



**220 Arkell Road, Guelph  
Preliminary Servicing, Grading  
and Stormwater Management  
Report**

May 28, 2019

Prepared for:

Rockpoint Properties Inc.  
195 Hanlon Creek Blvd.  
Unit 100  
Guelph ON N1C 0A1

Prepared by:

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

Project Number: 161423338



Revision	Description	Author		Quality Check		Independent Review	



**220 ARKELL ROAD, GUELPH  
PRELIMINARY SERVICING, GRADING AND STORMWATER MANAGEMENT REPORT**

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Prepared by   
(signature)

**Michael Huisman, C.Tech, Project Coordinator**

Reviewed by   
(signature)

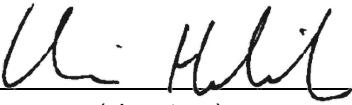
**Kevin Brousseau, C.E.T., Discipline Leader**

Prepared by   
(signature)

**Bryan Weersink, P. Eng., Water Resources Engineer**

Approved by   
(signature)

**Trevor Fraser, P.Eng., Water Resources Engineer**

Peer Reviewed by   
(signature)

**Chris Hendriksen, P.Eng.**



**220 ARKELL ROAD, GUELPH**  
**PRELIMINARY SERVICING, GRADING AND STORMWATER MANAGEMENT REPORT**

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**220 ARKELL ROAD, GUELPH  
PRELIMINARY SERVICING, GRADING AND STORMWATER MANAGEMENT REPORT**

INTRODUCTION  
May 28, 2019

## **1.0 INTRODUCTION**

### **1.1 SITE LOCATION**

The 220 Arkell Road site is located along the southeast limit of the City of Guelph, approximately 0.6 km west of the Arkell Road and Victoria Road South intersection as illustrated in Figure 1.0. The subject property is comprised of approximately 7.16 ha and is bounded by Victoria Park Village (VPV) Subdivision to the north, existing agricultural lands to the east, existing Arkell Meadows Subdivision to the South and Torrance Creek Swamp (Provincially Significant Wetlands [PSW]) to the west. The Proposed Draft Plan consists of 31 Single-Family Lots on a single road and a 1.73 ha Multiple-Family Residential Block, as well as a SWM Block, Park Block and Ecological Linkage Block. The described are illustrated on Figure 1.0 – Site Location Plan and the Proposed Draft Plan included in Appendix A.

### **1.2 PURPOSE OF THIS REPORT**

The purpose of this Preliminary Servicing, Grading and Stormwater Management (SWM) Report is to outline how the proposed 220 Arkell Road lands can be supplied with adequate services, including sanitary, municipal water, storm drainage, SWM, and utilities. This report is prepared in support of the Draft Plan Application. Please refer to the Proposed Draft Plan illustrated on Figure 2.0.

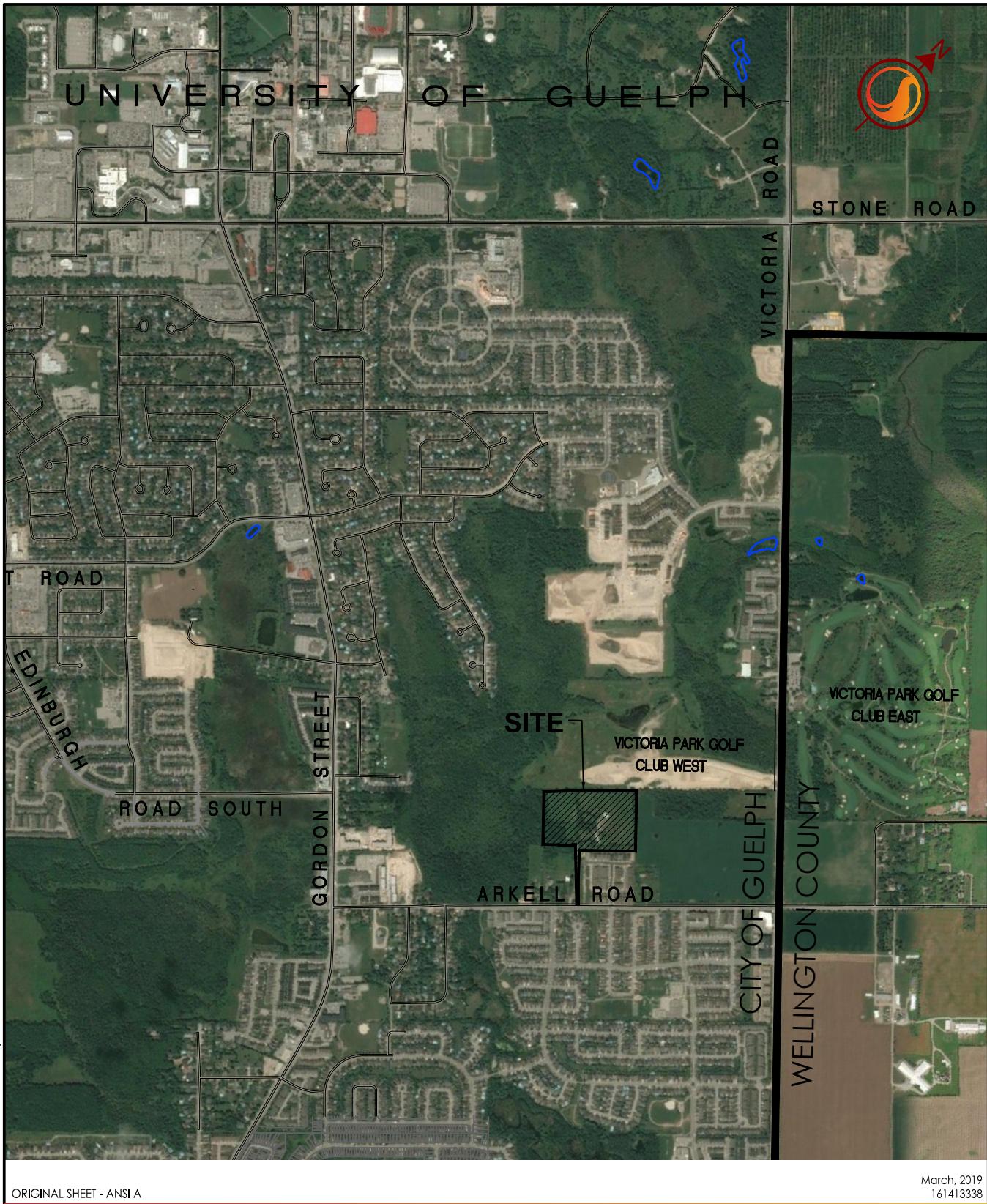
Supplementary reports that should be read in conjunction with this report include:

- Tree Preservation Plan, prepared by Stantec Consulting Ltd., May 2019
- Hydrological Assessment, prepared by Stantec Consulting Ltd., May 2019
- Environmental Impact Study (EIS), prepared by Stantec Consulting Ltd., May 2019
- Geotechnical Investigation, prepared by Stantec Consulting Ltd., May 2019
- Phase 1 Environmental Site Assessment, prepared by Stantec Consulting Ltd., May 2019

This Report demonstrates that the 220 Arkell Road lands can be developed with full municipal servicing, SWM, and utilities to the requirements of the various approval agencies.

The servicing strategies presented in this Report are conceptual. Detailed engineering drawings (for construction) and a Final SWM Report will be submitted as part of the final engineering design process once the proposed Subdivision has received Draft Plan Approval.





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

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Figure No.

1.0

Title

SITE LOCATION PLAN

**220 ARKELL ROAD, GUELPH  
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INTRODUCTION  
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**1.3 ENVIRONMENTAL ASSESSMENT REQUIREMENTS**

Under the procedures set out in the Municipal Class Environmental Assessment Act (Class EA), projects completed by the Private Sector through a Planning Act Process are considered as having fulfilled the Class EA requirements, except for some specific Schedule 'C' projects that are outlined in the Act.

All of the works required for the 220 Arkell Road lands are described in the subsequent sections of this Report. The plans, included in this Report, show the location of the proposed sanitary and storm sewers, proposed watermains, as well as grading and utilities. The intent of this Report and the supplementary Reports is to ensure that the commenting agencies and the Public are made aware of the servicing strategies for the proposed Development.

As above, all of the other works, and in particular all of the works required for the 220 Arkell Road lands will be completed by the Developer (i.e., by the Private Sector), are clearly described/shown in this Report in support of the Draft Plan and, therefore, is exempt from the Class EA.



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PRELIMINARY SERVICING, GRADING AND STORMWATER MANAGEMENT REPORT**

OVERALL GRADING AND DRAINAGE  
May 28, 2019

## **2.0 OVERALL GRADING AND DRAINAGE**

### **2.1 EXISTING LAND USE AND SITE TOPOGRAPHY**

The existing site conditions for the subject site are illustrated on Drawing No. C-050 included in Appendix A.

The subject lands are presently used as a single-family home and former horse pasture. Existing vegetation surrounds the north, east and west property lines.

The topography of the site is generally rolling with elevations ranging from approximately 340.0 m at the center and southeast corner of the site falling northeast to approximately 337.0 m or falling southwest towards the Torrance Creek Swamp at approximately 333.50 m. The site slopes ranging from 0.5% to 15% with the high point situated in the centre of the property. There are two major existing drainage patterns; the first and largest drains approximately 4.70 ha to Torrance Creek Swamp along the southwest property line; and the second drains approximately a 2.47 ha area via sheet flow uncontrolled offsite to the northeast corner. This area then flows via sheet flow to an existing woodlot approximate 70.0 m east of the property line. This is illustrated on the Existing Conditions Plan, Drawing No. C-050, included in Appendix A.

### **2.2 EXISTING LAND USE AND SITE TOPOGRAPHY**

Constraints in designing the road profiles and lot grading are as follows:

- Match existing grades, where possible, to minimize grading and cut/fill quantities and minimize changes to the surface hydrology and hydrogeology of the area
- Maintain grades along the north limits of the property as it is identified to be protected with a 50.0 m wide ecological linkage for wildlife preservation
- Account for future urbanization of adjacent lands
- Match Hutchison Road elevations proposed for Victoria Park Village
- Satisfy the City of Guelph requirements for minimum and maximum road grades
- Provide a major overland flow route for flows in excess of the storm sewer capacity
- Maintain adequate cover over storm, sanitary sewers and watermain
- Match existing grades along the entire perimeter of the site
- Provide sufficient Parkland Area and ensure 80% of park area is suitable table land (i.e., 2 to 3% slope)



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OVERALL GRADING AND DRAINAGE  
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## **2.3 PROPOSED ROAD PROFILES AND OVERALL SITE GRADING**

A preliminary road profile within the subject site was established based on the proposed street pattern to satisfy the constraints outlined in the previous Section 2.2. The road profile has been designed with grades ranging from 0.5% to 2.00% in order to match perimeter grades as well as meet criteria and optimized grading for the proposed servicing solution.

The proposed centerline road elevations are illustrated on the Servicing Concept Plan, Drawing No. C-100, and the Road Profile Concept Drawing No C-200, all included in Appendix A.

The subject lands have a narrow frontage onto the north side of Arkell Road. This narrow frontage facilitates an existing driveway access, constrained by the property boundary which tapers from 6.0 m wide at the Arkell Road Right-of-Way to 14.0 m wide at the end of the access approximately 190.0 m north of Arkell Road. Due to this restriction, the Draft Plan supports one road access through the VPV Subdivision which provides connection to Victoria Road. In the interim, a 10.0 m wide Emergency Access will be provided from the proposed internal road, through the Park Block connecting to the existing road Dawes Avenue, located in the Arkell Meadows Subdivision. The proposed Emergency Access Profile identifying the access grades and slopes is shown on Figure 2.0. This interim emergency access strategy has been reviewed with the City prior to proceeding with the Reports and Plans to support the Draft Plan Subdivision. Additional coordination with the Consultant for the adjacent Developer for 190-216 Arkell Road has occurred to coordinate the future profile of Dawes Avenue and impacts to the Emergency Access connection as shown on Figure 3.0.

A 17.0 m Right-of-Way cross-section in accordance with City Standards is proposed as it is a continuation of the existing road cross section for the Development lands to the north for the single-family road, shown on Figure 4.0 – 17 m Right-of Way.

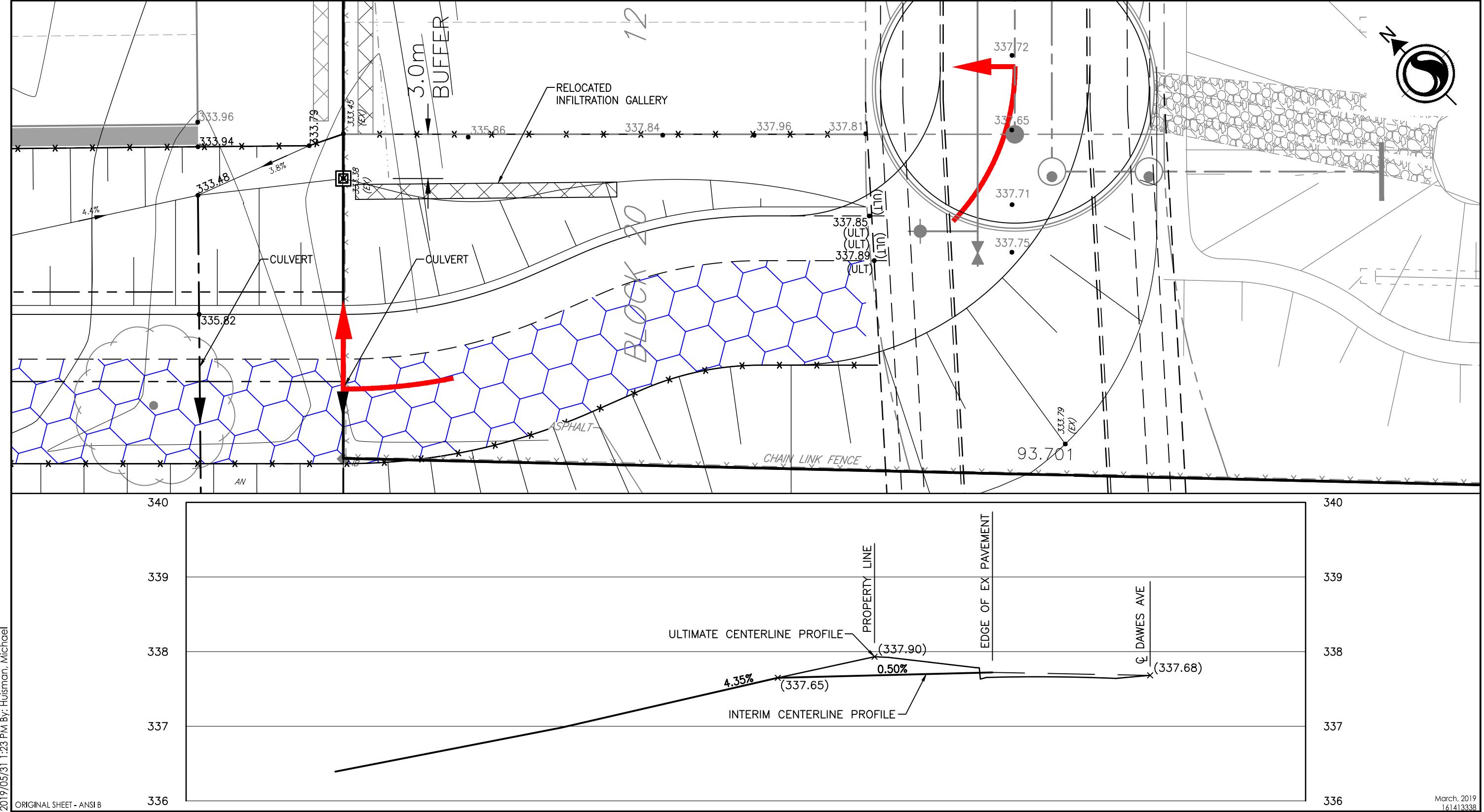
A typical road cross-section, similar to the other multiple Residential Developments constructed in the City, has been prepared for the multiple-residential block, during the preliminary review of the Development. The 6.1 m wide road cross-section is shown on Figure 5.0 and will be further reviewed during the Site Plan process.

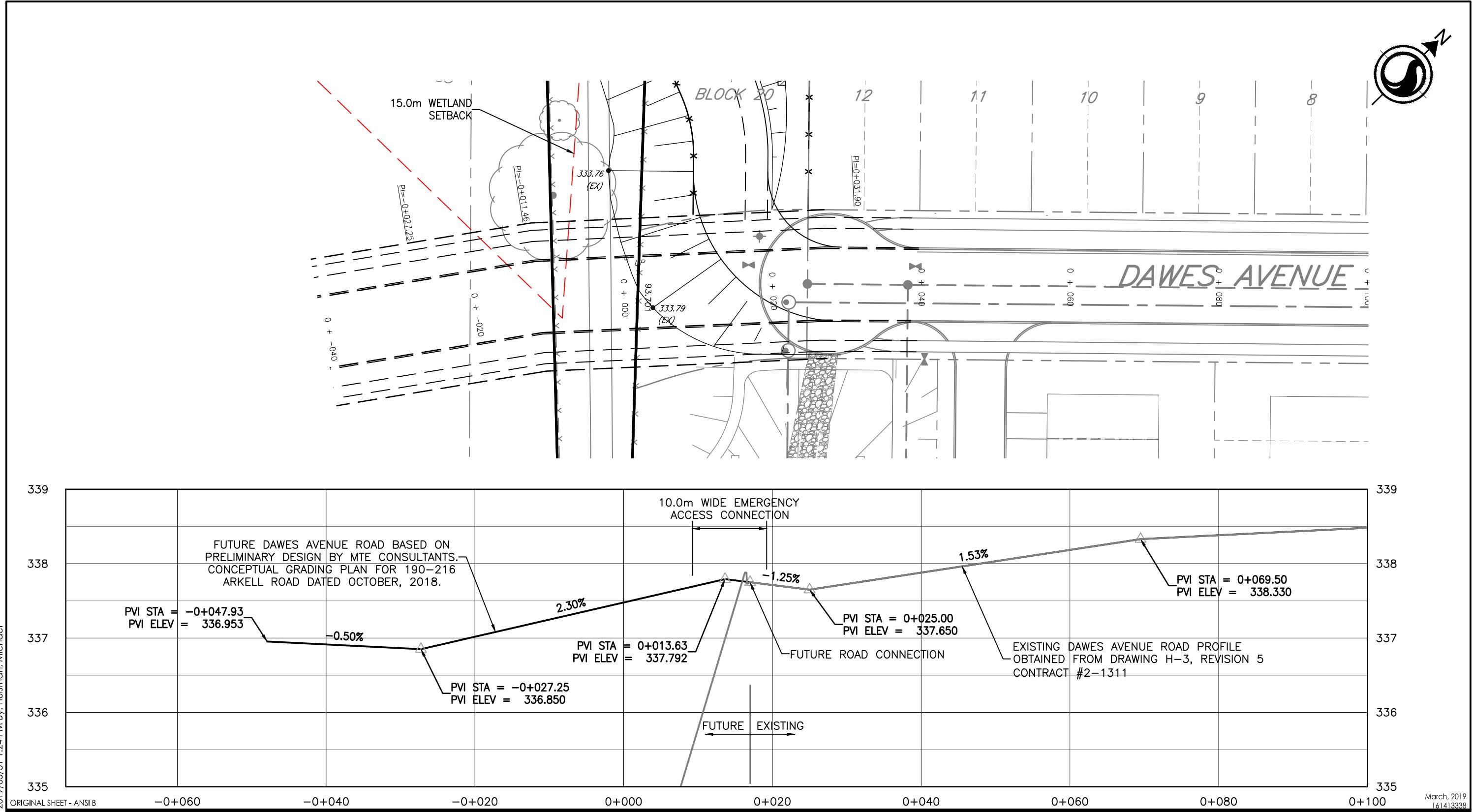
The proposed lot grading within the site ranges from 2.0% to a maximum of 5.0%, with 3:1 transition slopes or retaining walls utilized to accommodate the various grade changes within the proposed subdivision and at various perimeter locations. A combination of Type 'A' (back to front drainage), and Type 'D' (split drainage) or Type 'B' (walkout) are used in the proposed design. No Type 'C' (front walk-ins) lots are anticipated. The proposed lot grading is illustrated on the Conceptual Grading Plan, Erosion & Sediment Control Plan, Drawing No. C-400 included in Appendix A.

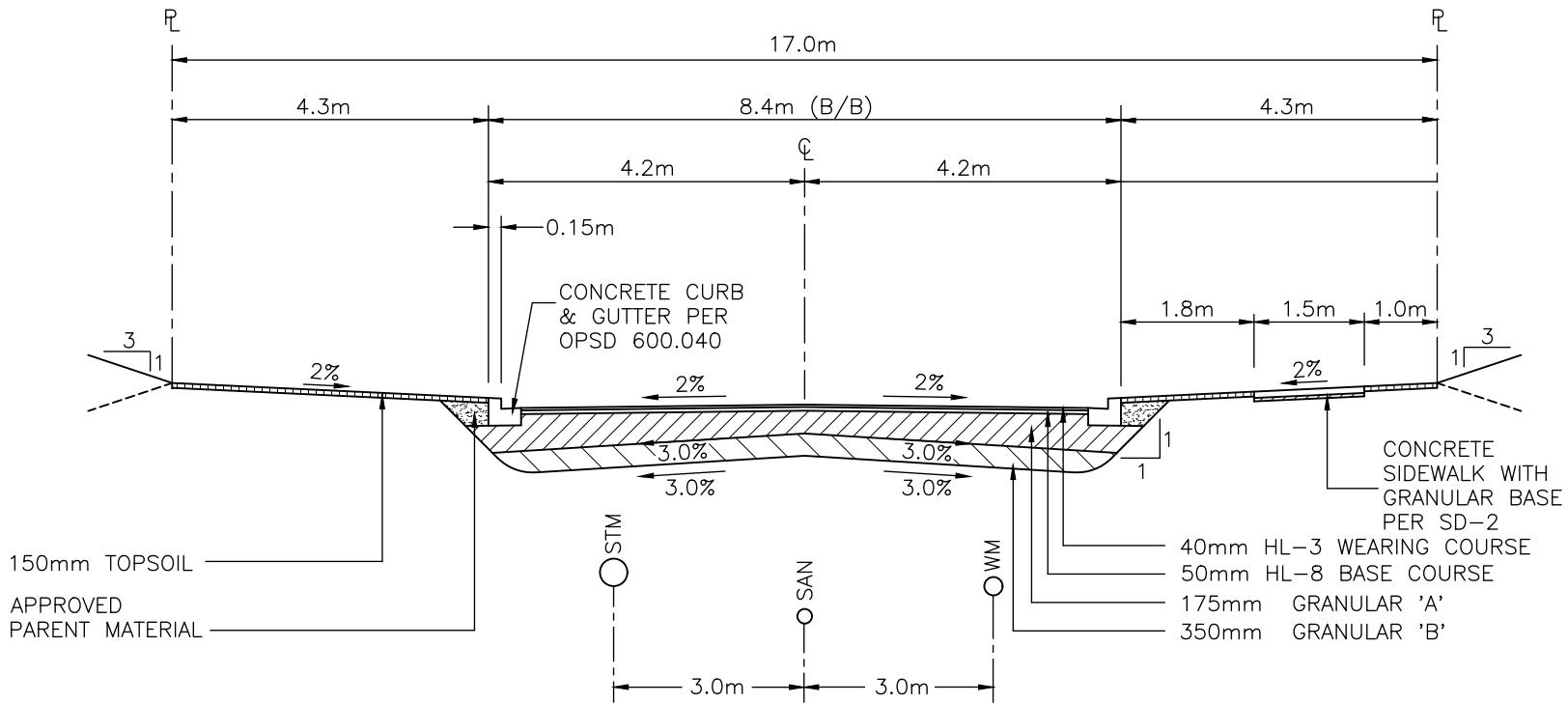
Preliminary earthwork calculations have been performed for the subject property which indicates that there is complete earth cut-/fill balance with surplus topsoil used as fill in park areas. A Preliminary Cut-Fill Plan, Drawing No. C-900 demonstrates the extents of earth cut/fill and is included in Appendix A.

At detailed design, profiles and grading will be refined to minimize the required earth cut/fill volumes.









CROSS SECTIONAL POINTS		
DESCRIPTION	VERTICAL OFFSET FR. C/L	HORIZONTAL OFFSET FR. C/L
EDGE / PAVEMENT	-0.074	3.70
GUTTER LINE	-0.099	4.00
TOP / CURB	+0.051	4.20
FRONT / WALK	+0.087	6.00
BACK / WALK	+0.117	7.50
PROPERTY LINE	+0.137	8.50

### TYPICAL ROAD CROSS-SECTION

17.0m R.O.W. (8.4m ROAD)

STREET 'A'  
STA. 0+000 TO END  
NTS

2019/05/31 1:25 PM By: Huisman, Michael

March, 2019  
161413338

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Figure No.

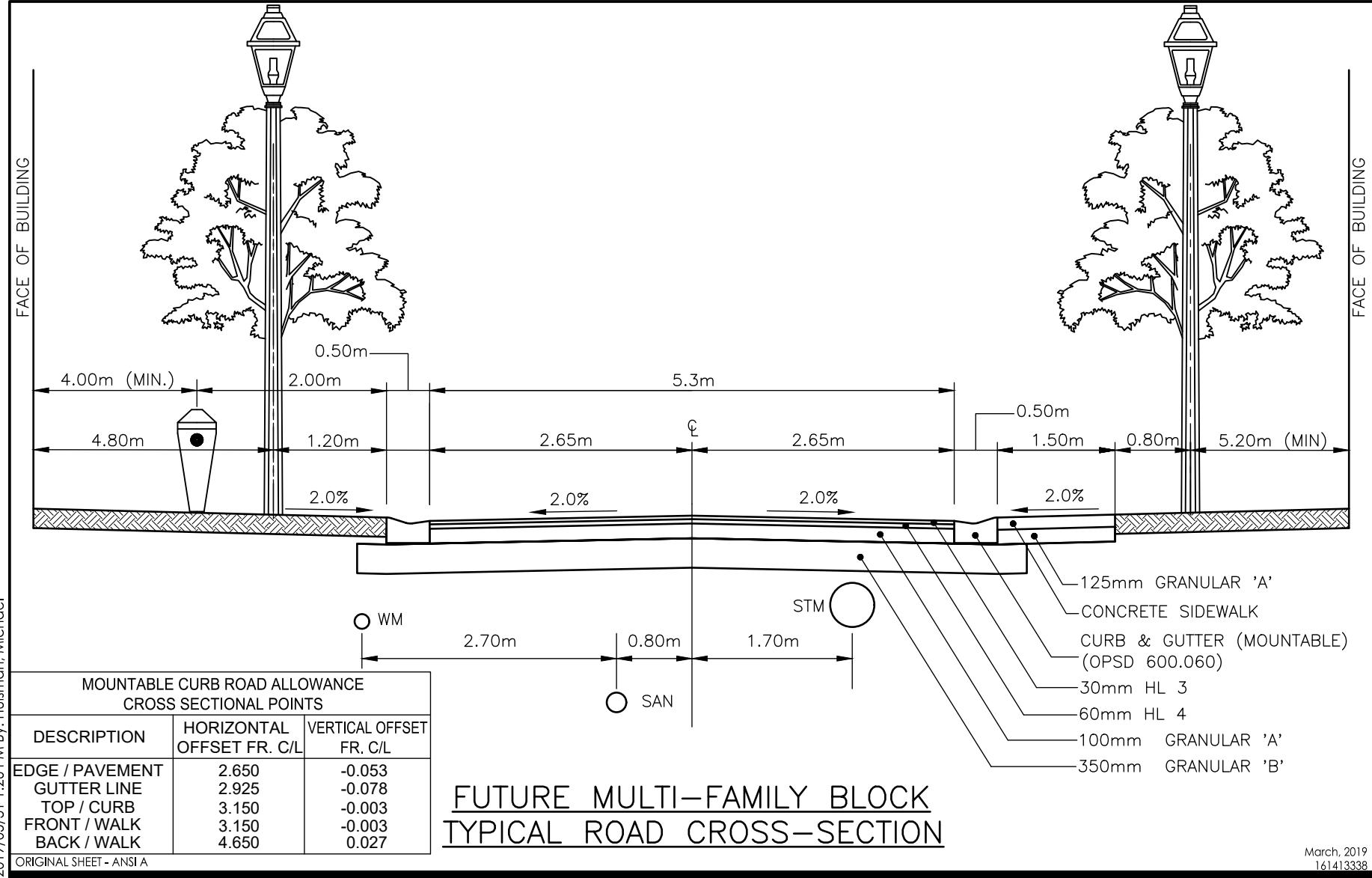
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17.0m RIGHT OF WAY  
TYPICAL ROAD CROSS-SECTION



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



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

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Figure No. 5.0  
Title MULTI-FAMILY BLOCK  
TYPICAL ROAD CROSS-SECTION

**220 ARKELL ROAD, GUELPH  
PRELIMINARY SERVICING, GRADING AND STORMWATER MANAGEMENT REPORT**

SANITARY SERVICING  
May 28, 2019

## **3.0 SANITARY SERVICING**

### **3.1 ULTIMATE SERVICING**

As part of the VPV Subdivision, a 300 mm dia. sanitary sewer was extended from the trunk line on Victoria Road into the aforementioned Development. This sanitary sewer provides an outlet for the VPV Subdivision as well as makes provision to service the upstream lands south of the VPV Development as shown in the approved Sanitary Drainage Area Plans included in Appendix C.

The VPV sanitary servicing strategy accounted for one 200 mm dia. outlet located on Poole Street to accommodate 7.0 ha of external lands. This outlet is located east of the subject property and access to this outlet is not available.

For this Report, we are demonstrating the ability to accommodate flow from the subject Development by making a connection at the intersection of Hutchison Road and Jell Street intersection within the VPV Subdivision and providing a sewer connection south to the north limits of the subject Development.

Local sanitary sewers of 200 mm dia. will be constructed throughout the proposed subject lands and within the proposed roadway for Street A and a service stub will be provided for the future Multi-family Block.

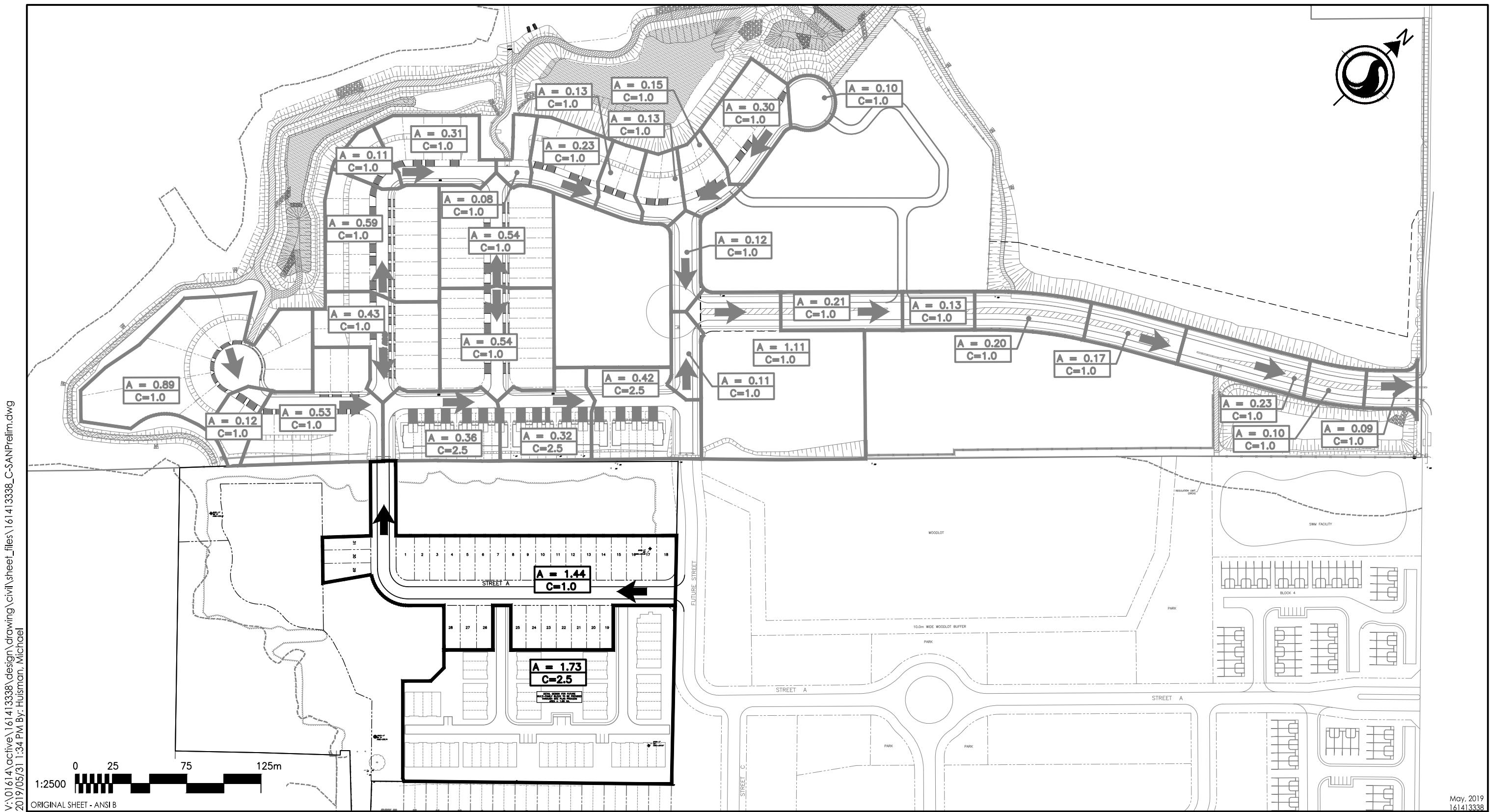
Based on the City of Guelph Design Manual, when calculating the sanitary flow, the proposed or future zoning/density for the Development is to be utilized. Single-family homes are designed based on a factor of 1.0 L/s/ha and Multi-family Block based on 2.52 L/s/ha equating to a total flow of 5.64 L/s/ha from the subject Development. Please refer to our Sanitary Drainage Area Plan, Figure 6.0.

With our proposed sanitary servicing strategy of making a connection at the Hutchison Road and Jell Street intersection, by inserting this flow we confirm there is sufficient capacity in the downstream sewers within the VPV Subdivision to accommodate the subject lands. Please refer to our (post-development) Sanitary Design Sheet in Appendix C.

In conclusion, routing the flow from the subject Development up to the Hutchison Road intersection does not adversely affect the sanitary sewers downstream.

Onsite sewers will have adequate capacity and will be installed at sufficient depths to enable servicing the subject lands by gravity. Please refer to the Conceptual Servicing Plan Drawing No. C-100 (Appendix A) for an illustration of the sanitary servicing strategy.





#### Legend

- |                           |   |
|---------------------------|---|
| <b>A = 1.68<br/>C=2.5</b> | PROPOSED DRAINAGE AREA (HECTARES)<br>SANITARY CO-EFFICIENT<br>(CUBIC METRES PER SECOND PER HECTARE) |
|---------------------------|---|
- PROPOSED FLOW DIRECTION  
PROPOSED DRAINAGE BOUNDARY

- EXISTING DRAINAGE AREA (HECTARES)  
SANITARY CO-EFFICIENT  
(CUBIC METRES PER SECOND PER HECTARE)
- EXISTING FLOW DIRECTION  
EXISTING DRAINAGE BOUNDARY

#### Notes

**220 ARKELL ROAD, GUELPH  
PRELIMINARY SERVICING, GRADING AND STORMWATER MANAGEMENT REPORT**

WATER DISTRIBUTION SYSTEM ANALYSIS  
May 28, 2019

## **4.0 WATER DISTRIBUTION SYSTEM ANALYSIS**

The proposed water servicing layout is show on the Conceptual Servicing Plan, Drawing No. C-100 (Appendix A).

Water supply for domestic water service use and fire protection to the proposed Development will be provided by a single connection in the interim to the existing 150 mm diameter watermain stub on Hutchison Road.

The Internal watermains will be terminated at the east limits of Street A with the intention of 'looping' the watermain back to the adjacent Development to the east providing the ultimate connection back to existing Poole Street to the north.

The proposed residential units will be provided with 25 mm dia. water service connections from the 150 mm dia. watermain and a 150 mm dia. water stub will be provided at the property limits of the Multi-family Block.

Watermain flow and pressure analysis to confirm appropriate supply and capacity for the subject Development will be completed by the City of Guelph at a later time



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STORMWATER MANAGEMENT  
May 28, 2019

## **5.0 STORMWATER MANAGEMENT**

### **5.1 OVERVIEW**

This section has been completed in support of the proposed development located at 220 Arkell Road within the Torrance Creek watershed in the City of Guelph. As mentioned in previous sections of this Report, the subject property is approximately 7.2 ha in size and is generally bounded by Victoria Park Village Subdivision to the North, existing woodlot and greenfield property to the East, developed and established Arkell Meadows Subdivision to the South and a large wetland and woodland to the West. The Proposed Draft Plan consists of 31 single-family lots on a single road, a multiple-family residential block, a SWM block, a wildlife corridor, and a wetland setback. The total developable area is 4.4 ha. The described areas are illustrated on Figure 1.0 – Site Location Plan and the Proposed Draft Plan included in Appendix A.

This section outlines the analysis undertaken to assess the existing hydrology for the site and design a SWM system to meet the City of Guelph criteria using traditional SWM and Low Impact Development (LID) features to achieve the water quantity and water quality targets.

### **5.2 BACKGROUND**

A following sources have been referenced during the preparation of this Report in addition to the documents referenced in Chapter 1.0, Section 1.2 and should be read in conjunction with this Report:

- *Letter Re: 220 Arkell Road – Response to Stormwater Management City Comments Dated July 19, 2018*, Stantec Consulting Ltd., November 5, 2018
- *City of Guelph Development Engineering Manual*, City of Guelph, November 2018
- *Low Impact Development Stormwater Management Planning and Design Guide*, Credit Valley Conservation Authority and Toronto and Region Conservation Authority, 2010
- *Stormwater Management Planning and Design Manual (SWMPD Manual)*, Ontario Ministry of the Environment, March 2003
- *Torrance Creek Subwatershed Study (TCSS), Management Strategy Addendum*, Totten Sims Hubucki et al, January 1999
- *Eramosa River Watershed Hydrology Study*, H.O. Schroeter and D.K. Boyd, 1998



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STORMWATER MANAGEMENT  
May 28, 2019

## **5.3 DESIGN CRITERIA**

SWM criteria were established based on the *Torrance Creek Subwatershed Study* (TCSS) and the characteristics of the receiving systems. The SWM criteria applied to the site are as follows:

- Water Quality – Provide quality control to meet MECP Enhanced (Level 1) criteria as identified in Table 3.2 of the SWMPD Manual
- Water Quantity – Control post-development peak flows to Torrance Creek, to target flow rates from the TCSS. Target peak flow rates have been pro-rated to the developed area
- Extended Detention – Provide at least 24 hours of extended detention of the 25 mm event
- Infiltration – Evaluate the infiltration potential on site as it relates to the existing water budget and maintain existing infiltration rates on the site where possible
- Temperature – The thermal impacts of stormwater discharge to Torrance Creek be assessed and appropriate mitigation practices implemented
- Erosion and Sediment Control – Provide appropriate erosion and sediment control during construction to protect neighbouring properties and downstream receivers from potential siltation

## **5.4 EXISTING CONDITIONS**

### **5.4.1 Geotechnical Information**

As identified in the Geotechnical Investigation, the soils for the site are comprised of sand or fill overlaying glacial till, which was generally comprised of silty sand and gravel till.

Groundwater was measured in four (4) onsite boreholes with measurements during spring conditions in April 2017 ranging from 333.19 mASL in the north-west corner of the site to 337.10 mASL in the south-east corner of the site. Groundwater levels were also monitored from April 2017 to May 2018 as part of the *Hydrogeological Assessment* (Stantec, 2019) with the above reported levels representing the seasonally high levels for the site. Groundwater generally flows from east to west towards the Torrance Creek Swamp PSW.

Estimates for infiltration rates were calculated based on percolation times determined in the *Geotechnical Investigation* (Stantec, 2019) which were based on soils from borehole logs. Percolation times were estimated for Glacial Till and Sand onsite and ranged from 8 min/cm to 50 min/cm. Using the approach outlined in the *LID SWM Planning and Design Manual* (CVC/TRCA, 2010), the factored infiltration rates were determined to range from 4.8 mm/hr to 30 mm/hr based on the above percolation times. These factored infiltration rates use the required safety factor of 2.5 for areas where the soil horizon is found to be continuous within 1.5 m below the proposed bottom elevation of the infiltration trench. It is recommended that in-situ infiltration tests be performed at detailed design at the locations and depths of any proposed infiltration measures to confirm that the soils are sufficiently permeable.



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STORMWATER MANAGEMENT  
May 28, 2019

## **5.5 STORMWATER MANAGEMENT DESIGN**

### **5.5.1 Hydrologic Modeling**

Per City of Guelph requirements, a hydrologic model was prepared using the software program MIDUSS to simulate drainage conditions for the subject development under proposed development conditions. The model was employed to predict flows and design a SWM system to ensure the design criteria are achieved. An existing conditions model was not prepared since all flow targets for the site are based on unit requirements from the TCSS.

Precipitation events were taken from the TCSS and are based on a regional analysis due to a lack of long-term streamflow information for Torrance Creek. A large known rainfall pattern (Hurricane Hazel) was selected and its volume and intensity adjusted to known return-period streamflows in Torrance Creek, similar to the Eramosa River Watershed Hydrology Study (Schroeter and Body, 1998). Table 1 presents the rainfall adjustment factors taken from Table 4.6.3 of the TCSS.

**Table 1: Rainfall Factors Applied to the Regional Storm Pattern to Match Frequency Flows in the Eramosa River Watershed**

Return Period	Adjustment Factor (Table 4.6.3 in TCSS)	Last 24-hour Volume (mm)
2-year	0.345	81.8
5-year	0.425	100.7
10-year	0.495	117.3
25-year	0.525	124.4
100-year	0.627	148.6

The 25 mm rainfall event was used in the design of infiltration and erosion control measures for the site and not considered from a peak flow or quantity control perspective as a target rate for the 25 mm event is not included in the TCSS.

#### **5.5.1.1 Existing Conditions**

The existing drainage conditions for the site were originally delineated in the TCSS and have been updated based on revised topographic information of the site. The original subcatchments are illustrated on Figure 4.6.1 from the TCSS (provided in Appendix D). The site covers three (3) of the TCSS subcatchments. A detailed topographic survey of the site was completed to improve the accuracy of the existing drainage patterns. The hydrologic model only includes the portion of the site that is proposed for development.



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The existing conditions catchment delineation is based on the original delineation shown on Figure 4.6.1 of the TCSS. The revisions are shown on Figure 7.0 and are summarized as follows:

- Catchment 105: 0.85 ha of wooded/wetland area at the west end of the site draining to Torrance Creek
- Catchment 106: 3.85 ha of agricultural land, some forested and lawn coverage, and a residential property including a driveway and several buildings draining from west to Torrance Creek
- Catchment 110: 2.47 ha of mostly agricultural and lawn area with a portion of the residential building draining northeast, eventually to Torrance Creek

Additionally, the Arkell Meadows Subdivision is located immediately south of the proposed site.

No existing conditions hydrologic model was created for this site as the target flow rates are based on pro-rated targets from the GAWSER hydrologic model created for the TCSS. Details for specific subcatchments were taken directly from the output of the GAWSER model and are included in Appendix D. A summary of the peak flow rates for each of the TCSS catchments relevant to the subject site is presented in Table 2. Calculations are provided in Appendix D.

