------|
```

```
*Routing of EX3A
*This is the routing of the Keating property through the N-S Ditch which
*ultimately outlets to the Nichol Drain

ROUTE CHANNEL       IDout=[5], NHYD=["EX3R"], IDin=[4],
                    RDT=[2](min),
                    CHLGTH=[700](m),  CHSLOPE=[0.7](%),
                                        FPSLOPE=[0.7](%),
                    SECNUM=[1.1],       NSEG=[1]
                    ( SEGROUGH, SEGDIST (m))=[0.035,8.2] NSEG times
                    ( DISTANCE (m), ELEVATION (m))=[0,414.2]
                                                   [4.3,412.7]
                                                   [8.2,414.2]
*%-----------------|-----------------------------------------------------------|
*Sum of the pre-development flows from Catchment 101 and EX3A (SWM Pond target
*flow rates)

ADD HYD             IDsum=[6], NHYD=["Nor"], IDs to add=[3,5]
*%-----------------|-----------------------------------------------------------|
*External area to the south of the NWFSPA (Catchment EX2A).
*
*This catchment area drains, via the Beatty Line roadside ditch
*and drains directly to the Nichol Drain

DESIGN NASHYD       ID=[7], NHYD=["EX2A"], DT=[2]min, AREA=[2.14](ha),
                    DWF=[0](cms), CN/C=[71], TP=[.32]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*%-----------------|-----------------------------------------------------------|
*Total Flows (including external flows) draining to Node N1
ADD HYD             IDsum=[8], NHYD=["N1"], IDs to add=[2,6,7]
*%-----------------|-----------------------------------------------------------|
*
*Catchment 104
*This catchment is a small portion of land draining to a ditch along the west
*SPA boundary area (north of the woodlot), which drains through the Woodlot
*to the Nichol Drain.

DESIGN NASHYD       ID=[3], NHYD=["104"], DT=[2]min, AREA=[2.92](ha),
                    DWF=[0](cms), CN/C=[65], TP=[0.6]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*%-----------------|-----------------------------------------------------------|
*Catchment 105
*
*This catchment refers to the Woodlot, which drains to the Nichol Drain.

DESIGN NASHYD       ID=[4], NHYD=["105"], DT=[2]min, AREA=[5.11](ha),
                    DWF=[0](cms), CN/C=[65], TP=[.41]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*%-----------------|-----------------------------------------------------------|
*Adding pre-development flows from Catchment 104 and 105 to Total Flows
*
ADD HYD             IDsum=[5], NHYD=["N2"], IDs to add=[3,4,8]
*%-----------------|-----------------------------------------------------------|
*Pre-Development flows from the area south of Nichol Drain
*
*Catchment 102
*Total area south of the Nichol Drain sheet flowing to the Nicol Drain.
*This is the peak release rate for the south area for the storm event.
*This corresonds to Node S1
*%-----------------|-----------------------------------------------------------|

DESIGN NASHYD       ID=[1], NHYD=["102"], DT=[5]min, AREA=[26.53](ha),
                    DWF=[0](cms), CN/C=[71], TP=[0.71]hrs,
```

```
                    RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*%-----------------|-----------------------------------------------------------|
*Remaining Catchments Draining to the Nichol Drain
*
*Catchment 103
*This peak flows corresonpond to the Pre-Development flows that are leaving
*the SPA flowing in a southerly direction via the 400mm culvert at Colborne St.
*******
* FLOW FROM THIS CATCHMENT IS Node S2
*******

DESIGN NASHYD       ID=[9], NHYD=["103S2"], DT=[1]min, AREA=[7.13](ha),
                    DWF=[0](cms), CN/C=[71], TP=[0.28]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*%-----------------|-----------------------------------------------------------|

