LOWES ROAD PROPERTY (19, 29, 35, 41, 51 AND 59 LOWES ROAD), GUELPH

FUNCTIONAL SERVICING REPORT

Prepared for:
Reid's Heritage Homes Ltd.
R.R. #2
6783 Wellington Road #34
Cambridge ON N3C 2V4

Prepared by:
Stantec Consulting Ltd.
100-300 Hagey Boulevard
Waterloo ON N2L 0A4

Project: 1614-13228

August 2016

Sign-off Sheet

This document entitled LOWES ROAD PROPERTY (19, 29, 35, 41, 51 AND 59 LOWES ROAD), GUELPH FUNCTIONAL SERVICING REPORT was prepared by Stantec Consulting Ltd. ("Stantec") for the account of Reid's Heritage Homes Ltd., (the "Client"). The material in it reflects Stantec's best judgment in light of the information available to it at the time of preparation.

Prepared by _____
(signature)

Ms. Adele Figliomeni, C.E.T
Project Coordinator, Community Development
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Fax: (519) 579-6733
adele.figliomeni@stantec.com

LICENSED PROFESSIONAL ENGINEER
P. D. FITZGERALD
16.08.25
PROVINCE OF ONTARIO

Reviewed by _____
(signature)

Mr. Peter Fitzgerald, P.Eng.
Senior Project Manager, community Development
Phone: (519) 585-7437
Fax: (519) 579-6733
peter.fitzgerald@stantec.com

Stantec

Table of Contents

Page

1.0 INTRODUCTION 1.1
1.1 OTHER REPORTS 1.1

2.0 SANITARY SERVICING 2.1

3.0 WATER DISTRIBUTION 3.1

4.0 STORM DRAINAGE 4.1
4.1 STORMWATER MANAGEMENT 4.1

5.0 AREA GRADING AND ROADWORKS 5.1

6.0 UTILITIES 6.1

7.0 CONCLUSIONS 7.1

List of Appendices

APPENDIX A – CONCEPT PLAN

APPENDIX B – SANITARY CAPACITY CONFIRMATION AND CONCEPTUAL SITE SERVICING PLAN

APPENDIX C – LOWES ROAD RECONSTRUCTION DRAWING

APPENDIX D – ZESS COURT AS-RECORDED DRAWINGS

APPENDIX E – STORMWATER MANAGEMENT DESIGN BRIEF

APPENDIX F – CONCEPTUAL GRADING PLAN

APPENDIX G - GEOTECHNICAL INVESTIGATION REPORT, ENGLOBE - MAY 24, 2016

APPENDIX H - HYDROGEOLOGY STUDY, ENGLOBE - JUNE 29, 2016

List of Figures

Following Page

FIGURE 1.0 - SITE LOCATION PLAN..... 1.1

1.0 INTRODUCTION

This report has been prepared in support of the Zone Change Application to permit 60 new residential townhouse units on properties currently known as 19, 29, 35, 41, 51, and 59 Lowes Road in Guelph.

The proposed property is comprised of approximately 1.6 hectares (ha) of land bounded by residential buildings on two sides, an approved mixed use building to the east and Lowes Road on the south side. The site is south of Zess Court bounded by existing development on Dawn Avenue. See illustration Figure 1.

The Concept Plan for the proposed development has been prepared by Astrid J. Clos, Planning Consultants and it forms the basis for the design of the servicing, grading, and tree Preservation Plan. The Concept Plan has been submitted as part of the overall complete submission for zone change approval and a copy is included as Appendix A.

This report documents how the servicing requirements for the proposed development can be achieved including sanitary servicing, water distribution and storm drainage as well as grading, road works and utilities.

1.1 OTHER REPORTS

This report should be read in conjunction with the reports listed below, all of which guided the preliminary engineering design.

- Full Stormwater Management Design Brief, August 2016 (Appendix E)
- Geotechnical Investigation Report, Englobe, May 24, 2016 (Appendix G)
- Hydrogeology Study, Englobe, June 29, 2016 (Appendix H)
- Tree Preservation Plan - Summary Report, Abound & Associates Inc., August 2016

The servicing strategies presented in this report are conceptual. Detailed engineering drawings and Final Stormwater Management report will be submitted as part of the detailed engineering design process once the proposed Zone Change has been approved and prior to the issuance of Site Plan approval.

2.0 SANITARY SERVICING

The existing downstream sanitary system has been confirmed by the City to have sufficient capacity for the proposed development. (Appendix B)

Sanitary servicing for the proposed site development will be provided via one connection to the sanitary main on Lowes Road. See Conceptual Servicing Plan in Appendix B.

Lowes Road was reconstructed in 2001. A 450 mm sanitary sewer is shown on the City of Guelph as-recorded drawing for the Lowes Road Reconstruction Contract 2-0124 (Appendix C). An existing manhole will line up well with proposed sewer connection for the site, limiting the required works on Lowes.

The proposed 'internal' sanitary sewers will generally be located within the proposed private roadway at an approximate minimum depth of 2.8 m.

From the proposed sanitary mains, the units will be provided with 150 mm diameter services.

3.0 WATER DISTRIBUTION

Watermains for the proposed site development will be provided via two connections to Lowes Road (Appendix B).

The proposed development for 60 townhouse units is not expected to result in a significant demand change on the water distribution system.

Backflow prevention devices are proposed at the limit of City/private mains where the private system connects to the City of Guelph system on Lowes Road.

Fire protection will be provided via installation of onsite hydrants, adequately spaced to ensure proper coverage to all buildings. Offsite, an existing hydrant is located in front of #34 Lowes Road.

25 mm Type 'K' water service connections will be provided to each single detached residential townhouse unit along the common element streets.

4.0 STORM DRAINAGE

The site drainage shall mimic existing conditions including road drainage that flows across southern boundary of the site.

The Lowes Road profile "see-saws" and is super elevated along the frontage of the subject lands. A shallow swale provides drainage towards Dawn Avenue and north along Dawn Avenue. There are two outlets at the north end of the site that drain to established stormwater easements in favour of the City which were established when the Conservation Estates Subdivision was developed. These existing stormwater easements are shown on the Concept Plan (Appendix D). The proposed drainage design generally maintains existing flow to these outlets.

The site has been designed to drain generally internally towards the proposed stormwater management (SWM) facility where possible and towards the existing easements on Zess Court. Storm sewers are proposed to provide road drainage onsite. A super-elevated road cross-section is proposed to allow for storm sewers and catchbasins to be located on one side of the road. See Appendix B for servicing layout.

4.1 STORMWATER MANAGEMENT

The onsite SWM uses a treatment train approach. The SWM facilities consist of an oil-grit separator (OGS) unit for enhanced stormwater quality control (80% TSS removal) combined with a dry pond and two underground storage tanks on the east and west sides of the site. The pond and the two tanks are designed to be 1m above the high groundwater level to facilitate infiltration for stormwater quantity control.

For further details refer to Stormwater Management Design Brief (Appendix E).

5.0 AREA GRADING AND ROADWORKS

Utilizing the proposed Concept Plan, existing Lowes Road grades and abutting lot grading the preliminary grading plan has been designed to generally meet the following criteria:

- Match existing road grades at limits.
- Match existing boundary grades around the perimeter of the site outside of the drip line of existing trees that are to be preserved.
- Ensure underside of footing is 0.75 m above high groundwater as identified in the Geotechnical Report prepared by Englobe.
- Ensure infiltration is 1.0 m above high groundwater.
- Ensure adequate cover is provided over services.
- Ensure "major" overland flow routes are maintained with a maximum ponding depth of 0.3 m onsite.
- Comply with municipal standards for minimum and maximum road grades.

A 2 m high retaining wall at the north east corner of Unit 60 has been added along the north edge of the development to match existing grades and maintain drainage to the SWM pond.

The Hydrogeology Study report prepared by Englobe dated June 29, 2016 is included as Appendix H to this report. A Monitoring Program is currently in place to create the pre-development base line for groundwater levels.

Given the findings of the seasonal high groundwater table elevation, the proposed infiltration facilities at the north end of the site and the proposed SWM storage at the west end of the site can be designed to be 1.0 m above expected high groundwater elevation 329.91- 330.03 m. This information is identified in the Geotechnical Investigation report prepared by Englobe – May 24, 2016, as well.

See Appendix F for Conceptual Grading Plan.

6.0 UTILITIES

Utility servicing (electrical, telephone, natural gas, and cable TV) for the proposed development will generally be provided through use of the existing services currently in place around the perimeter of the site.

Further coordination with Guelph Hydro and all other utility providers including Union Gas (natural gas), Bell Canada (telephone), and Rogers (cable) will be required prior to construction.

Stantec has initiated consultation and coordination with each utility provider and will continue to work closely with the representatives to ensure servicing is provided.

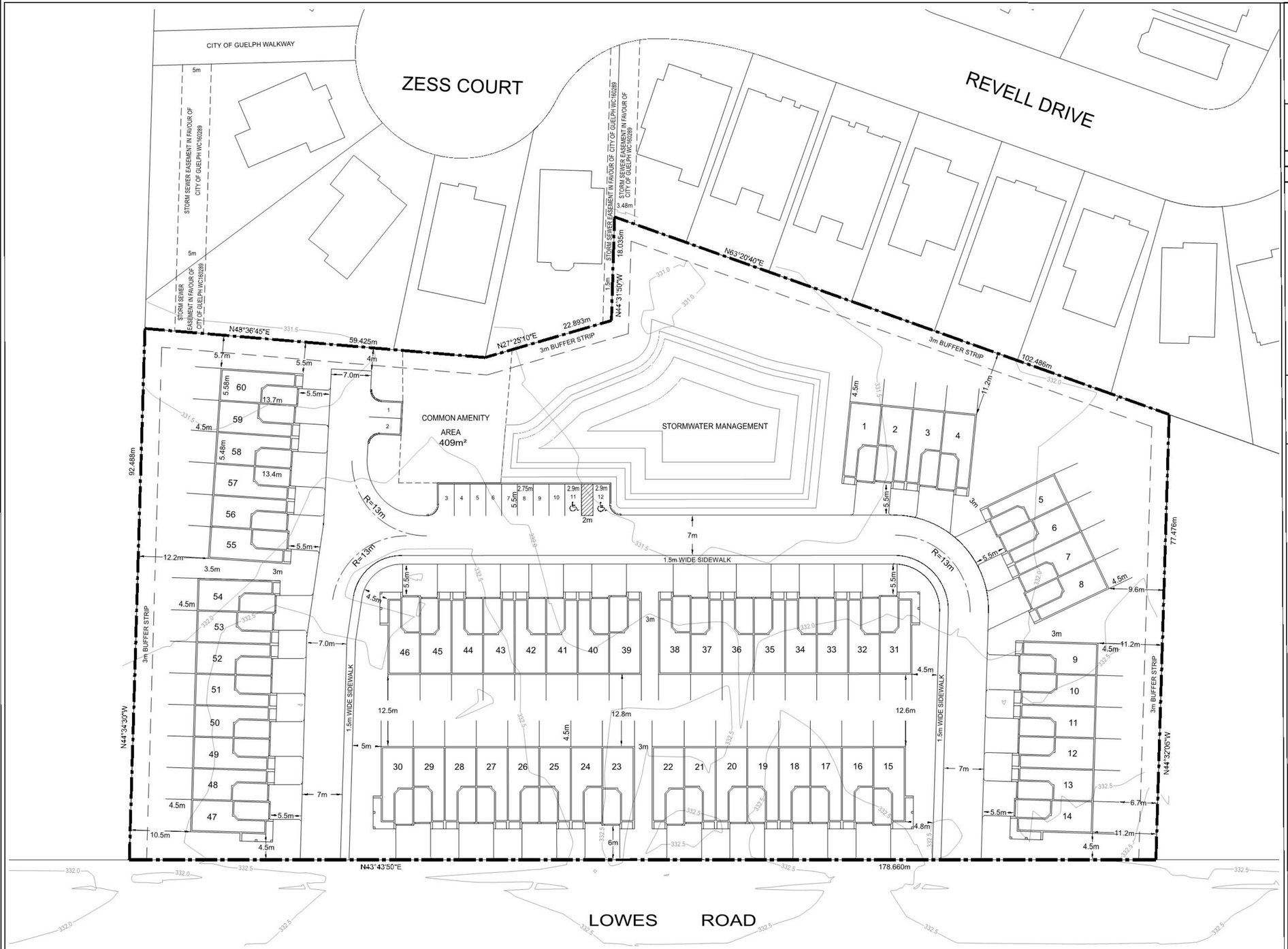
7.0 CONCLUSIONS

Based on the foregoing it is concluded that:

- The proposed development can be adequately serviced through the connection to the existing Sanitary and Watermain on Lowes Road.
- SWM for this development has been accommodated through onsite SWM facilities and existing outlets and provisions have been made for infiltration for a water balance and to address outlet constraints.
- Overall site grading will provide for "major" overland flow conveyance to the SWM facility, provide adequate cover over private services and generally match existing roads and boundary grades.
- The preliminary grading plan will match existing boundary grades around the perimeter of the site outside of the drip line of existing trees that are to be preserved.
- We will continue to work with the utilities to ensure that the proposed development can be adequately serviced through the extension of existing utilities including hydro, gas, cable TV and telephone.

APPENDIX A

Concept Plan



ASTRID J. CLOS
PLANNING CONSULTANTS

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GUELPH - ONTARIO
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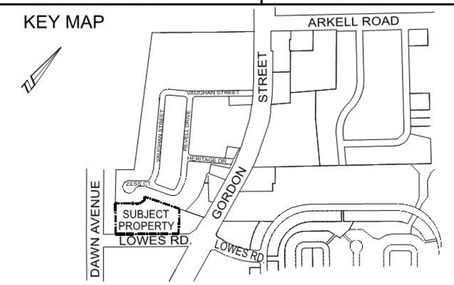
Email: astrid.clos@ajcplanning.ca
Web: www.ajcplanning.ca

LOWES ROAD CONCEPT PLAN
REID'S HERITAGE HOMES

DATE: AUGUST 22, 2016	DRAWN BY : A.R.N.
PROJECT No. : 1322	SCALE 1:400

KEY MAP



NOT TO SCALE

ALL OF LOTS 3, 4, 5 & 6, REGISTERED PLAN 508
PART OF LOTS 15 AND 16, REGISTERED PLAN 467
(GEOGRAPHIC TOWNSHIP OF PUSLINCH)
CITY OF GUELPH

Specialized R.3A- Cluster Townhouse Zone	
Existing Definition: "Townhouse" means a Building that is divided vertically into 3 or more separate Dwelling Units and includes a row house.	Proposed definition: "Townhouse" means a Building that is divided vertically into 2 or more separate Dwelling Units and includes a row house.

Zoning Regulation	Required	Provided	Compliance
Minimum Lot Area	800 m²	16,542 m²	Yes
Minimum Lot Area Per Dwelling	270 m² (60 units)	275.7 m²	Yes
Minimum Lot Frontage	18 m	178 m	Yes
Minimum Front Yard	6 m	4.5 m	No
Minimum Side Yard Section 5.3.2.2	half the building height, not less than 3 metres	10.5 m	Yes
Minimum Rear Yard 5.3.2.2	half the building height, not less than 3 metres	5.5 m	Yes
Maximum Building Coverage	30% (4,496 m²)	27%	Yes
Maximum Building Height	3 storeys	2 storeys	Yes
Minimum Distance between buildings both with windows to habitable rooms 5.3.2.3	15 m	12.8 m	No
Minimum distance between buildings with one building having windows to habitable rooms	12 m	18 m	Yes
Minimum distance between buildings with no windows to habitable rooms	3 m	3 m	Yes
10.5 metres between a private amenity area and a building with windows to habitable rooms. 5.3.2.3.4	10.5 m	8.3 m	No
50 m² Minimum Common Amenity Area. 5.3.2.4.1 a)	50 m²	409 m²	Yes
Minimum 5 m² of Amenity Area per dwelling. 5.3.2.4.1	300 m² 60 units x 5 m²	409 m²	Yes
Amenity Areas length shall not exceed 4 times the width. 5.3.2.4.2			Yes
Common Amenity Area shall not be located in Front Yard or Exterior Side Yard. 5.3.2.4.3			Yes
Minimum Private Amenity Area. 5.3.2.5	4.5 m and the unit width		Yes
Minimum Landscaped Open Space	40% (8,462 m²)	51%	Yes
Buffer Strip	Required abutting a residential zone.		Yes
Off-Street parking 1 per unit. 20% visitor parking. (4.13)	 60 parking spaces 12 visitor spaces	60 driveway 60 garage 12 visitor	Yes
Maximum Number of Dwellings in a Row	12, 8 adjacent to street	8	Yes
Maximum Density of Site 5.3.2.6	37.5 dwellings per hectare	36.2 dwellings per hectare	Yes
Measurement of Driveway Width Driveway width is measured parallel to the front of Garage 4.13.7.2.6	3 m	3 m	Yes
Minimum Driveway width of 3 metres. Driveway width may be 2.5 metres at the point of entry to a garage. 4.13.7.2.7	3 m	3 m	Yes

Aug 22,2016–11:20am (21493–13)
H:\13–214\21493–13\acad\Concept 16 Reids (Lowes and Gordon).dwg

APPENDIX B

Sanitary Capacity Confirmation and

Conceptual Site Servicing Plan

Fitzgerald, Peter

From: Michelle.Thalen@guelph.ca
Sent: Monday, March 07, 2016 9:57 AM
To: Fitzgerald, Peter
Cc: Terry.Gayman@guelph.ca; Rino.DalBello@guelph.ca; Arun.Hindupur@guelph.ca
Subject: 19 - 59 Lowes Road - Sanitary Sewer Capacity

Good Morning Peter.

After an extensive infrastructure review, the City of Guelph Engineering Services can confirm that at this time, there is sufficient capacity in the adjacent sanitary sewer for the proposed development at the above address as presented to the Development Review Committee on December 16, 2015.

Should you have any further questions, feel free to contact me at your convenience.

Regards,

Michelle Thalen, C.Tech, Development Technologist
Development and Environmental Engineering, **Engineering and Capital Infrastructure Services**
City of Guelph

T 519-822-1260 x 2333
E michelle.thalen@guelph.ca

www.guelph.ca

ZESS COURT

REVELL DRIVE

HP	ELEV.	COVER
ELEV.	333.3	
STORM	–	–
SANITARY	208.9	7.2

LP	ELEV.	COVER
ELEV.	330.30	
STORM	330.35	0.00
SANITARY	–	–

	ELEV.	COVER
ELEV.	333.3	
STORM	331.3	2.0
SANITARY	330.0	3.3

	ELEV.	COVER
ELEV.	333.2	
STORM	2.0	2.4
SANITARY	330.2	3.0

LP	ELEV.	COVER
ELEV.	332.9	
STORM	330.9	2
SANITARY	–	–

HP	ELEV.	COVER
ELEV.	333.30	
STORM	–	–
SANITARY	329.6	3.7

HP	ELEV.	COVER
ELEV.	333.40	
STORM	331.60	1.8
SANITARY	329.20	4.2

	ELEV.	COVER
ELEV.	332.9	
STORM	–	–
SANITARY	330.1	2.8

	ELEV.	COVER
ELEV.	332.40	
STORM	–	–
SANITARY	332.4	5.0

COMMON AMENITY AREA

STORMWATER MANAGEMENT

STORMCEPTOR

150mmø WTM

INSULATE SHALLOW CULVERT

INSULATE SHALLOW CULVERT

BACK-FLOW PREVENTOR

BACK-FLOW PREVENTOR

CONNECT USING 150x150 TEE

CONNECT USING 150x150 TEE

1.160m

LOWES ROAD

EX. 150mmø WTM

MH T/G=331.81

MH T/G=332.66

MH T/G=332.37

MH T/G=332.85

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2016/08/25 9:37 AM By: Brown, Kevin

ORIGINAL SHEET - ANSI B

June, 2016
161413228

Stantec
300 Hagey Blvd. Suite 100
Waterloo, ON, N2L 0A4
Tel. 519.579.4410
www.stantec.com

Legend

- PROPOSED STORM SEWER
- PROPOSED INFILTRATION TRENCH
- EXISTING SANITARY SEWER
- PROPOSED SANITARY SEWER
- EXISTING WATERMAIN
- PROPOSED WATERMAIN

LP	ELEV.	COVER
ROAD	340.82	
STORM	339.30	1.5
SANITARY	337.80	3.0

- ROAD STATUS (LP = LOW POINT, HP = HIGH POINT)
- ROAD ELEVATION
- COVER OVER SEWER
- SEWER OBVERT ELEVATION

POTENTIAL UNDERGROUND STORAGE LOCATIONS

Notes

0 7.5 22.5 37.5m

1:750

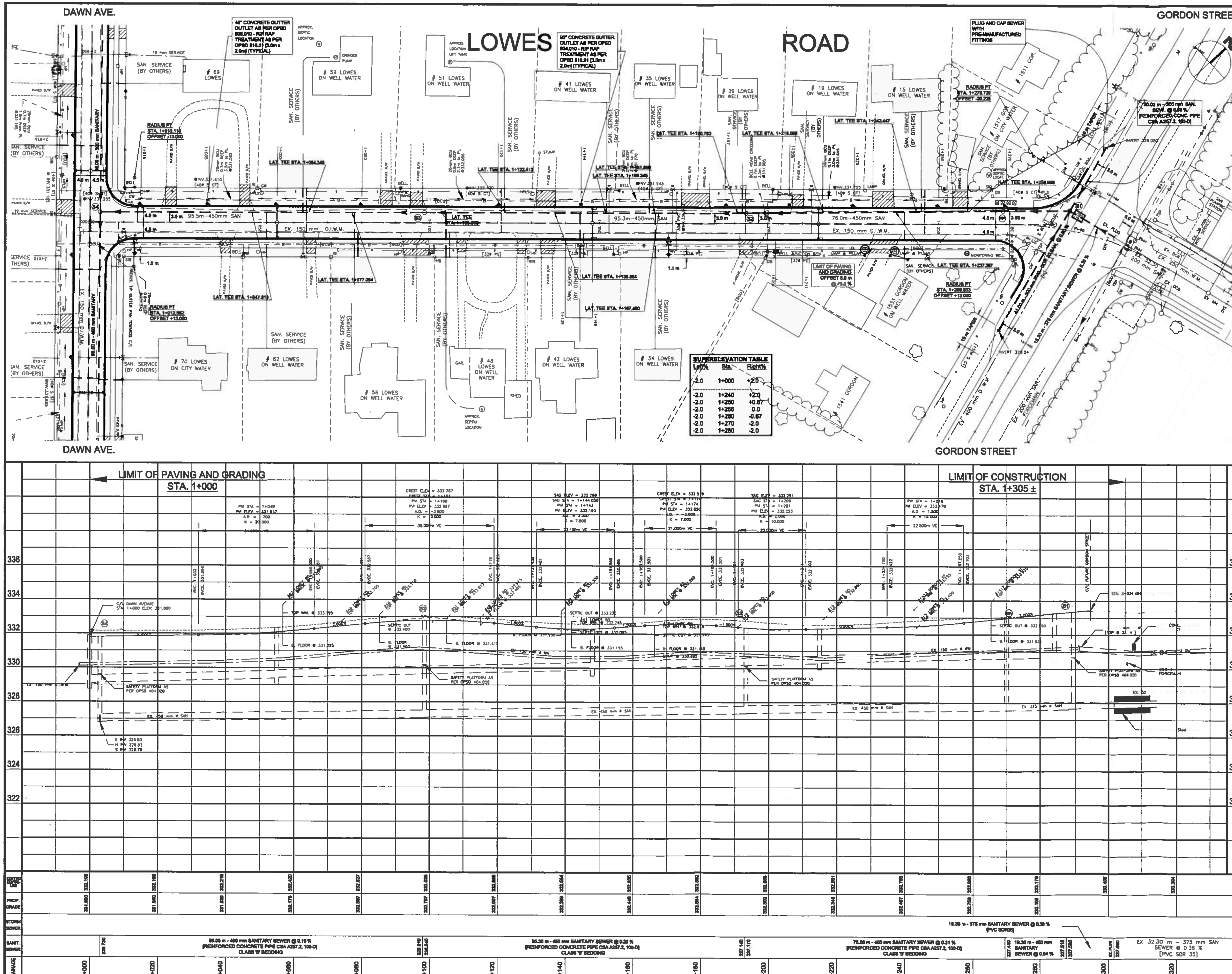
Client/Project
Reid's Heritage Homes
Lowes Road Property, Guelph

Figure No.
FIG 4.0

Title
CONCEPTUAL SERVICING PLAN

APPENDIX C

Lowes Road Reconstruction Drawing



G - 75

1

KEY PLAN Scale · NOT TO SCALE

LEGEND:

ENTRANCE GRADES:

+y – MEANS THE GRADE FALLS TOWARDS THE C/L OF THE ROAD

-y – MEANS THE GRADE FALLS AWAY FROM THE C/L OF THE ROAD

— — SANITARY SERVICE LATERAL [100 mm PVC DR18 TO PROPERTY LINE ONLY

THE POSITION OF POLES LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

GENERAL NOTES:

FIELD NOTES:

BENCH MARK: No. ELEVATION:

PLAN REFERENCES:

YEAR OF CONSTRUCTION:

No.	DATE	DESCRIPTION	BY	CHKD.
4	JUN.2004	RECORD DRAWING	T.F.	-
3	NOV 2001	ISSUED FOR CONSTRUCTION	D.E.S.	P.A.A.
2	OCT 2001	ISSUED FOR TENDER	D.E.S.	P.A.A.
1	AUG. 2001	ISSUED FOR APPROVALS	D.E.S.	P.A.A.

SCHEDULE OF REVISIONS

WORKS DEPARTMENT

LOWES ROAD
DAWN AVE. TO GORDON ST.

LOWES AND DAWN SANITARY TRUNK SEWER

DESIGNED BY: PETER A. ANGELO, PROJECT ENGINEER

APPROVED BY: RICK M. TOLKUNOW, DESIGN & CONSTRUCTION ENGINEER

SCALES: H. 1:500 V. 1:100

DATE DRAWN: AUGUST 16, 2001

DRAWN BY: D.E.S., P.A.A.

CHECKED BY: P.A.A.

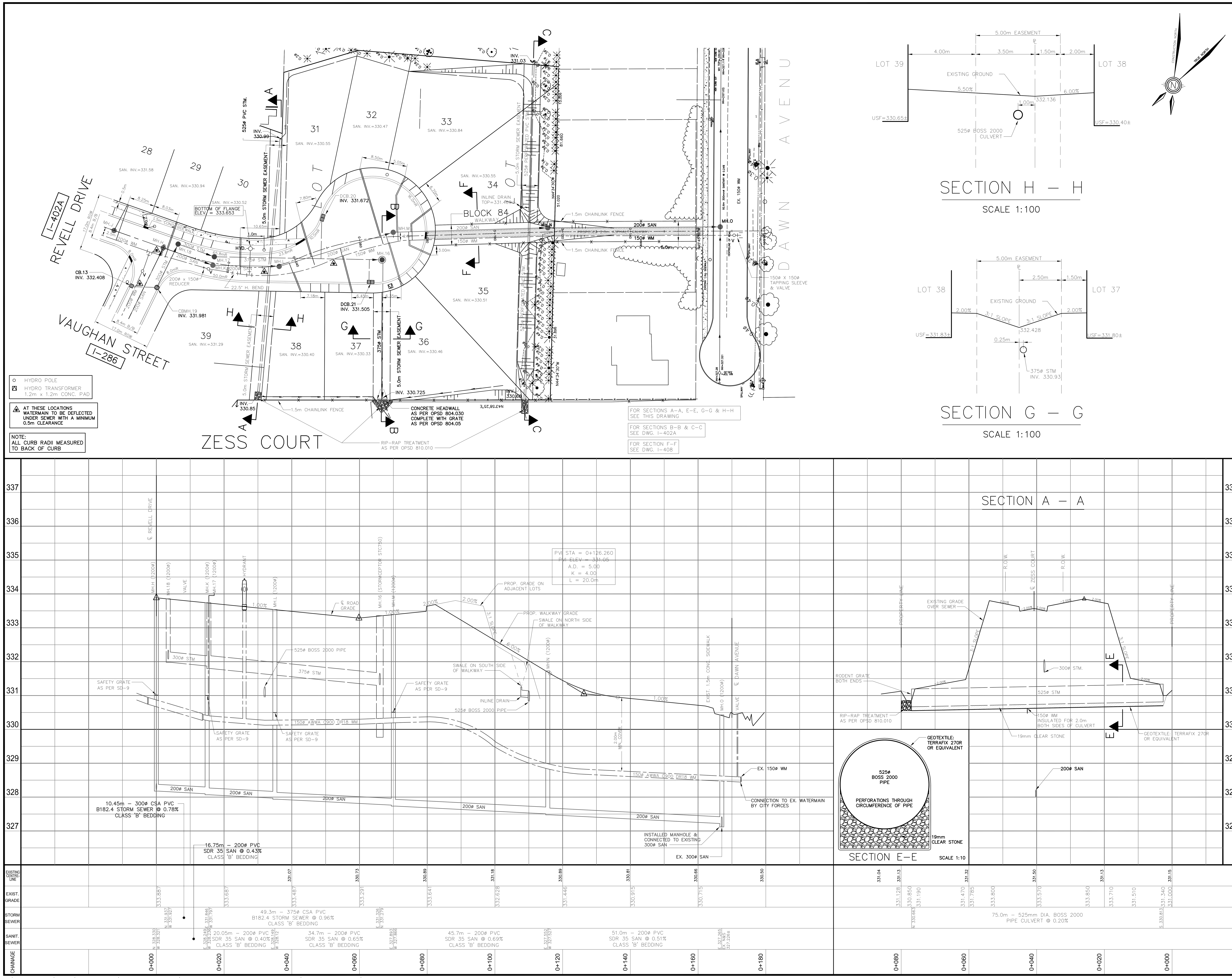
CONTRACT No. 2-0124

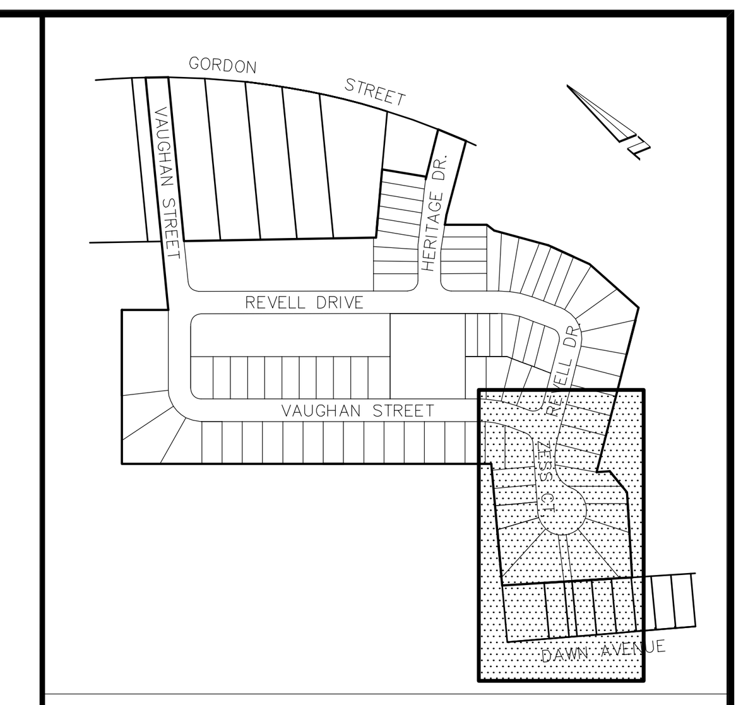
DRAWING No. G - 75

APPENDIX D

Zess Court As-recorded Drawings

I-402





KEY PLAN Scale : NOT TO SCALE

LEGEND

- PROPERTY LINE
- EX. SANITARY SEWER
- EX. STORM SEWER
- EX. WATERMAIN
- EX. FENCE LINE
- EX. CATCH BASIN
- EX. FIRE HYDRANT
- SANITARY SEWER
- STORM SEWER
- CATCH BASIN
- WATERMAIN
- FIRE HYDRANT
- RETAINING WALL
- HEDGE
- CONIFEROUS/DECIDUOUS TREES (0.1Ø, 0.3Ø)

THE POSITION OF POLES, LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

GENERAL NOTES:

FIELD NOTES:

BENCH MARK: No. 186 ELEVATION: 333.860

BROCK RD. SCHOOL (D.H.O. 9589)

PLAN REFERENCES:

YEAR OF CONSTRUCTION:

No.	DATE	DESCRIPTION	BY:	CH'KD.
8.	03.20.07	AS RECORDED	H.K.C.	A.E.K.
7.	09.27.06	ISSUED FOR CONSTRUCTION	M.A.R.	C.R.R.S.
6.	08.30.06	ISSUED FOR TENDER	S.E.O.	C.R.R.S.
5.	07.19.06	ADDED SERVICES TO BLOCKS 81 & 82	M.A.R.	C.R.R.S.
4.	05.03.06	ISSUED FOR M.O.E. APPROVAL	M.A.R.	C.R.R.S.

SCHEDULE OF REVISIONS

CORPORATION OF THE CITY OF GUELPH

ENGINEERING SERVICES

ZESS COURT

Sta. 0+000 to Sta. 0+180

CONSERVATION ESTATES SUBDIVISION

DESIGNED BY:

APPROVED BY:

LICENSED PROFESSIONAL ENGINEER May 12/08 C. R. R. SIMS PROVINCE OF ONTARIO

GAMSBY AND MANNEROW Limited
CONSULTING PROFESSIONAL ENGINEERS
GUELPH OWEN SOUND LISTOWEL

SCALES: H. 1:500 V. 1:50

DATE DRAWN: JANUARY 2006

DRAWN BY: M.A.R.

CHECKED BY: C.R.R.S.

CONTRACT No. 2-0615

DRAWING No. I-402

I-402

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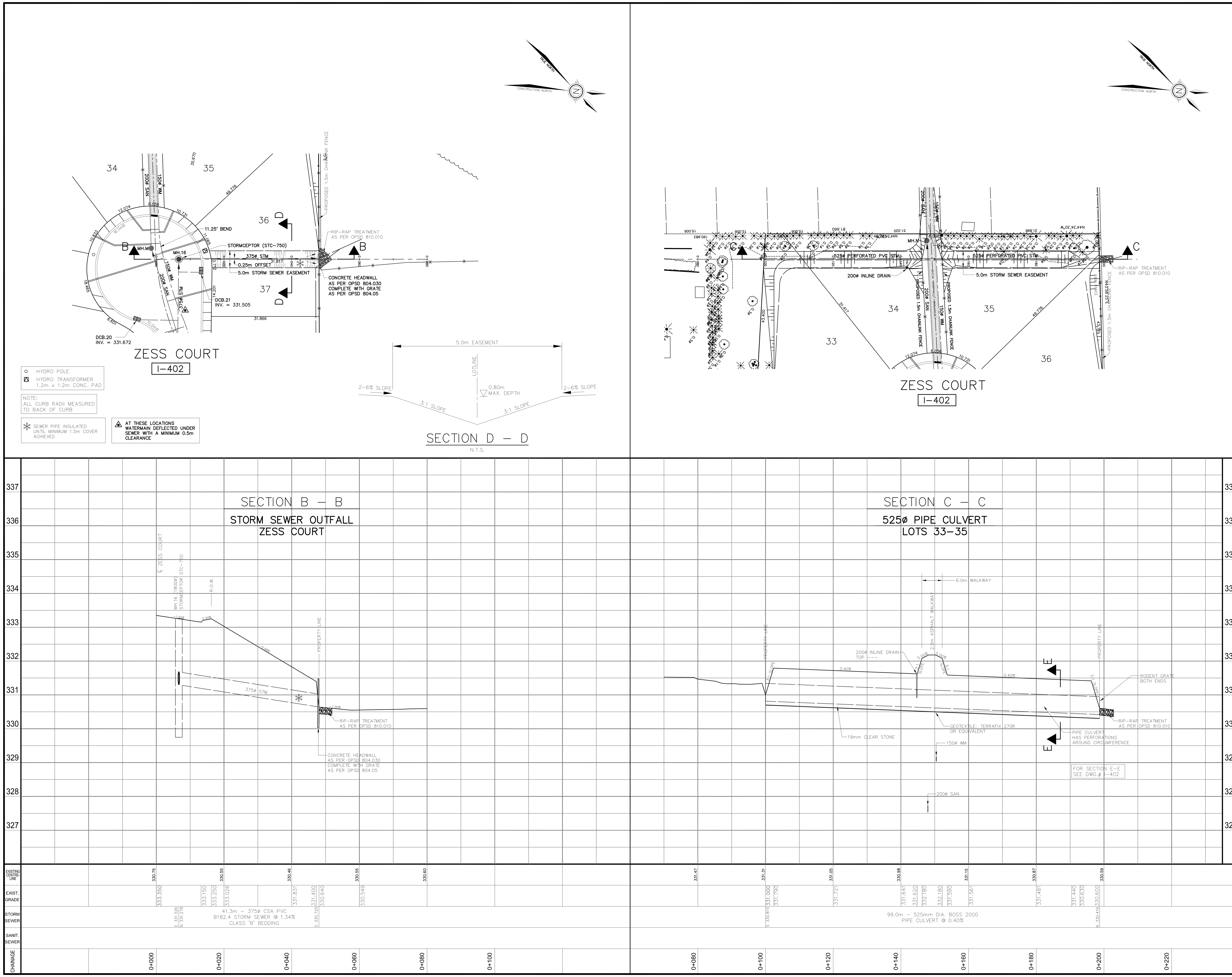
MAY 12, 2008

I-402A



KEY PLAN Scale : NOT TO SCALE

LEGEND

- PROPERTY LINE
- EX. SANITARY SEWER
- EX. STORM SEWER
- EX. WATERMAIN
- EX. FENCE LINE
- EX. CATCH BASIN
- EX. FIRE HYDRANT
- SANITARY SEWER
- STORM SEWER
- CATCH BASIN
- WATERMAIN
- FIRE HYDRANT
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- CONIFEROUS/DECIDUOUS TREES

THE POSITION OF POLES, LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

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FIELD NOTES:

BENCH MARK: No. 186 ELEVATION: 333.860

BROCK RD. SCHOOL (D.H.O. 9589)

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5.	07.19.06	ADDED SERVICES TO BLOCKS 81 & 82	M.A.R.	C.R.R.S.
4.	05.03.06	ISSUED FOR M.O.E. APPROVAL	M.A.R.	C.R.R.S.

SCHEDULE OF REVISIONS

CORPORATION OF THE CITY OF GUELPH

ENGINEERING SERVICES

ZESS COURT

CROSS SECTIONS B-B & C-C

CONSERVATION ESTATES SUBDIVISION

DESIGNED BY:

APPROVED BY:

LICENSED PROFESSIONAL ENGINEER C.R.R. SIMS PROVINCE OF ONTARIO

GAMSBY AND MANNEROW Limited
CONSULTING PROFESSIONAL ENGINEERS
GUELPH OWEN SOUND LISTOWEL

SCALES: H. 1:500 V. 1:50

DATE DRAWN: JANUARY 2006

DRAWN BY: M.A.R.

CHECKED BY: C.R.R.S.

CONTRACT No. 2-0615

DRAWING No. I-402A

R:\ENGINEER\CAD\DRAWINGS\RECORD DWGS\Conservation Estates 2-0615\AS RECORDED\I-402A.dwg
MAY 12, 2008

APPENDIX E

Stormwater Management Brief

1.0 Introduction

The following is a Design Brief which outlines the preliminary stormwater management (SWM) strategy for the proposed residential townhouse development, located at 19-59 Lowes Road, Guelph, Ontario ("site"). The purpose of this Brief is to present the proposed SWM design for review by the City with the intention of attaining a Zoning By-Law Amendment (ZBA). The analysis was undertaken to assess the existing hydrology for the site and design a SWM system to meet the City of Guelph criteria using both traditional SWM and low impact development (LID) features to achieve the water quantity and water quality targets.

Included in this package are:

- Hydrologic modelling files and analysis
- Plans showing existing and proposed internal and external catchment delineation
- Recommendations for detailed design

2.0 Background

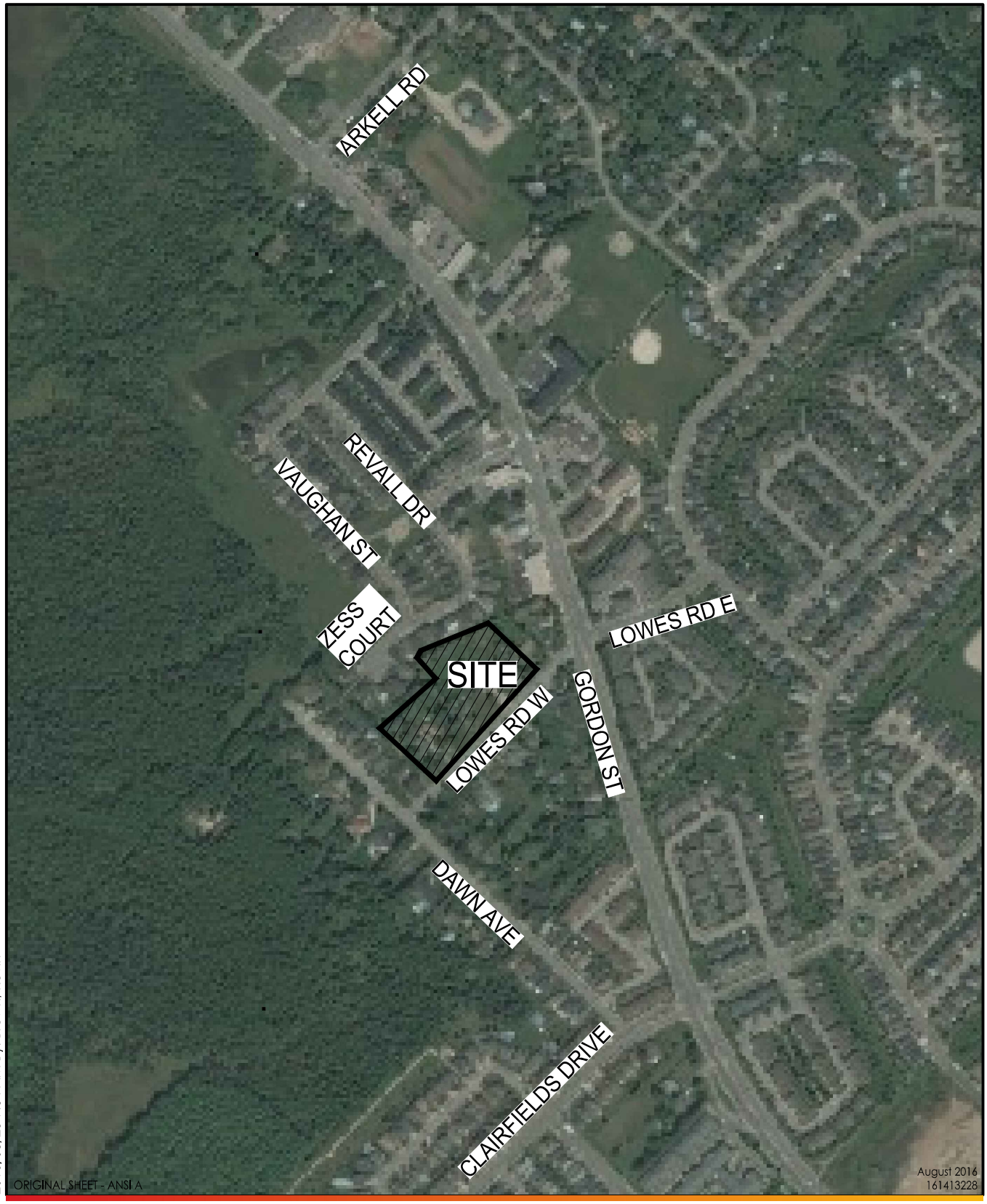
The following report and primary guidance documents were referenced in the completion of the proposed SWM design:

- *City of Guelph REVISED Stormwater Management Criteria: 19-59 Lowes Rd.*, Kime Toole, C.E.T., August 2016.
- *Reid's Heritage Homes – Proposed Residential Development, Lowes Road, Guelph, Ontario – Geotechnical Investigation Report*, Englobe, May 2016.
- *Reid's Heritage Homes – Scoped Hydrogeology Study, Lowes Road, Guelph, Ontario – Hydrogeology Study*, Englobe, May 2016.
- *Conservation Estates Subdivision Drainage Areas, Figure 3, Stormwater Management Design Report,* Gamsby and Mannerow Limited, May 2006.
- *Stormwater Management Planning and Design Manual*, Ministry of the Environment, March 2003

3.0 Stormwater Management Design Criteria

The SWM criteria, as outlined by the City of Guelph are as follows:

Water Quantity: The City of Guelph's allowable outlet rate to the 525 mm diameter Boss 2000 pipe (0.2%) is as follows: 0.013 m^3/s – 2-yr, 0.017 m^3/s – 5-yr, 0.037 m^3/s – 100-yr, 0.053 m^3/s – Regional Storm; sites that do not have a positive outlet must be designed to provide storage on-site for twice the 5-year design storm runoff volume;



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2016/08/25 9:34 AM By: Brown, Kevin

ORIGINAL SHEET - ANSI A

August 2016
161413228

Stantec

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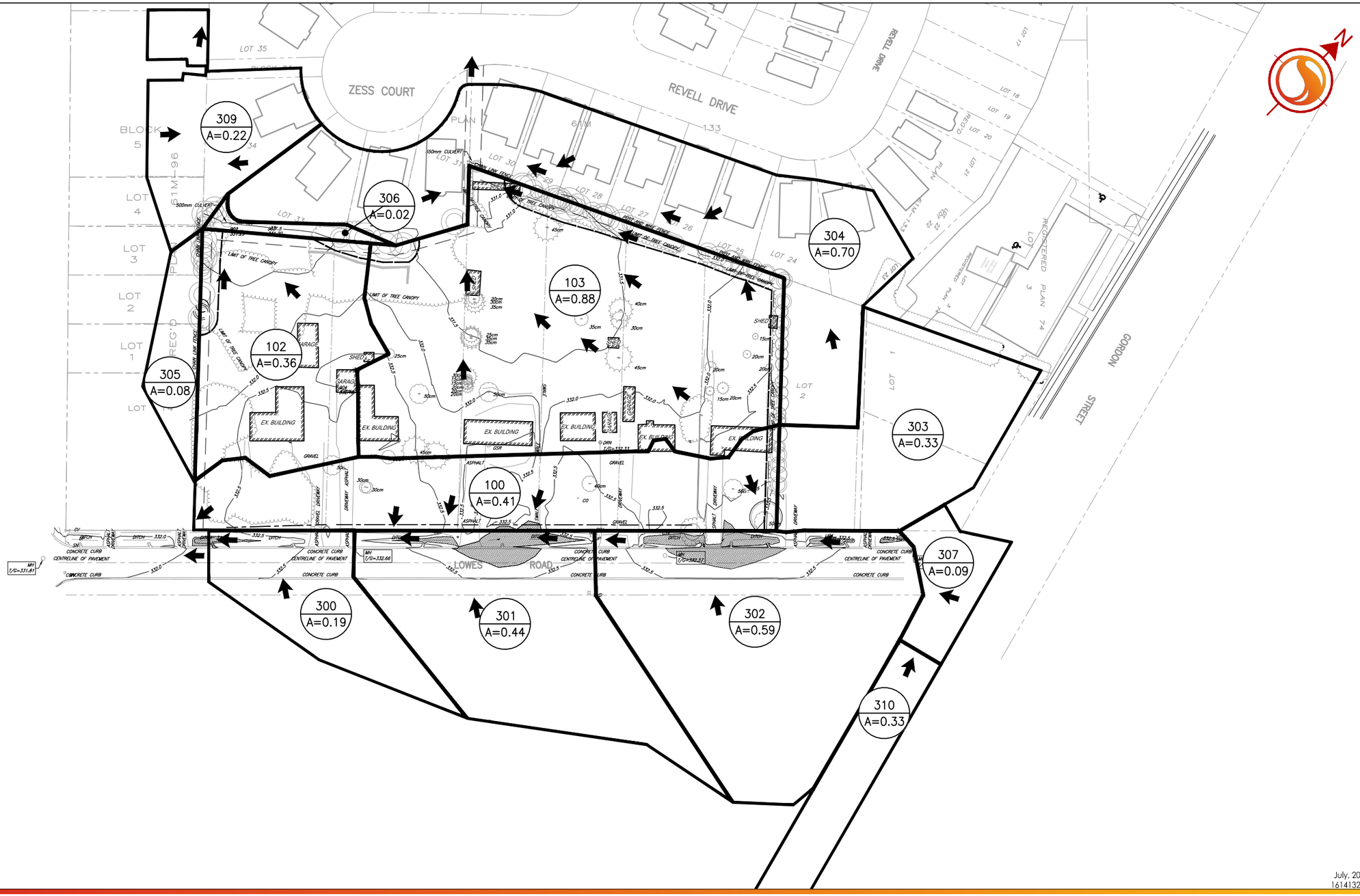
Client/Project
Reid's Heritage Homes
Lowes Road Property, Guelph

Figure No.
FIG 1.0

Title
LOCATION PLAN



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2016/08/25 9:35 AM By: Brown, Kevin

ORIGINAL SHEET - ANSI B

July, 2016
161413228

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www.stantec.com

Legend

- 1 / A=0.25 — CATCHMENT ID / CATCHMENT AREA (ha)
- MAJOR OVERLAND FLOOD ROUTE
- DRAINAGE BOUNDARY
- EXISTING PONDING AREAS

Notes

1:1250 — 0, 12.5, 37.5, 62.5m

Client/Project
Reid's Heritage Homes
Lowes Road Property, Guelph

Figure No.
FIG 2.0

Title
EXISTING
DRAINAGE AREA PLAN

Water Quality: 'Enhanced' water quality (80% total suspended solids removal rate) treatment for storm water prior to leaving the site; and

Water Balance: clean runoff must be directed to pervious areas for infiltration to encourage ground water recharge (Low Impact Development).

4.0 Existing Conditions

TOPOGRAPHY AND SURFACE DRAINAGE

The site is located in the City of Guelph and is bounded by Lowes Road to the south, a subdivision on Dawn Avenue to the west, a subdivision on Zess Court to the north, and a proposed commercial property to the east (see Figure 1 for the site location). Six (6) houses are located on the site under existing conditions with large, grassed front and backyards. The Dawn Avenue and Zess Court subdivisions are both single family residential lots that back on to the site's property limits.

According to Figure 3 of the *Conservation Estates Subdivision Stormwater Management Report* (attached), approximately 1.13 ha of Catchment 500 is located on the site and drains northwest to an existing 525 mm diameter Boss 2000 HDPE perforated pipe at 0.2% (Outlet 1). It is understood that the target rates for the site provided by the City of Guelph in August 2016 are based on the existing area of the site draining to the Boss 2000 pipe and have been pro-rated based on the capacity of the pipe. The area fronting onto Lowes Road drains south to the existing roadside ditch system (Outlet 2). There are no culverts within the roadside ditch; leading to the assumption that runoff generated from frequent rainfall events remains in the ditches to infiltrate or flows west to Dawn Avenue.

A survey was completed as part of the Functional Servicing Report (FSR) and identified an additional outlet on the site located at the northwest corner of the property. The pipe is a 525 mm diameter Boss 2000 HDPE perforated pipe at 0.4% (Outlet 3). According to the survey and local topography, a small external area and some internal area from the site drain to the newly identified pipe under existing conditions. A local high point splits site drainage to the east and west with the majority of the site draining to Outlet 1 and a small portion of the site draining to Outlet 3.

No external areas drain through the site; however, there are several areas draining adjacent to the site under existing conditions. External areas are located to the north, south, west, and east and drain to Outlet 1, Outlet 2, Outlet 3 and Gordon Street, respectively. It should be noted that a portion of Gordon Street south of the site may potentially drain to Lowes Road and the on-site roadside ditching. Figure 2 illustrates the existing site drainage.

GEOTECHNICAL INFORMATION

As identified in the *Geotechnical Investigation*, the soils for the site are generally comprised of sand and sand and gravel with a small pocket of silt located in the south end of the site near Lowes Road (BH-07-16). Groundwater levels at the time of the hydrogeological study (May 2016) ranged from 1.36 – 2.78 m below ground surface (BGS). A long-term groundwater

monitoring program is in place to observe the seasonal fluctuations in the shallow groundwater aquifer to confirm depth to water level.

Estimates for infiltration rates presented in the *Geotechnical Investigation* range from 18 – 45 mm/hr across the site.

5.0 Stormwater Management Design

To assess the site hydrology and proposed SWM strategy, the hydrologic model MIDUSS was used to simulate the catchment response to various design storms events. Rainfall distributions using the City of Guelph's IDF data were used as input to the model to generate peak runoff rates and volumes for the catchments within the study area to facilitate the design of SWM and LID features. The site was divided into catchments based on existing topography, detailed site survey, and preliminary grading design.

Preliminary hydrologic models were created for existing and proposed conditions for the 2-, 5-, and 100-year storms as well as the Regional rainfall event (48-hour Hurricane Hazel distribution).

Table 1: Rainfall Events – City of Guelph Parameters

Return Period	IDF Parameters			
	A	B	C	Depth (mm)
2-year, 3-hr	743	6.0	0.799	47.9
5-year, 3-hr	1593	11.0	0.879	65.8
100-year, 3-hr	4688	17.0	0.962	110.1
Regional, 48-hr	-	-	-	285

EXISTING HYDROLOGIC MODELLING

As mentioned above, MIDUSS models were prepared for existing and proposed conditions to simulate drainage and determine peak flow rates from the site. Under existing conditions, the site is low density residential with mainly pervious area and six (6) homes. Delineation of the site catchments under existing conditions is outlined below and illustrated on Figure 2:

- Catchment 100: 0.41 ha of pervious front yards draining to Outlet 2, the Lowes Road ditch system, flowing west to Dawn Avenue and, ultimately, the wetland to the north;
- Catchment 102: 0.36 ha of existing residential area draining northwest to Outlet 3, the 525 mm diameter Boss 2000 recently identified by survey;
- Catchment 103: 0.88 ha of existing residential area draining north to Outlet 1, the 525 mm diameter Boss 2000.

- Catchment 300: 0.19 ha of external area to the south draining to the Lowes Road ditch system, flowing west to Dawn Avenue and, ultimately the wetland to the north;
- Catchment 301: 0.44 ha of external area to the south draining to the Lowes Road ditch system, flowing west to Dawn Avenue and, ultimately the wetland to the north;
- Catchment 302: 0.59 ha of external area to the south draining to the Lowes Road ditch system, flowing west to Dawn Avenue and, ultimately the wetland to the north;
- Catchment 303: 0.33 ha of proposed, external commercial area draining east to Gordon Street;
- Catchment 304: 0.70 ha of existing residential area on Zess Court, external to the site and draining to the rear yard ditch, ultimately to Outlet 1;
- Catchment 305: 0.08 ha of existing residential area on Dawn Avenue, external to the site;
- Catchment 306: 0.02 ha of external pervious area draining to Outlet 2;
- Catchment 307: 0.09 ha of external area on Gordon Street draining to Lowes Road and the roadside ditch system;
- Catchment 309: 0.22 ha of existing residential area, external to the site and draining to Outlet 3; and
- Catchment 310: 0.33 ha of external area on Gordon Street draining north and potentially flowing west down Lowes Road to the roadside ditch.

PROPOSED HYDROLOGIC MODELLING

The proposed residential development consists of approximately 1.69 ha of townhouses, internal roadways, grassed yards, and a SWM facility. The proposed drainage plan is illustrated on Figure 3 and is described below:

Catchment 200: 0.29 ha of proposed residential and roadway draining south to Lowes Road and the roadside ditch (Outlet 2);

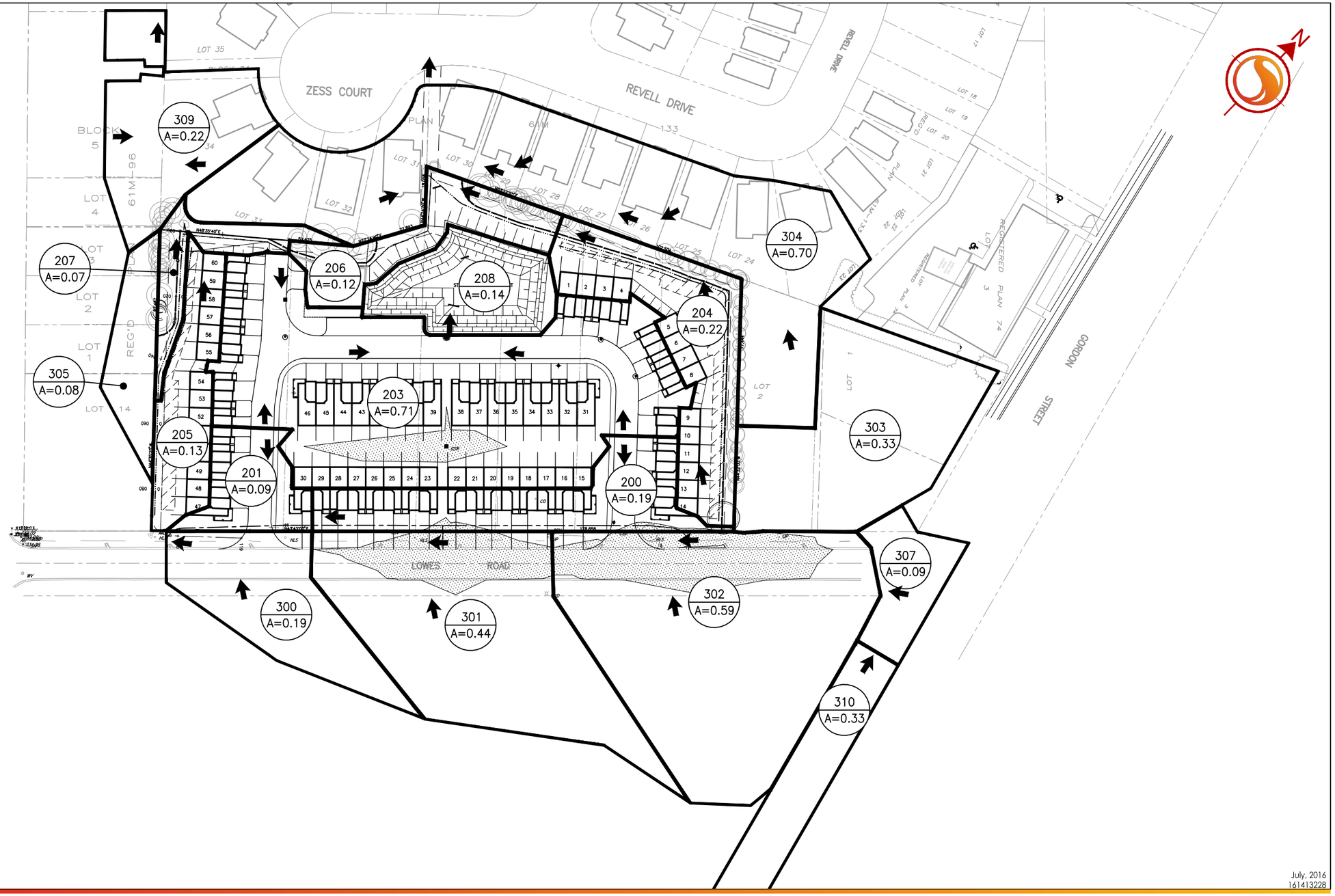
Catchment 203: 0.71 ha of proposed residential and roadway draining to the proposed dry SWM facility and ultimately to Outlet 1;

Catchment 204: 0.22 ha of proposed residential backyards and roof area draining to infiltration galleries with overflows to Outlet 1;

Catchment 205: 0.13 ha of proposed residential backyards and roof area draining to infiltration galleries with overflows to Outlet 3;

Catchment 206: 0.12 ha of proposed pervious, amenity area draining to Outlet 1;

Catchment 207: 0.07 ha of proposed pervious, backyard area draining to Outlet 3; and



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July, 2016
161413228

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Legend

- 1 / A=0.25 — AREA I.D. / CATCHMENT AREA
- MAJOR OVERLAND FLOOD ROUTE
- DRAINAGE BOUNDARY
- PROPOSED PONDING AREAS

Notes

1:1250 — 0 12.5 37.5 62.5m

Client/Project
Reid's Heritage Homes
Lowes Road Property, Guelph

Figure No.
FIG 3.0

Title
PRELIMINARY
DRAINAGE AREA PLAN

Catchment 208: 0.14 ha of grassed area and dry SWM facility

All external areas remain the same as existing conditions under the proposed scenario.

PROPOSED SWM STRATEGY

Water quantity and quality control for the site are provided through a combination of a dry SWM facility, oils and grit separator (OGS) unit, and infiltration trenches (LID). As discussed previously, the City of Guelph water quantity design criteria are based on a single outlet for the site; however as outlined in the previous sections, detailed survey and topography show that there are three (3) potential outlets for the site: two 525 mm diameter Boss 2000 pipes to the north and Lowes Road to the south. Similar to existing conditions, the proposed SWM strategy conveys runoff and/or infiltration to each outlet to maintain the existing hydrologic regime for the site.

Due to grading constraints and the limited capacity of the pipe identified as the site outlet by the City, portions of the site do not have a positive outlet. In addition, it is assumed the majority of runoff under existing conditions infiltrates on-site and does not reach the outlet except under large rainfall events. Consequently, all quantity control measures on-site have been designed to hold at least twice the runoff volume resulting from the 5-year rainfall event as outlined by the City of Guelph design criteria. The following sections address each site outlet and its respective SWM strategy.

Outlet 1: 525 mm diameter Boss 2000 pipe at 0.2% located north of site (original target outlet)

The City of Guelph design criteria assumes the drainage for the entire site is directed to a single 525 mm diameter pipe located north of the site. The pipe travels under Zess Court and outlets at the PSW located north of the adjacent subdivision. Under proposed conditions, Catchments 203 and 208 drain to a dry SWM facility which then discharges to the 525 mm pipe. The pipe is also an outlet for Catchment 206 and receives overland flow from Catchment 204 during the Regional rainfall event.

A combination of an OGS unit and dry SWM facility will provide water quantity and quality treatment for internal roadways and the majority of impervious area. For the purposes of this preliminary assessment, the outlet for the dry SWM facility is the 525 mm diameter Boss 2000 pipe under Zess Court; however, by raising the invert of the outlet of the facility, there is the potential for additional infiltration by using bioretention or a similar LID approach.

The preliminary design of the dry SWM facility has a bottom elevation of 331.20 mASL and a top of bank of 332.80 mASL. The maximum 100-year ponding elevation is 332.25 mASL. 'Enhanced' water quality treatment for the majority of the site is provided through a treatment train approach which includes an OGS unit and a downstream SWM facility prior to discharging to the site outlet. The OGS unit is sized to remove 80% TSS while the downstream dry SWM facility will provide a polishing of 60% TSS removal (as per Table 3.2 of the *SWMPD Manual*). An orifice plate has been included in the design to attenuate peak flows rates and provide a greater drawdown time to improve effluent water quality. The preliminary SWM facility design characteristics are presented in Table 2.

Table 2: SWM Facility Design Characteristics

Parameter	Characteristics
Total Contributing Area	0.85 ha
Total Percent Impervious to SWMF	90%
Bottom of SWM Facility	331.20 m
Top of SWM Facility	332.80 m
Total Available Volume	820 m^3
Quality Control (Basic – 60%)	
Unit Area Storage Requirement	253 m^3/ha
Total Volume Required	215 m^3
MOECC Extended Detention Volume Required (40 m^3/ha)	34 m^3
Extended Detention Volume Provided in Pond	820 m^3
MOECC Extended Detention Drawdown Time	61 hrs
Outlet Structure Details	
Orifice Invert	333.20 m
Orifice #1 Diameter	50 mm

Table 3: Peak Flow Rates from Site to Outlet 1 (525 mm dia. Boss 2000 pipe at 0.2%)

Storm Event	Target from City	Outlet 1 (m^3/s)	
		Existing	Proposed
2-year	0.013	0.02	0.01
5-year	0.017	0.03	0.01
100-year	0.037	0.11	0.03
Regional	0.053	0.08	0.11

Notes: No external areas included for these values (on-site targets only)

As shown in Table 3, the dry SWM facility attenuates peak flows from the site to match both the existing flow rates at this location and the City's design criteria.

Clean rooftop runoff will be directed to an infiltration trench for all rainfall events (up to and including the 100-year storm) to reduce surface runoff to the pipe outlet and promote groundwater recharge. The trench is proposed at the east property limits and receives drainage from Catchment 204. Based on the results of the hydrogeological investigation and the proposed location of the east trench, there is at least 1 m separation from the bottom of the trench to the groundwater. The trench is sized to hold the runoff volume resulting from twice the 5-year rainfall event with the intention of infiltrating the runoff from all storms up to and including the 100-year storm. The total volume and high level design details for the east trench are presented in Table 4.

As presented above, there is sufficient volume in the proposed infiltration trenches to hold twice the 5-year runoff volume while it infiltrates into the underlying sand and gravel layers.

Table 4: East Infiltration Trench Volume Details

Infiltration Trench Characteristics	East (204)
Total Preliminary Drainage Area to Trench (ha)	0.22
Volume of twice the runoff from City of Guelph, 5-year, 3-hr storm (48 mm depth) (m^3)	80
Assumed Percolation rate (refer to notes) (mm/hr)	30
Total Preliminary Available Storage Volume (m^3)	202

As presented above, there is sufficient volume in the east infiltration trench to hold twice the 5-year runoff volume while it infiltrates into the underlying sand and gravel layers.

Outlet 2: Lowes Road and Roadside Ditch

Approximately 0.28 ha of proposed site area drains south to Lowes Road, similar to existing conditions. In addition to the site area draining to Lowes Road, external areas from the property south of Lowes Road and major flows from Gordon Street drain to the Lowes Road system. Runoff flows west to Dawn Avenue and is then conveyed north to the PSW. The internal Catchments 200 and 201 contribute to Lowes Road drainage under proposed conditions. Table 5 presents the internal and external flows to Lowes Road, downstream of the site.

Table 5: Peak Flow Rates from Site to Outlet 2 (Lowes Road)

Storm Event	Outlet 2 (m^3/s)	
	Existing	Proposed
2-year	0.23	0.27
5-year	0.31	0.35
100-year	0.56	0.64
Regional	0.20	0.20

It is recommended that additional LID approaches to provide attenuation for Catchments 200 and 201 in order to meet existing flow rates from the site be explored at detailed design.

Outlet 3: 525 mm diameter Boss 2000 pipe at 0.4% located at the northwest corner of the site

Under proposed conditions, Catchments 205 and 207 drain to the northwest pipe outlet. Similar to the east end of the site, clean rooftop runoff from Catchment 205 will be directed to an infiltration trench for all rainfall events (up to and including the 100-year storm) to reduce surface runoff to the northwest pipe outlet and promote groundwater recharge. Based on the results of the hydrogeological investigation and the proposed location of the east trench, there is at least 1 m separation from the bottom of the trench to the groundwater. The trench is sized to hold the runoff volume resulting from twice the 5-year rainfall event with the intention of infiltrating the runoff from all storms up to and including the 100-year storm. During the Regional event, overflows will spill to the pipe, similar to existing conditions.

Table 6 presents the proposed peak flow rates from the site to the northwest outlet.

Table 6: Peak Flow Rates from Site to Outlet 3 (525 mm dia. Boss 2000 pipe at 0.4%)

Storm Event	Outlet 3 (m^3/s)	
	Existing	Proposed[1]
2-year	0.01	0
5-year	0.01	0
100-year	0.06	0
Regional	0.04	0.02

[1]The total runoff volume the 2-, 5-, and 100-year storms is all infiltrated

The total volume and high level design details for the east trench are presented in Table 7.

Table 7: West Infiltration Trench Volume Details

Infiltration Trench Characteristics	West (205)
Total Preliminary Drainage Area to Trench (ha)	0.13
Volume of twice the runoff from City of Guelph, 5-year, 3-hr storm (48 mm depth) (m^3)	60
Assumed Percolation rate (refer to notes) (mm/hr)	30
Total Preliminary Available Storage Volume (m^3)	156

Notes: Percolation rate based on rates provided in the *Geotechnical Investigation* (Englobe, 2016)

As presented above, there is sufficient volume in the proposed infiltration trenches to hold twice the 5-year runoff volume while it infiltrates into the underlying sand and gravel layers.

6.0 Conclusions

Based on the preliminary SWM analysis of the Lowes Road site, the following conclusions can be drawn:

- Three (3) outlets exist for the site under existing conditions and are generally maintained during proposed conditions to match the existing hydrologic regime;
- 'Enhanced' water quality control for roadways and non-rooftop impervious areas is provided by an OGS unit and a dry SWM facility;
- Water quantity control for the site is provided by a dry SWM facility and on-site infiltration;
- Due to grading constraints and insufficient outlet capacity, storage volumes are based on twice the runoff volume resulting from the 5-year rainfall event;

- Infiltration trenches with sufficient capacity to hold the runoff volume from clean rooftop runoff for all storms up to and including the 100-year storm are provided at the east and west limits of the site; and

- Additional attenuation may be required for the area draining to Lowes Road which may be accomplished by directing more drainage to the proposed SWM facility.

We trust this design brief is sufficient to address the City of Guelph requirements for the SWM design for the proposed Lowes Road residential development.

Should you have any questions or comments relating to this design, please do not hesitate to contact the undersigned at your convenience.

Sincerely,

STANTEC CONSULTING LTD.