**Table 2: Existing Conditions Unit Flow Rates from TCSS**

TCSS Catchment within Subject Lands ID	TCSS Point of Interest ID (from Table 6.2.2 in TCSS)	Unit Flow Rates (m <sup>3</sup> /s/ha)			
		2-year event	5-year event	20-year event	100-year event
105	505	0.0002	0.0003	0.0003	0.0003
106	505	0.004	0.006	0.010	0.013
110	510	0.004	0.006	0.009	0.012

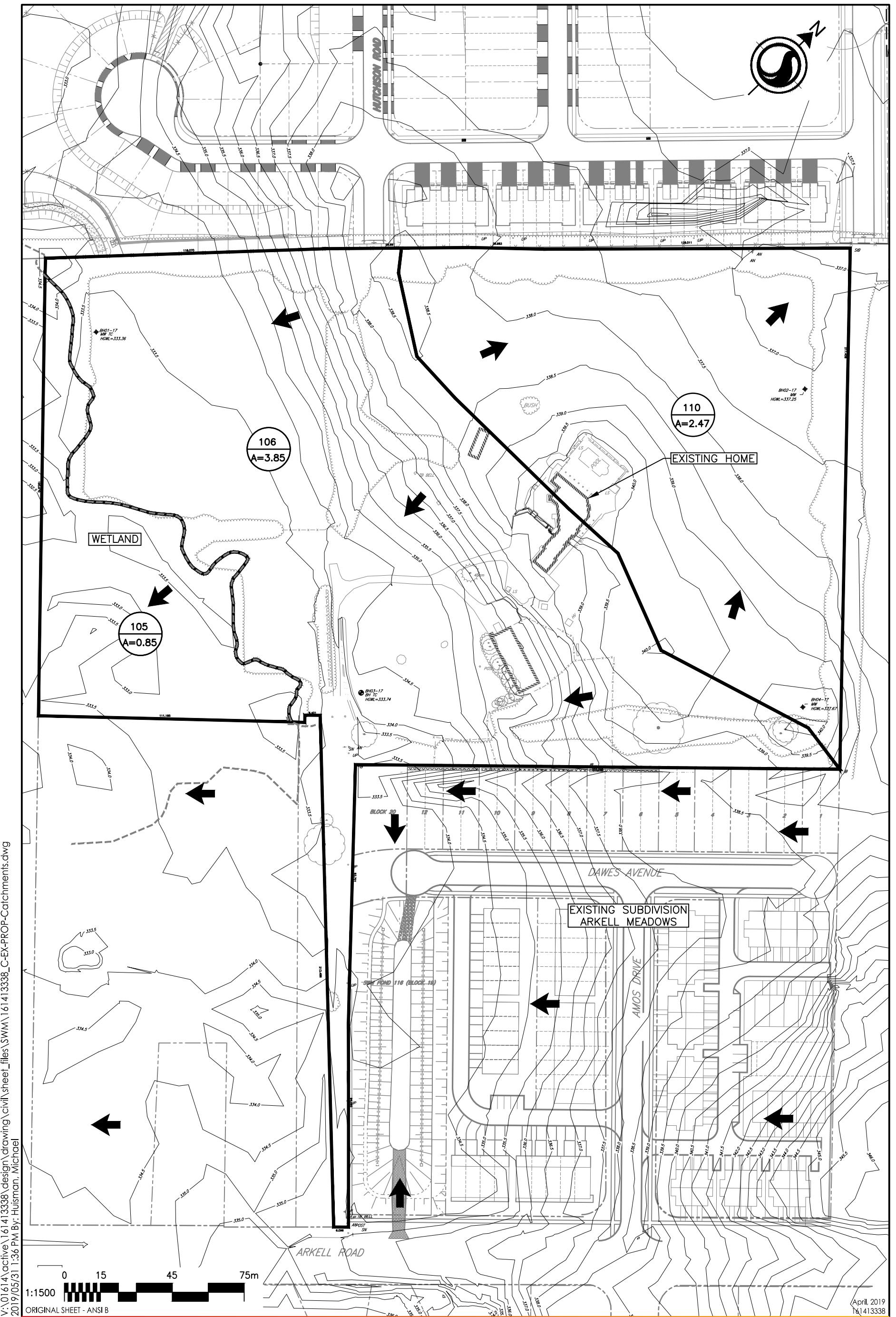
### **5.5.1.2 Proposed Conditions**

The proposed development incorporates primarily residential land use with an onsite Stormwater Management Facility (SWMF) located adjacent to the Torrance Creek Swamp PSW. As per City of Guelph Standards, preliminary estimates for Horton infiltration parameters were used for each catchment based on land use and soil type and are provided in Appendix D.

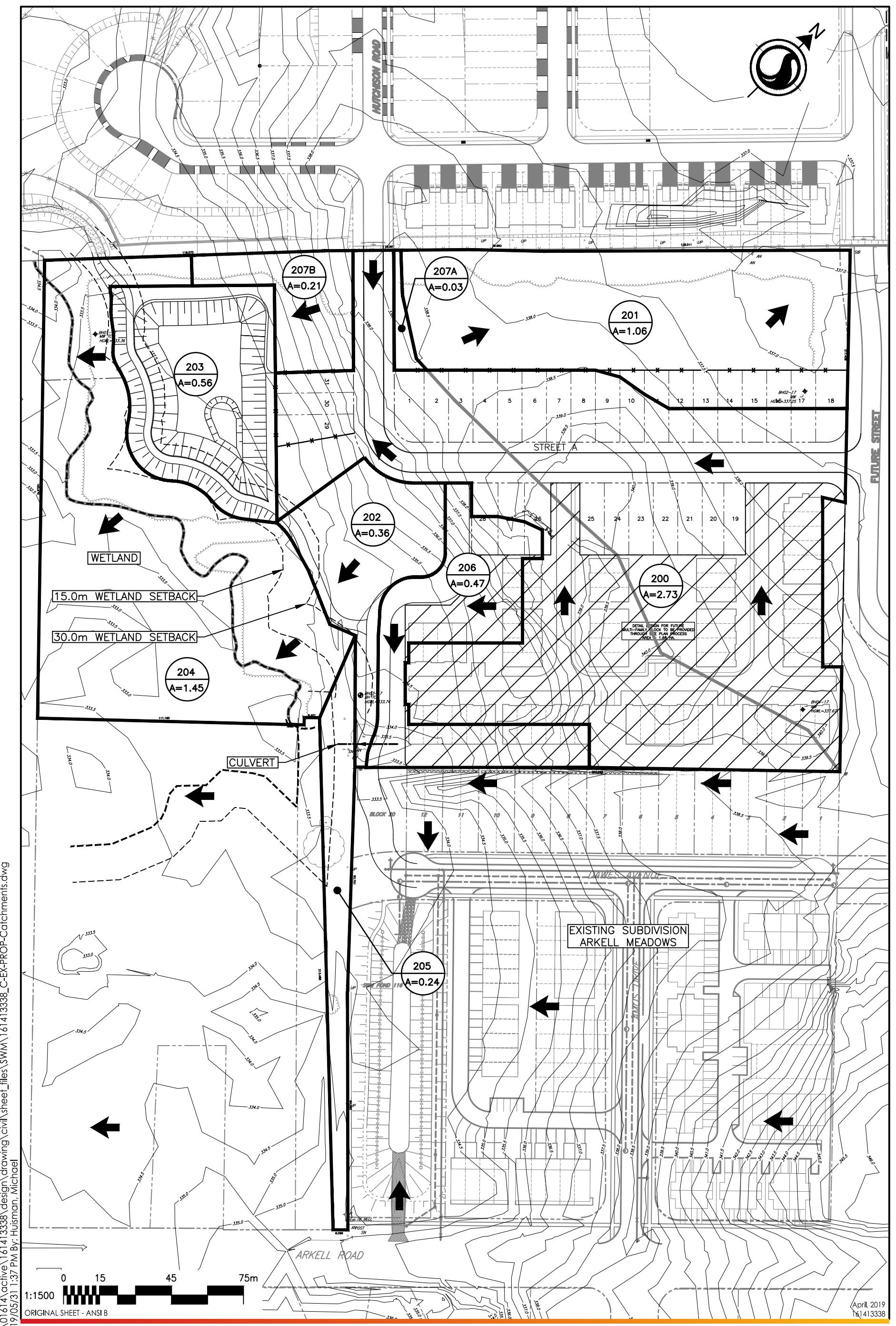
MIDUSS modelling files are provided in Appendix D. The delineation of the proposed drainage catchments is provided on Figure 8.0 and is summarized as follows:

- Catchment 200: 2.73 ha of internal drainage from single family homes, Multi-Family Block, and roadway draining to the onsite SWMF
- Catchment 201: 1.06 ha of naturalized area (ecological linkage) draining uncontrolled, offsite to the neighbouring site
- Catchment 202: 0.36 ha of park area draining uncontrolled to Torrance Creek





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



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

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- Catchment 203: 0.56 ha representing the onsite SWMF Block
- Catchment 204: 1.45 ha forested/wetland coverage including the required buffer distance remaining undeveloped and draining to Torrance Creek
- Catchment 205: 0.24 ha of existing driveway draining uncontrolled to Torrance Creek
- Catchment 206: 0.47 ha of asphalt pathway and rear yards draining to a low-lying area before spilling to Torrance Creek via a proposed culvert. Ponding occurs in the low-lying area, similar to existing conditions, promoting infiltration and delaying flows to the wetland to mimic the current flow regime. This area accounts for the 10 m wide access to the site from Dawes Avenue, which will eventually be reduced to just a 3 m wide pathway
- Catchment 207A: 0.03 ha of naturalized area (ecological linkage) draining uncontrolled, west through the proposed wildlife crossing culvert and subsequently to Torrance Creek (around proposed SWMF)
- Catchment 207B: 0.21 ha of naturalized area (ecological linkage) draining uncontrolled, west to Torrance Creek (around proposed SWMF)

## **5.6 STORMWATER MANAGEMENT STRATEGY**

The proposed stormwater management strategy adheres to the Guidelines as presented in the *SWMPD Manual* (2003) and *City of Guelph Development Engineering Manual* (November 2018).

The strategy incorporates a combination of lot level and centralized infiltration trenches to promote groundwater recharge of rooftop runoff and an end of pipe dry SWMF promoting infiltration and quantity control. A treatment train approach using an Oil/Grit Separator (OGS) unit in series with a forebay in the dry SWMF has been designed to achieve the required quality control target. The preliminary calculations and design of the SWM components are described in the following sections. All design calculations are provided in Appendix D.

The target rates for the proposed SWMF are pro-rated and are based on the contributing areas from each TCSS catchment. They are presented in Table 3. Proposed Catchments 201, 204, and 207 have not been included in the calculations or modelling as they will remain undeveloped from existing to proposed conditions and will therefore not change hydrologically. See Appendix D for calculations.



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**Table 3: Pro-rated Target Rates for SWMF from TCSS Existing Conditions**

	Rainfall Events			
	2-year	5-year	25-year	100-year
Pro-rated Target Peak Flow Rates (m <sup>3</sup> /s)	0.02	0.03	0.04	0.05

### **5.6.1 Water Quality Control**

The water quality requirement for the site is to achieve the long-term removal of 80% TSS (Level 1) from developed areas. This will be achieved using a treatment train approach per City of Guelph criteria. To treat runoff from the developed portion of the site, the grading and servicing have been designed to convey ‘clean’ runoff (i.e., rooftop areas) to infiltration facilities where a groundwater separation of 1 m (minimum) is achieved. ‘Clean’ runoff does not require additional treatment to remove TSS prior to entering the subsurface infiltration facilities and is therefore directly connected via dedicated roof leaders to the infiltration facilities. The remaining impervious portions of the site consisting of parking, roadways, and drive isles require treatment prior to infiltration.

Runoff from all roads, driveways and other impervious surfaces enters the onsite storm sewer system which connects to an OGS unit prior to discharging to the end of pipe facility. The OGS unit provides initial removal of TSS and oil from the runoff while a combination of a forebay and the end of pipe dry SWMF provides additional sediment removal. The forebay has been sized to provide ‘Enhanced’ sediment removal in the SWMF as well as provide an isolated location of sediment deposition to facilitate the cleanout and maintenance of the SWMF. The remaining areas flowing uncontrolled from the site are pervious or undeveloped and do not require water quality treatment.

The proposed OGS unit (EF10 or approved equivalent – must meet the Canadian Environmental Technology Verification Program per City of Guelph requirements) has been sized to provide 60% TSS removal for the contributing area (refer to OGS Sizing Calculations in Appendix D); however, it is understood that the City of Guelph recognizes OGS units only provide up to a long term TSS removal of 50% due to long-term maintenance concerns. Therefore, following treatment by the OGS, runoff flows to a forebay at the inlet of the end of pipe ‘dry’ SWMF to provide further treatment as well as to isolate sediment to facilitate future cleanouts. Per Table 3.2 in the *Stormwater Management Planning and Design Manual* (MOE, 2003), the dry SWMF can provide up to 60% TSS removal. In addition, the dry SWMF is intended to promote end-of-pipe infiltration due to its raised outlet configuration. As such, minimal runoff is anticipated during smaller, more frequent rainfall events thereby reducing sediment loading to the downstream receiver.

Overall, with the OGS achieving a 50% TSS removal efficiency and the dry SWMF achieving another 60% TSS removal minimum (without accounting for the end-of-pipe infiltration), the combined TSS removal rate between these two systems conservatively achieves the required 80% TSS removal efficiency.

Sizing of the OGS is provided in Appendix E. SWMF design characteristics are summarized in Table 4, with detailed design calculations provided in Appendix D.



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### **5.6.2 Water Quantity Control**

To meet the target peak flow rates as outlined by the TCSS, control for the site will be provided through a combination of lot level and end-of-pipe controls. Lot level and centralized infiltration trenches provide retention for all storms up to and including the 4-hour, 25 mm rainfall event while an end of pipe dry SWMF provides detention prior to discharging to the adjacent wetland. Additionally, the end of pipe dry SWMF has been designed with a raised outlet to promote infiltration in the bottom 0.2 m of the pond. Modelling for quantity control events only accounted for active storage above the 0.2 m of infiltration in order to provide a conservative estimate of volumes and flow rates in the event that the infiltration portion of the pond is saturated prior to a rainfall event. Further discussion on the infiltration measures is described in Section 5.7. The proposed end-of-pipe SWMF is located at the northwest corner of the site, adjacent to the Torrance Creek Swamp PSW and provides attenuation for runoff from the majority of the site including roadways, driveways, rooftops and landscaped coverage. The design uses a dry SWMF configuration with an upstream OGS unit to provide an enhanced level of water quality control (as discussed above) with a maximum ponding elevation of approximately 335.06 m during the 100-year return-period rainfall event.

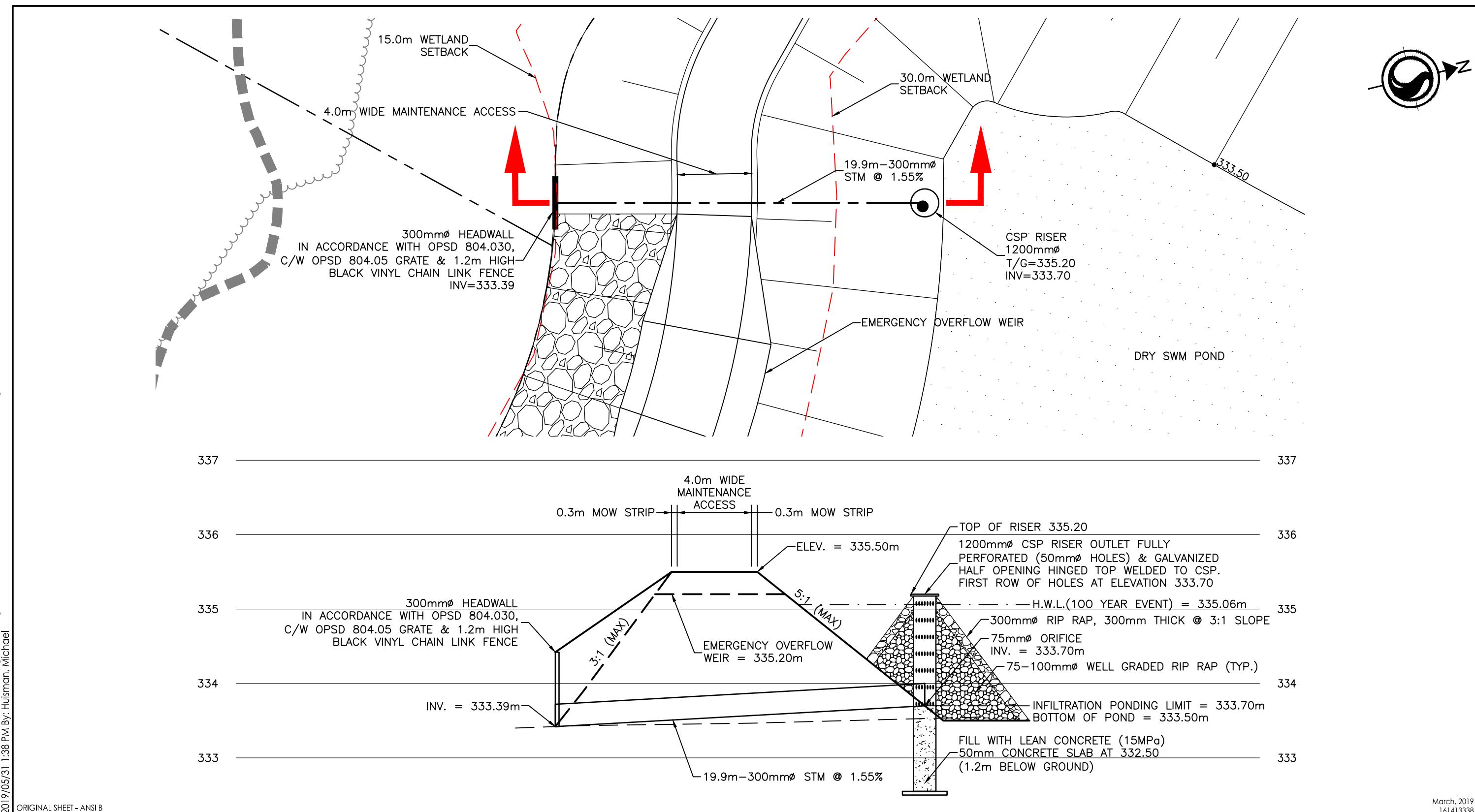
The preliminary outlet structure for the dry SWMF consists of a low flow orifice to meet the peak flow targets outlined by the TCSS and an overflow emergency weir in the event the orifice gets clogged or for rainfall events larger than the 100-year event. Details of the outlet structure are provided in Table 4 and shown on Figure 9.0 with further details and calculations provided in Appendix D.

**Table 4: SWMF Design Characteristics**

Parameter	Basin Characteristics
Total Contributing Area (Including Major Flow Drainage)	3.5 ha
Total Contributing Area req. Quality Control	2.8 ha
Total Percent Impervious	65%
Bottom Elevation of forebay	333.00 m
Bottom Elevation Dry Facility	333.50 m
Facility Top Elevation	335.50 m
High Water Level (100-Year Storm Event)	335.06 m
Freeboard Provided Above High Water Level	0.44 m
Orifice Control Outlet	
Orifice 1 Diameter	75 mm
Orifice 1 Invert Elevation	333.70 m
Emergency Weir	
Spillway Width (m)	5 m
Spillway Invert (m)	335.20 m
Side slopes	10:1

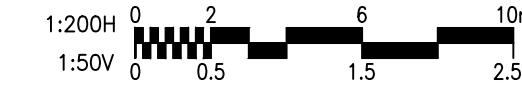
Peak flow rates from the proposed SWMF and overall developed site area are summarized in Table 5 with detailed modeling files included in Appendix C. The volumes and depths reported in the table below do not include the bottom 0.2 m of the SWMF that is proposed for infiltration. The facility is proposed to discharge to the adjacent Torrance Creek Swamp PSW. It is recommended at detailed design to explore





Legend

Scale



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different methods of dispersing flow to reduce potential erosion effects from discharge to the wetland. The preliminary outlet design is illustrated on Figure 9.0.

**Table 5: SWMF Operating Characteristics**

	Rainfall Event		
	2-year	5-year	100-year
Pro-Rated Target Rate from TCSS (m <sup>3</sup> /s) <sup>1</sup>	0.02	0.03	0.05
Proposed Peak Flow from Facility (m <sup>3</sup> /s)	0.01	0.01	0.01
Proposed Peak Flow Site (m <sup>3</sup> /s)	0.02	0.03	0.05
Maximum Active Storage Volume (m <sup>3</sup> )	1,355	1,795	2,930
Maximum Active Ponding Depth (m)	0.73	0.93	1.36
Maximum Active Ponding Elevation (m)	334.43	334.63	335.06
Drawdown Time (hours)	80	92	118

As shown in Table 5, the peak flow rates from the proposed SWMF and overall site are equal to or less than site targets for all storm events and therefore meet the water quantity requirements for Torrance Creek.

Due to the very low release rate targets established for the site based on TCSS requirements, the drawdown times for the proposed SWMF are longer than typically desired; however, reducing the drawdown times would require an increase in peak flow rates which would no longer meet the design targets. The proposed lot level and centralized infiltration measures upstream as well as the infiltration proposed in the SWMF have not been considered in the MIDUSS modelling to provide a conservative estimate of facility volumes; however, realistically these measures will reduce the volume of runoff to the facility and increase the rate at which water draws down. As such, drawdown times are anticipated to be less than those reported in Table 5.

### **5.6.3 Surface Water to the PSW**

The existing Arkell Meadows Subdivision calculated a 41% increase in runoff to the adjacent PSW from pre-development to the current condition (17 mm/year to 24 mm/year). With the proposed access road from the site running through Block 20 to Dawes Avenue, there was an overall post-development increase in the Arkell Meadows site runoff from 24 mm/year to 25 mm/year, or 4%, bringing the overall percentage increase from pre-development to post-development conditions to 47% as identified in City comments in response to *Re: 220 Arkell Road – Response to Stormwater Management City comments dated July 19, 2018* (Stantec, 2018) which is presented in Appendix D . As a result of this concern and as mentioned previously, Stantec proposes a slight change to the access road culvert configuration to mimic the current hydrologic regime and maintain surface flow to the wetland.



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Under current conditions along the existing driveway, there is a low-lying area east of the existing driveway at the location of the proposed culvert under the access road/trail where surface water ponds, allowing for infiltration and evaporation prior to spilling west to the wetland (contour 333.5 m). Given the location of the proposed access road and ultimate trail alignment illustrated on Figure 10.0, surface water runoff from Catchment 206 flows west through a culvert and under the road/trail to the PSW. As outlined in *Re: 220 Arkell Road – Response to Stormwater Management City comments dated July 19, 2018* (Stantec, 2018), a culvert is proposed to convey surface flows under the access road/trail to maintain this flow west under proposed conditions; however, to attenuate surface flows to address City of Guelph concerns (i.e., reduce surface flow to the wetland and increase evapotranspiration and infiltration), the proposed culvert is reverse sloped to encourage ponding and infiltration, similar to the existing hydrologic regime, and to match existing grades on the site (natural depression within the site). The specific details of this ponding area will be finalized at detailed design.

## **5.7 INFILTRATION ASSESSMENT & WATER BALANCE**

### **5.7.1 Water Balance Analysis**

Water balance calculations were completed as part of the *Hydrogeological Assessment* (Stantec 2019) for pre-development and post-development conditions to quantify infiltration volumes at the Site and confirm the recharge function.

Under pre-development conditions, the average annual volume of infiltration is estimated at 15,950 m<sup>3</sup>/year for a rate of 223 mm/year and the average annual volume of runoff is estimated at 10,030 m<sup>3</sup>/year for a rate of 140 mm/year. Under post-development conditions, impervious surfaces are expected to cover 47% of the Site (3.4 ha of 7.2 ha), resulting in a projected infiltration volume deficit of 4,910 m<sup>3</sup>/year. Details of the calculations and results can be found in the *Hydrogeological Assessment, 220 Arkell Road, City of Guelph, Ontario* (Stantec, 2019).

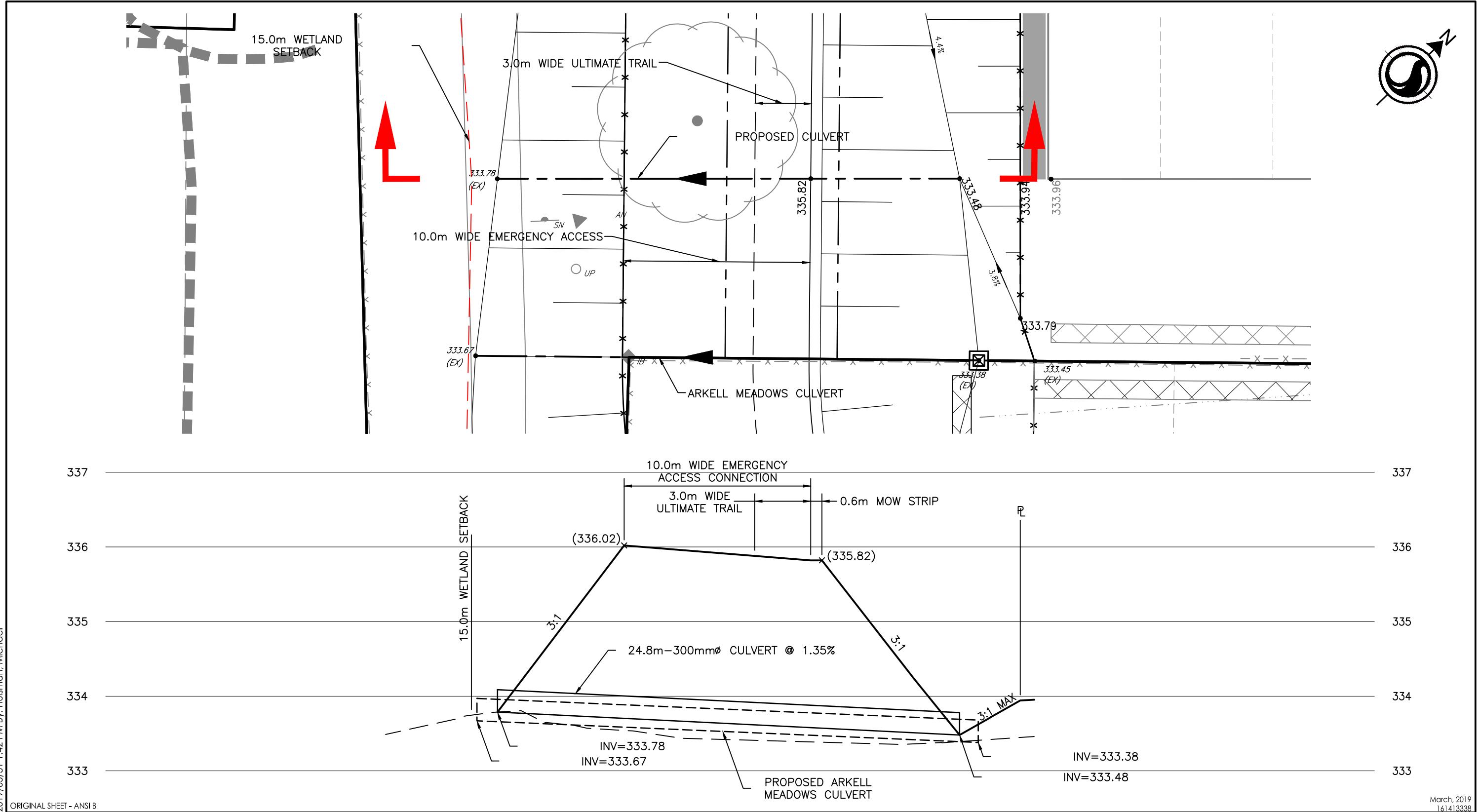
To reduce the infiltration deficit and establish a recharge balance, rear yard soakaway pits and centralized infiltration trenches are recommended to be implemented throughout the site.

Based on the results of the *Geotechnical Investigation* (Stantec 2019), site soils generally consist of a mix of glacial till to sand which are both generally conducive to infiltration practices. As discussed in previous sections, the estimated percolation rates for these soils correspond to factored infiltration rates of 5 – 30 mm/hour; however, per City of Guelph guidelines, it is recommended that in-situ infiltration tests, such as the double-ring infiltrometer or the Guelph permeameter tests, be performed at the detailed design stage at the locations and depths of the proposed infiltration trenches to confirm the underlying soil infiltration rates.

### **5.7.2 Lot Level and Centralized Infiltration**

Rear yard soakaway pits infiltrating roof water are proposed for all single-family homes within the subdivision, provided the separation from the high groundwater table is achieved. Similarly, centralized infiltration trenches are proposed for the multi-family block to direct shared roof areas to recharge locations. Rooftop runoff is considered ‘clean’ and does not require water quality treatment prior to





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infiltrating. As such, roof leaders from all homes are to be connected to the soakaway pits or centralized trenches via direct connection or via surface flow with an overflow provided at grade for single family lots or an overflow connection to the storm sewer for the centralized trenches. Specific connection details will be provided at detailed design.

Both soakaway pits and centralized trenches have been sized assuming 40% of the lot is building coverage. This value was taken from *Section 5 – Residential Zones* of the City of Guelph Zoning Bylaw. There will be a mix of different residential units within the subdivision; however, this provides an accurate preliminary estimate on recharge volumes from the development. The average rooftop area has therefore been conservatively estimated as 120 m<sup>2</sup>.

### **5.7.3 End-of-Pipe Infiltration**

End-of-pipe infiltration in the dry SWMF is proposed by using a raised catchbasin grate for the SWMF's outlet to encourage ponding and infiltration through the bottom of the facility and to delay the peak flow to the receiving PSW; however, due to the facility's proximity to the PSW, the high groundwater table is close to surface, particularly during spring months, so infiltration is anticipated to occur during the summer and fall months only from June to November when groundwater levels are typically lower (as shown in the appended calculations). Despite this high groundwater condition, it is recommended to incorporate end-of-pipe infiltration to promote recharge to the adjacent PSW for as much of the year as possible. In addition to the groundwater recharge benefits, the ponded water will help to promote evapotranspiration and maintain the natural hydrologic regime of the site.

The infiltration component of the SWMF provides sufficient retention volume to contain the runoff resulting from all rainfall events up to and including the 10 mm rainfall event. This event has been assumed to represent 50% of the average annual rainfall volume.

A key constraint to the proposed infiltration measures on-site is the high groundwater table. Based on the proposed grades and the seasonally high groundwater results from the *Hydrogeological Assessment* (Stantec 2019), the proposed lot level infiltration trenches can maintain at least 1 m of separation from the bottom of the systems to the seasonally high groundwater level for the majority of the site. Trenches are not proposed in areas where this separation is not achieved. This requires the centralized trench locations (particularly in the multi-block) to be located in specific areas to avoid the measured high groundwater table. Monitoring of the high groundwater table is ongoing and design assumptions will be revised, if required, at detailed design.

Details of the proposed infiltration trenches for rooftop runoff as well as potential implementation of alternative LID and/or Green Infrastructure (GI) or infiltration measures shall be explored at the detailed design stage of the project.



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The post-development water balance values following implementation of the proposed retention practices are presented in Table 6.

**Table 6 - Results of Site Water Balance**

Site Condition	Site Area (ha)	Annual Volumes (m <sup>3</sup> /yr.)			
		Rainfall	ET	Runoff	Infiltration
Pre-Development	7.2	65,580	39,610	10,030	15,950
Post-Development			28,220	26,330	11,040
Post-Development with Infiltration			28,220	17,480	19,880

By implementing the recharge augmentation practices, there is a recharge surplus of 3,940 m<sup>3</sup>/year, a runoff surplus of 7,450 m<sup>3</sup>/year, and an ET deficit of 11,390 m<sup>3</sup>/year.

#### **5.7.4 Consideration of Multi-Block**

At this stage in the design, the site plan for the multi-family block is unknown. It is assumed that all rooftop areas within the block can and will be directed to centralized infiltration trenches to achieve the intended recharge target. At a minimum, the multi-family block must infiltrate all rainfall events up to and including the 25 mm storm from all rooftops (assumed rooftop coverage is 6,000 m<sup>2</sup> or approximately 30% of the block) for a total average annual rooftop infiltration volume of 3,500 m<sup>3</sup>/year. This is the target annual recharge volume for the multi-block and should be met at the Site Plan Approval stage.

#### **5.7.5 Interim Access Road**

In addition to the water balance and infiltration assessment conducted within the site boundaries, an assessment was conducted for the addition of a 10 m wide maintenance access path connecting to Dawes Avenue to the south of the site. Details of this assessment are documented within a letter from Stantec to the City of Guelph, sent on November 5, 2018 *Re: 220 Arkell Road – Response to Stormwater Management City comments dated July 19, 2018*, which has also been included in Appendix D for reference. The maintenance access increases the impervious area slightly within the site to the south but was shown to not result in a significant change in the overall water balance or affect the function of the rear-yard infiltration trench.



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## **6.0 STORM SERVICING**

Storm drainage for the proposed Development will discharge at a single outlet. The storm sewer system will convey run-off and lot level flows from the single-family units and Multi-family Block and drain via servicing easement between the Park Block and single-family lotting discharging to a dry pond SWMF along the west limits of the subject Development. The major overland flow for the route follows generally the same path following the servicing easement west into the main cell of the dry pond SWMF.

The proposed storm sewer system will be designed to convey all minor storm events or those less than 5-year return-period, as per the City of Guelph Standards. The conveyance system for major flow events or those greater than a 5-year return-period frequency will be confined to the road Right-of-Ways and generally mimics the direction of the minor system.



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## **7.0 EROSION AND SEDIMENT CONTROL PLAN**

An Erosion and Sediment Control Strategy will be completed during the final design and implemented during the construction process in order to minimize the potential for offsite discharge of sediment and the resultant negative environmental impacts. This Plan will focus on the protection of downstream watercourses and lands.

### **7.1 EROSION POTENTIAL**

The *Greater Golden Horseshoe Area Conservation Authorities' Erosion and Sediment Control Guideline for Urban Construction* (2006) was used to determine the erosion potential of the site. The erosion potential is based on slope gradient, slope length and soil texture and is then used to determine the appropriate erosion control methods, as follows:

- Site Slopes: Moderate (2-10%) – average slope is approximately 3.0%
- Slope Lengths: Long (generally greater than 30 m)
- Erodibility Factor: For Silty Sand, K = high

Therefore, based on this classification, the site has a high erosion potential.

### **7.2 PRELIMINARY EROSION AND SEDIMENTATION CONTROL PLAN**

The following approach to erosion and sediment control onsite has been prepared to minimize the potential impacts associated with onsite erosion and/or offsite transport of sediment.

Prior to any grading or servicing works commencing onsite, erosion and sedimentation control measures shall be implemented as detailed on the Pre-grading, Erosion and Sedimentation Control Plans (prepared during detail design). The erosion and sedimentation controls will include the following items:

- Steep slopes (>3:1) shall have erosion blankets
- Light and/or heavy-duty silt fencing will be erected on all site boundaries where there is potential for runoff to be discharged offsite, to protect adjacent downstream lands from migration of sediment in overland flow. The location of this fencing will be adjacent to the limit of grading. Silt fence attached to paige wire fencing will be installed periodically throughout the site adjacent to sensitive areas. Silt fencing should be erected before grading begins to protect adjacent and downstream areas from migration of sediment in overland flow
- Double row of Heavy-Duty silt fencing to be installed at the limits of grading adjacent to the existing Torrance Creek PSW to provide addition protection from migration of sediment into the adjacent wetland
- Storm service outlets will be installed during servicing and roadworks construction to provide lot level dead and live storage



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- Erosion control berms/swales will be located in appropriate (critical) areas to divert flows to temporary sediment basins
- A construction entrance feature (“mud-mat”) will be provided at all site entrances to minimize the offsite transport of sediment via construction vehicles
- Swales constructed onsite will have temporary rock check dams to help attenuate flows and encourage deposition of suspended sediment where appropriate
- All disturbed areas where construction is not expected for 30 days shall be re-vegetated with 50 mm of topsoil and hydro-seeding according to OPSS 572
- During construction, all catchbasins are to be sealed until roads are paved to prevent sediment deposition in the catchbasin’s sumps and conveyance of silt to the SWMF
- An Erosion Control Implementation Schedule will be included with the Detailed Erosion and Sedimentation Control Plan, prepared in conjunction with the pregrading application and/or final engineering design
- Following completion of construction, defined as 90% house construction, and site stabilization, all erosion and sediment control measures and accumulated sediment are to be removed

The erosion control measures shall be maintained in good repair during the entire construction period and shall only be removed as contributing drainage areas are restored and stabilized. In addition, the condition of erosion control works, their overall performance, and any repairs, replacement or modifications to the installed items shall be noted in Monitoring Reports submitted to the Grand River Conservation Authority (GRCA) and the City of Guelph. Monitoring Reports should be submitted bi-monthly (quarterly during periods of inactivity or house construction) and should be based on inspection completed bi-weekly or after any significant rainfall events (>13 mm), whichever is more frequent.

### **7.3 MONITORING, MAINTENANCE AND MITIGATION**

Monitoring and maintenance activities are an important part of a SWM Strategy to ensure the designed features continue to operate as intended. As such, it is recommended that regularly scheduled inspections take place to observe any evidence of sediment deposition or malfunctioning of the proposed infiltration trenches or SWM facility. Given the proximity of the site to the Torrance Creek Swamp PSW, the details and frequency of these inspections should be discussed with the City and the GRCA with details provided at the detailed design stage. Similarly, upon receipt of an Environmental Compliance Approval (ECA) from the MECP, the maintenance and monitoring schedule outlined in the ECA should be incorporated into the site development. The inspections should occur following significant rainfall events (where possible) and will also include inspection of the conditions of any temporary SWM controls (such as temporary sedimentation basins and sediment traps).



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## **8.0 UTILITIES**

### **8.1 HYDRO**

Hydro is currently supplying the property via an overhead system located on the south side of Arkell Road, adjacent the 220 Arkell property. Alectra Utilities (formerly Guelph Hydro) has indicated that an electrical distribution system will be supplied from the Victoria Park Village Subdivision located northwest of the property. There will be no constraints with providing hydro service to the proposed Development.

### **8.2 BELL CANADA**

Bell has indicated that they would supply the proposed Development with a joint trench from Guelph Hydro Electric Systems Inc. They do not foresee any issues servicing the proposed Development.

### **8.3 ROGERS CABLE**

Rogers Cable Systems will follow the services of Bell Canada. It was indicated by Rogers Cable that services will be supplied from the Victoria Park Village Subdivision and do not anticipate any restraints with servicing the proposed Development.

### **8.4 GAS**

Gas service to the 220 Arkell Development would be provided from the Victoria Park Village Subdivision. Union Gas has expressed that they see no constraints with an extension of distribution.

Hydro, Bell, Cable and Gas lines would be buried within the boulevards per the City of Guelph typical road cross-section.



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## **9.0 CONCLUSIONS AND RECOMMENDATIONS**

Based on the finding of this report, it is concluded that:

- The proposed 220 Arkell Road Subdivision can be adequately serviced through the connection to the existing sanitary, watermain, and utilities available on Hutchison Road to the north
- Stormwater management for the subject Development can be accommodated by the facility proposed by achieving the targets of the TCSS and water balance requirements

It is further recommended that:

- This report be circulated to the Municipality and various approval agencies in support of Draft Plan of Subdivision Approval for the 220 Arkell Road lands
- Detailed grading and servicing design drawings be prepared, a Final Stormwater Management Report and Erosion Settlement Control Plan be completed once the Draft Plan of Subdivision for 220 Arkell Road lands has been approved



# **APPENDIX A**

Proposed Draft Plan

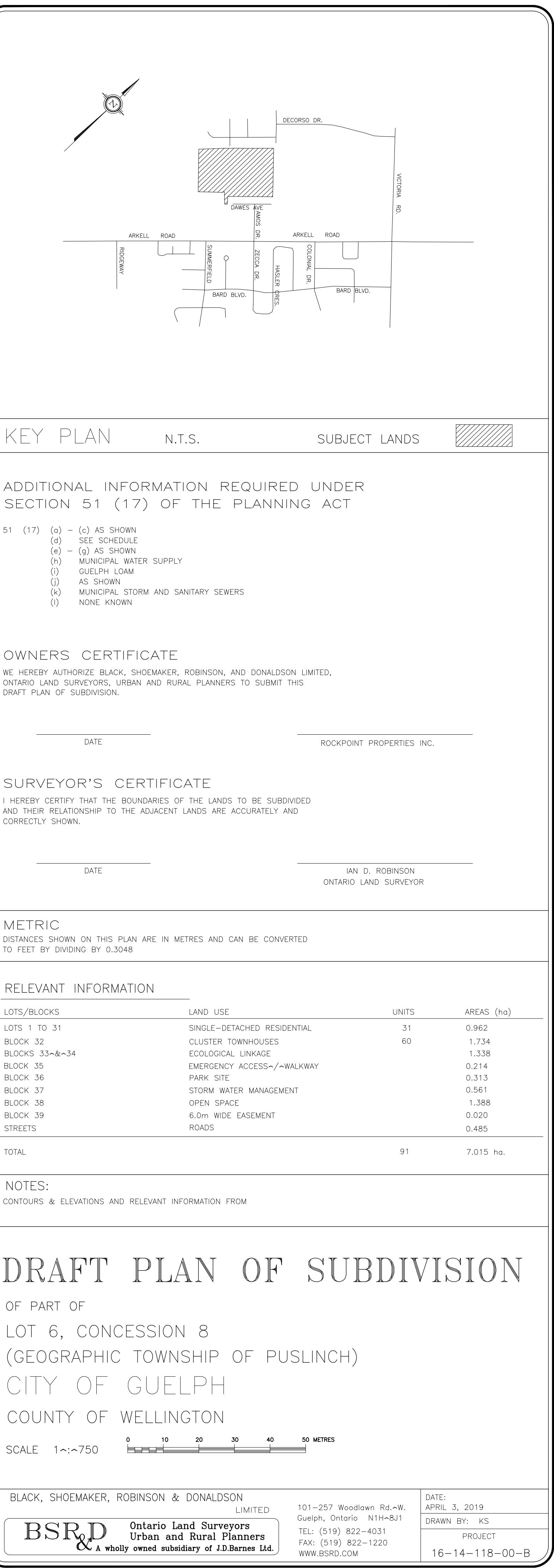
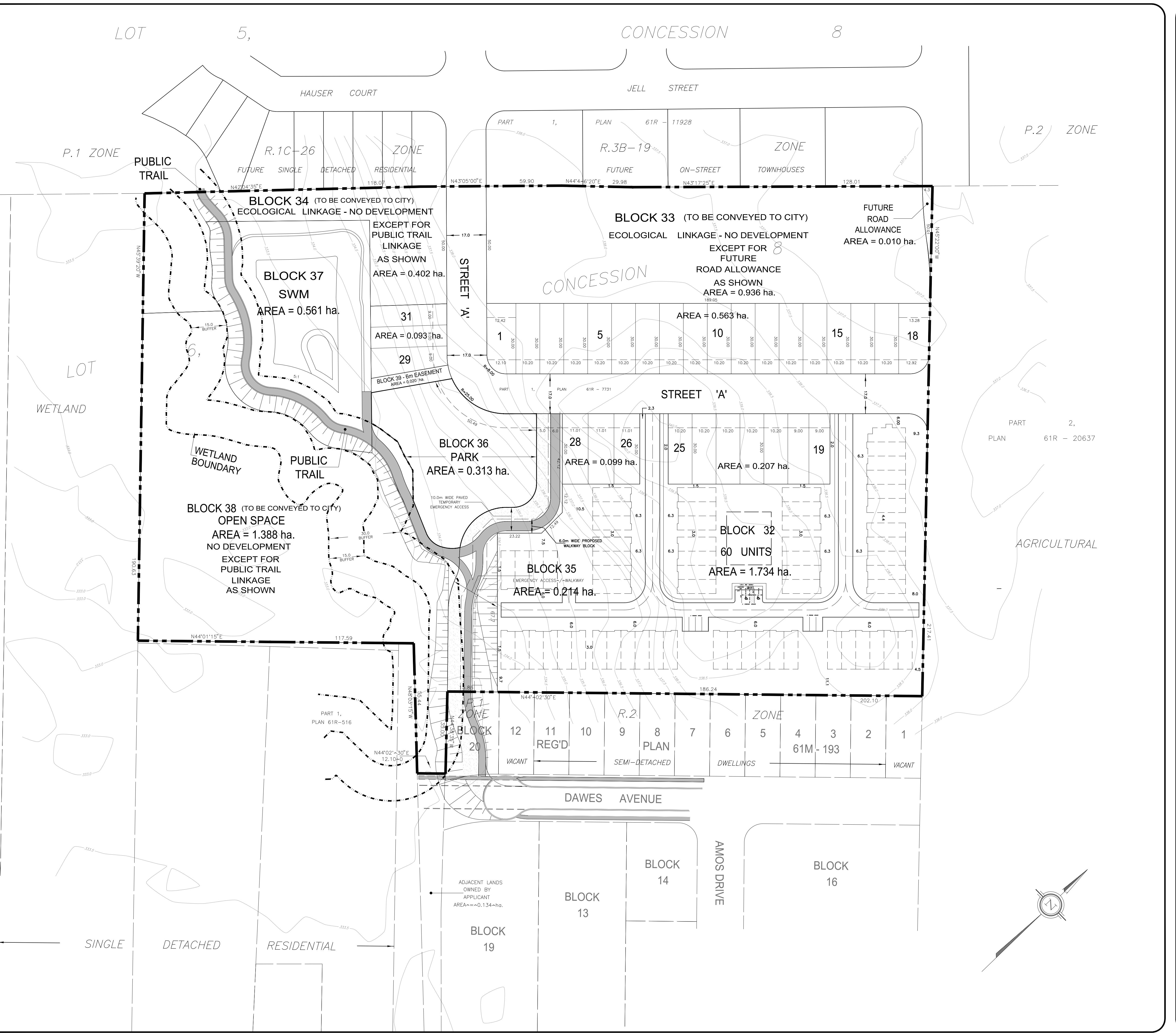
Existing Conditions Plan (Drawing No. C-050)

Conceptual Servicing Plan (Drawing No. C-100)

Conceptual Plan and Profiles (Drawing No. C-200)

Conceptual Grading Plan (Drawing No. C-400)

Preliminary Cut/Fill Plan (Drawing No. C-900)





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The Contractor shall verify and be responsible for all dimensions. DO NOT scale the drawing - any errors or omissions shall be reported to Stantec without delay.  
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Notes

1. BENCHMARK RD-271 PWNKA-3 GUELPH BENCHMARK #392. BENCHMARK PLATE ON TRAFFIC CONTROL BOX LOCATED ON SOUTH WEST CORNER OF THE INTERSECTION OF ARKELL ROAD AND VICTORIA ROAD. ELEVATION: 332.245m
2. TOPOGRAPHICAL SURVEY BY STANTEC CONSULTING LTD, DATED JULY 2017.
3. LEGAL PLAN PROVIDED BY BLACK, SHOEMAKER, ROBINSON & DONALDSON LIMITED, DATED MARCH 2019.
4. DRAFT PLAN BY BLACK, SHOEMAKER, ROBINSON & DONALDSON LIMITED MARCH, 2019.