*All Flows (including external flows) leaving the NWFSPA
*(corresponds to Node ND)
ADD HYD             IDsum=[9], NHYD=["ND"], IDs to add=[1,5]
*%-----------------|-----------------------------------------------------------|
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[2]
*%                   ["50Year.050"] <--storm filename
*%-----------------|-----------------------------------------------------------|
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[3]
*%                   ["25Year.025"] <--storm filename
*%-----------------|-----------------------------------------------------------|
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[4]
*%                   ["10Year.010"] <--storm filename
*%-----------------|-----------------------------------------------------------|
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[5]
*%                   ["5Year.005"] <--storm filename
*%-----------------|-----------------------------------------------------------|
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[6]
*%                   ["2Year.002"] <--storm filename
*%-----------------|-----------------------------------------------------------|
FINISH
```

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

   SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO       999   999   =========
   S      W W W  MM MM  H   H   Y Y   MM MM  O   O     9   9 9   9
   SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ## 9   9 9   9   Ver  4.05
       S   W W   M   M  H   H    Y    M   M  O   O      9999  9999   Sept 2011
   SSSSS   W W   M   M  H   H    Y    M   M   OOO          9     9   =========
                                                       9   9 9   9   # 3877524
        StormWater Management HYdrologic Model          999   999    =========

 ********************************************************************************
 ***************************** SWMHYMO Ver/4.05  ******************************
 *********  A single event and continuous hydrologic simulation model  *********
 *********     based on the principles of HYMO and its successors     *********
 *********                OTTHYMO-83 and OTTHYMO-89.                  *********
 ********************************************************************************
 ********* Distributed by:  J.F. Sabourin and Associates Inc.          *********
 *********                  Ottawa,  Ontario: (613) 836-3884          *********
 *********                  Gatineau, Quebec: (819) 243-6858          *********
 *********                  E-Mail: swmhymo@jfsa.Com                  *********
 ********************************************************************************

 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++++ Licensed user: R.J. Burnside & Associates Ltd              +++++++++
 +++++++++                Brampton              SERIAL#:3877524        +++++++++
 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 ********************************************************************************
 *********            ++++++ PROGRAM ARRAY DIMENSIONS ++++++          *********
 *********            Maximum value for ID numbers  :     10          *********
 *********            Max. number of rainfall points: 105408          *********
 *********            Max. number of flow points    : 105408          *********
 ********************************************************************************

 ***** DESCRIPTION SUMMARY TABLE HEADERS (units depend on METOUT in START) *****
 *****-----------------------------------------------------------------------*****
 *****    ID:  Hydrograph IDentification numbers, (1-10).                    *****
 *****  NHYD:  Hydrograph reference numbers, (6 digits or characters).       *****
 *****  AREA:  Drainage area associated with hydrograph, (ac.) or (ha.).     *****
 ***** QPEAK:  Peak flow of simulated hydrograph, (ft^3/s) or (m^3/s).       *****
 ***** TpeakDate_hh:mm is the date and time of the peak flow.                *****
 *****  R.V.:  Runoff Volume of simulated hydrograph, (in) or (mm).          *****
 *****  R.C.:  Runoff Coefficient of simulated hydrograph, (ratio).          *****
 *****     *:  see WARNING or NOTE message printed at end of run.            *****
 *****    **:  see  ERROR  message printed at end of run.                    *****
 ********************************************************************************
 ********************************************************************************

:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

 ********************************************************************************

 ***********************   S U M M A R Y   O U T P U T   ***********************
 ********************************************************************************
 *         DATE: 2017-07-17     TIME: 10:17:40     RUN COUNTER: 000353          *
 ********************************************************************************
 * Input   filename: C:\Users\hknill\Desktop\Projects\170714~1\PRE2016.DAT     *
 * Output  filename: C:\Users\hknill\Desktop\Projects\170714~1\PRE2016.out     *
 * Summary filename: C:\Users\hknill\Desktop\Projects\170714~1\PRE2016.sum     *
 * User comments:                                                              *
 * 1:__________________________________________________________________________*
 * 2:__________________________________________________________________________*
 * 3:__________________________________________________________________________*
```

```
 ***********************************************************************************


#*********************************************************************************
#  Project Name: [SB] Project Number: [300031145]
#  Date         : 03-23-2017
#  Modeller     : [JMS/AJC]
#  Company      : R.J. Burnside & Associates
#  License #    :  3245976
#*********************************************************************************
 RUN:COMMAND#

001:0001------------------------------------------------------------------------
     START
      [TZERO =    .00 hrs on        0]
      [METOUT=   2    (1=imperial, 2=metric output)]
      [NSTORM=   1 ]
      [NRUN  =   1 ]

001:0002------------------------------------------------------------------------
     READ STORM
      Filename = STORM.001
      Comment  =
      [SDT= 5.00:SDUR=   4.00:PTOT=  99.17]
# *********************************************************************
# North West Fergus Secondary Area (NWFSPA) Pre Development         *
# *********************************************************************

001:0003---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:EX1A          42.09    2.546 No_date    2:35   51.04 .515
      [CN= 74.0: N= 3.00]
      [Tp=  .92:DT= 2.50]

001:0004---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE CHANNEL   -> 01:EX1A          42.09    2.546 No_date    2:35   51.04  n/a
      [RDT= 2.50] out<- 02:EX1R          42.09    2.514 No_date    2:42   51.04  n/a
      [L/S/n=  700./ .700/.035]
      {Vmax= 1.292:Dmax=  .847}

001:0005---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      03:101           51.10    4.121 No_date    2:00   47.36 .478
      [CN= 71.0: N= 3.00]
      [Tp=  .52:DT= 5.00]

001:0006---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      04:EX3A          11.51     .890 No_date    2:05   47.36 .478
      [CN= 71.0: N= 3.00]
      [Tp=  .56:DT= 5.00]

001:0007---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE CHANNEL   -> 04:EX3A          11.51     .890 No_date    2:05   47.36  n/a
      [RDT= 1.67] out<- 05:EX3R          11.51     .844 No_date    2:16   47.36  n/a
      [L/S/n=  700./ .700/.035]
      {Vmax=  .991:Dmax=  .570}

001:0008---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:101           51.10    4.121 No_date    2:00   47.36  n/a
                     +  05:EX3R          11.51     .844 No_date    2:16   47.36  n/a
      [DT= 1.67]  SUM=  06:Nor           62.61    4.915 No_date    2:04   47.36  n/a

001:0009---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      07:EX2A           2.14     .226 No_date    1:47   47.36 .478
      [CN= 71.0: N= 3.00]
```

```
      [Tp=  .32:DT= 2.50]

001:0010---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:EX1R            42.09    2.514 No_date    2:42   51.04  n/a
                     +  06:Nor             62.61    4.915 No_date    2:04   47.36  n/a
                     +  07:EX2A             2.14     .226 No_date    1:47   47.36  n/a
      [DT= 1.67]  SUM=  08:N1             106.84    6.985 No_date    2:15   48.81  n/a

001:0011---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      03:104              2.92     .184 No_date    2:10   40.69 .410
      [CN= 65.0: N= 3.00]
      [Tp=  .60:DT= 2.50]

001:0012---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      04:105              5.11     .401 No_date    1:55   40.69 .410
      [CN= 65.0: N= 3.00]
      [Tp=  .41:DT= 2.50]

001:0013---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:104              2.92     .184 No_date    2:10   40.69  n/a
                     +  04:105              5.11     .401 No_date    1:55   40.69  n/a
                     +  08:N1             106.84    6.985 No_date    2:15   48.81  n/a
      [DT= 1.67]  SUM=  05:N2             114.87    7.507 No_date    2:11   48.24  n/a

001:0014---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:102             26.53    1.762 No_date    2:15   47.36 .478
      [CN= 71.0: N= 3.00]
      [Tp=  .71:DT= 5.00]

001:0015---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:103S2            7.13     .804 No_date    1:45   47.36 .478
      [CN= 71.0: N= 3.00]
      [Tp=  .28:DT= 1.00]

001:0016---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            01:102             26.53    1.762 No_date    2:15   47.36  n/a
                     +  05:N2             114.87    7.507 No_date    2:11   48.24  n/a
      [DT= 1.67]  SUM=  09:ND             141.40    9.265 No_date    2:15   48.08  n/a
  ** END OF RUN :   1

*******************************************************************************




 RUN:COMMAND#

002:0001-----------------------------------------------------------------------------
     START
      [TZERO =    .00 hrs on        0]
      [METOUT=   2    (1=imperial, 2=metric output)]
      [NSTORM=   1 ]
      [NRUN  =   2 ]
#******************************************************************************
#  Project Name: [SB] Project Number: [300031145]
#  Date        : 03-23-2017
#  Modeller    : [JMS/AJC]
#  Company     : R.J. Burnside & Associates
#  License #   :  3245976
#******************************************************************************

002:0002-----------------------------------------------------------------------------
```

```
     READ STORM
      Filename = STORM.001
      Comment  =
      [SDT= 5.00:SDUR=   4.00:PTOT=  88.24]
# ********************************************************************
# North West Fergus Secondary Area (NWFSPA) Pre Development         *
# ********************************************************************

002:0003---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:EX1A          42.09    2.119 No_date    2:35   42.75 .484
      [CN= 74.0: N= 3.00]
      [Tp=  .92:DT= 2.50]

002:0004---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE CHANNEL   -> 01:EX1A          42.09    2.119 No_date    2:35   42.75  n/a
      [RDT= 2.50] out<- 02:EX1R          42.09    2.091 No_date    2:42   42.75  n/a
      [L/S/n=  700./ .700/.035]
      {Vmax= 1.236:Dmax=  .792}

002:0005---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      03:101           51.10    3.420 No_date    2:00   39.50 .448
      [CN= 71.0: N= 3.00]
      [Tp=  .52:DT= 5.00]

002:0006---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      04:EX3A          11.51     .738 No_date    2:05   39.50 .448
      [CN= 71.0: N= 3.00]
      [Tp=  .56:DT= 5.00]

002:0007---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE CHANNEL   -> 04:EX3A          11.51     .738 No_date    2:05   39.50  n/a
      [RDT= 1.67] out<- 05:EX3R          11.51     .696 No_date    2:16   39.50  n/a
      [L/S/n=  700./ .700/.035]
      {Vmax=  .945:Dmax=  .531}

002:0008---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:101           51.10    3.420 No_date    2:00   39.50  n/a
                     +  05:EX3R          11.51     .696 No_date    2:16   39.50  n/a
      [DT= 1.67]  SUM=  06:Nor           62.61    4.069 No_date    2:04   39.50  n/a

002:0009---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      07:EX2A           2.14     .188 No_date    1:47   39.50 .448
      [CN= 71.0: N= 3.00]
      [Tp=  .32:DT= 2.50]

002:0010---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:EX1R          42.09    2.091 No_date    2:42   42.75  n/a
                     +  06:Nor           62.61    4.069 No_date    2:04   39.50  n/a
                     +  07:EX2A           2.14     .188 No_date    1:47   39.50  n/a
      [DT= 1.67]  SUM=  08:N1           106.84    5.777 No_date    2:15   40.78  n/a

002:0011---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      03:104            2.92     .151 No_date    2:10   33.66 .381
      [CN= 65.0: N= 3.00]
      [Tp=  .60:DT= 2.50]

002:0012---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      04:105            5.11     .331 No_date    1:55   33.66 .381
      [CN= 65.0: N= 3.00]
      [Tp=  .41:DT= 2.50]

002:0013---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:104            2.92     .151 No_date    2:10   33.66  n/a
```

```
                 +  04:105             5.11     .331 No_date    1:55   33.66  n/a
                 +  08:N1            106.84    5.777 No_date    2:15   40.78  n/a
      [DT= 1.67]  SUM=  05:N2            114.87    6.206 No_date    2:13   40.28  n/a

002:0014---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:102            26.53    1.461 No_date    2:15   39.50 .448
      [CN= 71.0: N= 3.00]
      [Tp=  .71:DT= 5.00]

002:0015---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:103S2           7.13     .671 No_date    1:44   39.50 .448
      [CN= 71.0: N= 3.00]
      [Tp=  .28:DT= 1.00]

002:0016---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            01:102            26.53    1.461 No_date    2:15   39.50  n/a
                 +  05:N2            114.87    6.206 No_date    2:13   40.28  n/a
      [DT= 1.67]  SUM=  09:ND            141.40    7.663 No_date    2:15   40.13  n/a
  ** END OF RUN :   2

*******************************************************************************




 RUN:COMMAND#

003:0001------------------------------------------------------------------------
     START
      [TZERO =    .00 hrs on        0]
      [METOUT=   2    (1=imperial, 2=metric output)]
      [NSTORM=   1 ]
      [NRUN  =   3 ]
#******************************************************************************
#  Project Name: [SB] Project Number: [300031145]
#  Date        : 03-23-2017
#  Modeller    : [JMS/AJC]
#  Company     : R.J. Burnside & Associates
#  License #   :  3245976
#******************************************************************************

003:0002------------------------------------------------------------------------
     READ STORM
      Filename = STORM.001
      Comment  =
      [SDT= 5.00:SDUR=   4.00:PTOT=  77.92]
# *********************************************************************
# North West Fergus Secondary Area (NWFSPA) Pre Development          *
# *********************************************************************

003:0003---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:EX1A           42.09    1.713 No_date    2:35   35.25 .452
      [CN= 74.0: N= 3.00]
      [Tp=  .92:DT= 2.50]

003:0004---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE CHANNEL   -> 01:EX1A           42.09    1.713 No_date    2:35   35.25  n/a
      [RDT= 2.50] out<- 02:EX1R           42.09    1.687 No_date    2:42   35.25  n/a
      [L/S/n=  700./ .700/.035]
      {Vmax= 1.169:Dmax=  .730}

003:0005---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
```

```
     DESIGN NASHYD      03:101          51.10    2.752 No_date    2:00   32.41 .416
      [CN= 71.0: N= 3.00]
      [Tp=  .52:DT= 5.00]

003:0006---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      04:EX3A         11.51     .593 No_date    2:05   32.41 .416
      [CN= 71.0: N= 3.00]
      [Tp=  .56:DT= 5.00]

003:0007---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE CHANNEL   -> 04:EX3A         11.51     .593 No_date    2:05   32.41  n/a
      [RDT= 1.67] out<- 05:EX3R         11.51     .557 No_date    2:16   32.41  n/a
      [L/S/n=  700./ .700/.035]
      {Vmax=  .895:Dmax=  .490}

003:0008---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:101          51.10    2.752 No_date    2:00   32.41  n/a
                     +  05:EX3R         11.51     .557 No_date    2:16   32.41  n/a
      [DT= 1.67]  SUM=  06:Nor          62.61    3.265 No_date    2:04   32.41  n/a

003:0009---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      07:EX2A          2.14     .152 No_date    1:47   32.41 .416
      [CN= 71.0: N= 3.00]
      [Tp=  .32:DT= 2.50]

003:0010---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:EX1R         42.09    1.687 No_date    2:42   35.25  n/a
                     +  06:Nor          62.61    3.265 No_date    2:04   32.41  n/a
                     +  07:EX2A          2.14     .152 No_date    1:47   32.41  n/a
      [DT= 1.67]  SUM=  08:N1          106.84    4.631 No_date    2:15   33.53  n/a

003:0011---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      03:104           2.92     .120 No_date    2:10   27.39 .352
      [CN= 65.0: N= 3.00]
      [Tp=  .60:DT= 2.50]

003:0012---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      04:105           5.11     .264 No_date    1:55   27.39 .352
      [CN= 65.0: N= 3.00]
      [Tp=  .41:DT= 2.50]

003:0013---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:104           2.92     .120 No_date    2:10   27.39  n/a
                     +  04:105           5.11     .264 No_date    1:55   27.39  n/a
                     +  08:N1          106.84    4.631 No_date    2:15   33.53  n/a
      [DT= 1.67]  SUM=  05:N2          114.87    4.970 No_date    2:13   33.10  n/a

003:0014---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:102          26.53    1.174 No_date    2:15   32.41 .416
      [CN= 71.0: N= 3.00]
      [Tp=  .71:DT= 5.00]

003:0015---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:103S2         7.13     .543 No_date    1:44   32.41 .416
      [CN= 71.0: N= 3.00]
      [Tp=  .28:DT= 1.00]

003:0016---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            01:102          26.53    1.174 No_date    2:15   32.41  n/a
                     +  05:N2          114.87    4.970 No_date    2:13   33.10  n/a
      [DT= 1.67]  SUM=  09:ND          141.40    6.142 No_date    2:15   32.97  n/a
  ** END OF RUN :   3
```

```
********************************************************************************



 RUN:COMMAND#

004:0001-----------------------------------------------------------------------------
     START
      [TZERO =    .00 hrs on        0]
      [METOUT=   2    (1=imperial, 2=metric output)]
      [NSTORM=   1 ]
      [NRUN  =   4 ]
#*******************************************************************************
#  Project Name: [SB] Project Number: [300031145]
#  Date        : 03-23-2017
#  Modeller    : [JMS/AJC]
#  Company     : R.J. Burnside & Associates
#  License #   :  3245976
#*******************************************************************************

004:0002-----------------------------------------------------------------------------
     READ STORM
      Filename = STORM.001
      Comment  =
      [SDT= 5.00:SDUR=   4.00:PTOT=  63.67]
# *********************************************************************
# North West Fergus Secondary Area (NWFSPA) Pre Development         *
# *********************************************************************

004:0003---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:EX1A           42.09    1.217 No_date    2:35   25.52 .401
      [CN= 74.0: N= 3.00]
      [Tp=  .92:DT= 2.50]

004:0004---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE CHANNEL   -> 01:EX1A           42.09    1.217 No_date    2:35   25.52  n/a
      [RDT= 2.50] out<- 02:EX1R           42.09    1.196 No_date    2:45   25.52  n/a
      [L/S/n=  700./ .700/.035]
      {Vmax= 1.074:Dmax=  .642}

004:0005---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      03:101            51.10    1.944 No_date    2:00   23.29 .366
      [CN= 71.0: N= 3.00]
      [Tp=  .52:DT= 5.00]

004:0006---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      04:EX3A           11.51     .418 No_date    2:05   23.29 .366
      [CN= 71.0: N= 3.00]
      [Tp=  .56:DT= 5.00]

004:0007---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE CHANNEL   -> 04:EX3A           11.51     .418 No_date    2:05   23.29  n/a
      [RDT= 1.67] out<- 05:EX3R           11.51     .387 No_date    2:18   23.29  n/a
      [L/S/n=  700./ .700/.035]
      {Vmax=  .817:Dmax=  .428}

004:0008---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:101            51.10    1.944 No_date    2:00   23.29  n/a
                     +  05:EX3R           11.51     .387 No_date    2:18   23.29  n/a
      [DT= 1.67]  SUM=  06:Nor            62.61    2.294 No_date    2:04   23.29  n/a
```

```
004:0009---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      07:EX2A           2.14     .108 No_date    1:45   23.29 .366
      [CN= 71.0: N= 3.00]
      [Tp=  .32:DT= 2.50]

004:0010---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:EX1R          42.09    1.196 No_date    2:45   25.52  n/a
                     +  06:Nor           62.61    2.294 No_date    2:04   23.29  n/a
                     +  07:EX2A           2.14     .108 No_date    1:45   23.29  n/a
      [DT= 1.67]  SUM=  08:N1           106.84    3.246 No_date    2:15   24.17  n/a

004:0011---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      03:104            2.92     .084 No_date    2:10   19.43 .305
      [CN= 65.0: N= 3.00]
      [Tp=  .60:DT= 2.50]

004:0012---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      04:105            5.11     .184 No_date    1:55   19.43 .305
      [CN= 65.0: N= 3.00]
      [Tp=  .41:DT= 2.50]

004:0013---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:104            2.92     .084 No_date    2:10   19.43  n/a
                     +  04:105            5.11     .184 No_date    1:55   19.43  n/a
                     +  08:N1           106.84    3.246 No_date    2:15   24.17  n/a
      [DT= 1.67]  SUM=  05:N2           114.87    3.480 No_date    2:13   23.84  n/a

004:0014---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:102           26.53     .828 No_date    2:15   23.29 .366
      [CN= 71.0: N= 3.00]
      [Tp=  .71:DT= 5.00]

004:0015---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:103S2          7.13     .387 No_date    1:44   23.29 .366
      [CN= 71.0: N= 3.00]
      [Tp=  .28:DT= 1.00]

004:0016---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            01:102           26.53     .828 No_date    2:15   23.29  n/a
                     +  05:N2           114.87    3.480 No_date    2:13   23.84  n/a
      [DT= 1.67]  SUM=  09:ND           141.40    4.307 No_date    2:15   23.74  n/a
  ** END OF RUN :   4

********************************************************************************



 RUN:COMMAND#

005:0001------------------------------------------------------------------------------
     START
      [TZERO =    .00 hrs on        0]
      [METOUT=   2    (1=imperial, 2=metric output)]
      [NSTORM=   1 ]
      [NRUN  =   5 ]
#*******************************************************************************
#  Project Name: [SB] Project Number: [300031145]
#  Date        : 03-23-2017
#  Modeller    : [JMS/AJC]
#  Company     : R.J. Burnside & Associates
#  License #   :  3245976
```

```
#*******************************************************************************

005:0002------------------------------------------------------------------------
     READ STORM
      Filename = STORM.001
      Comment  =
      [SDT= 5.00:SDUR=   4.00:PTOT=  52.43]
# *********************************************************************
# North West Fergus Secondary Area (NWFSPA) Pre Development          *
# *********************************************************************

005:0003---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:EX1A          42.09     .868 No_date    2:35   18.50 .353
      [CN= 74.0: N= 3.00]
      [Tp=  .92:DT= 2.50]

005:0004---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE CHANNEL   -> 01:EX1A          42.09     .868 No_date    2:35   18.50  n/a
      [RDT= 2.50] out<- 02:EX1R          42.09     .850 No_date    2:45   18.50  n/a
      [L/S/n=  700./ .700/.035]
      {Vmax=  .986:Dmax=  .565}

005:0005---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      03:101           51.10    1.378 No_date    2:00   16.77 .320
      [CN= 71.0: N= 3.00]
      [Tp=  .52:DT= 5.00]

005:0006---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      04:EX3A          11.51     .296 No_date    2:05   16.77 .320
      [CN= 71.0: N= 3.00]
      [Tp=  .56:DT= 5.00]

005:0007---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE CHANNEL   -> 04:EX3A          11.51     .296 No_date    2:05   16.77  n/a
      [RDT= 1.67] out<- 05:EX3R          11.51     .270 No_date    2:18   16.77  n/a
      [L/S/n=  700./ .700/.035]
      {Vmax=  .749:Dmax=  .376}

005:0008---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:101           51.10    1.378 No_date    2:00   16.77  n/a
                     +  05:EX3R          11.51     .270 No_date    2:18   16.77  n/a
      [DT= 1.67]  SUM=  06:Nor           62.61    1.617 No_date    2:04   16.77  n/a

005:0009---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      07:EX2A           2.14     .077 No_date    1:45   16.77 .320
      [CN= 71.0: N= 3.00]
      [Tp=  .32:DT= 2.50]

005:0010---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:EX1R          42.09     .850 No_date    2:45   18.50  n/a
                     +  06:Nor           62.61    1.617 No_date    2:04   16.77  n/a
                     +  07:EX2A           2.14     .077 No_date    1:45   16.77  n/a
      [DT= 1.67]  SUM=  08:N1           106.84    2.282 No_date    2:15   17.45  n/a

005:0011---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      03:104            2.92     .059 No_date    2:10   13.82 .264
      [CN= 65.0: N= 3.00]
      [Tp=  .60:DT= 2.50]

005:0012---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      04:105            5.11     .130 No_date    1:52   13.82 .264
      [CN= 65.0: N= 3.00]
      [Tp=  .41:DT= 2.50]
```

```
005:0013---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:104             2.92      .059 No_date    2:10   13.82  n/a
                     +  04:105             5.11      .130 No_date    1:52   13.82  n/a
                     +  08:N1            106.84     2.282 No_date    2:15   17.45  n/a
      [DT= 1.67]  SUM=  05:N2            114.87     2.445 No_date    2:15   17.20  n/a

005:0014---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:102            26.53      .586 No_date    2:15   16.77 .320
      [CN= 71.0: N= 3.00]
      [Tp=  .71:DT= 5.00]

005:0015---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:103S2           7.13      .277 No_date    1:43   16.77 .320
      [CN= 71.0: N= 3.00]
      [Tp=  .28:DT= 1.00]

005:0016---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            01:102            26.53      .586 No_date    2:15   16.77  n/a
                     +  05:N2            114.87     2.445 No_date    2:15   17.20  n/a
      [DT= 1.67]  SUM=  09:ND            141.40     3.030 No_date    2:15   17.12  n/a
  ** END OF RUN :   5

*******************************************************************************




 RUN:COMMAND#

006:0001------------------------------------------------------------------------------
     START
      [TZERO =    .00 hrs on        0]
      [METOUT=   2    (1=imperial, 2=metric output)]
      [NSTORM=   1 ]
      [NRUN  =   6 ]
#******************************************************************************
#  Project Name: [SB] Project Number: [300031145]
#  Date        : 03-23-2017
#  Modeller    : [JMS/AJC]
#  Company     : R.J. Burnside & Associates
#  License #   :  3245976
#******************************************************************************

006:0002------------------------------------------------------------------------------
     READ STORM
      Filename = STORM.001
      Comment  =
      [SDT= 5.00:SDUR=   4.00:PTOT=  35.43]
# *********************************************************************
# North West Fergus Secondary Area (NWFSPA) Pre Development          *
# *********************************************************************

006:0003---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:EX1A           42.09      .425 No_date    2:35    9.34 .264
      [CN= 74.0: N= 3.00]
      [Tp=  .92:DT= 2.50]

006:0004---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE CHANNEL   -> 01:EX1A           42.09      .425 No_date    2:35    9.34  n/a
      [RDT= 2.50] out<- 02:EX1R           42.09      .412 No_date    2:47    9.34  n/a
      [L/S/n=  700./ .700/.035]
```

```
      {Vmax=  .820:Dmax=  .431}

006:0005---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      03:101           51.10     .669 No_date    2:00    8.36 .236
      [CN= 71.0: N= 3.00]
      [Tp=  .52:DT= 5.00]

006:0006---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      04:EX3A          11.51     .143 No_date    2:05    8.36 .236
      [CN= 71.0: N= 3.00]
      [Tp=  .56:DT= 5.00]

006:0007---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE CHANNEL   -> 04:EX3A          11.51     .143 No_date    2:05    8.36  n/a
      [RDT= 1.67] out<- 05:EX3R          11.51     .126 No_date    2:21    8.36  n/a
      [L/S/n=  700./ .700/.035]
      {Vmax=  .617:Dmax=  .284}

006:0008---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:101           51.10     .669 No_date    2:00    8.36  n/a
                     +  05:EX3R          11.51     .126 No_date    2:21    8.36  n/a
      [DT= 1.67]  SUM=  06:Nor           62.61     .774 No_date    2:04    8.36  n/a

006:0009---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      07:EX2A           2.14     .038 No_date    1:45    8.36 .236
      [CN= 71.0: N= 3.00]
      [Tp=  .32:DT= 2.50]

006:0010---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:EX1R          42.09     .412 No_date    2:47    9.34  n/a
                     +  06:Nor           62.61     .774 No_date    2:04    8.36  n/a
                     +  07:EX2A           2.14     .038 No_date    1:45    8.36  n/a
      [DT= 1.67]  SUM=  08:N1           106.84    1.083 No_date    2:15    8.75  n/a

006:0011---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      03:104            2.92     .028 No_date    2:07    6.74 .190
      [CN= 65.0: N= 3.00]
      [Tp=  .60:DT= 2.50]

006:0012---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      04:105            5.11     .062 No_date    1:52    6.74 .190
      [CN= 65.0: N= 3.00]
      [Tp=  .41:DT= 2.50]

006:0013---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:104            2.92     .028 No_date    2:07    6.74  n/a
                     +  04:105            5.11     .062 No_date    1:52    6.74  n/a
                     +  08:N1           106.84    1.083 No_date    2:15    8.75  n/a
      [DT= 1.67]  SUM=  05:N2           114.87    1.160 No_date    2:15    8.61  n/a

006:0014---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:102           26.53     .283 No_date    2:15    8.36 .236
      [CN= 71.0: N= 3.00]
      [Tp=  .71:DT= 5.00]

006:0015---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:103S2          7.13     .138 No_date    1:42    8.36 .236
      [CN= 71.0: N= 3.00]
      [Tp=  .28:DT= 1.00]

006:0016---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            01:102           26.53     .283 No_date    2:15    8.36  n/a
                     +  05:N2           114.87    1.160 No_date    2:15    8.61  n/a
```

```
      [DT= 1.67]  SUM=  09:ND           141.40    1.443 No_date    2:15    8.56  n/a

006:0002------------------------------------------------------------------------------
      FINISH
------------------------------------------------------------------------------------
-
************************************************************************************
*
     WARNINGS / ERRORS / NOTES
     -------------------------
   Simulation ended on 2017-07-17     at 10:17:43
====================================================================================
=
```

```
2     Metric units
*#******************************************************************************
*#  Project Name: [SB] Project Number: [300031145]
*#  Date        : 02-19-2018
*#  Modeller    : [JMS/AJC]
*#  Company     : R.J. Burnside & Associates
*#  License #   :  3245976
*#******************************************************************************
*%-----------------|-----------------------------------------------------------|
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[1]
*%                   ["100Year.100"] <--storm filename
*%-----------------|-----------------------------------------------------------|
READ STORM          STORM_FILENAME=["STORM.001"]
*%-----------------|-----------------------------------------------------------|
*# *******************************************************************
*# North West Fergus Secondary Area - Post Development               *

*# *******************************************************************
*%-----------------|-----------------------------------------------------------|
*%-----------------|-----------------------------------------------------------|
*Nov 2016 - Updated to split major and minor flows in Park and School blocks
*
*Generated from latest Calc Plan dated Sep 8, 2016
*
*NWFSP Site Area north of the Nichol Drain, this area is assumed to be
*collected and conveyed to the Proposed North Pond for both major and minor.
*This includes both Catchments 201A and 201B on Fig 10.
*The area also includes the Keating Property (Beatty Line Project) based on
*grading plans and design sheet prepared by GM BluePlan Keating Area = 8.54ha
*with an imp 47% - added directly to NWFSPA (46.03ha)

DESIGN STANDHYD     ID=[3], NHYD=["201"], DT=[5]min, AREA=[54.56](ha),
                    XIMP=[0.296], TIMP=[0.539], DWF=[0](cms), LOSS=[2], CN=[71],
                    SLOPE=[1](%), RAINFALL=[ , , , , ](mm/hr), END=-1
*%-----------------|-----------------------------------------------------------|
*Includes the school and park blocks
*Minor flows are collected and conveyed to the North Pond, Major flows drain
*overland directly to Nichol Drain
*Refers to Catchment 202

DESIGN STANDHYD     ID=[4], NHYD=["202"], DT=[2]min, AREA=[3.86](ha),
                    XIMP=[0.283], TIMP=[0.467], DWF=[0](cms), LOSS=[2], CN=[71],
                    SLOPE=[1](%), RAINFALL=[ , , , , ](mm/hr), END=-1
*%-----------------|-----------------------------------------------------------|
*Split of major and minor flows
*Minor flow (5-year) was calculated using Rational Method

COMPUTE DUALHYD     IDin=[4], CINLET=[0.47](cms), NINLET=[1],
                    MAJID=[5], MajNHYD=["202Maj"],
                    MINID=[6], MinNHYD=["202min"],
                    TMJSTO=[0](cu-m)
*%-----------------|-----------------------------------------------------------|
*Area to North Pond
*Includes major and minor flows from 201 and minor flows from 202

ADD HYD             IDsum=[7], NHYD=["TO POND"], IDs to add=[3,6]
*%-----------------|-----------------------------------------------------------|
*This is the proposed North Pond, this pond collects SPA north of the
*Nichol Drain, plus a 8.54ha portion of the Beatty Line Project.
*
*This pond limits the post-development flow to the design storm's pre
*development flow rate.
*
```

```
ROUTE RESERVOIR     IDout=[1],   NHYD=["NPOND"],  IDin=[7],
                    RDT=[2](min),
                          TABLE of ( OUTFLOW-STORAGE ) values
                                      (cms) - (ha-m)
 [   0.0 ,  0.0 ]
 [0.076,0.1765]
 [0.107,0.372]
 [0.131,0.5675]
 [0.142,0.6652]
 [0.144,0.6863]
 [0.17,0.7203]
 [0.334,0.8336]
 [0.573,0.9469]
 [0.868,1.0483]
 [1.209,1.1734]
 [1.591,1.2986]
 [2.009,1.4237]
 [2.46,1.5489]
 [2.943,1.666]
 [3.455,1.7992]
 [4.56,2.0655]
 [3.994,1.9324]
 [4.56,2.0655]
 [   -1  ,  -1  ]  (max twenty pts)
                          IDovf=[   ], NHYDovf=[   ]
*%-----------------|------------------------------------------------------------|
*Area that runs uncontrolled in both major and minor conditions
*Includes rears of lots along Nichol Drain as well as some lots along
*Beatty Line
*Refers to Catchment 203

DESIGN STANDHYD     ID=[2], NHYD=["203"], DT=[1]min, AREA=[1.06](ha),
                    XIMP=[0.194], TIMP=[0.382], DWF=[0](cms), LOSS=[2], CN=[71],
                    SLOPE=[1](%), RAINFALL=[ , , , , ](mm/hr), END=-1
*%-----------------|------------------------------------------------------------|
*All flows to node NOR
*Includes outlet flows from the pond, major storms flows from the school and
*park blocks & flows from rear of lots along Nichol Drain and Beatty Line

ADD HYD             IDsum=[3], NHYD=["NOR"], IDs to add=[1,2,5]
*%-----------------|------------------------------------------------------------|
*External area to the north of the NWFSPA (Catchment EX1A).
*The existing land use for this catchment is agricultural. The CN number
*was established based on Soils Mapping (Listowel Loam) at 74.
*This drainage will by-pass the SPA SWM ponds via the N-S realigned ditch.

DESIGN NASHYD       ID=[1], NHYD=["EX1A"], DT=[2]min, AREA=[42.09](ha),
                    DWF=[0](cms), CN/C=[74], TP=[0.92]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*%-----------------|------------------------------------------------------------|
*Routing of EX1A
*This is the routing of the External catchment to the north of the SPA
*through the N-S ditch which would ultimately outlets to the Nichol Drain

ROUTE PIPE          PTYPE=[2]rect,  IDout=[2], NHYD=["EX1R"], RNUMBER=[1],
                    PWIDTH=[1800](mm), PHEIGHT=[900](mm),  PLNGTH=[915](m),
                    PROUGH=[0.013],  PSLOPE=[0.002](m/m), IDin=[1],
                    RDT=[2](min)
*%-----------------|------------------------------------------------------------|
*External area to the south of the NWFSPA (Catchment EX2A).
*
*This catchment area drains, via the Beatty Line roadside ditch
*and drains directly to the Nichol Drain
```

```
DESIGN NASHYD       ID=[9], NHYD=["EX2A"], DT=[2]min, AREA=[2.14](ha),
                    DWF=[0](cms), CN/C=[71], TP=[0.32]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*%-----------------|-----------------------------------------------------------|
*Total flows (including external) under post-development conditions to Node N1
*
ADD HYD             IDsum=[4], NHYD=["N1"], IDs to add=[2,3,9]
*%-----------------|-----------------------------------------------------------|
*This is the NWFSP Site Area adjacent to the Nichol Drain directly to the south.
*Drainage area based on Draft Plan and preliminary grading to South Pond.
*Refers to Catchment 204

DESIGN STANDHYD     ID=[1], NHYD=["204"], DT=[2]min, AREA=[27.40](ha),
                    XIMP=[0.296], TIMP=[0.545], DWF=[0](cms), LOSS=[2], CN=[71],
                    SLOPE=[1](%), RAINFALL=[ , , , , ](mm/hr), END=-1
*%-----------------|-----------------------------------------------------------|
*This is the proposed south pond.

ROUTE RESERVOIR     IDout=[8],   NHYD=["SPOND"],  IDin=[1],
                    RDT=[2](min),
                          TABLE of ( OUTFLOW-STORAGE ) values
                                      (cms) - (ha-m)
                                    [ 0,0 ]
                                    [ 0.07521,0.3249 ]
                                    [ 0.283,0.38 ]
                                    [ 0.586,0.55 ]
                                    [ 0.828,0.67 ]
                                    [ 1.174,0.87 ]
                                    [ 1.461,0.99 ]
                                    [ 1.762,1.15 ]
                                    [   -1  ,  -1  ]  (max twenty pts)
                          IDovf=[   ], NHYDovf=[   ]
*%-----------------|-----------------------------------------------------------|
*Major and minor flows run uncontrolled in this area (outlet to Nichol Drain)
*Refers to Catchment 205

DESIGN NASHYD       ID=[9], NHYD=["205"], DT=[2]min, AREA=[1.34](ha),
                    DWF=[0](cms), CN/C=[71], TP=[.33]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*%-----------------|-----------------------------------------------------------|
*All flows to node S1
*Includes outlet flows from the south pond and the uncontrolled area that
*outlets directly to Nichol Drain

ADD HYD             IDsum=[1], NHYD=["S1"], IDs to add=[8,9]
*%-----------------|-----------------------------------------------------------|
* Portion of the site which will continue to flow to the south uncontrolled
* mostly park and rear yards draining to wetland south side of Colbourne St.
*(via a 400mm CSP culvert).
* Refers to Catchment area 206
*******
* FLOW FROM THIS CATCHMENT IS Node S2
*******
DESIGN STANDHYD     ID=[5], NHYD=["206S2"], DT=[1]min, AREA=[2.69](ha),
                    XIMP=[0.252], TIMP=[0.495], DWF=[0](cms), LOSS=[2], CN=[71],
                    SLOPE=[1](%), RAINFALL=[ , , , , ](mm/hr), END=-1
*%-----------------|-----------------------------------------------------------|
*Remaining Catchments Draining to the Nichol Drain
*
*Catchment 207
*
*This catchment refers to the Woodlot, which drains to the Nichol Drain.
```

```
DESIGN NASHYD       ID=[2], NHYD=["207"], DT=[2]min, AREA=[7.96](ha),
                    DWF=[0](cms), CN/C=[65], TP=[0.41]hrs,
                    RAINFALL=[ ,  ,  ,  , ](mm/hr), END=-1
*%-----------------|------------------------------------------------------------|
*Total flows leaving the NWF SPA that discharge to Nichol Drain (node ND)
*Includes all external flows
*Does not include areas that are released uncontrolled from the site that do
*not discharge to Nichol Drain

ADD HYD             IDsum=[9], NHYD=["ND"], IDs to add=[2,1,4]
*%-----------------|------------------------------------------------------------|
*%-----------------|------------------------------------------------------------|
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[2]
*%                   ["50Year.050"] <--storm filename
*%-----------------|------------------------------------------------------------|
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[3]
*%                   ["25Year.025"] <--storm filename
*%-----------------|------------------------------------------------------------|
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[4]
*%                   ["10Year.010"] <--storm filename
*%-----------------|------------------------------------------------------------|
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[5]
*%                   ["5Year.005"] <--storm filename
*%-----------------|------------------------------------------------------------|
START               TZERO=[0.0],  METOUT=[2],  NSTORM=[1],  NRUN=[6]
*%                   ["2Year.002"] <--storm filename
*%-----------------|------------------------------------------------------------|
FINISH
```