LICENSED PROFESSIONAL ENGINEER
T. A. H. FRASER
100176040
2016/08/26
PROVINCE OF ONTARIO

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c. Mr. Peter Fitzgerald, Stantec Consulting Ltd.

ATTACHMENTS

DATE 11th August 2016

TO	Adele Figliomeni, C.E.T.	FROM	Kime Toole, C.E.T.
COMPANY	Stantec	DIVISION	Development Engineering
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		EMAIL	kime.toole@guelph.ca
		PHONE	519-822-1260 X 2250
		FAX	519-822-6194

CC Trevor Frazer, P.Eng.
Rachel Ellerman, C.E.T.

SUBJECT REVISED Stormwater Criteria: 19-59 Lowes Rd (±1.688 ha)

NOTE: *The following information is supplied to aid in the engineering or design of a project and is not all-inclusive. The applicant is advised to contact all relevant Departments and Agencies (including MOECC) to determine the requirements which pertain to a specific site.*

- The City of Guelph's allowable outlet rate is as follows: 0.013 m^3/s - *2yr*, 0.017 m^3/s - *5yr*, 0.037 m^3/s - *100yr*, and 0.053 m^3/s – *Regional Storm*;
- Sites that do not have a positive outlet must be designed to provide storage on site for twice the five year design storm runoff volume;
- On site control and storage (roof top/parking lot/ponds/superpipes) may be required to attenuate flows;
- For commercial, institutional and high density residential developments, excess runoff for the two year design storm is to be stored underground or on roof tops;
- Excess runoff from the five year design storm may pond in parking areas of least anticipated use to a maximum depth of 0.3m;
- Major storms are to be routed overland to the City's R.O.W. without exceeding a maximum parking lot pond depth of 0.3m. Sites which cannot meet these criteria are required to provide storage on the site for twice the five year design storm runoff volume;
- Clean runoff (roof water) must be directed to pervious areas for infiltration to encourage ground water recharge (Low Impact Development);
- Provide a water balance analysis;
- Infiltration devices are acceptable for the drainage of grassed and roof areas as long as they provide an overflow connection to the storm sewer and are fully infiltrated within a 24 hour time period. Soils reports must be provided along with the design of infiltration facilities, indicating "k" values (co-efficient of permeability) for soils and confirmation of at least 1.0m separation between the bottom of the infiltration gallery/drywell and ground water table/bedrock elevation. For infiltration gallery calculations, the bottom area is to be excluded as the bottom tends to clog-up over time. Establish calculations using side area of gallery only;
- Evaluate infiltration potential on site as it relates to the existing water budget, and recommend measures to meet the goal of maintaining or enhancing groundwater recharge;
- Quality control facilities are required to remove suspended solids (oil and grit) from areas draining driveways and parking lots (i.e. oil/grit interceptors, catch basins, and vegetative buffer strips or a combination thereof). Please note that Goss traps are not acceptable for areas larger than $250m^2$;
- Control water quality to an Enhanced Protection Level (80% TSS removal).
- The SWM report must include an erosion and sedimentation control plan to be employed during construction of the project;
- Any end-of-pipe stormwater management facility design must conform to the City of Guelph design guidelines;
- Existing overland drainage patterns from adjoining properties must be maintained and shown on the submitted drawing;
- A Professional Engineer must certify the design and construction of the SWM facility.

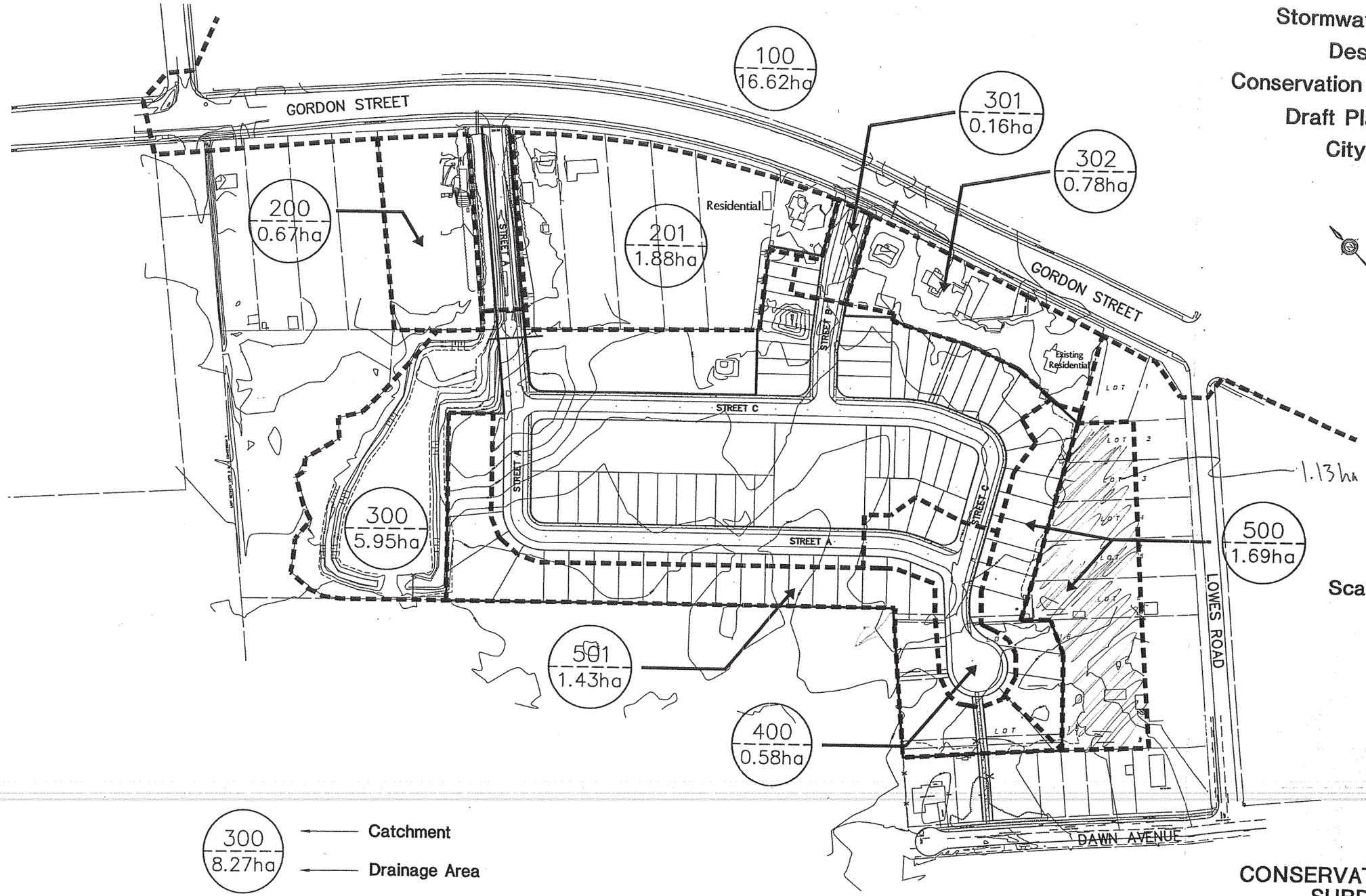
We require that the SWM modelling be submitted in Miduss format using the Horton Equation as this enables our office to complete our review in a timely fashion. The SWM Report is to show system performance for the 5 year and 100 year design storms and must include scale drawings showing drainage catchment areas, delineated pond limits for the 5yr and 100yr design storms (where applicable) and a schematic diagram reflecting the model (complex models).

City of Guelph design storm hyetographs and Miduss stormwater modelling parameters for the design storms and Miduss Guelph design storm electronic files are available upon request.

Engineering & Capital Infrastructure Services
Infrastructure, Development & Enterprise

Original will follow ☐ Yes ☐ No

Stormwater Management
Design Report
Conservation Estates Subdivision
Draft Plan 23T-03506
City of Guelph



Scale 1:2,500

300
8.27ha
Catchment
Drainage Area

CONSERVATION ESTATES
SUBDIVISION
DRAINAGE AREAS

Figure 3

GAMSBY AND MANNEROW Limited

Gamsby and Mannerow Limited APR 11 2006 105163 FIG3.DWG

1614-13228 Lowes Road, Guelph ON
MIDUSS Parameters

Existing Conditions

Catchment Number	Catchment Description	Downstream Outlet	Area (ha)	Impervious %	Impervious Area (ha)	Length (PERV) (m)	Length (IMPERV) (m)	Gradient (%)	Overland Manning n	Max Infiltration Rate (mm/hr)	Min Infiltration Rate (mm/hr)	Lag Constant	Pervious IA (mm)
100	Internal residential catchment draining south to Lowes Road	Outlet 2	0.41	10.0%	0.04	150	10	0.5%	0.25	75	13	0.5	5.1
102	Internal residential catchment draining northwest to existing 525 mm diameter Boss 2000 pipe at 0.4%; previously unidentified by City of Guelph as a site outlet	Outlet 3	0.36	10.0%	0.04	75	10	0.5%	0.25	75	13	0.5	5.1
103	Internal residential catchment draining north to 525 mm diameter Boss 2000 pipe at 0.2% draining under Zess Court (site outlet as per City of Guelph design criteria)	Outlet 1	0.88	10.0%	0.09	110	10	0.5%	0.25	75	13	0.5	5.1
300	External residential catchment on south side of Lowes Road draining north to the site and the roadside ditch	Outlet 2	0.19	40.0%	0.08	90	10	0.5%	0.25	75	13	0.5	5.1
301	External residential catchment on south side of Lowes Road draining north to the site and the roadside ditch	Outlet 2	0.44	40.0%	0.18	120	10	0.5%	0.25	75	13	0.5	5.1
302	External residential catchment on south side of Lowes Road draining north to the site and the roadside ditch	Outlet 2	0.59	40.0%	0.24	90	10	0.5%	0.25	75	13	0.5	5.1
303	External undeveloped catchment (proposed commercial) draining east to Gordon Street (assumed)	Gordon Street	0.33	20.0%	0.07	60	10	0.5%	0.25	75	13	0.5	10.0
304	External residential catchment draining to site ditch and ultimately the site outlet under Zess Court north of the site	Outlet 1	0.70	40.0%	0.28	150	10	0.5%	0.25	75	13	0.5	5.1
305	External residential rear yards draining to northwest site outlet (unidentified by City)	Outlet 3	0.08	5.0%	0.00	75	10	0.5%	0.25	75	13	0.5	5.1
306	External residential rear yard catchment draining to northwest site outlet (unidentified by City)	Outlet 3	0.02	1.0%	0.00	40	10	0.5%	0.25	75	13	0.5	5.1
307	External catchment at Lowes Road and Gordon Street intersection draining to Lowes Road and site ditch (assumed)	Outlet 2	0.09	90.0%	0.08	5	10	2.0%	0.25	75	13	0.5	2.0
309	External residential rear yard catchment draining to northwest site outlet (unidentified by City)	Outlet 3	0.22	20.0%	0.04	45	10	0.5%	0.25	75	13	0.5	5.1
310	External roadway catchment draining from south on Gordon Street and to ditch on site (assumed)	Outlet 2	0.33	90.0%	0.30	5	10	2.0%	0.25	75	13	0.5	2.0
Total (Internal)			**1.7**	**ha**									
Total (including external)			**4.6**	**ha**									

Proposed Conditions

Area Description	Subwatershed	Downstream Outlet	Area (ha)	Impervious %	Impervious Area (ha)	Length (PERV) (m)	Length (IMPERV) (m)	Gradient (%)	Manning n	Max Infiltration Rate (mm/hr)	Min Infiltration Rate (mm/hr)	Lag Constant	Pervious IA (mm)
200	Internal townhome catchment draining south to Lowes Road	Outlet 2	0.19	60.0%	0.11	120	10	0.5%	0.25	75	13	0.5	5.1
201	Internal townhome catchment draining south to Lowes Road	Outlet 2	0.09	60.0%	0.05	120	10	0.5%	0.25	75	13	0.5	5.1
203	Internal townhome catchment with internal roadways and parking areas draining to SWM facility	Outlet 1	0.71	90.0%	0.64	10	10	2.0%	0.25	75	13	0.5	2.0
204	Internal east townhouse rear yards to proposed infiltration trenches; overland to Outlet 1 during Regional storm event	Outlet 1	0.22	40.0%	0.09	150	10	2.0%	0.25	75	13	0.5	5.1
205	Internal west townhouse rear yards to proposed infiltration trenches; overland to Outlet 3 during Regional storm event	Outlet 3	0.16	40.0%	0.06	100	10	0.5%	0.25	75	13	0.5	5.1
206	Internal pervious/amenity area draining around SWM facility	Outlet 1	0.12	1.0%	0.00	50	10	1.0%	0.25	75	13	0.5	5.1
207	Internal pervious area at northwest corner of site	Outlet 3	0.07	2.0%	0.00	20	10	0.5%	0.25	75	13	0.5	5.1
208	Internal SWM block	Outlet 1	0.12	50.0%	0.06	10	10	1.0%	0.25	75	13	0.5	5.1
External Catchments Remain Unchanged from Existing Conditions (300 series catchments)													
Total (internal)			**1.7**	**ha**									