Legend

- PROPOSED WATERMAIN
- EXISTING WATERMAIN
- PROPOSED SANITARY SEWER
- EXISTING SANITARY SEWER
- FUTURE SANITARY FORCEMAIN
- PROPOSED STORM SEWER
- EXISTING STORM SEWER
- ← EXISTING OVERLAND FLOW DIRECTION
- OVERLAND FLOW DIRECTION
- ↑ FUTURE OVERLAND FLOW DIRECTION

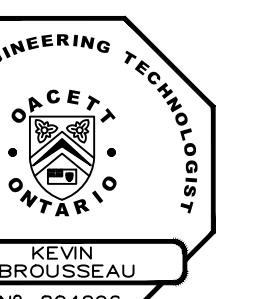
LP	ELEV. COVER	ROAD STATUS (LP = LOW POINT HP = HIGH POINT)
ROAD	300.82	ROAD ELEVATION
STORM	297.88	COVER OVER SEWER
SANITARY	297.11	SEWER OVERT ELEVATION

● Bore Hole GROUND WATER LEVEL

□ INfiltration GALLERY

0. FIRST SUBMISSION	MHH	KR8	19.05.30
Revision	By	Appd.	YY.MM.DD
File Name: 16141338_C-U-C Concept.dwg	Dwn.	Chkd.	19.05.31

Permit-Seal



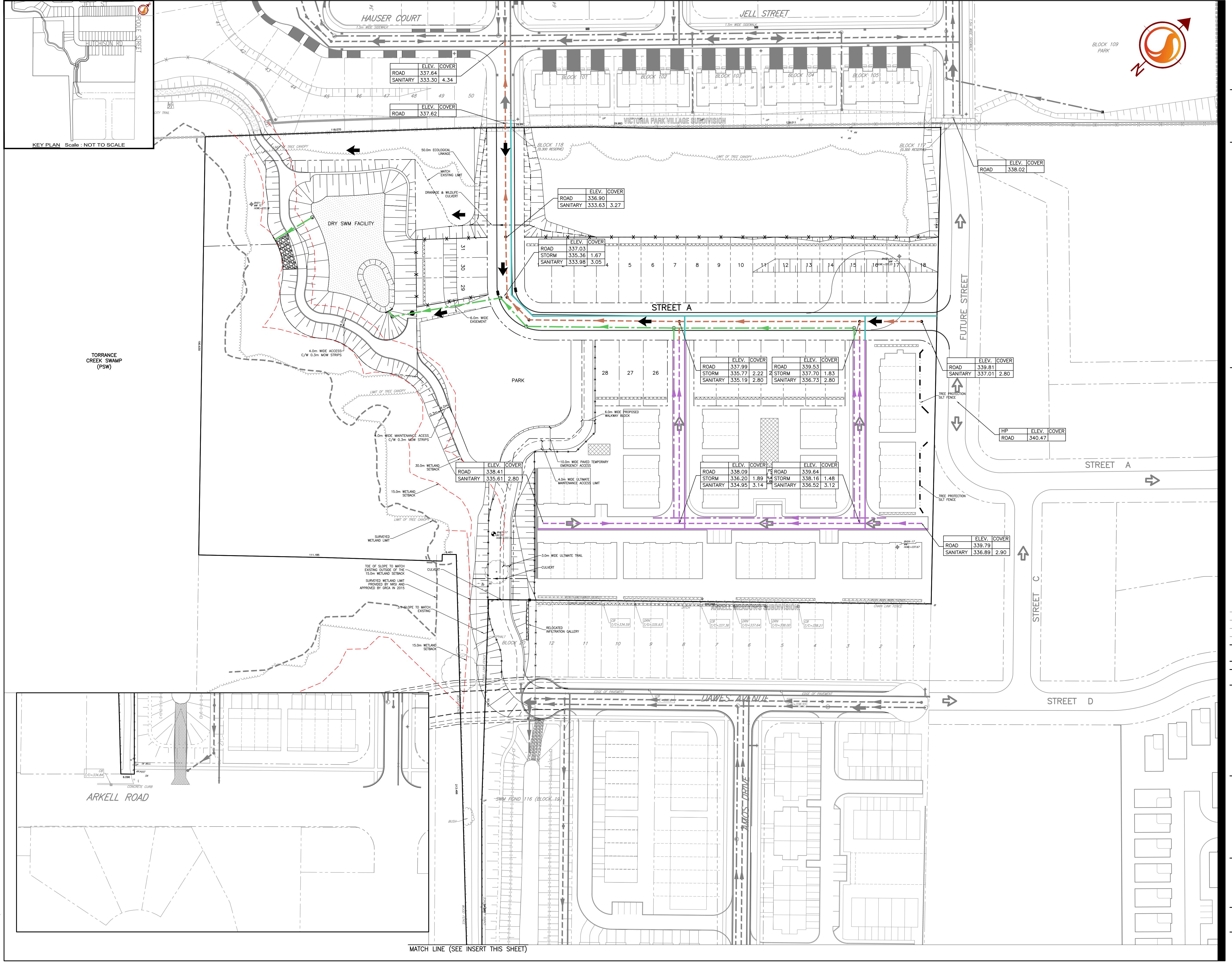
Client/Project  
ROCKPOINT PROPERTIES INC.

220 ARKELL ROAD

Guelph, ON

Title  
CONCEPTUAL SERVICING PLAN

Project No.	Scale	0	7.5	22.5	37.5
16141338	1:750				
Drawing No.	Sheet				
	Revision				

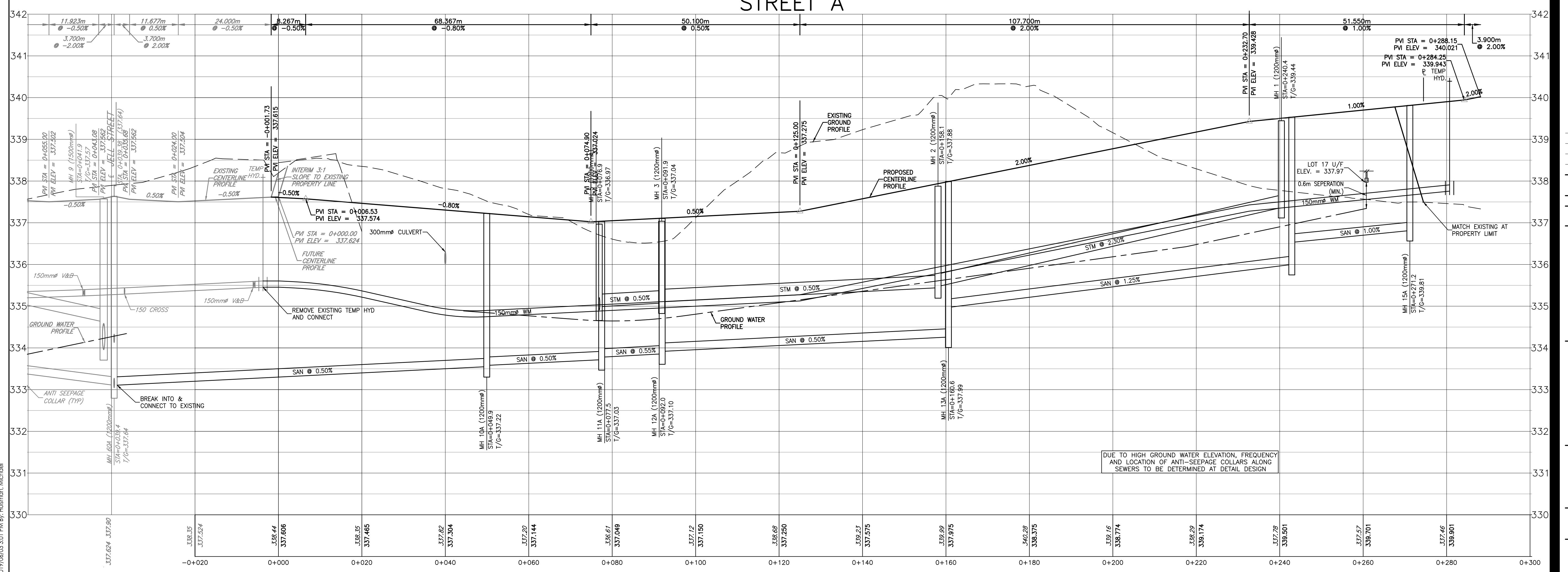
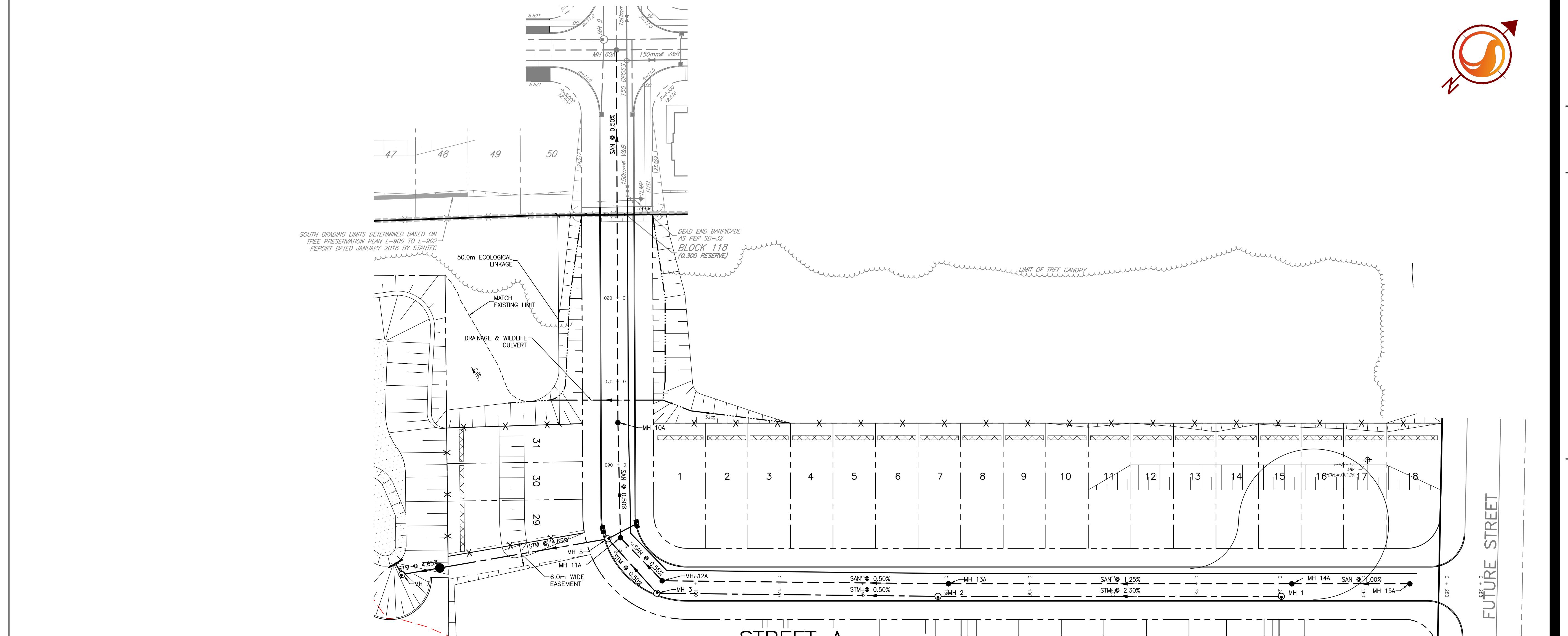


## Notes

1. BENCHMARK  
GUELPH BENCHMARK #392. BENCHMARK PLATE ON TRAFFIC CONTROL BOX LOCATED ON SOUTH WEST CORNER OF THE INTERSECTION OF ARKELL ROAD AND VICTORIA ROAD. ELEVATION: 332.245m
2. TOPOGRAPHICAL SURVEY BY STANTEC CONSULTING LTD. DATED JULY 2017.
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4. DRAFT PLAN BY BLACK, SHOEMAKER, ROBINSON & DONALDSON LIMITED MARCH 2019.

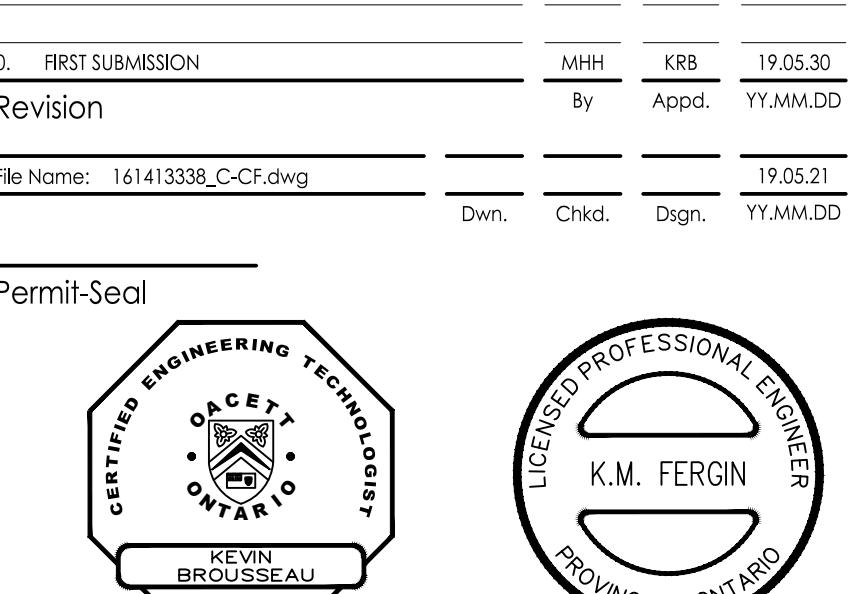


Legend





#### Legend



Client/Project  
ROCKPOINT PROPERTIES LTD.

220 ARKELL ROAD

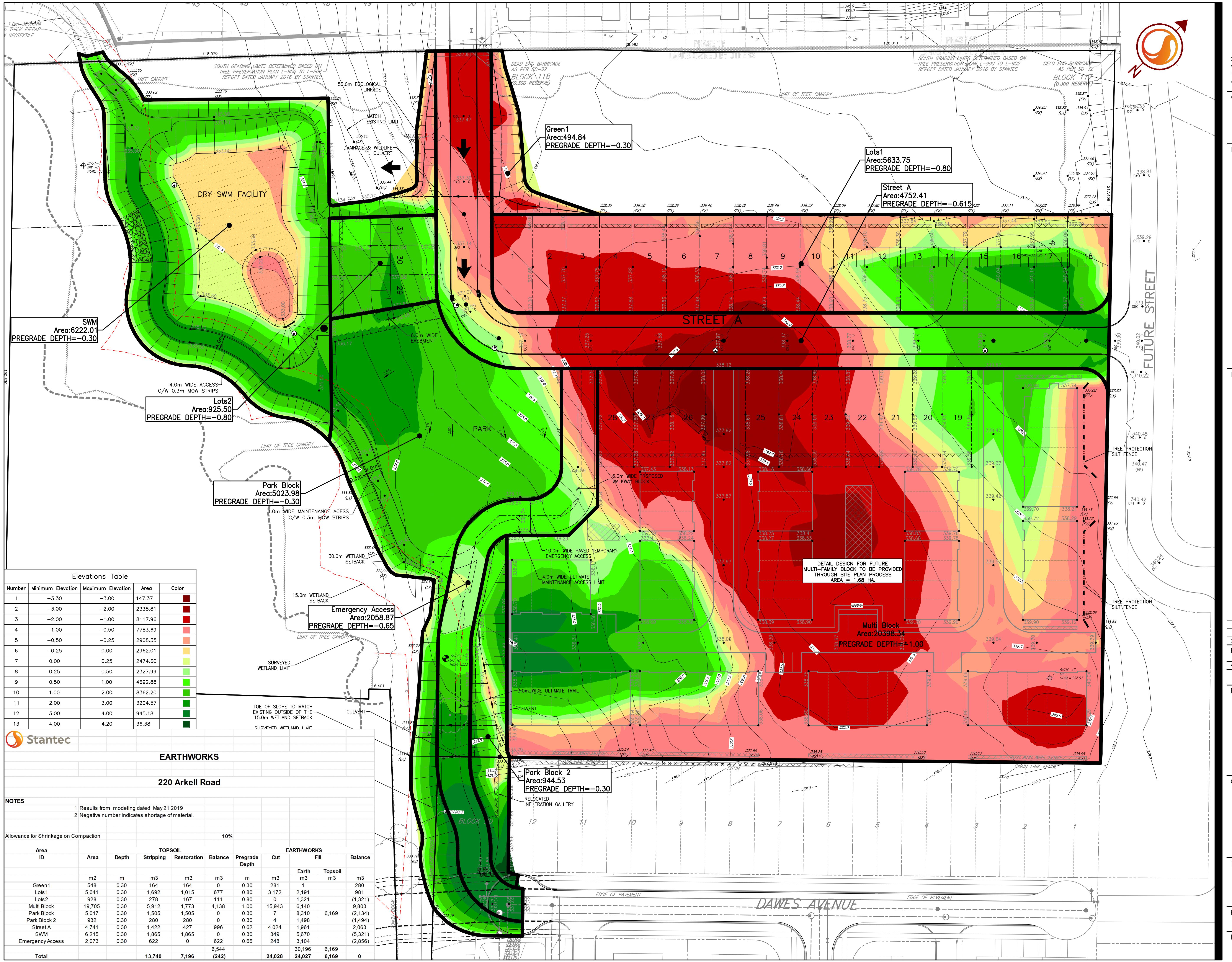
Guelph, ON

Title  
CONCEPTUAL CUT/FILL PLAN

Project No. 16141338 Scale 1:500 Drawing No. Sheet Revision

0

C-900



# **APPENDIX B**

City and Utility Correspondence

## Huisman, Michael

---

**From:** Ian Bolton <ibolton@guelphhydro.com>  
**Sent:** Tuesday, March 20, 2018 3:31 PM  
**To:** Huisman, Michael  
**Subject:** RE: 220 Arkell Road, City of Guelph  
**Attachments:** 220 Arkell Rd\_Existing.pdf

Michael,

The new development would be supplied from an electrical distribution system that connects to the Victoria Village subdivision to the north. We do not anticipate any supply constraints. The site is presently supplied from an overhead connection on Arkell Rd, along the driveway and then goes underground to supply a pad mount transformer.

Please see attached.

Thanks

Ian

### Ian Bolton, C.E.T.

Distribution Design Supervisor  
**Guelph Hydro Electric Systems Inc.**  
E: ibolton@guelphhydro.com  
P: 519 837-4717 | Cell: 519 241-1447



395 Southgate Drive, Guelph, Ontario N1G 4Y1  
[www.guelphhydro.com](http://www.guelphhydro.com) | [@GuelphHydro](https://twitter.com/GuelphHydro)

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***The use of laser pointers is also not permitted.***

---

**From:** Huisman, Michael [mailto:[Michael.Huisman@stantec.com](mailto:Michael.Huisman@stantec.com)]

**Sent:** March-19-18 12:41 PM

**To:** SArts@uniongas.com; Brian A Murray (BrianA.Murray@rci.rogers.com) <BrianA.Murray@rci.rogers.com>; Owen, Crystal (crystal.owen@bell.ca) <crystal.owen@bell.ca>; Ian Bolton <ibolton@guelphhydro.com>

**Cc:** Brousseau, Kevin <kevin.brousseau@stantec.com>; Vleeming, John <John.Vleeming@stantec.com>

**Subject:** 220 Arkell Road, City of Guelph

Good afternoon everyone,

We are currently working towards completing the preliminary engineering for the above noted site in support of Draft Plan approval which will follow with detail design.

Please refer to the attached proposed Draft Plan and Site Location plan for your reference.

At this time we understand that a potential/viable proposed utility connection would be subject to the construction of proposed Victoria Park Village Subdivision located at the North West property line. We wish to confirm that your utility has no constraints with providing service to the proposed development and request that you provide any additional available information which shows existing and proposed utilities within the area of the proposed development.

In the case that your organization does not have existing or proposed services within the area please provide a brief description as to how this site will be serviced.

Should you have any questions, please call or email to discuss.

Thank you,

**Michael Huisman**

C. Tech.

Engineering Technologist, Community Development

Direct: 519-585-7299

Mobile: 905-929-7056

Fax: 519-579-6733

Stantec Consulting Ltd.

100-300 Hagey Boulevard

Waterloo ON N2L 0A4 CA

<http://www.stantec.com/>" style='position:absolute;margin-left:0;margin-top:0;width:75pt;height:20.25pt;z-index:251659264;visibility:visible;mso-wrap-style:square;mso-width-percent:0;mso-height-percent:0;mso-wrap-distance-left:0;mso-wrap-distance-top:0;mso-wrap-distance-right:0;mso-wrap-distance-bottom:0;mso-position-horizontal:left;mso-position-horizontal-relative:text;mso-position-vertical:absolute;mso-position-vertical-relative:line;mso-width-percent:0;mso-height-percent:0;mso-width-relative:page;mso-height-relative:page' o:allowoverlap="f" o:button="t">> <http://www.stantec.com/content/dam/stantec/images/esignature/stantec.png>" />

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\*\*\* EXTERNAL EMAIL. Please be cautious and evaluate before you click on links, open attachments or provide credentials \*\*\*

## Huisman, Michael

---

**From:** Ackerman, R. Neil <neil.ackerman1@bell.ca>  
**Sent:** Monday, March 19, 2018 4:34 PM  
**To:** Huisman, Michael  
**Subject:** RE: 220 Arkell Road, City of Guelph

Perfect that is what I thought. My arrow was just the direction from which my fiber feed would come from.

We would be joint use trench with Guelph Hydro.



**Neil Ackerman**  
**Guelph, Acton, Breslau & Rockwood**  
**Specialist - Network Provisioning**

F1-575 Riverbend Drive  
Kitchener, Ontario  
N2K 3S3  
P 519.568.5797  
C 226.750.5389  
[neil.ackerman1@bell.ca](mailto:neil.ackerman1@bell.ca)

---

**From:** Huisman, Michael [mailto:[Michael.Huisman@stantec.com](mailto:Michael.Huisman@stantec.com)]  
**Sent:** Monday, March 19, 2018 4:10 PM  
**To:** Ackerman, R. Neil <neil.ackerman1@bell.ca>  
**Subject:** RE: 220 Arkell Road, City of Guelph

Hey Neil,

Sorry if my email wasn't clear. The area is correct but the road connection from Victoria Park Village would be from future Hutchison Road. I've attached a PDF of the road connection, in red, from Victoria Park Village Subdivision to 220 Arkell. If you need any further clarification please let me know.

Regards,

**Michael Huisman**  
C. Tech.  
Engineering Technologist, Community Development

Direct: 519-585-7299  
Mobile: 905-929-7056  
Fax: 519-579-6733

Stantec Consulting Ltd.  
100-300 Hagey Boulevard  
Waterloo ON N2L 0A4 CA

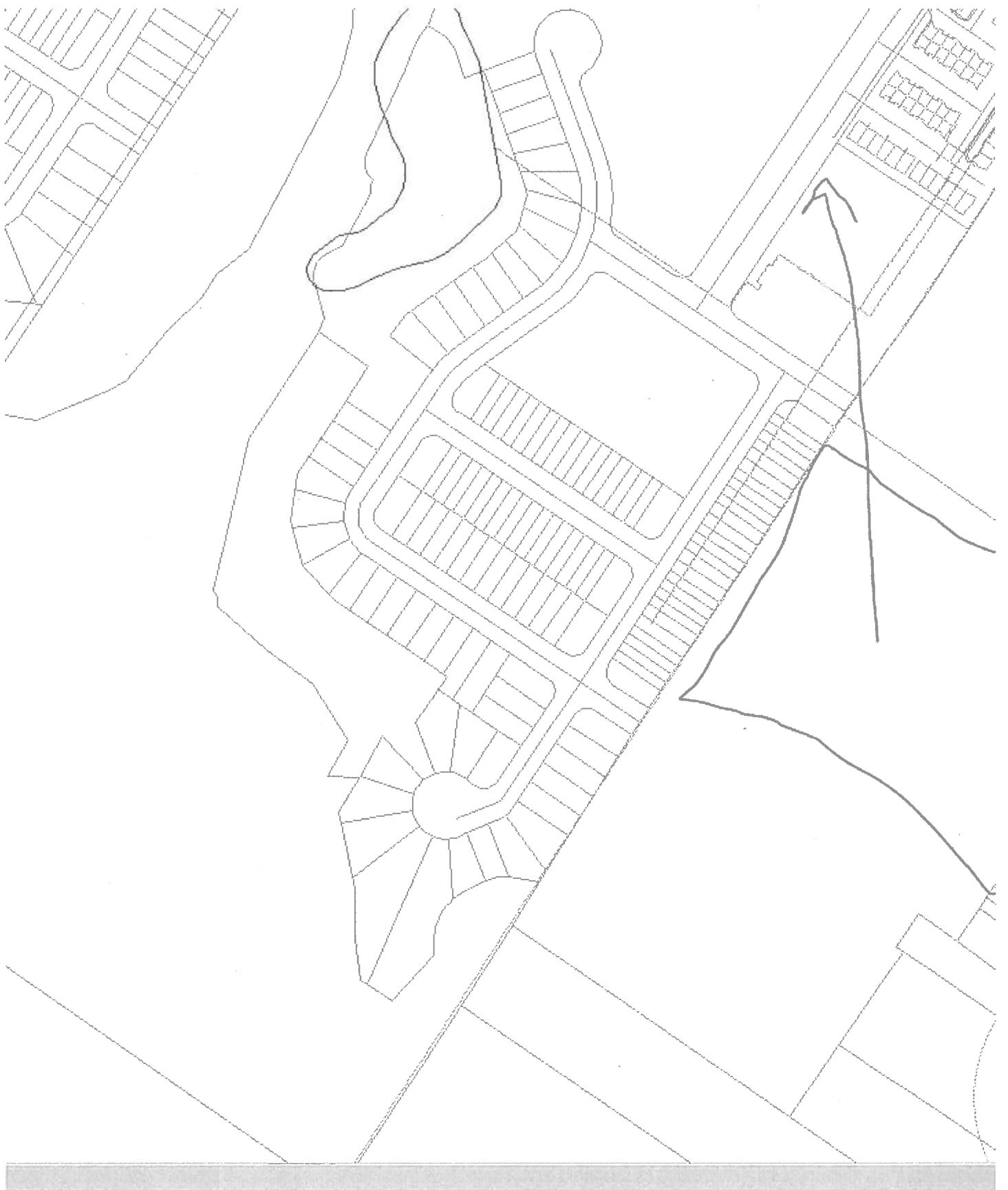


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**From:** Ackerman, R. Neil [<mailto:neil.ackerman1@bell.ca>]  
**Sent:** Monday, March 19, 2018 3:55 PM  
**To:** Huisman, Michael <[Michael.Huisman@stantec.com](mailto:Michael.Huisman@stantec.com)>  
**Subject:** FW: 220 Arkell Road, City of Guelph

Hello Michael

Please can you confirm your site is related to the new development with entrance off Victoria Rd S. See the red box below, this is where I perceive you to be.



**From:** Huisman, Michael [mailto:[Michael.Huisman@stantec.com](mailto:Michael.Huisman@stantec.com)]

**Sent:** March-19-18 12:41 PM

**To:** [SArtt@uniongas.com](mailto:SArtt@uniongas.com); Brian A Murray ([BrianA.Murray@rci.rogers.com](mailto:BrianA.Murray@rci.rogers.com)) <[BrianA.Murray@rci.rogers.com](mailto:BrianA.Murray@rci.rogers.com)>; Owen,

Crystal <[crystal.owen@bell.ca](mailto:crystal.owen@bell.ca)>; [ibolton@guelphhydro.com](mailto:ibolton@guelphhydro.com)

Cc: Brousseau, Kevin <[kevin.brousseau@stantec.com](mailto:kevin.brousseau@stantec.com)>; Vleeming, John <[John.Vleeming@stantec.com](mailto:John.Vleeming@stantec.com)>

Subject: 220 Arkell Road, City of Guelph

Good afternoon everyone,

We are currently working towards completing the preliminary engineering for the above noted site in support of Draft Plan approval which will follow with detail design.

Please refer to the attached proposed Draft Plan and Site Location plan for your reference.

At this time we understand that a potential/viable proposed utility connection would be subject to the construction of proposed Victoria Park Village Subdivision located at the North West property line. We wish to confirm that your utility has no constraints with providing service to the proposed development and request that you provide any additional available information which shows existing and proposed utilities within the area of the proposed development.

In the case that your organization does not have existing or proposed services within the area please provide a brief description as to how this site will be serviced.

Should you have any questions, please call or email to discuss.

Thank you,

**Michael Huisman**

C. Tech.

Engineering Technologist, Community Development

Direct: 519-585-7299

Mobile: 905-929-7056

Fax: 519-579-6733

Stantec Consulting Ltd.

100-300 Hagey Boulevard

Waterloo ON N2L 0A4 CA



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## Huisman, Michael

---

**From:** Gwen Keep <GKeep@uniongas.com>  
**Sent:** Tuesday, March 20, 2018 9:25 AM  
**To:** Huisman, Michael  
**Subject:** RE: [External] 220 Arkell Road, City of Guelph  
**Attachments:** Victoria Park Page1.pdf

Good Morning Michael,  
I am attaching the Union Gas proposal for servicing of the Victoria Park Village subdivision to the north of this proposed development.  
There are no constraints with supplying this proposed development with an extension of distribution main from the Victoria Park Village development.

Trusting this is the information required at this time.

Regards,

**Gwen Keep**  
New Business Project Coordinator  
Waterloo/Guelph  
Union Gas Limited | An Enbridge Company  
603 Kumpf Drive P.O. Box 340 | Waterloo, ON N2J 4A4  
Tel: 519-885-7400 ext 5067488  
[gkeep@uniongas.com](mailto:gkeep@uniongas.com)



Visit [www.uniongas.com/GetConnected](http://www.uniongas.com/GetConnected) to electronically submit service requests

---

**From:** Shawn Artt  
**Sent:** March 19, 2018 12:57 PM  
**To:** Kevin Schimus; Gwen Keep  
**Subject:** Fwd: [External] 220 Arkell Road, City of Guelph

Think this would be something for one of you two to look into!?

Thanks

Shawn

Sent from my iPhone

Begin forwarded message:

**From:** "Huisman, Michael" <[Michael.Huisman@stantec.com](mailto:Michael.Huisman@stantec.com)>  
**To:** "Shawn Artt" <[SArtt@uniongas.com](mailto:SArtt@uniongas.com)>, "Brian A Murray ([BrianA.Murray@rci.rogers.com](mailto:BrianA.Murray@rci.rogers.com))"  
<[BrianA.Murray@rci.rogers.com](mailto:BrianA.Murray@rci.rogers.com)>, "Owen, Crystal ([crystal.owen@bell.ca](mailto:crystal.owen@bell.ca))" <[crystal.owen@bell.ca](mailto:crystal.owen@bell.ca)>,

"[ibolton@guelphhydro.com](mailto:ibolton@guelphhydro.com)" <[ibolton@guelphhydro.com](mailto:ibolton@guelphhydro.com)>  
Cc: "Brousseau, Kevin" <[kevin.brousseau@stantec.com](mailto:kevin.brousseau@stantec.com)>, "Vleeming, John"  
<[John.Vleeming@stantec.com](mailto:John.Vleeming@stantec.com)>  
**Subject: [External] 220 Arkell Road, City of Guelph**

Good afternoon everyone,

We are currently working towards completing the preliminary engineering for the above noted site in support of Draft Plan approval which will follow with detail design.

Please refer to the attached proposed Draft Plan and Site Location plan for your reference.

At this time we understand that a potential/viable proposed utility connection would be subject to the construction of proposed Victoria Park Village Subdivision located at the North West property line. We wish to confirm that your utility has no constraints with providing service to the proposed development and request that you provide any additional available information which shows existing and proposed utilities within the area of the proposed development.

In the case that your organization does not have existing or proposed services within the area please provide a brief description as to how this site will be serviced.

Should you have any questions, please call or email to discuss.

Thank you,

**Michael Huisman**

C. Tech.  
Engineering Technologist, Community Development

Direct: 519-585-7299  
Mobile: 905-929-7056  
Fax: 519-579-6733

Stantec Consulting Ltd.  
100-300 Hagey Boulevard  
Waterloo ON N2L 0A4 CA

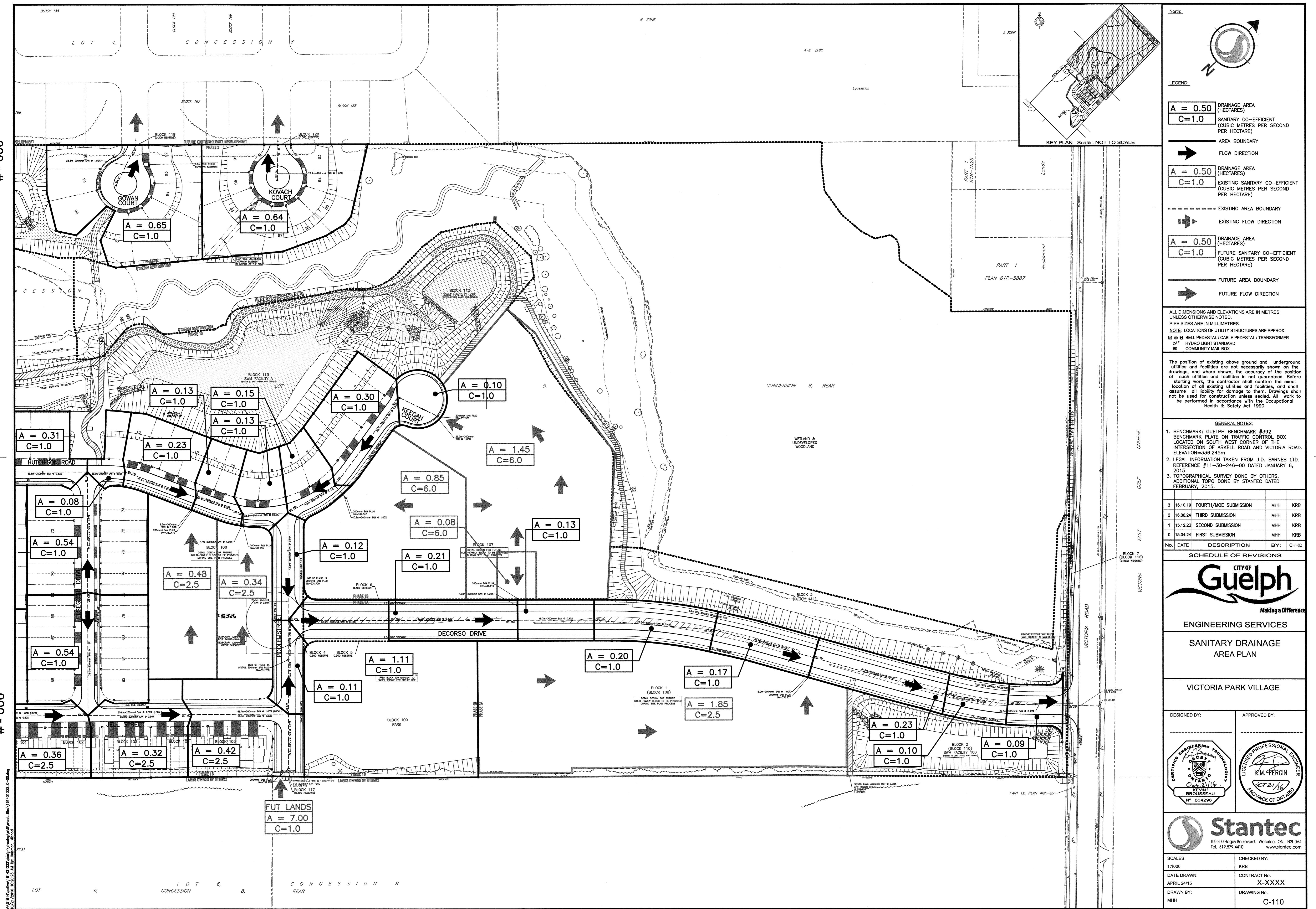


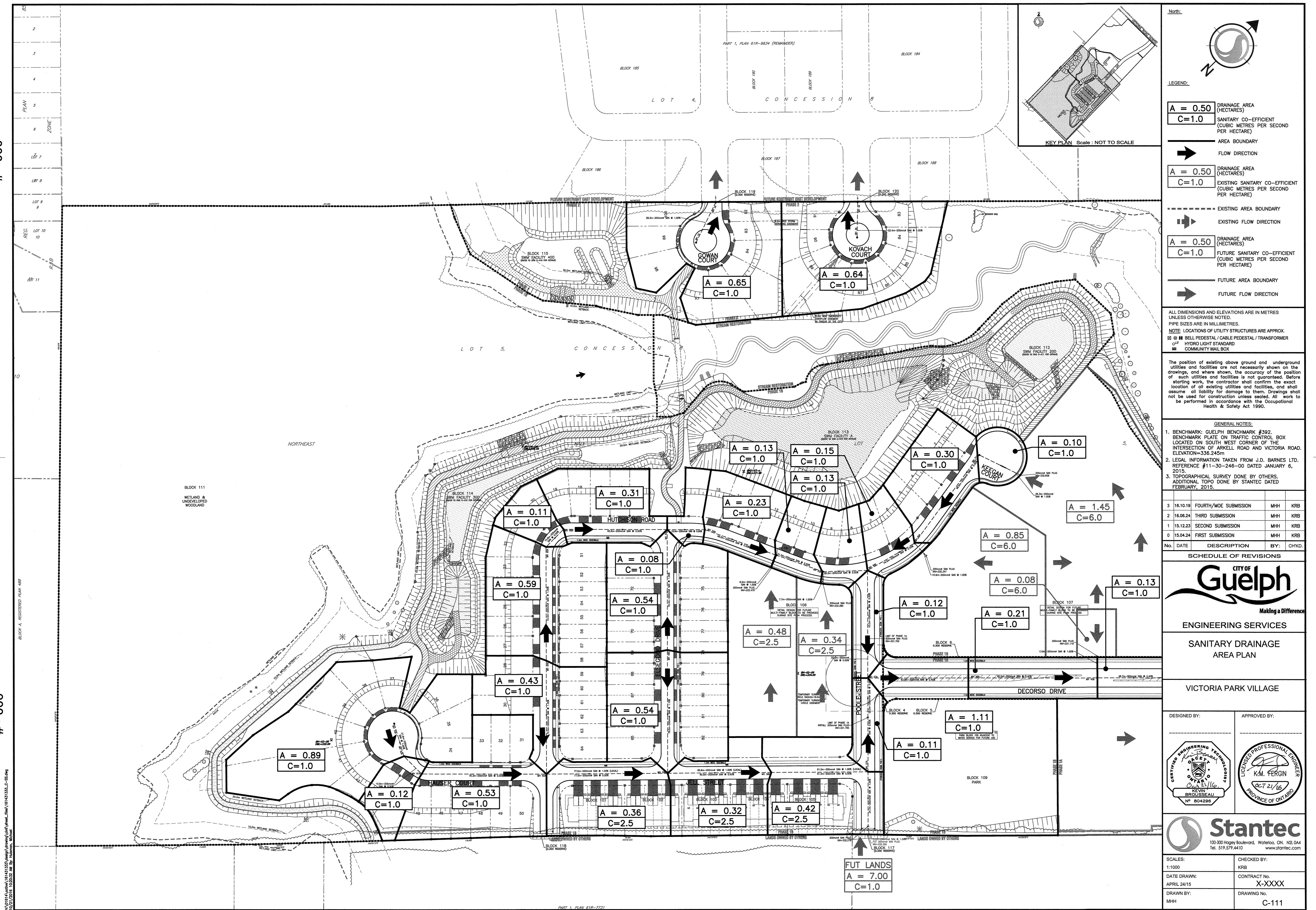
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# **APPENDIX C**

VPV Sanitary Drainage Area Plans (Drawing No. C-110 and C-111)  
(Post Development) Sanitary Design Sheets)