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

   SSSSS  W   W  M   M  H   H  Y   Y  M   M   OOO        999    999    =========
   S      W W W  MM MM  H   H   Y Y   MM MM  O   O      9   9  9   9
   SSSSS  W W W  M M M  HHHHH    Y    M M M  O   O  ##  9   9  9   9   Ver  4.05
       S   W W   M   M  H   H    Y    M   M  O   O       9999   9999   Sept 2011
   SSSSS   W W   M   M  H   H    Y    M   M   OOO          9      9   =========
                                                        9   9  9   9   # 3877524
        StormWater Management HYdrologic Model           999    999    =========

 *******************************************************************************
 ***************************** SWMHYMO Ver/4.05  ******************************
 *********  A single event and continuous hydrologic simulation model  *********
 *********     based on the principles of HYMO and its successors     *********
 *********                 OTTHYMO-83 and OTTHYMO-89.                  *********
 *******************************************************************************
 ********* Distributed by:  J.F. Sabourin and Associates Inc.          *********
 *********                  Ottawa,  Ontario: (613) 836-3884           *********
 *********                  Gatineau, Quebec: (819) 243-6858           *********
 *********                  E-Mail: swmhymo@jfsa.Com                   *********
 *******************************************************************************

 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 +++++++++ Licensed user: R.J. Burnside & Associates Ltd               +++++++++
 +++++++++                Brampton              SERIAL#:3877524        +++++++++
 +++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++

 *******************************************************************************
 *********           ++++++ PROGRAM ARRAY DIMENSIONS ++++++            *********
 *********           Maximum value for ID numbers  :     10            *********
 *********           Max. number of rainfall points: 105408            *********
 *********           Max. number of flow points    : 105408            *********
 *******************************************************************************

 ***** DESCRIPTION SUMMARY TABLE HEADERS (units depend on METOUT in START) *****
 *****---------------------------------------------------------------------*****
 *****    ID:  Hydrograph IDentification numbers, (1-10).                  *****
 *****  NHYD:  Hydrograph reference numbers, (6 digits or characters).     *****
 *****  AREA:  Drainage area associated with hydrograph, (ac.) or (ha.).   *****
 ***** QPEAK:  Peak flow of simulated hydrograph, (ft^3/s) or (m^3/s).     *****
 ***** TpeakDate_hh:mm is the date and time of the peak flow.              *****
 *****  R.V.:  Runoff Volume of simulated hydrograph, (in) or (mm).        *****
 *****  R.C.:  Runoff Coefficient of simulated hydrograph, (ratio).        *****
 *****     *:  see WARNING or NOTE message printed at end of run.          *****
 *****    **:  see  ERROR  message printed at end of run.                  *****
 *******************************************************************************
 *******************************************************************************

:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::

 *******************************************************************************

 ***********************   S U M M A R Y   O U T P U T   ***********************
 *******************************************************************************
 *         DATE: 2018-02-20     TIME: 13:10:54     RUN COUNTER: 001382         *
 *******************************************************************************
 * Input   filename: C:\SWMHYMO\STORYB~1\180218\Prop2016.DAT                   *
 * Output  filename: C:\SWMHYMO\STORYB~1\180218\Prop2016.out                   *
 * Summary filename: C:\SWMHYMO\STORYB~1\180218\Prop2016.sum                   *
 * User comments:                                                              *
 * 1:__________________________________________________________________________*
 * 2:__________________________________________________________________________*
 * 3:__________________________________________________________________________*
```

```
 *******************************************************************************

#*******************************************************************************
#  Project Name: [SB] Project Number: [300031145]
#  Date        : 02-19-2018
#  Modeller    : [JMS/AJC]
#  Company     : R.J. Burnside & Associates
#  License #   :  3245976
#*******************************************************************************
 RUN:COMMAND#

001:0001-----------------------------------------------------------------------------
     START
      [TZERO =    .00 hrs on        0]
      [METOUT=   2    (1=imperial, 2=metric output)]
      [NSTORM=   1 ]
      [NRUN  =   1 ]

001:0002-----------------------------------------------------------------------------
     READ STORM
      Filename = STORM.001
      Comment  =
      [SDT= 5.00:SDUR=   4.00:PTOT=  99.17]
# *********************************************************************
# North West Fergus Secondary Area - Post Development               *
# *********************************************************************

001:0003---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    03:201           54.56   10.043 No_date    1:30   69.97 .706
      [XIMP=.30:TIMP=.54]
      [SLP=1.00:DT= 5.00]
      [LOSS= 2 :CN= 71.0]

001:0004---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    04:202            3.86     .746 No_date    1:25   67.19 .678
      [XIMP=.28:TIMP=.47]
      [SLP=1.00:DT= 2.50]
      [LOSS= 2 :CN= 71.0]

001:0005---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     COMPUTE DUALHYD    04:202            3.86     .746 No_date    1:25   67.19  n/a
        Major System /  05:202Maj          .45     .276 No_date    1:25   67.19  n/a
        Minor System \  06:202min         3.41     .470 No_date    1:17   67.19  n/a

001:0006---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:201           54.56   10.043 No_date    1:30   69.97  n/a
                     +  06:202min         3.41     .470 No_date    1:17   67.19  n/a
      [DT= 2.50]  SUM=  07:TO POND       57.97   10.513 No_date    1:30   69.81  n/a

001:0007---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE RESERVOIR -> 07:TO POND       57.97   10.513 No_date    1:30   69.81  n/a
      [RDT= 2.50] out<- 01:NPOND         57.97    4.462 No_date    2:07   69.81  n/a
            overflow <= 04:         2      .00     .000 No_date    0:00     .00  n/a
     {MxStoUsed=.2043E+01, TotOvfVol=.0000E+00, N-Ovf=    0, TotDurOvf=    0.hrs}

001:0008---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    02:203            1.06     .183 No_date    1:30   62.70 .632
      [XIMP=.19:TIMP=.38]
      [SLP=1.00:DT= 1.00]
      [LOSS= 2 :CN= 71.0]

001:0009---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
```

```
     ADD HYD            01:NPOND          57.97    4.462 No_date    2:07   69.81  n/a
                     +  02:203             1.06     .183 No_date    1:30   62.70  n/a
                     +  05:202Maj           .45     .276 No_date    1:25   67.19  n/a
      [DT= 1.00]  SUM=  03:NOR            59.48    4.533 No_date    2:05   69.66  n/a

001:0010---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:EX1A           42.09    2.546 No_date    2:35   51.04 .515
      [CN= 74.0: N= 3.00]
      [Tp=  .92:DT= 2.50]

001:0011---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE PIPE      -> 01:EX1A           42.09    2.546 No_date    2:35   51.04  n/a
  *   [RDT= 2.50] out<- 02:EX1R           42.09    2.517 No_date    2:40   51.04  n/a
      [L/S/n=  915./ .200/.013]
      {Vmax= 1.892:Dmax=  .742}
      {HGTH=  .91:WDTH= 1.81}

001:0012---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:EX2A            2.14     .226 No_date    1:47   47.36 .478
      [CN= 71.0: N= 3.00]
      [Tp=  .32:DT= 2.50]

001:0013---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:EX1R           42.09    2.517 No_date    2:40   51.04  n/a
                     +  03:NOR            59.48    4.533 No_date    2:05   69.66  n/a
                     +  09:EX2A            2.14     .226 No_date    1:47   47.36  n/a
      [DT= 1.00]  SUM=  04:N1            103.71    6.727 No_date    2:17   61.64  n/a

001:0014---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    01:204            27.40    5.346 No_date    1:27   70.20 .708
      [XIMP=.30:TIMP=.55]
      [SLP=1.00:DT= 2.50]
      [LOSS= 2 :CN= 71.0]

001:0015---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE RESERVOIR -> 01:204            27.40    5.346 No_date    1:27   70.20  n/a
      [RDT= 2.50] out<- 08:SPOND          27.40    1.628 No_date    2:15   70.20  n/a
     {MxStoUsed=.1079E+01}

001:0016---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:205             1.34     .139 No_date    1:47   47.36 .478
      [CN= 71.0: N= 3.00]
      [Tp=  .33:DT= 2.50]

001:0017---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            08:SPOND          27.40    1.628 No_date    2:15   70.20  n/a
                     +  09:205             1.34     .139 No_date    1:47   47.36  n/a
      [DT= 2.50]  SUM=  01:S1             28.74    1.725 No_date    2:10   69.13  n/a

001:0018---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    05:206S2           2.69     .517 No_date    1:26   67.64 .682
      [XIMP=.25:TIMP=.50]
      [SLP=1.00:DT= 1.00]
      [LOSS= 2 :CN= 71.0]

001:0019---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      02:207             7.96     .625 No_date    1:55   40.69 .410
      [CN= 65.0: N= 3.00]
      [Tp=  .41:DT= 2.50]

001:0020---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:207             7.96     .625 No_date    1:55   40.69  n/a
                     +  01:S1             28.74    1.725 No_date    2:10   69.13  n/a
```

```
                     +  04:N1           103.71    6.727 No_date    2:17   61.64  n/a
      [DT= 1.00]  SUM=  09:ND           140.41    8.967 No_date    2:13   61.99  n/a
  ** END OF RUN :   1

*******************************************************************************




 RUN:COMMAND#

002:0001----------------------------------------------------------------------------
     START
      [TZERO =    .00 hrs on        0]
      [METOUT=   2    (1=imperial, 2=metric output)]
      [NSTORM=   1 ]
      [NRUN  =   2 ]
#******************************************************************************
#  Project Name: [SB] Project Number: [300031145]
#  Date        : 02-19-2018
#  Modeller    : [JMS/AJC]
#  Company     : R.J. Burnside & Associates
#  License #   :  3245976
#******************************************************************************

002:0002----------------------------------------------------------------------------
     READ STORM
      Filename = STORM.001
      Comment  =
      [SDT= 5.00:SDUR=   4.00:PTOT=  88.24]
# *******************************************************************
# North West Fergus Secondary Area - Post Development               *
# *******************************************************************

002:0003---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    03:201           54.56    8.640 No_date    1:30   60.42 .685
      [XIMP=.30:TIMP=.54]
      [SLP=1.00:DT= 5.00]
      [LOSS= 2 :CN= 71.0]