Notes:
Outlet 1 - 525 mm dia. perforated Boss 2000 pipe at 0.2% located at north end of site; original site outlet as assumed by City of Guelph design criteria
Outlet 2 - Drainage to Lowes Road and roadside ditch system, draining to Dawn Avenue
Outlet 3 - 525 mm dia. perforated Boss 2000 pipe at 0.4% located at northwest corner of site, previously unidentified by City of Guelph as site outlet

```
00001>          Output File (4.7) LOX2YR.OUT   opened 2016-08-17  16:42
00002>          Units used are defined by G =    9.810
00003>              36   240     5.000        are MAXDT MAXHYD & DTMIN values
00004>          Licensee: Paragon Engineering Limited
00005>    35    COMMENT
00006>         6     line(s) of comment
00007>          *********************
00008>          1614-13228 - Lowes Road
00009>          Existing Conditions - SWM Modelling
00010>          2-yr, 3 hour storm event
00011>          Functional Servicing Report - T.Fraser (July 2016)
00012>          *********************
00013>    23    FILE RAINFALL
00014>         1     1=READ: 2=WRITE
00015>        10     Guelph2.ST           is Filename
00016>     3    IMPERVIOUS
00017>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00018>            .013     Manning "n"
00019>            .000     Max.Infiltn. mm/hr
00020>            .000     Min.Infiltn. mm/hr
00021>            .050     Lag const (hours)
00022>           1.500     Dep.Storage mm
00023>    35    COMMENT
00024>         3     line(s) of comment
00025>          ************************************
00026>          Catchment 100 - Internal to Lowes Road
00027>          ************************************
00028>     4    CATCHMENT
00029>         100.000     ID No.ó 99999
00030>            .410     Area in hectares
00031>         150.000     Length (PERV) metres
00032>            .500     Gradient (%)
00033>          10.000     Per cent Impervious
00034>          10.000     Length (IMPERV)
00035>            .000     %Imp. with Zero Dpth
00036>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00037>            .250     Manning "n"
00038>          75.000     Max.Infiltn. mm/hr
00039>          13.000     Min.Infiltn. mm/hr
00040>            .500     Lag const (hours)
00041>           5.100     Dep.Storage mm
00042>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00043>                  .010       .000       .000       .000 c.m/s
00044>                  .000       .941       .094     C perv/imperv/total
00045>    15    ADD RUNOFF
00046>                  .010       .010       .000       .000 c.m/s
00047>    35    COMMENT
00048>         4     line(s) of comment
00049>          ****************************************
00050>          Catchment 300 - External flows from south
00051>          Drains to Lowes Road and west to Dawn Ave
00052>          ****************************************
00053>     4    CATCHMENT
00054>         300.000     ID No.ó 99999
00055>            .190     Area in hectares
00056>          90.000     Length (PERV) metres
00057>            .500     Gradient (%)
00058>          40.000     Per cent Impervious
00059>          10.000     Length (IMPERV)
00060>            .000     %Imp. with Zero Dpth
00061>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00062>            .250     Manning "n"
00063>          75.000     Max.Infiltn. mm/hr
00064>          13.000     Min.Infiltn. mm/hr
00065>            .500     Lag const (hours)
00066>           5.100     Dep.Storage mm
00067>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00068>                  .019       .010       .000       .000 c.m/s
00069>                  .000       .941       .376     C perv/imperv/total
00070>    15    ADD RUNOFF
00071>                  .019       .029       .000       .000 c.m/s
00072>    35    COMMENT
00073>         4     line(s) of comment
00074>          ****************************************
00075>          Catchment 301 - External flows from south
00076>          Drains to Lowes Road and west to Dawn Ave
00077>          ****************************************
00078>     4    CATCHMENT
00079>         301.000     ID No.ó 99999
00080>            .440     Area in hectares
00081>         120.000     Length (PERV) metres
00082>            .500     Gradient (%)
00083>          40.000     Per cent Impervious
00084>          10.000     Length (IMPERV)
00085>            .000     %Imp. with Zero Dpth
00086>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00087>            .250     Manning "n"
00088>          75.000     Max.Infiltn. mm/hr
00089>          13.000     Min.Infiltn. mm/hr
00090>            .500     Lag const (hours)
00091>           5.100     Dep.Storage mm
00092>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00093>                  .044       .029       .000       .000 c.m/s
00094>                  .000       .941       .376     C perv/imperv/total
00095>    15    ADD RUNOFF
00096>                  .044       .074       .000       .000 c.m/s
00097>    35    COMMENT
00098>         4     line(s) of comment
00099>          ************************************
00100>          Catchment 302 - External flows from south
00101>          Drains to Lowes Road and west to Dawn Ave
00102>          ************************************
00103>     4    CATCHMENT
00104>         302.000     ID No.ó 99999
00105>            .590     Area in hectares
00106>          90.000     Length (PERV) metres
00107>            .500     Gradient (%)
00108>          40.000     Per cent Impervious
00109>          10.000     Length (IMPERV)
00110>            .000     %Imp. with Zero Dpth
00111>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00112>            .250     Manning "n"
00113>          75.000     Max.Infiltn. mm/hr
00114>          13.000     Min.Infiltn. mm/hr
00115>            .500     Lag const (hours)
00116>           5.100     Dep.Storage mm
00117>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00118>                  .059       .074       .000       .000 c.m/s
00119>                  .000       .941       .376     C perv/imperv/total
00120>    15    ADD RUNOFF
00121>                  .059       .133       .000       .000 c.m/s
00122>    35    COMMENT
00123>         4     line(s) of comment
00124>          ************************************************
00125>          Catchment 307 - External flows Gordon St
00126>          Assumed to drain to Lowes Road and west to Dawn Ave
00127>          ************************************************
00128>     4    CATCHMENT
00129>         307.000     ID No.ó 99999
00130>            .090     Area in hectares
00131>           5.000     Length (PERV) metres
00132>           2.000     Gradient (%)
00133>          90.000     Per cent Impervious
00134>          10.000     Length (IMPERV)
00135>            .000     %Imp. with Zero Dpth
00136>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00137>            .250     Manning "n"
00138>          75.000     Max.Infiltn. mm/hr
00139>          13.000     Min.Infiltn. mm/hr
00140>            .500     Lag const (hours)
00141>           2.000     Dep.Storage mm
00142>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00143>                  .021       .133       .000       .000 c.m/s
00144>                  .071       .925       .839     C perv/imperv/total
00145>    15    ADD RUNOFF
00146>                  .021       .154       .000       .000 c.m/s
00147>    35    COMMENT
00148>         4     line(s) of comment
00149>          ************************************************
00150>          Catchment 310 - External flows Gordon St
00151>          Assumed to drain to Lowes Road and west to Dawn Ave
00152>          ************************************************
00153>     4    CATCHMENT
00154>         310.000     ID No.ó 99999
00155>            .330     Area in hectares
00156>           5.000     Length (PERV) metres
00157>           2.000     Gradient (%)
00158>          90.000     Per cent Impervious
00159>          10.000     Length (IMPERV)
00160>            .000     %Imp. with Zero Dpth
00161>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00162>            .250     Manning "n"
00163>          75.000     Max.Infiltn. mm/hr
00164>          13.000     Min.Infiltn. mm/hr
00165>            .500     Lag const (hours)
00166>           2.000     Dep.Storage mm
00167>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00168>                  .078       .154       .000       .000 c.m/s
00169>                  .071       .925       .839     C perv/imperv/total
00170>    15    ADD RUNOFF
00171>                  .078       .232       .000       .000 c.m/s
00172>    14    START
00173>         1     1=Zero; 2=Define
00174>    35    COMMENT
00175>         4     line(s) of comment
00176>          ************************************************************
00177>          Catchment 102 - Existing drainage to NW 525 mm pipe
00178>          Pipe not identified by City of Guelph as per design criteria
00179>          ************************************************************
00180>     4    CATCHMENT
00181>         102.000     ID No.ó 99999
00182>            .360     Area in hectares
00183>          75.000     Length (PERV) metres
00184>            .500     Gradient (%)
00185>          10.000     Per cent Impervious
00186>          10.000     Length (IMPERV)
00187>            .000     %Imp. with Zero Dpth
00188>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00189>            .250     Manning "n"
00190>          75.000     Max.Infiltn. mm/hr
00191>          13.000     Min.Infiltn. mm/hr
00192>            .500     Lag const (hours)
00193>           5.100     Dep.Storage mm
00194>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00195>                  .009       .000       .000       .000 c.m/s
00196>                  .000       .941       .094     C perv/imperv/total
00197>    15    ADD RUNOFF
00198>                  .009       .009       .000       .000 c.m/s
00199>    35    COMMENT
00200>         3     line(s) of comment
00201>          ************************************************************
00202>          Catchment 305 - Existing external backyard drainage to NW 52
00203>          ************************************************************
00204>     4    CATCHMENT
00205>         305.000     ID No.ó 99999
00206>            .080     Area in hectares
00207>          75.000     Length (PERV) metres
00208>            .500     Gradient (%)
00209>           5.000     Per cent Impervious
00210>          10.000     Length (IMPERV)
00211>            .000     %Imp. with Zero Dpth
00212>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00213>            .250     Manning "n"
00214>          75.000     Max.Infiltn. mm/hr
00215>          13.000     Min.Infiltn. mm/hr
00216>            .500     Lag const (hours)
00217>           5.100     Dep.Storage mm
00218>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00219>                  .001       .009       .000       .000 c.m/s
00220>                  .000       .941       .047     C perv/imperv/total
00221>    15    ADD RUNOFF
00222>                  .001       .010       .000       .000 c.m/s
00223>    35    COMMENT
00224>         3     line(s) of comment
00225>          ************************************************************
00226>          Catchment 306 - Existing external backyard drainage to NW 52
00227>          ************************************************************
00228>     4    CATCHMENT
00229>         306.000     ID No.ó 99999
00230>            .020     Area in hectares
00231>          40.000     Length (PERV) metres
00232>            .500     Gradient (%)
00233>           1.000     Per cent Impervious
00234>          10.000     Length (IMPERV)
00235>            .000     %Imp. with Zero Dpth
00236>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00237>            .250     Manning "n"
00238>          75.000     Max.Infiltn. mm/hr
00239>          13.000     Min.Infiltn. mm/hr
00240>            .500     Lag const (hours)
00241>           5.100     Dep.Storage mm
00242>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00243>                  .000       .010       .000       .000 c.m/s
00244>                  .000       .941       .009     C perv/imperv/total
00245>    15    ADD RUNOFF
00246>                  .000       .010       .000       .000 c.m/s
00247>    35    COMMENT
00248>         3     line(s) of comment
00249>          ************************************************************
00250>          Catchment 309 - Existing external backyard drainage to NW 52
00251>          ************************************************************
00252>     4    CATCHMENT
00253>         309.000     ID No.ó 99999
00254>            .220     Area in hectares
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00255>          45.000     Length (PERV) metres
00256>            .500     Gradient (%)
00257>          20.000     Per cent Impervious
00258>          10.000     Length (IMPERV)
00259>            .000     %Imp. with Zero Dpth
00260>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00261>            .250     Manning "n"
00262>          75.000     Max.Infiltn. mm/hr
00263>          13.000     Min.Infiltn. mm/hr
00264>            .500     Lag const (hours)
00265>           5.100     Dep.Storage mm
00266>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00267>                  .011       .010       .000       .000 c.m/s
00268>                 .000       .941       .188     C perv/imperv/total
00269>    15     ADD RUNOFF
00270>                  .011       .021       .000       .000 c.m/s
00271>    14     START
00272>          1     1=Zero; 2=Define
00273>    35     COMMENT
00274>          3     line(s) of comment
00275>           *****************************************************
00276>           Catchment 103 - Existing drainage to main site outlet
00277>           *****************************************************
00278>     4     CATCHMENT
00279>         103.000     ID No.ó 99999
00280>            .880     Area in hectares
00281>         110.000     Length (PERV) metres
00282>            .500     Gradient (%)
00283>          10.000     Per cent Impervious
00284>          10.000     Length (IMPERV)
00285>            .000     %Imp. with Zero Dpth
00286>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00287>            .250     Manning "n"
00288>          75.000     Max.Infiltn. mm/hr
00289>          13.000     Min.Infiltn. mm/hr
00290>            .500     Lag const (hours)
00291>           5.100     Dep.Storage mm
00292>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00293>                  .022       .000       .000       .000 c.m/s
00294>                 .000       .941       .094     C perv/imperv/total
00295>    15     ADD RUNOFF
00296>                  .022       .022       .000       .000 c.m/s
00297>    35     COMMENT
00298>          3     line(s) of comment
00299>           ************************************************************
00300>           Catchment 304 - Existing external drainage to main site outl
00301>           ************************************************************
00302>     4     CATCHMENT
00303>         304.000     ID No.ó 99999
00304>            .700     Area in hectares
00305>         150.000     Length (PERV) metres
00306>            .500     Gradient (%)
00307>          40.000     Per cent Impervious
00308>          10.000     Length (IMPERV)
00309>            .000     %Imp. with Zero Dpth
00310>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00311>            .250     Manning "n"
00312>          75.000     Max.Infiltn. mm/hr
00313>          13.000     Min.Infiltn. mm/hr
00314>            .500     Lag const (hours)
00315>           5.100     Dep.Storage mm
00316>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00317>                  .070       .022       .000       .000 c.m/s
00318>                 .000       .941       .376     C perv/imperv/total
00319>    15     ADD RUNOFF
00320>                  .070       .093       .000       .000 c.m/s
00321>    14     START
00322>          1     1=Zero; 2=Define
00323>    35     COMMENT
00324>          4     line(s) of comment
00325>           ****************************************
00326>           Catchment 303 - External flows from east
00327>           Assumed to drain to Gordon Street
00328>           ****************************************
00329>     4     CATCHMENT
00330>         303.000     ID No.ó 99999
00331>            .330     Area in hectares
00332>          60.000     Length (PERV) metres
00333>            .500     Gradient (%)
00334>          20.000     Per cent Impervious
00335>          10.000     Length (IMPERV)
00336>            .000     %Imp. with Zero Dpth
00337>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00338>            .250     Manning "n"
00339>          75.000     Max.Infiltn. mm/hr
00340>          13.000     Min.Infiltn. mm/hr
00341>            .500     Lag const (hours)
00342>          10.000     Dep.Storage mm
00343>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00344>                  .017       .000       .000       .000 c.m/s
00345>                 .000       .941       .188     C perv/imperv/total
00346>    15     ADD RUNOFF
00347>                  .017       .017       .000       .000 c.m/s
00348>    20     MANUAL
00349>
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```
00001>          Output File (4.7) LOX5YR.OUT   opened 2016-08-17  16:43
00002>          Units used are defined by G =    9.810
00003>              36   240     5.000        are MAXDT MAXHYD & DTMIN values
00004>          Licensee: Paragon Engineering Limited
00005>    35    COMMENT
00006>         6     line(s) of comment
00007>          *********************
00008>          1614-13228 - Lowes Road
00009>          Proposed Conditions - SWM Modelling
00010>          5-yr, 3 hour storm event
00011>          Functional Servicing Report - T.Fraser (August 2016)
00012>          *********************
00013>    23    FILE RAINFALL
00014>         1     1=READ: 2=WRITE
00015>        10     Guelph5.ST           is Filename
00016>     3    IMPERVIOUS
00017>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00018>            .013     Manning "n"
00019>            .000     Max.Infiltn. mm/hr
00020>            .000     Min.Infiltn. mm/hr
00021>            .050     Lag const (hours)
00022>           1.500     Dep.Storage mm
00023>    35    COMMENT
00024>         3     line(s) of comment
00025>          ************************************
00026>          Catchment 100 - Internal to Lowes Road
00027>          ************************************
00028>     4    CATCHMENT
00029>         100.000     ID No.ó 99999
00030>            .410     Area in hectares
00031>         150.000     Length (PERV) metres
00032>            .500     Gradient (%)
00033>          10.000     Per cent Impervious
00034>          10.000     Length (IMPERV)
00035>            .000     %Imp. with Zero Dpth
00036>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00037>            .250     Manning "n"
00038>          75.000     Max.Infiltn. mm/hr
00039>          13.000     Min.Infiltn. mm/hr
00040>            .500     Lag const (hours)
00041>           5.100     Dep.Storage mm
00042>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00043>                  .014       .000       .000       .000 c.m/s
00044>                  .105       .952       .190     C perv/imperv/total
00045>    15    ADD RUNOFF
00046>                  .014       .014       .000       .000 c.m/s
00047>    35    COMMENT
00048>         4     line(s) of comment
00049>          ****************************************
00050>          Catchment 300 - External flows from south
00051>          Drains to Lowes Road and west to Dawn Ave
00052>          ****************************************
00053>     4    CATCHMENT
00054>         300.000     ID No.ó 99999
00055>            .190     Area in hectares
00056>          90.000     Length (PERV) metres
00057>            .500     Gradient (%)
00058>          40.000     Per cent Impervious
00059>          10.000     Length (IMPERV)
00060>            .000     %Imp. with Zero Dpth
00061>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00062>            .250     Manning "n"
00063>          75.000     Max.Infiltn. mm/hr
00064>          13.000     Min.Infiltn. mm/hr
00065>            .500     Lag const (hours)
00066>           5.100     Dep.Storage mm
00067>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00068>                  .025       .014       .000       .000 c.m/s
00069>                  .105       .952       .444     C perv/imperv/total
00070>    15    ADD RUNOFF
00071>                  .025       .039       .000       .000 c.m/s
00072>    35    COMMENT
00073>         4     line(s) of comment
00074>          ****************************************
00075>          Catchment 301 - External flows from south
00076>          Drains to Lowes Road and west to Dawn Ave
00077>          ****************************************
00078>     4    CATCHMENT
00079>         301.000     ID No.ó 99999
00080>            .440     Area in hectares
00081>         120.000     Length (PERV) metres
00082>            .500     Gradient (%)
00083>          40.000     Per cent Impervious
00084>          10.000     Length (IMPERV)
00085>            .000     %Imp. with Zero Dpth
00086>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00087>            .250     Manning "n"
00088>          75.000     Max.Infiltn. mm/hr
00089>          13.000     Min.Infiltn. mm/hr
00090>            .500     Lag const (hours)
00091>           5.100     Dep.Storage mm
00092>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00093>                  .059       .039       .000       .000 c.m/s
00094>                  .105       .952       .444     C perv/imperv/total
00095>    15    ADD RUNOFF
00096>                  .059       .098       .000       .000 c.m/s
00097>    35    COMMENT
00098>         4     line(s) of comment
00099>          ************************************
00100>          Catchment 302 - External flows from south
00101>          Drains to Lowes Road and west to Dawn Ave
00102>          ************************************
00103>     4    CATCHMENT
00104>         302.000     ID No.ó 99999
00105>            .590     Area in hectares
00106>          90.000     Length (PERV) metres
00107>            .500     Gradient (%)
00108>          40.000     Per cent Impervious
00109>          10.000     Length (IMPERV)
00110>            .000     %Imp. with Zero Dpth
00111>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00112>            .250     Manning "n"
00113>          75.000     Max.Infiltn. mm/hr
00114>          13.000     Min.Infiltn. mm/hr
00115>            .500     Lag const (hours)
00116>           5.100     Dep.Storage mm
00117>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00118>                  .079       .098       .000       .000 c.m/s
00119>                  .105       .952       .444     C perv/imperv/total
00120>    15    ADD RUNOFF
00121>                  .079       .177       .000       .000 c.m/s
00122>    35    COMMENT
00123>         4     line(s) of comment
00124>          ************************************************
00125>          Catchment 307 - External flows Gordon St
00126>          Assumed to drain to Lowes Road and west to Dawn Ave
00127>          ************************************************
00128>     4    CATCHMENT
00129>         307.000     ID No.ó 99999
00130>            .090     Area in hectares
00131>           5.000     Length (PERV) metres
00132>           2.000     Gradient (%)
00133>          90.000     Per cent Impervious
00134>          10.000     Length (IMPERV)
00135>            .000     %Imp. with Zero Dpth
00136>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00137>            .250     Manning "n"
00138>          75.000     Max.Infiltn. mm/hr
00139>          13.000     Min.Infiltn. mm/hr
00140>            .500     Lag const (hours)
00141>           2.000     Dep.Storage mm
00142>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00143>                  .028       .177       .000       .000 c.m/s
00144>                  .169       .931       .855     C perv/imperv/total
00145>    15    ADD RUNOFF
00146>                  .028       .205       .000       .000 c.m/s
00147>    35    COMMENT
00148>         4     line(s) of comment
00149>          ************************************************
00150>          Catchment 310 - External flows Gordon St
00151>          Assumed to drain to Lowes Road and west to Dawn Ave
00152>          ************************************************
00153>     4    CATCHMENT
00154>         310.000     ID No.ó 99999
00155>            .330     Area in hectares
00156>           5.000     Length (PERV) metres
00157>           2.000     Gradient (%)
00158>          90.000     Per cent Impervious
00159>          10.000     Length (IMPERV)
00160>            .000     %Imp. with Zero Dpth
00161>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00162>            .250     Manning "n"
00163>          75.000     Max.Infiltn. mm/hr
00164>          13.000     Min.Infiltn. mm/hr
00165>            .500     Lag const (hours)
00166>           2.000     Dep.Storage mm
00167>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00168>                  .103       .205       .000       .000 c.m/s
00169>                  .169       .931       .855     C perv/imperv/total
00170>    15    ADD RUNOFF
00171>                  .103       .307       .000       .000 c.m/s
00172>    14    START
00173>         1     1=Zero; 2=Define
00174>    35    COMMENT
00175>         4     line(s) of comment
00176>          ************************************************************
00177>          Catchment 102 - Existing drainage to NW 525 mm pipe
00178>          Pipe not identified by City of Guelph as per design criteria
00179>          ************************************************************
00180>     4    CATCHMENT
00181>         102.000     ID No.ó 99999
00182>            .360     Area in hectares
00183>          75.000     Length (PERV) metres
00184>            .500     Gradient (%)
00185>          10.000     Per cent Impervious
00186>          10.000     Length (IMPERV)
00187>            .000     %Imp. with Zero Dpth
00188>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00189>            .250     Manning "n"
00190>          75.000     Max.Infiltn. mm/hr
00191>          13.000     Min.Infiltn. mm/hr
00192>            .500     Lag const (hours)
00193>           5.100     Dep.Storage mm
00194>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00195>                  .012       .000       .000       .000 c.m/s
00196>                  .105       .952       .189     C perv/imperv/total
00197>    15    ADD RUNOFF
00198>                  .012       .012       .000       .000 c.m/s
00199>    35    COMMENT
00200>         3     line(s) of comment
00201>          ************************************************************
00202>          Catchment 305 - Existing external backyard drainage to NW 52
00203>          ************************************************************
00204>     4    CATCHMENT
00205>         305.000     ID No.ó 99999
00206>            .080     Area in hectares
00207>          75.000     Length (PERV) metres
00208>            .500     Gradient (%)
00209>           5.000     Per cent Impervious
00210>          10.000     Length (IMPERV)
00211>            .000     %Imp. with Zero Dpth
00212>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00213>            .250     Manning "n"
00214>          75.000     Max.Infiltn. mm/hr
00215>          13.000     Min.Infiltn. mm/hr
00216>            .500     Lag const (hours)
00217>           5.100     Dep.Storage mm
00218>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00219>                  .001       .012       .000       .000 c.m/s
00220>                  .105       .952       .147     C perv/imperv/total
00221>    15    ADD RUNOFF
00222>                  .001       .014       .000       .000 c.m/s
00223>    35    COMMENT
00224>         3     line(s) of comment
00225>          ************************************************************
00226>          Catchment 306 - Existing external backyard drainage to NW 52
00227>          ************************************************************
00228>     4    CATCHMENT
00229>         306.000     ID No.ó 99999
00230>            .020     Area in hectares
00231>          40.000     Length (PERV) metres
00232>            .500     Gradient (%)
00233>           1.000     Per cent Impervious
00234>          10.000     Length (IMPERV)
00235>            .000     %Imp. with Zero Dpth
00236>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00237>            .250     Manning "n"
00238>          75.000     Max.Infiltn. mm/hr
00239>          13.000     Min.Infiltn. mm/hr
00240>            .500     Lag const (hours)
00241>           5.100     Dep.Storage mm
00242>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00243>                  .000       .014       .000       .000 c.m/s
00244>                  .105       .952       .113     C perv/imperv/total
00245>    15    ADD RUNOFF
00246>                  .000       .014       .000       .000 c.m/s
00247>    35    COMMENT
00248>         3     line(s) of comment
00249>          ************************************************************
00250>          Catchment 309 - Existing external backyard drainage to NW 52
00251>          ************************************************************
00252>     4    CATCHMENT
00253>         309.000     ID No.ó 99999
00254>            .220     Area in hectares
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00255>          45.000     Length (PERV) metres
00256>            .500     Gradient (%)
00257>          20.000     Per cent Impervious
00258>          10.000     Length (IMPERV)
00259>            .000     %Imp. with Zero Dpth
00260>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00261>            .250     Manning "n"
00262>          75.000     Max.Infiltn. mm/hr
00263>          13.000     Min.Infiltn. mm/hr
00264>            .500     Lag const (hours)
00265>           5.100     Dep.Storage mm
00266>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00267>                  .015       .014       .000       .000 c.m/s
00268>                  .105       .952       .274     C perv/imperv/total
00269>    15     ADD RUNOFF
00270>                  .015       .029       .000       .000 c.m/s
00271>    14     START
00272>          1     1=Zero; 2=Define
00273>    35     COMMENT
00274>          3     line(s) of comment
00275>           *****************************************************
00276>           Catchment 103 - Existing drainage to main site outlet
00277>           *****************************************************
00278>     4     CATCHMENT
00279>         103.000     ID No.ó 99999
00280>            .880     Area in hectares
00281>         110.000     Length (PERV) metres
00282>            .500     Gradient (%)
00283>          10.000     Per cent Impervious
00284>          10.000     Length (IMPERV)
00285>            .000     %Imp. with Zero Dpth
00286>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00287>            .250     Manning "n"
00288>          75.000     Max.Infiltn. mm/hr
00289>          13.000     Min.Infiltn. mm/hr
00290>            .500     Lag const (hours)
00291>           5.100     Dep.Storage mm
00292>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00293>                  .030       .000       .000       .000 c.m/s
00294>                  .105       .952       .190     C perv/imperv/total
00295>    15     ADD RUNOFF
00296>                  .030       .030       .000       .000 c.m/s
00297>    35     COMMENT
00298>          3     line(s) of comment
00299>           ************************************************************
00300>           Catchment 304 - Existing external drainage to main site outl
00301>           ************************************************************
00302>     4     CATCHMENT
00303>         304.000     ID No.ó 99999
00304>            .700     Area in hectares
00305>         150.000     Length (PERV) metres
00306>            .500     Gradient (%)
00307>          40.000     Per cent Impervious
00308>          10.000     Length (IMPERV)
00309>            .000     %Imp. with Zero Dpth
00310>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00311>            .250     Manning "n"
00312>          75.000     Max.Infiltn. mm/hr
00313>          13.000     Min.Infiltn. mm/hr
00314>            .500     Lag const (hours)
00315>           5.100     Dep.Storage mm
00316>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00317>                  .093       .030       .000       .000 c.m/s
00318>                  .105       .952       .444     C perv/imperv/total
00319>    15     ADD RUNOFF
00320>                  .093       .123       .000       .000 c.m/s
00321>    14     START
00322>          1     1=Zero; 2=Define
00323>    35     COMMENT
00324>          4     line(s) of comment
00325>           ****************************************
00326>           Catchment 303 - External flows from east
00327>           Assumed to drain to Gordon Street
00328>           ****************************************
00329>     4     CATCHMENT
00330>         303.000     ID No.ó 99999
00331>            .330     Area in hectares
00332>          60.000     Length (PERV) metres
00333>            .500     Gradient (%)
00334>          20.000     Per cent Impervious
00335>          10.000     Length (IMPERV)
00336>            .000     %Imp. with Zero Dpth
00337>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00338>            .250     Manning "n"
00339>          75.000     Max.Infiltn. mm/hr
00340>          13.000     Min.Infiltn. mm/hr
00341>            .500     Lag const (hours)
00342>          10.000     Dep.Storage mm
00343>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00344>                  .022       .000       .000       .000 c.m/s
00345>                  .000       .952       .190     C perv/imperv/total
00346>    15     ADD RUNOFF
00347>                  .022       .022       .000       .000 c.m/s
00348>    20     MANUAL
00349>
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00001>          Output File (4.7) LOX100.OUT   opened 2016-08-17  16:44
00002>          Units used are defined by G =    9.810
00003>              36   240     5.000        are MAXDT MAXHYD & DTMIN values
00004>          Licensee: Paragon Engineering Limited
00005>    35    COMMENT
00006>           6     line(s) of comment
00007>           *********************
00008>          1614-13228 - Lowes Road
00009>          Existing Conditions - SWM Modelling
00010>          100-yr, 3 hour storm event
00011>          Functional Servicing Report - T.Fraser (July 2016)
00012>           *********************
00013>    23    FILE RAINFALL
00014>           1     1=READ: 2=WRITE
00015>          10     Guelp100.S           is Filename
00016>     3    IMPERVIOUS
00017>                 2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00018>              .013     Manning "n"
00019>              .000     Max.Infiltn. mm/hr
00020>              .000     Min.Infiltn. mm/hr
00021>              .050     Lag const (hours)
00022>             1.500     Dep.Storage mm
00023>    35    COMMENT
00024>           3     line(s) of comment
00025>           ************************************
00026>          Catchment 100 - Internal to Lowes Road
00027>           ************************************
00028>     4    CATCHMENT
00029>          100.000     ID No.ó 99999
00030>            .410     Area in hectares
00031>          150.000     Length (PERV) metres
00032>            .500     Gradient (%)
00033>           10.000     Per cent Impervious
00034>           10.000     Length (IMPERV)
00035>             .000     %Imp. with Zero Dpth
00036>                2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00037>             .250     Manning "n"
00038>           75.000     Max.Infiltn. mm/hr
00039>           13.000     Min.Infiltn. mm/hr
00040>             .500     Lag const (hours)
00041>            5.100     Dep.Storage mm
00042>                1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00043>                    .045       .000       .000       .000 c.m/s
00044>                    .389       .958       .446     C perv/imperv/total
00045>    15    ADD RUNOFF
00046>                    .045       .045       .000       .000 c.m/s
00047>    35    COMMENT
00048>           4     line(s) of comment
00049>           ****************************************
00050>          Catchment 300 - External flows from south
00051>          Drains to Lowes Road and west to Dawn Ave
00052>           ****************************************
00053>     4    CATCHMENT
00054>          300.000     ID No.ó 99999
00055>            .190     Area in hectares
00056>           90.000     Length (PERV) metres
00057>            .500     Gradient (%)
00058>           40.000     Per cent Impervious
00059>           10.000     Length (IMPERV)
00060>             .000     %Imp. with Zero Dpth
00061>                2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00062>             .250     Manning "n"
00063>           75.000     Max.Infiltn. mm/hr
00064>           13.000     Min.Infiltn. mm/hr
00065>             .500     Lag const (hours)
00066>            5.100     Dep.Storage mm
00067>                1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00068>                    .046       .045       .000       .000 c.m/s
00069>                    .389       .958       .617     C perv/imperv/total
00070>    15    ADD RUNOFF
00071>                    .046       .074       .000       .000 c.m/s
00072>    35    COMMENT
00073>           4     line(s) of comment
00074>           ****************************************
00075>          Catchment 301 - External flows from south
00076>          Drains to Lowes Road and west to Dawn Ave
00077>           ****************************************
00078>     4    CATCHMENT
00079>          301.000     ID No.ó 99999
00080>            .440     Area in hectares
00081>          120.000     Length (PERV) metres
00082>            .500     Gradient (%)
00083>           40.000     Per cent Impervious
00084>           10.000     Length (IMPERV)
00085>             .000     %Imp. with Zero Dpth
00086>                2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00087>             .250     Manning "n"
00088>           75.000     Max.Infiltn. mm/hr
00089>           13.000     Min.Infiltn. mm/hr
00090>             .500     Lag const (hours)
00091>            5.100     Dep.Storage mm
00092>                1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00093>                    .107       .074       .000       .000 c.m/s
00094>                    .389       .958       .617     C perv/imperv/total
00095>    15    ADD RUNOFF
00096>                    .107       .181       .000       .000 c.m/s
00097>    35    COMMENT
00098>           4     line(s) of comment
00099>           ************************************
00100>          Catchment 302 - External flows from south
00101>          Drains to Lowes Road and west to Dawn Ave
00102>           ****************************************
00103>     4    CATCHMENT
00104>          302.000     ID No.ó 99999
00105>            .590     Area in hectares
00106>           90.000     Length (PERV) metres
00107>            .500     Gradient (%)
00108>           40.000     Per cent Impervious
00109>           10.000     Length (IMPERV)
00110>             .000     %Imp. with Zero Dpth
00111>                2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00112>             .250     Manning "n"
00113>           75.000     Max.Infiltn. mm/hr
00114>           13.000     Min.Infiltn. mm/hr
00115>             .500     Lag const (hours)
00116>            5.100     Dep.Storage mm
00117>                1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00118>                    .144       .181       .000       .000 c.m/s
00119>                    .389       .958       .617     C perv/imperv/total
00120>    15    ADD RUNOFF
00121>                    .144       .325       .000       .000 c.m/s
00122>    35    COMMENT
00123>           4     line(s) of comment
00124>           **************************************************
00125>          Catchment 307 - External flows Gordon St
00126>          Assumed to drain to Lowes Road and west to Dawn Ave
00127>           **************************************************
00128>     4    CATCHMENT
00129>          307.000     ID No.ó 99999
00130>            .090     Area in hectares
00131>            5.000     Length (PERV) metres
00132>            2.000     Gradient (%)
00133>           90.000     Per cent Impervious
00134>           10.000     Length (IMPERV)
00135>             .000     %Imp. with Zero Dpth
00136>                2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00137>             .250     Manning "n"
00138>           75.000     Max.Infiltn. mm/hr
00139>           13.000     Min.Infiltn. mm/hr
00140>             .500     Lag const (hours)
00141>            2.000     Dep.Storage mm
00142>                1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00143>                    .050       .325       .000       .000 c.m/s
00144>                    .415       .925       .874     C perv/imperv/total
00145>    15    ADD RUNOFF
00146>                    .050       .375       .000       .000 c.m/s
00147>    35    COMMENT
00148>           4     line(s) of comment
00149>           **************************************************
00150>          Catchment 310 - External flows Gordon St
00151>          Assumed to drain to Lowes Road and west to Dawn Ave
00152>           **************************************************
00153>     4    CATCHMENT
00154>          310.000     ID No.ó 99999
00155>            .330     Area in hectares
00156>            5.000     Length (PERV) metres
00157>            2.000     Gradient (%)
00158>           90.000     Per cent Impervious
00159>           10.000     Length (IMPERV)
00160>             .000     %Imp. with Zero Dpth
00161>                2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00162>             .250     Manning "n"
00163>           75.000     Max.Infiltn. mm/hr
00164>           13.000     Min.Infiltn. mm/hr
00165>             .500     Lag const (hours)
00166>            2.000     Dep.Storage mm
00167>                1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00168>                    .185       .375       .000       .000 c.m/s
00169>                    .415       .925       .874     C perv/imperv/total
00170>    15    ADD RUNOFF
00171>                    .185       .560       .000       .000 c.m/s
00172>    14    START
00173>           1     1=Zero; 2=Define
00174>    35    COMMENT
00175>           4     line(s) of comment
00176>           ************************************************************
00177>          Catchment 102 - Existing drainage to NW 525 mm pipe
00178>          Pipe not identified by City of Guelph as per design criteria
00179>           ************************************************************
00180>     4    CATCHMENT
00181>          102.000     ID No.ó 99999
00182>            .360     Area in hectares
00183>           75.000     Length (PERV) metres
00184>            .500     Gradient (%)
00185>           10.000     Per cent Impervious
00186>           10.000     Length (IMPERV)
00187>             .000     %Imp. with Zero Dpth
00188>                2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00189>             .250     Manning "n"
00190>           75.000     Max.Infiltn. mm/hr
00191>           13.000     Min.Infiltn. mm/hr
00192>             .500     Lag const (hours)
00193>            5.100     Dep.Storage mm
00194>                1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00195>                    .057       .000       .000       .000 c.m/s
00196>                    .389       .958       .446     C perv/imperv/total
00197>    15    ADD RUNOFF
00198>                    .057       .057       .000       .000 c.m/s
00199>    35    COMMENT
00200>           3     line(s) of comment
00201>           ************************************************************
00202>          Catchment 305 - Existing external backyard drainage to NW 52
00203>           ************************************************************
00204>     4    CATCHMENT
00205>          305.000     ID No.ó 99999
00206>            .080     Area in hectares
00207>           75.000     Length (PERV) metres
00208>             .500     Gradient (%)
00209>            5.000     Per cent Impervious
00210>           10.000     Length (IMPERV)
00211>             .000     %Imp. with Zero Dpth
00212>                2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00213>             .250     Manning "n"
00214>           75.000     Max.Infiltn. mm/hr
00215>           13.000     Min.Infiltn. mm/hr
00216>             .500     Lag const (hours)
00217>            5.100     Dep.Storage mm
00218>                1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00219>                    .013       .057       .000       .000 c.m/s
00220>                    .389       .958       .418     C perv/imperv/total
00221>    15    ADD RUNOFF
00222>                    .013       .070       .000       .000 c.m/s
00223>    35    COMMENT
00224>           3     line(s) of comment
00225>           ************************************************************
00226>          Catchment 306 - Existing external backyard drainage to NW 52
00227>           ************************************************************
00228>     4    CATCHMENT
00229>          306.000     ID No.ó 99999
00230>            .020     Area in hectares
00231>           40.000     Length (PERV) metres
00232>             .500     Gradient (%)
00233>            1.000     Per cent Impervious
00234>           10.000     Length (IMPERV)
00235>             .000     %Imp. with Zero Dpth
00236>                2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00237>             .250     Manning "n"
00238>           75.000     Max.Infiltn. mm/hr
00239>           13.000     Min.Infiltn. mm/hr
00240>             .500     Lag const (hours)
00241>            5.100     Dep.Storage mm
00242>                1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00243>                    .004       .070       .000       .000 c.m/s
00244>                    .388       .958       .394     C perv/imperv/total
00245>    15    ADD RUNOFF
00246>                    .004       .074       .000       .000 c.m/s
00247>    35    COMMENT
00248>           3     line(s) of comment
00249>           ************************************************************
00250>          Catchment 309 - Existing external backyard drainage to NW 52
00251>           ************************************************************
00252>     4    CATCHMENT
00253>          309.000     ID No.ó 99999
00254>            .220     Area in hectares
```

```
00255>          45.000     Length (PERV) metres
00256>            .500     Gradient (%)
00257>          20.000     Per cent Impervious
00258>          10.000     Length (IMPERV)
00259>            .000     %Imp. with Zero Dpth
00260>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00261>            .250     Manning "n"
00262>          75.000     Max.Infiltn. mm/hr
00263>          13.000     Min.Infiltn. mm/hr
00264>            .500     Lag const (hours)
00265>           5.100     Dep.Storage mm
00266>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00267>                  .043       .074       .000       .000 c.m/s
00268>                  .389       .958       .503     C perv/imperv/total
00269>    15     ADD RUNOFF
00270>                  .043       .114       .000       .000 c.m/s
00271>    14     START
00272>          1     1=Zero; 2=Define
00273>    35     COMMENT
00274>          3     line(s) of comment
00275>           *****************************************************
00276>           Catchment 103 - Existing drainage to main site outlet
00277>           *****************************************************
00278>     4     CATCHMENT
00279>         103.000     ID No.ó 99999
00280>            .880     Area in hectares
00281>         110.000     Length (PERV) metres
00282>            .500     Gradient (%)
00283>          10.000     Per cent Impervious
00284>          10.000     Length (IMPERV)
00285>            .000     %Imp. with Zero Dpth
00286>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00287>            .250     Manning "n"
00288>          75.000     Max.Infiltn. mm/hr
00289>          13.000     Min.Infiltn. mm/hr
00290>            .500     Lag const (hours)
00291>           5.100     Dep.Storage mm
00292>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00293>                  .114       .000       .000       .000 c.m/s
00294>                  .389       .958       .446     C perv/imperv/total
00295>    15     ADD RUNOFF
00296>                  .114       .114       .000       .000 c.m/s
00297>    35     COMMENT
00298>          3     line(s) of comment
00299>           ************************************************************
00300>           Catchment 304 - Existing external drainage to main site outl
00301>           ************************************************************
00302>     4     CATCHMENT
00303>         304.000     ID No.ó 99999
00304>            .700     Area in hectares
00305>         150.000     Length (PERV) metres
00306>            .500     Gradient (%)
00307>          40.000     Per cent Impervious
00308>          10.000     Length (IMPERV)
00309>            .000     %Imp. with Zero Dpth
00310>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00311>            .250     Manning "n"
00312>          75.000     Max.Infiltn. mm/hr
00313>          13.000     Min.Infiltn. mm/hr
00314>            .500     Lag const (hours)
00315>           5.100     Dep.Storage mm
00316>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00317>                  .168       .114       .000       .000 c.m/s
00318>                  .389       .958       .617     C perv/imperv/total
00319>    15     ADD RUNOFF
00320>                  .168       .230       .000       .000 c.m/s
00321>    14     START
00322>          1     1=Zero; 2=Define
00323>    35     COMMENT
00324>          4     line(s) of comment
00325>           ****************************************
00326>           Catchment 303 - External flows from east
00327>           Assumed to drain to Gordon Street
00328>           ****************************************
00329>     4     CATCHMENT
00330>         303.000     ID No.ó 99999
00331>            .330     Area in hectares
00332>          60.000     Length (PERV) metres
00333>            .500     Gradient (%)
00334>          20.000     Per cent Impervious
00335>          10.000     Length (IMPERV)
00336>            .000     %Imp. with Zero Dpth
00337>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00338>            .250     Manning "n"
00339>          75.000     Max.Infiltn. mm/hr
00340>          13.000     Min.Infiltn. mm/hr
00341>            .500     Lag const (hours)
00342>          10.000     Dep.Storage mm
00343>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00344>                  .049       .000       .000       .000 c.m/s
00345>                  .333       .958       .458     C perv/imperv/total
00346>    15     ADD RUNOFF
00347>                  .049       .049       .000       .000 c.m/s
00348>    20     MANUAL
00349>
```

```
00001>          Output File (4.7) LOXREG.OUT   opened 2016-08-17  16:41
00002>          Units used are defined by G =    9.810
00003>             192   450    15.000        are MAXDT MAXHYD & DTMIN values
00004>          Licensee: Paragon Engineering Limited
00005>    35    COMMENT
00006>         6     line(s) of comment
00007>          *********************
00008>          1614-13228 - Lowes Road
00009>          Existing Conditions - SWM Modelling
00010>          Regional, 48-hour storm event
00011>          Functional Servicing Report - T.Fraser (July 2016)
00012>          *********************
00013>    23    FILE RAINFALL
00014>         1     1=READ: 2=WRITE
00015>        10     Regional.S           is Filename
00016>     3    IMPERVIOUS
00017>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00018>            .013     Manning "n"
00019>            .000     Max.Infiltn. mm/hr
00020>            .000     Min.Infiltn. mm/hr
00021>            .050     Lag const (hours)
00022>           1.500     Dep.Storage mm
00023>    35    COMMENT
00024>         3     line(s) of comment
00025>          ************************************
00026>          Catchment 100 - Internal to Lowes Road
00027>          ************************************
00028>     4    CATCHMENT
00029>         100.000     ID No.ó 99999
00030>            .410     Area in hectares
00031>         150.000     Length (PERV) metres
00032>            .500     Gradient (%)
00033>          10.000     Per cent Impervious
00034>          10.000     Length (IMPERV)
00035>            .000     %Imp. with Zero Dpth
00036>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00037>            .250     Manning "n"
00038>          75.000     Max.Infiltn. mm/hr
00039>          13.000     Min.Infiltn. mm/hr
00040>            .500     Lag const (hours)
00041>           5.100     Dep.Storage mm
00042>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00043>                  .035       .000       .000       .000 c.m/s
00044>                  .259       .934       .326     C perv/imperv/total
00045>    15    ADD RUNOFF
00046>                  .035       .035       .000       .000 c.m/s
00047>    35    COMMENT
00048>         4     line(s) of comment
00049>          ****************************************
00050>          Catchment 300 - External flows from south
00051>          Drains to Lowes Road and west to Dawn Ave
00052>          ****************************************
00053>     4    CATCHMENT
00054>         300.000     ID No.ó 99999
00055>            .190     Area in hectares
00056>          90.000     Length (PERV) metres
00057>            .500     Gradient (%)
00058>          40.000     Per cent Impervious
00059>          10.000     Length (IMPERV)
00060>            .000     %Imp. with Zero Dpth
00061>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00062>            .250     Manning "n"
00063>          75.000     Max.Infiltn. mm/hr
00064>          13.000     Min.Infiltn. mm/hr
00065>            .500     Lag const (hours)
00066>           5.100     Dep.Storage mm
00067>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00068>                  .019       .035       .000       .000 c.m/s
00069>                  .259       .934       .529     C perv/imperv/total
00070>    15    ADD RUNOFF
00071>                  .019       .053       .000       .000 c.m/s
00072>    35    COMMENT
00073>         4     line(s) of comment
00074>          ****************************************
00075>          Catchment 301 - External flows from south
00076>          Drains to Lowes Road and west to Dawn Ave
00077>          ****************************************
00078>     4    CATCHMENT
00079>         301.000     ID No.ó 99999
00080>            .440     Area in hectares
00081>         120.000     Length (PERV) metres
00082>            .500     Gradient (%)
00083>          40.000     Per cent Impervious
00084>          10.000     Length (IMPERV)
00085>            .000     %Imp. with Zero Dpth
00086>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00087>            .250     Manning "n"
00088>          75.000     Max.Infiltn. mm/hr
00089>          13.000     Min.Infiltn. mm/hr
00090>            .500     Lag const (hours)
00091>           5.100     Dep.Storage mm
00092>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00093>                  .041       .053       .000       .000 c.m/s
00094>                  .259       .934       .529     C perv/imperv/total
00095>    15    ADD RUNOFF
00096>                  .041       .094       .000       .000 c.m/s
00097>    35    COMMENT
00098>         4     line(s) of comment
00099>          ************************************
00100>          Catchment 302 - External flows from south
00101>          Drains to Lowes Road and west to Dawn Ave
00102>          ************************************
00103>     4    CATCHMENT
00104>         302.000     ID No.ó 99999
00105>            .590     Area in hectares
00106>          90.000     Length (PERV) metres
00107>            .500     Gradient (%)
00108>          40.000     Per cent Impervious
00109>          10.000     Length (IMPERV)
00110>            .000     %Imp. with Zero Dpth
00111>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00112>            .250     Manning "n"
00113>          75.000     Max.Infiltn. mm/hr
00114>          13.000     Min.Infiltn. mm/hr
00115>            .500     Lag const (hours)
00116>           5.100     Dep.Storage mm
00117>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00118>                  .059       .094       .000       .000 c.m/s
00119>                  .259       .934       .529     C perv/imperv/total
00120>    15    ADD RUNOFF
00121>                  .059       .150       .000       .000 c.m/s
00122>    35    COMMENT
00123>         4     line(s) of comment
00124>          ************************************************
00125>          Catchment 307 - External flows Gordon St
00126>          Assumed to drain to Lowes Road and west to Dawn Ave
00127>          ************************************************
00128>     4    CATCHMENT
00129>         307.000     ID No.ó 99999
00130>            .090     Area in hectares
00131>           5.000     Length (PERV) metres
00132>           2.000     Gradient (%)
00133>          90.000     Per cent Impervious
00134>          10.000     Length (IMPERV)
00135>            .000     %Imp. with Zero Dpth
00136>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00137>            .250     Manning "n"
00138>          75.000     Max.Infiltn. mm/hr
00139>          13.000     Min.Infiltn. mm/hr
00140>            .500     Lag const (hours)
00141>           2.000     Dep.Storage mm
00142>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00143>                  .011       .150       .000       .000 c.m/s
00144>                  .268       .891       .829     C perv/imperv/total
00145>    15    ADD RUNOFF
00146>                  .011       .157       .000       .000 c.m/s
00147>    35    COMMENT
00148>         4     line(s) of comment
00149>          ************************************************
00150>          Catchment 310 - External flows Gordon St
00151>          Assumed to drain to Lowes Road and west to Dawn Ave
00152>          ************************************************
00153>     4    CATCHMENT
00154>         310.000     ID No.ó 99999
00155>            .330     Area in hectares
00156>           5.000     Length (PERV) metres
00157>           2.000     Gradient (%)
00158>          90.000     Per cent Impervious
00159>          10.000     Length (IMPERV)
00160>            .000     %Imp. with Zero Dpth
00161>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00162>            .250     Manning "n"
00163>          75.000     Max.Infiltn. mm/hr
00164>          13.000     Min.Infiltn. mm/hr
00165>            .500     Lag const (hours)
00166>           2.000     Dep.Storage mm
00167>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00168>                  .040       .157       .000       .000 c.m/s
00169>                  .268       .891       .829     C perv/imperv/total
00170>    15    ADD RUNOFF
00171>                  .040       .197       .000       .000 c.m/s
00172>    14    START
00173>         1     1=Zero; 2=Define
00174>    35    COMMENT
00175>         4     line(s) of comment
00176>          ************************************************************
00177>          Catchment 102 - Existing drainage to NW 525 mm pipe
00178>          Pipe not identified by City of Guelph as per design criteria
00179>          ************************************************************
00180>     4    CATCHMENT
00181>         102.000     ID No.ó 99999
00182>            .360     Area in hectares
00183>          75.000     Length (PERV) metres
00184>            .500     Gradient (%)
00185>          10.000     Per cent Impervious
00186>          10.000     Length (IMPERV)
00187>            .000     %Imp. with Zero Dpth
00188>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00189>            .250     Manning "n"
00190>          75.000     Max.Infiltn. mm/hr
00191>          13.000     Min.Infiltn. mm/hr
00192>            .500     Lag const (hours)
00193>           5.100     Dep.Storage mm
00194>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00195>                  .036       .000       .000       .000 c.m/s
00196>                  .259       .934       .326     C perv/imperv/total
00197>    15    ADD RUNOFF
00198>                  .036       .036       .000       .000 c.m/s
00199>    35    COMMENT
00200>         3     line(s) of comment
00201>          ************************************************************
00202>          Catchment 305 - Existing external backyard drainage to NW 52
00203>          ************************************************************
00204>     4    CATCHMENT
00205>         305.000     ID No.ó 99999
00206>            .080     Area in hectares
00207>          75.000     Length (PERV) metres
00208>            .500     Gradient (%)
00209>           5.000     Per cent Impervious
00210>          10.000     Length (IMPERV)
00211>            .000     %Imp. with Zero Dpth
00212>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00213>            .250     Manning "n"
00214>          75.000     Max.Infiltn. mm/hr
00215>          13.000     Min.Infiltn. mm/hr
00216>            .500     Lag const (hours)
00217>           5.100     Dep.Storage mm
00218>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00219>                  .008       .036       .000       .000 c.m/s
00220>                  .259       .934       .293     C perv/imperv/total
00221>    15    ADD RUNOFF
00222>                  .008       .044       .000       .000 c.m/s
00223>    35    COMMENT
00224>         3     line(s) of comment
00225>          ************************************************************
00226>          Catchment 306 - Existing external backyard drainage to NW 52
00227>          ************************************************************
00228>     4    CATCHMENT
00229>         306.000     ID No.ó 99999
00230>            .020     Area in hectares
00231>          40.000     Length (PERV) metres
00232>            .500     Gradient (%)
00233>           1.000     Per cent Impervious
00234>          10.000     Length (IMPERV)
00235>            .000     %Imp. with Zero Dpth
00236>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00237>            .250     Manning "n"
00238>          75.000     Max.Infiltn. mm/hr
00239>          13.000     Min.Infiltn. mm/hr
00240>            .500     Lag const (hours)
00241>           5.100     Dep.Storage mm
00242>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00243>                  .002       .044       .000       .000 c.m/s
00244>                  .257       .934       .264     C perv/imperv/total
00245>    15    ADD RUNOFF
00246>                  .002       .046       .000       .000 c.m/s
00247>    35    COMMENT
00248>         3     line(s) of comment
00249>          ************************************************************
00250>          Catchment 309 - Existing external backyard drainage to NW 52
00251>          ************************************************************
00252>     4    CATCHMENT
00253>         309.000     ID No.ó 99999
00254>            .220     Area in hectares
```

```
00255>          45.000     Length (PERV) metres
00256>            .500     Gradient (%)
00257>          20.000     Per cent Impervious
00258>          10.000     Length (IMPERV)
00259>            .000     %Imp. with Zero Dpth
00260>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00261>            .250     Manning "n"
00262>          75.000     Max.Infiltn. mm/hr
00263>          13.000     Min.Infiltn. mm/hr
00264>            .500     Lag const (hours)
00265>           5.100     Dep.Storage mm
00266>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00267>                  .024       .046       .000       .000 c.m/s
00268>                  .258       .934       .394     C perv/imperv/total
00269>    15     ADD RUNOFF
00270>                  .024       .068       .000       .000 c.m/s
00271>    14     START
00272>          1     1=Zero; 2=Define
00273>    35     COMMENT
00274>          3     line(s) of comment
00275>           *****************************************************
00276>           Catchment 103 - Existing drainage to main site outlet
00277>           *****************************************************
00278>     4     CATCHMENT
00279>         103.000     ID No.ó 99999
00280>            .880     Area in hectares
00281>         110.000     Length (PERV) metres
00282>            .500     Gradient (%)
00283>          10.000     Per cent Impervious
00284>          10.000     Length (IMPERV)
00285>            .000     %Imp. with Zero Dpth
00286>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00287>            .250     Manning "n"
00288>          75.000     Max.Infiltn. mm/hr
00289>          13.000     Min.Infiltn. mm/hr
00290>            .500     Lag const (hours)
00291>           5.100     Dep.Storage mm
00292>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00293>                  .082       .000       .000       .000 c.m/s
00294>                  .258       .934       .326     C perv/imperv/total
00295>    15     ADD RUNOFF
00296>                  .082       .082       .000       .000 c.m/s
00297>    35     COMMENT
00298>          3     line(s) of comment
00299>           ************************************************************
00300>           Catchment 304 - Existing external drainage to main site outl
00301>           ************************************************************
00302>     4     CATCHMENT
00303>         304.000     ID No.ó 99999
00304>            .700     Area in hectares
00305>         150.000     Length (PERV) metres
00306>            .500     Gradient (%)
00307>          40.000     Per cent Impervious
00308>          10.000     Length (IMPERV)
00309>            .000     %Imp. with Zero Dpth
00310>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00311>            .250     Manning "n"
00312>          75.000     Max.Infiltn. mm/hr
00313>          13.000     Min.Infiltn. mm/hr
00314>            .500     Lag const (hours)
00315>           5.100     Dep.Storage mm
00316>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00317>                  .062       .082       .000       .000 c.m/s
00318>                  .259       .934       .529     C perv/imperv/total
00319>    15     ADD RUNOFF
00320>                  .062       .144       .000       .000 c.m/s
00321>    14     START
00322>          1     1=Zero; 2=Define
00323>    35     COMMENT
00324>          4     line(s) of comment
00325>           ****************************************
00326>           Catchment 303 - External flows from east
00327>           Assumed to drain to Gordon Street
00328>           ****************************************
00329>     4     CATCHMENT
00330>         303.000     ID No.ó 99999
00331>            .330     Area in hectares
00332>          60.000     Length (PERV) metres
00333>            .500     Gradient (%)
00334>          20.000     Per cent Impervious
00335>          10.000     Length (IMPERV)
00336>            .000     %Imp. with Zero Dpth
00337>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00338>            .250     Manning "n"
00339>          75.000     Max.Infiltn. mm/hr
00340>          13.000     Min.Infiltn. mm/hr
00341>            .500     Lag const (hours)
00342>          10.000     Dep.Storage mm
00343>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00344>                  .034       .000       .000       .000 c.m/s
00345>                  .240       .934       .379     C perv/imperv/total
00346>    15     ADD RUNOFF
00347>                  .034       .034       .000       .000 c.m/s
00348>    20     MANUAL
00349>
```

```
00001>          Output File (4.7) LO2YR.OUT    opened 2016-08-18   9:54
00002>          Units used are defined by G =    9.810
00003>              36   240     5.000        are MAXDT MAXHYD & DTMIN values
00004>          Licensee: Paragon Engineering Limited
00005>    35    COMMENT
00006>         6     line(s) of comment
00007>          **********************
00008>          1614-13228 - Lowes Road
00009>          Proposed Conditions - SWM Modelling
00010>          2-yr, 3 hour storm event
00011>          Functional Servicing Report - T.Fraser (July 2016)
00012>          **********************
00013>    23    FILE RAINFALL
00014>         1     1=READ: 2=WRITE
00015>        10     Guelph2.ST           is Filename
00016>     3    IMPERVIOUS
00017>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00018>           .013     Manning "n"
00019>           .000     Max.Infiltn. mm/hr
00020>           .000     Min.Infiltn. mm/hr
00021>           .050     Lag const (hours)
00022>          1.500     Dep.Storage mm
00023>    35    COMMENT
00024>         3     line(s) of comment
00025>          **********************
00026>          Catchment 203 - Central townhouse block and roads
00027>          **********************
00028>     4    CATCHMENT
00029>        203.000     ID No.ó 99999
00030>           .730     Area in hectares
00031>        10.000     Length (PERV) metres
00032>         2.000     Gradient (%)
00033>         90.000     Per cent Impervious
00034>        10.000     Length (IMPERV)
00035>           .000     %Imp. with Zero Dpth
00036>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00037>           .250     Manning "n"
00038>         75.000     Max.Infiltn. mm/hr
00039>         13.000     Min.Infiltn. mm/hr
00040>           .500     Lag const (hours)
00041>         2.000     Dep.Storage mm
00042>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00043>                  .172       .000       .000       .000 c.m/s
00044>                  .072       .925       .840     C perv/imperv/total
00045>    15    ADD RUNOFF
00046>                  .172       .172       .000       .000 c.m/s
00047>    35    COMMENT
00048>         3     line(s) of comment
00049>          **********************
00050>          Catchment 208 - SWM Block
00051>          **********************
00052>     4    CATCHMENT
00053>        208.000     ID No.ó 99999
00054>           .120     Area in hectares
00055>         10.000     Length (PERV) metres
00056>          1.000     Gradient (%)
00057>         50.000     Per cent Impervious
00058>         10.000     Length (IMPERV)
00059>           .000     %Imp. with Zero Dpth
00060>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00061>           .250     Manning "n"
00062>         75.000     Max.Infiltn. mm/hr
00063>         13.000     Min.Infiltn. mm/hr
00064>           .500     Lag const (hours)
00065>         5.100     Dep.Storage mm
00066>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00067>                  .015       .172       .000       .000 c.m/s
00068>                  .000       .935       .467     C perv/imperv/total
00069>    15    ADD RUNOFF
00070>                  .015       .188       .000       .000 c.m/s
00071>    35    COMMENT
00072>         3     line(s) of comment
00073>          **********************
00074>          Pond 200 Stage-storage
00075>          **********************
00076>    10    POND
00077>        13 Depth - Discharge - Volume sets
00078>          331.300         .000          .0
00079>          331.400      .00100        31.0
00080>          331.600      .00300       107.6
00081>          331.800      .00400       206.3
00082>          331.900      .00450       263.8
00083>          332.000      .00470       326.6
00084>          332.100      .00500       394.8
00085>          332.200      .00550       468.4
00086>          332.300      .00570       547.4
00087>          332.500      .00600       721.5
00088>          332.600      .00650       816.6
00089>          332.700      .00670       917.2
00090>          332.900        .500      1134.4
00091>          Peak Outflow    =      .004 c.m/s
00092>          Maximum Depth   =   331.789 metres
00093>          Maximum Storage =      201. c.m
00094>                  .015       .188       .004       .000 c.m/s
00095>    16    NEXT LINK
00096>                  .015       .004       .004       .000 c.m/s
00097>    35    COMMENT
00098>         3     line(s) of comment
00099>          *******************************************
00100>          Catchment 206 - Pervious area adjacent to Pond
00101>          *******************************************
00102>     4    CATCHMENT
00103>        206.000     ID No.ó 99999
00104>           .120     Area in hectares
00105>         50.000     Length (PERV) metres
00106>          1.000     Gradient (%)
00107>          1.000     Per cent Impervious
00108>         10.000     Length (IMPERV)
00109>           .000     %Imp. with Zero Dpth
00110>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00111>           .250     Manning "n"
00112>         75.000     Max.Infiltn. mm/hr
00113>         13.000     Min.Infiltn. mm/hr
00114>           .500     Lag const (hours)
00115>         5.100     Dep.Storage mm
00116>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00117>                  .000       .004       .004       .000 c.m/s
00118>                  .000       .935       .009     C perv/imperv/total
00119>    15    ADD RUNOFF
00120>                  .000       .004       .004       .000 c.m/s
00121>    35    COMMENT
00122>         3     line(s) of comment
00123>          ************************************************************
00124>          Catchment 304 - Existing external drainage to main site outl
00125>          ************************************************************
00126>     4    CATCHMENT
00127>        304.000     ID No.ó 99999
00128>           .700     Area in hectares
00129>        150.000     Length (PERV) metres
00130>           .500     Gradient (%)
00131>         40.000     Per cent Impervious
00132>         10.000     Length (IMPERV)
00133>           .000     %Imp. with Zero Dpth
00134>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00135>           .250     Manning "n"
00136>         75.000     Max.Infiltn. mm/hr
00137>         13.000     Min.Infiltn. mm/hr
00138>           .500     Lag const (hours)
00139>         5.100     Dep.Storage mm
00140>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00141>                  .070       .004       .004       .000 c.m/s
00142>                  .000       .941       .376     C perv/imperv/total
00143>    15    ADD RUNOFF
00144>                  .070       .073       .004       .000 c.m/s
00145>    22    FILE HYDROGRAPH
00146>         2     1=READ: 2=WRITE
00147>         8     BASN200      .2YR    is Filename
00148>         2     1=Overland: 2=Inflow: 3=Outflow: 4=Temp'ary
00149>               SITE FLOW ONLY
00150>                  .070       .073       .004       .000 c.m/s
00151>    14    START
00152>         1     1=Zero; 2=Define
00153>    35    COMMENT
00154>         3     line(s) of comment
00155>          **********************
00156>          Catchment 204 - East townhouse rear yards
00157>          **********************
00158>     4    CATCHMENT
00159>        204.000     ID No.ó 99999
00160>           .220     Area in hectares
00161>        150.000     Length (PERV) metres
00162>          2.000     Gradient (%)
00163>         40.000     Per cent Impervious
00164>         10.000     Length (IMPERV)
00165>           .000     %Imp. with Zero Dpth
00166>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00167>           .250     Manning "n"
00168>         75.000     Max.Infiltn. mm/hr
00169>         13.000     Min.Infiltn. mm/hr
00170>           .500     Lag const (hours)
00171>         5.100     Dep.Storage mm
00172>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00173>                  .023       .000       .004       .000 c.m/s
00174>                  .000       .925       .370     C perv/imperv/total
00175>    15    ADD RUNOFF
00176>                  .023       .023       .004       .000 c.m/s
00177>    35    COMMENT
00178>         4     line(s) of comment
00179>          ************************
00180>          Subsurface Stage-storage
00181>          Ouflow is infiltration rate
00182>          ************************
00183>    10    POND
00184>         7 Depth - Discharge - Volume sets
00185>          330.800         .000          .0
00186>          330.900      .000800        40.0
00187>          331.000      .000810        80.0
00188>          331.100      .000820       120.0
00189>          331.200      .000830       160.0
00190>          331.300      .000840       200.0
00191>          331.310         .500       300.0
00192>          Peak Outflow    =      .000 c.m/s
00193>          Maximum Depth   =   330.861 metres
00194>          Maximum Storage =       25. c.m
00195>                  .023       .023       .000       .000 c.m/s
00196>    16    NEXT LINK
00197>                  .023       .000       .000       .000 c.m/s
00198>    22    FILE HYDROGRAPH
00199>         1     1=READ: 2=WRITE
00200>        11     BASN200.2YR          is Filename
00201>         1     1=Overland: 2=Inflow: 3=Outflow: 4=Temp'ary
00202>                  .073       .000       .000       .000 c.m/s
00203>    15    ADD RUNOFF
00204>                  .073       .073       .000       .000 c.m/s
00205>    14    START
00206>         1     1=Zero; 2=Define
00207>    35    COMMENT
00208>         3     line(s) of comment
00209>          **********************
00210>          Catchment 205 - West townhouse rear yards
00211>          **********************
00212>     4    CATCHMENT
00213>        205.000     ID No.ó 99999
00214>           .160     Area in hectares
00215>        100.000     Length (PERV) metres
00216>           .500     Gradient (%)
00217>         40.000     Per cent Impervious
00218>         10.000     Length (IMPERV)
00219>           .000     %Imp. with Zero Dpth
00220>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00221>           .250     Manning "n"
00222>         75.000     Max.Infiltn. mm/hr
00223>         13.000     Min.Infiltn. mm/hr
00224>           .500     Lag const (hours)
00225>         5.100     Dep.Storage mm
00226>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00227>                  .016       .000       .000       .000 c.m/s
00228>                  .000       .941       .376     C perv/imperv/total
00229>    15    ADD RUNOFF
00230>                  .016       .016       .000       .000 c.m/s
00231>    35    COMMENT
00232>         4     line(s) of comment
00233>          ************************
00234>          Subsurface Stage-storage
00235>          Ouflow is infiltration rate
00236>          ************************
00237>    10    POND
00238>         7 Depth - Discharge - Volume sets
00239>          330.800         .000          .0
00240>          330.900      .000800        31.2
00241>          331.000      .000810        62.4
00242>          331.100      .000820        93.6
00243>          331.200      .000830       124.8
00244>          331.300      .000840       156.0
00245>          331.310         .500       200.0
00246>          Peak Outflow    =      .000 c.m/s
00247>          Maximum Depth   =   330.856 metres
00248>          Maximum Storage =       18. c.m
00249>                  .016       .016       .000       .000 c.m/s
00250>    16    NEXT LINK
00251>                  .016       .000       .000       .000 c.m/s
00252>    35    COMMENT
00253>         3     line(s) of comment
00254>          **********************
```

```
00255>          Catchment 207 - Small pervious area to northwest
00256>          **********
00257>    4     CATCHMENT
00258>         207.000     ID No.ó 99999
00259>           .040      Area in hectares
00260>          20.000     Length (PERV) metres
00261>           .500      Gradient (%)
00262>          2.000      Per cent Impervious
00263>          10.000     Length (IMPERV)
00264>           .000      %Imp. with Zero Dpth
00265>              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00266>           .250      Manning "n"
00267>          75.000     Max.Infiltn. mm/hr
00268>          13.000     Min.Infiltn. mm/hr
00269>           .500      Lag const (hours)
00270>          5.100      Dep.Storage mm
00271>              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00272>                  .000       .000       .000       .000 c.m/s
00273>                  .000       .941       .019     C perv/imperv/total
00274>    15    ADD RUNOFF
00275>                  .000       .000       .000       .000 c.m/s
00276>    35    COMMENT
00277>          3     line(s) of comment
00278>          ************************************************************
00279>          Catchment 305 - Existing external backyard drainage to NW 52
00280>          ************************************************************
00281>    4     CATCHMENT
00282>         305.000     ID No.ó 99999
00283>           .080      Area in hectares
00284>          75.000     Length (PERV) metres
00285>           .500      Gradient (%)
00286>          5.000      Per cent Impervious
00287>          10.000     Length (IMPERV)
00288>           .000      %Imp. with Zero Dpth
00289>              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00290>           .250      Manning "n"
00291>          75.000     Max.Infiltn. mm/hr
00292>          13.000     Min.Infiltn. mm/hr
00293>           .500      Lag const (hours)
00294>          5.100      Dep.Storage mm
00295>              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00296>                  .001       .000       .000       .000 c.m/s
00297>                  .000       .941       .047     C perv/imperv/total
00298>    15    ADD RUNOFF
00299>                  .001       .001       .000       .000 c.m/s
00300>    35    COMMENT
00301>          3     line(s) of comment
00302>          ************************************************************
00303>          Catchment 306 - Existing external backyard drainage to NW 52
00304>          ************************************************************
00305>    4     CATCHMENT
00306>         306.000     ID No.ó 99999
00307>           .020      Area in hectares
00308>          40.000     Length (PERV) metres
00309>           .500      Gradient (%)
00310>          1.000      Per cent Impervious
00311>          10.000     Length (IMPERV)
00312>           .000      %Imp. with Zero Dpth
00313>              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00314>           .250      Manning "n"
00315>          75.000     Max.Infiltn. mm/hr
00316>          13.000     Min.Infiltn. mm/hr
00317>           .500      Lag const (hours)
00318>          5.100      Dep.Storage mm
00319>              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00320>                  .000       .001       .000       .000 c.m/s
00321>                  .000       .941       .009     C perv/imperv/total
00322>    15    ADD RUNOFF
00323>                  .000       .001       .000       .000 c.m/s
00324>    35    COMMENT
00325>          3     line(s) of comment
00326>          ************************************************************
00327>          Catchment 309 - Existing external backyard drainage to NW 52
00328>          ************************************************************
00329>    4     CATCHMENT
00330>         309.000     ID No.ó 99999
00331>           .220      Area in hectares
00332>          45.000     Length (PERV) metres
00333>           .500      Gradient (%)
00334>          20.000     Per cent Impervious
00335>          10.000     Length (IMPERV)
00336>           .000      %Imp. with Zero Dpth
00337>              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00338>           .250      Manning "n"
00339>          75.000     Max.Infiltn. mm/hr
00340>          13.000     Min.Infiltn. mm/hr
00341>           .500      Lag const (hours)
00342>          5.100      Dep.Storage mm
00343>              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00344>                  .011       .001       .000       .000 c.m/s
00345>                  .000       .941       .188     C perv/imperv/total
00346>    15    ADD RUNOFF
00347>                  .011       .012       .000       .000 c.m/s
00348>    14    START
00349>          1     1=Zero; 2=Define
00350>    35    COMMENT
00351>          3     line(s) of comment
00352>          ************************************************
00353>          Catchments 200-202 - South townhouses to Lowes Road
00354>          ************************************************
00355>    4     CATCHMENT
00356>         202.000     ID No.ó 99999
00357>           .290      Area in hectares
00358>         120.000     Length (PERV) metres
00359>           .500      Gradient (%)
00360>          60.000     Per cent Impervious
00361>          10.000     Length (IMPERV)
00362>           .000      %Imp. with Zero Dpth
00363>              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00364>           .250      Manning "n"
00365>          75.000     Max.Infiltn. mm/hr
00366>          13.000     Min.Infiltn. mm/hr
00367>           .500      Lag const (hours)
00368>          5.100      Dep.Storage mm
00369>              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00370>                  .044       .000       .000       .000 c.m/s
00371>                  .000       .941       .564     C perv/imperv/total
00372>    15    ADD RUNOFF
00373>                  .044       .044       .000       .000 c.m/s
00374>    35    COMMENT
00375>          4     line(s) of comment
00376>          ****************************************
00377>          Catchment 300 - External flows from south
00378>          Drains to Lowes Road and west to Dawn Ave
00379>          ****************************************
00380>    4     CATCHMENT
00381>         300.000     ID No.ó 99999
00382>           .190      Area in hectares
00383>          90.000     Length (PERV) metres
00384>           .500      Gradient (%)
00385>          40.000     Per cent Impervious
00386>          10.000     Length (IMPERV)
00387>           .000      %Imp. with Zero Dpth
00388>              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00389>           .250      Manning "n"
00390>          75.000     Max.Infiltn. mm/hr
00391>          13.000     Min.Infiltn. mm/hr
00392>           .500      Lag const (hours)
00393>          5.100      Dep.Storage mm
00394>              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00395>                  .019       .044       .000       .000 c.m/s
00396>                  .000       .941       .376     C perv/imperv/total
00397>    15    ADD RUNOFF
00398>                  .019       .063       .000       .000 c.m/s
00399>    35    COMMENT
00400>          4     line(s) of comment
00401>          ****************************************
00402>          Catchment 301 - External flows from south
00403>          Drains to Lowes Road and west to Dawn Ave
00404>          ****************************************
00405>    4     CATCHMENT
00406>         301.000     ID No.ó 99999
00407>           .440      Area in hectares
00408>         120.000     Length (PERV) metres
00409>           .500      Gradient (%)
00410>          40.000     Per cent Impervious
00411>          10.000     Length (IMPERV)
00412>           .000      %Imp. with Zero Dpth
00413>              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00414>           .250      Manning "n"
00415>          75.000     Max.Infiltn. mm/hr
00416>          13.000     Min.Infiltn. mm/hr
00417>           .500      Lag const (hours)
00418>          5.100      Dep.Storage mm
00419>              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00420>                  .044       .063       .000       .000 c.m/s
00421>                  .000       .941       .376     C perv/imperv/total
00422>    15    ADD RUNOFF
00423>                  .044       .107       .000       .000 c.m/s
00424>    35    COMMENT
00425>          4     line(s) of comment
00426>          ****************************************
00427>          Catchment 302 - External flows from south
00428>          Drains to Lowes Road and west to Dawn Ave
00429>          ****************************************
00430>    4     CATCHMENT
00431>         302.000     ID No.ó 99999
00432>           .590      Area in hectares
00433>          90.000     Length (PERV) metres
00434>           .500      Gradient (%)
00435>          40.000     Per cent Impervious
00436>          10.000     Length (IMPERV)
00437>           .000      %Imp. with Zero Dpth
00438>              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00439>           .250      Manning "n"
00440>          75.000     Max.Infiltn. mm/hr
00441>          13.000     Min.Infiltn. mm/hr
00442>           .500      Lag const (hours)
00443>          5.100      Dep.Storage mm
00444>              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00445>                  .059       .107       .000       .000 c.m/s
00446>                  .000       .941       .376     C perv/imperv/total
00447>    15    ADD RUNOFF
00448>                  .059       .166       .000       .000 c.m/s
00449>    35    COMMENT
00450>          4     line(s) of comment
00451>          ************************************************
00452>          Catchment 307 - External flows Gordon St
00453>          Assumed to drain to Lowes Road and west to Dawn Ave
00454>          ************************************************
00455>    4     CATCHMENT
00456>         307.000     ID No.ó 99999
00457>           .090      Area in hectares
00458>          5.000      Length (PERV) metres
00459>          2.000      Gradient (%)
00460>          90.000     Per cent Impervious
00461>          10.000     Length (IMPERV)
00462>           .000      %Imp. with Zero Dpth
00463>              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00464>           .250      Manning "n"
00465>          75.000     Max.Infiltn. mm/hr
00466>          13.000     Min.Infiltn. mm/hr
00467>           .500      Lag const (hours)
00468>          2.000      Dep.Storage mm
00469>              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00470>                  .021       .166       .000       .000 c.m/s
00471>                  .071       .925       .839     C perv/imperv/total
00472>    15    ADD RUNOFF
00473>                  .021       .188       .000       .000 c.m/s
00474>    35    COMMENT
00475>          4     line(s) of comment
00476>          ************************************************
00477>          Catchment 310 - External flows Gordon St
00478>          Assumed to drain to Lowes Road and west to Dawn Ave
00479>          ************************************************
00480>    4     CATCHMENT
00481>         310.000     ID No.ó 99999
00482>           .330      Area in hectares
00483>          5.000      Length (PERV) metres
00484>          2.000      Gradient (%)
00485>          90.000     Per cent Impervious
00486>          10.000     Length (IMPERV)
00487>           .000      %Imp. with Zero Dpth
00488>              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00489>           .250      Manning "n"
00490>          75.000     Max.Infiltn. mm/hr
00491>          13.000     Min.Infiltn. mm/hr
00492>           .500      Lag const (hours)
00493>          2.000      Dep.Storage mm
00494>              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00495>                  .078       .188       .000       .000 c.m/s
00496>                  .071       .925       .839     C perv/imperv/total
00497>    15    ADD RUNOFF
00498>                  .078       .266       .000       .000 c.m/s
00499>    14    START
00500>          1     1=Zero; 2=Define
00501>    35    COMMENT
00502>          4     line(s) of comment
00503>          ****************************************
00504>          Catchment 303 - External flows from east
00505>          Assumed to drain to Gordon Street
00506>          ****************************************
00507>    4     CATCHMENT
00508>         303.000     ID No.ó 99999
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00509>            .330     Area in hectares
00510>          60.000     Length (PERV) metres
00511>            .500     Gradient (%)
00512>          20.000     Per cent Impervious
00513>          10.000     Length (IMPERV)
00514>            .000     %Imp. with Zero Dpth
00515>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00516>            .250     Manning "n"
00517>          75.000     Max.Infiltn. mm/hr
00518>          13.000     Min.Infiltn. mm/hr
00519>            .500     Lag const (hours)
00520>          10.000     Dep.Storage mm
00521>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00522>                  .017       .000       .000       .000 c.m/s
00523>                 .000       .941       .188     C perv/imperv/total
00524>    15     ADD RUNOFF
00525>                  .017       .017       .000       .000 c.m/s
00526>    20     MANUAL
00527>
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00001>          Output File (4.7) LO5YR.OUT    opened 2016-08-18   9:53
00002>          Units used are defined by G =    9.810
00003>              36   240     5.000        are MAXDT MAXHYD & DTMIN values
00004>          Licensee: Paragon Engineering Limited
00005>    35    COMMENT
00006>         6     line(s) of comment
00007>          **********************
00008>          1614-13228 - Lowes Road
00009>          Proposed Conditions - SWM Modelling
00010>          5-yr, 3 hour storm event
00011>          Functional Servicing Report - T.Fraser (August 2016)
00012>          **********************
00013>    23    FILE RAINFALL
00014>         1     1=READ: 2=WRITE
00015>        10     Guelph5.ST           is Filename
00016>     3    IMPERVIOUS
00017>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00018>           .013     Manning "n"
00019>           .000     Max.Infiltn. mm/hr
00020>           .000     Min.Infiltn. mm/hr
00021>           .050     Lag const (hours)
00022>          1.500     Dep.Storage mm
00023>    35    COMMENT
00024>         3     line(s) of comment
00025>          **********************
00026>          Catchment 203 - Central townhouse block and roads
00027>          **********************
00028>     4    CATCHMENT
00029>        203.000     ID No.ó 99999
00030>           .710     Area in hectares
00031>         10.000     Length (PERV) metres
00032>          2.000     Gradient (%)
00033>         90.000     Per cent Impervious
00034>         10.000     Length (IMPERV)
00035>           .000     %Imp. with Zero Dpth
00036>              2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00037>           .250     Manning "n"
00038>         75.000     Max.Infiltn. mm/hr
00039>         13.000     Min.Infiltn. mm/hr
00040>           .500     Lag const (hours)
00041>          2.000     Dep.Storage mm
00042>              1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00043>                  .218       .000       .000       .000 c.m/s
00044>                  .169       .931       .854     C perv/imperv/total
00045>    15    ADD RUNOFF
00046>                  .218       .218       .000       .000 c.m/s
00047>    35    COMMENT
00048>         3     line(s) of comment
00049>          **********************
00050>          Catchment 208 - SWM Block
00051>          **********************
00052>     4    CATCHMENT
00053>        208.000     ID No.ó 99999
00054>           .120     Area in hectares
00055>         10.000     Length (PERV) metres
00056>          1.000     Gradient (%)
00057>         50.000     Per cent Impervious
00058>         10.000     Length (IMPERV)
00059>           .000     %Imp. with Zero Dpth
00060>              2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00061>           .250     Manning "n"
00062>         75.000     Max.Infiltn. mm/hr
00063>         13.000     Min.Infiltn. mm/hr
00064>           .500     Lag const (hours)
00065>          5.100     Dep.Storage mm
00066>              1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00067>                  .021       .218       .000       .000 c.m/s
00068>                  .104       .943       .524     C perv/imperv/total
00069>    15    ADD RUNOFF
00070>                  .021       .239       .000       .000 c.m/s
00071>    35    COMMENT
00072>         3     line(s) of comment
00073>          **********************
00074>          Pond 200 Stage-storage
00075>          **********************
00076>    10    POND
00077>        13 Depth - Discharge - Volume sets
00078>          331.300         .000          .0
00079>          331.400      .00100        31.0
00080>          331.600      .00300       107.6
00081>          331.800      .00400       206.3
00082>          331.900      .00450       263.8
00083>          332.000      .00470       326.6
00084>          332.100      .00500       394.8
00085>          332.200      .00550       468.4
00086>          332.300      .00570       547.4
00087>          332.500      .00600       721.5
00088>          332.600      .00650       816.6
00089>          332.700      .00670       917.2
00090>          332.900        .500      1134.4
00091>          Peak Outflow    =      .005 c.m/s
00092>          Maximum Depth   =   331.931 metres
00093>          Maximum Storage =      283. c.m
00094>                  .021       .239       .005       .000 c.m/s
00095>    16    NEXT LINK
00096>                  .021       .005       .005       .000 c.m/s
00097>    35    COMMENT
00098>         3     line(s) of comment
00099>          *********************************************
00100>          Catchment 206 - Pervious area adjacent to Pond
00101>          *********************************************
00102>     4    CATCHMENT
00103>        206.000     ID No.ó 99999
00104>           .120     Area in hectares
00105>         50.000     Length (PERV) metres
00106>          1.000     Gradient (%)
00107>          1.000     Per cent Impervious
00108>         10.000     Length (IMPERV)
00109>           .000     %Imp. with Zero Dpth
00110>              2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00111>           .250     Manning "n"
00112>         75.000     Max.Infiltn. mm/hr
00113>         13.000     Min.Infiltn. mm/hr
00114>           .500     Lag const (hours)
00115>          5.100     Dep.Storage mm
00116>              1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00117>                  .003       .005       .005       .000 c.m/s
00118>                  .105       .943       .113     C perv/imperv/total
00119>    15    ADD RUNOFF
00120>                  .003       .007       .005       .000 c.m/s
00121>    35    COMMENT
00122>         3     line(s) of comment
00123>          ************************************************************
00124>          Catchment 304 - Existing external drainage to main site outl
00125>          ************************************************************
00126>     4    CATCHMENT
00127>        304.000     ID No.ó 99999
00128>           .700     Area in hectares
00129>        150.000     Length (PERV) metres
00130>           .500     Gradient (%)
00131>         40.000     Per cent Impervious
00132>         10.000     Length (IMPERV)
00133>           .000     %Imp. with Zero Dpth
00134>              2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00135>           .250     Manning "n"
00136>         75.000     Max.Infiltn. mm/hr
00137>         13.000     Min.Infiltn. mm/hr
00138>           .500     Lag const (hours)
00139>          5.100     Dep.Storage mm
00140>              1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00141>                  .093       .007       .005       .000 c.m/s
00142>                  .105       .952       .444     C perv/imperv/total
00143>    15    ADD RUNOFF
00144>                  .093       .097       .005       .000 c.m/s
00145>    22    FILE HYDROGRAPH
00146>         2     1=READ: 2=WRITE
00147>         8     BASN200      .5YR    is Filename
00148>         2     1=Overland: 2=Inflow: 3=Outflow: 4=Temp'ary
00149>               SITE FLOW ONLY
00150>                  .093       .097       .005       .000 c.m/s
00151>    14    START
00152>         1     1=Zero; 2=Define
00153>    35    COMMENT
00154>         3     line(s) of comment
00155>          **********************
00156>          Catchment 204 - East townhouse rear yards
00157>          **********************
00158>     4    CATCHMENT
00159>        204.000     ID No.ó 99999
00160>           .220     Area in hectares
00161>        150.000     Length (PERV) metres
00162>          2.000     Gradient (%)
00163>         40.000     Per cent Impervious
00164>         10.000     Length (IMPERV)
00165>           .000     %Imp. with Zero Dpth
00166>              2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00167>           .250     Manning "n"
00168>         75.000     Max.Infiltn. mm/hr
00169>         13.000     Min.Infiltn. mm/hr
00170>           .500     Lag const (hours)
00171>          5.100     Dep.Storage mm
00172>              1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00173>                  .030       .000       .005       .000 c.m/s
00174>                  .105       .931       .435     C perv/imperv/total
00175>    15    ADD RUNOFF
00176>                  .030       .030       .005       .000 c.m/s
00177>    35    COMMENT
00178>         4     line(s) of comment
00179>          ************************
00180>          Subsurface Stage-storage
00181>          Ouflow is infiltration rate
00182>          ************************
00183>    10    POND
00184>         7 Depth - Discharge - Volume sets
00185>          330.800         .000          .0
00186>          330.900      .000800        40.0
00187>          331.000      .000810        80.0
00188>          331.100      .000820       120.0
00189>          331.200      .000830       160.0
00190>          331.300      .000840       200.0
00191>          331.310         .500       300.0
00192>          Peak Outflow    =      .001 c.m/s
00193>          Maximum Depth   =   330.901 metres
00194>          Maximum Storage =       40. c.m
00195>                  .030       .030       .001       .000 c.m/s
00196>    16    NEXT LINK
00197>                  .030       .001       .001       .000 c.m/s
00198>    22    FILE HYDROGRAPH
00199>         1     1=READ: 2=WRITE
00200>        11     BASN200.5YR          is Filename
00201>         1     1=Overland: 2=Inflow: 3=Outflow: 4=Temp'ary
00202>                  .097       .001       .001       .000 c.m/s
00203>    15    ADD RUNOFF
00204>                  .097       .097       .001       .000 c.m/s
00205>    14    START
00206>         1     1=Zero; 2=Define
00207>    35    COMMENT
00208>         3     line(s) of comment
00209>          **********************
00210>          Catchment 205 - West townhouse rear yards
00211>          **********************
00212>     4    CATCHMENT
00213>        205.000     ID No.ó 99999
00214>           .160     Area in hectares
00215>        100.000     Length (PERV) metres
00216>           .500     Gradient (%)
00217>         40.000     Per cent Impervious
00218>         10.000     Length (IMPERV)
00219>           .000     %Imp. with Zero Dpth
00220>              2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00221>           .250     Manning "n"
00222>         75.000     Max.Infiltn. mm/hr
00223>         13.000     Min.Infiltn. mm/hr
00224>           .500     Lag const (hours)
00225>          5.100     Dep.Storage mm
00226>              1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00227>                  .021       .000       .001       .000 c.m/s
00228>                  .105       .952       .444     C perv/imperv/total
00229>    15    ADD RUNOFF
00230>                  .021       .021       .001       .000 c.m/s
00231>    35    COMMENT
00232>         4     line(s) of comment
00233>          ************************
00234>          Subsurface Stage-storage
00235>          Ouflow is infiltration rate
00236>          ************************
00237>    10    POND
00238>         7 Depth - Discharge - Volume sets
00239>          330.800         .000          .0
00240>          330.900      .000800        31.2
00241>          331.000      .000810        62.4
00242>          331.100      .000820        93.6
00243>          331.200      .000830       124.8
00244>          331.300      .000840       156.0
00245>          331.310         .500       200.0
00246>          Peak Outflow    =      .001 c.m/s
00247>          Maximum Depth   =   330.893 metres
00248>          Maximum Storage =       29. c.m
00249>                  .021       .021       .001       .000 c.m/s
00250>    16    NEXT LINK
00251>                  .021       .001       .001       .000 c.m/s
00252>    35    COMMENT
00253>         3     line(s) of comment
00254>          **********************
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00255>          Catchment 207 - Small pervious area to northwest
00256>          **********
00257>    4     CATCHMENT
00258>        207.000     ID No.ó 99999
00259>          .040      Area in hectares
00260>         20.000     Length (PERV) metres
00261>          .500      Gradient (%)
00262>         2.000      Per cent Impervious
00263>         10.000     Length (IMPERV)
00264>          .000      %Imp. with Zero Dpth
00265>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00266>          .250      Manning "n"
00267>         75.000     Max.Infiltn. mm/hr
00268>         13.000     Min.Infiltn. mm/hr
00269>          .500      Lag const (hours)
00270>         5.100      Dep.Storage mm
00271>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00272>                .001       .001       .001       .000 c.m/s
00273>                .105       .952       .121     C perv/imperv/total
00274>    15    ADD RUNOFF
00275>                .001       .002       .001       .000 c.m/s
00276>    35    COMMENT
00277>          3     line(s) of comment
00278>          ************************************************************
00279>          Catchment 305 - Existing external backyard drainage to NW 52
00280>          ************************************************************
00281>     4    CATCHMENT
00282>        305.000     ID No.ó 99999
00283>          .080      Area in hectares
00284>         75.000     Length (PERV) metres
00285>          .500      Gradient (%)
00286>         5.000      Per cent Impervious
00287>         10.000     Length (IMPERV)
00288>          .000      %Imp. with Zero Dpth
00289>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00290>          .250      Manning "n"
00291>         75.000     Max.Infiltn. mm/hr
00292>         13.000     Min.Infiltn. mm/hr
00293>          .500      Lag const (hours)
00294>         5.100      Dep.Storage mm
00295>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00296>                .001       .002       .001       .000 c.m/s
00297>                .105       .952       .147     C perv/imperv/total
00298>    15    ADD RUNOFF
00299>                .001       .003       .001       .000 c.m/s
00300>    35    COMMENT
00301>          3     line(s) of comment
00302>          ************************************************************
00303>          Catchment 306 - Existing external backyard drainage to NW 52
00304>          ************************************************************
00305>     4    CATCHMENT
00306>        306.000     ID No.ó 99999
00307>          .020      Area in hectares
00308>         40.000     Length (PERV) metres
00309>          .500      Gradient (%)
00310>         1.000      Per cent Impervious
00311>         10.000     Length (IMPERV)
00312>          .000      %Imp. with Zero Dpth
00313>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00314>          .250      Manning "n"
00315>         75.000     Max.Infiltn. mm/hr
00316>         13.000     Min.Infiltn. mm/hr
00317>          .500      Lag const (hours)
00318>         5.100      Dep.Storage mm
00319>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00320>                .000       .003       .001       .000 c.m/s
00321>                .105       .952       .113     C perv/imperv/total
00322>    15    ADD RUNOFF
00323>                .000       .003       .001       .000 c.m/s
00324>    35    COMMENT
00325>          3     line(s) of comment
00326>          ************************************************************
00327>          Catchment 309 - Existing external backyard drainage to NW 52
00328>          ************************************************************
00329>     4    CATCHMENT
00330>        309.000     ID No.ó 99999
00331>          .220      Area in hectares
00332>         45.000     Length (PERV) metres
00333>          .500      Gradient (%)
00334>         20.000     Per cent Impervious
00335>         10.000     Length (IMPERV)
00336>          .000      %Imp. with Zero Dpth
00337>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00338>          .250      Manning "n"
00339>         75.000     Max.Infiltn. mm/hr
00340>         13.000     Min.Infiltn. mm/hr
00341>          .500      Lag const (hours)
00342>         5.100      Dep.Storage mm
00343>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00344>                .015       .003       .001       .000 c.m/s
00345>                .105       .952       .274     C perv/imperv/total
00346>    15    ADD RUNOFF
00347>                .015       .017       .001       .000 c.m/s
00348>    14    START
00349>          1     1=Zero; 2=Define
00350>    35    COMMENT
00351>          3     line(s) of comment
00352>          **************************************************
00353>          Catchments 200-202 - South townhouses to Lowes Road
00354>          **************************************************
00355>     4    CATCHMENT
00356>        202.000     ID No.ó 99999
00357>          .290      Area in hectares
00358>        120.000     Length (PERV) metres
00359>          .500      Gradient (%)
00360>         60.000     Per cent Impervious
00361>         10.000     Length (IMPERV)
00362>          .000      %Imp. with Zero Dpth
00363>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00364>          .250      Manning "n"
00365>         75.000     Max.Infiltn. mm/hr
00366>         13.000     Min.Infiltn. mm/hr
00367>          .500      Lag const (hours)
00368>         5.100      Dep.Storage mm
00369>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00370>                .058       .000       .001       .000 c.m/s
00371>                .105       .952       .613     C perv/imperv/total
00372>    15    ADD RUNOFF
00373>                .058       .058       .001       .000 c.m/s
00374>    35    COMMENT
00375>          4     line(s) of comment
00376>          ****************************************
00377>          Catchment 300 - External flows from south
00378>          Drains to Lowes Road and west to Dawn Ave
00379>          ****************************************
00380>     4    CATCHMENT
00381>        300.000     ID No.ó 99999
00382>          .190      Area in hectares
00383>         90.000     Length (PERV) metres
00384>          .500      Gradient (%)
00385>         40.000     Per cent Impervious
00386>         10.000     Length (IMPERV)
00387>          .000      %Imp. with Zero Dpth
00388>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00389>          .250      Manning "n"
00390>         75.000     Max.Infiltn. mm/hr
00391>         13.000     Min.Infiltn. mm/hr
00392>          .500      Lag const (hours)
00393>         5.100      Dep.Storage mm
00394>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00395>                .025       .058       .001       .000 c.m/s
00396>                .105       .952       .444     C perv/imperv/total
00397>    15    ADD RUNOFF
00398>                .025       .083       .001       .000 c.m/s
00399>    35    COMMENT
00400>          4     line(s) of comment
00401>          ****************************************
00402>          Catchment 301 - External flows from south
00403>          Drains to Lowes Road and west to Dawn Ave
00404>          ****************************************
00405>     4    CATCHMENT
00406>        301.000     ID No.ó 99999
00407>          .440      Area in hectares
00408>        120.000     Length (PERV) metres
00409>          .500      Gradient (%)
00410>         40.000     Per cent Impervious
00411>         10.000     Length (IMPERV)
00412>          .000      %Imp. with Zero Dpth
00413>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00414>          .250      Manning "n"
00415>         75.000     Max.Infiltn. mm/hr
00416>         13.000     Min.Infiltn. mm/hr
00417>          .500      Lag const (hours)
00418>         5.100      Dep.Storage mm
00419>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00420>                .059       .083       .001       .000 c.m/s
00421>                .105       .952       .444     C perv/imperv/total
00422>    15    ADD RUNOFF
00423>                .059       .142       .001       .000 c.m/s
00424>    35    COMMENT
00425>          4     line(s) of comment
00426>          ****************************************
00427>          Catchment 302 - External flows from south
00428>          Drains to Lowes Road and west to Dawn Ave
00429>          ****************************************
00430>     4    CATCHMENT
00431>        302.000     ID No.ó 99999
00432>          .590      Area in hectares
00433>         90.000     Length (PERV) metres
00434>          .500      Gradient (%)
00435>         40.000     Per cent Impervious
00436>         10.000     Length (IMPERV)
00437>          .000      %Imp. with Zero Dpth
00438>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00439>          .250      Manning "n"
00440>         75.000     Max.Infiltn. mm/hr
00441>         13.000     Min.Infiltn. mm/hr
00442>          .500      Lag const (hours)
00443>         5.100      Dep.Storage mm
00444>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00445>                .079       .142       .001       .000 c.m/s
00446>                .105       .952       .444     C perv/imperv/total
00447>    15    ADD RUNOFF
00448>                .079       .221       .001       .000 c.m/s
00449>    35    COMMENT
00450>          4     line(s) of comment
00451>          ************************************************
00452>          Catchment 307 - External flows Gordon St
00453>          Assumed to drain to Lowes Road and west to Dawn Ave
00454>          ************************************************
00455>     4    CATCHMENT
00456>        307.000     ID No.ó 99999
00457>          .090      Area in hectares
00458>         5.000      Length (PERV) metres
00459>         2.000      Gradient (%)
00460>         90.000     Per cent Impervious
00461>         10.000     Length (IMPERV)
00462>          .000      %Imp. with Zero Dpth
00463>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00464>          .250      Manning "n"
00465>         75.000     Max.Infiltn. mm/hr
00466>         13.000     Min.Infiltn. mm/hr
00467>          .500      Lag const (hours)
00468>         2.000      Dep.Storage mm
00469>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00470>                .028       .221       .001       .000 c.m/s
00471>                .169       .931       .855     C perv/imperv/total
00472>    15    ADD RUNOFF
00473>                .028       .249       .001       .000 c.m/s
00474>    35    COMMENT
00475>          4     line(s) of comment
00476>          ************************************************
00477>          Catchment 310 - External flows Gordon St
00478>          Assumed to drain to Lowes Road and west to Dawn Ave
00479>          ************************************************
00480>     4    CATCHMENT
00481>        310.000     ID No.ó 99999
00482>          .330      Area in hectares
00483>         5.000      Length (PERV) metres
00484>         2.000      Gradient (%)
00485>         90.000     Per cent Impervious
00486>         10.000     Length (IMPERV)
00487>          .000      %Imp. with Zero Dpth
00488>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00489>          .250      Manning "n"
00490>         75.000     Max.Infiltn. mm/hr
00491>         13.000     Min.Infiltn. mm/hr
00492>          .500      Lag const (hours)
00493>         2.000      Dep.Storage mm
00494>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00495>                .103       .249       .001       .000 c.m/s
00496>                .169       .931       .855     C perv/imperv/total
00497>    15    ADD RUNOFF
00498>                .103       .352       .001       .000 c.m/s
00499>    14    START
00500>          1     1=Zero; 2=Define
00501>    35    COMMENT
00502>          4     line(s) of comment
00503>          ****************************************
00504>          Catchment 303 - External flows from east
00505>          Assumed to drain to Gordon Street
00506>          ****************************************
00507>     4    CATCHMENT
00508>        303.000     ID No.ó 99999
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```
00509>            .330     Area in hectares
00510>          60.000     Length (PERV) metres
00511>            .500     Gradient (%)
00512>          20.000     Per cent Impervious
00513>          10.000     Length (IMPERV)
00514>            .000     %Imp. with Zero Dpth
00515>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00516>            .250     Manning "n"
00517>          75.000     Max.Infiltn. mm/hr
00518>          13.000     Min.Infiltn. mm/hr
00519>            .500     Lag const (hours)
00520>          10.000     Dep.Storage mm
00521>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00522>                  .022       .000       .001       .000 c.m/s
00523>                 .000       .952       .190     C perv/imperv/total
00524>    15     ADD RUNOFF
00525>                  .022       .022       .001       .000 c.m/s
00526>    20     MANUAL
00527>
```

```
00001>          Output File (4.7) LO100.OUT    opened 2016-08-18   9:51
00002>          Units used are defined by G =    9.810
00003>              36   240     5.000        are MAXDT MAXHYD & DTMIN values
00004>          Licensee: Paragon Engineering Limited
00005>    35    COMMENT
00006>         6     line(s) of comment
00007>          **********************
00008>          1614-13228 - Lowes Road
00009>          Proposed Conditions - SWM Modelling
00010>          100-yr, 3 hour storm event
00011>          Functional Servicing Report - T.Fraser (July 2016)
00012>          **********************
00013>    23    FILE RAINFALL
00014>         1     1=READ: 2=WRITE
00015>        10     Guelp100.S           is Filename
00016>     3    IMPERVIOUS
00017>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00018>           .013     Manning "n"
00019>           .000     Max.Infiltn. mm/hr
00020>           .000     Min.Infiltn. mm/hr
00021>           .050     Lag const (hours)
00022>          1.500     Dep.Storage mm
00023>    35    COMMENT
00024>         3     line(s) of comment
00025>          **********************
00026>          Catchment 203 - Central townhouse block and roads
00027>          **********************
00028>     4    CATCHMENT
00029>        203.000     ID No.ó 99999
00030>           .730     Area in hectares
00031>        10.000     Length (PERV) metres
00032>         2.000     Gradient (%)
00033>        90.000     Per cent Impervious
00034>        10.000     Length (IMPERV)
00035>          .000     %Imp. with Zero Dpth
00036>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00037>          .250     Manning "n"
00038>        75.000     Max.Infiltn. mm/hr
00039>        13.000     Min.Infiltn. mm/hr
00040>          .500     Lag const (hours)
00041>         2.000     Dep.Storage mm
00042>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00043>                  .402       .000       .000       .000 c.m/s
00044>                  .422       .925       .874     C perv/imperv/total
00045>    15    ADD RUNOFF
00046>                  .402       .402       .000       .000 c.m/s
00047>    35    COMMENT
00048>         3     line(s) of comment
00049>          **********************
00050>          Catchment 208 - SWM Block
00051>          **********************
00052>     4    CATCHMENT
00053>        208.000     ID No.ó 99999
00054>           .120     Area in hectares
00055>        10.000     Length (PERV) metres
00056>         1.000     Gradient (%)
00057>        50.000     Per cent Impervious
00058>        10.000     Length (IMPERV)
00059>          .000     %Imp. with Zero Dpth
00060>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00061>          .250     Manning "n"
00062>        75.000     Max.Infiltn. mm/hr
00063>        13.000     Min.Infiltn. mm/hr
00064>          .500     Lag const (hours)
00065>         5.100     Dep.Storage mm
00066>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00067>                  .044       .402       .000       .000 c.m/s
00068>                  .387       .944       .665     C perv/imperv/total
00069>    15    ADD RUNOFF
00070>                  .044       .446       .000       .000 c.m/s
00071>    35    COMMENT
00072>         3     line(s) of comment
00073>          **********************
00074>          Pond 200 Stage-storage
00075>          **********************
00076>    10    POND
00077>        13 Depth - Discharge - Volume sets
00078>          331.300         .000          .0
00079>          331.400      .00100        31.0
00080>          331.600      .00300       107.6
00081>          331.800      .00400       206.3
00082>          331.900      .00450       263.8
00083>          332.000      .00470       326.6
00084>          332.100      .00500       394.8
00085>          332.200      .00550       468.4
00086>          332.300      .00570       547.4
00087>          332.500      .00600       721.5
00088>          332.600      .00650       816.6
00089>          332.700      .00670       917.2
00090>          332.900        .500      1134.4
00091>          Peak Outflow    =      .006 c.m/s
00092>          Maximum Depth   =   332.345 metres
00093>          Maximum Storage =      586. c.m
00094>                  .044       .446       .006       .000 c.m/s
00095>    16    NEXT LINK
00096>                  .044       .006       .006       .000 c.m/s
00097>    35    COMMENT
00098>         3     line(s) of comment
00099>          ********************************************
00100>          Catchment 206 - Pervious area adjacent to Pond
00101>          ********************************************
00102>     4    CATCHMENT
00103>        206.000     ID No.ó 99999
00104>           .120     Area in hectares
00105>        50.000     Length (PERV) metres
00106>         1.000     Gradient (%)
00107>         1.000     Per cent Impervious
00108>        10.000     Length (IMPERV)
00109>          .000     %Imp. with Zero Dpth
00110>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00111>          .250     Manning "n"
00112>        75.000     Max.Infiltn. mm/hr
00113>        13.000     Min.Infiltn. mm/hr
00114>          .500     Lag const (hours)
00115>         5.100     Dep.Storage mm
00116>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00117>                  .026       .006       .006       .000 c.m/s
00118>                  .389       .944       .394     C perv/imperv/total
00119>    15    ADD RUNOFF
00120>                  .026       .031       .006       .000 c.m/s
00121>    35    COMMENT
00122>         3     line(s) of comment
00123>          ************************************************************
00124>          Catchment 304 - Existing external drainage to main site outl
00125>          ************************************************************
00126>     4    CATCHMENT
00127>        304.000     ID No.ó 99999
00128>           .700     Area in hectares
00129>        150.000     Length (PERV) metres
00130>          .500     Gradient (%)
00131>         40.000     Per cent Impervious
00132>         10.000     Length (IMPERV)
00133>          .000     %Imp. with Zero Dpth
00134>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00135>          .250     Manning "n"
00136>         75.000     Max.Infiltn. mm/hr
00137>         13.000     Min.Infiltn. mm/hr
00138>          .500     Lag const (hours)
00139>         5.100     Dep.Storage mm
00140>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00141>                  .168       .031       .006       .000 c.m/s
00142>                  .389       .958       .617     C perv/imperv/total
00143>    15    ADD RUNOFF
00144>                  .168       .178       .006       .000 c.m/s
00145>    22    FILE HYDROGRAPH
00146>         2     1=READ: 2=WRITE
00147>         8     BASN200      .100    is Filename
00148>         2     1=Overland: 2=Inflow: 3=Outflow: 4=Temp'ary
00149>               SITE FLOW ONLY
00150>                  .168       .178       .006       .000 c.m/s
00151>    14    START
00152>         1     1=Zero; 2=Define
00153>    35    COMMENT
00154>         3     line(s) of comment
00155>          **********************
00156>          Catchment 204 - East townhouse rear yards
00157>          **********************
00158>     4    CATCHMENT
00159>        204.000     ID No.ó 99999
00160>           .220     Area in hectares
00161>        150.000     Length (PERV) metres
00162>         2.000     Gradient (%)
00163>        40.000     Per cent Impervious
00164>        10.000     Length (IMPERV)
00165>          .000     %Imp. with Zero Dpth
00166>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00167>          .250     Manning "n"
00168>        75.000     Max.Infiltn. mm/hr
00169>        13.000     Min.Infiltn. mm/hr
00170>          .500     Lag const (hours)
00171>         5.100     Dep.Storage mm
00172>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00173>                  .054       .000       .006       .000 c.m/s
00174>                  .389       .925       .603     C perv/imperv/total
00175>    15    ADD RUNOFF
00176>                  .054       .054       .006       .000 c.m/s
00177>    35    COMMENT
00178>         4     line(s) of comment
00179>          ************************
00180>          Subsurface Stage-storage
00181>          Ouflow is infiltration rate
00182>          ************************
00183>    10    POND
00184>         7 Depth - Discharge - Volume sets
00185>          330.800         .000          .0
00186>          330.900      .000800        40.0
00187>          331.000      .000810        80.0
00188>          331.100      .000820       120.0
00189>          331.200      .000830       160.0
00190>          331.300      .000840       200.0
00191>          331.310         .500       300.0
00192>          Peak Outflow    =      .001 c.m/s
00193>          Maximum Depth   =   331.074 metres
00194>          Maximum Storage =      110. c.m
00195>                  .054       .054       .001       .000 c.m/s
00196>    16    NEXT LINK
00197>                  .054       .001       .001       .000 c.m/s
00198>    22    FILE HYDROGRAPH
00199>         1     1=READ: 2=WRITE
00200>        11     BASN200.100          is Filename
00201>         1     1=Overland: 2=Inflow: 3=Outflow: 4=Temp'ary
00202>                  .178       .001       .001       .000 c.m/s
00203>    15    ADD RUNOFF
00204>                  .178       .179       .001       .000 c.m/s
00205>    14    START
00206>         1     1=Zero; 2=Define
00207>    35    COMMENT
00208>         3     line(s) of comment
00209>          **********************
00210>          Catchment 205 - West townhouse rear yards
00211>          **********************
00212>     4    CATCHMENT
00213>        205.000     ID No.ó 99999
00214>           .160     Area in hectares
00215>        100.000     Length (PERV) metres
00216>          .500     Gradient (%)
00217>         40.000     Per cent Impervious
00218>         10.000     Length (IMPERV)
00219>          .000     %Imp. with Zero Dpth
00220>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00221>          .250     Manning "n"
00222>         75.000     Max.Infiltn. mm/hr
00223>         13.000     Min.Infiltn. mm/hr
00224>          .500     Lag const (hours)
00225>         5.100     Dep.Storage mm
00226>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00227>                  .039       .000       .001       .000 c.m/s
00228>                  .389       .958       .617     C perv/imperv/total
00229>    15    ADD RUNOFF
00230>                  .039       .039       .001       .000 c.m/s
00231>    35    COMMENT
00232>         4     line(s) of comment
00233>          **********************
00234>          Subsurface Stage-storage
00235>          Ouflow is infiltration rate
00236>          **********************
00237>    10    POND
00238>         7 Depth - Discharge - Volume sets
00239>          330.800         .000          .0
00240>          330.900      .000800        31.2
00241>          331.000      .000810        62.4
00242>          331.100      .000820        93.6
00243>          331.200      .000830       124.8
00244>          331.300      .000840       156.0
00245>          331.310         .500       200.0
00246>          Peak Outflow    =      .001 c.m/s
00247>          Maximum Depth   =   331.056 metres
00248>          Maximum Storage =       80. c.m
00249>                  .039       .039       .001       .000 c.m/s
00250>    16    NEXT LINK
00251>                  .039       .001       .001       .000 c.m/s
00252>    35    COMMENT
00253>         3     line(s) of comment
00254>          **********************
```

```
00255>          Catchment 207 - Small pervious area to northwest
00256>          **********
00257>    4     CATCHMENT
00258>        207.000     ID No.ó 99999
00259>          .040      Area in hectares
00260>         20.000     Length (PERV) metres
00261>          .500      Gradient (%)
00262>         2.000      Per cent Impervious
00263>         10.000     Length (IMPERV)
00264>          .000      %Imp. with Zero Dpth
00265>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00266>          .250      Manning "n"
00267>         75.000     Max.Infiltn. mm/hr
00268>         13.000     Min.Infiltn. mm/hr
00269>          .500      Lag const (hours)
00270>         5.100      Dep.Storage mm
00271>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00272>                .010       .001       .001       .000 c.m/s
00273>                .388       .958       .400     C perv/imperv/total
00274>    15    ADD RUNOFF
00275>                .010       .011       .001       .000 c.m/s
00276>    35    COMMENT
00277>          3     line(s) of comment
00278>          ************************************************************
00279>          Catchment 305 - Existing external backyard drainage to NW 52
00280>          ************************************************************
00281>    4     CATCHMENT
00282>        305.000     ID No.ó 99999
00283>          .080      Area in hectares
00284>         75.000     Length (PERV) metres
00285>          .500      Gradient (%)
00286>         5.000      Per cent Impervious
00287>         10.000     Length (IMPERV)
00288>          .000      %Imp. with Zero Dpth
00289>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00290>          .250      Manning "n"
00291>         75.000     Max.Infiltn. mm/hr
00292>         13.000     Min.Infiltn. mm/hr
00293>          .500      Lag const (hours)
00294>         5.100      Dep.Storage mm
00295>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00296>                .013       .011       .001       .000 c.m/s
00297>                .389       .958       .418     C perv/imperv/total
00298>    15    ADD RUNOFF
00299>                .013       .022       .001       .000 c.m/s
00300>    35    COMMENT
00301>          3     line(s) of comment
00302>          ************************************************************
00303>          Catchment 306 - Existing external backyard drainage to NW 52
00304>          ************************************************************
00305>    4     CATCHMENT
00306>        306.000     ID No.ó 99999
00307>          .020      Area in hectares
00308>         40.000     Length (PERV) metres
00309>          .500      Gradient (%)
00310>         1.000      Per cent Impervious
00311>         10.000     Length (IMPERV)
00312>          .000      %Imp. with Zero Dpth
00313>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00314>          .250      Manning "n"
00315>         75.000     Max.Infiltn. mm/hr
00316>         13.000     Min.Infiltn. mm/hr
00317>          .500      Lag const (hours)
00318>         5.100      Dep.Storage mm
00319>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00320>                .004       .022       .001       .000 c.m/s
00321>                .388       .958       .394     C perv/imperv/total
00322>    15    ADD RUNOFF
00323>                .004       .026       .001       .000 c.m/s
00324>    35    COMMENT
00325>          3     line(s) of comment
00326>          ************************************************************
00327>          Catchment 309 - Existing external backyard drainage to NW 52
00328>          ************************************************************
00329>    4     CATCHMENT
00330>        309.000     ID No.ó 99999
00331>          .220      Area in hectares
00332>         45.000     Length (PERV) metres
00333>          .500      Gradient (%)
00334>         20.000     Per cent Impervious
00335>         10.000     Length (IMPERV)
00336>          .000      %Imp. with Zero Dpth
00337>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00338>          .250      Manning "n"
00339>         75.000     Max.Infiltn. mm/hr
00340>         13.000     Min.Infiltn. mm/hr
00341>          .500      Lag const (hours)
00342>         5.100      Dep.Storage mm
00343>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00344>                .043       .026       .001       .000 c.m/s
00345>                .389       .958       .503     C perv/imperv/total
00346>    15    ADD RUNOFF
00347>                .043       .068       .001       .000 c.m/s
00348>    14    START
00349>          1     1=Zero; 2=Define
00350>    35    COMMENT
00351>          3     line(s) of comment
00352>          **************************************************
00353>          Catchments 200-202 - South townhouses to Lowes Road
00354>          **************************************************
00355>    4     CATCHMENT
00356>        202.000     ID No.ó 99999
00357>          .290      Area in hectares
00358>        120.000     Length (PERV) metres
00359>          .500      Gradient (%)
00360>         60.000     Per cent Impervious
00361>         10.000     Length (IMPERV)
00362>          .000      %Imp. with Zero Dpth
00363>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00364>          .250      Manning "n"
00365>         75.000     Max.Infiltn. mm/hr
00366>         13.000     Min.Infiltn. mm/hr
00367>          .500      Lag const (hours)
00368>         5.100      Dep.Storage mm
00369>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00370>                .104       .000       .001       .000 c.m/s
00371>                .389       .958       .731     C perv/imperv/total
00372>    15    ADD RUNOFF
00373>                .104       .104       .001       .000 c.m/s
00374>    35    COMMENT
00375>          4     line(s) of comment
00376>          ****************************************
00377>          Catchment 300 - External flows from south
00378>          Drains to Lowes Road and west to Dawn Ave
00379>          ****************************************
00380>    4     CATCHMENT
00381>        300.000     ID No.ó 99999
00382>          .190      Area in hectares
00383>         90.000     Length (PERV) metres
00384>          .500      Gradient (%)
00385>         40.000     Per cent Impervious
00386>         10.000     Length (IMPERV)
00387>          .000      %Imp. with Zero Dpth
00388>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00389>          .250      Manning "n"
00390>         75.000     Max.Infiltn. mm/hr
00391>         13.000     Min.Infiltn. mm/hr
00392>          .500      Lag const (hours)
00393>         5.100      Dep.Storage mm
00394>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00395>                .046       .104       .001       .000 c.m/s
00396>                .389       .958       .617     C perv/imperv/total
00397>    15    ADD RUNOFF
00398>                .046       .150       .001       .000 c.m/s
00399>    35    COMMENT
00400>          4     line(s) of comment
00401>          ****************************************
00402>          Catchment 301 - External flows from south
00403>          Drains to Lowes Road and west to Dawn Ave
00404>          ****************************************
00405>    4     CATCHMENT
00406>        301.000     ID No.ó 99999
00407>          .440      Area in hectares
00408>        120.000     Length (PERV) metres
00409>          .500      Gradient (%)
00410>         40.000     Per cent Impervious
00411>         10.000     Length (IMPERV)
00412>          .000      %Imp. with Zero Dpth
00413>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00414>          .250      Manning "n"
00415>         75.000     Max.Infiltn. mm/hr
00416>         13.000     Min.Infiltn. mm/hr
00417>          .500      Lag const (hours)
00418>         5.100      Dep.Storage mm
00419>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00420>                .107       .150       .001       .000 c.m/s
00421>                .389       .958       .617     C perv/imperv/total
00422>    15    ADD RUNOFF
00423>                .107       .257       .001       .000 c.m/s
00424>    35    COMMENT
00425>          4     line(s) of comment
00426>          ****************************************
00427>          Catchment 302 - External flows from south
00428>          Drains to Lowes Road and west to Dawn Ave
00429>          ****************************************
00430>    4     CATCHMENT
00431>        302.000     ID No.ó 99999
00432>          .590      Area in hectares
00433>         90.000     Length (PERV) metres
00434>          .500      Gradient (%)
00435>         40.000     Per cent Impervious
00436>         10.000     Length (IMPERV)
00437>          .000      %Imp. with Zero Dpth
00438>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00439>          .250      Manning "n"
00440>         75.000     Max.Infiltn. mm/hr
00441>         13.000     Min.Infiltn. mm/hr
00442>          .500      Lag const (hours)
00443>         5.100      Dep.Storage mm
00444>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00445>                .144       .257       .001       .000 c.m/s
00446>                .389       .958       .617     C perv/imperv/total
00447>    15    ADD RUNOFF
00448>                .144       .401       .001       .000 c.m/s
00449>    35    COMMENT
00450>          4     line(s) of comment
00451>          **************************************************
00452>          Catchment 307 - External flows Gordon St
00453>          Assumed to drain to Lowes Road and west to Dawn Ave
00454>          **************************************************
00455>    4     CATCHMENT
00456>        307.000     ID No.ó 99999
00457>          .090      Area in hectares
00458>         5.000      Length (PERV) metres
00459>         2.000      Gradient (%)
00460>         90.000     Per cent Impervious
00461>         10.000     Length (IMPERV)
00462>          .000      %Imp. with Zero Dpth
00463>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00464>          .250      Manning "n"
00465>         75.000     Max.Infiltn. mm/hr
00466>         13.000     Min.Infiltn. mm/hr
00467>          .500      Lag const (hours)
00468>         2.000      Dep.Storage mm
00469>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00470>                .050       .401       .001       .000 c.m/s
00471>                .415       .925       .874     C perv/imperv/total
00472>    15    ADD RUNOFF
00473>                .050       .451       .001       .000 c.m/s
00474>    35    COMMENT
00475>          4     line(s) of comment
00476>          **************************************************
00477>          Catchment 310 - External flows Gordon St
00478>          Assumed to drain to Lowes Road and west to Dawn Ave
00479>          **************************************************
00480>    4     CATCHMENT
00481>        310.000     ID No.ó 99999
00482>          .330      Area in hectares
00483>         5.000      Length (PERV) metres
00484>         2.000      Gradient (%)
00485>         90.000     Per cent Impervious
00486>         10.000     Length (IMPERV)
00487>          .000      %Imp. with Zero Dpth
00488>             2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00489>          .250      Manning "n"
00490>         75.000     Max.Infiltn. mm/hr
00491>         13.000     Min.Infiltn. mm/hr
00492>          .500      Lag const (hours)
00493>         2.000      Dep.Storage mm
00494>             1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00495>                .185       .451       .001       .000 c.m/s
00496>                .415       .925       .874     C perv/imperv/total
00497>    15    ADD RUNOFF
00498>                .185       .636       .001       .000 c.m/s
00499>    14    START
00500>          1     1=Zero; 2=Define
00501>    35    COMMENT
00502>          4     line(s) of comment
00503>          ****************************************
00504>          Catchment 303 - External flows from east
00505>          Assumed to drain to Gordon Street
00506>          ****************************************
00507>    4     CATCHMENT
00508>        303.000     ID No.ó 99999
```

```
00509>            .330     Area in hectares
00510>          60.000     Length (PERV) metres
00511>            .500     Gradient (%)
00512>          20.000     Per cent Impervious
00513>          10.000     Length (IMPERV)
00514>            .000     %Imp. with Zero Dpth
00515>               2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
00516>            .250     Manning "n"
00517>          75.000     Max.Infiltn. mm/hr
00518>          13.000     Min.Infiltn. mm/hr
00519>            .500     Lag const (hours)
00520>          10.000     Dep.Storage mm
00521>               1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
00522>                  .049       .000       .001       .000 c.m/s
00523>                 .333       .958       .458     C perv/imperv/total
00524>    15     ADD RUNOFF
00525>                  .049       .049       .001       .000 c.m/s
00526>    20     MANUAL
00527>
```

```
          Output File (4.7) LOREG.OUT    opened 2016-08-18   9:57
          Units used are defined by G =    9.810
             192   384    15.000        are MAXDT MAXHYD & DTMIN values
          Licensee: Paragon Engineering Limited
    35    COMMENT
     6      line(s) of comment
           **********************
           1614-13228 - Lowes Road
           Proposed Conditions - SWM Modelling
           Regional Storm event - 48 hour
           Functional Servicing Report - T.Fraser (July 2016)
           **********************
    23    FILE RAINFALL
     1      1=READ: 2=WRITE
    10      Regional.S           is Filename
     3    IMPERVIOUS
              2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .013     Manning "n"
           .000     Max.Infiltn. mm/hr
           .000     Min.Infiltn. mm/hr
           .050     Lag const (hours)
          1.500     Dep.Storage mm
    35    COMMENT
     3      line(s) of comment
           **********************
           Catchment 203 - Central townhouse block and roads
           **********************
     4    CATCHMENT
       203.000     ID No.ó 99999
          .730     Area in hectares
        10.000     Length (PERV) metres
         2.000     Gradient (%)
        90.000     Per cent Impervious
        10.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        75.000     Max.Infiltn. mm/hr
        13.000     Min.Infiltn. mm/hr
          .500     Lag const (hours)
         2.000     Dep.Storage mm
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .088       .000       .000       .000 c.m/s
                .261       .891       .828     C perv/imperv/total
    15    ADD RUNOFF
                .088       .088       .000       .000 c.m/s
    35    COMMENT
     3      line(s) of comment
           **********************
           Catchment 208 - SWM Block
           **********************
     4    CATCHMENT
       208.000     ID No.ó 99999
          .120     Area in hectares
        10.000     Length (PERV) metres
         1.000     Gradient (%)
        50.000     Per cent Impervious
        10.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        75.000     Max.Infiltn. mm/hr
        13.000     Min.Infiltn. mm/hr
          .500     Lag const (hours)
         5.100     Dep.Storage mm
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .014       .088       .000       .000 c.m/s
                .249       .912       .580     C perv/imperv/total
    15    ADD RUNOFF
                .014       .102       .000       .000 c.m/s
    35    COMMENT
     3      line(s) of comment
           **********************
           Pond 200 Stage-storage
           **********************
    10    POND
       13 Depth - Discharge - Volume sets
          331.300        .000          .0
          331.400      .00100        31.0
          331.600      .00300       107.6
          331.800      .00400       206.3
          331.900      .00450       263.8
          332.000      .00470       326.6
          332.100      .00500       394.8
          332.200      .00550       468.4
          332.300      .00570       547.4
          332.500      .00600       721.5
          332.600      .00650       816.6
          332.700      .00670       917.2
          332.900        .500      1134.4
          Peak Outflow    =      .093 c.m/s
          Maximum Depth   =   332.735 metres
          Maximum Storage =      955. c.m
                .014       .102       .093       .000 c.m/s
    16    NEXT LINK
                .014       .093       .093       .000 c.m/s
    35    COMMENT
     3      line(s) of comment
           ******************************************
           Catchment 206 - Pervious area adjacent to Pond
           ******************************************
     4    CATCHMENT
       206.000     ID No.ó 99999
          .120     Area in hectares
        50.000     Length (PERV) metres
         1.000     Gradient (%)
         1.000     Per cent Impervious
        10.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        75.000     Max.Infiltn. mm/hr
        13.000     Min.Infiltn. mm/hr
          .500     Lag const (hours)
         5.100     Dep.Storage mm
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .013       .093       .093       .000 c.m/s
                .257       .912       .264     C perv/imperv/total
    15    ADD RUNOFF
                .013       .106       .093       .000 c.m/s
    35    COMMENT
     3      line(s) of comment
           ************************************************************
           Catchment 304 - Existing external drainage to main site outl
           ************************************************************
     4    CATCHMENT
       304.000     ID No.ó 99999
          .700     Area in hectares
       150.000     Length (PERV) metres
          .500     Gradient (%)
        40.000     Per cent Impervious
        10.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        75.000     Max.Infiltn. mm/hr
        13.000     Min.Infiltn. mm/hr
          .500     Lag const (hours)
         5.100     Dep.Storage mm
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .062       .106       .093       .000 c.m/s
                .259       .934       .529     C perv/imperv/total
    15    ADD RUNOFF
                .062       .167       .093       .000 c.m/s
    22    FILE HYDROGRAPH
     2      1=READ: 2=WRITE
     8      BASN200      .REG    is Filename
     2      1=Overland: 2=Inflow: 3=Outflow: 4=Temp'ary
            SITE FLOW ONLY
                .062       .167       .093       .000 c.m/s
    14    START
     1      1=Zero; 2=Define
    35    COMMENT
     3      line(s) of comment
           **********************
           Catchment 204 - East townhouse rear yards
           **********************
     4    CATCHMENT
       204.000     ID No.ó 99999
          .220     Area in hectares
       150.000     Length (PERV) metres
         2.000     Gradient (%)
        40.000     Per cent Impervious
        10.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        75.000     Max.Infiltn. mm/hr
        13.000     Min.Infiltn. mm/hr
          .500     Lag const (hours)
         5.100     Dep.Storage mm
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .023       .000       .093       .000 c.m/s
                .259       .891       .512     C perv/imperv/total
    15    ADD RUNOFF
                .023       .023       .093       .000 c.m/s
    22    FILE HYDROGRAPH
     1      1=READ: 2=WRITE
    11      BASN200.REG          is Filename
     1      1=Overland: 2=Inflow: 3=Outflow: 4=Temp'ary
                .167       .023       .093       .000 c.m/s
    15    ADD RUNOFF
                .167       .190       .093       .000 c.m/s
    14    START
     1      1=Zero; 2=Define
    35    COMMENT
     3      line(s) of comment
           **********************
           Catchment 205 - West townhouse rear yards
           **********************
     4    CATCHMENT
       205.000     ID No.ó 99999
          .160     Area in hectares
       100.000     Length (PERV) metres
          .500     Gradient (%)
        40.000     Per cent Impervious
        10.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        75.000     Max.Infiltn. mm/hr
        13.000     Min.Infiltn. mm/hr
          .500     Lag const (hours)
         5.100     Dep.Storage mm
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .016       .000       .093       .000 c.m/s
                .259       .934       .529     C perv/imperv/total
    15    ADD RUNOFF
                .016       .016       .093       .000 c.m/s
    35    COMMENT
     3      line(s) of comment
           **********************
           Catchment 207 - Small pervious area to northwest
           **********************
     4    CATCHMENT
       207.000     ID No.ó 99999
          .040     Area in hectares
        20.000     Length (PERV) metres
          .500     Gradient (%)
         2.000     Per cent Impervious
        10.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        75.000     Max.Infiltn. mm/hr
        13.000     Min.Infiltn. mm/hr
          .500     Lag const (hours)
         5.100     Dep.Storage mm
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .004       .016       .093       .000 c.m/s
                .255       .934       .269     C perv/imperv/total
    15    ADD RUNOFF
                .004       .020       .093       .000 c.m/s
    35    COMMENT
     3      line(s) of comment
           ************************************************************
           Catchment 305 - Existing external backyard drainage to NW 52
           ************************************************************
     4    CATCHMENT
       305.000     ID No.ó 99999
          .080     Area in hectares
        75.000     Length (PERV) metres
          .500     Gradient (%)
         5.000     Per cent Impervious
        10.000     Length (IMPERV)
          .000     %Imp. with Zero Dpth
             2     Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
          .250     Manning "n"
        75.000     Max.Infiltn. mm/hr
        13.000     Min.Infiltn. mm/hr
          .500     Lag const (hours)
         5.100     Dep.Storage mm
             1     Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .008       .020       .093       .000 c.m/s
```

```
                .259       .934       .293     C perv/imperv/total
    15     ADD RUNOFF
                .008       .027       .093       .000 c.m/s
    35     COMMENT
         3     line(s) of comment
          ************************************************************
          Catchment 306 - Existing external backyard drainage to NW 52
          ************************************************************
     4    CATCHMENT
         306.000     ID No.ó 99999
           .020      Area in hectares
          40.000     Length (PERV) metres
           .500      Gradient (%)
          1.000      Per cent Impervious
          10.000     Length (IMPERV)
           .000      %Imp. with Zero Dpth
              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
          75.000     Max.Infiltn. mm/hr
          13.000     Min.Infiltn. mm/hr
           .500      Lag const (hours)
          5.100      Dep.Storage mm
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .002       .027       .093       .000 c.m/s
                .257       .934       .264     C perv/imperv/total
    15     ADD RUNOFF
                .002       .029       .093       .000 c.m/s
    35     COMMENT
         3     line(s) of comment
          ************************************************************
          Catchment 309 - Existing external backyard drainage to NW 52
          ************************************************************
     4    CATCHMENT
         309.000     ID No.ó 99999
           .220      Area in hectares
          45.000     Length (PERV) metres
           .500      Gradient (%)
          20.000     Per cent Impervious
          10.000     Length (IMPERV)
           .000      %Imp. with Zero Dpth
              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
          75.000     Max.Infiltn. mm/hr
          13.000     Min.Infiltn. mm/hr
           .500      Lag const (hours)
          5.100      Dep.Storage mm
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .024       .029       .093       .000 c.m/s
                .258       .934       .394     C perv/imperv/total
    15     ADD RUNOFF
                .024       .053       .093       .000 c.m/s
    14     START
         1     1=Zero; 2=Define
    35     COMMENT
         3     line(s) of comment
          ****************************************************
          Catchments 200-202 - South townhouses to Lowes Road
          ****************************************************
     4    CATCHMENT
         202.000     ID No.ó 99999
           .290      Area in hectares
          120.000    Length (PERV) metres
           .500      Gradient (%)
          60.000     Per cent Impervious
          10.000     Length (IMPERV)
           .000      %Imp. with Zero Dpth
              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
          75.000     Max.Infiltn. mm/hr
          13.000     Min.Infiltn. mm/hr
           .500      Lag const (hours)
          5.100      Dep.Storage mm
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .030       .000       .093       .000 c.m/s
                .259       .934       .664     C perv/imperv/total
    15     ADD RUNOFF
                .030       .030       .093       .000 c.m/s
    35     COMMENT
         4     line(s) of comment
          ****************************************
          Catchment 300 - External flows from south
          Drains to Lowes Road and west to Dawn Ave
          ****************************************
     4    CATCHMENT
         300.000     ID No.ó 99999
           .190      Area in hectares
          90.000     Length (PERV) metres
           .500      Gradient (%)
          40.000     Per cent Impervious
          10.000     Length (IMPERV)
           .000      %Imp. with Zero Dpth
              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
          75.000     Max.Infiltn. mm/hr
          13.000     Min.Infiltn. mm/hr
           .500      Lag const (hours)
          5.100      Dep.Storage mm
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .019       .030       .093       .000 c.m/s
                .259       .934       .529     C perv/imperv/total
    15     ADD RUNOFF
                .019       .049       .093       .000 c.m/s
    35     COMMENT
         4     line(s) of comment
          ****************************************
          Catchment 301 - External flows from south
          Drains to Lowes Road and west to Dawn Ave
          ****************************************
     4    CATCHMENT
         301.000     ID No.ó 99999
           .440      Area in hectares
          120.000    Length (PERV) metres
           .500      Gradient (%)
          40.000     Per cent Impervious
          10.000     Length (IMPERV)
           .000      %Imp. with Zero Dpth
              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
          75.000     Max.Infiltn. mm/hr
          13.000     Min.Infiltn. mm/hr
           .500      Lag const (hours)
          5.100      Dep.Storage mm
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .041       .049       .093       .000 c.m/s
                .259       .934       .529     C perv/imperv/total
    15     ADD RUNOFF
                .041       .090       .093       .000 c.m/s
    35     COMMENT
         4     line(s) of comment
          ****************************************
          Catchment 302 - External flows from south
          Drains to Lowes Road and west to Dawn Ave
          ****************************************
     4    CATCHMENT
         302.000     ID No.ó 99999
           .590      Area in hectares
          90.000     Length (PERV) metres
           .500      Gradient (%)
          40.000     Per cent Impervious
          10.000     Length (IMPERV)
           .000      %Imp. with Zero Dpth
              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
          75.000     Max.Infiltn. mm/hr
          13.000     Min.Infiltn. mm/hr
           .500      Lag const (hours)
          5.100      Dep.Storage mm
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .059       .090       .093       .000 c.m/s
                .259       .934       .529     C perv/imperv/total
    15     ADD RUNOFF
                .059       .149       .093       .000 c.m/s
    35     COMMENT
         4     line(s) of comment
          ************************************************
          Catchment 307 - External flows Gordon St
          Assumed to drain to Lowes Road and west to Dawn Ave
          ************************************************
     4    CATCHMENT
         307.000     ID No.ó 99999
           .090      Area in hectares
          5.000      Length (PERV) metres
          2.000      Gradient (%)
          90.000     Per cent Impervious
          10.000     Length (IMPERV)
           .000      %Imp. with Zero Dpth
              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
          75.000     Max.Infiltn. mm/hr
          13.000     Min.Infiltn. mm/hr
           .500      Lag const (hours)
          2.000      Dep.Storage mm
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .011       .149       .093       .000 c.m/s
                .268       .891       .829     C perv/imperv/total
    15     ADD RUNOFF
                .011       .160       .093       .000 c.m/s
    35     COMMENT
         4     line(s) of comment
          ************************************************
          Catchment 310 - External flows Gordon St
          Assumed to drain to Lowes Road and west to Dawn Ave
          ************************************************
     4    CATCHMENT
         310.000     ID No.ó 99999
           .330      Area in hectares
          5.000      Length (PERV) metres
          2.000      Gradient (%)
          90.000     Per cent Impervious
          10.000     Length (IMPERV)
           .000      %Imp. with Zero Dpth
              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
          75.000     Max.Infiltn. mm/hr
          13.000     Min.Infiltn. mm/hr
           .500      Lag const (hours)
          2.000      Dep.Storage mm
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .040       .160       .093       .000 c.m/s
                .268       .891       .829     C perv/imperv/total
    15     ADD RUNOFF
                .040       .200       .093       .000 c.m/s
    14     START
         1     1=Zero; 2=Define
    35     COMMENT
         4     line(s) of comment
          ****************************************
          Catchment 303 - External flows from east
          Assumed to drain to Gordon Street
          ****************************************
     4    CATCHMENT
         303.000     ID No.ó 99999
           .330      Area in hectares
          60.000     Length (PERV) metres
           .500      Gradient (%)
          20.000     Per cent Impervious
          10.000     Length (IMPERV)
           .000      %Imp. with Zero Dpth
              2      Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
           .250      Manning "n"
          75.000     Max.Infiltn. mm/hr
          13.000     Min.Infiltn. mm/hr
           .500      Lag const (hours)
          10.000     Dep.Storage mm
              1      Option 1=Trianglr; 2=Rectanglr; 3=SWM HYD; 4=Lin. Reserv
                .034       .000       .093       .000 c.m/s
                .240       .934       .379     C perv/imperv/total
    15     ADD RUNOFF
                .034       .034       .093       .000 c.m/s
    20     MANUAL
```