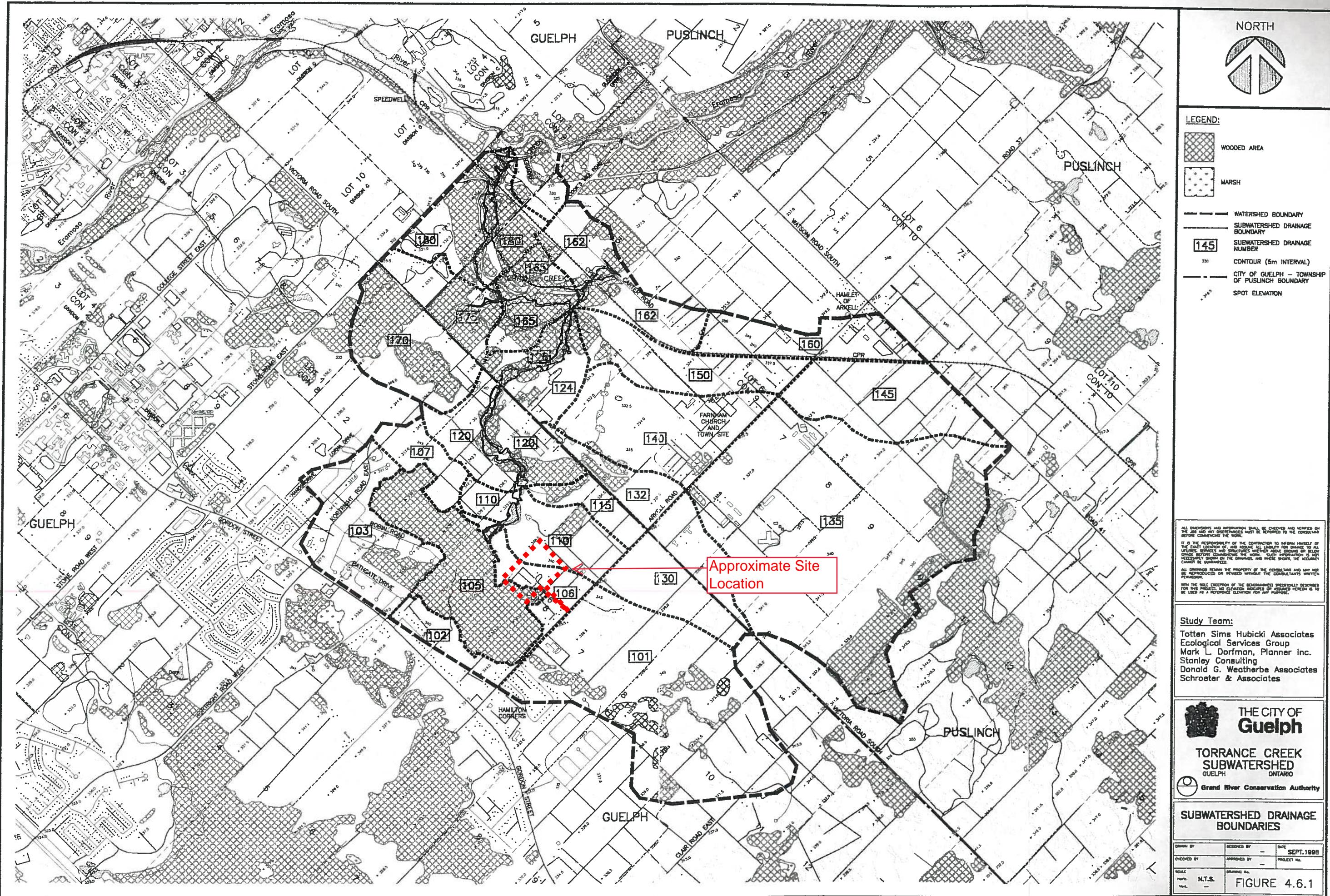


Stantec			SUBDIVISION <b>VICTORIA PARK VILLAGE</b> 1159 VICTORIA ROAD SOUTH	<b>SANITARY SEWER</b> <b>DESIGN SHEET</b>										DESIGN PARAMETERS		City of Guelph				4.000					
														AVERAGE DAILY FLOW PER PERSON =				275 l/p/day		RESIDENTIAL:					
																	COMMERCIAL/INDUST:		1.0000 L/s/ha						
																	1.7000 L/s/Ha								
																	MINIMUM VELOCITY =		0.600 m/s		SCHOOL/MULTI FAMILY:				
																	n =		0.013		APARTMENT 150U/HA				
																	MAX PEAK FAC.=		4.500		APARTMENT 295U/Ha				
																	MIN PEAK FAC.=		1.500		7.0000 L/s/Ha				
																	RESIDENTIAL HARMON PEAKING FACTOR								
LOCATION			RESIDENTIAL AREA				COMM/INDUST				SCHOOL/MULTI-FAMILY				APT		C+H-I	TOTAL	PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	FLOW RATE (L/s/Ha)	FLOW (L/s)	CUMML. FLOW (L/s)	AREA (ha)	FLOW RATE (L/s/Ha)	FLOW (L/s)	CUMML. FLOW (L/s)	AREA (ha)	FLOW RATE (L/s/Ha)	FLOW (L/s)	CUMML. FLOW (L/s)	AREA (ha)	FLOW RATE (L/s/Ha)	FLOW (L/s)	FLOW (L/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (L/s)	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)	% Capacity
<b>PHASE 1</b>																									
HAUSER COURT	70	62	0.89	1.000	0.890	0.890	1.70	0.00	0.00	2.50	0.00	0.00	0.00	6.00	0.00	0.00	0.000	0.890	21.60	200	1.0	31.9	1.03	0.41	2.8%
	62	61	0.12	1.000	0.120	1.010	1.70	0.00	0.00	2.50	0.00	0.00	0.00	6.00	0.00	0.00	0.000	1.010	15.90	200	0.5	22.6	0.73	0.34	4.5%
	61	60	0.53	1.000	0.530	1.540	1.70	0.00	0.00	2.50	0.00	0.00	0.00	6.00	0.00	0.00	0.000	1.540	79.30	200	0.5	22.6	0.73	0.38	6.8%
HUTCHISON RD	64	60	0.43	1.000	0.430	0.430	1.70	0.00	0.00	2.50	0.00	0.00	0.00	6.00	0.00	0.00	0.000	0.430	72.00	200	1.3	36.3	1.17	0.00	1.2%
220 Arkel	PLUG	60	1.44	1.000	1.440	1.440	1.70	0.00	0.00	1.68	2.50	4.20	4.20	6.00	0.00	0.00	4.200	5.64	39.70	200	1.0	31.9	1.03	0.74	17.7%
JELL STREET	60	59	0.00	1.000	0.000	1.97	1.70	0.00	0.00	0.36	2.50	0.90	5.10	6.00	0.00	0.00	5.100	7.07	77.00	200	0.5	22.6	0.73	0.64	31.3%
ELSEGOOD DR	56	59	0.54	1.000	0.540	0.540	1.70	0.00	0.00	2.50	0.00	0.00	0.00	6.00	0.00	0.00	0.000	0.540	78.00	200	1.15	34.1	1.10	0.00	1.6%
JELL STREET	59	58	0.00	1.000	0.000	2.51	1.70	0.00	0.00	0.32	2.50	0.80	5.90	6.00	0.00	0.00	5.900	8.41	65.90	200	0.5	22.6	0.73	0.66	37.2%
	58	57	0.00	1.000	0.000	2.51	1.70	0.00	0.00	0.42	2.50	1.05	6.95	6.00	0.00	0.00	6.950	9.46	61.50	200	0.5	22.6	0.73	0.69	41.9%
POOLE STREET	PLUG	57	0.00	1.000	0.000	0.000	1.70	0.00	0.00	5.00	2.50	12.50	12.50	6.00	0.00	0.00	12.500	12.500	39.70	200	1.0	31.9	1.03	0.95	39.2%
POOLE STREET	57	47	0.11	1.000	0.110	2.62	1.70	0.00	0.00	2.50	0.00	19.45	19.45	6.00	0.00	0.00	19.450	22.07	59.40	250	0.5	41.6	0.85	0.86	53.1%
HUTCHISON RD	64	65	0.59	1.000	0.590	0.590	1.70	0.00	0.00	2.50	0.00	0.00	0.00	6.00	0.00	0.00	0.000	0.590	72.00	200	1.0	31.9	1.03	0.00	1.8%
	65	66	0.11	1.000	0.110	0.700	1.70	0.00	0.00	2.50	0.00	0.00	0.00	6.00	0.00	0.00	0.000	0.700	15.80	200	0.5	22.6	0.73	0.29	3.1%
	66	55	0.31	1.000	0.310	1.010	1.70	0.00	0.00	2.50	0.00	0.00	0.00	6.00	0.00	0.00	0.000	1.010	65.80	200	0.5	22.6	0.73	0.34	4.5%
ELSEGOOD DR	56	55	0.54	1.000	0.540	0.540	1.70	0.00	0.00	2.50	0.00	0.00	0.00	6.00	0.00	0.00	0.000	0.540	76.30	200	1.0	31.9	1.03	0.00	1.7%
HUTCHISON RD	55	54	0.08	1.000	0.080	1.630	1.70	0.00	0.00	2.50	0.00	0.00	0.00	6.00	0.00	0.00	0.000	1.630	23.90	200	0.5	22.6	0.73	0.38	7.2%
	54	53	0.23	1.000	0.230	1.860	1.70	0.00	0.00	2.50	0.00	0.00	0.00	6.00	0.00	0.00	0.000	1.860	48.50	200	0.5	22.6	0.73	0.42	8.2%
BLOCK 106 WEST	PLUG	53	0.00	1.000	0.000	0.000	1.70	0.00	0.00	0.48	2.50	1.20	1.20	6.00	0.00	0.00	1.200	1.200	8.50	200	1.0	31.9	1.03	0.41	3.8%
HUTCHISON RD	53	52	0.13	1.000	0.130	1.990	1.70	0.00	0.00	2.50	0.00	1.20	1.20	6.00	0.00	0.00	1.200	3.190	31.30	200	0.5	22.6	0.73	0.50	14.1%
BLOCK 106 EAST	PLUG	52	0.00	1.000	0.000	0.000	1.70	0.00	0.00	0.34	2.50	0.85	0.85	6.00	0.00	0.00	0.850	0.850	7.60	200	1.0	31.9	1.03	0.41	2.7%
HUTCHISON RD	52	48	0.13	1.000	0.130	2.120	1.70	0.00	0.00	2.50	0.00	2.05	2.05	6.00	0.00	0.00	2.050	4.170	28.30	200	0.5	22.6	0.73	0.54	18.5%
BLOCK 107 EAST	PLUG	51	0.10	1.000	0.100	0.100	1.70	0.00	0.00	2.50	0.00	0.00	0.00	1.45	6.00	8.70	8.700	8.800	29.30	200	1.0	31.9	1.03	0.84	27.6%
	51	50	0.30	1.000	0.300	0.400	1.70	0.00	0.00	2.50	0.00	0.00	0.00	6.00	0.00	8.70	8.700	9.100	69.50	200	0.5	22.6	0.73	0.69	40.3%



# **APPENDIX D**

Stormwater Management  
Stormwater Management Hydrologic Model  
Design Calculations



```

I 21-15_GAWSER_i nput_TCSS. txt
* Torrance Creek Watershed Model
* =====
* File created by Dr. H. O. Schroeter, P. Eng., April 17, 1998
* Revised: May 18, 1998; September 17, 1998
* =====
* Soil Drainage parameters
* =====
* Note: Here, soil zones defined by infiltrability and cover type.
* Zone Descriptions:
*   1=Impervious
*   2=wetlands
*   3=Low vegetative cover, lacustrine, kame outwash sand, like muck
*   4=Low vegetative cover, Wentworth Till (sandy till)
*   5=Low vegetative cover, Kame, eskers, sand and gravel
*   6=Low vegetative cover, Outwash gravel
*   7=Forest Cover, bedrock
*   8=Forest Cover, Like RU 4 and 5 but lumped together
*   9=Forest Cover, Outwash gravel
* =====
READ SOIL PARAMETERS NZONE=9
      Wet Low Vegetative Cover Forest Cover
      IMP Lands Muck St I S & G Gravel BedR Sand Gravel
      DS= 2 200 5 5.0 5.0 6.0 10.0 15.0 15.0
      KEFF= 0 0.5 2.0 8.0 16.0 20.0 4.0 40.0 60.0
      CS= 0 0.5 1.5 6.0 12.0 15.0 3.0 30.0 45.0
      D= 0 0.5 0.1 0.4 1.6 2.0 0.4 4.0 6.0
      SAV= 0 200 200 200 200 200 200 200 200
      HI = 0 0.01 100 100 100 150 200 200 200
      SMCI = 0 0.56 0.56 0.46 0.46 0.40 0.40 0.46 0.40
      FCAP1= 0 0.46 0.46 0.23 0.23 0.10 0.10 0.23 0.10
      IMCI = 0 0.46 0.46 0.23 0.23 0.10 0.10 0.23 0.10
      WLTI = 0 0.27 0.27 0.07 0.07 0.04 0.04 0.07 0.04
      HII = 0 0.01 400 800 800 1000 800 1000 1000
      SMCI1= 0 0.56 0.56 0.46 0.46 0.40 0.40 0.46 0.40
      FCAP1I= 0 0.46 0.46 0.23 0.23 0.10 0.10 0.23 0.10
      IMCI1= 0 0.46 0.46 0.23 0.23 0.10 0.10 0.23 0.10
      WLTI1= 0 0.27 0.27 0.07 0.07 0.04 0.04 0.07 0.04
      X= 0 1 1 1 0 0 1 0 0
      FATR= 1 1 1 1 1 1 1 1 1
      INCs= 0 2.0 0.5 0.5 1.0 1.0 2.5 2.5 2.5
* Go to event file
* =====
CHANGE INPUT FILE
* =====
* Typical off-channel (Flat areas) 6
COMPUTE RATING CURVE ID=1 VS= 1.000 NSEGS=3
  MIN EL= 100.00 MAX EL= 100.60
  CHNSLP= 0.0050 FLNSLP= 0.0050
  N= 0.350 DIST= 39.15
  N= -0.150 DIST= 40.85
  N= 0.350 DIST= 80.00
    DIST ELEV DIST ELEV DIST ELEV
    0.00 100.60 39.15 100.20 39.75 100.00
    40.25 100.00 40.85 100.20 80.00 100.60
RFN=0.0000 PCODE=1
* Typical off-channel (Steep areas) 6
COMPUTE RATING CURVE ID=5 VS= 2.000 NSEGS=3
  MIN EL= 100.00 MAX EL= 100.80
  CHNSLP= 0.0100 FLNSLP= 0.0100

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I 21-15_GAWSER_i nput_TCSS. txt
N= 0.350 DIST= 24.45
N=-0.150 DIST= 25.55
N= 0.350 DIST= 50.00
  DIST ELEV DIST ELEV DIST ELEV
  0.00 100.80 24.45 100.30 24.75 100.00
  25.50 100.00 25.55 100.30 50.00 100.80
RFN=0.0000 PCODE=1
* Part of SW quadrant of Arkell & Victoria Rd intersect.
* VS= 1.000 is main channel & VS= 2.000 is off-channel
* =====
COMPUTE FLOWRATE ID=1 NHD= 130 AREA= 0.5030 Sq km L= 1230 m W= 410 m
  SOIL ZONE I II III IV V VI VII VIII IX
  2.0 0.0 0.0 5.0 0.6 92.4 0.0 0.0 0.0
  RATING CURVES: IDMC=1 IDOC=5 QRMC= 0.50 QROC= 0.05
  ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
  SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WOPCODE=1
  RBASIN=0 IDA=0 IDb=0 IDC=0 IDD=0 RBDUMP=0
  GWFAC=0.00 GWON=0
* Divert flow from 130 into ground and hold
* =====
DIVERT FLOWS INFLO/THRU=1 DIVERT ID=5 HYD=3130 PCODE=1 OPTION=1
  INLET CAPACITY= 0.4600 CMS IDFFLAG=2 TDSTOR=0
* =====
* SECTION G-G 16
* =====
COMPUTE RATING CURVE ID=2 VS= 20062.900 NSEGS=3
  MIN EL= 322.96 MAX EL= 324.00
  CHNSLP= 0.0190 FLNSLP= 0.0190
  N= 0.120 DIST= 18.72
  N=-0.070 DIST= 30.22
  N= 0.120 DIST= 70.00
    DIST ELEV DIST ELEV DIST ELEV
    0.00 323.12 6.89 323.02 7.57 323.05
    14.21 323.03 18.41 323.17 18.72 323.17
    22.17 323.15 24.17 322.96 25.00 322.98
    30.22 323.11 30.85 323.08 31.38 323.05
    39.24 323.05 39.88 323.05 50.00 323.14
RFN=0.0000 PCODE=1
* Route 3130 through reach 30
* Using Valley Section 20062.900 As channel Rating Curve
* =====
ROUTE CHANNEL ID=2 HYD NO= 30 INFLOW=5 LENGTH= 800 m SLOPE=0.0062
  RCID=2 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY= 0.0%
* =====
* Compute runoff hydrograph from area 132
* VS= 1.000 is main channel & VS= 2.000 is off-channel
* =====
COMPUTE FLOWRATE ID=3 NHD= 132 AREA= 0.1730 Sq km L= 450 m W= 250 m
  SOIL ZONE I II III IV V VI VII VIII IX
  2.0 0.0 0.0 0.0 0.0 81.3 0.0 5.2 11.5
  RATING CURVES: IDMC=1 IDOC=5 QRMC= 0.50 QROC= 0.05
  ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
  SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WOPCODE=1
  RBASIN=0 IDA=0 IDb=0 IDC=0 IDD=0 RBDUMP=0
  GWFAC=0.00 GWON=0
* Sum hydr. 132 & 30 call result 232
* =====
ADD HYD ID=4 HYD NO= 232 IDA=3 IDb=2 IDCODE=0
  Page 2
  AREA=

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I 21-15\_GAWSER\_i nput\_TCSS. txt

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0.173
* Area draining U of G Poultry Farm
* VS= 1.000 is main channel & VS= 2.000 is off-channel
COMPUTE FLOWRATE ID=2 NHD= 135 AREA= 2.2800 Sq km L= 1900 m W= 650 m
SOIL ZONE I II III IV V VI VII VIII IX
2.0 0.0 0.0 8.3 8.8 66.7 0.0 12.9 1.2
RATING CURVES: IDMC=1 IDOC=5 ORMC= 0.50 QROC= 0.05
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
RBASIN=2 RBPCODE=0 FACTOR= 0.347
I LEVEL= 250.000 HDIFF= 8.0 00= 0.0000
ZG= 250.000 CG= 0.000 EG= 1.000 Gate
ZS= 256.000 CS= 100.000 ES= 1.500 Spillway
ZD= 250.000 DZ= 4.0 Recharge
AS= 80.000 AN= 0.000 N= 0.000 Storage
FSS=0.000 FGW=0.000 GLEVEL= 0.000 QGWI = 0.0000
IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0 GWFACT=0.00 GWON=0
*
* Divert flow from 135 into ground and hold
*
DIVERT FLOWS INFLO/THRU=2 DIVERT ID=5 HYD=3135 PCODE=1 OPTION=1
INLET CAPACITY= 0.9000 CMS IDFFLAG=2 IDSTOR=0
*
* Add GW components from 130 and 135 together
*
ADD HYD ID=3 HYD NO=4135 IDA=1 IDB=2 ICODE=0 AREA=
0.000
*
* Route flows through Channel 35
* Using Valley Section 20062.900 As channel Rating Curve
*
ROUTE CHANNEL ID=1 HYD NO= 35 INFLOW=5 LENGTH= 800 m SLOPE=0.0062
RCID=2 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY= 0.0%
*
* Part of Southern Tributary thru Golf Course
* VS= 1.000 is main channel & VS= 2.000 is off-channel
*
COMPUTE FLOWRATE ID=2 NHD= 140 AREA= 0.5890 Sq km L= 970 m W= 365 m
SOIL ZONE I II III IV V VI VII VIII IX
7.3 0.0 0.0 0.0 0.0 89.3 0.0 0.0 3.3
RATING CURVES: IDMC=1 IDOC=5 ORMC= 0.50 QROC= 0.05
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
GWFACT=0.00 GWON=0
*
* Sum hydr. 140 & 35 call result 235
*
ADD HYD ID=5 HYD NO= 235 IDA=2 IDB=1 ICODE=0 AREA=
0.589
*
* Southern Tributary through Golf Course
*
ADD HYD ID=1 HYD NO= 240 IDA=5 IDB=4 ICODE=0 AREA=
0.762
*
* Route 240 through reach 40
* Using Valley Section 20062.900 As channel Rating Curve
*
ROUTE CHANNEL ID=2 HYD NO= 40 INFLOW=1 LENGTH= 900 m SLOPE=0.0062
RCID=2 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY= 0.0%

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I 21-15\_GAWSER\_i nput\_TCSS. txt

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* Compute runoff hydrograph from area 145
* VS= 1.000 is main channel & VS= 2.000 is off-channel
*
COMPUTE FLOWRATE ID=1 NHD= 145 AREA= 0.5540 Sq km L= 1680 m W= 315 m
SOIL ZONE I II III IV V VI VII VIII IX
2.0 0.0 0.0 12.9 0.0 85.1 0.0 0.0 0.0
RATING CURVES: IDMC=1 IDOC=5 ORMC= 0.50 QROC= 0.05
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
GWFACT=0.00 GWON=0
*
* Divert flow from 145 into ground
*
DIVERT FLOWS INFLO/THRU=1 DIVERT ID=5 HYD=3145 PCODE=1 OPTION=1
INLET CAPACITY= 0.4200 CMS IDFFLAG=2 IDSTOR=0
*
* Add GW components from 145 to running total
*
ADD HYD ID=4 HYD NO=4145 IDA=3 IDB=1 ICODE=0 AREA=
0.000
*
* Valley Section for Channel 35
*
COMPUTE RATING CURVE ID=3 VS= 35.000 NSEGS=3
MIN EL= 335.00 MAX EL= 337.50
CHNSLP= 0.0010 FLNSLP= 0.0010
N= 0.120 DIST= 20.00
N= 0.080 DIST= 40.00
N= 0.120 DIST= 60.00
DIST ELEV DIST ELEV DIST ELEV
0.00 337.50 20.00 335.20 30.00 335.00
40.00 335.20 60.00 337.50
RFN=0.0000 PCODE=1
*
* Eastern Side of Arkell U of G Farm
* Using Valley Section 35.000 As channel Rating Curve
*
ROUTE CHANNEL ID=1 HYD NO= 50 INFLOW=5 LENGTH= 1240 m SLOPE=0.0010
RCID=3 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY= 0.0%
*
* Compute runoff hydrograph from area 150
* VS= 1.000 is main channel & VS= 2.000 is off-channel
*
COMPUTE FLOWRATE ID=3 NHD= 150 AREA= 0.3990 Sq km L= 500 m W= 207 m
SOIL ZONE I II III IV V VI VII VIII IX
6.6 0.0 0.0 0.0 0.0 87.3 0.0 0.0 6.1
RATING CURVES: IDMC=1 IDOC=5 ORMC= 0.50 QROC= 0.05
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
GWFACT=0.00 GWON=0
*
* Sum hydr. 150 & 50 call result 245
*
ADD HYD ID=5 HYD NO= 245 IDA=3 IDB=1 ICODE=0 AREA=
0.399
*
* Outflow from Southern Tributary =====
*
ADD HYD ID=1 HYD NO= 250 IDA=2 IDB=5 ICODE=0 AREA=
1.161

```

Page 4

```

I 21-15_GAWSER_i nput_TCSS.txt
*
PRINT HYD      ID=1 PCODE=1
*
* Divert flow from 250 into ground
*
DIVERT FLOWS    INFLO/THRU=1 DIVERT ID=5 HYD=3250 PCODE=1 OPTION=5
PERCENT INFLOW= 90.00 IDFLAG=2 IDSTOR=0
*
* Add GW from 250 to running total
*
ADD HYD        ID=2 HYD NO=4250 IDA=4 IDB=1 ICODE=0          AREA=
0.000
*
* Area u/s Arkell Road, inc Hamilton Corners
* VS= 1.000 is main channel & VS= 2.000 is off-channel
*
COMPUTE FLOWRATE ID=1 NHD= 101 AREA= 1.4200 Sq km L= 2290 m W= 625 m
SOIL ZONE I II III IV V VI VII VIII IX
3.1 0.0 0.0 7.2 33.2 43.8 0.0 4.5 8.2
RATING CURVES: IDMC=1 IDOC=5 ORMC= 0.50 QROC= 0.05
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
RBASIN=2 RBPCODE=0 FACTOR= 0.386
I LEVEL= 250.000 HDIFF= 8.0 00= 0.0000
ZG= 250.000 CG= 0.000 EG= 1.000 Gate
ZS= 256.000 CS= 100.000 ES= 1.500 Spillway
ZO= 250.000 K= 20.000 DZ= 4.0 Recharge
AS= 55.230 AN= 0.000 N= 0.000 Storage
FSS=0.000 FGW=0.000 GLEVEL= 0.000 GWI= 0.0000
IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0 GWFACT=0.00 GWON=0
*
* Divert flow from 101 into ground
*
DIVERT FLOWS    INFLO/THRU=1 DIVERT ID=6 HYD=3101 PCODE=1 OPTION=1
INLET CAPACITY= 0.4800 CMS IDFLAG=2 IDSTOR=0
*
* Add GW from 101 to running total
*
ADD HYD        ID=3 HYD NO=4101 IDA=2 IDB=1 ICODE=0          AREA=
0.000
*
* Typical Urban Cross-section
*                                         6
*
COMPUTE RATING CURVE ID=4 VS= 3.000 NSEGS=3
MIN EL= 120.00 MAX EL= 125.00
CHNSLP= 0.0050 FLNSLP= 0.0050
N= 0.015 DIST= 33.30
N=-0.015 DIST= 66.67
N= 0.015 DIST= 100.00
DIST ELEV DIST ELEV DIST ELEV
0.00 125.00 0.01 120.00 33.33 120.00
66.67 120.00 99.99 120.00 100.00 125.00
RFN=0.0000 PCODE=1
*
* Typical Urban Cross-section
*                                         6
*
COMPUTE RATING CURVE ID=6 VS= 3.000 NSEGS=3
MIN EL= 120.00 MAX EL= 125.00
CHNSLP= 0.0050 FLNSLP= 0.0050
N= 0.015 DIST= 33.30
N=-0.015 DIST= 66.67
N= 0.015 DIST= 100.00
DIST ELEV DIST ELEV DIST ELEV

```

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I 21-15_GAWSER_i nput_TCSS.txt
0.00 125.00 0.01 120.00 33.33 120.00
66.67 120.00 99.99 120.00 100.00 125.00
RFN=0.0000 PCODE=1
*
* Southwestern urban area
* VS= 3.000 is main channel & VS= 3.000 is off-channel
*
COMPUTE FLOWRATE ID=1 NHD= 102 AREA= 0.1400 Sq km L= 450 m W= 50 m
SOIL ZONE I II III IV V VI VII VIII IX
25.0 0.0 17.0 58.0 0.0 0.0 0.0 0.0 0.0
RATING CURVES: IDMC=4 IDOC=6 ORMC= 0.25 QROC= 0.15
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 1.2 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
GWFACT=0.00 GWON=0
*
* Part 1 of Inflow to big swamp
*
ADD HYD        ID=2 HYD NO= 202 IDA=6 IDB=1 ICODE=0          AREA=
0.140
*
* Compute runoff hydrograph from area 103
* VS= 3.000 is main channel & VS= 3.000 is off-channel
*
COMPUTE FLOWRATE ID=1 NHD= 103 AREA= 0.4620 Sq km L= 450 m W= 50 m
SOIL ZONE I II III IV V VI VII VIII IX
35.0 0.0 4.8 4.7 48.1 0.0 0.0 7.4 0.0
RATING CURVES: IDMC=4 IDOC=4 ORMC= 0.25 QROC= 0.15
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 1.2 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
GWFACT=0.00 GWON=0
*
* Part 2 inflow to big swamp
*
ADD HYD        ID=4 HYD NO= 203 IDA=1 IDB=2 ICODE=0          AREA=
0.602
*
* Divert flow from 203 into ground
*
DIVERT FLOWS    INFLO/THRU=4 DIVERT ID=6 HYD=3203 PCODE=1 OPTION=1
INLET CAPACITY= 0.0008 CMS IDFLAG=2 IDSTOR=0
*
* Add GW from 250 to running total
*
ADD HYD        ID=1 HYD NO=4203 IDA=3 IDB=4 ICODE=0          AREA=
0.000
*
* Catchment area directly to swamp
* VS= 1.000 is main channel & VS= 2.000 is off-channel
*
COMPUTE FLOWRATE ID=2 NHD= 105 AREA= 0.6830 Sq km L= 826 m W= 826 m
SOIL ZONE I II III IV V VI VII VIII IX
2.0 98.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
RATING CURVES: IDMC=1 IDOC=5 ORMC= 0.50 QROC= 0.05
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 3.0 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
GWFACT=0.00 GWON=0
*
* Part 3 inflow to big swamp
*
ADD HYD        ID=3 HYD NO= 205 IDA=2 IDB=6 ICODE=0          AREA=
Page 6

```

I 21-15\_GAWSER\_i nput\_TCSS. txt

```

0.683
*
* Compute runoff hydrograph from area 106
* VS= 1.000 is main channel & VS= 2.000 is off-channel
*
COMPUTE FLOWRATE ID=2 NHD= 106 AREA= 0.1870 Sq km L= 1000 m W= 350 m
SOIL ZONE I II III IV V VI VII VIII IX
    2.8 0.0 8.0 24.8 0.0 64.4 0.0 0.0 0.0
RATING CURVES: IDMC=1 IDOC=5 QRCM= 0.50 QROC= 0.05
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WOPCODE=1
RBASIN=0 IDA=0 IDb=0 IDC=0 IDD=0 RBDUMP=0
GWFACT=0.00 GWON=0

*
* Part 4 inflow to big swamp
*
ADD HYD ID=4 HYD NO= 206 IDA=2 IDb=3 ICODE=0 AREA=
0.870
*
* Compute runoff hydrograph from area 107
* VS= 1.000 is main channel & VS= 2.000 is off-channel
*
COMPUTE FLOWRATE ID=2 NHD= 107 AREA= 0.1880 Sq km L= 1000 m W= 200 m
SOIL ZONE I II III IV V VI VII VIII IX
    2.0 0.0 9.0 31.9 51.8 5.3 0.0 0.0 0.0
RATING CURVES: IDMC=1 IDOC=5 QRCM= 0.50 QROC= 0.05
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WOPCODE=1
RBASIN=0 IDA=0 IDb=0 IDC=0 IDD=0 RBDUMP=0
GWFACT=0.00 GWON=0

*
* Part 5 inflow to big swamp
*
ADD HYD ID=3 HYD NO= 207 IDA=2 IDb=4 ICODE=0 AREA=
1.058
*
PRINT HYD ID=3 PCODE=1
*
* Route flows through Big Swamp
*
ROUTE RESERVOIR ID=2 HYD NO= 505 INFLOW=3 PCODE=0 OPTION=1
I LEVEL= -1.000 HDIFF= 6.0
CONSTANT OUTFLOW OO= 0.0000
ZG= 331.100 CG= 0.900 EG= 0.500 Gate
ZS= 333.000 CS= 6.000 ES= 1.500 Spillway
ZO= 331.000 AS= 30.000 AN= 55.280 N= 2.000
*
* Go to event file: Route flows through Big Swamp
*
CHANGE INPUT FILE
*
* Area contributing to Headwater Pond (No. 8)
* VS= 1.000 is main channel & VS= 2.000 is off-channel
*
COMPUTE FLOWRATE ID=3 NHD= 110 AREA= 0.3330 Sq km L= 1030 m W= 260 m
SOIL ZONE I II III IV V VI VII VIII IX
    2.6 0.0 7.7 13.7 8.3 60.7 0.0 0.4 6.6
RATING CURVES: IDMC=1 IDOC=5 QRCM= 0.50 QROC= 0.05
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WOPCODE=1
RBASIN=0 IDA=0 IDb=0 IDC=0 IDD=0 RBDUMP=0
GWFACT=0.00 GWON=0

```

I 21-15\_GAWSER\_i nput\_TCSS. txt

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* Inflow to Pond 8
*
ADD HYD ID=4 HYD NO= 210 IDA=3 IDb=2 ICODE=0 AREA=
1.391
*
* Route flows through Pond 8
*
ROUTE RESERVOIR ID=2 HYD NO= 510 INFLOW=4 PCODE=0 OPTION=1
I LEVEL= -1.000 HDIFF= 6.0
CONSTANT OUTFLOW OO= 0.0000
ZG= 330.670 CG= 0.500 EG= 0.500 Gate
ZS= 331.400 CS= 4.000 ES= 1.500 Spillway
ZO= 330.670 AS= 0.000 AN= 0.150 N= 2.100
*
* SECTION U-U
17
*
COMPUTE RATING CURVE ID=3 VS= 3577.700 NSEGS=3
MIN EL= 329.90 MAX EL= 331.26
CHNSLP= 0.0062 FLNSLP= 0.0062
N= 0.120 DIST= 20.62
N= 0.070 DIST= 31.58
N= 0.120 DIST= 60.00
DIST ELEV DIST ELEV DIST ELEV
0.00 330.81 20.62 330.63 28.86 330.38
28.92 330.36 29.59 329.90 29.60 329.91
30.00 329.91 30.20 329.94 30.27 329.97
31.58 330.54 31.74 330.54 38.81 331.26
39.13 331.25 39.71 331.26 40.92 331.23
54.92 330.94 60.00 330.59
RFN=0.0000 PCODE=1
*
* Route 510 through reach 10
* Using Valley Section 3577.700 As channel Rating Curve
*
ROUTE CHANNEL ID=3 HYD NO= 10 INFLOW=2 LENGTH= 1030 m SLOPE=0.0062
RCID=3 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY= 0.0%
*
* South Central Area (includes Victoria Road)
* VS= 1.000 is main channel & VS= 2.000 is off-channel
*
COMPUTE FLOWRATE ID=2 NHD= 115 AREA= 0.1250 Sq km L= 430 m W= 290 m
SOIL ZONE I II III IV V VI VII VIII IX
    2.7 0.0 40.9 0.0 0.0 39.9 0.0 16.5 0.0
RATING CURVES: IDMC=1 IDOC=5 QRCM= 0.50 QROC= 0.05
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WOPCODE=1
RBASIN=0 IDA=0 IDb=0 IDC=0 IDD=0 RBDUMP=0
GWFACT=0.00 GWON=0
*
* Sum hydr. 115 & 10 call result 215
*
ADD HYD ID=4 HYD NO= 215 IDA=2 IDb=3 ICODE=0 AREA=
1.516
*
* Remove some flow from groundwater
*
DIVERT FLOWS INFLOW/THRU=1 DIVERT ID=6 HYD= 415 PCODE=1 OPTION=5
PERCENT INFLOW= 50.00 IDFLAG=2 IDSTOR=0
*
* Sum hydr. 415 & 215 call result 1215
*
ADD HYD ID=2 HYD NO=1215 IDA=6 IDb=4 ICODE=0 AREA=
1.516

```

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```
* SECTION S-S
* COMPUTE RATING CURVE ID=3 VS= 3101.800 NSEGS=3
  MIN EL= 328.22 MAX EL= 329.25
  CHNSLP= 0.0021 FLNSLP= 0.0021
  N= 0.120 DIST= 10.85
  N=-0.070 DIST= 11.26
  N= 0.120 DIST= 50.00
    DIST ELEV DIST ELEV DIST ELEV
    0.00 328.60 0.62 328.61 1.16 328.62
    6.20 328.69 10.85 328.47 10.94 328.22
   11.26 328.44 12.47 328.66 12.52 328.70
   15.00 328.70 17.49 328.71 20.94 328.72
   21.20 328.71 23.23 328.72 30.00 328.72
  50.00 329.25
RFN=0.0000 PCODE=1
* Route 1215 through reach 20
* Using Valley Section 3101.800 As channel Rating Curve
ROUTE CHANNEL ID=3 HYD NO= 20 INFLOW=2 LENGTH= 1230 m SLOPE=0.0062
RCID=3 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY= 0.0%
* Compute runoff hydrograph from area 120
* VS= 1.000 is main channel & VS= 2.000 is off-channel
COMPUTE FLOWRATE ID=2 NHD= 120 AREA= 0.4210 Sq km L= 560 m W= 383 m
SOIL ZONE I II III IV V VI VII VIII IX
  2.0 15.0 2.7 14.9 5.3 47.2 0.0 13.0 0.0
  RATINGS CURVES: IDMC=1 IDOC=5 QRMC= 0.50 QROC= 0.05
  ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 4.0 TLO= 0.0
  SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
  RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
  GWFAC=0.00 GWON=0
* Inflow to Victoria Pond (Number 5)
ADD HYD ID=4 HYD NO= 220 IDA=2 IDB=3 ICODE=0 AREA=
1.937
* Remove some flow from groundwater
DIVERT FLOWS INFLO/THRU=1 DIVERT ID=6 HYD= 420 PCODE=1 OPTION=5
PERCENT INFLOW=100.00 IDFLAG=2 IDSTOR=0
* Sum hydr. 420 & 220 call result 1220
ADD HYD ID=2 HYD NO=1220 IDA=6 IDB=4 ICODE=0 AREA=
1.937
* Route flows through Victoria Pond
ROUTE RESERVOIR ID=3 HYD NO= 520 INFLOW=2 PCODE=0 OPTION=1
I LEVEL= -1.000 HDIFF= 6.0
CONSTANT OUTFLOW OO= 0.0000
ZG= 327.160 CG= 0.000 EG= 0.500 Gate
ZS= 327.160 CS= 2.550 ES= 1.500 Spillway
ZO= 327.160 AS= 0.000 AN= 0.230 N= 3.000
* Go to event file: Route flows through Victoria Pond
CHANGE INPUT FILE
```

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```
* SECTION R-R
* COMPUTE RATING CURVE ID=3 VS= 2556.800 NSEGS=3
  MIN EL= 326.89 MAX EL= 333.02
  CHNSLP= 0.0024 FLNSLP= 0.0024
  N= 0.120 DIST= 44.82
  N=-0.070 DIST= 49.37
  N= 0.120 DIST= 100.00
    DIST ELEV DIST ELEV DIST ELEV
    0.00 333.02 1.19 332.93 8.62 331.41
    21.46 328.70 24.91 328.60 26.90 328.58
   42.17 327.63 44.82 327.37 45.02 327.29
   45.85 326.95 46.42 326.94 48.18 326.89
   48.82 327.22 48.99 327.31 49.37 327.52
   50.00 327.52 51.82 327.53 74.47 328.59
   75.54 328.64 85.80 329.99 89.19 330.44
  90.09 330.64 99.31 332.78 100.00 332.84
RFN=0.0000 PCODE=1
* Route 520 through reach 24
* Using Valley Section 2556.800 As channel Rating Curve
ROUTE CHANNEL ID=2 HYD NO= 24 INFLOW=3 LENGTH= 450 m SLOPE=0.0021
RCID=3 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY= 0.0%
* Route flows through Pond 4
ROUTE RESERVOIR ID=3 HYD NO= 524 INFLOW=2 PCODE=0 OPTION=1
I LEVEL= -1.000 HDIFF= 6.0
CONSTANT OUTFLOW OO= 0.0000
ZG= 327.160 CG= 0.000 EG= 0.500 Gate
ZS= 327.160 CS= 3.000 ES= 1.500 Spillway
ZO= 327.160 AS= 0.030 AN= 0.000 N= 2.000
* Compute runoff hydrograph from area 124
* VS= 1.000 is main channel & VS= 2.000 is off-channel
COMPUTE FLOWRATE ID=2 NHD= 124 AREA= 0.1820 Sq km L= 450 m W= 251 m
SOIL ZONE I II III IV V VI VII VIII IX
  2.0 0.0 0.0 38.1 0.0 35.6 0.0 3.6 20.7
  RATINGS CURVES: IDMC=1 IDOC=5 QRMC= 0.50 QROC= 0.05
  ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
  SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
  RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
  GWFAC=0.00 GWON=0
* Sum hydr. 524 & 124 call result 224
ADD HYD ID=4 HYD NO= 224 IDA=3 IDB=2 ICODE=0 AREA=
2.119
* Compute runoff hydrograph from area 126
* VS= 1.000 is main channel & VS= 2.000 is off-channel
COMPUTE FLOWRATE ID=2 NHD= 126 AREA= 0.0990 Sq km L= 200 m W= 133 m
SOIL ZONE I II III IV V VI VII VIII IX
  2.0 0.0 0.0 0.0 1.8 29.2 0.0 7.1 59.6
  RATINGS CURVES: IDMC=1 IDOC=5 QRMC= 0.50 QROC= 0.05
  ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
  SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
  RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
  GWFAC=0.00 GWON=0
```

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\* Sum hydr. 224 & 126 call result 226  
 ADD HYD ID=3 HYD NO= 226 IDA=4 IDB=2 ICODE=0  
 2. 218

\* SECTION M-M

COMPUTE RATING CURVE ID=3 VS= 2071.500 NSEGS=3  
 MIN EL= 324.84 MAX EL= 326.79  
 CHNSLP= 0.0003 FLNSLP= 0.0003  
 N= 0.250 DIST= 80.14  
 N=-0.150 DIST= 84.87  
 N= 0.250 DIST= 100.00  
 DIST ELEV DIST ELEV DIST ELEV  
 0.00 326.25 18.67 325.99 19.01 325.98  
 37.50 325.77 38.28 325.76 50.00 325.63  
 56.67 325.56 57.15 325.56 64.38 325.59  
 64.76 325.58 69.10 325.44 69.65 325.45  
 75.10 325.52 75.60 325.47 80.14 325.09  
 80.91 324.84 83.89 324.87 83.97 324.84  
 84.26 324.85 84.82 325.15 84.87 325.17  
 88.17 325.50 88.39 325.52 93.17 325.83  
 93.42 325.84 96.49 326.12 96.59 326.13  
 99.90 326.77 99.93 326.78 100.00 326.79  
 RFN=0.0000 PCODE=1

\* Main Stem flows u/s confluence with south branch  
 \* Using Valley Section 2071.500 As channel Rating Curve

ROUTE CHANNEL ID=2 HYD NO= 26 INFLOW=3 LENGTH= 450 m SLOPE=0.0006  
 RCI D=3 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY= 0.0%

\* Main Stem Flows d/s of South Tributary =====

ADD HYD ID=3 HYD NO= 251 IDA=2 IDB=5 ICODE=0  
 2. 218

\* Arkell Tributary, headwaters  
 \* VS= 1.000 is main channel & VS= 2.000 is off-channel

COMPUTE FLOWRATE ID=2 NHD= 160 AREA= 0.3150 Sq km L= 1500 m W= 417 m  
 SOIL ZONE I II III IV V VI VII VIII IX  
 7.0 0.0 0.0 51.6 12.8 28.6 0.0 0.0 0.0  
 RATING CURVES: IDMC=1 IDOC=5 ORMC= 0.50 OROC= 0.05  
 ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0  
 SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WOPCODE=1  
 RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0  
 GWFAC=0.00 GWON=0

\* Divert flow from 160 into ground

DIVERT FLOWS INFLO/THRU=2 DIVERT ID=5 HYD=3160 PCODE=1 OPTION=1  
 INLET CAPACITY= 0.3300 CMS IDFAG=2 IDSTOR=0

\* Add GW from 160 to running total

ADD HYD ID=4 HYD NO=4160 IDA=1 IDB=2 ICODE=0  
 0.000

\* Valley Section for Channel 35

COMPUTE RATING CURVE ID=3 VS= 35.000 NSEGS=3  
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MIN EL= 335.00 MAX EL= 337.50  
 CHNSLP= 0.0010 FLNSLP= 0.0010  
 N= 0.120 DIST= 20.00  
 N=-0.080 DIST= 40.00  
 N= 0.120 DIST= 60.00  
 DIST ELEV DIST ELEV DIST ELEV  
 0.00 337.50 20.00 335.20 30.00 335.00  
 40.00 335.20 60.00 337.50  
 RFN=0.0000 PCODE=1

\* Route flows alongside CPR Tracks  
 \* Using Valley Section 35.000 As channel Rating Curve

ROUTE CHANNEL ID=1 HYD NO= 60 INFLOW=5 LENGTH= 780 m SLOPE=0.0010  
 RCI D=3 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY= 0.0%

\* Compute runoff hydrograph from area 162  
 \* VS= 1.000 is main channel & VS= 2.000 is off-channel

COMPUTE FLOWRATE ID=2 NHD= 162 AREA= 0.3930 Sq km L= 350 m W= 233 m  
 SOIL ZONE I II III IV V VI VII VIII IX  
 2.0 0.0 0.0 17.9 0.0 52.8 0.0 0.0 27.3  
 RATING CURVES: IDMC=1 IDOC=5 ORMC= 0.50 OROC= 0.05  
 ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0  
 SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WOPCODE=1  
 RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0  
 GWFAC=0.00 GWON=0

\* Outflow from Arkell Tributary

ADD HYD ID=5 HYD NO= 260 IDA=1 IDB=2 ICODE=0  
 0.393

\* Main Stem Flows d/s Arkell Tributary

ADD HYD ID=1 HYD NO= 262 IDA=3 IDB=5 ICODE=0  
 2.611

\* SECTION F-F 13

COMPUTE RATING CURVE ID=3 VS= 995.900 NSEGS=3  
 MIN EL= 322.09 MAX EL= 323.25  
 CHNSLP= 0.0011 FLNSLP= 0.0011  
 N= 0.250 DIST= 38.70  
 N=-0.120 DIST= 63.96  
 N= 0.250 DIST= 100.00  
 DIST ELEV DIST ELEV DIST ELEV  
 0.00 322.45 30.98 322.29 35.89 322.31  
 38.70 322.30 45.52 322.09 45.94 322.09  
 48.21 322.10 63.96 322.20 76.96 322.47  
 77.06 322.47 91.89 322.55 95.46 322.97  
 100.00 323.25  
 RFN=0.0000 PCODE=1

\* Route 262 through reach 65  
 \* Using Valley Section 995.900 As channel Rating Curve

ROUTE CHANNEL ID=2 HYD NO= 65 INFLOW=1 LENGTH= 535 m SLOPE=0.0021  
 RCI D=3 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY= 0.0%

\* Compute runoff hydrograph from area 165  
 \* VS= 1.000 is main channel & VS= 2.000 is off-channel

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COMPUTE FLOWRATE ID=1 NHD= 165 AREA= 0. 2390 Sq km L= 550 m W= 367 m
SOIL ZONE I II III IV V VI VII VIII IX
2.0 0.0 0.0 0.0 2.7 24.5 0.0 2.4 68.4
RATING CURVES: IDMC=1 IDOC=5 ORMC= 0.50 OROC= 0.05
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
GWFACT=0.00 GWON=0
*
* Sum hydr. 165 & 265 call result 265
*
ADD HYD ID=3 HYD NO= 265 IDA=1 IDB=2 ICODE=0 AREA=
2.850
*
* Divert flow from 265 into ground
*
DIVERT FLOWS INFLO/THRU=3 DIVERT ID=5 HYD=3265 PCODE=1 OPTION=5
PERCENT INFLOW= 75.00 IDFLAG=2 IDSTOR=0
*
* Add GW from 265 to running total
*
ADD HYD ID=1 HYD NO=4265 IDA=4 IDB=3 ICODE=0 AREA=
0.000
*
* Compute runoff hydrograph from area 170
* VS= 1.000 is main channel & VS= 2.000 is off-channel
*
COMPUTE FLOWRATE ID=2 NHD= 170 AREA= 0. 4530 Sq km L= 507 m W= 338 m
SOIL ZONE I II III IV V VI VII VIII IX
2.0 18.4 5.3 7.0 17.3 14.6 0.0 21.8 13.6
RATING CURVES: IDMC=1 IDOC=5 ORMC= 0.50 OROC= 0.05
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 4.0 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
GWFACT=0.00 GWON=0
*
* Northern Tributary Swamp
*
ROUTE RESERVOIR ID=3 HYD NO= 570 INFLOW=2 PCODE=0 OPTION=1
I LEVEL= -1.000 HDIFF= 6.0
CONSTANT OUTFLOW 00= 0.0000
ZG= 332.000 CG= 1.000 EG= 0.500 Gate
ZS= 333.000 CS= 10.000 ES= 1.000 Spillway
ZO= 332.000 AS= 8.290 AN= 0.000 N= 2.000
*
* SECTION H-H
10
*
COMPUTE RATING CURVE ID=3 VS= 20346.900 NSEGS=3
MIN EL= 328.32 MAX EL= 329.66
CHNSLP= 0.0026 FLNSLP= 0.0026
N= 0.120 DIST= 17.87
N= 0.070 DIST= 28.69
N= 0.120 DIST= 36.31
DIST ELEV DIST ELEV DIST ELEV
0.00 329.66 0.53 329.63 5.12 328.72
10.17 328.60 17.86 328.40 20.65 328.32
21.16 328.32 28.34 328.44 28.69 328.45
36.31 328.75
RFN=0.0000 PCODE=1
*
* Route 570 through reach 75
* Using Valley Section 20346.900 As channel Rating Curve