002:0004---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    04:202            3.86     .602 No_date    1:25   57.88 .656
      [XIMP=.28:TIMP=.47]
      [SLP=1.00:DT= 2.50]
      [LOSS= 2 :CN= 71.0]

002:0005---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     COMPUTE DUALHYD    04:202            3.86     .602 No_date    1:25   57.88  n/a
        Major System /  05:202Maj          .21     .132 No_date    1:25   57.88  n/a
        Minor System \  06:202min         3.65     .470 No_date    1:17   57.88  n/a

002:0006---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:201           54.56    8.640 No_date    1:30   60.42  n/a
                     +  06:202min         3.65     .470 No_date    1:17   57.88  n/a
      [DT= 2.50]  SUM=  07:TO POND       58.21    9.110 No_date    1:30   60.26  n/a

002:0007---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE RESERVOIR -> 07:TO POND       58.21    9.110 No_date    1:30   60.26  n/a
      [RDT= 2.50] out<- 01:NPOND         58.21    3.599 No_date    2:10   60.26  n/a
            overflow <= 04:         2      .00     .000 No_date    0:00     .00  n/a
     {MxStoUsed=.1835E+01, TotOvfVol=.0000E+00, N-Ovf=    0, TotDurOvf=    0.hrs}
```

```
002:0008---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    02:203            1.06      .152 No_date    1:30   53.65 .608
      [XIMP=.19:TIMP=.38]
      [SLP=1.00:DT= 1.00]
      [LOSS= 2 :CN= 71.0]

002:0009---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            01:NPOND         58.21    3.599 No_date    2:10   60.26  n/a
                     +  02:203            1.06      .152 No_date    1:30   53.65  n/a
                     +  05:202Maj          .21      .132 No_date    1:25   57.88  n/a
      [DT= 1.00]  SUM=  03:NOR           59.48    3.657 No_date    2:08   60.13  n/a

002:0010---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:EX1A          42.09    2.119 No_date    2:35   42.75 .484
      [CN= 74.0: N= 3.00]
      [Tp=  .92:DT= 2.50]

002:0011---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE PIPE      -> 01:EX1A          42.09    2.119 No_date    2:35   42.75  n/a
      [RDT= 2.50] out<- 02:EX1R          42.09    2.093 No_date    2:40   42.75  n/a
      [L/S/n=  915./ .200/.013]
      {Vmax= 1.800:Dmax=  .654}
      {HGTH=  .90:WDTH= 1.80}

002:0012---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:EX2A           2.14      .188 No_date    1:47   39.50 .448
      [CN= 71.0: N= 3.00]
      [Tp=  .32:DT= 2.50]

002:0013---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:EX1R          42.09    2.093 No_date    2:40   42.75  n/a
                     +  03:NOR           59.48    3.657 No_date    2:08   60.13  n/a
                     +  09:EX2A           2.14      .188 No_date    1:47   39.50  n/a
      [DT= 1.00]  SUM=  04:N1           103.71    5.526 No_date    2:20   52.65  n/a

002:0014---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    01:204           27.40    4.627 No_date    1:27   60.62 .687
      [XIMP=.30:TIMP=.55]
      [SLP=1.00:DT= 2.50]
      [LOSS= 2 :CN= 71.0]

002:0015---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE RESERVOIR -> 01:204           27.40    4.627 No_date    1:27   60.62  n/a
      [RDT= 2.50] out<- 08:SPOND         27.40    1.352 No_date    2:17   60.62  n/a
     {MxStoUsed=.9447E+00}

002:0016---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:205            1.34      .116 No_date    1:47   39.50 .448
      [CN= 71.0: N= 3.00]
      [Tp=  .33:DT= 2.50]

002:0017---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            08:SPOND         27.40    1.352 No_date    2:17   60.62  n/a
                     +  09:205            1.34      .116 No_date    1:47   39.50  n/a
      [DT= 2.50]  SUM=  01:S1            28.74    1.430 No_date    2:12   59.64  n/a

002:0018---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    05:206S2          2.69      .439 No_date    1:27   58.22 .660
      [XIMP=.25:TIMP=.50]
      [SLP=1.00:DT= 1.00]
      [LOSS= 2 :CN= 71.0]

002:0019---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
```

```
     DESIGN NASHYD      02:207             7.96     .515 No_date    1:55   33.66 .381
      [CN= 65.0: N= 3.00]
      [Tp=  .41:DT= 2.50]

002:0020---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:207             7.96     .515 No_date    1:55   33.66  n/a
                     +  01:S1             28.74    1.430 No_date    2:12   59.64  n/a
                     +  04:N1            103.71    5.526 No_date    2:20   52.65  n/a
      [DT= 1.00]  SUM=  09:ND            140.41    7.368 No_date    2:15   53.00  n/a
  ** END OF RUN :   2

*******************************************************************************




 RUN:COMMAND#

003:0001------------------------------------------------------------------------
     START
      [TZERO =    .00 hrs on        0]
      [METOUT=   2    (1=imperial, 2=metric output)]
      [NSTORM=   1 ]
      [NRUN  =   3 ]
#******************************************************************************
#  Project Name: [SB] Project Number: [300031145]
#  Date        : 02-19-2018
#  Modeller    : [JMS/AJC]
#  Company     : R.J. Burnside & Associates
#  License #   :  3245976
#******************************************************************************

003:0002------------------------------------------------------------------------
     READ STORM
      Filename = STORM.001
      Comment  =
      [SDT= 5.00:SDUR=   4.00:PTOT=  77.92]
# *********************************************************************
# North West Fergus Secondary Area - Post Development                 *
# *********************************************************************

003:0003---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    03:201            54.56    7.292 No_date    1:30   51.59 .662
      [XIMP=.30:TIMP=.54]
      [SLP=1.00:DT= 5.00]
      [LOSS= 2 :CN= 71.0]

003:0004---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    04:202             3.86     .520 No_date    1:20   49.30 .633
      [XIMP=.28:TIMP=.47]
      [SLP=1.00:DT= 2.50]
      [LOSS= 2 :CN= 71.0]

003:0005---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     COMPUTE DUALHYD    04:202             3.86     .520 No_date    1:20   49.30  n/a
        Major System /  05:202Maj           .05     .050 No_date    1:20   49.30  n/a
        Minor System \  06:202min          3.81     .470 No_date    1:20   49.30  n/a

003:0006---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:201            54.56    7.292 No_date    1:30   51.59  n/a
                     +  06:202min          3.81     .470 No_date    1:20   49.30  n/a
      [DT= 2.50]  SUM=  07:TO POND        58.37    7.762 No_date    1:30   51.44  n/a
```

```
003:0007---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE RESERVOIR -> 07:TO POND        58.37    7.762 No_date    1:30   51.44  n/a
      [RDT= 2.50] out<- 01:NPOND          58.37    2.770 No_date    2:12   51.44  n/a
            overflow <= 04:         2       .00     .000 No_date    0:00     .00  n/a
     {MxStoUsed=.1624E+01, TotOvfVol=.0000E+00, N-Ovf=    0, TotDurOvf=    0.hrs}

003:0008---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    02:203             1.06     .123 No_date    1:30   45.35 .582
      [XIMP=.19:TIMP=.38]
      [SLP=1.00:DT= 1.00]
      [LOSS= 2 :CN= 71.0]

003:0009---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            01:NPOND          58.37    2.770 No_date    2:12   51.44  n/a
                      + 02:203             1.06     .123 No_date    1:30   45.35  n/a
                      + 05:202Maj           .05     .050 No_date    1:20   49.30  n/a
      [DT= 1.00]  SUM=  03:NOR            59.48    2.813 No_date    2:11   51.33  n/a

003:0010---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:EX1A           42.09    1.713 No_date    2:35   35.25 .452
      [CN= 74.0: N= 3.00]
      [Tp=  .92:DT= 2.50]

003:0011---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE PIPE      -> 01:EX1A           42.09    1.713 No_date    2:35   35.25  n/a
      [RDT= 2.50] out<- 02:EX1R           42.09    1.691 No_date    2:42   35.25  n/a
      [L/S/n=  915./ .200/.013]
      {Vmax= 1.694:Dmax=  .561}
      {HGTH=  .90:WDTH= 1.80}

003:0012---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:EX2A            2.14     .152 No_date    1:47   32.41 .416
      [CN= 71.0: N= 3.00]
      [Tp=  .32:DT= 2.50]

003:0013---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:EX1R           42.09    1.691 No_date    2:42   35.25  n/a
                      + 03:NOR            59.48    2.813 No_date    2:11   51.33  n/a
                      + 09:EX2A            2.14     .152 No_date    1:47   32.41  n/a
      [DT= 1.00]  SUM=  04:N1            103.71    4.372 No_date    2:22   44.41  n/a

003:0014---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    01:204            27.40    3.718 No_date    1:27   51.77 .664
      [XIMP=.30:TIMP=.55]
      [SLP=1.00:DT= 2.50]
      [LOSS= 2 :CN= 71.0]

003:0015---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE RESERVOIR -> 01:204            27.40    3.718 No_date    1:27   51.77  n/a
      [RDT= 2.50] out<- 08:SPOND          27.40    1.068 No_date    2:20   51.77  n/a
     {MxStoUsed=.8089E+00}

003:0016---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:205             1.34     .094 No_date    1:47   32.41 .416
      [CN= 71.0: N= 3.00]
      [Tp=  .33:DT= 2.50]

003:0017---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            08:SPOND          27.40    1.068 No_date    2:20   51.77  n/a
                      + 09:205             1.34     .094 No_date    1:47   32.41  n/a
      [DT= 2.50]  SUM=  01:S1             28.74    1.126 No_date    2:15   50.87  n/a
```

```
003:0018---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    05:206S2           2.69      .360 No_date    1:27   49.54 .636
      [XIMP=.25:TIMP=.50]
      [SLP=1.00:DT= 1.00]
      [LOSS= 2 :CN= 71.0]

003:0019---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      02:207             7.96      .412 No_date    1:55   27.39 .352
      [CN= 65.0: N= 3.00]
      [Tp=  .41:DT= 2.50]

003:0020---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:207             7.96      .412 No_date    1:55   27.39  n/a
                     +  01:S1             28.74     1.126 No_date    2:15   50.87  n/a
                     +  04:N1            103.71     4.372 No_date    2:22   44.41  n/a
      [DT= 1.00]  SUM=  09:ND            140.41     5.808 No_date    2:18   44.77  n/a
  ** END OF RUN :   3

*******************************************************************************




 RUN:COMMAND#

004:0001----------------------------------------------------------------------------
     START
      [TZERO =    .00 hrs on        0]
      [METOUT=   2    (1=imperial, 2=metric output)]
      [NSTORM=   1 ]
      [NRUN  =   4 ]
#******************************************************************************
#  Project Name: [SB] Project Number: [300031145]
#  Date        : 02-19-2018
#  Modeller    : [JMS/AJC]
#  Company     : R.J. Burnside & Associates
#  License #   :  3245976
#******************************************************************************

004:0002----------------------------------------------------------------------------
     READ STORM
      Filename = STORM.001
      Comment  =
      [SDT= 5.00:SDUR=   4.00:PTOT=  63.67]
# *******************************************************************
# North West Fergus Secondary Area - Post Development               *
# *******************************************************************

004:0003---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    03:201            54.56     5.616 No_date    1:25   39.79 .625
      [XIMP=.30:TIMP=.54]
      [SLP=1.00:DT= 5.00]
      [LOSS= 2 :CN= 71.0]

004:0004---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    04:202             3.86      .419 No_date    1:20   37.88 .595
      [XIMP=.28:TIMP=.47]
      [SLP=1.00:DT= 2.50]
      [LOSS= 2 :CN= 71.0]

004:0005---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     COMPUTE DUALHYD    04:202             3.86      .419 No_date    1:20   37.88  n/a
```

```
        Major System /  05:202Maj          .00      .000 No_date    0:00     .00  n/a
        Minor System \  06:202min         3.86      .419 No_date    1:20   37.88  n/a

004:0006---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:201           54.56    5.616 No_date    1:25   39.79  n/a
                     +  06:202min         3.86     .419 No_date    1:20   37.88  n/a
      [DT= 2.50]  SUM=  07:TO POND       58.42    5.996 No_date    1:25   39.66  n/a

004:0007---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE RESERVOIR -> 07:TO POND       58.42    5.996 No_date    1:25   39.66  n/a
      [RDT= 2.50] out<- 01:NPOND         58.42    1.745 No_date    2:20   39.66  n/a
            overflow <= 04:         2      .00     .000 No_date    0:00     .00  n/a
     {MxStoUsed=.1345E+01, TotOvfVol=.0000E+00, N-Ovf=    0, TotDurOvf=    0.hrs}

004:0008---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    02:203            1.06     .090 No_date    1:21   34.37 .540
      [XIMP=.19:TIMP=.38]
      [SLP=1.00:DT= 1.00]
      [LOSS= 2 :CN= 71.0]

004:0009---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            01:NPOND         58.42    1.745 No_date    2:20   39.66  n/a
                     +  02:203            1.06     .090 No_date    1:21   34.37  n/a
                     +  05:202Maj          .00     .000 No_date    0:00     .00  n/a
      [DT= 1.00]  SUM=  03:NOR           59.48    1.773 No_date    2:20   39.56  n/a

004:0010---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:EX1A          42.09    1.217 No_date    2:35   25.52 .401
      [CN= 74.0: N= 3.00]
      [Tp=  .92:DT= 2.50]

004:0011---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE PIPE      -> 01:EX1A          42.09    1.217 No_date    2:35   25.52  n/a
      [RDT= 2.50] out<- 02:EX1R          42.09    1.199 No_date    2:42   25.52  n/a
      [L/S/n=  915./ .200/.013]
      {Vmax= 1.528:Dmax=  .442}
      {HGTH=  .90:WDTH= 1.80}

004:0012---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:EX2A           2.14     .108 No_date    1:45   23.29 .366
      [CN= 71.0: N= 3.00]
      [Tp=  .32:DT= 2.50]

004:0013---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:EX1R          42.09    1.199 No_date    2:42   25.52  n/a
                     +  03:NOR           59.48    1.773 No_date    2:20   39.56  n/a
                     +  09:EX2A           2.14     .108 No_date    1:45   23.29  n/a
      [DT= 1.00]  SUM=  04:N1           103.71    2.949 No_date    2:30   33.53  n/a

004:0014---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    01:204           27.40    2.898 No_date    1:27   39.94 .627
      [XIMP=.30:TIMP=.55]
      [SLP=1.00:DT= 2.50]
      [LOSS= 2 :CN= 71.0]

004:0015---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE RESERVOIR -> 01:204           27.40    2.898 No_date    1:27   39.94  n/a
      [RDT= 2.50] out<- 08:SPOND         27.40     .765 No_date    2:22   39.94  n/a
     {MxStoUsed=.6387E+00}

004:0016---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:205            1.34     .067 No_date    1:47   23.29 .366
      [CN= 71.0: N= 3.00]
```

```
      [Tp=  .33:DT= 2.50]

004:0017---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            08:SPOND          27.40     .765 No_date    2:22   39.94  n/a
                     +  09:205             1.34     .067 No_date    1:47   23.29  n/a
      [DT= 2.50]  SUM=  01:S1             28.74     .802 No_date    2:20   39.16  n/a

004:0018---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    05:206S2           2.69     .278 No_date    1:22   37.97 .596
      [XIMP=.25:TIMP=.50]
      [SLP=1.00:DT= 1.00]
      [LOSS= 2 :CN= 71.0]

004:0019---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      02:207             7.96     .287 No_date    1:55   19.43 .305
      [CN= 65.0: N= 3.00]
      [Tp=  .41:DT= 2.50]

004:0020---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:207             7.96     .287 No_date    1:55   19.43  n/a
                     +  01:S1             28.74     .802 No_date    2:20   39.16  n/a
                     +  04:N1            103.71    2.949 No_date    2:30   33.53  n/a
      [DT= 1.00]  SUM=  09:ND            140.41    3.938 No_date    2:25   33.88  n/a
  ** END OF RUN :   4

*******************************************************************************




 RUN:COMMAND#

005:0001------------------------------------------------------------------------------
     START
      [TZERO =    .00 hrs on        0]
      [METOUT=   2    (1=imperial, 2=metric output)]
      [NSTORM=   1 ]
      [NRUN  =   5 ]
#******************************************************************************
#  Project Name: [SB] Project Number: [300031145]
#  Date        : 02-19-2018
#  Modeller    : [JMS/AJC]
#  Company     : R.J. Burnside & Associates
#  License #   :  3245976
#******************************************************************************

005:0002------------------------------------------------------------------------------
     READ STORM
      Filename = STORM.001
      Comment  =
      [SDT= 5.00:SDUR=   4.00:PTOT=  52.43]
# *********************************************************************
# North West Fergus Secondary Area - Post Development                 *
# *********************************************************************

005:0003---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    03:201            54.56    4.139 No_date    1:25   30.89 .589
      [XIMP=.30:TIMP=.54]
      [SLP=1.00:DT= 5.00]
      [LOSS= 2 :CN= 71.0]

005:0004---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
```

```
     DESIGN STANDHYD    04:202            3.86     .357 No_date    1:20   29.31 .559
      [XIMP=.28:TIMP=.47]
      [SLP=1.00:DT= 2.50]
      [LOSS= 2 :CN= 71.0]

005:0005---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     COMPUTE DUALHYD    04:202            3.86     .357 No_date    1:20   29.31  n/a
        Major System /  05:202Maj          .00     .000 No_date    0:00     .00  n/a
        Minor System \  06:202min         3.86     .357 No_date    1:20   29.31  n/a

005:0006---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:201           54.56    4.139 No_date    1:25   30.89  n/a
                     +  06:202min         3.86     .357 No_date    1:20   29.31  n/a
      [DT= 2.50]  SUM=  07:TO POND       58.42    4.441 No_date    1:25   30.78  n/a