161413228 - Lowes Road
Preliminary SWM Facility Stage-Storage-Discharge

Rating Curve for MIDUSS				
Elevation (m)	Discharge (m³/s)	Active Storage (m³)	Drawdown (hrs) Increment	Drawdown (hrs) Total
331.30				
331.40	0.001	30.5	11.9	11.9
331.50	0.002	66.4	5.5	17.4
331.60	0.003	107.6	4.7	22.0
331.70	0.003	154.3	4.4	26.4
331.80	0.004	206.3	4.3	30.7
331.90	0.004	263.8	4.2	34.9
332.00	0.004	326.6	4.2	39.1
332.10	0.005	394.8	4.3	43.4
332.20	0.005	468.4	4.3	47.7
332.30	0.005	547.4	4.4	52.1
332.40	0.005	631.7	4.4	56.5
332.50	0.006	721.5	4.5	61.0
332.60	0.006	816.6	4.6	65.6
332.70	0.006	917.2	4.6	70.2
332.80	0.006	1023.1	4.7	75.0
332.90	0.007	1134.4	4.8	79.8

Volume Estimation				
	Elevation (m)	Dry Pond Volumes Area (m²)	Dry Pond Volumes Vol (m³)	Total Act Vol (m³)
Bottom of dry pond	331.30	278		
	331.40	332	30	30
	331.50	386	66	66
	331.60	440	108	108
	331.70	494	154	154
	331.80	547	206	206
	331.90	601	264	264
	332.00	655	327	327
	332.10	709	395	395
	332.20	763	468	468
	332.30	817	547	547
	332.40	871	632	632
	332.50	925	722	722
	332.60	978	817	817
	332.70	1032	917	917
	332.80	1086	1023	1023
Top of pond	332.90	1140	1,134	1,134

Outlet Controls				
Elevation (m)	Orifice 1 (m³/s)	Overflow Weir (m³/s)	Total Flow (m³/s)	Parameters
331.30				Orifice 1
331.40	0.001		0.001	Orifice Invert Elev. (m) 331.30 / Orifice Coeff. 0.60
331.50	0.002		0.002	
331.60	0.003		0.003	Orifice Mid-point Elev. (m) 331.33 / Perimeter (m) 0.16
331.70	0.003		0.003	
331.80	0.004		0.004	Orifice Diam.(mm) 50 / Area (m^2) 0.002
331.90	0.004		0.004	
332.00	0.004		0.004	Weir Coeff. (semi-circular) 1.62 / Orientation Vertical
332.10	0.005		0.005	
332.20	0.005		0.005	Overflow Spillway
332.30	0.005		0.005	Spillway Invert (m) / Top of Berm (m)
332.40	0.005		0.005	
332.50	0.006		0.006	Spillway Length @ Invert (m) / Max. Flow Depth (m)
332.60	0.006		0.006	
332.70	0.006		0.006	Left Side Slope / Right Side Slope
332.80	0.006		0.006	
332.90	0.007		0.007	Weir Coefficient (Rectangle) 1.7 / Topwidth
				Weir Coefficient (Triangle) 1.3

Orifice Flow Calculations: Orifice flow equation

$Q = C \cdot A \cdot (2 \cdot g \cdot H)^{0.5}$

where

C = orifice coefficient
A = area of orifice
g = acceleration due to gravity
H = head above centre line of orifice
Note: used when water elevation is above 3/4 of the orifice diameter

Sharp crested semi-circular weir equation

$Q = C * D^{2.5} * (H/D)^{1.88}$

where

C = sharp crested semi-circular weir coefficient
D = diameter of orifice
H = head above orifice invert
Note: used when water elevation is below 3/4 of the orifice diameter

Broad Crested Weir Equation: $Q = C_{wb} * L * H^{1.5} + C_{wt} * S * H^{2.5}$

where

L = bottom width of spillway
H = head above weir invert
S = side slopes (ratio of H:V)
C_{wt} = broad-crested triangular weir coefficient
C_{wb} = broad-crested rectangular weir coefficient

161413228 - 19-59 Lowes Road, Guelph ON
Preliminary Annual Water Balance and Infiltration Calculations

Existing Drainage Conditions

The soils are: Fine Sandy Loam — 291 mm/yr Infiltration Rate (1) — lawns — 525 mm/yr Evapotranspiration Rate - Pervious Areas (3)

Topography: Rolling land, average slope between 0.28% and 0.38%

						Water	
Area with:	Fine Sandy Loam	1.7	ha (5)	% Impervious	10%	0.0	ha
			ha (6)				
	Total	1.7	ha	% Impervious	0%	0.0	ha

	Fine Sandy Loam		
Precipitation	940.0	mm/yr (2)	
Evapotranspiration	472.5	mm/yr (3)	(ET*(1-%IMP))
Infiltration	261.5	mm/yr (1)	(INFIL*(1-%IMP))
Evaporation (Open Water)	0.0	mm/yr (4)	
Runoff	206.1	mm/yr	(= Precipitation - Evaporation - Infiltration - Evaporation)

	Total		Total	
Precipitation	15,510	m^3/yr	940.0	mm/yr
Total Evapotranspiration (pre)	7,796	m^3/yr	472.5	mm/yr
Total Infiltration (pre)	4,314	m^3/yr	261.5	mm/yr
Total Evaporation (pre)	0	m^3/yr	0.0	mm/yr
Total Runoff (pre)	3,400	m^3/yr	206.1	mm/yr

Proposed Drainage Conditions

Surface Water Regime

The soils are: Fine Sandy Loam — 218 mm/yr Infiltration Rate (1) — cultivated — 543 mm/yr Evapotranspiration Rate - Pervious Areas (3)

Topography: Rolling land, average slope between 0.28% and 0.38%

						Water	
Area with:	Fine Sandy Loam	1.7	ha (5)	% Impervious	60%	0.0	ha
	Total	1.7	ha				

	Fine Sandy Loam		
Precipitation	940.0	mm/yr (2)	
Evapotranspiration	217.2	mm/yr (3)	(ET*(1-%IMP))
Infiltration	87.3	mm/yr (1)	(INFIL*(1-%IMP))
Evaporation	0.0	mm/yr (4)	
Runoff	635.5	mm/yr	

	Total		Total	
Precipitation	15,510	m^3/yr	940.0	mm/yr
Total Evapotranspiration (post)	3,584	m^3/yr	217.2	mm/yr
Total Infiltration (post)	1,441	m^3/yr	87.3	mm/yr
Total Evaporation (post)	0	m^3/yr	0.0	mm/yr
Total Runoff (post)	10,485	m^3/yr	635.5	mm/yr
Total Runoff (post)	10485	m^3/yr	635	mm/yr

Infiltration Augmentation

Rear Yard Infiltration Trenches (Catchments 204 and 205)

Clean impervious area to infiltration trenches (6)	1520	m^2
Estimated total infiltration per year	725	mm/year (7)
	1,102	m^3/year

Centralized Infiltration Trench for Rooftop Recharge (Catchment 203)

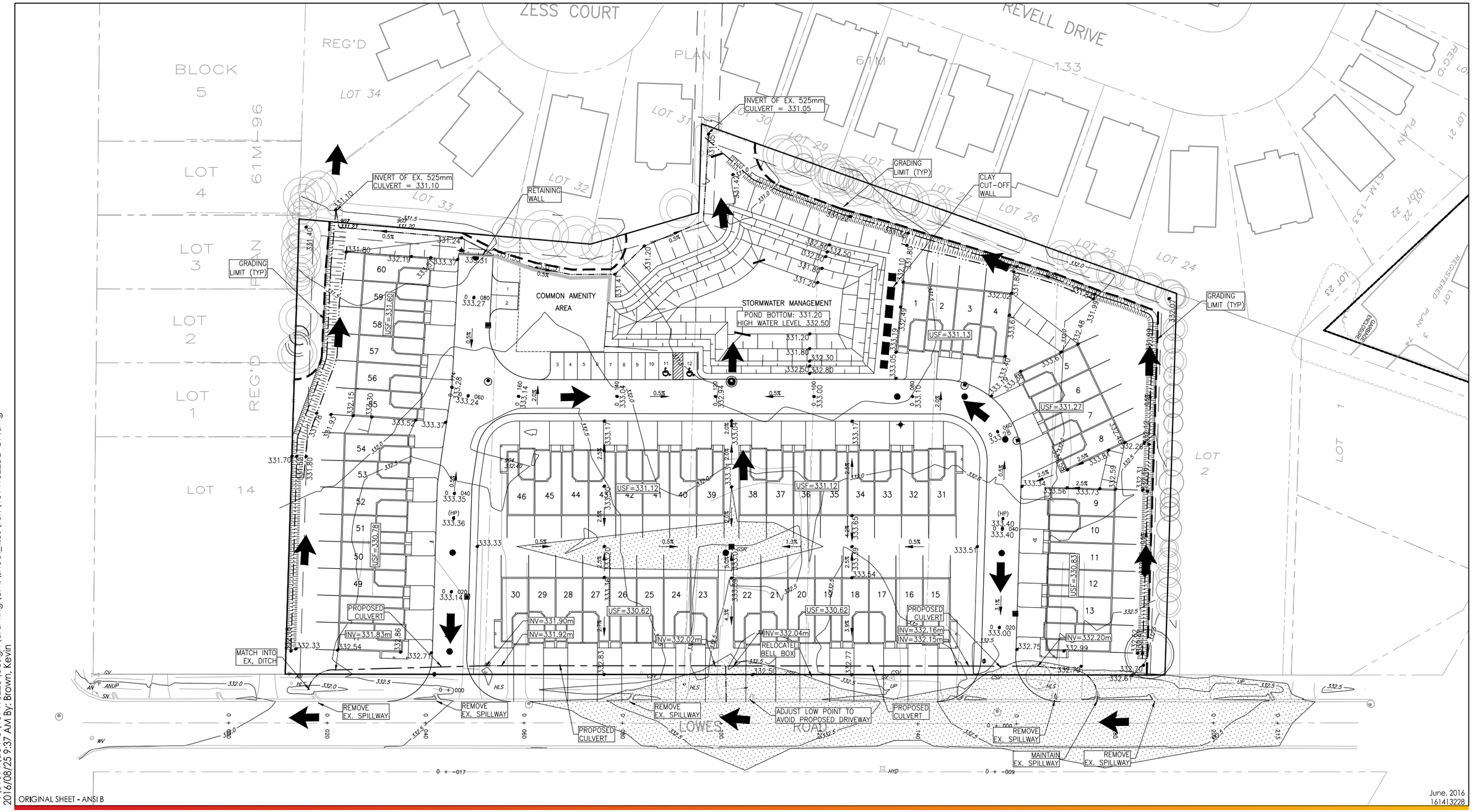
Total rooftop area (approximate) (8)	2800	m^2
Estimated total infiltration per year	725	mm/year (7)
	2,030	m^3/year

Infiltration Post Development is	**1,441**	**m^3/yr**	87.3	mm/yr
Total Infiltration Deficit:	**-2,873**	**m^3/yr**	-174.1	mm/yr
Total Runoff Surplus:	**7,085**	**m^3/yr**	429.4	mm/yr
Total Post Development Infiltration:	**4,573**	**m^3/yr**	277.2	
Final Infiltration Surplus:	**259**	**m^3/yr**	15.7	
Final Runoff Surplus:	**3,953**	**m^3/yr**	239.6	
Therefore there remains a post development infiltration surplus of	**259**	**m^3/yr**	**6%**	
and a runoff surplus of	**3,953**	**m^3/yr**	**14%**	

(1) Infiltration rate based on MOE SWMPP Manual (2003), Table 3.1 Hydrologic Cycle Components
soils information from: *Geotechnical Investigation, Exp Services, 2013.*
(2) Precipitation based on MOE SWMPP Manual (2003), Table 3.1 Hydrologic Cycle Components
(3) Evapotranspiration values based on MOE SWMPP Manual (2003), Table 3.1 Hydrologic Cycle Componentsn
(4) Open water evaporation (650 mm/yr) based on Environment Canada Calculated Lake Evaporation Data, 1951-1980 (Ontario Climate Centre)
(5) External area delineated using GIS data while internal area measured using survey data
(6) Catchment 204 - 40% impervious, 0.22 ha; Catchment 205 - 40% impervious, 0.16 ha
(7) Conservatively estimated at 80% of total rainfall from Catchments 204 and 205 directed to rear yard infiltration trenches
(8) 32 units in Catchment 203; assumed average rooftop area is 175 sq. m per 2 units

APPENDIX F

Conceptual Grading Plan



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2016/08/25 9:37 AM By: Brown, Kevin

ORIGINAL SHEET - ANSI B

June, 2016
161413228

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Legend

- POTENTIAL PONDING AREA
- OVERLAND FLOW ROUTE
- CULVERT
- RETAINING WALL
- GRADING LIMIT

Notes

HIGH GROUND WATER LEVEL FOR SITE VARIES BETWEEN 329.91–330.34m BASED ON HYDROGEOLOGIC ASSESSMENT

1:750 0 7.5 22.5 37.5m

Client/Project
Reid's Heritage Homes
Lowes Road Property, Guelph

Figure No.
FIG 5.0

Title
CONCEPTUAL GRADING

APPENDIX G

Geotechnical Investigation Report, Englobe - May 24, 2016

Englobe
Soils Materials Environment

Reid's Heritage Homes

Proposed Residential Development
Lowes Road
Guelph, Ontario

Geotechnical Investigation Report

Date: May 24, 2016
Ref. N°: 160-P-0010233-0-01-GE-R-0001-00

Reid's Heritage Homes

Proposed Residential Development
Lowes Road
Guelph, Ontario

Geotechnical Investigation Report | 160-P-0010233-0-01-100

Prepared by:

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TABLE OF CONTENTS

INTRODUCTION 1

1 GENERAL INFORMATION 2

2 INVESTIGATION PROCEDURE 2

2.1 Field Program 2
2.2 Laboratory Testing 3

3 SUMMARIZED CONDITIONS 4

3.1 Topsoil 4
3.2 Fill 4
3.3 Native Mineral Soils 4
3.4 Groundwater 5

4 DISCUSSION AND RECOMMENDATIONS 6

4.1 Site Preparation 6
4.2 Site Servicing 7
4.2.1 Excavations and Dewatering 8
4.2.2 Pipe Bedding 8
4.2.3 Trench Backfill 9
4.3 Surface Works 9
4.3.1 Curbs and Sidewalk 9
4.3.2 Pavement Design 9
4.4 House Construction 10
4.4.1 Foundations 10
4.4.2 Basements 11
4.4.3 Radon Gas 11
4.5 Stormwater Management 12
4.5.1 At-source Infiltration 12
4.5.2 Stormwater Management Pond 13
4.6 Construction Inspection and Testing 14

5 STATEMENT OF LIMITATIONS 15

Tables

Table 1: Results of Particle Size Distribution Analyses – Sand and Gravel, Sand, and Silt .. 5
Table 2: Stabilized Groundwater Level Measurements – May 12, 2016 6
Table 3: Pavement Component Thicknesses 10
Table 4: Infiltration Potential 13

Appendices

Appendix 1 Drawings
Appendix 2 Borehole Logs
Appendix 3 Figures

Property and Confidentiality

Reid's Heritage Homes
6783 Wellington Road 34, RR22
Cambridge, Ontario N3C 2V4
Attention: Mr. Alfred Artinger, P.Eng.

REVISION AND PUBLICATION REGISTER		
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INTRODUCTION

Englobe Corp. (Englobe) was retained to carry out a geotechnical investigation for the proposed residential subdivision development at the properties located at 19, 29, 35, 41, 51, and 59 Lowes Road in Guelph, Ontario as shown on the Location Plan, Drawing 1 in Appendix 1. This work was authorized by Mr. Alfred Artinger, P.Eng. of Reid's Heritage Homes following submission of a fee proposal.

The purpose of this geotechnical investigation was to determine the soil and groundwater conditions at the site and, based on this information, provide recommendations pertaining to site preparation, site servicing, surface works, house construction, and stormwater management, and construction inspection and testing.

Concurrent with this geotechnical investigation, Englobe is completing a scoped hydrogeology study of the subject site. The findings of the scoped hydrogeology study will be issued under separate cover.

Further, MTE Consultants Inc. is currently completing an environmental site assessment for the subject properties and the borehole drilling and installation of monitoring wells for this study were completed concurrently with the fieldwork for the geotechnical investigation.

1 GENERAL INFORMATION

The project involves the redevelopment of the residential properties located at 19, 29, 35, 41, 51, and 59 Lowes Road in Guelph, Ontario. The site layout of the proposed redevelopment is currently preliminary and conceptual; however, it is understood that the new residential development will comprise several townhouse blocks and internal roadways. A stormwater management block is proposed in the northwest portion of the site (rear of Lots 35, 41, and 51 Lowes Road).

The subject site has a total area of approximately 1.6 hectares. All properties currently comprise residential houses fronting along Lowes Road with grassed areas with trees in the rear of the properties. A secondary building structure is currently located in the rear of 41 Lowes Road. Grades at the subject site generally slope toward the northeast portion of the site with grades at borehole locations ranging from Elevation 331.3 m at Borehole BH-06-16 in the northeast to Elevation 332.8 m at Borehole BH-01-16 in the south near Lowes Road.

2 INVESTIGATION PROCEDURE

2.1 FIELD PROGRAM

The fieldwork for the proposed residential subdivision development was completed from May 2 to 4, 2016 and involved the drilling of thirteen boreholes (Boreholes BH-01-16 to BH-13-16) to depths between 3.7 and 6.6 m. The borehole locations are illustrated on the appended Site Plan, Drawing 2 in Appendix 1. The boreholes were advanced with a CME-75 track-mounted drillrig equipped with continuous flight hollow stem augers supplied and operated by Geo-Environmental Drilling Ltd.

Local utility companies were contacted prior to the start of the drilling activities in order to demarcate underground utilities near the borehole locations.

Soil samples were recovered from the boreholes at regular 0.75 and 1.50 m depth intervals using a 50 mm outside diameter split spoon sampler in accordance with the Standard Penetration Test (SPT) procedure. The SPT N-values are plotted on the appended borehole logs in Appendix 2.

Groundwater observations and measurements were carried out in the open boreholes during and upon completion of drilling, and the observations are summarized on the appended borehole logs.

Monitoring wells were installed in eight of the boreholes advanced at the subject site to allow measurement of the stabilized groundwater levels. The remaining boreholes were backfilled according to Ontario Regulation 903 (as amended).

The monitoring wells were installed by inserting a 50 mm diameter screen and pipe into the open boreholes. Sand filter material was added to pack the screen in place until the level of the sand was approximately 300 mm above the top of the screens. Bentonite seals were placed above the sand pack at the well locations to prevent the infiltration of surface water. Protective steel covers were installed at existing grade and concreted in place. The top of the riser pipes were vented to allow accurate measurement of the stabilized groundwater levels.

Details of the monitoring well installations, as well as groundwater observations and measurements, are provided on the appended borehole logs.

The monitoring wells were tagged and a completed well record was submitted to the Ministry of Environment and Climate Change. A licensed well technician must properly decommission the monitoring wells before construction.

The fieldwork was observed by a member of our geotechnical engineering staff who documented the drilling and sampling procedures; recorded the SPT N-values; documented the soil stratigraphies; recorded the groundwater observations; and cared for the recovered soil samples.

The borehole locations and ground surface elevations were surveyed by Englobe using a Sokkia Model GXR 2 Global Navigation Satellite System (GNSS) rover. The borehole locations were referenced to Universal Trans Mercator North American Datum of 1983 (UTM NAD83) coordinates; the zone reference (17T) has been excluded for presentation purposes. The ground surface elevations are geodetic, based on GNSS and local base station telemetry with a vertical root mean squared error of less than 20 mm.

2.2 LABORATORY TESTING

The soil samples secured during this investigation were returned to our laboratory for visual examination as well as moisture content tests. The moisture content test results are plotted on the borehole logs. The geotechnical laboratory testing also included four particle size distribution analyses (ASTM D422) with results plotted on Figure 1 (Reference Number P-0010233-0-01-100) in Appendix 3 and summarized in Section 3.3.

Laboratory testing completed as part of the scoped hydrogeology study included three particle size distribution analyses. The results of these analyses are included in Section 3.3 and the Figure 2 (Reference Number P-0010233-0-02-300) is included in Appendix 3.

The soil samples will be stored for a period of three months from the date of sampling. After this time, they will be discarded unless prior arrangements have been made for longer storage.

3 SUMMARIZED CONDITIONS

We refer to the appended borehole logs for detailed soil descriptions and stratigraphies; results of SPT; moisture content profiles; and groundwater observations.

The overall subsurface stratigraphy comprises surficial fill or topsoil underlain by sand and gravel. Layers of sand were contacted at variable depths within the predominant sand and gravel deposit. A layer of silt was contacted in Borehole BH-07-16 advanced in the southeast portion of the site.

3.1 TOPSOIL

Topsoil was contacted surficially in Boreholes BH-01-16, BH-06-16, BH-08-16, BH-10-16, BH-12-16, and BH13-16 and was between 180 and 360 mm thick at the borehole locations. The topsoil generally comprised of dark brown silt with nil to some sand and/or gravel. At the time of fieldwork the topsoil was moist.

3.2 FILL

Fill was contacted surficially in Boreholes BH-02-16 to BH-05-16, BH-07-16, BH-09-16, and BH-11-16 and varies in thickness from 0.2 to 1.5 m. The fill ranges in composition from dark brown silt (topsoil) to silty sand and gravel. Traces of organics and/or traces to some topsoil were contacted within the lower fill in Boreholes BH-02-16, BH-04-16, and BH-09-16. At the time of sampling the fill was moist to very moist. SPT N-values of 8 to 19 blows per 300 mm penetration of a split spoon sampler indicate loose to compact relative densities.

3.3 NATIVE MINERAL SOILS

The predominant soils underlying the topsoil and fill at the site comprise sand and gravel. The deposit ranges in composition from silty sand and gravel to sand and gravel with traces of silt. Occasional to numerous cobbles as well as layers of sand were contacted within the sand and gravel at variable depths. Traces of topsoil were contacted within the upper sand and gravel at Borehole BH-10-16. At the time of fieldwork the deposit above the stabilized groundwater table was moist to wet. SPT N-values from 11 to greater than 50 blows per 300 mm indicate compact to very dense relative densities.

Sand was contacted interlayered with the sand and gravel at variable depths. The deposit ranges in composition from sand with some silt and traces of gravel to gravelly silty fine sand with traces of clay. Traces of topsoil were contacted within the upper sand in Boreholes BH-06-16 and BH-08-16. At the time of fieldwork the sand above the stabilized groundwater table was moist to very moist. SPT N-values of 5 to16 blows per 300 mm indicate loose to compact relative densities.

A layer of silt was contacted in Borehole BH-07-16 underlying the fill and comprises sandy silt with some gravel, traces of clay, and occasional cobbles. Traces of topsoil were noted within the silt. At the time of sampling the silt was moist. An SPT N-value of 15 indicates a compact relative density.

Seven particle size distribution analyses were completed on representative samples of the sand and gravel, sand, and silt as part of the geotechnical and scoped hydrogeology studies and the results are illustrated on the appended Figures (Figure 1, Reference Number P-0010233-0-01-100) and Figure 2 (Figure 2, Reference Number P-0010233-0-02-300) and summarized in Table 1.

Table 1: Results of Particle Size Distribution Analyses – Sand and Gravel, Sand, and Silt

BOREHOLE AND SAMPLE NUMBER	SAMPLE DEPTH (m)	SOIL TYPE	CLAY (%)	SILT (%)	SAND (%)	GRAVEL (%)
BH-01-16, SS-1 to SS-5	0.8 – 5.0	Sand and Gravel	--	10	40	50
BH-01-16, SS-6	6.1 – 6.6	Sand	9	34	36	21
BH-02-16, SS-3 to SS-6	1.5 – 4.4	Sand and Gravel	--	11	38	51
BH-06-16, SS-4 to SS-7	2.3 – 5.2	Sand and Gravel	--	6	55	39
BH-07-16, SS-1	0.8 – 1.2	Silt	6	51	30	13
BH-10-16, SS-2 to SS-6	1.5 – 6.6	Sand and Gravel	--	8	44	48
BH-11-16, SS-2 to SS-6	1.5 – 6.6	Sand and Gravel	--	8	42	50

3.4 GROUNDWATER

Groundwater observations and measurements carried out in the open boreholes are summarized on the appended borehole logs.

Stabilized groundwater levels were collected on May 12, 2016 from the monitoring wells installed at the subject site and the results are included on the borehole logs and summarized in Table 2. Groundwater was contacted at depths between 1.5 and 2.9 m below current grades (Elevation 329.8 and 330.2 m). The groundwater generally occurs under unconfined groundwater conditions within the granular soils contacted at the site.

We refer to the scoped hydrogeology study currently completed by Englobe for further details. Seasonal fluctuations and local variations in the groundwater levels should be expected at the site.

Table 2: Stabilized Groundwater Level Measurements – May 12, 2016

	MAY 12, 2016	
BOREHOLE NUMBER	DEPTH TO GROUNDWATER (m)	GROUNDWATER ELEVATION (m)
BH-01-16	2.9	329.8
BH-02-16	2.6	329.8
BH-04-16	2.4	329.9
BH-06-16	1.5	329.9
BH-09-16	2.2	330.0
BH-10-16	2.0	330.0
BH-12-16	2.0	330.0
BH-13-16	2.3	330.2

4 DISCUSSION AND RECOMMENDATIONS

The project involves the residential redevelopment at 19, 29, 35, 41, 51, and 59 Lowes Road in Guelph, Ontario. The properties are currently occupied by residential dwellings fronting along Lowes Road with grassed areas with trees in the rear. A secondary building structure is located in the rear of 41 Lowes Road. Site grades gently slope toward the northwest with grades at the borehole locations ranging between Elevation 331.3 and Elevation 332.8 m.

It is understood that the existing structures will be demolished as part of the site redevelopment. The new residential development will include multiple townhouse blocks, internal roadways, and a stormwater management block in the northeast portion of the site. The design for the proposed residential development is currently conceptual and preliminary and it is understood that the finished grades at the site are not finalized at this point.

4.1 SITE PREPARATION

The existing fill and topsoil and any demolition debris encountered at the site are not considered suitable to remain below the new buildings, internal roadways, driveways, stormwater management pond and need to be removed. The general thickness of the topsoil contacted at the borehole locations ranges between 180 to 360 mm. The thickness of the fill ranges from 0.2 to 1.5 m.

In general, for calculating the approximate quantity of soil to be stripped, we recommend that the thicknesses of fill and topsoil provided on the individual borehole logs be increased by 100 mm to account for variations and some stripping of the native mineral soil. The topsoil could be used for landscaping fill to raise grades in the rear yards of lots or in park areas.

Following removal of the topsoil and fill, the exposed subgrade should be inspected by Englobe and any loosened or soft pockets subexcavated. Loose deposits (i.e. Boreholes BH-05-16, BH-06-16, and BH-08-16) as well as native soils containing organic content (i.e., Boreholes BH-06-16 to BH-08-16, and BH-10-16) extending below the subgrade level must be subexcavated from below roadways and residential lots; however, may remain below proposed park lands. The finished subgrade should be sloped to promote rainwater drainage.

Any material required to raise grades at the site should comprise approved on-site native soils or imported granular materials. In order to minimize the effects of groundwater on the site grading operations, it is recommended that the work be carried out during the normally drier summer months. Tracked hydraulic excavators may be needed to remove some of the fill as some trafficability problems may be encountered for earth scrapers.

Structural fill below buildings should be placed in thin lifts (max. 300 mm) and compacted to minimum 100% standard Proctor maximum dry density (SPMDD). The structural fill should extend at least 1.0 m beyond the footing edge of any building and outwards and downwards to the subgrade level at a slope of 1.0 horizontal to 1.0 vertical. A typical standard detail for structural fill placement is shown on Drawing 3, appended. Any fill required to raise grades below driveways and roads should be compacted to 95% SPMDD.

The major soils likely to be generated from cut areas of the property comprise sand and gravel soils. Based on the results of insitu moisture contents, the majority of the on-site excavated soil located above the stabilized groundwater table will be suitable for reuse as road subgrade fill and structural fill. Inorganic portions of the existing fill material may be suitable for reuse as road subgrade and structural fill following approval by a geotechnical engineer and should be stockpiled separately. Soils with high silt content should be used during the dry summer months to reduce exposure to rain, which would cause problems during the fill placement and compaction. Cobbles and boulders should be expected within the sand and gravel materials at the site and should be removed from material reused as structural or road subgrade fill.

Full-time inspection by experienced geotechnical personnel should be carried out during fill placement and compaction to examine and approve the fill material, and to carefully monitor the placement and verify the compaction by insitu density testing.

4.2 SITE SERVICING

Following site grading operations, it is anticipated that the site will be provided with services including sanitary, watermain, and storm. It is anticipated that the invert levels for the watermain, storm and sanitary connections will be at conventional depths, some 2 to 3 m below finished grade.

4.2.1 Excavations and Dewatering

Temporary excavations to conventional depths for installation of site services should be straightforward. All trench excavations must comply with Ontario Regulation 213/91 (Construction Projects) under the Occupational Health and Safety Act. The predominant granular soils contacted in the boreholes would be classified as Type 3 soils (O.Reg. 213/91, s. 226(4)). Temporary side slopes must be cut at an inclination of 1 horizontal to 1 vertical or less from the base of the excavation for open cut pipe installation (exclusive of groundwater effects) as per O.Reg. 213/91, s. 234(2). Where saturated deposits are exposed in the trench sides, the sidewalls may have to be sloped back to 3 horizontal and 1 vertical to ensure stability.

Moderate to significant groundwater inflow should be expected for excavations extending into the saturated granular soils encountered at the site. Based on hydraulic conductivity testing and gradation analyses the estimated hydraulic conductivity of the sand and gravel deposits is in the order of 10^{-5} m/s. The actual design and site layout is preliminary and conceptual and it is recommended that the site service plans be reviewed by Englobe to determine if positive dewatering will be required, and to provide more specific recommendations for excavations and dewatering requirements for service installations. Care should be taken to direct surface runoff away from open excavations.

4.2.2 Pipe Bedding

The subgrade soils beneath the watermain and sewer pipes will comprise recompacted fill or native mineral soils. No support problems are anticipated for flexible or rigid pipes founded in approved fill or compact native deposit.

Prior to installation of the sewers and watermain, the subgrade should be inspected by a Geotechnical Engineer. Any loose or soft areas noted during inspection should be subexcavated and replaced with compacted granular material such as OPSS Granular 'A'.

The pipe bedding for the sewer services and watermain should be conventional Class B pipe bedding comprising a minimum 150 mm thick layer of OPSS Granular 'A' aggregate below the pipe invert. The bedding course may be thickened if portions of the subgrade become wet during excavation. Granular 'A' type aggregate should be provided around the pipe to at least 300 mm above the top, and the bedding should be compacted to a minimum 100% SPMDD. Water and sewer lines installed outside of heated areas should be provided with a minimum 1.2 m of soil cover or equivalent insulation for frost protection.

A well-graded clear stone such as Coarse Aggregate for HL4 Asphaltic Concrete (OPSS 1003) could be used in the sewer trenches as bedding below the spring line of the pipe to facilitate sump pump dewatering, if necessary and stabilize the base of the bedding. The clear stone should be compacted with a plate tamper.

4.2.3 Trench Backfill

The trenches above the specified pipe bedding should be backfilled with inorganic soils placed in 300 mm thick lifts and compacted to at least 95% SPMDD. Based on the results of insitu moisture content tests carried out on the native overburden deposits, the native mineral soils above the stabilized groundwater table are considered suitable for reuse as trench backfill.

Any wet or saturated soils or soils with organic content are not considered suitable for reuse as trench backfill. Stockpiling, mixing, and double handling of wet or saturated soils would be required to dry the material to near the optimum moisture content for compaction prior to reuse on-site. If necessary, compensation for wet trench backfill conditions can be made with additional Granular 'B' in the pavement structure. It should be noted, however, that the wet backfill material must be compacted to at least 90% SPMDD or post-construction settlements could occur.

To minimize potential problems, backfilling operations should follow closely after excavation so that only a minimal length of trench is exposed. Care should be taken to direct surface runoff away from the excavations. Should construction extend into the winter season, particular attention should be given to ensure that frozen material is not used as backfill.

Frequent inspection and compaction testing by experienced geotechnical personnel should be carried out to examine and approve backfill material, and to verify that the specified degree of compaction has been achieved.

4.3 SURFACE WORKS

4.3.1 Curbs and Sidewalk

The concrete for curb and gutter and sidewalks should be proportioned, mixed, placed, and cured in accordance with the requirements of City of Guelph Specifications for Sidewalks and Curbs.

During cold weather, the freshly placed concrete must be covered with insulating blankets to protect against freezing. Three cylinders from each day's pour should be taken for compressive strength testing. Air entrainment, temperature, and slump tests should be made from the same batch of concrete from which test cylinders are made.

4.3.2 Pavement Design

It is anticipated that driveways and internal roadways will be constructed to provide access for the residential development to Lowes Road following sewer and watermain installation.

The following flexible pavement component thicknesses are recommended based on the proposed pavement usages, frost susceptibility, strength of the subgrade soil, and City of Guelph standards.

Table 3: Pavement Component Thicknesses

PAVEMENT COMPONENT	LIGHT DUTY	HEAVY DUTY
Asphaltic Concrete	90 mm	100 mm
Granular 'A' Base Course	175 mm	175 mm
Granular 'B' Subbase Course	350 mm	400 mm

The pavement subgrade materials should be thoroughly proof-rolled prior to placement of the Granular 'B' subbase course. If the subgrade is wet or unstable, or if the road construction must be carried out during poor weather conditions, then the subbase thickness may have to be increased.

Samples of both the Granular 'A' and Granular 'B' aggregates should be checked for conformance to OPSS 1010 prior to utilization on site and during construction. The Granular 'B' subbase and Granular 'A' base courses must be compacted to 100% SPMDD, as verified by insitu density testing.

The asphaltic concrete should comprise 35 mm of HL3 surface over 55 mm of HL8 binder (light duty) and 40 mm of HL3 surface over 60 mm HL8 binder (heavy duty). The asphaltic concrete paving materials should conform to the requirements of OPSS 1150. The asphalt should be placed and compacted in accordance with OPSS 310. The recommended Performance Graded Asphalt Cement designation for the asphaltic concrete is 58-28.

Subdrains are recommended if the subgrade below the pavement structure has a poor natural drainage (soils with high silt content). Subdrains may be excluded if the subgrade comprises sand, or sand and gravel. The purpose of subdrains is to remove excess surface water in order to improve overall pavement serviceability and increase pavement life. Locations where subdrains will be required should be confirmed by a geotechnical engineer at the time of subgrade preparation. A typical pavement subdrain detail is shown on Drawing 4, appended.

4.4 HOUSE CONSTRUCTION

4.4.1 Foundations

In general, the undisturbed compact native mineral soils or approved structural fill are considered suitable to support residential house foundations. House footings must be designed as per Part 9 of the Ontario Building Code (2012).

The exterior footings or footings in unheated areas should be provided with a minimum 1.2 m of earth cover upon final grading for frost protection.

All founding surfaces for residential dwellings on structural fill or native soils should be inspected by a geotechnical engineer prior to placing concrete. The purpose of the inspection is to ensure that the subgrade soils are capable of supporting the house foundations, and to confirm that the house envelopes do not extend beyond the limits of the structural fill pads.

Additional geotechnical investigation work would be required in order to provide recommendations for larger buildings, such as apartment style buildings.

4.4.2 Basements

Basement floor levels at the site must be designed 0.75 m above the stabilized groundwater level. We refer the reader to our scoped hydrogeology study for groundwater elevations at the site. Englobe would be happy to review and provide comments on final grading plans and basement floor levels for the site.

The house basements must be provided with perimeter weeping tile systems as per the Ontario Building Code (2012). The drain tile or pipe should be laid on undisturbed or well-compacted soil so that the top of the tile or pipe is below the bottom of the basement floor slab. The weeping tile must drain to a suitable frost-free outlet or sump.

The portion of the exterior basement wall below finished ground level must be damp proofed as per the Ontario Building Code (2012). Free-draining sand/sand and gravel materials are well-suited for use as basement wall backfill. Where clay or silt soils are used for basement wall backfill, a manufactured drainage layer is recommended. The basement wall backfill should be graded to allow drainage away from the foundation.

The basement walls should be designed to resist the lateral earth pressure. For calculating the lateral earth pressure, the coefficient of at rest earth pressure (K_0) may be assumed as 0.50 for cohesionless sandy soils. The bulk unit weight of the retained backfill may be taken as 21 kN/m^3 for well-compacted sandy soil. An appropriate factor of safety should be employed.

The subgrade for the basement floor slabs should comprise undisturbed native soil or well-compacted fill. A minimum 100 mm thick layer of coarse clean granular material shall be placed beneath slabs in houses as per the Ontario Building Code.

4.4.3 Radon Gas

Radon gas has been detected in unacceptable levels in some areas of Ontario. As the concentration of radon gas depends not only on the soil conditions, but also on the house construction and operation, it is recommended that each house basement be tested for the presence of radon gas after house completion and provisions be made to allow for installation of soil gas control as prescribed by MMAH Supplementary Standard SB-9 Requirements for Soil Gas Control if concentrations greater than Canadian guidelines (200 Bq/m3) are found.

When constructing a new home, builders can use a range of approaches, including installing an air barrier under the basement slab and an air tight cover for the sump pit to prevent the entry of radon and a rough-in for a possible future subfloor depressurization system, should radon problems emerge. (It is noted that no test can be conducted during the geotechnical investigation, site servicing, or site grading stages that could determine the concentrations of radon gas that will be experienced in finished basements.)

4.5 STORMWATER MANAGEMENT

4.5.1 At-source Infiltration

It is anticipated that infiltration of water from roof leaders for houses within the subdivision is being considered. It is noted that infiltration facilities generally require native soils with a minimum percolation rate of 15 mm/hr and a minimum separation between the bottom of the pit and the seasonally high water table of 1 m (MOE, 2003).

A total of seven particle size distribution analyses have been completed of the sand and gravel, sand, and silt deposits contacted at the site. The results of the particle size distribution analyses were used to empirically determine the hydraulic conductivity values of the soils. The Kozeny-Carman and Kaubisch formulae were selected as best suited regarding its formula criteria and limitations for the particle size distribution analyses results. The calculated hydraulic conductivity values are summarized in Table 4.

The estimated design infiltration rate is based on recommendations found in the ‘’Low Impact Development Stormwater Management Planning and Design Guide, Appendix C’’, published by the Toronto and Region (TRCA) and the Credit Valley (CVC) Conservation Authority, and the approximate relationship between hydraulic conductivity and infiltration rate.

It should be noted that hydraulic conductivity and infiltration rate are two different concepts, and that conversion from one parameter to another cannot be done through unit conversion. A factor of safety was applied to the approximate infiltration rate to account for soil variability, gradual accumulation of fine soil sediments during the lifespan of the facility, and compaction during construction. The results are summarized in the Table 4.

Table 4: Infiltration Potential

BOREHOLE AND SAMPLE NUMBER	SAMPLE DEPTH (m)	ELEVATION (m)	SOIL TYPE	K-VALUE (m/sec)	FACTORED INFILTRATION RATE (mm/hr)
BH-01-16, SS-1 to SS-5	0.8 – 5.0	332.0 – 327.8	Sand and Gravel	1.2×10^{-5}	30
BH-01-16, SS-6	6.1 – 6.6	326.7 – 326.2	Sand	4.2×10^{-7}	18
BH-02-16, SS-3 to SS-6	1.5 – 4.4	330.9 – 328.0	Sand and Gravel	9.0×10^{-6}	30
BH-06-16, SS-4 to SS-7	2.3 – 5.2	329.0 – 326.1	Sand and Gravel	4.8×10^{-5}	45
BH-07-16, SS-1	0.8 – 1.2	331.7 – 331.2	Silt	8.2×10^{-7}	20
BH-10-16, SS-2 to SS-6	1.5 – 6.6	330.5 – 325.4	Sand and Gravel	3.1×10^{-5}	40
BH-11-16, SS-2 to SS-6	1.5 – 6.6	330.6 – 325.6	Sand and Gravel	1.7×10^{-5}	35

4.5.2 Stormwater Management Pond

The design of the proposed stormwater management facility is still preliminary and proposed grades were not available at the time of report preparation. Boreholes BH-05-16, BH-06-16, and BH-08-16 have been advanced within the area of the stormwater management block proposed in the northwest portion of the site. The subsurface soils contacted within the stormwater management block comprise topsoil and fill overlying a thin deposit of sand which in turn is underlain by the site predominant sand and gravel deposit. Groundwater was measured at Borehole BH-06-16 at a 1.5 m depth (Elevation 329.9 m).

Depending on the final design grades and groundwater table at the time of pond construction, dewatering of the soils will be required. We refer the reader to section 4.2.1 for details on excavations and dewatering.

The sand and gravel contacted at depth would be suitable for stormwater infiltration having a permeability in the order of 10^{-5} m/s corresponding to a factored infiltration rate range of 30 to 45 mm. It is noted that the groundwater table within the proposed pond block occurred at a depth of 1.5 m (Elevation 329.9 m). Although the existing sand and gravel soils possess high infiltration rates, the relative close proximity of the water table reduces the absorptive capacity of the soil. Depending on final pond grades, infiltration could only be expected if the water level in the pond were to rise above the existing groundwater level.

The contacted sand may be suitable for stormwater infiltration depending on the silt content. Infiltration could be restricted by the silty sand layers and consideration could be given to subexcavate the silty material and replace it with higher hydraulic conductivity material borrowed from other parts of the subject site, if infiltration is required.

Depending on the final grades and if a permanent pool level is to be maintained a pond liner would be required. Once design grades are finalized Englobe would be pleased to provide further detail pertaining to the requirement of a pond liner.

For berms constructed around the perimeter of the pond, the existing topsoil layer and the fill should be removed from beneath the plan area of the berms. The berms should be founded in the inorganic native soil deposits. Any loose deposits should be subexcavated and the subsoil inspected by a geotechnical engineer.

Following the subgrade preparation, the berms may be constructed as a homogeneous-type earth fill structure using approved inorganic on-site soils. The berm fill should be placed in 300 mm thick lifts and compacted to a minimum of 95% SPMDD. It is recommended that the slopes of the berms be over-built and cut into shape following the overfill placement. A typical detail for overfill placement and cutting of earth slopes is illustrated on the appended Drawing 5.

We recommend to cut the slopes of the pond with an inclination of 3.0 horizontal to 1.0 vertical or less. The finished slopes above the permanent water level should be topsoiled and vegetated as soon as possible after construction to minimize surface erosion. Some routine maintenance of the slope surfaces will likely be required to address minor long-term weathering and erosion.

To control the groundwater and reduce the slumping of the saturated soils in the slopes above the design water level we recommend that slope subdrains be installed where required during the construction of the pond. Slope subdrains should be installed into the slope upon reaching the groundwater level and prior to proceeding any deeper with the excavation. The subdrain should positively drain to a frost free outlet. A typical slope subdrain detail is shown on Drawing 6, appended.

Englobe would be pleased to provide additional geotechnical recommendations for the SWM facility once the location and site grading details have been confirmed.

4.6 CONSTRUCTION INSPECTION AND TESTING

Geotechnical inspections and insitu density testing should be conducted during site grading in order to verify that all organic and otherwise deleterious soils have been properly stripped; and, to ensure that all fill materials are being adequately compacted. During servicing contracts, daily compaction testing of pipe bedding and trench backfill should be carried out.

Appropriate laboratory and field testing of the pavement structure components (granulars and asphaltic concrete) should be conducted, as well as concrete testing for the curbs and sidewalks. All materials and construction services required for the work should be in accordance with the applicable sections of the OPSS, City of Guelph Specifications, and Region of Waterloo Specifications.

5 STATEMENT OF LIMITATIONS

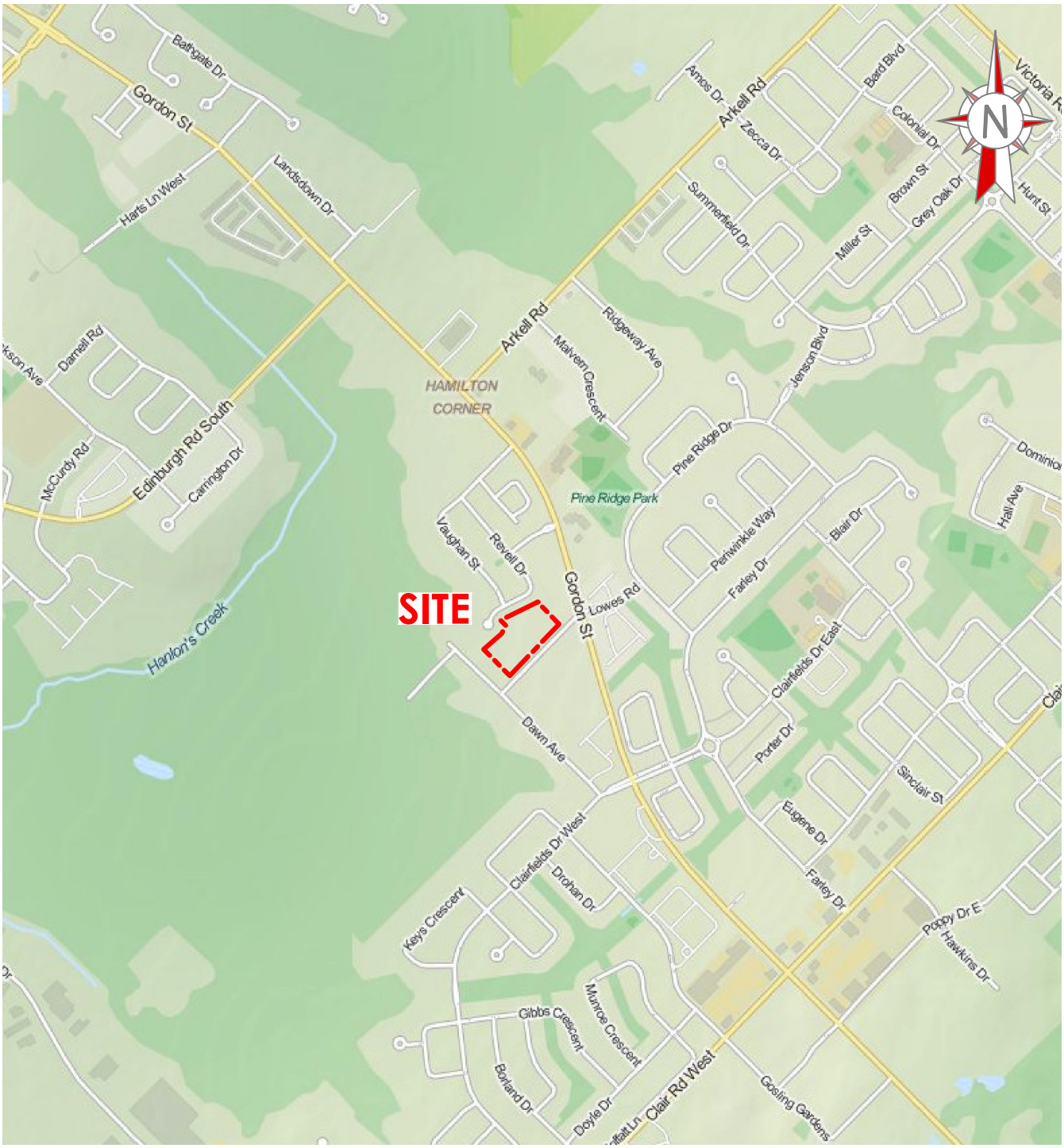
The geotechnical recommendations provided in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known at the time of report preparation, we recommend that we be retained during the final design stage to verify that the geotechnical recommendations have been correctly interpreted in the design. Also, if any further clarification and/or elaboration are needed concerning the geotechnical aspects of the project, Englobe should be contacted. We recommend that we be retained during construction to confirm that the subsurface conditions do not deviate materially from those encountered in the test holes and to ensure that our recommendations are properly understood.

The geotechnical recommendations provided in this report are intended for the use of the owner and its retained designer. They are not intended as specifications or instructions to contractors. Any use which a contractor makes of this report, or decisions made based on it, are the responsibility of the contractor. The contractor must also accept the responsibility for means and methods of construction, seek additional information if required, and draw their own conclusions as to how the subsurface conditions may affect their work. Englobe accepts no responsibility and denies any liability whatsoever for any damages arising from improper or unauthorized use of the report or parts thereof.

It is important to note that the geotechnical investigation involves a limited sampling of the site gathered at specific test hole locations and the conclusions in this report are based on this information gathered. The subsurface geotechnical, hydrogeological, environmental and geologic conditions between and beyond the test holes will differ from those encountered at the test holes. Also such conditions are not uniform and can vary over time. Should subsurface conditions be encountered which differ materially from those indicated at the test holes, we request that we be notified in order to assess the additional information and determine whether or not changes should be made as a result of the conditions.

Appendix 1 Drawings

Drawing 1: Location Plan
Drawing 2: Site Plan
Drawing 3: Typical Structural Fill Pad Detail
Drawing 4: Subdrain beneath Curb of Asphalt Pavement
Drawing 5: Fill Placement for Earth Slopes
Drawing 6: SWM Pond Slope Subdrain



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1-REFERENCES : © OpenStreetMap contributors (2016).

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Project

Proposed Residential Development

Lowes Road, Guelph, Ontario

Title

LOCATION PLAN

Englobe

Englobe Corp.
353, Bridge Street East
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Prepared	E.Ciochon	Discipline	GEOTECHNICAL	Project manager	K.Thrams
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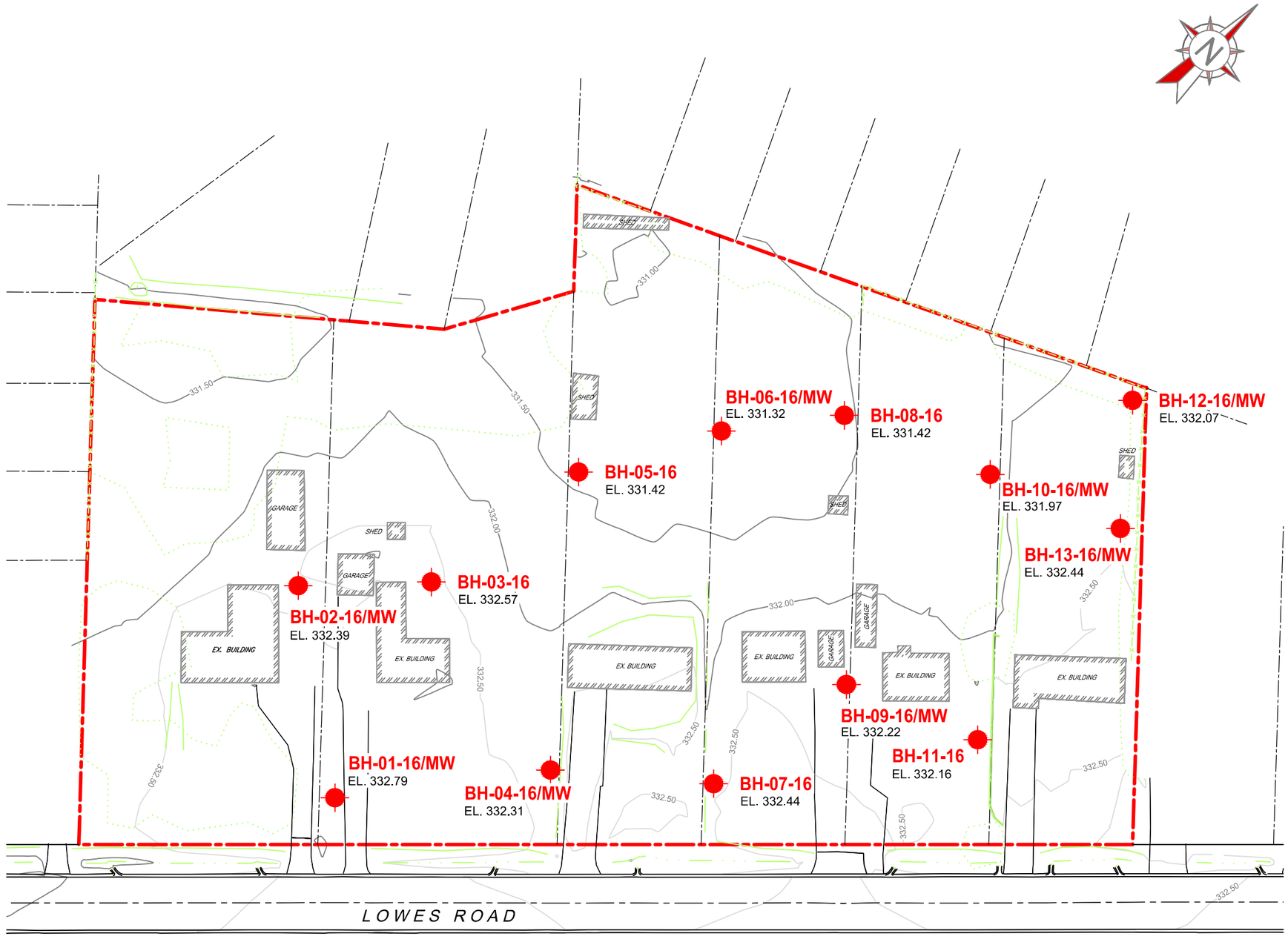
Checked	K.Thrams	Date	2016-05-06		

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0010233-0-01-100	GE	001	00



LEGEND :

SITE OUTLINE

BOREHOLE LOCATION

EL. 331.32 GROUND SURFACE ELEVATION (m)

0 10 20 30 m

SCALE 1:750

NOTES :

1-REFERENCES: STANTEC, Topographic Sketch of Lots 2, 3, 4 &5 Registered Plan 508 and Part of Lots 15 &16 Registered Plan 467, received in April 2016.

2-Borehole coordinates and elevations based on Sokkia network data.

3-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

4-MW refers to monitoring well installed at borehole location.

Project

Proposed Residential Development

Lowes Road, Guelph, Ontario

Title

SITE PLAN

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Project manager	K.Thrams	Sequence no.	02 of 06

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0010233-0-01-100	GE	002	00

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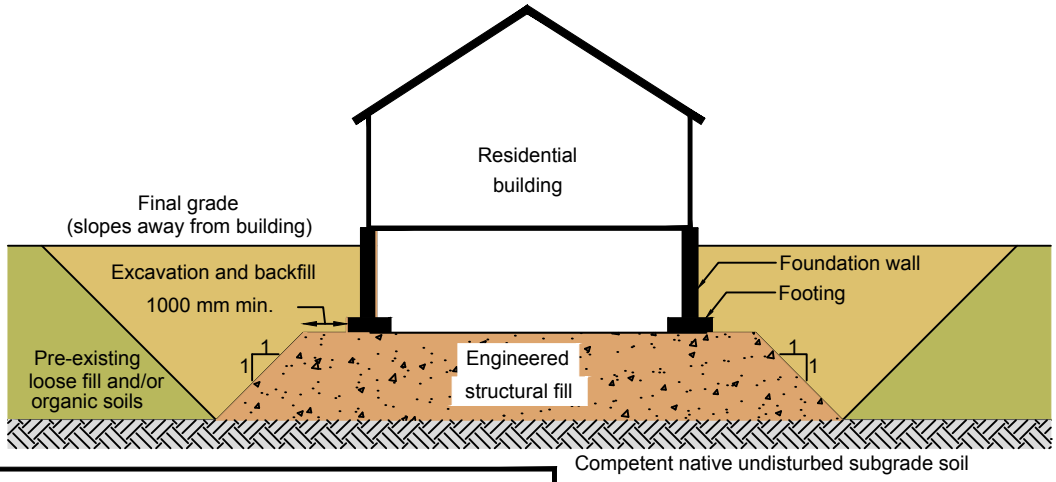
ENGINEERED STRUCTURAL FILL PAD



GENERAL REQUIREMENTS FOR ENGINEERED STRUCTURAL FILL

1. The area must be excavated of all pre-existing loose fill, topsoil, and/or organic soil until competent native undisturbed soil is reached.

2. The excavation should allow for the structural fill to extend 1000 mm beyond the outside edge of the building footings and down to the approved subgrade soil at a slope of 1 horizontal to 1 vertical (45°).

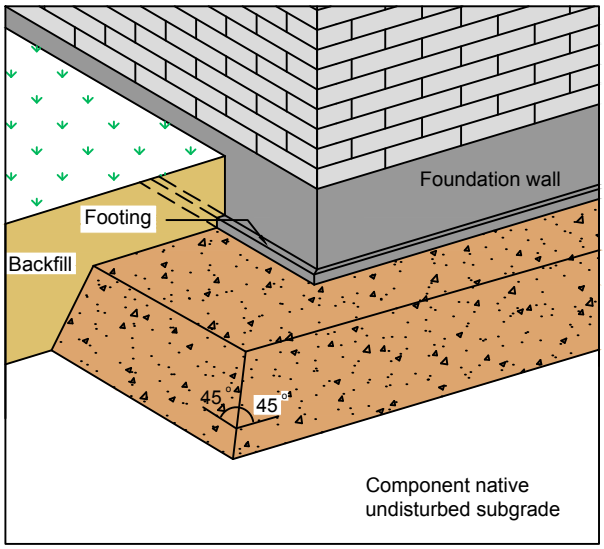
3. The subgrade below the engineered fill should be inspected and approved by a geotechnical engineer prior to fill construction. Fill placement and compaction operations to be carried out under full-time geotechnical supervision.

4. The structural fill should comprise sand and gravel aggregate placed in 300 mm thick lifts and compacted to at least 100% Standard Proctor Maximum Dry Density (SPMDD). The exterior backfill should consist of approved inorganic soil also placed in 300 mm thick lifts and compacted to minimum 95% SPMDD.

5. All excavations must be carried out in conformance with the current Ontario Occupational Health and Safety Act and Regulations 213/91 for construction projects.

6. Exterior footings must be provided with minimum 1.2 m of soil cover for frost protection.

7. This is not a design drawing or contract specification.



Project

Proposed Residential Development

Lowes Road, Guelph, Ontario

Title

TYPICAL STRUCTURAL FILL PAD DETAIL

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M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0010233-0-01-100	GE	003	00

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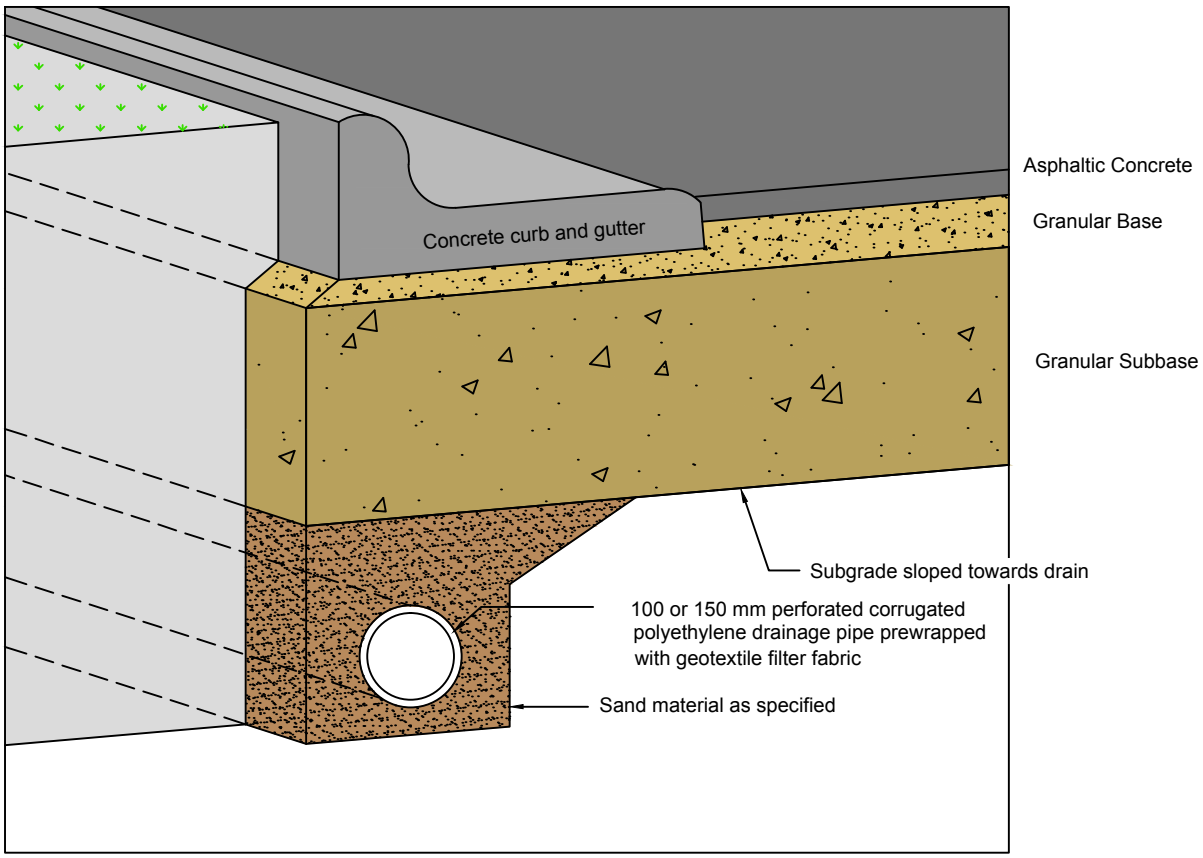
PAVEMENT SUBDRAIN



GENERAL REQUIREMENTS FOR PAVEMENT SUBDRAINS

1. Perforated corrugated polyethylene drainage pipe shall meet the requirements of OPSS 1840.
2. Pipe filter fabric conforming to OPSS 1860 for geotextile Class 1 with a filtration opening size of 150 to 450 microns shall be supplied on all sections of perforated pipe.
3. The open upstream ends of pipes should be capped.
4. Subdrain pipes to be set on at least 1% grade draining to a positive frost-free outlet. If the subdrains are outletted to a ditch then the last 1.5 m of the outlet pipe should consist of a corrugated galvanized steel pipe equipped with a rodent gate.
5. Bedding and backfill material shall be concrete sand meeting the gradation requirements of OPSS 1002 (Fine Aggregate for Concrete).
6. This is not a design drawing or contract specification.