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ROUTE CHANNEL ID=2 HYD NO= 75 INFLOW=3 LENGTH= 607 m SLOPE=0.0062
RCID=3 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY= 0.0%
*
* Compute runoff hydrograph from area 175
* VS= 1.000 is main channel & VS= 2.000 is off-channel
*
COMPUTE FLOWRATE ID=3 NHD= 175 AREA= 0. 2570 Sq km L= 340 m W= 250 m
SOIL ZONE I II III IV V VI VII VIII IX
9.0 0.0 0.0 0.0 43.1 3.3 0.0 38.6 5.9
RATING CURVES: IDMC=1 IDOC=5 ORMC= 0.50 OROC= 0.05
ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
RBASIN=0 IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0
GWFACT=0.00 GWON=0
*
* Sum hydr. 75 & 175 call result 275
*
ADD HYD ID=4 HYD NO= 275 IDA=2 IDB=3 ICODE=0 AREA=
0.710
*
* Main Stem Flows d/s of Northern Tributary
*
ADD HYD ID=2 HYD NO= 277 IDA=5 IDB=4 ICODE=0 AREA=
0.710
*
* Remove some flow from groundwater
*
DIVERT FLOWS INFLO/THRU=1 DIVERT ID=5 HYD= 477 PCODE=1 OPTION=5
PERCENT INFLOW=100.00 IDFLAG=2 IDSTOR=0
*
* Sum hydr. 477 & 277 call result 1277
*
ADD HYD ID=3 HYD NO=1277 IDA=5 IDB=2 ICODE=0 AREA=
0.710
*
* Divert flow into low flow channel (79)
*
DIVERT FLOWS INFLO/THRU=3 DIVERT ID=5 HYD=3277 PCODE=1 OPTION=1
INLET CAPACITY= 0. 3000 CMS IDFLAG=2 IDSTOR=0
*
* SECTION D-D
19
*
COMPUTE RATING CURVE ID=3 VS= 328.300 NSEGS=3
MIN EL= 318.22 MAX EL= 321.02
CHNSLP= 0.0061 FLNSLP= 0.0061
N= 0.250 DIST= 23.45
N= -0.120 DIST= 28.26
N= 0.250 DIST= 40.00
DIST ELEV DIST ELEV DIST ELEV
0.00 319.31 4.29 318.27 4.35 318.26
4.49 318.26 15.16 318.46 17.72 318.46
20.00 318.46 23.45 318.47 23.65 318.38
24.04 318.22 25.00 318.22 25.33 318.22
28.26 319.17 28.87 319.37 30.65 320.37
30.98 320.55 38.17 320.54 38.25 320.54
40.00 321.02
RFN=0.0000 PCODE=1
*
* High flow channel
*
ROUTE CHANNEL ID=2 HYD NO= 78 INFLOW=3 K= -37.000 TL= 0.000
X= 0.400 NS=1 PCODE=1 IDX=1 PIPE=0 CANOPY= 0.0%
*
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* SECTION D-D
* COMPUTE RATING CURVE ID=3 VS= 30328.301 NSEGS=3
  MIN EL= 318.22 MAX EL= 321.02
  CHNSLP= 0.0121 FLNSLP= 0.0121
  N= 0.250 DIST= 23.45
  N=-0.070 DIST= 28.26
  N= 0.250 DIST= 40.00
    DIST ELEV DIST ELEV DIST ELEV
    0.00 319.31 4.29 318.27 4.35 318.26
    4.49 318.26 15.16 318.46 17.72 318.46
    20.00 318.46 23.45 318.47 23.65 318.38
    24.04 318.22 25.00 318.22 25.33 318.22
    28.26 319.17 28.87 319.37 30.65 320.37
    30.98 320.55 38.17 320.54 38.25 320.54
    40.00 321.02
  RFN=0.0000 PCODE=1

* Low flow channel
* Using Valley Section 30328.301 As channel Rating Curve
* ROUTE CHANNEL ID=3 HYD NO= 79 INFLOW=5 LENGTH= 1200 m SLOPE=0.0120
  RCID=3 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY= 0.0%
* Sum flows for channel 78*
* ADD HYD ID=4 HYD NO= 279 IDA=3 IDB=2 ICODE=0 AREA=
  0.000
* Compute runoff hydrograph from area 180
* VS= 1.000 is main channel & VS= 2.000 is off-channel
* COMPUTE FLOWRATE ID=2 NHD= 180 AREA= 0.4700 Sq km L= 800 m W= 300 m
  SOIL ZONE I II III IV V VI VII VIII IX
  14.0 3.8 0.0 3.3 18.6 8.2 18.4 12.6 21.0
  RATING CURVES: IDMC=1 IDOC=5 ORMC= 0.50 OROC= 0.05
  ROUTING MODEL=2 CONSTANTS: OVERLAND FTB= 2.0 TLO= 0.0
  SUBSURFACE: KSS= 5.0 KGW= 384 h PCODE=1 WQPCODE=1
  RBASIN=0 RBPCode=0 FACTOR= 0.400
  ILEVEL= 250.000 HDIFF= 8.0 00= 0.0000
  ZG= 250.000 CG= 0.000 EG= 1.000 Gate
  ZS= 256.000 CS= 100.000 ES= 1.500 Spillway
  ZO= 250.000 K= 22.000 DZ= 4.0 Recharge
  AS= 22.300 AN= 0.000 N= 0.000 Storage
  FSS=0.000 FGW=0.000 GLEVEL= 0.000 OGWI= 0.0000
  IDA=0 IDB=0 IDC=0 IDD=0 RBDUMP=0 GWFACT=0.00 GWON=0

* Inflow to Mill Pond (Number 1)
* ADD HYD ID=3 HYD NO= 278 IDA=4 IDB=2 ICODE=0 AREA=
  0.470
* Torrance Creek flows out of Mill Pond
* ROUTE RESERVOIR ID=2 HYD NO= 580 INFLOW=3 PCODE=0 OPTION=1
  ILEVEL= -1.000 HDIFF= 8.0
  CONSTANT OUTFLOW QO= 0.0000
  ZG= 320.220 CG= 0.000 EG= 0.500 Gate
  ZS= 320.220 CS= 1.360 ES= 1.500 Spillway
  ZO= 319.220 AS= 0.000 AN= 0.078 N= 2.100

* Go to event file: Torrance Creek flows out of Mill Pond

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CHANGE INPUT FILE
* Divert flow from 580 into ground
* DIVERT FLOWS INFLO/THRU=2 DIVERT ID=5 HYD=3580 PCODE=1 OPTION=1
  INLET CAPACITY= 0.0250 CMS IDFAG=2 IDSTOR=0
* SECTION D-D
* COMPUTE RATING CURVE ID=3 VS= 328.300 NSEGS=3
  MIN EL= 318.22 MAX EL= 321.02
  CHNSLP= 0.0061 FLNSLP= 0.0061
  N= 0.250 DIST= 23.45
  N=-0.120 DIST= 28.26
  N= 0.250 DIST= 40.00
    DIST ELEV DIST ELEV DIST ELEV
    0.00 319.31 4.29 318.27 4.35 318.26
    4.49 318.26 15.16 318.46 17.72 318.46
    20.00 318.46 23.45 318.47 23.65 318.38
    24.04 318.22 25.00 318.22 25.33 318.22
    28.26 319.17 28.87 319.37 30.65 320.37
    30.98 320.55 38.17 320.54 38.25 320.54
    40.00 321.02
  RFN=0.0000 PCODE=1