005:0007---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE RESERVOIR -> 07:TO POND       58.42    4.441 No_date    1:25   30.78  n/a
      [RDT= 2.50] out<- 01:NPOND         58.42    1.076 No_date    2:35   30.78  n/a
            overflow <= 04:         2      .00     .000 No_date    0:00     .00  n/a
     {MxStoUsed=.1125E+01, TotOvfVol=.0000E+00, N-Ovf=    0, TotDurOvf=    0.hrs}

005:0008---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    02:203            1.06     .074 No_date    1:20   26.21 .500
      [XIMP=.19:TIMP=.38]
      [SLP=1.00:DT= 1.00]
      [LOSS= 2 :CN= 71.0]

005:0009---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            01:NPOND         58.42    1.076 No_date    2:35   30.78  n/a
                     +  02:203            1.06     .074 No_date    1:20   26.21  n/a
                     +  05:202Maj          .00     .000 No_date    0:00     .00  n/a
      [DT= 1.00]  SUM=  03:NOR           59.48    1.092 No_date    2:35   30.70  n/a

005:0010---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:EX1A          42.09     .868 No_date    2:35   18.50 .353
      [CN= 74.0: N= 3.00]
      [Tp=  .92:DT= 2.50]

005:0011---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE PIPE      -> 01:EX1A          42.09     .868 No_date    2:35   18.50  n/a
      [RDT= 2.50] out<- 02:EX1R          42.09     .852 No_date    2:42   18.50  n/a
      [L/S/n=  915./ .200/.013]
      {Vmax= 1.371:Dmax=  .351}
      {HGTH=  .90:WDTH= 1.80}

005:0012---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:EX2A           2.14     .077 No_date    1:45   16.77 .320
      [CN= 71.0: N= 3.00]
      [Tp=  .32:DT= 2.50]

005:0013---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:EX1R          42.09     .852 No_date    2:42   18.50  n/a
                     +  03:NOR           59.48    1.092 No_date    2:35   30.70  n/a
                     +  09:EX2A           2.14     .077 No_date    1:45   16.77  n/a
      [DT= 1.00]  SUM=  04:N1           103.71    1.966 No_date    2:38   25.46  n/a

005:0014---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    01:204           27.40    2.238 No_date    1:22   31.01 .592
      [XIMP=.30:TIMP=.55]
      [SLP=1.00:DT= 2.50]
      [LOSS= 2 :CN= 71.0]

005:0015---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
```

```
     ROUTE RESERVOIR -> 01:204            27.40    2.238 No_date    1:22   31.01  n/a
      [RDT= 2.50] out<- 08:SPOND          27.40     .523 No_date    2:32   31.01  n/a
     {MxStoUsed=.5149E+00}

005:0016---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:205             1.34     .047 No_date    1:47   16.77 .320
      [CN= 71.0: N= 3.00]
      [Tp=  .33:DT= 2.50]

005:0017---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            08:SPOND          27.40     .523 No_date    2:32   31.01  n/a
                      + 09:205             1.34     .047 No_date    1:47   16.77  n/a
      [DT= 2.50]  SUM=  01:S1             28.74     .545 No_date    2:27   30.35  n/a

005:0018---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    05:206S2           2.69     .226 No_date    1:21   29.29 .559
      [XIMP=.25:TIMP=.50]
      [SLP=1.00:DT= 1.00]
      [LOSS= 2 :CN= 71.0]

005:0019---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      02:207             7.96     .202 No_date    1:52   13.82 .264
      [CN= 65.0: N= 3.00]
      [Tp=  .41:DT= 2.50]

005:0020---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:207             7.96     .202 No_date    1:52   13.82  n/a
                      + 01:S1             28.74     .545 No_date    2:27   30.35  n/a
                      + 04:N1            103.71    1.966 No_date    2:38   25.46  n/a
      [DT= 1.00]  SUM=  09:ND            140.41    2.620 No_date    2:33   25.80  n/a
  ** END OF RUN :    5

*******************************************************************************




 RUN:COMMAND#

006:0001------------------------------------------------------------------------------
     START
      [TZERO =    .00 hrs on        0]
      [METOUT=   2    (1=imperial, 2=metric output)]
      [NSTORM=   1 ]
      [NRUN  =   6 ]
#******************************************************************************
#  Project Name: [SB] Project Number: [300031145]
#  Date        : 02-19-2018
#  Modeller    : [JMS/AJC]
#  Company     : R.J. Burnside & Associates
#  License #   :  3245976
#******************************************************************************

006:0002------------------------------------------------------------------------------
     READ STORM
      Filename = STORM.001
      Comment  =
      [SDT= 5.00:SDUR=   4.00:PTOT=  35.43]
# **********************************************************************
# North West Fergus Secondary Area - Post Development                  *
# **********************************************************************
```

```
006:0003---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    03:201           54.56    2.721 No_date    1:25   18.41 .520
      [XIMP=.30:TIMP=.54]
      [SLP=1.00:DT= 5.00]
      [LOSS= 2 :CN= 71.0]

006:0004---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    04:202            3.86     .271 No_date    1:20   17.37 .490
      [XIMP=.28:TIMP=.47]
      [SLP=1.00:DT= 2.50]
      [LOSS= 2 :CN= 71.0]

006:0005---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     COMPUTE DUALHYD    04:202            3.86     .271 No_date    1:20   17.37  n/a
        Major System /  05:202Maj          .00     .000 No_date    0:00     .00  n/a
        Minor System \  06:202min         3.86     .271 No_date    1:20   17.37  n/a

006:0006---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            03:201           54.56    2.721 No_date    1:25   18.41  n/a
                     +  06:202min         3.86     .271 No_date    1:20   17.37  n/a
      [DT= 2.50]  SUM=  07:TO POND       58.42    2.902 No_date    1:25   18.34  n/a

006:0007---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE RESERVOIR -> 07:TO POND       58.42    2.902 No_date    1:25   18.34  n/a
      [RDT= 2.50] out<- 01:NPOND         58.42     .313 No_date    3:52   18.34  n/a
            overflow <= 04:         2      .00     .000 No_date    0:00     .00  n/a
     {MxStoUsed=.8190E+00, TotOvfVol=.0000E+00, N-Ovf=    0, TotDurOvf=    0.hrs}

006:0008---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    02:203            1.06     .055 No_date    1:20   15.04 .424
      [XIMP=.19:TIMP=.38]
      [SLP=1.00:DT= 1.00]
      [LOSS= 2 :CN= 71.0]

006:0009---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            01:NPOND         58.42     .313 No_date    3:52   18.34  n/a
                     +  02:203            1.06     .055 No_date    1:20   15.04  n/a
                     +  05:202Maj          .00     .000 No_date    0:00     .00  n/a
      [DT= 1.00]  SUM=  03:NOR           59.48     .318 No_date    3:50   18.28  n/a

006:0010---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      01:EX1A          42.09     .425 No_date    2:35    9.34 .264
      [CN= 74.0: N= 3.00]
      [Tp=  .92:DT= 2.50]

006:0011---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE PIPE      -> 01:EX1A          42.09     .425 No_date    2:35    9.34  n/a
      [RDT= 2.50] out<- 02:EX1R          42.09     .413 No_date    2:47    9.34  n/a
      [L/S/n=  915./ .200/.013]
      {Vmax= 1.073:Dmax=  .218}
      {HGTH=  .90:WDTH= 1.80}

006:0012---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:EX2A           2.14     .038 No_date    1:45    8.36 .236
      [CN= 71.0: N= 3.00]
      [Tp=  .32:DT= 2.50]

006:0013---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:EX1R          42.09     .413 No_date    2:47    9.34  n/a
                     +  03:NOR           59.48     .318 No_date    3:50   18.28  n/a
                     +  09:EX2A           2.14     .038 No_date    1:45    8.36  n/a
      [DT= 1.00]  SUM=  04:N1           103.71     .697 No_date    3:02   14.45  n/a
```

```
006:0014---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    01:204           27.40    1.499 No_date    1:25   18.48 .522
      [XIMP=.30:TIMP=.55]
      [SLP=1.00:DT= 2.50]
      [LOSS= 2 :CN= 71.0]

006:0015---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ROUTE RESERVOIR -> 01:204           27.40    1.499 No_date    1:25   18.48  n/a
      [RDT= 2.50] out<- 08:SPOND         27.40     .212 No_date    3:05   18.48  n/a
     {MxStoUsed=.3612E+00}

006:0016---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      09:205            1.34     .023 No_date    1:45    8.36 .236
      [CN= 71.0: N= 3.00]
      [Tp=  .33:DT= 2.50]

006:0017---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            08:SPOND         27.40     .212 No_date    3:05   18.48  n/a
                     +  09:205            1.34     .023 No_date    1:45    8.36  n/a
      [DT= 2.50]  SUM=  01:S1            28.74     .218 No_date    3:02   18.01  n/a

006:0018---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN STANDHYD    05:206S2          2.69     .167 No_date    1:21   17.21 .486
      [XIMP=.25:TIMP=.50]
      [SLP=1.00:DT= 1.00]
      [LOSS= 2 :CN= 71.0]

006:0019---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     DESIGN NASHYD      02:207            7.96     .097 No_date    1:52    6.74 .190
      [CN= 65.0: N= 3.00]
      [Tp=  .41:DT= 2.50]

006:0020---------------ID:NHYD-----------AREA----QPEAK-TpeakDate_hh:mm----R.V.-R.C.-
     ADD HYD            02:207            7.96     .097 No_date    1:52    6.74  n/a
                     +  01:S1            28.74     .218 No_date    3:02   18.01  n/a
                     +  04:N1           103.71     .697 No_date    3:02   14.45  n/a
      [DT= 1.00]  SUM=  09:ND           140.41     .951 No_date    3:00   14.74  n/a