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Project

Proposed Residential Development

Lowes Road, Guelph, Ontario

Title

SUBDRAIN BENEATH CURB OF ASPHALT PAVEMENT

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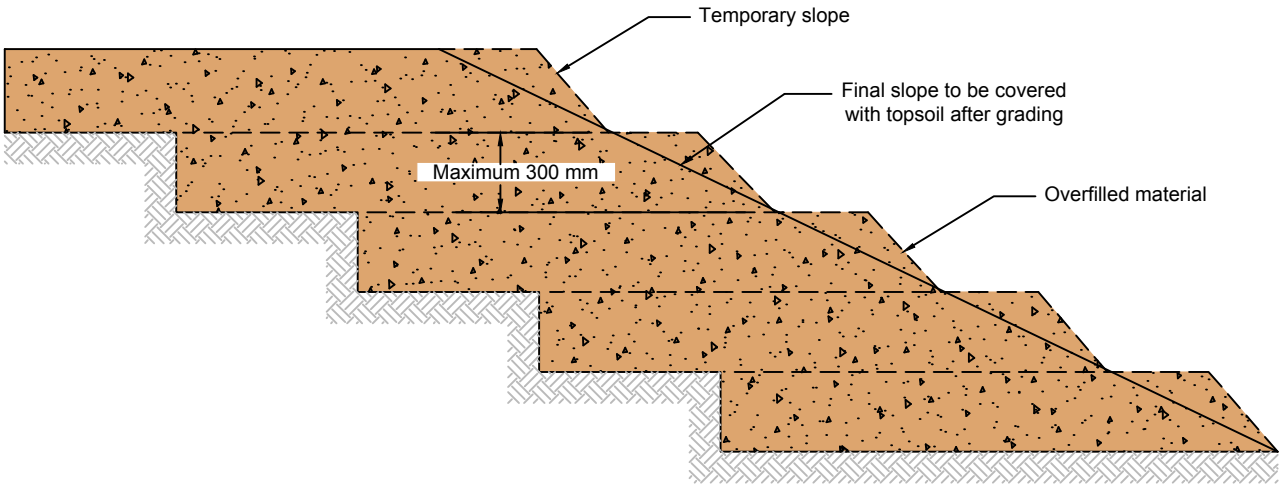
Checked	K.Thrams	Date	2016-05-06		

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0010233-0-01-100	GE	004	00



GENERAL REQUIREMENTS

1. The subgrade should be inspected and approved by Englobe prior to fill construction. Fill placement and compaction operations to be carried out under engineering supervision.

2. Poor subgrade soil conditions or groundwater seepage may require special drainage provisions, geotextile fabric and/or granular fill.

3. Lifts should be placed one level at a time and the fill compacted before the next benching level is placed.

4. The overfill material should be excavated and reused if possible.

5. The finished slope should be graded at maximum 3H:1V and covered with 200mm of topsoil and hydroseeded immediately after grading.

Project

Proposed Residential Development

Lowes Road, Guelph, Ontario

Title

FILL PLACEMENT FOR EARTH SLOPES

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M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0010233-0-01-100	GE	005	00

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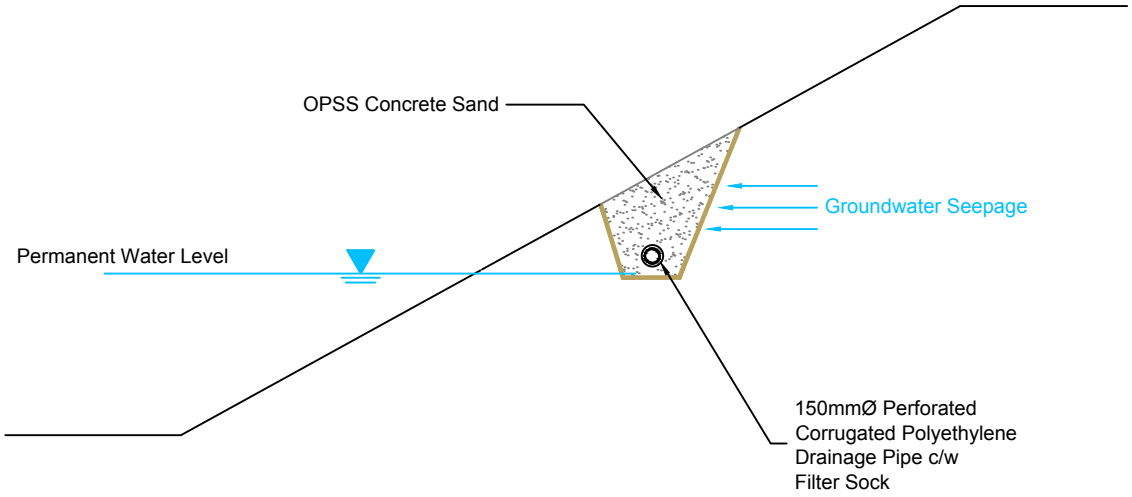
SWM POND SLOPE SUBDRAIN



NOTES:

1. Perforated corrugated polyethylene drainage pipe shall meet the requirements of OPSS 1840.
2. Pipe filter fabric conforming to OPSS 1860 for geotextile Class 1 with a filtration opening size of 150 to 450 microns shall be supplied on all sections of perforated pipe.
3. Subdrain pipes to be set on at least 1% grade draining to positive outlet. If the pipe is outletted to the pond, then the last 1.5 m should comprise of a corrugated steel pipe equipped with a rodent gate.
4. Bedding and backfill material shall be concrete sand meeting the gradation requirements of OPSS 1002 (Fine Aggregate for Concrete).
5. The open upstream ends of pipes must be capped.
6. The installation of a drainage pipe and the placement of the pipe bedding and backfill should be inspected by Englobe.
7. This is not a design drawing or contract specification.

Project

Proposed Residential Development

Lowes Road, Guelph, Ontario

Title

STORMWATER MANAGEMENT POND TYPICAL SUBDRAIN DETAIL

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M. dept.	Project	Disc.	Dwg no.	Rev.
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Appendix 2 Borehole Logs

List of Abbreviations
Boreholes BH-01-16 to BH-13-16

LIST OF ABBREVIATIONS

The abbreviations commonly employed on the borehole logs, on the figures, and in the text of the report, are as follows:

Sample Types		Soil Tests and Properties	
AS	Auger Sample	SPT	Standard Penetration Test
CS	Core Sample	UC	Unconfined Compression
RC	Rock Core	FV	Field Vane Test
SS	Split Spoon	ø	Angle of internal friction
TW	Thinwall, Open	γ	Unit weight
WS	Wash Sample	w_p	Plastic limit
BS	Bulk Sample	w	Water content
GS	Grab Sample	w_L	Liquid limit
WC	Water Content Sample	I_L	Liquidity index
TP	Thinwall, Piston	I_p	Plasticity index
		PP	Pocket penetrometer

Penetration Resistances	
Dynamic Penetration Resistance	The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) diameter 60º cone a distance 300 mm (12 in.). The cone is attached to 'A' size drill rods and casing is not used.
Standard Penetration Resistance, N (ASTM D1586)	The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a standard split spoon sampler 300 mm (12 in.)
WH	sampler advanced by static weight of hammer
PH	sampler advanced by hydraulic pressure
PM	sampler advanced by manual pressure

Soil Description		
Cohesionless Soils	**SPT N-Value**	**Relative Density (D_r)**
Compactness Condition	(blows per 0.3 m)	(%)
Very Loose	0 to 4	0 to 20
Loose	4 to 10	20 to 40
Compact	10 to 30	40 to 60
Dense	30 to 50	60 to 80
Very Dense	over 50	80 to 100
Cohesive Soils	**Undrained Shear Strength (C_u)**	
Consistency	**kPa**	**psf**
Very Soft	less than 12	less than 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very Stiff	100 to 200	2000 to 4000
Hard	over 200	over 4000
DTPL	Drier than plastic limit	Low Plasticity, W_L <30
APL	About plastic limit	Medium Plasticity, 30 < W_L < 50
WTPL	Wetter than plastic limit	High Plasticity, W_L > 50

Englobe

Ground Elevation:	*332.79 m*	**Borehole Number:**	**BH-01-16**
Northing:	*4817479.66 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564870.78 m*	**Drill Date:**	*2016-05-02*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value
	Ground Elevation		332.79			
	TOPSOIL: dark brown silt, some sand and gravel, numerous cobbles, moist		0.00 / 332.61 / 0.18			
1	***SAND AND GRAVEL:*** dense brown sand and gravel, trace silt, occasional cobbles, moist			SS-1	8-18 20	38
	very dense, numerous cobbles		331.27 / 1.52	SS-2	23-33 35	68
2				SS-3	50 /150 mm	
3	dense, saturated		329.74 / 3.05	SS-4	20-31 17	48
4						
	compact, occasional cobbles		328.22 / 4.57	SS-5	10-12 10	22
5						
6			326.69			
	SAND: compact brown gravelly silty fine sand, trace clay, wet to saturated		6.10 / 326.24	SS-6	4-6 10	16
	Borehole terminated at 6.55 m		6.55			
7						
8						

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 (Initial / Remold)

Water Content (%): WP WL; 10 20 30

Groundwater Observations and Standpipe Details

- flushmount cover and concrete
- el. 329.85 m 2016-05-12
- bentonite seal
- sand pack
- 50 mm pipe
- 1.52 m slotted screen
- native cave

Reviewed by: *K.Thrams* **Drafted by:** *E.Ciochon* **Sheet:** *1 of 1*

Notes:

Vertical Scale = 1 : 50.0

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EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*332.39 m*	**Borehole Number:**	**BH-02-16**
Northing:	*4817500.03 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564840.49 m*	**Drill Date:**	*2016-05-02*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Initial / Remold / Shear Strength (FV) kPa	WP WL / Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		332.39							
	FILL: loose brown silty sand and gravel, very moist		0.00 / 332.24	SS-1	5-5 3-3	8				flushmount cover and concrete
	loose dark brown silt, some topsoil, trace sand and organics, moist		0.15 / 332.11							
	brown sandy silt, trace gravel, very moist		0.28 / 331.48	SS-2	4-6 9-9	15				bentonite seal
1	***SAND AND GRAVEL:*** compact brown sand and gravel, some silt, occasional cobbles, moist		0.91 / 330.87	SS-3	18-20 30-26	50				
	very dense, numerous cobbles		1.52							
2				SS-4	46-23 21-16	44				el. 329.76 m 2016-05-12
	dense, wet		329.65 / 2.74							
3	compact, saturated		329.34 / 3.05	SS-5	13-14 14-12	28				sand pack
	very dense to dense		328.58 / 3.81	SS-6	27-30 35-30	65				50 mm pipe 3.05 m slotted screen
4										
5				SS-7	12-19 21-20	40				
	compact, occasional cobbles		327.06 / 5.33	SS-8	17-13 12-10	25				native cave
6	Borehole terminated 5.94 m		326.45 / 5.94							
7										
8										

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Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*332.57 m*	**Borehole Number:**	**BH-03-16**
Northing:	*4817516.77 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564855.63 m*	**Drill Date:**	*2016-05-02*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Shear Strength (FV) kPa	Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		332.57							
	FILL: dark brown silt (topsoil), trace gravel, moist		0.00 332.26	SS-1	2-2 4-6	6				
	SAND AND GRAVEL: dense brown sand and gravel, some silt, numerous cobbles, moist		0.30	SS-2	7-24 16-20	40				native backfill
	very dense		331.05 1.52	SS-3	17-60 /150 mm					
				SS-4	46-45 50	95				
	wet		329.67 2.90							native cave
	dense, occasional cobbles, saturated		329.52 3.05	SS-5	14-17 20-27	37				
	Borehole terminated at 3.66 m		328.91 3.66							At drilling completion, dry cave at 2.24 m.

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 (Initial / Remold)

Water Content (%): WP WL; 10 20 30

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*332.31 m*	**Borehole Number:**	**BH-04-16**
Northing:	*4817509.32 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564892.64 m*	**Drill Date:**	*2016-05-02*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Initial / Remold / Shear Strength (FV) kPa	WP WL / Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		332.31							
	FILL: dark brown silt (topsoil), trace sand and gravel, moist		0.00 / 332.16 / 0.15							flushmount cover and concrete
	brown sandy silt, some gravel, trace topsoil, very moist		331.70 / 0.61							
1	***SAND AND GRAVEL:*** dense brown sand and gravel, some silt, occasional cobbles, moist			SS-1	6-15 25	40				
				SS-2	12-22 25	47				el. 329.91 m 2016-05-12
2	saturated		330.02 / 2.29							bentonite seal
				SS-3	7-13 19	32				
3				SS-4	9-16 16	32				
4										
				SS-5	12-20 24	44				sand pack
5										50 mm pipe 1.52 m slotted screen
6	compact		326.21 / 6.10	SS-6	12-12 12	24				native cave
	Borehole terminated at 6.55 m		325.76 / 6.55							
7										
8										

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Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*331.42 m*	**Borehole Number:**	**BH-05-16**
Northing:	*4817547.70 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564859.41 m*	**Drill Date:**	*2016-05-02*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Initial / Remold / Shear Strength (FV) kPa	WP WL / Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		331.42							
	FILL: loose dark brown silt (topsoil), trace sand and gravel, very moist		0.00 331.19 0.23	SS-1	1-2 3-5	5				native backfill
	SAND: loose brown sand, some silt, trace gravel, moist		330.66 0.76	SS-2	7-11 17-20	28				
1	***SAND AND GRAVEL:*** compact to dense brown sand and gravel, some silt, moist									bentonite seal
	dense, saturated		329.90 1.52	SS-3	10-14 21	35				
2										
	trace silt		329.13 2.29	SS-4	11-15 15	30				
3				SS-5	6-17 19	36				
4										native cave
	compact		326.85 4.57	SS-6	8-10 14	24				
5										
6				SS-7	7-8 9	17				
	Borehole terminated at 6.55 m		324.87 6.55							At drilling completion, dry cave at 2.13 m.
7										
8										

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*331.32 m*	**Borehole Number:**	**BH-06-16**
Northing:	*4817570.01 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564871.12 m*	**Drill Date:**	*2016-05-03*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Shear Strength (FV) kPa	Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		331.32							
	TOPSOIL: dark brown silt, moist		0.00 / 331.12							
	SAND: loose brown/dark brown silty sand, trace gravel and topsoil, very moist		0.20 / 330.56	SS-1	2-3 5-5	8				
1	compact, brown, some gravel, occasional cobbles, moist		0.76 / 329.80	SS-2	9-7 6-6	13				
	SAND AND GRAVEL: very dense grey/brown sand and gravel, trace silt, numerous cobbles, saturated		1.52 / 329.03	SS-3	16-24 39-20	63				
2	dense		2.29 / 328.27	SS-4	31-20 23-32	43				
3	compact		3.05 / 327.51	SS-5	12-13 14-16	27				
	very dense		3.81 / 326.75	SS-6	17-15 /75 mm					
4	compact, brown, occasional cobbles		4.57 / 326.14	SS-7	9-11 15-19	26				
5	Borehole terminated at 5.18 m		5.18							
6										
7										
8										

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 — Initial / Remold

Water Content (%): WP WL — 10 20 30

Groundwater Observations and Standpipe Details:
- flushmount cover and concrete
- bentonite seal
- el. 329.86 m 2016-05-12
- sand pack
- 50 mm pipe
- 3.05 m slotted screen
- native cave

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*332.44 m*	**Borehole Number:**	**BH-07-16**
Northing:	*4817527.72 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564913.43 m*	**Drill Date:**	*2016-05-04*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Initial / Remold / Shear Strength (FV) kPa	Water Content (%) WP WL	Groundwater Observations and Standpipe Details
	Ground Elevation		332.44							
	FILL: dark brown silt (topsoil), trace sand and gravel, occasional cobbles, moist		0.00 / 331.83							topsoil; native backfill
1	***SILT:*** compact brown/dark brown sandy silt, some gravel and topsoil, trace clay, occasional cobbles, moist		0.61 / 331.22	SS-1	1-3 12	15				bentonite seal
	SAND AND GRAVEL: compact brown sand and gravel, some silt, numerous cobbles, moist		1.22	SS-2	9-11 15	26				
2	dense		330.15 / 2.29	SS-3	12-22 20	42				
	wet		329.85 / 2.59							
3	compact, saturated		329.39 / 3.05	SS-4	10-13 13	26				
4										native cave
5				SS-5	8-9 17	26				
6				SS-6	11-12 15	27				
	Borehole terminated at 6.55 m		325.89 / 6.55							At drilling completion, dry cave at 1.52 m.
7										
8										

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 — Initial, Remold

Water Content (%): 10 20 30 — WP, WL

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*331.42 m*	**Borehole Number:**	**BH-08-16**
Northing:	*4817586.89 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564883.60 m*	**Drill Date:**	*2016-05-03*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Initial / Remold / Shear Strength (FV) kPa	Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		331.42							
	TOPSOIL: loose dark brown silt, moist		0.00 / 331.22	SS-1	2-2 3	5				topsoil
	SAND: loose brown silty sand, some gravel, trace topsoil, moist		0.20 / 330.66							native backfill
1	***SAND AND GRAVEL:*** very dense brown sand and gravel, some silt, numerous cobbles, moist		0.76	SS-2	9-23 35	58				bentonite seal
	dense, saturated		329.90 / 1.52	SS-3	13-15 15	30				
2			329.13							
	very dense		2.29	SS-4	16-31 35	66				
3			328.37							
	dense		3.05	SS-5	16-18 24	42				
4										native cave
5				SS-6	14-17 20	37				
6				SS-7	8-14 17	31				
	Borehole terminated at 6.55 m		324.87 / 6.55							At drilling completion, wet cave at 1.52 m.
7										
8										

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 — Initial, Remold

Water Content (%): WP, WL; 10 20 30

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Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*332.22 m*	**Borehole Number:**	**BH-09-16**
Northing:	*4817555.61 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564916.85 m*	**Drill Date:**	*2016-05-04*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value
	Ground Elevation		332.22			
	FILL: compact brown silty sand and gravel, some topsoil, moist		0.00 / 331.99			
	dark brown silt, some sand, trace gravel and organics, moist		0.23 / 331.46	SS-1	6-10 9-8	19
1	loose brown/dark brown mottled silt, some sand, topsoil and gravel, occasional cobbles, moist		0.76 / 330.70	SS-2	4-3 5-9	8
	SAND AND GRAVEL: dense brown sand and gravel, some silt, numerous cobbles, moist		1.52	SS-3	16-20 22-22	42
2	very dense, saturated		329.93 / 2.29	SS-4	23-50 /150 mm	
3	compact, some medium sand layers		329.17 / 3.05	SS-5	9-10 17-18	27
4				SS-6	15-10 18-21	28
	dense		327.65 / 4.57	SS-7	10-19 17-12	36
5						
6				SS-8	14-16 20-31	36
	Borehole terminated at 6.10 m		326.12 / 6.10			
7						
8						

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 — Initial / Remold

Water Content (%): WP WL — 10 20 30

Groundwater Observations and Standpipe Details

- flushmount cover and concrete
- bentonite seal
- Tel. 329.99 m 2016-05-12
- sand pack
- 50 mm pipe
- 3.05 m slotted screen
- native cave

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*331.97 m*	**Borehole Number:**	**BH-10-16**
Northing:	*4817597.87 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564907.94 m*	**Drill Date:**	*2016-05-03*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE		SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Initial / Remold / Shear Strength (FV) kPa	Water Content (%) WP WL	Groundwater Observations and Standpipe Details
	Ground Elevation		331.97							
	TOPSOIL: dark brown silt, trace sand and gravel, occasional cobbles, moist		0.00 331.72 0.25							protective cover and concrete
1	***SAND AND GRAVEL:*** compact brown silty sand and gravel, trace topsoil, moist			SS-1	3-5 6	11				
	very dense, trace silt, numerous cobbles		330.45 1.52	SS-2	9-29 35	64				
2	saturated		329.68 2.29	SS-3	60 /150 mm					el. 330.00 m 2016-05-12
3	compact		328.92 3.05	SS-4	7-11 15	26				sand pack
4										50 mm pipe 1.52 m slotted screen
5				SS-5	8-10 12	22				
6	dense		325.87 6.10	SS-6	8-21 26	47				native cave
	Borehole terminated at 6.55 m		325.42 6.55							
7										
8										

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 — Initial, Remold

Water Content (%): 10 20 30

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*332.16 m*	**Borehole Number:**	**BH-11-16**
Northing:	*4817565.23 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564938.99 m*	**Drill Date:**	*2016-05-04*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Initial / Remold / Shear Strength (FV) kPa	Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		332.16							
	FILL: dark brown silt (topsoil), trace sand and roots, moist		0.00							topsoil
	compact brown silty sand, some gravel, very moist		331.75 / 0.41							native backfill
1				SS-1	4-9 10	19				
	SAND AND GRAVEL: very dense brown sand and gravel, trace silt, numerous cobbles, moist to very moist		330.94 / 1.22							bentonite seal
2				SS-2	23-29 29	58				
	dense, saturated		329.87 / 2.29	SS-3	10-23 18	41				
3										
				SS-4	10-13 18	31				
4										native cave
	compact, occasional cobbles, some sand layers		327.59 / 4.57	SS-5	10-11 10	21				
5										
6				SS-6	11-16 12	28				
	Borehole terminated at 6.55 m		325.61 / 6.55							At drilling completion, wet cave at 2.29 m.
7										
8										

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 — Initial / Remold

Water Content (%): WP WL — 10 20 30

Reviewed by: *K.Thrams* **Drafted by:** *E.Ciochon* **Sheet:** *1 of 1*

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

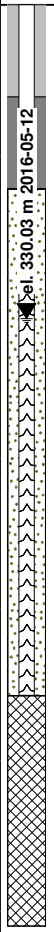
Englobe

Ground Elevation:	*332.07 m*	**Borehole Number:**	**BH-12-16**
Northing:	*4817620.24 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564915.94 m*	**Drill Date:**	*2016-05-03*
		Field Tech:	*D.Souter*
Project:	*Proposed Residential Development*		
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value
	Ground Elevation		332.07			
	TOPSOIL: loose dark brown silt, trace sand and gravel, moist		0.00 / 331.76	SS-1	1-2 7-10	9
	SAND AND GRAVEL: compact brown sand and gravel, trace silt, numerous cobbles, moist		0.30 / 331.31			
1	very dense, grey/brown		0.76	SS-2	21-25 45-45	70
				SS-3	14-50 /75 mm	
2			329.78			
	dense, saturated		2.29	SS-4	12-20 18-14	38
3			329.02			
	compact		3.05	SS-5	8-11 12-16	23
			328.26			
4	dense		3.81	SS-6	12-14 19-12	33
				SS-7	13-17 18-20	35
5			326.58			
	compact		5.49	SS-8	11-13 15-16	28
6			325.97			
	Borehole terminated at 6.10 m		6.10			
7						
8						

Dynamic Cone: 20 40 60 80
Std Penetration: 20 40 60 80
Shear Strength (PP) kPa: 50 100 150 200
Initial
Remold
Shear Strength (FV) kPa: 50 100 150 200
WP WL
Water Content (%): 10 20 30

Groundwater Observations and Standpipe Details



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Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

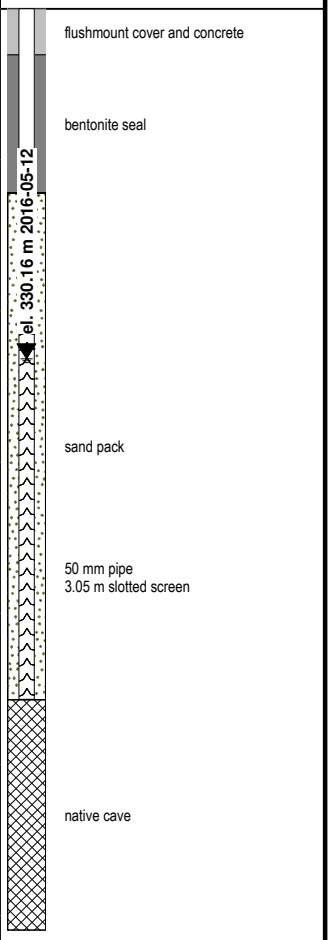
Englobe

Ground Elevation:	*332.44 m*	**Borehole Number:**	**BH-13-16**
Northing:	*4817607.48 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564929.82 m*	**Drill Date:**	*2016-05-04*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value
	Ground Elevation		332.44			
	TOPSOIL: loose dark brown silt, trace sand, moist		0.00 / 332.08	SS-1	1-2 5-5	7
	SAND AND GRAVEL: loose brown sand and gravel, some silt, numerous cobbles, moist		0.36 / 331.68			
1	dense		0.76 / 330.92	SS-2	23-17 24-50	41
	very dense		1.52 / 330.15	SS-3	23-22 33-45	55
2	compact, occasional cobbles, saturated		2.29	SS-4	10-12 14-15	26
3				SS-5	8-9 10-10	19
	dense		3.81 / 328.63	SS-6	9-15 15-20	30
4						
				SS-7	13-14 16-17	30
5						
	compact		5.49 / 326.95	SS-8	10-11 8-8	19
6			326.34			
	Borehole terminated at 6.10 m		6.10			
7						
8						

Dynamic Cone: 20 40 60 80
Std Penetration: 20 40 60 80
Shear Strength (PP) kPa: 50 100 150 200
Initial
Remold
Shear Strength (FV) kPa: 50 100 150 200
WP WL
Water Content (%): 10 20 30

Groundwater Observations and Standpipe Details



Reviewed by: *K.Thrams* **Drafted by:** *E.Ciochon* **Sheet:** *1 of 1*

Notes:

Z:\Style_LVM_Ontario\LogBorehole_Log_LVM_Ontario.sty- Printed : 2016-05-17 15h

Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Appendix 3 Figures

Figure 1: Particle Size Distribution Analyses

Figure 2: Particle Size Distribution Analyses (Reference Number 160-P-0010233-0-02-300)

Englobe

PARTICLE SIZE ANALYSIS

Project: **Proposed Residential Development**

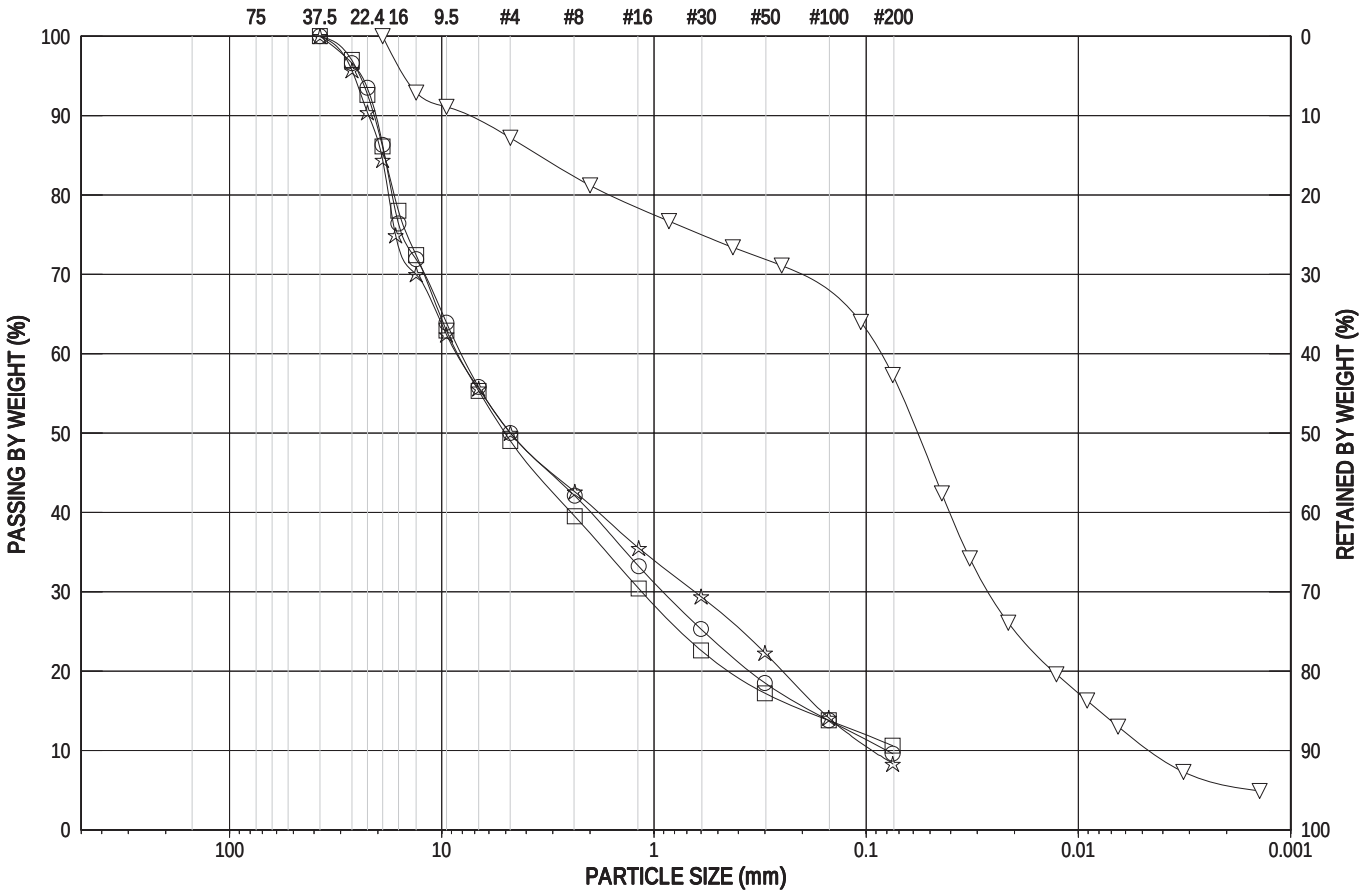
Figure No : **1**

Location: **Lowes Road, Guelph, Ontario**

File No : **P-0010233-0-01-100**

UNIFIED SOIL CLASSIFICATION

COBBLES	*GRAVEL*		*SAND*			*SILT OR CLAY*
	COARSE	FINE	COARSE	MEDIUM	FINE	
U.S. SIEVE SIZE IN MILLIMETRES			*U.S. STANDARD SIEVE No.*			*HYDROMETER*



Symbol	Borehole n°	Sample n°	Depth (m)	Description
○	BH-01-16	SS-1 to SS-5	0.76 - 1.22	SAND and GRAVEL, trace Silt
□	BH-02-16	SS-3 to SS-6	1.52 - 2.13	SAND and GRAVEL, some Silt
▽	BH-07-16	SS-1	0.76 - 1.22	Sandy SILT, some Gravel, trace Clay
☆	BH-11-16	SS-2 to SS-6	1.52 - 1.98	SAND and GRAVEL, trace Silt

PARTICLE SIZE ANALYSIS

Project: **Proposed Residential Development**

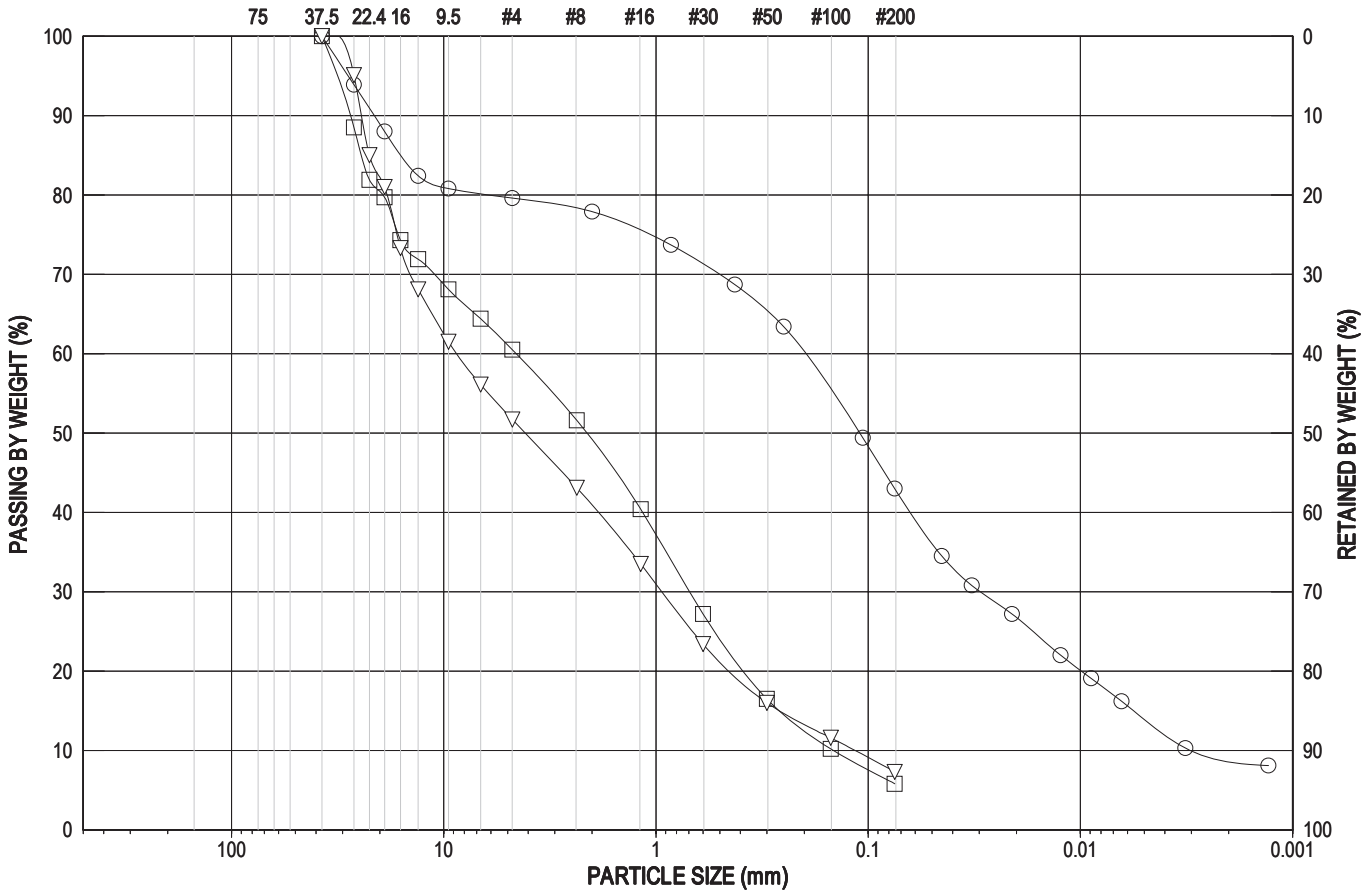
Figure No : 2

Location: **Lowes Road, Guelph, Ontario**

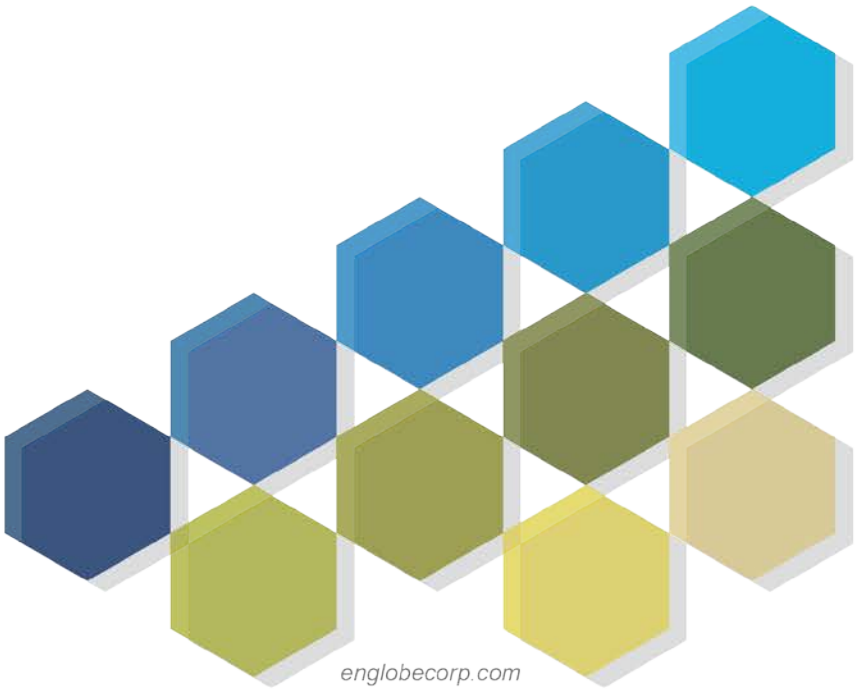
File No : **P-0010233-0-02-300**

UNIFIED SOIL CLASSIFICATION

COBBLES	*GRAVEL*		*SAND*			*SILT OR CLAY*
	COARSE	FINE	COARSE	MEDIUM	FINE	
U.S. SIEVE SIZE IN MILLIMETRES			*U.S. STANDARD SIEVE No.*			*HYDROMETER*



Symbol	Borehole n°	Sample n°	Depth (m)	Description
—○—	BH-01-16	SS-6	6.10 - 6.55	Gravelly Silty SAND, trace Clay
—□—	BH-06-16	SS-4 to SS-7	2.29 - 2.90	SAND and GRAVEL, trace Silt
—▽—	BH-10-16	SS-2 to SS-6	1.52 - 1.98	SAND and GRAVEL, trace Silt



APPENDIX H

Hydrogeology Study, Englobe - June 29, 2016

Englobe
Soils Materials Environment

Reid's Heritage Homes

Scoped Hydrogeology Study
Lowes Road
Guelph, Ontario

Hydrogeology Study

Date: June 29, 2016
Ref. N°: 160-P-0010233-0-02-0300-HD-R-0001-00

Reid's Heritage Homes

Scoped Hydrogeology Study
Lowes Road
Guelph, Ontario

Hydrogeology Study |160-P-0010233-0-02-300

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INTRODUCTION 1

1 OBJECTIVE OF THIS STUDY 2

1.1 Study Area Context 2
1.2 Current and Proposed Land Use 2

2 PHYSICAL SETTING OF THE STUDY AREA 2

2.1 Topography and Physiography 2
2.2 Climate 3
2.3 Overburden & Bedrock Geology 4
2.3.1 Surface Water Features 4

3 HYDROGEOLOGICAL STUDY METHODOLOGY 4

3.1 Review of Previous Studies 5
3.2 Field Program 5
3.2.1 Borehole Drilling 5
3.2.2 Monitoring Well Installations 5
3.2.3 Surveying 6
3.3 Laboratory Soil Testing 6
3.4 Hydraulic Conductivity Testing 7
3.4.1 Slug Testing 7
3.4.2 Grain Size Analyses 8
3.5 Groundwater Chemistry Testing 8

4 HYDROGEOLOGICAL INVESTIGATION RESULTS 8

4.1 Subsoils 8
4.2 Hydraulic Conductivity 9
4.3 Groundwater Elevations and Flow Direction 9
4.4 Seasonal Fluctuation of Groundwater Elevations 9
4.5 Groundwater Chemistry 10

5 PRE-DEVELOPMENT WATER BALANCE 10

5.1.1 Precipitation and Evapotranspiration 11
5.1.2 Infiltration and Runoff 11
5.2 Infiltration of Precipitation 12
5.3 Post-Development Water Balance Considerations 12

6 POTENTIAL IMPACTS OF LAND DEVELOPMENT 13
6.1 Water Users 13
6.2 Burke Well 14
6.2.1 Wellhead Protection Areas (WHPAs) *14*
6.2.2 WHPA Vulnerability *14*
6.2.3 Aquifer Intrinsic Vulnerability *14*
6.2.4 Groundwater Recharge Vulnerability *15*
6.3 Sensitive Areas 15
6.3.1 Wetlands *15*
6.3.2 Streams *15*
7 CONCLUSIONS AND RECOMMENDATIONS 16
7.1 Conclusions 16
7.2 Recommendations 16
8 STATEMENT OF LIMITATIONS 17
REFERENCES 19

Tables

Table 1 Monthly Climate Summary data[1] 3
Table 2 Borehole with Provincial Site Cluster Tag Identification Number 6
Table 3 Geometric Mean of Hydraulic Conductivities based on Soil Type 9
Table 4 Pre-Development Water Balance for the Study Area (SA) 11

Appendices

Appendix 1 Drawings
Appendix 2 Borehole Logs
Appendix 3 Figures
Appendix 4 Tables
Appendix 5 Slug Test Analysis
Appendix 6 MOECC Water Well Records
Appendix 7 Laboratory Certificate of Analysis

Property and Confidentiality

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1 electronic copy	Mr. Peter Fitgerald, Stantec Consulting Ltd.
1 electronic copy	File

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INTRODUCTION

Englobe Corp. (Englobe) was retained to carry out a scoped hydrogeology study for the proposed residential subdivision development at the properties located at 19, 29, 35, 41, 51, and 59 Lowes Road in Guelph, Ontario as shown on the Location Plan, Drawing 1 in Appendix 1. This work was authorized by Mr. Alfred Artinger, P.Eng. of Reid's Heritage Homes following submission of a fee proposal.

The scope of work for this scoped hydrogeology study included a review of available topographic, geological and hydrogeological information for the Study Area and adjacent lands, and a subsurface investigation within the Study Area. The subsurface investigation was performed to identify the subsoil stratigraphy and hydrogeological properties, groundwater conditions and hydraulic gradients, and the relationship between groundwater and surface water features. It also includes long term continuous monitoring of groundwater levels in the monitoring wells installed on the site for approximately one year. Continuous groundwater levels and temperatures are being collected via pressure transducers (dataloggers) and will be barometrically compensated. Once the long term monitoring program is complete, a hydrograph of compensated groundwater elevations and temperatures will be summarized.

The objectives of this report are:

- To assess the geological and hydrogeological conditions beneath the Study Area;
- To calculate a pre-development water balance;
- To describe the soil physical properties;
- To identify water users and sensitive areas within the Study Area; and,
- To identify potential impacts and provide suggested mitigation measures.

Concurrent with this scoped hydrogeology study, Englobe completed a geotechnical investigation (Englobe project number 160-P-0010233-0-01-100-GE-R-0001-00 dated May 24, 2016). Further, MTE Consultants Inc. is currently completing an environmental site assessment for the subject properties and the borehole drilling and installation of monitoring wells for this study were completed concurrently by Englobe with the fieldwork for the geotechnical investigation.

1 OBJECTIVE OF THIS STUDY

1.1 STUDY AREA CONTEXT

The Study Area (1.6 ha) is located on the south side of the City of Guelph on Lowes Road West as illustrated on the appended Drawing 1. The Study Area is bounded by residential buildings in all directions. The Study Area is east and south of GRCA delineated wetlands. An unnamed contributing tributary to Hanlon Creek lies about 640 m northwest of the Study Area.

1.2 CURRENT AND PROPOSED LAND USE

Currently, the land use of the Study Area is low density residential consisting of single residential dwellings. All subject properties face Lowes Road West. They are residential houses with grassed areas with trees in the rear of the properties. A secondary building structure is located in the rear of 41 Lowes Road.

The project involves the redevelopment of the residential properties located at 19, 29, 35, 41, 51, and 59 Lowes Road West in Guelph, Ontario. The site layout of the proposed redevelopment is preliminary and conceptual; however, it is understood that the new residential development will comprise several townhouse blocks and internal roadways. The appended Drawing 2, Site Plan depicts the existing buildings. A stormwater management facility is proposed in the northwest portion of the site (rear of 35, 41, and 51 Lowes Road). The proposed development of the Study Area will be fully serviced with municipal sewers and water supply.

2 PHYSICAL SETTING OF THE STUDY AREA

2.1 TOPOGRAPHY AND PHYSIOGRAPHY

The Study Area is situated within the Guelph drumlin field physiographic region of Southern Ontario (Chapman and Putnam, 1984) and more specifically located within the spillways physiographic landform as described by Chapman and Putnam (2007).

The Study Area is also located within the Hanlon Creek Subwatershed. The Hanlon Creek Subwatershed boundaries are between the Hanlon Parkway on the west to just past Gordon Street on the east, from the north on Stone Road and south to Maltby Road. The underlying bedrock aquifer is part of a regional aquifer system which discharges to the Speed River (Stantec Consulting Ltd., 2008).

Ground surface elevations across the Study Area are found to be between 331 – 333 mASL. The topography is sloping to the northwest toward Hanlon Creek Wetland Complex with an approximate elevation of 328 mASL and an unnamed tributary of the Hanlon Creek. Hanlon Creek discharges about 4.6 km east into the Speed River.

2.2 CLIMATE

Guelph's climate is characterized by variable annual temperatures and less variable total monthly precipitation. The average annual temperature was approximately 7.0°C and the inferred average total precipitation is 916.5 mm/yr[1]. Precipitation is typically lower in the fall and winter months, and late spring months experience higher amounts of runoff due to the effect of winter snow melt. Table 1 below lists monthly average precipitation and temperature data; from the Kitchener/Waterloo station located at the Region of Waterloo International Airport in Breslau (Latitude: 43°46'00" N Longitude: 80°38'00" W; Elevation: 321.60 m).

Table 1 Monthly Climate Summary data[1]

MONTH	PRECIPITATION **mm/month**	TEMPERATURE **deg. Celsius**
Jan	65.2	-6.5
Feb	54.9	-5.5
Mar	61.0	-1.0
Apr	74.5	6.2
May	82.3	12.5
Jun	82.4	17.6
Jul	98.6	20.0
Aug	83.9	18.9
Sep	87.8	14.5
Oct	67.4	8.2
Nov	87.1	2.5
Dec	71.2	-3.3
Total	916.5	--
Average	--	7.0

[1] Canadian Climate Centre, 1981-2010, for Region of Waterloo International Airport

2.3 OVERBURDEN & BEDROCK GEOLOGY

The Surficial Geology Map of the Guelph Area (GRCA, 2016) and the Quaternary (Pleistocene) Geology Map of the Guelph Area (Karrow, 1963) indicates that primarily outwash gravel deposits are found within the Study Area, as depicted on the appended Drawing 3.

The overburden is underlain by a major carbonate bedrock formation, Guelph Formation, which consists of tan to brown sucrosic dolostone. The bedrock formation dates from the Upper Silurian Period, approximately 420 million years ago (Armstrong & Dodge, 2007; The Geological Society of America, 2012).

According to the Bedrock Topography of the Guelph Area (Karrow et al. 1979), depth to bedrock in the Study Area is between 320.0 - 323.1 mASL (1050 – 1060 fASL). According to WWR Nº 6702463 overburden thickness in the Study Area ranges is estimated to be at 11.3 m.

2.3.1 Surface Water Features

The appended Drawing 1 depicts Hanlon Creek (and tributaries) and Torrance Creek as surface water features in proximity to the Study Area. West and north of the Study Area are GRCA delineated wetland areas. To the northwest is the Hanlon Creek Wetland Complex, and to the north is the Torrance Creek Wetland Complex. The Torrance Creek Wetland Complex belongs to the Torrance Creek Subwatershed. A topographic divide occurs east of Gordon Street separating the two subwatersheds. Surface waters flowing from the Study Area will not affect the Torrance Creek (Dougan & Associates with Ecological Outlook, 2005).

3 HYDROGEOLOGICAL STUDY METHODOLOGY

The study methodology involved a number of tasks, which included:

- reviewing topographic, geological, and hydrogeological mapping and reports for the area; and the Ontario Ministry of the Environment and Climate Change (MOECC) Water Well Record (WWR) database;
- drilling of thirteen (13) boreholes, eight (8) of which were completed as 50 mm monitoring wells, for investigation of subsurface stratigraphy and hydrogeology;
- collecting soil samples for moisture content analysis, and for particle size distribution analysis to determine hydraulic conductivity values;
- performing single response in-situ (slug) tests in the monitoring wells to determine hydraulic conductivity values of the water-bearing deposits; and,
- measuring groundwater levels to establish the flow direction and horizontal gradient.

3.1 REVIEW OF PREVIOUS STUDIES

The review of previous studies for the Study Area included a Geotechnical Investigation completed by Englobe in May 2016 (Report Number 160-P-0010233-0-01-GE-R-0001-00). Concurrent to the Geotechnical Investigation and Scoped Hydrogeology Study, MTE Consultants Inc. is currently completing an environmental site assessment for the subject properties.

3.2 FIELD PROGRAM

3.2.1 Borehole Drilling

The present field program involved the advancement of thirteen (13) boreholes (BH-01-16 to BH-13-16) to depths ranging from 3.66 to 6.55 m to identify the subsurface soil and groundwater conditions at the locations shown on the appended Drawing 2. The boreholes were advanced between May 2 and May 4, 2016 by Geo-Environmental Drilling Inc. under the full-time observation of a senior technician from Englobe using a CME-75 track-mounted drill-rig equipped with continuous flight hollow stem augers.

Soil samples were recovered from the boreholes at regular 0.75 and 1.50 m depth intervals using a 50 mm diameter split-spoon sampler in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). Soil samples obtained from the boreholes were submitted for moisture content analysis and seven (7) particle size distribution analyses. The laboratory results for moisture content are included on the borehole logs in Appendix 2. The laboratory results for the particle size distribution analyses are included in Appendix 3.

3.2.2 Monitoring Well Installations

During the borehole drilling program, monitoring wells were installed in eight (8) boreholes BH-01-16, BH-02-16, BH-04-16, BH-06-16, BH-09-16, BH-10-16, BH-12-16, and BH-13-16 for measurement of groundwater levels and saturated soil hydrogeological parameters.

The 50 mm diameter monitoring wells were constructed by inserting slotted, Schedule 40 PVC well screen and riser pipe into the open auger holes. Sand was added in order to place a filter pack around the screen, until the level of the sand was approximately 300 mm above the top of the screen. Bentonite seals were then placed above the sand pack to prevent the infiltration of surface water. The tops of all the well riser pipes were vented to allow accurate measurement of stabilized groundwater levels, and the flush mount wells were concreted in place to house each of the monitoring wells. Details of the monitoring well installations and soil and groundwater conditions encountered are provided on the borehole logs included in Appendix 2.

All of the monitoring wells were constructed in accordance with Ontario Regulation 903 (as amended) as administered by the Ontario Ministry of the Environment and Climate Change (MOECC). Well records were submitted to the MOECC based on the cluster system whereby one well record can be submitted on behalf of an entire property. Provincial Site Cluster Tag Identification Numbers were placed on the boreholes listed in Table 2. A licensed well technician must properly decommission the monitoring wells prior to construction.

Table 2 Borehole with Provincial Site Cluster Tag Identification Number

BOREHOLE	PROVINCIAL SITE CLUSTER TAG IDENTIFICATION NUMBER
BH-01-16	A192785

Manual measurements of stabilized groundwater levels in the monitoring wells on site were collected on May 12, 2016 and will be collected on a quarterly basis for one year to determine seasonal changes of groundwater levels. Measured groundwater levels are summarized in Table 101 in Appendix 4.

Continuous groundwater monitoring is currently being conducted using electronic pressure transducers (dataloggers) installed in all eight monitoring wells, and a barologger has been installed in BH-10-16 to continuously record barometric pressure fluctuations. All datalogger data has been barometrically compensated.

3.2.3 Surveying

The boreholes completed as monitoring wells and ground surface elevations were surveyed by Englobe using a Sokkia Model GXR 2 Global Navigation Satellite System (GNSS) rover. The boreholes completed as monitoring wells locations were referenced to Universal Trans Mercator North American Datum of 1983 (UTM NAD83) coordinates; the zone reference (17T) has been excluded for the presentation purposes. The ground surface elevations are geodetic, based on GNSS and local base station telemetry with a vertical root mean squared error of less than 20 mm.

3.3 LABORATORY SOIL TESTING

All soil samples obtained during borehole drilling were returned to Englobe laboratory facilities for visual examination, with selected samples undergoing physical testing. The soil moisture content test results obtained from borehole samples are plotted on the appended borehole logs, and the particle size analyses are plotted on Figures 1 and 2 in Appendix 3.

3.4 HYDRAULIC CONDUCTIVITY TESTING

Hydraulic conductivity estimates for the site soils were determined using two methods. The first method is applicable to saturated soils at depth, and involves single response in-situ hydraulic (slug) tests at monitoring wells.

The second method involves a calculated estimation of hydraulic conductivity based on soil sample particle size analysis using the Kozeny-Carman and Kaubisch formulae where appropriate. The two methods used for this study are described in the following subsections.

3.4.1 Slug Testing

Hydraulic conductivity estimates were determined for the saturated soils at depth using single response slug tests for six (6) monitoring wells within and in proximity to the Study Area.

Each monitoring well was developed prior to slug testing. Well purging was implemented to remove silt and sand introduced into the well during construction, and to remove fine particles from the coarse sand pack placed around the outside of the well screen during construction.

The slug test procedure employs the hydrostatic time-lag method for groundwater recovery following the introduction of a slug of known volume into a monitoring well, and makes use of the theory of Hvorslev (1951), as described in Freeze and Cherry (1979). Hvorslev's method is expressed by the following equation:

$$K = \frac{r^2 \ln (L/R)}{2LT_0}$$

where:

K = hydraulic conductivity of the tested material (m/sec)
r = inner radius of the well riser pipe (m)
R = outer radius of the well riser pipe (m)
L = length of screen and sand pack (m)
T_o = time lag (sec), where $(H-h)/(H-H_o) = 0.37$
h = water level at each time of measurement (m)
H_o = initial water level (m, start of test)
H = stabilized water level prior to introducing slug (m)

The time lag, T_0, is defined as the time required for the water level to recover to 63 % of the stabilized level if the initial flow rate into the well is maintained. This time lag is determined graphically as the time for which (H-h) divided by $(H-H_o)$ is equal to 0.37.

Slug test data was analyzed using MS Excel 2010 software. A summary of the hydraulic conductivity estimates is provided in the appended Table 102, and graphed results of the slug tests completed for the monitoring wells are included in Appendix 5.

3.4.2 Grain Size Analyses

Hydraulic conductivity values of seven (7) soil samples were derived empirically using the particle size distribution test and the Kozeny-Carman and Kaubisch formulae where the grain size analyses met the appropriate formulae criteria.

The particle size distribution analysis graphs are shown on Figures 1 and 2 in Appendix 3 and the calculated conductivity values for the samples from the boreholes are listed in the appended Table 102.

3.5 GROUNDWATER CHEMISTRY TESTING

Samples of groundwater were obtained from three (3) on-site monitoring wells (BH-02-16, BH-04-16 and BH-10-16) on May 13, 2016 and submitted to ALS Laboratories in Waterloo, Ontario for analysis of general chemistry parameters. Analysis results are summarized in the appended Table 103 with comparison to the Ontario Drinking Water Standards (ODWS), and the laboratory Certificates of Analysis are included in Appendix 7.

4 HYDROGEOLOGICAL INVESTIGATION RESULTS

4.1 SUBSOILS

The borehole logs in Appendix 2 show that the soil composition varies across the Study Area. As shown in the cross section on the appended Drawing 4, the sediments of the Study Area consist mostly of sand and gravel deposits with trace to some silt. Some to numerous cobbles are found throughout the majority of the samples. Trace amounts of clay were encountered in Borehole BH-01-16 between 6.1 – 6.6 mbgs. Imported fill material was encountered at ground surface in seven boreholes (BH-02-16 – BH-05-16, BH-07-16, BH-09-16 and BH-11-16). Native topsoil material consisting of mainly silts with some sand and gravel was encountered at ground surface in the remaining six boreholes. According to water well records in the vicinity of the Study Area (WWR Nº 6702440, 6703251), a discontinuous layer of clay is found overlying the dolostone bedrock.

Granular deposits encountered within the boreholes across the Study Area range in depth from approximately 3.4 – 6.4 m. Saturated conditions were encountered in the boreholes completed as monitoring wells ranging in depth from 1.4 – 2.8 mbgs.

MOECC WWR (Nºs 6702440 & 6703251) in the vicinity of the Study Area indicates that a discontinuous layer of clay exists at depth overlying bedrock.

The appended borehole logs (Appendix 2) describe soil types, lithological stratigraphy, results of STP testing, moisture content profiles, pocket penetrometer test results, details of the monitoring well construction, and groundwater level measurements and observations.

4.2 HYDRAULIC CONDUCTIVITY

Hydraulic conductivity estimates determined by the various testing methods are summarized in Table 102 in Appendix 4, with graphical analyses of slug test data included in Appendix 5, and particle size distribution graphs on Figures 1 and 2 in Appendix 3.

The analyzed soil types were sand and gravel with trace to some silt, a gravelly silt and sand, and a sandy silt with some gravel and trace clay. Based on the 13 calculated results for hydraulic conductivity (7 derived from grain size analysis and 6 derived from slug test analysis), Table 3 describes the geometric means of the two main soil types.

Table 3 Geometric Mean of Hydraulic Conductivities based on Soil Type

SOIL TYPE	GEOMETRIC MEAN [M/S]	NUMBER OF SAMPLES
Sand and gravel with trace to some silt	3.7×10^{-5}	11
Gravelly silt and sand	5.9×10^{-7}	2

4.3 GROUNDWATER ELEVATIONS AND FLOW DIRECTION

Groundwater is typically found within the granular deposits beneath the Study Area. The granular deposits occurring at varying depths across the Study Area are interpreted to be hydraulically connected and build an unconfined Shallow Overburden Aquifer.

The Study Area is a recharge zone belonging to the headwater area of Hanlon Creek subwatershed. Across the Study Area, groundwater in the Shallow Overburden Aquifer flows towards an unnamed tributary to the Hanlon Creek in a westerly direction. The general flow gradient slopes towards Hanlon Creek. The observed depth to water table in the boreholes varies across the site from approximately 1.4 – 2.8 mbgs. Shallow groundwater contours are shown on the appended Drawing 5. The depicted groundwater levels were measured on May 12, 2016.

4.4 SEASONAL FLUCTUATION OF GROUNDWATER ELEVATIONS

A long term groundwater monitoring program is in place to observe the seasonal fluctuations in the shallow groundwater aquifer across the site through the use of electronic pressure transducers (dataloggers).

The ongoing program includes quarterly site visits with a manual groundwater level measurement and a datalogger download. The data from the dataloggers will be barometrically corrected with the use of a barologger. A summary of the seasonal groundwater level fluctuations will be addressed in the final report after the completion of the one year long term monitoring program.

4.5 GROUNDWATER CHEMISTRY

Groundwater samples were obtained from three new monitoring wells (BH-02-16, BH-04-16 and BH-10-16) on May 13, 2016. Chemical parameters were compared to ODWS concentration limits in the appended Table 103. It is important to note that the ODWS was used for comparative purposes only as none of the monitoring wells are used to supply drinking water.

As shown on the appended Table 103, Borehole BH-02-16 had measured exceedances of Apparent Colour, Hardness, Total Dissolved Solids, Turbidity, Total and Dissolved Aluminum, Total Iron, and Total Manganese. Boreholes BH-04-16 and BH-10-16 had measured exceedances in Hardness and Total Dissolved Solids. In each case, these parameters are not health related, pertaining to aesthetic qualities or the effectiveness of water treatment systems.

5 PRE-DEVELOPMENT WATER BALANCE

The water balance accounts for all water in- and out-flows in the hydrologic cycle. Precipitation (P) falls as rain and snow. Then it can run off towards wetlands, ponds, lakes, and streams (R), infiltrate to the groundwater table (I), or evaporate from surface water and vegetation (ET). When long-term average values of P, R, I, and ET are used then minimal or no net change to groundwater storage (ΔS) is assumed.

The annual water balance can be stated as:

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

where:

P = Precipitation (mm/year)

ET = Evapo-transpiration (mm/year)

R = Runoff (mm/year)

I = Infiltration (mm/year)

ΔS = Change in groundwater storage (taken as zero) (mm/year)

5.1.1 Precipitation and Evapotranspiration

The average annual precipitation[2] for the study area is assumed to be 917 mm/yr, and this rate is used for estimating the predevelopment water budget.

An evapotranspiration rate of 592 mm/yr was inferred for this site. Applying these figures to the pre-development water budget for the subject property gives a water surplus of 325 mm/year (precipitation minus evapotranspiration), which then becomes the infiltration and runoff components of the budget.

5.1.2 Infiltration and Runoff

The pre-development recharge/infiltration rates from the GRCA dataset (shown on the appended Drawing 6) indicate rates ranging from 200 - 300 mm/year across the Study Area. The average infiltration rate for the Study Area is interpreted to be approximately 300 mm/year because of the granular and permeable nature of the soils.

It is important to consider that the localized infiltration rates commonly vary. The ability of soils to infiltrate under post-development conditions will change accordingly. It is important to note that infiltration rates may vary based on certain variables such as the saturated hydraulic conductivity of surface soils, land slope, rainfall intensity, relative soil moisture at the start of a rainfall event, and vegetative cover of the ground surface.

According to the appended Drawing 7, Average Annual Runoff, the estimated runoff for the Study Area is approximately 25 mm/year. This low value is due to the larger areas of pervious surface (lawns) across the Study Area.

The average pre-development water balance for the Study Area is presented in Table 3 below.

Table 4 Pre-Development Water Balance for the Study Area (SA)

HYDROLOGIC COMPONENT	STUDY AREA (mm/year)	%
Total Precipitation	917	100.0
Evapotranspiration	592	64.6
Infiltration	300	32.7
Runoff	25	2.7

[2] Canadian Climate Centre Normals, 1981-2010 for Waterloo Wellington Airport.

It is noted that the overall runoff component of the Study Area is relatively low, and the infiltration rate is relatively high. These runoff and infiltration values are a result of the well-draining soils contributing increased infiltration to the water balance.

5.2 INFILTRATION OF PRECIPITATION

Hydraulic conductivity values of sub-surface soils within the study area were calculated using a variety of methods. Based on the borehole lithological stratigraphy, near-surface soils are typically sand and gravel with trace to some silt components resulting in a relatively high permeability. It is important to consider that the site infiltration rate calculated previously represents an average of the soil types encountered across the study area.

At-source infiltration of precipitation from rooftops and other impervious surfaces, or infiltration under roadways, will be dependent on the native soil types exposed by grading and/or the physical characteristics of fill placed; along with the thickness of unsaturated soils above the shallow groundwater table.

As the pre-development infiltration rate is high, and the wetland areas are supported in part by groundwater, measures to maintain infiltration volumes will be important to maintain the function of the wetlands. Depression-focused infiltration within the wetland areas will be maintained by maintaining groundwater flow to the wetlands.

It is noted that the rates presented in Table 4 above take into account the area included within the Study Area only, and do not account for additional infiltration resulting from runoff from the Study Area infiltrating within adjacent wetlands located outside of the Study Area. Under post-development conditions, maintenance of infiltration rates within the Study Area and runoff contributions from the Study Area to adjacent areas will be necessary to ensure the overall water balance within and outside of the Study Area is maintained.

It is noted that the estimated water balance reflects past meteorological conditions and cannot take into consideration possible changes to these conditions in the future. However, by developing the Study Area in such a way that infiltration rates and spatial distribution of infiltration are maintained, and that seasonal runoff volumes to wetlands are maintained, changes in meteorological conditions will likely not adversely impact recharge/runoff rates across the study any differently than if the land remained undeveloped.

5.3 POST-DEVELOPMENT WATER BALANCE CONSIDERATIONS

It is important to consider that cutting and filling during grading operations may result in different soil types being exposed at the ground surface, which would be expected to result in changes to soil infiltration rates.

Design of grading must consider shallow groundwater elevations as well as subsurface soil types to avoid the potential of localized groundwater mounding from at-source infiltration impacting footings and foundations.

As a large portion of groundwater discharges to the wetland complex and creek tributary, levels of salt and other contaminants in the water being infiltrated must be considered; and appropriate mitigation measures are recommended.

Post-development site infiltration should be designed to attempt to match pre-development rates within the Study Area through methods such as at-source infiltration from rooftops connected to soakaway pits, where feasible. Under post-development conditions, runoff contributions from the Study Area to the closest wetland should also match pre-development rates.

6 POTENTIAL IMPACTS OF LAND DEVELOPMENT

6.1 WATER USERS

Well Records from the Ministry of the Environment and Climate Change (MOECC) Water Well Record (WWR) Database were reviewed to determine the number of wells present. One hundred fourteen (114) wells are located within an approximate radius of the Study Area according to the MOECC WWR database. Monitoring wells, abandoned wells, and wells that are classified as not in use are going to be excluded from further consideration, bringing the total amount of wells within the area to sixty-nine (69). Five (5) wells are completed in overburden soils, and sixty-one (64) wells have unknown completion details. The appended Drawing 8 depicts the sixty-nine (69) wells under consideration. It must be noted that all of these sixty-one (61) wells are drilled to bedrock approximately 11.3 - 13.1 mbgs, and it is assumed the screen is completed within the bedrock. A summary of the Water Well records is included in Appendix 6.

One municipal well, known as the Burke Well, is located along Arkell Road, approximately 1200 m north of the site. It is noted that the well record summary includes another municipal well (WWR Number 6702440); however, further investigation revealed this well no longer exists.

Maintaining the distribution of pre-development infiltration rates across the Study Area will help to preserve recharge to the Shallow Overburden Aquifer; therefore, no impacts to shallow overburden water supply wells would be expected. Wells screened in deeper overburden and bedrock aquifers are principally supplied by precipitation that infiltrates over a much broader area, and are unlikely reliant upon infiltration within the Study Area.

As discussed in Section 5.2, the post-development water balance will be designed with the intention to match pre-development conditions.

6.2 BURKE WELL

The City of Guelph has a municipal supply well located at 164 Arkell Road that is approximately 1200 m of the Study Area. According to the water well record, the Burke Well was drilled in June 1966 to a depth of 78.9 m (259 feet) and completed into blue shale bedrock. The screen depth and screen length of the production well is unknown.

6.2.1 Wellhead Protection Areas (WHPAs)

The Grand River Source Protection Area (GRSPA) Approved Assessment Report (2012) defines Wellhead Protection Areas (WHPAs) for the studied wellfields. WHPAs correspond to the travel time of groundwater flowing through an aquifer to a municipal well. The GRSPA identifies WHPA classes as follows:

- WHPA-A: 100 m radius from a municipal supply well;
- WHPA-B: between 100 m and the 2 year travel time;
- WHPA-C: Between the 2 year and 5 year travel time;
- WHPA-D: Between the 5 year and 25 year travel time;

As shown on the appended Drawing 9, the Study Area lies within WHPA-C of the Burke Well. It is noted that the WHPA corresponds to travel times for the City of Guelph's Burke Well (a deep bedrock well).

6.2.2 WHPA Vulnerability

Wellhead Protection Area adjusted vulnerability scoring mapping combines the WHPA and the intrinsic vulnerability to provide vulnerability scoring inside the WHPA. The adjusted vulnerability score for a WHPA accounts for both the rate of vertical and horizontal movement of water to the well and range from 2 to 10, with 10 being the highest score. Generally, vulnerability scores increase in proximity to a supply well. The appended Drawing 10 shows the majority of the Study Area has a vulnerability score of 8, with a small portion of the northwest corner of the property scoring a 6.

6.2.3 Aquifer Intrinsic Vulnerability

Mapping of the intrinsic vulnerability within WHPAs is based on the Intrinsic Susceptibility Index (ISI). The ISI is intended to reflect the intrinsic degree of protection of an aquifer based on the thickness and properties of the materials overlying the aquifer, which is analogous to the vertical travel time of a contaminant to the given aquifer.

The appended Drawing 11 depicts the intrinsic vulnerability mapping (GRCA, 2013) of the bedrock aquifer, indicating that the Study Area is in an area of medium intrinsic vulnerability.

6.2.4 Groundwater Recharge Vulnerability

The appended Drawing 12 illustrates groundwater recharge vulnerability for Significant Groundwater Recharge Areas (SGRAs) surrounding the Study Area. SGRAs correspond to areas where recharge is greater than or equal to 115% of the average recharge rate within a watershed. The Study Area is found to be within an area of medium vulnerability with a score of 4.

6.3 SENSITIVE AREAS

6.3.1 Wetlands

Wetlands are sensitive to changes in seasonal runoff volumes, and changes in shallow groundwater elevations. Runoff, coupled with groundwater inflows from the Shallow Overburden Aquifer, increases the surface area of the wetlands.

Based on the general shallow groundwater flow direction and elevation, and the groundwater contours converging towards the Hanlon Creek Wetland Complex, it is concluded that Hanlon Creek and its associated wetlands are partially dependent on groundwater flowing (and discharging) from the Study Area. The groundwater contours on the appended Drawing 6 suggests that a portion of groundwater discharges into the tributary of Hanlon Creek.

As a result, any detrimental changes to the pre-development water balance, causing a reduction of the infiltration rates or lowering of groundwater levels in the Shallow Overburden Aquifer, would adversely impact the wetland ecosystem by shrinking the size of this habitat.