* Torrance Creek Flows at Eramosa River (outlet)
* Using Valley Section 328.300 As channel Rating Curve
* ROUTE CHANNEL ID=2 HYD NO= 80 INFLOW=5 LENGTH= 578 m SLOPE=0.0120
  RCID=3 NS=1 PCODE=1 INDEX=1 PIPE=0 CANOPY= 0.0%
* Go to event file: Torrance Creek Flows at Eramosa River (outlet)
* CHANGE INPUT FILE
* FINISH

```

I 21-15_GAWSER_summary_TCSS.txt						
1	130	0. 5030	12. 54	0. 1066	0. RCFLAGS	0
				scene1.wat		return1.dat
1	3130	0. 5030	0. 00	0. 0000	0. RCFLAGS	0
1	30	0. 5030	0. 00	0. 0000	0. RCFLAGS	0
1	132	0. 1730	12. 01	0. 0656	0. RCFLAGS	0
1	232	0. 6760	3. 07	0. 0656	0. RCFLAGS	0
1	135	2. 2800	7. 10	0. 2192	15. RCFLAGS	0
1	3135	2. 2800	0. 00	0. 0000	0. RCFLAGS	0
1	4135	2. 7830	8. 08	0. 3216	0. RCFLAGS	0
1	35	2. 2800	0. 00	0. 0000	0. RCFLAGS	0
1	140	0. 5890	15. 10	0. 1630	0. RCFLAGS	0
1	235	2. 8690	3. 10	0. 1630	0. RCFLAGS	0
1	240	3. 5450	3. 10	0. 2235	0. RCFLAGS	0
1	40	3. 5450	3. 06	0. 2172	0. RCFLAGS	0
1	145	0. 5540	12. 60	0. 1042	0. RCFLAGS	0
1	3145	0. 5540	0. 00	0. 0000	0. RCFLAGS	0
1	4145	3. 3370	8. 83	0. 4253	0. RCFLAGS	0
1	50	0. 5540	0. 00	0. 0000	0. RCFLAGS	0
1	150	0. 3990	16. 51	0. 1859	0. RCFLAGS	0
1	245	0. 9530	6. 91	0. 1859	0. RCFLAGS	0
1	250	4. 4980	3. 88	0. 3764	0. RCFLAGS	0
1	3250	4. 4980	3. 49	0. 3388	0. RCFLAGS	0
1	4250	7. 8350	3. 98	0. 4615	0. RCFLAGS	0
1	101	1. 4200	7. 56	0. 1387	12. RCFLAGS	0
1	3101	1. 4200	0. 00	0. 0000	0. RCFLAGS	0
1	4101	9. 2550	4. 53	0. 5936	0. RCFLAGS	0
1	102	0. 1400	65. 45	0. 7214	0. RCFLAGS	0
1	202	1. 5600	5. 87	0. 7214	0. RCFLAGS	0
1	103	0. 4620	56. 41	2. 1189	0. RCFLAGS	0
1	203	2. 0220	17. 42	2. 8403	0. RCFLAGS	0
1	3203	2. 0220	17. 31	2. 8395	0. RCFLAGS	0
1	4203	11. 2770	3. 74	0. 5944	0. RCFLAGS	0
1	105	0. 6830	3. 06	0. 0153	0. RCFLAGS	0
1	205	2. 7050	13. 71	2. 8501	0. RCFLAGS	0
1	106	0. 1870	23. 43	0. 0779	0. RCFLAGS	0
1	206	2. 8920	14. 34	2. 8737	0. RCFLAGS	0
1	107	0. 1880	33. 20	0. 1138	0. RCFLAGS	0
1	207	3. 0800	15. 49	2. 9073	0. RCFLAGS	0
1	505	3. 0800	5. 94	0. 1564	70000. RCFLAGS	0
1	110	0. 3330	20. 87	0. 1231	0. RCFLAGS	0
1	210	3. 4130	7. 40	0. 2771	0. RCFLAGS	0
1	510	3. 4130	7. 37	0. 2766	165. RCFLAGS	0
1	10	3. 4130	7. 22	0. 2746	0. RCFLAGS	0
1	115	0. 1250	37. 54	0. 1167	0. RCFLAGS	0
1	215	3. 5380	8. 30	0. 3710	0. RCFLAGS	0
1	415	11. 2770	1. 87	0. 2972	0. RCFLAGS	0
1	1215	3. 5380	14. 26	0. 6652	0. RCFLAGS	0
1	20	3. 5380	13. 69	0. 6434	0. RCFLAGS	0
				return1.dat		
				scene1.wat		
1	120	0. 4210	14. 51	0. 0970	0. RCFLAGS	0
1	220	3. 9590	13. 78	0. 7262	0. RCFLAGS	0
1	420	11. 2770	1. 87	0. 2972	0. RCFLAGS	0
1	1220	3. 9590	19. 10	1. 0108	0. RCFLAGS	0
1	520	3. 9590	19. 08	1. 0097	378. RCFLAGS	0
1	24	3. 9590	18. 95	1. 0086	0. RCFLAGS	0
1	524	3. 9590	18. 93	1. 0086	145. RCFLAGS	0
1	124	0. 1820	23. 36	0. 1208	0. RCFLAGS	0
1	224	4. 1410	19. 12	1. 0819	0. RCFLAGS	0
1	126	0. 0990	6. 15	0. 0321	0. RCFLAGS	0
1	226	4. 2400	18. 82	1. 0911	0. RCFLAGS	0
1	26	4. 2400	17. 82	0. 9756	0. RCFLAGS	0
1	251	8. 7380	10. 44	1. 1815	0. RCFLAGS	0
1	160	0. 3150	26. 08	0. 1229	0. RCFLAGS	0

I 21-15_GAWSER_summary_TCSS.txt						
1	3160	0. 3150	0. 00	0. 0000	0. RCFLAGS	0
1	4160	11. 5920	0. 71	0. 1229	0. RCFLAGS	0
1	60	0. 3150	0. 00	0. 0000	0. RCFLAGS	0
1	162	0. 3930	16. 90	0. 2278	0. RCFLAGS	0
1	260	0. 7080	9. 38	0. 2278	0. RCFLAGS	0
1	262	9. 4460	10. 36	1. 2655	0. RCFLAGS	0
1	65	9. 4460	10. 06	1. 2592	0. RCFLAGS	0
1	165	0. 2390	5. 54	0. 0320	0. RCFLAGS	0
1	265	9. 6850	9. 95	1. 2747	0. RCFLAGS	0
1	3265	9. 6850	7. 46	0. 9560	0. RCFLAGS	0
1	4265	21. 2770	1. 52	0. 4181	0. RCFLAGS	0
1	170	0. 4530	13. 52	0. 0986	0. RCFLAGS	0
1	570	0. 4530	12. 02	0. 0565	1440. RCFLAGS	0
1	75	0. 4530	11. 61	0. 0565	0. RCFLAGS	0
1	175	0. 2570	20. 64	0. 1725	0. RCFLAGS	0
1	275	0. 7100	14. 88	0. 1972	0. RCFLAGS	0
1	277	10. 3950	7. 97	1. 0631	0. RCFLAGS	0
1	477	21. 2770	1. 52	0. 4181	0. RCFLAGS	0
1	1277	10. 3950	11. 08	1. 4811	0. RCFLAGS	0
1	3277	10. 3950	7. 52	1. 1811	0. RCFLAGS	0
1	78	10. 3950	1. 50	0. 2174	0. RCFLAGS	0
1	79	10. 3950	7. 40	1. 1801	0. RCFLAGS	0
1	279	10. 3950	8. 90	1. 2847	0. RCFLAGS	0
1	180	0. 4700	17. 90	0. 1398	12. RCFLAGS	0
1	278	10. 8650	9. 29	1. 3668	0. RCFLAGS	0
1	580	10. 8650	9. 17	1. 3634	3350. RCFLAGS	0
1	3580	10. 8650	8. 63	1. 3384	0. RCFLAGS	0
1	80	10. 8650	8. 51	1. 3380	0. RCFLAGS	0
2	130	0. 5030	23. 12	0. 1944	0. RCFLAGS	0
				return1.dat		
				scene1.wat		
2	3130	0. 5030	0. 00	0. 0000	0. RCFLAGS	0
2	30	0. 5030	0. 00	0. 0000	0. RCFLAGS	0
2	132	0. 1730	23. 13	0. 1214	0. RCFLAGS	0
2	232	0. 6760	5. 92	0. 1214	0. RCFLAGS	0
2	135	2. 2800	12. 20	0. 3793	27. RCFLAGS	0
2	3135	2. 2800	0. 00	0. 0000	0. RCFLAGS	0
2	4135	2. 7830	14. 17	0. 5696	0. RCFLAGS	0
2	35	2. 2800	0. 00	0. 0000	0. RCFLAGS	0
2	140	0. 5890	26. 31	0. 2834	0. RCFLAGS	0
2	235	2. 8690	5. 40	0. 2834	0. RCFLAGS	0
2	240	3. 5450	5. 50	0. 4003	0. RCFLAGS	0
2	40	3. 5450	5. 44	0. 3927	0. RCFLAGS	0
2	145	0. 5540	22. 15	0. 1825	0. RCFLAGS	0
2	3145	0. 5540	0. 00	0. 0000	0. RCFLAGS	0
2	4145	3. 3370	15. 50	0. 7520	0. RCFLAGS	0
2	50	0. 5540	0. 00	0. 0000	0. RCFLAGS	0
2	150	0. 3990	30. 97	0. 3234	0. RCFLAGS	0
2	245	0. 9530	12. 97	0. 3234	0. RCFLAGS	0
2	250	4. 4980	7. 04	0. 6775	0. RCFLAGS	0
2	3250	4. 4980	6. 33	0. 6097	0. RCFLAGS	0
2	4250	7. 8350	7. 00	0. 8179	0. RCFLAGS	0
2	101	1. 4200	12. 19	0. 2241	20. RCFLAGS	0
2	3101	1. 4200	0. 00	0. 0000	0. RCFLAGS	0
2	4101	9. 2550	7. 80	1. 0342	0. RCFLAGS	0
2	102	0. 1400	86. 01	0. 8904	0. RCFLAGS	0
2	202	1. 5600	7. 72	0. 8904	0. RCFLAGS	0
2	103	0. 4620	74. 82	2. 6353	0. RCFLAGS	0
2	203	2. 0220	23. 05	3. 5257	0. RCFLAGS	0
2	3203	2. 0220	22. 94	3. 5249	0. RCFLAGS	0
2	4203	11. 2770	6. 42	1. 0350	0. RCFLAGS	0
2	105	0. 6830	3. 30	0. 0176	0. RCFLAGS	0
2	205	2. 7050	17. 98	3. 5369	0. RCFLAGS	0
2	106	0. 1870	36. 50	0. 1200	0. RCFLAGS	0

I 21-15_GAWSER_summary_TCSS.txt								
2	206	2. 8920	19. 18	3. 5730	0.	RCFLAGS	0	0
2	107	0. 1880	48. 44	0. 1627	0.	RCFLAGS	0	0
2	207	3. 0800	20. 97	3. 6356	0.	RCFLAGS	0	0
2	505	3. 0800	7. 94	0. 2102	81800.	RCFLAGS	0	0
2	110	0. 3330	32. 61	0. 1915	0.	RCFLAGS	0	0
2	210	3. 4130	10. 35	0. 3972	0.	RCFLAGS	0	0
2	510	3. 4130	10. 31	0. 3814	557.	RCFLAGS	0	0
2	10	3. 4130	10. 13	0. 3811	0.	RCFLAGS	0	0
2	115	0. 1250	53. 25	0. 1607	0.	RCFLAGS	0	0
2	215	3. 5380	11. 66	0. 4955	0.	RCFLAGS	0	0
2	415	11. 2770	3. 21	0. 5175	0.	RCFLAGS	0	0
2	1215	3. 5380	21. 89	1. 0130	0.	RCFLAGS	0	0
2	20	3. 5380	21. 14	0. 9962	0.	RCFLAGS	0	0
						return1.dat		
						scene1.wat		
2	120	0. 4210	23. 12	0. 1554	0.	RCFLAGS	0	0
2	220	3. 9590	21. 35	1. 1289	0.	RCFLAGS	0	0
2	420	11. 2770	3. 21	0. 5175	0.	RCFLAGS	0	0
2	1220	3. 9590	30. 49	1. 6251	0.	RCFLAGS	0	0
2	520	3. 9590	30. 45	1. 6216	950.	RCFLAGS	0	0
2	24	3. 9590	30. 23	1. 6200	0.	RCFLAGS	0	0
2	524	3. 9590	30. 20	1. 6200	199.	RCFLAGS	0	0
2	124	0. 1820	35. 46	0. 1782	0.	RCFLAGS	0	0
2	224	4. 1410	30. 43	1. 7275	0.	RCFLAGS	0	0
2	126	0. 0990	10. 94	0. 0562	0.	RCFLAGS	0	0
2	226	4. 2400	29. 97	1. 7442	0.	RCFLAGS	0	0
2	26	4. 2400	28. 56	1. 5939	0.	RCFLAGS	0	0
2	251	8. 7380	17. 12	1. 9813	0.	RCFLAGS	0	0
2	160	0. 3150	38. 16	0. 1779	0.	RCFLAGS	0	0
2	3160	0. 3150	0. 00	0. 0000	0.	RCFLAGS	0	0
2	4160	11. 5920	1. 04	0. 1779	0.	RCFLAGS	0	0
2	60	0. 3150	0. 00	0. 0000	0.	RCFLAGS	0	0
2	162	0. 3930	27. 61	0. 3619	0.	RCFLAGS	0	0
2	260	0. 7080	15. 32	0. 3619	0.	RCFLAGS	0	0
2	262	9. 4460	16. 98	2. 1267	0.	RCFLAGS	0	0
2	65	9. 4460	16. 55	2. 1163	0.	RCFLAGS	0	0
2	165	0. 2390	9. 54	0. 0550	0.	RCFLAGS	0	0
2	265	9. 6850	16. 38	2. 1451	0.	RCFLAGS	0	0
2	3265	9. 6850	12. 28	1. 6088	0.	RCFLAGS	0	0
2	4265	21. 2770	2. 43	0. 6828	0.	RCFLAGS	0	0
2	170	0. 4530	20. 02	0. 1471	0.	RCFLAGS	0	0
2	570	0. 4530	16. 77	0. 0808	2490.	RCFLAGS	0	0
2	75	0. 4530	16. 17	0. 0808	0.	RCFLAGS	0	0
2	175	0. 2570	33. 31	0. 2530	0.	RCFLAGS	0	0
2	275	0. 7100	22. 37	0. 2812	0.	RCFLAGS	0	0
2	277	10. 3950	12. 97	1. 7662	0.	RCFLAGS	0	0
2	477	21. 2770	2. 43	0. 6828	0.	RCFLAGS	0	0
2	1277	10. 3950	17. 94	2. 4489	0.	RCFLAGS	0	0
2	3277	10. 3950	14. 09	2. 1489	0.	RCFLAGS	0	0
2	78	10. 3950	1. 62	0. 2228	0.	RCFLAGS	0	0
2	79	10. 3950	13. 90	2. 1481	0.	RCFLAGS	0	0
2	279	10. 3950	15. 52	2. 2595	0.	RCFLAGS	0	0
2	180	0. 4700	24. 57	0. 1932	17.	RCFLAGS	0	0
2	278	10. 8650	15. 91	2. 3798	0.	RCFLAGS	0	0
2	580	10. 8650	15. 73	2. 3732	5120.	RCFLAGS	0	0
2	3580	10. 8650	15. 18	2. 3482	0.	RCFLAGS	0	0
2	80	10. 8650	15. 01	2. 3478	0.	RCFLAGS	0	0
3	130	0. 5030	33. 79	0. 2832	0.	RCFLAGS	0	0
						return1.dat		
						scene1.wat		
3	3130	0. 5030	0. 00	0. 0000	0.	RCFLAGS	0	0
3	30	0. 5030	0. 00	0. 0000	0.	RCFLAGS	0	0
3	132	0. 1730	34. 74	0. 1806	0.	RCFLAGS	0	0
3	232	0. 6760	8. 89	0. 1806	0.	RCFLAGS	0	0
3	135	2. 2800	17. 46	0. 5439	37.	RCFLAGS	0	0

I 21-15_GAWSER_summary_TCSS.txt								
3	3135	2. 2800	0. 00	0. 0000	0.	RCFLAGS	0	0
3	4135	2. 7830	20. 41	0. 8214	0.	RCFLAGS	0	0
3	35	2. 2800	0. 00	0. 0000	0.	RCFLAGS	0	0
3	140	0. 5890	39. 95	0. 4104	0.	RCFLAGS	0	0
3	235	2. 8690	8. 20	0. 4104	0.	RCFLAGS	0	0
3	240	3. 5450	8. 33	0. 5841	0.	RCFLAGS	0	0
3	40	3. 5450	8. 25	0. 5742	0.	RCFLAGS	0	0
3	145	0. 5540	31. 58	0. 2596	0.	RCFLAGS	0	0
3	3145	0. 5540	0. 00	0. 0000	0.	RCFLAGS	0	0
3	4145	3. 3370	22. 26	1. 0809	0.	RCFLAGS	0	0
3	50	0. 5540	0. 00	0. 0000	0.	RCFLAGS	0	0
3	150	0. 3990	43. 88	0. 4634	0.	RCFLAGS	0	0
3	245	0. 9530	18. 37	0. 4634	0.	RCFLAGS	0	0
3	250	4. 4980	10. 40	0. 9856	0.	RCFLAGS	0	0
3	3250	4. 4980	9. 36	0. 8871	0.	RCFLAGS	0	0
3	4250	7. 8350	10. 08	1. 1767	0.	RCFLAGS	0	0
3	101	1. 4200	16. 58	0. 3044	27.	RCFLAGS	0	0
3	3101	1. 4200	0. 00	0. 0000	0.	RCFLAGS	0	0
3	4101	9. 2550	11. 08	1. 4699	0.	RCFLAGS	0	0
3	102	0. 1400	103. 05	1. 0298	0.	RCFLAGS	0	0
3	202	1. 5600	9. 25	1. 0298	0.	RCFLAGS	0	0
3	103	0. 4620	90. 65	3. 0796	0.	RCFLAGS	0	0
3	203	2. 0220	27. 85	4. 1094	0.	RCFLAGS	0	0
3	3203	2. 0220	27. 74	4. 1086	0.	RCFLAGS	0	0
3	4203	11. 2770	9. 11	1. 4707	0.	RCFLAGS	0	0
3	105	0. 6830	3. 51	0. 0196	0.	RCFLAGS	0	0
3	205	2. 7050	21. 62	4. 1217	0.	RCFLAGS	0	0
3	106	0. 1870	48. 56	0. 1595	0.	RCFLAGS	0	0
3	206	2. 8920	23. 36	4. 1716	0.	RCFLAGS	0	0
3	107	0. 1880	61. 20	0. 2031	0.	RCFLAGS	0	0
3	207	3. 0800	25. 67	4. 2582	0.	RCFLAGS	0	0
3	505	3. 0800	9. 66	0. 2564	92000.	RCFLAGS	0	0
3	110	0. 3330	43. 75	0. 2568	0.	RCFLAGS	0	0
3	210	3. 4130	12. 99	0. 5063	0.	RCFLAGS	0	0
3	510	3. 4130	12. 94	0. 4989	873.	RCFLAGS	0	0
3	10	3. 4130	12. 72	0. 4961	0.	RCFLAGS	0	0
3	115	0. 1250	67. 95	0. 2043	0.	RCFLAGS	0	0
3	215	3. 5380	14. 67	0. 6502	0.	RCFLAGS	0	0
3	415	11. 2770	4. 55	0. 7354	0.	RCFLAGS	0	0
3	1215	3. 5380	29. 19	1. 3855	0.	RCFLAGS	0	0
3	20	3. 5380	28. 30	1. 3613	0.	RCFLAGS	0	0
						return1.dat		
						scene1.wat		
3	120	0. 4210	32. 02	0. 2151	0.	RCFLAGS	0	0
3	220	3. 9590	28. 69	1. 5475	0.	RCFLAGS	0	0
3	420	11. 2770	4. 55	0. 7354	0.	RCFLAGS	0	0
3	1220	3. 9590	41. 67	2. 2576	0.	RCFLAGS	0	0
3	24	3. 9590	41. 28	2. 2428	1800.	RCFLAGS	0	0
3	524	3. 9590	41. 24	2. 2421	261.	RCFLAGS	0	10
3	124	0. 1820	46. 63	0. 2317	0.	RCFLAGS	0	0
3	224	4. 1410	41. 48	2. 3827	0.	RCFLAGS	0	0
3	126	0. 0990	16. 02	0. 0819	0.	RCFLAGS	0	0
3	226	4. 2400	40. 89	2. 4066	0.	RCFLAGS	0	0
3	26	4. 2400	39. 23	2. 2292	0.	RCFLAGS	0	0
3	251	8. 7380	23. 85	2. 8152	0.	RCFLAGS	0	0
3	160	0. 3150	48. 79	0. 2259	0.	RCFLAGS	0	0
3	3160	0. 3150	0. 00	0. 0000	0.	RCFLAGS	0	0
3	4160	11. 5920	1. 33	0. 2259	0.	RCFLAGS	0	0
3	60	0. 3150	0. 00	0. 0000	0.	RCFLAGS	0	0
3	162	0. 3930	37. 85	0. 4916	0.	RCFLAGS	0	0
3	260	0. 7080	21. 01	0. 4916	0.	RCFLAGS	0	0
3	262	9. 4460	23. 64	3. 0248	0.	RCFLAGS	0	0
3	65	9. 4460	23. 18	3. 0134	0.	RCFLAGS	0	0

I 21-15_GAWSER_summary_TCSS.txt								
3	165	0. 2390	13. 56	0. 0786	0. RCFLAGS	0	0	
3	265	9. 6850	22. 94	3. 0572	0. RCFLAGS	0	0	
3	3265	9. 6850	17. 21	2. 2929	0. RCFLAGS	0	0	
3	4265	21. 2770	3. 33	0. 9550	0. RCFLAGS	0	0	
3	170	0. 4530	26. 72	0. 1974	0. RCFLAGS	0	0	
3	570	0. 4530	21. 67	0. 1063	3600. RCFLAGS	0	0	
3	75	0. 4530	20. 87	0. 1063	0. RCFLAGS	0	0	
3	175	0. 2570	44. 36	0. 3406	0. RCFLAGS	0	0	
3	275	0. 7100	29. 38	0. 3720	0. RCFLAGS	0	0	
3	277	10. 3950	18. 04	2. 5094	0. RCFLAGS	0	0	
3	477	21. 2770	3. 33	0. 9550	0. RCFLAGS	0	0	
3	1277	10. 3950	24. 86	3. 4641	0. RCFLAGS	0	0	
3	3277	10. 3950	20. 76	3. 1641	0. RCFLAGS	0	0	
3	78	10. 3950	1. 72	0. 2270	0. RCFLAGS	0	0	
3	79	10. 3950	20. 49	3. 1629	0. RCFLAGS	0	0	
3	279	10. 3950	22. 20	3. 2798	0. RCFLAGS	0	0	
3	180	0. 4700	30. 69	0. 2425	21. RCFLAGS	0	0	
3	278	10. 8650	22. 57	3. 4379	0. RCFLAGS	0	0	
3	580	10. 8650	22. 33	3. 4263	7040. RCFLAGS	0	0	
3	3580	10. 8650	21. 78	3. 4013	0. RCFLAGS	0	0	
3	80	10. 8650	21. 59	3. 4006	0. RCFLAGS	0	0	
4	130	0. 5030	40. 13	0. 3345	0. RCFLAGS	0	0	return1.dat
				scene1.wat				
4	3130	0. 5030	0. 00	0. 0000	0. RCFLAGS	0	0	
4	30	0. 5030	0. 00	0. 0000	0. RCFLAGS	0	0	
4	132	0. 1730	41. 57	0. 2136	0. RCFLAGS	0	0	
4	232	0. 6760	10. 64	0. 2136	0. RCFLAGS	0	0	
4	135	2. 2800	20. 55	0. 6390	44. RCFLAGS	0	0	
4	3135	2. 2800	0. 00	0. 0000	0. RCFLAGS	0	0	
4	4135	2. 7830	24. 09	0. 9667	0. RCFLAGS	0	0	
4	35	2. 2800	0. 00	0. 0000	0. RCFLAGS	0	0	
4	140	0. 5890	46. 83	0. 4810	0. RCFLAGS	0	0	
4	235	2. 8690	9. 61	0. 4810	0. RCFLAGS	0	0	
4	240	3. 5450	9. 81	0. 6863	0. RCFLAGS	0	0	
4	40	3. 5450	9. 74	0. 6806	0. RCFLAGS	0	0	
4	145	0. 55540	37. 17	0. 3042	0. RCFLAGS	0	0	
4	3145	0. 55540	0. 00	0. 0000	0. RCFLAGS	0	0	
4	4145	3. 3370	26. 26	1. 2708	0. RCFLAGS	0	0	
4	50	0. 55540	0. 00	0. 0000	0. RCFLAGS	0	0	
4	150	0. 3990	51. 50	0. 5418	0. RCFLAGS	0	0	
4	245	0. 9530	21. 56	0. 5418	0. RCFLAGS	0	0	
4	250	4. 4980	12. 25	1. 1829	0. RCFLAGS	0	0	
4	3250	4. 4980	11. 02	1. 0646	0. RCFLAGS	0	0	
4	4250	7. 8350	11. 89	1. 3829	0. RCFLAGS	0	0	
4	101	1. 4200	19. 14	0. 3505	31. RCFLAGS	0	0	
4	3101	1. 4200	0. 00	0. 0000	0. RCFLAGS	0	0	
4	4101	9. 2550	13. 00	1. 7198	0. RCFLAGS	0	0	
4	102	0. 1400	112. 75	1. 1085	0. RCFLAGS	0	0	
4	202	1. 5600	10. 12	1. 1085	0. RCFLAGS	0	0	
4	103	0. 4620	99. 62	3. 3790	0. RCFLAGS	0	0	
4	203	2. 0220	30. 57	4. 4875	0. RCFLAGS	0	0	
4	3203	2. 0220	30. 46	4. 4867	0. RCFLAGS	0	0	
4	4203	11. 2770	10. 69	1. 7206	0. RCFLAGS	0	0	
4	105	0. 6830	3. 62	0. 0206	0. RCFLAGS	0	0	
4	205	2. 7050	23. 68	4. 5004	0. RCFLAGS	0	0	
4	106	0. 1870	55. 60	0. 1820	0. RCFLAGS	0	0	
4	206	2. 8920	25. 75	4. 5616	0. RCFLAGS	0	0	
4	107	0. 1880	68. 49	0. 2259	0. RCFLAGS	0	0	
4	207	3. 0800	28. 36	4. 6621	0. RCFLAGS	0	0	
4	505	3. 0800	10. 65	0. 2828	97800. RCFLAGS	0	0	
4	110	0. 3330	50. 26	0. 2940	0. RCFLAGS	0	0	
4	210	3. 4130	14. 51	0. 5685	0. RCFLAGS	0	0	
4	510	3. 4130	14. 44	0. 5636	961. RCFLAGS	0	0	

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4	10	3. 4130	14. 21	0. 5613	0. RCFLAGS	0	0	
4	115	0. 1250	76. 41	0. 2287	0. RCFLAGS	0	0	
4	215	3. 5380	16. 41	0. 7415	0. RCFLAGS	0	0	
4	415	11. 2770	5. 34	0. 8603	0. RCFLAGS	0	0	
4	1215	3. 5380	33. 45	1. 6011	0. RCFLAGS	0	0	
4	20	3. 5380	32. 42	1. 5706	0. RCFLAGS	0	0	return1.dat
		scene1.wat						
4	120	0. 4210	37. 11	0. 2487	0. RCFLAGS	0	0	
4	220	3. 9590	32. 92	1. 7875	0. RCFLAGS	0	0	
4	420	11. 2770	5. 34	0. 8603	0. RCFLAGS	0	0	
4	1220	3. 9590	48. 14	2. 6220	0. RCFLAGS	0	0	
4	520	3. 9590	48. 03	2. 5996	2420. RCFLAGS	0	0	
4	24	3. 9590	47. 68	2. 5964	289. RCFLAGS	0	0	
4	124	0. 1820	53. 07	0. 2615	0. RCFLAGS	0	0	
4	224	4. 1410	47. 88	2. 7542	0. RCFLAGS	0	0	
4	126	0. 0990	18. 98	0. 0956	0. RCFLAGS	0	0	
4	226	4. 2400	47. 21	2. 7821	0. RCFLAGS	0	0	
4	26	4. 2400	45. 39	2. 5940	0. RCFLAGS	0	0	
4	251	8. 7380	27. 70	3. 2767	0. RCFLAGS	0	0	
4	160	0. 3150	55. 16	0. 2540	0. RCFLAGS	0	0	
4	3160	0. 3150	0. 00	0. 0000	0. RCFLAGS	0	0	
4	4160	11. 5920	1. 50	0. 2540	0. RCFLAGS	0	0	
4	60	0. 3150	0. 00	0. 0000	0. RCFLAGS	0	0	
4	162	0. 3930	43. 85	0. 5637	0. RCFLAGS	0	0	
4	260	0. 7080	24. 34	0. 5637	0. RCFLAGS	0	0	
4	262	9. 4460	27. 45	3. 5199	0. RCFLAGS	0	0	
4	65	9. 4460	26. 93	3. 5066	0. RCFLAGS	0	0	
4	165	0. 2390	15. 93	0. 0919	0. RCFLAGS	0	0	
4	265	9. 6850	26. 66	3. 5583	0. RCFLAGS	0	0	
4	3265	9. 6850	19. 99	2. 6688	0. RCFLAGS	0	0	
4	4265	21. 2770	3. 85	1. 1049	0. RCFLAGS	0	0	
4	170	0. 4530	30. 56	0. 2258	4240. RCFLAGS	0	0	
4	570	0. 4530	24. 50	0. 1209	0. RCFLAGS	0	0	
4	75	0. 4530	23. 91	0. 1209	0. RCFLAGS	0	0	
4	175	0. 2570	50. 62	0. 3886	0. RCFLAGS	0	0	
4	275	0. 7100	33. 57	0. 4266	0. RCFLAGS	0	0	
4	277	10. 3950	20. 92	2. 9196	0. RCFLAGS	0	0	
4	477	21. 2770	3. 85	1. 1049	0. RCFLAGS	0	0	
4	1277	10. 3950	28. 80	4. 0243	0. RCFLAGS	0	0	
4	3277	10. 3950	24. 63	3. 7243	0. RCFLAGS	0	0	
4	78	10. 3950	1. 74	0. 2282	0. RCFLAGS	0	0	
4	79	10. 3950	24. 36	3. 7235	0. RCFLAGS	0	0	
4	279	10. 3950	26. 11	3. 8414	0. RCFLAGS	0	0	
4	180	0. 4700	34. 15	0. 2702	23. RCFLAGS	0	0	
4	278	10. 8650	26. 46	4. 0209	0. RCFLAGS	0	0	
4	580	10. 8650	26. 18	4. 0069	8140. RCFLAGS	0	0	
4	3580	10. 8650	25. 64	3. 9819	0. RCFLAGS	0	0	
4	80	10. 8650	25. 42	3. 9810	0. RCFLAGS	0	0	
5	130	0. 5030	51. 02	0. 4192	0. RCFLAGS	0	0	return1.dat
		scene1.wat						
5	3130	0. 5030	0. 00	0. 0000	0. RCFLAGS	0	0	
5	30	0. 5030	0. 00	0. 0000	0. RCFLAGS	0	0	
5	132	0. 1730	54. 04	0. 2707	0. RCFLAGS	0	0	
5	232	0. 6760	13. 83	0. 2707	0. RCFLAGS	0	0	
5	135	2. 2800	26. 04	0. 8038	55. RCFLAGS	0	0	
5	3135	2. 2800	0. 00	0. 0000	0. RCFLAGS	0	0	
5	4135	2. 7830	30. 56	1. 2145	0. RCFLAGS	0	0	
5	35	2. 2800	0. 00	0. 0000	0. RCFLAGS	0	0	
5	140	0. 5890	58. 74	0. 5987	0. RCFLAGS	0	0	
5	235	2. 8690	12. 06	0. 5987	0. RCFLAGS	0	0	
5	240	3. 5450	12. 40	0. 8587	0. RCFLAGS	0	0	
5	40	3. 5450	12. 31	0. 8524	0. RCFLAGS	0	0	

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5 145	0. 5540	46. 76	0. 3785	0. RCFLAGS	0	0
5 3145	0. 5540	0. 00	0. 0000	0. RCFLAGS	0	0
5 4145	3. 3370	33. 25	1. 5930	0. RCFLAGS	0	0
5 50	0. 5540	0. 00	0. 0000	0. RCFLAGS	0	0
5 150	0. 3990	64. 83	0. 6712	0. RCFLAGS	0	0
5 245	0. 9530	27. 14	0. 6712	0. RCFLAGS	0	0
5 250	4. 4980	15. 46	1. 4760	0. RCFLAGS	0	0
5 3250	4. 4980	13. 91	1. 3284	0. RCFLAGS	0	0
5 4250	7. 8350	15. 05	1. 7325	0. RCFLAGS	0	0
5 101	1. 4200	23. 72	0. 4320	38. RCFLAGS	0	0
5 3101	1. 4200	0. 00	0. 0000	0. RCFLAGS	0	0
5 4101	9. 2550	16. 38	2. 1480	0. RCFLAGS	0	0
5 102	0. 1400	129. 02	1. 2400	0. RCFLAGS	0	0
5 202	1. 5600	11. 58	1. 2400	0. RCFLAGS	0	0
5 103	0. 4620	114. 87	3. 8659	0. RCFLAGS	0	0
5 203	2. 0220	35. 18	5. 1059	0. RCFLAGS	0	0
5 3203	2. 0220	35. 07	5. 1051	0. RCFLAGS	0	0
5 4203	11. 2770	13. 46	2. 1488	0. RCFLAGS	0	0
5 105	0. 6830	3. 82	0. 0225	0. RCFLAGS	0	0
5 205	2. 7050	27. 18	5. 1199	0. RCFLAGS	0	0
5 106	0. 1870	67. 63	0. 2192	0. RCFLAGS	0	0
5 206	2. 8920	29. 80	5. 2037	0. RCFLAGS	0	0
5 107	0. 1880	80. 75	0. 2639	0. RCFLAGS	0	0
5 207	3. 0800	32. 91	5. 3274	0. RCFLAGS	0	0
5 505	3. 0800	12. 32	0. 3278	108000. RCFLAGS	0	0
5 110	0. 3330	61. 72	0. 3578	0. RCFLAGS	0	0
5 210	3. 4130	17. 14	0. 6750	0. RCFLAGS	0	0
5 510	3. 4130	16. 99	0. 6708	1110. RCFLAGS	0	0
5 10	3. 4130	16. 74	0. 6689	0. RCFLAGS	0	0
5 115	0. 1250	91. 15	0. 2702	0. RCFLAGS	0	0
5 215	3. 5380	19. 37	0. 8877	0. RCFLAGS	0	0
5 415	11. 2770	6. 73	1. 0744	0. RCFLAGS	0	0
5 1215	3. 5380	40. 82	1. 9586	0. RCFLAGS	0	0
5 20	3. 5380	39. 69	1. 9288	0. RCFLAGS	0	0 return1.dat
			scene1.wat			
5 120	0. 4210	46. 07	0. 3067	0. RCFLAGS	0	0
5 220	3. 9590	40. 36	2. 1995	0. RCFLAGS	0	0
5 420	11. 2770	6. 73	1. 0744	0. RCFLAGS	0	0
5 1220	3. 9590	59. 54	3. 2496	0. RCFLAGS	0	0
5 520	3. 9590	59. 36	3. 2074	3670. RCFLAGS	0	0
5 24	3. 9590	58. 96	3. 2040	0. RCFLAGS	0	0
5 524	3. 9590	58. 92	3. 2039	313. RCFLAGS	0	0
5 124	0. 1820	65. 37	0. 3186	0. RCFLAGS	0	0
5 224	4. 1410	59. 20	3. 3982	0. RCFLAGS	0	0
5 126	0. 0990	27. 98	0. 1428	0. RCFLAGS	0	0
5 226	4. 2400	58. 47	3. 4401	0. RCFLAGS	0	0
5 26	4. 2400	56. 67	3. 2708	0. RCFLAGS	0	0
5 251	8. 7380	34. 66	4. 1628	0. RCFLAGS	0	0
5 160	0. 3150	65. 64	0. 2999	0. RCFLAGS	0	0
5 3160	0. 3150	0. 00	0. 0000	0. RCFLAGS	0	0
5 4160	11. 5920	1. 78	0. 2999	0. RCFLAGS	0	0
5 60	0. 3150	0. 00	0. 0000	0. RCFLAGS	0	0
5 162	0. 3930	55. 73	0. 7054	0. RCFLAGS	0	0
5 260	0. 7080	30. 94	0. 7054	0. RCFLAGS	0	0
5 262	9. 4460	34. 38	4. 4906	0. RCFLAGS	0	0
5 65	9. 4460	33. 81	4. 4736	0. RCFLAGS	0	0
5 165	0. 2390	24. 08	0. 1419	0. RCFLAGS	0	0
5 265	9. 6850	33. 57	4. 5569	0. RCFLAGS	0	0
5 3265	9. 6850	25. 18	3. 4177	0. RCFLAGS	0	0
5 4265	21. 2770	4. 79	1. 3994	0. RCFLAGS	0	0
5 170	0. 4530	38. 29	0. 2833	0. RCFLAGS	0	0
5 570	0. 4530	30. 16	0. 1503	5520. RCFLAGS	0	0
5 75	0. 4530	29. 42	0. 1503	0. RCFLAGS	0	0

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5 175	0. 2570	62. 64	0. 4825	0. RCFLAGS	0	0
5 275	0. 7100	41. 45	0. 5268	0. RCFLAGS	0	0
5 277	10. 3950	26. 29	3. 7418	0. RCFLAGS	0	0
5 477	21. 2770	4. 79	1. 3994	0. RCFLAGS	0	0
5 1277	10. 3950	36. 10	5. 1412	0. RCFLAGS	0	0
5 3277	10. 3950	31. 80	4. 8412	0. RCFLAGS	0	0
5 79	10. 3950	31. 46	4. 8399	0. RCFLAGS	0	0
5 279	10. 3950	33. 26	4. 9581	0. RCFLAGS	0	0
5 180	0. 4700	40. 90	0. 3258	28. RCFLAGS	0	0
5 278	10. 8650	33. 59	5. 1836	0. RCFLAGS	0	0
5 580	10. 8650	33. 26	5. 1626	10400. RCFLAGS	0	0
5 3580	10. 8650	32. 71	5. 1376	0. RCFLAGS	0	0
6 130	0. 5030	56. 06	0. 4579	0. RCFLAGS	0	0 return1.dat
		scene1.wat				
6 3130	0. 5030	0. 00	0. 0000	0. RCFLAGS	0	0
6 30	0. 5030	0. 00	0. 0000	0. RCFLAGS	0	0
6 132	0. 1730	59. 85	0. 2966	0. RCFLAGS	0	0
6 232	0. 6760	15. 32	0. 2966	0. RCFLAGS	0	0
6 135	2. 2800	28. 60	0. 8800	60. RCFLAGS	0	0
6 3135	2. 2800	0. 00	0. 0000	0. RCFLAGS	0	0
6 4135	2. 7830	33. 56	1. 3285	0. RCFLAGS	0	0
6 35	2. 2800	0. 00	0. 0000	0. RCFLAGS	0	0
6 140	0. 5890	64. 26	0. 6524	0. RCFLAGS	0	0
6 235	2. 8690	13. 19	0. 6524	0. RCFLAGS	0	0
6 240	3. 5450	13. 60	0. 9374	0. RCFLAGS	0	0
6 40	3. 5450	13. 51	0. 9307	0. RCFLAGS	0	0
6 145	0. 5540	51. 22	0. 4126	0. RCFLAGS	0	0
6 3145	0. 5540	0. 00	0. 0000	0. RCFLAGS	0	0
6 4145	3. 3370	36. 49	1. 7411	0. RCFLAGS	0	0
6 50	0. 5540	0. 00	0. 0000	0. RCFLAGS	0	0
6 150	0. 3990	71. 00	0. 7296	0. RCFLAGS	0	0
6 245	0. 9530	29. 73	0. 7296	0. RCFLAGS	0	0
6 250	4. 4980	16. 94	1. 6092	0. RCFLAGS	0	0
6 3250	4. 4980	15. 25	1. 4483	0. RCFLAGS	0	0
6 4250	7. 8350	16. 52	1. 8931	0. RCFLAGS	0	0
6 101	1. 4200	25. 84	0. 4694	44. RCFLAGS	0	10
6 3101	1. 4200	0. 00	0. 0000	0. RCFLAGS	0	0
6 4101	9. 2550	17. 95	2. 3448	0. RCFLAGS	0	0
6 102	0. 1400	136. 49	1. 2999	0. RCFLAGS	0	0
6 202	1. 5600	12. 25	1. 2999	0. RCFLAGS	0	0
6 103	0. 4620	121. 84	4. 0972	0. RCFLAGS	0	0
6 203	2. 0220	37. 29	5. 3971	0. RCFLAGS	0	0
6 3203	2. 0220	37. 18	5. 3963	0. RCFLAGS	0	0
6 4203	11. 2770	14. 75	2. 3456	0. RCFLAGS	0	0
6 105	0. 6830	3. 91	0. 0233	0. RCFLAGS	0	0
6 205	2. 7050	28. 78	5. 4115	0. RCFLAGS	0	0
6 106	0. 1870	73. 16	0. 2362	0. RCFLAGS	0	0
6 206	2. 8920	31. 65	5. 5059	0. RCFLAGS	0	0
6 107	0. 1880	86. 37	0. 2812	0. RCFLAGS	0	0
6 207	3. 0800	34. 99	5. 6402	0. RCFLAGS	0	0
6 505	3. 0800	13. 09	0. 3483	112000. RCFLAGS	0	0
6 110	0. 3330	67. 02	0. 3870	0. RCFLAGS	0	0
6 210	3. 4130	18. 35	0. 7237	0. RCFLAGS	0	0
6 510	3. 4130	18. 17	0. 7212	1170. RCFLAGS	0	0
6 115	0. 1250	97. 96	0. 2891	0. RCFLAGS	0	0
6 215	3. 5380	20. 72	0. 9562	0. RCFLAGS	0	0
6 415	11. 2770	7. 37	1. 1728	0. RCFLAGS	0	0
6 1215	3. 5380	44. 23	2. 1238	0. RCFLAGS	0	0
6 20	3. 5380	43. 01	2. 0905	0. RCFLAGS	0	0 return1.dat
		scene1.wat				

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6 120	0. 4210	50. 24	0. 3334	0. RCFLAGS	0	0
6 220	3. 9590	43. 77	2. 3857	0. RCFLAGS	0	0
6 420	11. 2770	7. 37	1. 1728	0. RCFLAGS	0	0
6 1220	3. 9590	64. 78	3. 5333	0. RCFLAGS	0	0
6 520	3. 9590	64. 58	3. 4837	4320. RCFLAGS	0	0
6 24	3. 9590	64. 14	3. 4796	0. RCFLAGS	0	0
6 524	3. 9590	64. 10	3. 4796	331. RCFLAGS	0	0
6 124	0. 1820	71. 09	0. 3446	0. RCFLAGS	0	0
6 224	4. 1410	64. 40	3. 6896	0. RCFLAGS	0	0
6 126	0. 0990	32. 26	0. 1641	0. RCFLAGS	0	0
6 226	4. 2400	63. 65	3. 7376	0. RCFLAGS	0	0
6 26	4. 2400	61. 70	3. 5531	0. RCFLAGS	0	0
6 251	8. 7380	37. 79	4. 5262	0. RCFLAGS	0	0
6 160	0. 3150	70. 47	0. 3209	0. RCFLAGS	0	0
6 3160	0. 3150	0. 00	0. 0000	0. RCFLAGS	0	0
6 4160	11. 5920	1. 91	0. 3209	0. RCFLAGS	0	0
6 60	0. 3150	0. 00	0. 0000	0. RCFLAGS	0	0
6 162	0. 3930	61. 27	0. 7697	0. RCFLAGS	0	0
6 260	0. 7080	34. 01	0. 7697	0. RCFLAGS	0	0
6 262	9. 4460	37. 51	4. 8845	0. RCFLAGS	0	0
6 65	9. 4460	36. 94	4. 8688	0. RCFLAGS	0	0
6 165	0. 2390	27. 97	0. 1651	0. RCFLAGS	0	0
6 265	9. 6850	36. 72	4. 9663	0. RCFLAGS	0	0
6 3265	9. 6850	27. 54	3. 7248	0. RCFLAGS	0	0
6 4265	21. 2770	5. 22	1. 5211	0. RCFLAGS	0	0
6 170	0. 4530	41. 92	0. 3101	0. RCFLAGS	0	0
6 570	0. 4530	32. 83	0. 1642	6120. RCFLAGS	0	0
6 75	0. 4530	32. 02	0. 1642	0. RCFLAGS	0	0
6 175	0. 2570	68. 27	0. 5259	0. RCFLAGS	0	0
6 275	0. 7100	45. 14	0. 5732	0. RCFLAGS	0	0
6 277	10. 3950	28. 74	4. 0808	0. RCFLAGS	0	0
6 477	21. 2770	5. 22	1. 5211	0. RCFLAGS	0	0
6 1277	10. 3950	39. 43	5. 6017	0. RCFLAGS	0	0
6 3277	10. 3950	35. 07	5. 3017	0. RCFLAGS	0	0
6 78	10. 3950	1. 81	0. 2310	0. RCFLAGS	0	0
6 79	10. 3950	34. 71	5. 3004	0. RCFLAGS	0	0
6 279	10. 3950	36. 52	5. 4200	0. RCFLAGS	0	0
6 180	0. 4700	44. 04	0. 3515	30. RCFLAGS	0	0
6 278	10. 8650	36. 85	5. 6651	0. RCFLAGS	0	0
6 580	10. 8650	36. 49	5. 6415	11400. RCFLAGS	0	0
6 3580	10. 8650	35. 95	5. 6165	0. RCFLAGS	0	0
6 80	10. 8650	35. 70	5. 6155	0. RCFLAGS	0	0
7 130	0. 5030	116. 18	0. 9108	0. RCFLAGS	0	0
return1.dat						
Scene1.wat						
7 3130	0. 5030	25. 31	0. 4508	0. RCFLAGS	0	0
7 30	0. 5030	25. 50	0. 4473	0. RCFLAGS	0	0
7 132	0. 1730	130. 27	0. 6018	0. RCFLAGS	0	0
7 232	0. 6760	52. 31	0. 9451	0. RCFLAGS	0	0
7 135	2. 2800	60. 61	1. 8019	123. RCFLAGS	0	0
7 3135	2. 2800	17. 01	0. 9019	0. RCFLAGS	0	0
7 4135	2. 7830	52. 14	1. 3600	0. RCFLAGS	0	0
7 35	2. 2800	17. 04	0. 8997	0. RCFLAGS	0	0
7 140	0. 5890	129. 97	1. 2812	0. RCFLAGS	0	0
7 235	2. 8690	40. 22	2. 0728	0. RCFLAGS	0	0
7 240	3. 5450	42. 53	2. 9916	0. RCFLAGS	0	0
7 40	3. 5450	42. 41	2. 9877	0. RCFLAGS	0	0
7 145	0. 5540	104. 47	0. 8126	0. RCFLAGS	0	0
7 3145	0. 5540	24. 28	0. 3926	0. RCFLAGS	0	0
7 4145	3. 3370	56. 80	1. 7800	0. RCFLAGS	0	0
7 50	0. 5540	24. 74	0. 3733	0. RCFLAGS	0	0
7 150	0. 3990	144. 64	1. 4098	0. RCFLAGS	0	0
7 245	0. 9530	74. 94	1. 4519	0. RCFLAGS	0	0
7 250	4. 4980	49. 30	4. 4138	0. RCFLAGS	0	0

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7 3250	4. 4980	44. 37	3. 9724	0. RCFLAGS	0	0
7 4250	7. 8350	27. 02	2. 2214	0. RCFLAGS	0	0
7 101	1. 4200	51. 79	0. 9215	82. RCFLAGS	0	0
7 3101	1. 4200	15. 02	0. 4415	0. RCFLAGS	0	0
7 4101	9. 2550	28. 52	2. 7014	0. RCFLAGS	0	0
7 102	0. 1400	226. 57	2. 0055	0. RCFLAGS	0	0
7 202	1. 5600	34. 01	2. 0055	0. RCFLAGS	0	0
7 103	0. 4620	205. 52	6. 4698	0. RCFLAGS	0	0
7 203	2. 0220	73. 20	8. 4753	0. RCFLAGS	0	0
7 3203	2. 0220	73. 09	8. 4745	0. RCFLAGS	0	0
7 4203	11. 2770	23. 42	2. 7022	0. RCFLAGS	0	0
7 105	0. 6830	57. 59	0. 6046	0. RCFLAGS	0	0
7 205	2. 7050	69. 18	8. 5085	0. RCFLAGS	0	0
7 106	0. 1870	140. 30	0. 4361	0. RCFLAGS	0	0
7 206	2. 8920	73. 78	8. 7278	0. RCFLAGS	0	0
7 107	0. 1880	154. 74	0. 4868	0. RCFLAGS	0	0
7 207	3. 0800	78. 72	8. 9894	0. RCFLAGS	0	0
7 505	3. 0800	19. 25	0. 5048	220000. RCFLAGS	0	0
7 110	0. 3330	135. 18	0. 7376	0. RCFLAGS	0	0
7 210	3. 4130	30. 56	1. 1678	0. RCFLAGS	0	0
7 510	3. 4130	30. 25	1. 1657	1600. RCFLAGS	0	0
7 110	3. 4130	29. 85	1. 1643	0. RCFLAGS	0	0
7 115	0. 1250	180. 44	0. 5133	0. RCFLAGS	0	0
7 215	3. 5380	35. 17	1. 6062	0. RCFLAGS	0	0
7 415	11. 2770	11. 71	1. 3511	0. RCFLAGS	0	0
7 1215	3. 5380	72. 50	2. 9429	0. RCFLAGS	0	0
7 20	3. 5380	70. 49	2. 9267	0. RCFLAGS	0	0
Scene1.wat						
7 120	0. 4210	110. 46	0. 7182	0. RCFLAGS	0	0
7 220	3. 9590	74. 74	3. 5881	0. RCFLAGS	0	0
7 420	11. 2770	11. 71	1. 3511	0. RCFLAGS	0	0
7 520	3. 9590	108. 10	4. 9392	0. RCFLAGS	0	0
7 24	3. 9590	107. 38	4. 8625	8400. RCFLAGS	0	0
7 524	3. 9590	106. 56	4. 8589	0. RCFLAGS	0	0
7 124	0. 1820	142. 92	0. 6597	454. RCFLAGS	0	10
7 224	4. 1410	108. 09	5. 2831	0. RCFLAGS	0	0
7 126	0. 0990	90. 01	0. 4373	0. RCFLAGS	0	0
7 226	4. 2400	107. 67	5. 4374	0. RCFLAGS	0	0
7 26	4. 2400	104. 63	5. 3049	0. RCFLAGS	0	0
7 251	8. 7380	73. 61	9. 0289	0. RCFLAGS	0	0
7 160	0. 3150	129. 58	0. 5717	0. RCFLAGS	0	0
7 3160	0. 3150	21. 67	0. 2417	0. RCFLAGS	0	0
7 4160	11. 5920	2. 93	0. 3300	0. RCFLAGS	0	0
7 60	0. 3150	22. 07	0. 2281	0. RCFLAGS	0	0
7 162	0. 3930	130. 24	1. 5455	0. RCFLAGS	0	0
7 260	0. 7080	82. 11	1. 5455	0. RCFLAGS	0	0
7 262	9. 4460	74. 25	10. 2229	0. RCFLAGS	0	0
7 65	9. 4460	73. 41	10. 1683	0. RCFLAGS	0	0
7 165	0. 2390	81. 11	0. 4745	0. RCFLAGS	0	0
7 265	9. 6850	73. 60	10. 5094	0. RCFLAGS	0	0
7 3265	9. 6850	55. 20	7. 8821	0. RCFLAGS	0	0
7 4265	21. 2770	9. 97	2. 9574	0. RCFLAGS	0	0
7 170	0. 4530	102. 65	0. 7436	0. RCFLAGS	0	0
7 570	0. 4530	77. 89	0. 3884	15900. RCFLAGS	0	0
7 75	0. 4530	76. 27	0. 3884	0. RCFLAGS	0	0
7 175	0. 2570	140. 00	1. 0564	0. RCFLAGS	0	0
7 275	0. 7100	99. 34	1. 1576	0. RCFLAGS	0	0
7 277	10. 3950	58. 22	8. 7581	0. RCFLAGS	0	0
7 477	21. 2770	9. 97	2. 9574	0. RCFLAGS	0	0
7 1277	10. 3950	78. 63	11. 7134	0. RCFLAGS	0	0
7 3277	10. 3950	73. 45	11. 4134	0. RCFLAGS	0	0
7 78	10. 3950	2. 04	0. 2395	0. RCFLAGS	0	0
return1.dat						

I 21-15\_GAWSER\_summary\_TCSS.txt

7	79	10. 3950	72. 99	11. 4100	0.	RCFLAGS	0	0
7	279	10. 3950	75. 03	11. 5367	0.	RCFLAGS	0	0
7	180	0. 4700	85. 32	0. 6873	59.	RCFLAGS	0	0
7	278	10. 8650	75. 48	12. 0968	0.	RCFLAGS	0	0
7	580	10. 8650	74. 80	11. 9749	25500.	RCFLAGS	0	0
7	3580	10. 8650	74. 26	11. 9499	0.	RCFLAGS	0	0
7	80	10. 8650	73. 93	11. 9473	0.	RCFLAGS	0	0

**1614-13338 220 Arkell Road**

Torrance Creek Subwatershed Study Management Strategy (Revised November 1998)

Target Unit Flow Rates

**TOTAL FROM SITE**

<b>TCSS Subcatchments</b>	Area from TCSS (ha)	<b>Flow Rate from TCSS GAWSER Model (cms)</b>				
		2-year	5-year	10-year	25-year	100-year
105	68.3	0.015	0.018	0.020	0.021	0.023
106	18.7	0.078	0.120	0.160	0.182	0.236
110	33.3	0.123	0.192	0.257	0.294	0.387

<b>TCSS Subcatchments</b>	<b>Unit Flow Rate (m<sup>3</sup>/s/ha)</b>			
	2-year	5-year	25-year	100-year
105	0.0002	0.0003	0.0003	0.0003
106	0.0042	0.0064	0.0097	0.0126
110	0.0037	0.0058	0.0088	0.0116

<b>Catchment ID</b>	<b>Proposed drainage from TCSS catchments to proposed SWMF</b>			<b>Total (ha)</b>	
	(ha)	105	106	110	
200			1.36	1.37	2.73
202			0.36		0.36
203			0.56		0.56
206			0.5		0.5

<b>Total (ha)</b>	0	2.78	1.37	
		<b>Total</b>		<b>4.15</b>

<b>Targets per catchment</b>	<b>Weighted Target Rates (m<sup>3</sup>/s)</b>			
	2-year	5-year	25-year	100-year
200	0.011	0.017	0.025	0.033
202	0.001	0.002	0.004	0.005
203	0.002	0.004	0.005	0.007
206	0.002	0.003	0.005	0.006

<b>Total from site</b>	<b>0.02</b>	<b>0.03</b>	<b>0.04</b>	<b>0.05</b>
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**1614-13338 220 Arkell Road  
Proposed MIDUSS Parameters**

**Proposed Conditions**

Area Description	Catchment Number	Area (ha)	Pervious Length (m)	Gradient (%)	% Impervious	Impervious Length (m)	Overland Manning's 'n'	Max Infiltration (1) (mm/hr)	Min Infiltration (2) (mm/hr)	Lag Constant (3) (hrs)	Depression Storage (4) (mm)
Residential area consisting of approximately half single family and half townhomes	200	2.73	20	2	65	46	0.25	75	13	0.5	5.1
Ecological Linkage draining east	201	1.04	150	2	0	10	0.25	75	13	0.5	5.1
Park	202	0.36	50	3	10	4	0.25	75	13	0.5	5.1
SWM Block	203	0.56	50	1	15	10	0.25	75	13	0.5	5.1
Wetland	204	1.49	50	1	0	10	0.25	75	13	0.5	5.1
Former Driveway to site/landscaped area	205	0.24	10	1	0	10	0.25	75	13	0.5	5.1
Rear lots and portion or rooftops from townhome units	206	0.47	90	2	40	40	0.25	75	13	0.5	5.1
Ecological Linkage draining west (around SWM)	207A + 207B	0.24	70	3	0	10	0.25	75	13	0.5	5.1

Total      7.1  
Developed    4.1

**Notes:**

1. Maximum infiltration rate based on neighbouring Victoria Park Village as well as Geotechnical Investigation for 220 Arkell Road (Stantec, 2018)
2. Minimum infiltration rate based on neighbouring Victoria Park Village as well as Geotechnical Investigation for 220 Arkell Road (Stantec, 2018)
3. Typical value for lag constant from MTO Design Chart 1.13 from the MTO Drainage Management Manual (1997)
4. Depression storage based on typical values for a pasture from *Water Resources Engineering* (Chin, 2000)

**1614-13338 220 Arkell Road**  
**SWM Facility: Stage-Storage-Discharge Calculations**

SSD used in MIDUSS modelling

Rating Curve for MIDUSS							
Elevation (m)	Infiltration (m³/s)	Discharge to PSW (m³/s)	Total Outflow (m³/s)	Active Storage (m³)	Storage without Infiltration Portion (m³)	Drawdown (hrs) - including infiltration	
						Increment	Total
333.00							
333.10							
333.20							
333.30							
333.30							
333.40							
333.50							
333.60	0.003	0.003	0.003	139	23.1	23.1	
333.70	0.003	0.003	0.003	286	12.2	35.4	
333.80	0.003	0.003	0.006	441	156	9.0	44.4
333.90	0.003	0.005	0.008	605	320	6.4	50.7
334.00	0.003	0.006	0.009	779	493	5.5	56.2
334.10	0.003	0.007	0.010	961	676	5.1	61.4
334.20	0.003	0.008	0.011	1,153	867	4.9	66.3
334.30	0.003	0.009	0.012	1,355	1,069	4.8	71.1
334.40	0.003	0.010	0.013	1,566	1,280	4.7	75.8
334.50	0.003	0.010	0.014	1,787	1,502	4.6	80.4
334.60	0.003	0.011	0.014	2,019	1,733	4.6	85.0
334.70	0.003	0.012	0.015	2,261	1,976	4.6	89.7
334.80	0.003	0.012	0.015	2,515	2,229	4.6	94.3
334.90	0.003	0.013	0.016	2,779	2,493	4.7	99.0
335.00	0.003	0.013	0.017	3,055	2,769	4.7	103.7
335.10	0.003	0.014	0.017	3,343	3,057	4.8	108.5
335.20	0.003	0.094	0.097	3,643	3,358	1.5	109.9
335.30	0.003	0.486	0.490	3,957	3,671	0.3	110.2
335.40	0.003	0.993	0.996	4,285	3,999	0.1	110.3
335.50	0.003	1.650	1.654	4,630	4,344	0.1	110.4

Weir Equation Used:

$$Q = C_{wb} * L * H^{1.5} + C_w * S * H^{2.5}$$

where

L = bottom width of spillway  
H = head above weir invert  
S = side slopes (ratio of H:V)  
C<sub>wb</sub> = weir coefficient (triangular)  
C<sub>wb</sub> = weir coefficient (broad-crested)

Volume Estimation					
Elevation (m)	Forebay		Main Cell		Total
	Area (m²)	Perm Vol (m³)	Area (m²)	Perm Vol (m³)	
333.000					
333.100		14			
333.200		31			
333.300		50			
333.400		73			
333.500		98			
333.600			139	139	
333.700		286	286		
333.800		441	441		
333.900		605	605		
334.000		779	779		
334.100		961	961		
334.200		1,153	1,153		
334.300		1,355	1,355		
334.400		1,566	1,566		
334.500		1,787	1,787		
334.600		2,019	2,019		
334.700		2,261	2,261		
334.800		2,515	2,515		
334.900		2,779	2,779		
335.000		3,055	3,055		
335.100		3,343	3,343		
335.200		3,643	3,643		
335.300		3,957	3,957		
335.400		4,285	4,285		
335.500		4,630	4,630		

Outlet Controls									Parameters	
Elevation (m)	Orifice 1 (m³/s)	Orifice 2 (m³/s)	DICB Flow (m³/s)	Control (m³/s)	Overflow	Weir (m³/s)	Total Flow (m³/s)	Infiltration (m³/s)	Orifice 1	
									Orifice Invert Elev. (m)	Orifice Coeff.
333.00									333.70	0.60
333.10									Orifice Mid-point Elev. (m)	Perimeter (m)
333.20									333.74	0.24
333.30									Orifice Diam.(mm)	Area (m²)
333.40									75	0.004
333.50									Weir Coeff. (semi-circular)	Orientation Vertical
333.60									1.62	
333.70									Orifice 2 + DICB	
333.80									DICB Elev. (low side):	DICB width (m)
333.90									335.10	0.60
334.00									Orifice Invert Elev. (m)	Orifice Coeff.
334.10									334.00	0.60
334.20									Orifice Mid-point Elev. (m)	Perimeter (m)
334.30									334.74	0.24
334.40									Orifice Diam.(mm)	Area (m²)
334.50									75	0.004
334.60									Weir Coeff. (semi-circular)	Orientation Vertical
334.70									1.62	
334.80									Orifice 1	
334.90									Orifice Invert Elev. (m)	Orifice Coeff.
335.00									335.70	0.60
335.10									Orifice Mid-point Elev. (m)	Perimeter (m)
335.20									335.74	0.24
335.30									Orifice Diam.(mm)	Area (m²)
335.40									75	0.004
335.50									Weir Coeff. (semi-circular)	Orientation Vertical
335.60									1.62	
335.70									Orifice 2	
335.80									335.10	0.60
335.90									335.70	0.60
336.00									Orifice Mid-point Elev. (m)	Perimeter (m)
336.10									336.74	0.24
336.20									Orifice Diam.(mm)	Area (m²)
336.30									75	0.004
336.40										

2202YR. OUT  
Output File (4.7) 2202YR.OUT opened 2019-05-22 14:15  
Units used are defined by G = 9.810  
192 533 15.000 are MAXDT MAXHYD & DTMIN values  
Licensee: Paragon Engineering Limited  
35 COMMENT  
6 Line(s) of comment  
\*\*\*\*\*  
1614-1338 220 Arkel  
Stormwater Management Modelling  
2-yr, 48-hour adjusted storm (TCSS)  
Modeler: B. Weersink (March 2019)  
\*\*\*\*\*  
23 FILE RAINFALL  
1 1=READ; 2=WRITE  
10 2yr48hr.ST is filename  
3 IMPERVIOUS  
2 Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat  
.013 Manning "n"  
.000 Max. Infiltr. mm/hr  
.000 Min. Infiltr. mm/hr  
.050 Lag const (hours)  
1.500 Dep. Storage mm  
35 COMMENT  
3 Line(s) of comment  
\*\*\*\*\*  
Catchment 200 - Developed Area to SWM  
\*\*\*\*\*  
4 CATCHMENT  
200.000 ID No. 99999  
2.730 Area in hectares  
20.000 Length (PERV) metres  
2.000 Gradient (%)  
65.000 Per cent Impervious  
47.000 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. Infiltr. mm/hr  
13.000 Min. Infiltr. mm/hr  
.500 Lag const (hours)  
5.000 Dep. Storage mm  
1 Option 1=Triangl r; 2=Rectangl r; 3=SWM HYD; 4=Lin. Reserv  
.090 .000 .000 .000 c.m/s  
.002 .969 .631 C perv/imperc/total  
15 ADD RUNOFF  
.090 .090 .000 .000 c.m/s  
4 CATCHMENT  
203.000 ID No. 99999  
.560 Area in hectares  
50.000 Length (PERV) metres  
2.000 Gradient (%)  
15.000 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. Infiltr. mm/hr  
13.000 Min. Infiltr. mm/hr  
.500 Lag const (hours)  
5.000 Dep. Storage mm  
1 Option 1=Triangl r; 2=Rectangl r; 3=SWM HYD; 4=Lin. Reserv  
.004 .090 .000 .000 c.m/s  
.002 .925 .140 C perv/imperc/total

2202YR. OUT  
15 ADD RUNOFF .004 .093 .000 .000 c.m/s  
35 COMMENT  
3 Line(s) of comment  
\*\*\*\*\*  
Dry SWM Stage-storage  
\*\*\*\*\*  
10 POND  
6 Depth - Discharge - Volume sets  
333.700 .000 .0 .0  
334.200 .00800 867.0  
334.500 .01000 1502.0  
335.100 .0140 3057.0  
335.200 .0940 3358.0  
335.500 1.651 4344.0  
Peak Outflow = 010 c.m/s  
Maximum Depth = 334.430 metres  
Maximum Storage = 1355. c.m  
.004 .093 .010 .000 c.m/s  
16 NEXT LINK  
.004 .010 .010 .000 c.m/s  
4 CATCHMENT  
202.000 ID No. 99999  
.360 Area in hectares  
50.000 Length (PERV) metres  
2.000 Gradient (%)  
10.000 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. Infiltr. mm/hr  
13.000 Min. Infiltr. mm/hr  
.500 Lag const (hours)  
5.000 Dep. Storage mm  
1 Option 1=Triangl r; 2=Rectangl r; 3=SWM HYD; 4=Lin. Reserv  
.002 .010 .010 .000 c.m/s  
.002 .925 .094 C perv/imperc/total  
15 ADD RUNOFF  
.002 .010 .010 .000 c.m/s  
4 CATCHMENT  
206.000 ID No. 99999  
.470 Area in hectares  
100.000 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. Infiltr. mm hr  
13.000 Min. Infiltr. mm hr  
.500 Lag const (hours)  
5.000 Dep. Storage mm  
1 Option 1=Triangl r; 2=Rectangl r; 3=SWM HYD; 4=Lin. Reserv  
.008 .010 .010 .000 c.m/s  
.002 .925 .371 C perv/imperc/total  
15 ADD RUNOFF  
.008 .018 .010 .000 c.m/s  
20 MANUAL

2205YR. OUT  
Output File (4.7) 2205YR.OUT opened 2019-05-22 14:26  
Units used are defined by G = 9.810  
192 533 15.000 are MAXDT MAXHYD & DTMIN values  
Licensee: Paragon Engineering Limited  
35 COMMENT  
6 line(s) of comment  
\*\*\*\*\*  
1614-1338 220 Arkel  
Stormwater Management Modelling  
5-yr, 48-hour adjusted storm (TCSS)  
Modeler: B. Weersink (March 2019)  
\*\*\*\*\*  
23 FILE RAINFALL  
1 1=READ: 2=WRITE  
10 5yr48hr.ST is filename  
3 IMPERVIOUS  
2 Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat  
.013 Manning "n"  
.000 Max. Infiltr. mm/hr  
.000 Min. Infiltr. mm/hr  
.050 Lag const (hours)  
1.500 Dep. Storage mm  
35 COMMENT  
3 line(s) of comment  
\*\*\*\*\*  
Catchment 200 - Developed Area to SWM  
\*\*\*\*\*  
4 CATCHMENT  
200.000 ID No. 99999  
2.730 Area in hectares  
20.000 Length (PERV) metres  
2.000 Gradient (%)  
65.000 Per cent Impervious  
47.000 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. Infiltr. mm/hr  
13.000 Min. Infiltr. mm/hr  
.500 Lag const (hours)  
5.000 Dep. Storage mm  
1 Option 1=Triangl r; 2=Rectangl r; 3=SWM HYD; 4=Lin. Reserv  
.122 .000 .000 .000 c.m/s  
.063 .976 .657 C perv/imperc/total  
15 ADD RUNOFF  
.122 .122 .000 .000 c.m/s  
4 CATCHMENT  
203.000 ID No. 99999  
.560 Area in hectares  
50.000 Length (PERV) metres  
2.000 Gradient (%)  
15.000 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. Infiltr. mm/hr  
13.000 Min. Infiltr. mm/hr  
.500 Lag const (hours)  
5.000 Dep. Storage mm  
1 Option 1=Triangl r; 2=Rectangl r; 3=SWM HYD; 4=Lin. Reserv  
.010 .122 .000 .000 c.m/s  
.063 .919 .192 C perv/imperc/total

2205YR. OUT  
15 ADD RUNOFF .010 .130 .000 .000 c.m/s  
35 COMMENT  
3 line(s) of comment  
\*\*\*\*\*  
Dry SWM Stage-storage  
\*\*\*\*\*  
10 POND  
6 Depth - Discharge - Volume sets  