006:0002----------------------------------------------------------------------------
      FINISH
------------------------------------------------------------------------------------
-
************************************************************************************
*
     WARNINGS / ERRORS / NOTES
     -------------------------
 001:0011 ROUTE PIPE      ->
      *** WARNING: New pipe size used for routing.
   Simulation ended on 2018-02-20     at 13:10:57
====================================================================================
=
```

Project: NW Fergus
File: 300031145
Designed by: J.Scott, A. Crookes
Checked by: L.Niemi, J. Smith
Date: 16-Feb-18

BURNSIDE

NORTH POND IMPERVIOUS CALCULATIONS

Total Drainage Area= 594900 m2 **or** 59.49 ha

Institutional Areas (m2)

25770	School	(maj & min split)

Total Area= 2.577 ha

		Area	
TIMP	65%	1.68	ha
XIMP	40%	1.03	ha

Commercial Areas(m2)

Total Area 0 ha

		Area	
TIMP	90%	0.00	ha
XIMP	90%	0.00	ha

External Areas (m2)

85400	Keating Land

Total Area 8.54 ha

		Area	
TIMP	47%	4.01	ha
XIMP	30%	2.56	ha

SWM Block(m2)

21715	North Pond

Total Area 2.17 ha

		Area	
TIMP	50%	1.09	ha
XIMP	50%	1.09	ha

Residential Areas(m2)

357585	remainder
16935	Medium Density (Ph 1)
53235	Medium Density (Ph 2)
6665	Low Density (Uncont)

Total Area 43.44 ha

		Area	
TIMP low	55%	19.67	ha
XIMP low	28%	10.01	ha

		Area	
TIMP med	65%	4.56	ha
XIMP med	35%	2.46	ha

		Area	
TIMP uncont	55%	0.37	ha
XIMP uncont	28%	0.19	ha

Parkland Areas(m2)

12865	Park (Ph 1)	(maj & min split)
10760	Park (Ph 2)	(incl. controlled Ph 1)
3970	Park (Uncont)	

Total Area 2.76 ha

		Area	
TIMP ph 1	10%	0.13	ha
XIMP ph 1	5%	0.06	ha

		Area	
TIMP ph 2	10%	0.11	ha
XIMP ph 2	5%	0.05	ha

		Area	
TIMP uncont	10%	0.040	ha
XIMP uncont	5%	0.020	ha

Total Area (less Residential)= 16.05 ha
Total Residential Area(if not able to directly measure)= 43.44 ha

CATCHMENT 201 - Both Major and Minor to Pond

				Total Area
Total TIMP=	**29.44 ha**	**Overall TIMP=**	**53.9 %**	
Total XIMP=	**16.17 ha**	**Overall XIMP=**	**29.6 %**	
TOTAL Area (201)=	**54.56 ha**	**TOTAL Pervious (201)=**		**25.13 ha**

CATCHMENT 202 - Only Minor to Pond

Total TIMP=	**1.80 ha**	**Overall TIMP=**	**46.7 %**	
Total XIMP=	**1.10 ha**	**Overall XIMP=**	**28.3 %**	
TOTAL Area (202)=	**3.86 ha**	**TOTAL Pervious (202)=**		**2.06 ha**

CATCHMENT 203 - Both Major and Minor to Nichol Drain

Total TIMP=	**0.41 ha**	**Overall TIMP=**	**38.2 %**	
Total XIMP=	**0.21 ha**	**Overall XIMP=**	**19.4 %**	
TOTAL Area (203)=	**1.06 ha**	**TOTAL Pervious (203)=**		**0.66 ha**

TOTAL Modelled Area=	**59.49 ha**	**TOTAL Pervious Area=**	**27.84 ha**
OVERALL TIMP	**0.532**		
OVERALL XIMP	**0.294**		

TOTAL Area to Pond=	**58.43 ha**	**TOTAL Pervious Area=**	**27.19 ha**
OVERALL TIMP	**0.535**		
OVERALL XIMP	**0.295**		

BURNSIDE

Project:	NW Fergus
File:	300031145
Designed by:	J.Scott
Checked by:	L.Niemi
Date:	16-Feb-18

SOUTH POND IMPERVIOUS CALCULATIONS

Total South Plan Area=	**329106**	**m2**	**or**	**32.91**	**ha**
Total Drainage Area to Colborne=	**26900**	**m2**	**or**	**2.69**	**ha**
Total Site Control Area=	**14800**	**m2**	**or**	**1.48**	**ha**
Total Drainage Area to Nichol=	**13400**	**m2**	**or**	**1.34**	**ha**
Total Drainage Area to Pond=	**274006**	**m2**	**or**	**27.40**	**ha**

Note: Roof leaders will discharge to the lawn

Institutional Areas (m2)

Total Area= 0 ha

		Area
TIMP	55%	0.00 ha
XIMP	30%	0.00 ha

Commercial Areas(m2)

0	to pond
14800	to drain

Area to Pond 0 ha

Area to Drain 1.48 ha

		Area
TIMP (pond)	90%	0.00 ha
XIMP (pond)	90%	0.00 ha

		Area
TIMP (drain)	90%	1.33 ha
XIMP (drain)	90%	1.33 ha

Medium Density Residential (m2)

22900	Colborne Street

Total Area 2.29 ha

		Area
TIMP	65%	1.49 ha
XIMP	35%	0.80 ha

SWM Block(m2)

18800	South Pond

Total Area 1.88 ha

		Area
TIMP	50%	0.94 ha
XIMP	50%	0.94 ha

Residential Areas(m2)

226406	to Pond
23600	to Colborne
13400	to Nichol

Area to Pond 22.64 ha

Area to Colborne 2.36 ha

Area to Nichol 1.34 ha

		Area
TIMP (Pond)	55%	12.45 ha
XIMP (Pond)	28%	6.34 ha

		Area
TIMP (colborne)	55%	1.30 ha
XIMP (colborne)	28%	0.66 ha

		Area
TIMP (nichol)	55%	0.74 ha
XIMP (nichol)	28%	0.38 ha

Parkland Areas(m2)

5900	to pond/drain
3300	to Colborne

Area to Pond 0.59 ha

Area to Colborne 0.33 ha

		Area
TIMP (Pond)	10%	0.06 ha
XIMP (Pond)	5%	0.03 ha

		Area
TIMP (colborne)	10%	0.03 ha
XIMP (colborne)	5%	0.02 ha

TOTAL Area to Pond **27.40 ha**

Total TIMP=	**14.94 ha**	**Overall TIMP=**	**54.5 %**
Total XIMP=	**8.11 ha**	**Overall XIMP=**	**29.6 %**

TOTAL Area to Colborne Culvert **2.69 ha**

Total TIMP=	**1.33 ha**	**Overall TIMP=**	**49.5 %**
Total XIMP=	**0.68 ha**	**Overall XIMP=**	**25.2 %**

TOTAL Area with site controls **1.48 ha**

Total TIMP=	**1.33 ha**	**Overall TIMP=**	**90.0 %**
Total XIMP=	**1.33 ha**	**Overall XIMP=**	**90.0 %**

TOTAL Area directly to Nichol Drain **1.34 ha**

Total TIMP=	**0.74 ha**	**Overall TIMP=**	**55.0 %**
Total XIMP=	**0.38 ha**	**Overall XIMP=**	**28.0 %**

Project: NW Fergus
File: 300031145
Designed by: L.Niemi
Date: 16-Feb-18

BURNSIDE

Wet Pond Permament Pool Requirement - SOUTH POND

MOE Table 3.2 Water Quality Storage Requirements Based on Receiving Waters.

IMPERVIOUSNESS 54.5 %
Protection Level (1, 2, or 3) 1

NOTE - 40 cu.m/ha has been removed from MOE table values for Ex. Detention Portion

Enhanced (Level 1) Protection

x	**y**	**Known (x)**	**Calc (y)**	
Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Total Permanent Pool Required (cu.m)
35	100	**54.5**	**148.81**	**4077.47**
55	150			
70	185			
85	210			
95.0	**236**	**Extrapolated**		

Normal (Level 2) Protection

x	**y**	**Known (x)**	**Calc (y)**	
Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Total Permanent Pool Required (cu.m)
35	50	**54.5**	**69.52**	**1904.99**
55	70			
70	90			
85	110			
95.0	**121**	**Extrapolated**		

Basic (Level 3) Protection

x	**y**	**Known (x)**	**Calc (y)**	
Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Total Permanent Pool Required (cu.m)
35	20	**54.5**	**34.64**	**949.23**
55	35			
70	45			
85	55			
95.0	**62**	**Extrapolated**		

Project: NW Fergus
File: 300031145
Designed by: J.Scott, A. Crookes
Checked by: L.Niemi, J. Smith
Date: 16-Feb-18

BURNSIDE

Wet Pond Permament Pool Requirement - NORTH POND

MOE Table 3.2 Water Quality Storage Requirements Based on Receiving Waters.

IMPERVIOUSNESS 53.47 %
Protection Level (1, 2, or 3) 1

NOTE - 40 cu.m/ha has been removed from MOE table values for Ex. Detention Portion

Enhanced (Level 1) Protection

x	**y**	**Known (x)**	**Calc (y)**	
Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Total Permanent Pool Required (cu.m)
35	100	**53.47**	**146.17**	**8540.10**
55	150			
70	185			
85	210			
95.0	**236**	**Extrapolated**		

Normal (Level 2) Protection

x	**y**	**Known (x)**	**Calc (y)**	
Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Total Permanent Pool Required (cu.m)
35	50	**53.47**	**68.47**	**4000.31**
55	70			
70	90			
85	110			
95.0	**121**	**Extrapolated**		

Basic (Level 3) Protection

x	**y**	**Known (x)**	**Calc (y)**	
Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Imperviousness (%)	Permanent Pool StorageVolume (cu.m./ha)	Total Permanent Pool Required (cu.m)
35	20	**53.47**	**33.85**	**1977.77**
55	35			
70	45			
85	55			
95.0	**62**	**Extrapolated**		

EXTENDED DETENTION CALCULATIONS

BURNSIDE

Project: NW Fergus
File: 300031145
Designed by: J.Scott, A. Crookes
Checked by: L.Niemi, J. Smith
Date: 16-Feb-18

Extended Detention Storage Required - SCS Method SOUTH POND

Q = (P-IA)^2/P-(IA-S)
S = -254+25400/CN
T IMP = **54.5** %

SOUTH POND

Pervious Area			**Impervious Area**		
P =	**25**	mm	P =	25	mm
IA =	**2.5**	mm	IA =	**2.5**	mm
CN =	**71**		CN =	98	
S =	103.7		S =	5.2	
Q =	4.0	mm	Q =	18.3	mm

	per	**imp**	**total**	
SCS Runoff Volume	4.0	18.3		mm
Drainage Area	12.46	14.94	**27.40**	ha
Storage Volume	500	2732	3232	cu.m

Extended Detention Component of SOUTH Pond : 3232 cu.m

Orifice Sizing per MOE 2003 SWM Manual - Falling Head Equation

t = 2*Ap*(h^0.5)/(C*Ao*(g*2)^0.5)

t =	drawdown time	**86400**	seconds	*based on 24hr ED req.
Ao =	cross sectional area of orifice		sq.m	*to be calculated
h =	maximum water elevation above orifice (depth of ED)	**0.40**	m	*depth of ED
C =	discharge coefficient	0.64		
Ap =	average pond surface area for extended detention	**8765.00**	sq.m	*based on pond design

Ao =	0.0453 sq.m	d =	240	mm		
Actual Diameter		d =	**230**	mm	Ao =	0.042
Actual Drawdown Time			26.148	hrs		

EXTENDED DETENTION CALCULATIONS

BURNSIDE

Project: NW Fergus
File: 300031145
Designed by: J.Scott, A. Crookes
Checked by: L.Niemi, J. Smith
Date: 16-Feb-18

Extended Detention Storage Required - SCS Method NORTH POND

Q = (P-IA)^2/P-(IA-S)
S = -254+25400/CN
T IMP = **53.47** %

NORTH POND

Pervious Area			**Impervious Area**		
P =	**25**	mm	P =	25	mm
IA =	**2.5**	mm	IA =	**2.5**	mm
CN =	**71**		CN =	98	
S =	103.7		S =	5.2	
Q =	4.0	mm	Q =	18.3	mm

	per	**imp**	**total**	
SCS Runoff Volume	4.0	18.3		mm
Drainage Area	27.19	31.24	**58.43**	ha
Storage Volume	1090	5713	6803	cu.m

Extended Detention Component of NORTH Pond : 6803 cu.m

Orifice Sizing per MOE 2003 SWM Manual - Falling Head Equation

t = 2*Ap*(h^0.5)/(C*Ao*(g*2)^0.5)

t =	drawdown time	**86400**	seconds	*based on 24hr ED req.
Ao =	cross sectional area of orifice		sq.m	*to be calculated
h =	maximum water elevation above orifice (depth of ED)	**0.72**	m	*depth of ED
C =	discharge coefficient	0.6		
Ap =	average pond surface area for extended detention	**9465.00**	sq.m	*based on pond design

Ao = 0.0700 sq.m — d = 298 mm
Actual Diameter — d = **285** mm — Ao = 0.064
Actual Drawdown Time — 26.317 hrs

SEDIMENT FOREBAY SIZING SOUTH POND

BURNSIDE

Project: NW Fergus
File: 300031145
Designed by: J.Scott, A. Crookes
Checked by: L.Niemi, J. Smith
Date: 16-Feb-18

NORTH FOREBAY

SOUTH POND Forebay Length: Two calculations (per MOE SWMP Manual, 2003)

1) Settling Calculations **Dist = SQRT(r * Qp / Vs)**
(Equation 4.5, MOE 2003)

where:
Dist = Forebay length (m)
r = Length to width ratio of forebay
Qp = Peak flowrate from the pond during quality design storm (cms)
Vs = Settling velocity (m/s)

given:
r = 2
Qp = 0.07481 cms *see below
Vs = 0.0003 m/s

therefore:
Dist = 22.3 metres
Width= 11.2 metres

Peak quality flowrate (Qp) from pond based on release rate and volume of extended detention multiplied by a factor of 2.0 for peaking

Extended Detention Vol 3232 cu.m (extended det. volume)
Release Rate 24 hrs (typically 24 or 48)
Qp 0.07481 cms

2) Dispersion Length **Dist = (8 * Q) / (d * Vf)**
(Equation 4.6,MOE 2003)

where:
Dist = Forebay length (m)
Q = inlet flowrate (cms)
d = depth of permanent pool in forebay (m)
Vf = desired forebay velocity (m/s)

given:
Q = 1.164 cms *see below
d = 2 m
Vf = 0.5 m/s

therefore:
Dist = 9.3 metres
Width= 4.7 metres
Min Bottom Width= 1.2 metres *MOE equation 4.6
Pond Side Slopes: 5
Calc. Top Width= 21.164 metres
Calc. Top Length= 42.328 meters

Peak inflow rate calculated based on STORM SEWER DESIGN FLOW per rational method sewer calculation.

NOTE - 5 year Storm sewer design Sheet output

Minimum Forebay Dimension:

Length= 42.3 meters
Width= 21.2 meters