6.3.2 Streams

Post-development runoff from the Study Area is expected to drain into a storm water management (SWM) facility and not directly into surface water features. Wetlands on and in proximity to the Study Area will likely receive runoff treated by SWM facilities, plus clean runoff from naturalized areas. The proposed at-source infiltration infrastructure and SWM facilities across the Study Area will mitigate the potential for impacts to wetlands (and streams) by matching pre-development infiltration and runoff rates.

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

The geotechnical and hydrogeological studies conducted by Englobe have provided information about the subsurface stratigraphy across the Study Area. The subsurface stratigraphy across the Study Area is mainly sand and gravel with trace to minor silt. MOECC WWR in the vicinity of the Study Area indicates that a discontinuous layer of clay exists at depth overlying bedrock. The nature of the soils across the Study Area allow for high infiltration of water.

A long term monitoring program is currently in place to gain a better understanding of the groundwater levels across the Study Area. The results of the long term monitoring will be summarized in the Final Report of the scoped hydrogeology study once the one year monitoring period is complete. Groundwater was encountered in the near surface granular soils between 1.4 – 2.8 mbgs on May 12, 2016.

Surface water features within the vicinity of the Study Area include a tributary to the Hanlon Creek as well as the Hanlon Creek Wetland Complex, found northwest of the Study Area. The Study Area was found to be within the WHPA C delineation for the City of Guelph's Burke Well, located approximately 1200 m north of the Study Area on Arkell Road. The Study Area has scored between 6- 8 on the WHPA vulnerability, and has a moderate level of intrinsic vulnerability. The Study Area is within a moderate significant groundwater recharge area scoring a level of 6.

A pre-development water balance was calculated. Under post-development conditions, maintenance of infiltration rates within the Study Area and runoff contributions from the Study Area to adjacent areas will be necessary to ensure the overall water balance within and outside of the Study Area is maintained. Runoff water chemistry can generally be addressed by SWM facilities through treatment of runoff from the Study Area prior to discharge to the unnamed tributary.

By ensuring the water balance is maintained and that the water chemistry of infiltrated water is not significantly degraded, the potential impacts to the Shallow Overburden Aquifer will be mitigated.

7.2 RECOMMENDATIONS

A combination of spatially distributed at-source and other infiltration measures may be applied where subsurface soils are adequately permeable and there is sufficient separation between groundwater and footing elevations.

Englobe recommends giving consideration of the chemistry of water being infiltrated in order to minimize detrimental impacts to users of the Shallow Groundwater Aquifer, and to wetlands and surface water features. Infiltration of clean water should be considered; otherwise, treatment of infiltrating water will likely be necessary to maintain groundwater quality.

Englobe suggests maintaining, but not enhancing, the pre-development high infiltration rates within the granular soils.

During the design phase of the proposed development within the Study Area, grading and footing information should be compared to groundwater monitoring data to achieve separation between the seasonally high groundwater table elevation and house footings. Additionally, proposed mitigation measures to maintain the groundwater chemistry within the Study Area should be evaluated for their effectiveness.

The post-development water balance should endeavour to match the pre-development water balance, by maintaining spatial distribution of infiltration across the Study Area. In order to maintain the form and function of wetlands, the proposed residential development will need to conserve pre-development groundwater levels, and keep seasonal runoff volumes low.

Post-development runoff from the Study Area should be collected in SWM ponds, and treated to meet MOECC “Enhanced Level” stormwater management standards prior to discharging to the unnamed Hanlon Creek tributary.

8 STATEMENT OF LIMITATIONS

The hydrogeology recommendations provided in this report are applicable only to the project described in the text and are intended for the use of the project designer. Any use which a contractor makes of this report, or decisions made based on it, are the responsibility of the contractor. The contractor must also accept the responsibility for means and methods of construction, seek additional information if required, and draw their own conclusions as to how the subsurface conditions may affect their work. Englobe accepts no responsibility and denies any liability whatsoever for any damages arising from improper or unauthorized use of the report or parts thereof.

It is important to note that this investigation involves a limited sampling of the study area gathered at specific test hole locations, and the conclusions in this report are based on this information gathered. The subsurface conditions between and beyond the boreholes may differ from those encountered at the boreholes. Should subsurface conditions be encountered which differ materially from those indicated in the borehole logs, we request that we be notified in order to assess the additional information and determine whether or not changes should be made as a result of the conditions.

Additionally, much of the information and conclusions presented in this report have been based on, and taken from, data and reports collected and prepared by other consultants. Englobe is not responsible for any errors or omissions in these third party reports.

The professional services provided for this project include only the hydrogeological aspects of the subsurface conditions at the study area, unless otherwise stated specifically in the report. The recommendations and opinions given in this report are based on our professional judgment and are for the guidance of the Client and Consultant in the design of the specific project. No other warranties or guarantees, expressed or implied, are made.

We trust that this report is suitable for your present requirements and we thank Reid's Heritage Homes for this opportunity to have provided hydrogeological engineering services. If you have any questions or require further hydrogeological or geotechnical consultation, please do not hesitate to contact our office.

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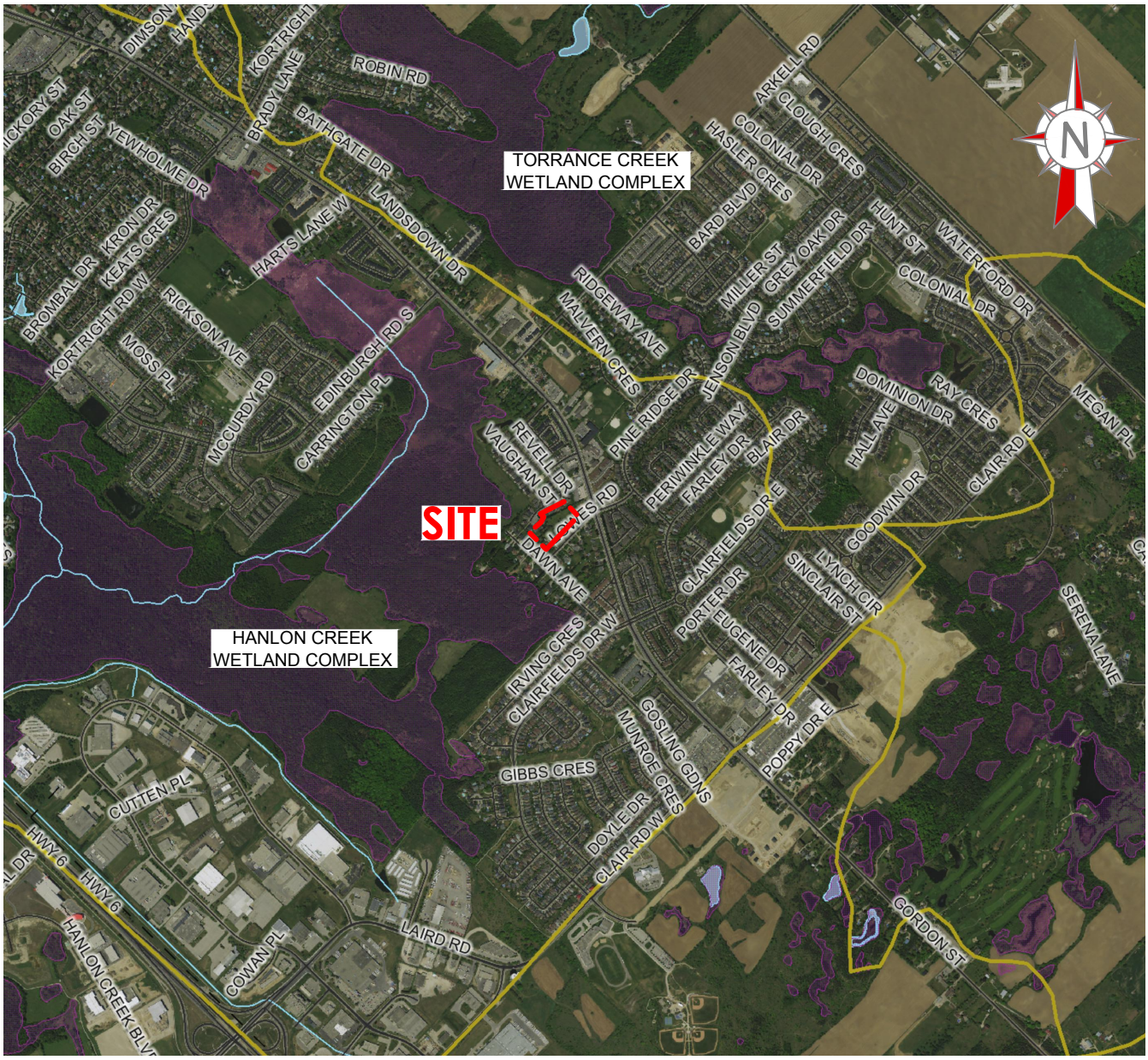
Appendix 1 Drawings

Drawing 1: Location Plan
Drawing 2: Site Plan
Drawing 3: Surficial Geology
Drawing 4: Cross Section A-A'
Drawing 5: Shallow Groundwater Contours
Drawing 6: Average Annual Recharge
Drawing 7: Average Annual Runoff
Drawing 8: MOECC Water Well Records
Drawing 9: Wellhead Protection Areas Map
Drawing 10: Wellhead Protection Area Vulnerability
Drawing 11: Intrinsic Vulnerability
Drawing 12: Significant Groundwater Recharge Area Vulnerability

Englobe



LEGEND :

GRCA WETLANDS

GRCA SUBWATERSHED BOUNDARY

NOTES :

1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, 2010 Aerial Photograph (2016).

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

0 250 500 750 1000 m

SCALE 1:25000

Project

Lowes Road Development, Hydrogeology Study

Lowes Road, Guelph, Ontario

Title

LOCATION PLAN

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Checked	S. Meteer	Date	2016-05-16		

M. dept.	Project	Disc.	Dwg no.	Rev.
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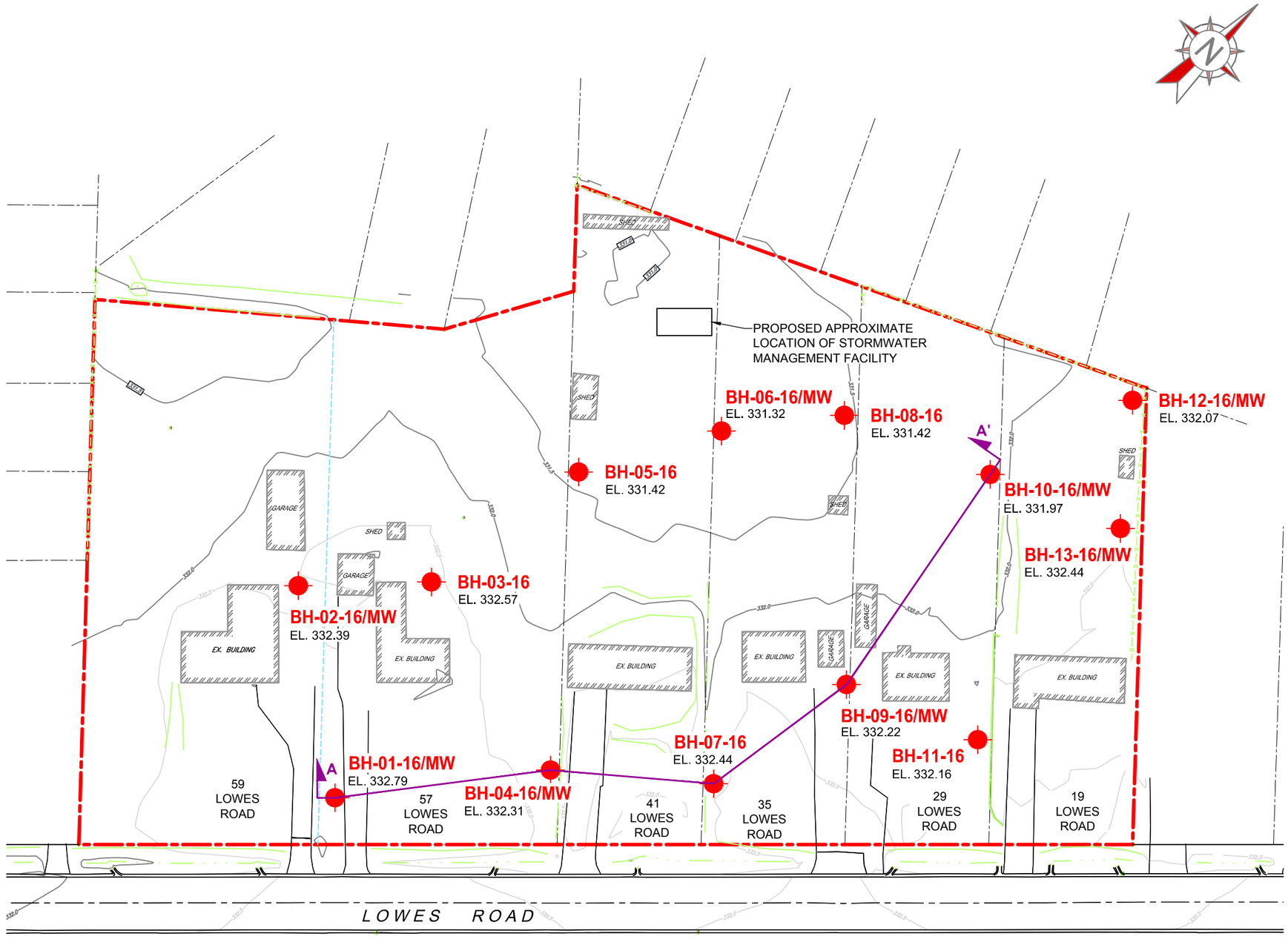

LEGEND :

- SITE OUTLINE
- BOREHOLE LOCATION
- EL. 331.32 — GROUND SURFACE ELEVATION (m)
- A A' — CROSS SECTION (Refer to Drawing 3)

0 10 20 30 m

SCALE 1:750

NOTES :

1-REFERENCES: STANTEC, Topographic Sketch of Lots 2, 3, 4 &5 Registered Plan 508 and Part of Lots 15 &16 Registered Plan 467, received in April 2016.

2-Borehole coordinates and elevations based on Sokkia network data.

3-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

4-MW refers to monitoring well installed at borehole location.

Project

Lowes Road Development, Hydrogeology Study

Lowes Road, Guelph, Ontario

Title

SITE PLAN

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M. dept.	Project	Disc.	Dwg no.	Rev.
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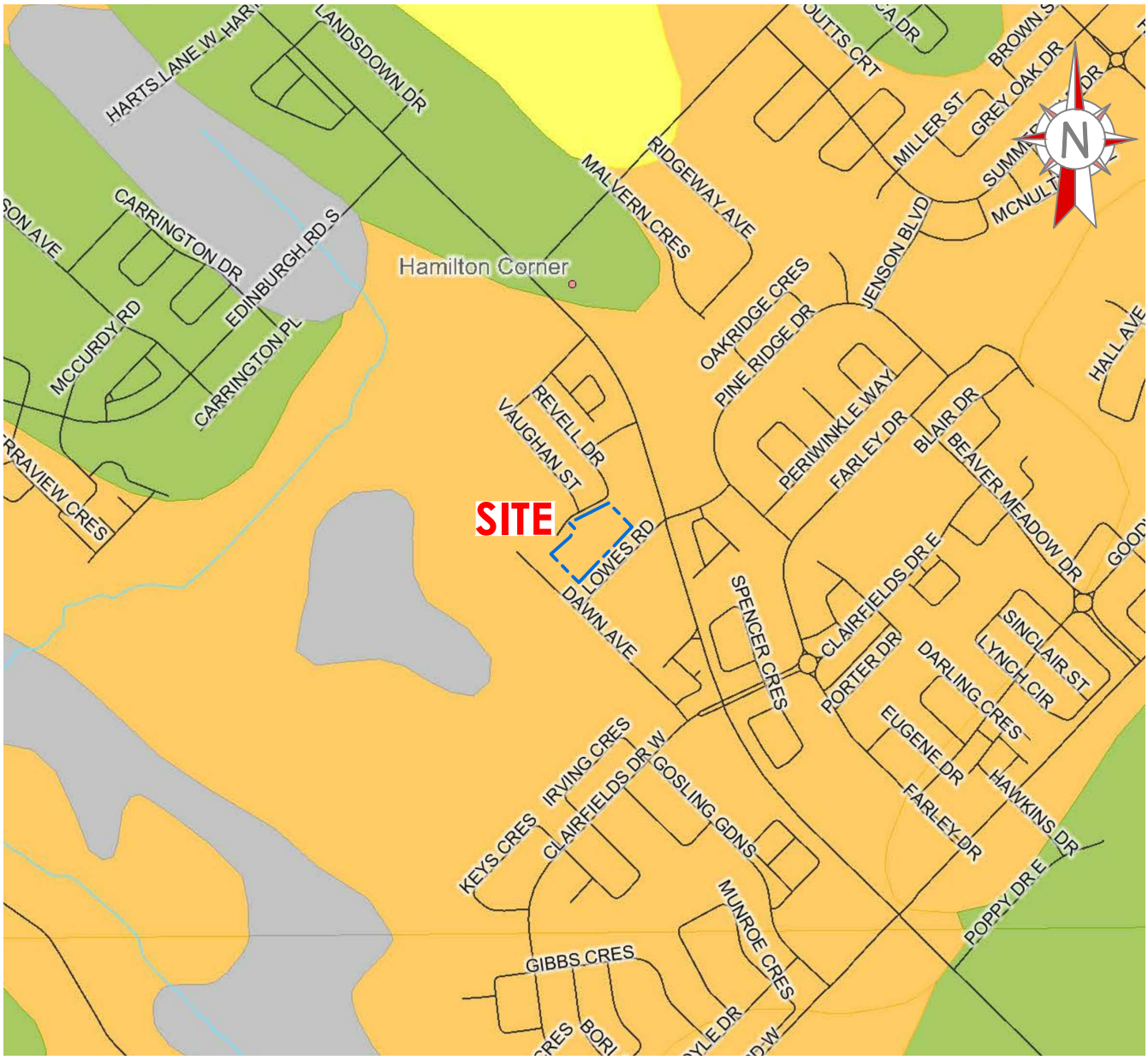

LEGEND :

- DIAMICTION
- GRAVEL
- ORGANIC DEPOSITS
- SAND

NOTES :

1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, Surficial Geology, (2016).

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

0 100 200 300 400 500 m

SCALE 1:15000

Project

Lowes Road Development Hydrogeology Study

Lowes Road, Guelph, Ontario

Title

SURFICIAL GEOLOGY

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M. dept.	Project	Disc.	Dwg no.	Rev.
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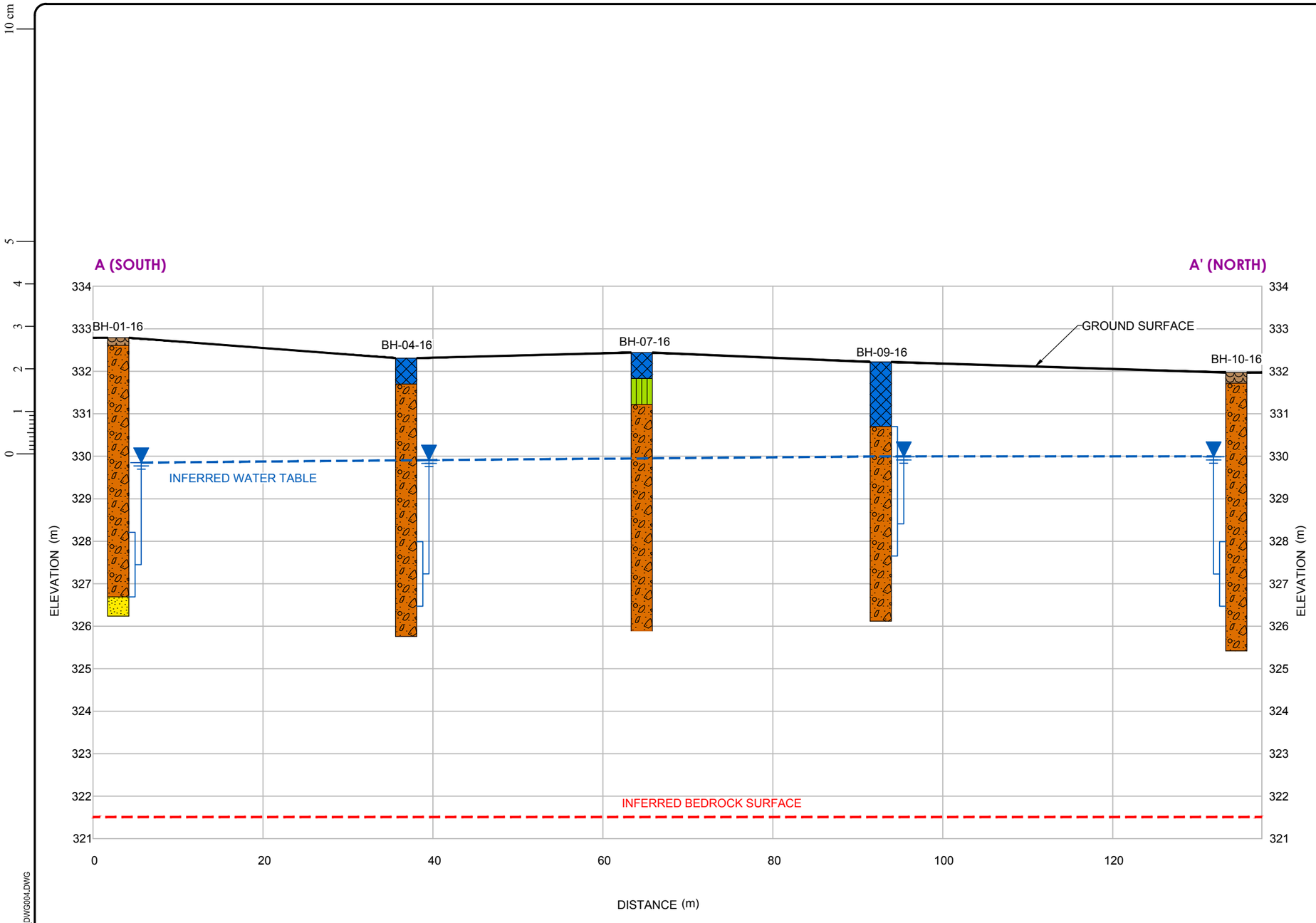

LEGEND :

- FILL
- TOPSOIL
- SILT
- SAND
- SAND AND GRAVEL
- SCREENED INTERVAL
- WATER LEVEL (May 12, 2016)

NOTES :

1-Groundwater measurements taken on (May 12, 2016).
Seasonal fluctuations in groundwater levels would be expected.

2-The inferred stratigraphy shown on this cross-section is based on the subsurface stratigraphy contacted at the Boreholes. The subsurface conditions between the Boreholes will vary.

3-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

Project

Lowes Road Development, Hydrogeology Study

Lowes Road, Guelph, Ontario

Title

CROSS SECTION A - A'

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M. dept.	Project	Disc.	Dwg no.	Rev.
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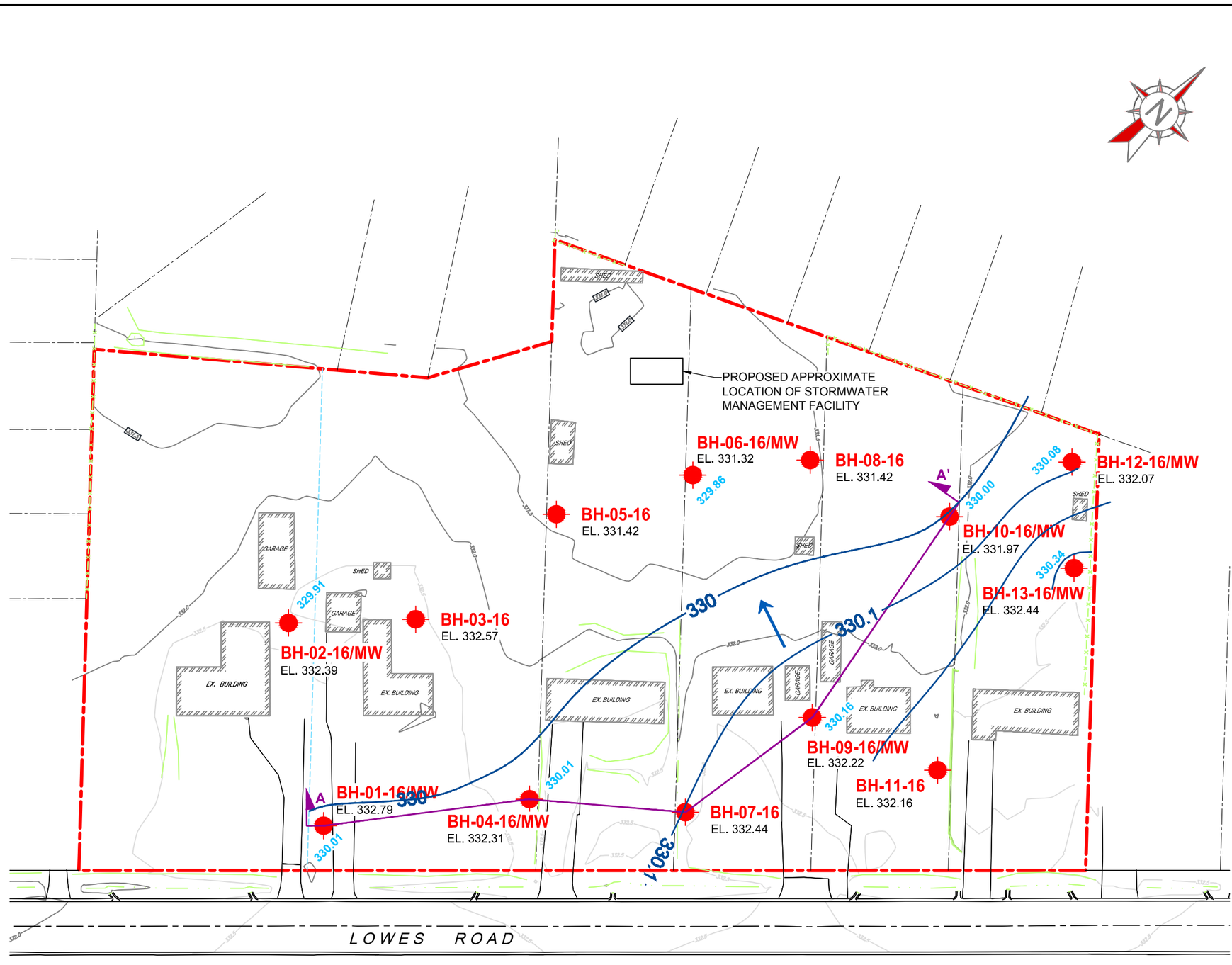

LEGEND :

- SITE OUTLINE
- BOREHOLE LOCATION
- EL. 331.32 — GROUND SURFACE ELEVATION (m)
- A A' — CROSS SECTION (Refer to Drawing 3)
- GROUNDWATER CONTOUR (May 12, 2016)
- 329.86 — GROUNDWATER ELEVATION (mASL) (May 12, 2016)
- GROUNDWATER FLOW DIRECTION

0 10 20 30 m
SCALE 1:750

NOTES :

1-REFERENCES: STANTEC, Topographic Sketch of Lots 2, 3, 4 &5 Registered Plan 508 and Part of Lots 15 &16 Registered Plan 467, received in April 2016.

2-Borehole coordinates and elevations based on Sokkia network data.

3-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

4-MW refers to monitoring well installed at borehole location.

Project

Lowes Road Development, Hydrogeology Study

Lowes Road, Guelph, Ontario

Title

SHALLOW GROUNDWATER CONTOURS

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M. dept.	Project	Disc.	Dwg no.	Rev.
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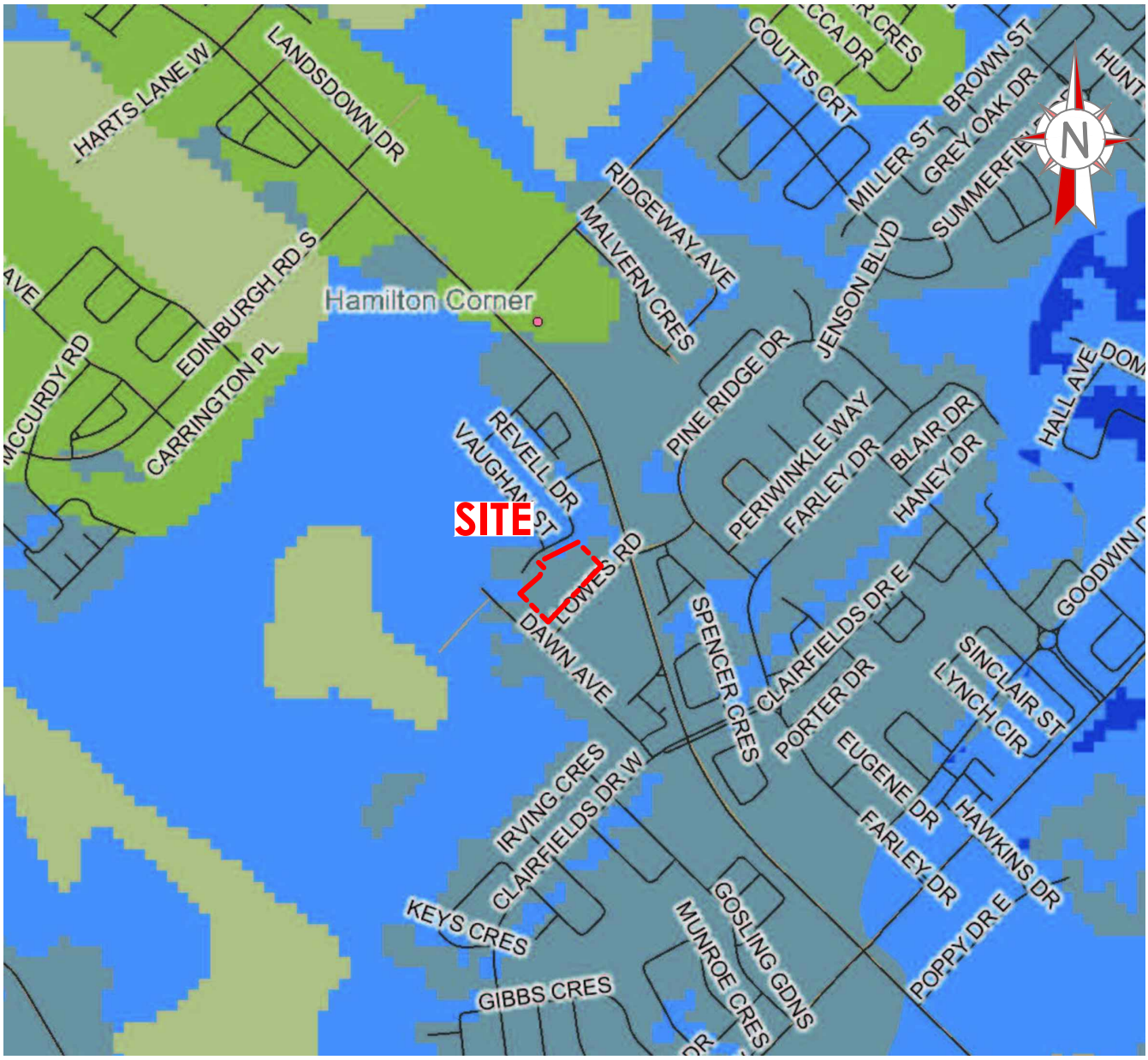

LEGEND :

- less than 50 mm/yr
- 50 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- > 400

NOTES :

1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, Average Annual Recharge, (2016).

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

0 100 200 300 400 500 m

SCALE 1:15000

Project

Lowes Road Development Hydrogeology Study

Lowes Road, Guelph, Ontario

Title

AVERAGE ANNUAL RECHARGE

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M. dept.	Project	Disc.	Dwg no.	Rev.
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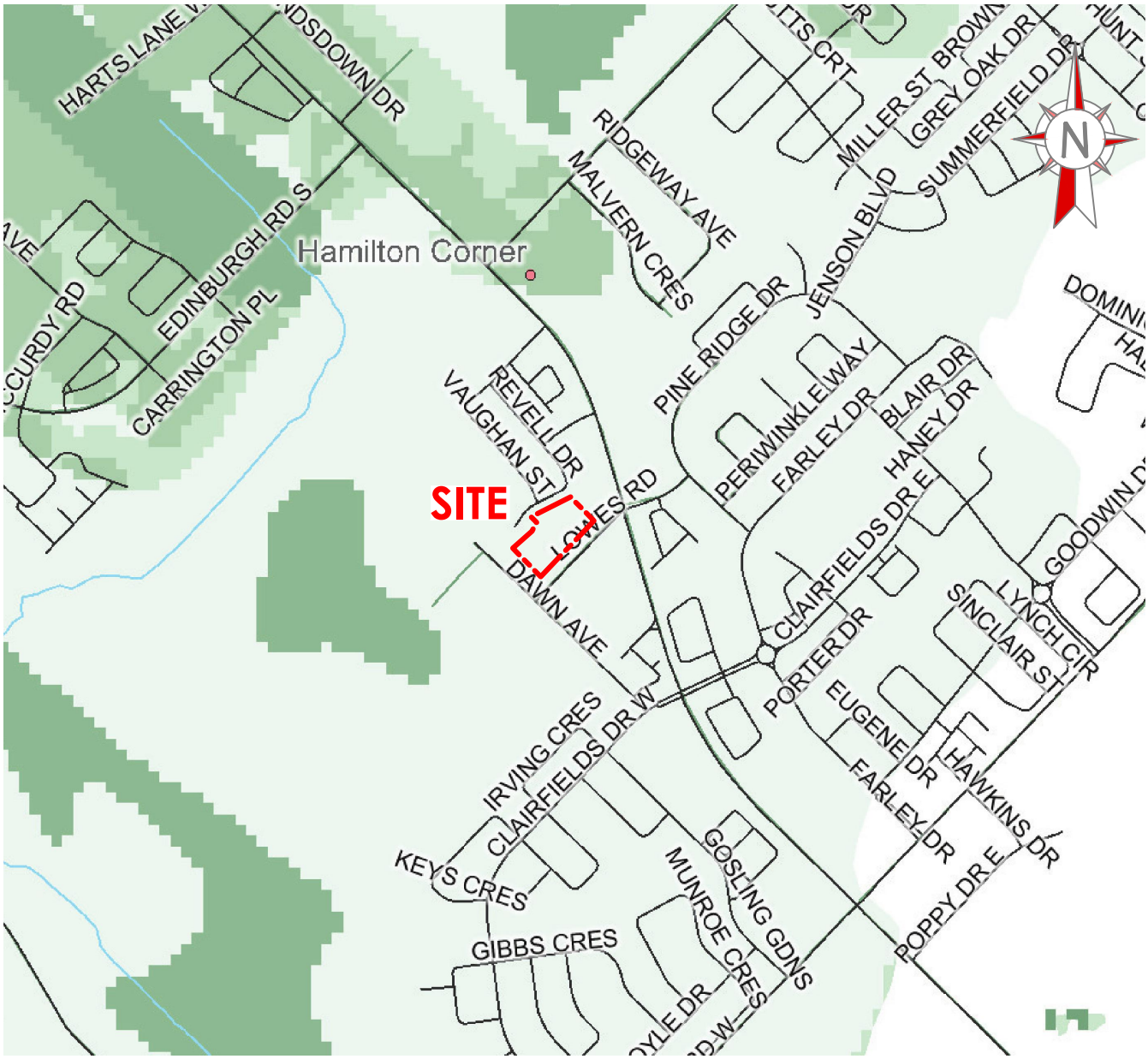

LEGEND :

- less than 50 mm/yr
- 50 - 125
- 125 - 250
- 250 - 400
- > 400

NOTES :

1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, Average Annual Runoff, (2016).

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

0 100 200 300 400 500 m

SCALE 1:15000

Project

Lowes Road Development Hydrogeology Study

Lowes Road, Guelph, Ontario

Title

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M. dept.	Project	Disc.	Dwg no.	Rev.
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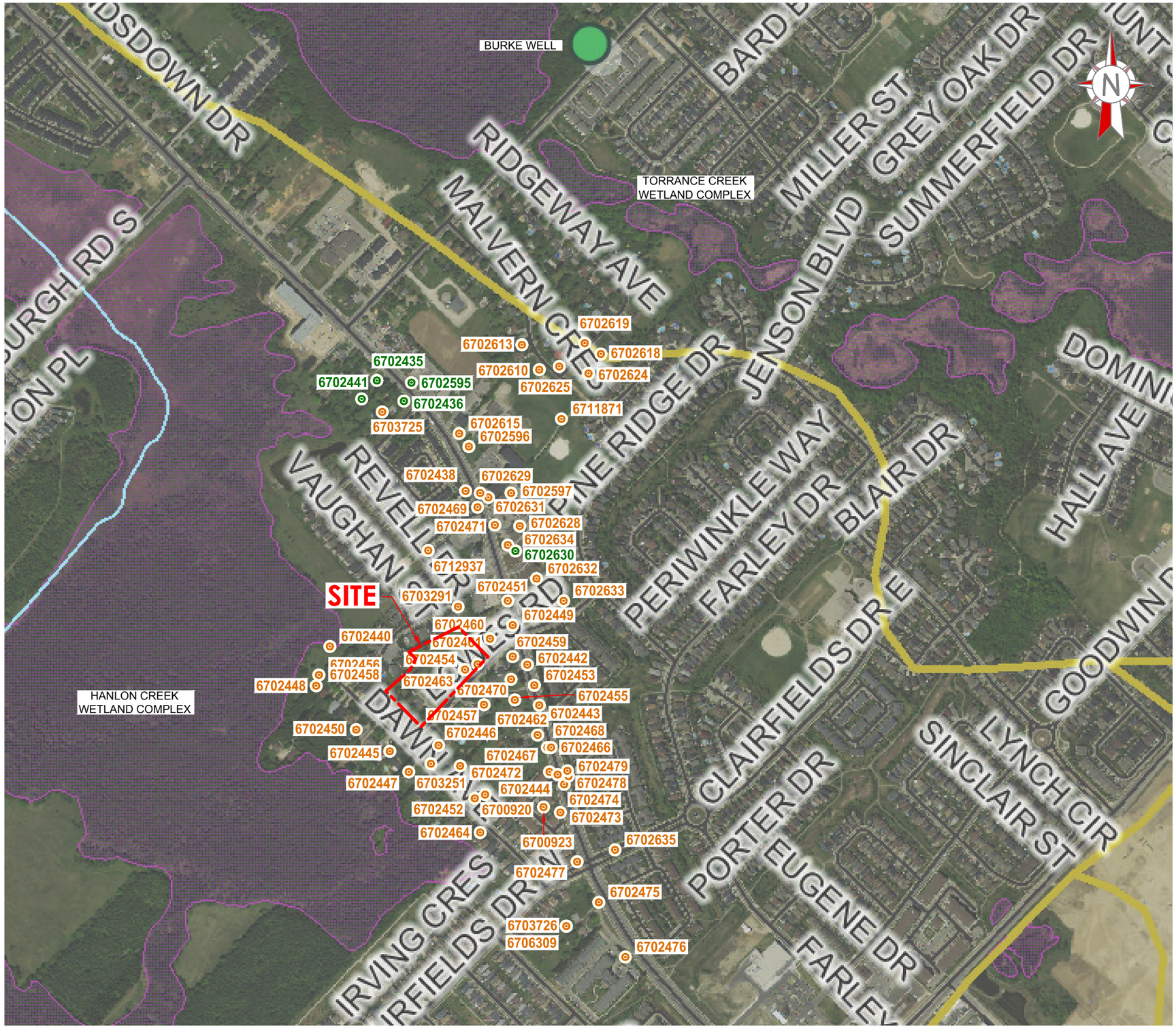

LEGEND :

- MOECC WATER WELL LOCATION - Overburden
- MOECC WATER WELL LOCATION - Bedrock
- GRCA SUBWATERSHED BOUNDARY

0 100 200 300 m

SCALE 1:7500

NOTES :

1-REFERENCES :

- GRAND RIVER CONSERVATION AUTHORITY, 2010 Aerial Photograph (2016).
- MOECC - MINISTRY OF ENVIRONMENT AND CLIMATE CHANGE Water Well Record, 2016.

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

Project

Lowes Road Development, Hydrogeology Study

Lowes Road, Guelph, Ontario

Title

MOECC WATER WELL RECORD

Englobe Corp.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
Fax : 519.741.5422

Prepared	K. Ashe	Discipline	HYDROGEOLOGY
Drawn	K. Ashe	Scale	1:7500
Checked	S. Meteer	Date	2016-05-16
Project manager	S. Meteer	Sequence no.	08 of 12

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0010233-0-02-300	HD	008	00

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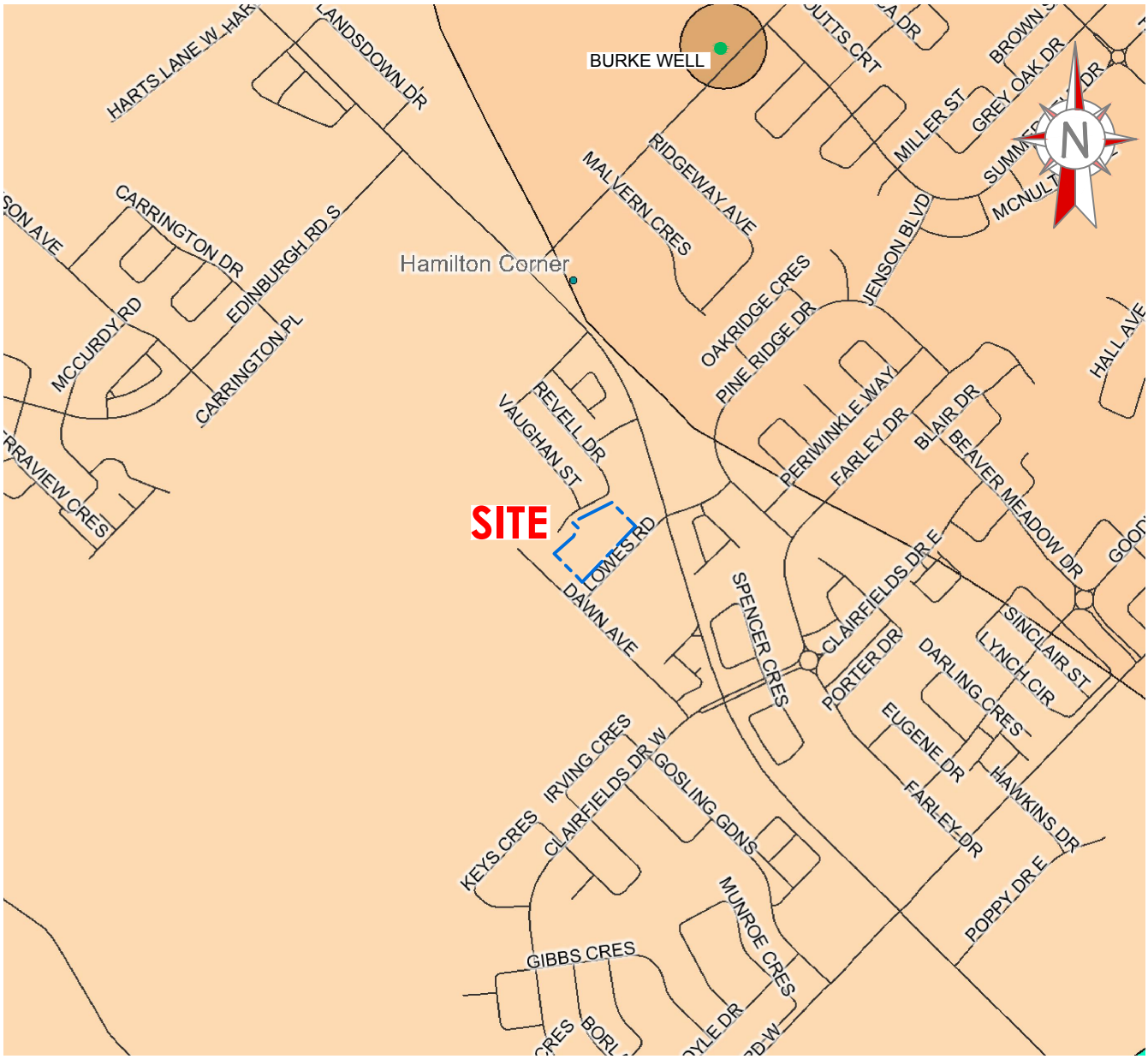

LEGEND :

- WHPA-A
- WHPA-B
- WHPA-C
- WHPA-D
- MUNICIPAL WATER WELL

NOTES :

1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, WHPA Protection Area, (2016).

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

0 100 200 300 400 500 m

SCALE 1:15000

Project

Lowes Road Development Hydrogeology Study

Lowes Road, Guelph, Ontario

Title

WELL HEAD PROTECTION AREA

Englobe Corp.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
Fax : 519.741.5422

Prepared	E.Ciochon	Discipline	HYDROGEOLOGY	Project manager	S.Meteer
Drawn	E.Ciochon	Scale	1 : 15000	Sequence no.	09 of 12
Checked	S.Meteer	Date	2016-05-06		

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0010233-0-02-300	HD	009	00

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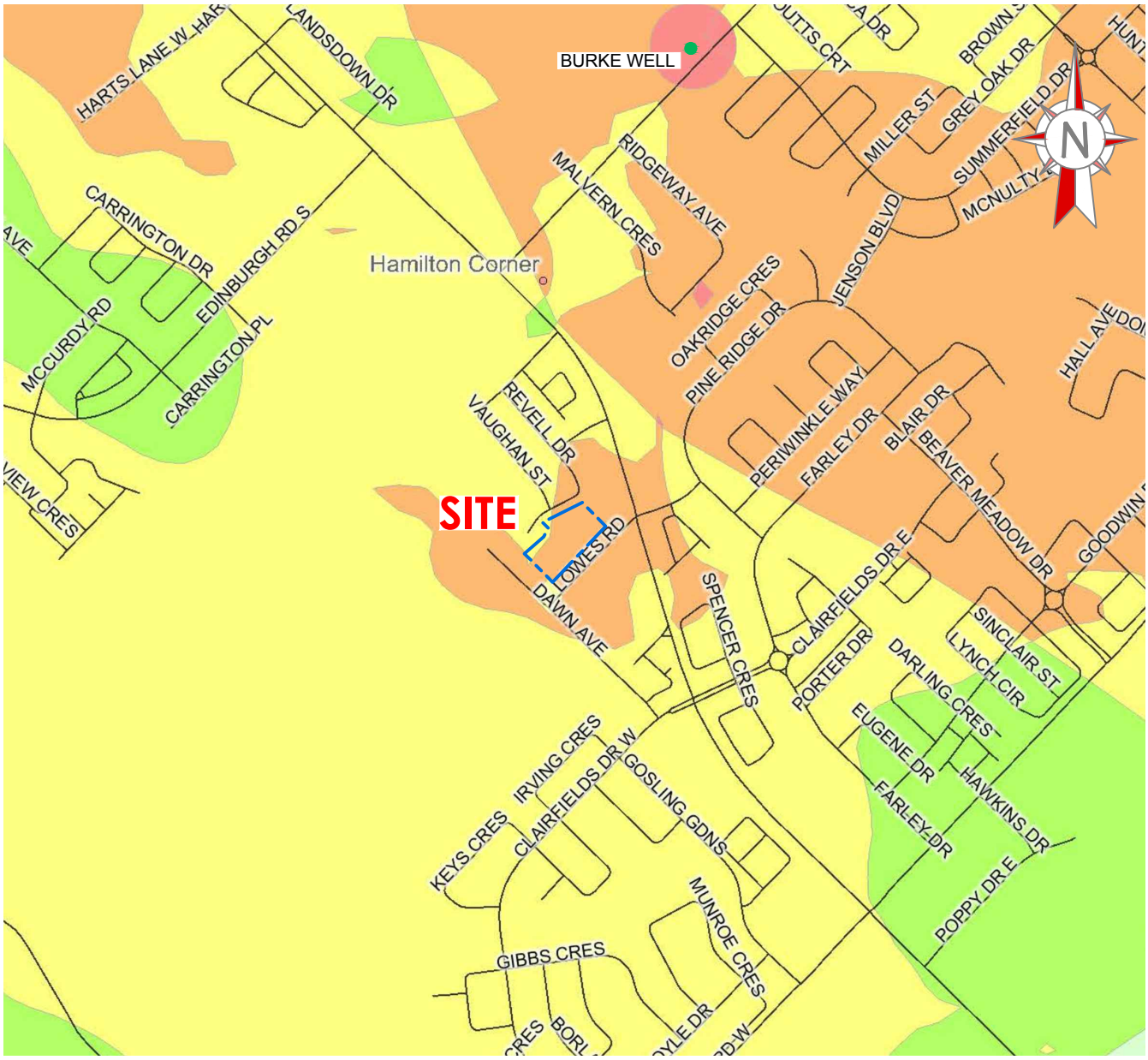

LEGEND :

10	MUNICIPAL WATER WELL
8	
6	
4	
2	

NOTES :

1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, Wellhead Protection Area Vulnerability, (2016).

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

0 100 200 300 400 500 m

SCALE 1:15000

Project

Lowes Road Development Hydrogeology Study

Lowes Road, Guelph, Ontario

Title

WELLHEAD PROTECTION AREA VULNERABILITY

Englobe Corp.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
Fax : 519.741.5422

Prepared	K. Ashe	Discipline	HYDROGEOLOGY	Project manager	S. Meteer
Drawn	K. Ashe	Scale	1 : 15000	Sequence no.	10 of 12
Checked	S. Meteer	Date	2016-05-16		

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0010233-0-02-300	HD	010	00

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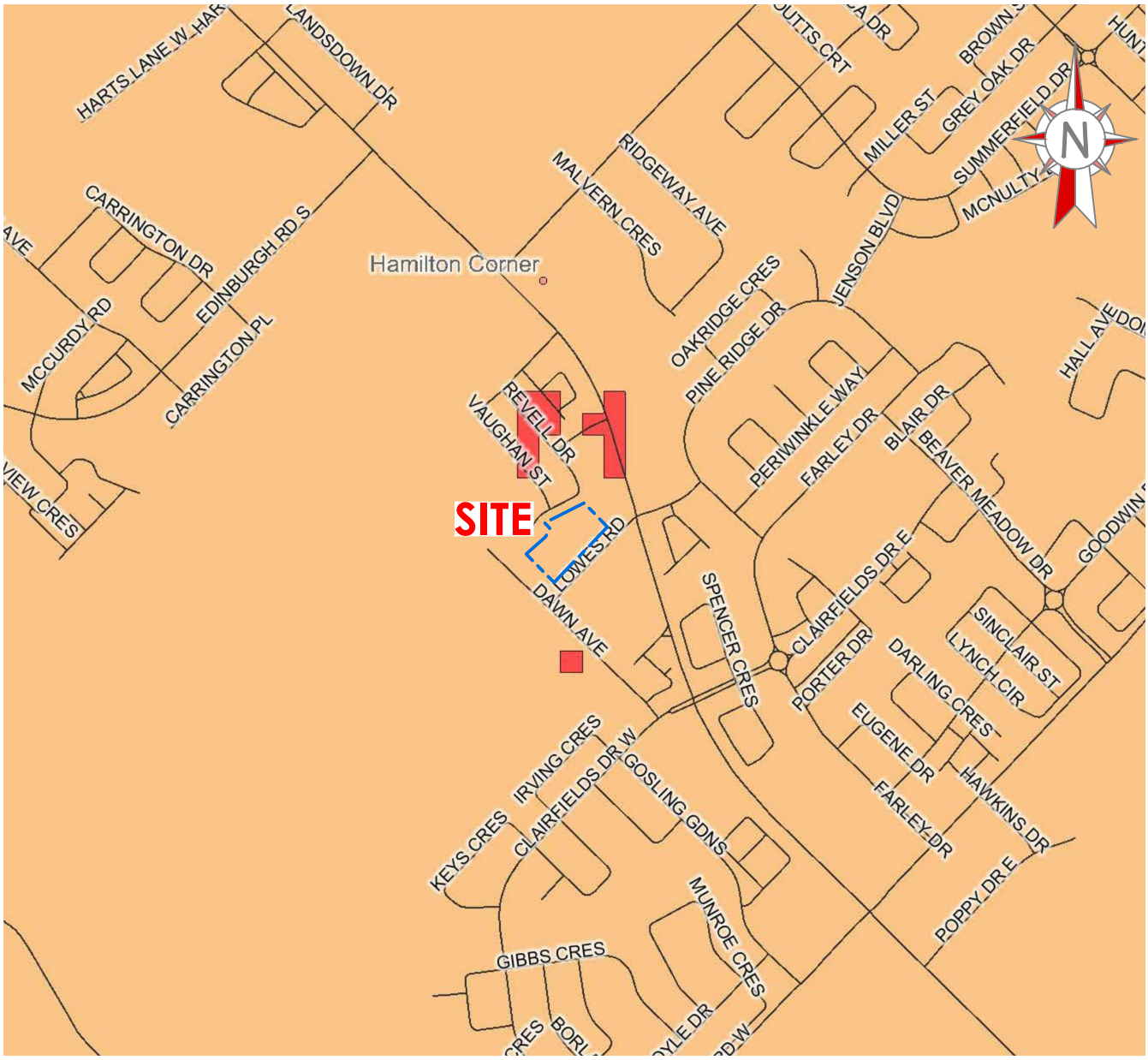

LEGEND :

- HIGH
- MEDIUM

NOTES :

1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, Intrinsic Vulnerability, (2016).

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

0 100 200 300 400 500 m

SCALE 1:15000

Project

Lowes Road Development Hydrogeology Study

Lowes Road, Guelph, Ontario

Title

INTRINSIC VULNERABILITY

Englobe Corp.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
Fax : 519.741.5422

Prepared	K. Ashe	Discipline	HYDROGEOLOGY	Project manager	S. Meteer
Drawn	K. Ashe	Scale	1 : 15000	Sequence no.	11 of 12
Checked	S. Meteer	Date	2016-05-16		

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0010233-0-02-300	HD	011	00

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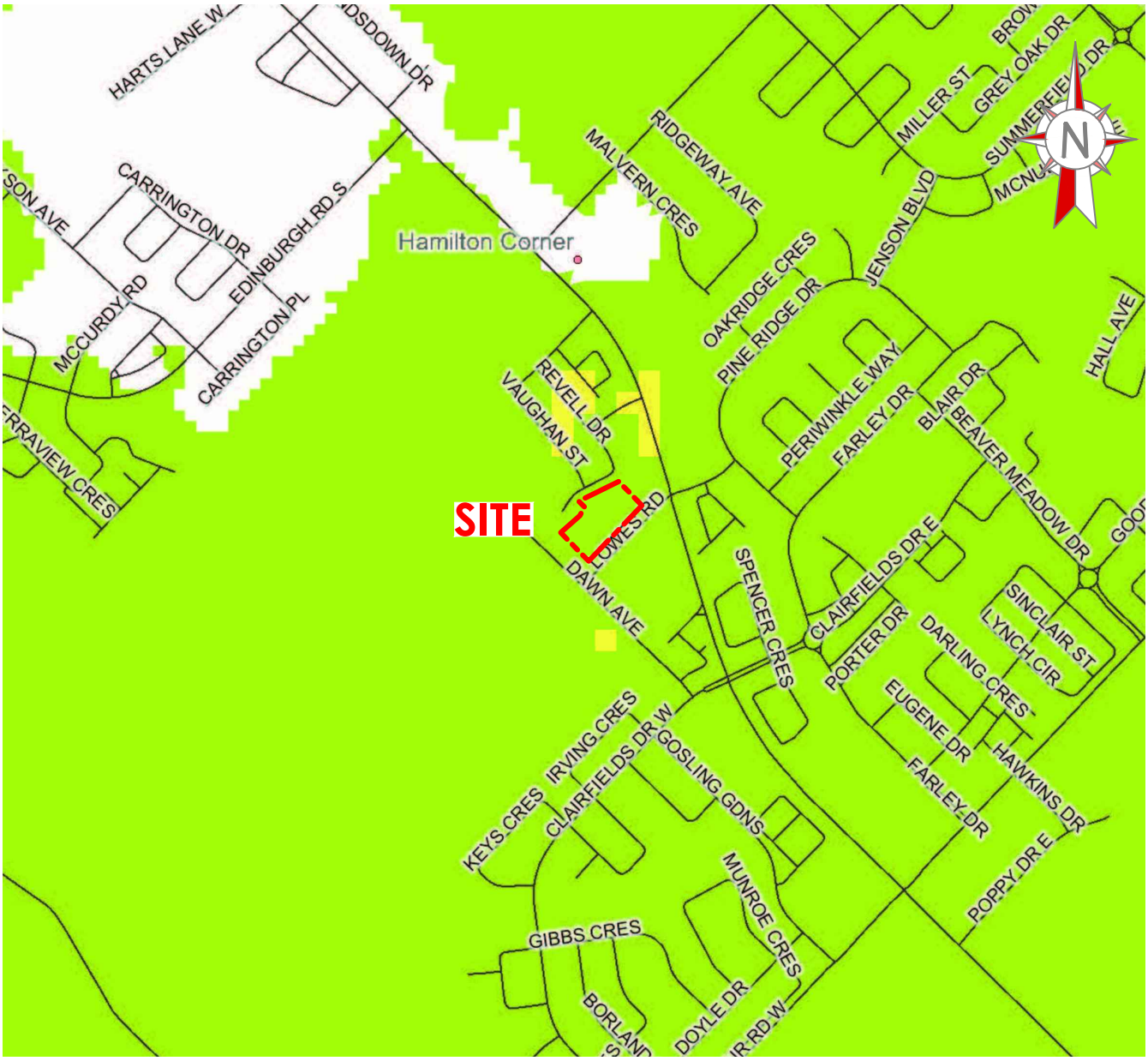

LEGEND :

6	HIGH
4	MEDIUM
2	LOW

NOTES :

1-REFERENCES : GRAND RIVER CONSERVATION AUTHORITY, Intrinsic Vulnerability, (2016).

2-Drawing scale may be distorted due to file conversion and/or copying. Measurements taken from the drawing must be verified in the field.

0 100 200 300 400 500 m

SCALE 1:15000

Project

Lowes Road Development Hydrogeology Study

Lowes Road, Guelph, Ontario

Title

SIGNIFICANT GROUNDWATER RECHARGE VULNERABILITY

Englobe Corp.
353, Bridge Street East
Kitchener (Ontario) N2K 2Y5
Telephone : 519.741.1313
Fax : 519.741.5422

Prepared	E.Ciochon	Discipline	HYDROGEOLOGY	Project manager	S. Meteer
Drawn	E.Ciochon	Scale	1 : 15000	Sequence no.	12 of 12
Checked	S. Meteer	Date	2016-06-16		

M. dept.	Project	Disc.	Dwg no.	Rev.
160	P-0010233-0-02-300	HD	012	00

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Appendix 2 Borehole Logs

List of Abbreviations
Boreholes BH-01-16 to BH-13-16

LIST OF ABBREVIATIONS

The abbreviations commonly employed on the borehole logs, on the figures, and in the text of the report, are as follows:

Sample Types		Soil Tests and Properties	
AS	Auger Sample	SPT	Standard Penetration Test
CS	Core Sample	UC	Unconfined Compression
RC	Rock Core	FV	Field Vane Test
SS	Split Spoon	ø	Angle of internal friction
TW	Thinwall, Open	γ	Unit weight
WS	Wash Sample	w_p	Plastic limit
BS	Bulk Sample	w	Water content
GS	Grab Sample	w_L	Liquid limit
WC	Water Content Sample	I_L	Liquidity index
TP	Thinwall, Piston	I_p	Plasticity index
		PP	Pocket penetrometer

Penetration Resistances	
Dynamic Penetration Resistance	The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) diameter 60º cone a distance 300 mm (12 in.). The cone is attached to 'A' size drill rods and casing is not used.
Standard Penetration Resistance, N (ASTM D1586)	The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) required to drive a standard split spoon sampler 300 mm (12 in.)
WH	sampler advanced by static weight of hammer
PH	sampler advanced by hydraulic pressure
PM	sampler advanced by manual pressure

Soil Description		
Cohesionless Soils	**SPT N-Value**	**Relative Density (D_r)**
Compactness Condition	(blows per 0.3 m)	(%)
Very Loose	0 to 4	0 to 20
Loose	4 to 10	20 to 40
Compact	10 to 30	40 to 60
Dense	30 to 50	60 to 80
Very Dense	over 50	80 to 100
Cohesive Soils	**Undrained Shear Strength (C_u)**	
Consistency	**kPa**	**psf**
Very Soft	less than 12	less than 250
Soft	12 to 25	250 to 500
Firm	25 to 50	500 to 1000
Stiff	50 to 100	1000 to 2000
Very Stiff	100 to 200	2000 to 4000
Hard	over 200	over 4000
DTPL	Drier than plastic limit	Low Plasticity, W_L <30
APL	About plastic limit	Medium Plasticity, 30 < W_L < 50
WTPL	Wetter than plastic limit	High Plasticity, W_L > 50

Englobe

Ground Elevation:	*332.79 m*	**Borehole Number:**	**BH-01-16**
Northing:	*4817479.66 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564870.78 m*	**Drill Date:**	*2016-05-02*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE								
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Shear Strength (FV) kPa	Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		332.79							
	TOPSOIL: dark brown silt, some sand and gravel, numerous cobbles, moist		0.00 / 332.61 / 0.18							flushmount cover and concrete
	SAND AND GRAVEL: dense brown sand and gravel, trace silt, occasional cobbles, moist			SS-1	8-18 20	38				
	very dense, numerous cobbles		331.27 / 1.52	SS-2	23-33 35	68				
				SS-3	50 /150 mm					bentonite seal
	dense, saturated		329.74 / 3.05	SS-4	20-31 17	48				el. 329.85 m 2016-05-12
	compact, occasional cobbles		328.22 / 4.57	SS-5	10-12 10	22				sand pack
										50 mm pipe 1.52 m slotted screen
	SILT AND SAND: compact brown gravelly silty fine sand, trace clay, wet to saturated		326.69 / 6.10	SS-6	4-6 10	16				native cave
	Borehole terminated at 6.55 m		326.24 / 6.55							

Dynamic Cone: 20 40 60 80 — Std Penetration: 20 40 60 80

Shear Strength (PP) kPa: 50 100 150 200 — Initial / Remold — Shear Strength (FV) kPa: 50 100 150 200

WP WL — Water Content (%): 10 20 30

Reviewed by: *K.Thrams* **Drafted by:** *E.Ciochon* **Sheet:** *1 of 1*

Notes: *MOECC Well Tag No.A192785.*
Well Record for Well Cluster: C27745.

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*332.39 m*	**Borehole Number:**	**BH-02-16**
Northing:	*4817500.03 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564840.49 m*	**Drill Date:**	*2016-05-02*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Initial / Remold / Shear Strength (FV) kPa	WP WL / Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		332.39							
	FILL: loose brown silty sand and gravel, very moist		0.00 / 332.24	SS-1	5-5 3-3	8				flushmount cover and concrete
	loose dark brown silt, some topsoil, trace sand and organics, moist		0.15 / 332.11							
	brown sandy silt, trace gravel, very moist		0.28 / 331.48	SS-2	4-6 9-9	15				bentonite seal
1	***SAND AND GRAVEL:*** compact brown sand and gravel, some silt, occasional cobbles, moist		0.91 / 330.87	SS-3	18-20 30-26	50				
	very dense, numerous cobbles		1.52							
2				SS-4	46-23 21-16	44				el. 329.76 m 2016-05-12
	dense, wet		329.65 / 2.74							
3	compact, saturated		329.34 / 3.05	SS-5	13-14 14-12	28				sand pack
	very dense to dense		328.58 / 3.81	SS-6	27-30 35-30	65				50 mm pipe 3.05 m slotted screen
4										
5				SS-7	12-19 21-20	40				
	compact, occasional cobbles		327.06 / 5.33	SS-8	17-13 12-10	25				native cave
6	Borehole terminated 5.94 m		326.45 / 5.94							
7										
8										

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Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*332.57 m*	**Borehole Number:**	**BH-03-16**
Northing:	*4817516.77 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564855.63 m*	**Drill Date:**	*2016-05-02*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Shear Strength (FV) kPa	Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		332.57							
	FILL: dark brown silt (topsoil), trace gravel, moist		0.00 332.26	SS-1	2-2 4-6	6				
	SAND AND GRAVEL: dense brown sand and gravel, some silt, numerous cobbles, moist		0.30	SS-2	7-24 16-20	40				native backfill
	very dense		331.05 1.52	SS-3	17-60 /150 mm					
				SS-4	46-45 50	95				
	wet		329.67 2.90							native cave
	dense, occasional cobbles, saturated		329.52 3.05	SS-5	14-17 20-27	37				
	Borehole terminated at 3.66 m		328.91 3.66							At drilling completion, dry cave at 2.24 m.