333.700 .000 .0  
334.200 .00800 867.0  
334.500 .01000 1502.0  
335.100 .0140 3057.0  
335.200 .0940 3358.0  
335.500 1.651 4344.0  
Peak Outflow = 011 c.m/s  
Maximum Depth = 334.613 metres  
Maximum Storage = 1795. c.m  
.010 .130 .011 .000 c.m/s  
16 NEXT LINK  
.010 .011 .011 .000 c.m/s  
4 CATCHMENT  
202.000 ID No. 99999  
.360 Area in hectares  
50.000 Length (PERV) metres  
2.000 Gradient (%)  
10.000 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. Infiltr. mm/hr  
13.000 Min. Infiltr. mm/hr  
.500 Lag const (hours)  
5.000 Dep. Storage mm  
1 Option 1=Triangl r; 2=Rectangl r; 3=SWM HYD; 4=Lin. Reserv  
.006 .011 .011 .000 c.m/s  
.063 .919 .149 C perv/imperc/total  
15 ADD RUNOFF  
.006 .016 .011 .000 c.m/s  
4 CATCHMENT  
206.000 ID No. 99999  
.470 Area in hectares  
100.000 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. Infiltr. mm hr  
13.000 Min. Infiltr. mm hr  
.500 Lag const (hours)  
5.000 Dep. Storage mm  
1 Option 1=Triangl r; 2=Rectangl r; 3=SWM HYD; 4=Lin. Reserv  
.011 .016 .011 .000 c.m/s  
.063 .919 .406 C perv/imperc/total  
15 ADD RUNOFF  
.011 .027 .011 .000 c.m/s  
20 MANUAL

220V5. OUT  
Output File (4.7) 220V5. OUT opened 2019-05-22 14:08  
Units used are defined by G = 9.810  
192 533 15.000 are MAXDT MAXHYD & DTMIN values  
Licensee: Paragon Engineering Limited  
35 COMMENT  
6 Line(s) of comment  
\*\*\*\*\*  
1614-1338 220 Arkel  
Stormwater Management Modelling  
100-yr, 48-hour adjusted storm (TCSS)  
Modeler: B. Weersink (March 2019)  
\*\*\*\*\*  
23 FILE RAINFALL  
1 1=READ; 2=WRI TE  
10 10048h. STM is filename  
3 IMPERVIOUS  
2 Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat  
.013 Manning "n"  
.000 Max. Infiltr. mm/hr  
.000 Min. Infiltr. mm/hr  
.050 Lag const (hours)  
1.500 Dep. Storage mm  
35 COMMENT  
3 Line(s) of comment  
\*\*\*\*\*  
Catchment 200 - Developed Area to SWM  
\*\*\*\*\*  
4 CATCHMENT  
200.000 ID No. 99999  
2.730 Area in hectares  
20.000 Length (PERV) metres  
2.000 Gradient (%)  
65.000 Per cent Impervious  
47.000 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. Infiltr. mm/hr  
13.000 Min. Infiltr. mm/hr  
.500 Lag const (hours)  
5.000 Dep. Storage mm  
1 Option 1=Triangl r; 2=Rectangl r; 3=SWM HYD; 4=Lin. Reserv  
.215 .000 .000 .000 c.m/s  
.153 .981 .691 C perv/imperc/total  
15 ADD RUNOFF  
.215 .215 .000 .000 c.m/s  
4 CATCHMENT  
203.000 ID No. 99999  
.560 Area in hectares  
50.000 Length (PERV) metres  
2.000 Gradient (%)  
15.000 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. Infiltr. mm/hr  
13.000 Min. Infiltr. mm/hr  
.500 Lag const (hours)  
5.000 Dep. Storage mm  
1 Option 1=Triangl r; 2=Rectangl r; 3=SWM HYD; 4=Lin. Reserv  
.030 .215 .000 .000 c.m/s  
.152 .906 .265 C perv/imperc/total

220V5. OUT  
15 ADD RUNOFF .030 .245 .000 .000 c.m/s  
35 COMMENT  
3 Line(s) of comment  
\*\*\*\*\*  
Dry SWM Stage-storage  
\*\*\*\*\*  
10 POND  
6 Depth - Discharge - Volume sets  
333.700 .000 .0  
334.200 .00800 867.0  
334.500 .01000 1502.0  
335.100 .0140 3057.0  
335.200 .0940 3358.0  
335.500 1.651 4344.0  
Peak Outflow = .014 c.m/s  
Maximum Depth = 335.051 metres  
Maximum Storage = 2930. c.m  
.030 .245 .014 .000 c.m/s  
16 NEXT LINK  
.030 .014 .014 .000 c.m/s  
4 CATCHMENT  
202.000 ID No. 99999  
.360 Area in hectares  
50.000 Length (PERV) metres  
2.000 Gradient (%)  
10.000 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. Infiltr. mm/hr  
13.000 Min. Infiltr. mm/hr  
.500 Lag const (hours)  
5.000 Dep. Storage mm  
1 Option 1=Triangl r; 2=Rectangl r; 3=SWM HYD; 4=Lin. Reserv  
.019 .014 .014 .000 c.m/s  
.152 .906 .228 C perv/imperc/total  
15 ADD RUNOFF  
.019 .031 .014 .000 c.m/s  
4 CATCHMENT  
206.000 ID No. 99999  
.470 Area in hectares  
100.000 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. Infiltr. mm hr  
13.000 Min. Infiltr. mm hr  
.500 Lag const (hours)  
5.000 Dep. Storage mm  
1 Option 1=Triangl r; 2=Rectangl r; 3=SWM HYD; 4=Lin. Reserv  
.024 .031 .014 .000 c.m/s  
.153 .906 .454 C perv/imperc/total  
15 ADD RUNOFF  
.024 .054 .014 .000 c.m/s  
20 MANUAL

## Brief Stormceptor Sizing Report - 220 Arkell

Project Information & Location			
Project Name	220 Arkell	Project Number	1614-13338
City	Guelph	State/ Province	Ontario
Country	Canada	Date	10/25/2017
Designer Information		EOR Information (optional)	
Name	Bryan Weersink	Name	
Company	Stantec Consulting Ltd.	Company	
Phone #	519-569-4333	Phone #	
Email	bryan.weersink@stantec.com	Email	

### Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

Site Name	
Target TSS Removal (%)	60
TSS Removal (%) Provided	61
Recommended Stormceptor Model	EF10

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

EF Sizing Summary	
EF Model	% TSS Removal Provided
EF4	50
EF6	54
EF8	58
EF10	61
EF12	63
Parallel Units / MAX	Custom

Sizing Details			
Drainage Area		Water Quality Objective	
Total Area (ha)	2.73	TSS Removal (%)	60.0
Imperviousness %	65.0	Runoff Volume Capture (%)	
Rainfall			
Station Name	WATERLOO WELLINGTON A	Oil Spill Capture Volume (L)	
State/Province	Ontario	Peak Conveyed Flow Rate (L/s)	
Station ID #	9387	Water Quality Flow Rate (L/s)	
Years of Records	34	Up Stream Storage	
Latitude	43°27'N	Storage (ha-m)	Discharge (cms)
Longitude	80°23'W	0.000	0.000
Up Stream Flow Diversion			
Max. Flow to Stormceptor (cms)			

Particle Size Distribution (PSD) The selected PSD defines TSS removal		
CA ETV		
Particle Diameter (microns)	Distribution %	Specific Gravity
2.0	5.0	2.65
5.0	5.0	2.65
8.0	10.0	2.65
20.0	15.0	2.65
50.0	10.0	2.65
75.0	5.0	2.65
100.0	10.0	2.65
150.0	15.0	2.65
250.0	15.0	2.65
500.0	5.0	2.65
1000.0	5.0	2.65

### Notes

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

For Stormceptor Specifications and Drawings Please Visit:  
<http://www.imbriumsystems.com/technical-specifications>

# **STANDARD SPECIFICATION FOR “OIL GRIT SEPARATOR” (OGS) STORMWATER QUALITY TREATMENT DEVICE**

## **PART 1 – GENERAL**

### **1.1 WORK INCLUDED**

This section specifies requirements for selecting, sizing, designing, maintaining, and constructing an underground Oil Grit Separator (OGS) device for stormwater quality treatment, with third-party testing results and a Statement of Verification in accordance with ISO 14034 Environmental Management – Environmental Technology Verification (ETV). Work includes supply and installation of concrete bases, precast sections, and the appropriate precast section with OGS internal components correctly installed within the system, watertight sealed to the precast concrete prior to arrival to the project site.

### **1.2 REFERENCE STANDARDS**

#### **1.2.1 For Canadian projects only, the following reference standards apply:**

CAN/CSA-A257.4-14: Joints for Circular Concrete Sewer and Culvert Pipe, Manhole Sections, and Fittings Using Rubber Gaskets

CAN/CSA-A257.4-14: Precast Reinforced Circular Concrete Manhole Sections, Catch Basins, and Fittings

CAN/CSA-S6-00: Canadian Highway Bridge Design Code

#### **1.2.2 For ALL projects, the following reference standards apply:**

ASTM D-4097: Contact Molded Glass Fiber Reinforced Chemical Resistant Tanks

ASTM C 478: Specification for Precast Reinforced Concrete Manhole Sections

ASTM C 443: Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

ASTM C 891: Standard Practice for Installation of Underground Precast Concrete Utility Structures

ASTM D2563: Standard Practice for Classification of Visual Defects in Reinforced Plastics

### **1.3 SHOP DRAWINGS**

1.3.1 Shop drawings shall be submitted upon request with each order to the contractor then forwarded to the Engineer of Record for review and acceptance. Shop drawings shall detail the precast concrete components and OGS internal components prior to shipment, including the sequence for installation.

1.3.2 Unless directed otherwise by the Engineer of Record, OGS stormwater quality treatment product substitutions or alternatives submitted within ten days prior to project bid shall not be accepted. All alternatives or substitutions submitted shall be based on the exact same criteria detailed in Section 3, in entirety, subject to review and approval by the Engineer of Record. Any and all changes to project cost estimates, bonding amounts, plan check fees for revision of approved documents, or design impacts due to regulatory requirements as a result of a product substitution shall be coordinated by the Contractor with the Engineer of Record.

### **1.4 HANDLING AND STORAGE**

Prevent damage to materials during storage and handling.

1.4.1 OGS internal components supplied by the Manufacturer for attachment to the precast concrete vessel shall be pre-fabricated, bolted to the precast and watertight sealed to the precast vessel surface prior to site delivery to ensure Manufacturer's internal assembly process and quality control processes are fully adhered to, and to prevent materials damage on site.

1.4.2 Follow all instructions including the sequence for installation in the shop drawings during installation.

## PART 2 – PRODUCTS

### 2.1 GENERAL

2.1.1 The OGS vessel shall be cylindrical and constructed from precast concrete riser and slab components.

2.1.2 The precast concrete OGS internal components shall include a fiberglass insert bolted and watertight sealed inside the precast concrete vessel, prior to site delivery. Primary internal components that are to be anchored and watertight sealed to the precast concrete vessel shall be done so only by the Manufacturer prior to arrival at the job site to ensure product quality.

2.1.3 The OGS shall be allowed to be specified and have the ability to function as a 240-degree bend structure in the stormwater drainage system, or as a junction structure.

2.1.4 The OGS to be specified shall have the capability to accept influent flow from an inlet grate and an inlet pipe.

### 2.2 PRECAST CONCRETE SECTIONS

All precast concrete components shall be designed and manufactured to meet highway loading conditions per State/Provincial or local requirements.

### 2.3 GASKETS

Only profile neoprene or nitrile rubber gaskets that are oil resistant shall be accepted. For Canadian projects only, gaskets shall be in accordance to CSA A257.4-14. Mastic sealants, butyl tape/rope or Conseal CS-101 alone are not acceptable gasket materials.

### 2.4 JOINTS

The concrete joints shall be watertight and meet the design criteria according to ASTM C-990. For projects where joints require gaskets, the concrete joints shall be watertight and oil resistant and meet the design criteria according to ASTM C-443. Mastic sealants or butyl tape/rope alone are not an acceptable alternative.

### 2.5 FRAMES AND COVERS

Frames and covers shall be manufactured in accordance with State/Provincial or local requirements for inspection and maintenance access purposes. A minimum of one cover, at least 22-inch (560 mm) in diameter, shall be clearly embossed with the OGS manufacturer's product name to properly identify this asset's purpose is for stormwater quality treatment.

### 2.6 PRECAST CONCRETE

All precast concrete components shall conform to the appropriate CSA or ASTM specifications.

### 2.7 FIBERGLASS

The fiberglass portion of the OGS device shall be constructed in accordance with ASTM D2563, and in accordance with the PS15-69 manufacturing standard, and shall only be installed, bolted and watertight sealed to the precast concrete by the Manufacturer prior to arrival at the project site to ensure product quality.

## **2.8 OGS POLLUTANT STORAGE**

The OGS device shall include a sump for sediment storage, and a fiberglass insert for the capture and storage of petroleum hydrocarbons and buoyant gross pollutants. The total sediment storage capacity shall be a minimum 40 ft<sup>3</sup> (1.1 m<sup>3</sup>). The total petroleum hydrocarbon storage capacity shall be a minimum 50 gallons (189 liters). The access opening to the sump of the OGS device for periodic inspection and maintenance purposes shall be a minimum 16 inches (406 mm) in diameter.

## **2.9 LADDERS**

Ladder rungs shall be provided upon request or to comply with State/Provincial or local requirements.

## **2.10 INSPECTION**

All precast concrete sections shall be level and inspected to ensure dimensions, appearance, integrity of internal components, and quality of the product meets State/Provincial or local specifications and associated standards.

# **PART 3 – PERFORMANCE & DESIGN**

## **3.1 GENERAL**

The OGS stormwater quality treatment device shall be verified in accordance with ISO 14034:2016 Environmental management – Environmental technology verification (ETV). The OGS stormwater quality treatment device shall remove oil, sediment and gross pollutants from stormwater runoff during frequent wet weather events, and retain these pollutants during less frequent high flow wet weather events below the insert within the OGS for later removal during maintenance. The Manufacturer shall have at least ten (10) years of local experience, history and success in engineering design, manufacturing and production and supply of OGS stormwater quality treatment device systems, acceptable to the Engineer of Record.

## **3.2 HYDROLOGY AND RUNOFF VOLUME**

The OGS device shall be engineered, designed and sized to treat a minimum of 90 percent of the average annual runoff volume, unless otherwise stated by the Engineer of Record, using historical rainfall data. Rainfall data sets should be comprised of a minimum 15-years of rainfall data or a longer continuous period if available for a given location, but in all cases a minimum 5-year period of rainfall data.

## **3.3 ANNUAL (TSS) SEDIMENT LOAD AND STORAGE CAPACITY**

The OGS device shall be capable of removing and have sufficient storage capacity for the calculated annual total suspended solids (TSS) mass load and volume without scouring previously captured pollutants prior to maintenance being required. The annual (TSS) sediment load and volume transported from the drainage area should be calculated and compared to the OGS device's available storage capacity by the specifying Engineer to ensure adequate capacity between maintenance cycles. Sediment loadings shall be determined by land use and defined as a minimum of 450 kg (992 lb) of sediment (TSS) per impervious hectare of drainage area per year, or greater based on land use, as noted in Table 1 below.

Annual sediment volume calculations shall be performed using the projected average annual treated runoff volume, a typical sediment bulk density of 1602 kg/m<sup>3</sup> (100 lbs/ft<sup>3</sup>) and an assumed Event Mean Concentration (EMC) of 125 mg/L TSS in the runoff, or as otherwise determined by the Engineer of Record.

Example calculation for a 1.3-hectares parking lot site:

- 1.28 meters of rainfall depth, per year

- 1.3 hectares of 100% impervious drainage area
- EMC of 125 mg/L TSS in runoff
- Treatment of 90% of the average annual runoff volume
- Target average annual TSS removal rate of 60% by OGS

Annual Runoff Volume:

- 1.28 m rain depth x 1.3 ha x 10,000 m<sup>2</sup>/ha = 16,640 m<sup>3</sup> of runoff volume
- 16,640 m<sup>3</sup> x 1000 L/m<sup>3</sup> = 16,640,000 L of runoff volume
- 16,640,000 L x 0.90 = 14,976,000 L to be treated by OGS unit

Annual Sediment Mass and Sediment Volume Load Calculation:

- 14,976,000 L x 125 mg/L x kg/1,000,000 mg = 1,872 kg annual sediment mass
- 1,872 kg x m<sup>3</sup>/1602 kg = 1.17 m<sup>3</sup> annual sediment volume
- 1.17 m<sup>3</sup> x 60% TSS removal rate by OGS = 0.70 m<sup>3</sup> minimum expected annual storage requirement in OGS

As a guideline, the U.S. EPA has determined typical annual sediment loads per drainage area for various sites by land use (see Table 1). Certain States, Provinces and local jurisdictions have also established such guidelines.

**Table 1 – Annual Mass Sediment Loading by Land Use**

	Commercial	Parking Lot	Residential			Highways	Industrial	Shopping Center
			High	Med.	Low			
(lbs/acre/yr)	1,000	400	420	250	10	880	500	440
(kg/hectare/yr)	1,124	450	472	281	11	989	562	494

Source: U.S. EPA Stormwater Best Management Practice Design Guide Volume 1, Appendix D, Table D-1, Burton and Pitt 2002

### 3.4 SIZING METHODOLOGY

The OGS device shall be engineered, designed and sized to provide stormwater quality treatment based on treating a minimum of 90 percent of the average annual runoff volume and a minimum removal of an annual average 60% of the sediment (TSS) load based on the Particle Size Distribution (PSD) specified in Table 2, Section 3.5, and based on third-party performance testing conducted in accordance with the Canadian Environmental Technology Verification (ETV) Program's **Procedure for Laboratory Testing of Oil-Grit Separators**. Sizing shall be determined using historical rainfall data (as specified in Section 3.2) and a sediment removal performance curve derived from the actual third-party verified laboratory testing data. The OGS device shall also have sufficient annual sediment storage capacity as specified and calculated in Section 3.3.

3.4.1 The Peclet Number is not an approved method or model for calculating TSS removal, sizing, or scaling OGS devices.

3.4.2 If an alternate OGS device is proposed, supporting documentation shall be submitted that demonstrates:

- Canadian ETV or ISO 14034 ETV Verification Statement which verifies third-party performance testing conducted in accordance with the **Procedure for Laboratory Testing of Oil-Grit Separators**
- Equal or better sediment (TSS) removal of the PSD specified in Table 2 at equivalent surface loading rates, as compared to the OGS device specified herein.
- Equal or greater sediment storage capacity, as compared to the OGS device specified herein.
- Supporting documentation shall be signed and sealed by a local registered Professional Engineer. All costs associated with preparing and certifying this documentation shall be born solely by the Contractor.

### 3.5 PARTICLE SIZE DISTRIBUTION (PSD) FOR SIZING

The OGS device shall be sized to achieve the Engineer-specified average annual percent sediment (TSS) removal based solely on the test sediment used in the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators**. This test sediment is comprised of inorganic ground silica with a specific gravity of 2.65, uniformly mixed, and containing a broad range of particle sizes as specified in Table 2. No alternative PSDs or deviations from Table 2 shall be accepted.

Table 2 Canadian ETV Program Procedure for Laboratory Testing of Oil-Grit Separators Particle Size Distribution (PSD) of Test Sediment		
Particle Diameter (Microns)	% by Mass of All Particles	Specific Gravity
1000	5%	2.65
500	5%	2.65
250	15%	2.65
150	15%	2.65
100	10%	2.65
75	5%	2.65
50	10%	2.65
20	15%	2.65
8	10%	2.65
5	5%	2.65
2	5%	2.65

### 3.6 CANADIAN ETV or ISO 14034 ETV VERIFICATION OF SCOUR TESTING

The OGS device shall have Canadian ETV or ISO 14034 ETV Verification of third-party scour testing conducted in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators**. This scour testing is conducted with the device pre-loaded with test sediment comprised of the particle size distribution (PSD) illustrated in Table 2.

3.6.1 To be acceptable for on-line installation, the OGS device must demonstrate an average scour test effluent concentration less than 10 mg/L at each surface loading rate tested, up to and including 2600 L/min/m<sup>2</sup>.

Data generated from laboratory scour testing performed with an OGS device pre-loaded with a coarser PSD than in Table 2 (i.e. the coarser PSD has no particles in the 1-micron to 50-micron size range, or the D<sub>50</sub> of the test sediment exceeds 75 microns) shall not be acceptable for the determination of the device's suitability for on-line installation.

### 3.7 DESIGN ACCOUNTING FOR BYPASS

3.7.1 The OGS device shall be specified to achieve the TSS removal performance and water quality objectives without washout of previously captured pollutants. The OGS device shall also have sufficient hydraulic conveyance capacity to convey the peak storm event, in accordance with hydraulic conditions per the Engineer of Record. To ensure this is achieved, there are two design options with associated requirements:

3.7.1.1 The OGS device shall be placed **off-line** with an upstream diversion structure (typically in an upstream manhole) that only allows the water quality volume to be diverted to the OGS device, and excessive flows diverted downstream around the OGS device to prevent high flow washout of pollutants previously captured. This design typically incorporates a triangular layout including an upstream bypass manhole with an appropriately engineered weir wall, the OGS device, and a downstream junction manhole, which is connected to both the OGS device and bypass structure. In this case with an external bypass required, the OGS device manufacturer must provide calculations and designs for all structures, piping and any other required material applicable to the proper functioning of the system, stamped by a Professional Engineer.

3.7.1.2 Alternatively, OGS devices in compliance with Section 3.6 shall be acceptable for an **on-line** design configuration, thereby eliminating the requirement for an upstream bypass manhole and downstream junction manhole.

3.7.2 The OGS device shall also have sufficient hydraulic conveyance capacity to convey the peak storm event, in accordance with hydraulic conditions per the Engineer of Record. If an alternate OGS device is proposed, supporting documentation shall be submitted that demonstrates equal or better hydraulic conveyance capacity as compared to the OGS device specified herein. This documentation shall be signed and sealed by a local registered Professional Engineer. All costs associated with preparing and certifying this documentation shall be born solely by the Contractor.

### **3.8 PETROLEUM HYDROCARBONS AND FLOATABLES STORAGE CAPACITY**

Petroleum hydrocarbons and floatables storage capacity in the OGS device shall be a minimum 50 gallons (189 Liters), or more as specified.

3.8.1 The OGS device shall have gasketed precast concrete joints that are watertight, and oil resistant and meet the design criteria according to ASTM C-443 to provide safe oil and other hydrocarbon materials storage and ground water protection. Mastic sealants or butyl tape/rope alone are not an acceptable alternative.

### **3.9 SURFACE LOADING RATE SCALING OF DIFFERENT MODEL SIZES**

The reference device for scaling shall be an OGS device that has been third-party tested in accordance with the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators**. Other model sizes of the tested device shall only be scaled such that the claimed TSS removal efficiency of the scaled device shall be no greater than the TSS removal efficiency of the tested device at identical **surface loading rates** (flow rate divided by settling surface area). The depth of other model sizes of the tested device shall be scaled in accordance with the depth scaling provisions within Section 6.0 of the Canadian ETV Program's **Procedure for Laboratory Testing of Oil-Grit Separators**.

3.9.1 The Peclet Number and volumetric scaling are not approved methods for scaling OGS devices.

## **PART 4 – INSPECTION & MAINTENANCE**

The OGS manufacturer shall provide an Owner's Manual upon request.

- 4.1 A Quality Assurance Plan that provides inspection and maintenance for a minimum of 5 years shall be included with the OGS stormwater quality device, and written into the Environmental Compliance Approval (ECA) or the appropriate State/Provincial or local approval document.
- 4.2 OGS device inspection shall include determination of sediment depth and presence of petroleum hydrocarbons and floatables below the insert. Inspection shall be easily conducted from finished grade through a Frame and Cover of at least 22 inch (560 mm) in diameter.
- 4.3 Inspection and pollutant removal from below the OGS's insert shall be conducted as a periodic maintenance practice using a standard maintenance truck and vacuum apparatus, and shall be easily conducted from finished grade through a Frame and Cover of at least 22-inches (560 mm) in diameter, and through an access opening to the OGS device's sump with a minimum 16-inches diameter (406 mm).

4.4 No confined space for sediment removal or inspection of internal components shall be required for normal operation, annual inspection or maintenance activity.

## PART 5 – EXECUTION

### 5.1 PRECAST CONCRETE INSTALLATION

The installation of the precast concrete OGS stormwater quality treatment device shall conform to ASTM C 891, ASTM C 478, ASTM C 443, CAN/CSA-A257.4-14, CAN/CSA-A257.4-14, CAN/CSA-S6-00 and all highway, State/Provincial, or local specifications for the construction of manholes. Selected sections of a general specification that are applicable are summarized below. The Contractor shall furnish all labor, equipment and materials necessary to offload, assemble as needed the OGS internal components as specified in the Shop Drawings.

### 5.2 EXCAVATION

5.2.1 Excavation for the installation of the OGS stormwater quality treatment device shall conform to highway, State/Provincial or local specifications. Topsoil that is removed during the excavation for the OGS stormwater quality treatment device shall be stockpiled in designated areas and not be mixed with subsoil or other materials. Topsoil stockpiles and the general site preparation for the installation of the OGS stormwater quality device shall conform to highway, State/Provincial or local specifications.

5.2.2 The OGS device shall not be installed on frozen ground. Excavation shall extend a minimum of 12 inch (300 mm) from the precast concrete surfaces plus an allowance for shoring and bracing where required. If the bottom of the excavation provides an unsuitable foundation additional excavation may be required.

5.2.3 In areas with a high water table, continuous dewatering shall be provided to ensure that the excavation is stable and free of water.

### 5.3 BACKFILLING

Backfill material shall conform to highway, State/Provincial or local specifications. Backfill material shall be placed in uniform layers not exceeding 12 inches (300 mm) in depth and compacted to highway, State/Provincial or local specifications.

### 5.4 OGS WATER QUALITY DEVICE CONSTRUCTION SEQUENCE

5.4.1 The precast concrete OGS stormwater quality treatment device is installed and leveled in sections in the following sequence:

- aggregate base
- base slab, or base
- riser section(s) (if required)
- riser section w/ pre-installed fiberglass insert
- upper riser section(s)
- internal OGS device components
- connect inlet and outlet pipes
- riser section, top slab and/or transition (if required)
- frame and access cover

5.4.2 The precast concrete base shall be placed level at the specified grade. The entire base shall be in contact with the underlying compacted granular material. Subsequent sections, complete with oil resistant, watertight joint seals, shall be installed in accordance with the precast concrete manufacturer's recommendations.

5.4.3 Adjustment of the OGS stormwater quality treatment device can be performed by lifting the upper sections free of the excavated area, re-leveling the base, and re-installing the sections.

Damaged sections and gaskets shall be repaired or replaced as necessary. Once the OGS stormwater quality treatment device has been constructed, any lift holes must be plugged with mortar.

#### **5.5 DROP PIPE AND OIL INSPECTION PIPE**

Once the upper precast concrete riser has been attached to the lower precast concrete riser section, the OGS device Drop Pipe and Oil Inspection Pipe must be attached, and watertight sealed to the fiberglass insert using Sikaflex 1a. Installation instructions and required materials shall be provided by the OGS manufacturer.

#### **5.6 INLET AND OUTLET PIPES**

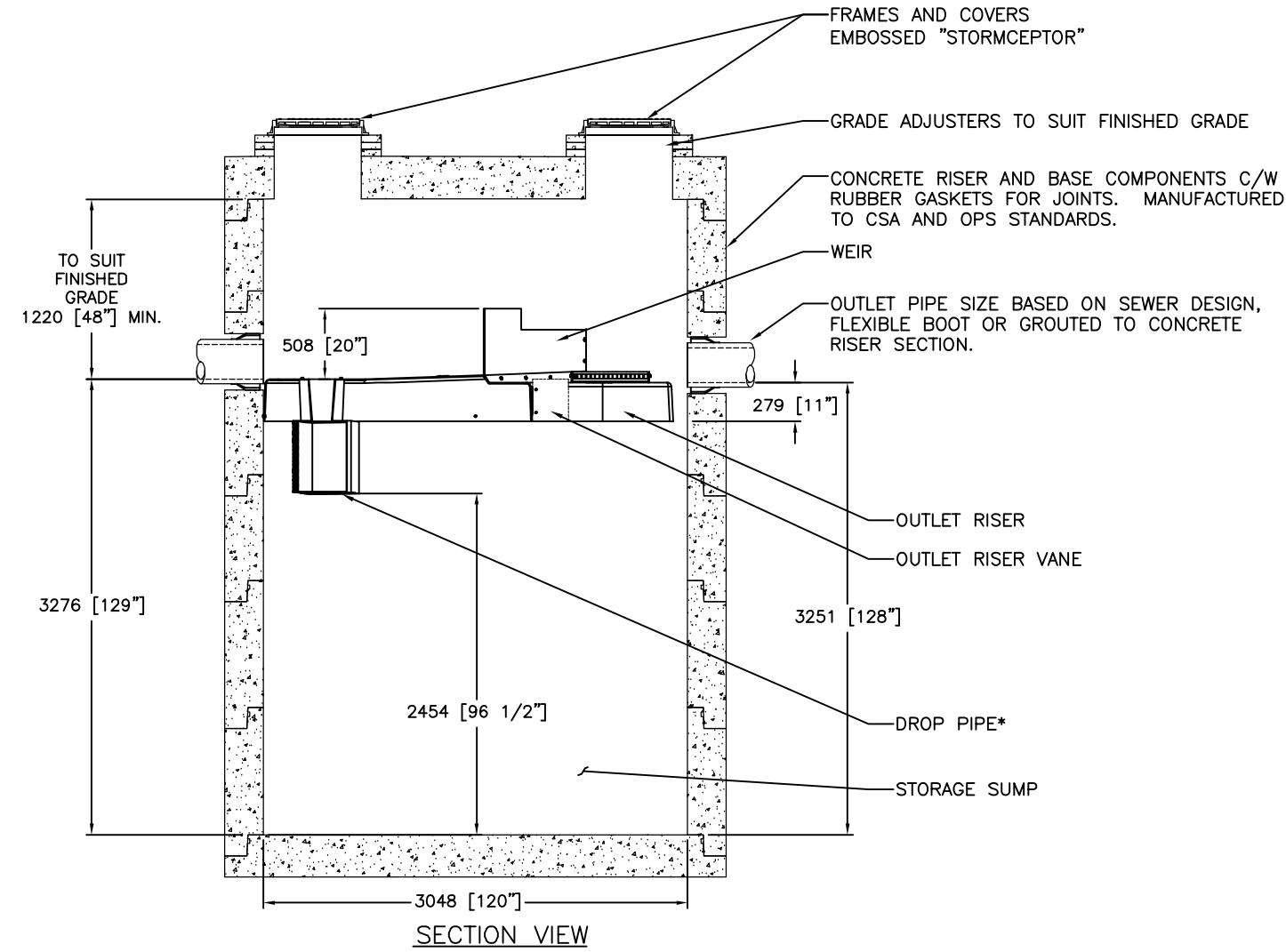
Inlet and outlet pipes shall be securely set using grout or approved pipe seals (flexible boot connections, where applicable) so that the structure is watertight. Non-secure inlets and outlets will result in improper performance.

#### **5.7 FRAME AND COVER OR FRAME AND GRATE INSTALLATION**

Precast concrete adjustment units shall be installed to set the frame and cover/grate at the required elevation. The adjustment units shall be laid in a full bed of mortar with successive units being joined using sealant recommended by the manufacturer. Frames for the cover/grate should be set in a full bed of mortar at the elevation specified.

5.7.1 A minimum of one cover, at least 22-inch (560 mm) in diameter, shall be clearly embossed with the OGS device brand or product name to properly identify this asset's purpose is for stormwater quality treatment.

# DRAWING NOT TO BE USED FOR CONSTRUCTION



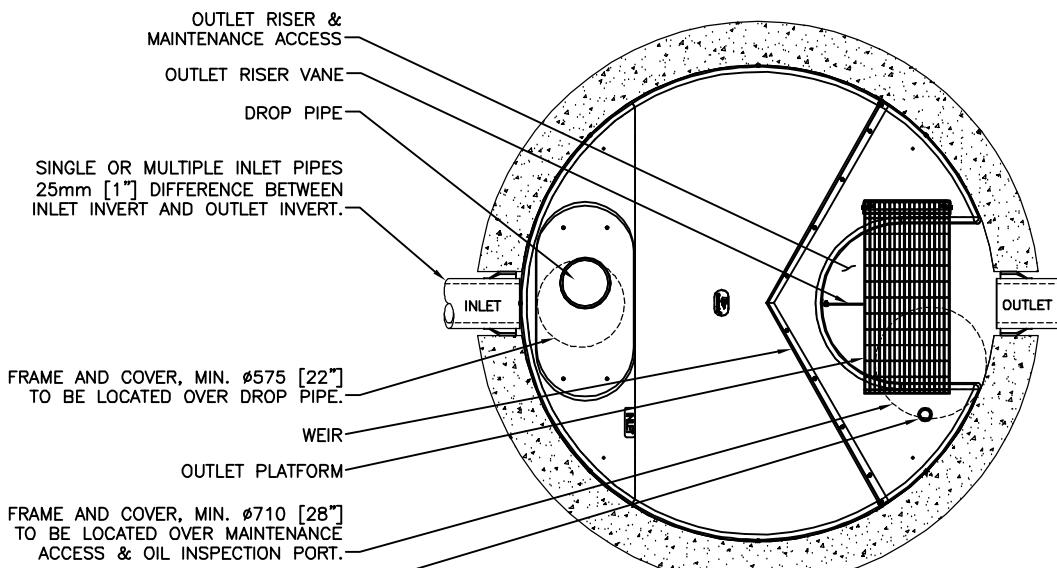
IMBRIUM PRODUCTS STORMCEPTOR® EF10 DRAWINGS & DETAILS STANDARD DETAIL DWG. 10/19/2018 8:38 AM

## GENERAL NOTES:

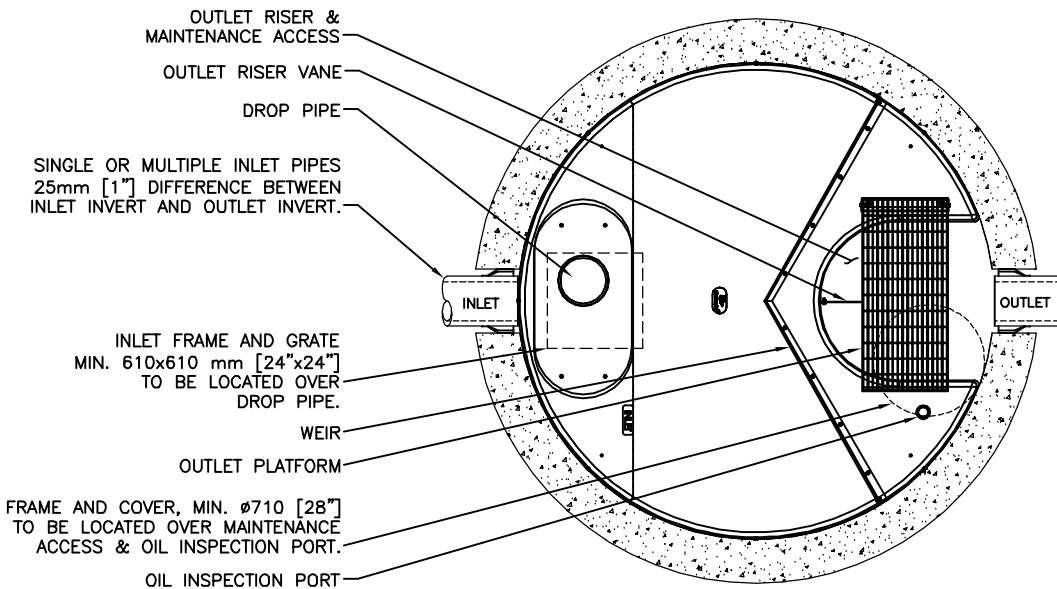
- \* MAXIMUM SURFACE LOADING RATE (SLR) INTO LOWER CHAMBER THROUGH DROP PIPE IS 1135 L/min/m<sup>2</sup> (27.9 gpm/ft<sup>2</sup>) FOR STORMCEPTOR EF10 AND 535 L/min/m<sup>2</sup> (13.1 gpm/ft<sup>2</sup>) FOR STORMCEPTOR EFO10 (OIL CAPTURE CONFIGURATION).
- 1. ALL DIMENSIONS INDICATED ARE IN MILLIMETERS (INCHES) UNLESS OTHERWISE SPECIFIED.
- 2. STORMCEPTOR STRUCTURE INLET AND OUTLET PIPE SIZE AND ORIENTATION SHOWN FOR INFORMATIONAL PURPOSES ONLY.
- 3. UNLESS OTHERWISE NOTED, BYPASS INFRASTRUCTURE, SUCH AS ALL UPSTREAM DIVERSION STRUCTURES, CONNECTING STRUCTURES, OR PIPE CONDUITS CONNECTING TO COMPLETE THE STORMCEPTOR SYSTEM SHALL BE PROVIDED AND ADDRESSED SEPARATELY.
- 4. DRAWING FOR INFORMATION PURPOSES ONLY. REFER TO ENGINEER'S SITE/UTILITY PLAN FOR STRUCTURE ORIENTATION.
- 5. NO PRODUCT SUBSTITUTIONS SHALL BE ACCEPTED UNLESS SUBMITTED 10 DAYS PRIOR TO PROJECT BID DATE, OR AS DIRECTED BY THE ENGINEER OF RECORD.

FOR SITE SPECIFIC DRAWINGS PLEASE CONTACT YOUR LOCAL STORMCEPTOR REPRESENTATIVE. SITE SPECIFIC DRAWINGS ARE BASED ON THE BEST AVAILABLE INFORMATION AT THE TIME. SOME FIELD REVISIONS TO THE SYSTEM LOCATION OR CONNECTION PIPING MAY BE NECESSARY BASED ON AVAILABLE SPACE OR SITE CONFIGURATION REVISIONS. ELEVATIONS SHOULD BE MAINTAINED EXCEPT WHERE NOTED ON BYPASS STRUCTURE (IF REQUIRED).

**STANDARD DETAIL  
NOT FOR CONSTRUCTION**



PLAN VIEW (STANDARD)



PLAN VIEW (INLET TOP)

## INSTALLATION NOTES

- A. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
- B. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE STRUCTURE (LIFTING CLUTCHES PROVIDED)
- C. CONTRACTOR WILL INSTALL AND LEVEL THE STRUCTURE, SEALING THE JOINTS, LINE ENTRY AND EXIT POINTS (NON-SHRINK GROUT WITH APPROVED WATERSTOP OR FLEXIBLE BOOT)
- D. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO PROTECT THE DEVICE FROM CONSTRUCTION-RELATED EROSION RUNOFF.
- E. DEVICE ACTIVATION, BY CONTRACTOR, SHALL OCCUR ONLY AFTER SITE HAS BEEN STABILIZED AND THE STORMCEPTOR UNIT IS CLEAN AND FREE OF DEBRIS.

## SITE SPECIFIC DATA REQUIREMENTS

STORMCEPTOR MODEL	EF10				
STRUCTURE ID					*
WATER QUALITY FLOW RATE (L/s)					*
PEAK FLOW RATE (L/s)					*
RETURN PERIOD OF PEAK FLOW (yrs)					*
DRAINAGE AREA (HA)					*
DRAINAGE AREA IMPERVIOUSNESS (%)					*
DATE:	5/26/2017				
DESIGNED:	JSK				
CHECKED:	BSF				
APPROVED:	SP				
PROJECT No.:	EF10				
SEQUENCE No.:	*				
SHEET:	1 OF 1				
* PER ENGINEER OF RECORD					

**Stormceptor® EF**

imbrium®

TORT RIDGE ROAD, SUITE 550, HANOVER, MD 21076  
USA 888.271.8420 CA 800.568.4501 INT'L +1 410.820.5810  
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JSK	####	####	####	####	BY
	####	####	####	####	
	####	####	####	####	
	####	####	####	####	
	####	####	####	####	

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**TABLE 5**  
**PRE-DEVELOPMENT MONTHLY WATER BALANCE**  
**220 Arkell Road, Guelph, Ontario**

Model Type: Thornthwaite and Mather (1955)

Client: Rockpoint Holdings

Total Site Area (ha) 7.16

Sub-Area Descriptions (topography, soils, cover)	
Sub-Area A (pre)	flat, silty sand, woodland (Wetland)
Sub-Area B (pre)	flat to gently rolling, silty sand, pastures and shrubs
Sub-Area C (pre)	rolling, silty sand, cultivated

Land Description Factors	Sub-Area A (pre)	Sub-Area B (pre)	Sub-Area C (pre)											Total
Topography	0.30	0.25	0.20											
Soils	0.40	0.40	0.40											
Cover	0.20	0.15	0.10											
Sum (Infiltration Factor) <sup>†</sup>	0.90	0.80	0.70											
Soil Moisture Capacity (mm)	300	150	150											
Site area (ha)	0.83	2.31	4.01											7.16
Imperviousness Coefficient	0.00	0.00	0.15											
Impervious Area (ha)	0.00	0.00	0.60											0.60
Percentage of Total Site Area	0.0%	0.0%	8.4%											8%
Remaining Pervious Area (ha)	0.83	2.31	3.41											6.56
Total Pervious Site Area (ha)	0.83	2.31	3.41											6.56
Percentage of Total Site Area	11.6%	32.3%	47.7%											92%

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
<b>Climate Data<sup>‡</sup></b>													
Average Daily Temperature (°C)	-6.5	-5.5	-1	6.2	12.5	17.6	20	18.9	14.5	8.2	2.5	-3.3	7.0
Precipitation (mm)	65.2	54.9	61	74.5	82.3	82.4	98.6	83.9	87.8	67.4	87.1	71.2	916

Potential Evapotranspiration Analysis for Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Heat Index	0.0	0.0	0.0	1.4	4.0	6.7	8.2	7.5	5.0	2.1	0.4	0.0	35
Unadjusted Potential Evapotranspiration (mm)	0.0	0.0	0.0	29.0	60.8	87.2	99.8	94.0	71.1	39.0	11.1	0.0	492
Potential Evapotranspiration Adjusting Factor for Latitude*	0.77	0.87	0.99	1.12	1.23	1.29	1.26	1.16	1.04	0.92	0.81	0.75	
Adjusted Potential Evapotranspiration (PET)(mm)	0	0	0	32	75	112	126	110	74	36	9	0	573
Precipitation - PET (mm)	65	55	61	42	8	-30	-27	-26	14	32	78	71	343

Evapotranspiration Analysis	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
<b>Sub-Area A (pre)</b>													
Precipitation (m <sup>3</sup> )	0	0	0	0	0	-30	-57	-82	-69	-37	0	0	7,605
Accumulated Potential Water Loss (APWL)	300	300	300	300	300	272	225	171	185	216	300	300	
Storage (S)	0	0	0	0	0	-28	-47	-54	14	32	84	0	
Change in Storage	0	0	0	0	0	0	0	0	0	0	0	0	
<b>Actual Evapotranspiration (mm)</b>	0	0	0	32	75	111	145	138	74	36	9	0	620
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	-6	71	296
Potential Infiltration (l)	59	49	55	38	7	0	0	0	0	0	-5	64	267
Potential Direct Surface Water Runoff (R)	7	5	6	4	1	0	0	0	0	0	-1	7	30
Potential Infiltration (mm)	0	0	0	265	7	0	0	0	0	0	-5	0	267
Pervious Evapotranspiration (m <sup>3</sup> )	0	0	0	270	620	919	1207	1144	615	297	75	0	5,147
Pervious Runoff (m <sup>3</sup> )	54	46	51	35	6	0	0	0	0	0	-5	59	246
Pervious Infiltration (m <sup>3</sup> )	0	0	0	2199	57	0	0	0	0	0	-43	0	2,213
Potential Impervious Evaporation (mm)	7	5	6	7	8	8	10	8	9	7	9	7	92
Potential Impervious Runoff (mm)	59	49	55	67	74	74	89	76	79	61	78	64	825
Impervious Runoff (m <sup>3</sup> )	0	0	0	0	0	0	0	0	0	0	0	0	0

**TABLE 5**  
**PRE-DEVELOPMENT MONTHLY WATER BALANCE**  
**220 Arkell Road, Guelph, Ontario**

Evapotranspiration Analysis													
Sub-Area B (pre)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Precipitation (m³)													21,191
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-69	-37	0	0	
Storage (S)	150	150	150	150	150	123	84	49	62	94	150	150	
Change in Storage	0	0	0	0	0	-27	-39	-36	14	32	56	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	109	137	120	74	36	9	0	592
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	22	71	324
Potential Infiltration (I)	52	44	49	34	6	0	0	0	0	0	18	57	259
Potential Direct Surface Water Runoff (R)	13	11	12	8	2	0	0	0	0	0	4	14	65
Potential Infiltration (mm)	0	0	0	235	6	0	0	0	0	0	18	0	259
Pervious Evapotranspiration (m³)	0	0	0	751	1728	2529	3177	2764	1714	828	208	0	13,699
Pervious Runoff (m³)	302	254	282	194	35	0	0	0	0	0	102	329	1,499
Pervious Infiltration (m³)	0	0	0	5445	140	0	0	0	0	0	408	0	5,994
Potential Impervious Evaporation (mm)	7	5	6	7	8	8	10	8	9	7	9	7	92
Potential Impervious Runoff (mm)	59	49	55	67	74	74	89	76	79	61	78	64	825
Impervious Runoff (m³)	0	0	0	0	0	0	0	0	0	0	0	0	0

Evapotranspiration Analysis													
Sub-Area C (pre)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Precipitation (m³)													36,787
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-69	-37	0	0	
Storage (S)	150	150	150	150	150	123	84	49	62	94	150	150	
Change in Storage	0	0	0	0	0	-27	-39	-36	14	32	56	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	109	137	120	74	36	9	0	592
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	22	71	324
Potential Infiltration (I)	46	38	43	29	5	0	0	0	0	0	15	50	227
Potential Direct Surface Water Runoff (R)	20	16	18	13	2	0	0	0	0	0	7	21	97
Potential Infiltration (mm)	0	0	0	206	5	0	0	0	0	0	15	0	227
Pervious Evapotranspiration (m³)	0	0	0	1108	2549	3732	4687	4078	2529	1222	307	0	20,213
Pervious Runoff (m³)	667	562	624	430	78	0	0	0	0	0	226	729	3,317
Pervious Infiltration (m³)	0	0	0	7031	181	0	0	0	0	0	527	0	7,739
Potential Impervious Evaporation (mm)	7	5	6	7	8	8	10	8	9	7	9	7	92
Potential Impervious Runoff (mm)	59	49	55	67	74	74	89	76	79	61	78	64	825
Impervious Evaporation (m³)	39	33	37	45	50	50	59	51	53	41	52	43	552
Impervious Runoff (m³)	353	298	331	404	446	447	534	455	476	365	472	386	4,966

Pre-Development Infiltration	15,946 (m³/yr)	223 mm/yr	0.5 L/s
Pre-Development Runoff	10,027 (m³/yr)	140 mm/yr	0.3 L/s
Pre-Development Evapotranspiration	39,610 (m³/yr)	553 mm/yr	1.3 L/s
Total	65,584 (m³/yr)	916 mm/yr	2.1 L/s
Precipitation	65,584 (m³/yr)	916 mm/yr	2.1 L/s

**Notes:**

† Infiltration factors after Ontario Ministry of the Environment, 2003. Stormwater Management Planning and Design Manual. March 2003.; and Ontario Ministry of Environment and Energy (MOEE). 1995. MOEE Hydrogeological Technical Information Requirements for Land Development Applications. April 1995.

\* PET adjustment factors after Thornthwaite, C.W., and J.R. Mather, 1957. Instructions and Tables for Computing Potential Evapotranspiration and the water balance. Drexel Institute of Technology, Laboratory of Climatology, Publications in Climatology, Volume X, No. 3. Centerton, New Jersey.

‡ Climate Data after Environment Canada, 2018. Canadian Climate Normals 1981-2010, Waterloo Wellington A Climate Station, Climate ID 6149387. [Online] [http://climate.weather.gc.ca/climate\\_normals/index\\_e.html](http://climate.weather.gc.ca/climate_normals/index_e.html)

**Assumptions:**

- [1] The monthly average precipitation collected at the Waterloo-Wellington A climate station is reflective of the precipitation trends that have historically occurred at the Site.
- [2] Surplus water is not available for runoff and recharge during months where water losses from actual evapotranspiration exceed precipitation inputs.
- [3] Runoff, infiltration and evapotranspiration do not occur in months where the average daily temperature is below 0°C, which is the case for the months of December through March at the Site.
- [4] Precipitation during freezing months (i.e., December to March) is assumed to accumulate as snow and result in additional precipitation in the first month thereafter where the average temperature is greater than 0°C (i.e., April).
- [5] Soil moisture capacity is at a maximum in April.

**TABLE 6**  
**POST-DEVELOPMENT MONTHLY WATER BALANCE**  
**220 Arkell Road, Guelph, Ontario**

Model Type: Thornthwaite and Mather (1955)  
Client: Rockpoint Holdings  
Total Site Area (ha) 7.16

Sub-Area Descriptions (topography, soils, cover)	
Sub-Area A (post)	flat, silty sand, woodland (Wetland)
Sub-Area B (post)	rolling, silty sand, cultivated
Sub-Area C (post)	rolling, silty sand, cultivated

Land Description Factors	Sub-Area A (post)	Sub-Area B (post)	Sub-Area C (post)									Total