Actual Forebay Design:

Length= 45.0 meters
Width= 22.0 meters

Check Average velocity in forebay <= 0.15 m/s
Pond Side Slopes: 5 H : 1 V
Q = V x A Q = 1.164 A = 24 sq.metres

therefore: V = 0.0485 m/s
Design: **OK**

SEDIMENT FOREBAY SIZING SOUTH POND

BURNSIDE

Project: NW Fergus
File: 300031145
Designed by: J.Scott, A. Crookes
Checked by: L.Niemi, J. Smith
Date: 16-Feb-18

SOUTH FOREBAY

SOUTH POND Forebay Length: Two calculations (per MOE SWMP Manual, 2003)

1) Settling Calculations **Dist = SQRT(r * Qp / Vs)**
(Equation 4.5, MOE 2003)

where:
Dist = Forebay length (m)
r = Length to width ratio of forebay
Qp = Peak flowrate from the pond during quality design storm (cms)
Vs = Settling velocity (m/s)

given:
r = 2
Qp = 0.07481 cms *see below
Vs = 0.0003 m/s

therefore:
Dist = 22.3 metres
Width= 11.2 metres

Peak quality flowrate (Qp) from pond based on release rate and volume of extended detention multiplied by a factor of 2.0 for peaking

Extended Detention Vol 3232 cu.m (extended det. volume)
Release Rate 24 hrs (typically 24 or 48)
Qp 0.07481 cms

2) Dispersion Length **Dist = (8 * Q) / (d * Vf)**
(Equation 4.6,MOE 2003)

where:
Dist = Forebay length (m)
Q = inlet flowrate (cms)
d = depth of permanent pool in forebay (m)
Vf = desired forebay velocity (m/s)

given:
Q = 0.979 cms *see below
d = 2 m
Vf = 0.5 m/s

therefore:
Dist = 7.8 metres
Width= 3.9 metres
Min Bottom Width= 1.0 metres *MOE equation 4.6
Pond Side Slopes: 5
Calc. Top Width= 20.979 metres
Calc. Top Length= 41.958 meters

Peak inflow rate calculated based on STORM SEWER DESIGN FLOW per rational method sewer calculation.

NOTE - 5 year Storm sewer design Sheet output

Minimum Forebay Dimension:

Length= 42.0 meters
Width= 21.0 meters

Actual Forebay Design:

Length= 45.0 meters
Width= 22.0 meters

Check Average velocity in forebay <= 0.15 m/s
Pond Side Slopes: 5 H : 1 V
Q = V x A Q = 0.979 A = 24 sq.metres

therefore: V = 0.0408 m/s
Design: **OK**

SEDIMENT FOREBAY SIZING NORTH POND

BURNSIDE

Project: NW Fergus
File: 300031145
Designed by: J.Scott, A. Crookes
Checked by: L.Niemi, J. Smith
Date: 16-Feb-18

NORTH FOREBAY

NORTH POND Forebay Length: Two calculations (per MOE SWMP Manual, 2003)

1) Settling Calculations Dist = SQRT(r * Qp / Vs)

(Equation 4.5, MOE 2003)

where:
Dist = Forebay length (m)
r = Length to width ratio of forebay
Qp = Peak flowrate from the pond during quality design storm (cms)
Vs = Settling velocity (m/s)

given:
r = 2
Qp = 0.15747 cms *see below
Vs = 0.0003 m/s

therefore:
Dist = 32.4 metres
Width= 16.2 metres

Peak quality flowrate (Qp) from pond based on release rate and volume of extended detention multiplied by a factor of 2.0 for peaking

Extended Detention Vol 6803 cu.m (extended det. volume)
Release Rate 24 hrs (typically 24 or 48)

Qp 0.15747 cms

2) Dispersion Length Dist = (8 * Q) / (d * Vf)

(Equation 4.6,MOE 2003)

where:
Dist = Forebay length (m)
Q = inlet flowrate (cms)
d = depth of permanent pool in forebay (m)
Vf = desired forebay velocity (m/s)

given:
Q = 4.092 cms *see below
d = 2 m
Vf = 0.5 m/s

therefore:
Dist = 32.7 metres
Width= 16.4 metres
Min Bottom Width= 4.1 metres *MOE equation 4.6
Pond Side Slopes: 5
Calc. Top Width= 24.092 metres
Calc. Top Length= 48.184 meters

Peak inflow rate calculated based on STORM SEWER DESIGN FLOW per rational method sewer calculation.

NOTE - 5-year Storm sewer design Sheet output for total north storm sewer inlet flow

Minimum Forebay Dimension:

Length= 48.2 meters
Width= 24.1 meters

Actual Forebay Design:

Length= 52.0 meters
Width= 25.0 meters

Check Average velocity in forebay <= 0.15 m/s
Pond Side Slopes: 5 H : 1 V
Q = V x A Q = 4.092 A = 30 sq.metres

therefore: V = 0.1364 m/s
Design: **OK**

SECONDARY SEDIMENT FOREBAY SIZING

Project: NW Fergus
File: 300031145
Designed by: J.Scott, A. Crookes
Checked by: L.Niemi
Date: 16-Feb-18

SOUTH FOREBAY

NORTH POND Forebay Length: Two calculations (per MOE SWMP Manual, 2003)

1) Settling Calculations

Dist = SQRT(r * Qp / Vs)

(Equation 4.5, MOE 2003)

where:
Dist = Forebay length (m)
r = Length to width ratio of forebay
Qp = Peak flowrate from the pond during quality design storm (cms)
Vs = Settling velocity (m/s)

given:
r = 2
Qp = 0.15747 cms *see below
Vs = 0.0003 m/s

therefore:
Dist = 32.4 metres
Width= 16.2 metres

Peak quality flowrate (Qp) from pond based on release rate and volume of extended detention multiplied by a factor of 2.0 for peaking

Ext. Detention Vol 6803 cu.m (extended det. volume)
Release Rate 24 hrs (typically 24 or 48)

Qp 0.15747 cms

2) Dispersion Length

Dist = (8 * Q) / (d * Vf)

(Equation 4.6,MOE 2003)

where:
Dist = Forebay length (m)
Q = inlet flowrate (cms)
d = depth of permanent pool in forebay (m)
Vf = desired forebay velocity (m/s)

given:
Q = 1.328 cms *see below
d = 1.5 m
Vf = 0.5 m/s

therefore:
Dist = 14.2 metres
Width= 7.1 metres
Min Bottom Width= 1.8 metres *MOE equation 4.6
Pond Side Slopes: 5
Calc. Top Width= 16.77 metres
Calc. Top Length= 33.54 metres

Peak inflow rate calculated based on STORM SEWER DESIGN FLOW per rational method sewer calculation.

NOTE - Combination of 5-year and 100-year capture within the sewers

Minimum Forebay Dimension:

Length= 33.5 meters
Width= 16.8 meters

Actual Forebay Design:

Length= 36.0 meters
Width= 17.0 meters

Check Average velocity in forebay <= 0.15 m/s
Pond Side Slopes: 5 H : 1 V
Q = V x A Q = 1.328 A = 14 sq.metres

therefore: V = 0.093 m/s
Design: **OK**

POND DESIGN PARAMETERS

Project:	NW Fergus
File:	300031145
Designed by:	J.Scott, A. Crookes
Checked by:	L.Niemi, J. Smith
Date:	16-Feb-18

North Pond Design Parameters:

Total Minor System Drainage Area to Pond Forebay (including Collie Court)

Catchment Area:	58.43	ha
Calculated CN:	71	
Total Impervious:	53.5	%
Directly Connected Impervious:	29.5	%

Total Major System Drainage Area to Pond (excludes Park and School)

Catchment Area:	54.56	ha
Total Impervious:	53.9	%
Directly Connected Impervious:	29.6	%

North Pond Control Parameters:

	Pre Dev Flow (cms)	**Unc. Flow to Pond* (cms)**	**HYMO Output Pond Outflow (cms)**	**Required Storage (cu.m)**	**Stage (m)**	**Provided Storage (cu.m)**	**Unc. Flow to Nichol** (cms)**	**Total Flow to Nichol*** (cms)**
Ex. Det.				6,803	409.57	6,857		
2 year	0.774	2.902	0.313	8,190	409.69	8,190	0.005	0.318
5 year	1.617	4.441	1.076	11,250	409.96	11,250	0.016	1.092
10 year	2.294	5.996	1.745	13,450	410.14	13,450	0.028	1.773
25 year	3.265	7.762	2.770	16,240	410.36	16,240	0.043	2.813
50 year	4.069	9.110	3.599	18,350	410.53	18,350	0.058	3.657
100 year	4.915	10.513	4.462	20,430	410.68	20,430	0.071	4.533

* Includes all of Catchment 201 and the minor flows from Catchment 202

** Includes all of Catchment 203 and the major flows from Catchment 202

*** Includes outflow from pond, all of Catchment 203 and the major flows from Catchment 202 (flow to NOR

Berm/Overflow Spillway - North Pond

Qw = Cd*b*H^1.5

Cd = Coefficient of discharge = 1.705

H = Head over weir

b = Length of weir

Emergency Overflow

Flow (Max 100 year)	**10.513**	cms
Maximum Head	**0.3**	m
Calculated Length	37.52	m

	Spill 1	
Provided Length	**38.0**	**m**
Calculated Flow	10.646	cms

Permanent Pool Volumes

Volume Required	8,540	cu.m	
Volume Provided	11,327	cu.m	
Forebay PP Volume	1,780	cu.m	
Forbay PP Volume R	16%		**OK**
Forebay PP Area	1,890	sq.m	
Forebay PP Area Rat	23%		**OK**

Forebay Berm	**North**	**South**	
Flow (Pipe Inflow)	4.092	1.328	cms
Maximum Head	**0.3**	**0.3**	**m**
Calculated Length	14.61	4.74	m
Provided Length	15.00	5.00	m
Calculated Flow	4.202	1.401	cms

Inlet Spillway Depth Calculation

(from Drainage Block 100 YEAR)

100 year flow (Hymo)	10.513	cu.m/s
Pipe flow (from design sheet)	5.420	cu.m/s
Spillway Flow (100yr-pipe)	5.093	cu.m/s
Calc. Flow Depth (Pond Slope)	0.2	m
Spillway Width	10	m
Spillway Roughness	0.035	(based on grass surface)

100 YEAR FLOW DEPTHS

						Spillway Data			
Drainage Block	Spillway Side Slopes V (m)	H (m)	Bottom Width (m)	Peak Flow (L/s)	Flow Depth (m)	Slope (%)	Area (sq. m)	Wetted Perimeter (m)	Capacity (L/s)
Typ. Pond Slope	1	4	8.4	5.093	0.2	20	1.840	10.05	7.58
Access Road	1	4	8.4	5.093	0.2	10	1.840	10.05	5.36

POND DESIGN PARAMETERS

BURNSIDE

Project:	NW Fergus
File:	300031145
Designed by:	J.Scott
Checked by:	L.Niemi
Date:	16-Feb-18

South Pond Design Parameters:

Total Drainage Area to Pond Forebay & to Pond for Quantity Control

Catchment Area:	27.40	ha
Calculated CN:	71	
Total Impervious:	54.5	%
Directly Connected Impervious:	29.6	%

South Pond Control Parameters:

	Pre Dev Flow (cms)	**Unc. Flow to Pond* (cms)**	**HYMO Output Pond Outflow (cms)**	**Required Storage (cu.m)**	**Unc. Flow to Nichol (1) (cms)**	**Site Controlled Flow to Nichol (2) (cms)**	**Total Flow to Nichol (3) (cms)**
Ex. Det.				3,232			
2 year	0.283	1.499	0.212	3,612	0.023	0.029	0.218
5 year	0.586	2.238	0.523	5,149	0.047	0.059	0.545
10 year	0.828	2.898	0.765	6,387	0.067	0.083	0.802
25 year	1.174	3.718	1.068	8,089	0.094	0.116	1.126
50 year	1.461	4.627	1.352	9,447	0.116	0.143	1.430
100 year	1.762	5.346	1.628	10,790	0.139	0.172	1.725

* Includes all of Catchment 204
(1) Includes all of Catchment 205
(2) Includes controlled flow from Catchment 207
(3) Includes outflow from pond and all of Catchment 205 (flow to S1)

Permanent Pool Volumes

Volume Required	4,077	cu.m	
Volume Provided	12,095	cu.m	
Forebay PP Volume	2,605	cu.m	
Forbay PP Volume Ratio	22%		**OK**
Forebay PP Area	2,720	sq.m	
Forebay PP Area Ratio	34%		**OK**

South Uncontrolled (flow to S2)

Drainage Area 2.69 ha

	Pre Dev. Flow (cms)	Uncont. Post Dev. Flow (cms)
2 Year	0.138	0.107
5 Year	0.277	0.226
10 Year	0.387	0.287
25 Year	0.543	0.360
50 Year	0.671	0.439
100 Year	0.804	0.517

Commercial Site Controls (Catchment 207)

Drainage Area 1.48 ha

	Pre Dev. Flow (cms)	Uncont. Post Dev. Flow (cms)	Controlled Post Dev. Flow (cms)
2 Year	0.029	0.096	0.029
5 Year	0.059	0.176	0.059
10 Year	0.083	0.237	0.083
25 Year	0.116	0.324	0.116
50 Year	0.143	0.391	0.143
100 Year	0.172	0.632	0.172

* Post to be controlled to Pre rates or lower

Nichol Drain @ D/S Limits of Site (flow to ND)

Drainage Area 140.41 ha

	Pre Dev. Flow (cms)	Controlled Post Dev. Flow (cms)
2 Year	1.443	0.951
5 Year	3.030	2.620
10 Year	4.307	3.938
25 Year	6.142	5.808
50 Year	7.663	7.368
100 Year	9.265	8.967

Project:	NW Fergus
File:	300031145
Designed by:	J.Scott, A. Crookes
Checked by:	L.Niemi, J. Smith
Date:	2/16/2018

BURNSIDE

NORTH POND

SWM Pond Storage Calculations

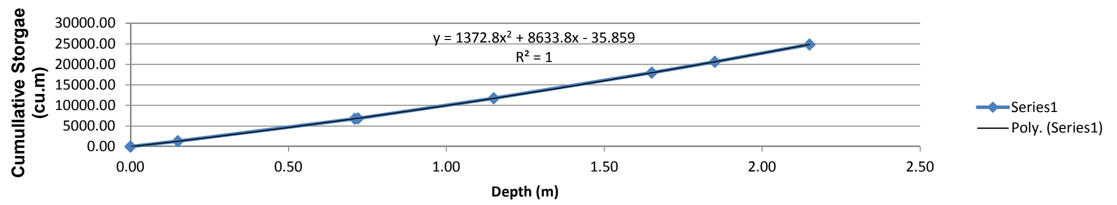
INPUT AREA

Base of Pond:	**405.85**	
N.W.L.:	**408.85**	masl
Increment for Volume:	0.2	m
Required Permanent Pool Volume:	8540	m^3
Permanent Pool Volume Provided:	11327	m^3

Red numbers indicate user input areas.

PERMANENT POOL ELEVATION / STORAGE INFORMATION

Description	**Elevation** (m)	**Stage** (m)	**Elev Above PP** (m)	**Deep Pool 1** (m2)	**Deep Outlet**	**Forebay** (m2)	**Total Area** (m2)	**Avg. Area** (m2)	**Incremental Storage** (m3)	**Cumulative Storage** (m3)	**Cumulative Storage in Outlet Pool**	**Cumulative Storage in Forebay**	**Cumulative Storage above Permanent Pool** (m3)
	405.85	-1.65		**0**	**825**	**0**	825.00					0.00	
	406.00	-1.50		**0**	**950**	**0**	950.00	887.50	133.12	133.12	133.12	0.00	