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 (Initial / Remold)

Water Content (%): WP WL; 10 20 30

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Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*332.31 m*	**Borehole Number:**	**BH-04-16**
Northing:	*4817509.32 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564892.64 m*	**Drill Date:**	*2016-05-02*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Initial / Remold / Shear Strength (FV) kPa	WP WL / Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		332.31							
	FILL: dark brown silt (topsoil), trace sand and gravel, moist		0.00 / 332.16 / 0.15							flushmount cover and concrete
	brown sandy silt, some gravel, trace topsoil, very moist		331.70 / 0.61							
1	***SAND AND GRAVEL:*** dense brown sand and gravel, some silt, occasional cobbles, moist			SS-1	6-15 25	40				
				SS-2	12-22 25	47				el. 329.91 m 2016-05-12
2	saturated		330.02 / 2.29							bentonite seal
				SS-3	7-13 19	32				
3				SS-4	9-16 16	32				
4										
				SS-5	12-20 24	44				sand pack
5										50 mm pipe 1.52 m slotted screen
6	compact		326.21 / 6.10	SS-6	12-12 12	24				native cave
	Borehole terminated at 6.55 m		325.76 / 6.55							
7										
8										

Reviewed by: *K.Thrams* **Drafted by:** *E.Ciochon* **Sheet:** *1 of 1*

Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*331.42 m*	**Borehole Number:**	**BH-05-16**
Northing:	*4817547.70 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564859.41 m*	**Drill Date:**	*2016-05-02*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Initial / Remold / Shear Strength (FV) kPa	WP WL / Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		331.42							
	FILL: loose dark brown silt (topsoil), trace sand and gravel, very moist		0.00 331.19 0.23	SS-1	1-2 3-5	5				native backfill
	SAND: loose brown sand, some silt, trace gravel, moist		330.66 0.76	SS-2	7-11 17-20	28				
1	***SAND AND GRAVEL:*** compact to dense brown sand and gravel, some silt, moist									bentonite seal
	dense, saturated		329.90 1.52	SS-3	10-14 21	35				
2										
	trace silt		329.13 2.29	SS-4	11-15 15	30				
3				SS-5	6-17 19	36				
4										native cave
	compact		326.85 4.57	SS-6	8-10 14	24				
5										
6				SS-7	7-8 9	17				
	Borehole terminated at 6.55 m		324.87 6.55							At drilling completion, dry cave at 2.13 m.
7										
8										

Reviewed by: *K.Thrams* **Drafted by:** *E.Ciochon* **Sheet:** *1 of 1*

Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*331.32 m*	**Borehole Number:**	**BH-06-16**
Northing:	*4817570.01 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564871.12 m*	**Drill Date:**	*2016-05-03*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Shear Strength (FV) kPa	Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		331.32							
	TOPSOIL: dark brown silt, moist		0.00 / 331.12							
	SAND: loose brown/dark brown silty sand, trace gravel and topsoil, very moist		0.20 / 330.56	SS-1	2-3 5-5	8				
1	compact, brown, some gravel, occasional cobbles, moist		0.76 / 329.80	SS-2	9-7 6-6	13				
	SAND AND GRAVEL: very dense grey/brown sand and gravel, trace silt, numerous cobbles, saturated		1.52 / 329.03	SS-3	16-24 39-20	63				
2	dense		2.29 / 328.27	SS-4	31-20 23-32	43				
3	compact		3.05 / 327.51	SS-5	12-13 14-16	27				
	very dense		3.81 / 326.75	SS-6	17-15 /75 mm					
4	compact, brown, occasional cobbles		4.57 / 326.14	SS-7	9-11 15-19	26				
5	Borehole terminated at 5.18 m		5.18							
6										
7										
8										

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 — Initial / Remold

Water Content (%): WP WL — 10 20 30

Groundwater Observations and Standpipe Details:
- flushmount cover and concrete
- bentonite seal
- el. 329.86 m 2016-05-12
- sand pack
- 50 mm pipe
- 3.05 m slotted screen
- native cave

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Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*332.44 m*	**Borehole Number:**	**BH-07-16**
Northing:	*4817527.72 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564913.43 m*	**Drill Date:**	*2016-05-04*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Initial / Remold / Shear Strength (FV) kPa	Water Content (%) WP WL	Groundwater Observations and Standpipe Details
	Ground Elevation		332.44							
	FILL: dark brown silt (topsoil), trace sand and gravel, occasional cobbles, moist		0.00 / 331.83							topsoil; native backfill
1	***SILT:*** compact brown/dark brown sandy silt, some gravel and topsoil, trace clay, occasional cobbles, moist		0.61 / 331.22	SS-1	1-3 12	15				bentonite seal
	SAND AND GRAVEL: compact brown sand and gravel, some silt, numerous cobbles, moist		1.22	SS-2	9-11 15	26				
2	dense		330.15 / 2.29	SS-3	12-22 20	42				
	wet		329.85 / 2.59							
3	compact, saturated		329.39 / 3.05	SS-4	10-13 13	26				
4										native cave
5				SS-5	8-9 17	26				
6				SS-6	11-12 15	27				
	Borehole terminated at 6.55 m		325.89 / 6.55							At drilling completion, dry cave at 1.52 m.
7										
8										

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 — Initial, Remold

Water Content (%): 10 20 30 — WP, WL

Reviewed by: *K.Thrams* **Drafted by:** *E.Ciochon* **Sheet:** *1 of 1*

Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*331.42 m*	**Borehole Number:**	**BH-08-16**
Northing:	*4817586.89 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564883.60 m*	**Drill Date:**	*2016-05-03*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Initial / Remold / Shear Strength (FV) kPa	Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		331.42							
	TOPSOIL: loose dark brown silt, moist		0.00 / 331.22	SS-1	2-2 3	5				topsoil
	SAND: loose brown silty sand, some gravel, trace topsoil, moist		0.20 / 330.66							native backfill
1	***SAND AND GRAVEL:*** very dense brown sand and gravel, some silt, numerous cobbles, moist		0.76	SS-2	9-23 35	58				bentonite seal
	dense, saturated		329.90 / 1.52	SS-3	13-15 15	30				
2			329.13							
	very dense		2.29	SS-4	16-31 35	66				
3			328.37							
	dense		3.05	SS-5	16-18 24	42				
4										native cave
5				SS-6	14-17 20	37				
6				SS-7	8-14 17	31				
	Borehole terminated at 6.55 m		324.87 / 6.55							At drilling completion, wet cave at 1.52 m.
7										
8										

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 — Initial, Remold

Water Content (%): WP, WL; 10 20 30

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Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*332.22 m*	**Borehole Number:**	**BH-09-16**
Northing:	*4817555.61 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564916.85 m*	**Drill Date:**	*2016-05-04*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value
	Ground Elevation		332.22			
	FILL: compact brown silty sand and gravel, some topsoil, moist		0.00 / 331.99			
	dark brown silt, some sand, trace gravel and organics, moist		0.23 / 331.46	SS-1	6-10 9-8	19
1	loose brown/dark brown mottled silt, some sand, topsoil and gravel, occasional cobbles, moist		0.76 / 330.70	SS-2	4-3 5-9	8
	SAND AND GRAVEL: dense brown sand and gravel, some silt, numerous cobbles, moist		1.52	SS-3	16-20 22-22	42
2	very dense, saturated		329.93 / 2.29	SS-4	23-50 /150 mm	
3	compact, some medium sand layers		329.17 / 3.05	SS-5	9-10 17-18	27
4				SS-6	15-10 18-21	28
	dense		327.65 / 4.57	SS-7	10-19 17-12	36
5						
6				SS-8	14-16 20-31	36
	Borehole terminated at 6.10 m		326.12 / 6.10			
7						
8						

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 — Initial / Remold

Water Content (%): WP WL — 10 20 30

Groundwater Observations and Standpipe Details

- flushmount cover and concrete
- bentonite seal
- Tel. 329.99 m 2016-05-12
- sand pack
- 50 mm pipe
- 3.05 m slotted screen
- native cave

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Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*331.97 m*	**Borehole Number:**	**BH-10-16**
Northing:	*4817597.87 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564907.94 m*	**Drill Date:**	*2016-05-03*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE		SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Initial / Remold / Shear Strength (FV) kPa	Water Content (%) WP WL	Groundwater Observations and Standpipe Details
	Ground Elevation		331.97							
	TOPSOIL: dark brown silt, trace sand and gravel, occasional cobbles, moist		0.00 331.72 0.25							protective cover and concrete
1	***SAND AND GRAVEL:*** compact brown silty sand and gravel, trace topsoil, moist			SS-1	3-5 6	11				
	very dense, trace silt, numerous cobbles		330.45 1.52	SS-2	9-29 35	64				
2	saturated		329.68 2.29	SS-3	60 /150 mm					el. 330.00 m 2016-05-12
3	compact		328.92 3.05	SS-4	7-11 15	26				sand pack
4										50 mm pipe 1.52 m slotted screen
5				SS-5	8-10 12	22				
6	dense		325.87 6.10	SS-6	8-21 26	47				native cave
	Borehole terminated at 6.55 m		325.42 6.55							
7										
8										

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 — Initial, Remold

Water Content (%): 10 20 30

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Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Englobe

Ground Elevation:	*332.16 m*	**Borehole Number:**	**BH-11-16**
Northing:	*4817565.23 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564938.99 m*	**Drill Date:**	*2016-05-04*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

SOIL PROFILE			SAMPLE							
Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value	Dynamic Cone / Std Penetration	Shear Strength (PP) kPa / Initial / Remold / Shear Strength (FV) kPa	Water Content (%)	Groundwater Observations and Standpipe Details
	Ground Elevation		332.16							
	FILL: dark brown silt (topsoil), trace sand and roots, moist		0.00							topsoil
	compact brown silty sand, some gravel, very moist		331.75 / 0.41							native backfill
1				SS-1	4-9 10	19				
	SAND AND GRAVEL: very dense brown sand and gravel, trace silt, numerous cobbles, moist to very moist		330.94 / 1.22							bentonite seal
2				SS-2	23-29 29	58				
	dense, saturated		329.87 / 2.29	SS-3	10-23 18	41				
3										
				SS-4	10-13 18	31				
4										native cave
	compact, occasional cobbles, some sand layers		327.59 / 4.57	SS-5	10-11 10	21				
5										
6				SS-6	11-16 12	28				
	Borehole terminated at 6.55 m		325.61 / 6.55							At drilling completion, wet cave at 2.29 m.
7										
8										

Dynamic Cone / Std Penetration: 20 40 60 80

Shear Strength (PP) kPa / Shear Strength (FV) kPa: 50 100 150 200 — Initial / Remold

Water Content (%): WP WL — 10 20 30

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Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

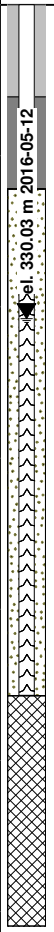
Englobe

Ground Elevation:	*332.07 m*	**Borehole Number:**	**BH-12-16**
Northing:	*4817620.24 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564915.94 m*	**Drill Date:**	*2016-05-03*
		Field Tech:	*D.Souter*
Project:	*Proposed Residential Development*		
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value
	Ground Elevation		332.07			
	TOPSOIL: loose dark brown silt, trace sand and gravel, moist		0.00 / 331.76	SS-1	1-2 7-10	9
	SAND AND GRAVEL: compact brown sand and gravel, trace silt, numerous cobbles, moist		0.30 / 331.31			
1	very dense, grey/brown		0.76	SS-2	21-25 45-45	70
				SS-3	14-50 /75 mm	
2			329.78			
	dense, saturated		2.29	SS-4	12-20 18-14	38
3			329.02			
	compact		3.05	SS-5	8-11 12-16	23
			328.26			
4	dense		3.81	SS-6	12-14 19-12	33
				SS-7	13-17 18-20	35
5			326.58			
	compact		5.49	SS-8	11-13 15-16	28
6			325.97			
	Borehole terminated at 6.10 m		6.10			
7						
8						

Dynamic Cone: 20 40 60 80
Std Penetration: 20 40 60 80
Shear Strength (PP) kPa: 50 100 150 200
Initial
Remold
Shear Strength (FV) kPa: 50 100 150 200
WP WL
Water Content (%): 10 20 30

Groundwater Observations and Standpipe Details



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Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

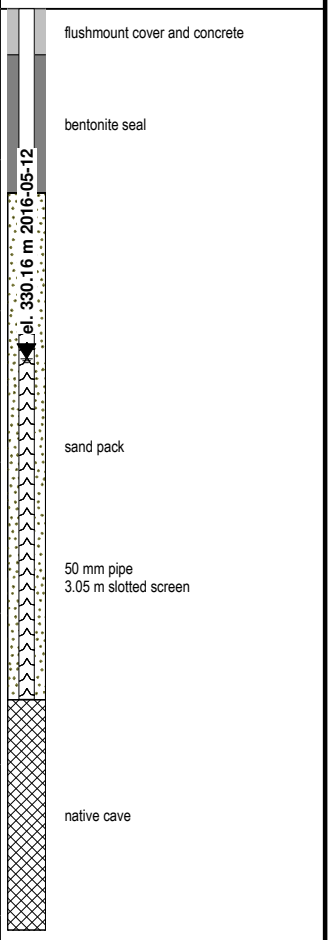
Englobe

Ground Elevation:	*332.44 m*	**Borehole Number:**	**BH-13-16**
Northing:	*4817607.48 m*	**Job N°:**	*P-0010233-0-01-100*
Easting:	*564929.82 m*	**Drill Date:**	*2016-05-04*
Project:	*Proposed Residential Development*	**Field Tech:**	*D.Souter*
Location:	*Lowes Road, Guelph, Ontario*	**Drill Method:**	*Hollow Stem Auger*

Depth (m)	Description	Symbol	Elevation (m) / Depth (m)	Type and Number	"Blows" /150 mm	SPT 'N' Value
	Ground Elevation		332.44			
	TOPSOIL: loose dark brown silt, trace sand, moist		0.00 / 332.08	SS-1	1-2 5-5	7
	SAND AND GRAVEL: loose brown sand and gravel, some silt, numerous cobbles, moist		0.36 / 331.68			
1	dense		0.76 / 330.92	SS-2	23-17 24-50	41
	very dense		1.52 / 330.15	SS-3	23-22 33-45	55
2	compact, occasional cobbles, saturated		2.29	SS-4	10-12 14-15	26
3				SS-5	8-9 10-10	19
	dense		3.81 / 328.63	SS-6	9-15 15-20	30
4						
				SS-7	13-14 16-17	30
5						
	compact		5.49 / 326.95	SS-8	10-11 8-8	19
6			326.34			
	Borehole terminated at 6.10 m		6.10			
7						
8						

Dynamic Cone: 20 40 60 80
Std Penetration: 20 40 60 80
Shear Strength (PP) kPa: 50 100 150 200
Initial
Remold
Shear Strength (FV) kPa: 50 100 150 200
WP WL
Water Content (%): 10 20 30

Groundwater Observations and Standpipe Details



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Notes:

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Vertical Scale = 1 : 50.0

EQ-09-Ge-72 R.1 18.02.2011

Appendix 3 Figures

Figures 1 and 2 (particle size distribution curves)

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PARTICLE SIZE ANALYSIS

Project: **Proposed Residential Development**

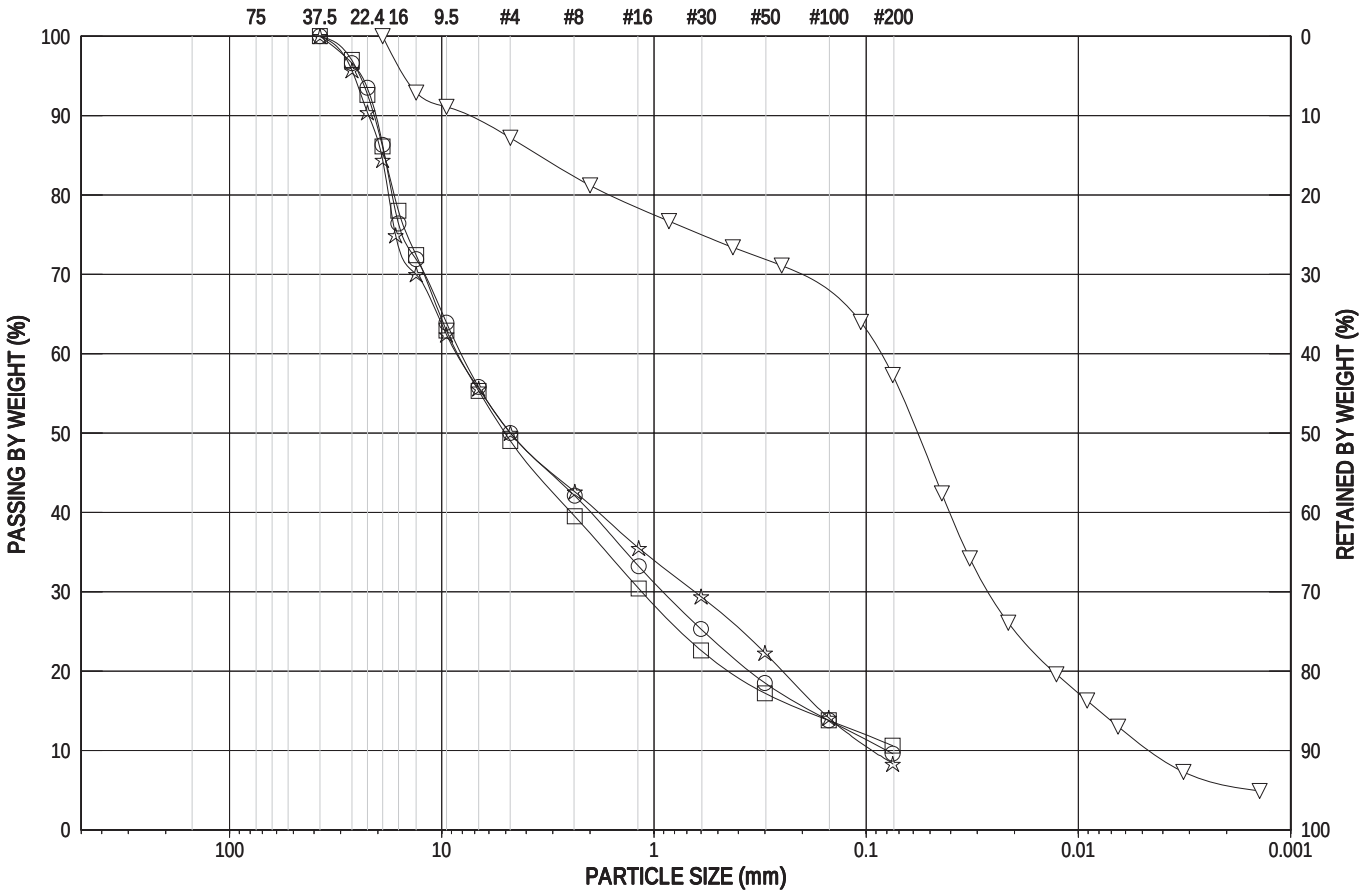
Figure No : **1**

Location: **Lowes Road, Guelph, Ontario**

File No : **P-0010233-0-01-100**

UNIFIED SOIL CLASSIFICATION

COBBLES	*GRAVEL*		*SAND*			*SILT OR CLAY*
	COARSE	FINE	COARSE	MEDIUM	FINE	
U.S. SIEVE SIZE IN MILLIMETRES			*U.S. STANDARD SIEVE No.*			*HYDROMETER*



Symbol	Borehole n°	Sample n°	Depth (m)	Description
○	BH-01-16	SS-1 to SS-5	0.76 - 1.22	SAND and GRAVEL, trace Silt
□	BH-02-16	SS-3 to SS-6	1.52 - 2.13	SAND and GRAVEL, some Silt
▽	BH-07-16	SS-1	0.76 - 1.22	Sandy SILT, some Gravel, trace Clay
☆	BH-11-16	SS-2 to SS-6	1.52 - 1.98	SAND and GRAVEL, trace Silt

Englobe

PARTICLE SIZE ANALYSIS

Project: **Proposed Residential Development**

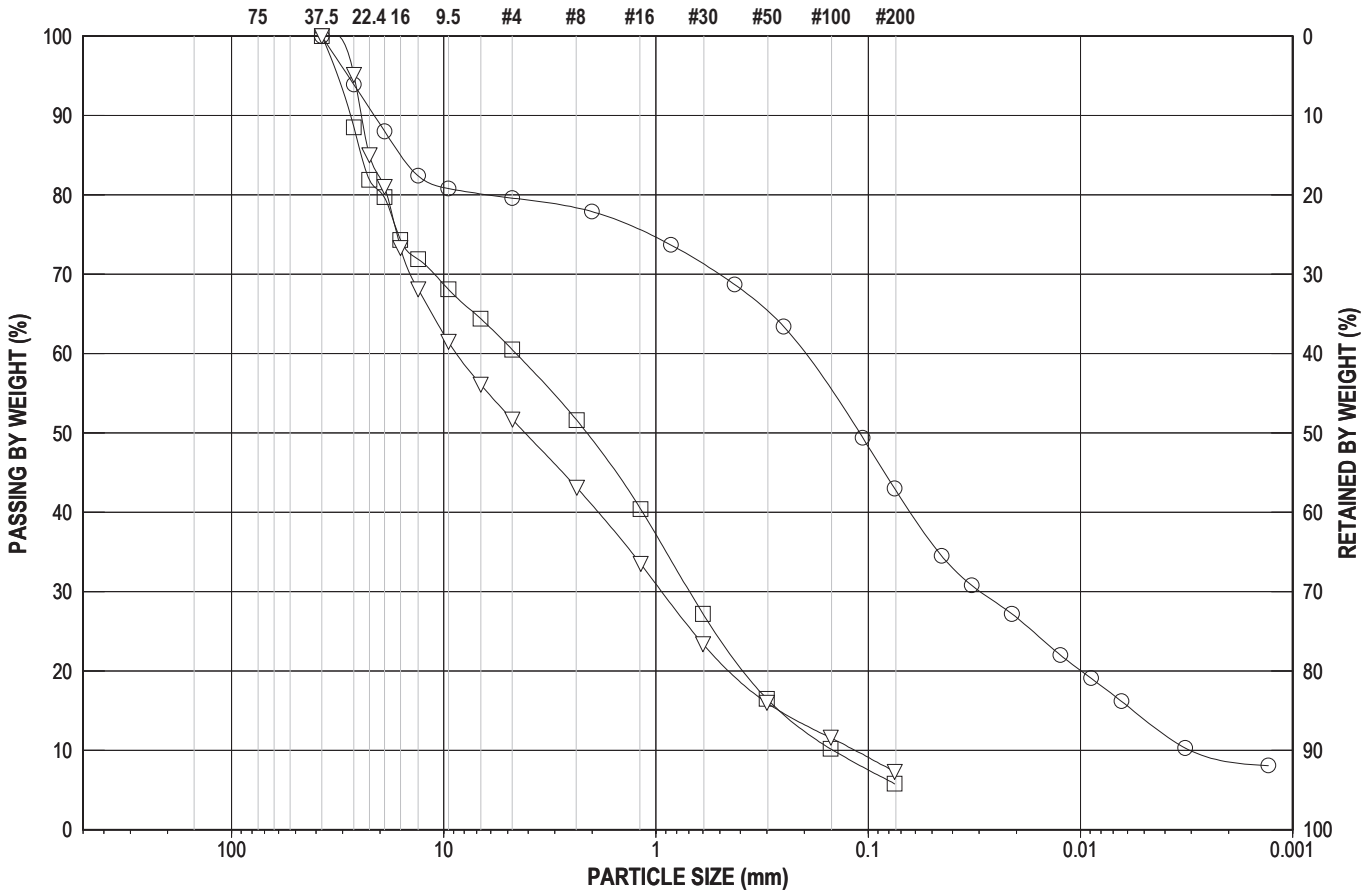
Figure No : **2**

Location: **Lowes Road, Guelph, Ontario**

File No : **P-0010233-0-01-100**

UNIFIED SOIL CLASSIFICATION

COBBLES	*GRAVEL*		*SAND*			*SILT OR CLAY*
	COARSE	FINE	COARSE	MEDIUM	FINE	
U.S. SIEVE SIZE IN MILLIMETRES			*U.S. STANDARD SIEVE No.*			*HYDROMETER*



Symbol	Borehole n°	Sample n°	Depth (m)	Description
○	BH-01-16	SS-6	6.10 - 6.55	Gravelly SILT and SAND, trace Clay
□	BH-06-16	SS-4 to SS-7	2.29 - 2.90	SAND and GRAVEL, trace Silt
▽	BH-10-16	SS-2 to SS-6	1.52 - 1.98	SAND and GRAVEL, trace Silt

Appendix 4 Tables

Table 101: Measured Groundwater Elevations
Table 102: Hydraulic Conductivity Estimates
Table 103: Groundwater Chemistry Analysis Results

Englobe

TABLE 101

MEASURED GROUNDWATER ELEVATIONS

Scoped Hydrogeology Study
Lowes Road
Guelph, Ontario

					May-12-16		
WELL NAME	GROUND SURFACE ELEVATION (mASL)	TOP OF PIPE ELEVATION (mASL)	TOP OF CASING ELEVATION (mASL)	STICK-UP (m)	DEPTH TO WL (mBTOP)	DEPTH TO WL (mBGS)	WL ELEVATION (mASL)
BH-01-16	332.79	--	332.79	--	--	2.78	330.01
BH-02-16	332.39	--	332.39	--	--	2.48	329.91
BH-04-16	332.31	--	332.31	--	--	2.30	330.01
BH-06-16	331.32	--	331.32	--	--	1.36	329.96
BH-09-16	332.22	--	332.22	--	--	2.06	330.16
BH-10-16	331.97	332.83	--	0.86	2.83	--	330.00
BH-12-16	332.07	332.80	--	0.73	2.72	--	330.08
BH-13-16	332.44	--	332.44	--	--	2.10	330.34

Notes:

1. mBTOP – metres below top of pipe.
2. mASL – metres above sea level.
3. WL – water level.

TABLE 102

HYDRAULIC CONDUCTIVITY ESTIMATES

Lowes Road Development – Hydrogeology Study
Guelph, Ontario

Borehole Name / Location	Ground Surface Elevation (mASL)	Grain Size Analyses			
		Soil Description	Sample Depth (mBGS)	Hydraulic Conductivity (m/sec)	Method
BH-01-16	332.79	Sand and gravel, trace silt, occasional cobbles	SS-1 – SS-5 0.8-5.0	1.2×10^{-5}	Kozeny- Carman, C_u = 104.9
BH-01-16	332.79	Gravelly Silt and Sand, occasional cobbles	SS-6, 6.1-6.6	4.2×10^{-7}	Kaubisch, P = 26
BH-02-16	332.39	Sand and gravel, some silt, occasional cobbles	SS-3 – SS- 6, 1.5 - 4.3	9.0×10^{-6}	Kozeny- Carman, C_u = 114.3
BH-06-16	331.32	Sand and gravel, trace silt, numerous cobbles	SS-4 – SS-7, 2.3 - 5.2	4.8×10^{-5}	Kozeny- Carman, C_u = 30
BH-07-16	332.44	Sandy Silt and gravel, numerous cobbles	SS-1 0.8-1.2	8.2×10^{-7}	Kaubisch, P = 23
BH-10-16	331.97	Sand and gravel, trace Topsoil, trace Silt, occasional cobbles	SS-2 – SS-6, 1.5 - 6.6	3.1×10^{-5}	Kozeny- Carman, C_u = 69.2
BH-11-16	332.16	Sand and gravel, trace silt, numerous cobbles	SS-2 – SS-6 1.5 – 6.6	1.7×10^{-5}	Kozeny- Carman, C_u = 17.3

Borehole Name / Location	Ground Surface Elevation (mASL)	Slug Tests			
		Soil Description	Screened Interval (mBGS)	Hydraulic Conductivity (m/sec)	Method
BH-01-16	332.79	Sand and gravel, trace Silt, occasional cobbles	4.6 – 6.1	4.8×10^{-5}	Pneumatic (rising head)
BH-02-16	332.39	Sand and gravel, some silt, occasional cobbles	1.5 - 4.6	2.3×10^{-5}	Water In (rising head)
BH-04-16	332.31	Sand and gravel, some silt, occasional cobbles	4.5 – 6.0	$> 2.0 \times 10^{-4}$	Pneumatic (rising head)
BH-06-16	331.32	Sand and gravel, trace silt, numerous cobbles	0.9 – 4.0	2.4×10^{-4}	Slug Out (rising head)
BH-09-16	332.22	Sand and gravel, some silt, numerous cobbles	1.5 - 4.6	1.3×10^{-4}	Slug Out (rising head)
BH-10-16	331.97	Sand and gravel, trace Topsoil, trace Silt, occasional cobbles	3.9 – 5.5	8.7×10^{-5}	Pneumatic (rising head)

Notes:
1. mASL – metres Above Sea Level
2. C_u = coefficient of uniformity value
3. P = percent of soil smaller than 0.02 mm
4. * = Insufficient data to determine the time lag

TABLE 103

GROUNDWATER CHEMISTRY ANALYSIS RESULTS

Scoped Hydrogeology Study
Lowes Road
Guelph, Ontario

SAMPLE ID	UNITS	TYPE OF OBJECTIVE	ODWS LIMIT	13-May-16		
				BH-02-16	BH-04-16	BH-10-16
Colour, Apparent	TCU	AO	5	**30.7**	<1.0	2.4
Conductivity	umhos/cm	-	-	1150	1120	1080
Hardness (as $CaCO_3$)	mg/L	OG	80-100	**372**	**341**	**359**
pH	pH units	OG	62-8.5	8.08	8.03	8.14
Total Dissolved Solids	mg/L	AO	500	**635**	**604**	**578**
Turbidity	NTU	AO	5	**37.2**	0.17	0.93
Alkalinity, Total (as $CaCO_3$)	mg/L	OG	30-500	271	246	256
Ammonia, Total (as N)	mg/L	-	-	0.075	0.033	0.184
Chloride (Cl)	mg/L	AO	250	185	197	167
Fluoride (F)	mg/L	MAC	1.5	<0.10	<0.10	<0.10
Nitrate (as N)	mg/L	MAC	10	4.39	4.6	5.65
Nitrite (as N)	mg/L	MAC	1	<0.050	<0.050	<0.050
Phosphate-P (ortho)	mg/L	-	-	<0.0030	<0.0030	0.0056
Sulfate (SO_4)	mg/L	AO	500	26.1	29.9	34.4
Aluminum (Al)-Total	mg/L	OG	0.1	**0.33**	<0.010	0.02
Antimony (Sb)-Total	mg/L	IMAC	0.006	<0.00010	<0.00010	<0.00010
Arsenic (As)-Total	mg/L	IMAC	0.025	0.00042	0.00011	0.00028
Barium (Ba)-Total	mg/L	MAC	1	0.0681	0.062	0.0507
Beryllium (Be)-Total	mg/L	-	-	<0.00010	<0.00010	<0.00010
Bismuth (Bi)-Total	mg/L	-	-	<0.000050	<0.000050	<0.000050
Boron (B)-Total	mg/L	IMAC	5.00	0.021	0.02	0.02
Cadmium (Cd)-Total	mg/L	MAC	0.005	0.000132	0.000119	0.000057
Calcium (Ca)-Total	mg/L	-	-	92.8	85.3	93
Cesium (Cs)-Total	mg/L	-	-	0.000042	<0.000010	<0.000010
Chromium (Cr)-Total	mg/L	MAC	0.05	0.00068	<0.00050	<0.00050
Cobalt (Co)-Total	mg/L	-	-	0.00031	<0.00010	<0.00010
Copper (Cu)-Total	mg/L	AO	1	0.0022	<0.0010	0.0015
Iron (Fe)-Total	mg/L	AO	0.3	**0.447**	<0.050	<0.050
Lead (Pb)-Total	mg/L	MAC	0.01	0.00704	0.00012	0.0004
Lithium (Li)-Total	mg/L	-	-	0.0022	0.0018	0.0022
Magnesium (Mg)-Total	mg/L	-	-	33.7	28.9	32.3
Manganese (Mn)-Total	mg/L	AO	0.05	**0.0599**	0.00176	0.0161
Molybdenum (Mo)-Total	mg/L	-	-	0.000769	0.000284	0.0007
Nickel (Ni)-Total	mg/L	-	-	0.00123	<0.00050	0.00083
Phosphorus (P)-Total	mg/L	-	-	<0.050	<0.050	<0.050
Potassium (K)-Total	mg/L	-	-	2.9	1.95	2.22
Rubidium (Rb)-Total	mg/L	-	-	0.00383	0.0019	0.00164
Selenium (Se)-Total	mg/L	MAC	0.01	0.000331	0.000324	0.00036
Silicon (Si)-Total	mg/L	-	-	3.94	3.35	3.44
Silver (Ag)-Total	mg/L	-	-	<0.000050	<0.000050	<0.000050
Sodium (Na)-Total	mg/L	AO	200	116	109	87
Strontium (Sr)-Total	mg/L	-	-	0.12	0.105	0.117
Sulfur (S)-Total	mg/L	-	-	10	10.6	12.7
Tellurium (Te)-Total	mg/L	-	-	<0.00020	<0.00020	<0.00020
Thallium (Tl)-Total	mg/L	-	-	0.000054	0.000016	0.000035
Thorium (Th)-Total	mg/L	-	-	<0.00010	<0.00010	<0.00010
Tin (Sn)-Total	mg/L	-	-	0.00016	<0.00010	<0.00010
Titanium (Ti)-Total	mg/L	-	-	0.0135	<0.00030	<0.00050
Tungsten (W)-Total	mg/L	-	-	<0.00010	<0.00010	<0.00010
Uranium (U)-Total	mg/L	MAC	0.02	0.000498	0.000454	0.000794
Vanadium (V)-Total	mg/L	-	-	0.00075	<0.00050	<0.00050
Zinc (Zn)-Total	mg/L	AO	5	0.0542	0.0395	0.0188
Zirconium (Zr)-Total	mg/L	-	-	<0.00030	<0.00030	<0.00030
Aluminum (Al)-Dissolved	mg/L	OG	0.1	**0.161**	<0.010	0.012
Antimony (Sb)-Dissolved	mg/L	IMAC	0.006	<0.0050	<0.0050	<0.0050
Arsenic (As)-Dissolved	mg/L	IMAC	0.025	<0.0010	<0.0010	<0.0010
Barium (Ba)-Dissolved	mg/L	MAC	1	0.068	0.063	0.053
Beryllium (Be)-Dissolved	mg/L	-	-	<0.0010	<0.0010	<0.0010
Bismuth (Bi)-Dissolved	mg/L	-	-	<0.0010	<0.0010	<0.0010
Boron (B)-Dissolved	mg/L	IMAC	5	<0.050	<0.050	<0.050
Cadmium (Cd)-Dissolved	mg/L	MAC	0.005	0.000141	0.000134	<0.000090
Calcium (Ca)-Dissolved	mg/L	-	-	94.3	87.6	91.8
Chromium (Cr)-Dissolved	mg/L	MAC	0.05	<0.00050	<0.00050	<0.00050
Cobalt (Co)-Dissolved	mg/L	-	-	<0.00050	<0.00050	<0.00050
Copper (Cu)-Dissolved	mg/L	AO	1	0.0018	<0.0010	0.0015
Iron (Fe)-Dissolved	mg/L	AO	0.3	0.189	<0.050	<0.050
Lead (Pb)-Dissolved	mg/L	MAC	0.01	0.0069	<0.0010	<0.0010
Magnesium (Mg)-Dissolved	mg/L	-	-	33.2	29.6	31.6
Manganese (Mn)-Dissolved	mg/L	AO	0.05	0.0584	0.0017	0.0155
Molybdenum (Mo)-Dissolved	mg/L	-	-	<0.0010	<0.0010	<0.0010
Nickel (Ni)-Dissolved	mg/L	-	-	<0.0020	<0.0020	<0.0020
Phosphorus (P)-Dissolved	mg/L	-	-	<0.050	<0.050	<0.050
Potassium (K)-Dissolved	mg/L	-	-	2.8	2	2.3
Selenium (Se)-Dissolved	mg/L	MAC	0.01	0.00043	0.00041	0.00045
Silicon (Si)-Dissolved	mg/L	-	-	3.5	3.3	3.4
Silver (Ag)-Dissolved	mg/L	-	-	<0.00010	<0.00010	<0.00010
Sodium (Na)-Dissolved	mg/L	AO	200	107	108	84.6
Strontium (Sr)-Dissolved	mg/L	-	-	0.122	0.109	0.119
Thallium (Tl)-Dissolved	mg/L	-	-	<0.00030	<0.00030	<0.00030
Tin (Sn)-Dissolved	mg/L	-	-	<0.0010	<0.0010	<0.0010
Titanium (Ti)-Dissolved	mg/L	-	-	<0.0080	<0.0020	<0.0020
Tungsten (W)-Dissolved	mg/L	-	-	<0.010	<0.010	<0.010
Uranium (U)-Dissolved	mg/L	MAC	0.02	<0.0050	<0.0050	<0.0050
Vanadium (V)-Dissolved	mg/L	-	-	<0.0010	<0.0010	<0.0010
Zinc (Zn)-Dissolved	mg/L	AO	5	0.0505	0.0423	0.0185
Zirconium (Zr)-Dissolved	mg/L	-	-	<0.0040	<0.0040	<0.0040

Notes:

1. Criteria from Ontario Drinking Water Standards (MOE, 2006).
2. Analytical analysis performed by ALS Laboratories, Waterloo, Ontario
3. Measurements in **bold and highlighted** text exceed ODWS criteria limits
4. The AO for sodium is 200 mg/L however; if this was drinking water the Medical Officer of Health would be notified to pass the information on to physicians working with patients with sodium reduced diets.

MAC - Maximum Acceptable Concentration (health related)
IMAC - Interim Maximum Acceptable Concentration (health related)
OG - Operational Guideline (parameters which must be controlled for effective treatment)
AO - Aesthetic Objective
TCU - True Colour Units
NTU - Nephelometric Turbidity Units

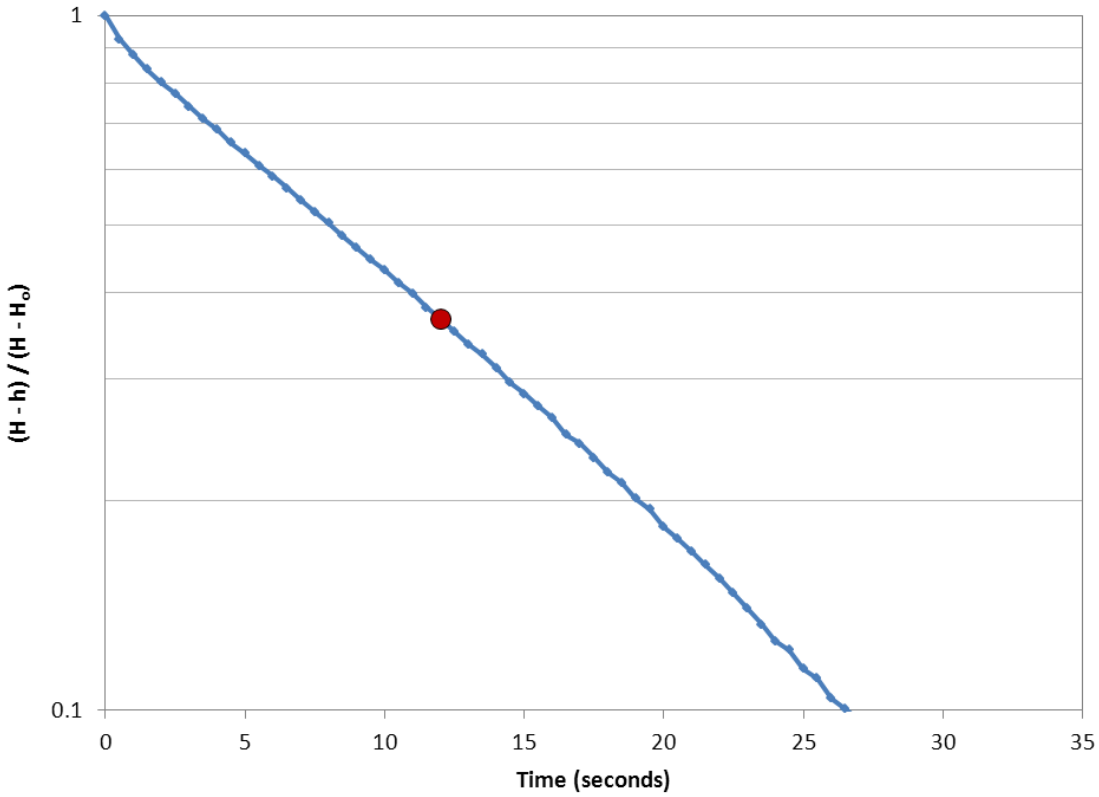
Appendix 5 Slug Test Analysis

Boreholes BH-01-16-BH-13-16

Slug Test Analysis Report

Project: Lowes Road Development – Hydrogeology Study
Project No.: P-0010233-0-02-300-01
Location: Lowes Road, Guelph, Ontario

Test Well: BH-01-16
Test Date(s): May 12, 2016
Analysis Date: June 8, 2016
Test Conducted by: D. Souter
Analysis Performed by: S. Meteer



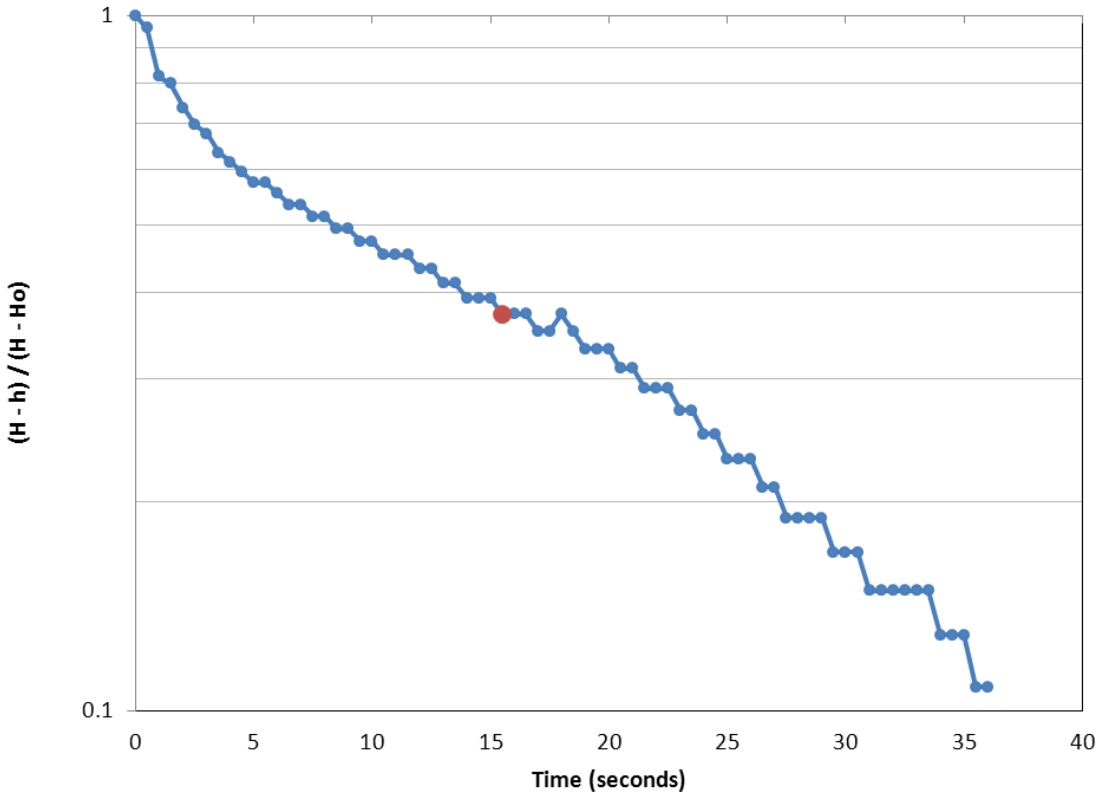
Time Lag: 11.5 seconds
Hydraulic Conductivity (m/s): 4.8×10^{-5}
Soil Type: Sand and gravel, trace silt, occasional cobbles
Notes:
Calculated using Hvorslev: pneumatic, rising head

Englobe

Slug Test Analysis Report

Project: Lowes Road Development – Hydrogeology Study
Project No.: P-0010233-0-02-300-01
Location: Lowes Road, Guelph, Ontario

Test Well: BH-02-16
Test Date(s): May 12, 2016
Analysis Date: June 8, 2016
Test Conducted by: D. Souter
Analysis Performed by: S. Meteer



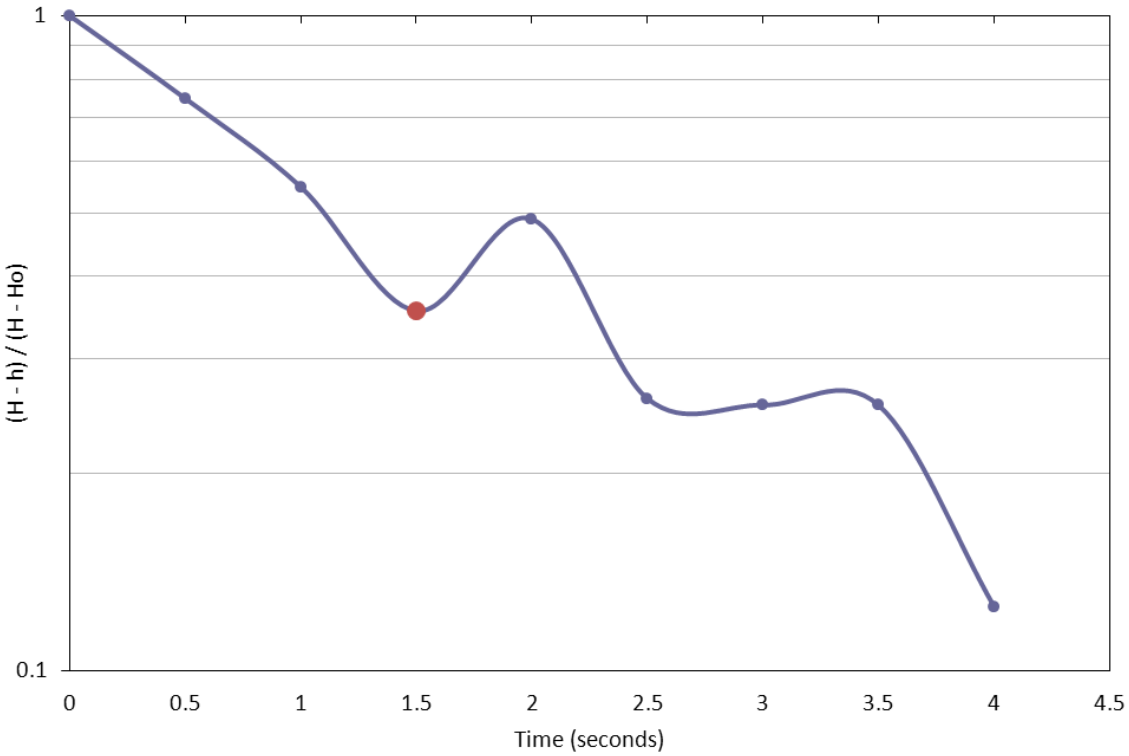
Time Lag: 15.5 seconds
Hydraulic Conductivity (m/s): 2.3×10^{-5}
Soil Type: Sand and gravel, some silt, occasional cobbles
Notes:
Calculated using Hvorslev: Water in, rising head

Englobe

Slug Test Analysis Report

Project: Lowes Road Development – Hydrogeology Study
Project No.: P-0010233-0-02-300-01
Location: Lowes Road, Guelph, Ontario

Test Well: BH-06-16
Test Date(s): May 12, 2016
Analysis Date: June 8, 2016
Test Conducted by: D. Souter
Analysis Performed by: E. Brears



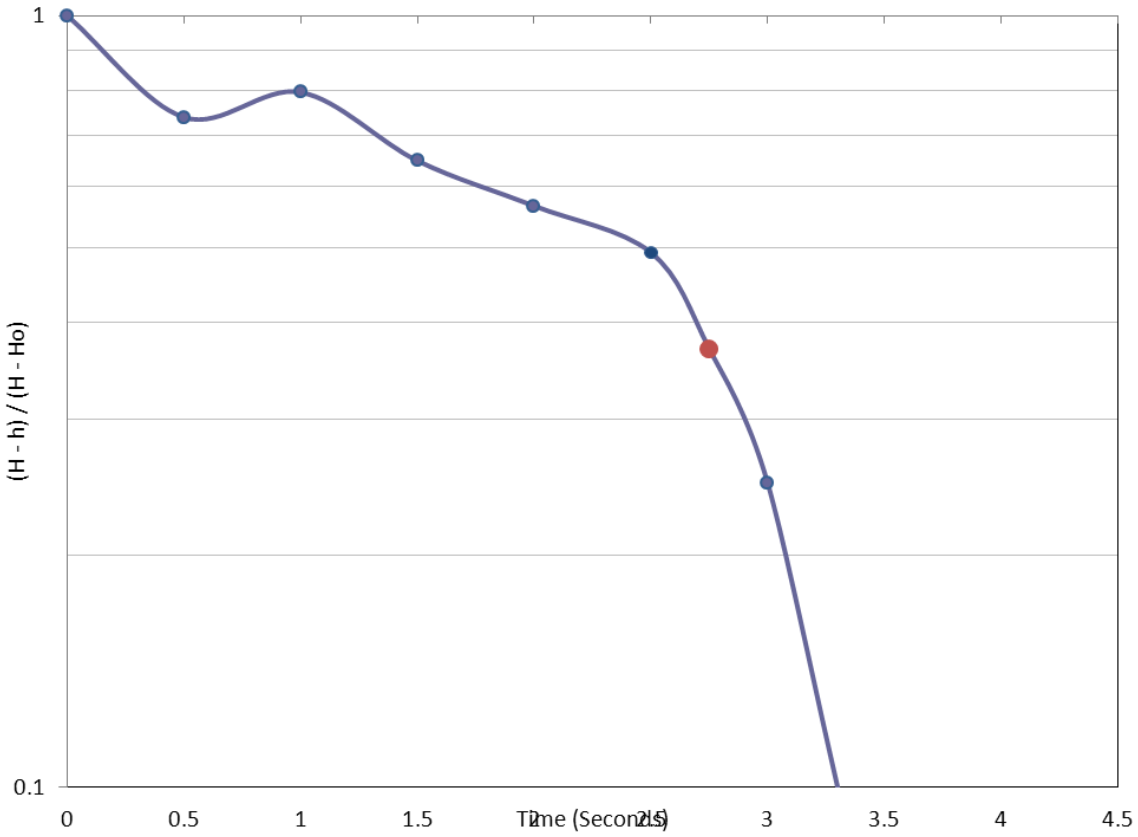
Time Lag: 1.5 seconds
Hydraulic Conductivity (m/s): 2.4×10^{-4}
Soil Type: Sand and gravel, trace silt, numerous cobbles
Notes:
Calculated using Hvorslev: Slug out, rising head

Englobe

Slug Test Analysis Report

Project: Lowes Road Development – Hydrogeology Study
Project No.: P-0010233-0-02-300-01
Location: Lowes Road, Guelph, Ontario

Test Well: BH-09-16
Test Date(s): May 12, 2016
Analysis Date: June 8, 2016
Test Conducted by: D. Souter
Analysis Performed by: E. Brears



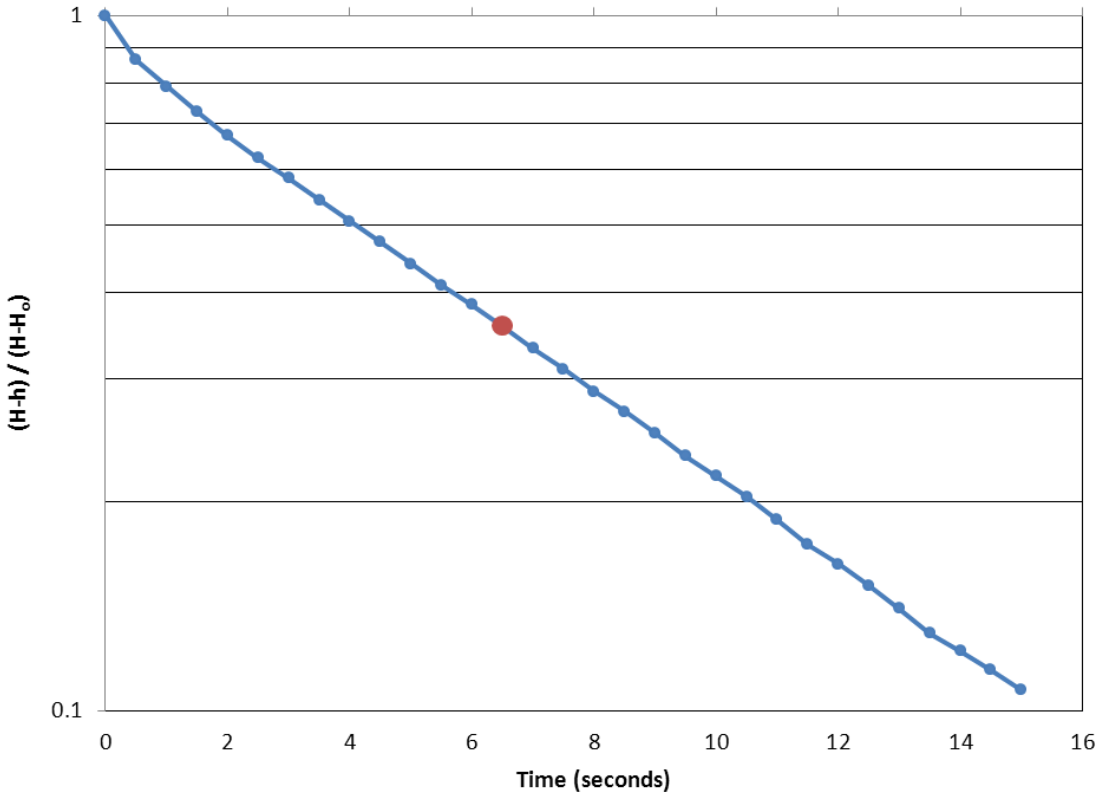
Time Lag: 2.75 seconds
Hydraulic Conductivity (m/s): 1.2×10^{-4}
Soil Type: Sand and gravel, some silt, numerous cobbles
Notes:
Calculated using Hvorslev: Slug out, rising head

Englobe

Slug Test Analysis Report

Project: Lowes Road Development – Hydrogeology Study
Project No.: P-0010233-0-02-300-01
Location: Lowes Road, Guelph, Ontario

Test Well: BH-10-16
Test Date(s): May 12, 2016
Analysis Date: June 13, 2016
Test Conducted by: D. Souter
Analysis Performed by: E. Brears



Time Lag: 6.5 seconds
Hydraulic Conductivity (m/s): 8.7×10^{-5}
Soil Type: Sand and gravel, trace topsoil, trace silt, occasional cobbles
Notes:
Calculated using Hvorslev: pneumatic, rising head

Englobe

Appendix 6 MOECC Water Well Records

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # STATE[12] DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
ERIN TOWNSHIP CON 07(009)	17 565133 4817188 W	2001/10 2663						6714024 (235127) A
PUSLINCH TOWNSHIP CON 07(008)	17 564906 4817339 W	2012/10 2663						7191242 (Z152021) A
PUSLINCH TOWNSHIP CON 07(008)	17 564886 4817321 W	2012/10 2663						7191240 (Z158929) A
PUSLINCH TOWNSHIP CON 07(008)	17 564906 4817243 W	2012/10 2663						7191245 (Z152022) A
PUSLINCH TOWNSHIP CON 07(008)	17 564902 4817121 W	2012/10 2663						7191243 (Z158930) A
PUSLINCH TOWNSHIP CON 07(008)	17 564974 4817644 W	2015/05 2663						7244796 (Z202468) A
PUSLINCH TOWNSHIP CON 07(008)	17 564888 4817315 W	2012/10 2663						7191246 (Z152023) A
PUSLINCH TOWNSHIP CON 07(008)	17 564940 4817379 W	2012/10 2663						7191244 (Z158931) A
PUSLINCH TOWNSHIP CON 07(009)	17 565159 4816993 W	2009/11 7238	02			TH	5 10	7134620 (Z105836) A091542 BRWN SAND GRVL 0015
PUSLINCH TOWNSHIP CON 07(009)	17 565251 4816982 W	2009/11 7238				TH	4 10	7134622 (Z105834) A091541 BRWN SAND GRVL 0014
PUSLINCH TOWNSHIP CON 07(009)	17 565200 4817001 W	2004/05 2336				NU		6714925 (Z10313) A
PUSLINCH TOWNSHIP CON 07(009)	17 565191 4817017 W	2004/05 2336				NU		6714924 (Z10312) A
PUSLINCH TOWNSHIP CON 07(009)	17 565214 4816969 W	2004/05 2336				NU		6714922 (Z10314) A
PUSLINCH TOWNSHIP CON 07(009)	17 565152 4817041 W	2004/05 2336				NU		6714923 (Z10311) A
PUSLINCH TOWNSHIP CON 08(006)	17 564755 4818105 W	2013/09 2663						7211045 (Z172128) A
PUSLINCH TOWNSHIP ()	17 564893 4817732 W	2013/01 7238	02	0010		MO	8 10	7202892 (Z160057) A143057 BRWN SAND GRVL LOOS 0010 BRWN SAND GRVL LOOS 0018

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # STATE[12] DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
PUSLINCH TOWNSHIP ()	17 564904 4817740 W	2013/01 7238	02			MO	8 10	7202891 (Z160056) A143071 BRWN SAND GRVL LOOS 0010 BRWN SAND GRVL LOOS 0018
GUELPH CITY (002)	17 564788 4817616 W	2006/04 2663			004 / / :0			6715815 (Z43935) A
GUELPH CITY ()	17 564884 4817933 W	2006/02 6607	02	0007			8 4	6715673 (Z44180) A037794 BRWN SILT LOAM 0001 BRWN SILT SAND 0002 BRWN SAND GRVL 0012
GUELPH CITY ()	17 564851 4818070 W	2006/01 7190	02	0004		NU	5 10	6715670 (Z31480) A029377 BRWN LOAM SOFT 0007 BRWN GRVL DNSE SILT STNS SOFT 0015
GUELPH CITY ()	17 564908 4817726 W	2006/04 2663						6715814 (Z43936) A
GUELPH CITY 08(007)	17 564799 4818094 W	2006/06 6607	02	FR 0006			4 10	6715765 (Z49028) A037753 BRWN SAND 0001 BRWN SAND GRVL SILT 0008 GREY SILT CLAY SAND 0014
GUELPH CITY (002)	17 565012 4817783 W	2006/09 2663				DO		6715960 (Z44000) A
GUELPH CITY ()	17 564848 4818098 W	2007/09 2336				MO		7050884 (Z68546) A029377 A
GUELPH CITY ()	17 565114 4817073 W	1976/09 1906	05	UK 0100	012 / 019 015 / 3:0	DO		6706309 () LOAM 0001 BRWN CLAY STNS 0022 GRVL SAND 0045 LMSN 0100 BRWN ROCK FCRD 0105
GUELPH CITY ()	17 564936 4817737 W	2006/07 1129	02				9 10	7039963 (Z48781) A039897 0001 BRWN SAND CLAY 0003 BRWN SAND GRVL 0012 GREY SAND GRVL 0021 SAND GRVL 0024 GREY SAND 0025 BRWN SILT TILL 0027
GUELPH CITY ()	17 564875 4817931 W	2006/11 2336				NU		6716016 (Z49330) A037794 A
GUELPH CITY ()	17 564824 4817889 W	2006/11 2336				NU		6716017 (Z49329) A
GUELPH CITY ()	17 564790 4817930 W	2006/11 2336				NU		6716018 (Z49328) A

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # STATE[12] DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
GUELPH CITY ()	17 564900 4817880 W	2006/11 2336				NU		6716020 (Z49326) A 0029
GUELPH CITY ()	17 564858 4817914 W	2006/11 2336				NU		6716021 (Z49325) A 0009
GUELPH CITY ()	17 564835 4817968 W	2006/11 2336				NU		6716022 (Z49324) A 0042
GUELPH CITY ()	17 564767 4817913 W	2007/01 2336				NU		7040683 (Z49336) A
GUELPH CITY ()	17 564914 4817663 W	1968/06 2521	04 04	FR 0100	009 / 015 015 / 2:0	DO		6703291 () GRVL 0040 BRWN LMSN 0100
GUELPH CITY ()	17 564859 4817767 W	1999/04 2336	06 06	FR 0047	015 / 020 010 / 1:0	DO		6712937 (196621) BRWN CLAY GRVL 0015 GREY CLAY GRVL 0043 BRWN ROCK 0047
GUELPH CITY ()	17 564843 4817873 W	2006/11 2336				NU		6716015 (Z49331) A
GUELPH CITY ()	17 564955 4817729 W	2007/02 6875	02	FR 0009			7 11	7046594 (Z50945) A044685 BRWN SAND GRVL STNS 0018
GUELPH CITY ()	17 564626 4818171 W	2007/12 6607	02	0002		MO		7101752 (M00745) A062421 BRWN SILT LOAM 0001 BRWN SILT 0002 BRWN SAND GRVL 0007 BRWN SAND SILT 0008 BLCK SILT CLAY 0010 GREY SILT SAND 0010
GUELPH CITY ()	17 564847 4818097 W	2007/08 2336				NU		7049247 (Z59195) A
GUELPH CITY ()	17 564924 4817707 W	2008/12 6607	02	UK 0008		MO		7118256 (M04268) A081364 BRWN SAND SILT GRVL 0004 BRWN SAND GRVL SILT 0014
GUELPH CITY ()	17 564951 4817784 W	2009/03 6607	02			MO		7122484 (M04570) A081324 BRWN SAND GRVL SILT 0002 BRWN SILT LOAM 0003 BRWN SAND GRVL SILT 0012 BRWN SILT SAND GRVL 0014
GUELPH CITY ()	17 564949 4817782 W	2009/04 6607				MO		7124643 (M04623) A081324 A

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # STATE[12] DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
GUELPH CITY ()	17 564978 4817864 W	2011/08 7190	04 01	0010		MO	15 10	7168694 (Z133798) A105800 BRWN LOAM LOOS 0006 BRWN SAND GRVL LOOS 0010 GREY SILT SAND GRVL 0025
GUELPH CITY ()	17 564690 4817485 W	2013/10 7238						7210045 (Z174751) A BRWN SAND GRVL 0003 GREY 0007
GUELPH CITY (PUSLINC CON 07(007)	17 564814 4818043 W	1961/02 2414	04	FR 0042	008 / 013 012 / 2:45	DO	39 5	6702436 () LOAM 0001 GRVL STNS 0018 BRWN CLAY GRVL 0040 CSND 0042 GRVL 0045
GUELPH CITY (PUSLINC CON 07(007)	17 564928 4817877 W	1962/03 2414	04 04	FR 0058	005 / 023 015 / 2:30	DO		6702438 () PRDG 0010 CSND GRVL 0016 BRWN CLAY GRVL 0040 GRVL CSND 0046 BRWN LMSN 0058
GUELPH CITY (PUSLINC CON 07(007)	17 564677 4817589 W	1966/11 2414	12 12	FR 0200 FR 0271	005 / 192 103 / 5:30	MN		6702440 () STNS GRVL 0020 GRVL 0023 CLAY MSND STNS 0043 BRWN LMSN 0135 GREY LMSN 0235 BLUE LMSN 0270 BLUE SHLE 0271
GUELPH CITY (PUSLINC CON 07(007)	17 564774 4818023 W	1970/07 1906	04	UK 0097	004 / 080 005 / 2:0	DO		6703725 () CLAY STNS GRVL 0030 CLAY GRVL 0040 GRVL CLAY 0055 GREY CLAY 0082 BRWN ROCK 0100
GUELPH CITY (PUSLINC CON 07(007)	17 564764 4818081 W	1959/09 2521	04	FR 0050	006 / 010 008 / 3:0	DO	47 3	6702435 () CLAY FILL 0008 GRVL 0050
GUELPH CITY (PUSLINC CON 07(007)	17 564736 4818047 W	1964/03 1906	05	FR 0039	003 / 015 010 / 5:0	DO		6702441 () FILL 0003 CLAY STNS 0015 MSND CLAY 0037 GRVL 0039
GUELPH CITY (PUSLINC CON 07(008)	17 565083 4817358 W	1962/03 2414	04 04	FR 0075	014 / 030 010 / 1:0	DO		6702444 () LOAM 0002 BRWN CLAY GRVL 0019 BRWN CLAY CSND 0029 GREY CLAY GRVL 0038 BRWN LMSN 0075
GUELPH CITY (PUSLINC CON 07(008)	17 565012 4817529 W	1962/08 2521	04 04	FR 0095	012 / 070 006 / 1:0	DO		6702470 () GRVL 0043 BRWN LMSN 0095
GUELPH CITY (PUSLINC CON 07(008)	17 565064 4817481 W	1961/07 2414	04 04	FR 0069	015 / 019 015 / 2:0	DO		6702443 () LOAM 0001 GRVL STNS 0012 BRWN CLAY GRVL 0037 BRWN LMSN 0070

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # STATE[12] DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
GUELPH CITY (PUSLINC CON 07(008)	17 564788 4817396 W	1962/07 2414	05 05 05	FR 0093	009 / 009 010 / 1:0	DO		6702445 () LOAM 0001 GRVL BLDR 0022 HPAN GRVL ROCK 0055 BRWN LMSN 0093
GUELPH CITY (PUSLINC CON 07(008)	17 564823 4817358 W	1963/11 2521	04 04	FR 0081	012 / 040 010 / 1:0	DO		6702447 () PRDG 0011 GRVL 0032 GREY LMSN 0081
GUELPH CITY (PUSLINC CON 07(008)	17 565015 4817629 W	1964/01 2521	04 04	FR 0092	010 / 025 010 / 2:0	DO		6702449 () GRVL MSND 0038 GREY LMSN 0092
GUELPH CITY (PUSLINC CON 07(008)	17 564726 4817436 W	1964/01 2521	04 04	FR 0095	005 / 035 006 / 2:0	DO		6702450 () GRVL 0040 GREY LMSN 0095
GUELPH CITY (PUSLINC CON 07(008)	17 564945 4817309 W	1965/05 1906	04 04	FR 0052 FR 0075	008 / 019 020 / 2:0	DO		6702452 () STNS GRVL 0015 MSND CLAY 0035 BRWN LMSN 0075
GUELPH CITY (PUSLINC CON 07(008)	17 564925 4817547 W	1954/09 2521	04 04	FR 0080	007 / 023 007 / 1:0	DO		6702454 () GRVL 0031 GREY LMSN 0080
GUELPH CITY (PUSLINC CON 07(008)	17 564863 4817405 W	1955/04 2521	04 04	FR 0081	006 / 015 020 / 1:0	DO		6702456 () GRVL 0032 GREY LMSN 0081
GUELPH CITY (PUSLINC CON 07(008)	17 564657 4817537 W	1956/03 2521	04 04	FR 0093	009 / 030 010 / 1:0	DO		6702458 () GRVL 0038 FSND 0041 GREY LMSN 0093
GUELPH CITY (PUSLINC CON 07(008)	17 564973 4817604 W	1958/04 2414	04 04	FR 0080	006 / 008 012 / 1:30	DO		6702460 () GRVL STNS 0012 GRVL CSND 0030 CLAY GRVL 0037 BRWN LMSN 0097
GUELPH CITY (PUSLINC CON 07(008)	17 564950 4817557 W	1958/04 2414	04 04	FR 0080	005 / 008 012 / 2:0	DO		6702461 () LOAM 0002 STNS GRVL 0028 GRVL CLAY 0036 BRWN LMSN 0098
GUELPH CITY (PUSLINC CON 07(008)	17 564927 4817547 W	1958/10 2414	04 04	FR 0075	008 / 020 010 / 2:0	DO		6702463 () LOAM 0002 GRVL STNS 0030 MSND 0037 BRWN LMSN 0088 BLCK LMSN 0090
GUELPH CITY (PUSLINC CON 07(008)	17 565079 4817403 W	1959/06 2414	04 04	FR 0077	010 / 015 010 / 2:30	DO		6702467 () BLDR GRVL 0018 GRVL 0034 BRWN LMSN 0077

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # STATE[12] DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
GUELPH CITY (PUSLINC CON 07(008)	17 564950 4817847 W	1961/10 4208	06 06	FR 0049	009 / 040 016 / 0:30	DO CO		6702469 () CLAY STNS 0010 LOAM MSND GRVL 0040 GRVL 0049 LMSN 0053
GUELPH CITY (PUSLINC CON 07(008)	17 564918 4817369 W	1967/07 2521	04 04	FR 0085	008 / 040 015 / 1:0	DO		6702472 () GRVL STNS 0034 GREY LMSN 0085
GUELPH CITY (PUSLINC CON 07(008)	17 564864 4817373 W	1968/11 1906	04 04	FR 0060 FR 0086	007 / 070 008 / 1:0	DO		6703251 () STNS CLAY 0034 LMSN 0080 WHIT LMSN 0087
GUELPH CITY (PUSLINC CON 07(008)	17 564878 4817407 W	1967/08 1906	04 04	FR 0061 FR 0052	010 / 015 015 / 2:0	DO		6702446 () STNS GRVL 0028 BRWN LMSN 0061
GUELPH CITY (PUSLINC CON 07(008)	17 564652 4817517 W	1964/01 2521	04 04	FR 0085	010 / 020 012 / 2:0	DO		6702448 () GRVL 0036 BRWN LMSN 0085
GUELPH CITY (PUSLINC CON 07(008)	17 565006 4817674 W	1964/02 2521	04 04	FR 0093	011 / 025 010 / 2:0	DO		6702451 () GRVL STNS 0040 BRWN LMSN 0093
GUELPH CITY (PUSLINC CON 07(008)	17 565055 4817518 W	1965/06 2521	04 04	FR 0094	011 / 040 010 / 2:0	DO		6702453 () GRVL STNS 0040 BRWN LMSN 0094
GUELPH CITY (PUSLINC CON 07(008)	17 565019 4817491 W	1955/02 2414	05 05	FR 0060	008 / 024 005 / :0	DO		6702455 () PRDG 0012 GRVL STNS 0032 BRWN LMSN 0085
GUELPH CITY (PUSLINC CON 07(008)	17 564962 4817482 W	1955/07 2411	04 04	FR 0116	016 / 020 010 / 1:0	DO		6702457 () GRVL BLDR 0040 LMSN 0117
GUELPH CITY (PUSLINC CON 07(008)	17 565015 4817571 W	1957/01 2521	04 04	FR 0093	012 / 022 010 / 1:0	DO		6702459 () GRVL 0044 GREY LMSN 0093
GUELPH CITY (PUSLINC CON 07(008)	17 565061 4817426 W	1958/06 2414	04 04	FR 0055	010 / 013 010 / 3:0	DO		6702462 () CLAY GRVL BLDR 0017 HPAN 0028 BRWN LMSN 0074
GUELPH CITY (PUSLINC CON 07(008)	17 564955 4817246 W	1958/11 2414	04 04	FR 0070	008 / 022 008 / 2:0	DO		6702464 () PRDG 0015 MSND CLAY 0028 BRWN LMSN 0087 BLCK LMSN 0090

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE[2] CNTR[3]	CASING DIA[4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # STATE[12] DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
GUELPH CITY (PUSLINC CON 07(008)	17 565098 4817353 W	1959/03 2521	04 04	FR 0092	015 / 025 010 / 1:0	DO		6702466 () GRVL 0033 BRWN LMSN 0092
GUELPH CITY (PUSLINC CON 07(008)	17 565086 4817403 W	1960/06 2414	04 04	FR 0050	012 / 012 012 / 1:0	DO		6702468 () BRWN CLAY STNS 0033 BRWN LMSN 0073
GUELPH CITY (PUSLINC CON 07(008)	17 564982 4817814 W	1962/03 2414	04 04	FR 0058	010 / 045 010 / 0:30	DO		6702471 () LOAM 0002 BRWN CLAY GRVL 0034 GREY HPAN GRVL 0049 BRWN LMSN 0058
GUELPH CITY (PUSLINC CON 07(008)	17 565042 4817556 W	1961/02 2414	04 04	FR 0045	008 / 013 012 / 1:30	DO		6702442 () LOAM 0001 GRVL STNS 0023 BRWN CLAY GRVL 0035 BRWN LMSN 0100
GUELPH CITY (PUSLINC CON 07(009)	17 565110 4817335 W	1963/10 2521	04 04	FR 0087	016 / 075 004 / 1:0	DO		6702474 () PRDG 0015 GRVL 0031 GREY LMSN 0087
GUELPH CITY (PUSLINC CON 07(009)	17 565174 4817117 W	1964/08 2521	04 04	FR 0084	011 / 035 019 / 1:0	DO		6702475 () PRDG 0009 CLAY 0032 BRWN LMSN 0084
GUELPH CITY (PUSLINC CON 07(009)	17 565114 4817073 W	1970/06 1906	04	FR 0079	011 / 020 010 / 3:0	DO		6703726 () CLAY STNS 0021 GRVL 0025 GRVL CLAY 0034 GREY CLAY 0039 GRVL 0049 LMSN 0079
GUELPH CITY (PUSLINC CON 07(009)	17 565118 4817350 W	1958/08 2414	04 04	FR 0070	013 / 030 006 / :0	DO		6702478 () PRDG 0013 CLAY BLDR 0020 HPAN 0028 BRWN LMSN 0084
GUELPH CITY (PUSLINC CON 07(009)	17 565134 4817192 W	1958/09 2414	04 04	FR 0080	013 / 020 006 / :0	DO		6702477 () PRDG 0013 BLDR CLAY 0039 GRVL CLAY 0052 BRWN LMSN 0100
GUELPH CITY (PUSLINC CON 07(009)	17 565103 4817283 W	1963/10 2521	04 04	FR 0090	015 / 070 004 / 1:0	DO		6702473 () PRDG 0014 GRVL 0029 GREY LMSN 0090
GUELPH CITY (PUSLINC CON 07(009)	17 565116 4817360 W	1956/03 2521	04 04	FR 0119	008 / 008 008 / 2:0	DO		6702479 () GRVL STNS 0032 FSND 0051 GREY LMSN 0119
GUELPH CITY (PUSLINC CON 07(009)	17 565223 4817016 W	1959/05 2414	04 04	FR 0110	007 / 017 007 / 3:0	DO		6702476 () PRDG 0009 STNS GRVL 0021 BRWN CLAY 0043 HPAN GRVL 0051 BRWN LMSN 0117