Topography	0.30	0.25	0.20									
Soils	0.40	0.40	0.40									
Cover	0.20	0.15	0.10									
<b>Sum (Infiltration Factor)<sup>†</sup></b>	<b>0.90</b>	<b>0.80</b>	<b>0.70</b>									
Soil Moisture Capacity (mm)	300	150	100									
Site area (ha)	0.83	2.31	4.01									
Imperviousness Coefficient	0.00	0.10	0.65									
Impervious Area (ha)	0.00	0.22	2.60									
Percentage of Total Site Area	0.0%	3.1%	36.3%									
Remaining Pervious Area (ha)	0.83	2.09	1.42									
Total Pervious Site Area (ha)	0.83	2.09	1.42									
Percentage of Total Site Area	11.6%	29.2%	19.8%									

Climate Data <sup>‡</sup>	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average Daily Temperature (°C)	-6.5	-5.5	-1	6.2	12.5	17.6	20	18.9	14.5	8.2	2.5	-3.3	7.0
Precipitation (mm)	65.2	54.9	61	74.5	82.3	82.4	98.6	83.9	87.8	67.4	87.1	71.2	916

Potential Evapotranspiration Analysis for Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Heat Index	0.0	0.0	0.0	1.4	4.0	6.7	8.2	7.5	5.0	2.1	0.4	0.0	35
Unadjusted Potential Evapotranspiration (mm)	0.0	0.0	0.0	29.0	60.8	87.2	99.8	94.0	71.1	39.0	11.1	0.0	492
Potential Evapotranspiration Adjusting Factor for Latitude*	0.77	0.87	0.99	1.12	1.23	1.29	1.26	1.16	1.04	0.92	0.81	0.75	
Adjusted Potential Evapotranspiration (PET)(mm)	0	0	0	32	75	112	126	110	74	36	9	0	573
Precipitation - PET (mm)	65	55	61	42	8	-30	-27	-26	14	32	78	71	343

Evapotranspiration Analysis	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Sub-Area A (post)	0	0	0	0	0	-30	-57	-82	-69	-37	0	0	
Accumulated Potential Water Loss (APWL)	300	300	300	300	300	272	225	171	185	216	300	300	
Storage (S)	0	0	0	0	0	-28	-47	-54	14	32	84	0	
Change in Storage	0	0	0	0	0	0	0	0	0	0	0	0	
<b>Actual Evapotranspiration (mm)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>32</b>	<b>75</b>	<b>111</b>	<b>145</b>	<b>138</b>	<b>74</b>	<b>36</b>	<b>9</b>	<b>0</b>	<b>620</b>
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	0	-6	71	296
Potential Infiltration (I)	59	49	55	38	7	0	0	0	0	0	-5	64	267
Potential Direct Surface Water Runoff (R)	7	5	6	4	1	0	0	0	0	0	-1	7	30
Potential Infiltration (mm)	0	0	0	265	7	0	0	0	0	0	-5	0	267
Pervious Evapotranspiration (m <sup>3</sup> )	0	0	0	270	620	919	1207	1144	615	297	75	0	5,147
<b>Pervious Runoff (m<sup>3</sup>)</b>	<b>54</b>	<b>46</b>	<b>51</b>	<b>35</b>	<b>6</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>-5</b>	<b>59</b>	<b>246</b>
<b>Pervious Infiltration (m<sup>3</sup>)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2199</b>	<b>57</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>-43</b>	<b>0</b>	<b>2,213</b>
Potential Impervious Evaporation (mm)	7	5	6	7	8	8	10	8	9	7	9	7	92
Potential Impervious Runoff (mm)	59	49	55	67	74	74	89	76	79	61	78	64	825
<b>Impervious Runoff (m<sup>3</sup>)</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

**TABLE 6**  
**POST-DEVELOPMENT MONTHLY WATER BALANCE**  
**220 Arkell Road, Guelph, Ontario**

Evapotranspiration Analysis													
Sub-Area B (post)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-69	-37	0	0	
Storage (S)	150	150	150	150	150	123	84	49	62	94	150	150	
Change in Storage	0	0	0	0	0	-27	-39	-36	14	32	56	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	109	137	120	74	36	9	0	592
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	22	71	324	
Potential Infiltration (l)	52	44	49	34	6	0	0	0	0	0	18	57	
Potential Direct Surface Water Runoff (R)	13	11	12	8	2	0	0	0	0	0	4	14	
Potential Infiltration (mm)	0	0	0	235	6	0	0	0	0	0	18	0	
Pervious Evapotranspiration (m³)	0	0	0	679	1562	2287	2872	2499	1549	749	188	0	
Pervious Runoff (m³)	273	230	255	176	32	0	0	0	0	0	92	298	
Pervious Infiltration (m³)	0	0	0	4923	127	0	0	0	0	0	369	0	
Potential Impervious Evaporation (mm)	7	5	6	7	8	8	10	8	9	7	9	7	
Potential Impervious Runoff (mm)	59	49	55	67	74	74	89	76	79	61	78	64	
Impervious Runoff (m³)	130	110	122	149	164	165	197	168	175	135	174	142	
Evapotranspiration Analysis													
Sub-Area C (post)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Accumulated Potential Water Loss (APWL)	0	0	0	0	0	-30	-57	-82	-69	-37	0	0	
Storage (S)	100	100	100	100	100	74	42	18	32	64	100	100	
Change in Storage	0	0	0	0	0	-26	-32	-24	14	32	36	0	
Actual Evapotranspiration (mm)	0	0	0	32	75	108	131	108	74	36	9	0	573
Recharge/Runoff Analysis													
Water Surplus (mm)	65	55	61	42	8	0	0	0	0	42	71	344	
Potential Infiltration (l)	46	38	43	29	5	0	0	0	0	0	29	50	
Potential Direct Surface Water Runoff (R)	20	16	18	13	2	0	0	0	0	0	13	21	
Potential Infiltration (mm)	0	0	0	206	5	0	0	0	0	0	29	0	
Pervious Evapotranspiration (m³)	0	0	0	460	1057	1530	1851	1522	1049	507	127	0	
Pervious Runoff (m³)	277	233	259	178	32	0	0	0	0	0	178	302	
Pervious Infiltration (m³)	0	0	0	2916	75	0	0	0	0	0	415	0	
Potential Impervious Evaporation (mm)	7	5	6	7	8	8	10	8	9	7	9	7	
Potential Impervious Runoff (mm)	59	49	55	67	74	74	89	76	79	61	78	64	
Impervious Runoff (m³)	1525	1284	1427	1743	1925	1928	2307	1963	2054	1577	2038	1666	
Rooftop Recharge													
Rooftop Recharge	411	346	384	469	518	519	621	528	553	425	549	448	
SWMF Recharge													
SWMF Recharge					489	586	498	522	400	579		3,075	

Post-Development Infiltration (no mitigation)	11,038	(m³/yr)	154	mm/yr	0.3	L/s
Post-Development Runoff (no mitigation)	26,327	(m³/yr)	368	mm/yr	0.8	L/s
Infiltration Deficit	4,908	(m³/yr)	69	mm/yr	0.2	L/s
Rooftop Recharge	5,771	(m³/yr)	81	mm/yr	0.2	L/s
Infiltration Deficit with Rooftop Galleries	-863	(m³/yr)	-12	mm/yr	0.0	L/s
SWMF Recharge	3,075	(m³/yr)	43	mm/yr	0.1	L/s
Total Infiltration with Recharge	19,884	(m³/yr)	278	mm/yr	0.6	L/s
Infiltration Deficit with Rooftop Galleries + SWMF	-3,938	(m³/yr)	-55	mm/yr	-0.1	L/s
Infiltration						
Post-Development Runoff (with mitigation)	17,481	(m³/yr)	244	mm/yr	0.6	L/s
Runoff surplus	7,453	(m³/yr)	104	mm/yr	0.2	L/s
Post-Development Evapotranspiration						
Evapotranspiration Deficit	28,219	(m³/yr)	394	mm/yr	0.9	L/s
Evapotranspiration Deficit	11,391	(m³/yr)	159	mm/yr	0.4	L/s

Sub-Area Descriptions (topography, soils, cover)			
Sub-Area A (post)	flat, silty sand, woodland (Wetland)		
Sub-Area B (post)	rolling, silty sand, cultivated		
Sub-Area C (post)	rolling, silty sand, cultivated		

**Notes:**

† Infiltration factors after Ontario Ministry of the Environment, 2003. Stormwater Management Planning and Design Manual. March 2003.; and Ontario Ministry of Environment and Energy (MOEE). 1995.

MOEE Hydrogeological Technical Information Requirements for Land Development Applications. April 1995.

\* PET adjustment factors after Thornthwaite, C.W., and J.R. Mather, 1957. Instructions and Tables for Computing Potential Evapotranspiration and the water balance. Drexel Institute of Technology, Laboratory of Climatology, Publications in Climatology, Volume X. No. 3. Centerton, New Jersey.

‡ Climate Data after Environment Canada, 2018. Canadian Climate Normals 1981-2010, Waterloo Wellington A Climate Station, Climate ID 6149387. [Online] [http://climate.weather.gc.ca/climate\\_normals/index\\_e.html](http://climate.weather.gc.ca/climate_normals/index_e.html)

**Assumptions:**

[1] The monthly average precipitation collected at the Waterloo-Wellington A climate station is reflective of the precipitation trends that have historically occurred at the Site.

[2] Surplus water is not available for runoff and recharge during months where water losses from actual evapotranspiration exceed precipitation inputs.

[3] Runoff, infiltration and evapotranspiration do not occur in months where the average daily temperature is below 0°C, which is the case for the months of December through March at the Site.

[4] Precipitation during freezing months (i.e., December to March) is assumed to accumulate as snow and result in additional precipitation in the first month thereafter where the average temperature is greater than 0°C (i.e., April).

[5] Soil moisture capacity is at a maximum in April.

November 5, 2018  
File: 161413338/11

**Attention: Mr. Jim Hall, P. Eng., Development Infrastructure Engineer**

City of Guelph  
Engineering and Capital Infrastructure  
Services Department  
1 Carden Street  
Guelph ON N1H 3A1

Dear Mr. Hall,

**Reference: 220 Arkell Road – Response to Stormwater Management  
City Comments Dated July 19, 2018**

The purpose of this letter is to respond to City comments dated July 19, 2018, specifically related to the proposed interim stormwater management (SWM) for the development (hereafter referred to as the 'site'). Stantec Consulting Ltd. (Stantec) met with City of Guelph (City) staff on September 10, 2018 to review the comments and to establish a general approach to the response. This letter addresses the analysis that was completed to ensure no negative impacts occur to the SWM design for the neighbouring Subdivision to the south, Arkell Meadows, following construction of the proposed interim access road to the 220 Arkell site.

## 1.0 BACKGROUND

Following the meeting on September 10, 2018, City staff requested that Stantec analyze the existing infiltration/SWM strategy for Arkell Meadows as the proposed alignment for the interim emergency access road passes over an Open Space Block (Block 20). A copy of the *Arkell Meadows Final Stormwater Management (FSWM) and Servicing Report* (KJ Behm and Associates, 2013) was obtained from the City to determine pre-development and current conditions and should be read in conjunction with this letter.

## 2.0 PRE-DEVELOPMENT AND CURRENT CONDITIONS

Under pre-development conditions, Block 20 is identified as a 'dead-end drainage' feature and provides additional recharge for the site (consistent with the Torrance Creek Subwatershed Study). The current Arkell Meadows design is illustrated on the attached Drawing H-1. An infiltration gallery receiving runoff from Lots 1-12 and Block 20 stretches along the rearyards of these lots and extends into Block 20. Under current conditions, Block 20 is 'Open Space' with no impervious coverage. According to the Arkell Meadows FSWM design and grading, the majority of Block 20 drains to a catchbasin located in the northwest corner of the Block which is connected to the rearyard infiltration gallery. Block 20 is part of Catchment 13 (from the hydrologic model MIDUSS) from the post-development drainage conditions which also includes parts of Lots 6-12. The hydrologic model presents Catchment 13 as 0.35 ha of residential area with an assumed 70% impervious coverage. The current Drainage Plan is attached and please refer to the original FSWM Report for the MIDUSS model output. Catchment 13 from the MIDUSS model seems to be a combination of Catchments 11, 12, 13, and 14 illustrated on the Drainage Plan. Please note the current MIDUSS parameters and catchment areas do not match the current Drainage Plan; however, the Plan has been included to give a general illustration of current drainage ditch.

The current Arkell Meadows SWM strategy uses a treatment train approach to provide water quality and water quantity control and maintains existing recharge volumes through several design infiltration components:

- Lot Level Controls: infiltration galleries in the rearyards of Lots 1-12
- Conveyance Controls: roadside catchbasins with sumps, oil/grit separator (OGS) units, sand filters, and vegetation at outlet points from the site
- End-of-Pipe Controls: a SWM facility providing polishing of runoff through interaction with vegetation as well as an infiltration system with a sand filter bottom to provide recharge and separate contaminants from runoff

November 5, 2018

Mr. Jim Hall, P. Eng., Development Infrastructure Engineer

Page 2 of 4

Reference: 220 Arkell Road – Response to Stormwater Management City Comments Dated July 19, 2018

### **3.0 PROPOSED CONDITIONS**

A proposed emergency access road alignment extends from Dawes Avenue through Block 20 to the north, ultimately connecting to the site as illustrated on Drawing C-400. This connection is for emergency access only and regular vehicular traffic is not anticipated to occur.

The interim emergency access road is a 10 m wide asphalt road and extends from Dawes Avenue into the site through Block 20 of the Arkell Meadows Subdivision. Ultimately, the width of the road/trail will be reduced to a 4 m asphalt trail for pedestrian use and maintenance access further north in the park area; however, for the purposes of this assessment it is assumed the 10 m road is the ultimate condition.

As a result of this proposal, the following tasks were completed to ensure the continued functioning of the Arkell Meadows hydrology and SWM system:

- Review the current Arkell Meadows Subdivision infiltration/SWM design for proposed conditions
- Ensure the water quantity control for the site is maintained under proposed conditions
- Ensure water quality treatment is provided for the proposed development

#### **3.1 WATER BALANCE, INFILTRATION AND WATER QUANTITY CONTROL**

The Arkell Meadows Subdivision maintains a groundwater recharge water balance by directing rooftop runoff to a rearyard infiltration gallery and all other post-development runoff to a SWM facility for filtration and ultimately infiltration. The drainage strategy also promotes evapotranspiration (ET) in the pond to enhance the post-development ET volumes.

Given the location of the proposed access road, the removal of the existing RYCB 32 receiving drainage from Block 20 (northwest corner of the Block) and connecting into the infiltration gallery is expected. To maintain drainage to the infiltration gallery, the proposed access road is super-elevated on the west side to direct drainage to the east to the grassed swale on the property line between Lot 12 and Block 20. Runoff drains north along this grassed area to a future catchbasin (CB) which will connect to the infiltration gallery. The proposed access road increases the impervious coverage on Block 20; however, as shown on the attached water balance calculation, the change to the ET and recharge components of the balance is negligible.

The table below illustrates the results of the post-development water balance analysis for Arkell Meadows. The full analysis is attached.

**Table 1: Summary of 2013 Water Balance for Arkell Meadows Subdivision**

Water Balance Component	Pre-Development	Current Conditions	Proposed Access Road
Evapotranspiration (mm/year)	600	419	416
Recharge (mm/year)	300	474	476
Runoff (mm/year)	17	24	25
Total Precipitation (mm/year)	917	917	917

Following construction of the access road, additional drainage is directed to the infiltration system for groundwater recharge; however, the increase in impervious coverage reduces the ET and increases the runoff (as expected). Under these proposed conditions and compared to the current conditions, the design has an ET reduction of 3 mm/year (0.7%), a recharge increase of 2 mm/year (0.4%), and a runoff increase of 1 mm/year (4%). Given

November 5, 2018

Mr. Jim Hall, P. Eng., Development Infrastructure Engineer

Page 3 of 4

**Reference:** 220 Arkell Road – Response to Stormwater Management City Comments Dated July 19, 2018

these relatively small changes, no negative impact to the local water balance is anticipated following construction of the proposed access road.

The SWM facility and rearyard infiltration system provide water quantity control for the site. The hydrologic model MIDUSS was used in the FSWM Report and has been recreated for the catchment in which the proposed access road is located (Catchment 13) to illustrate the impact on the gallery capacity. The additional impervious area from the proposed access road increases the impervious area to the infiltration gallery; however, the current design volume of the gallery has sufficient capacity to infiltrate all runoff up to and including the 1:100-year return period design storm. The supporting MIDUSS output is attached for reference.

The future site development at 220 Arkell Road, located north of the Arkell Meadows Subdivision, will also maintain surface water flows to the wetland to the west by installing a culvert under the proposed access road. A low area exists near the property line between 220 Arkell and Arkell Meadows, immediately north of Block 20 and Lot 12. Surface flow from this low area will be directed west under the proposed access road as illustrated on Drawing C-400. The culvert conveys surface water runoff from the future 220 Arkell Road development; however, in the event of overflows from the Arkell Meadows Subdivision, the culvert conveys water away from the existing subdivision and towards the wetland. The specific discharge and volume details flowing to the culvert will be provided at the detailed design stage.

### **3.2 WATER QUALITY CONTROL**

A treatment train approach consisting of lot level controls, conveyance controls, and end-of-pipe controls provides water quality for the site. These controls include vegetation, infiltration, and groundwater recharge. A similar approach is recommended for the proposed access road in the form of conveyance controls and end-of-pipe controls. The proposed access road is super-elevated and drains east to a grassed swale. The swale provides conveyance control as runoff drains north along the property line between Block 20 and Lot 12. Water quality benefits of the proposed grassed swale are also achieved as a result of the runoff / vegetation interaction which slows the velocity of runoff, as compared to a piped system, thereby promoting the sedimentation of particulate matter in the swale. The vegetation also provides nutrient uptake benefits to help reduce biological pollutants such as nitrogen and phosphorous. According to the *Low Impact Development SWM Planning and Design Manual* (CVC/TRCA, 2010), grassed swales provide a median sediment removal rate of 76%. In addition to conveyance control, it is recommended a CB insert (CB Shield or equivalent) is installed in the proposed CB as an end-of-pipe treatment prior to infiltrating in the rearyard gallery. Sediment removal rates for CB Shields range between 25.2 - 64% depending on inflow rates from the Environmental Technology Verification (ETV) testing specifications (please refer to CB Shield Website for details of the ETV Report). The combined minimum sediment removal rate is therefore 82% (76% plus an additional 25.2% of the remaining sediment). In addition, given the proposed access road is for emergency use only and its future use is a Public trail only, limited vehicular traffic is expected. Any water quality treatment strategies are expected to be more than sufficient for the limited sediment and oil/grit build-up on the road itself and in the runoff.

Drawing C-400 illustrates the proposed grading and drainage patterns in Block 20.

November 5, 2018

Mr. Jim Hall, P. Eng., Development Infrastructure Engineer

Page 4 of 4

Reference: 220 Arkell Road – Response to Stormwater Management City Comments Dated July 19, 2018

#### 4.0 SUMMARY

The following SWM strategies are proposed to maintain the Arkell Meadows hydrologic regime:

- Super-elevate access road to direct all runoff towards a grassed swale conveying runoff north between Block 20 and Lot 12 to a proposed catchbasin at the north property limits of Arkell Meadows
- Maintain water balance for the site by directing access road runoff to the proposed catchbasin which is connected to the existing infiltration gallery
- Install a culvert under the proposed access road near the property line between the future 220 Arkell Road Development and the existing Arkell Meadows Subdivision to maintain surface water flows to the wetland to the west
- Provide water quality treatment through the combination of a grassed swale (conveyance control) and a catchbasin insert (end-of-pipe) prior to infiltration to the existing gallery. Vehicular traffic is expected during emergency situations, only, so the runoff water quality should have limited sediment and oil/grit which is typical of heavily-used roads

No negative impacts to the stormwater management system for Arkell Meadows Subdivision are anticipated from the implementation of the proposed emergency access road.

If you have any questions or would like to clarify anything within this proposal, please do not hesitate to contact the undersigned.

Regards,

**Stantec Consulting Ltd.**



**Trevor Fraser** P.Eng.

Surface Water Resources Engineer

Phone: (519) 575-4120

trevor.fraser@stantec.com

Attachment: Arkell Meadows Drawing H-1

Arkell Meadows Current Drainage Plan

Arkell Meadows Current MIDUSS Model

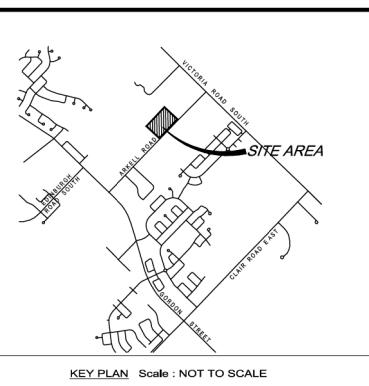
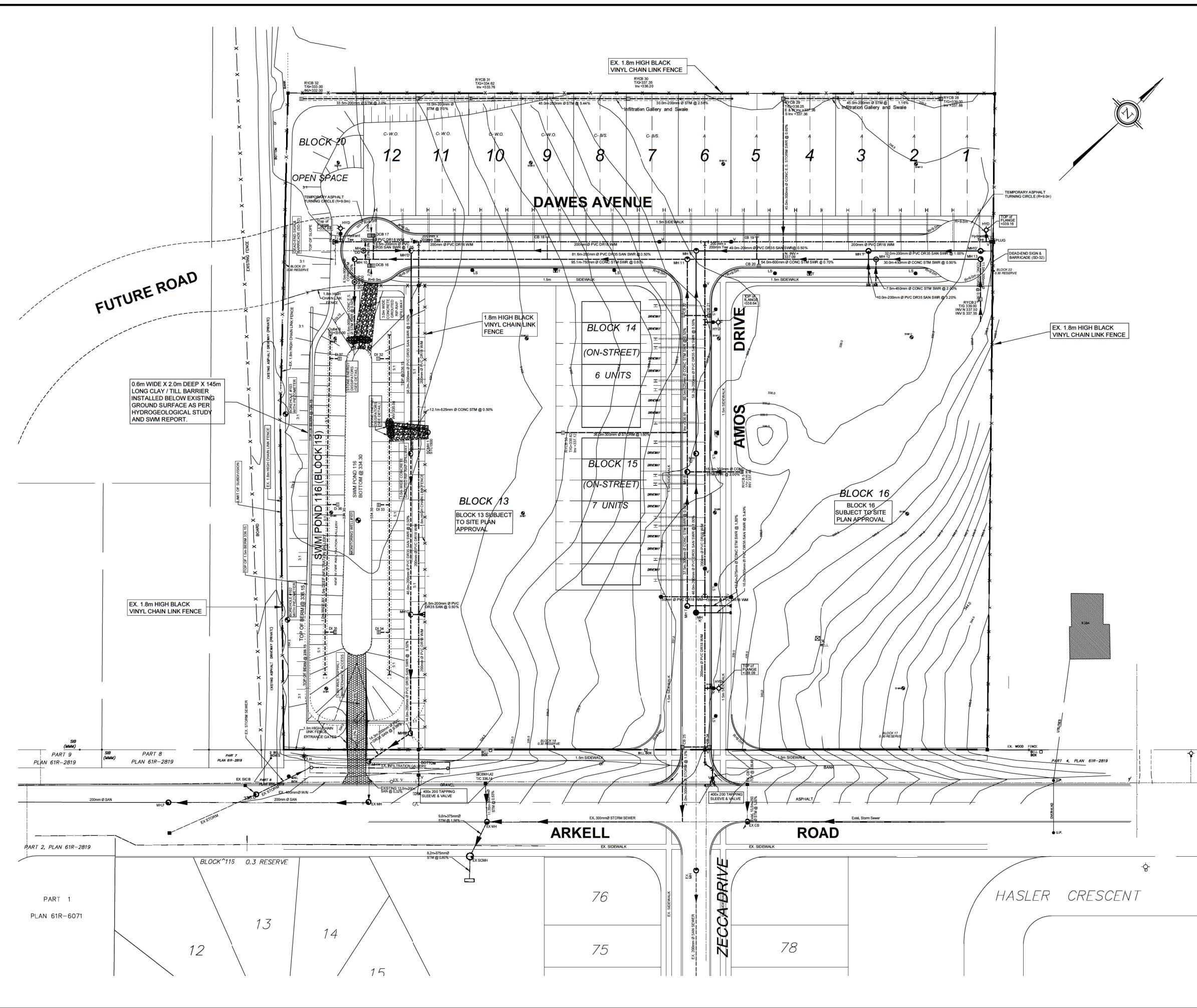
Proposed Drawing C-400

Water Balance – Pre-Development, Current, Proposed

Proposed MIDUSS Model

c. Mr. Carson Reid, Rockpoint Properties Inc.

Mr. Kevin Brousseau / Ms. Melissa Straus, Stantec Consulting Ltd.



GEND

The legend includes the following entries:

- CATCH BASIN**: Represented by a square symbol.
- WATERMAIN**: Represented by a solid line with a circle at the end.
- SANITARY SEWER**: Represented by a dashed line with a heart shape at the end.
- STORM SEWER**: Represented by a solid line with a circle containing a cross at the end.
- VALVE**: Represented by a solid line with a circle containing a dot at the end.
- LIGHT STANDARD**: Represented by a solid line with a circle containing a vertical bar at the end.
- TRANSFORMER**: Represented by a square symbol with a diagonal line through it.

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  
OR POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED.  
BEFORE STARTING WORK, THE CONTRACTOR SHALL INFORM HIMSELF OF THE  
EXACT LOCATION OF SUCH UTILITIES AND STRUCTURES, AND SHALL ASSUME  
LIABILITY FOR DAMAGE TO THEM.

GENERAL NOTES:  
NOTES: PLAN REFERENCES:  
MARK No. 392 ELEVATION: 336.245  
REFERENCES: TRAFFIC CONTROL BOX PAD SW  
10MME 2014-15 LAND AND HOSPITAL RD

04/14	GENERAL REVISIONS	KJB
11/13	MHS 'C, 'F, '2.7, 'K' RELOCATED	KJB
07/13	ISSUED FOR TENDER	KJB
06/13	GENERAL REVISIONS	KJB
04/13	GENERAL REVISIONS	KJB
02/13	GENERAL REVISIONS	KJB
DATE	DESCRIPTION	KJB

**SCHEDULE OF REVISIONS**

**CITY OF  
Guelph**

**ARKELL MEADOWS  
SUBDIVISION  
GUELPH ONTARIO**

## **GENERAL SERVICING PLAN**

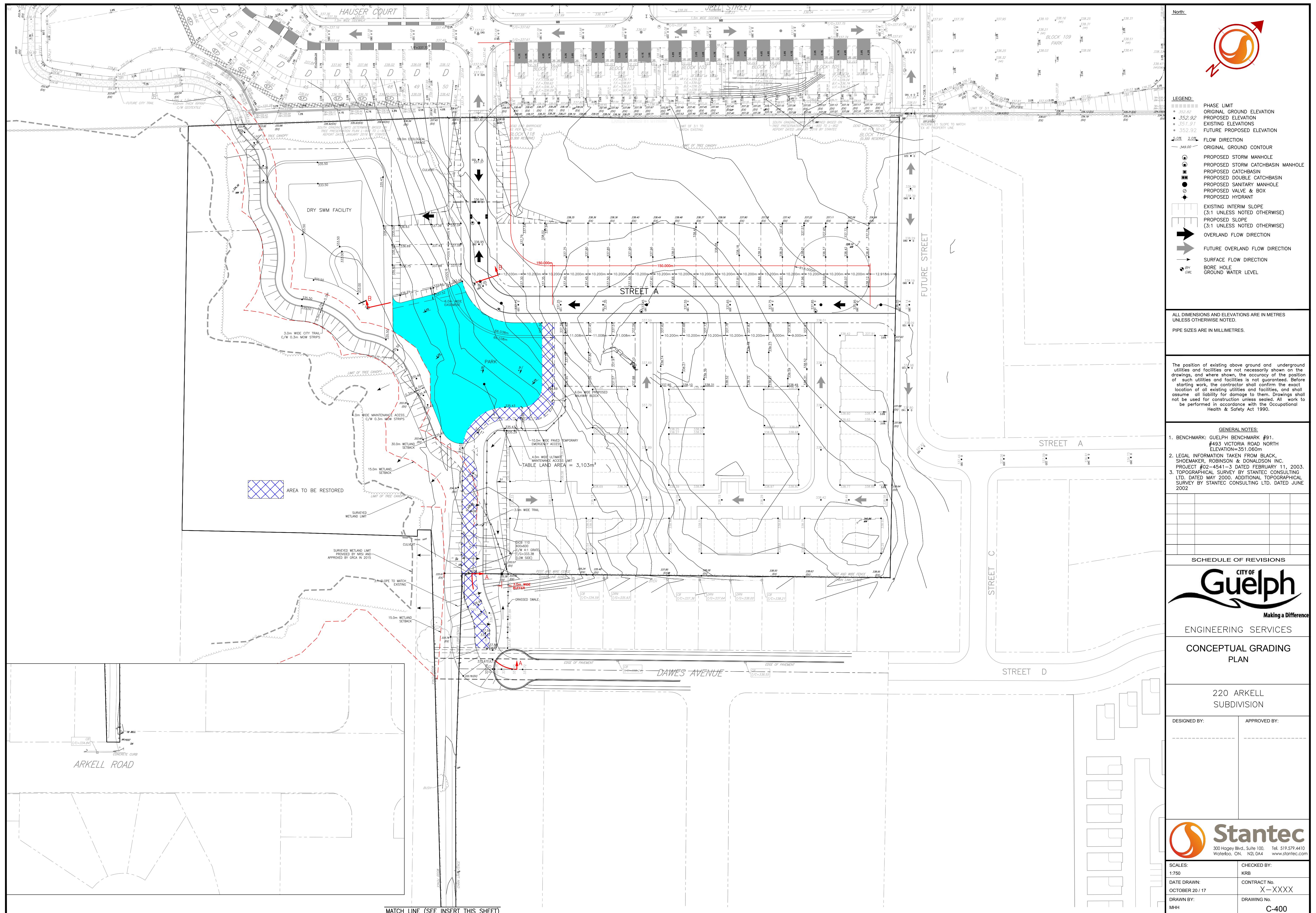


APPROVED:

**K. J. BEHM AND ASSOCIATES INC.**  
**CONSULTING ENGINEERS**  
55 ERB STREET EAST, SUITE 320  
WATERLOO, ONTARIO N2J 4K8  
PHONE (519) 742 3510 FAX (519) 742 3462

ED BY: KJB	SCALES Hor.=1:500 Vert.=1:50	DRAWING. NO.  H-1
N BY: SMS	DATE DRAWN: SEPT 2009	
ED BY: KJB	CONTRACT NO.: 2-1311	





### Monthly Water Balance Analysis

16141338 - 220 Arkell Road - Interim Access Road Analysis  
Pre-Development Conditions - KJ Behm, 2010 Analysis

#### Land Cover Descriptions

Pasture and grasses

Silt/Sand loam

Hilly

Main Site Area (ha) **4.3**  
Impervious

Land Description Factors		Impervious	Perm. Pool
Topography	0.10	-	-
Soils	0.30	-	-
Cover	0.15	-	-
Sum (Infiltration Factor)	0.55	-	-
Soil Moisture Capacity (mm)	250	-	-
Site Area	4.30	0.00	0
Percentage of Total Site Area	100%	0%	0%

100% OK

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Comment
<b>Climate Data (Data from Waterloo-Wellington Station - Climate Normals from 1966-1990)</b>														
Average Daily Temperature (°C)	-7.3	-6.8	-1.5	5.8	12.5	17.0	19.9	18.7	14.3	8.0	2.5	-4.0		
Precipitation (mm)	54.3	55.6	72.7	72.6	76.3	79.5	90.4	93.3	89.6	70.4	83.1	79.2	917.0	Daily average temperature in each month
<b>Evapotranspiration Analysis</b>														
PET (Thornthwaite, 1948) (mm/month)	0.0	0.0	0.0	30.2	75.1	104.7	124.1	107.7	70.8	35.6	9.1	0.0	557.3	Expected ET for 917 mm of annual rainfall per unit area of pervious area (zero impervious coverage)
Precipitation - PET (mm)	54.3	55.6	72.7	42.4	1.2	-25.2	-33.7	-14.4	18.8	34.8	74.0	79.2		
Accumulated Water Loss (mm)						-25.20	-58.90	-73.30						
Moisture Retention (mm)	250.0	250.0	250.0	250.0	250.0	226.0	196.0	186.0	204.8	239.6	250.0	250.0		From Table 30 of Thornthwaite and Mather, Instructions and Tables for Computing PET and the Water Balance (1957)
Change in Soil Moisture (mm)	0.0	0.0	0.0	0.0	0.0	-24.0	-30.0	-10.0	18.8	34.8	10.4	0.0		
<b>Actual Evapotranspiration (mm)</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>30.2</b>	<b>75.1</b>	<b>103.5</b>	<b>120.4</b>	<b>103.3</b>	<b>70.8</b>	<b>35.6</b>	<b>9.1</b>	<b>0.0</b>	<b>548.0</b>	
<b>Volume-Based Balance (m³)</b>														
Precipitation	2,335	2,391	3,126	3,122	3,281	3,419	3,887	4,012	3,853	3,027	3,573	3,406	39,431	917 mm/year
Evapotranspiration <sup>1</sup>	0	0	0	1,299	3,229	4,451	5,177	4,442	3,044	1,531	391	0	23,564	548 mm/year
Pervious Runoff	0	0	0	5,886	23	-464	-581	-194	364	673	1,432	0	7,140	166 mm/year
Impervious Runoff	0	0	0	0	0	0	0	0	0	0	0	0	0	0 mm/year
Total Runoff	0	0	0	5,886	23	-464	-581	-194	364	673	1,432	0	7,140	166 mm/year
Groundwater Recharge	0	0	0	7,194	28	-568	-710	-237	445	823	1,750	0	8,727	203 mm/year
<b>Recharge/Runoff Analysis</b>														
Surplus/Deficit	54.3	55.6	72.7	42.4	1.2	-24.0	-30.0	-10.0	18.8	34.8	74.0	79.2	369.0	
Weighted Infiltration Factor	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55		Based on MOE SWM Manual (2003)
Runoff (mm)	0.0	0.0	0.0	136.9	0.5	-10.8	-13.5	-4.5	8.5	15.7	33.3	0.0	166.1	
Recharge (mm)	0.0	0.0	0.0	167.3	0.7	-13.2	-16.5	-5.5	10.3	19.1	40.7	0.0	203.0	
Recharge (mm)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
<b>Dead-End Drainage Area<sup>2</sup></b>														
<i>Split total runoff from site into ET, recharge, runoff due to 'dead-end drainage' feature</i>														
Adjusted Runoff (10% of runoff)	0	0	0	589	2	-46	-58	-19	36	67	143	0	714	17 mm/year
Adjusted Recharge (60% of runoff)	0	0	0	10,638	42	-839	-1,049	-350	657	1,217	2,588	0	12,904	300 mm/year
Adjusted ET (30% of runoff)	0	0	0	3,153	3,237	4,304	4,994	4,381	3,159	1,743	842	0	25,813	600 mm/year

### Monthly Water Balance Analysis

16141338 - 220 Arkell Road - Interim Access Road Analysis  
Current Conditions - KJ Behm, 2010 Analysis

#### Land Cover Descriptions

Pasture and grasses Silt/Sand loam

Hilly

Main Site Area (ha)	3.5	See notes
Impervious Cover	50%	See notes
Land Description Factors		
Topography	0.10	-
Soils	0.30	-
Cover	0.15	-
Sum (Infiltration Factor)	0.55	-
Soil Moisture Capacity (mm)	50	-
Site Area	1.75	1.75
Percentage of Total Site Area <sup>2</sup>	50%	50% 0%

100% OK

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Comment
<b>Climate Data</b> (Data from Waterloo-Wellington Station - Climate Normals from 1966-1990)														
Average Daily Temperature (°C)	-7.3	-6.8	-1.5	5.8	12.5	17.0	19.9	18.7	14.3	8.0	2.5	-4.0		
Precipitation (mm)	54.3	55.6	72.7	72.6	76.3	79.5	90.4	93.3	89.6	70.4	83.1	79.2	917.0	Daily average temperature in each month
<b>Evapotranspiration Analysis</b>														
PET (Thornthwaite, 1948) (mm/month)	0.00	0.00	0.00	30.20	75.10	104.70	124.10	107.70	70.80	35.60	9.10	0.00	557.3	Expected ET for 917 mm of annual rainfall per unit area of pervious area (zero impervious coverage)
Precipitation - PET (mm)	54.3	55.6	72.7	42.4	1.2	-25.2	-33.7	-14.4	18.8	34.8	74.0	79.2		
Accumulated Water Loss (mm)						-25.2	-58.9	-73.3						From Table 30 of Thornthwaite and Mather, Instructions and Tables for Computing PET and the Water Balance (1957)
Moisture Retention (mm)	250.0	250.0	250.0	250.0	250.0	226.0	196.0	186.0	204.8	239.6	250.0	250.0		
Change in Soil Moisture (mm)	0.0	0.0	0.0	0.0	0.0	-24.0	-30.0	-10.0	18.8	34.8	10.4	0.0		
<b>Actual Evapotranspiration (mm)</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>30.2</b>	<b>75.1</b>	<b>103.5</b>	<b>120.4</b>	<b>103.3</b>	<b>70.8</b>	<b>35.6</b>	<b>9.1</b>	<b>0.0</b>	<b>548.0</b>	
<b>Volume-Based Balance (m<sup>3</sup>)</b>														
Precipitation	1,901	1,946	2,545	2,541	2,671	2,783	3,164	3,266	3,136	2,464	2,909	2,772	32,095	<b>917 mm/year</b>
Pervious Evapotranspiration	0	0	0	529	1,314	1,811	2,107	1,808	1,239	623	159	0	9,590	548 mm/year
Pervious Runoff	0	0	0	2,396	9	-189	-236	-79	148	274	583	0	2,906	166 mm/year
Impervious Runoff	0	0	0	5,852	1,335	1,391	1,582	1,633	1,568	1,232	1,454	0	16,048	917 mm/year
Pervious Groundwater Recharge	0	0	0	2,928	12	-231	-289	-96	181	335	712	0	3,552	<b>203 mm/year</b>
<b>Pervious Runoff to Pond</b>														
Split total runoff from pervious areas into ET, recharge, runoff due to pond retention														
Adjusted Runoff (5% of runoff)	0	0	0	120	0	-9	-12	-4	7	14	29	0	145	<b>8 mm/year</b>
Adjusted Recharge (75% of runoff)	0	0	0	1,797	7	-142	-177	-59	111	206	437	0	2,179	<b>125 mm/year</b>
Adjusted ET (20% of runoff)	0	0	0	479	2	-38	-47	-16	30	55	117	0	581	<b>33 mm/year</b>
<b>Impervious Runoff to Pond</b>														
Split total runoff from impervious areas into ET, recharge, runoff due to pond retention														
Adjusted Runoff (90% of runoff)	0	0	0	5,267	1,202	1,252	1,424	1,469	1,411	1,109	1,309	0	14,443	<b>825 mm/year</b>
Adjusted ET (10% of runoff)	0	0	0	585	134	139	158	163	157	123	145	0	1,605	<b>92 mm/year</b>
<b>Recharge/Runoff Analysis</b>														
Surplus/Deficit	54.3	55.6	72.7	42.4	1.2	-24.0	-30.0	-10.0	18.8	34.8	74.0	79.2	369.0	
Weighted Infiltration Factor	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55		Based on MOE SWM Manual (2003)
<b>Runoff (mm)</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>136.9</b>	<b>0.5</b>	<b>-10.8</b>	<b>-13.5</b>	<b>-4.5</b>	<b>8.5</b>	<b>15.7</b>	<b>33.3</b>	<b>0.0</b>	<b>166.1</b>	Assume no runoff in sub-zero months
<b>Recharge (mm)</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>167.3</b>	<b>0.7</b>	<b>-13.2</b>	<b>-16.5</b>	<b>-5.5</b>	<b>10.3</b>	<b>19.1</b>	<b>40.7</b>	<b>0.0</b>	<b>203.0</b>	
<b>Infiltration Augmentation</b>														
Pond Recharge (75% of runoff)	0	0	0	3,950	901	939	1,068	1,102	1,058	832	982	0	10,832	619 mm/year
Pond ET (20% of runoff)	0	0	0	1,053	240	250	285	294	282	222	262	0	2,889	165 mm/year
Pond Runoff (5% of runoff)	0	0	0	263	60	63	71	73	71	55	65	0	722	41 mm/year
<b>Final Recharge</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>8,675</b>	<b>920</b>	<b>566</b>	<b>602</b>	<b>947</b>	<b>1,350</b>	<b>1,372</b>	<b>2,131</b>	<b>0</b>	<b>16,563</b>	<b>473 mm/year</b>
<b>Final Runoff</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>383</b>	<b>61</b>	<b>53</b>	<b>59</b>	<b>70</b>	<b>78</b>	<b>69</b>	<b>95</b>	<b>0</b>	<b>867</b>	<b>25 mm/year</b>
<b>Final ET</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2,646</b>	<b>1,690</b>	<b>2,163</b>	<b>2,503</b>	<b>2,249</b>	<b>1,708</b>	<b>1,023</b>	<b>683</b>	<b>0</b>	<b>14,664</b>	<b>419 mm/year</b>

#### Notes:

Site area is 3.5 ha in KJ Behm post-development analysis as it does not include the SWM facility area

Impervious coverage assumed to be 50% based on KJ Behm analysis

Existing and current conditions water balances recreated using water balance spreadsheet from Arkell Meadows Final Stormwater Management and Servicing Report (KJ Behm, 2010)

Moisture retention from Table 30 of Thornthwaite and Mather: Instructions and Tables for Computing PET and the Water Balance (1957)

**Monthly Water Balance Analysis**  
16141338 - 220 Arkell Road Interim  
Proposed Conditions

**Land Cover Descriptions**  
Pasture and grasses      Silt/Sand loam      Hilly

Main Site Area (ha)	3.5	See notes
Impervious Cover	51%	See notes
Land Description Factors		
Topography	0.10	-
Soils	0.30	-
Cover	0.15	-
Sum (Infiltration Factor)	0.55	-
Soil Moisture Capacity (mm)	50	-
Site Area	1.72	1.79
Percentage of Total Site Area	49%	51%
	0%	

100%      OK

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year	Comment
<b>Climate Data</b> (Data from Waterloo-Wellington Station - Climate Normals from 1966-1990)														
Average Daily Temperature (°C)	-7.3	-6.8	-1.5	5.8	12.5	17.0	19.9	18.7	14.3	8.0	2.5	-4.0		
Precipitation (mm)	54.3	55.6	72.7	72.6	76.3	79.5	90.4	93.3	89.6	70.4	83.1	79.2	917.0	Daily average temperature in each month
<b>Evapotranspiration Analysis</b>														
PET (Thornthwaite, 1948) (mm/month)	0.0	0.0	0.0	30.2	75.1	104.7	124.1	107.7	70.8	35.6	9.1	0.0	557.3	Expected ET for 917 mm of annual rainfall per unit area of pervious area (zero impervious coverage)
Precipitation - PET (mm)	54.3	55.6	72.7	42.4	1.2	-25.2	-33.7	-14.4	18.8	34.8	74.0	79.2		
Accumulated Water Loss (mm)						-25.2	-58.9	-73.3						
Moisture Retention (mm)	250.0	250.0	250.0	250.0	250.0	226.0	196.0	186.0	204.8	239.6	250.0	250.0		From Table 30 of Thornthwaite and Mather, Instructions and Tables for Computing PET and the Water Balance (1957)
Change in Soil Moisture (mm)	0.0	0.0	0.0	0.0	0.0	-24.0	-30.0	-10.0	18.8	34.8	10.4	0.0		
<b>Actual Evapotranspiration (mm)</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>30.2</b>	<b>75.1</b>	<b>103.5</b>	<b>120.4</b>	<b>103.3</b>	<b>70.8</b>	<b>35.6</b>	<b>9.1</b>	<b>0.0</b>	<b>548.0</b>	
<b>Volume-Based Balance (m³)</b>														
Precipitation	1,901	1,946	2,545	2,541	2,671	2,783	3,164	3,266	3,136	2,464	2,909	2,772	32,095	<b>917 mm/year</b>
Pervious Evapotranspiration	0	0	0	518	1,288	1,775	2,065	1,772	1,214	611	156	0	9,398	548 mm/year
Pervious Runoff	0	0	0	2,348	9	-185	-232	-77	145	269	571	0	2,848	166 mm/year
Impervious Runoff	0	0	0	5,969	1,362	1,419	1,614	1,665	1,599	1,257	1,483	0	16,368	917 mm/year
Pervious Groundwater Recharge	0	0	0	2,869	11	-226	-283	-94	177	328	698	0	3,481	<b>203 mm/year</b>
<b>Pervious Runoff to Pond</b>														
Split total runoff from pervious areas into ET, recharge, runoff due to pond retention														
Adjusted Runoff (5% of runoff)	0	0	0	117	0	-9	-12	-4	7	13	29	0	142	<b>8 mm/year</b>
Adjusted Recharge (75% of runoff)	0	0	0	1,761	7	-139	-174	-58	109	201	428	0	2,136	<b>125 mm/year</b>
Adjusted ET (20% of runoff)	0	0	0	470	2	-37	-46	-15	29	54	114	0	570	<b>33 mm/year</b>
<b>Impervious Runoff to Pond</b>														
Split total runoff from impervious areas into ET, recharge, runoff due to pond retention														
Adjusted Runoff (90% of runoff)	0	0	0	5,372	1,226	1,277	1,452	1,499	1,439	1,131	1,335	0	14,732	<b>825 mm/year</b>
Adjusted ET (10% of runoff)	0	0	0	597	136	142	161	167	160	126	148	0	1,637	<b>92 mm/year</b>
<b>Recharge/Runoff Analysis</b>														
Surplus/Deficit	54.3	55.6	72.7	42.4	1.2	-24.0	-30.0	-10.0	18.8	34.8	74.0	79.2	369.0	
Weighted Infiltration Factor	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55		Based on MOE SWM Manual (2003)
<b>Runoff (mm)</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>136.9</b>	<b>0.5</b>	<b>-10.8</b>	<b>-13.5</b>	<b>-4.5</b>	<b>8.5</b>	<b>15.7</b>	<b>33.3</b>	<b>0.0</b>	<b>166.1</b>	Assume no runoff in sub-zero months
<b>Recharge (mm)</b>	<b>0.0</b>	<b>0.0</b>	<b>0.0</b>	<b>167.3</b>	<b>0.7</b>	<b>-13.2</b>	<b>-16.5</b>	<b>-5.5</b>	<b>10.3</b>	<b>19.1</b>	<b>40.7</b>	<b>0.0</b>	<b>203.0</b>	
<b>Infiltration Augmentation</b>														
Pond Recharge (75% of runoff)	0	0	0	4,029	919	958	1,089	1,124	1,080	848	1,001	0	11,049	619 mm/year
Pond ET (20% of runoff)	0	0	0	1,074	245	255	290	300	288	226	267	0	2,946	165 mm/year
Pond Runoff (5% of runoff)	0	0	0	269	61	64	73	75	72	57	67	0	737	41 mm/year
<b>Final Recharge</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>8,659</b>	<b>938</b>	<b>593</b>	<b>633</b>	<b>972</b>	<b>1,366</b>	<b>1,378</b>	<b>2,128</b>	<b>0</b>	<b>16,665</b>	<b>476 mm/year</b>
<b>Final Runoff</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>386</b>	<b>62</b>	<b>55</b>	<b>61</b>	<b>71</b>	<b>79</b>	<b>70</b>	<b>95</b>	<b>0</b>	<b>879</b>	<b>25 mm/year</b>
<b>Final ET</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2,659</b>	<b>1,671</b>	<b>2,135</b>	<b>2,470</b>	<b>2,222</b>	<b>1,691</b>	<b>1,016</b>	<b>686</b>	<b>0</b>	<b>14,551</b>	<b>416 mm/year</b>

**Notes:**

Impervious coverage based on 400 sq. m of emergency access road or approximately 50% of Block 20

Current water balance assumes 3.5 ha drainage area and ignores SWM facility area

Overall impervious coverage increases to 51% due to additional 400 sq. m of access road

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00001> Output File (4.7) ARK100.OUT opened 2018-10-26 13:07
00002> Units used are defined by G = 9.810
00003>      36   300   5.000 are MAXDT MAXHYD & DTMIN values
00004> Licensee: Paragon Engineering Limited
00005> 35 COMMENT
00006> 6 line(s) of comment
00007> *****
00008> 161413338 - 220 Arkell
00009> Proposed Conditions - SWM Modelling
0010> 100-yr, 3 hour storm event
0011> Interim access road - T.Fraser (Oct 2018)
0012> *****
0013> 2 STORM
0014>     1 l=Chicago;2=Huff;3=User;4=Cdnlnhr;5=Historic
0015> 4688.000 Coefficient a
0016> 17.000 Constant b (min)
0017> .962 Exponent c
0018> .400 Fraction to peak r
0019> 180.000 Duration δ 180 min
0020> 87.263 mm Total depth
0021> 3 IMPERVIOUS
0022>     2 Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
0023> .013 Manning "n"
0024> .000 Max.Infiltrn. mm/hr
0025> .000 Min.Infiltrn. mm hr
0026> .050 Lag const (hours)
0027> 1,500 Dep.Storage mm
0028> 35 COMMENT
0029> 3 line(s) of comment
0030> *****
0031> CURRENT CONDITIONS (KJ Behm parameters)
0032> *****
0033> 35 COMMENT
0034> 4 line(s) of comment
0035> *****
0036> Catchment 101 - check to match Behm results
0037> Entire Site pre-development
0038> *****
0039> 4 CATCHMENT
0040> 101.000 ID No.6 99999
0041> 4.309 Area in hectares
0042> 100.000 Length (PERV) metres
0043> 2.000 Gradient (%)
0044> .000 Per cent Impervious
0045> 100.000 Length (IMPERV)
0046> .000 %Imp. with Zero Dpth
0047> 2 Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
0048> .250 Manning "n"
0049> 100.000 Max.Infiltrn. mm/hr
0050> 100.000 Min.Infiltrn. mm/hr
0051> .250 Lag const (hours)
0052> 5.000 Dep.Storage mm
0053>     1 Option 1=Trianglrl; 2=Rectanglrl; 3=SWM HYD; 4=Lin. Reserv
0054> .297 .000 .000 .000 c.m/s
0055> .133 .000 .133 C perv/imperv/total
0056> 15 ADD RUNOFF
0057> .297 .297 .000 .000 c.m/s
0058> 14 START
0059> 1 l=Zero; 2=Define
0060> 35 COMMENT
0061> 3 line(s) of comment
0062> *****
0063> Catchment 13 - Current Conditions (duplicate)
0064> *****
0065> 4 CATCHMENT
0066> 201.000 ID No.6 99999
0067> .350 Area in hectares
0068> 23.000 Length (PERV) metres
0069> 2.000 Gradient (%)
0070> 70.000 Per cent Impervious
0071> 23.000 Length (IMPERV)
0072> .000 %Imp. with Zero Dpth
0073> 2 Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
0074> .250 Manning "n"
0075> 75.000 Max.Infiltrn. mm/hr
0076> 12.500 Min.Infiltrn. mm hr
0077> .250 Lag const (hours)
0078> 5.000 Dep.Storage mm
0079>     1 Option 1=Trianglrl; 2=Rectanglrl; 3=SWM HYD; 4=Lin. Reserv
0080> .157 .000 .000 .000 c.m/s
0081> .514 .963 .828 C perv/imperv/total
0082> 15 ADD RUNOFF
0083> .157 .157 .000 .000 c.m/s
0084> 35 COMMENT
0085> 3 line(s) of comment
0086> *****
0087> Infiltration Gallery - from Behm Design
0088> *****
0089> 10 POND
0090> 7 Depth - Discharge - Volume sets
0091> .000 .000 .0
0092> .001 .00300 .4
0093> .200 .0400 8.6
0094> .400 .0770 16.8
0095> .600 .114 25.1
0096> .800 .151 33.3
0097> 1.000 .188 43.4
0098> Peak Outflow = .139 c.m/s
0099> Maximum Depth = .735 metres
0100> Maximum Storage = 31. c.m
0101> .157 .157 .139 .000 c.m/s
0102> 16 NEXT LINK
0103> .157 .139 .139 .000 c.m/s
0104> 14 START
0105> 1 l=Zero; 2=Define
0106> 35 COMMENT
0107> 4 line(s) of comment
0108> *****
0109> Catchment 13 - Proposed Conditions
0110> Block 20 with access road; 70% imp.
0111> *****
0112> 4 CATCHMENT
0113> 301.000 ID No.6 99999
0114> .350 Area in hectares
0115> 23.000 Length (PERV) metres
0116> 2.000 Gradient (%)
0117> 81.000 Per cent Impervious
0118> 23.000 Length (IMPERV)
0119> .000 %Imp. with Zero Dpth
0120> 2 Option 1=SCS CN/C; 2=Horton; 3=Green-Ampt; 4=Repeat
0121> .250 Manning "n"
0122> 75.000 Max.Infiltrn. mm/hr
0123> 12.500 Min.Infiltrn. mm hr
0124> .250 Lag const (hours)
0125> 5.000 Dep.Storage mm
0126>     1 Option 1=Trianglrl; 2=Rectanglrl; 3=SWM HYD; 4=Lin. Reserv
0127> .175 .000 .139 .000 c.m/s

```