	406.50	-1.00		**0**	**1390**	**0**	1390.00	1170.00	585.00	718.12	718.12	0.00	
	406.85	-0.65		**0**	**2210**	**180**	2390.00	1890.00	661.50	1379.63	1328.63	51.00	
	407.00	-0.50		**0**	**2465**	**235**	2700.00	2545.00	381.75	1761.37	1692.21	69.17	
	407.35	-0.15		**0**	**3075**	**430**	3505.00	3102.50	1085.88	2847.25	2655.42	191.83	
	407.5	0.00		**0**	**3370**	**530**	3900.00	3702.50	555.37	3402.62	3134.29	268.33	
	408.00	0.50		**0**	**4365**	**920**	5285.00	4592.50	2296.25	5698.87	5068.04	630.83	
	408.5	1.00		**0**	**5380**	**1385**	6765.00	6025.00	3012.50	8711.37	7504.29	1207.08	
NWL	**408.85**	1.35	0.00	**0**	**6290**	**1890**	8180.00	7472.50	2615.38	11326.75	9546.54	1780.21	0.00
	409.00	1.50	0.15	**8830**	**0**	**0**	8830.00	8505.00	1275.75	12602.50	12602.50		1275.75
	409.56	2.06	0.71	**10720**	**0**	**0**	10720.00	9775.00	5474.00	18076.50	18076.50		6749.75
Extended Detention	**409.57**	2.07	0.72	**10750**	**0**	**0**	10750.00	10735.00	107.35	18183.85	18183.85		6857.10
	410.00	2.50	1.15	**11935**	**0**	**0**	11935.00	11342.50	4877.28	23061.12	23061.12		11734.37
	410.50	3.00	1.65	**13095**	**0**	**0**	13095.00	12515.00	6257.50	29318.62	29318.62		17991.87
HWL	**410.70**	3.20	1.85	**13540**	**0**	**0**	13540.00	13317.50	2663.50	31982.12	31982.12		20655.37
Freeboard	**411.00**	3.50	2.15	**14305**	**0**	**0**	14305.00	13922.50	4176.75	36158.87	36158.87		24832.12



The following cells contain the slope and X-intercept of the pond Stage-Storage Curve above.

Storage formula is y=C1* x^2 + C2 * x + b.

C1	**C2**	**b**
1372.85	8633.76	-35.86

Project:	**NW Fergus**
Location:	NW Fergus
Project #:	300031145
Designed by:	L.Niemi
Date:	2/16/2018

BURNSIDE

SWM Pond Storage Calculations - South Pond

INPUT AREA

Base of Pond:	405.65	
N.W.L.:	408.65	masl
Increment for Volume:	0.2	m
Required Permanent Pool Volume:	4077	m^3
Permanent Pool Volume Provided:	12095	m^3

Red numbers indicate user input areas.

ELEVATION / STORAGE INFORMATION

	Elevation (m)	Stage (m)	Area 1 (m2)	Area 2 (m2)	Total Area (m2)	Avg. Area (m2)	Incremental Storage (m3)	Cumulative Storage (m3)	Cumulative Storage above Permanent Pool (m3)	Required Volume (m3)
Base of Pond :	405.65	0.00	0	1090	1090.00		0.00			
	406.65	1.00	300	2270	2570.00	1830.00	1830.00	**1830.00**	**0.00**	
	407.65	2.00	1310	3670	4980.00	3775.00	3775.00	**5605.00**	**0.00**	
NWL :	408.65	3.00	2720	5280	8000.00	6490.00	6490.00	**12095.00**	**0.00**	4,077
ED	409.05	3.40	0	9530	9530.00	8765.00	3506.00	**15601.00**	**3506.00**	3,232
Top of Pond	409.80	4.15	0	11750	11750.00	10640.00	7980.00	**23581.00**	**11486.00**	10,790
Freeboard:	410.10	4.45	0	12560	12560.00	12155.00	3646.50	**27227.50**	**15132.50**	

EXTENDED DETENTION AND COOL WATER PERMANENT POOL VOLUME CALCULATIONS
NORTH POND

BURNSIDE

Project: NW Fergus
File: 300031145
Designed by: J. Scott
Checked by: L. Niemi
Date: 16-Feb-18

Cool Water Volume Required (between 1.5m and 3.0m deep in outlet) - SCS Method for 10mm Equivalent Runoff

Q = **(P-IA)^2/P-(IA-S)**
S = **-254+25400/CN**
T IMP = **53.5** %

Pervious Area			**Impervious Area**		
P =	10	mm	P =	10	mm
IA =	2.5	mm	IA =	2.5	mm
CN =	71		CN =	98	
S =	103.7		S =	5.2	
Q =	0.5	mm	Q =	4.4	mm

	per	**imp**	**total**	
SCS Runoff Volume	0.5	4.4		mm
Drainage Area	27.2	31.24	58.43	ha
Runoff Volume	137	1385	1523	cu.m

Permanent Pool Volume Required btwn 1.5 and 3.0m in Outle **1523** cu.m
Permanent Pool Available btwn 1.5 and 3.0m in Outle **2655** cu.m

Discharge time for Available Cool Water per MOE 2003 SWM Manual - Falling Head Equation

t = 2*Ap*(h^0.5)/(C*Ao*(g*2)^0.5)

h = water elevation above orifice for cool water volume 0.20 m
Ao = cross sectional area of orifice 0.06 sq.m
C = discharge coefficient 0.64
Ap = average pond surface area 8505 sq.m *based on pond design

t = **drawdown time** **=** **42064 seconds**
= **12 hrs**

EXTENDED DETENTION AND COOL WATER PERMANENT POOL VOLUME CALCULATIONS
SOUTH POND

BURNSIDE

Project: NW Fergus
File: 300031145
Designed by: J. Scott
Checked by: L. Niemi
Date: 16-Feb-18

Cool Water Volume Required (between 1.5m and 3.0m deep in outlet) - SCS Method for 10mm Equivalent Runoff

Q = **(P-IA)^2/P-(IA-S)**
S = **-254+25400/CN**
T IMP = **54.5** %

Pervious Area			**Impervious Area**		
P =	10	mm	P =	10	mm
IA =	2.5	mm	IA =	2.5	mm
CN =	71		CN =	98	
S =	103.7		S =	5.2	
Q =	0.5	mm	Q =	4.4	mm

	per	**imp**	**total**	
SCS Runoff Volume	0.5	4.4		mm
Drainage Area	12.5	14.94	27.40	ha
Runoff Volume	63	663	726	cu.m

Permanent Pool Volume Required btwn 1.5 and 3.0m in Outle **726** cu.m
Permanent Pool Available btwn 1.5 and 3.0m in Outle **1830** cu.m

Discharge time for Available Cool Water per MOE 2003 SWM Manual - Falling Head Equation

t = 2*Ap*(h^0.5)/(C*Ao*(g*2)^0.5)

h = water elevation above orifice for cool water volume 0.10 m
Ao = cross sectional area of orifice 0.04 sq.m
C = discharge coefficient 0.64
Ap = average pond surface area 7000 sq.m *based on pond design

t = **drawdown time** **=** **37588 seconds**
= **10 hrs**

POND DESIGN VOLUMETRIC TURNOVER CALCULATION
NORTH POND

BURNSIDE

Project:	NW Fergus
File:	300031145
Designed by:	J. Scott
Checked by:	L. Niemi
Date:	16-Feb-18

Permanent Pool Volumes

Volume Required	8,540	cu.m	(per PP Sheet)
Volume Provided	11,327	cu.m	(per design)

Site Runoff Coefficient Determination

Total Impervious Area	31.24	ha
Runoff Coefficient	0.57	
Total Pervious Area	27.19	ha
Runoff Coefficient	0.07	(sandy loam per MTO methodology)
Site Composite Runoff Coefficient	**0.34**	

Permanent Pool Requirements (per MOE Design Standards)

Volume = Runoff Coefficient * Drainage Area * Depth of Rainfall in Driest Month

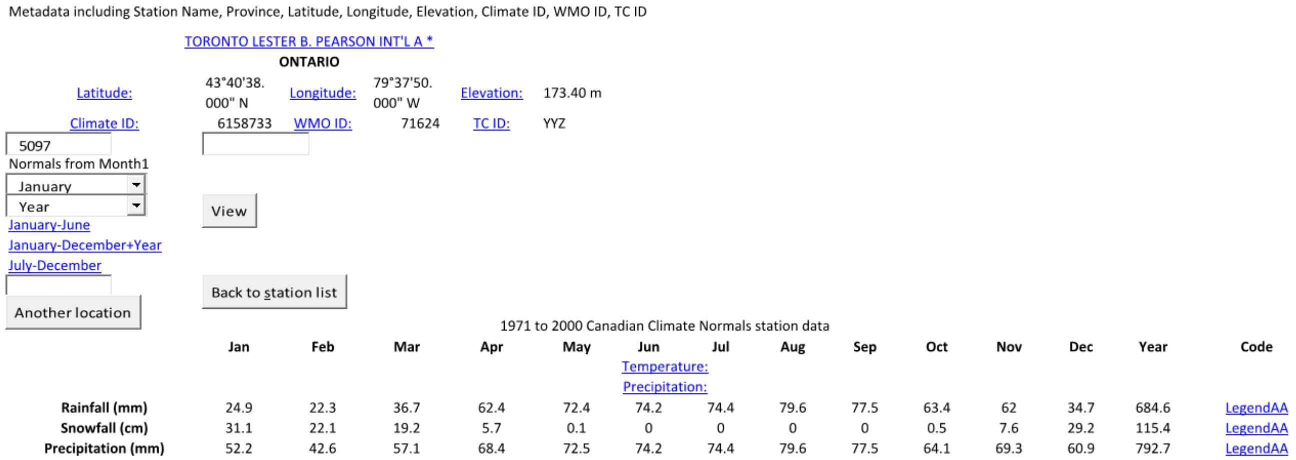
Site Drainage Area	58.43	ha
Site Composite Runoff Coefficient	0.34	
Rainfall Depth*	63.4	mm

* Rainfall based on October average monthly Rainfall data for Toronto Lester B Pearson International Airport Rain Guage data (1971 to 2000) as driest "non-winter" month

Minimum Permanent Pool Volume Required	8,540	cu.m
Maximum Permanent Pool Volume Permitted	12,580	cu.m

Total Permanent Pool Volume Provided	**11,327**	**cu.m**	**OK**

http://climate.weather.gc.ca/climate_normals/results_e.html?stnID=5097&autofwd=1



Metadata including Station Name, Province, Latitude, Longitude, Elevation, Climate ID, WMO ID, TC ID

TORONTO LESTER B. PEARSON INT'L A *
ONTARIO

Latitude:	43°40'38.000" N	Longitude:	79°37'50.000" W	Elevation:	173.40 m
Climate ID:	6158733	WMO ID:	71624	TC ID:	YYZ

1971 to 2000 Canadian Climate Normals station data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
						Temperature: Precipitation:								
Rainfall (mm)	24.9	22.3	36.7	62.4	72.4	74.2	74.4	79.6	77.5	63.4	62	34.7	684.6	LegendAA
Snowfall (cm)	31.1	22.1	19.2	5.7	0.1	0	0	0	0	0.5	7.6	29.2	115.4	LegendAA
Precipitation (mm)	52.2	42.6	57.1	68.4	72.5	74.2	74.4	79.6	77.5	64.1	69.3	60.9	792.7	LegendAA

POND DESIGN VOLUMETRIC TURNOVER CALCULATION
SOUTH POND

Project: NW Fergus
File: 300031145
Designed by: J. Scott
Checked by: L. Niemi
Date: 16-Feb-18

Permanent Pool Volumes

Volume Required	4,077	cu.m	(per PP Sheet)
Volume Provided	12,095	cu.m	(per design)

Site Runoff Coefficient Determination

Total Impervious Area	14.94	ha
Runoff Coefficient	0.58	
Total Pervious Area	12.46	ha
Runoff Coefficient	0.07	(sandy loam per MTO methodology)
Site Composite Runoff Coefficient	**0.35**	

Permanent Pool Requirements (per MOE Design Standards)

Volume = Runoff Coefficient * Drainage Area * Depth of Rainfall in Driest Month

Site Drainage Area	27.40	ha
Site Composite Runoff Coefficient	0.35	
Rainfall Depth*	63.4	mm

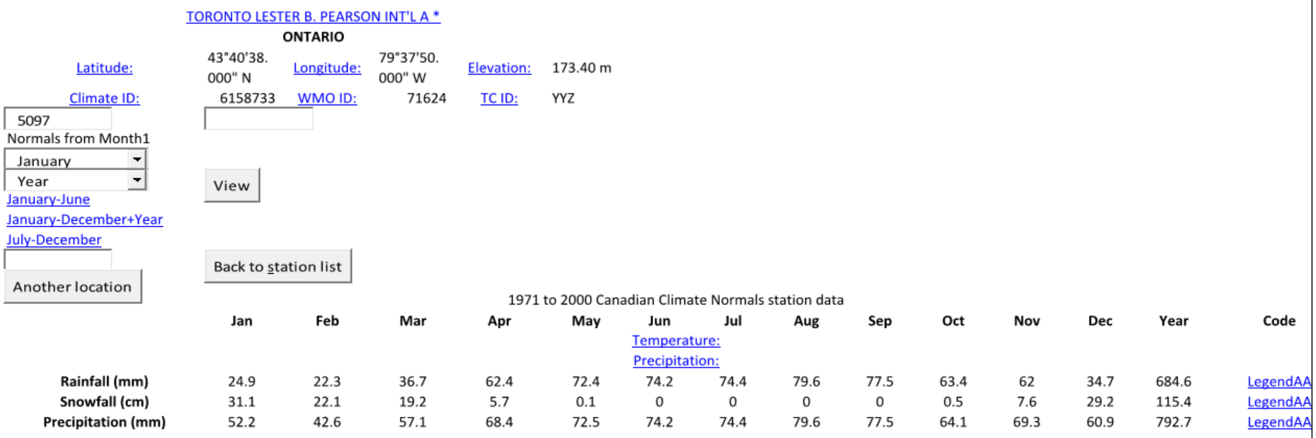
* Rainfall based on October average monthly Rainfall data for Toronto Lester B Pearson International Airport Rain Guage data (1971 to 2000) as driest "non-winter" month

Minimum Permanent Pool Volume Required	4,077	cu.m
Maximum Permanent Pool Volume Permitted	6,062	cu.m

Total Permanent Pool Volume Provided	**12,095**	**cu.m**	**OK**

http://climate.weather.gc.ca/climate_normals/results_e.html?stnID=5097&autofwd=1

Metadata including Station Name, Province, Latitude, Longitude, Elevation, Climate ID, WMO ID, TC ID



TORONTO LESTER B. PEARSON INT'L A *
ONTARIO

Latitude:	43°40'38.000" N	Longitude:	79°37'50.000" W	Elevation:	173.40 m
Climate ID:	6158733	WMO ID:	71624	TC ID:	YYZ

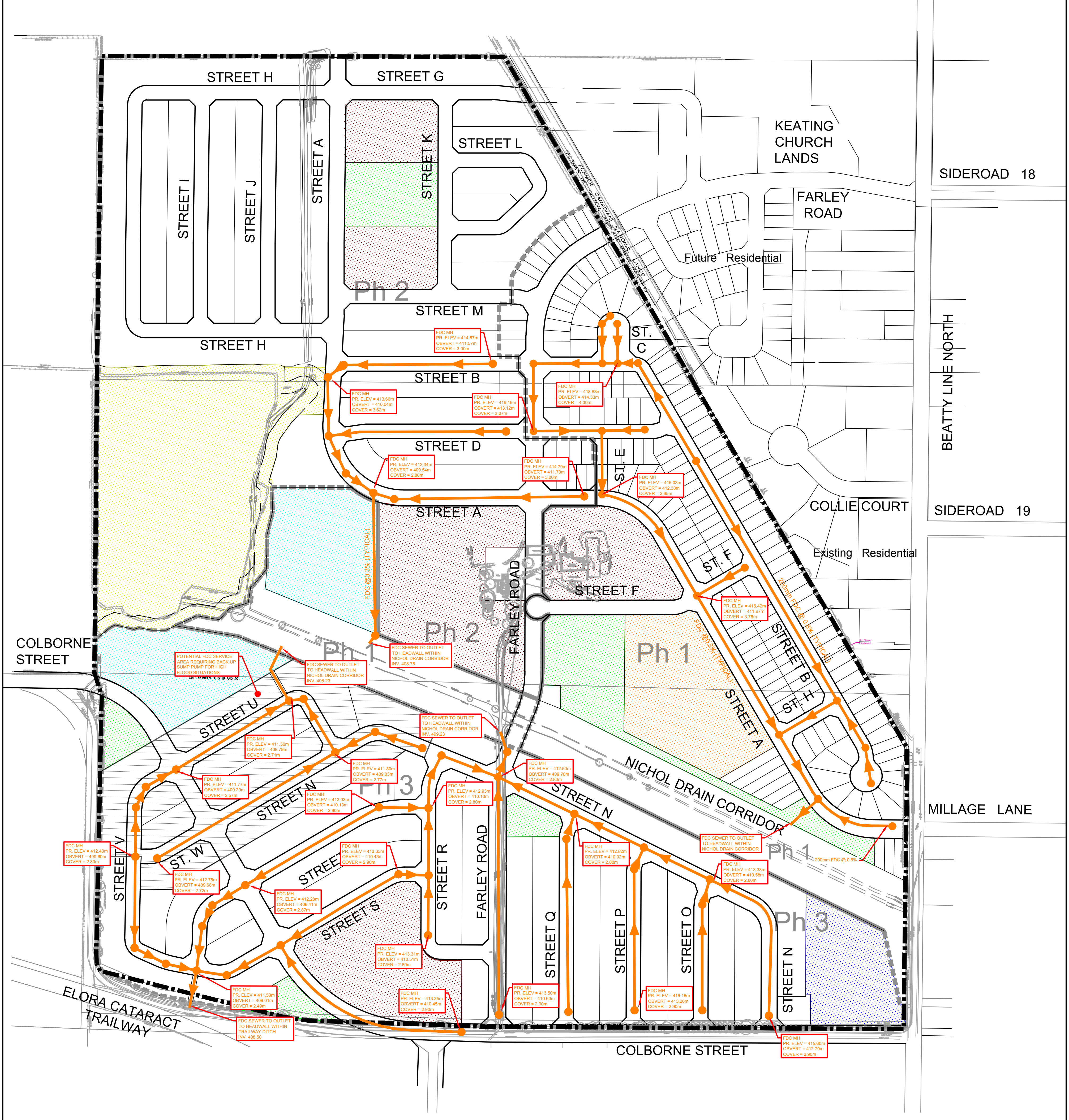
1971 to 2000 Canadian Climate Normals station data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Code
						Temperature:								
						Precipitation:								
Rainfall (mm)	24.9	22.3	36.7	62.4	72.4	74.2	74.4	79.6	77.5	63.4	62	34.7	684.6	LegendAA
Snowfall (cm)	31.1	22.1	19.2	5.7	0.1	0	0	0	0	0.5	7.6	29.2	115.4	LegendAA
Precipitation (mm)	52.2	42.6	57.1	68.4	72.5	74.2	74.4	79.6	77.5	64.1	69.3	60.9	792.7	LegendAA

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Drawings



LEGEND:

- ▬ · ▬ NORTH WEST FERGUS SECONDARY PLANNING AREA BOUNDARY
- ▪▪▪ PROPOSED PHASING LIMITS
- ●→ PROPOSED FDC SEWER
- 🟩 PROPOSED PARK BLOCK
- 🟥 PROPOSED MEDIUM DENSITY BLOCK
- 🟨 EXISTING WOODLOT
- 🟧 PROPOSED SCHOOL BLOCK
- 🟦 PROPOSED COMMERCIAL BLOCK
- 🟦 PROPOSED SWM FACILITY
- ▤ AREA REQUIRING BACK UP SUMP PUMPS

0 50 100 200 300 400
Metres

Figure Title

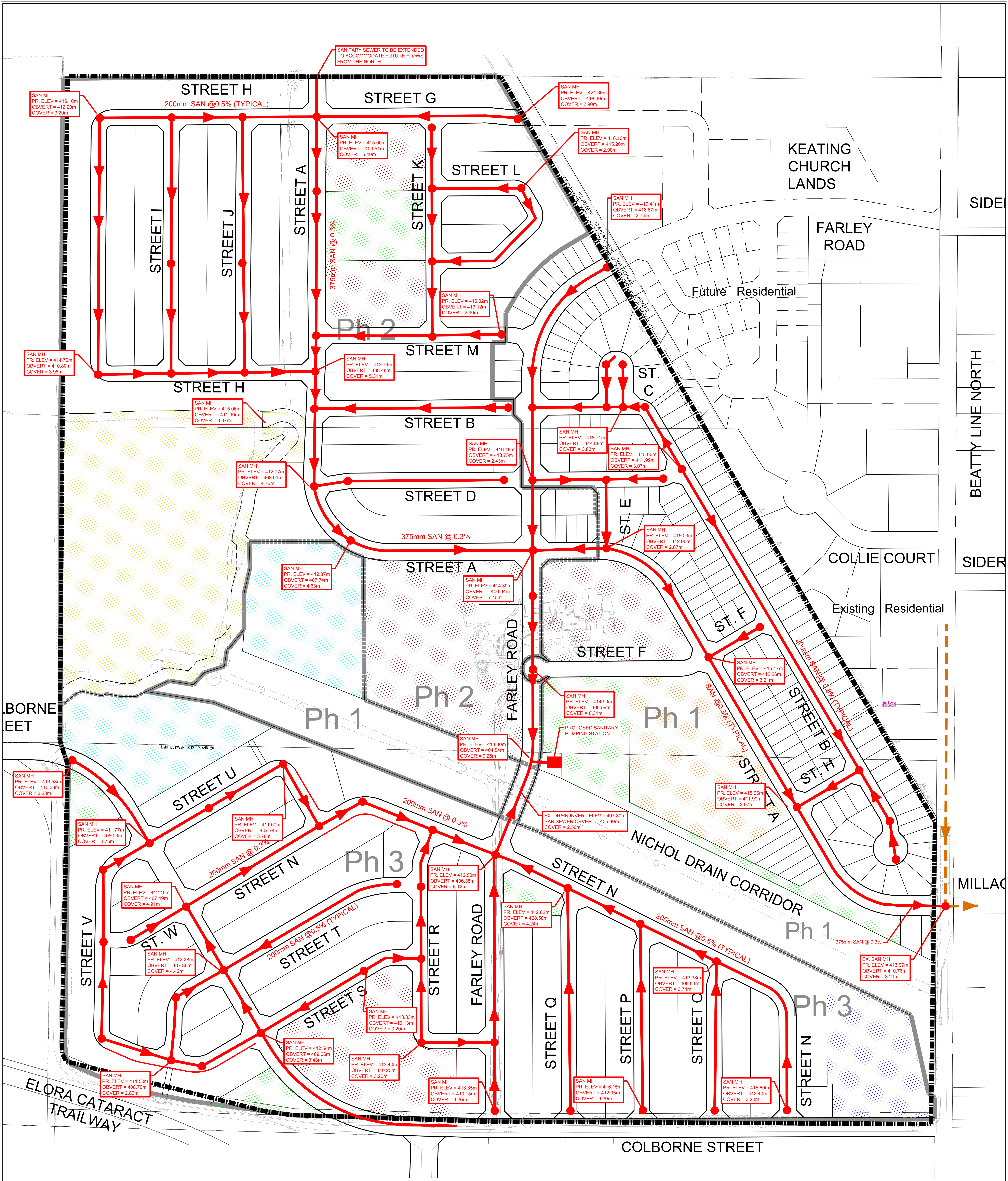
NW FERGUS SECONDARY PLANNING AREA DRAFT PLAN APPLICATION

PROPOSED FOUNDATION DRAINAGE COLLECTOR (FDC) SERVICING

Client

NIGUS FERGUS JOINT VENTURE INC.

Drawn	Checked	Date	Figure No.
PAG	LN	2016-11-30	**FDC1**
Scale		Project No.	
1:5000		300031145	



LEGEND:

▬·▬·▬	NORTH WEST FERGUS SECONDARY PLANNING AREA BOUNDARY	🟩	PROPOSED PARK BLOCK	🟧	PROPOSED SCHOOL BLOCK
▦▦▦	PROPOSED PHASING LIMITS	🟥	PROPOSED MEDIUM DENSITY BLOCK	🟦	PROPOSED COMMERCIAL BLOCK
– ▶ –	EXISTING SANITARY SEWER	🟨	EXISTING WOODLOT	🟦	PROPOSED SWM FACILITY
—▶—	PROPOSED SANITARY SEWER	🟥	PROPOSED SANITARY PUMPING STATION		
- - - -	PROPOSED SANITARY FORCEMAIN				
▬ · ▬	PHASE 1 GRAVITY SERVICING BOUNDARY				

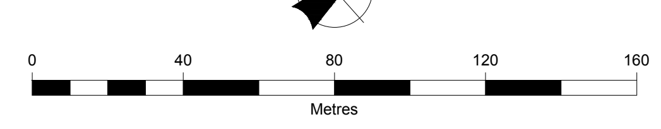


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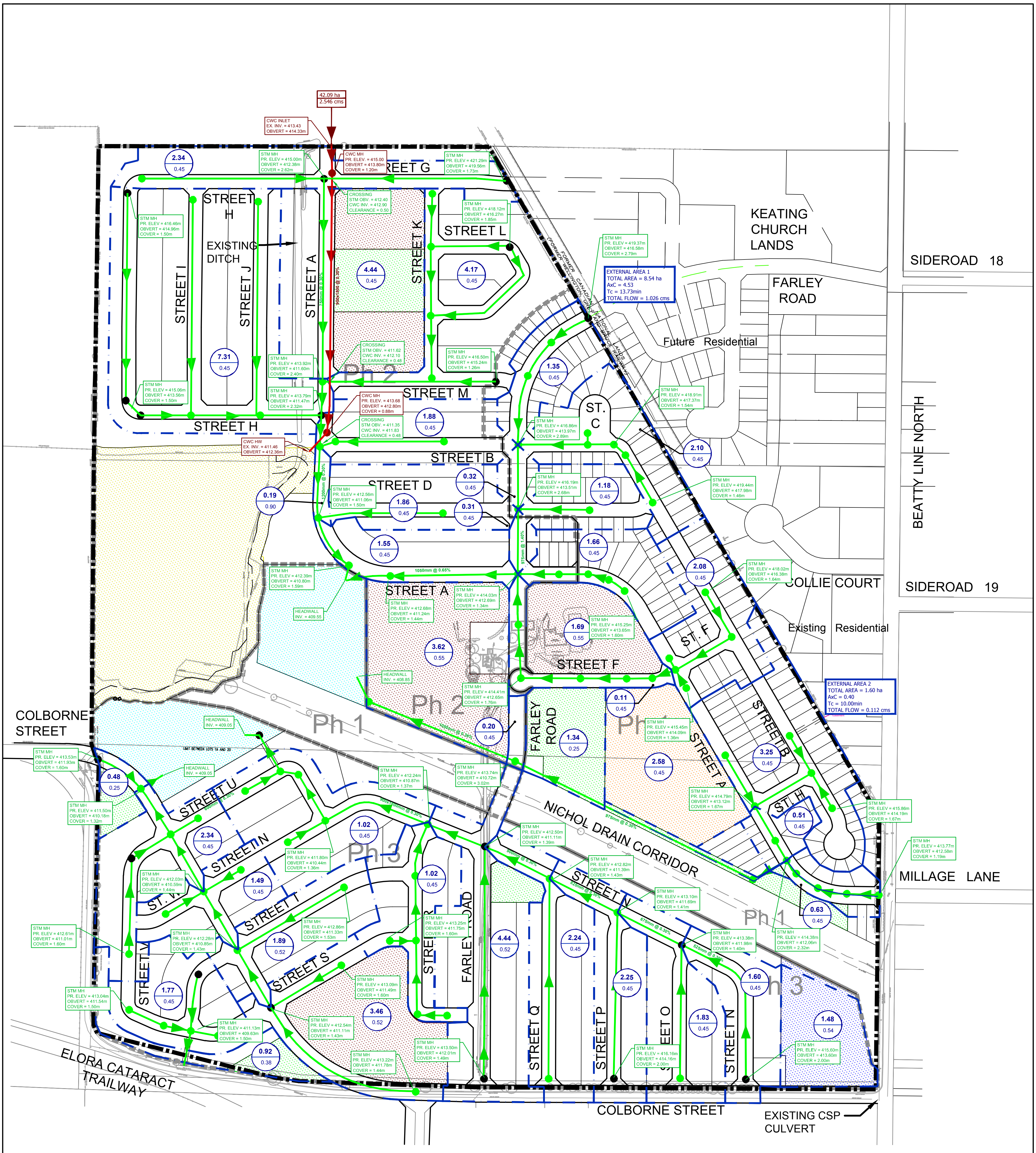
Figure Title
NW FERGUS SECONDARY PLANNING AREA

CONCEPTUAL SANITARY SERVICING

Client **SORBARA GROUP OF COMPANIES**	Drawn PAG Checked LN	Date 2015-04-08	Figure No. **SAN1**
	Scale 1:2000	Project No. 300031145	

File: \\monty\Shared Work Areas\031145 - Storybrook Ph1\07_Figures\FSR\180206\05_Figures\031145 FSR SanDrainPla



LEGEND:

- NORTH WEST FERGUS SECONDARY PLANNING AREA BOUNDARY
- PROPOSED PHASING LIMITS
- PROPOSED STORM SEWER
- PROPOSED DEDICATED CLEAN WATER SEWER FOR EXTERNAL FLOWS TO WOODLOT
- NEIGHBOURING SUBDIVISION STORM SEWER LAYOUT
- 🟩 PROPOSED PARK BLOCK
- 🟥 PROPOSED MEDIUM DENSITY BLOCK
- 🟨 EXISTING WOODLOT
- STORM DRAINAGE AREA
- 🟥 PROPOSED SCHOOL BLOCK
- 🟦 PROPOSED COMMERCIAL BLOCK
- 🟦 PROPOSED SWM FACILITY
- 6.88 STORM DRAINAGE AREA (HA)
- 0.45 RUN-OFF COEFFICIENT
- 100-YEAR CAPTURE

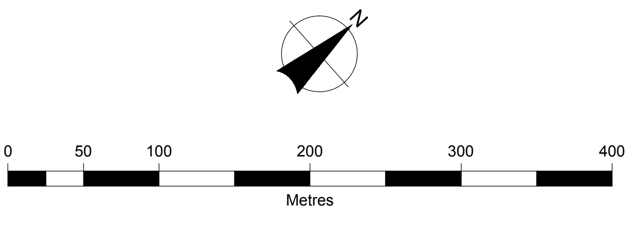


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Figure Title

NW FERGUS SECONDARY PLANNING AREA
DRAFT PLAN APPLICATION
PROPOSED STORM SERVICING

Client

NIGUS FERGUS JOINT VENTURE INC.

Drawn	Checked	Date	Figure No.
PAG	LN	2016-11-30	STM1
Scale		Project No.	
1:5000		300031145	