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # STATE[12] DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
GUELPH CITY (PUSLINC CON 08(007)	17 565101 4818107 W	1965/08 1906	04 04	UK 0052 FR 0073 FR 0075	006 / 015 010 / 3:0	DO		6702625 () STNS GRVL CLAY 0042 BRWN LMSN 0073 BLCK LMSN 0075
GUELPH CITY (PUSLINC CON 08(007)	17 565155 4818094 W	1965/07 2521	04 04	FR 0072	007 / 045 012 / 2:0	DO		6702624 () GRVL STNS 0043 BRWN LMSN 0072
GUELPH CITY (PUSLINC CON 08(007)	17 565178 4818130 W	1964/12 1906	04 04	FR 0060	012 / 020 010 / 4:0	DO		6702618 () STNS CLAY 0015 CLAY GRVL 0040 BRWN LMSN 0060
GUELPH CITY (PUSLINC CON 08(007)	17 565032 4818147 W	1963/08 2521	04 04	FR 0103	018 / 065 008 / 3:0	DO		6702613 () CLAY BLDR 0058 BRWN LMSN 0103
GUELPH CITY (PUSLINC CON 08(007)	17 564934 4817959 W	1954/06 2414	04 04	FR		DO		6702596 () LOAM 0001 CLAY STNS 0051 BRWN LMSN 0086
GUELPH CITY (PUSLINC CON 08(007)	17 565148 4818150 W	1964/12 1906	04 04	FR 0054 FR 0072	013 / 025 010 / 5:0	DO		6702619 () CLAY STNS 0015 STNS GRVL CLAY 0049 BRWN LMSN 0072
GUELPH CITY (PUSLINC CON 08(007)	17 564916 4817983 W	1963/12 2521	04 04	FR 0102	010 / 040 010 / 2:0	DO		6702615 () GRVL STNS MSND 0067 BRWN LMSN 0102
GUELPH CITY (PUSLINC CON 08(007)	17 565064 4818101 W	1961/11 2414	04 04	FR 0112	009 / 060 008 / 1:0	DO		6702610 () CLAY BLDR STNS 0058 BRWN LMSN 0095 BLCK LMSN 0114
GUELPH CITY (PUSLINC CON 08(007)	17 564828 4818077 W	1953/09 2411	04	FR	007 / 010 010 / 2:0	DO		6702595 () GRVL 0060
GUELPH CITY (PUSLINC CON 08(008)	17 565059 4817715 W	1961/07 2414	04 04	FR 0060	015 / 040 006 / 2:30	DO		6702632 () LOAM 0001 STNS GRVL 0020 GREY CLAY GRVL 0034 HPAN 0038 BRWN LMSN 0060
GUELPH CITY (PUSLINC CON 08(008)	17 565109 4817674 W	1962/02 2414	05 05	FR 0082	016 / 035 015 / 3:30	ST DO		6702633 () LOAM 0002 STNS GRVL SILT 0018 BRWN CLAY GRVL 0030 BRWN CLAY BLDR 0032 BRWN HPAN GRVL 0046 BRWN LMSN 0095
GUELPH CITY (PUSLINC CON 08(008)	17 565006 4817777 W	1963/04 2414	04 04 04	FR 0088	010 / 040 007 / 2:30	CO		6702634 () LOAM 0001 BRWN CLAY STNS 0018 BRWN CLAY GRVL 0072 BRWN LMSN 0088

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # STATE[12] DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
GUELPH CITY (PUSLINC CON 08(008)	17 565020 4817766 W	1949/11 2414	06	FR 0022	009 / 013 010 / 2:0	CO DO		6702630 () PRDG 0008 GRVL 0019 CLAY 0021 GRVL 0022
GUELPH CITY (PUSLINC CON 08(008)	17 564970 4817865 W	1964/03 2521	04 04	FR 0101	021 / 080 004 / 1:0	ST DO		6702631 () GRVL 0049 BRWN LMSN 0101
GUELPH CITY (PUSLINC CON 08(008)	17 564955 4817873 W	1953/09 2521	04 04	FR 0100	010 / 025 010 / 0:30	DO		6702629 () CLAY 0010 GRVL 0045 MSND 0059 LMSN 0100
GUELPH CITY (PUSLINC CON 08(008)	17 565012 4817873 W	1958/09 2414	05 05	FR 0080	006 / 016 012 / 3:30	PS		6702597 () PRDG 0017 GRVL 0036 MSND HPAN 0048 BRWN LMSN 0100
GUELPH CITY (PUSLINC CON 08(008)	17 565028 4817812 W	1955/04 2414	04 04	FR 0052	001 / 025 015 / :0	DO		6702628 () FILL GRVL 0008 STNS CLAY 0052 BRWN LMSN 0086
GUELPH CITY (PUSLINC CON 08(009)	17 565204 4817214 W	1962/02 2414	05 05	FR 0118	019 / 060 008 / 2:30	ST DO		6702635 () BRWN FILL 0006 GRVL BLDR 0024 GREY CLAY STNS 0039 BRWN LMSN 0120 LMSN 0130
GUELPH CITY (PUSLINC (007)	17 565105 4818010 W	1995/10 2336	06 06	FR 0055	/ 090 004 / 1:30			6711871 (163121) BRWN CLAY GRVL 0020 GREY CLAY GRVL 0040 BRWN ROCK 0060 BRWN ROCK 0075 BRWN ROCK 0100
GUELPH CITY (PUSLINC ()	17 565056 4817346 W	2003/12 2336				NU		6714788 (Z01892) A
GUELPH CITY (PUSLINC ()	17 565072 4818151 W	1966/10 2406	04 04	FR 0120	021 / 080 008 / 1:0	DO		6700923 () BRWN CLAY STNS 0015 BRWN CLAY GRVL 0054 BRWN LMSN 0102 BLCK LMSN 0120
GUELPH CITY (PUSLINC ()	17 565063 4817293 W	2003/12 2336				NU		6714786 (Z01893) A
GUELPH CITY (PUSLINC ()	17 564964 4817316 W	1966/06 1906	04 04	FR 0076	010 / 040 015 / 8:0	DO		6700920 () STNS GRVL 0016 MSND 0030 GRVL CLAY 0036 LMSN 0076
GUELPH CITY (PUSLINC ()	17 564925 4817794 W	2003/11 2336				NU		6714757 (Z01889) A

TOWNSHIP CONCESSION (LOT)	UTM[1]	DATE [2] CNTR [3]	CASING DIA [4]	WATER[5,6] DETAIL	STAT LVL/PUMP LVL[7] RATE[8]/TIME HR:MIN	WATER USE[9]	SCREEN INFO[10]	WELL # (AUDIT#) WELL TAG # STATE[12] DEPTHS TO WHICH FORMATIONS EXTEND[5,11]
GUELPH CITY (PUSLINC ())	17 565137 4818048 W	1974/01 2336	05		013 / / 0:5			6704987 () BRWN LOAM 0002 BRWN GRVL CLAY SAND 0014 BRWN GRVL CLAY BLDR 0019 BRWN CLAY STNS 0020

Notes:
1. UTM in Zone, Easting, Northing and Datum is NAD83; L: UTM estimated from Centroid of Lot; W: UTM not from Lot Centroid
2. Date Work Completed
3. Well Contractor Licence Number
4. Casing diameter in inches
5. Unit of Depth in Feet
6. See Table 4 for Meaning of Code
7. STAT LVL: Static Water Level in Feet ; PUMP LVL: Water Level After Pumping in Feet
8. Pump Test Rate in GPM, Pump Test Duration in Hour : Minutes
9. See Table 3 for Meaning of Code
10. Screen Depth and Length in feet
11. See Table 1 and 2 for Meaning of Code
12. A: Abandonment; P: Partial Data Entry Only

1. Core Material and Descriptive terms

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

2. Core Color

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

3. Water Use

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

4. Water Detail

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

Appendix 7 Laboratory Certificate of Analysis

ALS Environmental, Laboratory Work Order No. L1768544

EnGlobe Corp.
ATTN: Susanna Meteer
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5

Date Received: 13-MAY-16
Report Date: 24-MAY-16 08:47 (MT)
Version: FINAL

Client Phone: 519-741-1313

Certificate of Analysis

Lab Work Order #: L1768544

Project P.O. #: A03742
Job Reference: P-0010233-0-02-300
C of C Numbers: 14-457702
Legal Site Desc:

Mary-Lynn Pires
Client Services Supervisor

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1768544-1 02-16 Sampled By: D. SOUTER on 13-MAY-16 @ 09:00 Matrix: WATER							
Physical Tests							
Color, Apparent	30.7		1.0	C.U.		13-MAY-16	R3458963
Conductivity	1150		3.0	umhos/cm		15-MAY-16	R3458806
Hardness (as CaCO3)	372		10	mg/L		17-MAY-16	
pH	8.08		0.10	pH units		15-MAY-16	R3458799
Total Dissolved Solids	635	DLDS	20	mg/L		17-MAY-16	R3459879
Turbidity	37.2		0.10	NTU		14-MAY-16	R3457445
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	271		10	mg/L		18-MAY-16	R3460560
Ammonia, Total (as N)	0.075		0.020	mg/L		17-MAY-16	R3459966
Chloride (Cl)	185	DLDS	2.5	mg/L		17-MAY-16	R3460229
Fluoride (F)	<0.10	DLDS	0.10	mg/L		17-MAY-16	R3460229
Nitrate (as N)	4.39	DLDS	0.10	mg/L		17-MAY-16	R3460229
Nitrite (as N)	<0.050	DLDS	0.050	mg/L		17-MAY-16	R3460229
Phosphate-P (ortho)	<0.0030		0.0030	mg/L		17-MAY-16	R3459547
Sulfate (SO4)	26.1	DLDS	1.5	mg/L		17-MAY-16	R3460229
Total Metals							
Aluminum (Al)-Total	0.330		0.010	mg/L	13-MAY-16	13-MAY-16	R3458293
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Arsenic (As)-Total	0.00042		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Barium (Ba)-Total	0.0681		0.00020	mg/L	13-MAY-16	13-MAY-16	R3458293
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	13-MAY-16	13-MAY-16	R3458293
Boron (B)-Total	0.021		0.010	mg/L	13-MAY-16	13-MAY-16	R3458293
Cadmium (Cd)-Total	0.000132		0.000010	mg/L	13-MAY-16	13-MAY-16	R3458293
Calcium (Ca)-Total	92.8		0.50	mg/L	13-MAY-16	13-MAY-16	R3458293
Cesium (Cs)-Total	0.000042		0.000010	mg/L	13-MAY-16	13-MAY-16	R3458293
Chromium (Cr)-Total	0.00068		0.00050	mg/L	13-MAY-16	13-MAY-16	R3458293
Cobalt (Co)-Total	0.00031		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Copper (Cu)-Total	0.0022		0.0010	mg/L	13-MAY-16	13-MAY-16	R3458293
Iron (Fe)-Total	0.447		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293
Lead (Pb)-Total	0.00704		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Lithium (Li)-Total	0.0022		0.0010	mg/L	13-MAY-16	13-MAY-16	R3458293
Magnesium (Mg)-Total	33.7		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293
Manganese (Mn)-Total	0.0599		0.00050	mg/L	13-MAY-16	13-MAY-16	R3458293
Molybdenum (Mo)-Total	0.000769		0.000050	mg/L	13-MAY-16	13-MAY-16	R3458293
Nickel (Ni)-Total	0.00123		0.00050	mg/L	13-MAY-16	13-MAY-16	R3458293
Phosphorus (P)-Total	<0.050		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293
Potassium (K)-Total	2.90		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293
Rubidium (Rb)-Total	0.00383		0.00020	mg/L	13-MAY-16	13-MAY-16	R3458293
Selenium (Se)-Total	0.000331		0.000050	mg/L	13-MAY-16	13-MAY-16	R3458293
Silicon (Si)-Total	3.94		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1768544-1 02-16 Sampled By: D. SOUTER on 13-MAY-16 @ 09:00 Matrix: WATER							
Total Metals							
Silver (Ag)-Total	<0.000050		0.000050	mg/L	13-MAY-16	13-MAY-16	R3458293
Sodium (Na)-Total	116	DLHC	5.0	mg/L	13-MAY-16	13-MAY-16	R3458293
Strontium (Sr)-Total	0.120		0.0010	mg/L	13-MAY-16	13-MAY-16	R3458293
Sulfur (S)-Total	10.0		0.50	mg/L	13-MAY-16	13-MAY-16	R3458293
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	13-MAY-16	13-MAY-16	R3458293
Thallium (Tl)-Total	0.000054		0.000010	mg/L	13-MAY-16	13-MAY-16	R3458293
Thorium (Th)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Tin (Sn)-Total	0.00016		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Titanium (Ti)-Total	0.0135		0.00030	mg/L	13-MAY-16	13-MAY-16	R3458293
Tungsten (W)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Uranium (U)-Total	0.000498		0.000010	mg/L	13-MAY-16	13-MAY-16	R3458293
Vanadium (V)-Total	0.00075		0.00050	mg/L	13-MAY-16	13-MAY-16	R3458293
Zinc (Zn)-Total	0.0542		0.0030	mg/L	13-MAY-16	13-MAY-16	R3458293
Zirconium (Zr)-Total	<0.00030		0.00030	mg/L	13-MAY-16	13-MAY-16	R3458293
Dissolved Metals							
Dissolved Metals Filtration Location	FIELD					13-MAY-16	R3457419
Aluminum (Al)-Dissolved	0.161		0.010	mg/L	13-MAY-16	13-MAY-16	R3459470
Antimony (Sb)-Dissolved	<0.0050		0.0050	mg/L	13-MAY-16	13-MAY-16	R3459470
Arsenic (As)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Barium (Ba)-Dissolved	0.068		0.010	mg/L	13-MAY-16	13-MAY-16	R3459470
Beryllium (Be)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Bismuth (Bi)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Boron (B)-Dissolved	<0.050		0.050	mg/L	13-MAY-16	13-MAY-16	R3459470
Cadmium (Cd)-Dissolved	0.000141		0.000090	mg/L	13-MAY-16	13-MAY-16	R3459470
Calcium (Ca)-Dissolved	94.3		0.50	mg/L	13-MAY-16	13-MAY-16	R3459470
Chromium (Cr)-Dissolved	<0.00050		0.00050	mg/L	13-MAY-16	13-MAY-16	R3459470
Cobalt (Co)-Dissolved	<0.00050		0.00050	mg/L	13-MAY-16	13-MAY-16	R3459470
Copper (Cu)-Dissolved	0.0018		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Iron (Fe)-Dissolved	0.189		0.050	mg/L	13-MAY-16	13-MAY-16	R3459470
Lead (Pb)-Dissolved	0.0069		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Magnesium (Mg)-Dissolved	33.2		0.50	mg/L	13-MAY-16	13-MAY-16	R3459470
Manganese (Mn)-Dissolved	0.0584		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Molybdenum (Mo)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Nickel (Ni)-Dissolved	<0.0020		0.0020	mg/L	13-MAY-16	13-MAY-16	R3459470
Phosphorus (P)-Dissolved	<0.050		0.050	mg/L	13-MAY-16	13-MAY-16	R3459470
Potassium (K)-Dissolved	2.8		1.0	mg/L	13-MAY-16	13-MAY-16	R3459470
Selenium (Se)-Dissolved	0.00043		0.00040	mg/L	13-MAY-16	13-MAY-16	R3459470
Silicon (Si)-Dissolved	3.5		1.0	mg/L	13-MAY-16	13-MAY-16	R3459470
Silver (Ag)-Dissolved	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3459470
Sodium (Na)-Dissolved	107	DLHC	5.0	mg/L	13-MAY-16	13-MAY-16	R3459470
Strontium (Sr)-Dissolved	0.122		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1768544-1 02-16 Sampled By: D. SOUTER on 13-MAY-16 @ 09:00 Matrix: WATER							
Dissolved Metals							
Thallium (Tl)-Dissolved	<0.00030		0.00030	mg/L	13-MAY-16	13-MAY-16	R3459470
Tin (Sn)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Titanium (Ti)-Dissolved	<0.0080	DLUI	0.0080	mg/L	13-MAY-16	13-MAY-16	R3459470
Tungsten (W)-Dissolved	<0.010		0.010	mg/L	13-MAY-16	13-MAY-16	R3459470
Uranium (U)-Dissolved	<0.0050		0.0050	mg/L	13-MAY-16	13-MAY-16	R3459470
Vanadium (V)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Zinc (Zn)-Dissolved	0.0505		0.0030	mg/L	13-MAY-16	13-MAY-16	R3459470
Zirconium (Zr)-Dissolved	<0.0040		0.0040	mg/L	13-MAY-16	13-MAY-16	R3459470
L1768544-2 10-16 Sampled By: D. SOUTER on 13-MAY-16 @ 11:00 Matrix: WATER							
Physical Tests							
Color, Apparent	2.4		1.0	C.U.		13-MAY-16	R3458963
Conductivity	1080		3.0	umhos/cm		15-MAY-16	R3458806
Hardness (as CaCO3)	359		10	mg/L		17-MAY-16	
pH	8.14		0.10	pH units		15-MAY-16	R3458799
Total Dissolved Solids	578	DLDS	20	mg/L		18-MAY-16	R3462610
Turbidity	0.93		0.10	NTU		14-MAY-16	R3457445
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	256		10	mg/L		18-MAY-16	R3460560
Ammonia, Total (as N)	0.184		0.020	mg/L		17-MAY-16	R3459966
Chloride (Cl)	167	DLDS	2.5	mg/L		17-MAY-16	R3460229
Fluoride (F)	<0.10	DLDS	0.10	mg/L		17-MAY-16	R3460229
Nitrate (as N)	5.65	DLDS	0.10	mg/L		17-MAY-16	R3460229
Nitrite (as N)	<0.050	DLDS	0.050	mg/L		17-MAY-16	R3460229
Phosphate-P (ortho)	0.0056		0.0030	mg/L		17-MAY-16	R3459547
Sulfate (SO4)	34.4	DLDS	1.5	mg/L		17-MAY-16	R3460229
Total Metals							
Aluminum (Al)-Total	0.020		0.010	mg/L	13-MAY-16	13-MAY-16	R3458293
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Arsenic (As)-Total	0.00028		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Barium (Ba)-Total	0.0507		0.00020	mg/L	13-MAY-16	13-MAY-16	R3458293
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	13-MAY-16	13-MAY-16	R3458293
Boron (B)-Total	0.020		0.010	mg/L	13-MAY-16	13-MAY-16	R3458293
Cadmium (Cd)-Total	0.000057		0.000010	mg/L	13-MAY-16	13-MAY-16	R3458293
Calcium (Ca)-Total	93.0		0.50	mg/L	13-MAY-16	13-MAY-16	R3458293
Cesium (Cs)-Total	<0.000010		0.000010	mg/L	13-MAY-16	13-MAY-16	R3458293
Chromium (Cr)-Total	<0.00050		0.00050	mg/L	13-MAY-16	13-MAY-16	R3458293
Cobalt (Co)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Copper (Cu)-Total	0.0015		0.0010	mg/L	13-MAY-16	13-MAY-16	R3458293
Iron (Fe)-Total	<0.050		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1768544-2 10-16 Sampled By: D. SOUTER on 13-MAY-16 @ 11:00 Matrix: WATER							
Total Metals							
Lead (Pb)-Total	0.00040		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Lithium (Li)-Total	0.0022		0.0010	mg/L	13-MAY-16	13-MAY-16	R3458293
Magnesium (Mg)-Total	32.3		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293
Manganese (Mn)-Total	0.0161		0.00050	mg/L	13-MAY-16	13-MAY-16	R3458293
Molybdenum (Mo)-Total	0.000700		0.000050	mg/L	13-MAY-16	13-MAY-16	R3458293
Nickel (Ni)-Total	0.00083		0.00050	mg/L	13-MAY-16	13-MAY-16	R3458293
Phosphorus (P)-Total	<0.050		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293
Potassium (K)-Total	2.22		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293
Rubidium (Rb)-Total	0.00164		0.00020	mg/L	13-MAY-16	13-MAY-16	R3458293
Selenium (Se)-Total	0.000360		0.000050	mg/L	13-MAY-16	13-MAY-16	R3458293
Silicon (Si)-Total	3.44		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293
Silver (Ag)-Total	<0.000050		0.000050	mg/L	13-MAY-16	13-MAY-16	R3458293
Sodium (Na)-Total	87.0		0.50	mg/L	13-MAY-16	13-MAY-16	R3458293
Strontium (Sr)-Total	0.117		0.0010	mg/L	13-MAY-16	13-MAY-16	R3458293
Sulfur (S)-Total	12.7		0.50	mg/L	13-MAY-16	13-MAY-16	R3458293
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	13-MAY-16	13-MAY-16	R3458293
Thallium (Tl)-Total	0.000035		0.000010	mg/L	13-MAY-16	13-MAY-16	R3458293
Thorium (Th)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Tin (Sn)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Titanium (Ti)-Total	<0.00050	DLUI	0.00050	mg/L	13-MAY-16	13-MAY-16	R3458293
Tungsten (W)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Uranium (U)-Total	0.000794		0.000010	mg/L	13-MAY-16	13-MAY-16	R3458293
Vanadium (V)-Total	<0.00050		0.00050	mg/L	13-MAY-16	13-MAY-16	R3458293
Zinc (Zn)-Total	0.0188		0.0030	mg/L	13-MAY-16	13-MAY-16	R3458293
Zirconium (Zr)-Total	<0.00030		0.00030	mg/L	13-MAY-16	13-MAY-16	R3458293
Dissolved Metals							
Dissolved Metals Filtration Location	FIELD					13-MAY-16	R3457419
Aluminum (Al)-Dissolved	0.012		0.010	mg/L	13-MAY-16	13-MAY-16	R3459470
Antimony (Sb)-Dissolved	<0.0050		0.0050	mg/L	13-MAY-16	13-MAY-16	R3459470
Arsenic (As)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Barium (Ba)-Dissolved	0.053		0.010	mg/L	13-MAY-16	13-MAY-16	R3459470
Beryllium (Be)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Bismuth (Bi)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Boron (B)-Dissolved	<0.050		0.050	mg/L	13-MAY-16	13-MAY-16	R3459470
Cadmium (Cd)-Dissolved	<0.000090		0.000090	mg/L	13-MAY-16	13-MAY-16	R3459470
Calcium (Ca)-Dissolved	91.8		0.50	mg/L	13-MAY-16	13-MAY-16	R3459470
Chromium (Cr)-Dissolved	<0.00050		0.00050	mg/L	13-MAY-16	13-MAY-16	R3459470
Cobalt (Co)-Dissolved	<0.00050		0.00050	mg/L	13-MAY-16	13-MAY-16	R3459470
Copper (Cu)-Dissolved	0.0015		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Iron (Fe)-Dissolved	<0.050		0.050	mg/L	13-MAY-16	13-MAY-16	R3459470
Lead (Pb)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1768544-2 10-16 Sampled By: D. SOUTER on 13-MAY-16 @ 11:00 Matrix: WATER							
Dissolved Metals							
Magnesium (Mg)-Dissolved	31.6		0.50	mg/L	13-MAY-16	13-MAY-16	R3459470
Manganese (Mn)-Dissolved	0.0155		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Molybdenum (Mo)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Nickel (Ni)-Dissolved	<0.0020		0.0020	mg/L	13-MAY-16	13-MAY-16	R3459470
Phosphorus (P)-Dissolved	<0.050		0.050	mg/L	13-MAY-16	13-MAY-16	R3459470
Potassium (K)-Dissolved	2.3		1.0	mg/L	13-MAY-16	13-MAY-16	R3459470
Selenium (Se)-Dissolved	0.00045		0.00040	mg/L	13-MAY-16	13-MAY-16	R3459470
Silicon (Si)-Dissolved	3.4		1.0	mg/L	13-MAY-16	13-MAY-16	R3459470
Silver (Ag)-Dissolved	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3459470
Sodium (Na)-Dissolved	84.6		0.50	mg/L	13-MAY-16	13-MAY-16	R3459470
Strontium (Sr)-Dissolved	0.119		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Thallium (Tl)-Dissolved	<0.00030		0.00030	mg/L	13-MAY-16	13-MAY-16	R3459470
Tin (Sn)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Titanium (Ti)-Dissolved	<0.0020		0.0020	mg/L	13-MAY-16	13-MAY-16	R3459470
Tungsten (W)-Dissolved	<0.010		0.010	mg/L	13-MAY-16	13-MAY-16	R3459470
Uranium (U)-Dissolved	<0.0050		0.0050	mg/L	13-MAY-16	13-MAY-16	R3459470
Vanadium (V)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Zinc (Zn)-Dissolved	0.0185		0.0030	mg/L	13-MAY-16	13-MAY-16	R3459470
Zirconium (Zr)-Dissolved	<0.0040		0.0040	mg/L	13-MAY-16	13-MAY-16	R3459470
L1768544-3 04-16 Sampled By: D. SOUTER on 13-MAY-16 @ 12:00 Matrix: WATER							
Physical Tests							
Color, Apparent	<1.0		1.0	C.U.		13-MAY-16	R3458963
Conductivity	1120		3.0	umhos/cm		15-MAY-16	R3458806
Hardness (as CaCO3)	341		10	mg/L		17-MAY-16	
pH	8.03		0.10	pH units		15-MAY-16	R3458799
Total Dissolved Solids	604	DLDS	20	mg/L		18-MAY-16	R3462610
Turbidity	0.17		0.10	NTU		14-MAY-16	R3457445
Anions and Nutrients							
Alkalinity, Total (as CaCO3)	246		10	mg/L		18-MAY-16	R3460560
Ammonia, Total (as N)	0.033		0.020	mg/L		17-MAY-16	R3459966
Chloride (Cl)	197	DLDS	2.5	mg/L		17-MAY-16	R3460229
Fluoride (F)	<0.10	DLDS	0.10	mg/L		17-MAY-16	R3460229
Nitrate (as N)	4.60	DLDS	0.10	mg/L		17-MAY-16	R3460229
Nitrite (as N)	<0.050	DLDS	0.050	mg/L		17-MAY-16	R3460229
Phosphate-P (ortho)	<0.0030		0.0030	mg/L		17-MAY-16	R3459547
Sulfate (SO4)	29.9	DLDS	1.5	mg/L		17-MAY-16	R3460229
Total Metals							
Aluminum (Al)-Total	<0.010		0.010	mg/L	13-MAY-16	13-MAY-16	R3458293
Antimony (Sb)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Arsenic (As)-Total	0.00011		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1768544-3 04-16 Sampled By: D. SOUTER on 13-MAY-16 @ 12:00 Matrix: WATER							
Total Metals							
Barium (Ba)-Total	0.0617		0.00020	mg/L	13-MAY-16	13-MAY-16	R3458293
Beryllium (Be)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Bismuth (Bi)-Total	<0.000050		0.000050	mg/L	13-MAY-16	13-MAY-16	R3458293
Boron (B)-Total	0.021		0.010	mg/L	13-MAY-16	13-MAY-16	R3458293
Cadmium (Cd)-Total	0.000119		0.000010	mg/L	13-MAY-16	13-MAY-16	R3458293
Calcium (Ca)-Total	85.3		0.50	mg/L	13-MAY-16	13-MAY-16	R3458293
Cesium (Cs)-Total	<0.000010		0.000010	mg/L	13-MAY-16	13-MAY-16	R3458293
Chromium (Cr)-Total	<0.00050		0.00050	mg/L	13-MAY-16	13-MAY-16	R3458293
Cobalt (Co)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Copper (Cu)-Total	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3458293
Iron (Fe)-Total	<0.050		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293
Lead (Pb)-Total	0.00012		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Lithium (Li)-Total	0.0018		0.0010	mg/L	13-MAY-16	13-MAY-16	R3458293
Magnesium (Mg)-Total	28.9		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293
Manganese (Mn)-Total	0.00176		0.00050	mg/L	13-MAY-16	13-MAY-16	R3458293
Molybdenum (Mo)-Total	0.000284		0.000050	mg/L	13-MAY-16	13-MAY-16	R3458293
Nickel (Ni)-Total	<0.00050		0.00050	mg/L	13-MAY-16	13-MAY-16	R3458293
Phosphorus (P)-Total	<0.050		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293
Potassium (K)-Total	1.95		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293
Rubidium (Rb)-Total	0.00194		0.00020	mg/L	13-MAY-16	13-MAY-16	R3458293
Selenium (Se)-Total	0.000324		0.000050	mg/L	13-MAY-16	13-MAY-16	R3458293
Silicon (Si)-Total	3.35		0.050	mg/L	13-MAY-16	13-MAY-16	R3458293
Silver (Ag)-Total	<0.000050		0.000050	mg/L	13-MAY-16	13-MAY-16	R3458293
Sodium (Na)-Total	109	DLHC	5.0	mg/L	13-MAY-16	13-MAY-16	R3458293
Strontium (Sr)-Total	0.105		0.0010	mg/L	13-MAY-16	13-MAY-16	R3458293
Sulfur (S)-Total	10.6		0.50	mg/L	13-MAY-16	13-MAY-16	R3458293
Tellurium (Te)-Total	<0.00020		0.00020	mg/L	13-MAY-16	13-MAY-16	R3458293
Thallium (Tl)-Total	0.000016		0.000010	mg/L	13-MAY-16	13-MAY-16	R3458293
Thorium (Th)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Tin (Sn)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Titanium (Ti)-Total	<0.00030		0.00030	mg/L	13-MAY-16	13-MAY-16	R3458293
Tungsten (W)-Total	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3458293
Uranium (U)-Total	0.000454		0.000010	mg/L	13-MAY-16	13-MAY-16	R3458293
Vanadium (V)-Total	<0.00050		0.00050	mg/L	13-MAY-16	13-MAY-16	R3458293
Zinc (Zn)-Total	0.0395		0.0030	mg/L	13-MAY-16	13-MAY-16	R3458293
Zirconium (Zr)-Total	<0.00030		0.00030	mg/L	13-MAY-16	13-MAY-16	R3458293
Dissolved Metals							
Dissolved Metals Filtration Location	FIELD					13-MAY-16	R3457419
Aluminum (Al)-Dissolved	<0.010		0.010	mg/L	13-MAY-16	13-MAY-16	R3459470
Antimony (Sb)-Dissolved	<0.0050		0.0050	mg/L	13-MAY-16	13-MAY-16	R3459470
Arsenic (As)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1768544-3 04-16 Sampled By: D. SOUTER on 13-MAY-16 @ 12:00 Matrix: WATER							
Dissolved Metals							
Barium (Ba)-Dissolved	0.063		0.010	mg/L	13-MAY-16	13-MAY-16	R3459470
Beryllium (Be)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Bismuth (Bi)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Boron (B)-Dissolved	<0.050		0.050	mg/L	13-MAY-16	13-MAY-16	R3459470
Cadmium (Cd)-Dissolved	0.000134		0.000090	mg/L	13-MAY-16	13-MAY-16	R3459470
Calcium (Ca)-Dissolved	87.6		0.50	mg/L	13-MAY-16	13-MAY-16	R3459470
Chromium (Cr)-Dissolved	<0.00050		0.00050	mg/L	13-MAY-16	13-MAY-16	R3459470
Cobalt (Co)-Dissolved	<0.00050		0.00050	mg/L	13-MAY-16	13-MAY-16	R3459470
Copper (Cu)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Iron (Fe)-Dissolved	<0.050		0.050	mg/L	13-MAY-16	13-MAY-16	R3459470
Lead (Pb)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Magnesium (Mg)-Dissolved	29.6		0.50	mg/L	13-MAY-16	13-MAY-16	R3459470
Manganese (Mn)-Dissolved	0.0017		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Molybdenum (Mo)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Nickel (Ni)-Dissolved	<0.0020		0.0020	mg/L	13-MAY-16	13-MAY-16	R3459470
Phosphorus (P)-Dissolved	<0.050		0.050	mg/L	13-MAY-16	13-MAY-16	R3459470
Potassium (K)-Dissolved	2.0		1.0	mg/L	13-MAY-16	13-MAY-16	R3459470
Selenium (Se)-Dissolved	0.00041		0.00040	mg/L	13-MAY-16	13-MAY-16	R3459470
Silicon (Si)-Dissolved	3.3		1.0	mg/L	13-MAY-16	13-MAY-16	R3459470
Silver (Ag)-Dissolved	<0.00010		0.00010	mg/L	13-MAY-16	13-MAY-16	R3459470
Sodium (Na)-Dissolved	108	DLHC	5.0	mg/L	13-MAY-16	13-MAY-16	R3459470
Strontium (Sr)-Dissolved	0.109		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Thallium (Tl)-Dissolved	<0.00030		0.00030	mg/L	13-MAY-16	13-MAY-16	R3459470
Tin (Sn)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Titanium (Ti)-Dissolved	<0.0020		0.0020	mg/L	13-MAY-16	13-MAY-16	R3459470
Tungsten (W)-Dissolved	<0.010		0.010	mg/L	13-MAY-16	13-MAY-16	R3459470
Uranium (U)-Dissolved	<0.0050		0.0050	mg/L	13-MAY-16	13-MAY-16	R3459470
Vanadium (V)-Dissolved	<0.0010		0.0010	mg/L	13-MAY-16	13-MAY-16	R3459470
Zinc (Zn)-Dissolved	0.0423		0.0030	mg/L	13-MAY-16	13-MAY-16	R3459470
Zirconium (Zr)-Dissolved	<0.0040		0.0040	mg/L	13-MAY-16	13-MAY-16	R3459470

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Total	MS-B	L1768544-1, -2, -3
Matrix Spike	Calcium (Ca)-Total	MS-B	L1768544-1, -2, -3
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1768544-1, -2, -3
Matrix Spike	Silicon (Si)-Total	MS-B	L1768544-1, -2, -3
Matrix Spike	Sodium (Na)-Total	MS-B	L1768544-1, -2, -3
Matrix Spike	Strontium (Sr)-Total	MS-B	L1768544-1, -2, -3
Matrix Spike	Sulfur (S)-Total	MS-B	L1768544-1, -2, -3
Matrix Spike	Uranium (U)-Total	MS-B	L1768544-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1768544-1, -2, -3
Matrix Spike	Boron (B)-Dissolved	MS-B	L1768544-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1768544-1, -2, -3
Matrix Spike	Iron (Fe)-Dissolved	MS-B	L1768544-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1768544-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1768544-1, -2, -3
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1768544-1, -2, -3
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1768544-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1768544-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1768544-1, -2, -3
Matrix Spike	Uranium (U)-Dissolved	MS-B	L1768544-1, -2, -3
Matrix Spike	Nitrate (as N)	MS-B	L1768544-1, -2, -3

Qualifiers for Sample Submission Listed:

Qualifier	Description
CINT	Cooling initiated. Samples were received packed with ice or ice packs and were sampled the same day as received.

Sample Parameter Qualifier key listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
DLUI	Detection Limit Raised: Unknown Interference generated an apparent false positive test result.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-WT	Water	Alkalinity, Total (as CaCO3)	EPA 310.2
CL-IC-WT	Water	Chloride by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

COLOUR-WT	Water	Colour	APHA 2120

Apparent Colour is measured spectrophotometrically by comparison to platinum-cobalt standards using the single wavelength method after sample decanting. Colour measurements can be highly pH dependent, and apply to the pH of the sample as received (at time of testing), without pH adjustment. Concurrent measurement of sample pH is recommended.

EC-WT	Water	Conductivity	APHA 2510 B

Water samples can be measured directly by immersing the conductivity cell into the sample.

F-IC-N-WT	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-WT	Water	Hardness	APHA 2340 B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

MET-D-CCMS-WT	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Reference Information

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

MET-T-MS-WT	Water	Total Metals in Water by ICPMS	EPA 200.8

This analysis involves preliminary sample treatment by hotblock acid digestion (APHA 3030E). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

NH3-WT	Water	Ammonia, Total as N	EPA 350.1

Sample is measured colorimetrically. When sample is turbid a distillation step is required, sample is distilled into a solution of boric acid and measured colorimetrically.

NO2-IC-WT	Water	Nitrite in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-IC-WT	Water	Nitrate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-WT	Water	pH	APHA 4500 H-Electrode

Water samples are analyzed directly by a calibrated pH meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

PO4-DO-COL-WT	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P PHOSPHORUS

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

SO4-IC-N-WT	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SOLIDS-TDS-WT	Water	Total Dissolved Solids	APHA 2540C

A well-mixed sample is filtered though glass fibres filter. A known volume of the filtrate is evaporated and dried at 105–5°C overnight and then 180–10°C for 1hr.

TURBIDITY-WT	Water	Turbidity	APHA 2130 B

Sample result is based on a comparison of the intensity of the light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. Sample readings are obtained from a Nephelometer.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

14-457702

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid weight of sample
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1768544 Report Date: 24-MAY-16

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: Susanna Meteer

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-WT	**Water**							
Batch R3460560								
WG2311187-3 CRM		**WT-ALK-CRM**						
Alkalinity, Total (as CaCO3)			90.3		%		80-120	18-MAY-16
WG2311187-7 CRM		**WT-ALK-CRM**						
Alkalinity, Total (as CaCO3)			94.1		%		80-120	18-MAY-16
WG2311187-4 DUP		**L1767977-1**						
Alkalinity, Total (as CaCO3)		218	220		mg/L	1.0	20	18-MAY-16
WG2311187-8 DUP		**L1768309-5**						
Alkalinity, Total (as CaCO3)		24	23		mg/L	2.9	20	18-MAY-16
WG2311187-2 LCS								
Alkalinity, Total (as CaCO3)			105.4		%		85-115	18-MAY-16
WG2311187-6 LCS								
Alkalinity, Total (as CaCO3)			107.6		%		85-115	18-MAY-16
WG2311187-1 MB								
Alkalinity, Total (as CaCO3)			<10		mg/L		10	18-MAY-16
WG2311187-5 MB								
Alkalinity, Total (as CaCO3)			<10		mg/L		10	18-MAY-16
CL-IC-WT	**Water**							
Batch R3460229								
WG2309840-4 DUP		**WG2309840-3**						
Chloride (Cl)		7.33	7.32		mg/L	0.1	25	17-MAY-16
WG2309840-2 LCS								
Chloride (Cl)			99.9		%		70-130	17-MAY-16
WG2309840-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	17-MAY-16
WG2309840-5 MS		**WG2309840-3**						
Chloride (Cl)			100.9		%		70-130	17-MAY-16
COLOUR-WT	**Water**							
Batch R3458963								
WG2308283-3 CRM		**WT-COLOUR-CRM**						
Color, Apparent			93.4		%		80-120	13-MAY-16
WG2308283-4 DUP		**L1768501-1**						
Color, Apparent		3.7	4.2		C.U.	13	20	13-MAY-16
WG2308283-1 MB								
Color, Apparent			<1.0		C.U.		1	13-MAY-16
EC-WT	**Water**							

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: Susanna Meteer

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-WT	**Water**							
Batch R3458806								
WG2308731-4 DUP		**WG2308731-3**						
Conductivity		1190	1190		umhos/cm	0.6	10	15-MAY-16
WG2308731-2 LCS								
Conductivity			100.4		%		90-110	15-MAY-16
WG2308731-1 MB								
Conductivity			<3.0		umhos/cm		3	15-MAY-16
F-IC-N-WT	**Water**							
Batch R3460229								
WG2309840-4 DUP		**WG2309840-3**						
Fluoride (F)		0.055	0.054		mg/L	1.3	20	17-MAY-16
WG2309840-2 LCS								
Fluoride (F)			100.5		%		90-110	17-MAY-16
WG2309840-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	17-MAY-16
WG2309840-5 MS		**WG2309840-3**						
Fluoride (F)			100.3		%		75-125	17-MAY-16
MET-D-CCMS-WT	**Water**							
Batch R3459470								
WG2308317-4 DUP		**WG2308317-3**						
Aluminum (Al)-Dissolved		0.0673	0.0689		mg/L	2.4	20	13-MAY-16
Antimony (Sb)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	13-MAY-16
Arsenic (As)-Dissolved		0.00047	0.00048		mg/L	1.6	20	13-MAY-16
Barium (Ba)-Dissolved		0.0654	0.0665		mg/L	1.6	20	13-MAY-16
Beryllium (Be)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	13-MAY-16
Bismuth (Bi)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	13-MAY-16
Boron (B)-Dissolved		0.171	0.167		mg/L	2.6	20	13-MAY-16
Cadmium (Cd)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	13-MAY-16
Calcium (Ca)-Dissolved		72.2	71.3		mg/L	1.3	20	13-MAY-16
Chromium (Cr)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	13-MAY-16
Cobalt (Co)-Dissolved		0.00030	0.00029		mg/L	2.8	20	13-MAY-16
Copper (Cu)-Dissolved		0.00239	0.00236		mg/L	1.1	20	13-MAY-16
Iron (Fe)-Dissolved		0.241	0.247		mg/L	2.4	20	13-MAY-16
Lead (Pb)-Dissolved		0.000830	0.000829		mg/L	0.2	20	13-MAY-16
Magnesium (Mg)-Dissolved		19.0	18.6		mg/L	1.9	20	13-MAY-16
Manganese (Mn)-Dissolved		0.108	0.108		mg/L	0.7	20	13-MAY-16

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: Susanna Meteer

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R3459470								
WG2308317-4 DUP		**WG2308317-3**						
Molybdenum (Mo)-Dissolved		0.00222	0.00225		mg/L	1.1	20	13-MAY-16
Nickel (Ni)-Dissolved		0.00108	0.00107		mg/L	0.6	20	13-MAY-16
Phosphorus (P)-Dissolved		<0.050	<0.050	RPD-NA	mg/L	N/A	20	13-MAY-16
Potassium (K)-Dissolved		4.40	4.38		mg/L	0.5	20	13-MAY-16
Selenium (Se)-Dissolved		0.000326	0.000348		mg/L	6.4	20	13-MAY-16
Silicon (Si)-Dissolved		7.51	7.63		mg/L	1.6	20	13-MAY-16
Silver (Ag)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	13-MAY-16
Sodium (Na)-Dissolved		60.7	60.6		mg/L	0.1	20	13-MAY-16
Strontium (Sr)-Dissolved		0.369	0.369		mg/L	0.1	20	13-MAY-16
Thallium (Tl)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	13-MAY-16
Tin (Sn)-Dissolved		0.00153	0.00154		mg/L	0.5	20	13-MAY-16
Titanium (Ti)-Dissolved		0.00304	0.00306		mg/L	0.5	20	13-MAY-16
Tungsten (W)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	13-MAY-16
Uranium (U)-Dissolved		0.000474	0.000476		mg/L	0.2	20	13-MAY-16
Vanadium (V)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	13-MAY-16
Zinc (Zn)-Dissolved		0.0072	0.0071		mg/L	1.3	20	13-MAY-16
Zirconium (Zr)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	13-MAY-16
WG2308317-2 LCS								
Aluminum (Al)-Dissolved			100.5		%		80-120	13-MAY-16
Antimony (Sb)-Dissolved			98.6		%		80-120	13-MAY-16
Arsenic (As)-Dissolved			95.0		%		80-120	13-MAY-16
Barium (Ba)-Dissolved			96.4		%		80-120	13-MAY-16
Beryllium (Be)-Dissolved			102.2		%		80-120	13-MAY-16
Bismuth (Bi)-Dissolved			98.7		%		80-120	13-MAY-16
Boron (B)-Dissolved			102.3		%		80-120	13-MAY-16
Cadmium (Cd)-Dissolved			94.8		%		80-120	13-MAY-16
Calcium (Ca)-Dissolved			100.1		%		80-120	13-MAY-16
Chromium (Cr)-Dissolved			96.4		%		80-120	13-MAY-16
Cobalt (Co)-Dissolved			96.6		%		80-120	13-MAY-16
Copper (Cu)-Dissolved			95.8		%		80-120	13-MAY-16
Iron (Fe)-Dissolved			95.0		%		80-120	13-MAY-16
Lead (Pb)-Dissolved			99.3		%		80-120	13-MAY-16
Magnesium (Mg)-Dissolved			105.7		%		80-120	13-MAY-16

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: Susanna Meteer

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R3459470								
WG2308317-2 LCS								
Manganese (Mn)-Dissolved			97.6		%		80-120	13-MAY-16
Molybdenum (Mo)-Dissolved			98.3		%		80-120	13-MAY-16
Nickel (Ni)-Dissolved			96.3		%		80-120	13-MAY-16
Phosphorus (P)-Dissolved			107.9		%		80-120	13-MAY-16
Potassium (K)-Dissolved			101.7		%		80-120	13-MAY-16
Selenium (Se)-Dissolved			94.1		%		80-120	13-MAY-16
Silicon (Si)-Dissolved			101.3		%		80-120	13-MAY-16
Silver (Ag)-Dissolved			101.7		%		80-120	13-MAY-16
Sodium (Na)-Dissolved			101.1		%		80-120	13-MAY-16
Strontium (Sr)-Dissolved			95.1		%		80-120	13-MAY-16
Thallium (Tl)-Dissolved			98.7		%		80-120	13-MAY-16
Tin (Sn)-Dissolved			94.3		%		80-120	13-MAY-16
Titanium (Ti)-Dissolved			95.4		%		80-120	13-MAY-16
Tungsten (W)-Dissolved			98.8		%		80-120	13-MAY-16
Uranium (U)-Dissolved			98.9		%		80-120	13-MAY-16
Vanadium (V)-Dissolved			98.2		%		80-120	13-MAY-16
Zinc (Zn)-Dissolved			91.6		%		80-120	13-MAY-16
Zirconium (Zr)-Dissolved			95.6		%		80-120	13-MAY-16
WG2308317-1 MB								
Aluminum (Al)-Dissolved			<0.0050		mg/L		0.005	13-MAY-16
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	13-MAY-16
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	13-MAY-16
Barium (Ba)-Dissolved			<0.00010		mg/L		0.0001	13-MAY-16
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	13-MAY-16
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	13-MAY-16
Boron (B)-Dissolved			<0.010		mg/L		0.01	13-MAY-16
Cadmium (Cd)-Dissolved			<0.000010		mg/L		0.00001	13-MAY-16
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	13-MAY-16
Chromium (Cr)-Dissolved			<0.00050		mg/L		0.0005	13-MAY-16
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	13-MAY-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	13-MAY-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	13-MAY-16
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	13-MAY-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	13-MAY-16

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: Susanna Meteer

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R3459470								
WG2308317-1 MB								
Manganese (Mn)-Dissolved			<0.00050		mg/L		0.0005	13-MAY-16
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	13-MAY-16
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	13-MAY-16
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	13-MAY-16
Potassium (K)-Dissolved			<0.050		mg/L		0.05	13-MAY-16
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	13-MAY-16
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	13-MAY-16
Silver (Ag)-Dissolved			<0.000050		mg/L		0.00005	13-MAY-16
Sodium (Na)-Dissolved			<0.50		mg/L		0.5	13-MAY-16
Strontium (Sr)-Dissolved			<0.0010		mg/L		0.001	13-MAY-16
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	13-MAY-16
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	13-MAY-16
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	13-MAY-16
Tungsten (W)-Dissolved			<0.00010		mg/L		0.0001	13-MAY-16
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	13-MAY-16
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	13-MAY-16
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	13-MAY-16
Zirconium (Zr)-Dissolved			<0.00030		mg/L		0.0003	13-MAY-16
WG2308317-5 MS		**WG2308317-3**						
Aluminum (Al)-Dissolved			120.8		%		70-130	13-MAY-16
Antimony (Sb)-Dissolved			101.6		%		70-130	13-MAY-16
Arsenic (As)-Dissolved			112.0		%		70-130	13-MAY-16
Barium (Ba)-Dissolved			N/A	MS-B	%		-	13-MAY-16
Beryllium (Be)-Dissolved			107.8		%		70-130	13-MAY-16
Bismuth (Bi)-Dissolved			90.0		%		70-130	13-MAY-16
Boron (B)-Dissolved			N/A	MS-B	%		-	13-MAY-16
Cadmium (Cd)-Dissolved			103.9		%		70-130	13-MAY-16
Calcium (Ca)-Dissolved			N/A	MS-B	%		-	13-MAY-16
Chromium (Cr)-Dissolved			101.9		%		70-130	13-MAY-16
Cobalt (Co)-Dissolved			97.1		%		70-130	13-MAY-16
Copper (Cu)-Dissolved			93.8		%		70-130	13-MAY-16
Iron (Fe)-Dissolved			N/A	MS-B	%		-	13-MAY-16
Lead (Pb)-Dissolved			93.1		%		70-130	13-MAY-16
Magnesium (Mg)-Dissolved			N/A	MS-B	%		-	13-MAY-16

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: Susanna Meteer

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-WT	**Water**							
Batch R3459470								
WG2308317-5 MS		**WG2308317-3**						
Manganese (Mn)-Dissolved			N/A	MS-B	%		-	13-MAY-16
Molybdenum (Mo)-Dissolved			99.6		%		70-130	13-MAY-16
Nickel (Ni)-Dissolved			94.9		%		70-130	13-MAY-16
Phosphorus (P)-Dissolved			123.9		%		70-130	13-MAY-16
Potassium (K)-Dissolved			N/A	MS-B	%		-	13-MAY-16
Selenium (Se)-Dissolved			119.6		%		70-130	13-MAY-16
Silicon (Si)-Dissolved			N/A	MS-B	%		-	13-MAY-16
Silver (Ag)-Dissolved			82.2		%		70-130	13-MAY-16
Sodium (Na)-Dissolved			N/A	MS-B	%		-	13-MAY-16
Strontium (Sr)-Dissolved			N/A	MS-B	%		-	13-MAY-16
Thallium (Tl)-Dissolved			94.5		%		70-130	13-MAY-16
Tin (Sn)-Dissolved			99.6		%		70-130	13-MAY-16
Titanium (Ti)-Dissolved			100.1		%		70-130	13-MAY-16
Tungsten (W)-Dissolved			99.6		%		70-130	13-MAY-16
Uranium (U)-Dissolved			N/A	MS-B	%		-	13-MAY-16
Vanadium (V)-Dissolved			104.5		%		70-130	13-MAY-16
Zinc (Zn)-Dissolved			94.4		%		70-130	13-MAY-16
Zirconium (Zr)-Dissolved			100.1		%		70-130	13-MAY-16
MET-T-MS-WT	**Water**							
Batch R3458293								
WG2308159-4 DUP		**WG2308159-3**						
Aluminum (Al)-Total		0.025	0.030		mg/L	17	20	13-MAY-16
Antimony (Sb)-Total		0.00014	0.00012		mg/L	10	20	13-MAY-16
Arsenic (As)-Total		0.00019	0.00021		mg/L	7.2	20	13-MAY-16
Barium (Ba)-Total		0.0446	0.0422		mg/L	5.5	20	13-MAY-16
Beryllium (Be)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	13-MAY-16
Bismuth (Bi)-Total		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	13-MAY-16
Boron (B)-Total		0.020	0.020		mg/L	1.3	20	13-MAY-16
Cadmium (Cd)-Total		0.000014	0.000014		mg/L	0.2	20	13-MAY-16
Calcium (Ca)-Total		102	104		mg/L	2.1	20	13-MAY-16
Cesium (Cs)-Total		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	13-MAY-16
Chromium (Cr)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	13-MAY-16
Cobalt (Co)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	13-MAY-16

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: Susanna Meteer

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-MS-WT	**Water**							
Batch R3458293								
WG2308159-4 DUP		**WG2308159-3**						
Copper (Cu)-Total		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	13-MAY-16
Iron (Fe)-Total		<0.050	<0.050	RPD-NA	mg/L	N/A	20	13-MAY-16
Lead (Pb)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	13-MAY-16
Lithium (Li)-Total		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	13-MAY-16
Magnesium (Mg)-Total		18.5	18.1		mg/L	2.5	20	13-MAY-16
Manganese (Mn)-Total		0.00764	0.00742		mg/L	2.9	20	13-MAY-16
Molybdenum (Mo)-Total		0.000274	0.000283		mg/L	3.1	20	13-MAY-16
Nickel (Ni)-Total		0.00060	0.00056		mg/L	7.1	20	13-MAY-16
Phosphorus (P)-Total		<0.050	<0.050	RPD-NA	mg/L	N/A	20	13-MAY-16
Potassium (K)-Total		2.50	2.43		mg/L	2.8	20	13-MAY-16
Rubidium (Rb)-Total		0.00064	0.00066		mg/L	2.2	20	13-MAY-16
Selenium (Se)-Total		0.000813	0.000777		mg/L	4.4	20	13-MAY-16
Silicon (Si)-Total		2.73	2.63		mg/L	3.6	20	13-MAY-16
Silver (Ag)-Total		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	13-MAY-16
Sodium (Na)-Total		31.0	30.1		mg/L	2.9	20	13-MAY-16
Strontium (Sr)-Total		0.223	0.227		mg/L	1.4	20	13-MAY-16
Sulfur (S)-Total		7.67	7.16		mg/L	6.9	20	13-MAY-16
Tellurium (Te)-Total		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	13-MAY-16
Thallium (Tl)-Total		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	13-MAY-16
Thorium (Th)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	13-MAY-16
Tin (Sn)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	13-MAY-16
Titanium (Ti)-Total		0.00072	0.00086		mg/L	18	20	13-MAY-16
Tungsten (W)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	13-MAY-16
Uranium (U)-Total		0.00131	0.00127		mg/L	3.6	20	13-MAY-16
Vanadium (V)-Total		0.00052	0.00051		mg/L	1.8	20	13-MAY-16
Zinc (Zn)-Total		<0.0030	<0.0030	RPD-NA	mg/L	N/A	20	13-MAY-16
Zirconium (Zr)-Total		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	13-MAY-16
WG2308159-2 LCS								
Aluminum (Al)-Total			93.8		%		80-120	13-MAY-16
Antimony (Sb)-Total			102.0		%		80-120	13-MAY-16
Arsenic (As)-Total			97.5		%		80-120	13-MAY-16
Barium (Ba)-Total			98.2		%		80-120	13-MAY-16
Beryllium (Be)-Total			92.3		%		80-120	13-MAY-16

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: Susanna Meteer

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-MS-WT	**Water**							
Batch R3458293								
WG2308159-2 LCS								
Bismuth (Bi)-Total			98.5		%		80-120	13-MAY-16
Boron (B)-Total			88.9		%		80-120	13-MAY-16
Cadmium (Cd)-Total			100.2		%		80-120	13-MAY-16
Calcium (Ca)-Total			97.4		%		80-120	13-MAY-16
Cesium (Cs)-Total			98.8		%		80-120	13-MAY-16
Chromium (Cr)-Total			96.9		%		80-120	13-MAY-16
Cobalt (Co)-Total			97.0		%		80-120	13-MAY-16
Copper (Cu)-Total			96.7		%		80-120	13-MAY-16
Iron (Fe)-Total			96.4		%		80-120	13-MAY-16
Lead (Pb)-Total			101.2		%		80-120	13-MAY-16
Lithium (Li)-Total			89.7		%		80-120	13-MAY-16
Magnesium (Mg)-Total			98.4		%		80-120	13-MAY-16
Manganese (Mn)-Total			96.3		%		80-120	13-MAY-16
Molybdenum (Mo)-Total			99.8		%		80-120	13-MAY-16
Nickel (Ni)-Total			96.1		%		80-120	13-MAY-16
Phosphorus (P)-Total			100.5		%		80-120	13-MAY-16
Potassium (K)-Total			96.1		%		80-120	13-MAY-16
Rubidium (Rb)-Total			97.0		%		80-120	13-MAY-16
Selenium (Se)-Total			97.6		%		80-120	13-MAY-16
Silicon (Si)-Total			99.1		%		80-120	13-MAY-16
Silver (Ag)-Total			99.0		%		80-120	13-MAY-16
Sodium (Na)-Total			99.0		%		80-120	13-MAY-16
Strontium (Sr)-Total			99.8		%		80-120	13-MAY-16
Sulfur (S)-Total			93.6		%		80-120	13-MAY-16
Tellurium (Te)-Total			91.7		%		80-120	13-MAY-16
Thallium (Tl)-Total			98.6		%		80-120	13-MAY-16
Thorium (Th)-Total			97.7		%		80-120	13-MAY-16
Tin (Sn)-Total			99.8		%		80-120	13-MAY-16
Titanium (Ti)-Total			93.5		%		80-120	13-MAY-16
Tungsten (W)-Total			102.1		%		80-120	13-MAY-16
Uranium (U)-Total			99.0		%		80-120	13-MAY-16
Vanadium (V)-Total			98.5		%		80-120	13-MAY-16
Zinc (Zn)-Total			92.0		%		80-120	13-MAY-16

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: Susanna Meteer

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-MS-WT	**Water**							
Batch R3458293								
WG2308159-2 LCS								
Zirconium (Zr)-Total			96.4		%		80-120	13-MAY-16
WG2308159-1 MB								
Aluminum (Al)-Total			<0.010		mg/L		0.01	13-MAY-16
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	13-MAY-16
Arsenic (As)-Total			<0.00010		mg/L		0.0001	13-MAY-16
Barium (Ba)-Total			<0.00020		mg/L		0.0002	13-MAY-16
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	13-MAY-16
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	13-MAY-16
Boron (B)-Total			<0.010		mg/L		0.01	13-MAY-16
Cadmium (Cd)-Total			<0.000010		mg/L		0.00001	13-MAY-16
Calcium (Ca)-Total			<0.50		mg/L		0.5	13-MAY-16
Cesium (Cs)-Total			<0.000010		mg/L		0.00001	13-MAY-16
Chromium (Cr)-Total			<0.00050		mg/L		0.0005	13-MAY-16
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	13-MAY-16
Copper (Cu)-Total			<0.0010		mg/L		0.001	13-MAY-16
Iron (Fe)-Total			<0.050		mg/L		0.05	13-MAY-16
Lead (Pb)-Total			<0.00010		mg/L		0.0001	13-MAY-16
Lithium (Li)-Total			<0.0010		mg/L		0.001	13-MAY-16
Magnesium (Mg)-Total			<0.050		mg/L		0.05	13-MAY-16
Manganese (Mn)-Total			<0.00050		mg/L		0.0005	13-MAY-16
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	13-MAY-16
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	13-MAY-16
Phosphorus (P)-Total			<0.050		mg/L		0.05	13-MAY-16
Potassium (K)-Total			<0.050		mg/L		0.05	13-MAY-16
Rubidium (Rb)-Total			<0.00020		mg/L		0.0002	13-MAY-16
Selenium (Se)-Total			<0.000050		mg/L		0.00005	13-MAY-16
Silicon (Si)-Total			<0.050		mg/L		0.05	13-MAY-16
Silver (Ag)-Total			<0.000050		mg/L		0.00005	13-MAY-16
Sodium (Na)-Total			<0.50		mg/L		0.5	13-MAY-16
Strontium (Sr)-Total			<0.0010		mg/L		0.001	13-MAY-16
Sulfur (S)-Total			<0.50		mg/L		0.5	13-MAY-16
Tellurium (Te)-Total			<0.00020		mg/L		0.0002	13-MAY-16
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	13-MAY-16
Thorium (Th)-Total			<0.00010		mg/L		0.0001	13-MAY-16

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: Susanna Meteer

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-MS-WT	**Water**							
Batch R3458293								
WG2308159-1 MB								
Tin (Sn)-Total			<0.00010		mg/L		0.0001	13-MAY-16
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	13-MAY-16
Tungsten (W)-Total			<0.00010		mg/L		0.0001	13-MAY-16
Uranium (U)-Total			<0.000010		mg/L		0.00001	13-MAY-16
Vanadium (V)-Total			<0.00050		mg/L		0.0005	13-MAY-16
Zinc (Zn)-Total			<0.0030		mg/L		0.003	13-MAY-16
Zirconium (Zr)-Total			<0.00030		mg/L		0.0003	13-MAY-16
WG2308159-5 MS		**WG2308159-3**						
Aluminum (Al)-Total			105.6		%		70-130	13-MAY-16
Antimony (Sb)-Total			96.8		%		70-130	13-MAY-16
Arsenic (As)-Total			95.0		%		70-130	13-MAY-16
Barium (Ba)-Total			N/A	MS-B	%		-	13-MAY-16
Beryllium (Be)-Total			88.0		%		70-130	13-MAY-16
Bismuth (Bi)-Total			90.4		%		70-130	13-MAY-16
Boron (B)-Total			88.1		%		70-130	13-MAY-16
Cadmium (Cd)-Total			92.3		%		70-130	13-MAY-16
Calcium (Ca)-Total			N/A	MS-B	%		-	13-MAY-16
Cesium (Cs)-Total			94.5		%		70-130	13-MAY-16
Chromium (Cr)-Total			95.9		%		70-130	13-MAY-16
Cobalt (Co)-Total			93.0		%		70-130	13-MAY-16
Copper (Cu)-Total			95.8		%		70-130	13-MAY-16
Lead (Pb)-Total			92.8		%		70-130	13-MAY-16
Lithium (Li)-Total			94.0		%		70-130	13-MAY-16
Magnesium (Mg)-Total			N/A	MS-B	%		-	13-MAY-16
Manganese (Mn)-Total			93.4		%		70-130	13-MAY-16
Molybdenum (Mo)-Total			97.8		%		70-130	13-MAY-16
Nickel (Ni)-Total			90.4		%		70-130	13-MAY-16
Phosphorus (P)-Total			103.2		%		70-130	13-MAY-16
Potassium (K)-Total			97.0		%		70-130	13-MAY-16
Rubidium (Rb)-Total			95.6		%		70-130	13-MAY-16
Selenium (Se)-Total			90.4		%		70-130	13-MAY-16
Silicon (Si)-Total			N/A	MS-B	%		-	13-MAY-16
Silver (Ag)-Total			90.1		%		70-130	13-MAY-16
Sodium (Na)-Total			N/A	MS-B	%		-	13-MAY-16

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: Susanna Meteer

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-MS-WT	**Water**							
Batch R3458293								
WG2308159-5 MS		**WG2308159-3**						
Strontium (Sr)-Total			N/A	MS-B	%		-	13-MAY-16
Sulfur (S)-Total			N/A	MS-B	%		-	13-MAY-16
Tellurium (Te)-Total			82.6		%		70-130	13-MAY-16
Thallium (Tl)-Total			91.6		%		70-130	13-MAY-16
Thorium (Th)-Total			93.8		%		70-130	13-MAY-16
Tin (Sn)-Total			94.6		%		70-130	13-MAY-16
Titanium (Ti)-Total			98.0		%		70-130	13-MAY-16
Tungsten (W)-Total			97.9		%		70-130	13-MAY-16
Uranium (U)-Total			N/A	MS-B	%		-	13-MAY-16
Vanadium (V)-Total			97.8		%		70-130	13-MAY-16
Zinc (Zn)-Total			92.1		%		70-130	13-MAY-16
Zirconium (Zr)-Total			95.5		%		70-130	13-MAY-16
NH3-WT	**Water**							
Batch R3459966								
WG2309656-3 DUP		**L1768465-1**						
Ammonia, Total (as N)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	17-MAY-16
WG2309656-2 LCS								
Ammonia, Total (as N)			101.8		%		85-115	17-MAY-16
WG2309656-1 MB								
Ammonia, Total (as N)			<0.020		mg/L		0.02	17-MAY-16
WG2309656-4 MS		**L1768465-1**						
Ammonia, Total (as N)			95.0		%		75-125	17-MAY-16
NO2-IC-WT	**Water**							
Batch R3460229								
WG2309840-4 DUP		**WG2309840-3**						
Nitrite (as N)		<0.010	<0.010	RPD-NA	mg/L	N/A	25	17-MAY-16
WG2309840-2 LCS								
Nitrite (as N)			100.1		%		70-130	17-MAY-16
WG2309840-1 MB								
Nitrite (as N)			<0.010		mg/L		0.01	17-MAY-16
WG2309840-5 MS		**WG2309840-3**						
Nitrite (as N)			100.7		%		70-130	17-MAY-16
NO3-IC-WT	**Water**							

Quality Control Report

Workorder: L1768544 Report Date: 24-MAY-16

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: Susanna Meteer

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-IC-WT	**Water**							
Batch R3460229								
WG2309840-4 DUP		**WG2309840-3**						
Nitrate (as N)		<0.020	<0.020	RPD-NA	mg/L	N/A	25	17-MAY-16
WG2309840-2 LCS								
Nitrate (as N)			98.4		%		70-130	17-MAY-16
WG2309840-1 MB								
Nitrate (as N)			<0.020		mg/L		0.02	17-MAY-16
WG2309840-5 MS		**WG2309840-3**						
Nitrate (as N)			99.4		%		70-130	17-MAY-16
PH-WT	**Water**							
Batch R3458799								
WG2308727-6 DUP		**WG2308727-5**						
pH		7.98	7.99	J	pH units	0.01	0.2	15-MAY-16
WG2308727-4 LCS								
pH			6.98		pH units		6.9-7.1	15-MAY-16
PO4-DO-COL-WT	**Water**							
Batch R3459547								
WG2309825-3 DUP		**L1768554-1**						
Phosphate-P (ortho)		<0.0030	<0.0030	RPD-NA	mg/L	N/A	20	17-MAY-16
WG2309825-2 LCS								
Phosphate-P (ortho)			91.7		%		80-120	17-MAY-16
WG2309825-1 MB								
Phosphate-P (ortho)			<0.0030		mg/L		0.003	17-MAY-16
WG2309825-4 MS		**L1768554-1**						
Phosphate-P (ortho)			104.5		%		70-130	17-MAY-16
SO4-IC-N-WT	**Water**							
Batch R3460229								
WG2309840-4 DUP		**WG2309840-3**						
Sulfate (SO4)		5.22	5.22		mg/L	0.1	20	17-MAY-16
WG2309840-2 LCS								
Sulfate (SO4)			101.0		%		90-110	17-MAY-16
WG2309840-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	17-MAY-16
WG2309840-5 MS		**WG2309840-3**						
Sulfate (SO4)			100.9		%		75-125	17-MAY-16
SOLIDS-TDS-WT	**Water**							

Quality Control Report

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: Susanna Meteer

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SOLIDS-TDS-WT	**Water**							
Batch R3459879								
WG2309574-3 DUP		**L1768258-4**						
Total Dissolved Solids		280	272		mg/L	2.7	20	17-MAY-16
WG2309574-2 LCS								
Total Dissolved Solids			100.5		%		85-115	17-MAY-16
WG2309574-1 MB								
Total Dissolved Solids			<10		mg/L		10	17-MAY-16
Batch R3462610								
WG2310337-3 DUP		**L1768544-2**						
Total Dissolved Solids		578	584		mg/L	0.9	20	18-MAY-16
WG2310337-2 LCS								
Total Dissolved Solids			99.9		%		85-115	18-MAY-16
WG2310337-1 MB								
Total Dissolved Solids			<10		mg/L		10	18-MAY-16
TURBIDITY-WT	**Water**							
Batch R3457445								
WG2308348-3 DUP		**L1768544-2**						
Turbidity		0.93	0.87		NTU	7.2	15	14-MAY-16
WG2308348-2 LCS								
Turbidity			101.0		%		85-115	14-MAY-16
WG2308348-1 MB								
Turbidity			<0.10		NTU		0.1	14-MAY-16

Quality Control Report

Workorder: L1768544 Report Date: 24-MAY-16

Client: EnGlobe Corp.
353 BRIDGE ST. E.
KITCHENER ON N2K 2Y5
Contact: Susanna Meteer

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1768544-COFC

COC Number: 14 - 457702

Page 1 of 1

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	Englobe	Select Report Format:	PDF EXCEL EDD (DIGITAL)	R Regular (Standard TAT if received by 3pm)
Contact:	Sue Meteer	Quality Control (QC) Report with Report	Yes No	P Priority (2-4 business days if received by 3pm)
Address:	353 Bridge Street	Criteria on Report - provide details below if box checked		E Emergency (1-2 business days if received by 3pm)
		Select Distribution:	EMAIL MAIL FAX	E2 Same day or weekend emergency if received by 10am – contact ALS for surcharge.
Phone:	519 741 1313	Email 1 or Fax	Sue Meteer	Specify Date Required for E2,E or P:
		Email 2		

Invoice To	Same as Report To	Yes No	Invoice Distribution		Analysis Request
	Copy of Invoice with Report	Yes No	Select Invoice Distribution:	EMAIL MAIL FAX	Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below
Company:			Email 1 or Fax	Sue Meteer	
Contact:			Email 2		

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:		Approver ID:	Cost Center:
Job #:	P-0010233-0-02-300	GL Account:	Routing Code:
PO / AFE:	A03742	Activity Code:	
LSD:		Location:	

ALS Lab Work Order # (lab use only): L1768544 13C

ALS Contact: ML

Sampler: Dan Soute

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	(Gen Chem Pkg)	Number of Containers
	~~BH16~~	13-May-16				5
1	02-16	"	9:00	water	✓	5
	~~BH16~~					5
2	10-16	"	11:00	Water	✓	5
3	04-16	"	12:00	Water	✓	5

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☐ Yes ☑ No	
Are samples for human drinking water use? ☐ Yes ☑ No	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No ☐	
Ice packs	Yes ☑	No ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated	☑				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
			11.9		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
Dan Soute	May 13/16	1524				RH	13MAY16	1530

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.